Summary Brief

Establishment of GEO Global Rangelands and Pasture Productivity (RAPP)

Scope

With global population predicted to reach around 9 billion by 2050, not only intensive croplands, but also rangelands, scrublands and pasturelands will continue to come under pressure to further increase their productivity, grassland plant biomass and increase animal protein production, to supply an ever-growing global need for of essential animal protein. At the same time there is much focus on making sure that they are also being managed in a sustainable manner into the future, as their overall productivity is enhanced.

Currently there is no comprehensive global effort for monitoring the status and productivity of pastures and rangelands. Therefore GEO, the Group on Earth Observations and it's Global Agricultural Monitoring (GEOGLAM) initiative, propose to bring together space agencies, existing associated institutional frameworks, in-situ networks, and the pasture productivity modelling community, to establish a dedicated global system for observing pastures and rangeland status, and ultimately to also estimate biomass dynamics and productivity. The working definition of 'rangelands' used here, includes both small farms and extensive livestock operations covering grasslands, savannah woodlands and arid and semi-arid scrublands, where native plant species support production of livestock, while 'pasturelands' are defined as those lands, where improved plant species designed for livestock nutrition dominate the system, and where higher levels of inputs are used (nutrients, water, active stock management, etc.).

Termed "GEOGLAM Rangelands and Pasture Productivity (RAPP)", this new GEO initiative will provide the global community the means to regularly monitor the world's rangelands and pasture lands on a routine basis, and their capacity to produce animal protein in real-time, at global, regional and national levels. The primary scope of RAPP will therefore be to monitor those lands that are integral to producing animal protein on a 'free-range', open-field basis. Where technically possible and where national animal herd statistics are available, the system will include global and regional population information on beef cattle, goats, sheep, camels, pork, dairy cattle, wild and managed buffalo and deer. The system will not address at this point ocean fisheries, and fish-farms, intensive cattle yards, piggeries and chicken/duck farms, which depend on imported feed.

Building on other GEO capabilities and links to space agencies, RAPP will integrate earth observation and *in situ* data, with modelling approaches to map across the globe:

- the dynamics of the nature and quantity of available plant biomass, including its condition and trends in productivity, as affected by natural and human-induced impacts across the globe; and
- the nature and quality of the animals that feed on the biomass and their protein production.

Establishment Steps and Governance

From of April 2013, a small Australian interim GEOGLAM RAPP task team has been established, comprising representatives from the Commonwealth Scientific and Industrial Research Organisation (CSIRO), Queensland Department of Science, Information Technology, Innovation and the Arts (DSITIA) and the Australian Bureau of Agricultural and Resource Economics and Sciences (ABARES) (within the Australian Government Department of Agriculture, Fisheries and Forestry - DAFF). This group will work to establish a more formalised governance structure to connect in turn to the GEOGLAM initiative, and build international linkages to space agencies, relevant global institutions and in-country national programs and structures.

The final proposed governance structure would likely include: (1) a high-level Steering Group, made up of key global institutional partners, task leads, donors and users; (2) a Scientific Expert Advisory Panel, comprised of science and technical experts in the field of rangeland monitoring, livestock production modelling and ecosystem scientists, as well as (3) a RAPP Technical Implementation Group, comprising technical experts from relevant agencies or research bodies, as well as representatives of countries where demonstration projects would be undertaken.

The current draft work plan includes the following activities and outputs, delivered over three phases:

Phase 1 (Feb 2013 – December 2013):

- identify and bring together initial members of the community of practice
- establish contributors to the task and an appropriate governance structure
- establish an effective communication and liaison strategy
- identify the required functionality and associated technical specifications required for the RAPP, associated input data needs and type of information provided as output.
- develop an initial "strawman" draft implementation plan for the RAPP

Phase 2 (Jan 2014 – June 2015):

- agree on development of three or more regional rangeland monitoring demonstration/pilot projects for evaluation of mapping methods and model inter-comparison trials.
- evaluate available pasture and rangeland mapping methodologies applicable at global scales, that can be implemented in a future operational system.
- work with the Committee on Earth Observation Satellites (CEOS) and associated space agencies to support satellite data acquisition for the initial pilot systems.
- identify and evaluate, using contrasting pilot sites, those animal production and biomass growth models that would be suitable for future implementation in the global system.
- set up a subsidiary R&D program for continuous improvement of the operational RAPP System.
- gather and produce supporting information about the task and publish online.
- a review meeting to finalise a five year plan for RAPP implementation, including relevant R&D activities, capacity-building and operation arrangements of the RAPP

Phase 3 (June 2015- December 2017):

- coordinate and facilitate access to *in situ* observations, survey data and ancillary resource data, used for model parameterisation or validation of rangeland type and area maps.
- establish the data portal for users to access key datasets, information, updates and case study results.
- establish or facilitate the development and operation of at least one system monitoring pasture and rangelands at a global scale.
- develop an explicit connection to the Agricultural Market Information System (AMIS) (a related G20 initiative)
- develop guidelines, standards, and tested approaches to enhance the capacity of national observation systems.

- provide support to develop a regional system for countries at risk
- provide a focal point and R&D coordination around technologies and approaches and particular research priorities.

Specific Outcomes

The ultimate goal of GEOGLAM RAPP and the associated GEO task group that will establish the monitoring system, will be to develop a global monitoring capability and associated domain expertise, to track the amount and status of plant biomass and animal protein produced from open rangelands and managed pastures, and also importantly the status of the land systems that sustain this production into the future.

At a technical level, despite significant achievements in the measurement and monitoring of vegetation cover, tree cover, greenness and more recently dead cover, and in the detection and monitoring of tree cover, this has not translated into robust global operational systems that link to livestock production estimates/models, and move beyond regional coverage within some countries; there is no operational global assessment. Consequently, success will in the first instance will be measured by the development of at least one system established to monitor and report on rangelands / pasture lands status and production across key regions of the globe.

Key outcomes from success of the task will include:

- an improved capacity to manage risk and improve production of animal protein at a range of scales due to a better understanding of the trends in biomass and its use for protein production.
- the capacity to more effectively manage variability in production due to more timely and accurate national and regional agricultural statistical reporting and early warning of meat production shortfalls.
- more effective planning based on accurate forecasts of pasture and rangelands productivity variability.
- improved global understanding of risk across all landscapes as climate and land use change through the addition of these lands into global agricultural monitoring.

Success in the task and the RAPP *per se,* will be analogous to related GEOGLAM components, however, for many reasons, the institutional and operational capacity in rangelands monitoring lags behind that in the cropping arena, creating specific challenges in the development of this global system.

Draft System Components and Outputs

It is envisaged that the RAPP will be built from efficient integration of earth observation data, *in situ* observation data and robust pasture and livestock productivity models. This system will also need to be integrated into national environmental and agricultural statistics.

The RAPP will produce information in a spatially-explicit manner on:

- the amount of aboveground biomass and the various components of change – for example, the differentiation between expected seasonal variability versus the effects of degradation processes on long run decline *versus* the impact of drought or flood. To do this, the system will need to quantify the relative proportions of trees, live grass and forbs, dead plant remnants, bare soil – and water, as well as biomass dynamics.
- the proportion of biomass which is grazed or removed in other ways (eg. hay removal). This will require connection with *in situ* measurements/monitoring sites, the use of grazing system

models (eg. the GRASP model http://www.longpaddock.qld.gov.au/grasp/) and the various survey methods for herd estimation and hay removal.

Determining the spatial and temporal extent

To maximise its utility as a spatially explicit rangeland-management-support system, the RAPP system will use wall-to-wall satellite data and standardised land-cover mapping approaches, integrated with ground measurements of aboveground biomass and simulation modelling. The scale and frequency will be routinely revisited and refined through end-user and expert consultation – suggested components are likely to include:

- finest scale, lowest frequency: 25m; yearly
- broadest scale, highest frequency: 250-500m, seasonal
- selected global datasets that more directly relate to standing biomass (eg spaceborne stereo imaging, spaceborne lidar and SAR)
- integrated simulation modelling – process-based and/or probabilistic predictions

Input data sources

Regardless of the final scale and frequency chosen, input-data sources are likely to include:

- time series remote sensing of biomass and change (optical multispectral and SAR)
- *in situ* measurement of aboveground biomass using techniques ranging from conventional destructive sampling to proximal sensing devices (e.g. terrestrial lidar)
- ancillary data:
    - land use and tenure maps
    - pasture and woodland productivity models
    - survey data of various kinds – crucial to connect to data on animal distribution and movement
    - climatological, soils and soil-moisture data
    - the connection from local-to-global consumption and animal protein production

In addition, there are a number of measurements, modelling and monitoring activities, which are complementary to the aims of the sub-task, and are an essential connection. These include:

- land condition activities where the focus is on desertification prevention, biodiversity protection and related aims; and
- soil degradation monitoring developments, which sense ground cover dynamics, proportion of bare uncovered soil and algorithms to fractionate the cover into green and senescent vegetation and various forms of soil exposure (the accent in these programs has been on the modelling and prevention of soil erosion by wind or water).

While these programs are secondary to the core focus on biomass and food, they are important components to the overall environmental sustainability goals of the sub-task.

Start-Up Phase 1 (2013)

A proposed inaugural RAPP task meeting was held in Australia in conjunction with the International Grassland Congress - September 2013, to discuss the draft implementation plan and further build the community of practice and task participants. It also provided an opportunity to further develop the task goals, work plan, address technical issues, suggest countries/regions for initial demonstration, and confirm and start to build the governance structure.

Together with the invited September-2013 task meeting participants, the interim RAPP team provided an update during to the GEO Plenary in January 2014.
Further activities planned for 2014:

1. Conduct an environmental scan that:
    1.1. identifies and characterise current national and regional rangeland and pasture monitoring systems and exemplar projects
    1.2. identifies suitable pasture-growth and anima production models for use in the model inter-comparison trials over pilot sites
    1.3. provides an inventory of relevant operations and research
    1.4. collaborate with GLAM Leads on coordination of satellite data to fulfil key objectives
2. Refine the scope of the task including:
    2.1. facilitating the preparation of key documents including agreements
    2.2. facilitating discussions about possible methodologies with the science advisory committee
    2.3. identifying initial focus/pilot areas and operational systems with the potential of contributing to a global system, or as a template for enhanced national systems
    2.4. identifying initial research and development needs and activities – especially the establishment of rangelands JECAM sites (refer to Appendix 1)
    2.5. developing and distributing the first prospectus – aimed at likely funding sources
3. Develop a budget and funding activities including:
    3.1. strategy to connect with the GEO GLAM initiative and contribute to funding proposals / initiatives
    3.2. identifying funding options in specific geographic areas – eg. through developed country aid budgets
    3.3. establishing an initial funding base to support the development of the initiative.