

ITC NEWS

NATURE AND
AGRICULTURE
IN BALANCE

NRS DEPARTMENT



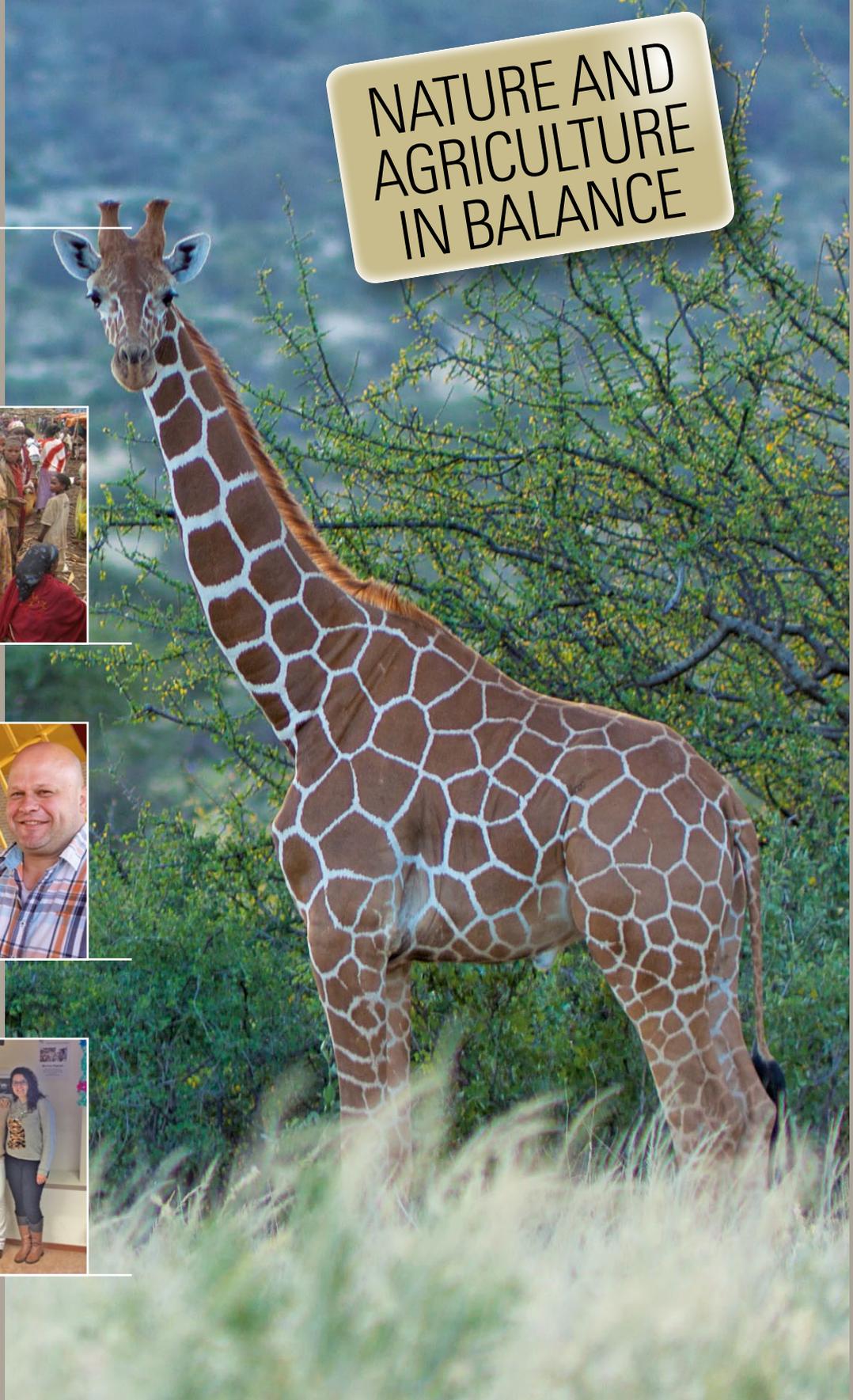
MICRO INSURANCE



RAMANI



NRM HERO



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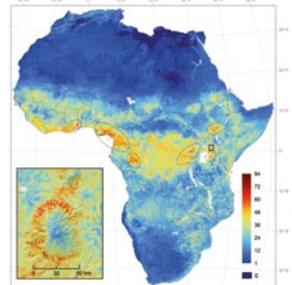
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3



12



14



16



21



cover

Content

■ SPECIAL FEATURE: NATURE AND AGRICULTURE IN BALANCE

- 3 Nature and Agriculture in Balance
- 4 Information for Sustainable Management of Forest Resources and Rural Energy Requirements (InForEnergy)
- 6 Climate Resilient Participatory Afforestation and Reforestation Project (CRPARP) Bangladesh
- 8 Geo-Information for Conservation
- 9 Geo-Information for Micro-Insurance
- 10 Quantifying Plant Trait from Remote Sensing
- 11 Remote Sensing Essential Biodiversity Variables
- 12 Species Distribution Modelling, Habitat Selection and Animal Tracking

■ RESERCH NEWS

- 14 Unique High Resolution Map on Bat Diversity in Africa
- 15 Systems and Sustainability in Time and Space

■ PARTNERSHIP NEWS

- 16 ITC and Namibia University of Science and Technology Pursue Collaboration

■ ENTREPRENEURSHIP AT ITC

- 17 ITC's First Spin-off Ramani Facilitates Public Use of Earth Observation Data
- 18 Producing High-Quality 3D Maps from LIDAR

21 GREETINGS FROM

■ EVENTS

- 22 NRM Hero Report

■ LIFE AFTER

- 24 Annual General Meeting of ITC Alumni Association Bangladesh

At all levels, from individuals or families, up to regions and nations, we are constantly challenged to find a sustainable balance in the way natural resources are used to provide society's needs such as food, materials and a healthy and diverse natural environment. Read more about the activities of the NRS Department from page 3 (Photo: Jelle Ferwerda, www.bio-vision.nl)

INTRODUCTION

Presenting the first issue of ITC News for 2016! And where better to publish reports of sophisticated entrepreneurial initiatives originating from the UT campus. Page 18 introduces readers to DIPPER, a spin-off company offering services related to LIDAR data processing and 3D scene modelling. To quote: "one operator working with DIPPER on one laptop can create high-quality 3D maps for 10,000 buildings within just one week". So definitely an article to arouse readers' curiosity and interest. And here comes another new name: Ramani (the Swahili word for "map"). This, the first spin-off company of ITC, is committed to facilitating public use of earth observation data, and a full description of the aims and solutions offered by this brand new technology provider can be found on page 17.

Although the Department of Natural Resources cannot be considered new to ITC News, as you can read in the special feature on page 3, innovation goes hand in hand with development as NRS pursues its vision of societal access to innovative spatial science for sustainable natural resources management – a vision that seeks to strengthen capabilities to meet the environmental challenges facing the world today. Departmental research, education and project work focus on the societal benefit areas biodiversity, agriculture and ecosystems, and all three are represented in the following pages. What say you to articles on essential biodiversity variables (page 11), micro-insurance (page 19) and forest resources and rural energy requirements (page 4)? Geo-information technology also plays a significant role in wildlife conservation, facilitating extensive research into such problems as habitat loss and human threat (highlighted on page 12), as well as the creation of species distribution models to chart species diversity and endemism patterns and enhance understanding (page 12).

Nevertheless, as ITC News is written by people for people, let us turn full circle by finishing with a report on another new initiative, this time an event to honour people of creativity who endeavour to mitigate adverse impacts on society and the environment: the NRM Hero election. All is revealed on page 22, where we are proud to introduce the very first NRM hero!

Virtually yours,
Jorien Terlouw
Editor

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Nature and Agriculture in Balance

Global change, driven by a growing population and rising economic productivity is increasingly placing pressure on scarce land resources. At all levels, from individuals or families, up to regions and nations, we are constantly challenged to find a sustainable balance in the way natural resources are used to provide society's needs such as food, materials and a healthy and diverse natural environment. Our landscape and our management of the landscape is constantly changing in response to changes in climate, technology, the economy, our knowledge and so on. Hence natural resource management has an implicit focus on the role of people in the production landscape, as well as the landscape itself.

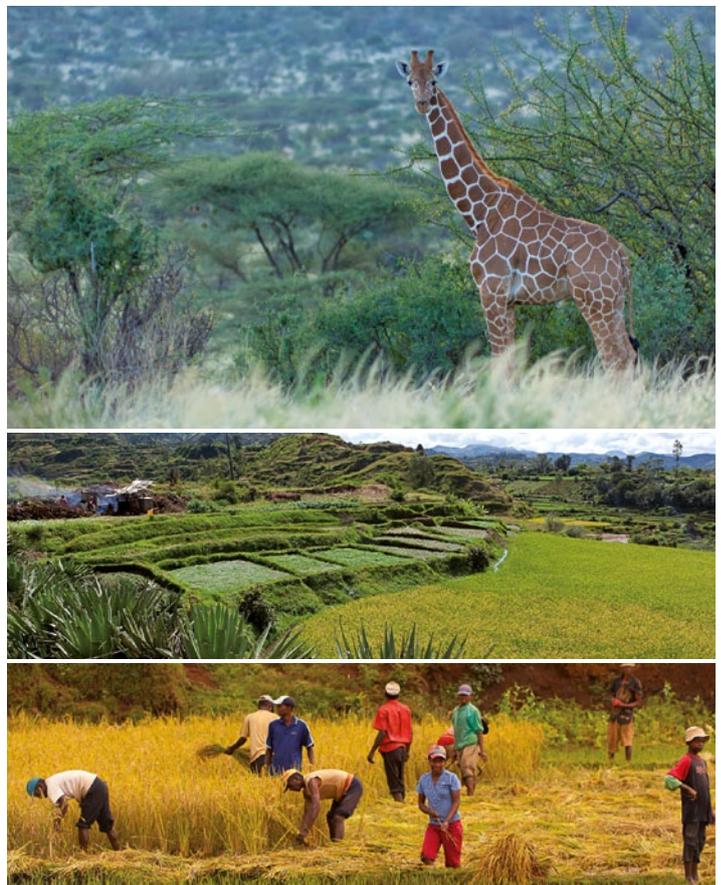
Adequate solutions to environmental challenges such as biodiversity loss, unsustainable agriculture, deforestation, overgrazing, landscape fragmentation and the depletion and contamination of land and water resources require an integration of multiple perspectives and knowledge fields. To address these challenges and help secure a productive and healthy environment for everyone, the Natural Resources Department (NRS) has the vision that society should have access to innovative spatial science for sustainable natural resources management. NRS, in collaboration with partners around the world, develops research, education and capacity development products around new methods in GIS and RS in order to enable planners, managers, policy makers and researchers to effectively use geo-information and earth observation insight and technologies for the sustainable management of agriculture and the environment.

In this special feature, we showcase some examples of our research, education and project work in three societal benefit areas that the NRS department focuses on:

- **Biodiversity:** remote sensing of essential biodiversity variables to measure the status and trends of the world's biodiversity, and supporting decision-making for the conservation and improved management of natural resources.
- **Agriculture:** insurance, risk assessment, advancing the accuracy of measurements for crop and crop management parameters for food security and production supply assessments, effects of climatic drivers and shifts of food production.
- **Ecosystems:** assessing and monitoring ecosystems with particular emphasis on forest, savanna and grassland resources, measuring the delivery of associated ecosystem services, and improving spatial information on ecosystem conditions and trends.

A clear theme throughout is that remote sensing and GIS play a central role in the search for clear analyses and viable policies for sustainable natural resources management at local to international level. The focus of NRS is on defining both the means and the measurements which are essential for monitoring trends, tracking changes and enabling action to sustain biologically

diverse environments and productive agricultural systems. By making our research and methods available and through collaboration with partners worldwide, NRS is answering the call for access to more timely, more detailed and more relevant data from all parts of society which is essential for guiding progress towards the UN Sustainable Development Goals and a ensuring more sustainable future for all. I thank my colleagues in the department who compiled the stories on the following pages and I hope you enjoy reading them. ■



Photos: Jelle Ferwerda, www.bio-vision.nl

Information for Sustainable Management of Forest Resources and Rural Energy Requirements (InForEnergy)

In the landlocked mountainous country of Bhutan about 75% of the land cover is forest. This forest used to be state owned but in 1979, the King of Bhutan stated that “The participation of the local community is the key to conservation and utilization of forest resources”. This was the starting point for the development of social forestry in Bhutan as a government supported program. Good progress has been made and many approved community forests (CF) were established in the country. In principle, when a village has a community forest, the villagers are supposed to meet all the wood requirements from their CF, including wood for energy.

However, neither the communities nor the Department of Forest and Park Services have the knowledge and skills to assess the quantity of available wood resources or analyse changes in forest and wood resources over time. As a consequence it is a challenge to quantify how much can be sustainably extracted. In various stages in the wood processing chain from forest to the end users, several waste products are produced. Some of these waste products can be used to generate bioenergy. To what extent people benefit from these waste streams is not yet clear as a complete overview of the production chain is lacking. Optimizing the use of forest waste

implies determining where these products are found and how to minimize transport of heavy and bulky biomass.

In order to meet their challenges, the Department successfully applied for a Tailor Made Training, funded by the NUFIC NFP-TMT program. Three staff members of the NRS department developed a comprehensive training program including 2 modules of classroom teaching, a distance education module and a study tour to Nepal, with a final workshop in Bhutan. Participants were selected from various districts.

In the first module, which took place in November 2015 in the Bhutanese capital Thimphu, Louise van Leeuwen and Kees Bronsveld introduced the participants to the use of remote sensing data for forest cover monitoring and assessment of available biomass. In addition participants spent a day in the field where they learned to use their mobile phones and Google Earth images for navigation and field data collection.

After six intensive days, participants and teachers happily went home and started on the subsequent distance education module focussing on identification of changes in



All participants received a certificate at the end of the course



forest cover, using the skills they learned in the first module.

In the third module, taught by Iris van Duren in January 2016, the focus was on wood energy assessment and energy production efficiency analysis. Participants were introduced to the concept of bioenergy and learned to create input maps for assessing bioenergy potential from the wood industry. They gained insight in sustainable production of energy from wood resources in a spatial context.

Then in February 2016 Louise took the group to Kathmandu in Nepal where

ICIMOD and the Ministry of Forest and Soil Conservation were visited amongst other places where the participants learned from the Nepalese experiences in community forestry. Of course it wasn't all work: a number of temples and Stupas, important in the Buddhist religion, were visited and ample time was reserved for shopping. One of the highlights of the 5 days in Kathmandu was the dinner with a group of NRM alumni at The Valley Restaurant in the city centre. Participants experienced Nepalese food and had lively interactions with the alumni.

A final workshop in Thimphu concluded the training program. In the workshop,

participants presented their achievements and ITC staff presented some options for more advanced training.

At the end of the workshop his Excellency Mr. Yeshey Dorji, the Minister of Agriculture and Forests, handed out the certificates to the participants and a group lunch concluded the event and the training program. ■



The traditional group picture of all the participants

Climate Resilient Participatory Afforestation and Reforestation Project (CRPARP) Bangladesh

Bangladesh is one of the most densely-populated countries in the world, highly vulnerable to natural disasters such as flood and drought and highly likely to be one of the most impacted countries from climate change, especially sea level rise and the increased frequency of extreme weather events.

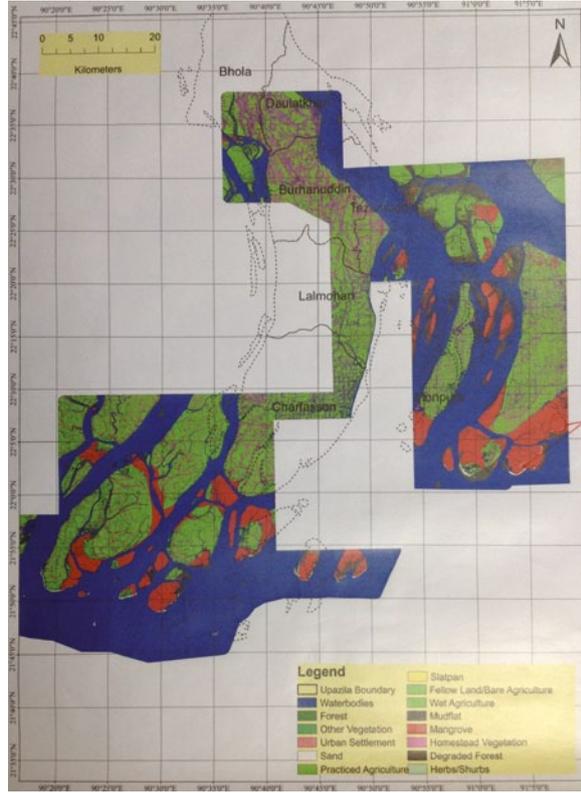
Global climate change models show that declining forest cover, especially in coastal (mangrove) and hillside areas significantly reduces the ability of countries to mitigate the impacts of climate change (CRPARP, 2015). For example, mangroves act as buffer zones against the impact of storm surges and tropical cyclones, while hillside forests increase the capacity of the land to absorb rainfall and reduce the risk of landslides and erosion. When sustainably managed these forests provide valuable natural resources and food sources as well. In this context, participatory afforestation and reforestation in coastal and hilly areas will be a key contributor in meeting the challenge of adapting to climate change through better and more sustainable management of forest resources.

Forests are a very important renewable resource in Bangladesh and play a crucial role for the livelihoods of local communities in the coastal and hillside areas of the country. In addition, forests provide valuable ecosystem services: they maintain local climate and strongly influence global fluxes of oxygen and carbon dioxide; protect top soil, prevent soil erosion and maintain food wave. The Bangladesh Forest Department (BFD) has been afforesting the coastal region since the 1960s to protect the environment (CRPARP, 2015).

BFD guided by The Ministry of Environment and Forest (MoEF) planned to increase the afforested and reforested areas in the selected coastal and hilly areas since these areas are ecologically critical. To strengthen the institutional capacity of the forest department to manage forest in a participatory and sustainable manner, Yousif Hussin is helping the Climate Resilient Participatory Afforestation and Reforestation Project (CRPARP) as a forest resources monitoring and assessment specialist by advising on the use of remote sensing and GIS in forest monitoring. Specifically staff members of MoEF are being trained in the use of the above mentioned technologies to assess the reforestation and afforestation activities of the project. In the long term, this capacity building and training role will improve the technical knowledge, improve forest resource monitoring and assessment, assist program monitoring and support long term planning for the sustainable development of the forest sector. ■

Reference: CRPARP (2015) Climate Resilient Participatory Afforestation and Reforestation Project
<http://crparp-bfd.org/about-crparp/>





Geo-information for Conservation

Global biodiversity loss is intensifying. But measuring and monitoring these changes on the ground is laborious and limited. Biodiversity monitoring aims at ensuring the conservation and sustainable use of resources and is receiving increased attention in the wake of the growing awareness about the detrimental effects of human activities and climate change.

Geo-information technology is crucial to addressing these challenges and it has become an important tool for many of us trying to conserve wildlife. Developing and applying geo-information technologies for biodiversity monitoring and conservation is one of the core education and research themes at the Department of Natural Resources in ITC. Many of our students are working on this topic. The following is based on a study done by two of our PhD researchers.

Endangered bird species conservation in China

The Asian crested ibis *Nipponia nippon* in China — like many other endangered bird species in many parts of the world — has suffered severe decline and range contraction due to historical and ongoing threats from habitat loss and anthropogenic disturbance. Geo-information and geospatial technologies allow for more data-intensive and spatially-explicit and extensive research than traditional ground-based methods. By using satellite data and GIS-based expert system, Ms. Yiwen Sun, a PhD candidate funded by the China Scholarship Council (CSC) has accurately mapped the habitat critical for crested ibis — the small and scattered patches of winter-flooded rice fields. Unexpectedly, this habitat was found to have continuously reduced even under protection, which is likely to pose a threat to the population recovery of crested ibis.

However, the analysis of spatial patterns in species and habitat distributions showed that the dependence of crested ibis on the

winter-flooded rice fields varied spatially and decreased over the years, with the recent return of crested ibis to more varied habitats. Moreover, species distribution modelling with satellite-derived environmental predictors offered insight into the habitat preferences of crested ibis and the potential suitable areas where it may recolonize in the future. Using historical data and future projections, the species distribution models were applied to establish baseline information on the geographical and ecological distributions of crested ibis, and to explore the impact of future climate and land-cover changes on its distribution. The advanced application of geo-information and geospatial technologies provides us with a simultaneous understanding of patterns and processes of landscape change as well as detailed responses of crested ibis to these modifications over geographical space and time at multiple scales. These findings enable the prioritization of conservation efforts, and facilitate the development of proactive strategies for *in situ* conservation and reintroduction of crested ibis.

Combating elephant poaching in Kenya

The African elephant *Loxodonta africana* is undergoing a massive onslaught across its range. Between 2011 and 2014, the poaching of African elephants reached the highest level ever recorded. In just three years' time, around 100,000 elephants were killed for their ivory. In a relatively short period, illegal killing has become the greatest threat to elephants, second to the loss of their habitat. Geo-information and geospa-

tial technologies are currently in use to monitor the elephant ranging patterns and human threats. Mr. Festus Ihwagi, a PhD candidate funded by the Netherlands organization for international co-operation in higher education (NUFFIC) program has modelled elephant response to poaching. Analyses of spatial patterns of poaching in landscapes under varied land use types have revealed where poaching was high as well as the most preferred land use types for safeguarding elephants from poachers. The statistical modelling approaches show that accommodating elephants in pastoral community-owned land is the most promising model of conservation, and in particular securing elephants from poachers. Exploring patterns of fine-scale movement metrics in relation to the poaching threat is revealing how the elephants adapt to poaching risk in a bid to escape the poacher's bullet. These findings increase our knowledge of how elephants make decisions in risky habitats as well as the best management practices for the largest land dwelling mammal on our planet. ■



Asian crested ibis (photo: Guoqing Zhang)



African elephants (photo: Frank af Petersens)

Geo-information for Micro-Insurance

Smallholder farmers can increase production and profits if they invest and adopt recommended management techniques. However, many farmers lack the financial security needed make these changes. They are generally wary of investment because of threats to their livelihood and income due to loss of production attributable to such perils as drought. Micro-insurance (MI) is seen as one mechanism to solve this problem and farmers have shown a lot of enthusiasm for such schemes.

The past ten years have seen increasing interest in and development of MI products that insure farmers against perils – notably against the impact of drought. Development organizations such as the World Bank (IFC), WFP (IFAD), ILO and USAid followed in the footsteps of many active NGOs, specifically OXFAM, with various implementation partners, notably Munich-Re and Swiss-Re, with knowledge and solution partners sharing in the action. Typically, the aim was to find modalities and methods to create sound and fair scalable models, while the focus lay on capturing the impacts of perils through weather indices and remotely sensed derived indices. A multitude of different schemes have followed; many were heavily subsidized pilots that contained heavy research components; few have survived, partly due to the lack of a sound business model.

In 2014, ITC joined in the MI efforts through a Dutch-funded G4AW project called GIACIS in Ethiopia. The G4AW “rules” dictated that the project must be based on proven methods (i.e. no research), must be at scale, and must be based on a sound business model. In addition, remote sensing imagery had to provide the data for the product, from which smallholders could reap the benefits.

A period of contemplation followed, which specifically considered the problems faced by previous MI pilots, but also considered the lengthy research track at ITC on the use of hypertemporal imagery for mapping and monitoring agricultural systems. This resulted in an innovative scheme that addressed the five G4AW rules. One key decision was not to insure yields because no one can know the exact impact of a single peril. The validation costs made in the field cannot be funded by the insured farmers themselves, and yield is basically an output of the farmers’ business model,

which should never be insured. Instead, the incidence and severity of the peril to which a farmer’s enterprise is exposed should be insured. Our MI product is thus crop-invariant, though very area-(pixel-) specific. Another key decision was not to strive for long time series of data (e.g. 30 years), but instead to try to group farmers into populations that historically have similar crop-growing conditions and similar variability concerning the peril in question. This grouping is carried out using the available time series of the index related to the peril. In our case, this is the NDVI (greenness of the land cover), which responds to water availability (drought). Thus, for each defined population, the required NDVI-based (trigger and exit) thresholds could be extracted with great accuracy for each 10-day period of the growing season at any given loss rate. The prepared area stratification (population) was labelled “Crop Production System Zoning” and supersedes, in our view, methods of mapping agro-ecological zones.

In 2015, all the population statistics and maps were generated and the method was embedded (at scale) into the public-private

partnership of the G4AW project, led by the private partner Kifiya. Then, in early 2016, the sales season was officially launched in Addis Ababa, with a target of 200,000 farmers to be insured in 2016, growing to 15 million in 2021.

The implementation efforts are coordinated by the Public Financial Enterprise Agency of Ethiopia, and are carried out in collaboration with the Ethiopian Insurance Corporation, the Agricultural Transformation Agency, the National Meteorological Agency, and Kifiya as private-partner enabler. Swiss-Re functions not only as advisor to the consortium but also as the reinsurer.

We expect to encounter some teething problems during the first year of implementation, particularly since the initiative is the first of its kind. However, we are confident that the underlying geo-information science will now undergo a valorization effort at scale that addresses needs, does not depend on subsidies, and will hopefully help to extricate farmers from the fix they find themselves in when contemplating investments. ■



Quantifying Plant Traits from Remote Sensing

Quantifying and mapping plant traits known as the biophysical and biochemical parameters of plants is a step towards the sustainable management of natural resources and biodiversity. Many of these traits are inputs into agricultural, ecological and meteorological models, and several have been recognized as essential biodiversity variables by GEOBON.

These include leaf area index (LAI), chlorophyll, specific leaf area (SLA), water content and nitrogen. Field measurement of these traits is labour-intensive, costly, and only practical for limited samples. Remote sensing has been recognized as a reliable method of mapping and monitoring vegetation and the only practical means of estimating these traits on a large scale.

Utilizing remote sensing for vegetation studies implies that knowledge of vegetation type, species, growth, health and productivity is obtained from their spectral signatures. Neglecting peripheral factors such as soil background and atmosphere, plant traits are the main features affecting the spectral signature of vegetation. Understanding the link between these traits and a plant's spectral signature is therefore essential. However, knowing the process by which these traits affect the plant's spectral signature is not sufficient; it is crucial to understand how these traits interact and how the combined interaction will affect the spectral signature of vegetation.

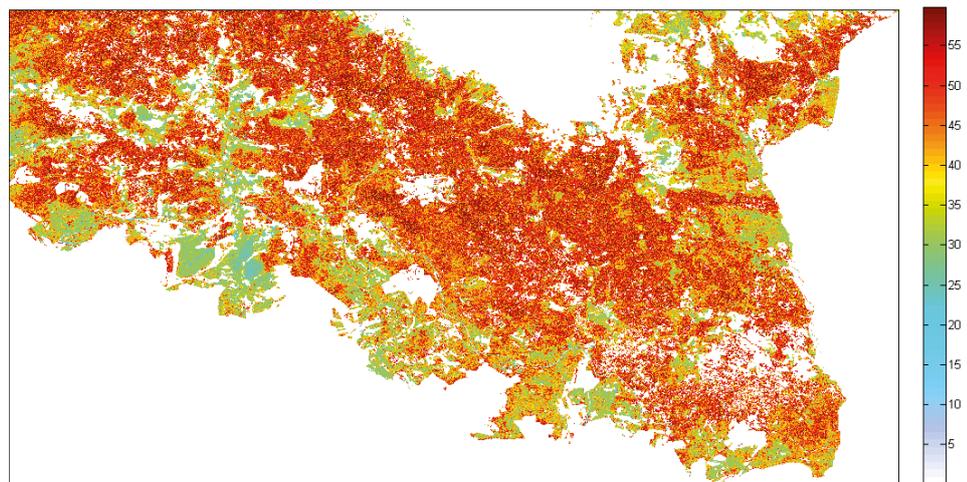
The Department of Natural Resources (NRS) of the Faculty ITC is leading in the innovative applications of a wide range of remote sensing data (including the new generation of multispectral, VIS/NIR/thermal hyperspectral, and LIDAR sources) and models (including empirical and radiative transfer models) to quantify, map and monitor plant traits. Client traits have been successfully retrieved at the laboratory, field, airborne and satellite levels.

We have examined the retrieval of plant traits in different ecosystems, including rangelands, croplands, wetlands and forest, at leaf and canopy levels. Many of these traits were estimated using spectral information obtained from narrow wavelengths that exist in hyperspectral data in the VIS/NIR regions. Our recent investigations on this journey through the work of several PhDs has shown that plants have interesting spectral features in the thermal

infrared domain, and some plant traits can be estimated from thermal hyperspectral data at leaf and canopy levels.

NRS continues to innovate and employ state-of-the-art science in earth observation and geo-information for quantifying plant traits, to gain a better understanding and foster sustainable management of the Earth's green cover. ■

“ Plant traits commonly referred to as biophysical and biochemical properties of vegetation play a significant role in characterizing the spectral signature of plants ”



Map of leaf chlorophyll content ($\mu\text{g cm}^{-2}$) for Bavaria Forest National Park obtained using Radiative Transfer Models and RapidEye data (Darvishzadeh et al., 2016)

Remote Sensing Essential Biodiversity Variables

Essential biodiversity variables (EBVs) are defined as the key variables required to study, report and manage biodiversity change, focusing on the status and trend in elements of biodiversity (Figure 1). They have been proposed as a layer between biodiversity observations and the biodiversity indicators used in policy, thus providing guidance to the observation system as well as insulating that system from changes in policy.

EBVs tend to fall into six classes, based on the general consensus at workshops and conference discussions (Pereira et al., 2013). Some EBVs can be derived from remote sensing observations. Because of their origin in satellite-based instruments, these RS-EBVs, while still EBVs, have some special characteristics that make them easier to implement. In particular, they are characterized by global periodic observations that are essentially spatially continuous. Furthermore, data providers are fewer in number (i.e. space agencies and private companies), which makes coordination easier, and most of the observations already exist or are in an advanced stage of planning (e.g. LIDAR and hyper-spectral, in which NRS researchers are very active). In addition, RS-EBVs can fill the spatial and temporal gaps left by in situ observations.

A remote sensing EBV development approach is suggested by Skidmore et al. (2015). They propose a list of candidate RS-EBVs (Table 1) by carefully considering such factors as scale, required resolution

(temporal, spatial), as well as priority, feasibility and implementation status.

These ten candidate variables represent some of the most relevant, achievable and comprehensive variables for assessing and monitoring biodiversity globally from remote sensing observations. The list contains RS-EBVs that are continuous and biophysical, such as leaf area index, as well as others that are threshold-based, such as land cover. Also, similar to some essential climate variables, some of these RS-EBVs are actually groups of related variables that may, for example, be derived from the same set of observations. A full list of the approximately 60 potential RS-EBVs generated by GEOBON experts are now being described in greater detail, identifying, for example, the multiple variables that a compound RS-EBV contains, and also sensors that could provide the needed observations. NRS staff, as well as MSc and PhD research, are focusing on the monitoring and mapping of these important environmental variables.

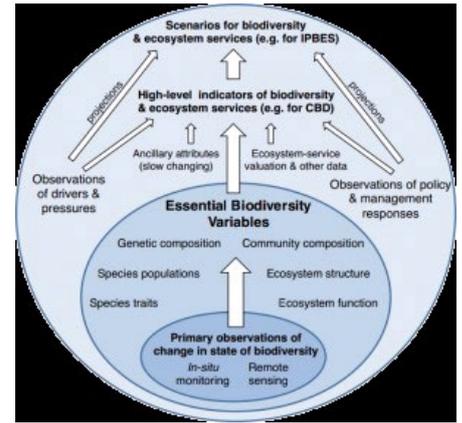
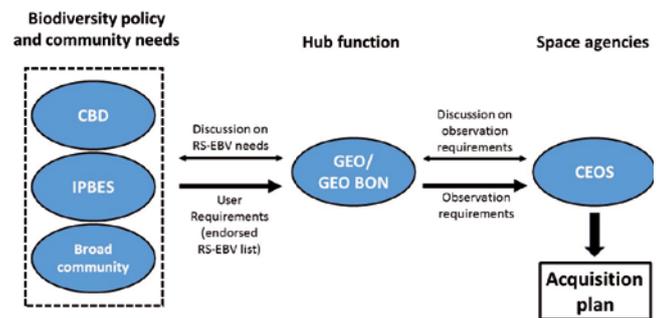


Figure 1 Contextual diagram showing how EBVs fit into the broader picture (Pereira et al 2013)

With this list as a starting point, the ultimate goal is putting a plan in place to acquire the needed satellite observations to generate the RS-EBVs. The key organizations for this are the CBD, IPBES, CEOS and GEOBON, with GEO playing a facilitative role; however, the broader biodiversity community is also involved. NRS/ITC is active in GEOBON, as well as IPBES. ■

Table 1 Candidate RS-EBVs identified during two GEOBON (Group on Earth Observation Biodiversity Observation Network) workshops; these are mapped into the Aichi targets to highlight their relevance to current global policy efforts.

EBV Class	Candidate RS-EBV	Suggested for Aichi target
Species populations	Species occurrence	4,5,7,9,10,11,12,14,15
Species traits	Plant traits (specific leaf area, leaf nitrogen content etc.)	7,9,12,14
Ecosystem structure	Ecosystem distribution	5,10,11,12,14,15
Ecosystem structure	Fragmentation and heterogeneity	5,11,12,14,15
Ecosystem structure	Land cover	5,7,10,11,12,15
Ecosystem structure	Vegetation height	5,7,9,14,15
Ecosystem function	Fire occurrence	7,9,10,12,14,15
Ecosystem function	Land surface phenology (variability)	5,9,11,12,14,15
Ecosystem function	Primary productivity and LAI	5,7,10,12,14,15



Further Reading

Pereira H.M. et al., 2013. Essential biodiversity variables for global Earth observation. *Science* 339:277-278.

Skidmore A.K. et al., 2015. Agree on biodiversity metrics to track from space. *Nature* 523:403-405.

Species Distribution Modelling, Habitat Selection and Animal Tracking

For the implementation of conservation measures, it is important to know where and in what densities species occur. But it is also important to know why these species occur in their specific habitats, because the protection of species, both plants and animals, relates to protecting not only the species itself but also its habitat.

Species distribution modelling (SDM) is a commonly used approach to secure more information on both the distribution and densities of a species (e.g. is it threatened or endangered?) and about the importance of the different environmental variables. These techniques are in principle correlative approaches where the presence or absence of a phenomenon (e.g. the presence of a rare species or a disease) is explained by other measurements, such as land cover or climatic conditions. Many different modelling techniques (such as generalized linear models, regression trees or machine learning techniques) exist, and the suitability of each technique depends on not only the objective but also the information available. In the NRS department, we investigate how the quality and quantity of the used information affects the reliability of these techniques, and which techniques work best under which conditions. Such insights contribute to making the application of SDM techniques more robust under the varying applications.

We use these insights in various research projects that aim at biodiversity conservation. For example, vast numbers of birds use the Strait of Gibraltar as a major corridor in their migration route, leading to the collision of many birds with local windfarm turbines. In a consortium with the University of Malaga, the Junta de Andalucia and Fundacion Migres, the NRS department contributes its expertise by tagging many raptors with GPS loggers and analysing the data using remote sensing, GIS and SDM techniques. In the same region, gap analysis has been carried out on how well raptor species are protected by conservation areas. Comparable studies have been conducted on the hybridization of the endangered endemic Capricorn with local goats, and the hybridization of the endangered wild cat with local house cats, both taking place in Crete, Greece. At the much wider extent of the European Union, an analysis was conducted for the European Commission to determine how well the pan-European Natura 2000 network covers all 211 occurring species of amphibians and reptiles.



A vast numbers of birds use the Strait of Gibraltar as a major corridor in their migration route, leading to the collision of many birds with local windfarm turbines



Apart from biodiversity conservation, the monitoring and management of invasive species and diseases is another important area of research where NRS is currently developing initiatives. For example, in cooperation with the European Centre for Disease Prevention and Control, we are investigating whether the population dynamics of the common house mosquito (*Culex pipiens*), which is the main vector for the West Nile virus, can be modelled. In Andalusia, Spain, we are involved in research concerning the prevention of the spread of the olive fruit fly. The research findings can guide control measures against these pests that cause damage to olives.

There is a clear demand to learn about SDM techniques and applications. A three-week elective in Species Distribution Modelling (SDM) forms part of our MSc course and is also offered as a short course outside ITC/UT. During the course, participants are free to introduce their own topics: these have ranged

from primate distributions in Africa and invasive pest species modelling in Guatemala to disease vector modelling in Southern Europe. In addition to in-house education, NUFFIC-funded tailor-made training courses have been performed in the past – for example, at the Polytechnic in Windhoek, Namibia, and the Gadjara Mada University in Yogyakarta, Indonesia. We are always on the lookout for opportunities to spread knowledge on the use of SDMs, so that practitioners and scientists are well equipped to deal with such problems as biodiversity loss, invasive species management and disease control, and so contribute to a better environment. ■



In a consortium with the University of Malaga, the Junta de Andalucia and Fundacion Migres, the NRS department contributes its expertise by tagging many raptors with GPS loggers and analysing the data using remote sensing, GIS and SDM techniques

Unique High Resolution Map on Bat Diversity in Africa

In collaboration with Ulm University (Germany), researchers from the ITC Faculty of Geo-Information Science and Earth Observation of the University of Twente have developed a unique map of all 250 African bat species at a high-resolution scale (1 km²). There are very few examples of biodiversity richness based on quantitative data at a continental scale, especially for challenging guilds such as bats. The research findings are presented in the January edition of the scientific journal *Ecological Modelling*.

The researchers have created state-of-the-art species distribution models (SDMs) for a large taxonomic group, and have demonstrated that by stacking these a plausible model of fine-grained continental species diversity and endemism patterns can be obtained, despite often scarce and biased occurrence data (the so-called “Wallacean shortfall”). Very few such studies have hitherto been published, covering a large and complete taxonomic group at fine resolution on a continental scale.

Bats in Africa

Numbering more than 1270 species globally, bats are the second most species-rich mammal group. Knowledge of their geographical distributions and diversity patterns, however, is very limited – possibly the poorest among mammals – due mainly to their nocturnal and volant life history, and the challenging fieldwork conditions in the tropics where most bat species occur.

The research findings suggest that African bat species richness generally increases towards the equator; varies substantially within the equatorial zone of elevated

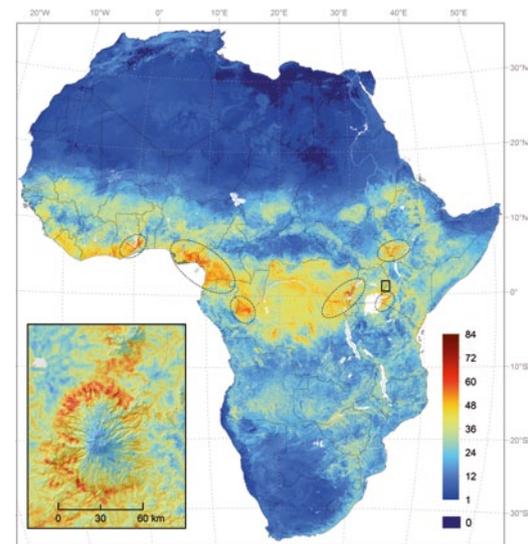
richness, often showing a positive association with high topo diversity at relatively low elevations; and accommodates surprisingly steep gradients over a few kilometres, especially near rivers in savanna biomes.

Centres of endemism (hotspots of summed range size rarity) are mostly found in or near areas characterized by substantial elevational ranges – on tropical mountains often at higher elevations than hotspots of species richness. Spatial congruence between richness and rarity hotspots is relatively low, although this depends on the definition of both rare species and hotspot size.

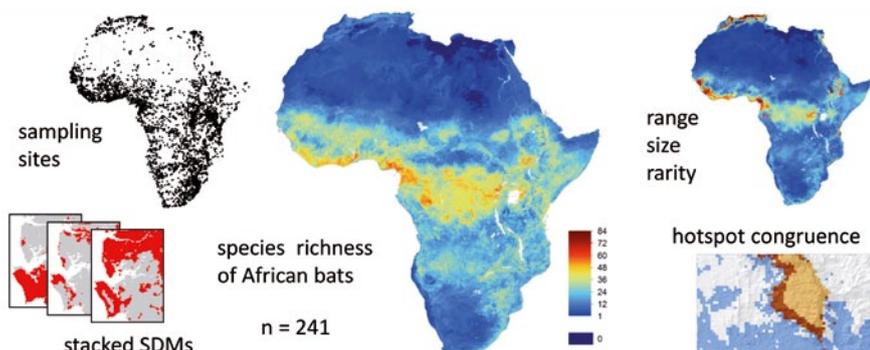
Further Deployment of the Approach

The approach in general, and the presented model in particular, should prove valuable for a range of applications because the maps of African bat diversity and endemism presented constitute one of the few published datasets featuring high spatial resolution, large geographical extent, and broad taxonomic scope.

Owing to these properties, and in combination with the underlying individual SDMs, the model may help to optimize protected area networks, support survey planning, and feed into biodiversity monitoring schemes. The generated data are also for a range of macro-ecological analyses, including tests of hypotheses across spatial grains finer than the common limit of 1°, as well as studies distinguishing taxonomic subsets and functional groups. ■



Matthias B. Herkt, Günter Barnikel, Andrew K. Skidmore and Jakob Fahr.
A high-resolution model of bat diversity and endemism for continental Africa. *Ecological Modelling*, Volume 320: 9-28, 24 January 2016,; doi:10.1016/j.ecolmodel.2015.09.009.



Systems and Sustainability in Time and Space

Increasing stakeholder involvement in modelling for sustainable development by engaging stakeholders in the process of building and analysing models can help people to change their behaviour towards more sustainable solutions. This was one of Professor Alexey Voinov's key messages during his inaugural lecture on 18 February 2016. Voinov is professor of Spatio-Temporal Systems Modelling for Sustainability Science at the ITC Faculty of Geo-information Science and Earth Observation of the University of Twente.

Bring about Change

The effect of large-scale transitions caused by climate change or the depletion of natural resources on the wellbeing of people is so far only marginally noticeable: not enough to bring about serious changes in human behaviour to turn the tide. However, science is quite clear that the consequences can be dire and action is needed now.

"We need to focus more on the communication side of our work," states Voinov.

"With our models, we are getting an understanding of the system, we make forecasts and analyse scenarios of what we may be hitting in the future. But we do need to put more effort into the communicative aspects. To create more awareness and show people what is going on. We can achieve this by more participatory modelling, which is a collaborative approach to building models with larger stakeholder involvement."

A higher degree of felt ownership and motivation will contribute greatly to achieving trust in science and inducing change, something that is very much needed.

Voinov: "We are all humans; we are driven by our values, biases, preferences and beliefs, and these are hard to change. However, we see that they are quite successfully modified by mass media, commercials or peer pressure. We need to learn to use similar approaches to deliver the scientific view. Humans have become a geological factor, vastly modifying the planet they live on. Quite a lot of processes are going on that come with delayed effects, both in space and time. We need to make this visible. Awareness can be raised by more collaboration with stakeholders."

Technological Development

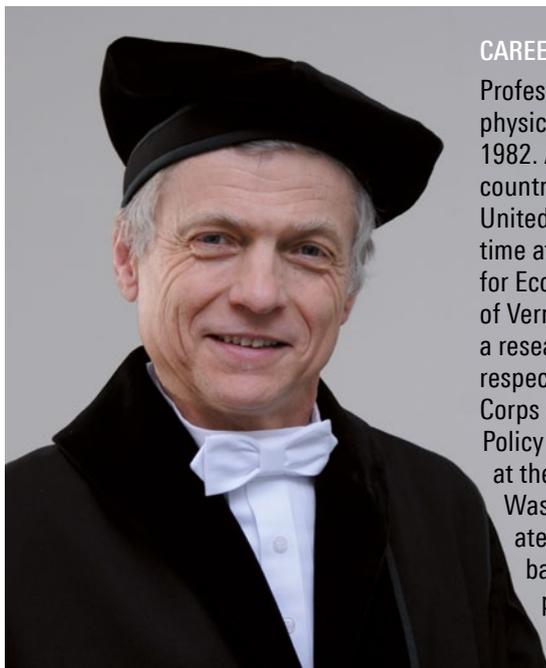
Voinov is hopeful that technological solutions will contribute towards solving some problems – for example in the domain of green energy. Voinov: "They offer great opportunities; however, until we are sure they work, a more cautious approach is essential. In many cases, it could be much cheaper simply to change our preferences and behaviour (e.g. switch off the unused lights or take the stairs instead of an elevator). Unfortunately, we often do not know how to make that happen."

Technological innovations can also play a key role in improving the interaction with stakeholders in participatory modelling.

"Web technology enables a stakeholder community to be much more involved via mobile devices, leading to better information about the processes and about how systems work. Social media can also inform us about people's preferences and priorities. All this is essential to jointly choose our most preferred future and the best way to get there." ■

The brochure of Professor Alexey Voinov's inaugural lecture can be downloaded here: www.itc.nl/library/papers_2016/scie/voinov_sys.pdf. Following the inaugural lecture, regional newspaper Tubantia published Voinov's research results on scooter emissions in the city of Enschede: "Verban de scooter uit Enschede" (in Dutch: www.tubantia.nl).

Participatory Models can Induce Change and Action



CAREER

Professor Voinov obtained his PhD in Biophysics at the Moscow State University in 1982. After a scientific career in his home country, Voinov continued his research in the United States, where he spent considerable time at the University of Maryland (Institute for Ecological Economics) and the University of Vermont (School of Natural Resources) as a research scientist and associate professor respectively. He also worked for the US Army Corps of Engineers as an AAAS Science and Policy Fellow, and spent two years working at the interface of science and policy in Washington DC. He was appointed associate professor at ITC in 2009 and embarked on a tenure track with the Department of Geo-information Processing (GIP) at ITC in 2012.

PARTNERSHIP NEWS

ITC and Namibia University of Science and Technology Pursue Collaboration

ITC has extended its collaboration with the Namibia University of Science and Technology (NUST). An extension of the MoU was signed by ITC Dean Tom Veldkamp and Professor Tjama Tjivikua, Vice-Chancellor of NUST, last month during the visit of an ITC delegation to the university's campus in Windhoek, Namibia. The collaboration is initially focused on education and training in Land Management to support the Namibian government's land reform programme.

The MoU, which dates back to 1996, is the cradle of a Land Management capacity building project that matured into a fully-fledged Department of Land Management at the Polytechnic of Namibia, offering a comprehensive suite of degrees, diplomas and certificates in Land Management-related fields comparable to none in the SADC region. More than 60 staff members of the former Ministry of Lands, Resettlement and Rehabilitation (MLR) graduated in Land Management-related disciplines at various levels at that time. In addition, the programme attracted over 60 students from Botswana, Lesotho, Mozambique, South Africa, Swaziland, Tanzania and Zambia during the same period.

Technical Support

This initiative, funded by the Royal Dutch Government for over a decade, was technically supported by ITC. The cooperation also afforded scholarships to academic and MLR staff to study at ITC in the Netherlands for Master's and PhD degrees. NUST also jointly hosted and delivered several refresher courses for ITC African alumni, capacity development and training for Mozambique, and the first regional Global Land Tool Network for decision makers with ITC.

In order to remain relevant, focal areas have been timely reviewed to meet the ever-changing needs of communities in Namibia in particular, and the SADC region at large. The Faculty of Natural Resources and Spatial Sciences now offers undergraduate and postgraduate programmes, with the first PhD in design this year, without losing the philosophy of integrating and fusing geospatial information and communication technologies (i.e. geo-ICTs) across all disciplines. The qualifications offered in these fields include Geomatics, Geo-information Technology, Town and Regional Planning, Regional and Rural Development, Agriculture Management, Natural Resources Management, Land Administration, Property Studies, and Architecture at undergraduate level, while Master's qualifications include Spatial Science, Earth Observations, Natural Resources Management and Agribusiness.

Renewed Focus

The renewed MoU now focuses on knowledge creation and deployment through research and innovation to take the existing land resources and manage them more efficiently. "Partnering with a globally recognized technical university with over 900 spin-off ventures is crucial for us and for Namibian society," stated Tjivikua.

Tom Veldkamp acknowledged NUST's vision and said that he and his team found great pleasure in working with the most innovative Namibian institution. He welcomed the need to lift the cooperation to enhance creation of new knowledge to support sustainable development in Namibia and the SADC region. ■



ENTREPRENEURSHIP AT ITC

ITC's first spin-off Ramani facilitates public use of Earth Observation data

The first spin-off company of the Faculty of Geo-Information Science and Earth Observation of the University of Twente (ITC) has been launched: Ramani. The new-born company intends to contribute to the advancement of public use of Earth Observation data. Ramani has expertise as a key-technology provider at some of Europe's largest innovation competition events, such as the Copernicus Masters and various App Developer Camps, of which the latest iterations were fully funded under contract with ESA and executed jointly with SAP.

Essential building stone

A harmonic system has been developed capable of cataloguing distributed (geo-spatial) data resources spanning across scientific communities, which is an essential building stone towards uniting providers and users of geo-spatial data. In conjunction with a VISual Maps-API, which is currently available for a broad range of client platforms (Android, iOS, SAP-HANA XS, nodeJS, JavaS-script, etc.), it enables the Mobile App Industry to integrate the rich data offerings that the Copernicus programme has offer into their mobile solutions with much greater ease and less prior geo-ICT knowledge than was previously necessary.

The API not only returns the maps of EO data for consumption on mobile devices, it can also analyse them to detect correlations or trends over time/space in five dimensions (5D: x, y, depths/height, time, forecast time). The results of analyses are returned in a variety of easy-to-understand graphics, either as PNG-image or as Scalable Vector-Graphics (SVG) for further client-based interaction, or as enhanced data-streams for downstream service providers to build other added-value services. The Maps-API connects to a rich Digital Data Library (DDL) hosted by Ramani on behalf of ESA, allowing developers to tap into Copernicus EO-data products. ■



Founder of Ramani: researcher Valentijn Venus (Photo Gijs van Ouwerkerk)

Making Copernicus data available

Named after the 16th Century astronomer, Nicolaus Copernicus, it is ESA's latest and most ambitious Earth observation programme to date with more than 10 satellites being launched into orbit in the next decade. Combined with Ramani's Maps-API, Copernicus provides relevant, timely, and easily accessible information to society. For example, to help improve the management of the environment, understand its impact on human well-being (and vice versa), follow the effects of climate change, etc.

Ramani was a co-organizer of a recent App Camp challenge at the latest Mobile World Congress (MWC) jointly funded by ESA and a leading industry provider of Cloud database technology, SAP. In the qualification rounds leading up to this event, Ramani provided on-line support to some 180 participants simultaneously across six locations in Europe (Finland, Germany, Italy, The Netherlands, Portugal, and the UK).

Knowledge spin-off

Ramani, named after the Swahili word for 'Map', is the first spin-off of the University of Twente's Faculty of Geo-Information Science and Earth Observation. It is a subsidiary of Ujuizi Holding B.V., which aims to accelerate mobile technology in BoP (Bottom of Pyramid) markets. Last month, the agreement with the initial investors was signed, including Holding Technopolis Twente B.V., which holds and manages the participations of the University of Twente in spin-offs and organizations for commercialization support. ITC's Natural Resources Department and Kennispark Twente provide entrepreneurial and content support for the Ramani initiators. ■

More info on Ramani via <http://ramani.ujuizi.com>

Producing High-Quality 3D Maps from LIDAR

GIM International

info@geomaris.nl

DIPPER, a spin-off company from the University of Twente (UT), provides a breakthrough solution for processing massive amounts of LIDAR data accurately and efficiently. It offers comprehensive services related to LIDAR data processing and 3D scene modelling. Since the self-developed software is highly automated, one operator working with DIPPER on one laptop can create high-quality 3D maps for 10,000 buildings within just one week – equivalent to at least ten times faster than normal. The high efficiency and accuracy boost large-scale applications such as asset management, smart city, securities development and urban planning. So far, DIPPER has successfully created 3D models for five international cities.

LIDAR is a remote sensing technology that measures distance by illuminating a target with a laser and analysing the reflected light. It is able to create intricate three-dimensional maps in places where bad weather or thick vegetation hamper traditional aerial mapping. In addition, an airborne LIDAR system provides 3D data with 5cm accuracy in the vertical direction, which is much better than the 50cm accuracy achieved by dense matching from stereo images. However, current LIDAR data processing involves intense manual work, making it very expensive and time-consuming. Ultimately, most companies on the market are either offering accurate 3D maps at high prices or producing affordable 3D maps with compromised

quality. It therefore becomes extremely difficult to achieve advanced LIDAR applications.

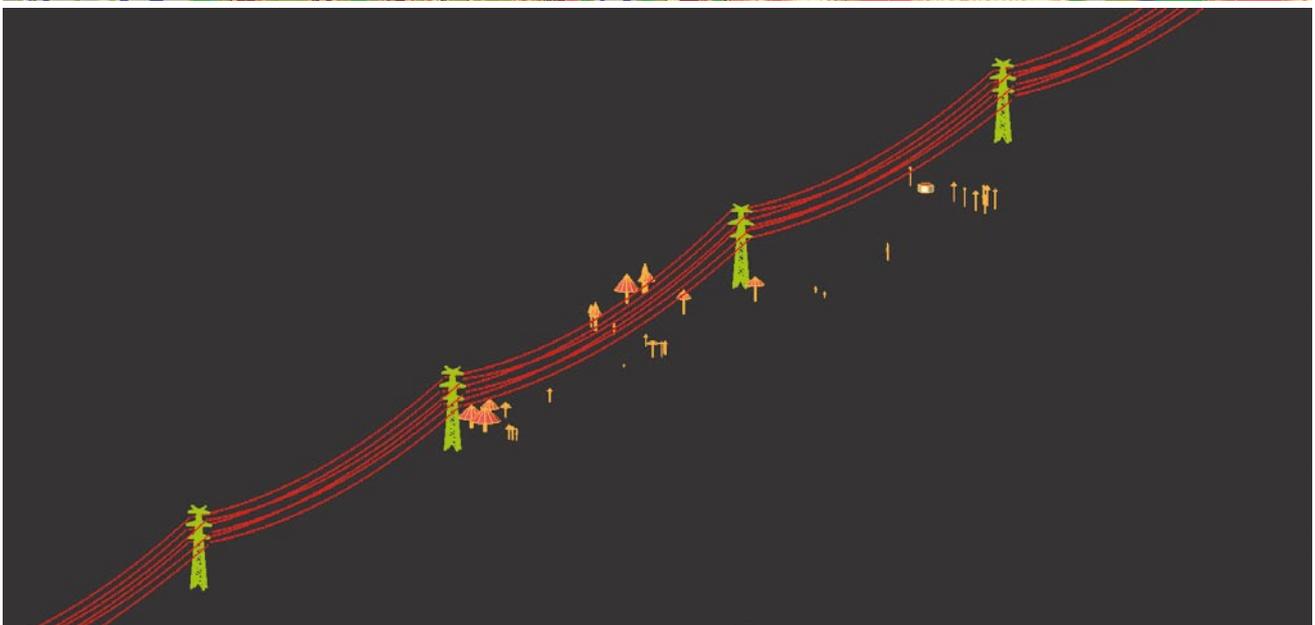
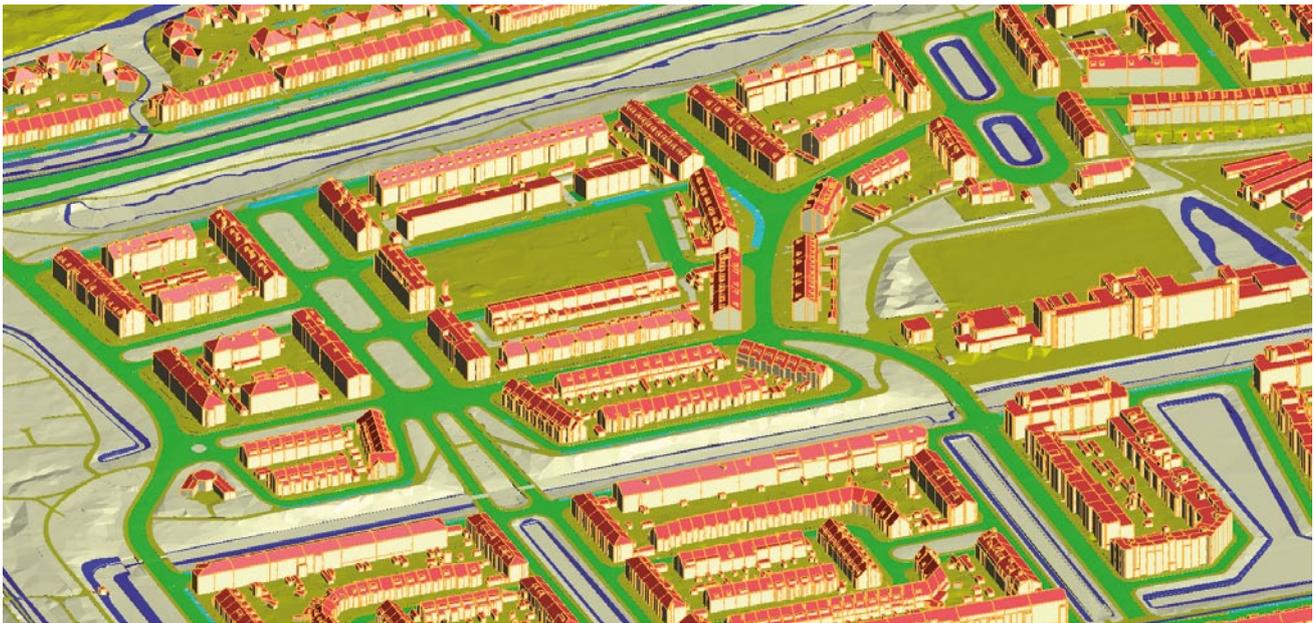
DIPPER, a spin-off from the UT, was founded in December 2014 in Enschede, the Netherlands. Supported by a top research group on LIDAR mapping, DIPPER has successfully converted 20 years of pioneering scientific achievements into commercial products. The company has developed novel algorithms which enable ultrafast and highly automated data processing. Meanwhile, it also provides reliable 3D ICT services, including solar energy calculation, flood control, noise simulation and sensor layout design. With its unique technology, competence and flexibility,

DIPPER can provide customized products and services according to situation, application and requirement.

For more information on Dipper:
www.dipper3d.com

Level of Detail

DIPPER's technology can significantly improve efficiency by creating high-quality 3D building models with a remarkable degree of automation. The quality levels of 3D maps can be determined by how many details they provide. At Level of Detail 1 (LoD1), buildings are reconstructed at just one height, which leads to all the building



Important function of the toolkits is to model the urban scene, such as buildings, terrain, power corridors and trees, with high efficiency and accuracy

models being displayed with flat roofs. In comparison, at Level of Detail 2 (LoD2) the roof constructions, including dormers, can be clearly modelled in 3D. Considerable effort is needed to raise the level of detail from LoD1 to LoD2. The DIPPER software can construct 3D building models at LoD2 using LIDAR data collected from a helicopter or an aircraft. During the data processing by the software, the LIDAR points on buildings are first recognized and segmented into individual roof faces. The roof structures are then inferred and primitive sub-buildings are detected and modelled. More impressively, if an error is discovered in the roof construction, the software is able to automatically recognize and memorize the error patterns, and then correct

repeated errors in other building models. Therefore, this algorithm ensures the high quality of the 3D model. The 3D map application market is currently booming. The international market reached USD1.90 billion in 2015 and is predicted to increase to USD16.99 billion by 2020 at an estimated CAGR of 55%, according to market research company M&M. From a regional perspective, the Dutch government is developing its national service for large-scale 3D topography. Cities such as Amsterdam, Rotterdam and The Hague have launched projects to invest in the application of 3D maps for city visualization, management and communication. Moreover, companies focusing on solar energy, insurance, security and city plan-

ning are increasingly using 3D information for business development and information support purposes. Accordingly, the demand for affordable and accurate 3D LIDAR processing and modelling is growing fast, and DIPPER is ahead of this trend.

Lidar Data Processing

In 2015, DIPPER developed advanced toolkits for LIDAR data processing. One important function of the toolkits is to model the urban scene, such as buildings, terrain, power corridors and trees, with high efficiency and accuracy. This means that DIPPER is able to combine 3D building models with environmental parameters and provide detailed overviews and smart suggestions for many advanced applica-

tions, including solar energy analysis, noise management, flood control and urban planning. Meanwhile, DIPPER has established close connections with many government organizations in both the Netherlands and China, including Dutch Kadaster, municipalities and utility firms. So far, DIPPER has made high-quality 3D maps for five Dutch cities and a Chinese power firm. Supported by these achievements, DIPPER is also exploring business opportunities within non-governmental organizations such as solar panel companies, insurance companies and the LoRa Alliance for the Internet of Things.

“Our aim is to provide easy-to-use applications. We are transforming massive LIDAR data into semantic and concise 3D vector data,” says Biao Xiong, DIPPER’s CEO. After completing his PhD degree at the UT, Xiong launched the start-up with four passionate colleagues: “We have successfully processed LIDAR data for city, forest, railway, power corridor and industry scenes. The data processing varies from multi-scan registration and point cloud classification to 3D scene modelling. Since we work closely and effectively in a flexible environment, we are able to respond quickly to the challenging problems raised by customers every day. DIPPER’s slogan is “Showing, Solving and Leading” and that perfectly sums up what we are trying to achieve (i.e. to show a new view of the world via 3D LIDAR maps; to solve complex problems and help with smart decision making by developing

toolkits; and to lead LIDAR processing technology by keeping innovation alive). Moreover, as an innovative company aiming to build a bright future, DIPPER is also willing to contribute to the development of new concepts such as self-driving cars and smart city development.”

Countrywide 3D Map

In 2016, DIPPER will make a detailed 3D map of the whole of the Netherlands from airborne LIDAR data. It will be the world’s first countrywide 3D map at LoD2. Over the next five years, DIPPER is planning to work with other pioneering countries that are eager to obtain accurate 3D maps. As an innovative company, it will continue to invest in research and development to improve the software and workflow and to apply cutting-edge technologies including deep learning, big data mining, cloud processing for automatic interpretation and 3D modelling. ■

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Greetings from...

NAME:

Janneke Ettema

JOB DESCRIPTION:

Janneke is assistant professor in 'Natural hazards and Climate Change' at the Earth Systems Analysis department.

ACTIVITIES IN EDUCATION:

She lectures MSc-topics as meteorological processes, meteorological hazards, atmospheric modelling and climate change.

ACTIVITIES IN RESEARCH:

Her main research interest is the making of the link between meteorological processes and hydro-meteorological hazards world-wide.



In 2010, I gained my PhD degree at IMAU on regional climate modelling of the Greenland ice sheet. Although the Greenland research was very intriguing, I decided to refocus my academic life. I obtained a position as assistant professor at Faculty ITC, University of Twente (UT), where I work in the department Earth Systems Analysis and my job is to link climate change to natural hazards.

Although ITC is a full faculty of the UT, its mission is "the international exchange of knowledge, focusing on capacity building and institutional development in developing countries and emerging economies". As a result, ITC has a huge international MSc and PhD student community. All our MSc students are non-Dutch. They have a tremendous drive to study because this is a once-in-a-lifetime opportunity. Having an MSc degree will enhance their career prospects enormously. For me as a lecturer, it is very rewarding to teach them, as they absorb all the knowledge that you provide.



As the only meteorologist in a research group on natural hazards and disaster risk management, I get all kinds of questions related to weather and climate. One moment I may be working on a basic lecture on monsoons, the next I may be involved in a meeting on local climate change scenarios for flash flood hazard in the Alps, or on remotely sensed rainfall extremes in India, or on climate impact on food security in Indonesia. This variation in topics makes my job highly diverse and interesting. Often my role is one of climate knowledge broker to other disciplines in relation to natural hazards.



One of the advantages of working at ITC is the opportunity to travel the world. Over the past five or so years, I have visited Nepal, Indonesia, Thailand and Vietnam – besides regular conferences and workshops in Europe and the USA. Embarking on a long-term collaboration often provides a unique opportunity to look beyond the usual tourist attractions. Examples of projects to which I contribute include university curricula development, tailor-made training courses, and climate-related research.

You could conclude that my work is at the intersection of climatology and hydrology, focused on weather extremes related to hydro-meteorological hazards. I find it a major challenge as well as a privilege to bring my meteorological knowledge to other disciplines involved in risk assessment. In this multidisciplinary field, I learn and teach every day – something I enjoy very much indeed.



As you can see, the professional link to Greenland has vanished. However, walking with our Siberian husky and Alaskan malamute often makes me feel that I'm back in the North.

EVENTS



NRM Hero Report

Stephania Zabala

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Tracy Zaarour

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Giving compliments to people is much more positive than complaining, punishing and limiting what they do. Following this principle, Dr Iris van Duren, assistant professor in the Natural Resources department and module coordinator, came up with the idea of the NRM Hero election.

The NRM Hero election is an educational and, at the same time, amusing event that seeks to recognize people from all over the world who have fought or are fighting to take care of our natural resources and avoid environmental degradation. The event is also intended to honour people who have come up with creative and innovative ideas to deal with the impact of human activities on the environment.

Through the NRM Hero event, students can learn from these extraordinary people and be inspired to act and react with perseverance.

Before the Event

A committee consisting of five students of different nationalities working hand in hand with Dr Iris van Duren and Ms Linlin Pei, the e-learning expert, took care of all the details to make this event possible. First of all, based on different criteria, the committee was responsible for choosing five candidates out of the pool of NRM hero nominees to compete during the event. The finalists were: Berenice Dapaah (Ghana), Ma Jun (China), Nnimmo Bassey (Nigeria), Phyllis Omido (Kenya) and Boyan Slat (Netherlands).

Going Viral

Thanks to the social media, Facebook and twitter, it was possible to get in touch with some of the nominees. Special thanks go to Nnimmo Bassey, who was kind enough to send us a video. You can take a look at the NRM Hero madness and find posts and pictures of the event following #NRMHero in Facebook and twitter.

The Event

The committee, with the help of student volunteers, managed to send invitations to staff, put up flyers on the walls, produce an introductory video about the event, set the mood, decorate the room, and of course serve some snacks. The event started with a brief but hot debate between the audience, MSc students, pro-

fessors and two special guests: Festus Ihwagi and Milica Miskovic. The debate about natural resources management and sustainability raised several interesting issues and stimulated active participation. Then, after running the introductory video, participating MSc students tried to persuade voters to pick their candidates through a short presentation about their accomplishments. With a candidate in mind, voters had one minute to cast their vote electronically using the Feedback Fruit platform.

Time was up, voting was closed, and the results were displayed immediately showing the winner: Phyllis Omido, who won the NRM Hero election with more than 50% of the votes.

The Winner

Phyllis Omido, dubbed the "East African Erin Brockovich", is a Kenyan environmental activist who was awarded the Goldman Environmental Prize in 2015 for succeeding in shutting down the smelter Owino Uhuru that was exposing people from the community of Mombasa to dangerous chemicals.

Phyllis was contacted to notify her that she was the winner of the NRM Hero election 2015, with congratulations, on behalf of ITC, from the NRM/GEM programme that organized the event. She personally replied with an email to Grace Mbaiorga, the MSc student who nominated her.

What did We Learn?

It was possible to acknowledge that there are fantastic people out there just like us who apply creative thinking to find solutions to environmental problems. Taking some time to find these heroes and to hear about their experiences is somehow like connecting with reality to understand the difference between theory and practice. ■

Thumbs up for the NRM Hero event!

NRM HERO

There are many ways to contribute to Natural Resources Management. Of course, we have researchers, teachers, policy makers, producers and users of natural resources who (hopefully) give their best to ensure quality and quantity of natural resources in the future. From all people involved in NRM, there are always a few outstanding, very special persons who become a source of inspiration to others. These persons create awareness about NRM issues in a surprising or convincing way and/or come with creative solutions to NRM problems. With their personal behaviour or lifestyle they show others how we can make the world more beautiful and safe.

Even though it is a cliché,
one can make a difference
in this world. You can be
the next HERO!

Grace Mbaiorga

Thanks a lot for the wonderful work you are doing for the environment and for finding our work worthy. Thank you also for the support you are giving us on social media. (Email reply to ITC MSc student)



Phyllis Omido

The water they were drinking was poisonous. It was a really, really painful situation that no one should allow another human being to live under.

(Omido, in an interview that Goldman Prize sponsors posted on youtube)



I am humbled and honoured. This award gives us a chance to go to court and seek accountability and justice.

(Omido, communicating through social media from the USA)

A big shout out to Phyllis for her accomplishment!



Annual General Meeting of ITC Alumni Association Bangladesh

Md Billal Hossain

mdbhossain@yahoo.com

The **Annual General Meeting** of the ITC Alumni Association Bangladesh, an organization of former students of ITC, the Netherlands, was held on the campus of Kaliakoir Hi-Tech Park, Gazipur, Bangladesh, on 4 March 2016.

The 18-strong executive committee of the association is now composed as follows:

- | | |
|-----------------------------------|---|
| President: | Md Billal Hossain |
| General Secretary: | Mohammed Solaiman Haider |
| Vice-presidents: | Md Shamsul Alam and
A.T.M. Asaduzzaman |
| Joint General Secretary: | Mohammad Ashraful Kamal |
| Treasurer: | Md Mosharaf Hossain |
| Publication & Cultural Secretary: | Md Rejaur Rahman |
| Members: | Ms Arfin Ara Begum, Jalal Uddin Md Shoab,
Farid Aziz, Mahamud Hasan, Dr Maksud Kamal,
Abu Syed, Motaleb Hossain Sarker, Istiak Sobhan,
Sania Rahman, Nurul Amin Sikder and a representa-
tive of the Water Development Board. |

The event was followed by a family get-together, where spouses and children of alumni members were also present. There were lots of fun, games and music during this event. I am grateful to everybody for the successful completion of the AGM and the most enjoyable picnic. ■



For more information about the ITC Alumni Association Bangladesh:
www.itc.nl/IAA_Bangladesh.html



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- ✓ Cartography
- ✓ Climate Change
- ✓ Computing in the Cloud
- ✓ Crime Mapping/ Modelling
- ✓ Data Capture/Collection
- ✓ DEM- Digital Elevation Model
- ✓ DGPS - Differential GPS
- ✓ Digital City Models
- ✓ Digital Mapping
- ✓ Digital Rights Management
- ✓ Disaster Management/ Monitoring
- ✓ DSM - Digital Surface Model
- ✓ DTM - Digital Terrain Model
- ✓ Dynamic Mapping
- ✓ Earth Observation
- ✓ Emergency Services
- ✓ ENC - Electronic Navigation Chart
- ✓ Environmental Monitoring
- ✓ Galileo
- ✓ Geo-ICT
- ✓ Geodesy
- ✓ Georeferencing
- ✓ Geosciences
- ✓ Geospatial Image Processing
- ✓ GIS
- ✓ GIS in Agriculture & Forestry
- ✓ GLONASS
- ✓ GMES
- ✓ GNSS
- ✓ GPS
- ✓ GSDI
- ✓ Hardware
- ✓ Hydrography
- ✓ Hyperspectral Imaging
- ✓ Image Analysis
- ✓ INSPIRE
- ✓ Integration
- ✓ Interoperability & Open Standards
- ✓ Land Information Systems
- ✓ Laser Scanning
- ✓ LBS
- ✓ LiDAR
- ✓ Mapping Software
- ✓ Marine Tracking & Navigation
- ✓ Mobile GIS/Mapping
- ✓ Municipal GIS
- ✓ Navigation
- ✓ Network Topology
- ✓ NSDI
- ✓ Open GIS
- ✓ Photogrammetric
- ✓ Photogrammetry
- ✓ Point Clouds
- ✓ Property Information Systems
- ✓ Radio Navigation
- ✓ Remote Sensing
- ✓ Risk Management
- ✓ RTK (Real Time Kinematic) Surveying
- ✓ Satellite Imagery/Navigation
- ✓ Scanning Technology
- ✓ SDI - Spatial Data Infrastructures
- ✓ Smart Grids
- ✓ Software
- ✓ Surveying Instrumentation
- ✓ Surveying Technology Sensor
- ✓ Telematics
- ✓ Topographic Mapping
- ✓ Total Station
- ✓ Tracking & Route Planning
- ✓ Transport
- ✓ Utilities GIS
- ✓ Vehicle Tracking & Navigation
- ✓ VRS - Virtual Reference Station
- ✓ Web Mapping

Sectors covered:

- ✓ Aerospace
- ✓ Agriculture
- ✓ Archaeology & Heritage
- ✓ Architecture
- ✓ Biosecurity
- ✓ Business Security/Service
- ✓ Central/Local/Regional Government
- ✓ Construction
- ✓ Consulting Services
- ✓ Cyber Security
- ✓ Defence
- ✓ Education
- ✓ Emergency Services
- ✓ Energy Utility
- ✓ Engineering
- ✓ Environmental Management
- ✓ Environmental Monitoring
- ✓ Financial Services
- ✓ Fisheries
- ✓ Forestry Management
- ✓ Geosciences
- ✓ Healthcare
- ✓ Infrastructure Protection
- ✓ Insurance
- ✓ Manufacturing
- ✓ Marine
- ✓ Military
- ✓ Mining
- ✓ Natural Resource Management
- ✓ Oil & Gas
- ✓ Property
- ✓ Public Safety/Works
- ✓ Retail
- ✓ Shipping
- ✓ Software Development
- ✓ Technical Services
- ✓ Telecommunications
- ✓ Tourism/Travel
- ✓ Training
- ✓ Transport
- ✓ Utilities (Energy & Water)

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