REGIONAL CENTRE FOR MAPPING OF RESOURCES FOR DEVELOPMENT

RCMRD International Conference

Space Science Touches Lives

27 to 29 September 2017

Nairobi, Kenya

RIC 2017 HANDBOOK

USAID FROM THE AMERICAN PEOPLE

NASA

SERVIR Eastern & Southern AFRICA

AIRBUS

http://ric2017.rcmrd.org

RIC Handbook 2017

#RIC2017

27th to 29th September 2017

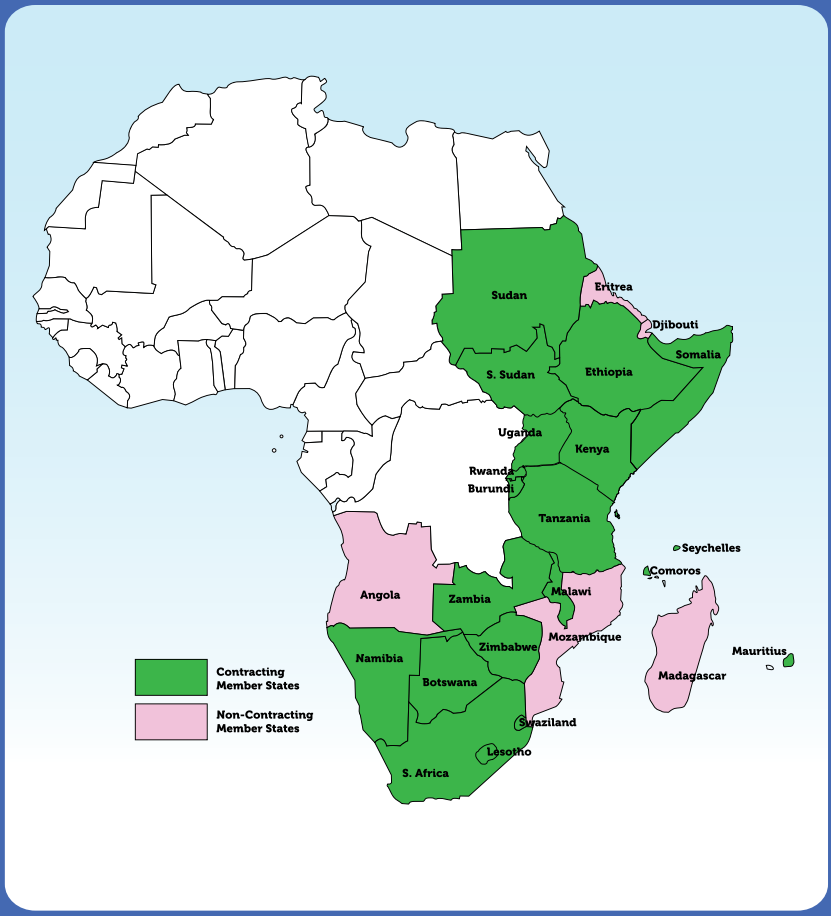
"Space Science Touches Lives"

RCMRD

Our Vision

To be a premier Centre of excellence in the provision of geo-information for sustainable development in the member States and beyond.

Member States



Botswana Burundi Comoros Ethiopia Kenya Lesotho Malawi Mauritius Namibia Rwanda Seychelles Somali South Africa Sudan South Sudan Swaziland Tanzania Uganda Zambia Zimbabwe

Table of Contents

LETTER OF WELCOME

Dr. Emmanuel Nkurunziza
Director General RCMRD

It is our great pleasure to welcome you to the first Regional Centre for Mapping of Resources for Development (RCMRD) International Conference (RIC 2017). The RIC 2017 provides an excellent platform to address the gap between science and policy. We live in an era of tremendous scientific and technological advancements and yet the percolation of tools, ideas and approaches arising therefrom into the policies adopted in many of our countries remains limited. By bringing together academic, scientific institutions, policy makers and policy implementing entities, it is hoped that RIC 2017 will provide an opportunity to bridge the divide. The conference brings together the implementing institutions, academic institutions, and the policy making institutions to discuss the best way forward in addressing the aforementioned gap.

RIC 2017 also provides a platform for the participants to present and discuss progress in research & development, applications of earth observation information, Geospatial standards, and geo-spatial technologies for societal benefit. The conference offers sessions for plenary talks from distinguished scholars and professionals in applications of earth observation information, oral presentations, and exhibitions, all aimed at sharing information and building networks on the uptake and use of geo-information in development decision making. The theme for RIC 2017 is ***Space Science Touches Lives*** which is meant to address the key question: How can we use earth observation data and information to effectively address mundane problems that impact livelihoods in Africa?

On behalf of RCMRD, I take this opportunity to welcome you to the conference. I hope you will enjoy your stay in Nairobi, Kenya.

Karibuni Sana!

CONFERENCE OVERVIEW

The Regional Centre for Mapping of Resources for Development (RCMRD) is a premier Centre of Excellence in the provision of geo-information for sustainable development in the member States and beyond. It was established in Nairobi, Kenya in 1975 under the auspices of the United Nations Economic Commission for Africa (UNECA). RCMRD is a non-profit intergovernmental organization and currently has twenty (20) contracting member States, namely: Botswana, Burundi, Comoros, Ethiopia, Kenya, Lesotho, Malawi, Mauritius, Namibia, Rwanda, Seychelles, Somalia, South Africa, South Sudan, Sudan, Swaziland, Tanzania, Uganda, Zambia and Zimbabwe.

SERVIR is a unique science, technology project that enables improved environmental decision making in SERVIR regions. It is a joint partnership between the United States Agency for International Development (USAID) and the National Aeronautics and Space Administration (NASA), in collaboration with regional institutions in East Africa, West Africa Himalaya, and Mesoamerica. The Eastern & Southern Africa hub is hosted at RCMRD.

The objective of this Conference is to spur exchange of ideas on fast tracking application of earth observation and geo-spatial technologies in development decision making. The key question is how can we use earth observation data and information to effectively address mundane problems that impact livelihoods in Africa? Take for instance; a community in the Kenyan Northern Rangelands grappling with the problem of invasive species affecting fragile ecosystems, or a farmer in Kericho, Kenya losing his/her tea crop due to frequent frost occurrences, or an urban planner in Kigali, Rwanda tasked with the duty of human resettlement from hazard prone areas, or a resident of Kasese, Uganda waking up to the reality of floods destroying his/her livelihood, or a Maasai lady in Tanzania struggling to empower herself economically and socially through improved access to education, healthcare, reliable and safe drinking water in the face of a changing climate or even a drought ravaged Horn of Africa where lack of water and pasture precipitates conflicts and loss of lives.

From the above scenarios the fundamental issue is how science can contribute towards empowering society and communities mitigate against and effectively adapt to climate change that continues to adversely affect biodiversity, ecosystems as well as livelihoods. RIC 2017 therefore, provides a platform for science policy exchange and user engagement between the geospatial world and various information users.

The theme for this year's conference **"Space Science Touches Lives"** aims to inspire presentation of innovative and creative ideas on the use of earth observation information in addressing societal problems.

PROGRAMME STRUCTURE

Abstracts will be presented under the following thematic areas

- **Agriculture and Food Security**
- **Land Use Land Cover & Ecosystems**
- **Land Surveying and Management**
- **Water Resources and Hydro-Climatic Disaster**
- **Weather and Climate**
- **Cross Cutting Themes**

Day 1 Keynote Address:
Dr. Shuiab Lwasa - Makerere University
Key Note Speaker on Science Policy Exchange

Day II Keynote Address:
Athina Trakas - Open Geospatial Consortium
Key Note Speaker on Capacity Development and Geospatial Standards

Day II Keynote Address:
Mark De blois- Upande Ltd
Key Note Speaker on Capacity Development in the Use of Drones in Mapping of Natural Resources

Day III Key Note Address:
Prof. Galcano Mulaku–University of Nairobi
Key Note Speaker:-Role of Universities in Geospatial Technology Development

PROGRAMME

Wednesday 27th, September 2017 Science Policy Exchange			
Time	**Agenda Item**	**Moderator**	**Venue**
8:00 – 9:00	Registration	Stella Masese	Plenary Tent
9:00 – 9:45	**OPENINIG CEREMONY** Welcome notes • ESRI East Africa • National Aeronautics and Space Administration (NASA) • USAID Kenya • Director General RCMRD • Government of Kenya • Ambassadors from RCMRD Member States • Chair RCMRD Governing Council	Byron Anangwe / J.B. Kiema	Plenary Tent
9.45 – 10.30	**Key Note Speaker 1:** Shuiab Lwasa - Makerere University	Byron Anangwe	Plenary Tent
10:30 – 11:30	**TEA BREAK & EXHIBITION/ POSTERS**	Booth Attendants	Exhibition Booth
11:30 – 13:00	**PLENARY SESSION: Science policy exchange** • Stockholm Environment Institute (SEI) • Kenya Institute for Public Policy Research and Analysis (KIPPRA) • Institute of Policy Analysis and Research Rwanda (IPAR) • Land Development Governance Institute (LDGI) • International Centre for Insect Physiology and Ecology (ICIPE) • UN Habitat • Airbus	Shuiab Lwasa **Rapporteurs:** Anthony Ndubi and Rose Waswa	Plenary Tent

13:00–14:00	**LUNCH BREAK**		
14:00 – 16:30	**PARALLEL SESSIONS - PRESENTATIONS**	Facilitator	Gichohi
	Agriculture and Food Security • Geospatial data analysis for assessment and characterization of Ensete in Ethiopia • Impact of internal conflict on agriculture and food security in South Sudan • Mapping leaf nitrogen and carbon concentrations of intact and fragmented indigenous forest ecosystems using empirical modeling techniques and worldview-2 data • Use of Earth Observation Data To Inform Food Security Assessments and Decision Making • Akorion – ICT for Agriculture	**Moderator:** Boitt/ Degelo Sedabo Rapporteurs: Anthony Ndubi and Rose Waswa	**Venue:** GIS Lab
	Land Use Land Cover and Ecosystems • Application of GIS and Remote Sensing Techniques in analysis of Land Use and Land Cover Changes threats to River Njoro Ecosystem • Assessing Spatio-temporal Land-Cover Changes in Gatumba Mining Area in Rwanda • Beyond Biodiversity - Using Geo-Information to drive conservation and development decision making • Delimitation and zoning of the Comoros national parks (marine and terrestrial) • Land degradation assessment in IGAD region using earth observation data	**Moderator:** Clifford Okembo / Charles Muya **Rapporteurs:** Pauline Ogola and Eunice Wangui	**Venue**: Conference Room

	Weather, Climate, Water and Hydro Climatic Disasters • An Assessment of the Impacts of Weather and Climate Patterns on Water Resources • Assessing bias in satellite rainfall products and their impact in water balance closure at the Zambezi headwaters • Assessing gullies development on hilly urban areas using cadastral maintenance data and erosion modeling • Participatory Hazard Mapping Risk Assessment and Analysis in in Six Sub counties of Kenya	**Moderator:** Oludhe/ Robinson Mugo **Rapporteurs:** Grace Koech and Stephen Sande	**Venue:** Remote Sensing Lab
	Cross Cutting and Land Surveying & Management • Fine resolution modelling of malaria risk factors and potential malaria risk prediction • GIS in Grid Management and Extension • GIS Location-allocation model in improving accessibility to health care facilities • Eastern Africa Forest Observatory • Communicating climate change by linking space and village	**Moderator:** Amos Tabilla/ Lawrence Okello **Rapporteurs:** Patrick Kabatha and Ian Asige	**Venue:** Plenary Tent
16:30 – 17:00	**TEA BREAK & EXHIBITION/ POSTERS**	Booth Attendants	Exhibition Booth

Thursday 28th, September 2017 Capacity Development and Geospatial Standards			
Time	**Agenda Item**	**Moderator**	**Venue**
9:00 – 9:30	**Key Note Speaker 2:** • Athina Trakas - Open Geospatial Consortium **Key Note Speaker 3:** • Mark De blois – Upande Ltd	Kenneth Mubea	Plenary Tent
9:30 – 10:30	**PLENARY SESSION: Capacity Development and Geospatial Standards** • Open Geospatial Consortium • East Africa Land Administration Network • Global Land Tool Network • ITC • ESRI East Africa • RECTAS • RCMRD	AthinaTrakas **Rapporteurs:** Anthony Ndubi and Rose Waswa	Plenary Tent
10:30-1050	OAKAR SERVICES		
10:50 – 11:30	**TEA BREAK & EXHIBITION/ POSTERS**	Booth Attendants	Exhibition Booth
11:30 – 13:00	**PARALLEL SESSIONS - PRESENTATIONS**	Facilitator	James Mumina
	Agriculture and Food Security ▪ Seasonal Crop Type Inventory Mapping from multitemporalTerraSAR; a case study of Kitale ▪ Understanding seasonality of browse herbage in Karamoja region, Uganda ▪ FROST Mapping and Forecasting ▪ Malawi 2018 Census Mapping	**Moderator:** Boitt/ Degelo Sedabo **Rapporteurs:** Anthony Ndubi and Rose Waswa	**Venue:** GIS Lab

	Land Use Land Cover and Ecosystems • Delimitation and zoning of the comoros national parks (marine and terrestrial) • Estimation of Tree Distribution and Canopy Heights in Ifakara, Tanzania Using Unmanned Aerial System (UAS) Stereo Imagery • Evaluating the Red Edge channel for improving C3 Festucaspp • Exploring the utility of Auto-sklearn and remotely sensed Sentinel-2 image data for mapping Parthenium weed in a heterogeneous landscape • Invasive species mapping	**Moderator:** Clifford Okembo/ Lawrence Okello **Rapporteurs:** Pauline Ogola and Eunice Wangui	Venue: Conference Room
	Weather, Climate, Water and Hydro Climatic Disasters • Estimation Of Evapotranspiration For Crop Water Requirement Using Satellite Imagery • GIS and Remote sensing based Assessment of water quality changes in Lake Malawi • Mapping Soil Moisture Content using Senstinel-1 and Sentinel-2 Case Studies from Kenya • Stream Flow monitoring • Water Resources Integration Development Initiative Tanzania (WARIDI) • Climate change vulnerability assessment in the northern rangelands	**Moderator:** Oludhe/ Robinson Mugo **Rapporteurs:** Grace Koech and Stephen Sande	**Venue:** Remote Sensing Lab

	Cross Cutting and Land Surveying & Management • Improved Cheetah Analysis • The role of planning support systems in National Policy Transfer and Policy translation in secondary cities • On-line spatial data mining a catalyst for national, continental and global initiatives • Establishment of a Common and Modern African Geodetic Reference System (AFREF) • Improving the capacity of Institutions on geospatial technologies for societal benefit	**Moderator:** Amos Tabilla/ Charles Muya **Rapporteurs:** Patrick Kabatha and Abdi Gedi	**Venue:** Plenary Tent
13:00 – 14:00	**LUNCH BREAK**		
14:00 – 16:30	**PARALLEL SESSIONS - PRESENTATIONS**	Facilitator	Eunice King'ori
	Agriculture and Food Security ▪ Use of Sentinel 2 data to estimate agricultural areas by speculation ▪ Using new earth observation (EO) tools for monitoring crop and rangeland productivity constraints in the context of safeguarding livelihoods in rural Africa ▪ Towards the development of a web based rangeland assessment and monitoring tool	**Moderator:** Boitt/ DegeloSedabo **Rapporteurs:** Anthony Ndubi and Rose Waswa	**Venue:** GIS Lab

	Land Use Land Cover and Ecosystems • GIS and Remote sensing based assessment of land use-land cover changes in the Coastal City of Lagos Nigeria • GIS application on socio-economic effect of road infrastructure development and sustainable development- case of Nairobi bypasses. • Land use and Land cover data changes in Indian Ocean Islands Case study of Unguja in Zanzibar Island • Savanna vegetation structure mapping using Synthetic Aperture Radar and Terrestrial Laser Scanning in Kruger National Park, South Africa • Enabling Annual Land Cover Mapping Across East Africa	**Moderator:** Clifford Okembo/ Charles Muya **Rapporteurs:** Pauline Ogola and Eunice Wangui	Venue: Conference Room
	Weather, Climate, Water and Hydro Climatic Disasters • Sedimentation dynamics of mudi dam using an unmanned aerial vehicle • Synthetic Aperture Radar for Vegetation and Soil Moisture Monitoring in Masai Mara • Determining extreme heat vulnerability of Harare Metropolitan City using multispectral remote sensing and socio-economic data • Vulnerability of Groundwater to Pollution: Locating Pollution Hot Spots in the Lake Nakuru Drainage Basin • Water Quality Monitoring	**Moderator:** Oludhe/ Robinson Mugo **Rapporteurs:** Grace Koech and Stephen Sande	**Venue:** Remote Sensing Lab

	Cross Cutting and Land Surveying & Management • A tool for ensuring policy- Impacting research results • Solid Waste Disposal Site Selection Using GIS, GombatoBongwe Ward, Kwale • Spatio-temporal patterns of malaria hotspots in Kigali City • Hydropower Resources Atlas of Kenya with Emphasis on Small Hydropower Resources • Geo-Information Training	**Moderator:** Amos Tabilla/ Lawrence Okello **Rapporteurs:** Patrick Kabatha and Ian Asige	
16:30 – 17:00	**TEA BREAK & EXHIBITION/ POSTERS**	Booth Attendants	Exhibition Booth

Friday 29th, September 2017 **Role of Universities in Geospatial Technology Development**			
Time	**Agenda Item**	**Moderator**	**Venue**
9:00 – 9:30	**Key Note Speaker 4:** • GalcanoMulaku -ITC	Kenneth Mubea	Plenary Tent
9:30 – 10:30	**PLENARY SESSION: Role of Universities in Geospatial Technology development** • Kenyatta University • Makerere University • Nairobi University • University of Kwazulu Natal • University of Rwanda • RCMRD	**Moderator** Simon Onywere **Rapporteurs:** Anthony Ndubi and Rose Waswa	Plenary Tent

10:30 – 11:30	**TEA BREAK & EXHIBITION/ POSTERS**	Booth Attendants	Exhibition Booth
11:30 – 13:00	**PARRALLEL SESSIONS - PRESENTATIONS**	Facilitator	Ian Asige
	Agriculture and Food Security ▪ Evaluation of remote sensing vegetation indices for monitoring maize crop condition and yields in Tanzania ▪ Using radar images for analysis of small and large scale crop production in Endebess sub county ▪ Use of Earth Observation Data to Inform Food Security Assessments and Decision Making ▪ Role of Monitoring and Evaluation in GIS	**Moderator:** Boitt/ DegeloSedabo **Rapporteurs:** Anthony Ndubi and Rose Waswa	**Venue:** GIS Lab
	Land Use Land Cover and Ecosystems • Urbanization in Lilongwe a spatial metrics analysis • Use of geospatial technology to map the distribution of vervet monkeys in urban areas • Use of GIS in Assessing the Appropriateness of an Existing Dumpsite and the Suitability of Future Landfill Sites for Nairobi • Mapping Land use and Land Cover Change and its influence on Soil Erosion in the Upper Ruvu Watershed, Tanzania • MESA Early Warning Applied to Protected Areas • Evaluation of Supervised Classifiers for Forest Resource and Land Cover Mapping based on Combination of SAR and Optical Remote Sensing data	**Moderator**: Clifford Okembo/ Charles Muya **Rapporteurs:** Pauline Ogola and Eunice Wangui	**Venue:** Conference Room

	Weather, Climate, Water and Hydro Climatic Disasters • Participatory Hazard Mapping Risk Assessment and Analysis in in Six Sub counties of Kenya • seasonal variability of herbage biomass resources for grazers in Karamoja sub region • Eastern and Southern Africa Fire Information System (ESAFIS): Supporting Fire Response & Management.	**Moderator:** Oludhe/ Robinson Mugo Rapporteurs: Grace Koech and Stephen Sande	**Venue:** Remote Sensing Lab
	Cross Cutting and Land Surveying & Management • The Geo Information Applications in Decision Making In Umeme • Unravelling kobo toolbox and kobo collect smartphone geospatial technology • Urban tree species classification on pixel and object level • Why spatial intelligence is critical to business models	**Moderator:** Amos Tabilla/ Lawrence Okello **Rapporteurs:** Patrick Kabatha and Abdi Gedi	**Venue:** Plenary Tent
13:00– 14:00	**LUNCH BREAK**		
14:00 – 15:00	**CLOSING CEROMONY** • Director Technical Service RCMRD • USAID Kenya • Director General RCMRD • Kenya Government • Chief Guest – RCMRD Governing Council	**Moderator:** Byron Anangwe	**Venue:** Plenary Tent

Abstracts

AGRICULTURE AND FOOD SECURITY (AFS)

AFS001: Geospatial Data Analysis for Assessment and Characterization of Ensete in Ethiopia

Meron Awoke[1], Binyam Tesfaw Hailu1 and Sebsebe Demissew[2]

[1] School of Earth science, College of Natural and Computational Sciences, Addis Ababa University, P.O. Box 1176, Ethiopia

[2]Department of plant biology and biodiversity management, College of Natural and Computational Sciences, Addis Ababa University P.O. Box 1176, Ethiopia

Abstract

Geographic Information System has a wide application nowadays. However, there is little has been done on plant species characterization. Hence, this study attempts to asses and characterize wild and cultivated Ensete ventricosum (Ensete) in Ethiopia. Ensete ventricosum varieties are a basis for agricultural and economic development of the country. Itis arguably the most important crop contributing to food security and rural livelihoods for about one fourth (~20 million people) of Ethiopian population. But, little information is documented on the existing characteristic of the species and distribution of different Ensete types across different agro-ecological zones. Hence, analyzing, assessing and characterizing of these species at spatial and temporal scale had a great importance for resource management, conservation planning and decision making. This characterization has been done with respective to land cover, climate, elevation, soil type, natural vegetation cover and agro ecological zone.For this purpose, geospatial data analyses were used to assess and characterize both wild and cultivated Ensete ventricosum. About 26 environmental variables were utilized including 19 bioclimatic variables, DEM, LULC, vegetation, agro-ecology and soil type, and 192 for cultivated and 20 for wild Ensete species occurrence records

were collected and used for the characterization of Ensete. Besides, Pearson correlation analyses were undertaken for 26 environmental variables to reduce highly correlated variables. Result revealed that the tropic-cool/humid and Dystric Cambisol are the most suitable agro ecological zone and soil type for cultivated Ensete respectively. Besides, these plant species are currently categorized under dry vegetation Afro-mountain forest and annual crop land. Unlike to cultivated Ensete, wild Ensete is dominantly grown in tropics –cool sub-humid agroecological zones. Both wild and cultivated Ensete were well grown in areas where the annual Precipitation ranges between 1100–2200 mm and mean annual temperature 10-210C. In terms of topography, about 1036 -3129 m altitude range is suitable for wild Ensete and cultivated Ensete is characterized under the altitude range of 1344-3129 m.

Keywords:Cultivated Ensete, Wild Ensete, Geospatial data analysis, Environmental Variables

AFS002: Impact of Internal Conflict on Agriculture and Food Security in South Sudan

Ms. Santa J. Justin Ali
Department of International & Comparative Law, University of Juba – South Sudan.
Email: santajima@yahoo.com

Abstract

South Sudan is a new country, with an area of 644,329 square kilometers and population of 8 million people. 82% of the population live in rural areas which is comprised of farmers and pastoralists who depend on land as main resources for their live hood. 51% of population live below the poverty line and 43% of the total population are severely food insecure. These made the country as one of the poorest country in the world, although it has the

potential to be the bread basket of Africa. Since more than half of its land is estimated to be suitable for agriculture. The conflict that started in 2013 has displaced thousands of population from their homes and currently living at the UN displaced centers in the country. Due to the internal conflict, the people are unable to cultivate and are left helpless. South Sudan has the largest savanna ecosystem in East Africa, and the second largest wetlands in Africa, characterize with the natural forests and wood lands cover almost 30% of total land. These areas are fertile for agriculture and food production. With this in mind, south Sudan is facing a lot of challenges: socially, economically and politically in all sectors because of internal conflicts. Agricultural system and food security in south Sudan is the biggest challenge, since the internal conflicts are hindering south Sudanese farmers and displacement continue to force farmers out of their land. The acute and wide reaching effects of conflicts left significant number of food insecure, as a result people in south Sudan are in need of urgent assistance of food security. The population of south Sudan has not given adequate attention to the core importance of agriculture sector generally, lack of capacity to provide extension services to farmers and security. This paper examine the impact of internal conflict on agriculture and food security in view of the rights to food and life as fundamental rights according to international conventions that widely provides right to food as fundamental rights. The work recommends reform and harmonization of the Agriculture system to ensure access to food, especially the rural areas which needs to be protected. Also there is a need to include investment in agriculture sector, establishment of the food security organization in south Sudan and increasing importance peace building and reconciliations awareness and more education campaigns to reduce conflict in the country.

Key Words: Agriculture, Conflict, Peace, Security, Ecosystems, Fertile, Displaced

AFS003: Mapping Leaf Nitrogen and Carbon Concentrations of Intact and Fragmented Indigenous Forest Ecosystems Using Empirical Modeling Techniques and Worldview-2 Data

Galal Omer[1],[2], Onisimo Mutanga[1], Elfatih M. Abdel-Rahman[1],[3], Kabir Peerbhay[1] and Elhadi Adam[4]

[1]School of Agricultural, Earth and Environmental Sciences, Pietermaritzburg Campus,
University of KwaZulu-Natal, Scottsville P/Bag X01, Pietermaritzburg 3209, South Africa; MutangaO@ukzn.ac.za; peerbhaykabir@gmail.com.

[2]Department of Forest Conservation and Protection, Faculty of Forestry, University of Khartoum, Khartoum North 13314, Sudan; gekhaled189@gmail.com.

[3]Department of Agronomy, Faculty of Agriculture, University of Khartoum, Khartoum North 13314, Sudan; elfatihabdelrahman@gmail.com.

[4]School of Geography, Archaeology and Environmental Studies, University of the Witwatersrand, Johannesburg 2050, South Africa; Elhadi.Adam@wits.ac.za.

Abstract

Forest nitrogen (N) and carbon (C) are among the most important biochemical components of tree organic matter, and the estimation of their concentrations can help to monitor the nutrient uptake processes and health of forest trees. Traditionally, these tree biochemical components are estimated using costly, labour intensive, time-consuming and subjectively analytical protocols. The use of very high spatial resolution multispectral data and advanced machine learning regression algorithms such as support vector machines (SVM) and artificial neural networks (ANN) provide an opportunity to accurately estimate foliar N and C concentrations over intact and fragmented forest ecosystems. In the present study, the utility of spectral vegetation indices calculated from WorldView-2 (WV-2) imagery for mapping leaf N and C concentrations of fragmented and intact indigenous forest ecosystems was explored using SVM and ANN regression algorithms.

The study further tested whether there were significant differences in the leaf N and C concentrations between the intact and fragmented indigenous forest ecosystems. The study showed that the intact forest obtained significantly higher ($p = 0.03$) mean values for N as compared to the fragmented indigenous forest. There was no significant difference ($p = 0.55$) in the C mean concentration between the intact and fragmented indigenous forest strata. The results further showed that the foliar N and C concentrations could be more accurately estimated using the fragmented stratum data compared with the intact stratum data. Specifically, the results showed that the most accurate N predictions were achieved when the fragmented data and support vector machines were utilized ($R^2_{Val} = 0.77$, $RMSE_{Val} = 1.07\%$ of the mean). In addition, the most accurate foliar C predictions were achieved for the fragmented data using the SVM regression method ($R2_{Val} = 0.67$, $RMSE_{Val} = 1.64\%$ of the mean). Overall, SVM regressions achieved more accurate models for estimating forest foliar N and C concentrations in the fragmented and intact indigenous forests compared to the ANN regression method. It is concluded that the successful application of the WV-2 data integrated with SVM can provide an accurate framework for mapping the concentrations of biochemical elements in two indigenous forest ecosystems.

Keywords: Intact indigenous forest, fragmented indigenous forest, nitrogen, carbon, WorldView-2, support vector machine, artificial neural networks

AFS004: Seasonal Crop Type Inventory Mapping from Multi-Temporal Terrasar-X Images (A Case Study of Kitale)

Benson Kipkemboi Kenduiywo[1]
[1]Department of Geomatic Engineering and Geospatial information Systems, Jomo Kenyatta University of Agriculture and Technology, Nairobi, Kenya, bkenduiywo@jkuat.ac.ke

Abstract

The continuous rise of world population has propelled pressure on arable land.

Consequently, the food basket continues to decline while its global demand has grown twofold. Therefore, it is necessary to continuously monitor and update existing crop inventory maps. Microwave remote sensing offers an effective data capture platform since it is daylight and weather independent which guarantees the highest temporal density of images regardless of climatic zones. This also means that images at different phenological stages can be captured by the radar sensors offering more chances of discriminating different crops. However, crops undergo dynamic phenological changes spatially and temporally. For this reason, the study adopts first order dynamic conditional random fields (DCRFs) integrated with an optimal seasonal map generating algorithm proposed in (Kenduiywo, Bargiel, & Soergel, 2016) to map crops from multi-temporal TerraSAR-X images. The DCRFs framework fuses spatial-temporal information form TerraSAR-X images for classification. This approach is different from conventional techniques that stack multi-temporal images as composite bands during crop classification thereby limiting spatial-temporal phenological information. To demonstrate this fact, DCRFs framework was compared to maximum likelihood classifier (MLC), random forest (RF) and conditional random fields (CRFs) based on stacked multi-temporal TerraSAR-X images. Results indicate that the DCRFs framework surpassed MLC, RF, and CRFs by 13.03%, 13.47% and 1.07% in overall accuracy respectively. More also, an evaluation of the results demonstrates that spatial-temporal phenological information modelled by DCRFs from TerraSAR-X improved crop discrimination compared to the other approaches.

Keywords: Crop type; classification; multi-temporal; spatial-temporal; phenology; radar

AFS005: Understanding Seasonality of Browse Herbage in Karamoja Region, Uganda

Benon B. Nabaasa[1] and Shuaib Lwasa[2]
[1]*Makerere University, Department of Geography, Geoinformatics and Climatic*

Sciences, nabaasabenon@gmail.com
[2]Makerere University, Department of Geography, Geoinformatics and Climatic Sciences, shuaiblwasa@gmail.com

Abstract

The Karamojong of North Eastern Uganda are a nomadic pastoralist group largely dependent on livestock for a livelihood. This group has evolved a robust livestock system over a long period of time. Pastoralism as a livelihood has proven for centuries to be a resilient system. However the past few decades in the history of our planet have witnessed alterations in the earth's systems. These shifts that have been largely blamed on anthropogenic activities, manifest in form of global environmental change most importantly climate change. Climate extremes, shocks, and disasters are devastating livelihoods including pastoralists. In Karamoja, grazing lands have continued to shrink with the multiplication of human settlements, extensive agriculture and the gazettement of grazing areas for wildlife. Exacerbating and interacting with these developments however is climate change manifesting as delayed and erratic rains, prolonged drought, dwindling rainfall totals, and extreme hydrometeorological events like floods. These events are posing serious risk to pastoralism, rendering its future bleak and uncertain and are diminishing resilience options for the Karamojong. Pastoralism in Karamoja is heavily weather dependent and understanding of seasonality in relation to biomass characteristics like quantity, vigour, and carrying capacity is a significant step to making adaptive interventions. Biomass estimation techniques have been largely field based, rigorous and very expensive. With remote sensing, biomass estimation has become cheaper and easier to conduct. Advanced and more sophisticated analyses can now be executed making projections more certain and decision making more evidence-based for pastoralists. This study employs a combination of satellite imagery (Landsat) with field surveys to quantify browse herbage in Karamoja and establish its carrying capacity over a period of 30 years. Deviating from other studies in the region, this study makes use of the four locally understood seasons instead of the two conventional dry and wet seasons. Remote sensing has made it possible

to observe and study these four gradually transitioning seasons in Karamoja. The study underpins the increasing importance of remote sensing in decision making even for informal livelihoods like pastoralism and the role spatial information on biomass can play in livestock development. Preliminary findings indicate significant biomass fluctuations between seasons and across the years and these strongly relate to the livestock numbers.

Keywords: Pastoralism, remote sensing, browse herbage, Karamoja, resilience

AFS006: Use of Sentinel-2 Data to Estimate Agricultural Areas by Speculation (Case of Millet, Maize and Groundnut)

Gayane FAYE[1], Fallou SECK[2], Mamadou Adama SARR[3], Thierno NGAMB[5] and Souleye WADE[5]

[1]. Laboratoire de Télédétection Appliquée/Institut des Sciences de la Terre / Cheikh Anta DIOP University of Dakar (LTA/IST/UCAD), SENEGAL. gayane.faye@gmail.com

[2]. Ecole Nationale Supérieure de l'Agriculture (ENSA) of Thies, SENEGAL. fallou.seck@univ-thies.sn

[3]. Centre de Suivi Ecologique (CSE) of Dakar, SENEGAL. mamadou_sarr74@hotmail.com

[4]. Gaston Berger University (UGB) of Saint-Louis, SENEGAL. thiernongamb18safar@yahoo.fr

[5]. Laboratoire de Télédétection Appliquée/Institut des Sciences de la Terre / Cheikh Anta DIOP University of Dakar (LTA/IST/UCAD), SENEGAL. wadesouleye@yahoo.fr

Abstract

Senegal is a country where agriculture is predominantly rainfed. Only 5% of cultivated land is irrigated. This agriculture is depending on climatic hazards, making it a particularly vulnerable system, especially in the context

of climate change. Because of unreliable agricultural information in time, Senegal government has difficulty in making a good policy of agricultural planning. Thus, geospatial technologies are relevant tools that would contribute to improving the reliability of information. The aims of this study is to set up a methodology for estimating the agricultural areas of millet, maize and groundnuts using sentinel-2 data. These data are adapted to agricultural monitoring in the Sahel due to a 10-day time repeat (soon 5 days with Sentinel-2 B) associated with a spatial resolution of 10 m, especially for a region characterized by a short rainy season and a small farm size. The current study shows promising results on the estimation of agricultural areas. Thus, the analyses of the temporal evolution of the spectral signature of the different speculations (millet, maize and groundnut) has made it possible to identify discriminants that make it possible to differentiate between them. Indeed, the three speculations studied do not have the same phenological cycle involving the differentiation of the temporal profile along the season of their temporal signature, although they may have the same spectral behaviors at times during their period of growth. This temporal dimension made it possible to better discriminate millet and maize which once had a spectral signature relatively identical to the beginning of their growth but differs throughout their phenological cycle. In Nioro (Center of Senegal), the areas occupied by peanuts are discriminated with 70% success, those of millet with 61% and those of maize with 68%. On the other hand, cloud cover do limitations on the availability of a significant number of reliable images to solve these problem of discrimination often associated with grass cover and / or growth deficits.By way of perspective on improving the results of the study, Sentinel-2 data will be combined with Sentinel-1 radar data. The arrival of Sentinel-2 B data may also increase the likelihood of cloudless images and may lead to a better estimate of the area under cultivation

Keywords: agricultural areas, Remote Sensing, Sentinel-2, Senegal

AFS007: Using New Earth Observation Tools for Monitoring Crop and Rangeland Productivity Constraints in the Context of Safeguarding Livelihoods in Rural Africa

Tobias Landmann, Elfatih Abdel-Rahman and Richard Kyalo
International Center of Insect Physiology and Ecology (icipe), Duduville, Kasarani Road, P.O. Box 30772, 00100 Nairobi, Kenya;
Corresponding author: tlandmann@icipe.org

Abstract

In spite of recent advances in Earth Observation (EO) data availability and better spatial and temporal resolutions of the satellite data sets, EO mapping routines have rarely been used in Africa to identify where crop and rangeland productivity interventions would be most effective and beneficial. Geospatial practitioners working in Africa are often not aware of the potential of EO routines in this regard, and mapping projects are largely performed haphazardly and localized. This contribution aims to show how advanced EO-based tools can be used to map important rangeland and cropland productivity constraints over larger areas in Sub Saharan Africa (SSA). As a first example, a mapping result is presented that shows the potential of 5meter RapidEye satellite data and in situ observations to map MLN (Maize Lethal Necrosis) infestation rates in maize agro-ecological systems in Kenya. Furthermore, invasive species propagation maps (i.e. for Prosopis juliflora and Partheniumhysterophorus) are presented for western Somaliland that were derived from vegetation productivity and phenology trends inferred from 250 meter MODIS (Moderate Resolution Imaging Spectroradiometer) EVI (Enhanced Vegetation Index) time-series data (from 2001 to 2015). In both examples, sophisticated mapping algorithms such as logistic regression modelling could be utilized and permissible mapping accuracies could be attained, i.e. for both invasivespecies the model prediction accuracies were >0.88. The investigated mapping examples show how spectral and temporal metrics coupled with sophisticated mapping algorithms can be used to map 'important to the region' agricultural and

rangeland constraints.

Keywords: Crop monitoring, invasive species, logistic regression, food security

AFS008: Using Radar Images for Analysis of Small and Large Scale Crop Production in Endebess Sub County

Bartholomew Thiong'o Kuria[1], Samuel Wanjohi Kibui[2] David Ndegwa Kuria[3],and Kenneth Mubea[3]

[1] University of Bonn, tbkuria@yahoo.com

[2] Geosymp Limited, swanjohi9@gmail.com

[3] Dedan Kimathi University of Technology, dn.kuria@gmail.com

Abstract

Agriculture and food security are some of the main drivers of strong societies, essentially propelling economies as well fed human resource are needed to drive various economic activities. However, the reality is that buffeted by climate change, urbanization and accompanying unsustainable human activities, crop yields have been on a monotonic decline as reported in the Kenya National Bureau of Statistics (KNBS) 2012 economic survey report. This research aims at mapping of both large and small scale agricultural crop fields in Endebess Sub County, in Trans Nzoia County with respect to the influence of urbanization on decreasing crop field sizes as well as emergence of other economic activities from farming. The region has been selected due to its history of high crop yields over the years. Radar images are unaffected by cloud cover presence as compared to the optical images and are therefore preferred since they can be acquired for the entire cropping season. A segmentation algorithm is applied to automatically extract field boundaries and classify the crop fields into small scale and large scale fields based on their area sizes. The results will then be analysed against the current crop production and establish the total decline in the production area and its

significant influence on food production in totality.

Keywords: crop mapping, radar, classification

AFS009: Evaluation of Remote Sensing Vegetation Indices for Monitoring Maize Crop Condition and Yields in Tanzania

[1] B. Yonah[1], S. Tumbo[2], B. Mbilinyi[3], J. Dempewolf[4] and M. S Maurice[5]
[1] Tanzania Metrologic Argency (yonah002@yahoo.co.uk);
[2] Centre for Agricultural Mechanization and Rural Technology (siza.tumbo@gmail.com);
[3] Sokoine University of Agriculture (mbly_sua@yahoo.com);
[4] University of Maryland (dempewol@umd.edu),
[5] Sokoine University of Agriculture (sixbert.mourice@gmail.com)

Abstract

The technology and use of remote sensing imagery from satellite and unmanned aerial vehicles (UAVs) has rapidly advanced in recent years but the application of these technologies for agricultural monitoring in subsistence agricultural areas have been limited. Monitoring smallholder production systems for crop condition through remote sensing techniques is challenging due to the heterogeneity of farming systems resulting from ill-defined plots, variation in planting dates, mixed cropping, atmospheric conditions and other factors. These factors have been reported to affect the ability of spectral vegetation indices (VIs) to detect changes in crop condition and to derive indicators for yield differences between agricultural fields. In this study we investigate the relation between VIs derived from UAV imagery and field measurements of crop condition as indicated by maize growth parameters, which are the green leaf area index (LAI), number of green leaves per plant, crop developmental stage, plant biomass, the crop water stress index (CWSI) and grain yields. The field measurements were

carried out every 4 days throughout the growing season in parallel with the collection of UAV imagery over experimental fields of pure and mixed cropping of two maize varieties (Situka and Pannar) and pigeonpea under different fertilizer treatments. The UAV system used was a multiSPEC 4C four channel multispectral camera (green, red, red-edge, near infrared and an upward facing irradiance sensor) mounted on a fixed-wing senseFly eBee aircraft. From the multiSPEC imagery we calculated four spectral vegetation indices, the normalized difference vegetation index (NDVI), wide dynamic range vegetation index (WDRVI), red edge chlorophyll index (Clred-edge), and green chlorophyll index (Clgreen) using the Emotion 2, Postflight Terra 3D mapper and QGIS software packages. Results showed that experimental field with pure maize crop and fertilizer treatment revealed a higher plant height, higher number of leaves per plant, and higher LAI than the intercropped maize-pigeon pea. The result was significant at the 5% probability level. Vegetation indices for each pair of experimental fields were compared through time, the differences among 11out of 28 different pairs were found significant at the 5% significance level. Clgreen showed significant differences between 11, Clred-edge 6, NDVI 2 and WDRVI between 0 pairs. Of these pairs, the differences of vegetation index values between the pure maize with fertilizer and intercropped maize-pigeon pea were significantly higher. This was true for both maize varieties. There is a significant correlation (at 5% probability level) between VIs and crop condition parameters. More significant correlations were observed at the flowering and anthesis maize stage. No significant relationships were found past this stage. In conclusion, Clgreen, Clred-edge and NDVI have shown ability to identify differences in maize crop signatures with Clgreen performing better than the other indices.

Keywords: remote sensing, vegetation indices, UAV, monitoring maize crop, Tanzania

AFS010: Malawi 2018 Census Mapping

Julius Buyengo
jbuyengo@rcmrd.org
Regional Centre for Mapping of Resources for Development

Abstract

Population census is the single most important source of socioeconomic information. Conducted once every ten years, the census offers almost complete coverage of the population, and the resulting information is processed to form a wide range of computer-readable data products. Census outputs play a critical role in central and local government planning for resource allocation. In many African Countries, Population and housing censuses are regularly conducted since the colonial era. In most cases, complete census enumerations have never been achieved due to lack of all inclusive mapping methodologies that account for the spatial location of all dwelling structures; hence the entire population in a country. In most cases, parts of a countries population are left due to the inability to be located, accessed and be accounted for during listing. In trying to solve this problem, the Government of Malawi through the National Statistical Office sought to employ the use of up to date high resolution (50cm) satellite images, GIS and GPS to aid in the spatial mapping of all dwellings in the country and use them as basis for demarcating accurate Enumeration Areas based on observable ground physical feature. The work was undertaken under technical support from Regional Centre for Mapping of Resources for Development (RCMRD), the Lead consultants and Surveys Malawi Limited as local consultants. The project timelines were from June 2016 to August 2017.

The applied methodology involved a series of activities with included: Baseline data review where the consultants interogated previous census datasets (1998 and 2008)and other baseline data in order to get their understanding including ascertaining their use as inputs into the project; Administrative boundary harmonization (Traditional Authorities and Districts) where the administrative boundaries extracted from 1:50,000 topographic maps were reworked to conform with features on the satellite

images; GIS Database development where filing structures were set on local computers/the server and feature attributes defined in preparation for data input; Dwelling frame capture, where house structures on the images were digitised as dwelling points data; Field validation; Enumeration area demarcation where Malawi's lowest administrative units were split into small portions containing between 200 to 300 dwelling points; Database quality checking for errors and corrections, and Enumeration Aarea map composition & production using automated tools in PDF and JPEG formats using a specially designed script in readiness for the main census. Based on the above activities the project delivered; Up-to-date satellite images covering the whole country, updated administrative boundaries, Dwelling Frame data for the whole country, a new enumeration Area database for 2018 census, Automated map production software that generated over 27,000 EA maps and well trained NSO staff in GIS applications for census mapping using high resolution images. In conlusion, the work undertaken at NSO Malawi was very successful and is a model of its kind with regard to the application of Earth Observation data in preparation for, and conducting population and housing surveys in Eastern and Central Africa.

AFS011:Towards the Development of a Web Based Rangeland Assessment and Monitoring Tool

Lilian Ndungu[1], Maungu Oware[1], Steve Omondi[1], Anastasia Wahome[1], Robinson Mugo[1]

[1]SERVIR-East and Southern Africa

Abstract

The Kenyan rangelands through livestock production, contribute to over 12% of the 40% Agricultural GDP with further contribution through the tourism sector. They cover over 70% of the country and are home to both wildlife and pastoral communities. With dependence on rain-fed pastures,

better management of the rangelands require near real time information on available resources. While information on vegetation conditions is important, other critical resources such as location of water, extent of unpalatable invasive species, location of water and other ancillary information is required for a comprehensive understanding of the condition of the rangelands. With a changing climate, an assessment of the vegetation productivity is critical in identifying degradation hotspots, but also monitoring areas where re-greening due to rehabilitation efforts has occurred. While a lot of information on vegetation conditions is available online, the tool specifically provides users with a centralized location for aggregation and synthesis to develop maps that can inform different decision making processes that need to be made in the rangelands at sub-regional levels. Some of the indicators used as an input include products derived Normalized Difference Vegetation Index (NDVI) at dekadal, monthly and Seasonal time steps and include current values, anomalies and deviations from long term mean. The tool allows users to select a boundary at county or conservancy level, select a greenness index and combine it with baselines of vegetation productivity such as degradation index. The maps can then be overlaid with other ancillary datasets such as invasive species, surface water maps, rivers, roads, names, sub-county boundaries; and downloaded either as an image or with the original datasets used for further analysis or application. Generated information can be used as a decision making tool by rangeland managers to influence development of proper grazing plans, livestock movement, conflicts and implementation of conservation measures meant to rehabilitate degraded lands, management of scarce water resources and mitigation of the spread of invasive species. Further, the generated maps can also be applied in reporting or monitoring county drought status or pasture conditions.

AFS012: Improving the Capacity of Institutions on Geospatial Technologies for Societal Benefit

Joseph Murage

Regional Centre for Mapping of Resources for Development (RCMRD), Nairobi, Kenya

Email: jmurage@rcmrd.org

Abstract

Timely geospatial data, Earth observations, and predictive models are critical to effective decision-making for sustainable development. Developing products with impact require efforts to reach out to decision-makers, understand their needs, design and develop tailored products and tools, monitor and evaluate and build capacities of decision-makers to use geospatial tools. RCMRD is implementing SERVIR-Eastern & Southern Africa (E&SA), a project with a goal to strengthen environmental management and resilience to climate change by improving the capacity of governments and other key stakeholders to integrate Earth observation information and geospatial technologies into development decision making. One core component in this project is development of Theory of Change (ToC), a planning and evaluation tool that conceptualizes in detail how activities and interventions will lead to desired impact. ToC requires regular consultations and feedback from stakeholders have a clear long-term goal, immediate outcomes, measurable indicators of success and activities to achieve the desired impact. ToC thinking brings greater clarity on the concepts of impact and supports useful frameworks for tracking changes and analyzing linkages. While the pathway of change is the centerpiece of a theory of change, and often the most, recognized component, a complete theory of change must also describe the types of activities that would be required to bring about the pathway of change. Theories of change also help stakeholders build consensus on how success will be documented. Further,

there is need to define where the impact is desired whether at institution or at the community level. In addition, it is important to understand that ToC is not linear and that there other factors outside the project control that would affect the ability to produce desired impact. Therefore the critical question is what else need to be done to make geospatial tools and products developed contribute to desired impact. Further, developing ToC allows stakeholders to understand and challenge the underlying logic of the connections between facilitating conditions and planned activities while everything is still on the drawing board. The extent to which capacity of institutions is improved greatly depend on the ability of users in utilizing data, tools or products. Therefore key role of monitoring and evaluation is to demonstrate how institutions have improved their capacity to integrate geospatial tools and products in decision making. Baseline data is collected from institutions to assess their capacity to use geospatial data in decision making.

Keywords: Monitoring & Evaluation, impact, Theory of Change, decision mak

AFS013: Use of Earth Observation Data to Inform Food Security Assessments and Decision Making

Antony Ndubi[1], Lilian Ndungu[1], Anastasia Wahome[1], Robinson Mugo[1]

[1]SERVIREastern and Southern Africa

Abstract

Kenya relies on agricultural production for supporting local consumption and other processing value chains. With changing climate in a rain-fed dependent agricultural production system, cropping zones are shifting and proper decision making will require updated data. Where up-to-date data is not available it is important that it is generated and passed over to relevant stakeholders to inform their decision making. SERVIR ESA

developed two epochs of crop masks based on 30m Landsat satellite image analysis of 2000 and 2015. The developed crop masks have information on the extent of cropland. Change maps for 2000-2015 period were also developed. The change maps are critical in showing the changes in cropping zones due to variability in climate and other factors. The results of the analysis show that the total area under cropland in 2000 and 2015 was 9,762,440 hectares and 10,263,200 hectares respectively. The change maps analysis show that there was a change of 539,433 hectares from non-cropland area to cropland. Similarly, there was a change of 39,310 hectares from cropland to non-cropland. Building on the cropland maps, SERVIR ESA developed a High Resolution Map based on10m Sentinel satellite images from which a GIS based sampling frame for identifying maize fields was generated. The identified maize fields are used in the crop insurance programme by the Kenyan State Department of Agriculture (SDA). Previously, SDA was using a list of farmers to identify the crop fields for insurance programme. In the GIS-based identification of farmers SDA uses 1 day to cover an area covered in 1 week by list identification of farmers. Similarly, SDA spends approximately 3,000 USD per sub-county to locate maize fields using GIS-based sampling as compared 10,000 USD they used to spend before. This has resulted in 70% cost reduction. It is important for food security decision making processes to be based on up-to-date data. Where this data does not exist it should be prepared and passed over to relevant stakeholders.

CROSS-CUTTING (CR)

CR001: Fine Resolution Modelling of Malaria Risk Factors and Potential Malaria Risk Prediction (A Case of Homa Bay County, Kenya)

Kasera Kenneth
Email:

Abstract

Malaria remains to be one of the major killers in the world; with governments spending billions of USD dollars on control measures yet malaria still poses a threat to 3.2 billion people globally. In Kenya, twenty-five million people are at risk of malaria, of which approximately 428,000 cases were reported in Homa Bay County in the year 2014. These measures range from vector control to malaria diagnosis and treatment. However, the operational challenge facing present-day elimination of malaria is the need for high-resolution location-based surveillance and targeted prevention responses. Geographic mapping has traditionally played a great role in diseases surveillance but its full potential has not yet being achieved. Moreover, previous malaria risk models are based on species presence data and malaria household surveys, which is expensive to acquire. This research uses malaria cases from the health records and readily available remote sensing (satellite imageries) and GIS datasets to model malaria risk factors and generate potential malaria risk map. Various remote sensing datasets were generated from Landsat 8 satellite (land surface temperature, normalized difference vegetation cover, land cover, water hyacinth, and topographical wetness), sentinel1 (wetlands), moderate resolution imaging spectroradiometer (evapotranspiration), and climate hazard group infrared precipitation with station data (rainfall). Soil drainage, poverty, population dataset, and altitude were sourced from Kenya soil survey, World resource institute, and NASA respectively. Additionally, the malaria occurrence data for each health facility was sourced from health sub-county headquarters in Homa Bay County. Raster based surface travel

time method based on multiple layers (slope, land cover, road and rivers) was used to generate health catchments for calculation of malaria infection rate per health facility. Moreover, identification and categorisation of malaria risk factors in Homa Bay County was done using factor analysis model. The association between factors and malaria infection rate was done using correlation analysis, and collinearity between factors assessed using the variance inflation factor model. Overlay index model was then used to create the potential risk map using the correlation coefficient between the risk factors and malaria infection rate as factor weights. Results from factor analysis reveal that malaria-causing factors in Homa Bay County are categorised into three, namely, biophysical (rainfall, normalized difference vegetation index, land cover, evapotranspiration, land surface temperature, distance to hyacinth and topographical wetness), topographical (altitude, slope and soil drainage) and socio-economical components (poverty, and distance to wetlands). In addition, rainfall, altitude, temperature, and normalized difference vegetation index are considered as very significant risk factors with land cover as the least. Results from correlation analysis and collinearity also reveal a weak linear association between risk factors and malaria infection rate, and that the factors are not correlated respectively. High-resolution remote sensing datasets and health records can be successfully combined to model and predict malaria risk. The potential risk map generated is 64% accurate using the malaria infection rate as the reference dataset for validation. The zones close to Lake Victoria are of high potential malaria risk with zones of high altitude and far from the lake considered as low risk. Moreover, moderate potential risk is experienced in more than half of the county. Approximately 287,0000 cases out of 428,000 reported malaria cases in the year 2014, occurred within 1km from wetlands and within 1km from water hyacinth; this makes wetlands and water hyacinth locations key actions areas apart from other potential risk areas within Homa bay county. Poverty stricken zones also have high infection rate; incorporating this complex aspect of human life into malaria prevention is highly needed in Homa Bay county. However, more investigation is needed to fully ascertain the risk since the risk map is a

potential risk map. Future research on multi-temporal analysis of malaria risk in Homa bay is however recommended to fully understand and ascertain the risk.

Keywords: Mosquito, Spatial Modelling, Malaria

CR002: Use of GIS in Grid Management and Extension

Victor Kazibwe
GIS Supervisor, Umeme Ltd, Victor.kazibwe@umeme.co.ug

Abstract

The Energy sector in Ugandaapparently applies Geographical Information Systems (GIS), remote sensing and mapping in order to determine or identify areas in rural areas that need electrification considering of the population growth rates in those places and existing.Umeme as the major power distributor in Uganda during the early 2000's its asset information register was a manual one which was based on saved spread spreadsheets to determine grid asset management and extensions but these assets being saved on spread sheets had a spatial location and there was a high degree of error and not having a proper updated asset register. GIS has over the years has tremendously moved stages from initially using linear referencing desktop GIS tools to automated mapping, further taking a new direction of embracing the use of ArcGIS Collector, Geoforms, and Web GIS Applications to map locations of network asset conditions such as Transformers, Poles and Conductor types, conditions, sizes used in electrification. Hence easily provide the decision makers with a powerful way to organize, retrieve, and display data based on its spatial characteristics. Such added importances have made the use of GIS in utilities a must since smart grids for utilities, or the networks based on information and communication technology, are ushering in a new era of energy demand.

Keywords: Energy Utilities, GIS, Automated Mapping, Arc GIS Collector, Web Applications, Smart Grids

CR003: GIS Location-Allocation Model in Improving Accessibility to Health Care Facilities (Centers) - A Case Study of Mt. Elgon District

Tom Kemboi Kiptenai[1] and Edward Hunja Waithaka[2]
[1.] Jomo Kenyatta University of Agriculture & Technology, School of Civil, Environmental and Geospatial Engineering, Nairobi 62000-00200, Kenya, tomkiptenai@email.com
[2.] Jomo Kenyatta University of Agriculture & Technology, School of Civil, Environmental and Geospatial Engineering, Nairobi 62000-00200, Kenya, hunja@eng.jkuat.ac.ke

Abstract

The World Health Organization in its 58th World Health Assembly (WHO) called upon all nations to ensure that citizens should have "access to promotive, preventive, curative and rehabilitative health intervention at affordable costs". International standards recommend that healthcare facilities should be located within 5 km distance. However, such recommendations failed to take into consideration the terrain, the states of rural roads and means of transport. In Mt. Elgon district, close to 200 people lose their lives annually as a result of delay in getting proper health care services which is largely attributed to poor roads, rough terrain and inadequate means of transport. There is a need to increase geographic accessibility to these facilities. Specific aims of the study include: showing geographic distribution of health centres in Mt. Elgon District, examining accessibility to health care centres in the District, and to use GIS capabilities to propose optimum locations where future health centres ought to be constructed. It is well known that locating

hospitals correctly is highly important in order to increase their accessibility. One method for identifying optimal locations in Euclidean space is a location-allocation model which minimizes the total travel time from supply locations (health centres) to the demand locations (human population). The types of data used include population data based on the 2009 national census, digital elevation model, and location of healthcare facilities, road network, disease statistics and Landsat image. From the findings, a total of 1 district hospital, a sub-district hospital and 10 health centres serve the entire district. Only 62.5.0% of the population can access the existing healthcare facilities within a distance of 5.0km. Construction of 6 health centres was found to help in improving accessibility to 90.0%. This ultimately can reduce the cost, pain and more so the number of deaths in the District linked to delays in accessing proper medical attention. The greatest limitation of the study rests on the idea that only health centres and District hospitals were used. Future studies should consider dispensaries and other private clinics in the analysis.

Keywords: Location-allocation, healthcare, geographic accessibility, minimum distance, GIS, accessibility

CR004: Improved Analysis of Cheetah (Acinonyx Jubatus) Occupancy and Gene Flow Using GIS Tools in Kenya

Mutoro Noreen[1], Schaab Gertrud[2] and Wykstra Mary[3]

[1.] Carnivores, Livelihoods and Landscapes; Acton for Cheetahs in Kenya (ACK), noreen.mutoro@actionforcheetahs.org

[2.] Karlsruhe University of Applied Sciences, Karlsruhe, Germany; gertrud.schaab@hs-karlsruhe.de

[3.] Carnivores, Livelihoods and Landscapes; Acton for Cheetahs in Kenya (ACK), mary.wykstra@actionforcheetahs.org

Abstract

Kenya holds one of the largest cheetah populations in the world. However, due to human demographic pressure in major parts of the country, over the past decades there has been a rapid transformation of wildlife areas into agricultural land. This has resulted in habitat loss and fragmentation and a decline in the distribution and population size of cheetahs. Currently, 80% of cheetah occurrences in Kenya are observed on either private or community property. Despite this, there is limited information on quantitative effects of human activities on cheetah populations and social-ecological determinants that influence their distribution and survival in Kenya. In response, Action for Cheetahs in Kenya (ACK) -the only range-wide cheetah conservation organization in Kenya, conducted the first Kenya national cheetah survey in collaboration with the Kenya Wildlife Service, Cheetah Conservation Fund and East African Wildlife Society between 2004 and 2007. We were the first to create a range-wide map of cheetahs based on actual site visitation across the entire country. Results from the survey formed the baseline for national and regional strategic planning. Pilot studies conducted between December 2015 and August 2016 form the framework for completing the range-wide GIS-based evaluation using the first survey as a baseline. A second range-wide survey (2017-2019) will be carried out to evaluate the population viability trends of the remaining cheetah populations. The survey will further assess anthropogenic, environmental and ecological variables that influence cheetah resource use. Occupancy modelling and genetic mapping will be used to map and analyse trends in cheetah status and genetic flow between populations. Detection dogs will also be used to locate scat. Scat samples will then be used to evaluate cheetah presence, prey selection, cheetah health and genetic variability. In addition, remote sensing technology will be used to assess the effects of land use change on cheetah habitat. This paper will highlight changes made from the first survey to ensure scientifically sound knowledge is applied in the formulation of conservation strategies for cheetahs not only in nature reserves and national parks across Kenya but also in human- dominated landscapes

Keywords:Cheetah, Gene flow, Remote Sensing, Species Occupancy, Species Distribution

CR005: The Role of Planning Support Systems in National Policy Transfer and Policy Translation in Secondary Cities.

Benson Mutuku [1], Luc Boerboom [2] and, Mafalda Madureira [3]
[1]iPlan Consult (Intl) Ltd, 28634-00100, Nairobi, Kenya,bmutuku90@gmail.com.
[2]Department of Urban and Regional Planning and Geo-information Management, University of Twente, Enschede Netherlands,l.g.j.boerboom@utwente.nl.
[3]Department of Urban and Regional Planning and Geo-information Management, University of Twente, Enschede, Netherlands, m.madureira@utwente.nl.

Abstract

Rwanda has developed a National Urbanization Policy (NUP) that identifies six secondary cities where effortsto promote urbanisation and economic growth should focus. The NUP was approved by the cabinet of Rwanda in 2015 and asserted to be the policy guiding urbanisation process in the country. The NUP is set to guide how governmental and non-governmental stakeholders work together in the urban planning processes to achieve sustainable development. In order to implement this NUP, one of the strategies used is to develop a Spatial Development Framework (SDF) that makes use of Planning Support Systems (PSS) to communicate the NUP goals to the local level. Planning support systems (PSS) are a set of computer-based geo-information tools which consist of special features that stakeholders within a planning process can utilise for tasks such as analysis, communication and handling information. These tools have captured the attention of many researchers who have shown that PSScan be used in various domains such as transport, water management and policy

implementation. Many of thePSS studies have focused on the application at one administrative level (national, regional and local levels) but little on how PSS can link the different administrative levels. In Rwanda, PSS present opportunities for stakeholders in planning processes to understand and translate national policies to their local planning contexts,by facilitating analysis, communication and handling information. However little is known about how this translation process of national-level objectives might happen at the local level. This paper explores how two secondary cities are likely to translate national policies with the aid of PSS tools. The study focused on potential users of the SDF and data was collected through research workshops and expert interviews. The results suggest that the use of SDF's PSS tools and outcomes can promote better spatial understanding, and communicate planning needs in an analytical manner. This can strengthen regional competition and economic development among the secondary cities across the country, in line with NUP. This paper concludes that the national government can transfer the SDF'S PSS tools and outcomes, through vertical transfer, to early adopters in the secondary cities. Through horizontal translation, these early adopters in secondary cities translatethese SDF'S PSS tools and outcomes to the late adopters. The study concludes that the SDF's PSS tools and outcomes, originally developed for national use, can be used for policy transfer by the national government and for policy translation by the secondary cities.

Keywords: PSS, Policy Translation, Policy Transfer, NUP, SDF, Secondary Cities, Rwanda

CR006:On-Line Spatial Data Mining: A Catalyst for National, Continental and Global Initiatives

Peter Kinyua Njagi,
Economic Commission for Africa,
Email: njagi1@un.org

Abstract

Spatial data mining is the application of data mining techniques to spatial data with the objective of identifying patterns that exhibit some spatial component. Within this context, data mining (which was traditionally the preserve of commercial entitles and whose techniques are contemporaneously used in many research areas), is understood as the process of sorting through data to identify patterns and establish relationships. To entrench the foregoing, UN-GGIM noted "…the SDG Agenda laid out meticulous road map to implement, measure and monitor the progress through 230 indicators under the 17 Goals, recognizing earth observation and geospatial data as a prerequisite underpinning the success of the Agenda." Linked to the above is the notion of online data mining, a type of data mining that draws on online data sources to detect patterns in user behaviour, and whose geographic disaggregation is paramount in pattern identification, owing to its ability to give a snapshot about what is happening where, and sometimes to whom. Yet, with the advancements in technology, mobile data, crowd sourced data and the associated data collection technologies, there has been a corresponding explosion in the volume of data, the speed with which data are produced, the number of data producers and users. This data, much of which is geo-tagged and spatially enabled, is now being leveraged by a range of stakeholders, including but not limited to governments, security agencies, researchers, and academia. All of this has to nonetheless been consistent with the principles of the data revolution, which states that "… Data should be translated into information that is simple, understandable and relevant. Information must be timely, accurate, relevant and accessible." In keeping with this, spatial data mining attempts to discover interesting,

useful, non-trivial patterns from large spatial datasets to facilitate planning and monitoring of various initiatives. The paper will give an overview of online data mining, look deeper into online spatial data mining, and examine the consumption and use of such data at national, continental and global development initiatives. It will consider the monitoring of global and African agenda by focusing on selected African vision 2063 and Sustainable Development Goals.In so doing, the paper will discuss how spatially-enabled data facilitates efficient and effective delivery of public services by supporting decision-making and resource allocation processes. By identifying gaps and challenges associated with official statistics the paper argues that spatial data plays a complementary function to official statistics within the data ecosystem. For example, mapping data from developing countries it expands the data ecosystem and upgrades our understanding of the spatial coverage of disaster monitoring and management. As envisaged in the Africa data consensus, the paper will examine the notion of open data, big data, Volunteer Geographic Information (VGI), crowd sourcing as entry points to understanding how data mining can be integrated into, for instance, National Spatial Data infrastructures, thereby dynamiting the ecosystem. It is understood that challenges such as data quality and privacy abound and therefore such considerations will be factored.

Keywords:Data Mining; Data Revolution; Volunteered Geographic Information; Spatial Data; Sustainable Development Goals

CR007: A Tool for Ensuring Policy- Impacting Research Results (Policy Advice on Reconciling Food production and Environmental Protection in Wetlands of East Africa)

John Kalisa
Department of Geography, University of Bonn, Germany.
Email: johnkalisabusiness@gmail.com

Abstract

The East Africa is frequently affected by food shortages and pockets of hunger although the region as a whole has a huge potential and capacity to produce enough food for regional consumption and large surplus for exports to the continental and global market. One of the many factors leading to this state of affairs is the high variability in agricultural production caused by high variability of weather which is becoming worse due to climate change. Wetlands occupy 20 million hectares in Kenya, Uganda, Tanzania and Rwanda. However, only a small proportion is currently used in a sustainable manner. An increased food production from wetlands that are already under agricultural use will be only achieved sustainably if intensified land use can be reconciled with the conservation of biodiversity and the maintenance of ecosystem services. Policy research is a prerequisite to determine the constraints and opportunities for translating the technology alternatives from scientific research results to policy making process. Over years, the agricultural research institutes in the East Africa ministries of agriculture and food security have been conducting wetlands management related research with notable success stories. This includes, among others, development of high yielding bean varieties with desirable agronomic characteristics, and environmentally friendly maize and bean varieties through breeding. However, the research results are still underutilized and have not caused the desired change in agricultural production through wetlands. The problems based research results communicated in the conventional scientific publication method have not made the desired outcomes of positive change. There is a need to devise tools at both research design level and at research results dissemination stage to ensure effective utilization for policy change.

The objective of this paper is to better integrate the results of research on national and regional problems such as food insecurity, wetlands use and management, environmental conservation, climate change and sustainable resource management into policy decision making. Four wetlands super sites identified in East Africa countries as case studies within GLOBE wetlands-Global Food Supply and a tool for ensuring policy impacting-scientific research results would be designed through the Policy geo-governance

formulation and recommended model of effective reforms known as 4Ms reforms package which stands for maintain, modernize, MARKETIZE and minimize. In addition, The World Bank Group (2017) Concept framework for Policy Governance and the Law for successful reforms would be applied especially on institutional functioning and power asymmetries resolutions in East Africa land use and planning through 3Cs- credible Commitment, support Coordination and promote Cooperation to achieve intended research outcomes.

Key words: East Africa, wetlands, food production, Governance, Policy, research, reform, environment.

CR008: Solid Waste Disposal Site Selection Using GIS, Gombato Bongwe Ward, Kwale

Brian Wanyama[1] and Maureen Muthui Katee[2]
[1] GIS Specialist Email.brianwanyama70@yahoo.com
[2] Mining Engineering Student Taita Taveta University Email.muthuimaureen.mk@gmail.com

Abstract

Solid waste management is a problem that is experienced by all countries world. The most common problems associated with improper management waste include diseases transmission, fire hazards, odor nuisance, atmospheric pollution, aesthetic nuisance and economic losses. This paper deals with selection of suitable site disposal of municipal solid waste generated from Gombato Bongwe using GIS. The present study integrated environmental and socio-economic criteria like proximity to road distances from residences and important built up areas; surface water (river), bore reservoirs to select the most suitable solid waste disposal site in the study area. Reveals that out of several candidate landfill sites, a site with reasonable size, an optimum distance from residences and accessible to the major roads was nominated

as the most suitable site for the solid waste disposal (landfill).

Keywords: Solid waste management, Landfill site selection, GIS, Gombato Ward

CR009: Spatio-Temporal Patterns of Malaria Hotspots in Kigali City

Jean Pierre Bizimana[1] and Gilibert Nduwayezu[2]
[1] University of Rwanda, College of Science and Technology, Department of Geography and Centre for Geographic Information Systems and Remote Sensing, Huye Campus, PoBox 212 Huye.
[2] Universities of Rwanda, College of Science and Technology, School of Science and Technology, Department of Civil, Environmental and Geomatics Engineering.

Abstract

Urban malaria control and elimination need to be guided by improved understanding of the geographic and socio-economic factors of malaria transmission by targeting interventions to the high risk of malaria transmission. Moreover, urban malaria elimination should not reproduce initiatives taken in rural areas as they are likely to result in a significant waste of resources due to inappropriate interventions. This paper investigates therefore the implications of population dynamics and unplanned urbanization on malaria distribution in rapidly urbanizing areas of Kigali City. Data on migration were collected from National Institute of statistics of Rwanda. Health centre catchment areas were delineated for mapping malaria incidence. Satellite images were classified to generate land use/cover changes and the main breeding sites of malaria vectors. Box plots were used to investigate the intensity of temporal variation of malaria incidence. Hotspots analysis was then applied to assess the clusters and spatial-temporal patterns of malaria hotspots. The results show that persistent malaria hotspots are clustered around water-based agro-ecosystems in peri-urban areas while

densely urbanized areas are the coldspots of malaria transmission. Spatio-temporal variation of malaria hotspots can help decision-and-policy marker in targeting interventions and limited resources in areas of the most need; and therefore providing a cost-effective tool for urban malaria elimination in Kigali City. As malaria incidence data is aggregated at health centre catchment areas, further research can use malaria prevalence at household level to identify malaria hotspots at very local scale. Furthermore effective malaria elimination in Kigali City should consider the effect of population movement, development activities, and ecological change that are induced by unbalanced urbanization of Kigali City.

Keywords: Urbanization, migrations, malaria hotspots, Kigali City

CR010: The Geo Information Applications in Decision Making in Umeme

Stella Namulondo
CAD Officer Umeme Uganda Ltd
Email: Stella.namulondo@umeme.co.ug

Abstract

Umeme is the largest energy distributor in Uganda, distributing 97 percent of all electricity used in the country.Geo information applications and Information used in Umeme has been of great importance in decision making more so to the planning and design department. The Geo Information datasets undergo constant editing are versioned and participate in a Multiuser environment. Geodatabase replication and archiving helps in getting the edited Network data from various locations synchronize straight with the central database and also allow viewing of historical versions hence supporting informed decision making based on Properly Updated Data.
The Geo Information gives you tools to analyze your data and see the results

in the form of Powerful, interactive maps that reveal how things work together, allowing you to make the most informed decisions possible.

Key Words: Multi user Environment, Geodatabase Replication, Interactive maps

CR011: Unravelling Kobotoolbox and Kobocollect Smartphone Geospatial Technology for County Spatial Planning in Kenya

Nyangueso, S. O.[1], Hayombe, P.O.[2] and Were, J.[3]
[1] PhD Student, Jaramogi Oginga Odinga University of Sccience and Technology, ouma.sam@gmail.com
[2] Senior Lecturer, Jaramogi Oginga Odinga University of Science and Technology, rapospat@yahoo.com
[3] Director of Surveying & GIS, County of Siaya, jecwere09@gmail.com

Abstract
Spatial planning projects are by no means data intensive endeavour at either local or regional scale. Unravelling KoBoToolbox, a smart phone geospatial technology, for collection of point-based planning data is long overdue. KoBoToolbox is an ensuite, a free and open source tool for field data collection in challenging environment. Initially designed for humanitarian work, KoBoToolbox is currently available for development practitioners, global health workers and researchers around the world. Enriched with desirable features that easily create survey forms; quickly and reliably collect/record spatial and attribute survey data either offline or online on Android, IOS, among other devices; ability to inspect data immediately after collection; and downloading as Excel, CSV and KML, KoBoToolbox is the way to go with increasing number of smart phone users in Kenya and globally.
The aim of the research is to explore innovative application of KoBoToolbox in massive point-based planning data collection for county spatial planning

projects in Kenya. Taking County of Siaya as a case study, the paper presents and describes the geospatial approach, exciting lessons and experiences from data collection, processing and analysis using KoBoToolbox technology for Siaya County Spatial Planning Project. In less than two weeks, with support of a number of data collectors using their own phones, over 95% of basic socio-economic data was collected, downloaded, stored, edited and analysed in a paperless and controlled environment. These comprised location and attribute data on education, health, water supply, markets & urban areas, bridges, abattoir, industries, hotels, cultural and tourist sites, beaches, financial institutions among others. It was concluded that KoBoToolbox is not only quick and reliable but also economical tool to deploy for planning data collection. However, awareness and skills dissemination on the technology should be improved.

Keywords: KoBoToolbox, Smartphone, Geospatial Technology, GIS Data Collection, Spatial Planning

CR012: Urban Tree Species Classification on Pixel and Object Level with Worldview-2 Image, Using Maximum Likelihood Classifier and Support Vector Machine

Lucy C. C[1], Dr. ir. W. Bijker[2] and V. Tolpekin[3]
[1]Lucy Chepkochei C. chepkosgei@gmail.com
[2] Dr. ir. Wietske Bijker, University of Twente (ITC), w.bijker@utwente.nl
[3]Dr. Valentyn Tolpekin, University of Twente (ITC) v.a.tolpekin@utwente.nl

Abstract

Urban forests play a significant role in improving air quality and climate protection, energy saving, recreation and human connection with nature. To maximize on the mentioned benefits, urban trees inventory is necessary to identify tree location, gain species information and their spatial distributions. Urban areas do have a mixed environment of land cover. In

addition, traditional techniques like ground survey, aerial photography are time-consuming, costly and limited. This study researched the classification of urban tree species using maximum likelihood classification and support vector machine on the WorldView-2 satellite image. This entailed using object and pixels in both methods. The main objective of this study was to classify urban tree species using Maximum Likelihood Classification (MLC) and Support Vector Machine (SVM). Object based and pixel based analysis was used in both methods. MLC performed better than SVM in both object and pixel based calssification. MLC pixel based overall accuracy was 66.93% with Kappa of 0.54 and 51.24% with Kappa of 0.36 for SVM pixel based. MLC object based overall accuracy was 71.17% with Kappa of 0.66 and 44.62% with Kappa of 0.31 for SVM object based analysis. Even though MLC perfoms better than SVM, the accuracy is still low compared to generally accepted accuracy. This indicates that both methods are still not satisfactory techniques of classifying high resolution images for Delft city. MLC, however, has been used for many years in image classification. It is straightforward and does not require extreme expert skills to apply. MLC algorithm can be found in most of the remote sensing application software. Examples of this software are ERDAS, ENVI and ILWIS among others. This makes MLC an easy available method for classification. MLC pixel based classification is effective in classifying medium and large trees (e.g. Plantanus Spp. and Fagus Spp.). MLC relies on mean and covariance of samples hence calculation of covariance matrix in small tree crowns (> 10 pixels) could not be determined. Class separability using J-M distance measure and NDVI mean and variation evaluation were the same. This gives possibilty of use of NDVI in separating tree species. SVM does not operate based on data distribution making it applicable to any type of data (i.e. normal or non-normal distribution. Its performance relies on kernel parameters. In this study, C value of 5 and value 5 for δ were used. Experimenting on optimum parameters values of C and δ can give satisfactory classification results. Though the study area is in The Netherlands, classification of tree species using MLC and SVM brings up possibilities to apply the same approach in other urban areas and to other tree species.

Keywords: Maximum Likelihood Classifier, Support Vector Machine, Urban tree species, Pixel, Object analysis

CR013: Why Spatial Intelligence is Critical to Business Models (Insights From Enterprises in Western Kenya)

Nashon Adero[1] and James Shikwati[2]
[1] Freiberg University of Mining and Technology, Germany, Email: nashon.adero@gmail.com
[2] IREN, Email: james@irenkenya.com

Abstract

Micro, Small and Medium-Scale Enterprises (MSMEs) have a proven record of substantial job creation globally. Smart devices that use sensors to detect precise geographical locations and disseminate information fast and widely through online global connectivity continue to extend the borders of possibilities in business innovations. As a result, there is a growing demand on the aspects of cost, speed, efficiency, convenience and reliability in delivering business solutions. Most datasets on MSMEs, however, still miss out on the exact spatial metrics required to complete the equation of providing comprehensive and location-specific business decisions. In the absence of real-world coordinates, analysts resort to the use of binary codes. The codes are used as proxies for proximity or spatial inclusion. Common examples take the form of dummies such as near (1) or far (0); within (1) or outside (0). Such dummy variables have been a major constraint on the spatial decision power of even the most acclaimed econometric models. By introducing spatially explicit parameters into business decision models, geospatial technologies present immense potential to transform the MSMEs. The geospatial technologies provide accurately determined geographical coordinates to replace the limited binary dummies. The resulting integrated models are more effective in exploring options for optimising logistics and

enhancing business revenues, as this case study revealed. Using GPS and GIS technologies, a questionnaire-based survey of 285 MSMEs and 17 key informants across Western Kenya integrated spatial metrics into the analysis framework for the business challenges presented by stakeholders. The fieldwork was carried out between February and March 2017.

Market access came out as the topmost problem, caused by difficulties in physical access and inadequate knowledge on geographically differentiated demand-supply characteristics. In a counterintuitive twist, GIS-based spatial analysis established that there was no relationship between business registration rates and proximity to development in the form of main centres or road infrastructure. The study provided a strong evidence-based framework for integrating spatial intelligence into the decision processes meant to enhance the performance of MSMEs. The geospatial premium infused into the resulting statistics by using GPS and adding various GIS data layers helped to overcome several limitations to scenario analysis. These limitations occur when the resulting datasets, because of missing spatial coordinates, cannot be linked to any standard geographical reference system. Location-based intelligence, availed through geospatial technologies and earth observation services, gives enterprises unparalleled opportunities for overcoming these limitations and achieving accelerated growth and impact. Further research on innovations for business therefore needs to prioritise the input of location-based business intelligence, which is a hallmark of the modern digital economy thriving on digital and big data platforms.

Keywords:Business model, dummy, GIS, GPS, spatial intelligence

CR014: Eastern Africa Forest Observatory

Ngugi Kimani
Regional Centre for Mapping of Resources for Development
Email: kngugi@rcmrd.org

Abstract

The Eastern Africa Forest observatory aims at providing a better

understanding of the trends and threats to forests in Kenya, Uganda, Tanzania and Mozambique in order to support better decision-making to improve the management of Forests. The Regional Forest Observatory will contribute to the collation and sharing of relevant data and information on Forests in East Africa and will provide support on decision-making processes to governments across the region. The forest observatory federates diverse sources of data and provides the users with a cross-cutting vision on the forests sector in the four countries by hosting a regional database and a website for the regional forest observatory. This will be regularly updated by the integration of new data sets regularly, when deemed necessary. The data and information compiled in this observatory has been provided by the four countries and thus arranged per country. The idea is to create a holistic monitoring system of East Africa forests in order to regularly update the knowledge database, to identify the important issues for future strategies and programs, and to allow for a fine analysis of these parameters for combating illegal logging and destruction. The ultimate goal is to re-enforce ownership by national services in charge of forest to include environmental information in the decision making processes. This will require the establishment of the mechanisms of data exchange, harmonization, and reinforcement of capacities for different monitoring systems and for the overall observatory, and the awareness raising of main target institutions and audience.

Keywords: Eastern Africa, Forest, Observatory, Kenya, Uganda, Tanzania and Mozambique

CR015: Communicating Climate Change by Linking Space and Village

Nesoba Dorah
Communications and Outreach Expert
Email: dnesoba@rcmrd.org

Abstract

Climate change poses a significant threat to lives and livelihoods in RCMRD

member States. Government policies, GIS technologies and financial support from international donors all play a role in RCMRD member States' response to climate change. But central to the fight against climate change in RCMRD member States is effective communication and public engagement. At every level of society – from ordinary citizens and farmers, to the media, civil society organisations and local and national government – the need for accurate and reliable information about climate change is very high. For RCMRD member States and citizens, the opportunity to have their concerns listened to and their voices heard is equally important. Numerous efforts are being made by stakeholders to combat climate change. However, we are confronted with a perpetuation of disparities between and within nations, a worsening of poverty, hunger, ill health and illiteracy, and the continuing deterioration of the ecosystems on which we depend for our well-being. A good example is the impact of polythene bags with the amount of plastic being used growing. By one estimate, Kenya gets through 24m bags a month, or two per person. Between 2010 and 2014 annual plastic production in Kenya expanded by a third, to 400,000 tons. Bags made up a large part of the growth. Hopes are high on effective integration of environment and development concerns and greater attention to climate change for a more prosperous future. Therefore developing necessary climate change information and promoting education, raising of public awareness through proper channels, which makes the public to understand the importance of climate change are linked to virtually all areas and even more closely to the ones on meeting basic needs, capacity building, data and information, science and the role of major groups. It is observed that climate change issues are challenged by multilevel barriers. There is an alarming gap between awareness and action on climate change. To bridge this gap, a holistic framework is required that operates at all levels of target group. Through this paper I have presented a case study of Nairobi, Kenya that was choking up in polythene carrier bags and propose a framework as to what can be done at each level of communication. Though this study lacks concrete measures, it puts forth an idea and a way forward for taking action that is expected to be incorporated through various policy and voluntary

initiatives. This paper thus highlights the role of role of multimedia channels for disseminating climate change information right from the individual level targeted groups like school children, community level uninformed people, regional level populations and RCMRD member States initiatives to spread the message of climate change vulnerabilities and ways to adapt to or mitigate climate change.

Keywords: Climate change, Communication, Literacy, RCMRD Member States, Information, Education

CR016: Establishment of a Common and Modern African Geodetic Reference System (AFREF)

Author: MuyaKamamia, Bsc, FISK, LSK
Email: muyack@rcmrd.org

Abstract

There are almost as many geodetic reference systems in African as there are countries. Sharing of data as is envisaged in Spatial Data Infrastructure (SDI) and seamless map coverage across borders therefore becomes difficult. As we move towards more regional integration and adopt regional approaches to peace and security, environmental management, trade and industry, we need maps that are continuous across national boundaries. Cross border, regional and continental geo-referenced applications, services and products require a uniform geodetic reference system. To solve the problem of lack of such a system in Africa, African Geodetic Reference Frame (AFREF) has therefore been proposed. AFREF is an initiative of United Nations Economic Commission for Africa (UNECA) Committee for Development Information, Science and Technology (CODIST). AFREF is expected to be established using GNSS technology following the standards of the World Geodetic System 1984 (WGS84) and the International Terrestrial Reference Frame (ITRF) Systems. It is proposed

that the project be implemented by the all countries in Africa through their National Mapping Agencies with the support of the international community through various scientific and research organizations in geo-sciences. The objective of the paper is to sensitize and seek a wider support for the AFREF project in the continent and the globe. The objectives, proposed implementation strategy, current status and expected benefits of AFREF will be addressed.

CR017: Geo Information Training

Author: Leornard Sweta
Email: sweta@rcmrd.org,

Capacity building in various fields of geo-formation is one the core mandates of RCMRD to her member states. This section trains average of 600 trainees a year in collaboration with professionals from other sections. The courses offered are introductory courses in GIS, advanced GIS, Digital cartography Remote sensing, handheld GPS and mobile mapping and application courses in use of GIS, GPS, and RS in Natural Resource management, urban planning and decision making, Disaster risk management as well as database and SQL server development. as well as It further coordinates trainings offered by other sections at such as GNSS and RTK, AutoCAD, Land Information, service and Calibration of surveying instruments, which are offered by Geospatial and engineering sections respectively. The trainings are offered using both commercial and open source software's. Under this section, participants/trainees are equipped with hands on skills necessary for market demands in the training areas highlighted above. All the trainings are conducted in our three fully equipped training labs with commercial software's such as ERDAS, ENVI, ArcGIS, AutoCAD, SQL server, Microsoft Office, IDRISI/TERRSET, and open source software's such as QGIS, SAGA, Beam VISAT, impact Tool, collect earth, google earth among others. All the trainings offered in thi section are instructor led accompanied by practical manual with training data for reinforcing further

understanding and good mastery among the trainees. Tailor made courses are also offered based on request and organized in consultation with clients. The mode of training is full on weekdays Monday to Friday where trainings run from 9 am to 4 pm with variation class timings as can be agreed within limits of 8am to 5pm. Comfort of trainees is ensured through comfortable lab stationery, availability of internet in training labs, provision of mineral water and tea to all participants and conducive room temperature since all our training labs are equipped with air conditioner. Group trainings of 15 persons and above from cooperate organizations are normally treated with cocktail send on the last day of training. Admission to the trainings is through scheduled programs in the training calendar uploaded on the organization website as well as through requests where admission forms are filled and upon receipt of dully filled forms, admission letter is issued through the office of the director general.

CR018: Improving the Capacity of Institutions on Geospatial Technologies for Societal Benefit

Joseph Murage
Regional Centre for Mapping of Resources for Development (RCMRD), Nairobi, Kenya
Email: jmurage@rcmrd.org

Abstract

Timely geospatial data, Earth observations, and predictive models are critical to effective decision-making for sustainable development. Developing products with impact require efforts to reach out to decision-makers, understand their needs, design and develop tailored products and tools, monitor and evaluate and build capacities of decision-makers to use geospatial tools. RCMRD is implementing SERVIR-Eastern & Southern Africa (E&SA), a project with a goal to strengthen environmental

management and resilience to climate change by improving the capacity of governments and other key stakeholders to integrate Earth observation information and geospatial technologies into development decision making. One core component in this project is development of Theory of Change (ToC), a planning and evaluation tool that conceptualizes in detail how activities and interventions will lead to desired impact. ToC requires regular consultations and feedback from stakeholders have a clear long-term goal, immediate outcomes, measurable indicators of success and activities to achieve the desired impact. ToC thinking brings greater clarity on the concepts of impact and supports useful frameworks for tracking changes and analyzing linkages. While the pathway of change is the centerpiece of a theory of change, and often the most, recognized component, a complete theory of change must also describe the types of activities that would be required to bring about the pathway of change. Theories of change also help stakeholders build consensus on how success will be documented. Further, there is need to define where the impact is desired whether at institution or at the community level. In addition, it is important to understand that ToC is not linear and that there other factors outside the project control that would affect the ability to produce desired impact. Therefore the critical question is what else need to be done to make geospatial tools and products developed contribute to desired impact. Further, developing ToC allows stakeholders to understand and challenge the underlying logic of the connections between facilitating conditions and planned activities while everything is still on the drawing board. The extent to which capacity of institutions is improved greatly depend on the ability of users in utilizing data, tools or products. Therefore key role of monitoring and evaluation is to demonstrate how institutions have improved their capacity to integrate geospatial tools and products in decision making. Baseline data is collected from institutions to assess their capacity to use geospatial data in decision making.

Keywords: Monitoring & Evaluation, impact, Theory of Change, decision making

CR019: Hydropower Resources Atlas of Kenya with Emphasis on Small Hydropower Resources

Daniel K. Theuri, Team Leader Que Energy Limited and Samuel Ng'ang'a GIS specialist (Career Skills Center)

Abstract

A national Hydropower Atlas is an important tool for policy makers, investors and others who need a quick synoptic view of the available hydropower resource at first instance. One of the single largest obstacles to wider utilization of hydropower and other renewable energy resources is lack of first hand information especially for project screening and identification. The primary objective of resource atlas therefore to enable initial navigation to a desired site and provide some hard data and information to support planning, investment decision making and policy. This provision of readily available options and alternatives to deliver energy systems using multiple sources is critical in securing energy supply in the country. An analytical assessment of the available hydropower in Kenya's river drainage system using Geographic information System (GIS) tools and a Digital Elevation Model (DEM) of the country was carried out. The tools used were open source type and the DEM was provided by NASA Shuttle Radar Topography Mission downloaded at 30 m x 30 m resolution from USGS. The atlas making involved digitizing all the rivers and streams of Kenya at 1:50,000 resolution and analyzing the national river flow regimes as obtained at various national river gauging nodes (RGS) to obtain Q40 flow exceedance used for power potential estimation. The flow modeling was carried out for each 3 km segments of the rivers and streams from their natural sinks like ocean, internal lakes. Application of the height difference between two nodes created by a 3-km segment of the river thereby obtaining the head in meters of each stretch and Q40 flow exceedance for each node created while accounting for losses. The hydraulic power equation was applied and a GIS thematic layer created for the whole country. Using various GIS tools, a number of important national statistics and data was added as thematic layers thereby

creating a hydropower atlas complete with relational attributes and other supporting themes critical in making decisions. Among these attributes are administrative units and boundaries, i.e. sub location and counties, roads, railway lines, protected areas like parks and forest, soils, geology, towns and cities, population density and energy infrastructure just to name a few. The atlas is therefore an important toolkit for identifying areas of potential and relating the potential to several other local policy and physical attributes.

LAND SURVEYING AND MANAGEMENT. (LSM)

LSM001: Feature Orientation and Positional Accuracy Assessment of Digital Orthophoto and Line Map for Large Scale Mapping (The Case Study on Bahir Dar Town, Ethiopia)

Zinabu Getahun Sisay
Bahir Dar University, Institute of Land Administration, Department of Land Administration and Surveying, Bahir Dar, Ethiopia
Email: gz2003@yahoo.com or Newgz2012@gmail.com

Abstract
This study used in-situ Global Positioning System (GPS) data to validate the accuracy of horizontal coordinates and orientation of linear features of orthophoto and line map for Bahir Dar city. GPS data is processed using GAMIT/GLOBK and Lieca GeoOfice (LGO) in a least square sense with a tie to local and regional GPS reference stations to predict horizontal coordinates at five checkpoints to assess the accuracy of orthophoto. Real-Time-Kinematic GPS measurement technique is used to collect the coordinates of road centerline to test the accuracy associated with the orientation of the photogrammetric line map. The accuracy of horizontal

coordinates of the checkpoints derived from orthophoto was evaluated by comparing it with the corresponding coordinates measured directly from in-situ GPS data. The orthophoto is in a good agreement with GPS data observed at five checkpoints with a root mean square error of 12.45 cm in x- and 13.97 cm in y-coordinates – the GPS coordinates were determined using GAMIT/GLOBK with the root mean square error ranging from 0.61 cm to 1.06cm. On the other hand, the horizontal accuracy of orthophoto is determined at 6.06 cm with 95% confidence level. Whereas, the horizontal coordinates of the orthophoto are in agreement with in-situ GPS coordinates at an accuracy of 16.71 cm and 18.98 cm in x and y-directions respectively, when the GPS data are processed using LGO with a tie to local GPS reference station. The finding of the result illustrates that the horizontal accuracy of orthophoto is determined at 11.07 cm with 95% confidence level, while the GPS data is processed with a tie to local GPS network. Similarly, the study showed that linear feature extracted from orthophoto is in a good fit with in-situ GPS data as acquired along the road centerline. The GPS coordinates of the road centerline deviates from the corresponding coordinates of line map by a mean value of 9.18cm in x-direction and -14.96cm in y-direction. Therefore, it can be concluded that, the accuracy of the orthophoto and line map is within the national standard of error budget (~ 25cm).

Keywords: orthophoto, line map, GPS data, horizontal accuracy, orientation accuracy

LAND USE LAND COVER AND ECOSYSTEM (LULC)

LULC001: Application of GIS and Remote Sensing Techniques in Analysis of Land Use and Land Cover Changes Threats to River Njoro Ecosystem: Njoro, Nakuru County

Moses Kamau Thiong'o
Email:

Abstract

Land use is the purpose for which land and water, either socially or economically is managed. The changes in land use have been risking the river ecosystem across Kenya and many places of the world. The changes in the land use have seen a great figure of the forest being converted and thus leading to the loss of tree coverage. This has been resulted by the increasing number of human population thus destabilizing the environment. Land uses include; recreational e.g. parks, agricultural like the farmlands, residential (housing), commercial (business and factories). According to Malaso and Onywere (2013), agriculture remains to be the most depended form of sustaining the population whereby about 80% of total population depends on this agricultural sector economy. In Kenya, around 75% of population live in the rural areas where they practise agriculture. A classic example is in the Njoro watershed where massive agricultural farms and grenhouses have come up than there was before. The buffer zone of the entire profile of River Njoro has experienced massive conversion into other land uses like agricultural farms. Greenhouses have been set up and thus leads to over extraction of water and discharge of effluents into the river. This polluted water flows down the catchment to Lake Nakuru. Studies have shown that the polluted water has been contibuting to the change in the water chemistry of the Lake thus resulting to unfavourable conditions for the growth of blue green Algae. This situation leads to too diluted water and the flamingoes and other birds of the Lake which are dependent on the Algae experiences a problem and may migrate away from this areas. Agricultural land use, as

it is evident from time series imagery indicates to have been growing over time and this happens near or not far from the riparian area of the River Njoro ecosystem. This has led to several challenges being imposed on to the waters of River Njoro/Ndarugo. Some of this challenges include loading of polution from non point and point sources, pesticides and agro chemicals usage. This all are brought about by the Pollution loading from point and non-point sources, use of agro chemicals and pesticides.

Keywords: Agriculture, Watershed, Riparian zone

LULC002: Assessing Spatio-Temporal Land-Cover Changes in Gatumba Mining Area in Rwanda

Jean Pierre Bizimana[1] Gilbert Nduwayezu[2] and Celse Gabineza[3]
[1] University of Rwanda College of Science and Technology, School of Science Department of Geography and Centre for Geographic Information Systems and Remote Sensing.
[2] University of Rwanda College of Science and Technology, School of Engineering, Department of Civil , Environment and Geomatic Engineering.
[3] Rwanda Natural Resource Authority, Geology and Mines Department.

Abstract

In areas where extensive underground and opencast mining is continuously being carried out, land cover change assessment is of paramount importance. In Gatumba Region of Western of Rwanda, mining activities are still inadequately developed and the surrounding environment suffers from the artisanal and small scale mining practices. Soil erosion, barren waste rock dumps, and polluted rivers reflect the lack of proper environmental protection measures. This study aims therefore to spatially and temporally analyse the land use and land cover changes induced by mining activities in Gatumba mining landscape. Landsat images were used to generate the land

use and the land cover maps for the periods of 1999, 2008 and 2015 by using maximum likelihood pixel-based classification method. A questionnaire survey was also administrated to investigate the driving forces of mining activities and the associated environmental impacts. Over the period of 16 years, the mining areas has increased progressively from 2.85 Km2 to 5.55 Km2 representing 3.95% of the total land coverage. There was also an increase in bare soil and built up by the proportion of 0.63% and 45.43% respectively. In contrast, vegetation and forest realized a loss of 2.62% and 47.38% respectively. Mining activities are widespread in central and southern part of Gatumba region. The use of spades and picks for minerals extraction result in soil erosion, river pollution, crop damages and forest degradation. Despite the local awareness of the environment degradation, the level of compliance with existing regulations and policies is still very low. Therefore, policies enforcement and more guidance are needed to restore the degraded environment while developing professionalism mining in Gatumba mining site.

Keywords: Mining, spatio-temporal assessment, land use/land cover, Gatumba

LULC003: Beyond Biodiversity - Using Geoinformation to Drive Conservation and Development Decision Making.

Steve Peedell, Lucy Bastin and Bastian Bertzky
European Commission Joint Research Centre
Christine Mentzel - International Union for Conservation of Nature

Abstract

The BIOPAMA (Biodiversity and Protected Areas Management) project has been created precisely to address the problem of providing a solid knowledge base to support decision making on conservation and the

interaction and integrationof wildlife and protected areas management withdevelopment and livelihoods. Far from being a pure biodiversity project, BIOPAMA integrates information on planning, ecosystem services, infrastructure, natural resources, management and governance, much of which is geospatial. BIOPAMA uses state-of-the-art online geoinformation technology (http://rris.biopama.org), deployed in regional observatories covering the 79 countries of the African, Caribbean, Pacific (ACP) group of states. In Africa, these observatories are often linked to the Regional Economic Communities, in order to mainstream conservation decisions into the wider development context, rather than remaining solely within the ecological and biodiversity domain. We will explain our approach to the technical challenges, as well as providing some solutions to the broader issues of presenting technical geoscientific data to a policy audience.

LULC004: Delimitation and Zoning of the Comoros National Parks (Marine and Terrestrial)

Nair Aboubacar[1], Moumadjadi Inrfane[2], Houssoyni Housseni[3] and Ben Anthoy Moussa[4]

[1] National GIS expert for the Comoros National Parks, aboubacarnair@gmail.com

[2] Assistant cartographer at the GIS department ministry of environment,moumadjadi90@gmail.com

[3] Conservator of Anjouan island national parks, h.houssoyni@yahoo.fr

[4] Watershed expert at the Moheli national Park,benanthoy@yahoo.fr

Abstract

Comoros is located the East African coast and the northwest coast of Madagascar at the northern entrance to the Mozambique Channel.

The country has a single Protected Area, the Mohéli National Park dating back to 2001. The latter is of major importance not only locally but also

internationally. Hence the importance of establishing five new Protected Areas (Ngazidja 3 APs and Anjouan 2) by the end of 2017 that will meet the needs of the populations and deal with environmental problems. Our work will be based on the importance of these PAs, the management as well as the means used to achieve the improvement of the living standards of the rural populations while preserving the natural resources.

Keywords: GIS, Cartography, Geo Spatial, Delimitation, Zoning, Protected Areas, Conservation of Endemic Species and Agro forestry, Sustainable Development and Gender

LULC005: Estimation of Tree Distribution and Canopy Heights in Ifakara, Tanzania Using Unmanned Aerial System (UAS) Stereo Imagery

*Ian Asige Mweresa[1], [2], *, Patroba Achola Odera[2], [3] and David Ndegwa Kuria[4], [5]*
[1] Regional Centre for Mapping of Resources for Development, Kenya
[2] Department of Geomatic Engineering and Geospatial Information Systems, JKUAT, Kenya
[3] University of Cape Town, Cape Town, South Africa
[4] National Lands Commission, Kenya
[5] Dedan Kimathi University of Technology, Nyeri, Kenya
*Corresponding author: ianasige@gmail.com: Telephone +254728736720

Abstract

Tree height estimation is fundamental in forestry inventory especially in the estimation of biomass. Traditional methods for tree height estimation do not provide for convenience of taking such measurements due to cost implications in terms of time, manpower and resources involved. Multiple return LiDAR capabilities offer convenient solutions for height estimations though at equally increased costs. This study seeks to provide an assessment

of the accuracy of UAS stereo imagery in establishing tree distribution and canopy heights in open forests as an inexpensive alternative. To achieve this, this study seeks to: generate accurate 3 dimensional surface and bare earth models from UAS data and using these products, establish tree distribution and estimate canopy heights using data filters; and validate these accuracies using ground methods. A Sirius UAV fitted with a 16 MP camera and flying at an average height of 371m AGL was used to image approximately 2km2 capturing 380 images per flight. An image overlap of up to 85% was sufficient for stereo generation at a GSD of 10cm for a flight period of 40 minutes. The stereo imagery captured were processed into orthomosaics and photogrammetric point clouds with an average point density of 23 points per square meters. Point cloud segmentation revealed tree distribution patterns in the Ifakara area, with the Near Infrared band proving useful in filtering out trees from non-vegetated areas. From the tree height estimations and with validation information from 46 trees from 2 sample plots yielded r2=0.7622. The study highlights a simplified and cost-effective approach for generation of accurate 3D models from stereo UAS data. With a survey grade GPS/IMU/INS for direct-on-board georeferencing, limited controls were required which reduces the cost of the project. With the ease of varying the size of imagery overlap and flying height, imagery with improved radiometry can be obtained hence improving the determination of tree distribution, and with multi-view image matching algorithms processing of UAS imagery is made accurate and inexpensive.

Keywords: UAS, Drones, DEM, DSM, Canopy Height Model

LULC006: Evaluating the Red Edge Channel for Improving C3 (Festuca SPP.) and Other Co-Occurring C3/C4 Grass Species Discrimination Based on High Resolution Multi Spectral Satellite Image Data

Charles Otunga[1], Onisimo Mutanga[2], John Odindi[3] and Clement Adjorlolo[4]
[1] University of KwaZulu-Natal, School of Agricultural, Earth & Environmental Sciences, Discipline of Geography, P/Bag X01, Scottsville, Pietermaritzburg, 3209, South Africa.E-mail: charlesotunga95@gmail.com
[2] University of KwaZulu-Natal, School of Agricultural, Earth & Environmental Sciences, Discipline of Geography, P/Bag X01, Scottsville, Pietermaritzburg, 3209, South Africa. E-mail: mutangao@ukzn.ac.za
[3] University of KwaZulu-Natal, School of Agricultural, Earth & Environmental Sciences, Discipline of Geography, P/Bag X01, Scottsville, Pietermaritzburg, 3209, South Africa. E-mail:odindi@ukzn.ac.za
[4] South African National Space Agency (SANSA) - Earth Observation, Enterprise Building, Mark Shuttleworth Street, Innovation Hub, PO Box 484, Silverton, 01,Pretoria 0087, South Africa. E-mail:cadjorlolo@sansa.org.za

Abstract

The incorporation of a Red Edge channel in multi-spectral satellite sensors is critical for improving vegetation discrimination, given that the related electromagnetic spectrum is specifically sensitive to the chlorophyll content in different vegetation species. Rapid Eye satellite is one of the readily available and/or affordable multi-spectral satellite sensor systems that provides a Red Edge band channel. The aim of this study was therefore to evaluate the potential of the Rapid Eye Red Edge band, for improving C3/C4 grass species discrimination in Fort Nottingham commonage rangeland, by comparing the results obtained from two discrimination processes. Discriminant analysis (DA) and maximum likelihood classification (MLC) algorithms were utilized using different sets of spectral feature analysis. This was achieved by including and excluding the Red Edge band information

in the analysis. Results show that, the integration of information from the Red Edge band improved discrimination accuracy of C3 (Festuca spp.) from other coexisting C3/C4 grass species distribution. For instance, when all the 5 bands of Rapid Eye satellite image were used in the analysis, the overall discrimination accuracy improved by 12.2%, when all the 5 bands of Rapid Eye imagery were utilized, as opposed to when the Red Edge channel was excluded in the discrimination process. Consequently, the normalized difference Red Edge index (NDVI-RE) produced a higher accuracy result compared to the classic normalized difference vegetation index (NDVI). The results have shown that, the readily available and/or affordable high resolution multispectral satellite data, such as the Rapid Eye image among others, can potentially improve mapping accuracies of C3/C4 grass species, hence offer detailed information critical for sustainable rangeland management in sub-Saharan Africa, where there is an impediment to data availability.

Key words: Rapid Eye sensor, C3 Festuca grass species, vegetation mapping, Red Edge channel, rangeland management.

LULC007: Exploring The Utility of Auto-Sklearn and Remotely Sensed Sentinel-2 Image Data for Mapping Parthenium Weed in a Heterogeneous Landscape

Serge Kiala[1], Onisimo Mutanga[2] and John Odindi[3]

[1.] Serge Kiala1, School of Agricultural, Earth and Environmental Sciences, University of KwaZulu-Natal, Pietermaritzburg, South Africa, serkial1@yahoo.fr

[2.] Onisimo Mutanga, School of Agricultural, Earth and Environmental Sciences, University of KwaZulu-Natal, Pietermaritzburg, South Africa, MutangaO@ukzn.ac.za

[3.] John Odindi, School of Agricultural, Earth and Environmental Sciences, University of KwaZulu-Natal, Pietermaritzburg, South Africa, Odindi@ukzn.ac.za

Abstract

The Parthenium weed (Parthenium hyterophorus) is known to adversely affect, among others, animal and human health, agricultural production, rural livelihoods, local and national economies and the environment. Its fast proliferation and resilience requires consistent and regular monitoring. Recently, new generation multi and hyperspectral sensors, in concert with robust statistical algorithms such as random forest and support vector machine have been used to generate invasive species maps with reliable accuracy. However, factors such as site conditions and underlying data characteristics determine the choice of an algorithm. Consequently, it is often challenging to determine the most optimal algorithm for a given dataset, as the process often involves tedious comparative analysis from a range of existing algorithms. In this study, we introduced the use of auto-sklearn, an automated system that jointly selects and tunes machine learning algorithms for classification or regression in mapping Parthenium infestation. Using Sentinel-2 image data, a novel spatial multispectral scanner, we compare our approach to the best performing and optimized algorithm identified from 15 classifiers determined using ten folds cross-validation (CV). Results show that auto-sklearn can be used to automatically identify the most robust algorithm, with similar performance as those selected manually. These findings are valuable to the remote sensing community as they significantly shorten the often laborious and time consuming process of identifying an optimal classification algorithm.

Keywords: Perthenium, Sentinel-2, auto-sklearn, Machine Learning, Classification

LULC008: GIS and Remote Sensing Based Assessment of Land Use-Land Cover Changes in The Coastal City of Lagos Nigeria

Temitope EzekielI DOWU and Rose Malot WASWA***

**Department of Civil/Environmental Engineering*
Pan African University-Institute for Basic Sciences, Technology & Innovation, Kenya.
lois.temitope@gmail.com
***Remote Sensing Department*
Regional Centre for Mapping of Resources for Development(RCMRD), Nairobi, Kenya.
rwaswa@rcmrd.org

Abstract

Coastal cities the world over have experienced dynamic changes in the past few decades. Lagos Nigeria, a fast rising mega city, characterised by a low-lying coastal strip, swamps, wetlands and lagoon is a typical case as there has been a substantial change in the dynamics of land use land cover in recent decades. This study, therefore, assessed the land use land cover changes from1986 to 2016 over the period of 30 years in intervals of 15 years. Landsat images for years1986 and 2001were obtained as well as 2016 sentinel2A images. ENVI software package was used for atmosphere correction, haze detection, layer stacking and classification. A pixel-based supervised classification was used to obtain the LULC maps. ArcGIS software was used for assessing the LULC changes and obtaining the statistics across the satellite images representing the epochs understudy. It was observed that the percentage coverage of built-up areas increased in leaps (9.52%, 19.0%, and 31.2%) while a loss of 60 to 75% wetland coverage was observed over the 30-year period. Generally, these changes were observed to be mainly due to rapid urbanisation, extensive deforestation and land reclamation activities within the state. This trend poses threats to sustainable development vis-à-vis ecosystem services, health, and livelihoods of the populace as well as disaster

management(flooding). It is therefore recommended that a more inclusive and holistic management be adopted for managing the rapid urbanization, deforestation, wetlands losses and other land use changes in the state.

Keywords: Land use-land cover, Land reclamation, Coastal areas, Lagos, Lagos lagoon, GIS, Remote sensing, Wetlands, ENVI, ArcGIS

LULC009: GIS Application on Socio-Economic Effect of Road Infrastructure Development and Sustainable Development (Case of Nairobi Bypasses)

S.Mwenda[1], F.Orina[2] and T.Gacoki[3]
Kenya National Highways Authority
[1] s.mwenda@kenha.co.ke
[2] f.orina@kenha.co.ke
[3] t.gacoki@kenha.co.ke

Abstract

Road infrastructure is one of the key components of sustainable development. UN Sustainable Development Goal advocates for building resilient infrastructure which provides the basic physical systems and structures essential to the operation of a society, promote inclusive and sustainable industrialization and foster innovation as the driver for economic growth, creation of job opportunities and reduction of poverty. Kenya's vision 2030 economic pillar, infrastructure sector aims to develop and maintain an integrated safe and efficient transport network. Kenya has a road network of about 177,800 km. Kenya National Highways Authority (KeNHA) is a state corporation, established under the Kenya Roads Act 2007 with the responsibility for the management, development, rehabilitation and maintenance of Class A, B and S road national trunk roads. The study analyses how the Nairobi bypasses road network has influenced the spatial patterns

and structure of urban development. The integration of remote sensing and Geographical Information System (GIS) and Remote Sensing was used in monitoring land use/cover changes of the spatial and temporal dynamics of the growth. The impact of transport infrastructure on land use change is necessary for evaluating the role of transportation development in the process of urban land use and land cover change. The expansion of the built-up areas assumed linear growth along the bypasses. The urban expansion has been accompanied by loss of forests and urban sprawl. Integration of demographic and socio-economic data with land use/cover change revealed that economic growth and proximity to the bypasses are the major factors promoting urban expansion.

Keywords:GIS, Remote Sensing, Infrastructure, Roads, KeNHA

LULC010: Land Use and Land Cover Data Changes in Indian Ocean Islands (Case Study Of Unguja in Zanzibar Island)

Sizah Mwalusepo[1],[2], Eliud Muli1,[3],Elfatih M.Abdel-Rahman[1],[4],Tobias Landmann[1], Asha Fakih[5]and Suresh Raina[1]*

[1]ICIPE-African Insect Science for Food and Health, P.O. Box 30772, Nairobi, Kenya

[2]Department of General Studies, Dares Salaam Institute of Technology, Dar es Salaam, Tanzania

[3]South Eastern Kenya University, P.O. Box170-90200, Kitui, Kenya

[4]Department of Agronomy, Faculty of Agriculture, University of Khartoum, Khartoum North 13314, Sudan

[5]Agricultural Sector Development Programme, P.O.Box 159, Zanzibar

Corresponding author:mwalusepo@yahoo.com/smwalusepo@icipe.org

Abstract

Land use and land coverchanges will continue to affect resilient human

communities and ecosystems as a result of climate change. However, an assessment of land use and land cover changes over time in Indian Ocean Islands is less documented. The land use/cover data changes over 10 years at smaller geographical scale across Unguja Island in Zanzibar were analyzed. Down scaling of the data was obtained from SERVIR through partnership with Kenya-based Regional Centre for Mapping of Resources for Development (RCMRD) database (http://www.servirglobal.net), and clipped down in ArcMap (Version 10.1) to Unguja Island. SERVIR and RCMRD Land Cover Dataset are mainly 30 meter maltispectral images include LandsatTM and ETM+Multispectral Images. Landscape ecology Statistics tool (LecoS) was used to analyse the land use and land cover changes. The data provide information on the status of the land use and land cover changes along the Unguja Island in Zanzibar. The data is of great significance to the future research on global change.

Keywords: Landscape ecology, Land use/cover, Geographical Information Systems tool, Unguja Island

LULC011: Savanna Vegetation Structure Mapping Using Synthetic Aperture Radar And Terrestrial Laser Scanning in Kruger National Park, South Africa

Odipo, V.O.1[1], Berger, C.[2] and Schmullius, C.[2]
[1]victor.onyango@uni-jena.de, christian.berger@uni-jena.de, c.schmullius@uni-jena.de
[2]Department of Earth Observation, Friedrich-Schiller-University Jena, Grietgasse 6, 07743 Jena, Germany

Abstract

Carbon storage by trees is directly correlated to vegetation structure variables such as tree biomass, woody cover and canopy cover (CC). Biomass, both

below- and aboveground, is very important in understanding current and future changes in the global climate system. Conventionally, destruction of trees and correlating dry weights with forest mensuration of trunk diameter (DBH) and tree height, have been used in developing allometric models for biomass estimation at both individual tree and biome levels, a tedious and costly process prone to systematic errors. Terrestrial laser scanner (TLS), with its 3-D capability is able to capture vegetation data at sub-meter resolution, making it easier to derive individual tree height, diameter, and canopy cover among other tree components. However, the TLS scans are restricted to few meters from scan positions thereby prompting use of other remote sensing data for area-wide extrapolation of these tree attributes. Tropical regions suffer high cloud cover, atmospheric interferences and erratic weather patterns, and in savannas, the heterogeneous nature of life forms (grass-shrub-trees) and accompanied near-similar spectral characteristics render the use of optical remote sensing data challenge in vegetation monitoring. Studies aimed at savanna ecosystem monitoring has shown relationship between Synthetic Aperture Radar (SAR) at all wavelengths (C-, L-band among others) with vegetation structure components like canopy cover, tree height, DBH and aboveground woody biomass (AGB), due to its penetrative and all-weather operation ability. The foregoing study attempts to use TLS-derived tree height, diameter and canopy cover in supplementing field inventory data in assessing the potential of C- and L- band SAR datasets in both aboveground biomass (AGB) and CC estimation within a savanna ecosystem in Kruger National Park, South Africa. Field inventory was carried out in March 2015 (dry season) and was followed with TLS field campaign in September 2013 (wet season). Trees in 42 plots, each measuring 30 m by 30 m were inventoried and allometric equation used in tree and plot-level biomass estimation. Regression models were developed between ALOS PALSAR L-band and multi-temporal Sentinel-1A C-band SAR variables (backscatter intensity, multi-temporal statistics, resolution, SAR filters) and both AGB and CC, with both showing relationships. Error (both RMSE and residual) and uncertainty analysis in AGB and CC prediction are assessed based on SAR polarization and seasons of data acquisition.

Keywords: SAR backscatter, savanna ecosystem, TLS, aboveground biomass, canopy cover, L-band, C-band.

LULC012: Urbanization in Lilongwe (A Spatial Metrics Analysis)

Kondwani Godwin Munthali
University of Malawi, Chancellor College, Zomba, Malawi
Email: kmunthali@cc.ac.mw

Abstract

The built-up urban landscape of Lilongwe was assessed by examining the landuse/cover change patterns. The built-up area grew from 5.08km^2 in 1990 to 34.73km^2 in 2013 and projected to increase to 41.24km^2 by 2020 and 53.08km^2 by 2030. The results further indicate that traditional high density areas and squatters contributed a combined land use/cover change of 21, 18 and 16% in 1990 to 1999, 1999 to 2011 and 2011 to 2013 respectively.

The spatial patterns of the built-up area were analysed using: percentage of landscape (PLAND) whose values increased from 0.55 to 5.79% between 1990 and 2013; patch density (PD); mean ENN (Euclidean nearest-neighbour) distance that decreased from 239.89m in 1990 to 177.72m in 2013; CIRCLE that decreased between 1990 and 2013 signifying a radial/circular pattern; and SHAPE. In 1990, PD was 0.43, increasing to 1.66 in 2013. The decrease in mean ENN is due to growth of the old patches (increasing PLAND) and rise of new patches in between the old patches (increasing PD values). The SHAPE metric fluctuated around 1.23 between 1990 and 2013 indi-cating a stable low level complexity. The results for the predicted patches in 2020 and 2030 would be more aggregated (increasing PLAND and decreasing PD). However, the increase in mean ENN indicates that average distance would increase between the newly formed bigger aggregated patches and the newly formed smaller patches. The increase in CIRCLE and SHAPE indicates more connected, elongated

and complex patches respectively as the built-up land outgrows the four designated growth centres and begin to follow road infrastructure. Analysed along the gradient of distance from the city centre, PLAND decreases as distance increases, indicating that the proportion of built-up near the city centre is higher. The trend is the same for PD except when the distances reach 25km indicating that there were more patches of built-up land near and in areas farther from the city centre. The patches are more dispersed around the middle distances as indicated by the mean ENN that increase up to 15km and then begins to decrease. The results show a stable trend of CIRCLE and SHAPE. The former indicates that the patches elongate in farther distances. The latter indicates that complexity was uniform across the distances. The PLAND of the predicted 2020 and 2030 patches would also be higher closer to the city centre. The PD would decrease by 2020 and 2030, but would still be relatively higher in the nearer and farther distances. The mean ENN is predicted to increase up to 15km and then begin to decrease. The CIRCLE would also increase by 2020 and 2030, and stabilise across the distances. The SHAPE metric would also increase by 2020 and 2030, but decrease as distance increases. The built-up area for Lilongwe is less fragmented concentrating in two (Old Town and Capital Hill) of its four growth centres. The growth pattern of the built-up land indicates a radial pattern around Old Town, Capital Hill, and Kanengo with a stable low level of complexity evidenced by more regular patches. While, the amount of urbanization occurring in the informal settlements is reducing over the years, the numbers are still significant to be ignored (16-21%).

Keywords: urbanization, land use/cover change, spatial metrics, spatial modelling, Lilongwe

LULC013: Use of Geospatial Technology to Map The Distribution of Vervet Monkeys in Urban Areas (Case Study of Nairibi County)

Rhoda R. Chai1, Dorcas Yole, Gordon Wayumba and Samson Ayugi
Technical University of Kenya
Email: rhodachai@gmail.com

Abstract

Vervet monkeys (Cercopithecus pygerythrus) are present and found within most parts of the city of Nairobi. They are among the most popular primate species used in biomedical research. Though not endangered, their spatial distribution has not been well documented, including issues like human-vervet interactions and conflicts, crop/house raids etc. There is also evidence that vervet monkeys harbor, and are able to transmit zoonotic disease to humans. With the potential risk of these serious zoonotic diseases like Marburg, Tuberculosis, Leishmaniasis etc. it is for this reason that monitoring their distribution, documenting the type of human–vervet interaction is important for public health. The main objective of this study is to map the distribution of Vervet monkeys in Nairobi County by employing the use of Geospatial technology, with specific objective of determining the Vervet distribution in Nairobi County. It also seeks to determine the interaction of vervet monkeys and human habitat in Nairobi County. A geospatial database will also be developed on the distribution of the vervet monkeys to aid in identifying their distribution. The methods to be employed include use of handheld GPS and GPS collars on the vervets to collect data on their location. Different troops in different areas have been identified and the matriarchs captured and fitted with GPS collars to monitor their movements. Satellite images are being employed to determine land use/land cover in the area of interest and understand the effect of urban landscape on the distribution and movements of these non-human primates. Technologies such Geographical Information System (GIS) are also increasingly being used in epidemiological and ecological studies.

Interviews and questionnaires are also be employed to meet the objectives of the study. The research aims to potentially benefit different sectors including; Public health officers who will monitor the human-vervet interaction in case of zoonotic diseases outbreaks, Conservationists will also monitor and control their population, Biologists/scientists will have a database on their location and can capture them for biomedical research. There is lack of sufficient knowledge on the movement of the primates and their interaction with human habitat especially in urban areas.

Keywords: Vervet monkeys, spatial distribution, Human- Non-human Interaction, Ecology, Urban areas

LULC014: Use of GIS in Assessing the Appropriateness of an Existing Dumpsite and The Suitability of Future Landfill Sites for Nairobi

Justin Kimani
Department of Environmental Sciences
Pwani University
Email: j.kimani@pu.ac.ke

Abstract

According to the Nairobi County Annual Development Plan 2017/2018, the City generates approximately 2,400 tons of solid waste per day. Numerous waste minimization strategies have been put in place, which have not been successful in reducing the amount that needs to be disposed of at a landfill site. This results in mounting pressure on the existing dumpsite thus necessitating the need for a new landfill. The construction of a landfill has significant impacts on the environment, which are directly related to the physical location of the project. Siting a landfill is one example of a spatial problem where set out guidelines can be expressed spatially in order to achieve the objective. This paper presents results of a spatial analysis of

suitable sites using guidelines borrowed from the Department of Water Affairs and Forestry, South Africa. The environmental criteria and GIS were used to evaluate the suitability of the existing and future sites for locating a landfill for Nairobi County. The research findings indicate that Nairobi does not have a suitable site for locating a landfill. In addition, the findings demonstrate that GIS is an efficient tool that can be implemented in landfill site studies that expedite decision making.

Keywords: Landfill, Criteria, Suitability, GIS, Nairobi

LULC015: Mapping Land Use and Land Cover Change and its Influence on Soil Erosion in The Upper Ruvu Watershed, Tanzania

Winfred Mbungu
Department of Engineering Sciences and Technology, Sokoine University of Agriculture, P. O Box 3003, CHUO KIKUU, Morogoro, Tanzania.
Email: winfried@suanet.ac.tz/winfred@vt.edu

Abstract

Soil erosion by water is a pressing environmental problem affecting the sustainability of many landscapes in Tanzania and around the world. Landscapes in the Uluguru Mountains in Tanzania are increasingly being affected by growing anthropogenic pressure leading to forest conversions into cropland and grazing areas. A significant surge of the cropland indicates deforestation, mainly due to the expansion of the rain-fed agriculture which has been a continuing trend in the watershed. Land use/land cover (LULC) change and its impacts on soil erosion were investigated in the Upper Ruvu Watershed over a 25 year period (1991 through 2015) using Landsat imagery and remote sensing techniques. Eight land use/land cover classes were identified and generated at three different time periods (1991, 2000,

and 2015). LULC classification was done using Random Forests (RFs) algorithm and satisfactory classification accuracy with kappa coefficients of 92%, 89% and 92% was obtained for the 1991, 2000 and 2015 data, respectively. Results show a decrease of natural forests by 77%, woodlands by 44% and wetland by 50%, and an increase of croplands by 111%, shrubland by 39% and grasslands between 1991 and 2015. The Revised Universal Soil Loss Equation (RUSLE) model was used to estimate the influence of the changing land uses on soil erosion. Mean soil losses of up to 34 t/ha/year were estimated in the uplands compared to mean soils of 2 t/ha/year in the lowlands. Higher soil erosion was estimated in the uplands which are characterized by steep slopes and higher rainfall, compared to the lowlands and foothills. Higher soil losses were estimated in cropland with a mean average of 28.4 t/ha/year in 2015 from just 19.8 t/ha/year in 1991 and negligible in natural forests. Average annual soil losses for the entire watershed were estimated to be 5.4, 7.5 and 14 t/ha/year for 1991, 2000 and 2015 respectively, showing increasing soil erosion with continued land use change. About 13% of the watershed was estimated to be in the high to severe erosion risk. Soil erosion rates were higher in sub-watersheds located in the uplands with soils losses ranging from 26 to 47 t/ha/year. These results help to quantify the extent and impact of soil erosion in the watershed, and identify areas contributing to sedimentation in the river and those areas at greater risk for land degradation.

Keywords: Land use, Land cover change, remote sensing, soil erosion, RUSLE, Landsat, Random Forest

LULC016: Evaluation of Supervised Classifiers for Forest Resource and Land Cover Mapping Based on Combination of Sar and Optical Remote Sensing Data

Dorothea Deus
Department of Geospatial Sciences and Technology, School of Earth Sciences, Real Estate, Business Studies and Informatics (SERBI), Ardhi University, P. O. Box 35176, Dar es Salaam, Tanzania.
E-mail: doroth@aru.ac.tz

Abstract

The research examines the performance of machine learning classifiers support vector machine (SVM), neural network (NN), Random Forest (RF) against maximum likelihood (ML) (traditional supervised classifier) in forest resources and land cover categorization, based on combination of ALOS PALSAR and Landsat TM data, in Northern Tanzania. Various data categories based on Landsat TM surface reflectance, ALOS PALSAR backscattering and their derivatives were generated for various classification scenarios. Then a separate and joint processing of Landsat and ALOS PALSAR data were executed using SVM, NN, RF and ML classifiers. The overall classification accuracy (OA) and kappa coefficient (KC) were computed. A two sample t-statistics was utilized to evaluate the performance of the classifiers using different data categories. The result indicates that machine learning classifiers are robust and accurate compared to ML classifier. The study suggests that machine learning algorithms should be applied for forest resource and land cover mapping and change detection studies in support of sustainable forest resource conservation and management. Keywords: Supervised classifier, Landsat, ALOS PALSAR, support vector machine, maximum likelihood, neural network, random forest, forest, land cover classification

LULC017: Land Degradation Assessment in IGAD Region Using Earth Observation Data

Eunice W. Mwangi, et. al
Regional Centre for Mapping of Resources for Development, Nairobi, Kenya

Abstract

Land degradation is a threat to food security and sustainable development in IGAD region. Demands on the land for economic development and pressures from a burgeoning population are leading to unprecedented land use change. In turn, unsustainable land use is driving land degradation. The result is a loss of land productivity with impacts on livelihoods and the economy. Unsustainable human activities that take place in already fragile areas and that are aggravated by natural disturbance such as drought or flooding lead to land degradation and thereafter desertification. Land degradation assessment using satellite data was conducted in the IGAD region comprising of Kenya, Uganda, South Sudan, Sudan, Ethiopia, Djibouti, Eritrea, Somalia, Rwanda and Burundi. The methodology behind land degradation assessment was based on RUSLE Model. The rationale was to consider soil erosion type of land degradation driven by runoff. The main parameters used in the land degradation model include: vegetation cover and condition, rainfall erosivity, soil erodibility, slope factor and population density. Earth observation satellite data used include: ESA Globcover, Proba V NDVI, FewsNet RFE, HWSD, SRTM DEM, World Pop and FAO Gridded livestock data respectively. Spatial model was created to combine by way of weighted overlay techniques all the five parameters. Weights were applied on each variable based on ranked influence in land degradation. Open spatial data was used derived mainly from Eumetcast, NASA broadcasting channels and other earth observation data provider internet sources. Land degradation index maps and bulletins were the main products, developed at regional and national levels. Wet and dry agronomic season of each country was considered in preparation of the biannual land

degradation products. The land degradation index maps show extent and severity levels of land degradation, the maps are represented using a scale of very low to very high degradation. Land degradation bulletins give a brief narrative of land degradation in relation to current socio economic challenges in the region. Statistical charts and graphs are used to extent of land degradation and change over time. The socio-economic comparative assessment considered climate change, food security, water resource management etc. Land degradation products user community cuts across policy makers, researchers, academic institutions, civil societies amongst others. The products are disseminated through MESA IGAD geoportal to reach a wider audience. To enhance sustainability capacity building through training of relevant government departments was done.

Land degradation assessment was implemented as a service under MESA project, whose objective was to enhance use of earth observation data for improved decision making on sustainable natural resource management. The products generated have been shared with various relevant government agencies in IGAD region to enable them make evidence based decisions related to national and regional ecosystem planning. The products have also supported policy review and harmonization in the IGAD region.

Key Words: Land degradation, RUSLE, Earth Observation

LULC018 : A Model For Invasive Alien Plant Species in Kenya's Northern Rangelands

Author: Edward Ouko
Email: Eouko@rcmrd.org

Abstract:

Invasive species in African savannas pose great threat to the native biodiversity and changes ecosystem functioning. In the forest sector, for instance Acacia species are important sources of fuel-wood, yet at the same time

they have increased strain on water resources and shrunken forage spaces for both livestock and wildlife. In recently infested regions, invasive species can progress through the stages of introduction, establishment and dispersal to a full range. Currently there is much worldwide interest in predicting distributions of invasive species, and several organizations are faced with questions of whether and how to tackle such environmental challenges, or how to interpret predictions from the science community. Conservation practioners require mapped estimates of where species could persist in a given region, and this is associated to information about the biotope – i.e. the geographic location of the species' niche. The process of collecting species distribution data for identifying the potential distribution of the invasive species in the invaded ranges has become a challenge both in terms of resource and time allocation. This study highlights innovative approaches in crowdsourcing validation data in mapping and modelling invasive species (Acacia reficiens and Cactus) through involvement of the local communities. The general approach was to model the distribution of A. reficiens and Cactus (OpuntiaSpp) using occurrence records from native range, then project the model into new regions to assess susceptibility to invasion using climatic and topographic environmental variables. The models performed better than random prediction ($P < 0.05$). The average testing omission rate varied from 11.3% to 14% for the two species. The average test AUC values for Acacia reficiens (0.97 ± 0.01) and Cactus (OpuntiaSpp) (0.96 ± 0.02) were high showing the fitted models had high discriminative ability to differentiate suitable environments for invasive plant species from random background points. Precipitation of the driest month & vegetation indices were most important variables. Results from Kappa tests revealed generally good model (s) performance, with all the two species achieving Kappa scores > 0.75.

LULC019: Enabling Annual Land Cover Mapping Across East Africa

Phoebe Oduour[1], Edward Ouko[1], Sean P. Healey[2], Warren B. Cohen[2], Yang Zhiqiang[3], Sylvia Wilson[4], Noel Gorelick[5]

[1]- RCMRD
[2]- US Forest Service
[3]- Oregon State University
[4]- US Geological Survey
[5]- Google Corporation

Storage of atmospheric carbon is an important terrestrial ecosystem service because it mitigates the effects of anthropogenic greenhouse gas emissions. International reporting of this service places a premium on the specificity and precision of monitoring data used to estimate carbon storage or emission. An inventory of land cover change is a critical component of most national-level accounting systems, and the Landsat series of satellites is a uniquely positioned to provide this land cover change "activity data." Such maps are also useful in food security and water demand assessments. In Eastern Africa, there are already high-quality Landsat-based cover maps for 2 or 3 points in time. However, these maps do not provide the annual land cover change information needed for many applications, and land cover changes inferred from independent maps at different dates cannot easily be assigned a level of uncertainty. We are developing innovative, annually produced land cover maps to meet needs of national partners within the East Africa region. Several different change detection algorithms will be run in parallel on the full series of archived Landsat images since 2000, and locally developed reference data will be used to calibrate a model that optimally integrates the output maps from each separate algorithm. This strategy was developed under an inter-agency, national change mapping project in the United States: the Landscape Change Monitoring System (LCMS). LCMS pilot research strongly suggests the value of integrating an ensemble of different approaches to map cover change. Cloud computing has only recently made

this data- and processing-intensive approach feasible, and the fact that images no longer have to be downloaded and stored locally circumvents traditional access barriers in bandwidth-limited locations. Our methods are globally scalable, and moving forward, they have the potential to support land cover change monitoring across multiple sectors and geographies.

WATER RESOURCES AND HYDRO-CLIMATIC DISASTERS (WRD).

WRD001: An Assessment of the Impacts of Weather and Climate Patterns on Water Resources

Bertha Othoche
Pwani University, Kenya
Email: b.othoche@pu.ac.ke

Abstract

The changing weather and climate conditions have impacted on water resources in the coastal region of Kenya. Rivers and streams have turned into seasonal channels and some have dried out completely leaving behind sand and gravel during the dry season. Water pans have also dried out and borehole water volume reduced. On the other hand bridges have been swept away or damaged during the wet season and water quality compromised hence adversely interfering with socio-economic activities. Water scarcity and quality issues are therefore pertinent issues in the coastal region of Kenya during the dry season, while at the same during the wet season, floods are experienced. Both drought and floods are associated with the water resources in the region hence there is need to create a balance to store water during the wet season to alleviate suffering during the dry season. The specific study

area is Bahari Division in the coastal region of Kenya. This study is set to establish the location of existing water resources in the study area with the aim of exposing the impacts of weather variability on their utilization. The objectives of the study include establishing the trend in weather and climate patterns in the region; establishing existing water resources and their current utilization; and to explore ways to enhance their utilization during dry and wet seasons. The study uses a triangulation of research designs to include survey and practical components that includes observation and geotagging of the relevant sources of water. This will be done using geospatial tools, especially Global Positioning System, (GPS) to establish the location of sources of water and impacts on the environment as weather and climate continue to be unpredictable. Ten Key Informants from the relevant line ministries will be interviewed using interview guides while questionnaires will be used to interview 50 local community households to establish facts on the ground. The data generated will be analyzed using both descriptive and referential statistics and presented accordingly. The study is expected to identify the water resources, their level of utilization, impacts and possible strategies. The findings will be shared with various stakeholders and policy implications at both local and national level highlighted

Keywords: Weather, Climate change, Geospatial Technology, Geotagging, Adaptation

WRD002: Assessing Bias in Satellite Rainfall Products and Their Impact in Water Balance Closure at the Zambezi Headwaters

Omondi, C.K[1],, Rientjes T.H.M[2],*, Maathuis B.H.P[3],* and Gumindoga W.[4],**

[1] c.k.omondi@utwente.nl

[2] t.h.m.rientjes@utwente.nl

[3] b.h.p.maathuis@utwente.nl

[4] w.gumindoga@utwente.nl

** Faculty of Geo-Information Science and Earth Observation, University of*

Twente
Presenting author: Omondi, C.K.

Abstract

The study aims at assessing the performance of three satellite rainfall estimates (i.e. CMORPH, CHIRPS and TMPA) for streamflow simulation at the Zambezi headwaters. Comparisons are carried out at 0.05, daily time-step, over dry and wet seasons, and 6 rain rate classes for the period 2008-2012. Detection indices (e.g. Probability of detection, Frequent alarm ratio and Critical success index) and frequency based statistics (e.g. RMSE, bias estimates and correlation coefficients) are computed and documented. The CHIRPS product was less skillful in detecting very light (< 2.5 mm/day) and very heavy rainfall (> 20 mm/day). The product exhibited reduced rainfall occurrence detection capability of 20% during the dry season but had however the least false alarm ratio (Frequent alarm ratio < 0.1 for dry period). Investigations reveal that better rainfall detections are achieved during wet than dry seasons (for example, 60-88% of rainfall occurrence could be detected during wet seasons compared to 16-88% during dry seasons. Falsely detected rainfall occurrence of up to 0.83 reported by TMPA were during the wet seasons). TMPA outperformed the other products by detecting up to 88% of rainfall occurrence during wet season while CMORPH exhibited the best critical success index between 0.69 and 0.8. The three products were found to underestimate rainfall depths (CMORPH bias: 1.56 mmd-1 and TMPA bias: 0.05 mmd-1). TMPA exhibited a closer agreement with gauge observation (standard deviation range 0.14 and 3.44 mm d-1). The study further corrected prevailing systematic errors in the products by adopting linear based (Spatio-temporal) and additive (Distribution Transformation) bias correction schemes. Results show that out of 5 selected bias correction schemes, distribution transformation was the most effective showing highest CC > 0.7, least standard deviation of 0.52 mm d-1 and daily accumulated error of 5.24-10.42 mm. Time-variable-space-variable scheme exhibited the lowest daily bias < 0.09 mm whereas Time-fixed-space-variable scheme was effective for correcting mean rainfall, respectively. The Topographic

driven rainfall-runoff model (TOPMODEL) is selected to illustrate how errors in the satellite rainfall products impact water balance closure. A clear improvement in water balance closure error (1.7%) was shown on using space-time variant bias corrected satellite rainfall estimates.

Keywords: Satellite rainfall estimates; Bias correction; TOPMODEL; Streamflow simulation, Zambezi Basin

WRD003: Assessing Gullies Development on Hilly Urban Areas Using Cadastral Maintenance Data and Erosion Modeling (A Case Study of Mpazi River Catchment in Kigali City)

Erick Ndahigwa[1] and Jean Pierre Bizimana[2]
[1]Ministry of Natural Resources; Rwanda Land Management and Use Authority, GIS Unit; Nyarugenge Pension Plaza, KN 3 Rd, Kigali, Rwanda.
[2]University of Rwanda; College of Science and Technology, Department of Geography; and Centre for Geographic Information System and Remote Sensing, Huye Campus, Rwanda.

Abstract

Due to the lack of load sediments monitoring systems, erosion model calibration becomes a problem in Rwanda. Referring to the reports of parcels boundaries corrections from Rwanda Land Management and Use Authority, there are quite consistent losses of land due to gullies development in Mpazi River catchment. The present study analyzed the riving factors of gullies development in hilly urban area of Mpazi River catchment through cadastral maintenance data and erosion modeling. The orthophoto of 2008 for Systematic Land Registration coupled with ancillary data were first used to delineate the shifts of parcel boundaries from 2012 to 2016. Hydrological modeling based Digital Elevation Model was also applied to investigate geo-physical characteristics and potential gullies. The high resolution GPS, tablet; Zeno field 2015 series was used to locate potential

gully polyline features that were then uploaded into ArcGIS10.3 software. The gullies intersecting with rectified parcels boundary were measured with tape meter to get the gully width. The gully length was measured using hydrological modelling tools and GPS coordinates captured during the field reconnaissance. The results showed that parcels intersecting with gully system were severely eroded. Gully system expanded from 7.5 to 20 meters and neighboring parcels had a shift of 3 to 12.5 meters depending on time of occurrence for each boundary change. Complementally to the results of soil modeling, this study reveals that between 100 and 150 tons per hectare and per year was the highest rate of soil loss in the study area. This has a policy implication to review the current land and environment policies and laws so that gully system can be classified and assigned appropriate buffers for ecologically sustainable management of hilly urban landscapes of Kigali City. More periodic data are required to feed the model and validating this approach bring the government institutions' responsibility to consider the need of training data for further soil erosion modeling in hilly and rapidly urbanizing areas of Rwanda.

Keywords:Cadastral Maintenance Data, Erosion Modeling, Gully, Urban Areas

WRD004: Estimation of Evapotranspiration for Crop Water Requirement Using Satellite Imagery

R.O. Gawala1 and O.S. Aboyeji2
1 Remote Sensing and GIS Consultant
E-mail: mercelromlus@gmail.com
2 HOD, RECTAS (Regional Center for Training in Aerospace Science, Obafemi Awolowo University, Nigeria).
E-mail: olatunjiaboyeji@yahoo.com

Abstract

Accurate estimation of the amount of water lost from a farm has been made

possible by the advent of space scince and technology using satellite data. This is important since effective design of an irrigation system requires requsite knowledge of water budget, that is, the amount of water lost from the farm through evapotranspiration and the amount needed to replenish the lost water. Evapotranspiration forms an integral part of the hydrologic cycle. Irrigation should supplement rainfed agriculture for Africa to sustainably feed her ever rising population. Little work has been done in Kenya to find the actual rate of evapotranspiration in agricultural farms. Therefore, the aim of this paper is to try to estimate the amount of evapotranspiration from crops for water resources mabnagement for irrigation.

The methodology involves downloading the Kenyan administrative shapefile and Sentinel data that is freely available online through Copernicus Program of European Space Agency. The satellite image is subjected to pre-processing operations using various software. Atmospheric correction is done using ERDAS Imagine to remove impurities such as water vapour, clouds, dust particles, or otherwise reffered to as noise. The image is then projected to World Geodetic survey of 1984, WGS-1984, under universal transverse Mercator of 36N (UTM 36N). The satellite image and shapefile are then clipped and a colour composite is created using ArcGIS. Interpolation is done using the dockable Arctoolbox. The spectral bands are achieved using ArcGIS composite bands tool. Supervised classification is conducted with Maximum Likelihood as the preferred algorithm. The Normalized Difference Vegetative Index (NDVI) is then evaluated. It serves as an input to fraction of vegetative cover. Reference evapotranspiration is computed from the point meteorological weather stations. The results obtained indicated that NDVI value was -0.9 minimum and +0.9 maximum. The average being 0.154. fraction of vegetative cover was 35.2% while the reference evaporation ranged from 1.2 to 4.3mm/month. Actual evapotranspiration was obtained from the product of reference evapotranspiration and fraction of vegetative cover and the value was 3.1mm/month. FAOCLim2 contains several input variables from meteorological data such as solar radiation, daily minimum and maximum air temperature, relative humidity, wind speed etc. FAO's ETo Calculator is used to compute the average meteorological parameters.

The weekly/monthly/yearly evapotranspiration is calculated from at least ten Automated Weather Data Network (AWDN) stations within and surrounding of the study area. This was achieved using the Geographic Information Systems software (GIS) CALLED ArcGIS. The values obtained here will be of great help to irrigation designers.

Keywords: Satellite, Remote Sensing, GIS, Irrigarion, Food Security, Evapotransporation, Water Budget

WRD005: GIS and Remote Sensing Based Assessment of Water Quality Changes in Lake Malawi

Charles Chisha Kapachika
Malawi Polytechnic,
Deparatment of Geomatics
Email: ckapachika@poly.ac.mw

Abstract

Lake Malawi is one of the world's greatest fresh water lakes in the world. It is ranked number five of the world's fresh water lakes based on its volume estimated to be 7775.00 km3. The lake has a biodiversity of up to 1000 aquatic species. Not only does the lake provide habitat to the aquatic life, it also provides economic as well as recreational services to the Malawian society. There has been growing concerns that the water quality in Lake Malawi is declining. These declines have been in both the absolute values of the water quality parameters as well as the extents of the changes. These water quality declines have been attributed to anthropogenic activities on the lake's catchment. These activities are in the form of agriculture and settlements. This paper assesses the changes in water quality, both absolute values and the coverage of the changes are used. The changes in the water

quality parameters is determined by image differencing. The significance of these changes are established using Anova with a single factor. It is observed that there is significance in changes of water quality. When an attempt was made to determine whether there were seasonal variations, the results suggested that the variations were insignificant. Such a conclusion was based on the comparison of the P value and the alpha value. An attempt is also made to assess changes in land cover. Land cover changes are indicative of human activities on the catchment. It is observed that there is an increase in human activities which are in the form of settlements and agriculture. The increase in these activities has led to the depletion of forest resources on the catchment. This is explained by the correlation coefficients on the outputs of the correlation analysis between the various land covers. A relationship between the changes in water quality and the changes in land cover is also established. However, there were weak relationships between absolute water quality parameter values and land cover changes except for forest resources versus Secchi Disk Transparency. The results suggested that reduction in forest resources leads to a decline in water clarity. Stronger relationships were established when coverages of declining water quality were used against the land cover changes in the correlation analysis. The results suggested that human activities have played an upper hand in the depletion of forest resources on the catchment and has resulted in the decline in water quality in the lake.

Keywords:Secchi Disk Transparency, Suspended sediments, Chlorophyl, land cover change, Lake Malawi

WRD006: Mapping Soil Moisture Content Using Senstinel-1 and Sentinel-2 (Case Studies from Kenya)

Degelo Sendabo[1], Felix Greifeneder[3], Erick Khamala[2], Degelo Sendabo[3], Marc Zebisch[2], Hussein Farah[1] and Claudia Notarnicola[2]
[1] Regional Centre for Mapping of Resources for Development (RCMRD),

Nairobi, Kenya
[2] Eurac Research, Bolzano, Italy
[3] LocateIT Ltd, Nairobi, Kenya
Corresponding author: degelo@rcmrd.org

Abstract

Soil moisture content (SMC) is an important element in the global cycles of water, energy, and carbon and an indicator for natural hazards such as drought, floods and land-slides. In Africa, up to date reliable SMC data that adequately responds to national and sub-national level applications is often lacking. This study, therefore, leverages the synergy between in-situ and Earth Observation techniques to derive SMC at sub-national level in five counties in Kenya. These counties, namely Elgeyo Marakwet, Kajiado, Machakos, Narok, and Uasin Gishu have crop and livestock production as their dominant sources of livelihoods, with drought increasingly becoming a major threat. Satellite remote sensing is one possibility for production of quick, direct, spatially continuous measurements of SMC. The new Copernicus family of Sentinel satellites affords us the aforementioned in levels of detail that adequately serve local to national purposes. The active Synthetic Aperture Radar (SAR) instrument aboard Sentinel-1 (S1) provides backscattering intensities that are directly related to the water content within the top soil layer. However, these measurements are influenced strongly by other surface parameter like roughness, vegetation, and topography. One of the important advantages of an active radar system is that these measurements are available independent of the Sun's illumination, clouds, and other atmospheric conditions. Sentinel-2 (S2), with its optical sensor, delivers detailed information on current surface conditions like land-use/land-cover and vegetation status. To exploit the information gathered from these two satellites in a complementary way, we introduced a data driven machine learning approach based on Support Vector Regression (SVR). During the training phase, known combinations of S1 backscatter, S2 reflectance, and in-situ measured SMC (using time-domain reflectometry or TDR probes) were used to construct an empirical model that subsequently estimated

SMC. Quantitatively, the estimated SMC showed a high correlation with the collected reference data (R=0.7, RMSE=4%).

Keywords: Sentinel, SAR, Soil Moisture, TDR, QGIS

WRD007: Sedimentation Dynamics of Mudi Dam Using an Unmanned Aerial Vehicle

Robert S.B.G. Suya[1] and Charles C. Kapachika[2]
[1] Robert S.B.G. Suya, Researcher in Geomatics Measurements Techniques, rsuya@poly.ac.mw
[2] Charles C. Kapachika, Lecturer in Geomatics, ckapachika@poly.ac.mw

Abstract

Mudi Dam is on Mudi River at latitude 15°47'29.00"S and longitude 35° 2'28.50"E in Blantyre City. The dam was completed in 1953 with a quest to supply water to the combined town of Blantyre-Limbe. The dam supplied water to the then Municipal boundary for 10 years. Then demand for water increased and necessitated the construction of Walker's Ferry on the banks of Shire River in 1963 to match the demand. Mudi dam has a perimeter of approximately 3450 meters and a design capacity of 45,000 cubic meters.
The study was executed during the rainy season in 2016 and was extended to 2017 purposefully to determine the existing depth of the reservoir; to estimate the volume of the sediments for the epochs; and compute the rate of sedimentation. The existing depth of the dam was determined from photos captured at predetermined flight plans by Unmanned Aerial Vehicle (Parrot Bepop Drone Version 1, UAV). The photos were processed in Visual Structure from Motion (VisualFSM) application (Volume 5.26) and MeshLab (Volume 1.3.3) where a 3D model was created for the bottom of the dam. Leica GPS 1200 unit was employed to pick the coordinates (Easting, Northing, Elevation) in pre-marked positions around the dam.

Then, the 3D model was geo-referenced using the GPS coordinates to deduce the elevations for the bottom of the dam at grid intervals. Preliminary analysis was also conducted in order to eliminate points that were beyond the extents of the study area. This was the case as to have a uniform coverage for the epochs that capitalised on the established control network. Point clouds for the epochs generated in Visual SFM were imported in CloudCompare (Version 2.6.3) to trace the changes in sedimentation. In CloudCompare package, Cloud - to - Cloud method was used to compare the point clouds of which the distances between the pixel values were the basis for estimating the quantity of sediments. Another epoch of Parrot Bepop Drone observations will be obtained by the end of March, 2017 using the same methodology. Then, the results obtained from the previous two epochs will be compared to the third measurements (epoch). The rate of sedimentation of the dam will be estimated from 1953 to 2017 (about 64 years) by the existing depth and the number of years. The year the dam will be completely silted up will be determined from the ratio of the percentage of the depth of accumulated silt to the depth of the water from its surface (to the top of silt level). The overall results will be obtained to determine the final existing depth of Mudi dam; to estimate the volume of the sediments; to compute the rate of sedimentation using the state of the art technology.

Keywords:Sedimentation, Mudi Dam, Unmanned Arial Vehicle, 3D Model, Top of Silt Level

WRD008: Synthetic Aperture Radar For Vegetation and Soil Moisture Monitoring in Masai Mara

*David Ongo[1], [2] *, Rogier Van der Velde1 and Zoltan Verkedy[1]*
[1]University of Twente (ITC), The Netherlands
[2]LocateIT Ltd
**Corresponding authoremail-address: davieongo@yahoo.com; Telephone No: +254 726 613 962*

Abstract

The Mara River Basin (MRB) is an important catchment both in Kenya and Tanzania. The Mau forest and Masai Mara wildlife reserve are important ecosystems located within MRB. This study is part of the larger Mau-Mara-Serengeti (MaMaSe) sustainable water initiative aimed at improving water safety and security in MRB. The main objective of this research is to evaluate the effects of vegetation on SAR backscatter using dual polarized RADARSAT-2 (RS2) Synthetic Aperture Radar (SAR) C-band over Masai Mara, between May 2011 and August 2012. This is to investigate the feasibility of using Sentinel-1 (S1) SAR C-band for vegetation and soil moisture monitoring over the MRB. As part of long term soil moisture monitoring, a description of the installation of near real time soil moisture monitoring stations, Kenya Mara Station (KMST) is given. KMST01 was destroyed and the instruments recovered from the field site. Dual polarized RS2 VV+VH and MODIS NDVI were used to study temporal and spatial variability of RS2 backscatter. There was a positive correlation of RS2 and MODIS NDVI in cropland and savannah. Cropland showed the highest coefficient of determination (R2) of 0.58 with VH polarization for the whole study period. Permanent vegetation showed insignificant relationship. Depolarization ratio (VV-VH) of RS2 was derived and it showed a positive relationship with MODIS NDVI, this agreement showed that the ratio can be used in vegetation monitoring. The standardized backscatter anomalies (anomaly maps) were derived both for RS2 and un-calibrated S1 data. The anomaly maps showed the variation of soil moisture. In-situ measurements derived from (KMST) was compared to S1 anomaly maps, the comparison showed agreement between the datasets. A visual comparison of RS2 and S1 anomaly maps showed similar pattern, thus showing potential of using S1 to carry out a similar study.

Keywords: Sentinel-1, SAR, Depolarization ratio, standardized anomaly

WRD009: Vulnerability of Groundwater to Pollution (Locating Pollution Hot Spots in The Lake Nakuru Drainage Basin)

Simon M. Onywere
Kenyatta University, Kenya
Email: Onywere.simon@ku.ac.ke

Abstract

The East Rift System in Kenya is formed by near N-S elongate and distinctly recognizable block structures detached from the main bounding faults; Elgeyo Detachment; Aberdare/Sattima Detachment and Nguruman Detachment. The faulted central basin of Nakuru-Elmenteita-Naivasha basin sits in the Aberdare/Sattima Detachment. Lake Nakuru area, the focus of this study lies in a graben between Lion Hill fracture zone and a series of step fault scarps leading to the Mau Escarpment. The lake is elongate in the N-S direction and dammed to the north by Menengai caldera. It is a shallow soda lake, rich in algae, the source of food for millions of flamingos that are an attraction to tourists visiting the country. The recharge to the lake is mainly by rainfall and increments from the surface runoff from Enjoro, Makalia, Larmudiac and Enderit rivers that drain the Mau. Sustainability of the hydrology of the Lake Nakuru Drainage Basin as an ecosystem and as a source of ground water supply to the community has over the years raised concern due to: land use, settlement trends, urbanization, land degradation and waste management and their impact; and lake and community vulnerability to impacts from surface and groundwater pollution. Because of the porous nature of the pumice and ash formations in the catchment area and the presence of fault fractured zones the surface runoff sinks into the ground before reaching the main streams or the lake itself. The poorly consolidated soils are largely exposed leading to increased surface runoff and soil erosion. In a sampling survey for water quality analysis of 22 boreholes, 2 springs and 10 raw surface water from the area. Most of the water samples showed measured values much higher than the standard for drinking water. Two borehole samples from Kwa-Rhoda; one directly on the bath of a fault

line passing through Kyoto Waste Dumpsite and the other one kilometre away and on the upthrow side of the fault showed: pH - Value 8.75 and 7.12 (6.0-8.5), Conductivity - 3420.0 and 1528.0 µs/cm (300), Pb - 0.711 and 0.192 mg/L (0.05), Cl - 667.0 and 87.0 mg/L (250), F - 14.0 and 9.8mg/L (2) respectively against the standard. The results show highly contaminated water especially for that sourced from within the fault line and which is a source of human health concerns. Pollution levels in Lake Nakuru from urban and industrial waste discharge are impacting on the Lake and its biodiversity. The problem was further compounded by the recent rift valley lake level rise that saw the lake Increasing its flood area from a low area of 31.8 Km^2 in January 2010 to a high of 54.67 Km^2 in Sept 2013, an increase of 22.87 Km^2 (71.92% by area) as evidenced from time series Landsat ETM and Aster image analysis. The flooding and submergence compromised the environmental integrity of the lake and its resources.

Keywords:Block detachment, hydrology, degradation, water quality, time series, lake level rise

WRD010: Monitoring Lake Victoria Water Quality from Space (Opportunities for Strengthening Trans-boundary Information Sharing for Effective Resource Management)

James Wanjohi - RCMRD

Abstract

Lake Victoria (LV) is an important freshwater resource in East Africa, covering 68,800 km2, and a catchment that spans 193,000km2. It is an important source of food, energy, drinking and irrigation water, transport and a repository for agricultural, human and industrial wastes generated from its catchment. For such a lake, and a catchment transcending 5 international boundaries, collecting data to guide informed decision making is a hard task.

Remote sensing is currently the only tool capable of providing information on environmental changes at high spatio-temporal scales. To address the problem of information availability for LV, we tackled two objectives; (1) we analyzed water quality parameters retrieved from MODIS data, and (2) assessed land cover changes in the catchment area using Landsat data. We used L1A MODIS-Aqua data to retrieve lake surface temperature (LST), total suspended matter (TSM), chlorophyll-a (CHLa) and diffuse attenuation coefficient (KD490) in four temporal periods i.e. daily, weekly, monthly and seasonal scales. An Empirical Orthogonal Function (EOF) analysis was done on monthly data. An analysis of land cover change was done using Landsat data for 3 epochs in order to assess if land degradation contributes to water quality changes. Our results indicate that MODIS-Aqua data provides synoptic views of water quality changes in LV at different temporal scales. The Winam Gulf in Kenya, the shores of Jinja town in Uganda, as well as the Mwanza region in Tanzania represent water quality hotspots due to their relatively high TSM and CHLa concentrations. High levels of KD490 in these areas would also indicate high turbidity and thus low light penetration due to the presence of suspended matter, algal blooms, and/or submerged vegetation. The EOF analysis underscores the areas where LST and water color variability are more significant. The changes can be associated with corresponding land use changes in the catchment, where for instance wetlands are converted to croplands. On-going dissemination of our findings together with capacity building efforts with the three main fishery and research institutions working in the lake, will enable informed decision making for the water management of LV. Enhanced capacity in trans-boundary water resources research is critical for successful decision making

WRD011: Regional Stream-Flow Monitoring and Forecasting

Author: Faith Mitheu
Email fmitheu@rcmrd.org

Identification of development problems in this region carried out by RCMRD/ SERVIR E&SA team have brought out the issue of water scarcity as a key problem. Most specifically, in Tanzania, the problem of water shortages have been reported from major river basins like Pangani, Wami-Ruvu and Rufiji among others. The problem of water scarcity is majorly associated with the climate issues like rainfall variability and rising temperatures which in turn leads to receding water levels in reservoirs and rivers and in the long term may result to drought. The problem of water scarcity is majorly felt and critical in basins that have many competing users for water which eventually may result to conflicts. Rufiji River Basin for example has recently unveiled their Integrated Water Resources Management and Development (IWRMD) plan which spells out some of the key issues resulting to water scarcity as the lack of reliable water resources data to support evidence-based water resources planning, development and management and increased vulnerability of communities in parts of Rufiji Basin to drought due to climatic factors and weak water resources monitoring networks. Institutions mandated to monitor water resources use and conservation, and provide information on rainfall and water availability to the society, do not have the capacity and skills to leverage the capability of geospatial information and tools to inform on these issues, hence the institutions always rely on the in-situ monitoring networks for decision making. The weak water resources monitoring networks and scarcity of reliable water resources data in some of these areas also contributes to in-efficient water management practices. The specific problem is the lack of required skills to use geospatial tools and products by stakeholders to estimate water quantities at resolutions useful to decision-making and to complement the already existing in-situ tools. The main objective of the service is to equip the key stakeholders with the skills and capacity to use geospatial data, products and tools developed in

addressing issues on water scarcity which could range from putting up water conservation measures within the affected basins among others.

The service proposes to replicate the methodology on Multimodel, Multiproduct Streamflow Forecast (MMSF) framework developed under SERVIR through a collaboration efforts of US researchers from the University of Arizona and the RCMRD team. The methodology makes use of multiple hydrological models with multiple satellite derived precipitation and other climatic data to simulate stream- flow products in different temporal scales. The products will inform on the availability of water at different time scales at the specific monitoring points(specific river gauging stations) which in turn can help inform on extreme events especially on low-flows, floods and hence institutions mandated with water management issues can put in place the required management measures to curb the negative effects of the extreme cases. The methods have been applied and set up for 3 basins in Africa, Mara in Kenya, Tekeze in Ethiopia and Upper Zambezi in Namibia and will be replicated and piloted for the Great Ruaha River (GRR) basin in Tanzania. The main users of the service in Tanzania cuts across different categories from government to research institutions with the main user being the Ministry of water and irrigation. Other key users include Basin Water office, Tanzania Electricity Supply Company (TANESCO), University of Dar-es Salaam, Zonal Irrigation office among others.

WEATHER AND CLIMATE (WC)

WC001: Determining Extreme Heat Vulnerability of Harare Metropolitan City Using Multispectral Remote Sensing and Socio-Economic Data

Terence Mushore[1], Onisimo Mutanga[2], John Odindi[3] and Timothy Dube[4]

[1] Terence Mushore, School of Agricultural, Earth and Environmental Sciences, University of KwaZulu-Natal, Pietermaritzburg, South Africa, tdmushore@gmail.com

[2] Onisimo Mutanga, School of Agricultural, Earth and Environmental Sciences, University of KwaZulu-Natal, Pietermaritzburg, South Africa, MutangaO@ukzn.ac.za

[3] John Odindi, School of Agricultural, Earth and Environmental Sciences, University of KwaZulu-Natal, Pietermaritzburg, South Africa, Odindi@ukzn.ac.za

[4]. Department of Geography & Environmental Studies, University of Limpopo, Sovenga, South Africa,timothydube3@gmail.com

Abstract

Urbanization alters surface landscape characteristics through conversion of natural landscapes to impervious surfaces. Such changes alter the thermal properties of urban landscape mosaics, increasing the urban heat island intensity and the population's vulnerability to heat-related stress. This study aimed at deriving detailed area-specific spatial information on the distribution of heat vulnerability in Harare city, Zimbabwe, valuable for informed urban thermal mitigation, planning and decision-making. Using Landsat-8-derived bio-physical surface properties and socio-demographic factors, findings show that vulnerability to heat-related distress was high in over 40 percent of the city, mainly in densely built-up areas with low-income groups. Comparatively, low to moderate heat vulnerability was observed in the high-income northern suburbs with low physical exposure and population density. Results also showed a strong spatial correlation (α =

0.61) between heat vulnerability and observed surface temperatures in the hot season, signifying that land surface temperature is a good indicator of heat vulnerability in the area. Furthermore, the study showed that indices derived from moderate-resolution Landsat 8 data improve thermal risk assessment in areas of close proximity. These findings demonstrate the value of readily available multispectral data-sets in determining areas vulnerable to temperature extremes within a heterogeneous urban landscape. The findings are particularly valuable for designing heat-mitigation strategies as well as identifying highly vulnerable areas during heat waves.

Keywords: Land surface temperature, vegetation indices, heat island, vulnerability, heat stress

WC002: Participatory Hazard Mapping Risk Assessment and Analysis in Six Sub Counties of Kenya

Degelo Sendabo, Siro Abdallah, Pauline Ogala and Rose Waswa
RCMRD
Corresponding author: degelo@rcmrd.org

Abstract

Hazards occur in different parts of the world in different ways. In some areas only one type occurs frequently whereas in other cases many, simultaneously. As they are exposed to, communities living in those areas have much better knowledge than anyone to explain where and how hazards occur and affect their livelihood. They have good traditional or oral mapping talent. The issue is using their talents for the inentification of hazard prone areas and making them digital database. The study is conducted in six counties of Kenya namely, Turkana, Tana River and Garissa, Baringo Kilifi and Kwale. The reason to conduct the study in these counties was due to the frequent occurrence of different types of hazards. The study includes vulnerability, floods, climate change, animal disease, human disease and conflict, land

degradation, land sliding, lightening, earth quakes and the likes. Different methods and techniques are applied to analyse the hazard condition. The community participation on identification of the hazards and mapping process was among many. Mapping of the hazard prone areas was done in a participatory approach. Further, the community had ranked the most affecting hazards in sub community level. Then the outputs were converted to the GIS format. Finds have become a tool for planning and decision making to combat hazards in such a way that can impact the livelihood of the community. In addition, stakeholders were able to analyse on the extent of hazard from the maps, models and approaches. Finally the output is presented in Atlas form in a simple way that anyone can use for different applications

Keywords:Community, Participatory, Hazard, Mitigation, Mapping

WC003: Seasonal Variability of Herbagebiomass Resources for Grazers in Karamoja Sub Region

Buyinza Ambrose[1] and Shuaib Lwasa[2]
Makerere University Dept. Of Geography,
ambrosebuyinza@gmail.com
shuaiblwasa@gmail.com
Corresponding author: Buyinza Ambrose

Abstract

Livestock in Karamoja, defines the socio-cultural facets, and is the main financial capital that defines wealth, status, and resilience to climate variability shocks. However herbage resources for livestock are becoming a major issue of concern to many scholars due to seasonal variations. Efforts have been tried out to quantify Pastures in this area before, although pasture resources are very delicate especially under variable climatic changes. Surprisingly no

efforts have been undertaken to determine the ecological carrying capacity of the grazing landscapes in Karamoja and less has been done to predict the impact of seasonal variations on herbage production and quantity given the rate at which the grazing areas are fading. Consequently it's upon these seasonal climatic variations in Karamoja region that bent curiosity to conduct a research on ecological carrying capacity of the rangelands for grazers (shoats and cows) and quantity herbage biomass in the area from 1987to 2016 across four traditional known seasons in the areas. The study is employing indirect methods of GIS and remote sensing to determine herbage quantity and ecological carrying capacity. The research materials consist of landsat7 thematic mapper satellite images of 1987, 2002,2005,2009,2014 and 2016. GPS points have been picked in the field to aid in the supervised image classification as training points. The final products of this research will be thematic maps and narratives showing the ecological carrying capacity of Karamoja rangelands across four traditional seasons. The larger implication of this research will be to advocate for pastoralism as way of life through local NGOs working in the area and also enhance decision making mechanisms in the pastoral communities of Karamoja region.

Keywords:Species composition, Herbage quantification, Ecological carrying capacity, seasonal variability and grazers

WC004: Participatory Hazard Mapping Risk Assessment and Analysis in Six Subcounties of Kenya.

Degelo Sendabo, Pauline Ogala, Rose Waswa (RCMRD)
degelo@rcmrd.org

Hazards occur in different parts of the world in different ways. In some areas only one type occurs frequently whereas in other cases many, simultaneously. As they are exposed to, communities living in those areas have much better

knowledge than anyone to explain where and how hazards occur and affect their livelihood. They have good traditional or oral mapping talent. The issue is using their talents for the inentification of hazard prone areas and making them digital database. The study is conducted in six counties of Kenya namely, Turkana, Tana River and Garissa, Baringo Kilifi and Kwale. The reason to conduct the study in these counties was due to the frequent occurrence of different types of hazards. The study includes vulnerability, floods, climate change, animal disease, human disease and conflict, land degradation, land sliding, lightening, earth quakes and the likes. Different methods and techniques are applied to analyse the hazard condition. The community participation on identification of the hazards and mapping process was among many. Mapping of the hazard prone areas was done in a participatory approach. Further, the community had ranked the most affecting hazards in sub community level. Then the outputs were converted to the GIS format. Finds have become a tool for planning and decision making to combat hazards in such a way that can impact the livelihood of the community. In addition, stakeholders were able to analyse on the extent of hazard from the maps, models and approaches. Finally the output is presented in Atlas form in a simple way that anyone can use for different applications

Key Words: Community, Participatory mapping, Hazard, Mitigation, Mapping

WC005: Climate Change Vulnerability Assessment in the Northern Rangelands

Grace J. Koech[1], Denis Macharia[1], Lilian Ndungu[1], Lawrence Okello[1], Anastasia Wahome[1] Robinson Mugo[1], John Bosco Kiema[1], Emmanuel Nkurunziza[1]

[1]RCMRD, SERVIR-Eastern & Southern Africa, P.O. Box 632 - 00618 Ruaraka, Nairobi, Kenya.

Climate change is considered the biggest environmental threat in human history. Climate change tends to magnify the frequency, size and distribution of the climate risk posing threats to the population. The Eastern African region is highly vulnerable to the impacts of climate change. Key sectors and drivers of the region's economy are at high risk of being adversely impacted by recurrent weather and climate extremes. Projected shifts and extremes in rainfall patterns and increasing temperatures will lead to adverse impacts on social, physical, ecological systems. In recent times Kenya has faced cyclic drought events that have occurred in the past years. Each of these drought events caused severe crop and livestock losses, famine and population displacement. Climate change introduces an additional uncertainty into existing vulnerabilities, particularly in the ASALs which cover over 80 per cent of the country. Increased temperatures and unpredictable rainy seasons in the northern parts of Kenya, have placed increased pressure on water resources, resulting in less dry season grazing lands, diminished livestock herds, and increased competition over grazing lands. In this regard SERVIR E&SA is working with the Northern Rangeland Trust to address these challenges through undertaking vulnerability assessments within these arid ecosystems. The overall goal is to work with Northern Rangelands Trust, regional partners (FEWSNET, and ICPAC) as well as with national partners (KMD and county governments) to map climate vulnerability in the northern rangelands; clearly understanding existing and future (projected) vulnerabilities and assist in the design of suitable climate change adaptation interventions for these rangelands. To determine vulnerability hotspots, a detailed vulnerability assessment methodology is adopted, based on the IPCC vulnerability components; Exposure, Sensitivity and Adaptive capacity. The vulnerability assessment model involves gathering and integrating geo-referenced socio-economic, biophysical data, and climate data to map vulnerability hotspots. The results from this assessments will inform rangeland managers and decision makers on better development decisions and improved climate change adaptation options based on information provided by the tools and products. SERVIR E&SA is working with a range of users in this service that include, Kenya

Meteorological Department (KMD),Laikipia Wildlife Fund ,FEWSNET, conservancy coordinators, and county governments.

WC006: Eastern and Southern Africa Fire Information System (Esafis) - Supporting Fire Response & Management.

Maungu Oware[a]), Wondimagegn T. Beshaha), James Mumina[a]), Robinson Mugo[a]), Hussein Farah[a]), Africa Flores[b]), Anastasia Wahome[a])

[a]) Regional Center for mapping of Resources for Development, Nairobi, Kenya
[b]) The SERVIR Coordination Office, NASA Marshall Space Flight Center, Huntsville, Alabama, USA

Abstract

Fire forms a crucial process in the healthy functioning of our ecosystems, yet fires threaten natural systems, infrastructure and most importantly life. Spatio-temporal awareness of fire likelihood, occurrence and behaviour forms a key to appropriate prevention, response and management.
The main objective of ESAFIS is to supports the services in charge of the protection of human life and property, forests and wildlife against fires in the RCMRD member states by providing an up-to-date and reliable information, and near real time alert on occurrences of wild fires in the Region. ESAFIS is to provide fire early warning system to fight forest fire through SMS and email and provide a user friendly interface that enable users visualize fire point, query historical data and subscribe for notifications. The methodology adopted utilizes the near real-time data acquired from real-time satellite (MODIS TERRA), processed through International Polar Orbiter Processing Package (IPOPP) technologies that provide the framework for real-time data processing capability maximizes the utility of earth science data for real-time applications and decision-making. All the data is stored in postgesSQL with PostGIS extension. The database

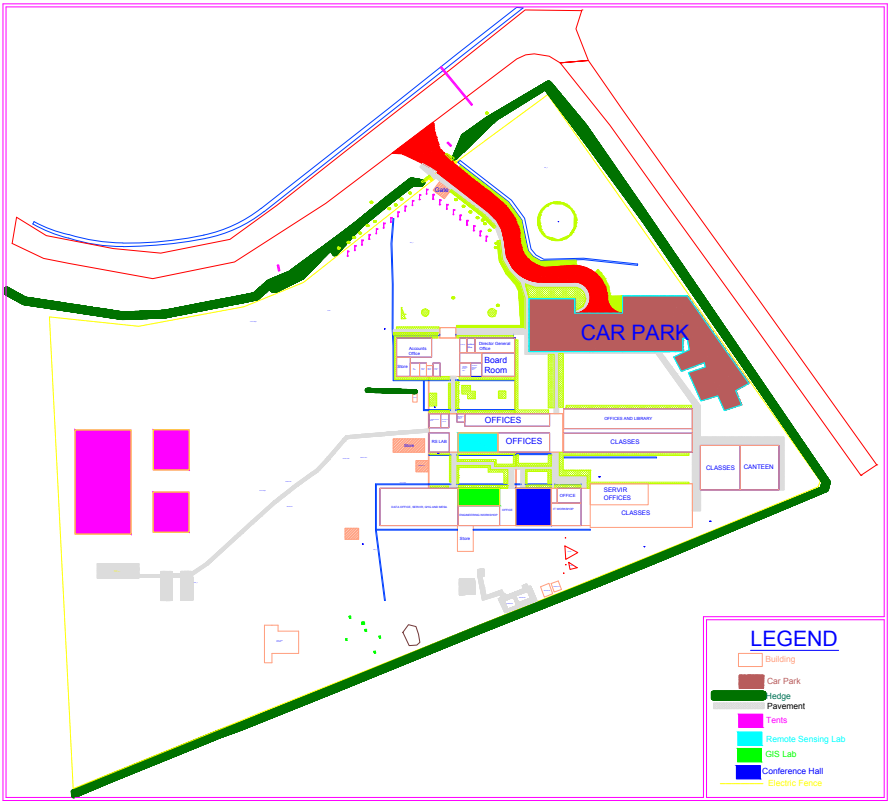
runs queries on newly added fire point to identify nearby conservation areas and town under 50 Km /31 Miles. ESAFIS then sends notification to subscribed users if their area they have subscribed for is affected by fire or near fire.

The ESAFIS provides an automated system that handles data entry, visualization and notifications of fire active areas. The system will improve fire early warning and response on forest fires and enhance fire disasters preparedness through fire prediction and trends analysis.

Key Words: Fire Information System, Forest fire, Near real-time, MODIS

End of Abstracts

EXHIBITION PLAN



GENERAL INFORMATION.

Nairobi is Kenya's capital city, situated at 1°17′S 36°49′E in South-Central Kenya, about 140 km^2 south of the Equator with an estimated population of 3.5 million people. It is surrounded by 113 km^2 of plains, cliffs and forest that make up the city's Nairobi National Park. The Park is home to the endangered black rhinos, giraffes, zebras and lions. Next to the Park is a highly-regarded elephant orphanage operated by the David Sheldrick Wildlife Trust. Nairobi is often used as a connection hub by people undertaking Safaris in various parts of Kenya and East Africa. It is adjacent to the eastern edge of the Rift Valley, and to the west of the city, are the Ngong Hills. The highest mount in Kenya, Mount Kenya is situated north of Nairobi, and Mount Kilimanjaro (the highest in Tanzania) is towards the south-east. The city is well served by international airlines, and also a regional road network linking it to other major East African urban centers. A new railway line now links Nairobi to Mombasa, Kenya's second largest city located on the shores of the Indian Ocean. Kisumu, located on the shores of Lake Victoria, and the third largest city in Kenya, is accessible by road and air from Nairobi.

WEATHER

Nairobi enjoys fairly good weather in September. The average temperature is 74°F (23°C), NE winds at 15 mph (24 km/h), and 53% humidity. Additional information on Nairobi, Kenya can be found at: http://www.nairobi.go.ke.

CURRENCY

The Kenyan currency is known as the Kenya Shilling (KES). Currently the United States dollar is exchanging at approximately one hundred and three Kenya Shillings (Kshs 103).

PERSONAL SECURITY & SAFETY

While the RCMRD Management and the Conference organizers have put in place adequate measures to ensure that all delegates are safe, you are

urged to exercise caution and avoid exposing yourself to unnecessary risks. The RCMRD Security Section requests all delegates to kindly cooperate and adhere to all security guidelines outlined by the institution. This will help the security staff to ensure the safety of your valuables, as well as your personal security. Please take a moment to familiarize yourself with the security guidelines outlined below:

At RCMRD premises

- Wear your Conference Badges visibly, and display it if requested to do so by an authorized person;
- Do not leave bags and parcels unattended; such will be confiscated or destroyed;
- Display the vehicle passes issued to you while entering the premises;
- Do not bring unauthorized persons and children into the Conference Venue;
- Safeguard your valuable property;
- Check your documents and items before you leave conference halls and meeting rooms;
- If you lose any valuable items within the premises, inform RCMRD Security Section and Service or inform the nearest Security Officer.

EMERGENCY NUMBERS

- Security Officer RCMRD Solomon Mumyao (24 hrs) +254-721575411
- Police Emergency Numbers (24 hrs) 911
- Kasarani Police Station - 0712 179 5637/0736350106
- Kenya Red Cross - 0789 859857
- Mr. Albert Mukabi, Head of Transport & Protocol – 0720803825/0717456006

RCMRD TO HOTEL MAP

Technical Diplomas &Certificates in Land surveying, ICT, Cartography and GIS, Photogrammetry and Remote Sensing,

RCMRD is an Inter-Governmental Organization with 20 Member States in the Eastern and Southern Africa region. Its mission is to promote sustainable development in the member states through the generation, application and dissemination of Geo-information and allied ICT products and services in Africa. We are offering the following Geo-Information programmes using modern technologies

COURSE	MINIMUM QUALIFICATION	NEW TECHNOLOGIES	CAREER OPPORTUNITIES
Diploma in **Land Surveying**	**C-** and **D+** in any two subjects (Maths, Physics/ PhysicalScience,English, Geography or Chemistry) **(two and half years)**	Learn using current and get separate certificates in **GIS, GPS, AutoCAD**; **Remote Sensing and civil 3D**)	Graduates can be employed in**:- Building** and **Construction** industry; **Physical planning**: **utility** and **resource mapping; Land adjudication; land surveying**; **Research; terrain analysis; military** and **security intelligence**; **forensic investigation**; **Agriculture; mining; web mapping** etc.
Diploma in **Cartography** and **GIS**			
Diploma. Photogrammetry Remote Sensing			
Certificate in **Land Surveying**	**D+** (**one** and**halve** years)		
Diploma in **IT**	**C-** (**two years)**	System development, administration and management	
Certificate in **IT**	**D+** (one year)		
ICDL – Digital Competency	KCSE duration **(3 months)**	IT Security	
GIS, AutoCAD or **civil 3D**	Relevant diploma or degree and IT knowledge		

We emphasize on student learning the Current Technology while building their Presentation and Communication Skills for today's challenges

Contact Julius 0722847649; jgichohi@rcmrd.org Kasarani OFF Thika super Highway Or 020 2680748/2680722 or 0723786161 or 0735981098

Attachment Guaranteed, Hostels Available, Day and Evening Classes Available.

MEMBER STATES:
Botswana, Burundi, Comoros, Ethiopia, Kenya, Lesotho Malawi, Mauritius, Namibia, Rwanda, Sychelles, Somali, South Africa, South Sudan, Swaziland, Tanzania, Uganda, Zambia & Zimbabwe

RCMRD

Regional Centre for Mapping of Resources for Development
Kasarani Road, Off Thika Road
P.O. Box 632-00618,
Ruaraka, Nairobi, Kenya
Tel: +254 20 2680722/2680748
Fax: +254 20 2680747
Email: rcmrd@rcmrd.org
Website: http//www.rcmrd.org

Kasarani Road, P.O. Box 632 Ruaraka, 00618, Nairobi Kenya | Tel: +254 20 2680748 | Cell: +254 723 786 161

Follow Us:-

facebook.com/rcmrd
flickr.com/photos/128418604@N04/albums/
rcmrd.org/
opendata.rcmrd.org/
twitter.com/rcmrd_
cloud.rcmrd.org/productcatalogue/
rcmrd.org/servir-esa/
discussion.rcmrd.org
rcmrd@rcmrd.org
apps.rcmrd.org
servirglobal.net/
geoportal.rcmrd.org