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BUILDING NATIONAL FOREST AND LAND-USE INFORMATION SYSTEMS: LESSONS FROM CAMEROON, INDONESIA, AND PERU

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SUMMARY

Countries adopting forest and land-use-based climate change mitigation policies are investing in infrastructure and capacity to track the impacts of these policies. A major capacity gap is the lack of coordination among ministries and sub-national governments that regulate drivers of forest and land-use change from both inside and outside the forest sector. Improving communication, data integration and data access among institutions is a key step towards identifying land-use policies that can balance a range of cross-sector objectives, and tracking these policies over time. To accomplish this, countries should develop data management systems that integrate spatial and non-spatial data from multiple sources.

This working paper focuses on the development of forest and land-use information systems (FLUIS), which are data management systems that integrate forest and land-use data. More specifically, this paper examines the institutional, human resources and financial capacities of three countries — Cameroon, Indonesia and Peru — that have developed a FLUIS, and highlights common enabling factors and challenges. Lessons learned from these countries include:

- Securing the support from the highest levels of the government is instrumental in encouraging ministries to work together to resolve conflicting land use policies and initiating the development of a national FLUIS.
- To account for all drivers of forest and land-use change, one of the first steps in developing a FLUIS is to undergo an institutional mapping exercise, where all relevant agencies affecting forests and land use are

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identified. These agencies, including those not directly governing the forest sector, should be included in the design and implementation of the system to help foster willingness to share data.

- Beyond the initial development and availability of external support, a FLUIS requires continued maintenance and updating. Due to the common cycle of staff turnover and the resulting loss of institutional memory, funding for staff training is necessary. Allocation of funds in the national and sub-national budgets is necessary for maintaining a staff dedicated to the FLUIS after external funding ends.

- In addition to funding for staff training and retention, there are other budget requirements for sustaining a FLUIS, such as equipment maintenance and data storage infrastructure. Availability of this funding would be more stable if incorporated into a policy framework that establishes support for improved data integration and management.

- To integrate data from sub-national governments in a national FLUIS, more capacity building and trainings on a set of standards for forest and land-use data collection are needed and regional governments should be included in the planning process and implementation of the system.

1. INTRODUCTION

Recognizing the important role of forests and land use in reducing greenhouse gas (GHG) emissions, many countries are adopting and strengthening climate change mitigation policies that aim to reduce deforestation and forest degradation. The development of effective mitigation policies requires accurate and complete understanding of the drivers of forest and land-use change. Furthermore, evaluating the success of these mitigation policies requires ongoing tracking of forest and land-use change and the associated greenhouse gas emissions. With the support of international initiatives and funding, many countries have been investing in capacity building and infrastructure to track GHG emissions from forests and land-use change using spatial and non-spatial data. Though some progress has been made, capacity gaps still remain (Herold 2009; Romijn et al. 2012). Much attention has focused on closing the technical gaps, including, but not limited to, the lack of regular and frequent data collection, the absence of standardized methods for data collection, the lack of complete and up-to-date forest inventories, and others (Austin, Cheung, and Stolle 2012). This paper, instead, focuses on the need for increased institutional coordination for better management of spatial and non-spatial forest and land-use data.

1.1 Need for Institutional Coordination in GHG Mitigation Tracking

Pressures on tropical forest ecosystems come from both inside and outside the forest sector (Kissinger, Herold, and De Sy 2012). Deforestation and forest degradation are driven by a range of activities including timber extraction, commercial and subsistence agriculture, mining, infrastructure development, biomass energy production, and livestock grazing. Notably, agricultural expansion is considered the leading cause of land conversion in the tropics, with implications on the global scale (Lambin and Meyfroidt 2011). Between 1980 and 2000, over 80 percent of new agricultural expansion across the tropics came from converting forests (Gibbs et al. 2010). Ineffective policy frameworks and weak governance enables the prioritization of non-forestry sector objectives over the forestry-sector, further entrenching land-use decision-making processes and undervaluing standing forests (Kanninen et al. 2007).

While drivers of forest change come from multiple sectors, the responsibilities of regulating these sectors are divided among various government ministries and agencies (Irwin and Ranganathan 2007). These agencies collect and maintain spatial and non-spatial data on activities that impact forest resources (e.g., mining, timber, agriculture), but rarely are these datasets integrated and made accessible to all relevant agencies. While there is growing recognition of the need for better coordination among the broad range of ministries and government agencies, many countries have not prioritized or successfully implemented cross-sectoral coordination for forest and land-use policy implementation (Kissinger 2011; Graham 2011; Chasek et al. 2011).

Furthermore, responsibilities for regulating forest management exist at both the national and sub-national levels. Many countries are decentralizing forest and resource management to a sub-national level (Larson 2005), but local-level activities are not always coordinated or aligned with decisions at the national level. This is due in part to the lack of systems to support coordination and data integration between national and sub-national governments (Brickell, McFarland, and Myawafu 2012). Other barriers to coordinated decision-making and activities across political levels include limited mandates, deployment of resources, political and financial incentives, and support

of a legal framework (Brickell, McFarland, and Myawafu 2012; Irwin and Ranganathan 2007; Davis et al. 2009). National governments are missing the opportunity to utilize an important source of information by not systematically taking into account locally derived data on land resources and spatial plans. Likewise, the unavailability of national data to local governments may result in conflicting spatial plans and management objectives.

Institutional coordination, both horizontal (across ministries) and vertical (between national and sub-national governments), is critical to tracking the drivers of forest and land-use change in a country, developing appropriate and effective land-use policies, and tracking the impact of these policies. Formalizing channels of communication and improving data integration for land use decision-making are first steps towards reconciling conflicting policy goals set by different ministries and agencies and identifying land-use options that can balance a range of cross-sector objectives.

1.2 What is a FLUIS?

To address the challenge of improving coordination, communication and data integration, countries are beginning to set up data management systems that integrate spatial and non-spatial data from a range of relevant sources. Many countries have also been working on improving their national spatial data infrastructure (Onsrud, n.d.; Hyman et al. 2002; Crompvoets et al. 2004). In Latin America alone, nearly all countries have made progress in advancing their spatial data management capacity (Hyman et al. 2002). On the regional level, organizations such as the Central African Forests Commission (COMIFAC)[1] and the Amazon Cooperation Treaty Organization (ACTO)[2] are also increasing capacity and data and information sharing among member countries. Their goal is to improve management and monitoring of the respective forest biomes, which extend beyond geopolitical boundaries.

In this publication, we define a forest and land-use information system (FLUIS) as a data management tool that stores, organizes and integrates large amounts of forest and land-use data from multiple sources. A FLUIS requires a number of components, including the technological infrastructure, data, protocols and standards for data collection and management, managers and users, and a policy framework that promotes the improvement of data management (Figure 1). The use of a FLUIS helps improve data integration across sectors for better understanding of drivers of forest and land-use change, and enables timely and efficient retrieval of available information for informed decision-making (Figure 2).

Figure 1 | **Components of a Forest and Land-Use Information System**

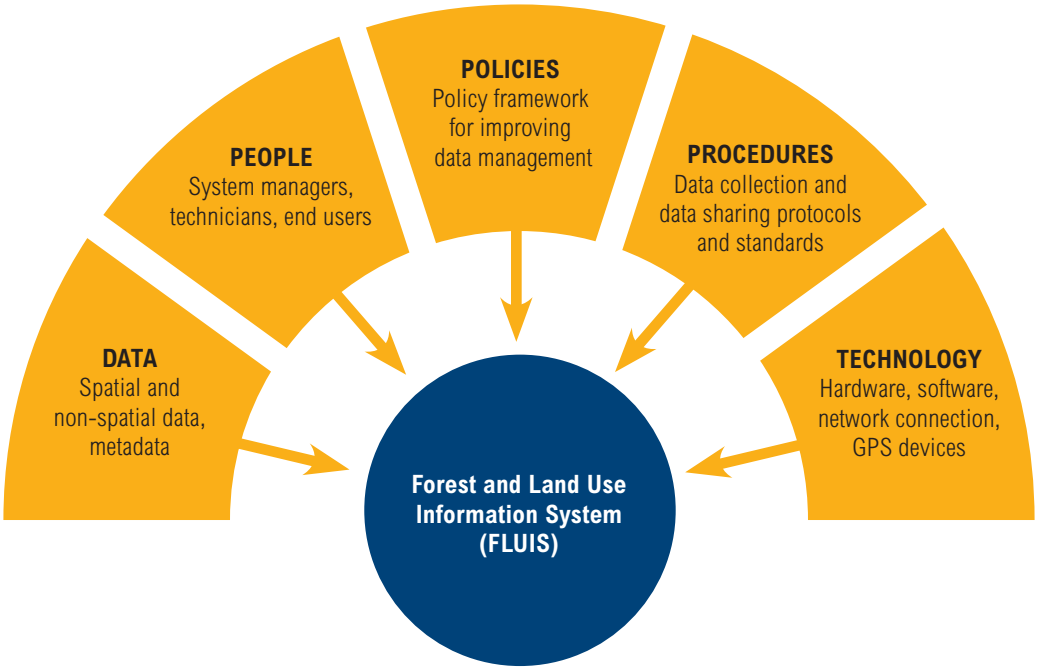
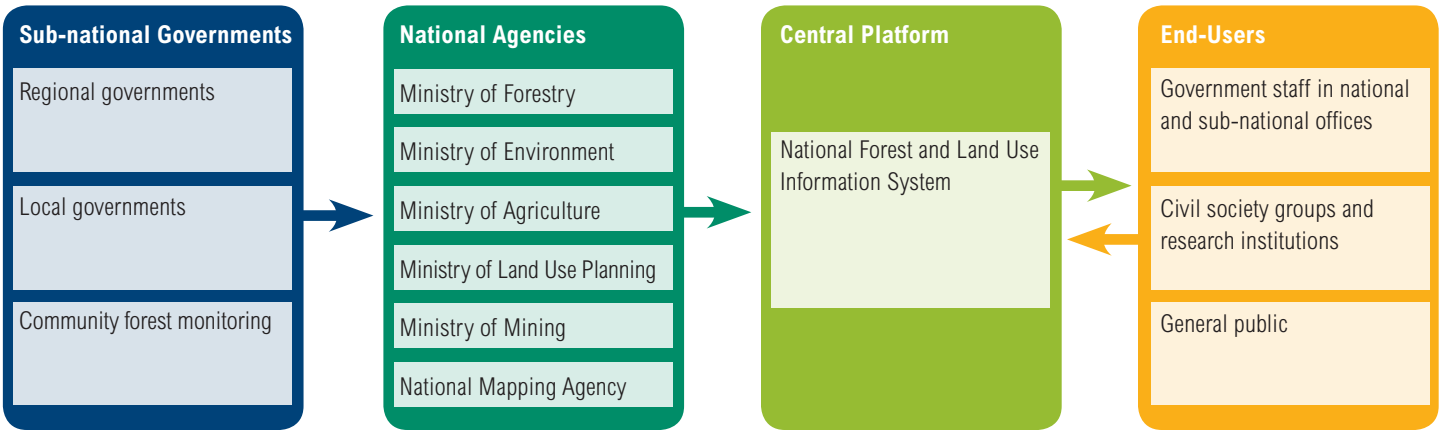


Figure 2 | **Sample Flow of Data from Data Collectors to End-Users**

Data are transferred from sub-national governments to national agencies for integration. National agencies send data to the managing body of the FLUIS for aggregation. Main end-users are government staff in national and sub-national offices. Depending on the government's decision, end-users may include civil society groups, research institutions and the general public, which in turn may contribute data to the FLUIS.



This paper presents the experiences and common themes and challenges of building national FLUIS in Cameroon, Indonesia and Peru. We examine the motivation behind developing these systems and provide lessons learned on institutional, human resource, and financial capacities needed for FLUIS development.

1.3 Approach and Country Selection

In order to characterize the FLUIS in the three selected countries, WRI completed desk research and conducted interviews with two to five key personnel involved in the development of the FLUIS for each of the three countries (see appendix for interview questions). Desk research and interviews focused on the motivations for developing the FLUIS, types of data included in the system, government entities involved in the development, how the system is used thus far or will be used once developed, and what capacities are needed for building and maintaining the system.

The three countries selected – Cameroon, Indonesia and Peru – all initiated the development of a FLUIS for the purpose of improving institutional coordination and data management. While the initial motivations for developing these systems were not specifically for GHG emissions monitoring, the capacity building activities undertaken for and the data integrated in these systems are also needed for forest and land-use GHG tracking. Two of these countries, Indonesia and Cameroon, have explicit plans to expand the scope of their systems to enable GHG tracking. Additionally, we chose countries where the development of the FLUIS is managed, at least in substantial part, by a government entity rather than non-government organizations or academic institutions in order to understand the capacities that are required at the governmental level.

2. EXAMPLES OF FOREST AND LAND-USE INFORMATION SYSTEMS

2.1 Cameroon

2.1.1 The Context

The Interactive Forest Atlas of Cameroon[3,4] was initiated under WRI's Global Forest Watch project in 1999. The objective of the project was to increase access to forest and land-use information, improve land-use planning, and assist the government and others in monitoring the country's forest resources. An assessment of Cameroon's available forest and land-use information and data management capacity showed that information was lacking and agencies were poorly coordinated and used different sets of data (WRI 2005). WRI, with the help of the World Bank, supported Cameroon to improve transparency and develop an Interactive Forest Atlas. Initially, as with other countries, there was some reluctance and skepticism towards providing data to external organizations (Steil, pers. comm.)[5]. However, after a period of cultivating a relationship and an understanding of the benefits of having a FLUIS, WRI and Cameroon partnered to build an Interactive Forest Atlas (Steil, pers. comm.).

The first step in developing the Forest Atlas was to identify and gather all available spatial and non-spatial forest and land-use data available within the government entities. From there, the team was able to assess what additional information was needed, and dedicate time and resources to filling data gaps and improving the quality of the data (Steil, pers. comm.). After four years of collaboration, WRI and the Ministry of Forestry and Wildlife (Ministère des Fôrets et de la Faune – MINFOF) released the first version of the Interactive Forest Atlas in 2004.

The Interactive Forest Atlas provides map-based information on the Cameroon forest sector, including forest allocation (e.g., forest management units, concessions, protected areas, community forests, and forest reserves, etc.), certification status, mining permits, volume of timber logged in concession areas, and location and capacity of sawmills. The Interactive Forest Atlas is a web-based tool built on a Geographic Information System (GIS) platform with a map-viewing application. The system lives within the MINFOF but can be accessed online by anyone with internet access. To reach those in remote regions and without internet access, the Forest Atlas is also available on CD-ROMs. Forest Atlas products (e.g., offline mapping applications, maps and reports) are widely distributed and available upon request. For example, ministries contributing data, as well as other ministries such as the Ministry of Economy, Planning and Regional Development (MINEPAT), as well as non-government organizations, civil society groups, universities and research institutions have requested Forest Atlas products (Mbouna, pers. comm.; Tessa, pers. comm.)[6,7].

The Interactive Forest Atlas has shown marked success in improving forest management in Cameroon. With improved data quality, increased personnel capacity in using information and increased access to information, Cameroon has improved land-use planning and monitoring of its forest resources (WRI 2012). For instance, Cameroon uses maps of areas with logging permits and locations of roads to identify where illegal logging may be happening (WRI 2012). The availability of spatial information has significantly improved the Cameroon government's ability to enforce forest laws and monitor illegal logging activities (WRI 2012).

WRI and MINFOF continue to work together to update the Forest Atlas and enhance the system with additional datasets. The latest version of the Forest Atlas released in October 2012 (Version 3.0) now provides map layers on mining permits and agro-industrial plantations (WRI 2012). In the next phase of improvements, WRI and MINFOF plan to expand the use of the Forest Atlas and add data useful for greenhouse gas mitigation policy tracking, such as maps of carbon stock and data on drivers of forest change including mining and logging concessions (Steil, pers. comm.).

As a result of the cooperation between WRI and Cameroon, neighboring Congo Basin countries also expressed interest in developing their own Forest Atlases and began working with WRI. Five other Congo Basin countries (Central African Republic, Congo, Democratic Republic of Congo, Equatorial Guinea, and Gabon) have also developed their own Interactive Forest Atlas in collaboration with WRI. More work is planned to continue enhancing the Forest Atlas for broader application, including further capacity building and involvement of sub-national governments and expanding the system to regularly collect and integrate data from all ministries affecting forest resource use (WRI 2012).

2.1.2 Institutional Framework and Capacity

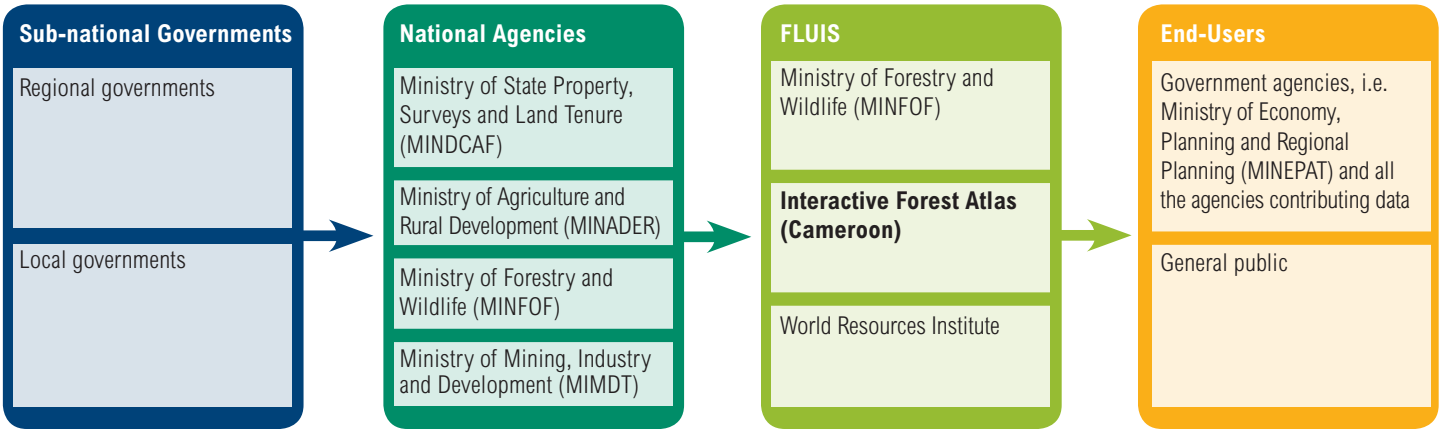
MINFOF is responsible for managing and monitoring the Permanent Forest Estate, which includes national and communal forests and protected areas. However, other ministries, such as the Ministry of Agriculture and the Ministry of Mining have conflicting demands on land and resource use. To fairly balance demands of different institutions, decisions on land-use allocation are made on a higher level by the President's office (Steil, pers. comm.).

The Interactive Forest Atlas is hosted by the MINFOF, who is responsible for most of the forest data collection, and is managed by a team consisting of staff from MINFOF and WRI (Figure 3). The Ministry of State Property and Land Affairs (Ministère des Domaines et des Affaires Foncière – MINDAF), Ministry of Agriculture and Rural Development (Ministère de l'Agriculture et du Développement Rural – MINADER), and Ministry of Mining, Industry and Technological Development (Ministre de l'Industrie, des Mines et du Développement Technologique – MIMDT) have provided data on an *ad hoc* basis (Mbouna, pers. comm.). In general, requests for data have not always been successful due to varying levels of distrust and reluctance in disclosing information (Mbouna, pers. comm.). The next phase of improvements to the Forest Atlas will aim to build formal relationships with these ministries and encourage regular contributions of data to the Forest Atlas (Steil, pers. comm.).

On the sub-national level, regional offices are required to submit reports on a quarterly basis. These reports are mostly paper-based. In the development of the Forest Atlas, the project team provided training to staff in the regional offices

Figure 3 | **Interactive Forest Atlas (Cameroon)**

Sub-national governments and four national agencies provide data to the Forest Atlas; the Ministry of Forestry and Wildlife (MINFOF) and WRI develop and manage the Forest Atlas; Forest Atlas products are distributed to government agencies and the general public.



on how to utilize the Forest Atlas. The national project coordinators of the project completed a tour of the provinces and provided Forest Atlas products while collecting available data from the regional offices (Mbouna, pers. comm.).

2.1.3 Staffing

The development of the Forest Atlas required three full-time staff at WRI headquarters in Washington, DC and five full time staff in Cameroon (Steil, pers. comm.). Right now, there is a maximum of three staff members in both offices working on the maintenance of the system (Mbouna, pers. comm.). At the MINFOF, two to five people are assigned to work on the Forest Atlas (Mbouna, pers. comm.). WRI and MINFOF plan to add more staff as needed for the next phase of work to enhance the system.

One difficulty faced by the project in developing and maintaining the Forest Atlas is the high turnover rate of local staff. To reduce the impact of staff turnover and recover capacity levels quickly, the next phase of Forest Atlas improvements aims to enhance the usability of the data-input platform to require less training of new staff (Steil, pers. comm.).

2.1.4 Financing

Funding for the development of the Interactive Forest Atlas came from the U.S. Agency for International Development (USAID) through the Central Africa Regional Program for the Environment (CARPE) and the International Union for Conservation of Nature (IUCN). From 2003-2013, IUCN contributed around $1.3 million and from 2009 to 2013, USAID-CARPE contributed around $500,000 to the development of Cameroon's Forest Atlas. The Cameroon government contributes to the maintenance of the system by paying the salaries of the staff (Mbouna, pers. comm.).

2.2 Indonesia

2.2.1 The Context

The Indonesian government currently lacks an official central database of geospatial information, including base maps for land cover and land allocation to support land-use decision making. It is common practice for the Ministry of Forestry, the Ministry of Development Planning, the Provincial government, and the District head to use different maps of the same area (Samadhi 2013), which often do not agree and frequently overlap. This fuels potential conflict when creating land-use policies, such as issuing permits or designating protected areas. The discrepancies occur between national ministries, and between local, provincial and national agencies. To address this problem, the President of Indonesia initiated the One Map policy to develop a National Spatial Data Network (JDSN – Jaringan Data Spasial Nasional) in order to harmonize data across ministries and jurisdictions.[8] The goal of the policy is to improve coordination and data sharing among 13 different government agencies and to develop a single authoritative map on which land-use decisions can be based.[9]

One Map began as a presidential instruction (Inpres No. 85/2007)[10] giving the National Coordinating Agency for Surveys and Mapping (Bakosurtanal) the mandate to

develop a National Spatial Data Infrastructure. One Map was then formalized and strengthened by the Geospatial Information Act (Law No. 4/2011)[11], which regulates how different Indonesian government agencies share and use spatial data for policymaking purposes. This step replaced Bakosurtanal with the new Geospatial Information Agency (Badan Informasi Geospasial - BIG) and gave BIG the lead role in developing a reference map for all spatial decision-making in the country. BIG is working with the Indonesia President's Delivery Unit for Development Monitoring and Oversight (UKP4)[12] and REDD+ Task Force (UKP4) to carry out this mandate.

BIG and UKP4's objectives for One Map include (Samadhi 2013):

- Creating a set of authoritative reference maps for use by all government agencies for policy planning, implementation and evaluation.
- Reducing duplication of effort among agencies, and redundancy of data production.
- Setting protocols and standards for collecting and sharing geospatial information to ensure data quality and reliability.
- Reducing cost of data acquisition and access.
- Strengthening data transparency while maintaining data security.
- Setting up a system to integrate new data from ministries and sub-national agencies, enabling participation of a broad range of stakeholders in spatial data input and use.
- Building technical capacity to use data for development planning and natural resource management.

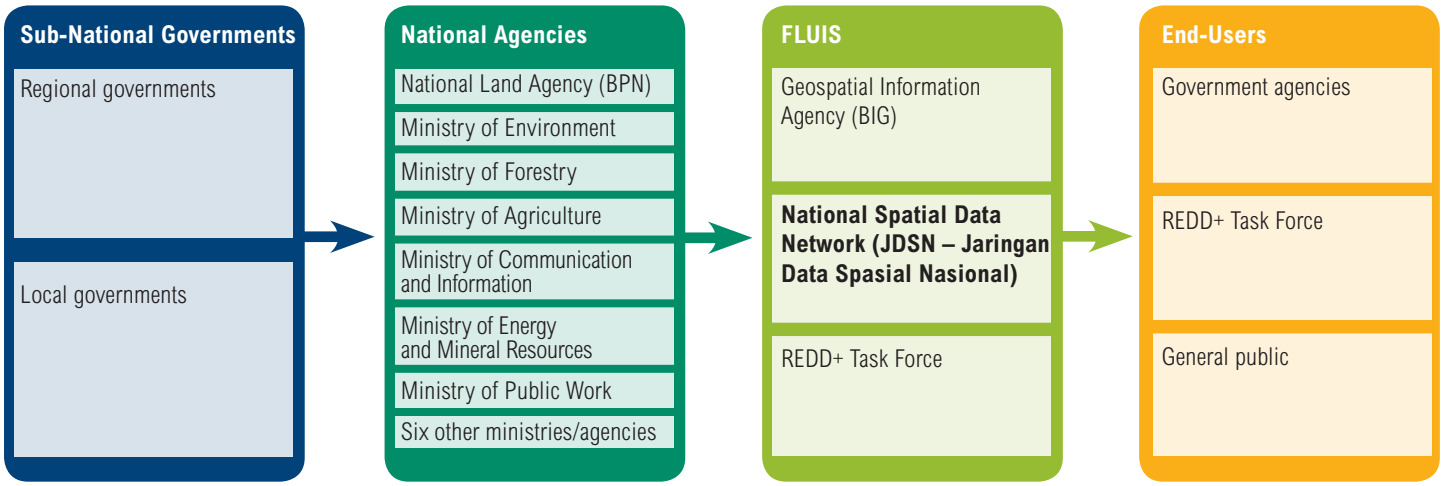
To achieve these goals, BIG is building the institutional, human resource, and technological capacities that underpin One Map and JDSN. This includes improving coordination between national-level institutions. Additionally, BIG and the REDD+ Task Force are implementing pilot projects in some of the REDD+ pilot provinces to improve sub-national coordination and data sharing (Matindas, n.d.). Furthermore, BIG is building a publicly accessible, web-based portal to make all the maps and data easy to find and freely available to the public.[13]

2.2.2 Institutional Framework and Capacity

Land use is administered under a dual system in Indonesia. The Ministry of Forestry (MoF) is responsible for decision-making within the state Forest Estate (*Kawasan Hutan*) and for managing information on forest cover and land cover throughout the country. The National Land Agency (Badan Pertanahan Nasional, BPN) has jurisdiction outside the Forest Estate and administers information on land ownership or land-use rights, while provincial governments and municipalities have limited licensing authorities for plantations and mining (Pradana, pers. comm.). Other national agencies play an important role in land-use planning and data management. For example, the Ministry of Agriculture

Figure 4 | **Indonesia's National Spatial Data Network**

Sub-national governments and 13 national agencies provide data to the system, the Geospatial Information Agency (BIG) and the UKP4 are tasked with implementing One Map and developing JDSN. Government agencies, civil society groups and the general public will have access.



is responsible for mapping peatlands, and the Ministry of Environment is responsible for collecting and reporting greenhouse gas emissions across all sectors, including forests and land use (CDKN 2012).

JDSN incorporates data from 13 different ministries and national agencies.[14] However, BIG faces coordination challenges among these agencies. Overlapping mandates present a particular challenge; there are several legal ways to conduct land-use planning and grant permits, and multiple agencies may do so at the same time without coordinating with each other (Contreras-Hermosilla and Fay 2005). This problem has been addressed through working group coordination meetings between related ministries. Additionally, turnover of high-level officials and potential budget adjustments after the 2014 election is also a potential challenge to maintaining momentum and ongoing coordination processes. To avoid this, the mandate for the One Map policy is undergoing further formalization and incorporation into government regulations and upcoming medium-term plans (Pradana, pers. comm.)[15]. Roles and responsibilities for each ministry will also be defined, obliging the ministries to maintain staff at the managerial and technical levels that are able to fulfill duties (Sumaryono, pers. comm.)[16].

In addition to coordination between national agencies, coordination with sub-national organizations is one of BIG's priorities (Sumaryono, pers. comm.). Since the early 2000s, there has been significant decentralization of some aspects of administrative and regulatory authority to local district governments, which were given the authority to issue certain forest conversion permits outside the Forest Estate and recommend permits for Ministry of Forestry approval within the Forest Estate (Barr et al. 2006). As a result, there are significant spatial data resources at the local level that need to be collected and fed into the national system. Bottom-up data acquisition and formal incorporation into JDSN can provide detailed, up-to-date information of natural resources and settlement boundaries. Incidences of conflict between government and communities can also be reduced by clarifying boundaries and agreeing on spatial plans (Pohnan 2013).

However, while there are plans to improve vertical data sharing and coordination, a system has not yet been put in place. Some obstacles include disagreement between national and sub-national entities regarding jurisdiction of land-use decision-making. For instance, the Ministry of Forestry has been reluctant to cede power over land-use decisions to local entities and vice versa (Fay, Sirait, and Kusworo 2000). Furthermore, there has historically been very little incentive for the national government to recognize the rights of local communities over their traditional lands (Siswanto and Wardojo 2005). Vertical coordination is slowly improving due to a growing recognition that districts, which are responsible for implementing land-use decisions, must be involved in the decision-making process. However, the legal mechanism and implementation of regulations for the incorporation of community maps into the formal spatial planning process remain unclear (Austin, Stolle, and Sheppard 2012).

Coordination is currently focused on harmonizing data at the national level, and little emphasis has been placed on vertical coordination outside of pilot activities in regions mentioned above. There have been initial efforts to share the One Map concept with district-level officials, and to establish regional working groups that will manage the relationship of district agencies with their national counterparts (Krecik, pers. comm.)[17]. The U.S. Forest Service (USFS) is financially supporting vertical coordination with the overall goal of ensuring that local plans are formally registered in the national database. In addition, civil society capacity is being built to support this (Krecik, pers. comm.).

2.2.3 Staffing

At the national level there are approximately three dozen people working directly on implementing the One Map policy at BIG (Krecik, pers. comm.). There are additional associated staff at the national and provincial levels working part-time within other Ministries.

Currently, BIG relies on academia to train personnel. Under BIG's coordination, a number of respected universities will set up programs in GIS, which will emphasize building capacity in geospatial analysis skills (JICA 2012). Participating universities include Bandung Institute of Technology (ITB), Gadjah Mada University (Yogyakarta), Syiah Kuala University (Aceh), Padang State University (Sumatra), Sepuluh Nopember Institute of Technology (Surabaya), and Mulawarman University (East Kalimantan). BIG's staff members have sufficient technical expertise to fulfill the project objective, and are not currently facing limitations in this respect (JICA 2012).

At the sub-national level, pilot institutions in Central Kalimantan have signed a Memorandum of Understanding (MoU) with the REDD+ the Task Force to participate in technical capacity training programs and to cooperate in data acquisition and sharing. The REDD+ Task Force has provided hardware and software resources, including computing servers, and consultants to support data inven-

tory and acquisition in these areas (Pradana, pers. comm.). If successful, the curriculum and training programs will need to be replicated in other areas.

2.2.4 Financing

The Indonesian government approved USD 156 million for five years (2009-2014) for geospatial data activities, not all of which will focus specifically on forest and land use (Roy and Hisham 2011). Ministries are currently including the operational budget for participation in the One Map implementation process from their existing mid-term plan (RPJMN), which did not include specific strategic budget allocations for One Map (Sumaryono, pers. comm.). As a result, it is at present difficult to track which budget items in each ministry/agency are dedicated to BIG. However, in the upcoming RPJMN budget period (2015-2019), BIG will coordinate with each ministry to include One Map budget allocations in their Annual Government Work Plan (RKP), which is the basis for formulating the Draft Government Budget (RAPBN) (Sumaryono, pers. comm.).

At the local level, pilot regions only have minimum budgets for involvement in One Map processes. These activities are at present mostly supported by external funders, including the Japanese International Cooperation Agency (JICA), USFS, the Norwegian Government, and UK Climate Change Unit (UKCCU). Next year regional agencies will have the opportunity to allocate budget resources for One Map, and the management/provision of spatial information, in their respective regions (Pradana, pers. comm.). In the long run, it is expected that regional or local level institutions will include data collection and management as part of their budget allocations (Pradana, pers. comm.).

The largest external funder of One Map is the Japanese International Cooperation Agency (JICA). JICA provided a large grant of 63 Million USD, 22 Million USD of which is designated for an NSDI networking system, with additional funds budgeted for data acquisition in target regions and other activities.

2.3 Peru

2.3.1 The Context

The Peru government initiated the development of a National Forest and Wildlife Information System (SNIFF) after signing the United States-Peru Trade Promotion Agreement in 2006, which took effect in February 2009. The agreement contains an Annex on Forest Sector Governance[18] that aims to combat illegal logging and trade in wildlife. The Annex lays out a set of activities that Peru will undertake, a few of which are:

- To develop a system to trace the legal origin and chain-of-custody[19] of tree species listed under the Convention on International Trade in Endangered Species (CITES) from point of harvest to point of export.
- To establish an independent agency, the Supervision Office of Wood Forest Concessions (OSINFOR), with the mandate to oversee timber concessions and permits and enforce forest governance regulations.
- To build capacity needed to meet objectives of the Annex, including institutional capacity for forest governance, improvement of the forest concession system, and increased transparency in forest resource planning and management.

The Peruvian Government and the USFS International Programs are working together on the Peru Forest Sector Initiative (PFSI), a project carrying out the activities laid out in the Annex. A primary focus of PFSI is to build a National Forest and Wildlife Information system (SNIFF) to enable tracking of timber legality (USFS, n.d.). The pilot software of the system, called the Control Module, would collect and organize annual operating plans, documentation of authorizations to harvest, transport and export, and documentation of inspections of products (Ramirez 2013). The software prototype was launched on February 1, 2013 and is currently in the testing phase.

While Peru's SNIFF is in the early stages of development and is currently focusing on the collection of non-spatial information, the system is intended to form the country's foundation of forest information management and Peru plans to expand the use of the system to include spatial data (Ramirez, pers. comm.)[20]. In addition to the pilot Control Module, additional modules will be developed and added to the system to support national forest information needs. These modules include a Forest Inventory Module and a Geographic Information System (GIS) Module for land-use and concession planning and forest monitoring (Miyakawa, pers. comm.; Ramirez, pers. comm.; Wayson, pers. comm.) [21,22]. These modules would include spatial data on logging and mining concessions, granted permits and authorizations, protected natural areas, land titles and others. The plan for the implementation of these modules is underway; the Terms of Reference for the development of the Control Module also included work on the development of a GIS system, which will form the basis of the GIS Module (Ramirez, pers. comm.).

Beyond the development of SNIFF, the Peru government has taken action through its legal framework to improve the country's information management and sharing among ministries; some of these laws and ministerial resolutions are specifically for geospatial information.[23] For instance, a Law No. 28799 was passed to call for the development of a National Operations Center for Satellite Images, which will be responsible for collecting, processing and distributing satellite images upon request to government agencies and the public. Additionally, with support from USFS and other institutions, the Peruvian Government is implementing a National Geospatial Data Infrastructure, a platform for standardized data repositories, data exchange protocols, and collaborative editing of geospatial information (Miyakawa, pers. comm.).

Prior to the U.S.-Peru Trade Promotion Agreement, Peru has made multiple attempts to develop a forest information system since the 1980s. These attempts focused on collecting forest data, including forest cover and concession allocation, and developing software for organizing collected data. These efforts were largely unsuccessful in establishing a permanent system due to various reasons, including lack of technical and financial capacity to maintain the system, slow transmission of paper-based information, and poor coordination between agencies (Miyakawa, pers. comm.). In addition, a lack of data quality mechanisms resulted in varying methodologies and quality of data, which diminished the willingness of institutions to share their data (Miyakawa, pers. comm.). Lessons learned from these trials helped to shape the current process of developing the SNIFF.

2.3.2 Institutional Framework and Capacity

A number of ministries are responsible for land-use decision-making. The Ministry of Environment is responsible for land-use planning, but the Ministry of Agriculture and the Ministry of Mining also have their own zoning for agriculture, forestry, and mining. There is some overlap in jurisdiction, which results in conflicting land-use designation in some places (Wayson, pers. comm.). Additionally, data collection activities are conducted independently and without coordination. The Ministry of Environment and the Ministry of Agriculture each collect forest data using different methods (Wayson, pers. comm.). Even within the Ministry of Environment, different departments collect data independently with some overlap (Miyakawa, pers. comm.).

The national government is responsible for forest policy development but is shifting the responsibility for policy implementation to local-level entities. However, this transfer of responsibility is slow and resources for policy implementation remain largely on the national level. There are plans to provide training and to increase capacity at the sub-national level, but they remain contingent on the availability of financial resources (Ramirez, pers. comm.).

Learning from past experiences, the Peruvian Government identified the need for technical expertise and proper control and management of the new system. With this notion, the General Directorate for Forestry and Wildlife (DGFFS) and the USFS approached the development of a new system with the goal of making systemic changes that would ensure the long-term success of the system (Miyakawa, pers. comm.). To develop the pilot Control Module and improve tracking of timber products from harvest to export or domestic end use, the Peru Government first identified all the institutions involved in the timber chain-of-custody. It found that each of the 18 institutions had their own documentation requirements and that there were overlaps in information requested (Figure 5). This inefficiency resulted from a lack of communication and coordination between the institutions. To resolve this problem, the 18 institutions and regional governments came together and, over two years, collaboratively mapped out each institution's documentation requirements, identified overlaps between the institutions and improved the efficiency and consistency of information across ministries (Miyakawa, pers. comm.; Ramirez, pers. comm.; USFS, n.d.).

Subsequently, the USFS developed a prototype system for the pilot timber tracking module, which was carefully implemented with consultation and cooperation with all 18 institutions. The Peruvian Forest Service, an autonomous institution linked to the Ministry of Agriculture, is responsible for hosting, managing, and coordinating information feeding into the SNIFF. Currently, the prototype for the Control Module is used by the Ministry of Agriculture and the regional governments of Loreto, Ucayali, Madre de Dios, San Martin and Amazonas. Once the system is fully launched, access will be extended to OSINFOR and other related authorities, such as the tax authority and the national police (Ramirez, pers. comm.).

For the planned Forest Inventory Module, the Ministry of Environment will coordinate with sub-national governments, who will conduct the inventory. Methods will be developed jointly between the sub-national governments to enable harmonization of data into one system. In addition to a national forest inventory, this module will also include data on permanent timber production in some regions (Ramirez, pers. comm.).

2.3.3 Staffing

The General Directorate of Forestry and Fauna (DGFFS) under the Ministry of Agriculture started with six staff members working on the SNIFF and now has 12 members. From the regional governments, 24 staff members are coordinating with DGFFS. The institutional mapping phase involved over 40 individuals from 18 institutions. The development of the prototype involved four staff members from USFS, four from DGFFS and three from regional governments (Ramirez, pers. comm.).

Regional governments, in particular five Amazonian governments that account for 60 percent of the country's total area, are very involved in the Control module (Miyakawa, pers. comm.). As work begins on the Forest Inventory Module, which will depend on the regional governments to provide data input, the national government intends to provide training to regional staff in inventory data collection and GIS. These Amazonian regional governments are also heavily involved in setting up the repositories for the National Geospatial Data Infrastructure.

2.3.4 Financing

The development of the Control Module of the SNIFF is primarily funded by the U.S. Agency for International Development (USAID). The grant funds multiple activities under the Peru Forest Sector Initiative and the exact amount used specifically for the Control Module is difficult to determine at this time, as implementation is still in progress. In addition to technical support, USFS has also contributed funding. Peru is financially contributing to the development of the Control Module through paying for the salaries of the staff working in the various offices of the General Directorate of Forestry and Wildlife. The Peruvian government is currently in the process of estimating the amount needed to develop other modules (e.g., forest inventory, geospatial information, legal information, etc.) of the SNIFF.

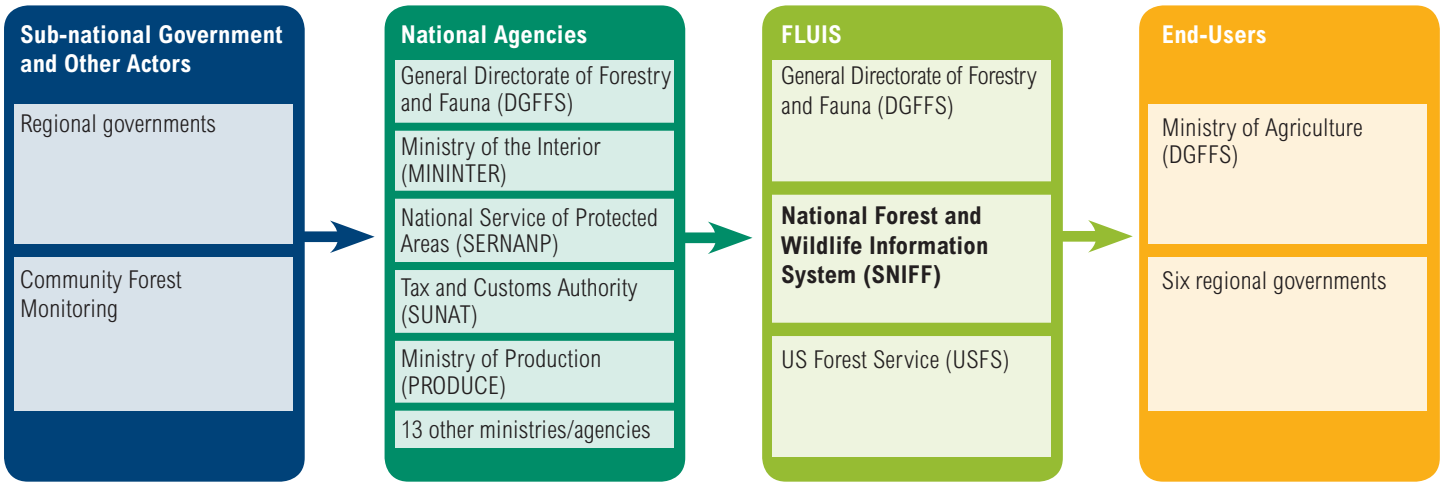
3. LESSONS LEARNED AND RECOMMENDATIONS

Secure high-level commitment from the government: In Cameroon, Indonesia and Peru, the commitment to develop their respective FLUIS came from the President's office. In Indonesia, for instance, the President was informed of the conflicting permits issued by national and sub-national government agencies, which resulted in his strong support for the development of the One Map policy. In each country, various ministries have opposing demands and interests regarding land use. Accordingly, commitment to inter-ministerial coordination and data integration had to be secured at a high level from authorities with the power to mobilize action and collaboration between ministries. This came in the form of a legal mandate in Indonesia and Peru, requiring ministries to share data and improve collaboration. Active support from the highest level is an important pre-condition to spur the development of a national FLUIS.

Bring all relevant agencies to the table: In each country, ministries collect data independently and use different land-use maps for decision-making, which results in

Figure 5 | **Peru's National Forest and Wildlife Information System (SNIFF)**

Regional governments, with the support of community forest monitoring, and 18 national agencies were involved in the planning and development of SNIFF. The General Directorate of Forestry and Fauna (DGFFS) hosts the system with technical support from the US Forest Service.



overlapping jurisdiction and conflicting land-use decisions. An example of this in all three countries is the overlap of logging permits with designated protected areas. Because logging permits are issued by the Ministry of Agriculture or Forestry and protected areas are under the control of the Ministry of Environment or an equivalent, this overlap has occurred in each case. Such conflicts prevent agencies from carrying out their responsibilities efficiently and can lead to tension and mistrust between agencies. All three countries are working towards bringing relevant stakeholders to the table, including those agencies not directly governing the forest sector.

Hence, one of the first steps in developing a FLUIS is to undergo an institutional mapping exercise where relevant stakeholders are identified and convened. These stakeholders should include those agencies that are not directly governing the forest sector but that are making decisions that affect land use. These stakeholders should be engaged early in the FLUIS design process to help foster trust among the stakeholders and willingness to share data.

Establish long-term financial support for the FLUIS through the policy framework: FLUIS are evolving systems that should go through an iterative process of updates and/or enhancements for expansion of applicability. Upfront costs for the initial development of the system are high due to significant labor dedicated to aggregating data, the establishment of required physical technologies, and staff capacity building activities. In all three countries, the initial development of the system was strongly supported by external funding. Beyond the initial development and availability of external support, however, countries need to be able to continue operating and updating the FLUIS and have a local staff that is sufficiently trained to support the system.

Financial support to maintain the FLUIS needs to be available beyond external funding and incorporated into domestic budgets. One way to better ensure that funds are available in the long term for continuous training and maintenance of the FLUIS is to establish the support for improving data integration and management in the policy framework, as Peru and Indonesia have done. Finally, clearly defined roles and responsibilities for each ministry through the policy framework would also encourage ministries to maintain a staff to fulfill duties.

Retain institutional memory: A common struggle that governments have with sustaining the functioning of a FLUIS is the retention of institutional memory. Staff attrition is a common occurrence and one that results in loss of institutional memory, which refers to the knowledge needed to operate and maintain any system. Systems that require more training of and expertise from staff are more at risk of running into difficulty when there is turnover. To address this, a FLUIS can be designed to reduce the amount of specialized knowledge—and hence the amount of training—needed to use, update and maintain the system. For instance, the next phase of Cameroon's Interactive Forest Atlas will include the development of a user platform that will streamline data input. This will reduce the risk of errors and inconsistencies in data entry, as well as the amount of training needed to use the system. Additionally, some institutional memory can also take the form of a user manual rather than knowledge transfer from person to person, thereby also reducing the amount of training needed.

However, while a well-designed FLUIS can reduce the amount of training needed, some level of technical competence and training is always necessary and is lost when there is staff turnover. Thus, training staff and maintaining a competent staff are ongoing expenses that need to be accounted for in order to sustain a FLUIS.

Build sub-national capacity and coordination: In all three countries, sub-national governments, including regional and local governments, have a growing role in data collection and implementation of forest policies. Initial work has started to improve sub-national capacity for data collection. In Indonesia for example, pilot projects at the provincial and district levels are building technical capacity on data acquisition and sharing. These initial efforts will need to be scaled up in order to address the limitations of capacity and resources at the sub-national level. Sub-national governments' growing responsibilities have not been supported by adequate financial, human resource and technological capacity building. Currently, the three countries are focusing on building the foundations of the system at the central level; sub-national capacity is considered a major gap that needs to be addressed.

Sub-national governments are a substantial resource for efficient and cost-effective data collection. With coordinated use of standard procedures and methods for data collection and sharing, sub-national monitoring can provide accurate, methodologically consistent data, which can then better inform policy decisions. To utilize this important source of data for national-level integration of data, more capacity building and training on a set protocol for forest data collection are needed and sub-national governments should be included in the planning and implementation of the system. Additionally, sufficient financial resources should be distributed to sub-national governments to enable them to carry out their data collection and sharing responsibilities.

4. CONCLUSION

The development of forest and land-use information systems is increasingly important, as forests come under increasing pressure from forestry, agriculture, and mining activities, and the emphasis continues to grow on monitoring greenhouse gas emissions, implementing climate mitigation policies and tracking the progress of these policies. Successful development of a FLUIS is not an end goal, but rather serves as the means to achieve the larger goals of enabling tracking of forest-based mitigation policies and making informed and sound policy decisions.

The three systems described here illustrate how three countries have made significant progress in improving coordination among national agencies and improving the collection, sharing and management of forest and land-use data within the government. While we highlighted common themes and challenges, these systems are not meant to be representative of how all systems should be developed or what all systems need in order to develop a FLUIS. Countries face unique sets of circumstances and FLUIS development should be adapted to suit the country's priorities and availability of resources.

Cameroon, Indonesia and Peru provide illustrative examples of countries that have initiated the development of a forest and land-use information system. Though these countries are still facing various capacity gaps and more improvements can be made to their systems, they have taken important steps towards increasing coordination and data integration. For all three countries, addressing the lack of institutional coordination was a central component of the initial phase of system development. Additionally, capacity building activities were carried out to improve human resource capacity to use and maintain the systems, though more is needed to ensure the continued operation and utility of the systems beyond the development phase and availability of external funding.

Pinpointing the fundamental capacity gaps that prevented effective integration and management of forest data and closing those gaps will be key to ongoing progress. Their experiences provide helpful lessons learned that other countries can consider when developing their own forest and land-use information systems.

APPENDIX – SURVEY QUESTIONS

Context and motivation for developing the FLUIS

- In (country), why is data integration and coordination between ministries needed? What problem or information gap is the FLUIS intended to solve?
- Which ministry/agency initiated the development of the FLUIS? Was there a main person or group that advocated for the FLUIS and drove the process?

Institutional capacity

- Which ministries are responsible for land-use decision making in (country) (e.g., ministry of agriculture, ministry of forestry, etc.)? Do these ministries have clear roles with respect to data collection and management? Are there formal agreements between ministries to share data?
- Which ministries provide their data to the FLUIS? What difficulties, if any, are faced in obtaining data from other ministries?
- How do regional or local level institutions coordinate data with ministries and national agencies? Are there clear mechanisms in place to support data sharing?
- Were non-government entities (e.g., NGOs, academia, private sector) involved with the FLUIS development? How were they involved?

Staffing

- How many staff are involved in developing and managing the FLUIS? What level and type of experience and technical knowledge do they need for this role? Is/was any training provided?
- Are clear standards for collecting data provided to sub-national entities? Has training been provided to local level officials? Do sub-national entities have sufficient technical systems/equipment to carry out data collection?
- Do regional or local level institutions have the capacity to fulfill their data collection/submission mandate? Have they been trained?
- How often does training occur? How is technical capacity maintained with changing personnel?

Financing

- What were the costs associated with the development of the FLUIS? What were the largest cost items?
- What were the major funding sources? Did the government contribute to the development of the FLUIS (including both cash and in-kind)?
- How long did it take to develop the FLUIS? Were there any interruptions or difficulties in financing the process over the period of the project?
- Do regional or local level institutions have the funds needed to carry out data collection and management?

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ENDNOTES

1 COMIFAC, formed in 2005, includes Cameroon, Central African Republic, Democratic Republic of Congo, Equatorial Guinea, Gabon, Chad, Burundi, Sao Tomé and Rwanda.

2 Bolivia, Brazil, Colombia, Ecuador, Guyana, Peru, Suriname, and Venezuela signed the Amazon Cooperation Treaty in 1978.

3 The Interactive Forest Atlas of Cameroon is part of WRI's larger initiative in Central Africa. Interactive Forest Atlases have also been developed for Central African Republic, Congo, Democratic Republic of Congo, Equatorial Guinea, and Gabon. In this working paper, 'Interactive Forest Atlas' refers to the one developed for Cameroon.

4 http://www.wri.org/publication/interactive-forest-atlas-cameroon-version-30

5 Steil, Matthew (Central Africa Forests Manager, World Resources Institute), in discussion with the author, July 2013.

6 Mbouna, Duclair (National Coordinator for Cameroon, World Resources Institute), in discussion with the authors, August-December 2013.

7 Tessa, Bertrand (Research Analyst/Program Coordinator, World Resources Institute), in discussion with authors, November 2013.

8 This is not the first attempt at improving the management of spatial data in Indonesia. Spatial data management was under discussion in Indonesia starting in 1993. Between 1993 and 2003 there were eight official national meetings to make decisions on issues such as data standards and formats. More recently increased momentum towards the development of One Map and JDSN has been prompted by the country's climate mitigation agenda. BIG officials estimate a ten-year time horizon to fully operationalize the system. (Roy and Hisham 2011)

9 JDSN aims to go beyond forest and land use purposes to also support other policy challenges and data needs in the country, including disaster management and marine resource management.

10 http://gis.deptan.go.id/uu/perpres-85-2007.pdf

11 The Indonesian Law on Geospatial Information (UU no 4/2011) regulates how different Indonesian government agencies share and use spatial data for policy making purposes, accessible at http://bit.ly/1c7UToH

12 The REDD+ Task Force has recently been formalized as a REDD+ Agency via Presidential Decree No 62/2013.

13 The basic architecture of the system is a server, ArcGIS Server, that allows sharing of GIS resources (e.g. maps, geodatabases, and tools) and a portal, esri GeoPortal Server, that enables agencies to publish data online internally for employees and externally for the public. ArcGIS Server allows sharing of GIS resources, such as maps, geodatabases, and tools, among a group of users. The GeoPortal Server enables agencies to publish data online, internally with employees or externally with the public.

14 National Land Agency (BPN), Ministry of Environment, Ministry of Transportation, Ministry of Public Work, National Disaster Agency, Statistics Agency, Ministry of Energy and Mineral Resources, Ministry of Forestry, Ministry of Agriculture, Ministry of Marine Affairs, Meteorology, Climatology, and Geophysics Agency, Aerospace agency, President's Delivery Unit for Development Monitoring and Oversight

15 Pradana, Adi (Pak Koni's Assistant, UKP4), in discussion with authors, October 2013.

16 Sumaryono (Head of Mapping, Disaster and Climate Change, BIG), in discussion with authors, October 2013.

17 Krecik, Stephen (Indonesia Program Specialist at US Forest Service), in discussion with authors, September 2013.

18 United States-Peru Trade Promotion Agreement - Annex on Forest Sector Governance: http://www.ustr.gov/sites/default/files/uploads/agreements/fta/peru/asset_upload_file953_9541.pdf

19 Chain-of-custody (CoC) is documentation that verifies the flow of the materials from their origin in the forest to their end-use.

20 Ramirez, Rafael (Director of Department of Information and Control of Forestry and Wildlife, Ministry of Agriculture), in discussion with authors, September 2013.

21 Miyakawa, Victor (Program Manager for Information & Participation program at USFS/PFSI), in discussion with authors, August 2013.

22 Wayson, Craig (Program Coordinator, USFS), in discussion with authors, July 2013.

23 In addition to Law No. 28799, other laws specifically targeting geospatial information include Supreme Decree No. 069-2011-PCM, which resolved to create the Spatial Data Information Portal of Peru (GEOIDEP), and Ministerial Resolution No. 325-2007-PCM, which created the Permanent Coordinating Committee on the Spatial Data Infrastructure of Peru (CCIDEP).

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WRI is a global research organization that works closely with leaders to turn big ideas into action to sustain a healthy environment—the foundation of economic opportunity and human well-being.

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