Space technology identifies vulnerable regions in West Africa

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A group of international researchers led by the Centre for Landscape and Climate Research at the University of Leicester have used space satellite technology to identify regions of West Africa which are vulnerable to the effects of land degradation through climate change.

The team studied land degradation in Sub-Saharan West Africa, covering an area of approximately 6,140,000 km2, using statistical residual trend analysis (RESTREND) of vegetation photosynthetic capacity data (GIMMS NDVI3g), soil moisture and rainfall measured by satellites.

The research was carried out as part of the thesis of a University of Leicester PhD student from Nigeria, Yahaya Zayyana Ibrahim. The study investigated the areas affected by land degradation in the region from 1982-2012 and suggests that land degradation is vividly seen when soil moisture is taken as controlling vegetation photosynthetic capacity rather than rainfall.

Soil moisture observations can map land degradation with more accuracy than typical rainfall data as soil moisture directly leads to plant growth.

This highlights the importance of soil moisture as the water reservoir directly available to plants in land degradation and desertification studies, which is often overlooked in studies which focus on rainfall.

Professor Heiko Balzter, Director of the Centre of Landscape and

Climate Research at University of Leicester and co-author of the study, said: "Our way of analysing the satellite data is able to detect areas where the vegetation is deteriorating or improving at a very large scale. This is after accounting for the effect of soil moisture changes on vegetation photosynthetic capacity or potential.

"What is left after adjusting the data for soil moisture is the net change in land productivity under a constant reference moisture level. Much to our surprise, over much of West Africa the land condition has improved over the period of study when soil moisture is taken into account."

The study was conducted in collaboration with Compton Tucker of NASA's Goddard Space Flight Centre, USA, who provided the NDVI3g data for the whole study region from 1982-2012.

Tucker commented: "Using soil moisture data improved greatly the determination of land degradation in the area studied in Sub-Saharan Africa."

PhD student Yahaya Ibrahim, who carried out the RESTREND analysis and produced the satellite maps, said: "The results of this study highlight the importance of soil moisture in understanding vegetation dynamics in Sub-Saharan West Africa and it can be used as a more reliable indicator of land degradation and vegetation recovery than instantaneous rainfall.

"This study is a step further in understanding land degradation in the dryland areas, particularly in Sub-Saharan Africa where the livelihood of millions of people is at risk due to myriad of factors both anthropogenic and natural environmental changes especially climate change."

Due to the lack of adequate meteorological gauge stations in Africa, the study used rainfall datasets produced by Climate Research Unit (CRU) University of East Anglia and Climate Prediction Center (CPC) soil

moisture datasets provided by National Oceanic and Atmospheric Administration (NOAA) USA, which combine local available gauge stations with satellite data widely in use among the scientific community.

Dr Jörg Kaduk of the University of Leicester's Department of Geography and the Centre of Landscape and Climate Research who co-authored the paper added: "This study highlights the potential of long term remote sensing records to advance our understanding of the interactions of ecosystems, climate and human land use and their feedbacks.

"It is only since we have remote sensing data that we can unravel bit by bit the sometimes devastating drought dynamics in West Africa. This will hopefully lay the basis for adaptation and mitigation in this vulnerable region to future climate change as well as the modelling of the system to provide enhanced insights into ecosystem functioning."

More information: Ibrahim, Y.Z.; Balzter, H.; Kaduk, J.; Tucker, C.J. Land Degradation Assessment Using Residual Trend Analysis of GIMMS NDVI3g, Soil Moisture and Rainfall in Sub-Saharan West Africa from 1982 to 2012. *Remote Sens.* 2015, 7, 5471-5494. www.mdpi.com/2072-4292/7/5/5471

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