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Abstract

In recent years there has been a strong global trend toward openness: more open data, more open science, more open innovation, more open government and more open governance of natural resources. According to advocates, open data fosters innovation, citizen science, and accountability; open science is more accessible and honest, and less vulnerable to manipulation by special interests; open government is more transparent, accountable and inclusive, and open governance of natural resources is more inclusive, transparent, and accountable to a wider range of stakeholders. There is compelling evidence of progress toward openness. For example, the G8 Ministers of Science issued a statement in June 2013 that encourages open scientific research data and open access for scientific research results; at least 62 countries have so far joined the Open Government Partnership (www.opengovpartnership.org); more than one million datasets have been released by governments around the world (Jetzek et al, 2013); there now is a central repository for international assistance data (http://aiddata.org/blog); and developing countries in Latin America, West Africa and Asia have made meaningful progress in implementing the 2016 Extractive Industries Transparency Initiative Standard (https://eiti.org/countries). At the same time, there have also been trends against openness. While public science agencies have been promoting open data and open access publishing, a larger share of research and development is being conducted through private companies that claim exclusive intellectual property (Fugile, 2016). In 2012, the Government of Canada passed legislation that severely restricted access to environmental assessment processes and reduced public funding for environmental monitoring. Current political trends against globalization may also reduce support for openness (King, 2017).

This paper reviews the linkages between openness of data, innovation and natural resource governance for the case of forestry resources. After a general review of key concepts around "openness", we develop an analytical framework that emphasizes the private and public values of forestry and forest data. That framework supports the development of several propositions regarding the links between value appropriation and open data. We then review the general case of forestry and three cases in which a relationship between forest governance and openness of forestry data can be observed: conflict timber in Liberia, deforestation in Brazil, and bioeconomy development in Finland.

Background

On July 2, 2017, Google announced that it would integrate Brazil's indigenous territories into its Google Earth and Google Maps products. Google's images and maps of the Amazon now show the names and borders of 472 indigenous territories that have been formally recognized in the Brazilian Amazon. Google is recognizing these territories in collaboration with Fundacao Nacional do Indio (FUNAI), the Brazilian agency responsible for indigenous people's affairs. A representative of FUNAI stated, "*by defining Brazil's indigenous territories we can show the world the role these communities play in maintaining global socio-biodiversity."* (Economic Times, 2017).

This example is one of many that illustrate the strong global trend toward more openness, in data, science, innovation, government and governance. Two common forces underlie these trends: globalization and Big Data. Big Data refers to the rapid development and uptake of technologies to generate, manage and transmit massive amounts of data. Governments are both producers and users of Big Data. Open government initiatives, such as President Obama's Open Government Directive of 2013, challenge government agencies to share the data they collect with one another and with the general public. Multiple values are expected from openness: more effective and efficient provision of government services (eg emergency response efforts directed to the places with greatest need); greater accountability of government agencies to taxpayers and clients (eg local government dashboards that report transit volumes and crime rates); greater collaboration between public, private and civil society organizations; more rapid and innovative systems of discovery and product development; more targeted marketing and expanded choice for consumers; new information-intensive technologies (eg self-driving cars); and more effective and responsible management of the natural environment. At least 62 countries have so far joined the Open Government Partnership (www.opengovpartnership.org); 17 national and 30 sub-national governments have adopted the open data charter (http://opendatacharter.net/adopted-by-countries-and-cities/); more than a million datasets have been released by governments around the world (Jetzek et al, 2013); a central repository of international assistance data has been posted (http://aiddata.org/blog).

Openness has limitations and unintended consequences. Because public data are often aggregations of data about individuals, there is potential to violate laws designed to protect the privacy of individuals and companies. Openness can be expensive. The data that public agencies collect for their own uses may include inaccuracies, imprecisions, or estimation methods that would not stand up to public or scientific scrutiny. It can be costly to manage data into formats that can be easily accessible to audiences with limited analytical capacities. Data is often the currency of collaboration: a government agency that provides free access to ites data may weaken its power to negotiate with other agencies.

Here we focus on openness in the governance of natural resources and their data. The Google case described above is one of many initiatives to encourage better management of natural resources and the environment through open data. The United Nations Economic Commission for Europe Aarhus Convention on Access to Information, public participation in decision making and access to justice in environmental matters was adopted in 1998 with the expectation that more open information would lead to more responsible environmental management. In the European Union, the INSPIRE Directive (2007/2/EC) requires the establishment of Infrastructure for Spatial Information in Europe to enable the sharing of environmental spatial information among public sector organisations, facilitate public access to spatial information across Europe and support policy-making across boundaries (http://inspire.ec.europa.eu). In his 2015 presentation in Dalian,

China, Matthew Hansen discussed two prime examples of open government data generated by the United States National Aerospace Administration (NASA): satellite images from Landsat Thematic Mapper and MODIS which date back to the 1970s; and Global Positioning System data. Developing countries in Latin America, West Africa and Asia have made meaningful progress in implementing the 2016 Extractive Industries Transparency Initiative Standard (https://eiti.org/countries). By July 3rd the updated Google maps had already been integrated into the web site of Global Forest Watch (www.globalforestwatch.org), which provides detailed historical and real-time data on the spatial distribution of intact and planted forests, indigenous territories, and current forest threats across the world. Appendix A provides a list of some of the openness initiatives in the forestry sector.

Natural resource and environmental data can generate both public and private values. Open data can inform management decisions, such as optimal harvest time, risk of damage from fire or invasive species, or designation of critical habitat for species conservation. Open data may also reduce the costs and increase assurance associated with certification systems. On the other hand, open environmental data may reveal negative impacts from resource development, environmental injustices, environmental crimes, or the theft of environmental resources. Actions that follow from the release of such information may in turn lead to more effective management by responsible public agencies to the benefit of effected groups, while those held responsible for environmental injustices or crimes may be negatively affected in various ways, including fines, loss of operating permits, or loss of credibility with investors, clients or employees. There may be negative indirect effects on others, including other companies that source outputs or provide inputs to sanctioned companies.

Data on forests and forestry is a particular case in point. More open data about deforestation may be used to hold private or public companies accountable for their effects on deforestation or for the sustainability of their logging practices. On the other hand, data that shows compliance with good environmental standards, such as Forest Stewardship Council Certification, can be required to sell outputs into some markets, or lead to a price premium of 15-20 percent for some types of tropical timber (https://ic.fsc.org/en/news-updates/id/66).

We anticipate the development of a large research agenda on the links between the governance of forest resources and the governance of forestry data. Here we contribute to that agenda in the following ways: 1) development of a conceptual model of the values of forestry, the values of open forest data, and appropriation of those values; and 2) applying that framework in a review of three cases of governance of forests and data.

Key concepts

This section presents and discusses definitions of key concepts related to openness and value. The conceptual framework developed in the following section draws upon these concepts.

Open government is government "*that earn's people's trust in their government by making government more open and transparent*." (then Senator Barak Obama, as quoted in Yu and Robinson, 2012, p. 193).

Open government data is "*non-privacy-restricted and non-confidential data which is produced with public money and made available without any restrictions on its usage or distribution*" (Janssen et al, 2014, p. 258).

Jetzek et al (2013, p.12) proposes that open government data typically have the following economic features: 1) valuable -- it can be converted into valuable knowledge; 2) re-usable -- it can be re-used in different contexts and combined with other data to produce new knowledge; 3) non-rivalrous – one user's use of the data does not diminish its value to that user or other users; 4) non-excludable – it is difficult for a single user to exclude others from using the same data; 5) high fixed costs – there are high upfront costs associated with collection, manipulation and delivery of data; and 6) very low marginal costs – once the upfront costs of data collection are met, there are low additional costs for sharing additional units of data. At the extreme, open government data thus has features of a pure public good.

Open innovation is "*a distributed innovation process based on purposively managed knowledge flows across organizational boundaries, using pecuniary and non-pecuniary mechanisms in line with the organization's business model*" (West et al., 2014, p. 806).

Open innovation thus ranges from open source software development, citizen science, public-private partnerships, or different types of partnerships or linkages between private companies.

Public value: "*What adds value to the public sphere, where the public [realm] includes state, market and civil society. The dimensions of public value include: 1) economic value – adding value to the public realm through the generation of economic activity, 2) social and cultural value --- adding value to the public realm by contributing to social cohesion and well-being, 3) political value – adding value to the public realm by stimulating and supporting democratic dialogue and active public participation, as well as citizen engagement and 4) ecological value – adding value to the public realm by actively promoting sustainable development and reducing pollution, waste and global warming*" (Benington, 2011).

Private value "*of any public service or program is defined as the value or benefit that comes directly to the participants of the service, there is a private gain or personal value received by the participant(s)*"Extension.org, 2017).

Value appropriation: "*when an actor is about to capture a portion of the value created by an activity*" (Jetzek et al, 2013, p.3).

Mixed good: "*A mixed good is like a private good in that it is rivalrous and excludable, but it provides significant non-rivalrous, non-excludable external benefits for which preferences are not revealed by the market mechanism. . . . . The balance between private and public benefit varies, and there is debate in each case – that is, it is not easy to determine the public benefits for a good for which private preferences can be revealed by the market mechanism.*" (www.blacksacademy.net/content/3404.html)

The openness literature often confounds the concepts of open government and open government data (Janssen et al, 2014). In this paper, however, open government refers to transparent decision making processes and open scrutiny by citizens. However, governments can be open and transparent without publishing large datasets, for example, by allowing journalists and the general public to observe and participate in decision-making processes. Governments collect large amounts of data for the purpose of planning, policy and budget allocation. Public access to that data – open government data -- can generate many private and public values, one of which may be more transparent and open government. There are instances, however, in which pressures to release government data actually lead to less transparent and less collaborative government.

"Open innovation views both internal and external ideas as equally important sources of valuable ideas and emphasizes the importance of aligning open innovation with the business model of the firm" (Henttonen and Lehtimaki, 2017, p. 329.)

Open government data can be combined with ideas and information to generate new products and services for more open innovation in both the public and private spheres of the economy. Open government data may contribute to more open innovation by the private sector, but only if the private sector can appropriate some of the value of those innovations. That is, while one of the features of open government data is that it is non-rival and non-excludable (see above), the private sector will only use that data to generate new products that are at least partially rival and excludable, otherwise they won't be able to appropriate value from those data. A major public policy challenge thus is to determine the types of data provision and manipulation services that should be provided by public agencies, and those that will be best provided through private companies, or private-public partnerships. There is much unknown, however, since many of the new uses of data may be difficult to anticipate.

Openness values and propositions

A review of the relevant literature reveals additional propositions about the values associated with openness of government, data and innovation, as well as possible limitations or unintended consequences of openness that have been suggested in previous studies. We summarize that literature in the first two columns of Table 1. Many of the counter narratives recognize that information and data bestow power on those who own and manage it. The third column of Table 1 describes the appropriation of that value, clarifying why there might be gainers and losers from openness.

Table 1. Propositions about appropriation of value from openness

Proposition regarding increase in public and private value	Possible limitations and unintended consequences	Propositions about appropriation of value
Open government: Greater efficiency and effectiveness of government action	Government agencies and departments may resist because data is a source of their power, exchanging data with other government agencies in exchange for money (service fees), data or special projects (Peled, 2011).	1. Taxpayers and citizens appropriate value from efficiency; public employees may equate efficiency with job loss or job insecurity; politicians may perceive political gain or loss from increases in government efficiency.
Open government: Greater transparency and accountability for government action	Selective opening or public exposure of government data can promote or oppose particular political, social or economic agendas (Enkel et al 2009).	2. Different strata of the society and economy will seek to appropriate different values from government data. The gains from open data may provide disproportionate benefits to owners of capital.
Open government: greater participation by	Greater public access to data may limit frank and open discussion within	3. There is a risk that most of the benefits of open government processes will be

society	government agencies (Peled, 2011).	appropriated by vocal minority interest groups.
Open government: greater feedback from public improves government services and public value (Janssen et al 2012).	Government systems of control may be inconsistent with feedback or criticism (Janssen et al 2012).	4. Government agencies have incentive to withhold or manipulate data that suggests weak performance.
Open data: Creation of new information products that draw upon different types of data (citizen apps) (Longo, 2011).	Concern that release of distorted, incomplete or misleading data could harm certain groups (Peled, 2011). Lack of control or inability to correct or update data that become embedded in other databases (Peled, 2011). Some data are expensive to open, but have limited public value (Janssen et al 2012).	5. The private sector will focus on new information products that are at least partially excludable and rival. NGOs or academics may give more attention to non-excludable, non-rival products. Governments are challenged to direct effort to areas that produce the most public value, which also having private good attributes.
Open data: facilitate citizens and businesses to make better and faster decisions about internal processes	Invasion of privacy of the individuals whose behaviors are the observations in the data sets. Machine learning can re-enforce human biases against certain groups (Caliskan, Bryson and Narayana, 2017).	6. Each company could generate distinct benefits from open data, despite being non-rival and non-excludable. Tech savy companies may benefit the most.
Open innovation: Couple external and internal data and ideas to create new products	Need to consider the value propositions of different groups, some of which are driven by profit but others by a social agenda, hobby, academic exercise, or to advance the public good (Chesbrough and Appleyard, 2007).	7. Some combinations of internal and external data may be ruled out by the available appropriation strategies (Van Lancker et al (2016).
Open innovation: relies on social networks among groups with complementary expertise and data	Many open innovation platforms rely on a mix of organizations motivated by monetary and non-monetary objectives (West et al, 2014).	8. NGOs may see value in new alliances with municipal governments or private firms.

In many ways, values and value appropriation are both the most essential and most problematic aspects of open data and open innovation. Economic principles tell us that publicly funded agencies should focus on the provision of valuable public goods and services – public values that are non-excludable and non-rival – that would not otherwise be provided to the market by private suppliers. But to produce economic value to those potential users, the products or services must directly create some benefit or facilitate some further action by non-public entities, with some portion of the benefit from that secondary action accumulating to those non-public entities. This implies that the open data that have greatest potential to generate public value through

the private sector are those that also generate private value that can be appropriated by private entities. Data that don't generate private value may be provided by non-government or governmental organizations. This supports proposition 5.

Forestry – increasing values of conservation and utilization

Forests have long been recognized for their dual roles in conservation and production. The world's forests are reservoirs of biodiversity and generate a range of ecosystem services, especially regulation of water, carbon and nutrient cycles. The United Nations Framework Convention on Climate Change (UNFCCC) pays special attention to the role of forests in regulating climate, especially through reduced emissions or sequestration of greenhouse gases. REDD+ (Reduced Emissions from Deforestation, forest degradation, forest conservation and reforestation) has been developed by the UNFCCC as a means to incentivize forest conservation and restoration of degraded forests (Thompson et al, 2011). Forests also produce a variety of ecosystem goods, including timber, paper, fuelwood, gathered foods and resins. The new bio-economy seeks to use renewable biomass, including forest biomass, to replace fossil inputs for the production of a wide range of value-added products (Van Lancker et al, 2016; Henttonen and Lehtimäaki, 2017). Some of the goods produced by forests can be easily appropriated as private goods, while many of the services are public goods. Forests can thus be appropriately governed as private, common or state property.

The new public value propositions for the world's forests – REDD+ and bioeconomy -- share some common challenges. First, the values that they produce are low in terms of price per tonne of output compared to other commodities. Despite decades of research, production costs still make cellulosic ethanol expensive compared to petrochemical fuels (Lynd et al., 2017). Second, these values are mostly determined by policies and markets for higher value substitutes, especially fossil fuels (Khanna et al, 2017). Third, they entail long and complex value chains. REDD+ mechanisms need to link smallholder farmers and forest dwellers in developing countries with donors and investors in more industrialized countries (Swallow and Goddard, 2013). The bioeconomy takes biomass from the agriculture, food and forestry sectors and processes it through bio-refineries that follow a cascade principle to extract maximum value. Bioeconomy innovations thus tend to not be incremental, but instead require new business models and supply chains (Van Lancker et al, 2016). Open innovation systems that make the most of public and private sector partnerships may thus be the key to success for both value propositions (Henttonen and Lehtimäaki, 2017).

There have been rapid advances in technologies for detecting and quantifying forest resources (eg Airborne Laser Scanning, forensic tools for identifying wood types, forensic tools for identifying wood origin) (Cavanaugh et al, 2015). Open access to NASA's Thematic Mapper satellite data, combined with powerful big data computing algorithms has led to new insights on the dynamics of global forest cover (Hansen et al, 2013). In 2018, NASA will launch its Global Ecosystem Investigation lidar satellite system to measure the volume of the world's forests and visualize them in 3 dimensions (Patterson, 2016, www.glad.umd.edu/media).

Governments are large owners of forestry resources that are held in trust for people of the country. The timber in those forests can be very valuable and government agencies or particular forest officers can be tempted to allow illegal logging. In West and Central Africa (eg. Liberia, Central African Republic, Democratic Republic of Congo) there have been several instances in which illicit sales of "conflict timber" have been used to fuel civil

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war and armed conflict. Open data on deforestation and timber trade can help to improve transparency and accountability of the public management of those public resources (Lowe et al 2016). Alternatively, it is possible that open data on the quantity and quality of forest data might help unscrupulous prospectors to discover new areas for illegal logging.

There are contradictory pressures toward devolution and centralization of forest governance across the world. Devolution of forest governance to indigenous and community groups is supported by general trends toward devolution of government, greater autonomy for indigenous groups, and findings of the effectiveness of community and co-managed forests. On the other hand, there is concern that REDD+ arrangements that operate between sovereign national governments will encourage re-centralization of forest ownership.

Forests cover large areas of land, often with relatively weak institutions for law enforcement. Open forest data generated from remote sensing can help public agencies to allocate scarce resources for on-the-ground monitoring and law enforcement. Open forest data can also expose / or support the actions of private sector actors that undertake pledges to avoid further deforestation (example of Brazil, Gibbs et al, 2016).

One of the reasons forests are held as state property is that there are other social values of forests. Forests are often special resources for indigenous and local communities. Open forest data can help to identify instances of environmental justice. Open data can be used to empower forest users to exercise their rights and multiple goals in forest management, but only when those forest users have the capacity to access, manage and use those data.

More open sharing of forest data may support multi-stakeholder collaboration in the forest sector, social learning and democratization of forest governance.

Open forest data can allow more effective management of forest resources, especially with small plots as in Finland.

Questions for case studies

The next section of this paper will consider three case studies of openness of forest resource governance. The case studies will be guided by the value orientation presented above. Three questions stand out.

1. What are the private and public values of forests?

2. Who appropriates those values? What mechanisms allow appropriation?

3. How does / could more open government data affect the generation and appropriation of public and private values?

Case 1: Transparency on trade of conflict timber

1.1 Background on trade in conflict and illegal timber

Concerns about the use of revenues from sale of timber to fuel civil conflict peaked in the 1990s when forest-rich developing countries around the world were involved in sustained civil wars and conflict. This included forested areas of Central America (e.g. Guatemala, Nicaragua), South America (e.g. Colombia, Peru, Surinam), South Asia (Pakistan, India), Southeast Asia (Indonesia, Cambodia), and Africa (Mozambique, Central African Republic, Sudan, Uganda, Liberia, Nigeria, and Sierra Leone (Donovan et al., 2007). Various reasons for the strong correlation between forest cover and conflict have been identified, including scarcity associated with resource degradation, safe havens provided by inaccessible forests for rebel groups, the use of timber revenue to finance the purchase of weaponry, and the "resource curse" association of timber wealth contributing to slow economic growth and weak governance, (Beevers, 2010).

One of the best known cases of conflict timber was Liberia during the Presidency of Charles Taylor (1997-2003). An ongoing case of conflict timber is the Democratic Republic of Congo (Boekhout van Solinge et al, 2016).

Civil war began in Liberia in 1989 and was at a peak in 1997 when Charles Taylor moved from being rebel leader to elected President of Liberia. After his election, Taylor and his close colleagues immediately began to extract resources from different sectors of the economy, using some of the gains to buy weapons for use against opposition forces. The first source of funds was ship registrations, which at that time represented 30% of Liberia's national budget. A second source was diamonds, most of which were mined and smuggled into Liberia from neighbouring Sierra Leone, where rebels from the Revolutionary United Front (RUF) exchanged diamonds for weapons. A third source of funds was high value tropical timber. Within the 5 years that Taylor was in office, approximately 50% of the timber resources of the country were extracted and sold on international markets. Third parties including the Oriental Timber Company were involved in harvesting and marketing Liberian "conflict timber" onto international markets (Beevers, 2010).

After 3 years of investigation and lobbying from organizations such as Global Witness and Greenpeace, in July 2003 the United Nations Security Council introduced sanctions against timber sold by Liberia through United Nations Security Council Resolution 1478. One month later, the Taylor regime collapsed and a peace treaty was signed by the government and rebels in Liberia. Taylor fled but was eventually detained tried by the Special Court for Sierra Leone in The Hague (Boekhout Van Solinge, 2008). In 2012, Taylor was sentenced to 50 years in prison for his role in supporting and arming rebel forces in Sierra Leone.

In 2006, the new president of Liberia, Ellen Johnson Sirleaf issued Executive Order No. 1 which canceled all forest concessions and established a forest reform monitoring committee. Later that year, the Government of Liberia enacted the new National Forestry Reform Law for the purpose of turning forest resources from sources of conflict to sources of shared revenue and improved livelihoods. With oversight and support from the United Nations Security Council, the new forestry law emphasized the importance of transparency, accountability and the rule of law. More open access to information about forest concessions appears to have eliminated the timber for arms problem, although controversy over the allocation of forestry concessions continues to the present time (Beevers, 2010). Many private companies complain that tight restrictions on timber trade limit the ability of communities to fully benefit from their forestry resources. Liberia's Open Government Score for 2015 is 0.48, which ranks it number 71 out of the 102 countries included in the World Justice Open Government Project (World Justice, 2017).

1.2   Private and public values of forests

The Liberia case shows that forests can produce private profits that are large enough to prompt the interest of organized crime syndicates with global connections. The United Nations Environment Program and INTERPOL have estimated that the worldwide value of illegal timber sales is USD 30-100 billion per year, comprising 10-30% of global timber trade (Nellemann and INTERPOL Environmental Crime Programme, 2012). Nellemann et al (2016) estimate that governments lose $9-26 billion per year in potential tax revenue as a result (cited in

Boekhout Van Solinge, 2016). Such large economic interests have attracted sophisticated international networks of timber traders. The value chains for high value tropical timber reflect diffuse customer bases, including furniture buyers in wealthy countries. To date, the international community has shown little ability to limit the international demand for illegal tropical timber, despite the efforts of the European Union Forest Law Enforcement Governance and Trade (FLEGT) initiative (Overdevest and Zeitlin, 2014).

1.3   Appropriation of values from conflict timber

Appropriation of the value of illegal and conflict timber depends upon temporary access to forest rich areas, which may or may not be attained through legal forest concessions. Government agencies responsible for governing state forest reserves are often understaffed relative to the size of the resources and areas that they are responsible for managing. Open access conditions often prevail by default or design. Once harvested, the timber needs to move onto national and international markets which requires evasion of law enforcement. Detection of illegal products becomes even more difficult when raw timber is processed into secondary products such as flooring or furniture.

1.4   More open forest data and appropriation of values

Non-governmental organizations such as Due Diligence Timber seek to estimate, compile and publicize the magnitude of illegal timber trade. Global Timber (2017) identifies China as the world's leading importer of illegal timber and wood products from around the world (http://www.globaltimber.org.uk/ChinaIllegalImpExp.htm, accessed 29 June 2017). The European Union, Japan, the United States and Korea are also large importers, while Indonesia, Russia and China are the world's largest exporters.

Boekhout Van Solinge et al (2016) discuss tools that can be used to detect forestry crimes such as those that occurred in Liberia. To date, satellite data have not been particularly useful for detecting timber extraction, partly due to issues such as cloud cover or the small spatial scale of selective timber harvesting. Innovations such as reported by Hanson et al (2016) and Patterson (2016) may facilitate radical improvements. More effective options, possibly used in combination with satellite generated data, include the use of waterproof GPS cameras by local residents to collect GPS-referenced pictures, such as used in the Brazilian Amazon. Forensic tools for accurate species identification include wood anatomical analysis, metabolic profiles, near-infrared spectroscopy, and DNA barcoding. Tools for accurate geographical identification include tree ring measurement, analysis of chemical properties, and DNA analysis. With support from the Government of Norway, INTERPOL has recently launched Project LEAF (Law Enforcement Assistance for Forests) which supports the governments of affected countries to conduct surveillance, gather information, and share intelligence (Cavanaugh et al, 2015).

Case 2:   Deforestation data in the Brazilian Amazon

2.1 Background

The forests of the Brazilian Amazon are highly contested by indigenous residents of the region, agricultural business interests, and the conservation community. Brazil's state and federal governments implement policies that seek to balance those interests, with the pendulum moving back and forth over time between pro-development and pro-conservation policies and enforcement (Tollefson, 2015). Assuncao et al (2013) and Sa and Grieco (2016) make the case that the availability of more open data on deforestation has helped to tip the balance toward conservation. Tense conflict over land use nonetheless continues. Global Witness reports that 448 environmental defenders were killed in Brazil between 2002 and 2014 (Global Witness, 2016

Deforestation of the Amazon peaked at 27,000 square kilometers per year in 2004 and decreased to about 5,000 square kilometers in 2011. This accomplishment was due to a number of actions, spearheaded by the Action Plan for the Prevention and control of deforestation in the Legal Amazon in 2004 (PPCDAm). A cornerstone of PPCDAm was the Real-Time System for Detection of Deforestation (DETER). DETER was developed by Brazil's National Institute for Space Research (INPE) and uses satellite imagery to detect changes in forest cover every 15 days, indicating areas of active deforestation. The Brazilian Institute for the Environment and Renewable Natural Resources (Ibama), targets law enforcement efforts at deforestation hot spots that are revealed by the DETER system. At the same time, Ibama has increased the resources spent on detection and enforcement of environmental crimes. Brazil's Open Government Score for 2015 is 0.56, which ranks it number 38 out of the 102 countries included in the World Justice Open Government Project (World Justice, 2017).

2.2 Private and public values of forests of the Brazilian Amazon

Forests in the Brazilian Amazon epitomize the range of private and public values of forests, including global values. Indigenous groups have long used the Amazon as a source of gathered products, such as rubber, resins and nuts. Forests also generate revenues through timber produced from intact forests, and through conversion to alternative land uses including plantation agriculture, smallholder agriculture, and ranching. The public values of forests include biodiversity conservation, carbon storage and sequestration, watershed protection, and regulation of local, regional and global climate.

2.3 Appropriation of the values of the Brazilian Amazon

Many of the global values of the Brazilian Amazon are non-rivalrous and non-excludable, producing benefits for current and future populations across Brazil and the world. This includes conservation of a large share of the world's biodiversity and regulation of global climate cycles. The global carbon storage and sequestration values of the Amazon are mostly non-rivalrous and non-excludable, although there is some potential for REDD+ mechanisms to generate financial value for the Government of Brazil in exchange for reductions in confirmed deforestation. The Governments of Brazil and Norway are experimenting with ways for the Government of Norway to compensate the Government of Brazil for foregone deforestation.

Logging and clearing of forests represents appropriation of the private values of the forests and loss of public values. The extent and longevity of that private appropriation depends upon the legality of land clearance, enforcement of deforestation laws, sanctions for deforestation, and tenure rights to the land. The Forest Code of Brazil requires land users to be registered and to retain forest on 80% of the land that they occupy. This can be seen as an attempt to maintain public value while allowing some private appropriation of that value. Non-compliance with the forest code has been common, however. The agricultural census of 2006 showed that the amount of private land under non-forest uses exceeded the legal limit of 20% in 749 of Brazil's 760 municipalities (Borner et al, 2014). In Pará state in the eastern Amazon, up to half of the land was settled without recognized land rights (L'Roe et al, 2016).

To alleviate contestation over land rights in the Amazon, several state governments have undertaken new land registration programs. The largest of these initiatives was in the state of Pará. Between 2007 and 2013 the Rural Environmental Registry of Pará registered about 100,000 properties covering 30 million hectares of self-declared land claims. This represented about half of the eligible land in the state.   The Pará registry system was to be comprised of two steps. The first step was to map the boundaries of land claims on satellite images of the area. The second stage was to provide a definitive land license to individual land owners after land boundaries

were verified and land users had submitted a plan for how they would comply with environmental laws. More restrictions were placed on the use of larger plots (greater than 300 hectares) than on small plots. By November 2013, only 2% of the properties registered had been issued with definitive licenses (L'Roe et al, 2016).

2.4 More open forest data and appropriation of value in the Brazilian Amazon

Using the number of fines levied by Ibama as a proxy for law enforcement, and clear skies as a measure of DETER detection, Assuncao et al (2013) found that areas with more intensive DETER monitoring had more effective enforcement of deforestation laws.

L'Roe et al (2016) used data from two open sources – the Pará land registry system and the PRODS project – to evaluate the proposition that Pará's land registry system encourages greater compliance with the Forest Code. They found evidence that land registration reduced deforestation among properties of 100-300 hectares, but not among any other land size category. They speculate that farmers in the 100-300 hectare land size category have greater incentive to comply with land use restrictions than farmers of other land sizes. In particular, these "small family farms" are allowed to purchase land from the government at below market rate provided that they can show that they comply with the Forest Code restrictions.

Case 3: More open and accurate data and the bioeconomy in Finland

3.1 Background

Promotion of growth based on bioeconomy and related innovations is a central goal of the current Prime Minister Sipilä's government in Finland. The development of digital forest services is one of "spearhead projects" within the bioeconomy theme, receiving significant budgetary inputs in 2015-2019 (Government of Finland 2015). The project includes the further development of a web portal Metsään.fi[1] which was launched in 2012 to facilitate forest information sharing between forest owners and service providers, and the revision of the Forest Information Act (2011) which regulates access to forest information. Metsään.fi development is also a key component of implementing the National Forest Strategy 2025 (Ministry of Agriculture and Forestry of Finland 2015). The forest sector developments are part of a broader policy reform to promote open data and digitalization in Finland, including a cross-sectoral open data programme initiated by the previous national government (Ministry of Finance of Finland 2014) and a policy goal to make open science – open publishing, sharing of data and research infrastructure – the norm in research by 2017 (Ministry of Education and Culture of Finland 2014). These policy developments indicate a stern belief by Finnish decision makers in the values of open data and digital services for the national economy and well-being. Finland's Open Government Score for 2015 is 0.76, which ranks it number 6 out of the 102 countries included in the World Justice Open Government Project (World Justice, 2017).

3.2 Private and public values of forests in Finland

Finland is a heavily forested country with a remarkably high proportion of the population are personally connected to the forest. Kangas and Niemelainen (1996) report that 20% of Finnish citizens are involved in some type of nature-related profession and that 87% of people report that they collect berries or mushrooms

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[1] "To the forest.fi"; www.metsaan.fi, website is available in Finnish and Swedish only.

from forests "sometimes" or "often". Finnish residents believe that forests should be maintained for the following results: (1) to maintain the vitality of forests, (2) scenic beauty, (3) minimizing impact on water systems, (4) conservation of biodiversity, (5) collection of berries and mushrooms, (6) nature conservation, (7) outdoor recreation, (8) employment, (9) wood production, and (10) hunting and game management. These survey results show the predominance of public versus private values of forests. A great deal of research has since been conducted on public preferences for different approaches to forest management. From a comprehensive literature search of forest preference surveys in Finland, Sweden and Norway, Gundersen et al (2016) conclude that most people prefer some level of management for forests that are located near to settled areas, which could include harvesting of dead or dying trees, logs, logging residue, thinning, removal of small stems or removal of trees along roads or under power lines. Thus there is some potential for the harvesting of biomass energy or bioeconomy products to be consistent with public preferences.

3.3 Appropriation of the values of Finland's forests

About 60% of forestland in the country, approximately 12 million hectares, is privately owned; 74% of it by families. State-owned forests comprise 26% of the total forest area, and the other 14% is owned by companies, municipalities and communities such as parishes. The average size of a family forest holding is fairly small, about 30 ha. The number of forest owners is greater than that of holdings, since forests are typically owned by spouses together or by estates involving on average of four persons. It is estimated that there are around 737,000 persons (about 13% of the population of the country) who own at least two hectares of forest in Finland (Finnish Forest Research Institute 2014).

About 11.2% of Finland is in protected areas, but only 2.2% of the land area of southern Finland is protected. Most of those protected areas are located at high elevations and high latitudes. Ironically, areas with the highest value for nature conservation are located on private land (Mantymaa et al, 2009).

There have been some attempts to reward private forest owners for the public values that their forests generate. Between 2003 and 2007, Finland experimented with a voluntary market-based program to preserve forest habitat on private land, called "Trading in Natural Values". That program allowed for fixed-term rental contracts between government agencies and private forest owners.   Experience with the initial phase led to an extension of the program from 2008 to 2016. Forest lands are rated on their importance for conservation and lump-sum payments are made at the beginning of the ten-year contract period (Hiedanpää and Bromley (2016).

3.4 Open data and appropriation of the values of Finland's forests

The Finnish national forest information system is one of the most comprehensive in the world. Systematic data have been collected for over 100 years, and current remote-sensing based methodologies have further increased the quantity and quality of the available data. Metsään.fi contains data on private forests collected and maintained by the government. The information on private forest holdings in Metsään.fi includes data on forest resources down to the level of individual stands, based on remote sensing and field sampling, as well as information on forest management and use, and land use and ownership. In November 2015, the system covered 75% of the private forest area[2]. In the Forest Information Act (2011), the information contained by the system is considered to be personal data of the forest owners, subject to the Personal Data Act (1999).

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[2] http://www.metsakeskus.fi/metsatiedon-luovutus#.Vsbd1ysqzEZ, website available in Finnish only

Agreement by the forest owner is a prerequisite for third-party access, including forest industry service providers. In Metsään.fi, forest owners can grant access to information on their forest holdings to registered service providers with a simple click of the mouse. Data may then be directly transferred using a digital communications interface. Initially, forest owners and service providers had to pay a yearly fee to use the service, but forest owners' fees were dropped in March 2015, and since March 2017, service providers have also been able to use Metsään.fi for free. Along with a gradual expansion of the informational content and applications of the service, free access is expected to increase user numbers, accelerate information sharing on private forests and boost the efficiency of forest management and economy, as services based on accurate forest information may be directly marketed to targeted forest owners.

Despite the existing and rapidly developing ICT infrastructure for producing, sharing and opening forest information, the rules of the game are still very much subject to a heated debate. At the core of this debate is the overhaul of the Forest Information Act of 2011. In September 2015, Finland received a Written Warning from the European Commission concerning the openness of forest data: the data is considered public environmental information which should be openly available in line with the INSPIRE directive (2007/2/EC). In 2016, the Ministry of Agriculture and Forestry released a proposal concerning reform of the law for public comments. The proposal sought to resolve tensions related to the requirement of fully open access to private forest information, which the Central Union of Agricultural Producers and Forest Owners (MTK), the self-appointed forest owner lobby in Finland, strongly and repeatedly equated with disclosing private bank account information of forest owners. The proposal would have given forest owners the right to order data on their forest holdings to be removed from public data banks and subsequently future information services such as Metsään.fi. However, the proposal was found to be judicially problematic; the right to data removal would mean that private persons could decide upon the content of public registers, in contradiction to the Constitution. The Ministry of Agriculture and Forestry is currently reworking the reform proposal, due in August 2017.

Conclusions from the case studies

This paper focuses on the links between openness of forest governance and openness of data about forests. The analytical framework has a central concern for values: the public and private values generated by the forests, the appropriation of those values, and the ways in which open data about forests affects that appropriation.

Three case studies are considered, which are judged to have relatively low (Liberia), moderate (Brazil) and high (Finland) levels of government openness. The Liberia case under Charles Taylor shows the way that corrupt government officials can appropriate public forest resources for personal gain, with data misrepresented or under-reported to disguise that appropriation. Rigorous international efforts in open data on the spatial pattern of deforestation and forensic analysis can help to illuminate this situation and reduce, although likely not eliminate, the market for conflict timber. Lasting action for sustainable timber harvest requires collaboration between local communities, national authorities, international certification authorities, and international buyers of timber.

The Brazil case shows the challenges of managing the large expanses of forests that make up the Amazon. Those forests generate huge public values for the international community, for the people of Brazil, and for local communities. There is large variation in private values, however, with indigenous people benefitting from the collection of non-timber forest products from intact forests, timber companies benefitting from selective forest harvest, and farmers and plantation owners benefitting from land clearing. Collection and open publication of data on deforestation can help to illuminate the causes of deforestation, but reductions in deforestation are only likely where public or private agencies are able to provide land users with real incentive to avoid being characterized as environmental law breakers. Incentives can be created through the market, eg the market for beef, more secure property rights, direct government incentives, or cross-compliance arrangements that link government support to compliance with the Forest Code.

The Finnish case demonstrates how public and private values are at the core of the debate on governing the opening of forest information. The Government of Finland is concerned with the public values of that information which include more effective management of the cultural and regulating services of the forests, as well as the private values which include the commercial values of forest products, including new values associated with the bioeconomy. The Government also wants to comply with the European Union INSPIRE Directive which it signed. Forest owners are concerned with both private and public values, but some of them, through MTK, oppose fully open access to private forest information out of fear of infringement of their personal data. While the reasoning behind this fear is not clearly articulated in the public debate, it is plausible that on the one hand, for instance, conservations organizations would also be interested in the private forests with high nature values. Drawing public attention to them through open data applications might increase the pressure to appropriate the public values of these forests related to cultural and regulating services. On the other hand, MTK and its local branches, the local forest associations, have traditionally played the part of middlemen between forest owners and the forest industry. This role could be undermined when opening forest information through ICT services such as Metsään.fi enables more direct deals between forest owners and the industry – including that related to new products and services associated with the bioeconomy, beyond the traditional timber industry which has a close relationship with MTK.

Overall conclusions

Overall these cases illustrate how values – public, private, mixed – their substitution, and their appropriation are at the center of social choices about the openness of forest data. The Finnish case shows that some of the private values of forests – collection of non-timber forest products such as mushrooms and berries and some biomass energy extraction – can be privately appropriated with very little negative consequence for the public values. Open data that increases those values may encounter little opposition. The Liberia cases shows that some of the private values of forests – extraction of high value timber products – can have large negative consequences for public values, including the values of peace and stability. Open data on conflict or illegal timber extraction is likely to encounter fierce opposition from those who benefit. To counter this, open data would need to be combined with local action and radical changes in respect for the rule of law.
In cases where appropriation of the private values of forests are consistent with public values, open data on forest resources is likely to produce both private and public benefits and thus can be managed as mixed goods. In cases where appropriation of private value generates negative tradeoffs with public values, both forests and their data are likely to be hotly contested. In cases where government agencies (or producers' associations)

prefer to protect the status quo, they may be reluctant to change the openness of forest data. In such cases, political processes may arise to enforce greater openness and the public values of forests.

New advances in the availability and use of open forest data for forest inventory and deforestation can help protect the international public good characteristics of forests. Without changes in the public and private values of forests, however, these initiatives can be perceived as challenges to the sovereignty of national or local governments. Future research should explore the potential for REDD+ to lead to the protection or openness of forest data.

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Appendix A: Examples of open forest data initiatives

Forestry data initiative	Access	Values and value appropriation	References and html
Euro Forest Portal	Open	Multiple	http://forestportal.efi.int/lists.php?pl=01.20
Earth Science Information Partners	Different types of partners	Multiple	www.esipfed.org
Finland	Currently restricted to forest owners, under debate	Private and public	http://www.xn--metsn-jraa.fi/ http://www.metsaan.fi/tietoa-palvelusta
ForestGEO	51 long-term forest study sites in 22 countries	Open, dash board of long-term monitoring data.	http://biogeodb.stri.si.edu/bioinformatics/en/
FAO Global Forest Assessment	Combines data from remote sensing and sample sites. Supports REDD+ countries to develop, implement and operationalize their national forest monitoring systems.	REDD+ (in theory)	(http://foris.fao.org/static/idf/RSS_2010update.pdf)
Global Land Analysis and Discovery Group, University of Maryland	Open results using open Land TM and Modus data from NASA.	Deforestation alerts, crop production	www.glad.umd.edu
IMAZON and DETER	Open	Public values	Sá, C. & Grieco, J. (2016)
International Forestry Resources and Institutions	Until 2008 data and tools were only for authors and network members. After 2008, tools open; data still restricted to network members.	Generalizable insights; public values	Wollenberg et al (2007). http://www.ifriresearch.net/resources/methods/