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Law enforcement and deforestation: Lessons for Indonesia from Brazil☆

Luca Tacconi[a,*], Rafael J. Rodrigues[a], Ahmad Maryudi[b]

[a] Crawford School of Public Policy, The Australian National University, Canberra, Australia
[b] Faculty of Forestry, Universitas Gadjah Mada, Yogyakarta, Indonesia

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ABSTRACT

The Government of Indonesia has committed to reducing emissions from deforestation and forest degradation. However, the country suffers from one of the most significant illegal logging and illegal land clearing conditions in the world. Brazil was in a similar condition to Indonesia when it implemented an aggressive and strategic forest law enforcement policy which enable it to significantly reduce deforestation. Indonesia does not have such a strategic approach to forest law enforcement. It should consider the features of Brazil's strategy in order to improve its forest law enforcement activities in order to be able to deliver on the reduction of forest emissions that it has pledged in Nationally Determined Contributions statement to the United Nations Framework Convention on Climate Change. Indonesia's efforts, and those of other countries, would be enhanced by research on the reasons at the root of the unsuccessful forest law enforcement policies and activities over the two decades since the spotlight was put on illegal logging at the first Forest Law Enforcement, Governance and Trade conference held in Bali in 2001.

1. Introduction

The Government of Indonesia has committed to reducing emissions from deforestation and forest degradation (Republic of Indonesia, 2016). Those commitments have been made in the context of deforestation that fluctuated from about 444,000 ha/year during the period 2000-03, doubling to about 918,000 ha/year during 2007-09, and then about 780,000 ha/year during 2011-12 (Republic of Indonesia, 2015). The deforestation trend in Indonesia is in sharp contrast with that of Brazil. Deforestation in the Amazon stood at about 1.8 Mha in 2000 and increased until 2004, when it peaked at almost 2.8 M ha, then it declined steadily to about 0.46 M ha in 2012.[1] It is because of these starkly diverging trends in deforestation that it is useful to compare the two countries to understand whether there may be lessons that Indonesia could learn from Brazil to improve its efforts to control illegal deforestation to reduce emissions from the sector. Addressing illegal forest activities is a must for Indonesia in order to reduce forestry emissions because illegal forest activities appear to account for a significant share of total deforestation and forest degradation as it will be discussed later on.

A recent global meta-analysis of the drivers of deforestation, and of the factors associated with lower deforestation (including demographic and geographic characteristics, economic variables, and policies) found that the policies that appear to be consistently associated with lower deforestation across a range of countries are law enforcement, establishment of protected areas and payments for environmental services (Busch and Ferretti-Gallon, 2017). Land use is normally regulated by a mix of policy instruments that may also have significant synergies (Lambin et al., 2014). A range of newer (compared to command and control) market-based instruments, such as commodity roundtables and eco-certification have been introduced by coalitions of public and private actors (Lambin et al., 2014).

Brazil has a mix of policy instruments in place to manage forests. The mix includes the regulatory framework (with key elements being the National Environment Policy and the Forest Code), law enforcement, indigenous territories, protected areas (which are also supported by intergovernmental fiscal transfers systems from state to municipal governments), forest monitoring systems, and payments for environmental services. The Brazilian government's efforts to reduce deforestation are also supported by the Amazon Fund, which can receive REDD+ related performance-based contributions, with the main financial contributor so far being Norway. The empirical literature has found that a decrease in commodity prices during the 2000s contributed to the decrease in deforestation, but it has also clearly

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* Corresponding author.
E-mail address: luca.tacconi@anu.edu.au (L. Tacconi).

[1] Deforestation in Brazil has gradually increased since 2012 – reaching almost 0.8 M ha in 2016 – but fell to 0.69M ha in 2017.

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established that the policies implemented by the Brazilian government, with law enforcement playing a prominent role, provided a significant contribution to reducing deforestation (Arima et al., 2014; Assunção et al., 2015; Hargrave and Kis-Katos, 2013). Importantly, Brazil has committed through its National Climate Change Policy to further reducing deforestation in the Amazon to around 0,4M ha in 2020, and pledged through its Nationally Determined Contribution (NDC) submitted to the UNFCCC to achieve zero illegal deforestation in the Amazon by 2030. Like Brazil, Indonesia has a mix of instruments to manage forests. The mix includes the regulatory framework which has a significant focus on land use planning (with forests allocated to conservation functions, protection of watersheds, production of timber, and conversion to other uses), law enforcement, timber legality verification (involving a Voluntary Partnership Agreement with the European Union), sustainable timber certification, and a moratorium on new logging licenses (MoEF, 2018).

This paper will focus on the question: what can Indonesia learn from Brazil's experience in forest law enforcement to reduce illegal deforestation? This focus on law enforcement is due to the following reasons. First, as already noted, 40% of deforestation in Indonesia occurred in forest classification types that restrict or prohibit land clearing (Margono et al., 2014), indicating that enforcement of the law to address illegal land clearing should be a priority for reducing deforestation. Second, as also noted above, law enforcement played a significant role in Brazil's efforts to reduce deforestation. That experience could provide relevant lessons for Indonesia. Finally, without law enforcement, other policies and approaches to forest management and conservation such as protected areas, timber legality and timber sustainability certification schemes, payments for environmental services schemes and even community based management cannot function effectively (e.g. Clarke et al., 1993; Börner et al., 2015).

From a methodological perspective, it is important to acknowledge that whilst Brazil and Indonesia are similar in that they both have extensive forests, they are also different in many social and economic aspects. This means that law enforcement measures that were found to be effective in Brazil do not necessarily have the same effects in Indonesia. It should be noted, however, that governments and companies experiment with policies and activities first implemented in contexts with different economic, environmental and social characteristics (e.g. Lambin et al., 2014, 2018). Therefore, the present study carries out an exploratory analysis of law enforcement policies implemented in Brazil that could be considered by Indonesia. However, it is not possible to establish with certainty whether those policies would work in the same way in Indonesia. If those policies were to be implemented by Indonesia, a comparison of their effectiveness with the case of Brazil would need to consider, among other issues, the specific economic, environmental, and social characteristics of the two countries.

The paper proceeds by considering the theory of law enforcement, then it addresses Brazil's approach to enforcing the law to reduce deforestation particularly during the period of significant deforestation slowdown from 2004 to 2012. That is followed by the analysis of Indonesia's experience with forest law enforcement to the present time. This difference in timeframe of analysis between the two countries is due to the fact there is significant literature analysing the reasons for Brazil's success over the period considered, and we are interested to study whether *current* forest law enforcement in Indonesia could benefit from Brazil's experience. The findings of the paper are presented in the discussion section, which is followed by the conclusion.

2. Theoretical and operational aspects of forest law enforcement

The seminal paper by Becker (1968) used an economic approach to consider the issue of optimal law enforcement: that is, to assess what might the optimal level of offences (i.e. offences permitted) be and, therefore, how many offenders are not punished. The optimal law enforcement literature focused therefore on the levels of fines, the enforcement agency's objective function and on the issue of full versus incomplete enforcement (Robinson et al., 2010).

Robinson et al. (2010) note that the literature on fines indicates that initially it was thought that preference should be given to a high level of fine and low probability of detection (as detection is costly). But they stress that more recent literature has concluded that the combination of lower level of fine and high probability of detection is preferable. Reasons that have led to preferring the latter option include (Robinson et al., 2010): i) high fines may not be politically viable; ii) in the presence of high levels of corruption, high levels of fines may simply result in greater bribe taking; and iii) fines should be *fair*, which involves taking into account both the social cost of the crime and the capacity to pay the fine. The latter point does not necessarily imply that fines should be low, given that if the social cost of a crime is high, the fine should also be high. But it does imply that the optimal level of fines for crimes that cause limited social costs, and may be committed by people with low income (e.g. stealing firewood from a protected area), are likely to be lower than it would be otherwise if fairness was not considered.

In relation to the enforcement agency's objective function, the focus of the literature has mostly been on the maximization of social welfare (which includes returns from illegal activity), and on the maximization of returns from legal activity (Robinson et al., 2010). In the latter case, the enforcement agency considers only the legal benefits that society would receive from reducing crimes. However, illegal activities may contribute to the livelihood of people (who may be even poor) so there has been debate about whether some weight in the objective function should be assigned to illegally derived benefits (Robinson et al., 2010). This debate is relevant to the forestry context, which has seen extensive debate around the question of criminalization of poor people taking products from protected forests, and the differentiation of small scale illegal logging - carried out to achieve livelihood goals - from large scale illegal logging activities carried out by companies for profit (Tacconi et al., 2016). Robinson et al. (2010) note that whilst the literature has considered giving weight to illegal livelihood benefits, they have not been formally considered by the law enforcement agencies. However, the authors also stress that there is anecdotal evidence of forest officials recognizing that people often do need to carry out some activities that are deemed illegal - such as collecting non-timber forest products from protected areas - and that they do not prosecute them.

With regard to issue of full versus incomplete enforcement, essentially the general literature on optimal law enforcement does not consider full law enforcement viable: eliminating all crimes would be close to impossible even if the resources for such a strategy were available, which normally are not as budgets are always constrained (Robinson et al., 2010). The authors note that in the environment field there have been attempts to implement full law enforcement in relation to the protection of highly endangered species. In those cases, very high enforcement expenditure was justified by the high social cost associated with the extinction of a species. However, full law enforcement would not be a viable strategy to address illegal deforestation. First, it would require an extremely large amount of resources. Second, given the extent of forest areas in large countries such as Brazil and Indonesia it might not be possible to implement full enforcement even with significantly higher budget allocations. Furthermore, a full law enforcement approach might not even be socially desirable as discussed below. Therefore, an incomplete law enforcement approach needs to be adopted. To be as effective as possible, such an approach will require a strategic approach. In the forest sector, examples of prioritization approaches to law enforcement include consideration of geospatial patterns of illegal activities (Gaveau et al., 2009; Pandit et al., 2016) and the implications of poverty and livelihood needs (Ostermann, 2016).

Poverty makes the cost of compliance with forestry laws very high, that is, it reduces compliance rates (Robinson et al., 2010; Ostermann, 2016). If compliance costs can be reduced – for example by providing access to alternative sources of forest products from community forests

(Ostermann, 2016) or buffer zones (Robinson et al., 2010) – compliance rates increase (Robinson et al., 2010; Ostermann, 2016). Consideration of the social equity of law enforcement is important for its effects on compliance itself and in relation to the allocation of the overall enforcement effort. With regard to the former, there tends to be higher acceptance of regulations that are considered to be fair (Robinson et al., 2010). The perception of fairness of rules also affects the behaviour of law enforcement officers, who are more likely to carry out strict enforcement when they perceive the rules to be fair (i.e. do not disproportionately impact on livelihoods) (Robinson et al., 2010). In relation to the fairness of the allocation of the overall enforcement effort, large scale illegal forest activities carried out by companies or rich individuals should be given higher law enforcement priority compared to the activities of poor individuals (Silva et al., 2002; Colchester et al., 2006), given that the former result in more significant environment impacts, with associated higher social costs.

The overall enforcement effort is also particularly influenced by two operational aspects: the budget available for enforcement activities and how those resources are distributed and employed across the layers of the enforcement apparatus (Robinson et al., 2010). Those authors note that developing countries often allocate very limited resources to forestry law enforcement, therefore whether there are opportunities for cost recovery is a significant issue. In relation to the enforcement apparatus, there are normally multiple layers (Robinson et al., 2010), from the national level (federal in a country like Brazil) down to the individual forestry officer. These layers not only need to receive resources appropriate to the strategy adopted, they also need to use them effectively. The effectiveness of resource use is influenced both by the enforcement strategy adopted, as noted earlier, as well as by the performance of law enforcement agents. In turn the performance of the agents is influenced by the incentives they face. Those incentives include the formal structure of work performance rewards, social relationships in the area they are patrolling, and opportunities for bribes.

The various factors that need to be considered in addressing forest law enforcement that emerge from the above arguments, and that will be addressed in the context of Brazil and Indonesia, are summarised in the framework presented in Fig. 1. The figure provides a visual representation of the many links that exists between the various elements of the framework, but it cannot fully describe all those complex links. The figure also highlights an element of the framework that will not be addressed, Social networks. That element is certainly significant in influencing forest law enforcement. However, the focus of this exploratory research is on understanding how the operational approach to enforcement could be improved. Further research on that element of the framework - as well as those that are considered to a rather limited extent, such as corruption - would certainly be useful. It could inform the implementation of an improved enforcement framework.

One of the elements of the enforcement framework that is not considered when addressing the forestry regulatory framework in Brazil and Indonesia is 'Perceptions about fairness'. This is due to the fact that the present research takes as a given the regulatory framework that defines where deforestation is allowed and where it is illegal. Those provisions may well be disputed within society, and research to consider those issues could inform revisions of the regulatory framework. However, as stated above, the focus of this research is on understanding how the operational approach to enforcement could be improved. Such an improved law enforcement approach could also be used in the enforcement of a revised regulatory framework. However, the issue of fairness of implementation of law enforcement is considered in the Discussion section.

3. Deforestation and forest law enforcement in Brazil

3.1. Deforestation in the Brazilian Amazon

Amazon rainforest deforestation has been a major topic in Brazil's national and international environmental agenda. Forest depletion in the Amazon since the 1990s averaged 1.86 M ha per year (Rodrigues-Filho et al., 2015) raising concerns about related carbon emissions, biodiversity loss, changes in hydrological cycles, and impacts on livelihoods (Aragão et al., 2014; Arima et al., 2014; Barlow et al., 2018). Several studies have discussed the causes, scale and patterns of deforestation in the Amazon. Drivers of deforestation are diverse, including national and global factors, in addition to more localised ones (Margulis, 2003; Godar et al., 2014; Hargrave and Kis-Katos, 2013). Commodity prices (e.g. soy and beef), exchange rate of Brazil's currency, distance-to-roads, infrastructure projects and migration processes have been linked to deforestation (Fearnside, 2017; Godar et al., 2012; Lapola et al., 2013). Deforestation and land degradation in the Amazon have been associated with the expansion of the agriculture frontier, with concentration of deforestation in hotspots forming a dynamic 'Arc of Deforestation' along the eastern and southern edges of the forest (Becker, 2016; Hecht, 2012). Yet several different types of deforestation frontiers occur concurrently (Brondizio and Moran, 2012; Schielein and Börner, 2018), posing continuous challenges to adapting public policies to heterogeneous local and actor-specific deforestation contexts (Assunção et al., 2017).

Deforestation spatial patterns and actor-specific contributions to deforestation in the Amazon have changed in the last decades (MMA, 2013; Rosa et al., 2012). Almost half of the total deforestation between 2004 and 2011 occurred in areas dominated by properties larger than 500 ha, whereas smallholders in properties below 100 ha accounted for 12% of the total (Godar et al., 2014). However, the relative contribution of smallholders to deforestation has been increasing, with more dispersed and fragmented deforestation patterns emerging more recently (Kalamandeen et al., 2018; Assunção et al., 2017). For example, more than 60% of total deforestation in 2012 occurred predominantly in polygons smaller than 25 ha, whereas large scale deforestation - over 500 ha - accounted for only 5% of the total (MMA, 2013). The importance of different actors to deforestation varies broadly within the region, presenting contrasts in terms of wealth, legality and intensive or extensive nature of their activities (Fearnside, 2008).

Despite deforestation slowdown, illegality in the Amazon is a pervasive and persisting issue (Hummel, 2016). Illegal deforestation occurs on private and public lands, being intricately linked to other illegal forest activities (Fearnside, 2017), corruption (MMA, 2013), organized crime (Perazzoni, 2018) and violence in the region (Hochstetler and Keck, 2007). For example, illegal logging is estimated to make up 80 per cent of log production in Brazil (INTERPOL and UN Environment, 2016). While protected areas and indigenous lands have overall been important deforestation deterrents in the Amazon, there are considerable variations in their effectiveness (Soares-Filho et al., 2010; Pfaff et al., 2014; Kere et al., 2017). Moreover, Brazil has a considerable amount of undesignated public forestlands, which are vulnerable to illegal deforestation (Azevedo-Ramos and Moutinho, 2018).

3.2. Forest law enforcement in Brazil

Brazil's framework on environmental crimes has been considered one of the most modern and comprehensive of its kind (Ungar, 2017) building on several laws and regulations. A key element is the Environmental Crimes Federal Act No. 9.605/1998, further regulated by the Environmental Administrative Infraction Decree No. 6.514/2008. They establish criminal and administrative sanctions for behaviour and activities that harm the environment, including crimes against the flora, such as illegal deforestation. Forest law enforcement is also based on acts and norms that regulate the conditions under which deforestation and other forest-activities can occur, in private and public lands. Main legislation includes Federal Law No. 12.651/2012, which establishes the new Forest Code with general norms on forest protection, forest removal and control of origin of forest products, including parameters for conservation of forests within private landholdings. Another related

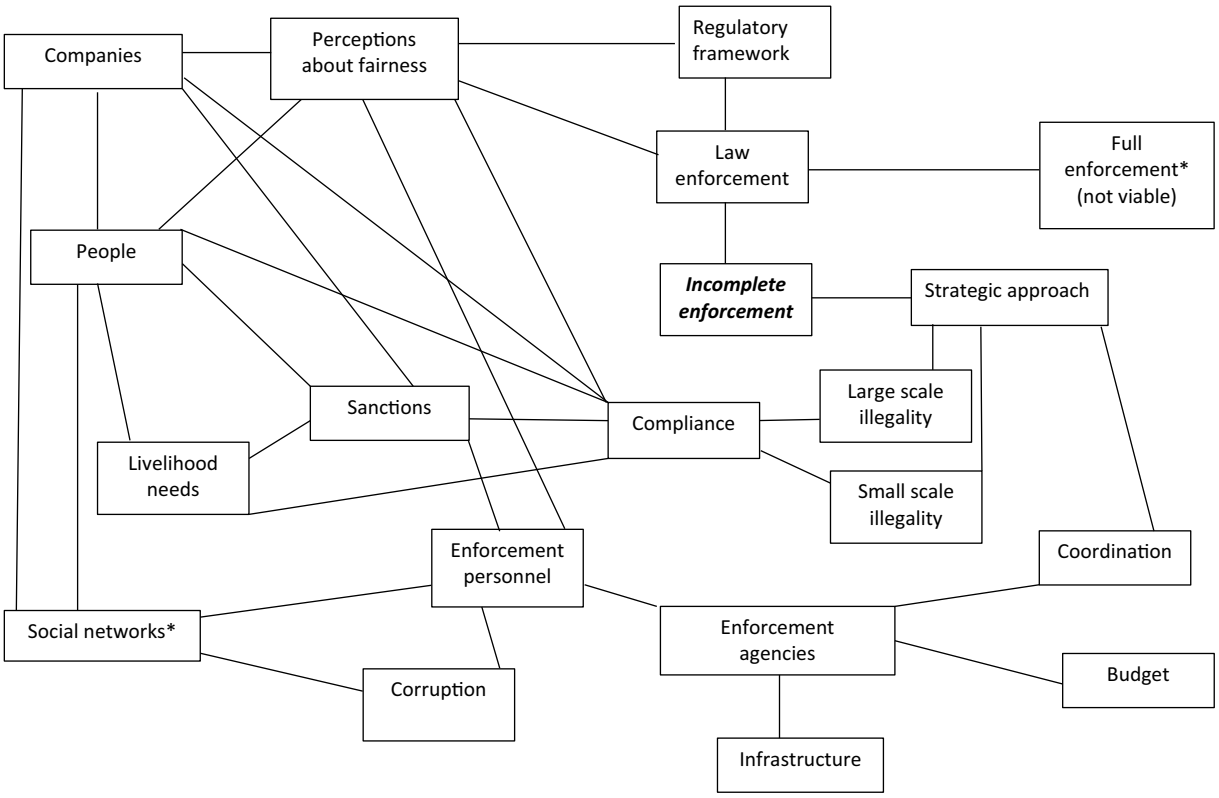

Fig. 1. Forest law enforcement framework (*denotes issue not considered in this research).

law enforcement legislation is the Federal Law No. 9.985/2000, which established the National System for Conservation Units and further regulated land-use and activities within protected areas.

Federal, state and municipal levels have the common responsibility of protecting the environment and preserving the forests, and efforts to prosecute environmental crime rely on a three-pillar structure of police, prosecutors, and courts (Ungar, 2017). Under this arrangement, various government agencies and organizations have formal attributions related to forest law enforcement through a National Environment System, including the environmental administrative bureaucracy at the three levels, and public security forces. The Brazilian Institute for the Environment and Renewable Resources (IBAMA) is the key federal environmental law enforcement agency. It tackles illegal deforestation by exercising the power of environmental police and carrying out actions related to environment monitoring, control and law enforcement. In 2007, forest law enforcement within federal protected areas became the responsibility of a new agency, the Chico Mendes Institute for Biodiversity Conservation (ICMBIO), which carries out forest law enforcement as part of a broader strategy to support federal protected areas' conservation and sustainable use. Both IBAMA and ICMBIO are linked to the Ministry of Environment, the latter being responsible for aspects such as the planning and coordination of deforestation prevention and control policies. At the subnational level, state environmental agencies roughly mirror the law enforcement model structure adopted at the federal level.

The forest law enforcement apparatus also relies on several security authorities, such as the Federal Police, the Military Police and the Civilian Police. While the Federal Police serve under the Ministry of Public Security, the Military and the Civilian Police are subordinated to the state government. Some states have specialized environmental units which are responsible for law enforcement (e.g. Environmental Military Police) and investigations tackling environmental crimes (e.g. Civilian Police Environment Offices). Law enforcement agencies often establish joint operations, depending on the jurisdiction and environmental issues at stake. For example, law enforcement within Indigenous Lands includes the Federal Agency for Indigenous Peoples (FUNAI); and broader investigative intelligence operations involve the Brazilian Agency of Investigation (ABIN). On more extreme cases, the National Public Security Force – an elite law enforcement unit - may provide support to operations in violent and prominent deforestation frontiers. Similarly, the Federal Highway Police joins operations against the transportation of illegal timber on federal roads. In addition, the Brazilian army supports forest law enforcement by tackling illegal activities, particularly in the borders of the Brazilian Amazon and neighbouring countries (MMA, 2013).

Efforts to improve law enforcement and deforestation control since 2004 include the establishment of an Action Plan to Prevent and Control Deforestation in the Brazilian Amazon – PPCDAm. Currently in its fourth implementation period (2016-2020), PPCDAm supports the prioritisation of law enforcement through regular planning and reviewing of monitoring and control measures, informed by accumulating data on deforestation geospatial patterns and drivers (Arima et al., 2014).

Forest monitoring has been a major component of this strategic law enforcement approach. The main tool used by IBAMA to target law enforcement activities in the Amazon since 2004 has been the Real-Time System for Detection of Deforestation (DETER), implemented by the National Institute of Space Research (INPE). It is a satellite-based system that captures and processes geo-referenced imagery of the forest cover at regular and frequent intervals, which are used to identify deforestation polygons, and then dispatch law enforcement teams (Arima et al., 2014; Boucher et al., 2013; Cisneros et al., 2015; Hargrave and Kis-Katos, 2013). DETER has provided valuable input to the planning and execution of operations, for example triggered by high concentration of deforestation alerts in a specific region, or by the identification of large deforestation processes. Importantly, the system was further developed in 2014 with DETER-B, adopting better spatial resolution to detect smaller deforestation and associated processes, such as forest

degradation and illegal logging (Diniz et al., 2015).

Moreover, Brazil also strategically targeted law enforcement by establishing a list of priority municipalities in the Amazon to strengthen illegal deforestation monitoring and control from federal agencies. The estimated effects of blacklisting municipalities on reducing deforestation are in the range of 0.6-0.67 Mha between 2008 and 2012 (Cisneros et al., 2015) and 0.23-1.165 Mha between 2008 and 2011 (Arima et al., 2014). Field-based inspections based on remote sensing systems have reduced deforestation by 14% per year, on average, from 2010 to 2011 (Börner et al., 2015). This 'dissuasion effect' has been considered important in the context of Amazon deforestation slowdown because enhanced monitoring and stricter law enforcement may create the perception of increasing risks of getting caught (Arima et al., 2014; Schmitt and Scardua, 2015).

Environmental offences are punishable by different sanctions depending on the type of infringement and seriousness of violations: the more serious the infringement, the more severe the punishment. Sanctions vary from mere warnings to fines, also including more restrictive measures such as the seizure or even the destruction of instruments, equipment or vehicles of any nature used in the infraction or production of goods derived from illegal deforestation. For example, enforcement agencies may destroy bulldozers to prevent further illegal forest clearings or confiscate cattle raised in illegally deforested areas (Arima et al., 2014). Importantly, sanctions may lead to temporary rural private property embargoes, and to partial or total suspension of economic activities. Contextual conditions (e.g. recidivism) may ease or enhance consequences for non-compliant individuals and corporations. Environmental crimes may result in alternative sentences and ultimately in deprivation of liberty and sentencing to penitentiary regime, although these cases are less common in practice (Barreto et al., 2009).

Administrative sanctions have been extensively used as mechanisms to tackle illegal forest activities, with law enforcement efforts aimed mostly at addressing illegal deforestation and large non-compliant landholders (Godar et al., 2014). Between 2004 and 2010, there was a seventy-fold increase in the number of infraction notices issued by environmental agencies compared with the period between 2000 and 2004, and most of these efforts targeted larger properties and critical municipalities (Godar et al., 2014). Likewise, the number of fines containing geographical coordinates increased from almost zero in the early 2000s to half of the total in 2010, reaching the totality of fines in 2014 (Rochedo et al., 2018). From 2004 to 2011, law enforcement agencies carried out approximately 650 joint field-inspections in priority areas. They issued USD 1.8 billion in environmental fines[2], and resulting in 0,6 M ha of embargoed areas (MMA, 2013). The Federal Police also conducted several special operations against illegal deforestation in the Amazon from 2010 to 2015, resulting in the execution of 659 search orders and 415 detentions (Perazzoni, 2018).

Measures to tackle illegal deforestation also included public disclosure of non-compliance with forestry laws (e.g. IBAMA's list of embargoed rural properties due to illegal deforestation), as well as investigations against corrupt public servants (MMA, 2013). Likewise, rural credit restrictions to illegal deforesters were also established by Brazil's key financial institution, the National Monetary Council (Arima et al., 2014).

The budget and personnel structure underpinning Brazil's forest law enforcement apparatus are non-trivial (Börner et al., 2014; Cunha et al., 2016). On average, Brazil spent USD 1 billion/year on forest conservation policies at the federal level, from 2000 to 2014, including law enforcement (Cunha et al., 2016). The slowdown of deforestation in the Amazon after 2004 was accompanied by a higher operational budget execution of federal disincentive measures, and an increase in both allocated and expended federal institutional budgets on forest conservation (Cunha et al., 2016). IBAMA disbursed around USD 98 million on law enforcement activities from 2010 to 2015[3]; and relied on nearly 1100 Federal Enforcement Agents during the period, on average, despite the decline of the agency's force number and budget over the last years (CGU, 2017). Moreover, tackling illegal deforestation in the Amazon has consumed a considerable part of IBAMA's budget and field-enforcement apparatus, in detriment to other institutional roles and responsibilities (Schmitt and Scardua, 2015).

Although funding derived from various sources, public budget cycle allocations have been critical to the implementation of law enforcement activities (Cunha et al., 2016). Periods of fiscal constraints – and budget cuts in forest-related policies – are thus likely to have critical implications for operations (Mueller, 2009). For example, IBAMA's law enforcement core budget programs decreased by nearly 40% from 2013 to 2016 (CGU, 2017). In this context, international cooperation projects have provided important alternative funding, particularly the Amazon Fund, which supports monitoring and law enforcement-related projects (Boucher et al., 2013).

Brazil's command-and-control policies face other major limitations. Firstly, field-based enforcement has faced challenges in deterring deforestation in the Amazon. Inspections were more effective in reducing large scale than small scale deforestation in the states of Mato Grosso and Pará (Börner et al., 2015). However, it appears that recently there has been progress in targeting small scale deforestation. In the state of Amapá, the branch of the police that specializes in crimes against the environment has been successfully using the Forest Watcher app which uses satellite imagery at 30m resolution (maintained by Global Forest Watch) to target small scale deforestation (Gonzales, 2019). Also, administrative sanctions such as fines, embargoes and confiscation of assets have not equally resulted in reduced deforestation. In a study at the municipal scale covering the years 2002 to 2009, Hargrave and Kis-Katos (2013) estimate that a 1% increase in the fining intensity (measured by total fines per deforested area) in a municipality on average reduces deforestation by 0.2%. However, the collection of fines remains critically low – less than 9% of fines issued from 2011 to 2015 were ultimately collected.[4] Although fines, embargoes and confiscation of assets were all negatively correlated with deforestation in the Southern Amazon from 2004 to 2012 (Sousa, 2016) there are important differences in the levels and consistency of law enforcement across the Amazon (Godar et al., 2014; Schmidt and McDermott, 2015). Furthermore, Brazil's ability to detect deforestation and enforce the rule of law has been only partial: during the period from 2008 to 2013, 45% of deforestation in the Amazon was not detected in time for law enforcement agents to act, and less than 25% of cases were held administratively accountable (Schmitt, 2015).

While Brazil has reduced deforestation in the Amazon, law enforcement effectiveness has been hampered by low and circumstantial punitive capacity, and lack of political will to enforce the law (Schmitt, 2015; Hochstetler and Keck, 2007). Brazil's complex myriad of forest-related regulations have also made it disproportionately difficult for small land users to achieve compliance, enhancing local perceptions of legal unfairness and influencing the acceptance of formal rules (Schmitt and Scardua, 2015). Furthermore, Brazil still fails to clearly disclose how much illegal deforestation takes place in the Amazon (Hummel, 2016), and law enforcement coordination between federal and state governments has been conflictual (e.g. states withhold information related to legal authorizations of deforestation). Another major challenge relates to the pressures to reform environmental regulations, such as recent changes to Brazil's Forest Code, which granted an amnesty of nearly 60% of the areas illegally deforested in the past (Costa et al., 2018).

[2] At the exchange rate on 14 August 2018.

[3] At the exchange rate of 14 August 2018.

[4] http://agenciabrasil.ebc.com.br/geral/noticia/2016-12/dez-maiores-multas-por-desmatamento-somam-r-260-milhoes-diz-greenpeace. Accessed on 02/11/2017.

4. Deforestation and forest law enforcement in Indonesia

4.1. Deforestation in Indonesia

Over the past 60 years, Indonesia's forest cover and conditions have changed dramatically. Between the 1970s and 1990s, deforestation and forest degradation were very much associated with commercial logging activities. It is estimated that over that period, the forest cover decreased from 74% to 56% of the country (FAO, 2010; Hurst, 1990). The annual rate of deforestation spiked from 300,000 hectares/ year in 1970s to about a million hectares/year in the early 1990s (World Bank, 1990). From the regulatory aspects, several authors (Dauvergne, 1997; Barr, 1998, 2001; Poffenberger, 1997) cited the log export ban to promote vertically-integrated industries as one of the primary underlying causes of deforestation. The policy led to high grading practices; downstream industries only processed high quality logs and left enormous timber waste in the forest. It encouraged excessive exploitation, including in both non-assigned coupes and post-extracted stands, to acquire more mature trees that led to further disturbance on secondary forests (Poffenberger, 1997; Gillis, 1988; Kasa, 1999; Kartawinata et al., 2001). This practice was aided by the nearly absent monitoring procedures (Maryudi, 2015). In the 1990s, the development of tree plantations started to significantly contribute to deforestation and forest degradation. The forest plantation policy was introduced to maintain timber supply for the country's processing industries (MoF, 1990) and to support the country's goal as one of the world's largest pulp and paper producers (Dauvergne, 1997). The development of tree plantations was made possible in 'unproductive' production forests (Kartodihardjo and Supriono, 2000), in which the concessions were allowed to harvest (clear cut) and sell all the timber regardless of tree size or species from the designated areas. In many cases, the forestlands were misclassified; a large fraction of the 'unproductive forests' was in fact well-stocked with commercial timber (Maryudi, 2015).

Oil palm is also identified as another chief driver of deforestation. Between 1990 and 2010, the total area of oil palm plantations increased from 1.1 million to 7.8 million hectares (Sheil et al., 2009; Obidzinski et al., 2012). The rapid development of oil palm plantations has been facilitated by the state's policies and further enhanced by the decentralisation policy that enabled local governments to issue plantation permits (Susanti and Maryudi, 2016; Setiawan et al., 2016). Driven by increasing global market demand (Lambin and Meyfroidt, 2011; Varkkey et al., 2018), its establishment tends to be uncontrolled (Fitzherbert et al., 2008; Koh and Wilcove, 2009). For instance, hundreds of permits covering nearly four million hectares of forestland in Central Kalimantan alone have been granted to investors without formal land release from the central forest authority (Setiawan et al., 2016).

Against the above background of legal deforestation and some activities that were at best borderline in term of their legality, outright illegal logging and illegal land clearing have been viewed as major contributors to deforestation and forest degradation in Indonesia since the end of the 1990s (Palmer, 2001; Brown, 2002; Nurrochmat et al., 2016; Obidzinski et al., 2006), although illegal forest activities had been occurring long before that (Maryudi, 2016). The scale of illegally harvested timber far outstripped sustainable timber supplies (Brown, 2002; Tacconi et al., 2004.; Casson et al., 2006; Obidzinski et al., 2006). Illegal logging occurs in all types of forests including in conservation areas (Luttrell et al., 2011; Reboredo, 2013). Estimated timber production from illegal logs in 2013 was in the order of 15 million m^3 of roundwood equivalent, accounting for 60% of total Indonesian timber production and 50% of the global supply of illegal timber (Hoare, 2015).

Overall, the above noted factors contributed to deforestation that over the past two decades fluctuated from about 444,000 ha/year during the period 2000-03, doubling to about 918,000 ha/year during 2007-09, and then about 780,000 ha/year during 2011-12 (Republic of Indonesia, 2015). The latest official data show that the rate of deforestation was 640,000 ha/year during the period 2013 to 2017 (MoEF, 2018).

4.2 Forest law enforcement in Indonesia

Forest law enforcement in Indonesia is regulated by the Law on Forestry (No. 41/ 1999) and the Law on Conservation of Living Resources and their Ecosystems (No. 5/ 1990) that define a range of forest crimes and the associated penalties, from fines to prison terms. Prior to them, Indonesian forestry regulations did not specify any concrete legal sanctions against forest crimes (Colchester et al., 2006). Existing studies show that weak law enforcement and inadequate monitoring exacerbated by chronic corruption among officials has been a major problem in Indonesia (Downs and Tacconi, 2017). Studies even reveal that bureaucrats, political parties and parliament members, army and police have been either directly or indirectly involved in illegal forest activities (Barr, 1998; Dauvergne, 1997; Mietzner and Misol, 2013; Mietzner, 2008). Forest officials were also involved in corruption, e.g. demanding bribes for obtaining a permit, and allowing exports without legal permits (Setiono and Husein, 2005; Smith et al., 2003). Similar corrupt behaviour was also widespread within the Indonesian courts, resulting in the very few cases reaching the trial stage, and even fewer convictions (Colchester et al., 2006).

In 2013, the government issued the Law on the Prevention and Eradication of Forest Destruction (No. 18/ 2013). It is aimed at strengthening forest law enforcement as it: i) mandates the establishment of a specific institution directly responsible to the President; ii) targets organised forest crime, iii) has more coverage than the Forestry Law, to also include oil palm plantations and mining in forested areas, and iv) allows the utilisation of corporate criminal liabilities (Santosa et al., 2015). For instance, oil palm plantations inside protected areas and the transactions of the products could face criminal charges. The legal measures to eradicate forest destruction cover investigation, indictment and examination in court sessions. Depending on the type of violation, besides criminal sanctions, other sanctions in the form of fines and revocation of permit can also be applied.

The government of Indonesia has established a number of agencies for forest law enforcement. Within the Ministry of Environment and Forestry (MoEF), there is a specialised Directorate General (DG) of Law Enforcement of Environment and Forestry tasked with the formulation and implementation of policies aiming to reduce disturbances and threats to forests and the violation of forest and environmental laws and regulations. In terms of field personnel, the DG employs forest rangers, and civil servant investigators. The latter are civil servants who have the authority to conduct the investigation of a criminal case (Manik et al., 2017). They are tasked to: i) inform public prosecutors about the start of investigation and hand the results to them, ii) ask the communication executing agency for information, and iii) ask for information from banks about the financial condition of suspects. The DG has also established a Fast Response Unit of Forest Police, which consists of highly qualified forest police.

Forest law enforcement conducted by the MoEF is often constrained by the limited budgets and field personnel (Ekawati, 2013). Between 2015 and 2017, the annual budgets of the Directorate General for Law Enforcement of Environment and Forestry amounted to about USD 13.7 million[5], equivalent to about USD 13 cents per hectare of forest (Forestry Statistics MOEF, 2018). Similarly, forestry personnel are far below the sufficient level. In the Java-Bali-Nusa Tenggara region, the personnel to forest ratio is only one police for every 60,000 hectares, while in Papua the ratio is even more extreme: one police for about half million hectares of forest.

To attempt to overcome the limited resources allocated, forest law

[5] At the exchange rate of 14 August 2018.

enforcement is also conducted in cooperation with a number of bureaucratic structures and agencies. For instance, amidst the rampant illegal logging experienced in the country during the early 2000s, in 2005 the President issued a Decree (Presidential Instruction No. 4/2005) that instructed ministries and state agencies (at the national and regional level) to accelerate eradication of illegal logging in forest areas and its trafficking across Indonesia (FWI, 2014). The coordinated operations, called sustainable forest operations, resulted in reduced smuggling in major timber hubs, but the timber and equipment seizures rarely led to the recovery of the financial losses (Luttrell et al., 2011). The joint enforcement sweeps were even said to have resulted in unlawful appropriation of timber by enforcement personnel (McCarthy, 2004; Luttrell et al., 2011). Enforcement operations were seen to have failed to arrest the main actors of illegal logging; only a small fraction of them was prosecuted with even minor sentences (FWI, 2014).

In recent years, forest law enforcement has adopted a so-called multi-door strategy, which involves the MoEF, the Ministry of Finance, the Attorney General, the National Police, and the Indonesian Transaction Reporting and Analysis Center (Dermawan and Sinaga, 2015). The multi-door approach seeks to establish coherence between the inquiry, investigation and prosecution of forestry crimes by using a combination of various laws related to environment, forestry, mining, taxation, money laundering, corruption, agriculture and taxation (Arwida et al., 2015). It targets crimes committed by corporations or corporate actors (Situmorang, 2015; Nellemann et al., 2014). The approach applies a follow-the-money approach in dealing with forest-related crime, in which law enforcers track the assets and bank accounts of the suspects, and perpetrators found guilty are obliged to pay the costs of rehabilitation of damaged areas and return lost state revenues.

Situmorang (2015) finds that coordination among institutions remains a significant challenge as criminal cases are still handled by the respective law enforcement agencies (Table 1). Although there were cases of heavy penalties imposed, e.g. long imprisonment and heavy fines (Nellemann et al., 2014), the sanctions of committing serious forest crimes are yet to have deterrent effects as they mostly range from probations to light fines (Situmorang, 2015). More importantly, they are yet to restore losses suffered by the state (Situmorang, 2015).

Forest law enforcement operations target three types of illegal forest activities (MoEF, 2018). The first focuses on forest area encroachment by securing the forest area from persons who have encroached upon it. The second type addresses illegal logging: these operations are carried out at the same time as forest encroachment operations or after a surveillance process of suspected illegal logging sites. The third type focuses on illegal wildlife trade. According to MoEF (2018), enforcement operations are held after receiving reports from the field, and from communities and NGOs. The outcomes of the two types of operations most relevant to this research (forest area encroachment and illegal logging) are available in summary form for recent years (Table 2).

The area that appears to have been recovered from encroachment is very sizeable, although it is not clear from the source whether it had already been deforested/degraded. In relation to illegal logging, the amount of timber recovered is rather insignificant if one looks at it from the perspective that estimated timber production from illegal logs in Indonesia in 2013 was in the order of 15 million m^3 of roundwood equivalent (Hoare, 2015) as already noted above.

Limited information is publicly available on the details about administrative sanctions imposed by the MoEF in relation to violations of forestry regulations (Table 3), and it is not publicly available for criminal sanctions. With regard to administrative sanctions it needs to be noted that it is not possible to assess the impacts of the sanctions as more information would be required for such an assessment, for instance on the reasons for the sanctions and the outcome of the procedures.

Table 1
Cases handled by law enforcement agencies.

Agencies	Period	No. of cases	No. of suspects
National Police	2012-2014	3213	3702
MoEF	2014-2015	113	n.a.

Source: Situmorang (2015).

5. Discussion: comparing Brazil and Indonesia

There are several similarities between Brazil and Indonesia in relation to their forest law enforcement approach, particularly at the more general level. As it could be expected, they both define a range of forest crimes and associated penalties, from fines to prison terms, including crimes by individuals and corporate crime. Multiple layers of law enforcement, with several bureaucratic structures and agencies at various levels, are used by both countries, that have specialized environmental law enforcement units. It is notable that both countries adopt the *follow the money principle* as one of the ways to identify illegal forest activities and the perpetrators, who are supposed to pay for the costs of rehabilitation of forest. The issue of the extent to which these measures are successfully implemented remains to be analyzed in both countries. Finally, both countries are faced with limited funding and human resources for forest law enforcement, with Indonesia to a greater extent than Brazil. The efficiency with which those resources are used may be limited but, again, this is an issue that deserves more work to properly assess it. Let us now consider the two countries in turn to distill the specific characteristics of forest law enforcement.

Brazil increased its enforcement capacity during the period, particularly when the fight against deforestation in the Amazon received significant political support. There is clear research evidence, discussed earlier, that this effort led to a significant reduction in illegal deforestation. Those law enforcement activities were focused on municipalities with the highest rates of deforestation. Particularly significant was the fact that this targeting was coupled with improved remoted sensing systems that could identify illegal deforestation in a timely manner, thus allowing the implementation of a more systematic and expeditious allocation of the enforcement effort. Enhanced law enforcement activities were also possible thanks to the building of institutional capacity, which in the case of IBAMA had been improved by increasing the number and skills of technically qualified employees.

Brazil also appears to have improved practical aspects that influence the overall enforcement effort, namely a higher operational budget execution of disincentive policies at the federal level, in addition to increased institutional budget availability to the implementation of forest conservation policies. However, further work is required to better understand the relationship between the amount and quality of government spending and deforestation dynamics.

It is also important to stress that the number of fines with geographical coordinates, arguably an important indicator to gauge the quality of the legal case against deforesters, increased from almost zero in 2001 to 100% of issued fines, in 2014. This would appear to be an important practical element of Brazil's efforts against illegal deforestation. Nevertheless, given Brazil's historical low level of fine collection (Börner et al., 2014), further analysis would be useful in order to assess the actual effect of this administrative sanction, as well as existing opportunities for cost recovery through optimisation of potential fine revenue, provided these fines could be collected. The latter seems relevant in the context of creating funding alternatives to deal with public budget constraints. Despite the need for more detailed analysis of the outcomes of specific elements of the Brazilian forest law enforcement approach, its demonstrated success in reducing deforestation in the Amazon shows that law enforcement does not have to be perfect to achieve a relevant deterrent effect.

Finally, Brazil's experience shows that forest law enforcement needs to involve an adaptive approach. It is clearly demonstrated by the fact that the law enforcement strategy that targeted the largest areas of

Table 2
Number and results of key law enforcement operations in Indonesia

Type of operation	2015		2016		2017	
	Number of operations	Results	Number of operations	Results	Number of operations	Results
Forest area encroachment	27	3,072,198 ha	65	986,529 ha	137	3,005,360 ha
Illegal logging	25	1,042 m^3	39	3,642 m^3	88	3,829 m^3

Source: MoEF (2018).

Table 3
Administrative sanctions by MoEF in Indonesia.

Type of sanction	2015	2016	2017
Revocation of licences	3	-	1
Suspension of licences	21	-	-
Government mandated corrective actions	16	90	125
Written reprimand	8	15	-
Written warnings	-	115	-

Source: MoEF (2018).

apparent illegal deforestation led to a reduction of the size of the areas being deforested. The resulting dispersed and fragmented illegal activities required Brazil to improve its capacity of detecting smaller patches of deforestation in a remote manner, thus optimizing the deployment of costly field-based operations, which are constrained by limited human and budgetary resources. Importantly, Brazil has regularly reviewed its enforcement strategy in the context of PPCDAm due to accumulating knowledge on the patterns and actor-specific contributions to illegal deforestation. Another interesting finding is that Brazil did not rely on a single or static forest law enforcement approach, combining centralized remote detection strategies with more ostensive and regular field-based enforcement in critical deforestation frontiers.

Similarly to Brazil, Indonesia has a comprehensive forest regulatory framework that includes regulations on forest law enforcement. Despite that, it still faces very significant levels of illegal deforestation (Margono et al., 2014; Hoare, 2015). Particularly relevant to this research is the fact it does not appear to have managed to reduce illegal deforestation. This is evident given that despite a Presidential Instruction (No. 4/2005) on eradicating illegal logging and the Law on the Prevention and Eradication of Forest Destruction (No. 18/ 2013), in 2013 illegal timber production was in the order of 15 million m^3 of roundwood equivalent (Hoare, 2015), whilst the illegal timber seized every year amounts to just a few thousand cubic metres (Table 2). The finding that protected areas established for the conservation of biodiversity in Indonesia are ineffective at slowing down deforestation (Brun et al., 2015) further supports the argument that forest law enforcement is not as effective as it could be expected, given that deforestation in protected areas is illegal.

Unlike Brazil, Indonesia does not appear to have a centralized, strategic approach to law enforcement that relies on timely remote sensing data. The fact that law enforcement operations are initiated at the local level means that: i) the national budget and human resources for forestry law enforcement are not necessarily being allocated to the areas that have the most significant illegal forestry activities, and ii) local forestry enforcement officers do not necessarily target the most significant illegal forestry activities in their areas as they are unlikely to be able to monitor large forest areas without frequent remote sensing information. Indonesia should therefore consider the development of a national law enforcement strategy, that needs to be supported by timely remote sensing information focused on detecting illegal deforestation. As it is has been noted in relation to Brazil, that information is now freely available through Forest Watcher, developed by the World Resources Institute.

A forest law enforcement strategy should be fair (Colchester et al., 2006; Robinson et al., 2010). This means that Indonesia's remote sensing analysis of illegal deforestation should distinguish between large scale illegal land clearing, which is normally carried out by companies, and small scale illegal land clearing, usually carried out by smallholders. Addressing illegal large scale land clearing should be the given priority over law enforcement to reduce illegal small scale land clearing. In relation to the latter, there would be a need to assess whether to support the development of alternative livelihoods (see also Irawan et al., 2019).

In relation to illegal land clearing, it has been reported that millions of hectares of encroached forest land have been recovered (Table 2). It is not clear whether this land was still forested, or had been deforested, and from whom it had been recovered from, i.e. companies and/or smallholders. More information about the recovered areas would be required to ascertain whether those operations contributed to reducing illegal land clearing (if the area was still forested) or whether they took place too late to achieve that outcome. The information on the subjects from whom it was recovered would be needed to ascertain fairness aspects as well as impacts on livelihoods.

Indonesia spends relatively low amounts per hectare to protect its forests. As a result, forest officers are responsible to control extremely large areas of forest, particularly in Papua. There is a lack of research on the efficiency and effectiveness of spending on forest law enforcement in Indonesia. This analysis would be useful to determine the extent to which funding for law enforcement should be increased, particularly in the context of a new forest law enforcement strategic approach as suggested above. Finally, in relation to the assessment of the effectiveness of forest law enforcement, further research would also be required to assess the deterrence effect of the enforcement penalties applied, such as revocation and suspension of licences, fines, and whether the encroached forest areas that were recovered (Table 2) were rehabilitated.

6. Conclusion

Indonesia has committed to reducing emissions from deforestation. However, it has not yet been successful at reducing illegal logging and illegal deforestation (Hoare, 2015). On the other hand, Brazil succeeded in significantly reducing deforestation, and research has shown that forest law enforcement played a significant role in that success. Brazil's forest law enforcement activities relied on a clear strategy that involved key elements that include timely remote sensing imaging to identify illegal deforestation, confiscation of timber and machinery, embargoes, fines, public disclosure of non-compliant behaviour and the blacklisting of municipalities that were not reducing deforestation. Forest law enforcement in Indonesia could significantly benefit from careful consideration of Brazil's experience. This does not mean that Indonesia should simply seek to copy the approach adopted by Brazil. Rather, it should consider its lessons and assess whether and how they could be transferred to its specific conditions.

The issue of forest law enforcement has received rather limited attention from recent research on REDD + . However, the present research demonstrates the practical significance of addressing illegal activities to reduce greenhouse gas emissions, not only in the context of REDD + but also in the broader strategies for reducing emissions as stated in Nationally Determined Commitments to the UNFCCC, given that illegal

deforestation accounts for a significant share of total deforestation in many countries (Hoare, 2015). Renewed research attention to illegal forest activities is also needed to explain why extensive illegal forest activities continue on a grand scale almost two decades after the first Forest Law Enforcement, Governance and Trade conference in Bali in 2001 shone the spotlight on them.

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