Crop Monitoring as an E-agricultural tool in Developing Countries

REPORT ON E-AGRICULTURAL WORKSHOP AND TRAINING ON REMOTE SENSING

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Table of content

1. Workshop on E-agricultural tools

1.1. Introduction of the Workshop

The project E-AGRI aims to transfer advanced European E-agriculture services in two developing economies, Morocco and China, by means of crop monitoring. The activities of capacity building will be carried out in the third developing country, Kenya, to raise the interest of local stakeholders on European E-agricultural practices and to pave the way for an eventual technological transfer in the future. As the exploitability of the European crop monitoring technologies in the country was not yet clear, some foundation and promotion work needs to be carried out first. This workshop had objective to introduce these E-agriculture tools to the local policy makers and technicians. In order to create the synergy with other agricultural monitoring and food security activities in the region, the workshop was co-organized with another FP7 project E-AGRI/AGRICAB.

The workshop will try to identify one or more crop monitoring technologies adapted for Africa continent, which can be operated in an economic and sustainable way, and will most likely be adopted and recognized by the regional governments.

The workshop, which took place on the Tuesday October 23, 2012, intended to analyse the present agricultural statistical systems in Kenya, with a focus on crop monitoring and area estimates, and to define user needs and possible linkages with the estimate of crop yields and early warning. Workshop Agenda:

1. Opening session
2. Self-Introduction
3. Opening speech
4. Overview of MEMR/E-AGRI/AGRICAB collaboration
5. Stakeholder Presentations
6. Discussion and wrap-up.

1.2. Participants for the Workshop

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35	Mr.Zacharia Oningo	MEMR	"		
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1.3. Workshop report

1.3.1. Opening session

The Chair Mr. Charles Situma after reiterating the importance of this workshop welcomed all members present to make self-introduction. The Director DSRS/MEMR, in His opening remarks invited participants from various institutions and especially Vito (Belgium), Alterra (The Netherlands) and Consorzio ITA (Italy) thanking them for sparing time to travel all the way to Kenya to attend this important workshop . He then gave a presentation introducing the activities of DSRS/MEMR stating the mission, vision and mandate of the department. While stating the objectives of the department, he emphasized that DSRS/MEMR had since 1984 been monitoring crop production in Kenya and this workshop and the E-AGRI/AGRICAB project at large had come at the opportune time in enabling the Department embrace use of Remote sensing for crop production monitoring.

On DSRS/MEMR methodology for resource data acquisition, he informed the participants that the department used a multisampling concept of remote sensing, Aerial surveys and Ground measurements/surveys to undertake its activities. The Director took through the participants on how DSRS/MEMR undertakes Crop forecasting (Maize & wheat) particularly using aerial photography as a remote Sensing technique clearly outlining Capabilities and constraints of the Department.

1.3.2. Overview of E-AGRI/AGRICAB Collaboration: use of remote sensing for crop production monitoring

Presenter: Mr. Henry Roimen & Mr. John Jogo, DSRS/MEMR

Mar. Roimen gave an overview on this, stating the three main components of the project and the role of DSRS/MEMR in E-AGRI/AGRICAB & E-AGRI projects.

He presented further on the Objective of the workshop, Outcome of E-AGRI/AGRICAB & E-AGRI, Basis of user case, Objectives of the user case, Methods and the use of data and Results. Finally he illustrated the planning process and how future work will be done.

Mr. John Njogu, DSRS/MEMR further took through the participants on the African Monitoring of Environment for sustainable Development (AMESD) project at DSRS/MEMR outlining the proposed usefulness of this programme within the E-AGRI/AGRICAB context. The AMSED project in general aims at *'helping African governments in designing, implementing, monitoring and evaluating their regional and continental policies towards sustainable development'.* He on the other hand explained the expected outputs, application areas and challenges of the project.

1.3.3. Advanced use of remote sensing in agricultural monitoring

Presenter**:** Carolien Tote, VITO

In her introduction, Mrs Tote gave outline of her presentation as follows:

- To give visibility to the E-AGRI/AGRICAB and E-AGRI projects

- To analyse needs / requirements / expectations of end-users and stakeholders
- To have a basis to develop the research use cases in Kenya

She further stated that the objectives of E-AGRI majorly focus on Demonstration, Dissemination, Providing added Values for EU funding and Collaboration.
Under the E-AGRI/AGRICAB project concept she further showed various use cases.
In the first use case: **Crop production systems** in monitoring crop production she talked of agricultural statistics, agro-meteorological modelling, early warning and crop mapping. On Early warning she pointed out that basically what to be considered were; Food security, Crop phenology and Time series analysis using low resolution satellite imagery. In her presentation she also pointed out why and how crop mapping should be done.
The second use case: **Forest Systems** is used in South Africa and handles tree cover information and fire information.
Use case three: **Livestock systems** are used in Niger, Kenya and Senegal and basically looks at capacity building, Livestock productivity and Training on methods for pasture monitoring.

Reactions/Questions:

- One of the participants from ICIPE indicated that there is a lot of work that can be done to provide more information to all the stakeholders. As a response the participant was told that it will be harder to use this monitoring process for pests. It might only be possible if they occur in large scale.
- The other participant from ILRI, Mr Mohammed pointed out that there are several stakeholders that do a lot in early warning yet had been left out and could be instrumental in establishing good crop statistics and providing good information to the policy makers. He therefore suggested to E-AGRI/AGRICAB to form a small steering team to customize this information and disseminate the outputs. It will be necessary to have a group to handle the information so that it can reach the end users.
- A participant from the University of Nairobi (UON) asked whether the organizers were able to initiate further awareness seminars so that other majority and specifically University students can participate.
- Another pertinent issue raised during the reactions was how remote sensing methods can be improved to predict food security at the local community level and application of climatic modelling at the same level.
- The response to this was that remote sensing is only good to show the status at (sub-) national level. At local level however, field verification is necessary although good indicators from remote sensing could be applied.

1.3.4. Agricultural statistics: a geo-referenced sampling approach

Presenter: Mr David Remotti, Consorzio ITA

Mr Remotti stated the objectives of his presentation as follows:

- To introduce rigorous sampling methods to achieve reliable crop area estimates, with known accuracy, for all major crops in Kenya.
- To assess the feasibility of a geo-referenced sampling approach to agricultural statistics, in the Kenyan.
- To start up a capacity building process in this field.

He then gave an introduction to Consorzio-ITA and the current activities in area sampling. He also elaborated on how random sampling can be used in food security assessment. He then stated the activities of 2013 where he said that 3 approaches will be addressed, including:

- Aerial photo interpretation and ground data for bias correction
- Integration of satellite images and aerial photos
- Point frame ground survey with satellite images to achieve better accuracy

Finally he gave a brief on the project schedule explaining the sampling techniques and also pointing out that there will be a follow-up workshop specifically to train DSRS/MEMR staff involved.

Reactions/Questions:

- Dennis Macharia (RCMRD) pointed out that it will be expensive to use commercial images for operational crop area estimation in all the areas to be covered by DSRS/MEMR in crop monitoring.
- As a response, Mr. Remotti advised that the potential benefit that will be got from the images compared to other methods. In the future, high resolution data will become less expensive.

Another participant (MoA) sought response to the following issues:

- Using estimates relying on administrative data originating from administrators how will this be factored in the model for the agriculture situation?
- On the agricultural data, climate change has become a challenge. Are the models flexible or how will it cater for the un-predictable factors.
- Local small-scale farmers mostly practice mixed cropping (70%): what are the mitigating factors in place to capture these?
- What are the measures provided for area measurements at the administrative level?

The response was:

- Subjective and objective information are different and farmers mostly give information and data based on subjective information rendering extrapolation difficult.
- Geo-referencing approach will be able to get information on the small farmer and mixed cropping.
- Surveyors are also given an option of registering more than one crop (even up to 6).

1.3.5. Crop yield forecasting in Kenya

Presenter: Mr Hendrik Boogaard (Alterra)

Mr Hendrik Boogaard gave a presentation on this giving the concept, rationale, E-AGRI/AGRICAB objectives, MARS services in weather and crop monitoring, remote sensing data and crop models, crop yield forecast in Kenya (DSRS/MEMR & MOA) training projects and other initiatives (GYGA & AGMIP).

Reactions/Questions:

- Remark by Mohammed Said (ILRI): DSRS/MEMR need to change how they have been working so that training can be done to more dedicated people.
- Remark by participant from FAO: After the training the government should take up the new systems so that they can be used in planning at a larger scale and on the long range to help the country.
- Remark by participant from DSRS/MEMR: MOA, KARI & DSRS/MEMR should sit down and chat the way forward on the discrepancies in their data. The government needs good quality data.

1.3.6. Kenya's experience on crops data collection and management

Presenter: Mr Clement Muyesu (MoA)

Mr Clement Muyesu gave a presentation on this highlighting the types of data collected by MoA, Sources of the data, Agricultural data management in MoA (collection, analysis, validation & archiving), Accessing stored agricultural data at MoA , Main challenges to data management and the improvement strategies in place. The Kenya Food Security Steering Group uses historical trends as a basis for area/production estimates. The data are disseminated in bi-monthly newsletters and annual reports. The major challenges are the low appreciation of the value of statistics, the shortage and low training level of extension workers, the lack of application of new technologies, low funds, lack of data quality control, conflicts of interests and the existence of different sources of data, and the lack of baseline data (e.g. from census). Training is needed on data validation and the integration of data in policy making.

1.3.7. Current Agricultural Data initiatives

Presenter: Mr Alex Mwaniki (MoA)

This was a presentation on Country STAT by MoA stating that it is a web-based tool to support evidence-based decision making and facilitate informed policy making at regional, national and sub national levels. He also explained what country STAT does and how it works. Data on production, yields, area and prices are centralized, harmonized, integrated and validated. The main challenges are the large number of data sources, which makes harmonization very hard, and data management.

1.3.8. Agricultural statistics in KARI, an overview of current status

Presenter**:** Mr Lucas Tanui (KARI)

Mr Tanui presented on this giving a brief introduction on how KARI carries out maize suitability mapping, their procedure, the assumption, and conversions methods, He further highlighted on the gaps in their methodology for yield estimation and the way forward.

Reactions/Questions:

- A participant raised an issue saying that most of the technologies used by KARI are too old and the information got might not be so accurate. He also said that KARI should look into working with other relevant stakeholders like ICRAF.
- Response was that that they were working with them in some projects.
- Another participant gave a suggestion saying that there should be absorption & utilization of technology and communication of information to the relevant stakeholders. Improved technology should also be used to get accurate data.
- He also pointed out that there is need for scientists to improve on how they communicate the information to the other Kenyans especially the policy makers. They also need to harmonize their methodologies to get the relevant data.
- A participant sought to know how KARI has used the knowledge on maize suitability mapping in Kenya.
- As a response he was told that it is used in advising the relevant stakeholders especially during the National Irrigation Policy.
- The other question was to know if the suitability maps for maize growing areas in the county levels have been produced.
- As a response he was told that when the counties will be operational, they will chip in so that mapping can be done using high resolution imagery.

1.3.9. Role of RCMRD in national food security initiatives

Presenter: Byron Anangwe, RCMRD

RCMRD comprises of 18-African member countries and soon they are expecting South Sudan to join making the number of countries to be 19.

The presenter talked of significant role of RCMRD in:

- Promoting Awareness on Application of EO Science
- Project Implementation & Building Capacity
- Formulation of data policies
- Creation synergies and partnerships

Activities in Sustenance Management include:

- Food Security and environmental monitoring (USGS/Fewsnet, ICPAC, DLCO, WFP, ILRI, LEWIS, GMFS)
- Flood modelling and prediction (USGS)
- Disease Modelling and Prediction- Rift Valley Fever (WRI, AU-IBAR, UoN, USGS) ,Mapping of HIV/AIDS on the Mombasa – Kampala highway (Manitoba University, UoN)
- Land degradation mapping and monitoring -Deforestation (Mau Forest),Land use / Land cover change (Kordofan Region, South Sudan)
- Capacity building - Training in the use of modern Geo-information technologies in early warning and food security, disease mapping, land degradation, disaster risk management

Project Activities are:

- Predicting Disease Outbreaks: Rift Valley Fever in GHA
- Food Security: Identification of hot spots
- Tsetse Mapping, Swaziland
- Agriculture Statistics - USGS/RLCM
- Mapping of Gums & Resins
- Water Quality Mapping:-Mapping to support Fishing in Lake Victoria for proper management and planning in the use of water resources

Presenter talked of SERVIR- Regional visualization and monitoring System [Early Warning System for East Africa]. It is for strengthening the capacity of governments and other key stakeholders to integrate Earth observations into decision-making. http://horn.rcmrd.org and www.servir.net/africa

On-going Projects are:-

- SERVIR-ROSES Flood forecasting using CREST Model , Coupled Routing and Excess Storage, or CREST, water balance model
- Assessing and Visualizing Biodiversity Vulnerability of Kenyan Flora and Fauna to Climate Change
- Coral Reef Tools
- African Ecosystem Classification
- GHG Inventory- LULUCF mapping
- Customization of GIS Flooding Tool for Food Security
- Forest Fires Monitoring
- Towards a Bioenergy Atlas for Africa, 2010-2015: Overall objective: Contribute to the sustainable utilization of bio-energy resources for Africa‘s development

Presenters last words were:

- There is a rapidly growing demand for efficient online access to fundamental spatial data

- There is need for technologists to stop talking to themselves and understand the speech of the policy makers/citizenry

Reactions/Questions:

- Mohammed Said (ILRI) raised the issue that capacity building is missing at regional level.

1.3.10. Food security assessment approach: The Kenya Food Security Steering Group (KFSSG)

Presenter: George Odingo (FAO)

The KFSSG approach is a government driven process - KFSSG leads. KFSSG is a national team: helps put together data from various sectors –data usually district based- socio-economic Information is collected over a period of 3 weeks, analysed by multi-stakeholders & projections-forecasts made. Geographical extent and focus areas targeted for information collection- are generalized livelihood zones- the classification makes areas as homogenized as possible.

Some Organizations Involved are: GoK, FEWSNET, UN Agencies, FAO, OCHA, UNICEF, WFP, and WVI-world vision inter.

Local & International NGOs: CARE,SCUK- save the children UK,OXFAM,KRC- Kenya red cross, Islamic Relief, CRS- catholic relief, GAA- German agro action ,Action AID,FH- food for the hungry, COOPI- Italian NGO,WASDA,VSF: Swiss, Belgium & Germany ,ACTED, CORDAID, ACF- Action against hunger

Mr Odingo presented the food security assessment approach, which takes into account:

- Role of assessment teams
- Overall food security situation
- Agro climatic information analysis
- Sampling methods and field data collection: households, livestock, markets, accessibility, water, sanitation, health etc.
- Integrated food security classification
- Sect oral checklists, guides and reporting formats
- Estimation of population affected and in need
- District report writing

Review of existing data and reference material

- District maps, IPC maps, Population data, Livelihood zone data, Coping strategies index, Food consumption scores Price data ,Historical beneficiary data ,NDMA bulletins, Food security update ,RFE and NDVI, Nutrition survey reports and data.

Remarks

- The approach is pretty subjective and more factual & scientific methods are needed.
- Crop yields and livestock visual observations may not be very accurate

- Cultural behaviours may affect data accuracy.
- FAO keen on application of remote sensing to food security forecasting process– cost usually prohibitive
- Monitoring of water towers is important.
- Also of interest to FAO & GoK are the farmer censors- for more accurate data bases.

1.3.11. Use of remote sensing for crop production monitoring in Kenya – A presentation by the University of Nairobi

Presenter: Prof. Gideon Nyamasyo (UON)
The benefits of crop production monitoring:

- To plan for food security by accurately estimating yields.
- To predict crop yield and prepare mitigation measures.
- Predict bumper harvest and prepare the management strategy to minimize the post-harvest losses.
- To come up with an early warning mechanisms for crop failure.

Degree programmes at UON that relate to Agricultural production and natural resources

- Environmental Sciences (conservation, Planning, Natural resource management, wildlife management).
- Conventional agriculture (Crop production, Livestock production).
- Biotechnology.
- ICT

Bridging the disconnection between new technologies and agricultural production (Leap-Frog strategy): there is a need to:

- Revise all degree programmes to include the use of ICT- based techniques.
- Survey for capacity building needs.
- Identify institutional partnership needs and develop partnership programmes.
- Ensure proper deployment of available technical manpower.

Proposed ICT integration with crop production monitoring

- Migrant pests (Locusts, armyworms, wheat aphids).
- Distribution of maize stalks borers & other pests.
- Distribution of pesticides applications.
- Climate matching to predict potential pest outbreaks.
- IPM country wide programmes.

A lot of data exists on:

- Crop yields from specific locations.
- Soil fertility.
- Crop varieties i.e. cultural practices.

- Use of pesticides.
- Pest species identification.

Conclusions:

- The benefits are on what you do with the available information.
- There is need to accurately estimate food production.
- Avoid unnecessary cultivation.
- Develop strategic management of crop yields e.g. Cash crops estimation to match industrial needs (sugarcane)
- Utilize agricultural land sustainably.

1.4. General discussions

Prof. Nyamasyo, asked whether RCMRD have partnerships/MOU's with local institutions i.e. Universities?

Response: RCMRD has signed MOU'S with JKUAT, KU and are willing if invited by institution to do the same. Currently RCMRD has a project known as MYCO-i.e. My Communities which they are funding, and are looking forward on expanding. E-AGRI/AGRICAB is on capacity building and soon RCMRD will be organizing regional trainings.

Dr. Said from ILRI insisted on capacity building at University level and even great need in research work and adoption of new technologies. Also there is need to develop curricula targeting thematic areas where students are taking courses. To attend at a workshop in one thing, another thing is to really adopt and implement the new technologies. It is important to connect with decision makers.

Mr J. Ngatia from FAO advised KSFG to put more emphasize on food security monitoring in high potential areas apart from the 22 ASAL areas. He stressed on working together and adoption of new technologies.

Mr. C. Situma from DSRS/MEMR said the Department was once a member of food steering committee, but when KFSG slowed down, DSRS/MEMR also slowed down.

According to Dr. Said (ILRI), there is need to form a small committee to discuss the various methodologies in crop yield assessment, data sharing and exchange, capacity building at national and regional levels. Also needs to be looked at scenarios: what will happen with climate change impacts?

Collaboration with DSRS/MEMR and other stakeholders in data sharing for decision makers, planners and policy formulators. Also Mr. Situma said we should not repeat the same stories now and then, we need to reach out to our data users, and users should drive the implementation. Issue of crop yield assessment requires instruments to be calibrated more often for purpose of accuracy level, and new technologies should be used. Departments with competences should come together, especially in quantifying the crop yield. Also estimates are needed before the harvest so to plan actions in case of deficits.

Mr. Omullo from DSRS/MEMR suggested that, the way forward is for MOA to take up the action as required in their mandate.
Prof. Nyamasyo said that we should not have data which is lying idle in archives. Partnerships with public universities should be formed, in order to turn data into information useful for policy formulation.
Mr. Situma from DSRS/MEMR gave vote of thanks on every one and every organization which participated, and shared information on new technologies in crop yield assessment. He also thanked the E-AGRI/AGRICAB and the EU for sponsoring the workshop.

Figure 1: The workshop on E-agricultural tools organized jointly by E-AGRi and AGRICAB project on October 23, 2012 in Redcourt Hotel, Nairobi, Kenya.

2. Training session

2.1. Introduction of the training session

The training session on agricultural monitoring using remote sensing was organized at the 'Department of Resource Surveys and Remote Sensing' (DSRS/MEMR) in Nairobi, Kenya, From Monday 25 November to Friday 29 November 2013. This training session focused on the analysis of high resolution satellite imagery and ground survey data to generate crop maps over targeted areas in Kenya. The derived crop maps will be used in further stages to improve crop acreage estimations.

The training was planned to be a 'hands-on training' for a group of about 15-20 people, namely the people involved in the generation of crop acreage statistics at DSRS/MEMR, operational crop monitoring (FAO, RCMRD), research oriented use cases (JKUAT) and interdisciplinary knowledge sharing (KMD).

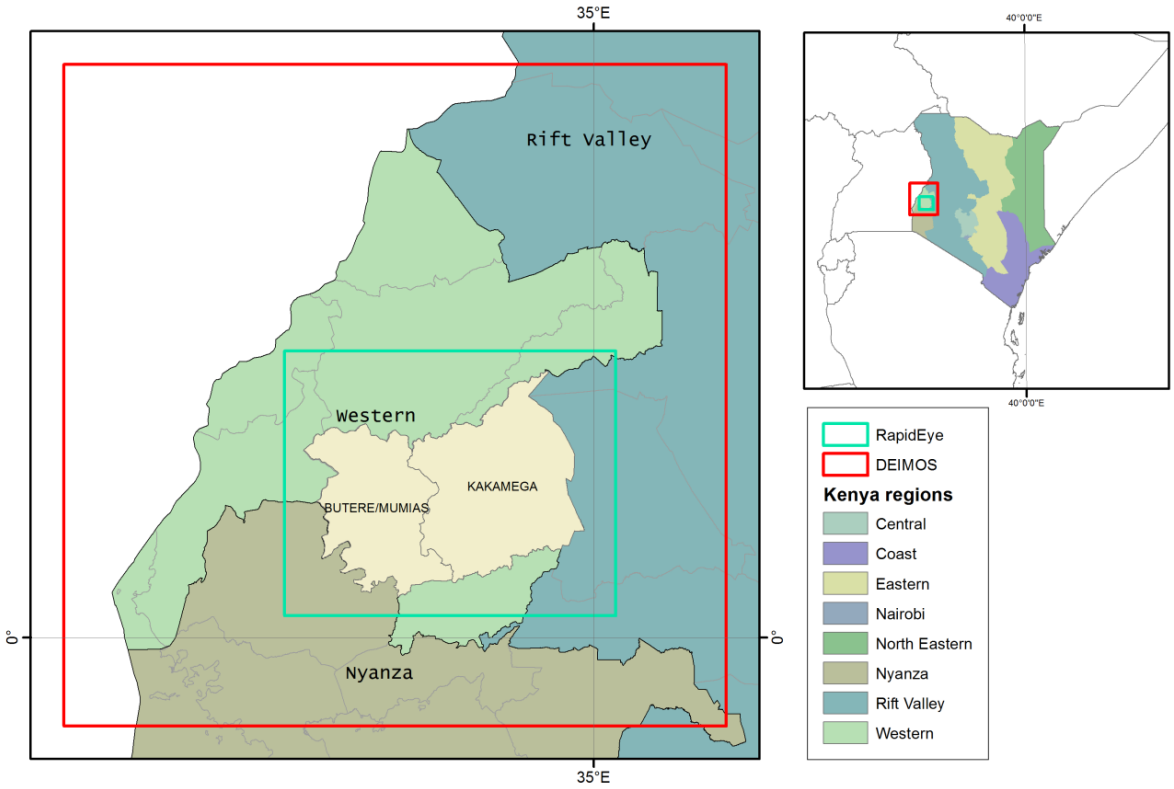

Figure 2: The study area of the workshop is located in Western Kenya. Data acquired over the Kakamega province was used in the exercises.

This training session focused on a case study on the use of remote sensing technology for crop specific mapping in the Kakamega and Butere province in Kenya (see figure 2). During the 2013 long rains crop season, single date high resolution RapidEye, three Deimos-1 and five Landsat8 images were acquired between April and July2013. Moreover, an extensive field and aerial survey was performed during June to July2013, in order to generate crop area statistics and ground truth data for image interpretation.

The acquired data was used in the workshop in hand on exercises on image classification using three different software packages: ENVI, QuantumGIS and GRASS.

2.2. Participants for the training session

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12	Christopher Chelule	DRSRS	C_chelule@yahoo.co.uk	X	X	X	X	X
13	Merceline Ojwala	DRSRS	mojwala@yahoo.com		X	X	X	X
14	Samuel M. Kiroso	DRSRS	sammykiroso@gmail.com		X	X	X	X
15	Christopher Amudavi	DRSRS	ameyou@gmail.com	X	X	X		X
16	Robert K. Nyarondia	DRSRS	robertkimutai8@yahoo.com		X	X	X	
17	Victoria K. Sila	DRSRS	sila.kalekye@gmail.com	X	X	X	X	X
18	Irene Onyango	DRSRS	irenetilda@gmail.com		X	X	X	X
19	Kiprop K.Chesire	DRSRS	chesisrekiprop@gmail.com		X	X	X	X
20	Japheth M. Katuse	DRSRS	katusejapethmkambi@gmail.com			X	X	X
21	Simon Kimath Nyaga	DRSRS	kimathsimons@gmail.com			X	X	X
21	Purity Wanjiru	DRSRS (support)		X	X	X	X	X
22	Pamela W. Njiru	DRSRS (support)		X	X	X	X	X
23	Etiud Nalimbe	DRSRS (support)		x	x		X	X
23	Michele Downie	ITA	studiomappe@gmail.com	x	X	X	X	X
24	Roel Van Hoolst	VITO	roel.vanhoolst@vito.be	x	X	X	X	X

2.3. Agenda

DAY/DATE	SESSION	ACTIVITY	VENUE	TRAINER/PRESENTER
MONDAY 25/11/2013	MORNING	- Registration of participants - Self-introduction - Opening remarks by Director,DRSRS - General introduction of E-AGRI/AGRICAB Projects	Main conference room	Mr.Roel Vanhoolst (VITO) Mr.Michele Downie (ITA)
	AFTERNOON	- Installation of software - Exercise_1		Mr.Roel Vanhoolst (VITO) Mr.Michele Downie (ITA)
TUESDAY 26/11/2013	MORNING	- Introduction on Remote Sensing for Land cover mapping(sensors, pre-processing & classification algorithms) - Exercise_2		Mr.Roel Vanhoolst (VITO)
	AFTERNOON	- Continuation of exercise_2 on ENVI		Mr.Roel Vanhoolst (VITO)
WEDNESDAY 27/11/2013	MORNING	- Rapid eye image processing & classification. a) Use of Rapid eye image in AGRICAB user case study in Kenya(Kakamega &Butere regions) b) Advantages & applications - Developing methodology		Mr.Michele Downie (ITA)
	AFTERNOON	- Exercise_3: GRASS introduction		Mr. Michele Downie (ITA) Mr.Roel Vanhoolst (VITO)
THURSDAY 28/11/2013	MORNING	- Land cover mapping, results of Chinese Academy of Agricultural sciences(**CAAS**) - Exercise:Landsat_8 processing & classification		Mr.Roel Vanhoolst (VITO) Mr.Michele Downi e(ITA)
	AFTERNOON	- GRASS Exercise - QGIS Exercise		Mr.Roel Vanhoolst (VITO) Mr.Michele Downie (ITA)
FRIDAY 29/11/2013	MORNING	- Feedback - Presentation of training certificates - Closure.	Main conference room	All Mr. Charles Situma, Roel, Michelle

2.4. Report of the Hands-On Training

VITO (Roel Van Hoolst) and ITA (Michele Downie) were accommodated in the Hanan Guest House, at about 1 km (5-10 minute drive) from DRSRS.

Michele Downie, consultant at ITA, was already one week before at DRSRS. He supported DRSRS in the ground survey in June-July/2013. During his stay at DRSRS his main task was to work with the acquired data and develop a RapidEye classification methodology. He spent his time the first week on giving dedicated training to a small number of DRSRS staff. On Sunday 24th Michele and Roel discussed and refined the workshop program together with Vincent Imala from DRSRS.

The official workshop started on Monday 25/11/2013 with an opening session. Mr. Charles Situma, SAD at DRSRS, welcomed the trainees and trainers and gave a brief introduction to AGRICAB and E-AGRI and previous work done within these projects and the objective of the current workshop. After the opening of the workshop, the trainers and participants presented themselves.

Roel Van Hoolst gave an introductory presentation on E-AGRI/AGRICAB and how the workshop fits within these projects. This introduction was followed by a general presentation on land cover mapping with satellite data. A focus was made on defining land cover categories. Here the LCCS software of FAO was introduced. After an explanation the software was installed at each trainees PC and a collective exploration of LCCS was done. After lunch a presentation was given by Roel Van Hoolst on basic remote sensing concepts: a brief recapitulation of the necessary theory for working with satellite data. After this the ENVI software was installed at the trainees PC. A temporal license key was available. Once installed a first exercise was given as an introduction to ENVI and to grasp the remote sensing concepts by hands on experience. Using dedicated tutorials each trainee could work at his/her own pace.

On Tuesday morning a presentation was given by Roel Van Hoolst on remote sensing concepts for image classification. Here, the theoretical details were explained that form the base for classification of satellite imagery. Following this presentation, a hands on exercise was done by the trainees. The exercises objective was to explorer the remote sensing concepts for image classification. E.g. spectral profile, display 2D feature space, define ROI's, unsupervised and supervised classification, post classification, and validation. All these modules were applied on Landsat imagery over the Kakamega province and data collected at the field survey of DRSRS. Some results of the exercises are shown in ANNEX I.
On Wednesday Michel Downie presented step by step the work he had done together with DRSRS in the previous week. Consecutively an introduction to the GRASS software was

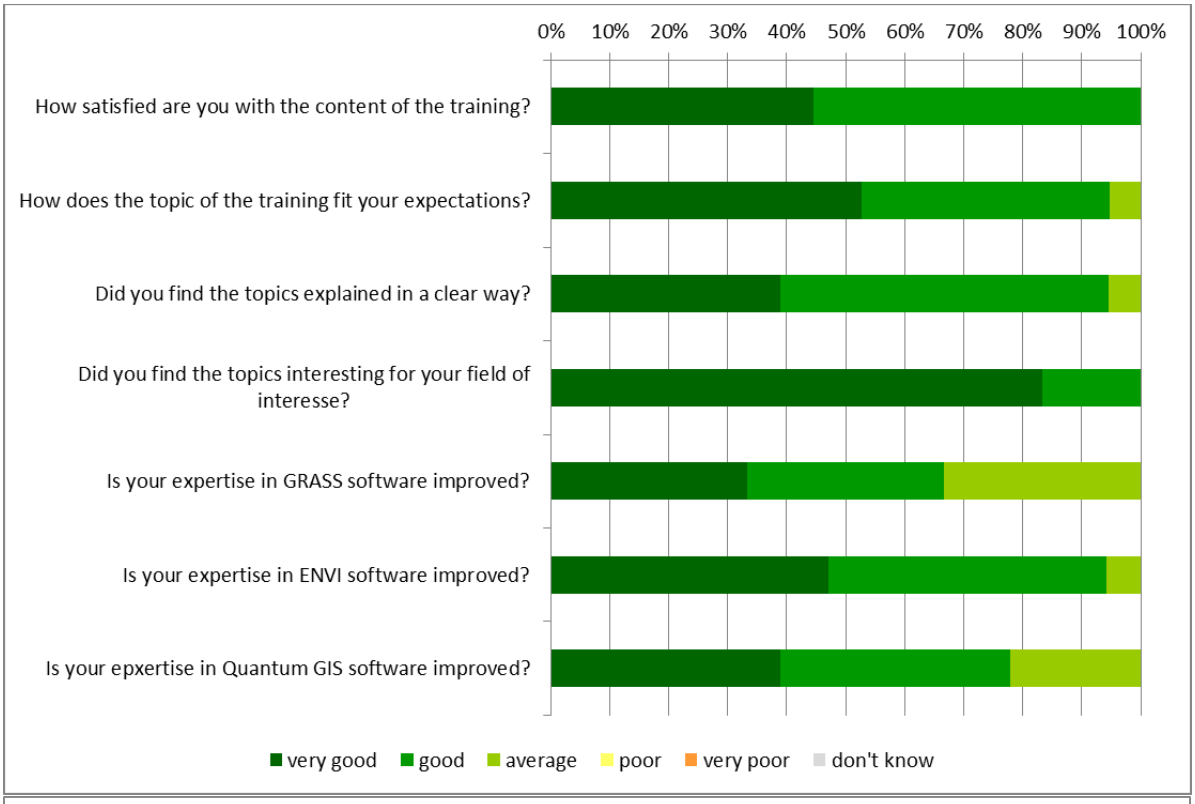
given by Michele. A special focus was made on the set up of a GRASS project and explaining the GRASS structure, the most difficult parts for most users. A number of modules (e.g. import raster, define region, colour image,…) were collectively tested.

CAAS (Chinese Academy of Agricultural Sciences), a partner within the E-AGRI project, was initially invited but had problems with the acquisition of their visa. CAAS did an extensive work within the E-AGRI project on crop classification over Kenya using limited ground truth data. Roel Van Hoolst presented on Thursday morning the work of CAAS on their behalf. Together with the local experts (i.e. the Kenyan trainees) the methodology and results of this ambitious work was discussed. Afterwards the ENVI exercises were completed and an exercise in QuantumGIS, using the interesting plugin OpenLayers, was given.

On Friday, the participants discussed in detail the ground survey approach based on their experiences. Next, a feedback conversation was done on the image classification workshop. In general, the participants were very satisfied except for some remarks on the duration (too short) and software (ENVI is not free; 3 softwares can be too much within one week). A detailed analysis of the feedback is given below. After the discussions, Charles Situma and the Director of DRSRS gave a closing word. Finally, certificates of attendance were given by the Director and the trainees to all participants. Around 2 pm the workshop was closed. Some pictures of the workshop are shown in ANNEX II.

2.5. Evaluation

A standard training evaluation form was used for the evaluation of the workshop. In general, the workshop was evaluated positively. One major drawback was the duration of the training, which was too short according to the trainees to get acquainted with all the three softwares. A suggestion was to focus on one software. Also, one suggested giving extra exercises as “homework” to maintain and improve the gained expertise. Alex Koton of FAO suggested including a knowledge sharing session between the invited institutes, i.e. presenting and comparing different methodologies for crop monitoring etc. He also commented to give more attention to the data acquisition. But in general participants were very enthusiastic, especially about the hands on exercises, and the workshop was well appreciated.



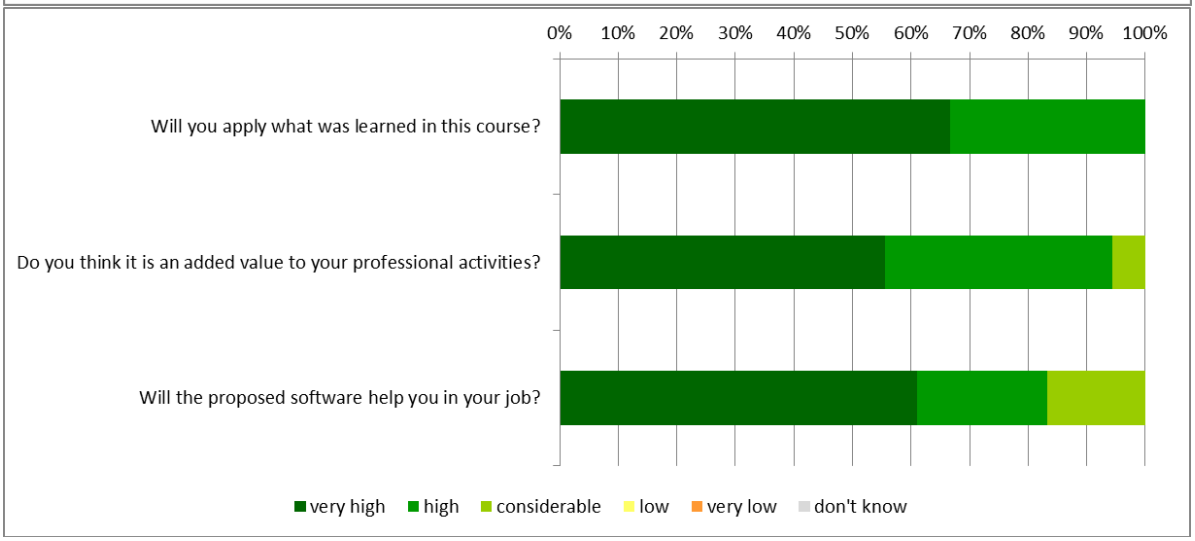


Figure 3 Evaluation of the workshop

ANNEX I: Data and results of image classification training

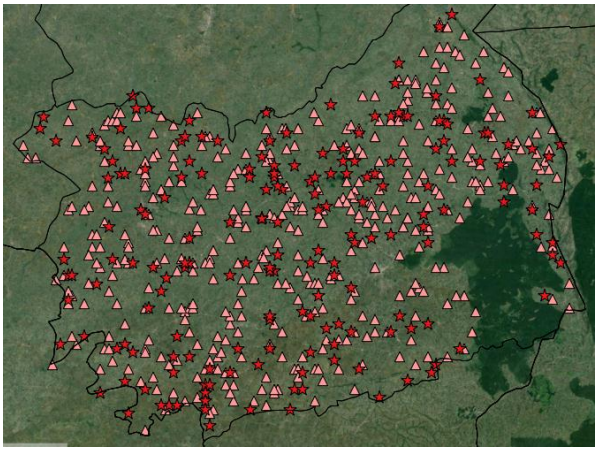


Figure 1: Point sample collected during the ground survey in June-July/2013. These data were used as reference data in the classification exercises.

Preprocessed DEIMOS and Landsat8

Although the time window for DEIMOS acquisitions coincided with the rainy season and thus chances for low cloud cover at the time of satellite overpass were relatively low, 3 relatively cloud free images could be acquired. The dataset is complemented with 5 Landsat8 images freely available through USGS-EarthExplorer. The images were preprocessed, including radiometric and atmospheric corrections, spatial sub setting, resampling to 25m resolution and cloud cover removal.

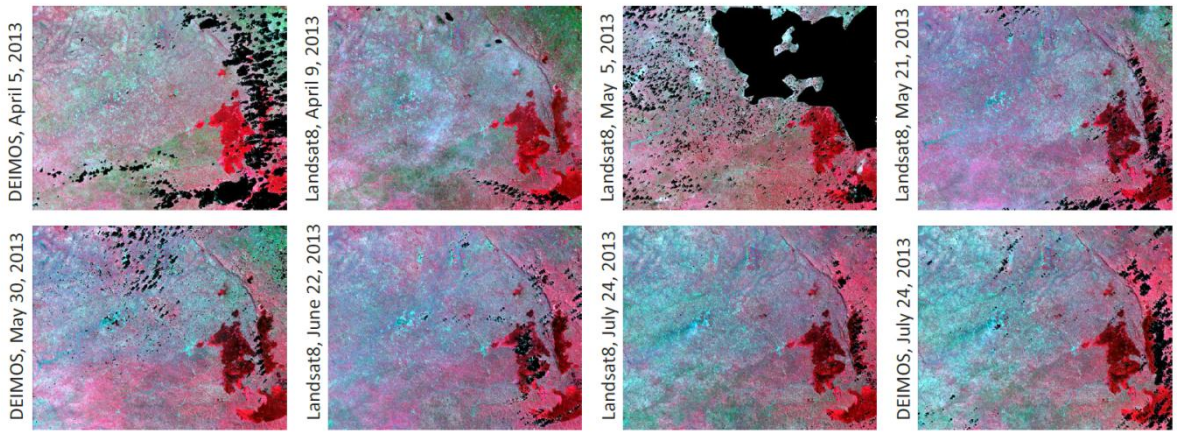


Figure 2: Overview on the acquired and pre-processed DEIMOS and Landsat8 data. The workshop focused on the classification the Landsat8, May 21, 2013 image (right top). Reference: Carolien Tote et al. Monitoring Agricultural Drought with Remote Sensing Data: Combining high resolution and multi-temporal remote sensing data for crop mapping in Africa, AfricaGIS 2013 & GDSI 14 Addis, Ethiopia, 04-08/11/2013

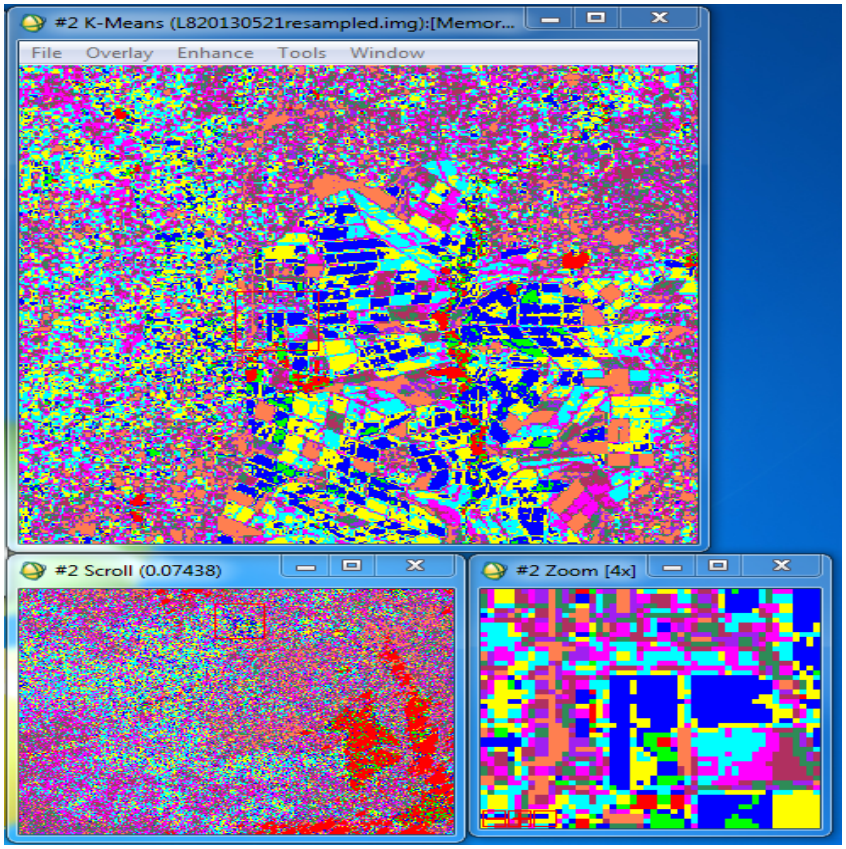


Figure 3: Result of the K-means classifier over the Kakamega province as displayed by the ENVI software.

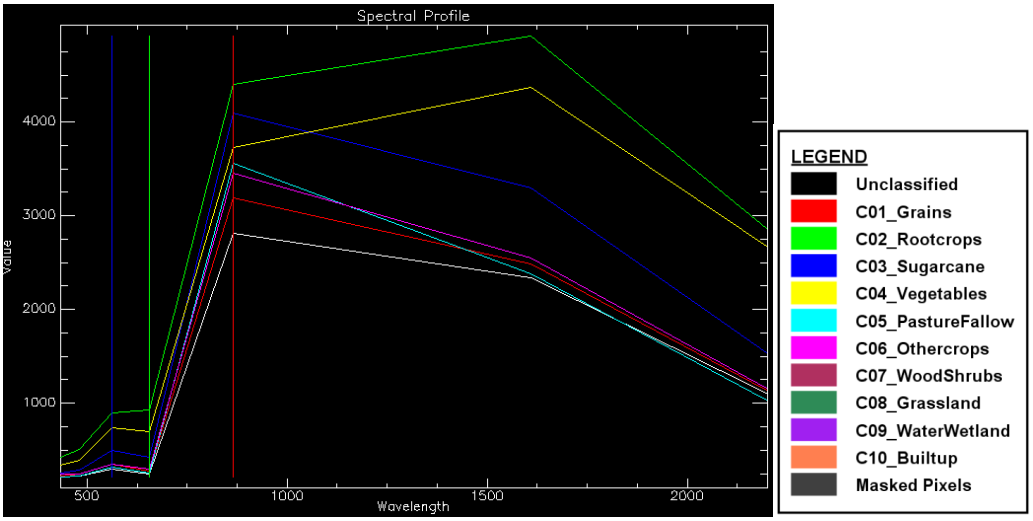


Figure 4: Analysis of the spectral profiles of the different training classes as displayed by the ENVI software.

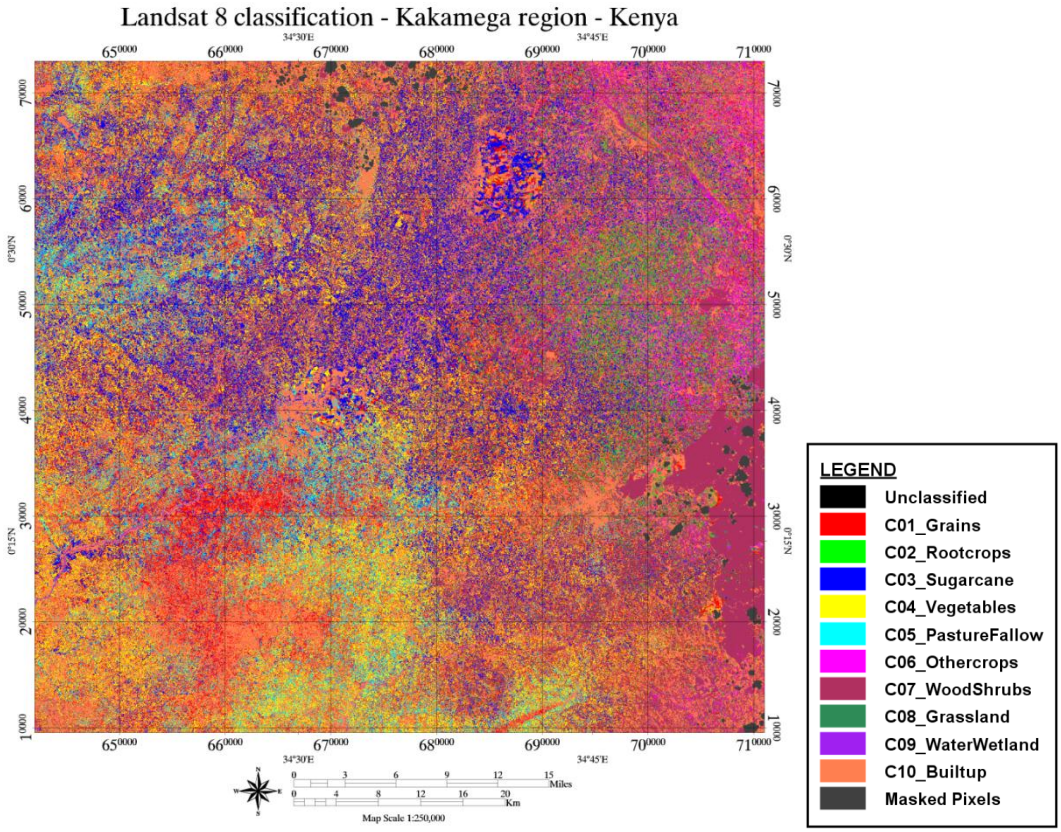


Figure 5: Result of the Maximum Likelihood classifier over the Kakamega province using ground truth dataset as training data.

Ground truth

Classification	V01_Grains	V02_Rootcrop	V03_Sugarcane	V04_Vegeta	V05_PastureFa	V06_Othercr	V07_WoodShru	V08_Grassland	V09_WaterWet	V10_Builtup	Total
C01_Grains	107	10	92	0	2	3	0	10	0	1	225
C02_Rootcrops	0	0	7	0	0	0	0	16	0	1	24
C03_Sugarcane	40	3	223	0	0	6	2	24	0	0	298
C04_Vegetable	22	0	19	0	18	0	1	1	0	2	63
C05_PastureFa	63	0	29	0	0	0	0	0	0	0	92
C06_Othercrop	8	0	0	0	0	0	0	0	0	0	8
C07_WoodShru	7	0	24	0	1	1	83	0	0	2	118
C08_Grassland	6	1	19	0	0	1	1	9	0	1	38
C09_WaterWetl	0	0	0	0	0	0	0	0	18	0	18
C10_Builtup	79	8	96	4	4	9	5	14	2	18	239
Total	332	22	509	4	25	20	92	74	20	25	1123

Figure 6: Result of the validation of the Maximum Likelihood classification (figure 5) over the Kakamega province using ground truth dataset as validation data.

Annex II: Pictures of training activities