



Infrastructure development and contested forest governance threaten the Leuser Ecosystem, Indonesia



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ARTICLE INFO

Keywords:

Connectivity
Deforestation
Spatial planning
Primary forest
Secondary forest
Roads
Indonesia

ABSTRACT

The Leuser Ecosystem in northern Sumatra, Indonesia is a globally-significant landscape for biodiversity conservation and ecosystem services. It is however increasingly threatened by infrastructure development, enabled by discordant forest governance amongst central and regional governments. Here we identify these infrastructure threats and related shortcomings in forest management and conservation planning. Environment-development conflicts were mapped across the Leuser Ecosystem, in addition to unofficial and official roads as well as planned road, electrical generation, and electrical transmission developments. We find that conflicts concentrate in the Leuser Ecosystem, where many protected forests were formerly degraded and are now undergoing *de facto* conversion. Unofficial roads, not observed within government maps, were nearly double the length of official roads within the Leuser Ecosystem (6818 km vs 3597 km). Approximately half of all roads occurred in forests, particularly historically-exploited forests. Consequently, small forest patches and narrow forest corridors comprise 27% of the Leuser Ecosystem, and most are subject to ongoing degradation and conversion. We identify eight conservation priority areas where concentrations of road developments have produced particularly vulnerable forests. Planned infrastructure developments would directly impact these priority areas and bisect the Leuser Ecosystem, contradicting national conservation planning directives. These trends are framed by an assertive decentralisation by regional governments, aggravating the legal-administrative volatility surrounding the Leuser Ecosystem and empowering development interests. Such volatility is poised to become more common in Indonesia at a time of rapidly expanding development pressures within remaining natural environments.

1. Introduction

Deforestation in Sumatra is largely associated with prior forest degradation (Margono et al., 2012; Margono et al., 2014), as by agricultural incursions, forest extraction (Gaveau et al., 2014a; Linkie et al., 2014), and fires (Gaveau et al., 2014b; Sloan et al., 2017), much of which is illegal. Such trends reflect development pressures amidst poor spatial planning and law enforcement (Robertson and Van Schaik, 2001). Recently, Indonesia undertook reforms to ‘rationalise’ its forest management (Sloan et al., 2012; Sloan, 2014; Samadhi, 2013; Astuti and McGregor, 2015; Wibowo and Giessen, 2015). Yet the implications of these reforms remain uncertain where developmental pressures are acute (Wijedasa et al., in press). A case in point is the Leuser Ecosystem in Sumatra, a globally-significant conservation landscape (Le Saout

et al., 2013) and the last habitat wherein orangutans, rhinoceros, elephants, and tigers co-occur (Fig. 1). The Leuser Ecosystem is subject to infrastructure development plans contested amongst central and regional governments while, in its most afflicted areas at least, nearly all forest destruction derives from breaches of environmental and planning laws (Tata et al., 2014). Here we assess current threats to the Leuser Ecosystem and highlight the governance challenges that play a pivotal role in its future.

Current threats to the Leuser Ecosystem (hereafter ‘Leuser’) center increasingly on infrastructure development. For instance, part of the Leuser is a World Heritage Site¹ (WHS) (Fig. 1) that has been listed as World Heritage in Danger since 2011 due to ‘serious and specific’ infrastructure threats (GOI, 2017). Indonesia has recently assured the UNESCO World Heritage Committee that there are no new road projects

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¹ The Tropical Rainforest Heritage of Sumatra, which encompasses forests within the Leuser Ecosystem as well as elsewhere in Sumatra.

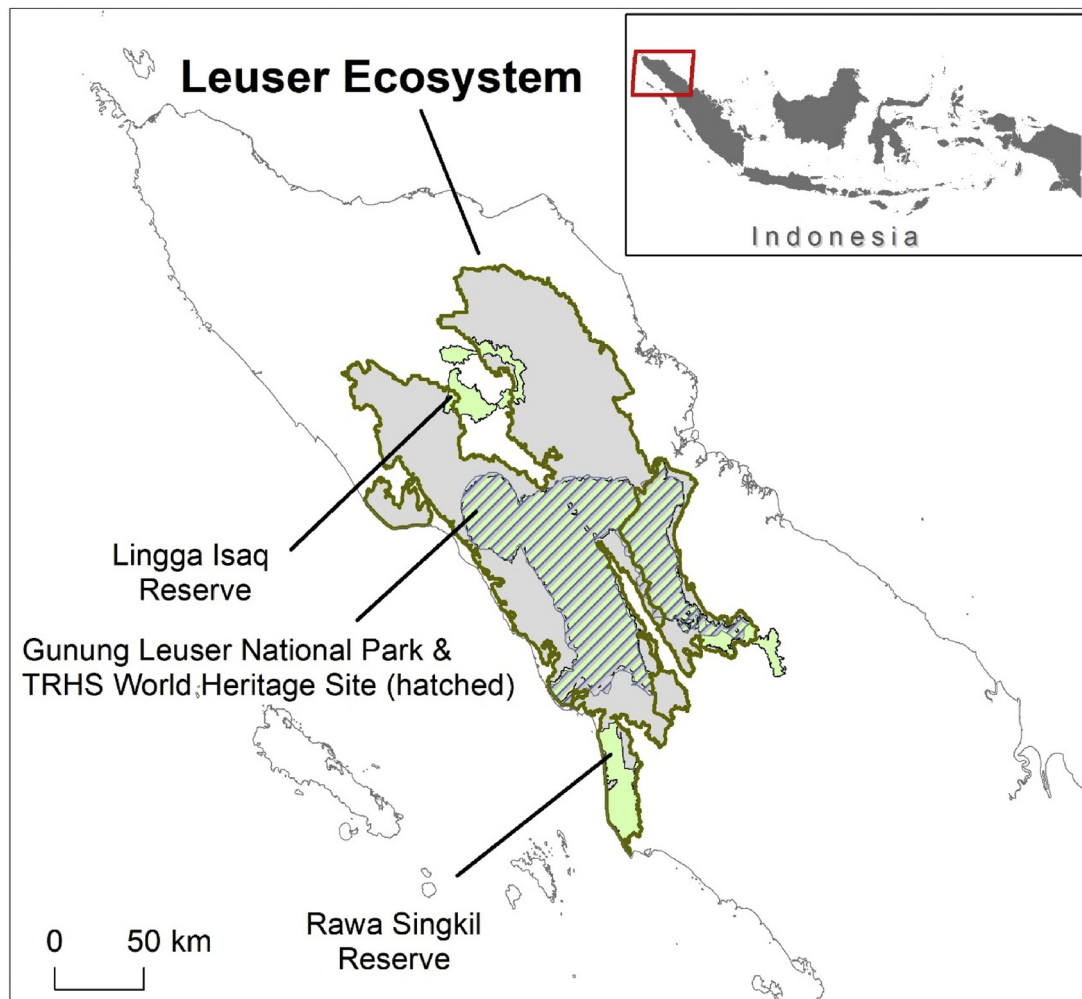


Fig. 1. The Leuser Ecosystem and its Protected Areas, Sumatra.
Note: 'TRHS' means Tropical Rainforest Heritage of Sumatra.

planned for the WHS, but ongoing road developments within the Leuser are still supported (GOI, 2017; Jong, 2017). A road-development proposal to bisect the WHS was recently stayed by the central government, but it is pending imminent reapplication by North Sumatra province. The 400-km Ladia Galaska road-expansion initiative facilitated small-holder agricultural encroachment into the Leuser along recently-built roads (Gaveau et al., 2009a). Meanwhile encroachment along older roads occurred in the adjacent Ulu Masen protected forest (Linkie et al., 2014). As detailed here, the Aceh provincial government, which is responsible for the vast majority of the Leuser's area, recently planned an array of road and hydroelectric development projects (Hanafiah, 2017) that would fragment and degrade the Leuser Ecosystem.

The 2.6-million-hectare Leuser Ecosystem falls under two legal umbrellas for conservation, the role of which are increasingly uncertain for development planning in northern Sumatra. First, as in Indonesia generally, forests within the Leuser are designated for either conservation, protection, production, or conversion, affording decreasing degrees of protection (Brockhaus et al., 2012). These designations are often loosely enforced in Indonesia (Fuller et al., 2004), or have appeared as such where different levels of government have interpreted them differently (Samadhi, 2013). Production forest designations may protect against deforestation effectively where they are relatively inaccessible (Gaveau et al., 2009b; Gaveau et al., 2012; Gaveau et al., 2013; Santika and Meijaard, 2015), but they have also served as an 'overflow' designation for expansive cultivation and settlement (Potter and Lee, 1998), including within the Leuser (Eddy, 2015). Second, the

Leuser is also relatively unique as a 'national strategic area' (NSA) for the protection of ecosystem services. NSAs broadly restrict infrastructure development and agricultural expansion to ensure ecological integrity. While clearly articulated in national legislation, the NSA status of the Leuser is increasingly ambiguous. In its latest spatial development plan, the Aceh provincial government failed to recognise the Leuser as a NSA and outlined countervailing infrastructure development plans. This has raised unresolved questions regarding the conservation status of the Leuser and the coherence of decentralised Indonesian forest governance.

The development pressures and challenges faced by the Leuser Ecosystem reflect those across Indonesia generally. Indonesia is pursuing six major road-development corridors to expand and consolidate estate agriculture (e.g. oil palm), timber extraction, mining, and international trade. These corridors are a priority for the central government and would traverse relatively remote, forested regions of Kalimantan, Papua, Sumatra, and Sulawesi, with investments of \$14 billion USD (187 trillion Rp) for roadways alone in the former three regions (CMEA, 2011). The environmentally-judicious development of these corridors is contingent on the coherence of national and regional land-use plans and corresponding laws. The case of the Leuser suggests that this coherence remains elusive, while the history of Indonesian development suggests that the corridors may proceed in some form regardless.

This article observes conflicts between infrastructure development and environmental conservation across the Leuser in the context of contested forest governance. We present exhaustive maps of current

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