GEOGLAM RAPP
Rangeland and Pasture Productivity

MINUTES

GEOGLAM RAPP WORKSHOP

Joint Expert Meeting on Pasture Analysis and Remote Sensing

PROTEA HOTEL – CENTURION, PRETORIA

20 JUNE 2016

The objectives of the workshop were to:

- Strengthen the RAPP Community of Practice and reaffirm the community's involvement (pilot sites, global dashboard, R&D developments).
- Review progress and development of a Global Monitoring system.
- Foster information exchange with the remote sensing and modelling community, and identify future collaborative research involving researchers from South Africa and Africa.

Please see more information (agenda and most of the PDF presentations on RAPP website: http://www.geo-rapp.org/news/events/4th-geoglam-rapp-workshop-south-africa-2016/

DAY 1: 20 JUNE 2016
WORKSHOP OFFICIAL WELCOME by Dr Malinga (SANSA) Dr Alex Held (CSIRO) and Dr Mjwara (DST)

- Dr. Malinga indicated that South Africa recognises the importance of RAPP as critical for monitoring and assessing the capacity of rangelands.
- He further indicated that SANSA seeks to contribute to the RAPP objectives and foster an information exchange relationship, by identifying future areas of collaboration with other African countries and the world, improve skills and competence to achieve these objectives.
- He welcomed everyone and expressed gratitude to Department of Science and Technology (DST) and the City of Tshwane for co-hosting the event and their support of national and international activities. He also thanked CSIRO and the GEOGLAM RAPP community for co-organising and being present for the discussions, respectively.
- Dr. Alex Held expressed gratitude to SANSA, DST and the City of Tswane for hosting the event and support, indicating that the current regional workshop is the fourth since inception of GEOGLAM RAPP Community of Practice (CoP) and the fifth is anticipated to be in the Asian region.

- He highlighted the objectives and the importance of the workshop for food security.
- He indicated that RAPP seeks to establish partnerships with government and NGOs on various areas including Human Capital Development (HCD), CoPs and data exchanges. He is looking forward to discussions and collaborations to come out of the workshop.
- Dr. Phi Mjwara presented on South African (SA) activities in the African continent.
- The presention highlighted the challenges faced by Africa in terms of growing population, declining agricultural productivity and its effects on South African GDP and the achievement of the 17 Sustainable Development Goals (SDGs).
- He presented global initiatives and programmes in which South Africa is participating including among others; Africa-EU R&I Roadmap, AFRIGEOSS, AFRIGAM (a concept for Continental implementation of the initiative on Food Security and Agriculture).
- He indicated that AFRIGAM can link with GEOGLAM and can be coordinated through Afri-JECAM because SA recognises the need for action in this continent that relies heavily on agriculture.
- He further alluded that SA wants to increase the use earth observation (EO) data and techniques for informed decision making, betterment of policies, curbing overgrazing and increasing productivity.
- He indicated that SANSA is working with Airbus Defense to monitor Crops and assisting farmers to manage crops and adapt to climate change.
- He further presented on the role of AFRIGEOSS in implementing African Political decisions.
- As Co-Chairs of GEO, SA wants to reiterate that GEO supports the RAPP initiative and will strive to offer required support where required.

See presentation for more information

GEOGLAM Update + Rationale for Rangelands and Pasture Productivity (RAPP) initiative: updates, coordination and strategy by Dr Alex Held and Ms. Flora Kerblat, CSIRO (Australia)

- Dr. Alex Held presented on the vision for GEO, the member countries, societal benefit areas for GEO.
- He indicated that GEO focuses on four GEO activities including Initiatives, Flagships, and Community activities.
- He further mentioned that CEOS is the space arm for GEO and briefly highlighted its missions and objectives.
- He introduced the background for GEOGLAM and its partners.
- Some activities by GEOGLAM include Crop Monitor for AMIS, Early Warning Crop Monitor (EWCM)
- He further showed that GEOGLAM has a strong G20 mandate and RAPP is a component of GEOGLAM, Global rangelands and extensive pasture condition and livestock productivity Information System was developed.

- RAPP elements include: Global Information System (Rangeland condition & anomalies, standing biomass, livestock statistics), National Pilot Sites, Community of Practice and Outreach.
- Flora indicated that 10 countries have been confirmed as National Pilot Sites. The pilot sites are used for validation of the products.
- RAPP products include among others: Vegetation cover anomaly, GEOGLAM RAPP Map,
- **Requirements & products**: Global Rangeland Vegetation Fractional Cover time-series (2-weekly composites) MODIS/S3/VIIRS/GCOM-C, Above Ground Biomass (Seasonal/Annual) – SAR-derived biomass – Sentinel-1, Radarsat constellation for model-data assimilation approach, Soil Moisture & climatic data – SMOS.SMAP & ECVs – Global, Grassland types & Nutritional quality – multi & hyperspectral data.
- Dr. Alex indicated that Sentinel 1-B being launched, new data and continuity will be ensured. He indicated that for AGB from SAR will need to be researched for stability and reliability.
- **RS & Field data requirements**: 3 pilot sites in 3 regions. Communication and Outreach: RAPP work plan late 2015, website with regular updates: https://www.geo-rapp.org . Any relevant information can be uploaded on the website, one will need to send an email to Flora.
- USDA/LTAR workshop in the US (May 2016)
- RAPP workshop (South Africa, 20-22 June 2016)
- Collaboration with CEOS.
- Component lead: looking for co-lead. Pilot sites have 10 people and the wider CoP has 20 people.
- Flora indicated that more people are needed in the initiative and thanked everyone for coming.

See presentation for more information.

GEOGLAM RAPP Visualizer/Interactive Platform online by Dr Juan Guerschman, CSIRO (Australia)

- Dr. Juan indicated that RAPP aims to provide humanity with a means to monitor food security through livestock, climate, vegetation types and time series of vegetation where the use of remote sensing data and model has become crucial.
- He indicated that RAPP is developing an online interactive platform that will act as a monitoring system whereby users can map and compare different layers such as Vegetation Fractional Cover based on MODIS (which can also be done using Landsat data); Vegetation GPP, NPP and Biomass. Soil Moisture and Anomalies, Land use/Land cover, livestock densities, among others.
- These global maps are under development and will track changes in climate anomalies, vegetation cover, livestock, etc.
- He demonstrated the GEOGLAM RAPP Map prototype which is accessible from http://map.geo-rapp.org/.

- He indicated that Vegetation Cover Anomaly Maps are produced every month and published on RAPP website and Twitter account.
- The metadata and all the links to sources of data will be made available onto the platform, by clicking the layers you can see data sources as well.
- **Questions**: (1) Who is the major end user? – Juan indicated that Regional agencies and government agencies looking at less detail based on MODIS data, mainly because of IT constraints. (2) How flexible is the system? – Juan indicated that the system is flexible, and users can query the data via polygons and can load their own data.

See Presentation for more details.

Data Requirements Definition and Data Services Options for RAPP by Dr Brian Killough (NASA, and CEOS representative)

- Dr Brian Killough presented on the role of CEOS in promoting data accessibility.
- He indicated that CEOS represents space agencies and government that aim to improve and promote data use and sharing. CEOS can facilitate getting data from the agencies that form part of CEOS for RAPP and can facilitate data service access.
- Free open source data will be available for RAPP and CEOS will figure out mechanisms to try negotiating open data with space agencies in restricted areas – This could be possible since data required by RAPP is not for personal profit but for R&D.
- He then introducted the Data Cube concept, mentioning that it is the future for time series analysis, and is computational efficiency.
- He mentioned that the concept has been proven by GeoScience Australia (GA) & CSIRO in Australia. The data is analysis ready (ARD) and the concept is currently being tested in Colombia and Kenya.
- He indicated that CEOS is targeting several platforms such as QGIS, ArcGIS and Google Earth Engine for hosting Data cube processing code and making it available to users.
- He indicated that most users are interested in cloud removal & Custom Mosaic Tool – using Data Cube.
- Within the data cube, one can use multisource data using ALOS/S-1 and Landsat.
- Other Data Cubes include: LCMAP USGS Land Change Monitoring Assessment in Australia.
- Data Cube Work Plan can be shared if interested.
- He indicated that increased volume, low capacity and slow internet are some obstacles with scene-based processing methods.
- Other users prefer to perform their own atmospheric correction and while others required analysis ready data, such as surface reflectance.
- The Data Cube can be deployed locally, on a Cloud, SERVIR Regional Geohub or GEONETCAST.

- He asked “how does the RAPP data requirements and GEOGLAM requirements differ?”
- RAPP focuses on smaller scaler and degradation. GEOGLAM also focus on single species, whereas RAPP focuses on a variety of crops within a scene.
- “Has the products been validated?”
- Juan indicates that the pilot sites will be used for validation and the process is still continuing – in South west of US, Argentina and Australia.

Updates & upcoming activities on current RAPP pilot sites by Dr Tony Palmer, ARC-South Africa; Dr Dan Zhao, RADI/CAS – China, & Juan Guerschman, USA/Canada/Brazil

1. South Africa (Dr Tony Palmer, ARC)

- Dr. Tony Palmer presented on the rangeland monitoring activities in SA.
- He indicated that the ARC has a project where they reuse historic photographs and compare those with the old ones to see changes in landscapes and track changes in vegetation productivity and seasonality.
- He mentioned that several agencies are involved in data collection in SA including among others; rePhotoSA - collects quarter degree aerial photographs; SANBI – collects information on the distribution of floristic plots; Emerging SA Flux Network; ARC – water use efficiency, Standing biomass using disk pasture meter (descending plate), and produces NDVI product, based on MODIS and ET based on LAI products from MODIS.
- He indicated that the Eastern Cape province in SA can be used as pilot site and was previously suggested to GFOI.
- The CSIR, SAEON, RHODES, ARC and Emerging SA Flux Network have flux towers that use methods to measure the exchanges of CO^2, water vapour, and energy between terrestrial ecosystems and the atmosphere.
- ARC focuses on water-use efficiency, point-based rangeland monitoring data.
- ARC uses MODIS and NDVI products to model evapotranspiration and vegetation versus the flux towers.
- Policies are necessary to cope with an increase in grass biomass; there is an increase in beef cattle herd nationally.
- SA proposed the Cathedral and Kruger National Park as their pilot sites.
- Dr. Alex Held indicated that the RAPP depends on countries for sites.
- Differences between rangeland monitoring and crop monitoring –
- Functional types are suggested instead of species which can be difficult for rangeland monitoring.
- SAOEN and CSIR are participating because of their involvement in certain sites.

- A suggestion was made to select the browsing areas in addition to grazing areas.
- C3/C4 discrimination is a problem and more research is needed in that area.
- 30 years anomalies are required for crop monitoring, because of 10 years might not be sufficient.
- Sentinel and Landsat are looking for common algorithms for atmospheric correction, which may benefit time series analysis.
- The impact of fire on rangelands (esp. for browse productivity) need to be incorporated.
- The farmers usually ignore the warnings from remotely sensed data - that is a major challenge.

  See Presentation for more details.

2. China (Dr. Dan Zhao, RADI/CAS)

- Dr. Dan Zhao presented on China's pilot site for GEOGLAM RAPP.
- He indicated that more studies were carried out on grazing intensity, Gazing Capacity Index - validated by samples in the field and Stocking Rates.
- Hyperion data has been used for experiments on grazing Intensity.
- AGB – annual Rainfall/temperature.
- PVI and grassland types – estimate AGB – using Landsat 8 and MODIS data.
- GLOBAL-V mission – 2018/19 (Optical & Thermal) and 2nd satellite (hyperspectral data).
- Multi-angular observations at 100m – standard user products will include 10 day composites and as per users request on customised products.
- Grassland quality and utilisation monitoring – AGB monitoring
- Fieldwork is conducted once a year in both China and Belgium.
- Grassland Degradation Monitoring
- China is monitoring the Mongolian rangelands and has a partnership with Belgium whereby China is able to monitor grassland quality (biomass and above-ground biomass).
- The partnership also included a satellite launch programme (to be launched in china 2018/2019 and 2020/2021).
- The Qinghai-Tibet plateau could also be another pilot site for China since the observation stations are also set out in this area.

See Presentation for more details.

3. Others (Juan Guerschman on behalf of Dr. Carlos di Bella, INTA)

- Agentina's pilot site has been introduced for monitoring rangelands, checking vegetation fractional cover in a national collaboration to collect data for calibration, monitoring and validation.
- The operational system uses MODIS to map out forage availability.
- Brazilian pilot site (LAPIG) on behalf of Laerte Ferreira and Michael Hill

See Presentation for more details.

4. COLOMBIA (Dr Carlos González Orozco, Corpoica), *(remotely)*

- Carimagua pilot site Colombia – Corpoica is characterised by higher plains, Flood plains and Andean Foothills and the Amazon Forest.
- The area divided into Paddocks – Paddock 1 approx. 74ha, 27 subplots from 1.4ha to 2.8 ha – pasture type Brachiaria dyctianeura.
- He also presented on other planned Paddocks – with approx. 100ha each.
    - Data requirements: High res. Landsat and Sentinel-2 data of 1-2 days temporal resolution.
    - Both Paddock 1 and 2 will require 250m res. from MODIS.
    - It receives rainfall 9 months of the year with 20 days of cloud cover, therefore optical remote sensing is challenging.
    - The 74 hectare plot is used for monitoring and divided into sub-plots of cattle rotation around the subplots every 5-7 days as the grazing period and 28-35 days of no grazing. There is one sampling per month of 10-20 random plots as in-situ data.
    - The Remote Sensing approach: MODIS 250m is not sufficient for this experiment which is one of the issues they have.
    - For cloud covered areas, sentinel-1 (RADAR) needs to be combined with high resolution optical images. In the future, the sizes of the plots will be increased, and one more site will be added.
      See Presentation for more details.

Progress on EO based estimation of grass nitrogen and biomass as indicators for rangeland quality and quantity by Dr. Abel Ramoelo, CSIR

- Earth Observation has opened up an opportunity to map leaf Nitrogen and biomass at various scales in the Kruger National Park.
- The estimation is based on empirical models based on Rapid Eye, Worldview 2 and Sentinel-2.
- Maps have been developed based on MODIS data.
- Near-real time estimation of herbaceous biomass.
- Contact Risk Modelling – with Belgian partners – for Buffalo and Cattle.
  See Presentation for more details.

Using Crowdsourced Validation Data to Produce a Best Global Grassland Mask for rangeland Monitoring & SIGMA overview by Dr. Steffen Fritz, IIASA

- Dr. Steffen Fritz indicated that crowd-sourcing in synergy of remote sensing was used to downgrade estimates of land availability
- It uses the best global forests, croplands, water masks to derive final products, through a multi-sensor, multi-data integrative approach.
- Crowd-sourcing of land cover, hybrid maps and other products and collection of in-situ biomass data.
- It uses Geo-Wiki engagement Platform.
- Products include: Cropland Mask has been generated from existing satellite-derived sources; Forest Mask (1km res.) from MODIS VCF, Global Land cover, and Global Forest Cover Map among others.
- Proposed methodologies can be applied to generate Rangeland mask using global forest, cropland, and water mask.
- Globland30 from China can be utilised as well.
- Presented also on SIGMA Achievements: Global Cropland
- fritz@iiasa.ac.at – Geo-wiki.org
- How is quality checking is done – using control points by recruits over the website.
- Participants echoed that standardisation of terminology is crucial and adoption of already standardised terms in ecology is encouraged.
- Continuous field approach.
  See Presentation for more details.

Group Discussions on Data requirements and Feedback on Global visualizer functionalities

- The participants were split into two groups led by Dr. Abel Ramoelo and Dr. Terry Newby
- User: Farmer extension services could cover subsistence farmers.
- Annual Woody cover (time series decomposition approaches) or based on LiDAR
- Fractional Bare soil cover (10 -30m) produced annually.
- Carrying capacity and stocking rates (seasonal)
- National products: Crop/Tree/Grass Mask (at 250 resolution)
- Degradation (at 250m res.)
- Visualisation: Visualization system presented by Dr. Juan Guerschman has a lot of potential, need more flexibility and will allow the development of decision making instrument.
- Conclusions:
  - Group led by Abel Ramoelo:

Users	Data type	Resolutions
FARMERS (mainly commercial)	Herbaceous biomass	10-30m (Sentinel/Landsat) - weekly
	Vegetation condition	10-30m (Sentinel/Landsat) - weekly
	Woody/ grass cover separation	250m (MODIS), Annually

	Fractional cover – bare soil	10-30m (Sentinel/Landsat) - Annually
	Soil moisture	1km, weekly
	Stocking rate	Ha, seasonal/ annually
	Carrying capacity	Ha, seasonal/ annually
National Decision/ Policy Makers	Crop/Tree/Grass Masks	250-500m, Annually
	Biomass/ productivity/ Degradation	250-500m, daily to weekly
	Soil Moisture	1km, weekly
	Stocking rate	Ha, seasonally/ annually
	Carrying capacity	Ha, seasonally/ annually

NB: For *in situ* data – users need to feedback to the data providers

Data visualization (Web Portal)

Current state – soil moisture and fractional cover

Some wish list for a portal or data visualization tool (near real time)

- **Should be a decision support system (DSS)**
    - Forecasting
    - Stocking rates
    - Carrying capacity
- System should be flexible to incorporate multiscale data
    - Group led by Terry Newby:

DAY 2: 21 JUNE 2016

The 4 per mil initiative on soils by Dr Jean-Francois Soussana, INRA (France) – *(remotely)*

- The 4% initiative is a multi-stakeholder program whose objective is to focus on soil carbon sequestration. The team found that there is a reduction in yield after soil restoration leading to an increase in organic matter.
- Since the UN aims to cut down emissions by 2^0C by 2030, there is a large gap to reduce carbon emissions; the initiative was launched at COP 21. It is an international research programme with seed funding from the French Ministry of Research that seeks to encourage evidence based policy making.
- The initiative was formed by UFO in France and aims to use soil sequestration for the reduction of degradation and improved agricultural productivity.
- The initiative uses metrics and methods for monitoring, verification and reporting of sequestration.
- A declaration of intention will be created for the consortium to decide on actions and in collaboration with RAPP. They can have a model inter-comparison with relation to rangelands.
- Collaboration with GEOGLAM RAPP is possible - to build a data model infrastructure and co-branded products: in order to create some joined products on soil carbon, need to decide on a gridscale and apply a mask excluding cells which are not dominated by grasslands/rangelands (e.g. based on FAO Global land cover).
- Use GEOGLAM RAPP estimates of annual GPP in each cell to calculate:
    - i) The organic carbon returned to soils. This would be primarily calculated as GPP – Rautotrophic – Intake + Organic C returns. However, correction factors for erosion, fires, leaching could also be applied.
    - ii) From the climate and soil data and from the organic carbon returned to soils, we would calculate based on a soil model (e.g. RothC) the soil carbon balance.
- Opportunity to create a first estimate of the soil C balance of rangelands. There would clearly be high uncertainties associated to such maps. **See Presentation for more details.**

Using SAR and LiDAR for mapping woody attributes in rangelands and savannas by Dr Renaud Mathieu, CSIR (South Africa)

- Dr Renaud Mathieu presented on the use of SAR and LiDAR in mapping the woody attributes.
- South Africa has nine biomes: dense forests are very rare and remnants of mostly plantations. Savannas are the largest biome – used mostly for cattle grazing. Densification of savannas is becoming extensive in South Africa.

- Woody information is important because they are the most dominant mixed grass/ woody landscape in South Africa, with browser versus grazing competition.
- The CSIR is focused on change detection and biomass mapping of rangelands. They have a large LiDAR inventory, storage and processing unit on their monitoring sites since 2006.
- The measurements of height, biomass, woody cover, forest types are taken. The challenge with EO is separation of woody vs. grass loads, gradual changes in vegetation, temporal variability, logging and anthropogenic factors, seasonal and climatic variability in the semi-arid and arid regions.
- The CSIR pilot sites: Lowveld Savannah (in KwaZulu-Natal, Limpopo and Mpumalanga provinces), Dukuduku/isimangaliso area, Addo Elephant Park Thicket shrub area and the Agulhas Plains woody alien vegetation.
- The mapping is done using SAR, Optical data and LiDAR (air borne) whereby they also measure carbon presence and classified non-forest areas to be those of less than 10% carbon presence. SAR is better at predicting woody volume than biomass cover. The scale of mapping is at 10-50m spatial scale.
- X, C, L multi-frequency SAR is used for woody cover, biomass and savannah modelling. A combination of L band SAR and optical LANDSAT datasets is also used. C-band data time series can also work in woody mapping in dry seasons with summer reflectance.
- ALOS PALSAR mosaics are used for calibration and validation. The in-situ data is done on field plots of ground biomass mapping and field sampling.
- Use Fieldwork in combination with the remotely sensed data (ALOS PALSAR/LiDAR). A 2010 map has been completed.
- Current and future works at CSIR include Development of systems and robust upscaling methods.
- Leaf area and leaf cover will be more appropriate than biomass.
- Have you considered combining the Landsat and SAR datasets? ALOS gives better accuracy
- How much information can Radar provide about biomass and structure in grasslands?
  See Presentation for more details.

Links between G-range rangeland model and remote sensing data by Ms Cecile Godde (PhD student), CSIRO (Australia)

- Cecile Godde presentedthe current and potential links between ecosystem models and Remote sensing products. She concluded that remote sensing models, ecosystems models and field observations can benefit each other in many ways (for models parametrisation, validation, etc.) and that we need to combine RS models and ecosystems models more efficiently to make use of the spatially dense RS observations.
- Cecile Godde also presented the model G-range which is a global rangeland ecosystem model of moderate complexity built on SAVANNA and Century models. It can simulate and forecast ecosystem dynamics in response to

climatic and management scenarios and has been validated at local and regional scales. It is freely available and can be downloaded online (http://www.nrel.colostate.edu/projects/grange).

See Presentation for more details.

Linking satellite data with forage and livestock models by Dr. Ben Henderson

- C-store model, which has been developed by CSIRO based on the LPJ dynamic vegetation model, uses remote sensed estimates of NDVI and fractional absorption of photosynthetically active radiation as well as burn event data to predict C mass of the various C stores.
- In this study, the authors develop a herd dynamic model that uses C-store carbon biomass estimates as inputs in order to provide near real time estimates livestock production. This herd dynamic model is tested for Wambiana cattle station, Northern Queensland-Australia.
- One of the objectives of this study is to assess the plausibility and value of linking dynamic modelled RS outputs with cattle herd models
- In a longer term, the authors wish to provide near present estimates of livestock production at global scale.
- **See Presentation for more details.**

FAO – GLEAM project (Zambia case study) – Dr. Felix Teillard, FAO *(remotely)*

- Rangelands represent large livestock production in Southern Africa. Livestock needs to increase in context with climate change and changes in rainfall seem to affect forage and production.

The GLEAM MODEL
Demand (Livestock)

- The model uses a demand and supply computing model. The demands include emissions by livestock, livestock populations, feed, contribution to greenhouse gas emissions etc. Feeding is divided into three categories depending on the feed the livestock prefers (grass, crop and by-products) and feed includes land use and diet composition and other feeding practices.

Supply (vegetation)

- The model includes: Dry matter productivity data, human consumption, loss of vegetation to development, access to animals, usable biomass versus total biomass (without the woody data), baseline and drought are calculated.
- Adaption capacity: the model shows a decrease in variability of livestock production year to year compared to the availability of biomass especially in the drought scenario.

Collaboration opportunity with GEOGLAM RAPP

- GEOGLAM RAPP can collaborate with the GLEAM project in terms of data sharing especially in terms of mobility of livestock, availability of biomass, country to country specific data and variations, biomass quality, feed and type of natural which could be useful to the GLEAM model as well.
  See Presentation for more details.

Global Change Impacts on grassland systems across land use gradients: How can SAEON in situ data help RAPP by Ms Sue Janse van Rensberg (SAEON)

- Sue indicated that the mandate of understanding the human induced Global change – by in-situ detection of impacts, uncertainty and knowledge network.
- SAEON has 6 nodes across the SA.
- Soil Moisture (COSMOS) over 30ha.
- She indicated that SAEON wants to extend its long term in-situ data into remote and rare-parameter sites.
- SAEON looks at climate envelope modelling, fire as a local driver for change, C3-C4 dynamics and balance fluxes in the soils, evapotranspiration, Leaf Area Index (LAI), biomass, species shifts, phenology, elevated temperatures, time since fires, energy balance, water balance, biodiversity and soil moisture measurements and how these change with respect to land use and climate change.
- SAEON uses earth-system processes and feedback in-situ data to investigate climate change impacts on rangelands.
- Area of Collaboration: Perhaps remote sensing data can scale up the in-situ data and back up information for farmers in the communities and they can share in-situ data with RAPP.
  See Presentation for more details.

Application of remote sensing derived products for Rangeland management in KZN – Mr Cobus Botha, Department of Agriculture

- Cobus indicated that the unit he is working for the KZN Provincial Department of Agriculture (DARD), in the Natural Resources Section (NRS), which is responsible of characterisation of agricultural resource base of KZN, Technology development and transfer and specialist advisory to land users.
- The natural rangeland of the province of KwaZulu-Natal is made up of 39% grassland, 8% woodland and 23% thicket.
- The NRS give rangeland management recommendations to , livestock farmers, game reserve managers and other organisations about sustainable natural resource management. Projects in this regard can extend to 50 000ha per annum.
- They use remote sensing (NDVI, SR, SPOT) to predict tree density and leaf mass which in turn are used as input variables to correct grazing and browsing capacity models at the landscape level.

- Other remote sensing related products currently in-use and/or in-development include the mapping and quantification of invasive alien plant species such as *Chromolaena ordata, Lantana camara* and *Rubus cuneifolius*; development of herbaceous biomass model based on disc pasture meter measurements for use in drought and fire prediction; correlating micophyllys woodland phenology to Landsat LAI outputs to develop remote sensing based woodland pgenology models and the mapping of C3 grass species using winter NDVI images from high resolution drone photography.

- Limitations include: processing power, and technical man-power to collect in-field data. **See Presentation for more details.**

Monitoring Namibian rangelands from space: Developing a system with farmers by Dr Cornelis Van Der Waal, Agri - Ecological Services

- Namibia is the mostly arid country in the Southern African region with very limited irrigation which cause pressure on rangelands and a decline in grass production.
- 50% of commercial areas causes decline in grass production.
- Early Warning System for Rangelands – crowd-sourced data, livestock market data, field data & earth observation data and GIS are conducted for farmers and supports. Agricultural/grazing NGOs projects.
- The drought and poor grazing habits results in loss of perennial grass and reduced productivity. Namibia has a large variation in forage production.
- They use eMODIS NDVI accessed through FEWS NET website every two weeks during growing season as a monitoring tool to reduce risk.
- They work with farmers who measure rainfall for statistics purposes and livestock market conditions from previous years to the see trends.
- The project also supports communal development project.
- Future plans: separate woody vs. herbaceous biomass in their models and use SAR RADAR data to account for the woody vegetation. They want to predict the end of growing season for herbaceous biomass to reduce uncertainty for farmers.
- www.namibiarangelands.com

See Presentation for more details.

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QUESTIONS/DISCUSSION ON MODELLING

- Educate the farmers on data usability and also obtain feedback.
- Links are required from farmer level to global level.
- Government level implementation is quite difficult rather focus on user level, with the rangeland management being the focus than animal production.
- Regional coordination apps,
- We do not understand the dynamics per regions, user needs oriented can be done easily as a service over smart phones since most users around the world are having smart phones.
- What should we be modelling and to what extent? Animals, Markets, productivity, etc.
- RAPP is a voluntary programme and relies on willingness to participate. What can be done together as a new experiment to provide funding for some activities?
- Forage condition – livestock production – any data needs? C3/4 discrimination?
- Land cover rates of changes, competing land uses and impacts on rangelands.
- Linkage needs to done to UN sustainable Development Goals – land cover, soil carbon & NPP products are needed. Advice need to be provided by RAPP community to the countries.
- Rangelands need to be defined, then identify what is it that need to be modelled, then identify missing activities in the pilot sites.
- Feed supplements and what are the stocking rates?
- Do we have methodologies for producing these products?
- Annual report could be required from pilot sites managers: learning from JECAM.
- There is a need for similar objectives, standards and methodologies RAPP national pilot sites.
- Advantages of participating in pilot sites: Opportunities on joint conferences, free access to datasets, benchmarking,
- Core datasets should include a number of parameters, but each site will have its own core parameters (e.g. cathedral park and Kruger can have different core parameters). The units of measurements (kg/ha), there is a need to characterise land use.
- Australia relies on the measurements from the field-based on transects. Vegetation cover protocol uses transects.
- RAPP should consider the possibility of having sensor specific campaign to look at rangelands.
- Modelling (including in-situ and remote sensing) should be inseparable – for filling in the links and constraining models in a data assimilation approach.
- **Q**: shouldn't the community clarify whether RAPP is about grasslands or about animal protein protection? **A**: the focus should not just be on animal protein but also on rangelands because they drive so much more than the animal protein production. This can be debated further as we move forward.

- RAPP should also include farmers on the ground as in-situ data to validate the information that remote sensing data has provided.
- Tree versus grass separation is possible and these two parameters can be segregated, RAPP should try to separate so the focus is on grass.
- Not all grass is edible and preferred by livestock, the edible grass depends on the nitrogen in the system, therefore nitrogen should also be the focus just as the carbon cycle since animals rely more on nitrogen than they do carbon.
- A high resolution (10-30m) model has more information than the 250m, RAPP wants to focus more on farmers than on government since farmers are the ones who decide whether to sell or keep livestock.
- RAPP should start working at a finer, higher resolution farmer level. Starting at a coarser 250m resolution would be flawed so the focus should start at the end user level.
- The parameters must be clearly outlined and defined, especially for Africa because there are different ecosystems and objectives as compared to other RAPP members which make it difficult as well.
- Approval of universal common grounds and a single structure approach might not be best and the system might have to be unique to countries or perhaps have sub-structures. The RAPP platform should be user friendly and user orientated service (could try apps, SMS, weather forecast app for pastoralists) from these remote sensing tools and farmer inputs.
- SOME OF THE SUGGESTED CORE PARAMETERS ACROSS SITES
    - RAPP should model across all sites(in situ, RS) from land cover, NVP, N2, C3 AND C4 soil moisture and other parameters across all sites.
    - RAPP must have activity data: detailed production, livestock, stocking rates, carrying capacity, and in-situ data across all sites.
    - Land use change, farmer reports, and aerial surveys.
- Full description of all pilot sites, parameters, description and the needs of all sites, data specifications (whether LANDSAT and SENTINEL) needs must all be submitted to RAPP to create a RAPP catalogue. Field data can be used to validate and fill in the gaps.
- Field data requirements protocol must be created so that all data is comparable across all sites and the data is standardised.
- RAPP could be open – so that all sites that have information and are willing to contribute can join, especially other African countries.
- Calibration of data, validation can rely on pilot sites and opportunistic measurements and repeated data collection. Validation methods may also need to be clarified.
- Users can have joint papers on rangelands benchmarking quality data to global standards with communication and citing benefits.
- RAPP must strive to develop tools that can be used at a local level, but can also be regionalised – with a central communications office to manage communication with members and to discuss funding which requires a lot of resources.
- Request for new members for RAPP, still needs a Co-Chair, pilot site coordinators and CoP members and those interested can join.

END