

In response to concerns over the industry's sustainability standards, the Roundtable on Sustainable Palm Oil (RSPO) was formed in 2004 by a collective of industry representatives and civil society groups (Ruysschaert and Salles 2014). As a market-based mechanism, RSPO broadly aims to provide an incentive for companies and producers to improve their practices and 'promote the growth and use of sustainable palm oil products through credible global standards and engagement of stakeholders' (RSPO 2004). Although any interested party can become an RSPO member, RSPO certification can only be achieved by adhering to the 8 operating Principles covering 39 criteria that form the scheme's guidelines. Currently under review, these Principles and Criteria (P&C) relate to economic, social and environmental aspects of palm oil plantation development, management and production (see RSPO P&C 2013). Since initial establishment RSPO has grown to represent over 2000 members, certifying 2.65 million hectares of palm oil plantations and 11.65 million tonnes of palm oil equating to about 20% of global trade (RSPO 2015). However, despite the initial hopes for the certification scheme, RSPO is frequently criticized as a 'slow bus' lacking the authority to uphold and regulate standards in the palm oil industry and giving rise to numerous stakeholder concerns (Laurance *et al* 2010, Moreno-Peñaranda *et al* 2015, Ruysschaert and Salles 2014, Meijer 2015, Ruysschaert 2016).

The major challenge currently faced by RSPO is the differing interpretation of its primary objective, to 'promote sustainable palm oil'. Despite sharing the underlying assumption that sustainability implies moving from an unsatisfactory state to a more satisfactory state, stakeholder groups perceive sustainability differently and as such will interpret the term within often mutually exclusive economic, social or environmental frameworks (Lélé and Norgaard 1996, Callicott and Mumford 1997, Farrell and Hart 1998, Jones *et al* 2008). For example, Callicott and Mumford (1997) argue that in the context of conservation, 'sustainability' should be used to denote the process of 'conserving the biota of ecosystems that are humanly habituated and economically exploited'. This ecocentric interpretation of sustainability is in contrast to Franklin's (1993) interpretation of sustainability as an anthropocentric concept whereby the natural system is managed in a way that 'maintains potential and production of goods and services in perpetuity'. As a result of these varying interpretations of sustainability, different RSPO stakeholder groups prioritise certain criteria over others.

How the RSPO can achieve multiple and at times conflicting sustainability outcomes remains uncertain. RSPO's governance framework has been subject to several evaluations focused on improving capacity (Nikoloyuk *et al* 2010, Paoli *et al* 2010), legitimacy (Schouten and Glasbergen 2011), knowledge sharing (Ponte and Cheyens 2013) and participation (Winters

et al 2015). Similarly, numerous critiques of the certification program's perceived short-comings, including weak standards (Laurance *et al* 2010), limited enforcement (Ruysschaert and Salles 2014) and a lack of sanctioning for non-compliance (Meijer 2015) have also been undertaken. To date however, few investigations have been undertaken to evaluate RSPO effectiveness in achieving sustainability aims and out of those that have, only single outcomes such as profitability (Levin *et al* 2012, Preusser 2016) and biodiversity conservation (McCarthy and Zen 2010, Carlson *et al* 2018) have been considered. Whilst these aforementioned studies have provided useful first steps, the focus on single and simplified components is inadequate for evaluating the success (or otherwise) of a multifaceted certification scheme. In addition, many of these studies fail to consider the counterfactual scenario, what would have happened in the absence of the scheme (Miteva *et al* 2012). Presently, there is no evidence-base to answer if investment in RSPO has been an effective means of obtaining outcomes better than business as usual.

This paper aims to determine the effectiveness of RSPO certification in delivering multiple sustainability outcomes covering attributes relating to environmental, social and economic sustainability (summarized in table 1). The analysis is focused on six of the eight central pillars of the RSPO Principles and Criteria (P&C) including conservation of biodiversity, responsible development of new plantings, responsible consideration of communities, consideration of social impacts, economic viability, and commitment to best practice (see supplementary material available at stacks.iop.org/ERL/13/064032/mmedia for further detail). The remaining two criteria—commitment to transparency and compliance with local laws and regulations—were excluded from this particular analysis as they are less focused on improving industry sustainability and rather on ethical and lawful plantation operation. Controlling for key confounding variables, the performance of RSPO certified and non-certified concessions are compared before and after the establishment of the sustainability scheme.

Methods

RSPO concession map

A novel map outlining RSPO certified concessions in Kalimantan was created by cross-referencing spatial and statistical data from multiple sources. A base map of palm oil concessions developed by the Indonesian Ministry of Agriculture (Kalimantan oil palm concession shape file 2014) was obtained through World Resources Institute (WRI). Names, parent companies and provinces of all 535 palm oil plantations in Indonesian Borneo were then obtained through the oil palm plantation company directory produced by the Indonesian Bureau of Statistics (2014).