Assessing the risk to the conservation status of temperate rainforest from exposure to mining, commercial logging, and climate change: A Tasmanian case study

Brendan Mackey[a,*], Sean Cadman[b], Nicole Rogers[c], Sonia Hugh[a]

[a] Griffith Climate Change Response Programme, Griffith University, Australia
[b] Cadman & Norwood, Environmental Consultancy, Australia
[c] School of Law and Justice, Southern Cross University, Australia

A B S T R A C T

Formal protected areas are a critical conservation measure so long as their tenure is defined and secure and they are well managed. Protected areas in developed countries are assumed to meet these criteria and therefore have not attracted the level of attention given to the adequacy of protected areas in developing countries. We investigate this assumption using as a case study the southern temperate rainforests of Tasmania, Australia. We examine the extent to which these rainforests are protected from potential exposure to mining, commercial logging and climate change. We analyse the tenure of Tasmania's rainforests and identify the protected area categories that prohibit or allow mining or logging. We also model the potential distribution of *Nothofagus cunninghamii*, a dominant rainforest canopy tree species, to future climate and compare this with modelled current and future forest fire danger index. Results showed that 90% of the total area of Tasmanian rainforest (715,773 ha^{-1}) is in a reserve. However, the area of rainforest in reserves secured from mining and/or commercial logging is only 47% (335,863 ha^{-1}) as 43% (308,897 ha^{-1}) is in a reserve category where these land uses are permitted. The protected area category with the highest level of protection, prohibiting all mining and logging, is the Tasmanian Wilderness World Heritage Area which encompasses 325,920 ha^{-1} of temperate rainforest. During a recent legislative review, 66,012 ha^{-1} of rainforest in protected areas was downgraded to a reserve category that permits logging or mining. A key conservation instrument therefore is the Management Plan for the World Heritage Area as it overrides land use activities otherwise permitted including the 21,257 ha^{-1} which is on a State-defined land tenure that allows for logging or mining. Climate change impacts, as modelled, suggest the main conservation challenges are in maintaining the integrity of the remaining intact rainforest blocks and better managing ignitions from lightning strikes and arsonists in the coniferous and alpine rainforests. Allowing structural degradation and fragmentation to intact rainforest blocks will reduce their capacity to buffer meso-climatic variability and resist fire events thereby undermining their ecosystem integrity. Noting that Aichi Target 11 includes the requirement that reserves are effectively managed, our case study highlights that assessing the effectiveness of a reserve system is not necessarily a straightforward matter as governance systems and regulatory frameworks involve a mix of international obligations, national and subnational policies and statutes, along with other agreements, administrative arrangements and plans of management, which can provide for a range of land use activities and be subject to modification over time.

1. Introduction

For many decades, the clearing and degradation of tropical forests has been a focus of international concern (Kim et al., 2015). Attracting less interest has been the plight of the world's remaining temperate rainforests despite temperate forest being the most cleared of all forest biomes (Mackey et al., 2015). The world's remaining temperate and boreal rainforests are restricted to 140,411,000 ha^{-1} in total area (Fig. 1). Policy responses to tropical deforestation and degradation often highlight the lack of well-defined and secure land tenure in developing countries as a major roadblock to forest protection (Nolte et al., 2013; Nepstad et al., 2006; Suwarno et al., 2015; Reichl et al., 2014). It could be assumed that the remnant temperate rainforest in developed countries must therefore be secured from threatening
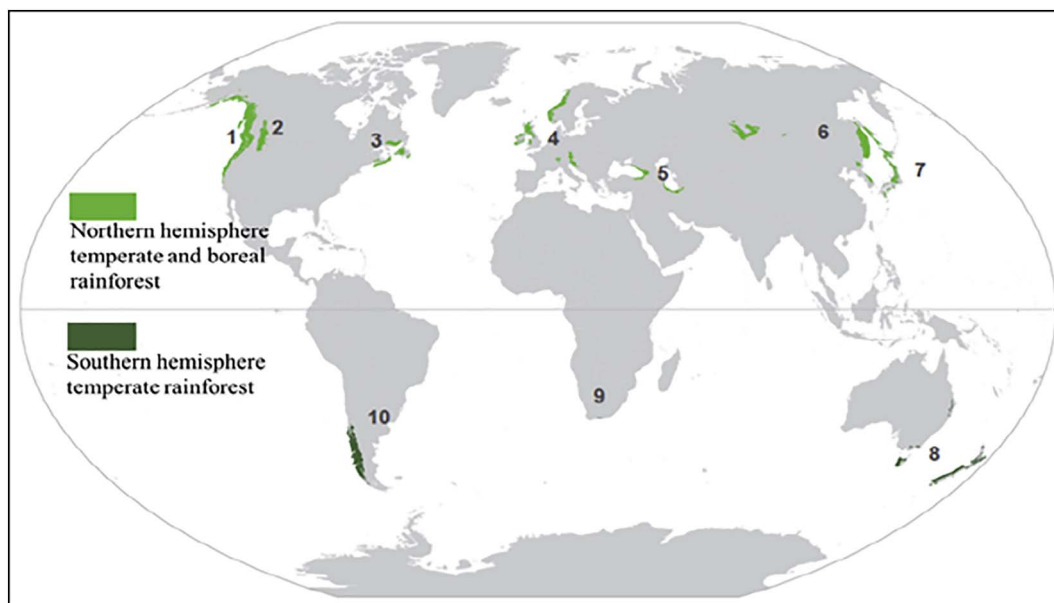
Fig. 1. The geographic distribution of the world's remaining temperate and boreal rainforest (data sources: world merge, DellaSala, 2011).

processes including the impacts of mining and commercial logging as these countries have well defined and legally enforced land tenure arrangements along with established and well managed protected area networks. However, this assumption warrants empirical verification given that mining and commercial logging are pervasive in their geographic distribution and global reach (Reichl et al., 2014; FAO, 2015). Furthermore, irrespective of land use, natural forests are subjected to the increasing impacts of a rapidly changing climate and the flow-on effects to processes with significant ecological implications, especially altered fire regimes (Fox-Hughes et al., 2014).

The temperate rainforests of the Australian island State of Tasmania (Fig. 2), have global conservation and natural heritage significance as defined by the criteria used for assessing outstanding universal value under the World Heritage Convention (UNESCO, 2016) as they represent, among other things, outstanding examples of (1) major stages of Earth's biological and geological history, (2) ongoing- ecological and biological processes in the evolution and development of ecosystems; and (3) contain important and significant natural habitats for in-situ conservation of biodiversity. Further details about the biodiversity, natural heritage and conservation values of Tasmania's temperate rainforests, including the forest occurring within the Tasmanian Wilderness World Heritage Area (TWWHA) are provided in Supplementary Material (A). Note that the core area of the TWWHA was inscribed on the World Heritage List in 1982 on the basis of all four natural criteria and three cultural criteria. Documentation of the area's cultural heritage values however remains inadequate and they are not considered further here (WHC, 2015).

The conservation status of Tasmania's temperate rainforests - in terms of the degree of protection an area is given from inappropriate land use activities - depends on the governance arrangements provided by a complex suite of regulatory mechanisms at international, national and state levels. It is therefore important to understand precisely what land uses are or are not permitted by these arrangements and on the various land tenures encompassed under the broad banner of 'reserves'.

In this paper we examine the conservations status of temperate rainforest in Tasmania and the extent to which the protected area network serves as a barrier to mining and commercial logging and provides resilience to climate change impacts. Tasmania presents an appropriate case study as Australia is an economically developed country (ranked 12th by GDP; World Bank, 2016) with strong land tenure arrangements, and a well-regarded national reserve system

managed according to IUCN protected area standards (Department of Environment and Energy, 2016a). Here we assess from a global perspective the conservation significance of Tasmania's temperate rainforests, review their conservation land tenure and governance arrangements, analyse their exposure to mining and commercial logging, and evaluate some potential impacts of climate change.

2. Methods and materials

We first assessed at a national level the distribution of the world's remaining temperate and boreal rainforests and identified the extent to which they are conserved in a protected area. The source data for these analyses were: (1) a global map of temperate and boreal rainforests (DellaSala, 2011); (2) the global protected area database (IUCN and UNEP-WCMC, 2016); and (3) a global data set of national borders (Sandvik, 2016).

We identified the multi-level governance arrangements articulated through legal instruments that influence the tenure and conservation status of Tasmania's temperate rainforest. We then analysed the extent to which Tasmania's temperate rainforest, including rare and threatened communities, are conserved in a reserve (i.e. a protected area) as defined by the Tasmanian Public Land Use Classification system. These analyses used three publicly available government maintained datasets: (1) Tasmanian Reserve Estate 2015 (DPIPWE (Department of Primary Industries, Parks, Water and Environment), 2015) - a digital map of the reserve system of Tasmania; (1) Tasveg 3.0 (DPIPWE (Department of Primary Industries, Parks, Water and Environment), 2013) - a comprehensive digital map of Tasmanian Vegetation Communities; and (3) Australian World Heritage Areas maintained by the Commonwealth of Australia (Department of Environment and Energy, 2015). These GIS-based spatial statistics and mapping were undertaken using ArcGIS (ESRI, 2016). The spatial data were filtered to exclude 'sliver polygons' at or below 0.05 ha. These data were also used to identify the largest remaining intact rainforest blocks.

Potential climate change impacts were examined using species distribution models (SDMs) for *Nothofagus cunninghamii*, the dominant Tasmanian rainforest canopy species, along with consideration of a map of the boundary of the major fire event of 2014–2015 (Bowman, 2016) and published modelled fire risk projections. The SDMs were calculated using the Biodiversity and Climate Change Virtual Laboratory (Hallgren et al., 2016). Details of the data sources and statistical algorithms