

New data infrastructures for environmental monitoring in Myanmar: Is digital transparency good for governance?

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journals.sagepub.com/home/ene**Jenny E Goldstein and Hilary Oliva Faxon**

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Abstract

The design and use of environmental data infrastructures, including software platforms, sensors, satellite data, mobile phone apps, and digitally generated visual representations, is increasingly inseparable from contemporary environmental governance. Such technologies are often intended to enable data transparency, which in turn is assumed to promote expanded participation in democratic governance. In this article, we investigate how environmental monitoring, as performed through domestic and globalized infrastructures that seek to make digital environmental data open and transparent, is playing out in Myanmar's forest sector. New data infrastructures are inseparable from the proliferation of non-state actors involved in environmental governance amid the country's transition from military surveillance state toward more liberal and democratic rule, yet participation is not universal. We argue that actors engage new platforms and tools based on different understandings of the role of increased data transparency in environmental governance, which in turn are structured by historical relations with and within the legacy of the surveillance state.

Keywords

Data infrastructure, Myanmar, environmental governance, forests, transparency

Introduction

The nature of contemporary environmental data infrastructures—software platforms, sensors, satellite-based monitoring, mobile phone apps, and digitally generated visual

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representations—is increasingly inseparable from environmental governance (Bakker and Ritts, 2018). Satellite- and internet-based environmental data infrastructures have been used by states and scientists for several decades to surveil land use activity, promote economic development, and bolster territorial claims (Edwards, 2010; Gabrys, 2020; Monteiro and Rajão, 2017; Parks, 2012). Few states have maintained spatial data infrastructure under centralized national agencies, however, and now instead rely on a patchwork of cartographic and sensor-derived data provided by individuals, companies, development institutions, and sub-national agencies (Goodchild, 2007). In this transition to diffusely produced environmental data, data infrastructures have also become publicly accessible to a more diverse user base. Small and inexpensive satellites with remote sensors and high-resolution cameras, like those owned by the US-based company Planet,¹ generate continuous streams of big data while advances in processing via algorithms, environmental sensors, online platforms, and smart phones have enabled diverse actors to make sense of the huge quantities of data in real time. Production of data infrastructures by dispersed actors and institutions has also provided an opening for non-state and extra-state actors to engage with these platforms, apps, and big datasets in ways that enable new forms of participation in environmental governance for otherwise marginalized actors. They also impact what people see in the environment as problems, how they respond to such problems, and shape citizen participation as well as legal interventions in ways that generate new political effects (Avron, 2017; Boucquey et al., 2019; Star, 1999; Fortun, 2004; Gabrys, 2016; Mol, 2016; Rajão and Hayes, 2009).

In countries that have more recently gained widespread internet access, data infrastructures are further articulated through changing political institutions (Rajão and Hayes, 2009) along what Schia (2018) calls the “cyber frontier,” or the “interface regarding digitalization, between local and national polities in the Global South and large-scale global forces” (822). Across Southeast Asia for instance, platforms such as Open Development Mekong² and SERVIR-Mekong³ that disseminate geospatial data and track development indicators have been rolled out through collaborations between external state development agencies, international non-governmental organizations (NGOs), and private corporations that provide the technical infrastructure, such as cloud server access and in some cases, the raw data itself. In development practice, infrastructure projects are no longer limited to things fixed in place—roads, power grids, waterways—but are inclusive of the structures and networks used for the generation and circulation of data (Jensen and Winthereik, 2013). In this article, we investigate how the relationship between environmental governance and new data infrastructures is playing out in Myanmar, a country undergoing simultaneous political and digital transformations, with a focus on forests, a prime object of global environmental governance through data (Gabrys, 2020). We trace how historic tensions between environmental conservation, commodity production, and subsistence use have reemerged in Myanmar’s contemporary digital monitoring as new and old actors harness data infrastructures to support competing visions of forest governance.

The roll out of data infrastructures in the Global South has, more generally, been influenced by a trend touting greater transparency and inclusive participation in environmental governance and development programs through partnerships between state, civil society, and private sector actors. For instance, the Global Partnership for Sustainable Development Data, a United Nations-facilitated network of businesses, government agencies, and NGOs, runs an Open Data for Development platform to promote data-driven socio-economic change, monitor progress on the UN Sustainable Development Goals, and assist governments in preventing corruption through data transparency.⁴ A 2015 World Bank report argues for the role of Open Data in “ensuring environmental sustainability through

transparent data that can help reduce pollution, conserve natural resources, and build resilience to climate change” by increasing government accountability, transparency, and citizen participation (Gurin et al., 2015: 3). Such initiatives demonstrate the value global development actors place on the creation and dissemination of data that is distinguished, as the World Bank report claims, not by its size or complexity “but the fact that it is made available as a public good” (Gurin et al., 2015: 7).

Yet technologies that monitor forest cover, track wildlife, and detect illegal activities such as poaching and timber harvesting can also justify new forms of coercive environmental management and control (Adams, 2019). We seek to refine the generalized assumption that Adams makes about the coercive nature of remote detection technologies by drawing attention to the ways that environmental monitoring can be deployed either as a technology of control—functioning as coercive surveillance—or to meet demands for increased data transparency with implications for broader democratic participation.⁵ Much of how this distinction might be leveraged depends on users’ existing political positions.

Myanmar presents a particularly acute example of how these tensions are playing out against a history of state coercion and absence of data transparency. Since 2011, Myanmar has gone from an informational black hole to a node in global data networks. As new civilian leaders liberalize the economy and undertake a messy and incomplete transition to democracy, internet and communications infrastructure, open data portals, and increased access to satellite-based monitoring have expanded exponentially. Prior to 2013, there was little internet and mobile phone access throughout the country; by the end of 2019, Myanmar had more SIM cards in circulation than citizens, and 82% of the country had access to the internet over 3G or 4G networks.⁶ Expanded internet access and subsequent proliferation of digital tools and platforms can enable broader participation of non-state actors, including in resource governance. At the same time, in a country with an entrenched military bureaucracy, these changes bring with them threats of continued state surveillance (Dean, 2017). Myanmar’s valuable natural resources, including land, teak, jade, rubies, oil and gas, and hydropower, have long been controlled by military generals, Ethnic Armed Organizations (EAOs), and well-connected cronies (Buchanan et al., 2013; Ferguson, 2014). Historically, the majority of the population saw little to no benefit from the country’s resource wealth. Today, civil society organizations (CSOs), domestic and international NGOs, and the private sector are wielding knowledge about valuable natural resources and the political–ecological contexts in which such resources are accessed and controlled.

To understand how digital environmental monitoring takes place in this context, we focus on how situated actors with different goals engage diverse and emergent data infrastructures with potential to make environmental knowledge more available and open. Myanmar is in the midst of what Barry (2006) calls the formation of a technological zone: a “space within which differences between technical practices, procedures or forms have been reduced, or common standards have been established” (239), leading to greater data sharing and participation. This notion goes hand in hand with ideals of democratization, as participants in democratic governance are presumed to have access to data (Marres and Rogers, 2008). To date, the Myanmar state has done little to generate new data infrastructures on its own, however, opening up space for non-state actors to lead the formation of the country’s technological zone both from within and beyond Myanmar’s state boundaries. New data infrastructures are thus inseparable from the proliferation of new actors involved in governance amid the country’s democratic transition and enable new forms of participation. International NGOs promote data transparency as a necessary means to democratic resource governance, characterized by increased participation from and shared benefits for diverse actors (“stakeholders”). Yet *contra* assumptions about open

data within the development community, in Myanmar we find that many non-state actors challenge the notion that more transparency leads to better environmental governance. Rather than assume more data are desirable for all actors, we argue that actors selectively and strategically engage new platforms and tools based on different understandings of the role of increased data transparency in environmental governance that are based on their relations with and within the legacy of the surveillance state.

To demonstrate these emergent politics of participation and transparency in digital environmental monitoring, we draw on interviews with 26 individuals conducted in Yangon and Naypyidaw⁷ by either author between January 2017 and January 2019 with informants selected across a range of actors, including international NGOs, domestic CSOs, and government staff.⁸ Knowledge of the broader political context for this research also draws on long-term fieldwork in Myanmar by one author (Faxon). In the following section, we highlight how new data infrastructures reshape debates over transparency, monitoring, and participation in environmental governance before situating the emergence of Myanmar's data infrastructures within the country's longer political, environmental, and technological history. We then turn to the question of participation in new forms of environmental monitoring. We describe how a wide range of actors, including international conservation NGOs, sustainable timber traders, and local CSOs and EAOs, engage digital forest monitoring before discussing the socio-technical limitations to contemporary efforts to achieve transparency, and ultimately "better" environmental governance, through data. In analyzing these qualitative empirical data we acknowledge that we do not yet know all of the consequences these new technologies may have for environmental governance. Nevertheless, we respond to calls to investigate these technologies as they emerge, "rather than waiting for many of their subsequent effects to unfold" (McCarthy and Thatcher, 2019: 11). This echoes many of our informants' perspectives that environmental data should be circulated and deployed in governance efforts despite being incomplete. As one foreign employee of an environmental NGO put it, "if we wait until we have perfect data, then there may be nothing left to protect" (personal communication, January 2017).

Transparency, participation, and monitoring in environmental governance

Contemporary environmental governance prioritizes involvement of non-state, supra-state, and/or extra state actors in exercising political authority over decision making about nature (Bridge and Perreault, 2016). Furthermore, as Bridge and Perreault (2016: 482) argue, new initiatives to formulate "good governance" regimes within extractive resources, including fossil fuels, minerals, and forestry products, frame the politics of resource control and use as a problem of actor inclusion and participation. Such initiatives, as they are often pushed by non-state actors as a means to monitor resources within state territories, along commodity chains, and across state lines, encourage participation from additional actors thereby creating new spaces for political contestation. We seek to push this question of participation further in asking how new data infrastructures also change how environments are "infrastructured" (Blok et al., 2016)—how they are known and managed, by whom, and to what effect—through environmental monitoring, in a shift away from exclusively state-based surveillance and control. New data infrastructures can enable a broader range of non-state actors to participate in forest governance, or the ways that actors set political and economic objectives for forest use and access. Furthermore, new data infrastructures have shifted the capacity of state actors to enact governance by providing alternative expertise

that undermines their authority. As Jasanoff (1997) has argued, non-state actors turn knowledge into action by questioning dominant narratives, providing alternative explanations of environmental problems, and linking local issues with global concerns. The internet and cross-national digital platforms also enable transnational NGOs to impose their priorities over local or domestic concerns as a medium that “renders visible the rise of networked forms of governmentality and the complicity of NGOs in the process” (Marres and Rogers, 2008: 254).

Within environmental governance initiatives, transparency is considered to be an unalloyed good that can empower the weak and hold the powerful accountable through the disclosure of information (Gupta, 2010; Levy and Johns, 2016). As Ananny and Crawford (2017) argue, “transparency concerns are commonly driven by a certain chain of logic: observation produces insights which create the knowledge required to govern and hold systems accountable” (974). In addition to enabling accountability, efficiency, and efficacy, transparency—or “governance-by-disclosure” initiatives (Gupta, 2008)—has become embedded in democracy itself, as the availability of information is “assumed to enable civil societies to perform epistemic checks on the validity of claims being made in regard to the achievement of environmental targets” (Turnhout et al., 2014: 582). The process of making information transparent under the assumption that such information can empower has furthermore “long been central to participation debates, for example, with much attention devoted to devising innovating procedures to enhance citizen involvement in environmental decision-making” (Gupta, 2008: 3). Yet as Gupta (2010: 6) also points out, democratic governance does not necessarily follow from transparency; there is also the possibility that transparency follows advances in democratic and environmental governance, rather than paving the way for those objectives. In practice, data and information transparency can also function as a means through which political goals unaligned with good governance can be enacted and exploited, what Levy and Johns (2016) call a “Trojan Horse” of data transparency. The darker side of transparency thus extends a system of control through observation but not necessarily deeper understanding, with the potential to be disconnected from power if those intended to be held accountable through transparency are not vulnerable to being shamed through public exposure (Ananny and Crawford, 2017: 978). Depending on an actor or institution’s socio-political status, transparency can also threaten privacy or provide undesirable publicity without necessarily building trust between actors (Ananny and Crawford, 2017).

These considerations raise new questions about how more transparent and accessible data can enable new actors’ participation—or actors to participate differently or more visibly—in environmental governance and whether this expanded participation can lead to new and more equitable forms of environmental governance. While expanded access to the internet is “said to provide a forum for civil society involvement in controversies over transnational issues and... to enable differently situated actors to challenge the exclusionary effects associated with political globalization” (Marres and Rogers, 2008: 254), the democratic potential of new data infrastructures may remain limited. Satellite-derived geospatial data and their visual representations deployed in tandem with on-the-ground environmental monitoring tactics determine how the knowledge generated by such strategies is used to negotiate political claims across a range of actors (Elwood and Leszczynski, 2012). Participation among actors, particularly those operating at the grassroots level, has historically been limited. As Haklay (2016) notes, participation inequality among open and crowd-sourced software users is a widespread phenomenon in which a small proportion of users generates the majority of information, leading to disparities in data coverage. In many cases, participation inequality correlates with social inequality, as participation is

determined by who has time and financial resources to be able to contribute data (Haklay, 2016). Yet perhaps more important than technical “data literacy” is what Gray et al. (2018) call “data infrastructure literacy,” or an understanding of the socio-politics of digital infrastructures. In some cases, participating in digital environmental monitoring premised on data transparency can distract from governance objectives while representing “another instrument of capital control and government surveillance” (Sieber, 2006: 491). Actors may opt out of participating when they recognize that grassroots and/or activist involvement in environmental monitoring does not necessarily lead to more power or policy influence.

The rapid rise of data infrastructure in Myanmar

The rapid expansion of internet access and attendant data infrastructures in Myanmar over the past several years has enabled societal changes ranging from the quotidian—the ability to use mobile phone apps to hail taxis in urban Yangon, for instance—to the profound, such as the capacity for human rights groups to use satellite imagery as convincing evidence for genocidal clearance operations.⁹ In their work on monitoring development aid, Jensen and Winthereik (2013) point out that constructing these new infrastructures involves more than the material: “Crucially, making aid infrastructures is not simply a matter of designing and implementing *technology*. Making aid infrastructures entails forging new platforms for action that are simultaneously imaginative and practical, simultaneously conceptual and technical” (4). We extend this insight to show how these new forms of data production, collection, and distribution produce a new terrain of practice for not only development aid, but also environmental governance. To function effectively, such infrastructures rely on a shared space of common practices, or “technological zones,” in which standards are made comparable and legible for institutions such as business organizations, civil society, international NGOs, and the state (Barry, 2006). Such zones enact a normative “structuring of relations” (Barry, 2006: 241) that can lead to greater transparency, unexpected alliances, and political possibilities. Technological zones also place demands on the actors, institutions, and infrastructures within them, circumscribing participation within their limits. We follow Barry’s call to attend to the conditions under which such technological zones emerge and evolve, but suggest that Myanmar is currently a technological zone-in-formation, one in which neither socio-political values—such as transparency—nor technical standards are fully established.

The collection and governance of data has served changing priorities of value extraction, surveillance, and “development” under Myanmar’s different regimes. Creating systems to gather data that facilitated taxation and resource extraction was a core activity of the British colonial state. These systems eroded under socialism from the 1960s to 1980s and the authoritarian regime maintained the residues of colonial reporting alongside heavy censorship, pervasive state surveillance, and restrictions on movement that made daily life both dangerous and precarious (Fink, 2009). The effects of bad and limited data were compounded by the fact that Myanmar was cut off from the broader world during the military regime, with access to telecoms restricted by a military-state monopoly. International development agencies and the government under President Thein Sein made rectifying Myanmar’s data gap central to political reform in the early 2010s, but the nation’s first census in over three decades was rife with flaws, and ethnicity data were never released due to methodological and political problems (Callahan, 2017).

In 2010, Myanmar’s military junta, the Tatmadaw, allowed free and fair national elections for the first time since 1960, beginning the process of a still-ongoing transition to

democracy. In November 2015, the world watched as Myanmar's citizens elected opposition leader and Nobel Laureate Aung San Suu Kyi and her party, the National League for Democracy, into power, formally ending a half-century of military rule. The election was a symbolic moment in much longer and contested transition from state socialism to capitalism and from dictatorship to democracy, a process shaped by entrenched cronyism and protracted violence in the borderlands (Jones, 2014). Since independence in 1948, continuing conflicts over ethnic self-determination and territorial control have incorporated different natural resources in complex ways, and created a variegated landscape of fragmented sovereignty and hybrid governance (Hong, 2017; Meehan, 2015; Smith, 1999; South, 2018). While recent reforms partially liberalized the economy, moved closer to representative democracy, and encouraged an influx of international investment and aid, the early years of the National League for Democracy government were marked by continued military impunity, violence, and state censorship (Callahan, 2018).

For international observers and Myanmar residents alike, liberalization of the telecommunications sector appeared to break with historic attempts to control and limit public information and communication. The Myanmar state began auctions for telecoms licenses in 2013 and officially awarded contracts to Norwegian-owned Telenor and Qatari-owned Ooredoo in January 2014 to build out the country's internet infrastructure in both urban and rural areas as part of reform under the Thein Sein government (Heijmans and Aung Kyaw Nyunt, 2014). According to government figures, the number of internet users in Myanmar rose from 2 million in 2014 to more than 39 million in the first two years after the liberalization of the telecoms sector, with the number of SIM cards in circulation quadrupling in the same period (Aung Kyaw Nyunt, 2016). In mid-2017, the Singaporean-owned telecommunications infrastructure firm Campana signed a deal to bring the country's first privately owned undersea internet cable to Myanmar, breaking the state-owned Myanmar Posts and Telecommunications long-held monopoly over telecommunications infrastructure and tripling the country's available bandwidth.

The use and utility of new data infrastructures is hindered by the partial formation of metrological, infrastructural, and qualification standards. Myanmar currently lacks common software and information norms, for example the government only recently declared it would use the international standard (unicode) encoding of Burmese script, but the local encoding and *zawgyi* fonts, developed independently and incompatible with many international platforms, remain popular. Different ministries use different projections and coordinate systems on their maps, resulting in government spatial data that are frequently internally and externally inconsistent. According to one government GIS expert, data collected by different government departments are of varying quality and rarely digitized; many government offices still lack computers (personal communication, January 2019). Connection standards for information and communications technologies, like the cell towers, internet cables, and data networks themselves, are under construction. New attempts to make official data accessible are slow-moving; ongoing cyber-attacks on poorly secured ministry websites have led some state ministries to remove online data repositories, making it particularly useful for CSOs to have access to raw data from multiple sources (personal communication, August 2018). Meanwhile, Myanmar is building a regulatory framework, including through an E-Governance Master Plan and discussions of data privacy and cyber security. Efforts at establishing quality and regulatory standards contend not only with a lack of appropriate policies, but also with an entrenched proprietary culture: today, Myanmar's official high-resolution map remains a military controlled state secret and sharing data even within the government requires high-level approval that is not always granted (personal communication, January 2019).

Myanmar's rapidly expanding telecommunications infrastructure has attracted billions of US dollars in foreign direct investment, but its social impacts have been far more ambiguous. Facebook, Viber, and new digital apps have changed how urban and rural residents alike gather information, connect socially, and engage in politics (McCarthy, 2018). At the same time, the political economy and use of digital media build on analog foundations (Brooten et al., 2019; Schissler, 2015). Given Myanmar's longstanding ethno-nationalist violence, it is deeply troubling but perhaps unsurprising that the internet and Facebook have been co-opted to extend old patterns of surveillance and repression and to stoke anti-Muslim violence (Dean, 2017; Fink, 2018; Lee, 2019).¹⁰ Though Myanmar's state surveillance during the military junta was not technologically advanced it was extensive, and emerging technologies of environmental monitoring must be placed in the context of this longer history in which much of the country remains wary of surveillance by any means and top-down authority. The formation of Myanmar's emergent technological zone is shaped by the recent arrival of affordable telecommunications within this authoritarian legacy. While technical standards may indeed evolve to be complete in Myanmar, resistance among some actors to full data transparency may render the country's technological zone forever partial.

Environmental monitoring in and beyond the state

New data infrastructures have rapidly been developed for and enrolled in diverse projects related to environmental conservation, policy-making, and claims, particularly of Myanmar's expansive and biodiverse tropical forests. The arrival of new actors, funding, and digital technologies are expanding participation in environmental monitoring, giving voice to longstanding debates about the value and governance of resources. While monitoring is conducted by a broad range of both domestic and international actors, some have better access to technological capacity and resources, reflecting uneven power dynamics among those with different environmental priorities. The hesitancy for some actors to engage foreign-built software platforms for remote monitoring points to the ways in which emergent data infrastructures exclude, as well as generate and aggregate, knowledge. The Myanmar case illustrates that even with full data transparency, the possibilities for digital monitoring to yield equitable environmental governance are limited by the politics of data creation, ownership, and use. We first discuss how new digital platforms are shaping and are shaped by actor participation before turning to a case study of how digital monitoring is unfolding within the country's forest sector.

With the rapid rise in internet connectivity, a wide variety of NGOs and CSOs in Myanmar have expanded their environmental governance initiatives into digital spaces. One of the earliest online platforms was the Myanmar Information Management Unit (MIMU), a public, searchable database of development and humanitarian datasets, documents, and maps created in the devastating wake of 2008's Cyclone Nargis to support development programs and disaster response.¹¹ The platform, funded and administered by the United Nations, also provides GIS and data management training to the government and makes free, customized maps for NGOs and government. After severe monsoon floods in 2015, MIMU used sentinel satellite imagery to create up-to-date maps of the flooding in order to support targeted emergency response (personal communication, January 2017). A local land rights NGO established the Myanmar Land, Agribusiness, and Forestry Issues (MYLAFF), a free, membership-based repository of documents and presentations related to land, in July 2014.¹² A Myanmar-specific site for Open Development Mekong, a platform that shares open data and short analyses for environment and development issues in Cambodia, Laos, Thailand, and Vietnam, was started the following year.¹³ Whether run

by local, regional, or international organizations, these platforms provide environmental documents, datasets, and maps from government as well as NGO, activist, and international sources. In the context of slow-moving attempts to get official state data online and ongoing cyber-attacks on poorly secured ministry websites, these sites play an important role in aggregating and maintaining access to existing government data (personal communication, August 2018). The platforms do not rely on the government, enabling activists, researchers, and development workers access to multiple types of information about resources, development, and disasters.

Some internationally led platforms cooperate closely with the Myanmar government. One Map Myanmar, a Swiss government-funded platform run in collaboration with the University of Bern, works with the government to centralize, standardize, and analyze spatial data. The US\$8 million dollar initiative was led by international donors' interest in increased data sharing within state ministries and officially launched in 2014 with a mandate for open government data (personal communication, January 2017). While the program runs participatory mapping activities and stakeholder consultations with CSOs, as of 2019 the One Map online platform itself had restricted access, primarily to government staff. The international NGO the Natural Resources Governance Institute (NRGI), which publishes resource datasets and advocates for benefit-sharing of oil, gas, and minerals, hosts Open Jade Data (OJD), a platform that publishes Myanmar government data on the official jade trade in accordance with international open data standards.¹⁴ OJD converts hard copies of government statistics into raw, machine-readable data, analyzed in short "data stories" and visualized with open-source tools such as Datawrapper. NRGIs staff cultivate data access through face-to-face meetings with government officials. The platform itself was formed after the state newspaper reported that Myanmar had received an abysmal ranking in the NRGIs global Resource Governance Index, spurring conversations between NRGIs staff and relevant ministries who were shamed, angry, and desperate to improve the situation, about how to more effectively manage information about the jade sector. In Myanmar, working closely with the government has historically entailed tremendous risk, particularly in departments governing gemstones, which are populated by former military officers. One Myanmar NRGIs staffer described their approach:

We don't come [to the government offices] with a preconceived assumption like ... 'these guys are the vanguard of the military.' Of course they are all ex-military ... But you can't have that kind of ... hostile attitude. So working with them requires of course a lot of diplomatic shuttling, but they have also been in that position long enough to think like a bureaucrat. Sometimes the military genes pop up, but ... you've just got to try! ... Many people in Myanmar, the organizations, they didn't want to try because they have the idea that it might not work. For us also, we never had the idea that we would have this type of relationship. Unless we try. (Personal communication, September 2018)

In this case, digital tools and the government's own selective embrace of transparency as part of the democratic transition and concern with an international image provided new opportunities for NRGIs to work with the government to make official statistics open-access. While these two platforms provide examples of new forms of cooperation between state and non-state actors in environmental monitoring, the current iterations are limited. In the case of One Map, this is most obvious in the issue of user access: only government staff can currently use the site. OJD, on the other hand, is publicly accessible but hindered by a lack of data: there are no government statistics on the massive illicit jade trade. These problems hint at participation inequality and the challenges of a transparency-based approach.

The case below demonstrates the ways in which different environmental objectives and selective engagement with data infrastructures are reconfiguring the roles and relationships of state and non-state actors in forest governance.

Expanded participation and its limits in forest monitoring

Remote monitoring of forests has become increasingly popular in recent years, driven by the growing availability of satellite imagery and its use by international environmental NGOs (Goldstein, 2014). For instance, the Global Forest Watch (GFW) online platform run by the US-based World Resources Institute draws on Google software and academic expertise to display national and sub-national data layers on forest cover, forest loss, and areas licensed for agriculture plantations and mining concessions (Figure 1). Launched in 2014 and funded by state development agencies such as USAID and the Inter-American Development Bank as well as private sector companies like Cargill, GFW promotes the idea that “It’s hard to manage what you can’t measure” through free access to forest and land data.¹⁵ For international NGOs, scientists, and policymakers working at national or supra-national scales, GFW has been useful for quantifying forest loss associated with large-scale plantation agriculture and for holding corporations accountable to sustainable certification commitments (webinar, WRI Global Forest Watch, 17 April 2015). Explaining that open access

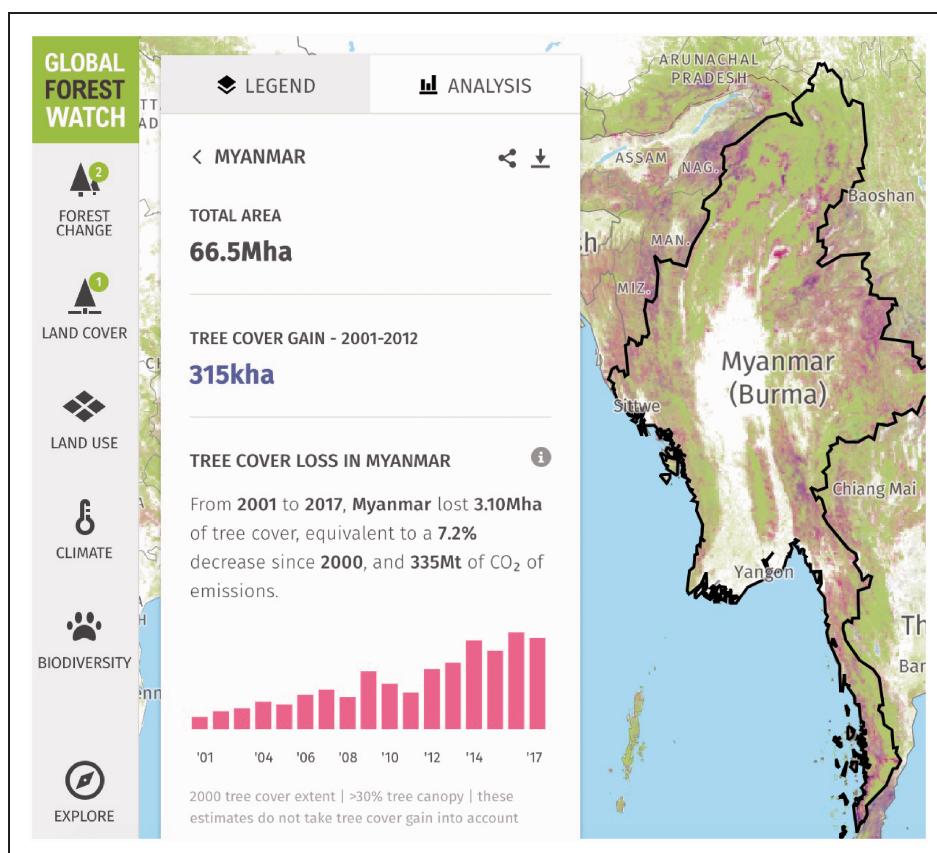


Figure 1. The World Resources Institute's Global Forest Watch displays data on forest cover change worldwide (<https://www.globalforestwatch.org/>).

mapping technologies like GFW and Google Earth allowed users to access and process large geospatial datasets in minutes as opposed to weeks, one foreign GIS consultant in Yangon we spoke to early in this project declared, “Google Earth is a game changer” (personal communication, January 2017).

However, the process by which more access to more data enables environmental monitoring is not self-evident, nor is it singular. When asked about GFW, conservationists working for international institutions in Yangon knew of the platform and sometimes used it for national scale land cover modeling, but said its resolution was too low to guide on-the-ground interventions. Those working in sustainable timber or at local CSOs, on the other hand, rarely mentioned the platform; the latter group was sometimes dismissive. The director of a Myanmar environmental NGO noted that GFW’s objectives to map forest change and concession boundaries do not align with his group’s objectives to report on community issues (personal communication, January 2017). Digital platforms such as GFW often contain many data layers, which are hard to transmit over the unstable or slow internet connections still common in parts of Myanmar. Myanmar-based environmental organizations without international collaborators often cannot afford to upgrade existing platforms or build independent software to meet their specific needs, meaning monitoring efforts rely on infrastructures built and maintained outside of the country. Furthermore, while Myanmar officially switched to the unicode standard in October 2019, during the course of this research most Myanmar users relied on *zawgyi* written language systems incompatible with international platforms. Divergent awareness of and engagements with this global platform highlight how monitoring efforts are conditioned by the parameters of the technology itself, as well as by the situated politics of resource use, value, and governance.

While the recent political transition has brought heightened international attention to protecting Myanmar’s forests for their biodiversity, carbon sequestration, local livelihood, and cultural value, dozens of complex threats to forest conservation and sustainable timber remain, including a lack of reliable and standardized statistics on species population and timber trade (Prescott et al., 2017; Springate-Baginski et al., 2014). The Myanmar state’s approach to forest governance has historically been dominated by a concern with timber extraction. Forests remain subject to an administrative framework rooted in the policies of British colonial Burma, which promoted the systematic growth, extraction, and worldwide export of valuable teak over the interests of subsistence users and local livelihoods (Bryant, 1997). Myanmar’s major resources and industries were nationalized in 1963, even as the government’s de facto control progressively eroded due to ongoing civil war. The timber trade fueled extensive logging throughout the country. Liberalization led to further forest loss: Myanmar lost almost 2% of its forests each year, a total of 1.34 million acres, between 2010 and 2015 (Food and Agriculture Organization of the United Nations (FAO), 2015) and an estimated 72% of timber exported between 2000 and 2013 was illicit (Environmental Investigation Agency, 2014). Despite a year-long ban on export timber and logging enacted in 2014 and again in 2016, deforestation rates remain among the highest in the world.

Myanmar’s political transition provided opportunities for new actors to work with and advocate to the Myanmar government on environmental issues. International conservation organizations like the World Wildlife Fund (WWF) opened offices and quickly expanded their in-country staff in the early 2010s, while groups already operating in Myanmar, such Flora & Fauna International (FFI), the International Union for Conservation of Nature, and the Wildlife Conservation Society redoubled their efforts to stem the loss of forest cover. In interviews, conservationists working for these transnational organizations emphasized that in the context of inaccurate and incomplete national data, publicly available

satellite data provide an important basis for analysis and strategic communications with government. Drawing lessons from elsewhere in Southeast Asia, one foreigner working at an international research center captured the promise of satellite data:

With Cambodia for example, you can see the deforestation and [the government is] constantly trying to doctor it, but everyone is like, we have the footage [proving deforestation is occurring]. Basically, it's a constant battle with the government. It just changes the dynamic when the Ministry of Forestry says, 'we have 77% forest cover' and you say, 'no, you don't.' (Personal communication, August 2018)

Whether and how these international conservation groups use satellite, drone, or field survey data depends on specific conservation goals. WWF's Green Economy program, for example, plugs GFW data into their own set of open-source software models, called InVEST (Integrated Valuation of Ecosystem Services and Tradeoffs), to monetize ecosystem services.¹⁶ These estimates, coupled with aerial photographs of extreme deforestation taken from parachutes, serve as the basis for targeted advocacy messages about road development, biodiversity conservation, and associated economic benefits of reducing deforestation. FFI, on the other hand, uses their own drones to collect terrestrial and marine data. While drone usage is controversial in Myanmar now, the footage is particularly evocative. FFI combines drone maps with species surveys, camera traps, and participatory mapping in select villages, and gives maps back to the communities and the local Forest Department in the hopes they will provide a basis for registering community forests and supporting conservation activities. Maps are not made public because the communities "own" these data, a stance that points to ways in which NGOs can empower communities to manage their local territory. At the same time, the international NGOs we spoke with emphasized that their digital monitoring activities were guided by an ultimate priority of global biodiversity conservation, an example of the ways in which international priorities can overpower local concerns. Conservation organizations are also limited by their commitment to working with the Myanmar government, upon whom they depend for permissions and visa letters, an arrangement that compromises their ability to empower local communities in a context in which nature conservation on forest frontiers can often be a tool for the expansion of state control (Woods, 2019).

In contrast to international organizations that have made data transparency a clear objective of increased environmental monitoring, the Myanmar government has embraced international funding and technical aid to monitor forests but without committing to data sharing beyond state institutions. Increased bi-lateral government donor support to stem deforestation has spurred improvements in the state's capacity to measure and manage forests. In 2019, the Forest Department's GIS and Remote Sensing unit included 26 staff, eight of whom had graduate degrees from Japan, Norway, or Thailand. The Department began changing their National Forest Inventory methodology from paper to digital around 2017, supported by the UN FAO as well as Finnish, Japanese, and German government agencies (personal communication, January 2019). In January 2019, one author observed a Forest Department training in mobile GIS for regional staff to monitor forests. An organizer noted that while hardware, software, and GIS skills are increasingly common in regional offices, data collection and especially publication face major challenges, for example the fact that the boundaries of some reserve forest areas remain confidential (author fieldnotes, January 2019). In a context where withholding information has long been a source of state power, the mere adoption of digital technologies in the absence of

institutional and policy shifts toward data sharing is not enough to ensure transparency in forest governance.

At the same time, EAOs have begun stepping up their remote management of forests. In 2017, one of Myanmar's oldest and most established EAOs, the Karen National Union (KNU), began building mapping units trained in ArcGIS to map agriculture and forest land that falls within their territory in Myanmar's Southeast. These state, or state-like, monitoring and management activities are often paid for by international donors, assisted by foreign experts, and facilitated with the help of local CSOs. For example, several years ago the Karen Environmental and Social Action Network (KESAN), a CSO closely allied with the KNU, obtained two drones and began mapping land and making documentaries about Karen customary conservation practices in coordination with new forest governance efforts (personal communication, May 2018). One foreign environmental activist working with ethnic Karen CSOs and EAOs explained:

Training and GIS has had a massive impact, not only on KESAN, but also on the Karen National Union. Predominantly through agriculture, forest, and farming mapping, in the last year or year and a half . . . we've seen a massive shift in the KNU's ability to govern, in a very short period of time. (Personal communication, May 2018)

In this case, digital tools strengthen the environmental governance capabilities of non-state actors who have long fought the Burmese government over the right to administer their customary territory, including large swaths of forest land. For groups that have relied on guns and weapons to defend their land, drones and GIS provide new technologies for spatial control in old battles over self-governance, resource sovereignty, and political legitimacy. While the production and circulation of maps and geospatial data has traditionally been used as a tool of territorialization (Goldstein, 2020), making the data produced through these technologies transparent, however, is not necessarily the end goal of these efforts. For EAOs like the KNU and their allies KESAN, generating geospatial data about the external boundaries of customary territory through new technologies can demonstrate capacity for self-governance.¹⁷ Yet this does not necessarily mean that such groups want to make these data transparent; sharing data in fact may make villagers vulnerable to military attacks or facilitate identification of fertile land for appropriation by agribusiness, thereby curtailing ethnic political objectives of self-determination.

Forest monitoring means something very different from the point of view of sustainable timber. Forest Law Enforcement, Governance and Trade (FLEGT), a European Union program that seeks to source sustainable timber for export to Europe, aims to prevent deforestation and clean up the illicit timber trade by eliminating corruption and enforcing market discipline. Tracking timber production and export can include high-tech solutions like QR codes or low-tech ones, like checking documents or walking through the forest taking photos of tree stumps that show evidence of illegal harvest. But in order to monitor timber production, the government, civil society, and foreign funders must first decide on the parameters of legality and sustainability, as one foreign consultant working on FLEGT noted:

You have to know what to look for and you have to report it . . . [when] we started here in 2015 . . . local civil society said, 'Yes, I will go and take photos [of illegal logging], but the forest department, they don't believe us.' . . . without providing this sort of structure [of FLEGT agreements], it is going to be much more difficult [to monitor forests]. (Personal communication, September 2018)

Without an agreement about what constitutes legal logging and mechanisms for reporting and enforcement, monitoring is impossible, even with robust data layers depicting deforestation. With an agreement, it becomes a complex procedure, in which international third parties and specially trained local CSOs verify the system is working properly, checking and double-checking various documents in a complex, step-by-step supply chain. This procedural view of monitoring “legal timber” is troubling the context of Myanmar’s forest sector, where, historically, legality is not correlated with either environmental or social benefits (Woods, 2013). The possibility of data infrastructures to enable more equitable forest governance appears to be subsumed by state and foreign goals.

Some Myanmar environmental activists take a much broader view of forest monitoring. We met with locals who watch for illegal logging on the ground, walking the reserve forests in danger of encountering armed loggers, and taking pictures of tree stumps. These “lone wolves” are different from the university-educated analysts who process data and write reports, one foreigner involved in the FLEGT process noted: “[They are] outliers... there’s only a certain type of person who wants to walk around the woods, and get dirty, and take photos and usually in his spare time... it’s a labor of love” (personal communication, August 2018). Often, these lone wolf monitors post their photos of illegal logging to Facebook groups and personal pages, using the online platform to bring broad attention to the issue and spark conversation. Rather than lining up to double-check documents, grassroots environmental monitors use digital platforms to tell personal stories that highlight forest destruction, even as they receive funding from or participate in trainings given by FLEGT (personal communication, September 2018). Foreign funders and local forest monitors embraced very different conceptions of forest monitoring from one another, using digital tools to standardize supply chains, on one hand, and publicize environmental crimes, on the other. The lack of a legal agreement and the conspicuous absence of China, the destination of most of Myanmar’s timber, make enforcing sustainable timber challenging with or without digital tools for compliance. In this context, the lone wolves’ digital publicity strategy offers a promising alternative.

Aside from Facebook, we found that many of Myanmar’s local CSOs and community-based groups, both those operating within EAO territory and those unaffiliated with EAOs, who conduct biodiversity or forest monitoring eschew digital tools. This phenomenon highlights the different modes and uneven levels of participation in data infrastructures and environmental governance. Some of the obstacles are technical, including the high cost of computing hardware, the lack of internet connectivity or electricity to charge smartphones in forested areas, and the incompatibility of the most commonly used Burmese font with existing software (personal communication, October 2018). But more durable and fundamental than the technical limitations is “data infrastructure literacy” (Gray et al., 2018) or an understanding of the socio-politics of digital infrastructures. The abstract, technocratic objectives of international funders armed with satellite data and eager to cooperate with government are sometimes in tension with those of justice-driven local groups motivated to call attention to illegal, corrupt, and cruel activities perpetrated by, or with the blessing of, government. In contrast to a faith in data transparency promoted by international institutions, our Myanmar interviewees were often acutely aware of the history and politics of data in ways that made them more cautious to use and share. In and beyond KNU territory where memories of armed conflict and state surveillance are fresh, the idea of making data public to the Myanmar state or foreign investors can seem deeply threatening. More broadly, local groups can harbor suspicion of “top-down” initiatives, outsiders, and the government not only because of historic persecution, but also because of a recognition of different priorities. Local groups motivated to monitor forests for their cultural and subsistence value

often find that representing these cultural and political views, unlike representing aggregate forest cover, can be challenging to do with data collected remotely. Whereas satellite-based monitoring can seem abstract and distant, Myanmar and foreigner interviewees working on community-based and participatory forest monitoring emphasized the need for ground-based data collection and for using different types of data to build personal networks within communities and with local officials. Underlying these tendencies is a political economy of infrastructure in which foreign experts more often have necessary equipment. Satellite data might provide tools to refute the government, but today those tools remain predominantly in the hands of foreign organizations and a few urban Myanmar elite, rather than grassroots communities and activists whose reluctance to engage stems not only from a lack of access or capacity, but also from a sophisticated understanding of the limits and threats of open data in this context.

This is not to say that local use of remotely collected data cannot promote more equitable forms of environmental governance. We found cases in which Myanmar CSOs, usually in collaboration with foreigners with technical expertise, use satellite images to report on forest loss. In October 2019, one author observed a local activist reference international remote satellite imagery to critique the expansion of deforestation, jade mining, and banana plantations in Kachin State, located in Myanmar's north (author fieldnotes, 2019). Similarly, a 2016 report by a consortium of community-based environmental activists overlaid concession boundaries, community maps, and satellite images of land use to reveal the extent of new oil palm concessions in the southern region of Tanintharyi, enabling locals to demand compensation for their land from companies.¹⁸ These examples highlight moments in which increased data transparency enabled increased participation in environmental monitoring. At the same time, the reluctance to engage foreign-built software platforms for remote forest monitoring points to the ways in which emergent data infrastructures not only produce and organize knowledge, but also validate certain perspectives, approaches, and values at the expense of others. Furthermore, the politics of conservation, territory, timber, and community use rights in Myanmar today mean that forest monitoring enabled by new data infrastructures is better suited to some actors' capabilities and priorities than others. While publicly accessible satellite images are useful for analyzing aggregate forest cover, they offer limited opportunities to assess biodiversity and explain who is responsible for illegal logging. Local activists may abandon digital compliance tools in favor of digital publicity, or choose not to share data when threats of persecution outweigh abstract promises of transparency.

Conclusions

Old disputes around Myanmar's resource use have been brought to the surface with new digital tools to know and manage the environment. Digital forest monitoring looks very different depending on whether the resource is being monitored by international NGOs aimed at conservation, traders facilitating sustainable timber, or ethnic minority communities protecting their way of life. Besides Facebook, a for-profit corporation, the platforms discussed above are funded by international donors under programs that seek to foster "good governance" through data transparency made possible through technology-based environmental monitoring, a tangible activity with the type of measurable output that makes it attractive to donors (Spiegel et al., 2012). While digital access and expertise was limited among some of our Myanmar interviewees and skewed toward international conservation groups, we did note increased local adoption of digital tools over the course of this study and it is likely that hardware and software will improve and that Myanmar users will

continue to engage with and construct more sophisticated data infrastructures in the coming years. The local and international actors described above are entangled and not always easy to distinguish, but their specific histories with and within the state influence how knowledge is generated through data and how (and whether) that data are made significant for environmental governance.

While remote and on-the-ground monitoring platforms have provided tools for diverse actors to articulate problems in and visions for forest and resource governance, environmental monitoring in Myanmar faces political limitations. International organizations can tempt officials with foreign funding for conservation, but ultimately rely on a growth-minded government for visas and permits. Local CSOs or EAOs, in contrast, often have limited access to the ministries and individuals who make important decisions related to resource management. We also heard about three internationally funded environmental monitoring platforms that have failed in the last few years in Myanmar due, in part, to lack of local interest. Furthermore, we found surprisingly little “pure” satellite monitoring in our investigations: actors instead combined (or ignored) remote images with available economic or on-the-ground data that took diverse forms. The result is a data assemblage that seeks to capture various aspects of resources, and often does so only partially. For international NGOs that have expanded their work in Myanmar since the country’s democratic transition, the use of high-caliber digital platforms and the quantitative data they generate has filled a political–technical vacuum left open by the state’s lack of digital capacity and provided them with leverage over government officials to push for environmental governance reform at a national scale. However, the limits of what can be measured and a failure to couple this with locally relevant data can obscure the most pressing political questions about forest governance. In other words, satellite imagery can capture the expanding scale of deforestation, but cannot address the issues of who profits, who suffers, and who decides. For many Myanmar officials, activists, and community members, remote monitoring remains illegible, if not threatening. Some local CSOs opt out of using such platforms in favor of qualitative data collected locally that align with community values. Yet this bottom-up data’s circulation value is limited since distributing it to more powerful actors is difficult, and sometimes seen as a risk to self-governance, reflective of the former authoritarian surveillance state and the political residues it left behind. In this context, the power of data is not determined by abstract ideas of transparency and participation, but rather mediated through social relations between individuals, institutions, and the state.

Environmental governance, in foregrounding the processes of political contestation around resources, can enable productive imagining of new environmental futures (Bridge and Perreault, 2016). We write at a moment in which the realization of Myanmar’s democratic project is very much in doubt. The early years of nominal civilian rule saw the arrest of dozens of journalists and criminal charges against activists and individuals for social media posts, stoking fear and practices of self-censorship (Human Rights Watch, 2019). The continuing power of the military, as indicated by atrocities committed against Muslim minorities and public support for denials of culpability despite mounting evidence of ethnic cleansing, starkly highlights the limits of working with and within the current state. Yet there is hope surrounding the potential for new and better data to contribute to better resource governance and developmental futures in Myanmar, particularly in relation to equitable distribution and governance of resource wealth. One foreign informant working with an NGO platform explained that, in her view, the point of environmental monitoring was, “communities being able to articulate the valuable resources they have and advocate for them” (personal communication, August 2018). However, in contexts in which digital expertise is limited, communities have been subject to historical persecution and

ground-truthing remains difficult due to ongoing violence, and powerful people are often directly linked to resource extraction and environmental degradation, the relationship between remote monitoring and effective advocacy is not straightforward. New data infrastructures have opened up a plurality of approaches to monitoring led by a diverse set of actors, whose participation and relationships in environmental governance are linked to shifts in Myanmar's broader democratic transition. Monitoring as a driver of actual shifts in governance, however, demands more durable legal and political action, an enormous challenge in a country in which state surveillance continues.

Highlights

- Remote monitoring of natural resources and a corresponding push for data transparency has become integral to contemporary environmental governance initiatives around the world.
- In Myanmar, environmental monitoring is expanding through emergent data infrastructures, challenging historic state surveillance.
- New data infrastructures are inseparable from the proliferation of new actors involved in environmental governance amid the country's democratic transition.
- We highlight how Myanmar's forests are being monitored by state and state-like entities, NGOs, and civil society groups for different governance objectives.
- Political history shapes participation in emergent data infrastructures and the forms of governance they enable.

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Notes

1. Formerly known as Planet Labs: <https://www.planet.com>.
2. <https://opendevelopmentmekong.net/>.
3. <https://servir.adpc.net/>.
4. <http://www.data4sdgs.org/partner/open-data-development>.
5. While environmental monitoring implies data collection for scientific research purposes but not necessarily the use of such data to control or change environments, surveillance is conducted under the premise that there will be a subsequent intervention in influencing behavior and/or outcomes (Ottinger, 2010). The distinction becomes clearer when parsing not simply how or under what conditions the data are collected, but how the data are interpreted and used. As Alvarez León and

- Gleason (2017) note, claims of remote sensing's objectivity when conducted for scientific research does not necessarily extend to remote sensing data produced by states for surveillance purposes even if the data themselves are the same.
6. GSMA Intelligence: <https://www.gsmaintelligence.com/markets/2274/dashboard/>.
 7. Yangon is Myanmar's socio-cultural center where many CSOs and NGOs are based, though the political capital of the country is Naypyidaw, 200 miles to the north.
 8. Interviewees included Myanmar individuals working with local organizations (7), internationals working with local organizations (6), Myanmar individuals working with international organizations (2), internationals working with international organizations (10), and government staff (1).
 9. A September 2018 report submitted to the UN Human Rights Council found a pattern of serious human rights violations principally committed by the Myanmar military in Rakhine State. The report suggests investigating senior generals for genocide, crimes against humanity and war crimes, and notes to major role of social media in ongoing violence: "The role of social media is significant. Facebook has been a useful instrument for those seeking to spread hate, in a context where, for most users, Facebook is the Internet" (UN Human Rights Council, 2018: 14).
 10. These issues are being actively debated in the public sphere, such as in the Myanmar Digital Rights Forum held in Yangon annually since January 2017, <https://www.digitalrightsmm.info/>.
 11. <https://themimu.info/>.
 12. <http://mylaff.org/>.
 13. <https://opendevelopmentmyanmar.net/>.
 14. NRGIs resource governance index and OJD are available at: <https://www.resourcedata.org/> and <http://www.openjadedata.org/>. Both platforms follow open data standards as set out in the open data charter <https://opendatacharter.net/principles/>.
 15. <https://www.globalforestwatch.org/about>.
 16. <https://naturalcapitalproject.stanford.edu/software/invest>.
 17. Salween Peace Park: <https://www.earthisland.org/journal/index.php/magazine/entry/the-revolutionary-forest-myanmar-peace-park>.
 18. Green Desert: Communities in Tanintharyi Renounce the MSPP Oil Palm Concession by Tarkapaw, TRIP NET, Southern Youth, Candle Light, Khaing Myae Thitsar, Myeik Lawyer Network and Dawei Development Association, <https://eia-international.org/wp-content/uploads/Green-Desert-FINAL.pdf>.

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