Project No: 334327

Project Acronym: LanDDApp

Project Full Name: A Land Degradation and Desertification Apprais
al System for South Africa

Marie Curie Actions

Final Report

Period covered: from 01/05/2013 **to** 19/02/2018

Start date of project: 01/05/2013

Project coordinator name:
Dr. Stephen Hoon

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Project coordinator organisation name:
THE MANCHESTER METROPOLITAN UNI
VERSITY

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Final Report

PROJECT FINAL REPORT

Grant Agreement number:	334327
Project acronym:	LanDDApp
Project title:	A Land Degradation and Desertification Appraisal System for South Africa
Funding Scheme:	FP7-MC-CIG
Project start date:	01/05/2013
Project end date:	19/02/2018

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1. FINAL PUBLISHABLE SUMMARY REPORT

Comments:

Land degradation and desertification (LDD) is a serious global threat to humans and the environment. Globally, 10-20% of drylands and 24% of the world's productive lands are potentially degraded, which affects 1.5 billion people and reduces GDP by €3.4 billion. Large parts of southern African arid, semi-arid and sub-humid areas are considered to be undergoing severe degradation processes, such as forest degradation, deforestation and bush encroachment that affect up to a third of the area, leading to a decline in the ecosystem services provided to some of the continent's poorest and most vulnerable communities. There is, therefore, a pressing need for an objective, repeatable, systematic and spatially explicit measure of land degradation over the region and this is why the main aim of the LanDDApp project was to develop an appraisal system for assessing LDD in the southern African region.

According to some assessments, only in South Africa bush encroachment, i.e. the advancement of woody plants into grasslands, and the subsequent conversion of savannahs and open woodlands into shrublands, has rendered 1.1 million ha of savannah unusable, it threatens another 27 million ha (~17% of the country), and has reduced the grazing capacity throughout the region by up to 50%. For this reason, one of the key objectives of LanDDApp was to devise an accurate methodology for mapping and monitoring bush encroachment using open access Earth Observation (EO) data. The use of multi-temporal and multi-sensor data from both the dry and the wet seasons proved to be a highly successful approach.

To describe and map changes in ecosystem functioning at the regional scale, LanDDApp also carried out time-series analyses of vegetation index data: a proxy for vegetation vigour. Spatio□temporal patterns of change in two different vegetation indices covering 33 years from 1981–2014 were identified. Areas of diverging trends in the vegetation indices were linked to well□known changes in land use and land cover, such as deforestation and bush encroachment. Moreover, the patterns of diverging vegetation index trends were used as a reference in evaluating the impacts of environmental changes related to trends in Net Primary Productivity and Rain Use Efficiency. Field visits to three diverse study sites were carried out to verify the results using a variety of cameras mounted on poles, fixed wing and octocopter Unmanned Aerial Vehicles (UAVs), as well as expert knowledge. The results indicate areas of localized land degradation where ecosystem functioning has been reducing. Degradation impacts were reflected as reductions in productivity that varied along a continuum from slight to severe, depending on the specific land use/cover.

The results from LanDDApp are relevant to various local, regional, national and international stakeholders related to savannah LDD, from small communal to larger private farmers, NGOs related with helping local communities maintain sustainable livelihoods while protecting their environment, Provincial and Central Government Organisations, Universities from all affected countries in the southern African region, research organisations as well as SMEs working on mapping tools and UAV/EO technologies.

Project website: www.land-degradation.org

Contact details: Elias Symeonakis, email: e.symeonakis@mmu.ac.uk, tel: +44 161 2471587

2. USE AND DISSEMINATION OF FOREGROUND

Section A (public) – DISSEMINATION MEASURES

Dissemination activities

Comments:

Conferences attended / sessions convened:

• October 2014: initial results from project presented orally at the ISPRS Conference in Toronto, Canada; paper was included in the ISPRS Archives (Annex 5).

Symeonakis, E., Higginbottom, T. 2014. Bush encroachment monitoring using multi-temporal Landsat data and random forests. International Archives of the Photogrammetry, Remote Sensing and Spatial Information Sciences - ISPRS Archives 40 (2), pp. 29-35. DOI: 10.5194/isprsarchives-XL-2-29-2014

• March 2015: poster presentation given at the 3rd United Nations Convention to Combat Desertification (UNCCD) Scientific Conference in Cancún, Mexico.

• April 2015: poster presentation at EGU 2015 General Assembly, Vienna, Austria (Annex 15).

• April 2015: Convener of two sessions at the EGU 2015, Vienna, Austria.

• May 2015: Presented orally and via posters at the 36th International Symposium on Remote Sensing of Environment (ISRSE), Berlin, Germany (Annex 20)

• Oct 2015: Attended the UNCCD COP10 (Conference of the Parties) as an observer (member of Desertnet International)

• Dec 2015: Attended the Global Landscapes Forum, Paris, France.

• April 2016: Oral and poster presentations at EGU 2016 General Assembly, Vienna, Austria (Annex 16).

• April 2016: Convener of two sessions on soil erosion modelling and three sessions on vegetation characteristics mapping, monitoring and modelling with remote sensing at the EGU 2016, Vienna, Austria (Annexes 12-14).

• May 2016: Attended European Space Agency (ESA) Living Planet Symposium, Prague, Czech Republic

• May 2016: Presented poster at the NASA/EARSEL Land Use/Land Cover Joint Symposium, Prague, Czech Republic (Annex 17)

• July 2016: Two oral presentations at the Geoscience and Remote Sensing Symposium (IGARSS) 2016, Beijing, China

• July 2016: Oral presentation at the 6th Digital Earth Summit, Beijing, China.

Paper published in Conference Proceedings (Annex 18)

First prize winner for Best Oral Presentation (Annex 19).

• July 2016: Oral presentation at the 23rd ISPRS Congress, Prague, Czech Republic and publication in the ISPRS Archives:

o Symeonakis, E., Petroulaki, K., Higginbottom, T.P., 2016. Landsat-based woody vegetation cover monitoring in southern African savannahs. International Archives of the Photogrammetry, Remote Sensing and Spatial Information Sciences - ISPRS Archives. DOI: 10.5194/isprs-archives-XLI-B7-563-2016 (Annex 3)

• March 2017: attended the European Space Agency (ESA) World Land Cover Symposium

• April 2017: Oral and poster presentations at EGU 2017 General Assembly, Vienna, Austria.

• April 2017: Convener of two sessions at the EGU 2017, Vienna, Austria.

• May 2017: Two oral presentations and one poster at the 37th International Symposium on Remote Sensing of Environment (ISRSE), Pretoria, South Africa.

• April 2018: Oral and poster presentations at the EGU 2018 General Assembly.

• April 2018: Accepted to present orally at the 7th Digital Earth Summit of the ISDE, El Jadida, Morocco.

• July 2018: Accepted to present orally at the 2018 IGARSS, Valencia, Spain.

Workshops/meetings/other presentations/outreach activities:

• In July 2013, a presentation regarding the LanDDApp project and its scope, was given at the CSIR Meraka Institute in Pretoria, South Africa. The audience included Dr Konrad Wessels and his re search team.
• Later in the same month, a similar presentation was organised at the CSIRO Floreat campus in Perth, Australia, in the presence of Dr Peter Caccetta and his team and Dr Graeme Behn and his col leagues from the Western Australian Department of Parks and Wildlife.
• In June 2015, a visit to the Kenya Wildlife Service Headquarters near Nyeri, Kenya, and a meeting was held with Chief Scientist to discuss collaboration prospects and how the methodological frame work developed through LanDDApp could be applied in parts of Kenya that are undergoing similar land degradation processes. It was decided that an MMU PhD student starting work in September 2015 would be co-supervised by Elias Symeonakis and would apply the multi-temporal Landsat-based approach to her habitat condition monitoring project. The student has already embarked on her project.
• In July 2015, during the second visit to South Africa, three workshops were organised and five talks were given by Dr Elias Symeonakis and the project scientific coordinator, Prof Steve Hoon. The workshops were co-organised with the respective institutions and took place at the Northwest Uni versity campus in Potschefstroom, the University of the Free State in Bloemfontein, and the Meraka Institute of the CSIR in Pretoria. Apart from members of the host Institution and their collaborators within the IDESSA project, a number of representatives and local stakeholders were also present from other institutions, namely from the University of KwaZulu-Natal; the Department of Agricul ture, Forestry and Fisheries; the Department of Agriculture, Conservation and Environment of the North West Province, and the private mapping company 'IRIS International Ltd'.
• In October 2015, the initial results from the project were presented and discussed with members of the advisory group Prof Klaus Kellner (NWU) and Prof Lindsay Stringer (U. of Leeds) and other South African stakeholders at the COP10 of the UNCCD in Ankara, Turkey.
• In September 2017 and February 2018, project results were presented in two workshops organised at the Surveying Engineering Department of the National Technical University of Athens and the In telligent Systems, Content and Interaction Laboratory of the same University.

Publications

	LIST OF SCIENTIFIC PUBLICATIONS, STARTING WITH THE MOST IMPORTANT ONES									
No.	Title / DOI	Main author	Title of the periodical or the series	Number, date or frequency	Publisher	Place of publication	Date of publication	Relevant pages	Is open access provided to this publication ?	Type
1	Optimisation of Savannah Land Cover Characterisation with Optical and SAR Data 10.3390/rs10040499	Elias Symeonakis , Thomas Higginbottom , Kyriaki Petroulaki , Andreas Rabe	Remote Sensing	Vol. 10/Issue 4	MDPI AG	Switzerland	01/04/2018	499	Yes	Peer reviewed
2	Mapping fractional woody cover in semi-arid savannahs using multi-seasonal composites from Landsat data 10.1016/j.isprsjprs.2018.02.010	Thomas P. Higginbottom , Elias Symeonakis , Hanna Meyer , Sebastian van der Linden	ISPRS Journal of Photogrammetry and Remote Sensing	Vol. 139	Elsevier	Netherlands	01/05/2018	88-102	No	Peer reviewed
3	Assessing Land Degradation and Desertification Using Vegetation Index Data: Current Frameworks and Future Directions 10.3390/rs6109552	Thomas Higginbottom , Elias Symeonakis	Remote Sensing	Vol. 6/Issue 10	MDPI AG	Switzerland	01/10/2014	9552-9575	Yes	Peer reviewed
	Bush encroachment monitoring using multi-temporal Landsat data and random forests	Elias Symeonakis and Thomas Higginbottom	ISPRS Technical Commission II Symposium		The International Archives of the Photogrammetry, Remote Sensing and Spatial Information Sciences		01/11/2014	29-35	Yes	Conference
	LANDSAT-BASED WOODY VEGETATION COVER MONITORING IN SOUTHERN AFRICAN SAVANNAHS	Elias Symeonakis, K. Petroulaki, and T. Higginbottom	XXIII ISPRS Congress		The International Archives of the Photogrammetry, Remote Sensing and Spatial Information Sciences		20/07/2016	563-567	Yes	Conference

Section B (confidential) - EXPLOITABLE FOREGROUND AND PLANS FOR EXPLOITATION

LIST OF APPLICATIONS FOR PATENTS, TRADEMARKS, REGISTERED DESIGNS,UTILITY MODELS, ETC.					
Type of IP Rights	Confidential	Foreseen embargo date dd/mm/yyyy	Application reference(s) (e.g. EP123456)	Subject or title of application	Applicant(s) (as on the application)

OVERVIEW TABLE WITH EXPLOITABLE FOREGROUND								
Type of Exploitable Foreground	Description of Exploitable Foreground	Confidential	Foreseen embargo date dd/mm/yyyy	Exploitable product(s) or measure(s)	Sector(s) of application	Timetable for commercial use or any other use	Patents or other IPR exploitation (licences)	Owner and Other Beneficiary(s) involved

ADDITIONAL TEMPLATE B2: OVERVIEW TABLE WITH EXPLOITABLE FOREGROUND	
Description of Exploitable Foreground	Explain of the Exploitable Foreground

3. SCIENTIST IN CHARGE QUESTIONNAIRE

RESEARCH TRAINING ASSESSMENT:

What is the size of the hosting research group?	8

How many researchers have you supervised, within the past 10 years? Of which funded by:	
EC/Marie Curie actions	0
EC Other Funding	0
University fellowships	6
National public bodies	3
Industry	1
Other	0
Other, please specify:	

How many researchers have you supervised within this project?	5
Corresponding to how many person months?	10

Number of publications resulting directly from the research project:	
Recruited researcher(s) and yourself	8
Recruited researcher(s) alone	0
Recruited researcher(s) with authors other than yourself	0

Participation of the recruited researcher(s) at conferences (number):	
Passive	0
Active	3
How do you rate the overall success of the re search training?	Very good

General assessment:	

RESEARCHERS ASSESSMENT:

Rate the overall level of the recruited researcher(s) integration in the research team and the host organisation with regards to:	
participation in meetings/seminars	Very good
discussions of results and project-related topics	Very good
co-operation with other team members	Very good
co-operation with other researchers of the host institution	Very good

Rate the overall performance of the recruited researcher(s) with regard to:

originality of fellow(s) approach towards research (initiative/independent thinking)	Very good
capacity to develop new skills and to benefit from training	Very good
productivity (research results/publications/international conference attendance)	Very good
communication skills	Very good
group leader skills (collaboration with other groups/project management)	Very good
training and/or teaching skills	Fair

Comment:

All aspects were very good except for the training in the teaching skills of one of the two recruited researchers who did not receive any training in this aspect. The other recruited researcher did and it was very successful, receiving very positive feedback from the students.

RESEARCH TRAINING OUTCOMES:

Has this project provided additional links with other research groups or institutions?	Yes

If yes, indicate the number of contacts in each case

Universities	19
Research Centres	3
Industry/private companies	3
Others	2

If Other, please specify:

Local Government Departments:
Department of Agriculture, Conservation and Environment of the North West Province (DACE, www.nwpg.gov.za/Agriculture/index.html ; contact.: Dr Franci Jordaan)
Western Australian Department of Parks and Wildlife (WPaW, https://www.dpaw.wa.gov.au/ ; contact Mr Graeme Behn and team of Landsat-based vegetation monitoring experts).

Rate the importance of the following outcomes of the research training:

results of the research	Very good
number of publications	Good
development of research	Very good
establishment of international collaborations	Very good
transfer of knowledge/technology	Very good
training of students/researchers	Good
further academic qualifications (PhD, habilitation etc.) for fellows	Very good

Comments:

National collaborations:

During the last four years and thanks to the activities funded by the Marie Curie CIG, the fellow has developed the following UK collaborations:

• Prof. Steve Hoon, MMU. Drylands expert. Co-written large project proposal. Carried out field visits and presentation in South Africa together.

• Prof. Lindsay Stringer (University of Leeds). Social scientist and land degradation/desertification expert. Co-written PhD Studentship proposal.

• Prof. Paul Aplin (Edge Hill University). Bush-encroachment expert. Invited speaker for talk organised by the fellow.

• Prof. Mark Danson, Prof Mike Wood, Dr Richard Armitage (Salford University). Collaborate in MSc in GIS distance learning programme, UNIGIS. Remote sensing experts.

• Prof. Nick Drake, Prof. Martin Wooster, Dr Mark Mulligan (King's College London, KLC). Co-written proposal to Google Earth Engine. Expertise in Big Data, remote sensing/soil erosion/hydrology.

• Dr Andrew Thomas (Aberystwyth University). Drylands expert, experience in the Kalahari and the Northwest Province. Co-supervising PhD student.

• Dr Katerina Michaelides (University of Bristol). Hydrologist. Invited speaker to MMU.

• Ms Emma Thomas, Marketing Director, Mapix Technologies(UAV company).

• Mr Gert Riemersma, CEO, Routescene (UAV company).

The International collaborations established by the fellow, include:

• Prof. Klaus Kellner, Northwest University, South Africa. Bush encroachment expert. Co-rganised workshop; co-written grant proposals; carried out field work together.

• Dr Konrad Wessels, CSIR, South Africa. Remote Sensing and Land degradation expert. Project advisory group.

• Dr Peter Caccetta, CSIRO, Australia. Remote Sensing Landsat-based monitoring expert (including soil salinity and woody vegetation cover monitoring). Project advisory group. Co-written a number of publications and NATO grant proposal.

• Dr Sebastian van der Linden and Prof Patrick Hostert, Humboldt University of Berlin. The Fellow spent 6 weeks as a visiting scientist of the Geography Department in 2016. Two papers have already been published from this collaboration (ANNEX X and X).

• Prof. Adolfo Calvo-Cases, University of Valencia. Geomorphologist, land degradation expert. Co-authored a number of papers together and EU Interreg proposal.

• Prof. Maria Roxo, University of Lisbon. Desertification expert. Co- authored EU Interreg Med proposal.

• Dr Sotirios Koukoulas, University of the Aegean. Land degradation and remote sensing expert. Co-authored a number of papers together and EU Interreg proposal.

• Agricultural Research Council (ARC, www.arc.agric.za ; contact: Dr Piet Nell)

• University of the Free State (UFS, http://www.ufs.ac.za/ ; cont.: Dr Jay Le Roux)

• University of KwaZulu-Natal (UKZN, http://www.ukzn.ac.za/ ; cont.: Prof. David Ward)

• Department of Agriculture, Forestry and Fisheries (DAFF, www.daff.gov.za ; cont.: Dr Theunis Morgenthal)

• Department of Agriculture, Conservation and Environment of the North West Province (DACE, www.nwpg.gov.za/Agriculture/index.html ; cont.: Dr Franci Jordaan)

• IRIS International Ltd. (20 Boom Street, Potchefstroom, 2531, South Africa; cont.: Hennie van den Berg)

• Western Australian Department of Parks and Wildlife (WPaW, https://www.dpaw.wa.gov.au/ ; Dr Graeme Behn) team of Landsat-based vegetation monitoring experts.

• Dr Emmanuel Mugabe: Dr Mugabe from the University of Hamburg has visited our research team and is working on a review paper with the Fellow related with climate change adaptation agricultural

practices in sub-Saharan Africa.

• Dr Ángel Marqués-Mateu, Univesidad Politecnica de Valencia (UPV), Spain. GIS expert. Dr Marqués visited our team twice and an arrangement of yearly exchange visits has been decided by both institutions. Dr Marqués is also working closely with the fellow to establish a collaborative PhD Programme between the Host Institution and the UPV which should start being operational from 2018-2019.

• Dr Gaspar Mora Navarro: from the Univesidad Politecnica de Valencia (UPV), Spain. He will visit our group in October 2018.

• Dr Jan Verbesselt and Prof Martin Herold, Wageningen University. The Fellow spent 6 weeks in Wageningen in 2016 working with the group of Laboratory of Geo-information Science and Remote Sensing
(https://www.wur.nl/en/Research-Results/Chair-groups/Environmental-Sciences/Laboratory-of-Geo-information-Science-and-Remote-Sensing.htm).

• Dr Vasilis Dakos, University of Montpellier: the Fellow has submitted a Marie Sklodowska Curie proposal in collaboration with Dr Dakos' Biodicee group (http://biodicee.edu.umontpellier.fr/) and is currently working on a new proposal. The Fellow is also applying for funds to carry out research at the University of Montpellier in 2018-2019.

• Dr Kostantinos Karantzalos, Remote Sensing Lab, National Technical University of Athens (NTUA; http://users.ntua.gr/karank/research.html). The Fellow has carried out field data collection during the project with the group of Dr Karantzalos. He has also carried out Workshops at NTUA and has received training on the processing and analysis of drone imagery. He is also currently preparing a joint paper submission for Land Degradation and Development (Annex 8).

• Assoc. Prof. Giorgos Stamou, Intelligent Systems, Content and Interaction Laboratory, NTUA (http://www.image.ntua.gr/~gstam/) . The Fellow is collaborating with Prof Stamou's group in developing a novel deep learning classification model for fractional woody vegetation mapping and monitoring. Their work will be submitted to ISPRS Journal of Photogrammetry and Remote Sensing (Annex 6).

YOUR OPINION ABOUT THE MARIE CURIE ACTIONS:

Comments:

Did you have previous knowledge of the Marie Curie actions? Yes

If yes, what sort of image do you think that the Marie Curie actions have among the scientific community in your research area?

Very good

Attachments

The content of this report has been approved by the researcher and the scientist in charge assigned to this project. The electronic submission of this report shall replace their signatures.

This declaration was visaed (signed) electronically by Elias SYMEONAKIS (ECAS user name nsymeoel) on 24/05/2018