Institution: Aston University

Unit of Assessment: 11 Computer Science

Title of case study: Development and application of the Digital Observatory for Protected Areas

Period when the underpinning research was undertaken: 2009 to present

Details of staff conducting the underpinning research from the submitting unit:

Name(s):	Role(s) (e.g. job title):	Period(s) employed by submitting HEI:
Dr Lucy Bastin	Senior Lecturer	2003- present (seconded to JRC 10/2010-09/2011 and 05/2014-05/2020)
Dr Dan Cornford	Reader	1995-2012 0.5 FTE 2012 0.2 FTE 2013-2019

Period when the claimed impact occurred: 2014-2020 (DOPA data services API launched in Jan 2015; DOPA Explorer and Reporter available from late 2014 / April 2016 respectively; eConservation launched June 2018).

Is this case study continued from a case study submitted in 2014? No

1. Summary of the impact

After previous successful collaborations with the European Commission's Joint Research Centre (JRC), Aston research was further developed and applied through **Bastin's** 2014-2020 work with the JRC, where she was lead developer of the Digital Observatory for Protected Areas (DOPA). DOPA's suite of tools and services are a reliable, transparent and evidence-based source of policy-relevant data for government departments, agencies and Non-Governmental Organisations (NGOs) on protected areas worldwide. DOPA has benefitted bodies such as the UN's Convention on Biological Diversity, the European Commission and regional economic communities, and led to substantial positive impacts on the planning, monitoring, reporting and evaluation of biodiversity conservation efforts.

2. Underpinning research

The European Commission's Joint Research Centre (JRC) commissions scientists to conduct research that informs, evidences and supports EU policy. Supported by Aston research, **Bastin** was seconded to the JRC between 2014 and 2020, where she worked as lead developer (with a team of up to five) of the JRC's Digital Observatory for Protected Areas (DOPA). DOPA is a web- and application-based biodiversity information system, which draws on data from a wide range of international sources, and functions as a tool for assessing, monitoring and forecasting biodiversity status and trends. By highlighting the state of, and pressures on, protected areas around the world, it supports decision- and policy-making and resource allocation on an international scale. It has been recognised by the United Nations (UN) Convention on Biological Diversity (CBD), a key beneficiary of this work – detail in **Section 4** below.

Aston research informed **Bastin's** work with the JRC and her development contribution to DOPA, which in turn continues to generate high-impact international collaborations. The key research which underpins the claimed impacts covers the following areas:

- Mapping, modelling and monitoring of biodiversity, in particular vegetation communities. (**R1, R5**)

- Benchmarking spatial systematic conservation planning tools, such as Marxan and Zonation, to evaluate their robustness to error in information-poor contexts where social and economic drivers interact with targets for conservation and restoration. (**R6**)

- Data curation following the FAIR (Findable, Accessible, Interoperable, Re-usable) principles to make data reproducible, transparent and accountable. (**R2**)

- Development of web-based modelling architectures allowing discovery, re-use and orchestration of models as services. (INTAMAP and UncertWeb) (**R2, R3**)

- Development of an interoperable framework to conceptualise, and a method to characterise and quantify, uncertainty in modelling for integrated workflows including web-based models (UncertWeb and UncertML). (**R2**)

- Development of techniques for modelling indicators and metrics of environmental state, pressure and change from heterogeneous data sources – including remote sensing, citizen science observations, socio-demographic covariates and infrastructure datasets (cadastral, building density, road networks etc.). (**R3, R4, R5**)

- Further development of these biodiversity indicators to deal with the specific challenges of planning protected areas for conservation. (**R3**)

- Developing visualisation and reporting tools to share environmental indicators of protected areas in a format relevant to stakeholders informing policy directions/decisions. (**R1**)

- Scaling up and systematising biodiversity indicators for production at global scale on distributed computing systems, exploiting near real-time data from remote sensing where appropriate. (**R5**)

Bastin's expertise in spatial analysis, software engineering and information management was extended and strengthened through Aston/JRC collaborations on the INTAMAP (**G1**) and Uncertweb (**G2**) projects. Coupled with her strong background in biodiversity and conservation, these technical skills laid the practical groundwork for the successful realisation of DOPA.

3. References to the research

Aston staff in bold, Aston PhD students in green

R1 McInerney D.; **Bastin L**.; Diaz L.;, Figueiredo C.;, Barredo J. I.; San-Miguel Ayanz J. (2012) Developing a Forest Data Portal to Support Multi-Scale Decision Making, *IEEE Journal of Selected Topics in Applied Earth Observations and Remote Sensing*, vol. 5, no. 6, pp. 1692-1699. **DOI:** 10.1109/JSTARS.2012.2194136

R2 Bastin, L., Cornford, D., Jones, R., Heuvelink, G.B.M., Pebesma, E., Stasch, C., Nativi, S., Mazzetti, P., Williams, M. (2013) Managing uncertainty in integrated environmental

modelling: The UncertWeb framework. *Environmental Modelling & Software* 39, pp. 116-134. https://doi.org/10.1016/j.envsoft.2012.02.008

R3 Dubois, G.; Schulz, M.; Skøien, J.; **Bastin, L**.; Peedell, S. (2013) eHabitat, a multi-purpose Web Processing Service for ecological modelling. *Environmental Modelling & Software*, 41, pp. 123–133 https://doi.org/10.1016/j.envsoft.2012.11.005

R4 Pekel J.F.; Vancutsem C.; **Bastin L**.; Clerici M.; Vanbogaert E.; Bartholome E.; Defourny P. (2014). A near real-time water surface detection method based on HSV transformation of MODIS multispectral time series data. *Remote Sensing of Environment*, 140, pp 704-716 https://doi.org/10.1016/j.rse.2013.10.008

R5 Rocchini, D., Luque, S., Pettorelli, N., **Bastin, L.,** Doktor, D., Faedi, N., …Nagendra, H. (2018). Measuring beta-diversity by remote sensing: a challenge for biodiversity monitoring. *Methods in Ecology and Evolution*, ISSN 2041-210X https://doi.org/10.1111/2041-210X.12941

R6 Langford WT, Gordon A, **Bastin L** (2009) When do conservation planning methods deliver? Quantifying the consequences of uncertainty. *Ecological Informatics* 4 (3), 123-135 https://doi.org/10.1016/j.ecoinf.2009.04.002

G1 INTAMAP project (INTeroperability and Automated MAPping, funded by the European Commission under the 6th Framework programme (1.8m Euro) Ran from September 2006 to August 2009, led by Dr Edzer Pebesma at Utrecht University.

G2 50058 - FP7 - STREP - ICT -The Uncertainty Enabled Model Web (UncertWEB) Cornford, D. & Bastin, L. 1/02/10 → 31/01/13, £3.7m Euro (Aston share £557,543), European Commission

4. Details of the impact

Biodiversity is a key global policy issue and DOPA enables the evidence-based planning, monitoring, reporting and evaluation of related conservation efforts. As well as leading DOPA's development (as detailed in **Section 2**), **Bastin** played a key role in promoting it to international governmental and non-governmental end users concerned with protected areas. **Bastin** supported DOPA presentations at the CBD conferences in Korea (2014), Mexico (2016) and Egypt (2018). In 2014, DOPA also formed the basis of several special sessions at the International Union for Conservation of Nature (IUCN) World Parks Congress – a landmark global forum staged once a decade.

Bastin also provided interactive training on DOPA to large groups of governmental and non-governmental experts, enabling them to access data and generate reports on protected area networks. Examples include:

- Regional Centre for Mapping for Resources and development (Kenya, 2015 and 2019), including participants working in diverse fields from Kenya, Burundi, Tanzania, Rwanda and Uganda.

- CBD's Subsidiary Body on Scientific, Technical & Technological Advice (Canada, 2018).

- Training on tools for assessing management effectiveness of protected areas, including 40 conservation stakeholders from 20 African countries (Rwanda, 2020) (**S1**).

- [Webinar on the practical use of data to generate information products](#) for specific policy needs, specifically in Eastern and Southern Africa.

Bastin also helped develop JRC services that prepare consistent reports tailored for end users' needs, reducing the need for stakeholders to be trained in basic data access and visualisation (**S2**).

Key beneficiaries and impacts

The impacts largely relate to public policy, law and services – and include:

- **Joint Research Centre (JRC):** The JRC has twice (2010-11; 2014-2020) seconded **Bastin** to access her research insights on modelling spatial-temporal data and handling uncertainty in modelling complex and diverse datasets. Her development of [the DOPA suite of services for the JRC](#) has enabled end-users to access "policy-ready conservation information" (**S3**). The JRC said: "*Bastin's unique combination of software development, spatial analysis and conservation expertise was crucial to the successful realisation of DOPA and its extended capabilities and tools. [Her].. cross-disciplinary experience…helped to bridge practitioners and technical solutions and strengthen the collaborative network of JRC*" (**S4**). DOPA is a key component of the [EU Knowledge Centre for Biodiversity](#), launched in late 2020 (**S4**).

- **Other European Commission Directorates General:** DOPA has enabled the production of defensible and transparent reports requested by the Directorates General to inform and support their planning and policy decisions (**S4**). For example, DOPA statistics formed the basis of a 2019 report on Cambodian coastal protection planning, for use by the Directorate-General for International Cooperation and Development (DG DEVCO) and the European External Action Service (EEAS).

- **UN Convention on Biological Diversity:** DOPA has played a key role in enabling countries and regions to measure progress against UN Sustainable Development Goals and Aichi Biodiversity Targets, including the development of 196 country data dossiers. The dossiers have supported 75 countries to identify 400 actions for implementing the Aichi targets. UN-CBD said: "The success of these capacity building activities would not have been achieved without the valuable reference information system, DOPA." (**S5**)

- **BIOPAMA:** (https://www.biopama.org/) An initiative financed by the European Development Fund (EDF), and jointly implemented by IUCN and JRC, "*BIOPAMA relies on DOPA as a key source of conservation metrics providing the backbone of their….Regional Reference Information Systems*" (**S4**). DOPA's informatics services supply the global context for regional specialist knowledge.

- **Regional economic communities:** Examples include the East African Community and Southern African Development Community. DOPA statistics and data visualisations inform key regional policy reports including the 2017 East African State of Protected Areas Report (**S6**) and the State of Protected and Conserved Areas Reports for Eastern and Southern Africa (2020), Pacific, and Caribbean (**S7**) (both due out in 2021).

- **Global NGOs:** DOPA data products were fundamental to the 2016 and 2018 Protected Planet Reports (published by UNEP-WCMC, IUCN and the National Geographic Society), particularly regarding the status of biodiversity and the safeguarding of ecosystems, species and genetic diversity.

  In its role as the secretariat of the international Biodiversity Indicators Partnership (BIP), UNEP-WCMC has adopted the ProtConn metric developed within DOPA for Aichi Target 11 reporting to the UN CBD – e.g. Ireland's Sixth National Report. This robust, transparent and peer-reviewed metric facilitates harmonised reporting across countries and political contexts, and will be embedded in the post-2020 reporting framework. In 2020, the European Commission commissioned Aston to extend the ProtConn metric to marine contexts, demonstrating Aston's key contribution (**S8**).

- **Other:** National government departments and statutory bodies, such as the Malawi Environmental Affairs Department and South African National Biodiversity Institute, and local NGOs have benefitted from access to biodiversity information from the DOPA/JRC suite of services. This has helped to inform changes to policy and practice around biodiversity and protected areas (**S2**).

  DOPA data services also underpin environmental modelling and analytics portals, for example the Observatory of Central African Forests (**S9**).

  DOPA tools and workflows are open source, decreasing the entry barriers for developing countries, and have been actively accepted by the open source community (e.g. **Bastin**'s paper was the second-most downloaded at FOSS4G 2017, the annual international conference of the Open Source Geospatial Foundation (515 downloads to date). (**S10**)

  DOPA is expected to form the basis for a UNEP Global Knowledge Platform for Biodiversity (**S4**). This will further increase the reach and impact of the architecture, models, algorithms and methodologies developed during **Bastin's** JRC secondment.

5. Sources to corroborate the impact

S1 Report on 2020 training workshop in Rwanda, including Dr **Bastin's** presentation slides regarding DOPA and other JRC tools (full workshop details at this link).

S2 Testimonial letter regarding the policy value of DOPA information products, services and training from Dr **Bastin**: from Malawi University of Science and Technology and South African National Biodiversity Institute

S3 Dubois, G.; **Bastin**, L.; Martínez-López, J.; Cottam, A.; Temperley, W.; Bertzky, B.;

Graziano, M. The Digital Observatory for Protected Areas (DOPA) Explorer 1.0; EUR 27162 EN; Publications Office of the European Union: Luxembourg, 2015; 53pp. https://doi.org/10.2788/436594

S4 Testimonial letter describing the importance of Aston research and training to the development of DOPA, from Project Leader of Global Conservation and Development (GCAD), Joint Research Centre of the European Commission.

S5 Letter from the Executive Secretary of the UN CBD to Director-General of the Joint Research Centre of the European Commission (2016), acknowledging the value of DOPA in the international work of the CBD. UN-CBD update report (2018) on the international status of Aichi Biodiversity Target 11, produced using DOPA services and statistics.

S6 2017 State of Protected Areas Report for East Africa. EAC/IUCN-ESARO/JRC, Nairobi, Kenya. 275pp. Dr **Bastin** is one of 6 lead authors.

S7 Testimonial letter from IUCN Caribbean re. use of DOPA for the Caribbean SOPACA report

S8 Consultancy contract between the European Commission and Aston University (2020) for the development of a marine ProtConn metric. Value of contract 14,850 euro.

S9 Screenshot showing DOPA data services in use in the Observatory of Central African Forests, and press release for the launch of the Observatory.

S10 Screenshot of paper download statistics from FOSS4G 2017 (Free and Open Source Software for GEO) and copy of the proceedings paper.