SMITH SCHOOL OF ENTERPRISE AND THE ENVIRONMENT

UNIVERSITY OF OXFORD

A National Spatial Data Infrastructure Index: Justification and Design

Discussion Paper

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About the Project for Protected Area Resilience

The Project for Protected Area Resilience (PPAR) seeks to reinvigorate the Protected Area (PA) conservation discourse. It examines the monetisable and non-monetisable values PA assets generate, who creates or captures this value, and how more value can be generated through new public, private, and philanthropic investments. The project is also concerned with how to safeguard PAs in light of current and emerging risks threatening their ability to generate value sustainably – in other words we want to avoid PA assets becoming 'stranded assets'. In addition, the project is looking at how to prioritise different types of PA funding and how PAs can maximise their impact given limited public funds. To find out more, visit: http://www.smithschool.ox.ac.uk/research-programmes/protected-area/index.php

The project is led by Ben Caldecott and Paul Jepson at the University of Oxford's Smith School of Enterprise and the Environment. PPAR's advisory board currently includes: Justin Adams (Managing Director, Global Lands, TNC), André Abadie (Managing Director/Head of Global Environmental & Social Risk Management, J.P. Morgan), Professor Jonathan Baillie (Conservation Programmes Director, ZSL), Robin Bidwell (The Woodchester Trust), Glyn Davies (Director of Programmes, WWF-UK), Christian del Valle (Managing Partner, Althelia Ecosphere), Rupert Edwards (Senior Adviser, Forest Trends), Professor Marc Hockings (Head of Science, World Commission on Protected Areas, Program Director of Environmental Management, University of Queensland), Naomi Kingston (Head of Protected Area Programme, UNEP-WCMC), Kathy MacKinnon (World Commission on Protected Areas), Stephanie Maier (Head of Corporate Responsibility, Aviva Investors), Therese Niklasson (Head of ESG Research, Investec Asset Management), Sue Stolton (Director, Equilibrium Research), Joshua Tewksbury (former Director, Luc Hoffmann Institute), Francis Vorhies (Director, Earthmind), and Sir Graham Wynne (Special Adviser, The Prince of Wales' International Sustainability Unit).

About the Authors

Georgina Chandler graduated from the MSc Biodiversity, Conservaiton, and Management in 2015 and developed the design for this index as her MSc dissertation project[1] under the supervision of Paul Jepson. She is currently dividing her time between working for 3Keel sustainability consultancy and developing this research at WWF-UK.

Mari Mulyani gained her doctorate from the School of Geography and the Enivironment (SoGE) at the University of Oxford in 2014. She is an expert in forest institutions and a lecturer at the University of Indonesia, as well as a research associate of SoGE.

Susanne Schmitt is the extractives and infrastructure manager with WWF-UK and has worked for 20-years at the interface of business and resource conservation.

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Discussion Paper

This Discussion Paper is intended to stimulate discussion within the research, development, and finance community. The views expressed in this paper represent those of the author(s) and do not necessarily represent those of the host institutions or funders.

[1] Chandler, G. *How can countries better integrate biodiversity conservation and development needs into spatial land use planning? Developing an index to benchmark the state of NSDI globally*. MSc Dissertation, University of Oxford (September 2015)

University of Oxford Disclaimer

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Introduction

The Sustainable Development Goals (SDGs) agreed in September 2015 express economic, human welfare, and environmental sustainability ambitions. Meeting the SDGs will not only require trade-offs between the needs of economy, society, and the environment, it will require that all sectors innovate to find synergies that will enhance all three. The can only be achived if countries have capacity for integrated land-use planning.

A National Spatial Data Infrastructure (NSDI) is a prerequisite for integrated land-use planning and coordination among sectors more generally. Put simply, it is a framework of technologies, policies, and institutional arrangements that facilitates and enables the creation, exchange, and use of geospatial data between sectors and other stakeholders.[2]

Surprisingly, comparative knowledge on the quality of different country's NSDIs is lacking. In response this paper presents a design for an index to benchmark the state of NSDIs globally.

Indonesia's move to upgrade its NSDI in 2007 made clear the benefits of spatial development planning for development. The 'One Map Initiative' was part of a reformist agenda to address, what in Indonesia are known as, 'ego-sectoral' attitudes - a bureaucratic culture where ministries prioritise their own interests over the public good. A situation where ministries develop sector plans without references to standardise spatial data generated by other agencies creates uncertainty over resource use and ownership, leading to conflict and sub-optimal development and investment outcomes. Whilst such uncertainty may benefit actors among political and bureaucratic elites (e.g. through rent-seeking practices) it propagates poverty and environmental degradation while undermining investment, innovation, and democracy (see Annex 1).

Indonesia's progressive 'One Map Initiative' simultaneously brought into focus the important role of a strong and independent national spatial data (mapping) agencies in driving institutional reforms to support sustainability and democracy. At the same time it can provide a blueprint for the institutional design of an effective NSDI. Drawing inspiration from Indonesian's lead, we conducted a study of NSDIs in Eastern and South African countries through policy review and interviews with fifteen in-country experts. Based on this research we developed a clear design for a NSDI index with robust indicators that simultaneously benchmark the state of a country's NSDI and provide guidance on steps needed improve a country's spatial data transparency. With financial support from WWF-UK, we are currently piloting our 'Phase 1' index in 11 countries in Amazonia, East Africa, Asia and including the UK, and are seeking a funding partner to support a larger scale application of the index.

We believe that rollout of a NDSI index has the potential to mobilise a collection of donors, investors, and NGOs, to pressure governments to modernise their NSDIs. This would strengthen capacity and demand for integrated land-use planning, with potentially profound long-term benefits for people, the environment, innovation, and investment.

The design of the National Spatial Data Infrastructure Index

An effective NSDI emerges from the combination of technical, human, and legal components. The technical component consists of mapping standards, fundamental data sets (maps), and the functional requirements needed to access and exchange spatial data. The human component encapsulates the skills and education, as well as the political and policy support and leadership required to drive a NSDI to success. The legal component

[2] ESRI (2009)

comprises of the quality of the legal and policy frameworks and capacity of government to implement them. This component crucially underpins the technical and human components; whilst a NSDI can operate on a voluntary basis, it becomes of force for effective integrated land-use planning and institutional reform when the system has a mandate in law (see Annex 1 for Indonesia One Map Initiative descriptor).

Our index disaggregates these components into sub-components that interact to produce a NSDI that can act as institutional asset for generating value in the form of coordinated, transparent, and participative planning and decision-making.

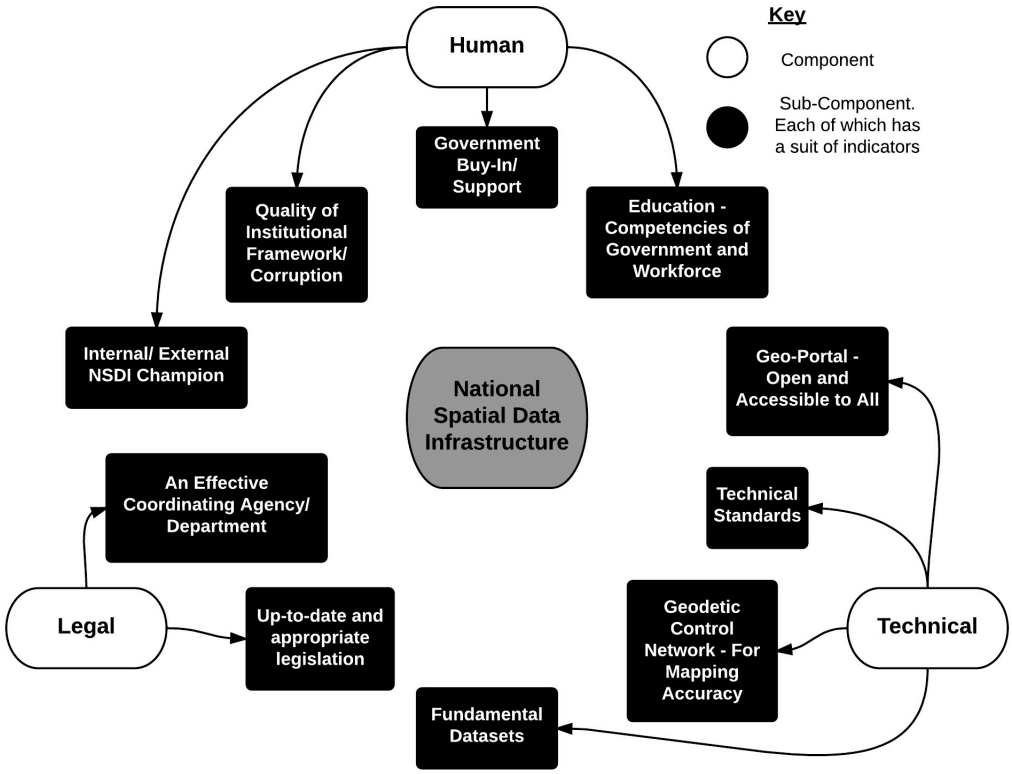

Figure 1 - The components of a National Spatial Data Infrastructure

Each sub-component is reliably scored against a suite of robust and meaningful indicators that are assembled to form the Index (Table 1). We plan to present the Index in a scorecard format; with a standardised scale across indicators, such as one to five, with qualifying descriptions for each score, to make clear what is needed to strengthen a NSDI and achieve a higher index score.

Table 1. Abridged list of indicators that are scored to generate the index
HE2. Spatial data competencies of the workforce. The highest education level at which Geographic Information Science is taught in a country. Indicates the status, capacity, and influence of spatial planning across all sectors of society. Scoring method: web-analysis.[3]
HE2: Spatial data competencies of government. The number of defined competency characteristics fulfilled by officials responsible for land-use decision-making. Indicates the degree of understating of the role of NSDI in achieving national and global development goals. Scoring method: expert review
HC3: The presence of an Internal or External NSDI champion. Attributes of NSDI leadership indicate qualities of a champion able to drives the process of NSDI establishment and role-out. Scoring method: Expert Review
HG4: Government buy-in for a NSDI. The presence of NSDI policy & strategy, and dedicated resources indicate the level of government buy-in. Scoring method: Expert and policy review.
HG5: Quality of wider governance frameworks. The higher the quality of a country's policy and institutional framework the better it can integrate a NSDI into its decision making. Scoring method: CPIA Ranking (World Bank)
TS7: Quality of technical standards. Mapping standards for classification and naming of features that are either published or conform with global standards are vital for preventing mapping inconsistencies. Scoring method: document review.
TS8 Metadata availability. Metadata standards describe the quality, location, and indicate the spatial data validty; they should be transparent, available, and consistent, and included alongside every spatial dataset. Scoring method: document review against ISO standards for metadata description.
TS9 Data interoperability. Interoperability standards determine the degree to which spatial data can be shared and used across platforms without manipulation, this reduces transaction costs and enhances data accessibility. Soring method: number of fundamental maps using same standards
TS10: Resolution of Geodetic Control Network. Consistent reference points (coordinates) are needed to ensure the same base projection and measures for mapping. Scoring method: frequency of a country's measuring stations.
TS11: State of fundamental datasets. The minimum set of basic data layers needed to carry out spatial planning. Scoring method: date of last update and frequency of updates.
TS12: Assessable Geo-portal. This is fundamental to the transparency and accessibility of spatial data to the public and stakeholders in decision making. Scoring method: size & presence of paywalls, ability to make data requests.
TS12: Geo-portal functionalities. The range of functionalities provided by the geo-portal will determine its usability. Scoring method: checklist of best-practice functionalities.

[3] Coetzee, Serena, and Sanet Eksteen. "Tertiary education institutions in Africa: Cloudy with a chance of GISc education in some countries." *South African Journal of Geomatics* 1.2 (2014): 119-132.

TS13: Internet penetration. Geo-portals are web-platforms and the transparency and impact they can have depends on internet access in a country. Scoring method: World Bank Citizen Internet Access Index.
TS14: Clearing house capacity. This is the technical infrastructure essential to enabling storage and access of data. Scoring method: expert review of state of development.
L15: Presence and quality of SDI legislation. A legal framework is required to legitimate and operationalise a NSDI. Scoring method: review of legislation against best practice checklist developed from review of recent NSDI legislation.
L16: Presence and effectiveness of a competent government agency. A responsible agency is necessary to develop and manage a NSDI effectively and efficiently. Scoring method: document and expert review.

The impact of a NSDI index

Indexes are prominent in sustainable development decision-making and are both generated and used by development banks, aid-agencies, asset-managers, and environmental groups. Well known examples include the World Bank's Human-Development Index[4], Transparency International's Corruption Perception Index[5], and WWF's Water Risk Filter[6]. The only index with a spatial data component is the Open Data Barometer[7], produced by the World Wide Web Foundation, which scores a country on the technical and legal openness of fifteen core datasets, of which one is access to an 1:250,000 base map. It does not include other components that, if measured, could provide more focused investment and policy outcomes for spatial data. As described above our NSDI index benchmarks institutional capacity for practices of ministerial/sectorial coordination and integrated land-use planning that are vital if the Sustainable Development Goals are to be achieved.

Deployment of a NSDI index would support the realisation of SDG goals in relation to building accountable and inclusive institutions (SDG 16), and reducing the opportunities for corruption (SDG 16.5). By focusing on a nation's capacity to conduct integrated spatial and land-use planning the NSDI Index directly addresses the references in SDGs 11a and 11.3. These outline the need for sustainable human settlement planning and for generating positive economic, social, and environmental links between urban, peri-urban, and rural areas through strengthening national and regional development planning. Furthermore, the goals of building resilient infrastructure (SDG 9) and ending hunger through food security and sustainable agriculture (SDG 2), link back to the need for coordinated and efficient spatial planning.

Access to consistent spatial data would also have profound implications for the quality of environment anddevelopment planning. For example, it would:

1) Strengthen the implementation of international environmental agreements by empowering those responsible to identify 'problematic' development projects and engage early to resolve issues;
2) Empower national political and civil-society actors to more effectively engage with decisions relating to land-use and development planning;
3) Enable companies and their investors to better screen and assess risk of projects with spatially-located components;
4) Provide corporations a steer on the level of due-diligence required before embarking on a project with spatial components.

[4] http://hdr.undp.org/en/content/human-development-index-hdi
[5] https://www.transparency.org/research/cpi/
[6] http://waterriskfilter.panda.org/
[7] http://www.opendatabarometer.org/

Significantly our index would draw policy attention to the crucial role of NSDIs in achieving SDGs. By benchmarking the state of NSDI globally it would reveal countries where development investments carry risks relating to poor performance and negative environmental and social impacts. A NSDI Index would enable governments to benchmark the state of the NSDIs and set investment goals to strengthen their spatial planning institutions and thereby improve their NSDI ranking. International finance institutions and multi- and bi-lateral donors could support this by integrating a NSDI ranking as conditionality of their loans and grant aid and investing in their development.

A NSDI index could be developed in conjunction with global organisations such as the Global Spatial Data Infra-structure organization (GSDI). Not only might such organisations help assure the quality of country scoring, the index would also act to increase ther profile and influence of such professional organisations.

In summary, a NSDI index would create a positive dynamic for change. Firstly for developing the institutional capacity across all nations to effectively balance trade-offs between economic development and the environment; second, to identify opportunities and risks early in the planning cycle; and third, to ensure greater equity and efficiency of investment and decision-making.

What next?

Georgina Chandler and Susanne Schmitt (WWF-UK) are conducting a pilot application of the index with the aim to further refine the indicators and components to be globally representative. The pilot will focus on scoring a selection of countries in the WWF-UK priority regions, including: Kenya, Tanzania, Mozambique, Brazil, Columbia, Peru, India, China, Nepal, Buhtan, and the UK. The pilot with involve expert review of the phase I index desogn and indicators , followed by text country apllications based on in country expert interviews and discussions. These will aim to gain a profile of the issues and successes surrounding spatial data transparency as well as the NSDI status, and barriers to its improvement. Through this process of understanding several countries situation in detail, the accuracy of the indexs representation of a situation in a country will be assessed. The results of this phase will be complied into country profiles, which will present the research findings and describe how they might affect conservation initiatives in the priority countries. This work is due for completion July 2016.

Annex I: Indonesia's One Map Initiative - the creation of a NSDI

Indonesia's One Map Initiative provides a design case study for the development of a NSDI index.

The **legal component** of Indonesia's NSDI is based on Presidential Decree No. 85/2007 (later updated PD Decree No. 27/2014), to increase data and information-sharing and their dissemination through the optimisation of network node geospatial data. Subsequently a new Geospatial Information Law (GIL No. 4 2011) created the legal framework to improve land-use planning through reforms to geospatial information and mapping and associated coordination and cooperation between relevant state agencies. In particular, the law provides a legal framework for acquiring accurate geospatial data, processing it, and ensuring its transparent and free access and distribution. The law designated the Indonesian Geospatial Information Agency (GIL previously 'Bakosurtanal') as the lead agency to coordinate the NSDI and establish a system of reliable, orderly, integrated, effective, and efficient spatial data through the creating of 'One Map' comprising four aspects: one reference, one standard, one database, and one portal. The aim is that the base-maps available from the one-map portal will used by all state ministries and institutions, as well as by all other stakeholders, including the private sector, civil society, and indigenous communities.

Relating to the **technical componet** Indonesia has been working towards achieving a standard 1: 1000 scale basemap as mandated by the GIL 2011. Gradually, the Geospatial Agency is completing the base map (which includes several data layers such as roads, rivers, bodies of water, and buildings, etc.) at various scales. The base map with a scale of 1:250.000 is completed (and is seamless and digital), and the 1:50.000 and 1:25.000 maps are scheduled for completion by the end of 2015. The Ina-Geoportal (http://maps.ina-sdi.or.id) is designed to be more extensive than platforms such as Google Maps making available data layers developed by government institutions with authority and control-ownership of the data. This portal is developed as an integrated database to store all spatial and non-spatial information to which the public can gain free access.

With regard to the **human component**, Indonesia's Geospatial Agency has established a "National Competence for Human Resource Development in Geospatial Industry' supported a decree from the Minister of Manpower and Transmigration (Decree No. 331/2013). This decree establishes a framework for establishing professional education and training, competency testing, and professional certification in collaboration with Indonesia's Institute of Technology Bandung (ITB). The human resource demands are significant: it is estimated that 27,000 skilled personal are required to serve at the various levels of government across the vast archipelago, yet current University capacity can train just 900 per year.

Significant financial resources are required to improve Indonesia's NSDI. To date external funding has made a significant contribution to the development of the One Map Initiative. The Japanese Government, through JICA, provided a loan for establishing IT integration with software such as ArcGIS for Server and Esri Geoportal Server that enhance the interoperability of the platform The REDD+ Task Force, using REDD+ funding from Norway, has procured the technology and licenses that enable direct reception of satellite data to support the 'one point system' for acquiring and processing satellite data images (as mandated by the GIL 2011). This is the first time in Indonesia's map-making history that the costly process of acquiring and curating satellite data images has been coordinated and provided by one government body, namely the National Institute of Aeronautics and Space (LAPAN). The calculated benefits are that cost efficiency will be one fourth when compared with the system prevailing previously, by which each ministry or agency bought satellite imaging data individually[8].

[8] Compiled From various sources including an interview with Asep Karsidi, then the head of Indonesia's Geospatial Agency; official website of BIG http://www.bakosurtanal.go.id; and Mulyani 2014 (unpublished D.Phil Thesis of University of Oxford)

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