Data for Development

A Needs Assessment for SDG Monitoring and Statistical Capacity Development

SUSTAINABLE DEVELOPMENT SOLUTIONS NETWORK
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WORLD BANK GROUP

April 17, 2015

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About This Report

This report is the result of seven months of work by a broad coalition of data for development experts, working in consultation with specialists from across the United Nations and academic institutions. The Sustainable Development Solutions Network (SDSN) brought the group together in October 2014, recognizing the need for a clear estimate of the scale of resources required for statistical capacity development in the context of the proposed Sustainable Development Goals and in advance of the Financing for Development (FFD) Conference in July 2015. Given the unique political opportunity afforded by the FFD Conference, this report was prepared within very tight timelines. Figures cited are based on pre-existing, known cost-estimates, or informed but not fully tested assumptions. They give an indication of the scale of resources required but are not intended to serve as a blueprint for directing investments. Administrative data improvements, for example, are crucial for effective governance and service delivery, but have been one of the hardest parts to estimate in this study. More work will be required to refine the exact level of investment for each sector and statistical production method and to identify the most efficient and effective ways to direct investments to build national statistical capacity. Furthermore, in-depth research should be conducted within each sector to identify cost-saving innovations that could be integrated into official statistical production methods over time.

Questions about this report should be sent to Jessica Espey (jessica.espey@unsdsn.org). To stay abreast of activities related to the report and other activities of the SDSN or this data coalition, please visit SDSN's website or sign up for our newsletter.

Acknowledgements

The writing of this report was led by Jessica Espey (SDSN); with Eric Swanson, Shaida Badiee, and Zach Christensen (Open Data Watch); Alex Fischer, Marc Levy, Greg Yetman, Alex de Sherbinin, Robert Chen, and Yue Qiu (CIESIN); Geoffrey Greenwell, Thilo Klein, and Johannes Jutting (PARIS21); Morten Jerven (SFU); Grant Cameron, Ana Milena Aguilar Rivera, Victoriano C. Arias, and Samuel Lantei Mills (World Bank); and Albert Motivans (UNESCO).

This report has benefited from the expert inputs of Guido Schmidt-Traub (SDSN), Anneke Schmider, and Rifat Hossein (WHO), Shyam Upadhyaya (UNIDO), Haishan Fu, Maurice Nsabimana, Barbro Hexeberg, Gero Carletto, and Amparo Ballivian (World Bank), Amanda Glassman (CGD), Jenna Slotin (UNF), David McNair (The One Campaign), Attila Hancioglu (UNICEF), Jacob Adetunji (USAID), and Matthias Reister (UN Statistics Division). Lauren Barredo, Kathy Zhang, and Carolina Rosero (SDSN) edited the report. Matt Smith (SDSN) designed the cover.

Acronyms and Abbreviations

AG	Agricultural Surveys
AOD	Aerosol Optical Depth
AZE	Alliance for Zero Extinction Site
CDR	Call Detail Record
CIESIN	Center for International Earth Science Information Network
CoIA	Commission on Information and Accountability
CPI	Consumer Price Index
CRS	Creditor Reporting System
CRVS	Civil Registration and Vital Statistics
CSO	Civil Society Organizations
CWIQ	Core Welfare Indicators Questionnaire
DAC	Development Assistance Committee
DETER	Sistema de Detecção do Desmatamento em Tempo Real na Amazônia
DFID	Department for International Development, UK
DFATD	Foreign Affairs, Trade and Development Canada
DHS	Demographic and Health Surveys
EMIS	Educational Management Information System
FFD	Financing for Development
FORMA	Forest Monitoring for Action
GDDS	General Data Dissemination System
GDP	Gross Domestic Product
GFW	Global Forest Watch
GIS	Geographic Information Systems
GNI	Gross National Income
GPE	Global Partnership for Education
GPS	Global Positioning System
HMIS	Health Management Information System
IBA	Important Bird Areas
ICT	Information and Communication Technologies
IDA	International Development Association
ILO	International Labor Organization
IMF	International Monetary Fund
INPE	Brazilian Institute for Space Research
IT	Information Technology
LDC	Least Developed Countries
LFS	Labor Force Surveys
LIC	Low Income Countries
LSMS	Living Standards and Measurement Study
MAPS	Marrakech Action Plan for Statistics
MDG	Millennium Development Goals
MICS	Multi-Indicator Cluster Surveys
NBS	National Bureau of Statistics
NIFI	National Infrastructure and Facility Inventories
NISP	National Industrial Statistics Program
NIBSP	New Industrial and Business Statistics Program
NSDS	National Strategy for the Development of Statistics

NSO	National Statistics Office
NUTS	Nomenclature for Territorial Units
OCGS	Office of the Chief Government Statistician
ODA	Official Development Assistance
ODW	Open Data Watch
OECD	Organization for Economic Cooperation and Development
PA	Protected Areas
PM	Particulate Matter
PPP	Purchasing Power Parity
PRESS	Partner Report on Support to Statistics
PRODES	Projeto de Monitoramento do Desmatamento na Amazônia Legal por Satélite
PSU	Primary Sampling Unit
RLI	Red List Index
SDG	Sustainable Development Goals
SDSN	Sustainable Development Solutions Network
SIDS	Small Island Developing States
SPSS	Statistical Package for the Social Science
STATCAP	World Bank Statistical Capacity Building Program
TA	Technical Assistance
TSMP	Tanzania Statistical Master Plan
UAV	Unmanned Aerial Vehicle
UID	Universal Identification Program
UNIDO	United Nations Industrial Development Organization
WDPA	World Database on Protected Areas
WHO	World Health Organization

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Executive Summary

Following the progress made under the Millennium Development Goals, which guided global development efforts in the years 2000 to 2015, the world's governments are currently negotiating a set of Sustainable Development Goals (SDGs) for the period 2016 to 2030. The SDGs will continue the fight against extreme poverty but will add the challenges of ensuring more equitable development and environmental sustainability.

Crucial to their success will be strong government systems and in particular strong statistical systems that can measure and incentivize progress across the goals. This study, prepared by a broad coalition of data for development experts, estimates that a total of US$1 billion per annum will be required to enable 77 of the world's lower-income countries to catch-up and put in place statistical systems capable of supporting and measuring the SDGs. Donors must maintain current contributions to statistics, of approximately US$300 million per annum, and go further, leveraging US$100-200 million more in Official Development Assistance (ODA) to support country efforts. For their part, recipient countries must commit to fill the gap, mobilizing domestic resources behind clear national strategies for the development of statistics (NSDSs).

Both donors and recipient countries must look to join the data revolution. The unprecedented rate of innovation in data collection techniques and technologies and the capacity to distribute data widely and freely has expanded the horizon of possibility. The adoption of the SDGs presents a strategic opportunity to build on the momentum of the data revolution and demonstrate the centrality of data for development. Particularly crucial is the Financing for Development Conference (FFD) being hosted by the Government of Ethiopia in July 2015. The FFD Conference will be the key forum at which to recognize the investment needed to rise to the challenge of the SDGs. With clear commitments from member states, international financial institutions, and the private sector, the FFD Conference could lay the ground for a meaningful Partnership for Development Data, backed up by adequate resources.

Our objective is to catalyze and inform the discussion on data at the FFD Conference, and the ensuing dialogue on the implementation of the SDGs, by demonstrating the scale of need, including total and additional resources required, as well as the key areas for investment. We also attempt to identify some of the ways in which data production, analysis, and communication can be modernized, taking into account emergent technologies and their cost-saving potential.

The estimates provided in this study are very conservative. We focus our analysis on 77 countries that currently qualify for concessional borrowing through the International Development Association (IDA) and are therefore likely to be in need of external assistance, and we cost a selection of core statistical products that will be essential for monitoring the social, economic and environmental dimensions of the SDGs. These products include surveys, census, civil registration and vital statistics systems, education management information systems, and select economic and environmental statistics, inclusive of geospatial data. We also allow an overhead for human resource investments and policy and legislative reforms based on current and planned expenditures.

We sense-check these figures through a separate analysis of the budgets included in recent National Strategies for the Development of Statistics (NSDSs). These strategies lay out countries' aspirational plans to boost the capacity of their statistical systems. The accompanying budgets demonstrate that countries aspire to spend as much as $1.1 billion annually to increase the capacity of their statistical systems, with a median share of 52 percent of the funding coming from external resources. Although these plans predate the proposed SDGs, they demonstrate that countries are ready and willing to improve their national statistical systems, in line with the requirements of the SDGs.

We have not included the costs of monitoring and evaluation systems in each sector, which will be needed for effective program design. Nor do we look at the costs of modernization over time. New methods of data collection and analysis based on new technologies may replace or reduce the cost of traditional methods, but they will require additional investments. Should they become available, countries may realize savings or they may seize the opportunity to go beyond the basic functionality assumed here.

We also recognize that other investments in the data ecosystem will be essential to underpin a more fully developed culture of statistical literacy, and for a more sophisticated government approach to data analytics, visualization, and communication. This study is focused on the core components of an effective national monitoring system and the resources required bringing low and lower-middle income countries up to this basic level.

We demonstrate that the scale of additional investment required for national statistical systems to realize the data revolution and monitor the SDGs is relatively modest. With just US$100-200 million in additional ODA, alongside increased domestic contributions, we can help the world's lower-income countries to put in place the building blocks of an effective monitoring system, which will improve governance and service delivery, and drive progress towards our shared objective of sustainable development.

Introduction

The discussion of the post-2015 development agenda and the Sustainable Development Goals (SDGs) has renewed interest in the quality and availability of statistics for management, program design, and monitoring performance. Most of the necessary statistics are produced by national statistical systems in developing countries, and this data is a crucial component for good governance. Without information on where people live, how much they earn and what services they can access, it is impossible to respond to the populations' needs. Therefore, improving statistics requires investment in national statistical capacity.

The advent of the Millennium Development Goals (MDGs) in 2000 drew attention to the many gaps in the statistical record. In 2003, PARIS21 formed a task team to examine ways to improve support to the statistical systems needed to monitor development goals. The team's findings would apply to many developing countries ten years on:

> "*The [National] statistical systems are characterized by under-funding, reliance on donor support, particularly for household surveys, and very weak administrative data systems. Overall, there is a shortfall in funding for the core statistical systems required to provide information both for economic management and for monitoring the MDGs*."

More than 10 years later, progress has been made in many ways, including the implementation of a National Strategy for the Development of Statistics (NSDS) in almost all developing countries[1] and the establishment of national data archives in about half of the IDA countries.[2] However, as recognized by the UN Secretary General's Independent Expert Advisory Group on the Data Revolution, national statistical systems are still beset by under-funding, low capacity, and inadequate investments in administrative data.[3]

In September 2015 countries will agree upon a framework to succeed the MDGs. The conclusions of the Open Working Group suggest this framework will be far broader than the MDGs, covering environmental, economic, social, and governance dimensions. It is vitally important that we have a sense of what will need to be measured, how it should be measured, and how much it will cost. But, perhaps more importantly, we must use this as an opportunity to showcase the huge potential for increased investments in national statistical systems, to encourage the use of modern, systematic data-collection methods across the whole of government, and a culture of evidence-based policy making. Such systems will enable the monitoring of the SDGs and, by encouraging new, reliable, and accessible government data, will provide governments the capacity to design better policies and programs. It will also enable citizens to hold leaders accountable for progress and improve their day-to-day decision-making.

There is a unique opportunity to make the case for investments in data and statistical systems over the next six months. In July 2015 the Government of Ethiopia will host the Third Financing for Development Conference (FFD). The FFD Conference will be the key forum in which to highlight investment needs in order to rise to the challenge of realizing the new SDGs. It will also be the forum in which to take stock of the paltry investment extended to data for development thus far and the need to modernize our approach to data, in the spirit of a data revolution.[4]

This report intends to inform the discussion at the FFD Conference, and the ensuing discussion on the implementation of the SDGs, by demonstrating the scale of both total and additional resources required; the key areas for investment; and by identifying some of the ways in which data production, analysis, and communication can be modernized, taking into account new technologies and their cost-saving potential.

[1] National Strategies for the Development of Statistics are available at http://www.paris21.org/nsds-status (accessed April 4, 2015)
[2] Accelerated Data Program Central Catalogue is available at: http://adp.ihsn.org/survey-catalogs (accessed April 4, 2015)
[3] Independent Expert Advisory Group on Data Revolution for Sustainable Development (2014). *A World That Counts: Mobilising the Data Revolution for Sustainable Development*.
[4] OECD (2014). *Strengthening national systems to monitor global goals*. OECD Post-2015 Reflections, Element 5, Paper 1. Paris: OECD and PARIS21.

Global and national statistical systems vary widely in both function and form, so costing their tasks and capacity requirements is not an easy job. But even rough estimates will help to better inform discussions and provide a basis for decision-making.

The paper attempts to clarify the key components that need to be assigned value in a typology of core development data. Recognizing that countries must take the lead on monitoring sustainable development, we have focused on the costs of essential statistical tools required to compute national level official statistics related to sustainable development. Nevertheless, we recognize that other investments in the data ecosystem will be essential to underpin a more fully developed culture of statistical literacy, and for a more sophisticated government approach to data analytics, encompassing discovery, acquisition, management processing, analysis, visualization, and communication. Facilitating information exchange will also be essential to improve the day-to-day lives of the poor. For example, systems could provide up-to-date data on market prices of commodities produced by smallholder farmers to help them make informed decisions about when to sell and potentially increase their incomes. Similarly, information on the location, cost, and quality of health or education services would allow individuals to make better decisions for their families.

This document is organized as follows: *I. The Cost of Improving the Global Statistical System* considers current evidence on the cost of basic necessary statistical improvements. Although a range of estimates exist we find them to be fragmented (related to one or other statistical production method) or out of date, with no timely overarching estimate currently available. In *II. A Typology for Development Data* we present a typology of core development data, based on a current draft list of indicators for measuring the SDGs. We identify the underlying statistical production method for each tool and use this to identify relevant costing elements.

In *III. Costing Statistical Instruments* and *IV. A Comprehensive Needs Assessment for a SDG Data Revolution* we consider the additional investments that will be required to bring statistical capacities to a basic minimum level of functionality to monitor the SDGs. We examine the total operational cost of each production method and aggregate it to a global estimate. In IV, part iii we contrast this estimate to current expenditures in data and statistics as recorded by national governments in their National Statistical Development Strategies (NSDSs). This comparative analysis helps to ensure that our investment estimates are in line with national plans and aspirations. We also examine current levels of external assistance, including official development assistance (ODA) as recorded in aid statistics and NSDSs, to identify the investment gap.

Recognizing that we are in the midst of a revolution, which has the potential to speed up data production and analytics, *V. Innovation for Cost Reduction* considers innovative approaches to collecting data, which should be integrated in to official statistical production methods to bring down the overall costs and efficiency of the production process. Our entire study is premised on the need for modernization and increased efficiency and frequency of data collection to foster a culture of evidence-based decision-making. Section V helps to illustrate this point with tangible examples of innovative approaches being employed across sectors.

We conclude by highlighting the important opportunity provided by the FFD Conference in July 2015. The scale of additional investment required to strengthen and modernize national statistical systems to realize the data revolution and monitor the SDGs is relatively modest. We estimate that the total cost of monitoring the SDGs to be approximately US$1 billion per annum, inclusive of current expenditures. Although it is hard to estimate an exact funding gap, it is clear that there is a large margin between current expenditures and future requirements. Our analysis of the NSDSs shows that countries are planning on aid at a level of half of current NSDS budgets. Current aid expenditures are approximately US$300 million (as of 2013), so a further US$100-200 million more will therefore be required in ODA (an average of US$1.30 to US$2.59 million per IDA recipient or blend country) to fulfill SDG monitoring demands, alongside increased domestic investments. With clear commitments from member states, international financing institutions and the private sector, the FFD Conference could lay the ground for a meaningful Partnership for Development Data, backed by adequate resources.

I. The Cost of Improving the Global Statistical System: Current Evidence

In 2004 the Marrakech Action Plan for Statistics (MAPS), an initiative of the World Bank, regional development banks, and the Organization for Economic Cooperation and Development (OECD), estimated that the annual cost of improving both national and international statistical systems up to acceptable levels would be somewhere between US$140 to 160 million per year in additional resources. This funding requirement would be on top of what governments and donors were already spending at the time - which was, and remains, unknown for the majority of developing countries. This estimate was based on the inputs of expert staff, "making reasonable but not fully tested assumptions." Countries were divided into three income classes (low, lower-middle, and upper-middle income as defined by the World Bank) and into three groups by population (less than 10 million, between 10 and 50 million, and more than 50 million). In each category estimates were made of the average annual running costs and the average level of budget allocations for statistics. Two important assumptions were made: on average low income countries were unable to afford the recurrent costs of a statistical system that would meet General Data Dissemination System (GDDS) recommendations, and middle-income countries' government allocations were sufficient to meet the annual running costs of such a system.

The Marrakech Action Plan for Statistics (MAPS) was a comprehensive attempt to estimate the scale of additional resources required to ensure a basic minimum operating system within national statistical offices. However, 10 years on, new estimates of the cost of 'core statistical products' serve to question the continuing relevance of the Marrakech figure, which appears a gross underestimate of current requirements. For example, a joint report by the World Bank and the World Health Organization (WHO) includes estimates of the cost of scaling up investment in global Civil Registration and Vital Statistics (CRVS).[5] They estimate that the total cost of scaling up and sustaining CRVS systems in 73 countries to be on the order of US$3.82 billion over 10 years.[6] Taking into account domestic contributions and recurrent expenditures they conclude that an additional US$1.99 billion is required to scale-up CRVS in the 73 countries over a 10-year period, or an average of US$199 million per year; this is US$40 million more than total annual Marrakech estimate for all MDG data needs.

Another recent cost estimate comes from a paper for the Copenhagen Consensus, prepared by Morten Jerven at Simon Fraser University (2014). Jerven argues that collecting information on just eight dimensions of development (the eight MDGs) on an annual basis, using survey techniques[7] and a population census would cost US$27 billion over a 25-year period.[8] This equates to US$1.08 billion per annum, but does not take into account domestic recurrent expenditures.[9] Jerven's estimate rests on four main assumptions: that the majority of MDG development data is survey-based and that the objectivity of data is higher in survey data, particularly in low income countries (LICs); that the cost of CRVS and administrative data collection is born by the ministries, rather than the national statistics office (NSO); that survey-based information should be collected annually (responding to the calls that poverty data should be collected annually rather than every three to five years, as previously recommended by GDDS[10]); and that there is existing statistical capacity in each region to support annual survey measurement.

Demombynes and Sandefur (2014) attempt to refine Jerven's estimate by identifying the funding gap, taking into account preexisting spending on household surveys. They conclude that Jerven's calculation gives an exaggerated sense of the international funds needed to close existing gaps, because middle-income countries

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[5] World Bank and World Health Organization (2014). *Global Civil Registration and Vital Statistics Scaling up Investment Plan 2015–2024*.
[6] This excludes India and China, who were identified as requiring separate analyses.
[7] He cites figures from the Demographic Health Surveys (DHS), Living Standards and Measurement Study (LSMS), and Core Welfare Indicators Questionnaire (CWIQ).
[8] He cites the MDG monitoring period of 1990 to 2015.
[9] Jerven, M. (2014). *Benefits and Costs of Data for Development: Targets for the Post-2015 Development Agenda.* Data for Development Assessment Paper. Copenhagen: Copenhagen Consensus Center.
[10] GDDS recommends annual data collection for health and education indicators.

can finance surveys with domestic resources. Surveys and censuses in Kuwait, South Korea, and Chile, for example, are included in the US$1 billion figure. Focusing on countries below UD$2,000 per capita gross domestic product (GDP) in purchasing power parity (PPP) dollars yields a total cost to international donors of closing all remaining survey gaps of less than US$300 million per annum, which they point out is a fairly small share of global aid budgets.[11] But Demombynes and Sandefur also call for greater investment in an integrated national statistics system, which includes a focus on other types of data, including the administrative data that is essential for monitoring equitable and effective services. They fall short of providing an estimate of the resources required to support these systems, but suggest that costing one or other tool individually is missing the much bigger and longer-term picture.

What these indicative costs suggest is that there has been little consensus on how best to cost the requirements of the global statistical system. The Marrakech figure is outdated and underestimates current requirements for greater periodicity of data as well as the call for more consistent use of a broader number of statistical products. Furthermore none of these estimates take into account the need to modernize data production methods, nor the accessibility, dissemination, and use of the data, which are essential if data are to support more effective governance.

Since October 2014, SDSN, Open Data Watch, PARIS21, the World Bank, and other partners have been working to overcome this challenge. We have agreed upon a typology of development data – or more accurately a set of common statistical tools – that will be required to comprehensively measure all of the elements identified in the SDG agenda, to agree common principles around their use, and to gather estimates of the scale of additional investment required. SDSN's report *Indicators and a Monitoring Framework for the SDGs* has provided a helpful frame, as it proposes 100 indicators to track the SDG agenda. We have used this set to identify core data source and statistical production methods (see Annex 1). Given the breadth of the SDGs-covering economic, social, and environmental dimensions – the tools identified will form the core of any countries' statistical system. These tools will enable us to monitor the SDGs but they will also produce a much wider set of data to support government performance, service-delivery, and accountability to citizens.

[11] Demombynes, G. and J. Sandefur (2014). *Costing a Data Revolution*. Copenhagen: Data for Development Viewpoint, Copenhagen Consensus Center.

II. A Typology of Development Data

Development data comes in many shapes and sizes. In its narrowest sense it refers to the data used to monitor progress on the MDGs, through 49 official indicators. More broadly it refers to the vast number of official statistics compiled by national statistical offices and line ministries to aid governance and program design, as well as very detailed data compiled by the international community to monitor the pace of economic and social development, as well as the status of the environment (broadly reflected in the World Bank's World Development Indicators).

This report focuses on the data that will be required to monitor progress on the 17 SDGs and their accompanying targets. Given the breadth and complexity of the SDG agenda, many different types of data will be required (demographic, economic, social, and environmental) with varying levels of coverage. We have identified a typology of the core types of development data by looking at the key statistical tools or production methods that are required to collect each of the SDSN's 100 Global Monitoring Indicators described in *Indicators and a Monitoring Framework for the SDGs*[12] (see Annex 1). Broadly defined, data are derived from the following eight sources:

i. ***Census data:*** A census is a procedure of systematically acquiring and recording information from all the members of a given population. It is a regularly occurring and official count of a particular population, which should take place (at a minimum) every 10 years. A census is usually conducted and/or managed by the NSO.

ii. ***Household surveys:*** Household surveys are designed to provide reliable data on demographic and socio-economic characteristics of the population. A typical household survey collects data from a national sample of households, randomly selected from a list of households (usually derived from the census), but some surveys may be confined to a particular region. Although the household is the primary sampling unit, the survey may provide information on individual household members.

iii. ***Agricultural surveys:*** Surveys of agriculture include farms and ranches and the people who operate them. Such surveys generally look at land use and ownership, operator characteristics, production practices, crop yields and productivity, income, and expenditures. Agricultural surveys can be a vital source of data on environmental and climatic events, crop productivity, soil quality, horticultural practices, and inputs and outputs and operating results.

iv. ***Administrative data:*** Administrative data refers to information collected primarily for administrative or management purposes. Government departments and other organizations collect this type of data for the purposes of registration, transaction, and record keeping, usually during the delivery of a service. Ministries and government departments are the main (although not exclusive) keepers of large administrative databases, including welfare, tax, health, and educational record systems. Administrative data systems are essential for evidence-based, accountable public service delivery.

v. ***Civil registration and vital statistics:*** Civil registration is a form of administrative data that records vital events in a person's life (including birth, marriage, divorce, adoption, and death) and is therefore a fundamental function of governments. Within governments, civil registration systems are the responsibility of a number of ministries or departments, including ministries of health, interior, justice, and national statistical offices. Civil registration contributes to public administration and governance by providing individuals with legal identity and civil status and by generating information that can be used as the source of civil registries and population databases. Furthermore, death registration including cause of death is an important source of public health information.

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[12] The current draft of the report is available at http://unsdsn.org/wp-content/uploads/2015/03/150320-SDSN-Indicator-Report.pdf.

vi. ***Economic statistics, including labor force and establishment surveys and trade statistics:*** Economic statistics measure the financial performance of economic agents in relation to global, national and local markets, as well as the economic status of individuals. Crucial measures for the SDG agenda include gross domestic product, gross national income, national poverty levels, household income, labor force participation and employment status, and economic losses from disasters. Domestic revenues, private flows, ODA and trade statistics are also important. These kinds of economic statistics are captured, predominantly, through labor force surveys (which measure individuals' employment status), establishment surveys (which to measure inputs, investments, and outputs of organizations), and trade statistics recorded by custom services.

vii. ***Geospatial data:*** Geospatial data refers to any environmental and socioeconomic data, including data in all of the previous categories that include specific location information to which the data apply. The spatial component of the data is usually stored as coordinates and topology, allowing the data to be mapped. Geospatial data are often accessed, manipulated, or analyzed through geographic information systems (GIS).[13] Environmental data at both moderate spatial resolution (~15 meters) and high resolution (~1.5 meters) are now readily available from satellites, aircraft, and a range of other public and private sensors. Geo-referencing of household surveys, census data, economic transactions, and other data is becoming increasingly common, using global positioning system (GPS) and related technologies. Geospatial data will be crucial for many of the environmental SDG indicators, as well as for disaggregated analysis of socioeconomic SDG indicators. Integrating geospatial data with household surveys, for example, can enable disaggregation and analysis by spatial characteristics, for example, proximity to roads or levels of urban development. In recent years there has been a revolution in the collection and use of geospatial data through many new mechanisms, including transactional data such as mobile phone data records and crowd-sourcing methods. These and other innovations are increasing the central role of these data products and tools.

viii. ***Other environmental data:*** Geospatial data encompasses and enables a wide-range of environmental monitoring, but there are a few environmental dimensions that require additional and more targeted measurements, using ground-technologies or surveys. Many environmental indicators also include real-time monitoring of on the ground conditions, such as air quality in urban areas or water supply. The cost estimates in this section are based on existing, widely adopted technology, but there is huge potential for technological innovation. Data collection for these indicators is often paired with geospatial tools such as remote sensing, but for the purposes of this costing exercise we consider them a distinct category of expenditure. Measures considered include biodiversity, air quality, hydrological monitoring, and forest and land use change.

It should be noted that there are often two or more production methods for any given indicator. For example, data on malnutrition could be derived from household surveys or from health administrative data such as hospital records. For the purposes of this study, we have identified the most commonly used production method in the countries in our sample (77 low and lower-middle income countries), but we recognize that approaches to production may change over time, as the capacity of national statistical offices improves and/or innovations are integrated into the official production process. Furthermore many of the types of data identified above are contingent upon each other; for example, CRVS enable targeted public service delivery, in which individuals use unique identifiers to access services. Likewise, census information is essential to effectively sample household surveys or to compile economic information, including GDP data, on a per capita basis. The complementarity and codependence of each of these data types makes a systematic and comprehensive approach to data strengthening all the more important.

[13] For more information see http://education.nationalgeographic.co.uk/education/encyclopedia/geographic-information-system-gis/?ar_a=1

Box 1: Examining National Strategies for the Development of Statistics

NSDS are a tool for planning improvements to national statistical systems in the medium term. Ideally, these documents provide plans to carry out major statistical activities (such as censuses, surveys, collection of administrative data, and so forth) and to improve the legal, bureaucratic, and technical context within which official statistics are gathered. NSDSs can also be used to budget for operational costs, plan improvements to the system, and coordinate donor support.

More than 100 countries have developed such strategies, which typically cover four or five years. PARIS21 provides guidelines, with periodic updates, for preparing NSDSs. However, countries produce different documents with very different styles and levels of thoroughness. Some encompass all statistical operations in the country. Others focus primarily on improvements sought by the national statistical office. Some NSDSs include budgets, but many do not.

Rwanda's 2009-2014 NSDS provides an interesting example.[14] The document bears the logos of several major donors and key ministries in the government. It discusses the current state of statistics in Rwanda and challenges ahead. It describes the national statistical system's mission and goals, key activities, and projects; presents a budget and implementation plan; and comments on long-term issues to consider.

"The NSDS is the blueprint of all statistical activities to be planned and implemented by government institutions in the country in the medium-term. Thus, we hope that financing of statistical activities from the government and development partners shall be based on the NSDS." Rwanda NSDS for 2009-2014.[15]

The budget for Rwanda's NSDS occupies 12 pages, indicating amounts to be dedicated to data production and management, information dissemination, capacity building, and to different statistical sectors. The document does not specify which components of this budget are to be funded locally or how much foreign assistance is sought. Reflecting the fact that NSDSs are planning documents and are subject to change, the budget allocated for the 2012 Household and Population Census was revised significantly from US$32.3 million to US$21.3 million in the most recent version.

Despite the differences among NSDSs, we are able to collect valuable information about national priorities for statistical capacity development and the expected level of funding needed to improve statistics. We have identified 22 NSDSs (from the 77 International Development Association (IDA) recipient and blend countries, see Annex 2) with useful budgetary information that are either ongoing or were completed in 2014. Positively, the major statistical tools identified in each NSDS closely correlate with the tools identified for this study. We therefore use the NSDS estimates to cross-check our assessment of the level of required investment in Section.

NSDSs or similar planning documents should play a major role in guiding national statistical systems toward the principles of the data revolution for sustainable development and for monitoring the SDGs. With further improvements to the budget presentation, the international community could better anticipate and respond to the costs associated with monitoring the SDGs.

[14] Government of Rwanda (2014). National Strategy for the Development of Statistics for Rwanda, 2009-2014. Rwanda.
[15] Government of Rwanda (2014), 5.

The production methods identified above are not only important to measuring the SDGs. Each of the sources will generate huge quantities of data, which can be used by the government to improve ministry performance and service delivery, as well as to better understand the well-being of the population. Their critical importance is further demonstrated by their prominence in NSDSs (see **Box 1**).

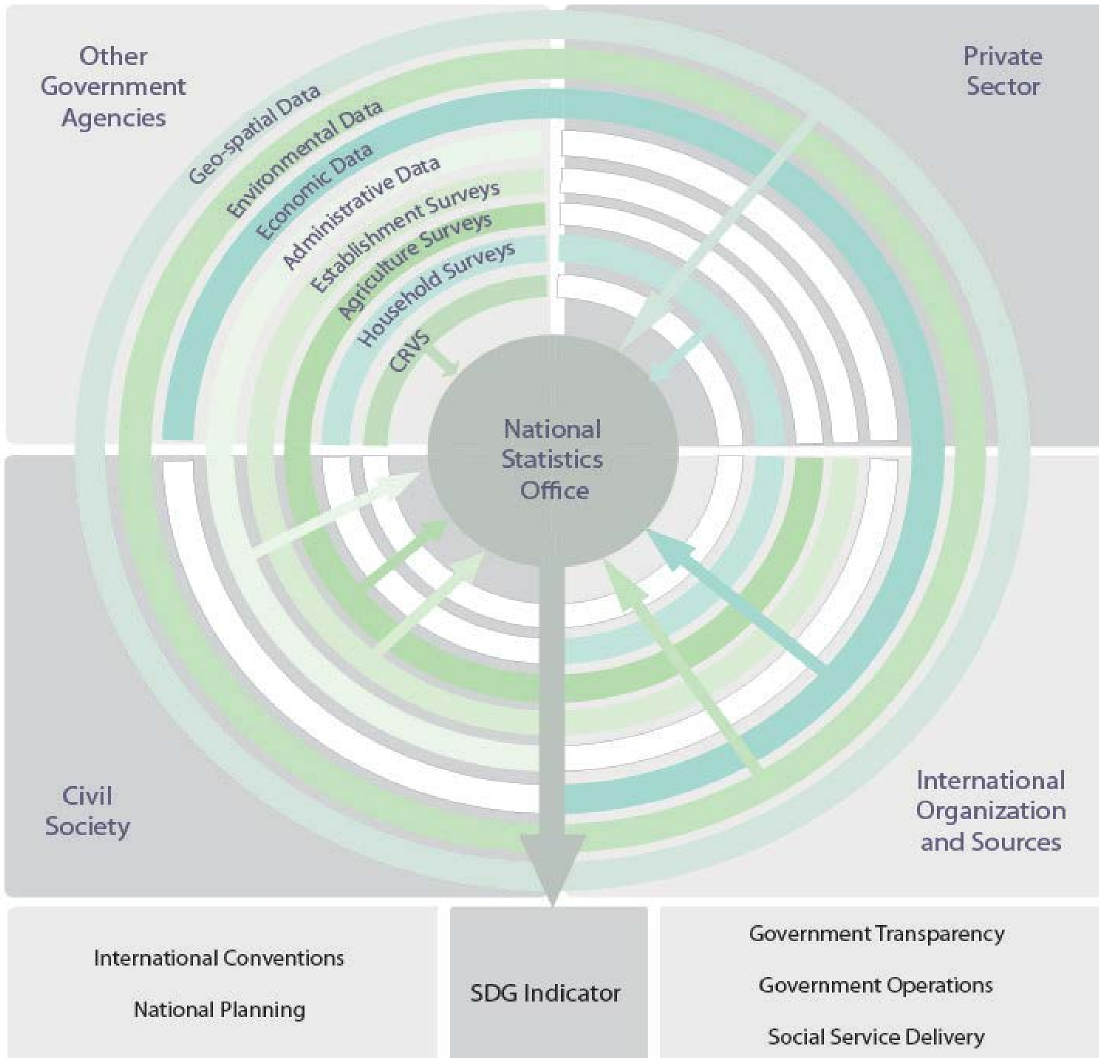
It is important to see data not as individual inputs, but as part of a broad ecosystem. Without census information, we cannot accurately calculate per capita economic statistics; without civil registration and vital statistics, we cannot track who is accessing services; without facility locations and spatial visualizations, we lack modern tools to identify access and need by geo-spatial areas; and without administrative data coupled with household surveys, we cannot see whether social protection measures are reaching the most in need. Each type of data builds upon and complements the other.

Because of the interdependence of data, there is often overlap in the statistical production methods. For example, effective administrative data systems in the health sector collect a wide range of input, output, and outcome data to monitor service performance and population well-being. Household surveys also measure population well-being and therefore, in some contexts, individual health or mortality data could be collected from either source. In general, household surveys play a crucial role in monitoring population well-being (whilst also capturing inter-household dynamics) where administrative data systems are weak. As administrative data systems improve, household surveys become less and less crucial for collecting vital statistics.

Figure 1, below, attempts to show the existing ecosystem of global development indicator data production and reporting methods. Many actors can contribute to data production, from government agencies, the private sector, civil society organizations (CSOs) and international organizations. The NSO is at the heart of this diagram because it is responsible for conducting the census (the baseline for national economic and social measurements) and for compiling and verifying other forms of national data in the national reporting processes. This data then feeds into a range of processes including SDG monitoring, but also national planning and general government operations.

Looking ahead, 15 years from now, the ecosystem described below may look very different. Rapid technological change is facilitating faster accumulation of data from more and more sources. This innovation may render current data collection processes obsolete or alternatively may change the way data are collated, analyzed, and communicated. In the short to medium term, however, this system will be essential for SDG monitoring.

Figure 1. Official Statistics in a Broader Data Ecosystem



Source: Author's own

III. Costing Statistical Instruments

In this study we consider the total cost of collecting the key statistical tools, identified above, over the 15-year period of the SDGs. We have calculated costs for the whole period and then calculated the cost per annum, but it should be noted that some costs need to be incurred upfront, such as putting in place essential geospatial infrastructures.

We focus our analysis on a subset of 77 poor countries that qualify for grants or concessional financing from the IDA. Our assumption is that being an IDA-recipient (or a "blend" country that receives both concessional and non-concessional financing) is a reasonable proxy for countries that require external assistance to improve statistical capacity to monitor the SDGs. We do not cost investments in non-IDA middle-income countries or in high-income countries, as we assume that they have sufficient domestic revenue to self-finance. Nor do we cost required investments in the international data and monitoring architecture.

Each of the statistical components discussed below includes an estimate of total costs for the production of data in the 77 IDA and blend countries, based on samples of costs from a subset of countries. The sample sizes range from 30 countries used to inform the household survey component to 26 countries used to inform the census cost estimate. When extrapolating costs out to the 77 countries we consider spending per person, per US$1 million GDP, and per US$1 million GNI in PPP terms. We base all of our estimates on 2010 to 2015 average price levels, not attempting to control for future inflation or deflation.[16]

Our estimates are predominantly focused on the direct costs of the data collection programs, including staff training and incidental information technology (IT) hardware and software, but do not include the administrative function of the statistical office or its infrastructure (unless explicitly stated).

As highlighted above, each of these tools needs to be seen as part of a complex data ecosystem. Certain data can be collected using multiple overlapping tools, but nonetheless each tool is crucial to comprehensive monitoring of the SDG agenda.

i. Costing National Survey Programs[17]

As noted in Section 1, surveys (household, consumption, agricultural, and labor force surveys) will be the key source of information for producing more than 26 percent of SDG indicators. Increasing their quality, frequency, and coverage is therefore crucial for effective monitoring of the SDG agenda.

This component projects the costs of the major national survey programs (see Table 3), taking into account the administrative domains, labor costs, and transportation costs specific to each country. Much of the cost of a survey is related to the cost of labor and transport. Mobile teams require transportation of enumerators and equipment, often to remote locations, and as a result survey costs can vary widely across countries.

This component looks at costs for household surveys including labor force surveys and agricultural surveys; censuses and economic establishment surveys are not included here (see subsequent components). We have made certain assumptions about the frequency of the surveys, per 10-year cycle, taking into account the increased demands of the SDG agenda, for higher quality, more timely data (see Table 1).

[16] Given that US inflation between 2010-2014 was relatively low we have not worried about making adjustments at this point in time, however we may do so in future iterations of the report.
[17] These results are part of an on-going exercise at PARIS21 to monitor costs required to sustain statistical systems in a post-2015 environment and within the context of the NSDS process.

Table 1: Basket of Surveys for a Country's 10-year Survey Program

Survey type	Frequency per 10-year cycle
DHS-MICS type surveys[18]	4
LSMS type surveys[19]	2
Labor Force surveys (LFS)	10
Agricultural surveys	2
Supplemental surveys[20]	2

Source: Author's own

The SDG agenda calls for a commitment to 'leave no one behind' and to ensure we measure the well-being of the most vulnerable. Doing so requires that we disaggregate data to a greater extent and include more consistent stratification variables. For the purposes of this analysis we have used a two-stage sampling design taking into account cluster size and geographic domains (see Annex 2). The geographic domains for disaggregation in administrative reporting are standardized based on the Nomenclature for Territorial Units (NUTS)[21] using a midpoint between the NUTS-2 range of 800,000 to three million population per domain. Clusters, as the primary sampling unit, are taken to be between 12 and 20 households,[22] depending on the survey type.

Cost estimates were obtained from 30 countries, either IDA recipients or blend countries. Countries were stratified along two dimensions: *income status* and *population density*. The rationale here is that (i) income status is a key determinant of local costs for enumerators and (ii) population density is a major driver of transportation cost. Income status is defined using the 2014/2015 World Bank classifications for 'Low income' and 'Lower middle income' countries, as of July 2014.[23] Within the income category, a further category was introduced for Small Island Developing States (SIDS). According to the UN classification,[24] SIDS account for 27 percent of the 77 IDA/Blend countries and this is reflected in the selection. Population density is based on World Bank data for 2013, on midyear population divided by land area in square kilometers.[25] The cut-off points used to delineate high, medium, and low density are 33 percent and 66 percent (46.80 and 124.02), of the 77 IDA/Blend countries.

A stratified sample of 30 countries was then drawn from the population of 77 IDA countries. Table 2 shows the frequency distribution of the resulting nine strata by population. For more information, including a list of the final sample countries, see Annex 2.

[18] DHS and MICS cover similar topics but at different levels of detail. Some countries undertake both in alternating periods. We have costed both DHS and MICS with this understanding. These have been costed separately due to different approaches. These can be understood to be household survey based activities designed to provide key demographic and health indicators and will be designed and adapted according to country priorities.
[19] LSMS type surveys are restricted to two per 10-year period because of the slower movement of income poverty measures. Other indicators may be used as proxies for short-term welfare changes.
[20] Included here as an allowance for additional surveys to fill data gaps, account for frequency in reporting, or undertake longitudinal studies. They could be CWIQ-type surveys or used for monitoring faster moving indicators. As they are fixed survey sample sizes, they could also be understood as panel components to standard household surveys.
[21] The NUTS is a classification scheme for administrative units that is used to determine statistical monitoring by the European Union.
[22] MICS cluster size ranges from 15 to 30 households, depending on household size and composition. For the purposes of this paper, clusters of 20 households were selected for MICS and DHS surveys.
[23] Country data available for download at http://siteresources.worldbank.org/DATASTATISTICS/Resources/CLASS.XLS
[24] See the Sustainable Development Knowledge Platform website on Small Island Developing Countries: https://sustainabledevelopment.un.org/topics/smallislanddevelopingstates
[25] See the World Bank website on population density: http://data.worldbank.org/indicator/EN.POP.DNST

Table 2: Cross Tabulation of Population of IDA/Blend Countries by Population Density and Income Status

		POPULATION DENSITY			
		High density	**Low density**	**Medium density**	**Total:**
STATUS	**Low income**	8	11	11	**30**
	Lower middle income	5	12	9	**26**
	SIDS	12	4	5	**21**
	Total:	**25**	**27**	**25**	**77**

Source: Author's own

For each country cost estimates relating to the fieldwork, administration, and processing of data were collected. Average costs per survey type are summarized in Table 3. The table divides cost into direct operations, which is the aggregate of training, transport, personnel, data processing, and field support, which is composed of costs for international technical assistance, administrative, and other costs.

Table 3: Average Cost Per Survey in US$*

	DHS	**Multi-Indicator Cluster Surveys (MICS)**	**LSMS type surveys**	**LFS**	**Agricultural Surveys (AG)**	**Supplemental**
Operations	800,186	716,040	1,235,852	331,204	1,117,303	319,002
Field Support*	805,027	340,985	495,427	133,128	431,135	125,974
Total Average	1,605,213	1,057,025	1,731,279	464,333	1,548,438	444,977

Source: Author's own

**Difference in field support costs mostly attributable to the difference in estimated daily rates for technical input and consulting services.*

To project total cost for the 15-year period of the SDGs, we assume a lower bound, using geographic domains according to the NUTS-2 classification (with midpoint 1.9 million), and an upper bound with domains based on actual administrative areas.

Using the cost obtained from the sample of 30 countries, total cost of national survey programs for 77 IDA countries (excluding census) ranges from US$2.0 billion to US$2.6 billion over a 15-year period, or US$134 million to US$173 million annually.

ii. Census

A population census is not only an essential statistical baseline for the activities of the statistical office; it also delivers key data for the government regarding resource allocation and electoral representation. One powerful reminder of the importance of having a regular census is that estimates based on population growth models often turn out to be off target when new population census estimates are made available.[26]

[26] Jerven, M. (2013). *Poor Numbers: How we are misled by African development statistics and what to do about it. Ithaca:* Cornell University Press. See Section 3.

For the purposes of this study, we have looked at census costs from a sample of 26 countries (see Table 16) and have extrapolated out an average cost to the 77 IDA recipient and blend countries in our sample.

The highest per capita estimate costs are for South Sudan and Kosovo – the result of these being young countries with new statistical offices and administrations. The rest of the sample varies from US$0.30 to US$5 per capita. It is notable that countries like Vietnam and Bangladesh, which have large populations and high population densities, have a low per capita cost for censuses. There are two ways of calculating the average: as the average across the 28 countries, or to derive it by adding all the countries' costs and populations together (the equivalent of a population weighted average). The weighted average is lower as the large and cheap censuses in Bangladesh and Vietnam offset the relatively expensive per capita censuses in small countries. The weighted average is US$2.04, while the arithmetic average of the 28 countries is US$2.44.

If we use US$2.04 for the unknown part of the sample (we have known costs for 28 countries which account for 789 million people at US$1.6 billion) we end up with US$3.174 billion for one census round.

How do we reach a total for 2015-2030? There is an internationally accepted standard that countries should have a census every decade. Some countries will have two censuses during the period (for example, one in 2015 and one in 2025) or just one (for example, one in 2022).[27] For the sake of simplicity we have accounted for this by multiplying the lower bound total with 1.5. As a result, we end up with an estimated total of US$4.8 billion for the 77 countries to complete one or more censuses during the 15 year SDG period.

iii. Administrative Data

Administrative data refers to information collected primarily for administrative or management purposes. Government departments and other organizations collect this type of data as part of registration, transaction, or other record keeping activities, usually during the delivery of a service. Ministries and government departments are the main (although not exclusive) keepers of large administrative databases, including welfare, tax, health, and educational record systems. Administrative data systems are essential for evidence-based, accountable public service delivery.

Because administrative data collection spans the whole of government and cuts across ministry and departmental functions, it is very difficult to isolate the costs for improving administrative data in general terms. In this section we therefore focus on two sectors, health and education, where there are comprehensive programs underway in a large number of countries to systematize approaches to the collection of administrative data.

It should be noted that the programs described do not cover the whole administrative data system in that sector, only core parts of it. CRVS systems, for example, should register marriages and divorces along with birth and death records, but different units of government usually conduct these functions.

Only improvements to birth and death registration are considered here. Birth registration is crucial for people to access health services and to maintain a unique medical record, but it is only one piece in the puzzle. Additional health administrative data are needed to record health facility and ministry performance. Likewise, education management information systems (EMIS) provide only part of the data needed measuring the effectiveness of school systems.

It is also important to see these systems not just as sectoral management systems, but also as crucial to effective governance more broadly. For example, all forms of social service (health, welfare, and social

[27] It is important to note that the 2010 census round began in 2005 and will end in 2014, so countries that conducted censuses early in the last round will begin their censuses in the next few years.

protection) are reliant on people having unique identifiers, so the services can be targeted most effectively. Without a functional CRVS system, people access services haphazardly, resulting in wastage and unnecessary cost. And without an EMIS information on attendance, school performance, and educational outcomes cannot be properly accounted.

a) *Civil Registration and Vital Statistics (CRVS)*

In 2014 the World Bank and the World Health Organization (WHO) produced a report on the investment requirements for achieving complete CRVS systems in developing countries by 2030.[28] The report estimates the cost of CRVS improvements for 73 countries involved in the United Nations Commission on Information and Accountability (CoIA) on Women's and Children's Health. Representative costs were derived from detailed plans of five countries and extrapolated to the remaining 68 countries based on their income level, status of their current CRVS systems, and population size. Estimates were made for four cost categories:[29]

- Development costs (incremental costs or additional funds for establishing and strengthening CRVS systems);
- Incremental recurrent costs for maintaining CRVS systems;
- International support to CRVS systems, including sharing knowledge and strengthening the evidence base; and
- Monitoring and evaluation.

The total CRVS systems costs for the 73 CoIA countries were estimated to be US$3.82 billion over a 10-year period (2015 to 2024).[30]

Of the 73 COIA countries, 55 are eligible for IDA or blend financing. Estimates of CRVS systems costs for the remaining 22 IDA and blend countries have been calculated from the CoIA unit costs after adjusting for population size and completeness of birth registration. Lacking other information on the status of their implementation plans, it was assumed that each of the additional countries will also carry out a comprehensive assessment or will need revisions to their plans at an average cost of US$100,000.

The estimated total cost for CRVS systems improvements and operation in the IDA and blend countries over a 10-year period (2015 to 2024), shown in Table 4, is US$2.75 billion and annual average costs US$275 million with a substantial portion front loaded. The CoIA report estimates the financing gap – the amount of external assistance needed – to be 52 percent of the total, extending through 2024. After 2024 it is expected that all operational CRVS costs will be met from domestic resources. Additional recurrent costs incurred between 2025 and 2030 are estimated to be about US$0.5 billion of which 96 percent is financed through domestic resources.

[28] World Bank and World Health Organization (2014).
[29] Ibid, Annex 8, 61-66.
[30] For more information on the methodology please see World Bank and WHO (2014), Annex 8. Costing of CRVS Scaling Up Plan.

Table 4: Estimated Financing Gap for 2015 to 2024 Scaling Up Investment Plan (US$ million)

	2015 to 2019	2020 to 2024	2024 to 2030	15-year total	Financing Gap
Development costs	826	826		**1,652**	1,193
Recurrent costs	288	558	558	**1,404**	53
International support to CRVS including sharing knowledge and strengthening the evidence base[2]	83	83		**165**	165
Monitoring and evaluation[3]	41	41		**83**	83
TOTAL	**1,238**	**1,508**	**558**	**3,304**	**1,494**

Source: Author's own

b) Education Management Information Systems (EMIS)

The SDGs present new measurement challenges for education authorities: the measurement of learning outcomes and the measurement of equity in education. Meeting these challenges will require more advanced EMISs, supported by timely and accurate data collection from administrative records, surveys, and censuses.

The core of an EMIS is a database that organizes school-based data, collected through an annual school census, transactional data about education stakeholders' operations, and other data sources (such as census data). Education ministries/departments, NGOs, researchers, donors, and other education stakeholders use it for planning, monitoring, and policy decision-making.[31]

An advanced EMIS that would capture the key policy priorities - education quality and equity - should incorporate the following elements:

- Supply-side data and indicators captured at the school level, including individual students and teachers, as a by-product of regular and comprehensive administrative data collections, such as school censuses and surveys which support management of the system;
- Data and indicators that measure the level of knowledge and skills, their distribution among the population, and determinants through system-level assessment at key points in individual educational trajectories from early childhood to adulthood, including population-based measures;
- Demand-side data and indicators captured at the individual and household level, typically through population censuses and household surveys which have greater potential for disaggregation and provide links to other sectors such as health, labor market, consumption, and wealth;
- Data and indicators on the financing of education systems and learning which include all sources of funding, public, private, international) and uses of funding.

Most of the low income IDA countries have EMISs that are considered, at best, partly functional. Substantial investment will be required to achieve fully functional systems. The Global Partnership for Education (GPE) has described the initial steps needed to improve measures of system level progress for about 60 low and lower-middle income countries that are partners in GPE. The "down payment" for advancing the measurement agenda in the short-term, with inputs from international partners, is US$19 million per annum. With new data collection instruments in at least half the countries, the amount would increase to US$36 million and with additional capacity development at the national level to US$42 million, with the caveat that

[31] See the UNESCO Open EMIS website: https://www.openemis.org/about#w2

not every country might need the same support.[32] While this effort would represent an important mobilization of resources and expertise, this amount would still be far from what is needed to ensure sustainable quality and use of national EMIS in the long-term.

Based on GPE estimates for meeting the information needs for a similar but not identical set of targets[33], the additional "down payment" for improving education management information systems (strengthening existing and piloting new tools, providing training, conducting new data collection and analysis), when extended to cover the 77 IDA countries would be roughly US US$90.5 million per annum. However, to implement, maintain, and update these tools and skills will require further substantial and regular support to ensure sustainability over the period.[34]

iv. Economic Statistics

The proposed SDGs put a stronger emphasis on economic statistics than the MDGs, including, but not limited to, indicators that would require regular reporting on economic growth, employment, and agricultural productivity as well as data on taxation, imports and exports, and other indicators of economic activity (along with environmental aspects of industrial activity).

All countries produce at least a minimum set of economic statistics. However, because of the increased emphasis on economic statistics in the SDGs and in response to concerns about the availability and quality of economic statistics in low income countries,[35] this section includes the cost of labor force and establishment surveys needed to maintain reporting of economic statistics for the SDGs, such as those relating to GDP growth, employment, and productivity, as well as broader enterprise statistics. Trade statistics, which record exports and imports and tariffs collected by countries are based on administrative records of custom services. For purposes of international comparisons and trade negotiations, trade statistics are compiled, standardized, and disseminated by international agencies. Improvements to the recording and reporting of trade statistics can be expected to come about as a consequence of bilateral and multilateral trade agreements. Gaps in the current coverage of trade statistics can generally be filled through partner reporting. Therefore the costs of improvements to trade statistics have not been included here.

In Box 2 we discuss and cost the technical assistance required to improve real sector statistics (essentially updating methodology and benchmark years for price and national account statistics).[36] Because this would be provided through international assistance and capacity development, it is considered apart from the other components of this assessment.

a) Labor Force Statistics[37]

The most common survey instruments for labor statistics are labor force surveys (LFS). These can be conducted in concert with other living standard surveys or as a standalone survey. Some low income countries report regular (annual, quarterly, or monthly) labor statistics based on smaller, more regular queries in known establishments in main cities. It should also be noted that different type of survey designs may deliver very different results – particularly because the answer to "are you employed" is not always

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[32] Global Partnership for Education (2013). Report of the Strategic Plan Working group: Recommendations for the Implementation Plan. BOD/2013/05 DOC 05. Washington, D.C.: GPE.

[33] Global Partnership for Education (2013).

[34] Prepared by UNESCO (as of March 31, 2015), based on GPE (2013).

[35] A summary is available at http://www.wider.unu.edu/publications/working-papers/2014/en_GB/wp2014-114.

[36] It does not include: 1) Improving availability of agricultural statistics (because these are covered in the survey component in the assessment); 2) Improving trade statistics (such as compliance with Balance of Payment manuals); and 3) Improving tax statistics (such as compliance with Government Finance manuals).

[37] Note: since this cost of LFS are already included in the survey component, they are not featured as a stand-alone category

straightforward, and depends on the definition of employment.[38] World Bank researchers, for example, found that for Tanzania, labor force participation rates vary by as much as 10 percentage points across four different surveys.[39]

This need assessment does not take a normative view on what survey design or tool is the most appropriate, but rather uses labor force surveys and establishment surveys as a proxies for how much it could cost to supply annual labor and business data for low income countries.

The International Labor Organization (ILO) is careful to note that the overall cost for a labor survey varies a lot from country to country. Physical characteristics and local capacity to handle the operation of the survey drive this variation.[40] A recent survey in Myanmar cost about US$700,000,[41] while a survey in Liberia cost about US$1.3 million.[42] Both of these cases were considered 'extreme' in terms of budget requirements. Because of low capacity in these countries, everything had to be done from scratch, and ILO had to use international experts for more than a year to manage the survey.

According to the ILO the best average estimates for an annual labor force survey in a low income country is about US$400,000, assuming the country has a reasonable capacity to carry out these surveys and not much international assistance is required. It should be noted that US$400,000 may well be on the low end of an estimate for countries with minimal capacity to collect such data on regular basis. This equates to US$462 million for the 77 countries in our sample, over 15 years.

Our own analysis of the cost of LFS taken from a sample of 30 IDA recipient countries suggests the average cost to be closer to US$577,000 per survey, inclusive of a 20 percent overhead for essential technical assistance. Assuming that a survey is completed every year for 15 years in the 77 countries in our sample, the total cost is US$643,560,000.

Of course, there is some current capacity to deliver annual labor data in LIC countries. According to the country metadata self-reported to the GDDS, seven countries report quarterly labor data and a further 16 countries survey on an annual basis.[43] That leaves 54 countries that are either unsure of how often they survey labor data or are currently reporting less frequently than annually.

b) Establishment Surveys

Surveys of business establishments yield important data for compiling economic statistics including employment, value added, and investment. Together with administrative data derived from tax reporting, unemployment programs, price surveys, and trade records, they are the basis for compiling the national accounts and related statistics. In estimating the cost of collecting economic data from industrial establishments, we assume that a hierarchical sampling frame will be used in which large enterprises and their constituent units will be sampled a high rate (perhaps 100 percent) while smaller enterprises will be sampled at reduced rates and very small and informal enterprises may not be sampled at all. Estimates of the output of informal enterprises (which, by definition, are not registered as economic units) may be derived from household surveys or other sources. It is recommended that business surveys be carried out annually. More

[38] Rizzo, M., Kilama, B., & Wuyts, M. (2014). The invisibility of wage employment in statistics on the informal economy in Africa: Causes and consequences. *The Journal of Development Studies*, (ahead-of-print), 1-13.
[39] Bardasi, E., et.al. (2010). Do labor statistics depend on how and to whom the questions are asked. *Results from a Survey Experiment in Tanzania. World Bank Policy Research Working Paper, 5192*, 5192.
[40] Main factors that define the costs include: local cost of living, existing capacity of the country to run, and process these surveys on their own, number of enumerators and other staff, sample size, existence of listing, assistance required from international experts, etc.
[41] See the ILO website: http://www.ilo.org/yangon/info/press/WCMS_229675/lang--en/index.htm search terms: "CWIQ", "LSMS", "DHS", "MICS", "Census".
[42] See the ILO video on Liberia's Labor Force Survey: https://www.youtube.com/watch?v=EOkQdbYoaQg
[43] See the GDDS website: http://dsbb.imf.org/pages/gdds/home.aspx

advanced statistical systems would carry out a census (that is a survey with complete coverage) every five years with sample surveys in intervening years. Considering only the poorest countries in the world, an annual program of establishment surveys would be an important step forward.

Box 2: Improving real sector statistics (updating Price and National Account Statistics)

With the labor force and establishment data discussed above, combined with the improved survey data on households' well-being and expenditures, it would be possible to improve the coverage in national accounts. However, in order to implement new data sources and to update methodologies significant investment in technical assistance will be required. In this section, unlike other components, we consider the cost of upgrading current total capacity – as opposed to the cost of financing all survey capacity. This is because the provision of economic statistics – such as the national accounts and consumer price index – is integral to the basic functioning of the statistical office. Conceptually then there would be two ways of computing this cost. One would be to calculate the share of total budget committed to economic statistics and add this to estimated required budget increases. The other, and the one chosen here, is to estimate how much technical assistance would be needed for an upgrade of methodologies in Price and National Account Statistics.

In order to adequately assess the technical assistance needed to update economic statistics more advanced diagnostics would be required,[44] but for this purpose we estimate that if the benchmark year for GDP and the benchmark year for the Consumer Price Index (CPI) is older than 10 years (i.e. from 2005 or older) it is an indication of a need for further technical assistance to update to internationally accepted methodologies. According to the country metadata self-reported to the GDDS,[45] eight countries have a benchmark year of 2005 or newer, and a further 13 countries report having a CPI that has been updated since 2005 or more recently. In sum, 69 technical assistance (TA) missions are needed to update methods for aggregating GDP, whereas 64 TA missions are required to update price statistics. If we further assume that all countries will need two more TA missions to further upgrade methods during the 2015-2030 period, we are looking at about 300 TA missions in total. A typical TA mission includes 2-4 weeks on site, plus a week preparation, a week for report writing and 4-5 travel days at a cost of US$50,000 to US$100,000, depending on whether the mission come from the International Monetary Fund (IMF) headquarters or from the regional technical assistance center. A typical mission includes diagnostics, data collection, and basic training, one mission for implementation, and a third, final follow up mission. It therefore seems a fair assumption to think that one 'upgrade' from start to end, not including survey costs for additional raw data, would require about US$200,000.

Estimated total investment need for upgrading real sector data:
TA mission cost of US$200,000 * 300 TA missions = US$60 million.

The United Nations Industrial Development Organization (UNIDO) proposed a comprehensive program for collecting industrial and business statistics. First devised in 1989, this is known as the National Industrial Statistics Program (NISP). In recent years NISPs have been expanded, under the title New Industrial and Business Statistics Programs (NIBSP), to include business registers, industrial censuses and surveys, as well as the collection of statistics relating to research and development expenditures, statistics on industrial innovation, statistics on Information and Communication Technologies (ICT) usage, energy consumption data, and so on.[46] NIBSPs also provide for data processing, management, and dissemination, including the use of ICT.

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[44] See the IMF website on the Reports on the Observance of Standards and Codes, for example: http://www.imf.org/external/NP/rosc/rosc.aspx.

[45] See the GDDS website: http://dsbb.imf.org/Pages/GDDS/CountryList.aspx

[46] Upadhyaya, S. (2010). *Towards a New Industrial and Business Statistics Programme (NIBSP) for Countries of Developing and Transitional Economies*, Working Paper 09/2009. Vienna: UNIDO.

The costs included here are based on Upadhaya (2010) who assumes that "most [least developed countries], especially where there is a critical data gap, will require full-scale program implementation."[47] The costs, which include the construction of a business register and survey operations, depend upon the number of eligible statistical units in the country. The survey operation cost consists of enumeration and supervision cost, data entry and processing cost, transport and communication cost, and stationery and field staff training cost. The total costs are estimated to be in the range of US$200,000 and US$250,000 for most small, developing countries. Larger countries with more business units may incur higher costs, but without additional evidence on the number of units in each country or the state of country business registers, we adopt the estimate of US$250,000 a year as an average for all 77 countries. This implies a total cost of US$289 million over the 15-year period or US$19 million a year.

v. Geospatial Data

There are two main clusters of costs associated with enabling the geospatial components for the SDG indicators.

The first cluster of costs includes the national core geospatial data layers and the data management infrastructure. These are the prerequisites to generate, share, and analyze geospatial data related to all of the proposed indicators with geospatial inputs. While national statistical services have become centralized institutions, the responsibility for geospatial data remains fragmented. Spatial data infrastructure allows for coordinated but still decentralized data management across government agencies, a platform critical for multi-sector data monitoring for the SDGs. The costs for spatial data infrastructure include four components: data collection, technology and human capacity, distribution and access networks and policies, and standards and organization. The core data layers represent select features that serve as references, or the common denominator for all other map production and analysis. These core layers include administrative boundaries, topography, built structures, digital elevation, transportation networks, hydrography, place names, and urban/rural zoning. Although satellite imagery and land use/land cover are considered core data layers, we provide separate cost estimates due to their explicit role in calculating the SDG indicators. These estimates are based on comparative case studies of national budgets and reports of five countries. These are primarily one-time upfront costs with a small annual operations budget.

The second cluster of costs relate to three data collection tools needed to compile SDG geospatial indicators. The tools below are designed to collect data related to multiple indicators, both as primary data and as secondary support for visualization and calculation.

The tools include the following:

1. **National facility and infrastructure inventories**. We propose using mobile-phone based and geospatial data collection tools to create national inventories of critical facilities and infrastructure relevant to achieving and monitoring the SDGs, including schools, health clinics, irrigation systems, municipal water systems, solid-waste treatment facilities, wastewater treatment facilities, agricultural warehouses, cold storage facilities, drying facilities, processing facilities, and public transit stations. In addition to information on facility locations, the tool would provide information on condition and attributes specifically related to SDG targets and indicators. This new proposed data collection tool is meant to remedy the gap of developing countries knowledge about their national physical assets and provide a platform for improving future ongoing administrative data and reporting. The cost estimates are based on estimates of total facilities by population density, time required to move between facilities, and an overall management cost.[48]

[47] Ibid, 18.

[48] This tool has been piloted in Nigeria by the Nigerian MDG Office and the Earth Institute and designed but not fully implemented for the Government of Haiti. Many countries already have partial inventories so this tool is meant to support and enhance existing sources. The objective of this tool is to ensure national coverage.

2. **Satellite imagery**. Satellite imagery constitutes a cost-effective, powerful tool for indicator calculation. It is underutilized because of uneven capacity to analyze data and cost barriers to acquisition. Therefore we include different imagery options including globally available free imagery. We include the costs to analyze this data within the core geospatial analytic teams. New models for making commercial higher-resolution data available to developing countries should be pursued aggressively, including setting up an organization specifically dedicated to provision of imagery for sustainable development agendas and countries.[49]

3. **Geo-coded census data**. Use of geo-coded population data is critical for calculating many environmental indicators. Cartography is included in the census section of this paper.

Differences in cost estimates arise from factors such as area and population, scale, and resolution of analysis, frequency of data collection, use of data collection tools, and baseline capacity. The estimates presented in Table 5 are preliminary estimates for discussion.

Table 5: Summary of costs by spatial data component

Component	Estimated Fixed Costs	Estimated Re-occurring Cost	Total Costs	Notes
Core Spatial Data Infrastructure	US$3,025,000/ country 77 IDA countries	US$600,000 /country 33 LIC countries US$850,000 /country 44 MIC countries	US$282,425,000	This is a base investment but will vary by country depending on pre-existing infrastructure.
Core Data Layers	US$3,000,000/ LIC country		US$99,000,000	This depends on data needs at national level.
National Infrastructure and Facilities Inventory	US$603,212,000		US$603,212,000	This cost varies by country size and population. Lowest cost is US$2,000,000 and highest is US$15,000,000.
Satellite Imagery	$150,000,000	US$5,000,000/year	US$225,000,000	These estimates are based assumptions creating a non-profit satellite company that would provide free high-resolution data to IDA countries.
Total Geospatial Monitoring			**US$1,209,637,000**	

Source: Author's own

vi. Other Environmental Data

The main SDGs that focus on the environment are 13, 14, and 15, with additional environment-specific targets in Goals 6, 11, and 12. There is no single survey tool to capture all the data for environmental indicators; some will be derived from surveys, including agricultural surveys (discussed above, in Section i), others from geospatial data (discussed above, in Section v), and others still from very specific air, water, and

[49] This estimate was the middle range cost and based on a range of assumptions. It is contingent on global agreements to provide high-resolution imagery at a more affordable rate to developing countries.

soil measurements. This makes the costing exercise more complicated than for other indicator clusters. To focus our assessment, we examine the production methods for eight potential SDG indicators, relating to biodiversity, air quality, hydrological monitoring, and forest and land use change (see Table 20).

We identified these types of data and the associated data collection requirements by examining the environmental indicators listed in SDSN (2015) *Indicators and a Monitoring Framework for the SDGs*.[50] However, it should be noted that estimates provided are initial and not comprehensive, nor are we endorsing a particular data collection methodology. We merely examine indicative costs for data collection under current, document methodologies.

Table 6: Summary of Component Costs for Environmental Monitoring

Component	Estimated Fixed Costs US$	Estimated Re-occurring Cost US$	Total Costs over 15 years US$	Notes
Biodiversity		5,500,000/ year	82,500,000	
Air Quality	33,000,000	8,300,000/ year	157,500,000	This does not account for existing stations, which could reduce total costs.
Hydrological Monitoring	32,200,000	16,100,000/ year	273,700,000	This does not account for existing stations, which could reduce total costs.
Forest			Included in geospatial/ satellite	This cost for ground-level monitoring is still pending.
Total Environmental Monitoring	**65,000,000**	**29,900,000/** year	**514,000,000**	This includes air, water, biodiversity, and land use change for all 15 years for all 77 countries.

Source: Author's own

[50] SDSN (2015). *Indicators and a Monitoring Framework for the SDGs*. From work draft February 18, 2015.

IV. A comprehensive Needs Assessment for a SDG Data Revolution

i. Assumptions

We have set out to estimate the costs that are likely to be incurred by the poorest developing countries in providing the statistical indicators needed to monitor the SDGs. Broadly speaking, our cost estimates represent the costs of conducting censuses and surveys, and upgrading administrative data systems and geospatial data infrastructures, to provide the data needed to produce the SDG indicators at an acceptable standard of reliability and frequency. Costs of individual components have been scaled up from average unit costs to reach the total costs expected for the 77 IDA and blend countries included in this study. However, country-by-county costs will vary widely from the average depending on the initial capacity and efficiency of their statistical systems. We are mindful of limitations to both our knowledge of conditions in countries that may affect operational costs and the extent to which cost elements have already been assumed by countries as part of their on-going statistical programs. We have not made a rigorous distinction between fixed and variable costs, although some of the components described in *Section III* distinguish capital and operating costs. In our view, over the 15-year time span of the SDGs, most of the expenditures included here may be viewed as recurrent.

Our working assumption is that the activities costed here will place additional demands on the national statistical systems, whether they represent the startup costs of entirely new activities, such as acquisition of geospatial and remote sensing data, or the operation of survey programs required to provide higher frequency and higher quality data, and therefore external assistance will be needed if countries are to carry out the statistical activities expected of them. Another implicit assumption is that the goal of the data revolution is for countries to become capable of producing – and using – statistics to guide their own development programs. We have therefore assumed that the statistical programs described here will be country-executed, even though significant external guidance and assistance may be required.

It is also important to note costs we have not included in our estimates. Although the budgets presented by countries as part of their national strategies for statistical development may include provisions for policy reform, revisions to the legal framework governing official statistics, and human resource development, those costs are not included in our individual estimates. In general the costs described correspond most closely to the costs associated with statistical infrastructure (such as sampling frames, business registers, and geocoding), and data collection costs, including some technical assistance. Physical infrastructures are included in the case of geospatial data, but this is an exception. We have not considered the operational costs assumed by multilateral or bilateral donors or NGOs as part of their support for statistical activities. Nor do we include the costs of data collection and statistical analysis for monitoring and evaluation of development programs.

Finally, we have not taken into account cost savings that might result from the use of new technologies or from complementarities between statistical programs. For example, improved CRVS systems may reduce the costs of producing vital statistics from surveys. The development of geospatial and remote sensing capabilities should improve the quality of agricultural statistics produced from surveys and increase the efficiency of census and household survey programs. As these potential savings emerge and the quality of statistics improves, priorities for investment in statistics may change. However, there is no reason to assume that the desired level of spending will decrease. Likewise, new technologies for data collection and analysis may yield lower costs in the long run, but in the near term they are likely to require new investments. Inter-temporal trade-offs such as these have not been considered here (see V. Innovations for Cost Reduction for further discussion of the impact of new technologies).

ii. The Total Cost of Core Statistical Components

Based on current information and informed but not fully-tested assumptions, we estimate the total cost of utilizing survey, census, administrative, economic, geospatial, and environmental monitoring tools to be between US$902 to US$941 million per annum (see Table 7). This is a very conservative estimate, which excludes the costs of strengthening administrative data collection across all ministries and departments (we have only looked at two administrative data sets) and the costs associated with strengthening statistical literacy, analytics, and communications. Furthermore, our costs exclude human resources and the costs associated with putting in place appropriate policy and legislative frameworks.

Table 7: Total Costs for the Production of SDG-Relevant Data, Over a 15-year Period and Per Annum

Statistical Instrument	Total cost for 77 IDA and blend countries 2016 to 2030 US$	Annual costs for 77 IDA and blend countries US$	Source
National Survey Programs (including household surveys, agricultural surveys, and labor force surveys)	2.0 billion to 2.6 billion	134 million to 173 million annually	Costs reported by a sample of 30 countries extrapolated to IDA/Blend countries (PARIS21)
Census	4.8 billion	320 million	Per capita costs based on sample of 26 countries extrapolated to IDA/Blend countries (Morten Jerven)
Administrative Data			
CRVS	3.3 billion	220 million (It should be noted that 80% of expenditure will be in the first 10 years)	Estimates for CoIA countries extrapolated by population to IDA/Blend countries (World Bank/WHO)
EMIS	1.4 billion	90.5 million	Estimate based upon a sample of 60 countries (GPE 2013)
Economic statistics (excluding LFS and trade statistics)			
Industrial establishment surveys	289 million	19 million	Country unit costs (UNIDO)
Improvements to real sector statistics	60 million	4 million	Country unit costs (Morten Jerven)
Geospatial	1.2 billion	80 million	Unit costs (CIESIN)
Environmental monitoring (other)	514 million	34 million	Unit costs (CIESIN)
Total Costs	**13.5 to 14.2 billion**	**902 to 941 million**	

Source: Author's own

iii. Comparison with NSDS Cost Estimates

National Strategies for the Development of Statistics are planning documents used by the national statistical offices of many developing countries. They provide a key source of information on the level of ambition and capacity requirements of their statistical systems, including, in some instances, proposed budgets and anticipated donor funding (see Box 1 above). In this section we review a sample of NSDS cost estimates for aspirational medium-term improvements to national statistical systems. This analysis serves to crosscheck the validity of our global estimate on the scale of statistical investment required to monitor the SDGs.

We have identified a sample of 22 NSDSs with robust cost estimates for projects planned through 2014 or later. We have used their budget costs to estimate average levels of investment across the 77 IDA recipient and blend countries. Activities planned by each country are shown in Annex 2. Countries were grouped by population density and World Bank income group classification, as was done for estimating costs of survey programs in *Section III.i.* Weights based on total population and GNI (both current World Bank Atlas and PPP values) were used to extrapolate from the sample data to the IDA77 group. Estimates of annual spending range from US$1.03 billion (World Bank Atlas GNI weights) to US$1.17 billion (population weights) with a geometric mean of US$1.10 billon.

Geometric means and shares of annual spending are shown in Table 8 disaggregated by country classification and World Bank Statistical Capacity Building Program (STATCAP) expenditure categories. The total cost for statistical infrastructure and data collection, as recorded in the NSDSs, is estimated to be US$830 million a year – within close range of the cost of the core statistical components, highlighted in Table 8 above. Including additional costs for legal and policy reform, human resources – mostly training and technical assistance – and physical infrastructure brings the total to US$1.1 billion.

Table 8: Average Spending (Geometric average of population and GNI weighted estimates), US$ millions

	Policy, legislative, and institutional framework		Statistical infrastructure (business register, sampling frame, and so forth) & data collection		Human resources		Physical infrastructure (IT, buildings, vehicles)		Total
Low density & Low income	5	2%	162	75%	20	9%	28	13%	220
Low density & lower-middle income	7	6%	89	82%	3	3%	10	9%	110
Middle density & Low income	4	5%	52	73%	4	5%	12	16%	70
Middle density & lower-middle income	9	2%	271	75%	54	15%	27	8%	360
High density & Low income	6	5%	98	73%	8	6%	22	16%	135
High density & lower-middle income	-	-	-	-	-	-	-	-	200
High density & Upper-middle income	0	1%	2	83%	0	16%	0	0%	5
Total – 77 countries	40	3%	830	75%	110	10%	120	11%	1,100

Source: Open Data Watch (2015)

** Note: Nigeria (High density and lower-middle income) did not provide a STATCAP breakdown of total spending. Subtotals have been imputed. Vertical and horizontal totals do not match due to averaging and rounding.*

We recognize the limitations of this exercise: this is a non-random sample of countries and years and the distinction between operating and investment costs is unclear. Furthermore, costs provided in the NSDSs are for the short- to medium-term (usually four to five years) and do not anticipate increased measurement demands as a result of the SDG agenda. Most of the countries in the sample did not plan for a census within the time horizon of their NSDS or for significant upgrades to their CRVS systems. Furthermore, these are only planning figures. We do not know whether expected funding was or will be obtained and whether the planned activities have been carried out. Nonetheless, we find these country-developed estimates a useful check on country-level ambition versus the ambition of the global SDG monitoring agenda.

Furthermore, we can use information on NSDS allocation patterns to estimate the additional resources that are required for human resources and the costs associated with policy and legislative frameworks, helping to fill some of the missing gaps in our estimates. The average expenditure on these two components across the sample of NSDS is 14 percent (see Table 8). If an additional 14 percent of the total costs of the statistical components is applied to the subtotal in Table 7, than we derive a grand total of approximately US$1.07 billion per annum.

iv. Donor Contributions to Statistics

Multilateral donors, bilateral donors, and foundations have been an important source of financing for statistics programs in developing countries. However, estimates of the amount of support provided are difficult to come by. The OECD Creditor Reporting System (CRS), which records data from OECD Development Assistance Committee (DAC) members and some non-DAC donors, provides a comprehensive accounting of ODA. Donors report specific codes for the sector to which their assistance will go. Statistical capacity building is designated by code 16062. However, when statistical capacity building is a component of a larger project, it may not be identified by this code, causing the CRS figures to underestimate actual levels of support for international aid. Additionally, many donors are not members of the DAC and do not report to the CRS.

PARIS21's Partner Report on Support to Statistics (PRESS) report seeks to reduce this downward bias by supplementing CRS data with projects whose descriptions suggest a statistical component. Specifically, they search out project descriptions for terms such as "census" or "monitoring and evaluation."[51] Additionally, PARIS21 administers surveys to donors reporting to the CRS and to non-DAC donors in order to identify other projects. However, in the PRESS report the statistical component of a project may sometimes be overstated. For example, a large education project that includes, among many other things, a census of schools, may be included in its entirety although only a small amount is allocated for statistical work. In some cases multiple donors participating in a project may report the same project more than once. Nevertheless, the data reported in PRESS provide the best information available about donors' support for statistics. CRS data for 2013 are currently being reviewed.

According to the PRESS Report[52] new commitments to statistics in 2013 were US$394 million. This includes amounts going to IDA, blend, and non-IDA countries. In 2013 88 percent of bilateral commitments reported in PRESS went to IDA or blend countries, so the $394 million reported in 2013 would represent commitment of approximately $350 million to IDA and blend countries.

In any given year, commitments are not evenly distributed across countries and they generally extend over many years, so they may not be representative of annual flows. In 2013 Bangladesh received 60 percent of all reported commitments, and 80 percent went to the top 15 largest recipients.

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[51] We note that the rest of this study has focused on costing tools for national statistics systems, which typically does not include monitoring and evaluation projects.
[52] PARIS21 (2013). *Partner Report on Support to Statistics PRESS 2013*. France.

Furthermore, commitments may not translate to actual disbursements. The commitments reported in CRS and PRESS are recorded for the year in which a project was committed (typically the first year). Disbursements are reported over the years thereafter, and it is hard to track whether funding in any given year relates to new or old commitments. An analysis of the PRESS database shows that for completed projects between 2006 and 2013, disbursements averaged about 80 percent of commitments. For the commitments made in 2013, the expected disbursements would be approximately US$280 million.

NSDS budgets also provide information on expected donor financing. Seventeen of the NSDSs contain data on the share of project budgets that is to be financed by donors (through grants or concessional loans), although there is wide variation amongst the sample. Some countries, such as Mauritania and Mongolia, seem to have designed their NSDSs primarily as a means to coordinate with donors and nearly the entire NSDS budget is expected to be financed externally. The larger countries, such as Bangladesh and Nigeria, have significantly lower shares, with donors financing 38 percent and 30 percent of the NSDSs, respectively. Samoa and the Maldives seek an even lower proportion of donor support with only 12 percent of their budgets to be financed externally. Across the 17 NSDSs the median value is 52 percent. Note that these amounts are not reflective of actual amounts committed or disbursed by donors, but only the amounts that some IDA countries have requested to implement their NSDS. Additionally, we note that many countries are becoming less dependent on external assistance across the board and this trend is also likely to apply to national statistical systems over the next 15 years. In light of these facts, we suspect that donors could reasonably be expected to finance between 35 percent and 60 percent of the costs of monitoring the SDGs over the next 15 years. For the purposes of this study we use the median figure of 52%.

Taking into account that donors committed $350 million to statistics in 2013, within the 77 IDA and blend countries, but that only 80% of commitments are generally disbursed, we estimate that a further US$100-200 million in ODA will be required each year to support lower income countries to put in place strong statistical systems. Any remaining shortfall should be filled through the mobilization of domestic resources, subject to country capacity.

v. Absorptive Capacity and the Effective Use of Scaled Up Resources

The capacity of a government to absorb increased funding is a consideration for all development assistance – whether from international or domestic sources. Indeed, a cursory review of statistical capacity building assistance to nearly 20 developing countries, supported by the World Bank in the past decade, suggests an average annual rate of disbursement of US$3 million per year. This figure reflects 'pipeline' effects, namely "disbursement constraints or disbursement slowness, evidenced by a low rate of utilization of credits or a long lag between commitments and disbursements."[53]

Moving forward effective use of increased resources will require dedicated efforts of the donor community to coordinate their activities, and to provide intensive, on-the-ground assistance to ensure the NSOs are well supported. The case of Tanzania (see Box 3) provides solid evidence that increased spending on statistics can be used effectively, if the enabling environment is in place.

[53] Guillaumont, P and S Jeanneney (2010). Big Push versus Absorptive Capacity: How to Reconcile the Two Approaches. Discussion Paper No. 2007/05. Helsinki: UNU-WIDER.

Box 3: The Effective Use of Increased Resources in Tanzania

The statistical system of Tanzania is fairly centralized. The National Bureau of Statistics (NBS), an executive agency under the Ministry of Finance, is responsible for most activities related to official statistics in the country including planning and implementing periodic censuses and surveys, designing and updating sampling frames and statistical registers, setting standards, keeping compendia of concepts and definitions up-to-date, and developing and maintaining compilation frameworks such as the Tanzania System of National Accounts. NBS also hosts periodic user-producer and producer-producer workshops on specific statistical topics and NBS organizes the Annual Review of Tanzania Statistical Master Plan as well as the Annual Africa Statistics Day in Tanzania.

In 2014, the World Bank's Statistical Capacity Indicator assigned a score of 72 of 100 to Tanzania's Statistical System. This is compared to a Sub-Saharan Africa and IDA-country average of 58 of 100. Thus, Tanzania's capacity is above average for the region and income-level.

The main products of the Tanzania statistical system include: Population and Housing Census (every 10 years, last one in 2012), Industrial Census (every 10 years, last one 2014) and Agricultural Sample Census (every 10 years, last one in 2008). NBS also conducts a suite of household and establishment-based survey including: Household Budget Survey (every 5 years, last one in 2012), Labor Force Survey (every 5 years, last one in 2014), Demographic and Health Survey (every 5 years, last one in 2009), Annual Survey of Industrial Production, and Annual Employment and Earnings Survey.

In terms of funding, recurrent costs of NBS' headquarters in Dar es Salaam, as well as regional offices, are funded through the annual allocation from the Government Budget. So are establishment-based surveys, the system of national accounts and monthly consumer price index. The program of household surveys, the decennial Population and Housing Census (the Census) and capital investments are generally fully or partly financed by Development Partners.

Funds allocated to statistics in Tanzania vary a lot from year to year depending on the scope and scale of primarily the household-survey program and the Census and secondly, the capital investment budget. In general, Tanzania has experienced a substantial increase in funding for statistics since 2010 due to two factors:

- *The 2012 Population and Housing with an approximate cost of US$75 million, of which roughly US$18 million was provided by Development Partners; and*
- *The Tanzania Statistical Master Plan 2009-2014 (TSMP), through which the government managed to receive pledges of roughly US$64.4 million. US$45 million of this has been provided by the Department for International Development (DFID), Foreign Affairs, Trade and Development Canada (DFATD) and the World Bank through a pooled basket fund arrangement.*

The combined US$140 million for the Census and the TSMP, which were planned to be executed over a five-year period, is an extraordinarily large amount of money for an agency with an annual budget of approximately US$7 to US$8 million even with the help of its smaller cousin, the Office of the Chief Government Statistician of Zanzibar.

The Census was successfully planned and executed in August 2012 and several high-value statistical products have been produced and disseminated as a result.

The TSMP Basket Fund itself had a slow start, but the budget execution rate has increased significantly since 2011 due to a combination of improved planning and increased execution capacity on the side of NBS and the Office of the Chief Government Statistician (OCGS). This has occurred partly because of training and close supervision by World Bank and other partners, but the primary factor is probably the on-the-job-learning experienced by the Project Coordination Team and implementing staff and managers.

Box 3 (cont.): The Effective Use of Increased Resources in Tanzania

Table 1: TSMP Annual Approved Budget and actual spending

	FY12	FY13	FY14	FY15 Q1*
TSMP Annual Approved Budget	15.1	11.5	15.3	16.5 (annual)
TSMP Basket Fund Execution	2.9	2.8	6.7	1.7 (Q1)
TSP Annual Budget Execution Rate	19%	24%	44%	

Source: Author's own

Given the experience of Tanzania since 2011, it is reasonable to conclude that NBS and OCGS in Tanzania Mainland and Zanzibar will soon reach their maximum absorption capacity of approximately US$7 to US$8 million for statistical operations in a 'normal' year (i.e. non-census year and in a year without extraordinary capital investments). This is roughly equivalent to one large, one medium and one small survey in addition to training, technical assistance and piloting, and experimentation financed by Development Partners; and implemented in parallel with the core statistical program of business surveys, price collections and national accounts, which are mostly funded by the government.

To oversee and support the implementation of the TSMP, the World Bank has spent on average US$350,000 a year since 2010. A good ballpark estimate of the annual combined administrative cost of other partners is roughly US$500,000 (including the Resident Census Technical Advisor and other long-term and short-term advisors funded by partners). This adds up to an estimated US$850,000 in annual administrative costs for development partners for support and supervision.

V. Innovations for Cost Reduction

This report has highlighted the need to invest in official statistics for core SDG monitoring, but as highlighted by the Independent Expert Advisory Group on the Data Revolution, new data collection and monitoring technologies are rapidly becoming available. These new innovations will dramatically advance our ability to monitor the impact of development programs, as well as change the way we collectively design and implement them. High-resolution satellite imagery, mobile devices, biometric data, and crowd-sourced citizen reporting will influence both official data collection processes and the operation of programs they monitor. A few innovative applications are discussed below, but there are others that will offer new forms of monitoring in the coming years, many of which are being rapidly developed. For example:

1. Satellite imagery
    - The cost of high-resolution image acquisition is falling while the availability of images and capacity for automated processing are increasing. There are many applications for such data across multiple goals, such as predicting harvests, disaster response, earth observations and food security situations; monitoring geographic patterns and likely transmission corridors of diseases that have geospatial determinants; measuring population density and the spread of new settlements; and mapping and planning transportation infrastructure.
2. Unmanned Aerial Vehicles (UAVs)
    - Closer to earth, UAVs are capable of collecting a range of useful measurements at low cost, with relevance to the full range of the post-2015 development agenda.
3. Crowd-sourcing
    - Global connectivity has created the opportunity for wide-scale participation in data collection and data processing, with applications in road mapping, land cover classification, human rights monitoring, price tracking, species inventories, and disaster response planning, with new applications unfolding regularly.
4. Smart-meters
    - The increasing use of smart-metered systems for energy and water distribution, that transmit usage information over communications networks, create novel capabilities to measure and manage service provision. Enel's Telegestore system in Italy is one of the largest and most successful examples.
5. Smart-phone and tablet-based data collection
    - As described in the SDSN Indicator report, many surveys are now being conducted on digital mobile platforms.[54] This practice reduces the time and cost for data collection, improves accuracy, simplifies collection of GIS and image data, streamlines integration with other information streams, and opens up the possibility of incorporating micro-chip based sensors into survey processes.
6. Data mining
    - New uses have been discovered for data sources emerging from processes not explicitly designed for such purposes, such as social media, mobile call data records, commercial transactions, and traffic records. Proven applications have been developed in a range of areas including crisis response, urban planning, and public health management.

These and other innovations will drive new approaches to achieving the SDGs, from pinpointing specific communities and households for health initiatives to integrating real-time monitoring of natural resources into allocation schemes and tracking government and donor investments. Such innovations also have huge potential to lower the cost of SDG monitoring, over time. Undoubtedly there will be upfront costs for software, hardware, and training, but over the medium- to long term new technologies, alongside system-

[54] SDSN (2015). *Indicators and a Monitoring Framework for the SDGs*, SDSN Report. USA: USA and Paris SDSN.

based approaches to data collection and better data-collection coordination and funding, could dramatically reduce recurrent costs.

In the context of the SDG process, expert thematic groups, reporting to an annual review of SDG progress under the High Level Political Forum, will play a crucial role in identifying innovative approaches to data collection. They can also encourage testing and refinement of methodologies, so innovative approaches can be integrated into the official statistical production process over time. Regional monitoring will also be important to encourage economies of scale as regional hubs, or centers of excellence, could be responsible for data analysis and verification and the compilation of geospatial information.

i. Satellite Data and CDRs in Malaria Elimination Interventions[55]

The prevalence of malaria around the world has declined significantly in recent years. Thirty-six of the 107 malaria-endemic countries have national policies for malaria elimination. Elimination requires targeted operations aimed at vector control, in addition to prophylaxis and treatment. Timely risk maps, incorporating information on human mobility, are vital. However, data on human movement in malaria-endemic regions have been difficult to obtain, and often restricted to local travel history surveys or census-derived migration data.[56]

The global proliferation of mobile phones presents unprecedented opportunities for measuring human movement via wireless network tower volume and call detail records (CDRs).[57] For example, Namibia integrates CDRs with rapid, case-based mapping to provide dynamic evidence for malaria elimination planning in low-transmission settings. As of late 2013 more than one year of aggregated movement patterns for over a million people across Namibia have been analyzed and linked with case-based risk maps built on satellite imagery to highlight the link between population movements and transmission risk areas.[58]

There is even more potential in integrating mobile phone CDRs with rapid, case-based mapping to provide a dynamic evidence base to support malaria elimination planning in low-transmission settings. Namibia is currently testing such an approach, using surveillance data, satellite imagery and mobile phone call records to support elimination planning.

Immediately communities were able to see higher levels of movement than previously assumed, with very specific, quantified estimates of net export and import of travellers and infection risks by region. Moving forward, these maps can aid the design of targeted interventions to reduce the number of cases exported to other regions while employing appropriate interventions to manage risk in places that import them.

Complementing core health administrative data and health survey data with dynamic risk maps can help to improve the efficiency and targeting of health programs, improving treatment and minimizing excess health expenditures. But traditional sources of data, such as surveys and censuses, remain essential for the construction of risk maps and the analysis of underlying population characteristics and behaviors.

ii. Predictive Crime Modeling Reducing Dependence on Administrative Records[59]

The City of Lancaster, California needed to gain greater understanding of where serious ("Part I") crimes, such as murder, rape, assault, and arson, were occurring and where they were expected to occur in the near future. Dealing with severe budget cuts, they had to cut back on staff time and administrative processes,

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[55] Tatem, A et al. (2014). Integrating rapid risk mapping and mobile phone call record data for strategic malaria elimination planning. *Malaria Journal* 13:52.
[56] Tatem et al (2014).
[57] Tatem et al (2014).
[58] Tatem et al (2014).
[59] Nucleus Research (2012). ROI Case Study: IBM SPSS City of Lancaster. Document M153. Boston: Nucleus Research.

compromising the quality of their administrative data. To overcome the challenge of doing more with less, they turned to the use of computer-generated predictive modeling twinned with GIS software.

Lancaster purchased IBM Statistical Package for the Social Science (SPSS) licenses to analyze existing data and understand trends associated with Part I crimes ESRI's ArcGIS geographic information system was used to map the location of each Part I crime.

The initial costs of this project included software, hardware, training costs, and ongoing support. The majority of the startup cost consisted of the original SPSS and ArcGIS licenses purchased prior to the beginning of the project. The software was hosted on pre-existing servers, which eliminated additional hardware costs. After initial setup, Lancaster's ongoing support has been minimal and consists primarily of ongoing software maintenance and assurance costs. Since reports are automated, the current support for the software takes less than an hour per month, which allows the City of Lancaster to spend less time finding the correct information and more time translating crime maps and trends into effective strategies to reduce crime.

Four years later, innovative mapping and modeling of crime has contributed to a 35 percent decrease in Part 1 crimes, with no increase to the City of Lancaster police budget.[60]

iii. Biometric Data Complementing CRVS Systems in India[61]

Across the developing world, poor identity systems and low rates of birth registration perpetuate poverty cycles and social exclusion by limiting access to education, health, banking, and opportunities for personal economic growth. Many countries with low GDPs do not have national identity systems in place, and when they do, many suffer from high rates of under-registration. This becomes problematic as social programs, including subsidies, banking, and aid interventions are based largely on claimed identities, which may or may not be valid, so these interventions may not be reaching the people who need them most. In 2008, for example, the Planning Commission of India demonstrated that more than one-third of grain intended for poor households was instead sold to non-poor households, and that 58 percent of subsidized grains did not reach intended recipients due to errors in delivery and identification.[62] The absence of effective registration systems means millions of dollars are lost on a daily basis, along with opportunities for personal development.

The standard process of identity registration is civil registration and vital statistics. CRVS systems record all of a person's most significant life events, from birth to marriage to death, and are essential for a functional social system (see *Section III*). However, some countries are adopting new biometric approaches to vital registration, which over the medium- to long-term may improve efficiency and lower administrative costs while improving social systems targeting and preventing social security fraud.[63]

India has embarked on an ambitious program to provide its citizens and residents a unique, official identity, through a biometric program that relies on fingerprinting and iris scans. The Universal Identification (UID) program aims to improve the delivery of government services, reduce fraud and corruption, facilitate robust voting processes, and improve security. According to Zelazny (2012), it is by far the largest application of biometric identification technology to date and will have far-reaching implications for other developing countries that are looking to adopt national ID programs to further social and economic development:

> *"Unlike many other national ID programs, the UID is designed from the ground up to support authentication. Its use of multimodal biometrics increases inclusion into the main enrollment database and has a huge impact in improving*

[60] Nucleus Research (2012).
[61] Zelazny, F. (2012). *The Evolution of India's UID Program: Lessons Learned and Implications for Other Developing Countries*. CGD Policy Paper 008. Washington, D.C.: Center for Global Development.
[62] Jha, R., et al., (2013). Food subsidy, income transfer and the poor: A comparative analysis of the public distribution system in India's states, Journal of Policy Modeling**,** Volume 35, Issue 6, November–December 2013, Pages 887–908.
[63] Zelazny, F (2012).

accuracy. It relies on mobile technology, but has also become a driving force behind the development of that technology. Its standards-based approach opens the way for vendor competition and cost reduction. At the same time, its exclusive focus on authentication still leaves the problem of how to validate certain aspects of identity, such as citizenship status."

Zelanzny provides a case study of the role-out of UID in Andhra Pradesh, which demonstrates enormous cost-saving potential. As of 2010 (the last point at which data was available for Zelanzny's analysis) with the work about 60 percent complete, the UID system had uncovered over seven million duplicate ration cards, 255,000 duplicate pensioners, and 347,000 duplicate housing beneficiaries. This equated to an estimated savings of US$6 million per month on the ration cards, US$1.6 million per month from pensioners, and a one-time savings of US$5 million in housing. Zelanzny concludes that "at a cost of US$10 million for the backend software, the system paid for itself within a month."[64] Nevertheless, the adoption of universal identity schemes has been controversial, with concerns over security, privacy, reliability, and potential misuse of the system. Lessons learned from India's experience include the need to establish clear legal authority for the collection of data and their subsequent use.[65]

iv. Real-Time Stock Management of Medicine (mTrac) in Uganda

mTrac is a health management information system of the government of Uganda that uses SMS surveys sent by health workers to alert public health officials to outbreaks of disease and to let them know how much medicine is on hand at health facilities so they can anticipate and resolve any shortages. The initial focus of mTrac is to speed up the transfer of Health Management Information System (HMIS) Weekly Surveillance Reports, provide a mechanism for community members to report on service delivery challenges, and empower District Health Teams by providing timely information for action.

UNICEF and WHO supported the Uganda Ministry of Health in developing mTrac. As of March 2014, registered users of mTrac comprise 1,203 district health officials, 18,690 health facility workers, and 7,381 village health team workers. Tapping into the mTrac database the government is now able to target thousands of health facilities, with results captured and analyzed within 48 hours at a total cost of less than US$150 per poll. [66]

v. Cost Savings Potential of Data Collection with Mobile Devices

Mobile devices offer substantial opportunities to collect data more cheaply. For example, if we assume a survey program of six surveys in a given 10-year period and about 13,000 households per survey (using an East-African country), traditional paper questionnaires and processing are estimated to cost about US$1.8 million per 10-year cycle. Such surveys require multiple steps, including reproducing the questionnaire, providing and supervising data entry personnel and machines at a central location, transporting the questionnaire, and running regular data edits. The same survey using Android mobile technology and free data processing software could cut data processing costs by about US$1.2 million, a saving of over 60 percent.

These estimates are based on a survey of 13,000 households in Rwanda using 50-page questionnaire. The cost estimates for the conventional survey methodology are based on the cost of reproducing and binding a questionnaire (32 data entry personnel at 12 months, 2 supervisors, 4 check-in officers, and 2 archivists storing questionnaires) and transport of questionnaires (round trip) every two weeks. Costs for the remote technology are based on the cost of Android devices depreciated across 3 years with 10% replacement cost

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[64] Idem.
[65] See a 2011 article in *Outlook* for additional information on some of the political issues in India: http://www.outlookindia.com/article/Aadhar-A-Few-Basic-Issues/279077
Alan Gelb and Julia Clark provide a more positive assessment: http://www.cgdev.org/sites/default/files/archive/doc/full_text/GelbClarkUID/1426583.html
[66] More information on mTrac is available at http://www.mtrac.ug.

for loss using free software (CSPro) and 45 days of additional TA and 30 days additional training for enumerators and supervisors plus peripherals required to transmit data. Using CSPro, development time is the same for conventional and remote since it uses the same language and just compiles to different formats. Overheads on development are the same.

The survey costing estimates in this report indicate the data processing component would be about US$74 million to undertake in a 15-year period for reporting on development indictors in all 77 IDA and Blend countries. Applying new technology for only one component of the survey program, namely data processing, could save about US$ 44 million. Applying new technologies in other areas could also add to the savings.

VI. Recommendations

Monitoring the SDG agenda will require substantive improvements in national statistical capacity. Collecting high frequency, quality data on the varied dimensions of sustainable development requires that we modernize statistical systems. This necessitates stronger and more systematic collection of administrative data to improve government performance and encourage evidence-based decision making, and substantive investments in building up geospatial infrastructures. These investments will be crucial for the SDG agenda to succeed, as data will be the backbone of implementation, helping to direct resources, prioritize investments, and ensure effective service delivery. Investments in data and statistical systems are also needed to strengthen the equity of implementation.

Member States have promised to "Leave No One Behind" in our pursuit of sustainable development, but monitoring equitable progress requires highly granular data. To fulfill this commitment Member States must be willing to invest in the systems that will enable us to know where the poorest and most vulnerable are, and what services and assistance they need. It is particularly important that we employ methods that allow for sub-national disaggregation and geospatial visualization, as these tools are critical for policy makers' and citizen engagement.

We have estimated the cost of building strong statistical systems for SDG monitoring to be approximately US$1 billion per annum. Although it is hard to estimate an exact funding gap, it is clear that there is a large margin between current expenditures and future requirements. Our analysis of NSDSs shows that countries are planning on aid at a level of 52 percent of current NSDS budgets. At least US$100 to US$200 million more will therefore be required in ODA to fulfill the monitoring demands of the SDGs, alongside increased domestic contributions to statistics.

We urge countries and donor partners (both private and public) to commit to a new Partnership for Development Data, backed up with adequate resources. A dialogue on this partnership should commence at the Addis Financing for Development Conference, in July 2015, and conclude at A World Forum on Data, as recommended by the Secretary General's Independent Expert Advisory Group on the Data Revolution and the Secretary General himself in *The Road to Dignity by 2030*. Such a forum, taking place in late 2015 or early 2016, may be an appropriate moment to launch the new coordinated effort.

The new partnership should support SDG implementation by strengthening government capacity to manage and utilize data, particularly administrative data, to improve service delivery and enable evidence-based decision-making. The partnership should also commit itself to more systematic integration of new technologies and approaches to data collection and processing. The SDG indicators require the use of modern, innovative technologies, including geospatial data, for comprehensive, disaggregated and frequent data collection, across all three dimensions of sustainable development (economic, environmental, and social). The partnership can actively apply the advances in ICTs, satellite imagery, smart-metering and other technologies to rapidly expand coverage, analytic capacity and help to bring down the cost of maintaining data systems, over time. This includes standardizing data collection methodologies, particularly for those data reliant upon new technologies, and weaving them into official statistics reporting.

As part of this partnership, countries must commit to a long-term program of improvement in their statistical systems, with clear estimates of need and a roadmap for expenditure. For their part, donor partners (both public and private) must work in close collaboration through the new partnership to support country efforts and devote significant financial and administrative resource to ensure that low-capacity NSOs get the support they need.

Between now and early 2016, other opportunities for action include the Intergovernmental Negotiations on Post-2015 in May, which will focus on monitoring and review mechanisms. Throughout this session Member States should make a strong call for greater investments in data and statistical systems. The level of capacity and investment required to monitor the sustainable development agenda, and to do with the requisite level of granularity, also suggests that Member States should call for the SDG monitoring framework to be concise, with a limited number of indicators, that build upon pre-existing monitoring systems and are easy to compile and interpret.

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Annex 1: Statistical Tools Required for SDG Monitoring, Based on SDSN's 100 Indicator Framework[67]

Indicator number	Potential and Indicative Indicator	Primary data source
Goal 1. End poverty in all its forms everywhere		
1	Proportion of population below $1.25 (PPP) per day (MDG Indicator)	Household surveys
2	Proportion of population living below national poverty line, differentiated by urban/ rural (modified MDG indicator)	Household surveys
3	Multidimensional Poverty Index	Household surveys
4	Percentage of eligible population covered by national social protection programs	Administrative data
5	Percentage of women, men, indigenous peoples, and local communities with secure rights to land, property, and natural resources, measured by (i) percentage with documented or recognized evidence of tenure, and (ii) percentage who perceive their rights are recognized and protected.	Administrative and census data, household surveys
6	Losses from natural disasters, by climate and non-climate-related events (in US$ and lives lost)	CRVS and administrative data
7	Total fertility rate	CRVS
Goal 2. End hunger, achieve food security and improved nutrition, and promote sustainable agriculture		
8	Proportion of population below minimum level of dietary energy consumption (MDG Indicator)	Administrative and census data, household surveys
9	Percentage of women of reproductive age (15-49) with anemia	Administrative data
10	Prevalence of stunting and wasting in children under 5 years of age	Household surveys
11	Percentage of infants under 6 months who are exclusively breast fed	Household surveys

[67] As of March 2015. The report is updated regularly (see version March 20, 2015). All versions of the report are available at http://unsdsn.org/resources/publications/indicators/
It is important to note that the final set of indicators for SDG monitoring is still being defined. The UN Statistical Commission has recommended the formation of an Inter-Agency and Expert Group to define the indicators over several months. A final set is expected at the 47th Session of the Statistical Commission in March 2016.

12	Percentage of women, 15-49 years of age, who consume at least 5 out of 10 defined food groups	Household surveys
13	Crop yield gap (actual yield as % of attainable yield)	Agricultural surveys
14	Number of agricultural extension workers per 1000 farmers [or share of farmers covered by agricultural extension programs and services]	Agricultural surveys
15	Nitrogen use efficiency in food systems	Environmental data
16	[Crop water productivity (tons of harvested product per unit irrigation water)] – to be developed	Environmental data
Goal 3. Ensure healthy lives and promote well-being for all at all ages		
17	Maternal mortality ratio (MDG Indicator) and rate	CRVS
18	Neonatal, infant, and under-five mortality rates (modified MDG Indicator)	CRVS
19	Percent of children receiving full immunization (as recommended by national vaccination schedules)	Household surveys
20	HIV incidence, treatment rate, and mortality (modified MDG Indicator)	Administrative data
21	Incidence, prevalence, and death rates associated with TB (MDG Indicator)	Administrative data
22	Incidence and death rates associated with malaria (MDG Indicator)	Administrative data
23	Probability of dying between exact ages 30 and 70 from any of cardiovascular disease, cancer, diabetes, chronic respiratory disease, [or suicide]	Administrative data
24	Percent of population overweight and obese, including children under 5	Household surveys
25	Road traffic deaths per 100,000 population	CRVS
26	[Consultations with a licensed provider in a health facility or the community per person, per year] – to be developed	TBD
27	[Percentage of population without effective financial protection for healthcare] – to be developed	TBD

28	Proportion of persons with a severe mental disorder (psychosis, bipolar affective disorder, or moderate-severe depression) who are using services	Household surveys / TBD
29	Contraceptive prevalence rate (MDG Indicator)	Household surveys
30	Current use of any tobacco product (age-standardized rate)	Household surveys
Goal 4. Ensure inclusive and equitable quality education and promote life-long learning opportunities for all		
31	Percentage of children (36-59 months) receiving at least one year of a quality pre-primary education program	Household surveys
32	Early Child Development Index (ECDI)	Household surveys
33	Primary completion rates for girls and boys	Administrative data
34	[Percentage of girls and boys who master a broad range of foundational skills, including in literacy and mathematics by the end of the primary school cycle (based on credibly established national benchmarks)] – to be developed	Administrative data
35	Secondary completion rates for girls and boys	Administrative data
36	[Percentage of girls and boys who achieve proficiency across a broad range of learning outcomes, including in literacy and in mathematics by end of lower secondary schooling cycle (based on credibly established national benchmarks)] – to be developed	Administrative data
37	Tertiary enrollment rates for women and men	Administrative data
Goal 5. Achieve gender equality and empower all women and girls		
38	Prevalence of girls and women 15-49 who have experienced physical or sexual violence [by an intimate partner] in the last 12 months	Household surveys
39	Percentage of referred cases of sexual and gender-based violence against women and children that are investigated and sentenced	Administrative data
40	Percentage of women aged 20-24 who were married or in a union by age 18	Household surveys
41	Percentage of girls and women aged 15-49 years who have undergone FGM/C	Household surveys
42	Average number of hours spent on paid and unpaid work combined (total work burden), by sex	Household surveys

43	Percentage of seats held by women and minorities in national parliament and/or sub-national elected office according to their respective share of the population (modified MDG Indicator)	Administrative data
44	Met demand for family planning (modified MDG Indicator)	Household surveys
Goal 6. Ensure availability and sustainable management of water and sanitation for all		
45	Percentage of population using safely managed water services, by urban/rural (modified MDG Indicator)	Household surveys and administrative data
46	Percentage of population using safely managed sanitation services, by urban/rural (modified MDG Indicator)	Household and administrative
47	Percentage of wastewater flows treated to national standards [and reused] – to be developed	Household, Administrative data and geospatial
48	[Indicator on water resource management] – to be developed	Administrative data,
49	Proportion of total water resources used (MDG Indicator)	Administrative data, environmental and geospatial
Goal 7. Ensure access to affordable, reliable, sustainable, and modern energy for all		
50	Share of the population with access to modern cooking solutions, by urban/rural	Household surveys
51	Share of the population with access to reliable electricity, by urban/rural	Household surveys
52	Implicit incentives for low-carbon energy in the electricity sector (measured as US$/MWh or US$ per ton avoided CO2)	Administrative data
53	Rate of primary energy intensity improvement	Administrative data
Goal 8. Promote sustained, inclusive and sustainable economic growth, full and productive employment and decent work for all		
54	GNI per capita (PPP, current US$ Atlas method)	Administrative data
55	Country implements and reports on System of Environmental-Economic Accounting (SEEA) accounts	International monitoring
56	Youth employment rate, by formal and informal sector	Labor force surveys

57	Ratification and implementation of fundamental ILO labor standards and compliance in law and practice	International monitoring
Goal 9. Build resilient infrastructure, promote inclusive and sustainable industrialization and foster innovation		
58	Access to all-weather road (% access within [x] km distance to road)	Geospatial
59	Mobile broadband subscriptions per 100 inhabitants, by urban/rural	Administrative data
60	Index on ICT maturity	TBD
61	Manufacturing value added (MVA) as percent of GDP	Establishment surveys
62	Total energy and industry-related GHG emissions by gas and sector, expressed as production and demand-based emissions (tCO2e)	Establishment surveys
63	Personnel in R&D (per million inhabitants)	R&D surveys
Goal 10. Reduce inequality within and among countries		
64	[Indicator on inequality at top end of income distribution: GNI share of richest 10% or Palma ratio]	Household surveys
65	Percentage of households with incomes below 50% of median income ("relative poverty")	Administrative data
Goal 11. Make cities and human settlements inclusive, safe, resilient and sustainable		
66	Percentage of urban population living in slums or informal settlements (MDG Indicator)	Household surveys
67	Percentage of people within 0.5km of public transit running at least every 20 minutes.	Administrative data
68	[Ratio of land consumption rate to population growth rate, at comparable scale] – to be developed	Geospatial & census
6 cross-reference	Losses from natural disasters, by climate and non-climate-related events (in US$ and lives lost)	CRVS and administrative data
69	Mean urban air pollution of particulate matter (PM10 and PM2.5)	Environmental data
70	Area of public and green space as a proportion of total city space	Geospatial

71	Percentage of urban solid waste regularly collected and well managed	Administrative data
95 cross-reference	Domestic revenues allocated to sustainable development as percent of GNI – by sector	Administrative data
Goal 12. Ensure sustainable consumption and production patterns		
72	Disclosure of Natural Resource Rights Holdings	Administrative data
73	Global Food Loss Indicator [or other indicator to be developed to track the share of food lost or wasted in the value chain after harvest]	Administrative data
74	Consumption of ozone-depleting substances (MDG Indicator)	Administrative data
75	Aerosol optical depth (AOD)	Geospatial
76	[Share of companies valued at more than [$1 billion] that publish integrated reporting] - to be developed	International monitoring
Goal 13. Take urgent action to combat climate change and its impacts		
77	Availability and implementation of a transparent and detailed deep decarbonization strategy, consistent with the 2°C - or below - global carbon budget, and with GHG emission targets for 2020, 2030 and 2050.	International reporting
78	CO_2 intensity of new power generation capacity installed (gCO_2 per kWh), and of new cars (gCO_2/pkm) and trucks (gCO_2/tkm)	Administrative data
79	Net GHG emissions in the Agriculture, Forest and other Land Use (AFOLU) sector (tCO_2e)	Administrative data
80	Official climate financing from developed countries that is incremental to ODA (in US$)	International monitoring
Goal 14. Conserve and sustainably use the oceans, seas and marine resources for sustainable development		
81	Share of coastal and marine areas that are protected	Administrative data
82	Percentage of fish tonnage landed within Maximum Sustainable Yield (MSY)	Environmental & administrative data
Goal 15. Protect, restore and promote sustainable use of terrestrial ecosystems, sustainably manage forests, combat desertification, and halt and reverse land degradation and halt biodiversity loss		

83	Annual change in forest area and land under cultivation (modified MDG Indicator)	Environmental data (including geospatial)
84	Area of forest under sustainable forest management as a percent of forest area	Environmental data
85	Annual change in degraded or desertified arable land (% or ha)	Environmental data (including geospatial)
86	Red List Index	International monitoring
87	Protected areas overlay with biodiversity	International monitoring
Goal 16. Promote peaceful and inclusive societies for sustainable development, provide access to justice for all and build effective, accountable and inclusive institutions at all levels		
88	Violent injuries and deaths per 100,000 population	Administrative data and CRVS
89	Number of refugees	International monitoring
90	Proportion of legal persons and arrangements for which beneficial ownership information is publicly available	Administrative data
91	Revenues, expenditures, and financing of all central government entities are presented on a gross basis in public budget documentation and authorized by the legislature	Administrative data
92	Percentage of children under age 5 whose birth is registered with a civil authority	CRVS
93	Existence and implementation of a national law and/or constitutional guarantee on the right to information	International reporting
94	Perception of public sector corruption	International reporting
Goal 17. Strengthen the means of implementation and revitalize the global partnership for sustainable development		
95	Domestic revenues allocated to sustainable development as percent of GNI, by sector	Administrative data
96	Official development assistance (ODA) and net private grants as percent of high-income country's GNI	Administrative data
97	Private net flows for sustainable development at market rates as share of high-income country GNI, by sector	Administrative data
98	Annual report by Bank for International Settlements (BIS), International Accounting Standards Board (IASB),	International monitoring

	International Financial Reporting Standards (IFRS), International Monetary Fund (IMF), World Intellectual Property Organization (WIPO), and World Trade Organization (WTO)	
99	Share of SDG Indicators that are reported annually	TBD
100	Evaluative Well-being and Positive Mood Affect	Household surveys

Source: Author's own

Annex 2: NSDS Budgets and Data Collection Costs Per Year (Prepared by Open Data Watch)

This table organizes the countries by their annual NSDS budgets and lists their planned surveys, censuses and economic data collection methods. In some cases administrative data collection costs have also been included in the surveys and budgets data.

NSDS Cost and Data Collection Costs Per Year (US$ 000s)					
Country Name	**Category**	**Total budget**	**Data collection costs per year**		**Surveys included**
		in US$ 000s	**in US$ 000s**	**% of total budget**	
Chad	Low density & low income	17,861	6,900	39%	Livestock Census; Agricultural Census; Enterprise and establishment census; National Accounts; EPA; Informal sector survey; Multidimensional poverty and vulnerability survey; Demography and Health 3; Perception of Poverty; and Others
Zimbabwe	Low density & low income	23,330	-	-	ZIMSTAT; Environment; Migration and Tourism; Labor and Social Services; Trade and Manufacturing; Science & Technology
Bhutan	Low density & lower-middle-income	531	249	47%	SNA; ISIC; SEEA
Bolivia	Low density & lower-middle-income	15,468	11,866	77%	SNA; Population and Household Census; Agricultural Census; Economic Establishment Census; Agricultural and Industrial data; ICP
Lao PDR	Low density & lower-middle-income	2,560	1,768	69%	Household survey; Agricultural statistics; Industrial statistics; Communication; transportation, postal, telecommunications, constructions, Tourism; Investment Statistics; International trade; Fiscal and Monetary Statistics; National Accounts; Price statistics; Population statistics; Poverty; Gender; MDGs; Education Statistics; Public health statistics; Labor and Welfare Statistics; Culture and Sport Statistics; Land use statistics; Environment statistics;
Mauritania	Low density & lower-middle-income	7,627	6,588	86%	Censuses and surveys; Economic and Financial Data; Common databases
Mongolia	Low density & lower-middle-income	1,786	801	45%	Population Census; Enterprise survey; HIES; Enterprise vs establishment statistics; Integrated Business Enterprise Survey; Surveys of economic activity; Price Statistics; Banking & Monetary statistics; Survey of financial institutions; Government finance statistics; External debt statistics; Balance of Payments; National Accounts; Census of Population; Population estimates; Social statistics; poverty analysis.
Afghanistan	Middle density & low income	3,500	1,059	30%	National Accounts; DHS; HIES; Integrated Business Establishment Survey

Ethiopia	Middle density & low income	18,907	17,434	92%	DHS; HIES; Labor Force Survey; Employment-Unemployment Survey; Time Use Survey (Pilot) ; Crop Production Forecast Survey; Crop Production Survey for Long Rainy Season; Crop Production Survey for Short Rainy Season; Land Use Survey; Farm Management Survey; Livestock Survey; Survey of Large & Medium Farms; Socioeconomic Survey of Pastoral Areas; Environmental Statistics; Natural Resource & Wildlife Survey; Agriculture Census; Business and Enterprise Census; Manufacturing & all other business survey; ICT Module in Large Enterprise Survey; Producer Price Survey; Construction Survey; Population Census Activities and projection; Intercensal Demographic Survey; Vital Registration;
Tajikistan	Middle density & low income	2,593	1,445	56%	Business register; International classification; Industry; Construction; Foreign & Domestic Trade; Transport & services; Housing; Agriculture; Environment; Demography; Labor force; Foreign labor migration; Wages; Household budget and poverty; Healthcare; Education; Social security; Culture; Crime; Science; Gender; Census of population
Tanzania	Middle density & low income	12,883	5,401	41%	Digital Cartography for 2014 Population Census; Agricultural data; Tanzania Socioeconomic; National Accounts; Price Statistics; Production Statistics; Tourism Statistics and Government Financial Statistics; Employment & Earnings Surveys; Annual Economic survey; Annual survey of Industrial Production; Trade Statistics; Construction Statistics; National Panel Survey; DHS; Agriculture Census; Integrated Business Survey; Core Welfare Indicator Questionnaire; CRVS
Cote d'Ivoire	Middle density & lower-middle-income	46,224	21,068	46%	Censuses of population, agriculture, livestock, businesses, health, tourism, skilled laborers and sports and leisure; Agricultural statistics; employment; private sector; industry; enterprise; HIV; GBV; crime; child labor; mortality; marriage, construction, informal sector; fisheries; Children and Women; physical education; public health; Quality of life; Demographics and health; MIVS; governance; HIV; sexual abuse; family planning; street children; knowledge of resolution 1325; time use; cultural product consumption; Enterprise Survey
Samoa	Middle density & lower-middle-income	2,496	156	6%	Population Census; Tourism Expenditure Survey; DHS; HIES; Labor Force Survey; Business Activity Survey; Agriculture Survey; Finance Statistics; Economic statistics; Migration statistics; Births, deaths and marriage registration and statistics
Senegal	Middle density & middle-lower-income	35,669	18,323	51%	National Agricultural Census; Annual Agricultural Survey; Livestock Census; Survey on slaughter of domestic animals; Survey of Fisheries; DHS; National Health Accounts; STEPS survey for Monitoring Risk Factors for Chronic Disease; National Labor Survey; Survey on Paid Wages; Study on Public Employment and Competences; Employment Study; Survey on Poverty in Senegal; Survey on Migration and Urbanization in Senegal; Survey on Services; Census of Industrial Enterprises; Informal Sector Survey; Survey on Tourism; Survey on Mineral Production; Data on Energy Sector; Survey on Financial Inclusion in Senegal; Survey of Professional Organizations; Administrative Statistics of Prison System; Administrative Statistics on Firefighting; Children and Youth (less than 21) in Danger or in Conflict with the Law

Timor-Leste	Middle density & lower-middle-income	1,635	1,230	75%	National accounts; Business Activity Survey; Agricultural Production Survey; CPI; Price Statistics; Population census; DHS; Household Expenditure Survey; Education; Trade and Tourism; Manufacturing and Tourism; External Trade data; Police; Immigration; Employment; Post and telecom; Electricity and Water; Labor Force Survey; Agricultural Census
Bangladesh	High density & low income	57,780	42,743	74%	GDP; National accounts; Food Blance sheet; Rural agriculture; Non-Crop statistics (fisheries, forests and livestock); Vital Statistics of Bangladesh; Health and demographic statistics; food security and nutritional status; Gender statistics; Violence against Women Survey; National Population Register; Labour Force Indicators; Annual establishment & Institutional Survey; Survey on manufacturing industries; Business register; Informal sector statistics;
Burundi	High density & low income	9,734	1,153	12%	Macroeconomic statistics; Socioeconomic Indicators; Establishment survey; HIES; Enterprise Census; Agriculture Census
Malawi	High density & low income	10,004	5,594	56%	Agricultural & livestock census; Welfare Monitoring Survey; Environmental & natural resources statistics; DHS; Biological Behavioral Statistics; Criminal justice statistics; Panel Integrated Household Survey; Annual Economic Survey; Industrial statistics; Medium Business Survey; Price Indexes; Tourism Statistics; External statistics; Balance of payments; Private capital flows; National Accounts; Labor Force Survey; MDG Survey
Rwanda	High density & low income	18,935	11,157	58%	Business registers; education administrative data; health administrative data; justice, reconciliation, law and order administrative data; infrastructure, environment and natural resources sector administrative data; gender statistics; youth, sport and culture statistics; labour statistics; household expenditures and income survey; DHS; Labor Force Survey; Establishment Census; Integrated Business Enterprise Survey; Agriculture Survey; Foreign Private Capital Census; Cross Border Trade Census; Land and Air Travel Expenditure Survey; Price statistics; Inter-census survey; Food Vulnerability Assessment; National Accounts; Governance Scorecard; Citizen report card; Rwanda Media barometer ; Civil Society Barometer;
Maldives	High density & upper-middle-income	1,017	844	83%	National Accounts; CPI; PPI; Industrial Production Survey & Index; Construction Index; Economic admin data collection/analysis; Social admin data collection/analysis; Statistics Yearbook; Maldiv Info; Population Census 2011 (10-yearly); Household Income & Expenditure Survey and VPA 2014 (5-yrly); Economic Survey (5-yearly); Economic Census (10-yrly)

Source : Author's Own

Annex 3: Methodological Note on Computing the Survey Costs for SDG Monitoring: Survey Typology (Prepared by PARIS21)

Surveys are expensive operations. Much of the cost of a survey is related to the cost of labor and transportation. Mobile teams of enumerators and equipment often require transport to remote locations. As such, survey costs can vary widely across countries due to labor and transportation costs incurred. In our proposed model, we project costs of major national survey programs by number of domains, labor cost, and transport cost specific to each country. Our framework looks strictly at costs for household surveys including agricultural surveys. Censuses, agricultural censuses, and facility surveys are not included.

Costing a 10-Year National Survey Program

To project the cost of national survey programs for a 10-year period, we assume the following configuration of survey program (excluding census):

Table 10: Basket of surveys for a country's 10-year survey program

Survey type	Frequency per 10-year cycle
DHS-MICS type surveys[68]	4
LSMS type surveys[69]	2
Labor Force Surveys (LFS)	10
Agricultural Surveys (AG)	2
Supplemental surveys	2

Source: Author's own

The choice of this program is based on the main survey data sources expected to feed into the SDGs. In addition, we included annual labor force surveys assuming that it is an essential data source not only for national policy needs, but also for the potential SDG indicators on labor and employment.

Cost Assumptions for Major Survey Programs

Local Cost
The cost of each survey largely depends on the sample size. For each type of survey, we make assumptions about the *sample size per geographic domain* and *cluster size*. In a two-stage sampling design, clusters are chosen as the primary sampling unit (PSU). These are important as teams are assigned to clusters and the time spent in a cluster will have an impact on the cost. Geographic domains for each country are assumed to follow NUTS. The NUTS is a classification scheme for administrative units used to determine statistical monitoring by the European Union.[70] NUTS-2 classification is a standard for normalizing cost assumptions for attributing the level of disaggregation. NUTS provides a hierarchical subdivision of geographical space, identifying areas at a series of nested levels, with NUTS 2 being in the range 800,000 to 3 million population. We use the midpoint of 1.9 million. SIDS are handled differently with islands or clusters becoming their own domains. In this way,

[68] Although the DHSs and MICS are independent survey programs, the trend may be to monitor the health sector with higher periodicity and therefore some countries undertake both. We have costed both DHS and MICS with this understanding.
[69] LSMS type surveys are restricted to two per 10-year period because other proxies can explain annual poverty changes.
[70] Eurostat–European Commission (2011). Regions in the European Union. Nomenclature of Territorial Units for Statistics. NUTS 2010/EU–27. Luxemburg: Publications Office of the European Union.

for the same type of survey, the projected total sample size and total number of clusters vary by the number of administrative divisions across countries.

Table 11: Assumptions of sample size per domain and cluster size by type of survey. Panel one is assumed to be 20 percent of the LSMS sample, and Panel two is assumed to be 20 percent of LFS.

Survey design and data collection	DHS	MICS	LSMS	LFS	AG	Supplemental surveys
Sample size per domain	500	450	400	250	300	200
Units per cluster	20	20	14	12	14	16

Source: Author's own

Fieldwork Cost

Fieldwork cost is composed of *cost of listing* and *cost of data collection*. For survey j in country i:

$$C_{listing\_ij} = N_{cluster\_ij} \cdot (r \cdot p_i + r' \cdot t_i)$$
$$C_{collection\_ij} = \frac{N}{v_j} \cdot p_i + \frac{N}{v'_j} \cdot t_i$$

where $N_{cluster\_ij}$ is the total number of clusters estimated by the survey design assumption presented above. p_i is the dollar amount per enumerator per day; t_i is the dollar amount per vehicle per day, both provided by countries. Assuming one vehicle per team, r and r' stand for person-days and team-days required for listing of each cluster. v_j and v'_j stand for number of households completed per person per day and per team per day for survey j. Team sizes and time in a cluster vary depending on the survey.

Technical Assistance Cost

Technical assistance cost is calculated based on the *number of days* for consultancy and *travel cost*. Total number of days for technical assistance is the sum of days needed for sample design, analysis, project management, data processing, and training support as assumed below:

Table 12: Assumptions of number of technical assistance days and number of trips required by type of survey. Technical assistance for panel surveys is assumed to be included in the LSMS and LFS.

Technical Assistance	DHS	MICS	LSMS	LFS	AG	Supplemental surveys
TA Sample design days	30	20	30	10	30	10
TA analysis days	30	30	30	5	20	10
TA Project Management days	60	30	40	5	20	10
TA data processing days	60	45	30	10	20	10
TA Training	30	30	35	10	25	15
Number of TA trips	10	7	5	2	5	1

Source: Author's own

Country selection

The countries for the analysis were selected from the sample of 77 IDA and blend countries (discussed in section 4, above).

Sample selection

Countries were stratified along two dimensions: *income status* and *population density*. The rationale here is that (i) income status is a key determinant of local costs for enumerators and (ii) population density is a major driver of transportation cost.

Income groups are based on the 2014/2015 World Bank classifications for 'Low income' and 'Lower middle income' countries, as of July 2014.[71] Within the income category, a further category was introduced for SIDS. According to the UN classification,[72] SIDS make up for 27 percent of the 77 IDA/Blend countries and this is reflected in the selection. Population density is based on World Bank data for 2013 on mid-year population divided by land area in square kilometers.[73] The cut-off points used to delineate high, medium and low density are 33 percent and 66 percent (46.80 and 124.02), of the 77 IDA/Blend countries.

A stratified sample of 30 countries was then drawn from the population of 77 IDA countries. Table 13 and Table 14 show the frequency distribution of the resulting nine strata in population and final sample, respectively.

Table 13: Cross tabulation of population of IDA/Blend countries by population density and income status

		POPULATION DENSITY			
		High density	Low density	Medium density	**Total:**
STATUS	Low income	8	11	11	**30**
	Lower middle income	5	12	9	**26**
	SIDS	12	4	5	**21**
	Total:	**25**	**27**	**25**	**77**

Source: Author's own

Table 14: Cross tabulation of final sample by population density and income status

		POPULATION DENSITY			**Total:**
		High density	Low density	Medium density	
Country status	Low income	1. Gambia 2. Malawi 3. Nepal 4. Rwanda	1. Afghanistan 2. Central African Republic 3. Liberia 4. Niger	1. Burkina Faso 2. Cambodia 3. Kenya 4. Tanzania	**12**
	Lower middle income	1. Sri Lanka 2. Vietnam	1. Bolivia 2. Lao PDR 3. Mongolia 4. Sudan 5. Yemen, Rep.	1. Cameroon 2. Côte d'Ivoire 3. Ghana 4. Moldova 5. Senegal	**12**
	SIDS	1. Comoros 2. Micronesia 3. Tuvalu	1. Vanuatu	1. Cabo Verde 2. Samoa	**6**
	Total:	**9**	**10**	**11**	**30**

Source: Author's own

Replacement and Imputation

[71] See the World Bank website for additional information on income classes: http://siteresources.worldbank.org/DATASTATISTICS/Resources/CLASS.XLS.
[72] A list of SIDS is available at https://sustainabledevelopment.un.org/topics/smallislanddevelopingstates.
[73] Data on population and land area are available at http://data.worldbank.org/indicator/EN.POP.DNST.

Because of non-responses in reported questionnaires some countries have been replaced[74] and missing values imputed.[75] Since the selection process was not smooth, the final cost estimates for each country were weighted with the inverse of the probability of a country from their stratum being sampled. To illustrate, if four out of eight countries are observed for any given stratum, then each observation represents two countries in the population and therefore has a weight of two assigned. Under the assumption that the non-respondents are missing at random, this inverse probability weighting ensures that the estimates for the sample are representative of those for the population of 77 IDA countries.

Preliminary Projections

Average Cost Per Survey

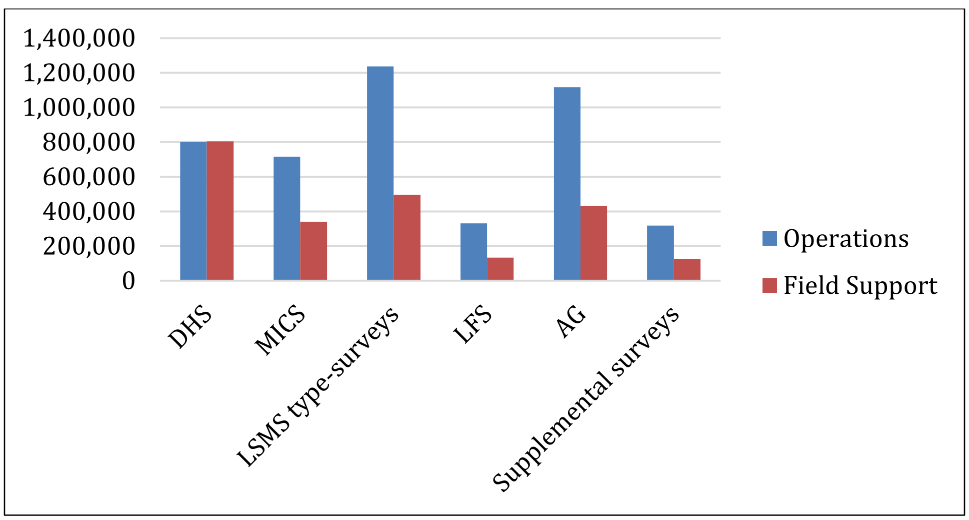
Table 15: Average cost per survey in US$

	DHS	MICS	LSMS type-surveys	LFS	AG	Supplemental surveys
Operations	800,186	716,040	1,235,852	331,204	1,117,303	319,002
Field Support*	805,027	340,985	495,427	133,128	431,135	125,974
Total Average	**1,605,213**	**1,057,025**	**1,731,279**	**464,333**	**1,548,438**	**444,977**

Source: Author's own

**Difference in field support costs mostly attributable to the estimated daily rates for technical input.*

Figure 2. Average cost per survey in US$



Source: Author's own

[74] Nonresponse countries were replaced by Afghanistan, Côte d'Ivoire, Federal States of Micronesia, and Tuvalu.
[75] Missing values for cost items in the country-level questionnaire were imputed with the average cost by income group.

15-year Total Cost

To project the total cost for the 15-year period of the SDGs we assume a lower bound, using geographic domains according to the NUTS-2 classification (with midpoint 1.9 million), and a higher bound with domains based on actual administrative areas.

Using the cost obtained from the sample of 30 countries, total cost of national survey programs for 77 IDA countries (excluding census) ranges from US$2.0 billion to US$2.6 billion over a 15-year period, or 134 million to 173 million annually.

Annex 4: Methodological Note on Computing Population Census (Prepared by Morten Jerven[76])

The quality of any survey depends on the representativeness of the sample. The quality of the sampling frame depends on an initial census of the population. It is recommended that a population census be updated every ten years. A population census is not only an essential statistical baseline for the activities of the statistical office, it also delivers key data for the government regarding resource allocation and political elections. One powerful reminder of the importance of having a regular update on the size of population is that estimates based on population growth projections often turn out to be off target when new population census estimates are made available.[77]

How much does a population census cost? For richer countries this cost is low as a share of total GDP, but for low income countries, census costs can be quite substantial, in particular if measured as a share of public spending on statistics. A rule of thumb for census costs has been US$1 per enumerated person.[78] This means that to provide a baseline for the measurement of trends in social, economic, political, and environmental development for the world population from 2015 to 2030 we would look at a minimum total initial outlay of US$7 billion and the double of that if we assume that this information would have to be updated once during the period. It has been suggested that more realistic figures today may be around US$3 per enumerated person.[79] But censuses may be more expensive for some countries. India and China have had relatively cheap censuses, at a cost of US$0.40 and US$1 per capita, respectively. By contrast, censuses in Canada have cost from US$16 to US$20 dollars per capita since 1991 and in the US the per capita cost has risen from about US$5 in 1970 to US$10 in 1980, US$13 in 1990, and US$23 in 2000.[80] USA's last census cost US$13 billion, or about US$42 per head.[81]

We have attempted to collect total cost data on population censuses in 77 IDA recipient countries. Of course, this is not to be equated with the needs assessment for total or increased donor funding. Population censuses in low income countries are regularly funded with a share from the government and with a share from donors.

The total population of the 77 IDA recipient countries is just above 1.5 billion. Thus we may infer that the lower bound of a total count would be US$1.5 billion (based on $1 per enumerated person), and the upper bound US$4.5 billion (based on $3 per enumerated person). Thus, by looking at general data, that does not incorporate detailed parameters and variables, we can estimate, that a full census round for all the 77 IDS countries would be approximately US$3 billion. Assuming that the countries will have two censuses conducted during this period, we multiply this number by two, giving an estimated requirement of US$3 to US$9 billion, in order to fund the total cost of creating one baseline for all 77 countries and to update that baseline once during the period. We can also use historical census costs proxies for the countries that lack historical census cost data. Jerven (2014) collected costs of the most recent censuses in all non-high income countries, finding data on 68 countries.[82] Only 28 of these are in the sample of the 77 IDA recipients. The population size, reported census cost, and per capita costs are reported in the table below.

Table 2: Population size, census cost, and per capita cost

[76] Prepared by Morten Jerven (mjerven@sfu.ca).
[77] Jerven, M. (2013). *Poor Numbers: How we are misled by African development statistics and what to do about it. Ithaca:* Cornell University Press.
[78] However, one dollar per capita may be too low. While technology improves processing time (from years to months) and precision (digital mapping), preparation costs and increased information demands drive costs up.
[79] Virtual Statistical System (2014). "Section 4 –Registers, Frames Censuses, sub-section 3: "Censuses", VSS, World Bank.
[80] Yacyshyn, Allison M. and David M. Swanson (2011). The Costs of Conducting a National Census: Rationale for Re-Designing Current Census Methodology in Canada and the United States, Center for Sustainable Suburban Development Working paper #11-05.
[81] The Economist (2011). "Censuses. Costing the Count'. June 2nd 2011.
[82] Jerven, M. (2014)..

Country	2013 Population (Millions)	Census Cost (US$ Millions**)	Per Capita (US$)
Afghanistan	30.6	44	1.4
Bangladesh	156.6	42	0.3
Benin	10.3	9	0.9
Bolivia	10.7	50	4.7
Cambodia	15.1	8	0.5
Chad	12.8	30	2.3
Djibouti	0.9	4	4.4
Gambia, The	1.8	6	3.2
Ghana	25.9	50	1.9
Guinea-Bissau	1.7	5	2.9
Guyana	0.8	4	5.0
Haiti	10.3	8	0.8
Kenya	44.4	75	1.7
Kosovo	1.8	15	8.2
Liberia	4.3	6	1.3
Malawi	16.4	10	0.6
Mali	15.3	3	0.2
Moldova	3.6	3	0.8
Nigeria	173.6	843	4.9
Rwanda	11.8	21	1.8
Sierra Leone	6.1	10	1.6
South Sudan*	11.3	99	8.8
Tajikistan	8.2	15	1.8
Tanzania	49.3	67	1.4
Timor-Leste	1.2	4	3.4
Uganda	37.6	62	1.6
Vietnam	89.7	33	0.4
Yemen, Rep.	24.4	68	2.8
Zimbabwe	14.1	16	1.1

Source: Population: World Development Indicators, 2014. Census Cost, see data appendix Jerven 2014 for source for each estimate.

* *The estimate for South Sudan was budgeted in advance of the 2014 census that has subsequently delayed.*[83]

** *These estimates are all current dollars, and no effort has been made to control for inflation. This may cause some inaccuracies, as some of the dollar estimates are very recent, whereas others are a decade old. See data appendix Jerven 2014 for the source of each estimate.*

[83] The Sudd Institute (2014). The 2015 National Census and Elections: An Analysis of President Kiir's Announcements.

The highest per capita cost estimates are for South Sudan and Kosovo –the result of these being young countries with new statistical offices and administrations. The rest of the samples vary from US$0.30 to US$5. It is notable that countries like Vietnam and Bangladesh, which have large populations and high population densities have a low per capita cost for censuses. There are two ways of calculating the average: as the average across the 28 countries, or to derive it by adding all the countries' costs and populations together (which would be the equivalent of a population weighted average). The weighted average is lower, mainly due to the large size and cheap census costs in Bangladesh and Vietnam, thus negating the effect of the smaller countries with relatively expensive per capita censuses. The weighted average is US$2.04, while the arithmetic average of the 28 countries is US$2.44.

If we use US$2.04 for the unknown part of the sample (we have known costs for 28 countries which account for 789 million people, prooviding a total of US$1.6 billion), we end up with US$3.174 billion for one census round.

How do we reach a total for 2015 to 2030? Using the internationally accepted standard of requiring a census every decade, it is conceivable that some countries will have two censuses during the period (e.g. one census in 2015 and one in 2025) or just one (e.g. one in 2022). Again, we could use data on the time frames in which each country conducted a census, and thus derive whether they should have one or two censuses in the coming 15 years. For the sake of simplicity we have accounted for this by multiplying the lower bound total with 1.5. As a result, we end up with an estimated total of US$4.8 billion for the 77 countries to complete one or more censuses during the 15 year SDG period.

Annex 5: Methodological Note on Computing Costs for SDG Indicators with Geospatial Dimensions (Prepared by CIESIN[84])

A large number of the proposed SDG indicators require geospatial data and more than two-thirds can be visualized spatially at various sub-national scales, if geo-coding is a standardized component in data collection from existing survey tools.

The objective of these data systems is multi-fold. They not only permit reporting of progress towards the SDGs, but also improve planning, design, transparency and program implementation. Studies have found that central investment in core open-access spatial data brings significant financial returns. For example, Danish investing US$125 million in spatial data infrastructure between 2012 and 2016 brought returns of an estimated US$33 million net benefit per annum for the public sector and US$66 million net benefit per annum for the private sector.[85] A similar Finnish study showed that business growth is 15 percent higher in countries where public-sector geographic data is freely available.[86]

The institutional home for geospatial divisions varies between countries. Sometimes it is officially within national statistics offices and sometimes located in other government agencies. The cost estimates for this section focus on the need to build capacity for geospatial analysis regardless of where the unit sits within government organizational structure.

There are two main clusters of cost associated with enabling the geospatial components for the SDG indicators.

The first cluster of cost estimates have to do with the core geospatial data layers and the data management infrastructure; these elements are prerequisites to generate, share, and analyze geospatial data related to all of the proposed indicators with geospatial dimensions. Spatial data infrastructure allows for coordinated data management across government agencies. The costs for spatial data infrastructure include four components: data collection, technology and human capacity, distribution and access networks and policies, standards and organization.[87] The core (or reference) data layers represent a limited number of fundamental features that are a common denominator for all other map production and analysis. These core layers include administrative boundaries, topography, built-structures, digital elevation, transportation networks, hydrography, place names, and urban/rural zoning. Although satellite imagery is considered core data layers, we provide separate cost estimates due to their explicit role in calculating the SDG indicators. These estimates are based on comparative case studies of national budgets and reports of five countries. These are primarily one-time upfront costs with a small annual operations budget.

The second cluster of costs concerns three data collection tools related to the SDG indicators. The tools described below are designed to collect data related to multiple indicators.

The tools include the following:

1. **Facility and infrastructure inventories**. This tool will systematically collect national inventories of a minimum of 10 infrastructure and facility types, including location, condition, and facility-specific attributes. These types include schools, health clinics, irrigation systems, municipal water systems, solid-waste treatment facilities, wastewater treatment facilities, agricultural warehouses, cold storage facilities, drying facilities, processing facilities, and public transit stations. The cost estimates are

[84] Prepared by Alex Fischer, Marc Levy, Robert Chen, Greg Yetman, Alex de Sherbinin, and Yue Qiu (CIESIN).
[85] The Danish Government (2012). Good basic data for everyone – a driver for growth and efficiency. Rosendahls – Schultz Distribution: Denmark.
[86] Koski, H. (2011). Does marginal cost pricing of public sector information spur firm growth? (No. 1260). ETLA Discussion Papers, The Research Institute of the Finnish Economy (ETLA).
[87] Adapted from Nebert, D. D. (2009). The Spatial Data Infrastructure Cookbook.

based on population density and logistic considerations, derived from examples in Nigeria and Haiti. Once a systematic baseline is produced, updating the data will be completed by the administrative data processes.

2. **Satellite imagery**. Countries are now able to acquire national scale imagery at various resolutions, spectral bands and price points. Multiple SDG indicators are dependent upon, or benefit from this imagery in addition to designing and implementing development strategies. Therefore our estimates present different imagery options including globally available free imagery. We include the costs to analyze this data within the core geospatial analytic teams. Opportunities to make higher-resolution commercial imagery more widely available should be vigorously pursued.

3. **Geo-coded census data**. Cartography is a significant portion of census budgets. This cost is already included in the census section, but it is noted here that the use of population data is critical for calculating many of these geospatial indicators. Therefore, ensuring census data is geo-coded is critical.

The costs for geospatial data collection vary significantly among countries. Difference in cost estimates arises from factors such as geographic size of the country; population size; scale; and resolution of analysis, frequency of data collection, and availability of data collection tools. This also includes time required to start data collection if it doesn't already exist. The following estimates are preliminary estimates for discussion.

Table 17: Summary of Costs by Spatial Data Component

Component	Estimated Fixed Costs	Estimated Re-occurring Cost	Total Costs over 15-year period	Notes
Core Spatial Data Infrastructure	US$233,000,000	US$57,200,000/yr	US$290,125,000	Total for all 77 IDA recipient countries.
Core Data Layers	US$99,000,000		US$99,000,000	This estimates based on the 33 LIC countries within our sample, which are presumed to be the countries without any core data layers already in existence.
National Infrastructure and Facilities Inventory	US$603,000,000		US$603,000,000	Total for all 77 IDA recipient countries. Country cost range from US$2,000,000 and highest is US$15,000,000.
Satellite Imagery	US$150,000,000	US$5,000,000/yr	US$225,000,000	Based on estimate of creating a non-profit satellite company that would provide free high-resolution data to IDA countries.
TOTAL			**US$1,217,125,000**	

Source: Author's own

Section 1: Costing National Geospatial Core Data Layers and Infrastructure

The role of geospatial data has continued to rapidly expand in governance and decision-making tools. While national statistics agencies exist in almost all countries, geospatial data management and responsibility remains largely fragmented across government agencies and organizational units.

The availability of core geospatial data is a pre-requisite for calculating the SDG indicators. These core data layers, noted in more detail below, range from topography to administrative boundaries to road networks to hydrography to satellite imagery. There is a growing body of global standards for processing and documenting these data layers from the geospatial community.

The total cost of establishing a functional national spatial data infrastructure varies on a case-by-case basis, depending on the geographic extent (i.e. country area), as well as the level of components and capacity already in place. The following estimates are drawn from the body of literature documenting previous efforts to establish coordinated national spatial data infrastructures. This includes feasibility analyses prior to the implementation, progress report from member states in a larger regional directive (e.g. INSPIRE), and open national budget reports[88,89,90,91,92].

Establishing Core Geospatial Data Analysis Capacity

Based on existing national-scale costing studies and expert opinion, we estimate that on average, IDA countries should budget at least US$3,000,000 to build geospatial data infrastructure and should plan for a re-occurring operating budgets of between US$600,000 and US$850,000 per year. We assume that lower-income countries would allocate US$600,000 per year and middle-income countries US$850,000 per year.

These costs include data management, technology, data policy support, and a limited amount of annual data analysis. These estimated costs assume that the country has no current spatial data infrastructure. This study has not been able to complete a country-by-country survey of existing geospatial data capacity but recommends a comprehensive assessment be undertaken directly with national governments.

Country studies with existing budget estimates for national geospatial data infrastructure demonstrate a range of costs and provide illustrative examples. We recognize that many countries have elements of the system, so each country investment will vary across categories of core data infrastructure. Any existing capacity or national-data layers would reduce the overall cost.

The table below shows the range of actual costs reported for establishing coordinated spatial data infrastructure in five countries.

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[88] Vandenbroucke, D. (2012). Reporting Cost/Benefit of INSPIRE.
[89] Almirall, P., et al. (2008). The Socio-economic Impact of the Spatial Data Infrastructure of Catalonia.
[90] DMR-Fujitsu (2012). Plan National Géomatique du Sénégal. Bien livrable 6- Plan de mise en œuvre du PNG.
[91] Infrastructure for Spatial Information in Europe (INSPIRE) (2013). Member State Report: Denmark 2010-2012.
[92] Ministry of Finance, Liberia (2012). National Budget for Fiscal Year 2012-2013.

Table 18: Range of Actual Costs Reported for Establishing Coordinated Spatial Data Infrastructure

Country	IDA	Region	Total Estimated Cost (US$ Millions)	Number of Years
Uganda[93]	Low income Country	East Africa	3.5	1
Senegal[94]	Low/Middle Income Country	West Africa	5.1	5
Tanzania[95]	Low income Country	East Africa	2.7	3
Poland[96]	High-Income Country	Europe	17.5	1
Liberia[97]	Low income Country	West Africa	3.2	1 (Included statistical capacity)

Source: Author's own

Table 19: Breakdown of Average Estimated Costs for Establishing National Geospatial Data Infrastructure

Category	Core Geospatial Infrastructure Component	Estimated Average Costs (US$)
Data Collection		
	Compilation of Exiting Data	250,000
	Data Harmonization	175,000
Technology		
	Hardware	200,000
	Software	50,000
	Networking/Server	75,000
Distribution and Access Network		
	Hosting/Management	200,000
	Data sharing/Web platform	200,000
	Training/Non-GIS Technician	200,000
Policy, Standards and Organization		
	Enabling Policy Framework	850,000
	Outreach/Training for Policy Application	300,000
	Metadata and documentation	50,000
	Data security policies	75,000
	Organizational agreements	400,000
	TOTAL	**3,025,000**

Source: Author's own

[93] GIC/ESRI Canada (2011). Feasibility Study for a National Spatial Data Infrastructure in Uganda. Washington, D.C.: InfoDev / World Bank.
[94] DMR-Fujitsu (2012).
[95] National Bureau of Statistics, Office of Chief Government Statistician (2010). Tanzania Statistical Master Plan.
[96] Infrastructure for Spatial Information in Europe (INSPIRE) (2013). Member State Report: Poland, 2010-2012.
[97] Ministry of Finance, Liberia (2012).

Core data layer collection and production

Core data layers are fundamental features that serve as a reference, or the common denominator, for all GIS data layers. They are required for calculating all other spatial data SDG indicators. Once these core data sets are shared between data users, each user does not have to repeat the calculation of the core data, and can avoid duplicated efforts of core data development.

These costs are not only required for fulfilling the SDG Indicator requirements, but also should be considered as critical components of multiple governance programs including E-Governance map platforms and government strategic development planning.

The costs for this vary significantly from country to country and there is no readily available inventory of these layers in each country. Therefore, we suggest allocating an average of US$3,000,000 per LIC[98]. This would be an upfront investment, not a recurring cost.

We do not include satellite imagery costs in this estimate as those data layers are explicit data layers for SDG indicators and require separate annual investments.

Figure 3. Core Geospatial Data Layers[99]

Digital base maps layers		Geo-Coded Statistical layers	Additional SDG Layers included in this costing
Digital Elevation Model (DEM)	Terrestrial	Demographic data	Protected Areas
	Bathymetry and coastlines		
Administrative boundaries (including statistical boundaries e.g. metropolitan areas/enumeration units)			
Hydrography/surface water networks			
Transportation networks			
Built Structures			
Urban and Rural classification			
Place names			
Land Use/Land Cover (Dependent on Satellite Imagery)			
Orthoimagery and Satellite imagery [Not included in core data cost estimates]			

Source: Author's own

[98] Based on key informant interviews.

[99] Adapted from Williamson, I. P., Rajabifard, A., & Feeney, M. E. F. (Eds.) (2004). Developing spatial data infrastructures: from concept to reality. CRC Press.

Section 2: Costing Major Geospatial Monitoring Tools

Specific data collection tools include satellite imagery, national infrastructure and facility inventories, geo-coded census, and/or population data. These are all tools that are based in geospatial analytic methodologies. The following section provides cost estimates for the proposed geospatial survey tools.

Summary of tools below:

- *Satellite Imagery*
- *National Infrastructure and Facilities Inventory*
- *Geo-Coded Census Data*

Satellite Imagery

Estimated Costs: This paper recommends investing US$150,000,000 for start-up costs and US$5,000,000 in annual costs covering all 77 countries. The total cost would be US$225,000,000 for 15 years.

Each country at a minimum should have the capacity to download, process, analyze, and utilize free moderate-resolution data on a daily frequency. The currently available global free imagery is in the 30-meter resolution range. For the post 2015 timeframe, it should be possible for countries to have access to imagery in the 5-meter resolution, 5-band range.

This study team has identified 23 indicators of which methodologies are dependent upon or could be enhanced by satellite imagery and nine that use remote sensing.[100] Previously, satellite imagery has been cost-prohibitive for many countries, both in terms of imagery acquisition and the ability to process, analyze, and integrate into decision-making systems.

Within this report, there are several options and pathways to provide satellite imagery data. This ranges from free globally available imagery provided by government agencies to over US$300 million for high-resolution commercially available imagery. Satellite imagery acquisition is one type of data collection in this report that could be gathered, processed and analyzed at national, regional, or even global scale.

Satellite imagery is available from public and commercial providers at different temporal, spectral, and spatial resolutions. There are currently imagery products that are available at global scales at no-cost, such as Landsat (resolution of 30 meters) and MODIS (resolution of 250 meters to 500 meters depending on the bands). There are a variety of available commercial imagery providers that offer products from one-meter to 10-meter resolutions with various spectral bands at a range of higher price points. New constellations of satellite networks are being established with global revisit time as low as one day, allowing for potential high frequency monitoring for specific environmental indicators. Early news reports suggest that the new satellites could cost 10 times less than the existing providers.[101]

Leading recommendation for future of satellite imagery for IDA countries:

One of the most cost-effective ways to achieve higher resolution imagery acquisition for the 77 IDA countries is to create a new non-profit organization charged with operating a satellite network and making available imagery at no cost to IDA recipient countries. Such a model would have estimated start-up costs of approximately US$150 million and annual operating costs of approximately US$5 million per year.[102] The goal would be to provide a minimum of five-meter resolution imagery with up to five bands at a frequency of

[100] Based on SDSN (2015).
[101] Mims, C. (2014, June 15). Amid Stratospheric Valuations, Google Unearths a Deal With Skybox. The Wall Street Journal.
[102] These are initial estimates based on 2011 estimates compiled by Gerald Nelson, Molly Jahn, and their colleagues. Their initial presentation, "Fast Track to Enhanced Global Monitoring." Other online sources include SpaceBusinessBlog 2011 article, "Business Case for a CubeSat-based Earth Imaging Constellation."

five to 10 images per year. Within this model, countries and global monitoring agencies would still use both free 30-meter resolution data and have the option of purchasing even higher resolution commercial imagery for specific priority areas.

Summary of Satellite Imaging Options
For the purposes of this exercise and the current availability of satellite imagery, we see three elements to integrating satellite imagery into national sustainable development planning and monitoring.

1. Free, moderate resolution:
    a. Countries should have the capacity to acquire, process, analyze, and build management tools around free data such as MODIS, LandSat, JAXA, and the EU Sentinel Satellites. This requires an analytic team. It can be complimented with machine learning algorithms to reduce costs.

2. Moderate to high-resolution imagery made available to all through new mechanisms:
    a. A new non-profit organization charged with operating a satellite and making available imagery at no cost. Such a model would have start-up costs of approximately US$150 million and annual operating costs of approximately US$5 million per year.

3. Other commercial high-resolution imagery will be needed, for select purposes:
    a. Data costs for high-resolution imagery can range from US$1.65/km^2 to US$13/km^2. If we assume countries are supplementing moderate resolution with specific areas focuses using this high-resolution imagery, we assume that would be five percent of the total land area. Therefore, purchasing commercial imagery would have cost range of US$3 million to US$19 million per year.

Within all costing models, we assume that national satellite monitoring and reporting has three key elements of costs:

1. Imagery acquisition: Costs vary depending on imagery source.
2. Imagery processing: Costs vary depending on imagery source and processing requirements.
3. Imagery analysis: Costs can be assumed roughly constant for purposes of this study. Core capacity to manage and store the imagery is included in the previous geospatial estimates. Additional analytic costs for specialized equipment for automated computer-learning analysis were not included. Computer learning approached, used by Brazil and global non-profits, could save money for each year's image processing costs.

Below is a table of existing commercial satellite imagery providers and costs for their products. This is just a sample of the earth imaging market and the team is not in any way making a specific recommendation of a particular imagery provider.

Table 20: Potential Satellite Cost Estimates

Data Source/ Company	Format	Resolution (meters)	Bands	Price US$
Landsat/NASA	Archival	30	4 bands	Free
Sentinel-2/ ESA	Archival	60	13 bands	TBD
MODIS	Archival	250 or 500		Free
ADEOS 2/JAXA	Archival	250m	7 Bands	Free
WorldView-2/Digital Globe	Archival	0.46	8 bands	US$13/km^2
Rapid Eye	Archival	5	R/B/G/NIR	U$1.65/km2

Source: Author's own

National Infrastructure and Facility Inventories (NIFI)

Indicators: 6, 14, 16, 26, 45, 46, 47, 67 and 71

The total cost estimated for all 77 IDA countries is US$603,000,000.

NIFI is a data collection methodology using mobile-phone tools intended to catalyze data-driven planning, investment, and good-governance for the modernization of the public and private sector investments. Many countries lack comprehensive inventories of their facilities and built infrastructures, information critical for management of service delivery, and investment planning as well as reporting on national sustainable development indicators. Similar to the structured data collection tools like the census that tracks demographic and population data, there is a need for a similar inventory tool for national physical assets with a large focus on geospatial representations. This approach assumes that most developing countries lack the comprehensive baseline inventory and that administrative data systems have gaps in their reporting processes. Once a base inventory exists, this can be updated and managed as part of administrative data.

This cost estimate in this study focuses on 10 facility types but, to be cost-effective, recommend government consider including more infrastructure categories during the data collection. Other facility and infrastructure categories include tourism infrastructure, transportation infrastructure, emergency services, and power generation to government offices.

This table below proposes facility inventories related to specific SDG indicators. These are data inputs into the indicator calculation but not the exclusive source of measurement. Many of the indicators have additional data inputs such as household survey data or complete baseline administrative data.

Table 21: Eight SDG Indicators Explicitly Requiring Data Layers that Geocode Facility Locations

Indicator/Goal Number	Indicator/Goal Description	Facility/Infrastructure Type to be Inventoried
Indicator 6	Losses from Natural Disasters	All types
Indicator 16	Crop water productivity	Irrigation systems
Goal 3	Healthy lives	Health requires location of health clinics and health facilities for multiple sub-set indicators. This is often collected so doesn't need to be repeated if already available.
Indicator 26	Consultations with licensed provider in a health facility	Health facilities
Goal 4	Education	Location and inventory of schools, universities and services provided such as sanitation on premise.
Indicator 45	Percentage of population with access to safely managed water	Inventory of municipal water systems
Indicator 46	Percentage of population using safely managed sanitation services	Location and capacity of solid-waste and wastewater treatment facilities
Indicator 47	Percentage of wastewater flows treated to national standards	Location and capacity of waste-water treatment facilities
Indicator 67	Percentage of people within 0.5km of public transit	Location and schedule of public transit routes and stations
Indicator 71	Percentage of urban solid waste regularly collected and well managed.	Location and capacity of solid waste treatment facilities.

Source: Author's own

This survey tool is designed to provide countries with detailed attribute information on public facilities such as if there are adequate sanitation service in schools, health facilities and markets. It can also provide detailed estimates on location of wastewater treatment facilities and solid-waste management sites, including estimates on population served and basic infrastructure for environmental safeguards. The specific attributes with each facility type add important layers to support policy makers and public and private investors.

We recommend that these data collection systems be standardized under a global review process so that each country can have a standardized base template and further adapt the surveys to fit national needs. This would ensure a minimum comparable global template for indicator calculation. We recommend that when the survey is first implemented, it is conducted under Government leadership and done in a systematic and comprehensive way to cover the entire country. After that process, there are several, much lower-cost techniques for updating and maintaining the data.

We based the cost estimates for this project on experience in Haiti and Nigeria implementing a similar survey tool. To calculate each country cost, we generated estimates of the total number of facilities per country based on population density using an estimate of average number facilities by population density. These ratios varied by population density under the assumption that low-density areas have fewer facilities and high-dense areas have more facilities per person. Based on these designations, we calculated the estimated number of facilities using the CIESIN/SEDAC 2010 country population estimates.[103]

Based on our previous experience, we estimated a cost of US$100 per facility plus transportation and a general operations and management cost. This is based on an assumption of using mobile phone technologies

[103] Center for International Earth Science Information Network (CIESIN) Columbia University, and Centro Internacional de Agricultura Tropical (CIAT) (2005). Gridded Population of the World, Version 3 (GPWv3): Population Density Grid, Future Estimates. Palisades, NY: NASA Socioeconomic Data and Applications Center (SEDAC).

for data collection with trained professional enumerators. The survey tool collects data on location, photograph, basic information and facility-specific information on facility conditions and capacity.

Below is an estimate of the cost to cover the 77 IDA countries. These should be treated as initial estimates subject to further refinement.

The total cost estimated for all 77 IDA countries is US$603,000,000.

Geo-Coded Census Data

This component of costing should be included in the census Section. This cost can often be a noticeable proportion of the overall census budget. Specific inclusion of geo-coded data collection should be standard and funded within each census budget.

Annex 6: Methodological Note on Computing Costs for other Environmental SDG Indicators (Prepared by CIESIN[104])

In the following section we consider four types of environmental data that are not fully captured through geospatial data collection. These include measures of biodiversity, air quality, hydrological monitoring, and forest and land use change. We identified these types of data and the associated data collection requirements by examining the environmental indicators listed in SDSN (2015) *Indicators and a Monitoring Framework for the SDGs*. However, it should be noted that estimates provided are initial and not comprehensive, nor are we endorsing a particular data collection methodology. We merely examine indicative costs for data collection under current, documented methodologies.

Table 22: Summary of Component Costs for Environmental Monitoring

Component	Estimated Fixed Costs US$	Estimated Re-occurring Cost US$	Total Costs over 15 years US$	Notes
Biodiversity		5,500,000/yr	82,500,000	
Air Quality	33,000,000	8,300,000/yr	157,500,000	This does not account for existing stations, which could reduce total costs.
Hydrological Monitoring	32,200,000	16,100,000/yr	273,700,000	This does not account for existing stations, which could reduce total costs.
Forest			Included in geospatial/ satellite	This cost for ground-level monitoring is still pending.
Total Environmental Monitoring	65,000,000	29,900,000/yr	514,000,000	This includes air, water, biodiversity, and land use change for all 15 years for all 77 countries.

Source: Author's own

i. Measuring biodiversity

Indicator 87: Protected areas overlaid with biodiversity
Estimated Costs: US$1,500,000 per year globally or a total of US$22,500,000 for all 15 years.

The proposed indicator currently includes three proposed data inputs to calculate the composite indicator. They include national protected areas (PA) with national or international designations, Important Bird and Biodiversity Areas (IBAs) and Alliance for Zero Extinction sites (AZEs). These are three distinct data layers and monitoring systems.[105]

The annual cost of the WDPA (served through "Protected Planet") for global collation, updating and maintenance of the WDPA dataset is currently reported at US$424,000.[106] The cost does not include the full cost of data generation and observations, which are largely born by national governments.

The two additional data sources are 1) Important Bird and Biodiversity Areas and 2) AZEs. There is no publicly available cost estimate associated with maintaining these other two datasets. For the purposes of this study, we will use the same costs as WDPA at ~US$500,000/year for global calculation. Additional national

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[104] Prepared by Alex Fischer, Marc Levy, Robert Chen, Greg Yetman, Alex de Sherbinin, and Yue Qiu (CIESIN).
[105] SDSN (2015), 172.
[106] Convention on Biological Diversity (2011). Adequacy of Biodiversity Bbservation Systems to Support the CBD 2020 Targets.

funds may be required by individual ministries and monitoring teams but those costs are unfortunately not immediately available for this study.

Indicator 86: Red List Index (RDL)
Estimated Costs: US$4 million per year or US$60,000,000 for all 15 years.

The RLI, drawing on the IUCN Red List of Threatened Species, tracks the rate of extinction for marine and terrestrial species groups in the near future (i.e. 10 to 50 years) in the absence of any conservation action. The RLI dated back to the 1980s and is comprehensive across all common and rare species within better-known taxonomic groups (mammals, birds, amphibians, corals). [107] However, the RLI is biased toward higher vertebrates. The vast majority of species—including most plants, invertebrates, and lower vertebrates, and almost all fungi— are still grossly underrepresented. The estimated cost for maintaining an updating the Red List is US$ 4 million in 2014.[108]

ii. Air Quality

Indicator 69: Mean urban air pollution of particulate matter (PM) (PM10 and PM2.5)
Indicator 75: Aerosol optical depth (AOD)

Estimated Costs | Upper limit costs at US$157,500,000 for all 15 years. This does not account for existing stations, national cost variations and new sensor technologies.

Many countries are already tracking the concentration of PM10 and PM2.5 for large cities and report these to WHO, but there are still large gaps in ground monitoring of air quality in low income countries. The current proposed indicator suggests tracking PM10 and PM2.5 in all urban agglomerations of greater than 250,000 people.

The cost estimate is calculated from 1) required minimum numbers of station per urban agglomeration, 2) initial capital investment per site, and 3) annual operation and management cost estimate per site.

Total recommended minimum number of stations is based on a publication on guidelines for ambient air quality monitoring by the Central Pollution Control Board, Ministry of Environment and Forests of India.[109] The criteria recommend the number of stations required for urban areas of 100,000 inhabitants, areas of between 100,000 and one million inhabitants and over one million inhabitants. Based on this classification, we estimate a total of 1,661 stations for the 77 countries.

The upper limit of estimated equipment and monitoring costs is estimated to be US$20,000 per ground monitoring station, followed by an annual operations and management cost of US$5,000 per station. [110, 111, 112] As discussed below, this does not take into consideration technological advances.

The total cost estimate for the 77 countries is US$33 million for the initial investment and US$8.3 million every year (or a total of US$124,500,000 for all 15 years). The cost estimate does not include already

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[107] Stuart, S.N. et al. (2010). The Barometer of Life. *Science* 328: 177.
[108] Rondinini, C., Marco, M., Visconti, P., Butchart, S. H., & Boitani, L. (2014). Update or Outdate: Long‐Term Viability of the IUCN Red List. *Conservation Letters*, 7(2), 127.
[109] Central Pollution Control Board (CPCB), Ministry of Environment & Forests, India (2003). Guidelines for Ambient Air Quality Monitoring.
[110] Yale Center for Environmental Law and Policy, and CIESIN (2010). 2010 Environmental Performance Index.
[111] de Sherbinin et al. (2014). Using satellite data to develop environmental indicators. *Environmental Research Letters*, *9*(8), 084013.
[112] Fujita, E. M., & Campbell, D. E. (2014). Review of Current Air Monitoring Capabilities near Refineries in the San Francisco Bay Area, Final Report.

functioning ground monitoring stations. Existing stations do not need to be replaced and will reduce the overall cost.

An alternative cheaper method is to use satellite data and remote-sensing technologies paired with a smaller number of ground monitoring stations for validation. In this approach, freely available daily MODIS/MISR AOD measures are used to derive surface level particulate matter concentrations using modeled location-specific AOD – PM relationships.[113] The amount of labor required to calculate a satellite-based air quality indicator for the entire world is estimated to be the same as the labor required to operate a few *in situ* monitoring stations in one city[114]. This is estimated to cost US$100,000 for initial capital and US$120,000 per year for analytic capacity. [115]

Additionally, the increasing involvement of citizen science in air quality monitoring could be another source of cost reduction and spatial distribution of sampling sites. Commercially available and low-cost sensors for continuous measurements of PM mass and physical properties ranges start as low as US$300 per unit, and the sensors are highly portable and easy to use. [116]

iii. Hydrological Monitoring

Indicator 52: Proportion of total water resources used
Estimated Costs: US$32,200,000 for installation at a one-time fixed cost and US$241,500,000 for 15 years of calibration, maintenance and management, summing a total of US$273,700,000.

The sixth SDG is to "ensure availability and sustainable management of water and sanitation for all" and includes an indicator on water resource consumption, reflecting the underlying need to understand overall water resource availability and estimates on consumption. In order to track progress towards this goal, it is essential to have rigorous monitoring of the various water fluxes and storages in hydrological processes. Recent studies have demonstrated the significance and benefits of comprehensive integrated monitoring system with multiple hydrological variables, including streamflow (discharge), precipitation, soil moisture, evaporation and evapotranspiration, and groundwater.[117]

For the purposes of this initial exercise, we only cost the *in situ* steamflow stations but recommend additional, and more comprehensive, costing for the other water variables. Existing *in situ* discharge monitoring systems are often considered too expensive for national scale systems. Technological advances now allow better access to more continuous stream flow data and satellite data can help provide new estimates.

There has been a widespread decline in hydrological monitoring since early 1990s due to budget constraints and privatization of data archives[118].A conscious effort to revitalize in situ monitoring is needed in measuring the relevant SDG indicators. Here, an adequate in situ monitoring system globally is advocated to complement satellite altimetry measurements. There is no substitute for in situ discharge monitoring.

A paper by Fekete et al provides cost estimates to establish global monitoring network of hydro stations. Their paper estimated that *in situ* monitoring stations would cost US$20,000/year/station.[119] For the initial purposes of this paper, we estimated that the 77 countries would need 1,610 stations based on an estimate of one station for every 150 cubic meters/second renewable water source. The total infrastructure cost, a one-

[113] van Donkellar, et al. (2015). "Use of Satellite Observation for Long-term Exposure Assessment of Global Concentrations of Fine Particulate Matter"; and de Sherbinin et al. (2014). "Using satellite data to develop environmental indicators."
[114] van Donkellar, et al. (2015).
[115] We thank Randall Martin of Dalhousie University (Canada) for his contributions to the cost estimates for this estimate.
[116] United States Environmental Protection Agency (USEPA) (2014). *Air Sensor Guidebook*. Washington, D.C.: USEPA.
[117] For review, Lawford, R., et al. (2013). "Earth observations for global water security." *Current Opinion in Environmental Sustainability* 5.6: 633-643.
[118] Ibid.
[119] Fekete, B. M., et. al. (2012). Rationale for monitoring discharge on the ground. *Journal of Hydrometeorology*, *13*(6), 1977-1986.

time investment, is estimated as at US$32,200,000 for all 77 countries based on a 2012 United States Geological Survey (USGS) estimate of US$20,000/station. Annual operating and analysis for the 1,610 stations is estimated at US$10,000/year/station. For 15 years of 1,610 stations, that would bring the total annual costs to US$241,500,000. Thus the high-end estimate on cost would therefore be US$273,700,000 over 15 years.

These numbers are based on USGS costs and do not incorporate new technologies such as radio data transmission or new monitoring technologies currently being developed. Staffing costs would likely be lower in the 77 IDA countries.

i. Forest and Land Use Change

Indicator 83: Annual change in forest area and land under cultivation (modified MDG Indicator)
Indicator 84: Area of forest under sustainable forest management as a percent of forest area
Indicator 85: Annual change in degraded or desertified arable land (percent or hectare)
Estimated Costs: Not Available

This proposed indicator aims to track and monitor both the net change in forest area and the expansion of agriculture into natural ecosystems, as well as the loss of productive agricultural land to the growth of urban areas, industry, roads, and other uses.

The first data layer for these indicators is an annual, or ideally more frequent (up to monthly), land use and land cover change detection. Utilizing satellite imagery and core geospatial analysis cost estimates, this data layer can be used to summarize change patterns and provide monitoring of key conservation policies. This would be based on coarse resolution MODIS or equivalent satellite imagery for rapid detection of changes, and then more fine-scaled high-resolution Landstat or equivalent imagery to calculate actual forest area change.[120] Additional analysis for forest area could potentially combine with new technologies for near-real-time forest monitoring to strengthen efforts by governments, businesses, and communities to conserve and sustainably manage the world's forests.[121] The case study from Brazil shows one specific country approach.

Box 4: PRODES and DETER Brazil

The PRODES (Projeto de Monitoramento do Desmatamento na Amazônia Legal por Satélite) and DETER (Sistema de Detecção do Desmatamento em Tempo Real na Amazônia), programs were established by the Government of Brazil to monitor forest change at high-frequency periods. The Brazilian Institute for Space Research (INPE) created the two satellite-based monitoring systems for policy-making and law enforcement in the Brazilian Amazon that aim to curb deforestation.[122] PRODES detects deforestation based on US Landsat and the Chinese-Brazilian CBERS satellite imageries, which are then processed and interpreted by local experts and technicians. The product is an annual geo-referenced map of forest clearing indicating the location and extent. DETER is based on the same principal, but acquired the imagery from course-resolution MODIS Terra and Aqua satellites at a much higher interval of every 15 days, which enables quick identification of new forest clearing. The exact cost of setting up and maintaining the two systems remains undisclosed[123].

There are also emerging partnerships among organizations contributing data, technology, funding, and expertise for near-real-time forest monitoring on a regional and global scale.

[120] Hansen, M. C., et.al. (2013). High-resolution global maps of 21st-century forest cover change. *Science*, *342*(6160), 850-853.
[121] Wheeler, D. et.al. (2014). Satellite-based forest clearing detection in the Brazilian Amazon: Forma, Deter, and Prodes. and Hammer, D., et. al. (2014). Alerts of forest disturbance from MODIS imagery. *International Journal of Applied Earth Observation and Geoinformation*, *33*, 1-9.
[122] Rajão, R. (2012). ICT-Based Monitoring of Climate Change-Related Deforestation: The Case of INPE in the Brazilian Amazon.
[123] Ibid.

Box 5: Forest Monitoring for Action

Forest Monitoring for Action (FORMA), similar to DETER, provides near-real-time information on new forest clearing in the humid tropical forests of Asia, Africa, and Latin America. It is part of the larger global forest monitoring initiative "Global Forest Watch" (GFW) convened by the World Resources Institute. The start-up cost in 2012 was estimated to be over US$30 million.[124]

For indicator 84, in addition to the land use data with forest classification, country level reporting of administrative data on areas with sustainable forest management plans and compliance is required. This is a function of government ministries and departments, thus no additional costs are added. Two proxies for calculating administrative costs are discussed above (Section 3).

For indicator 84, in addition to the land use data with forest classification, country level reporting of administrative data on areas with sustainable forest management plans and compliance is required. This is a function of government ministries and departments, and while these data are not consistently collected across countries at the present time, it is not possible to provide an exact cost estimate of the additional administrative costs beyond building geospatial analytic capacity.

For Indicator 85, there are a number of approaches to measuring land degradation using satellite imagery but all of them are still considered in the experimental phase rather than the standardized operational stage. In general terms, to calculate this indicator requires two data inputs: satellite imagery for remote sensing and ground-truthing for verification.

Remote sensing-based approaches are easiest to implement on a global scale, and because they are based on physical measurements, at least hold the possibility of validation. Yet they are also vulnerable to local inaccuracies. False positives can be winnowed out to a degree by carrying out more in-depth investigation into areas that appear to be degraded using the global methods. This can be done through use of higher resolution imagery or field validation. False negatives are harder to cope with, because the areas denoted as "not degraded" in the global methods are generally too large to investigate with detailed high-resolution imagery. To minimize the danger of false negatives, the most straightforward approach may be to monitor information streams relevant to crop and livestock yields. Where yields area falling over time, controlling for rainfall, there is a possibility that land degradation is occurring.

Some combination of satellite-observed greenness trends might be combined with socioeconomic and other biophysical data (e.g., deforestation and afforestation data described above) in a "next generation" spatial data integration approach in order to more precisely delineate areas of degradation by getting at covariates such as poverty and market access, or controlling for confounding variables such as cropping systems and de/afforestation. Technology is changing rapidly. UAVs and crowdsourcing, for example, are beginning to be used to study landscape changes with the potential for far more accuracy than satellite-based approaches. In summary, because of the fact that no global product yet exists and much of this work is characterized by experimentation, we are unable to provide cost estimates.

[124] USAID Impact Blog (2014). *Satellite Data for the People: USAID Supports Launch of New Forest Watch Tool*.