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RESEARCH ARTICLE

Wading through the swamp: what does tropical peatland restoration mean to national-level stakeholders in Indonesia?

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Ecological restoration is considered to play an important role in mitigating climate change, protecting biodiversity, and preventing environmental degradation. Yet, there are often multiple perspectives on what outcomes restoration should be aiming to achieve, and how we should get to that point. In this study we interview a range of policymakers, academics, and non-governmental organization (NGO) representatives to explore the range of perspectives on the restoration of Indonesia's tropical peatlands—key global ecosystems that have undergone large-scale degradation. Thematic analysis suggests that participants agreed about the importance of restoration, but had differing opinions on how effective restoration activities to date have been and what a restored peatland landscape should look like. These results exemplify how ecological restoration can mean different things to different people, but also highlight important areas of consensus for moving forward with peatland restoration strategies.

Key words: biodiversity; climate change; Indonesia; interviews; perceptions; stakeholders

Implications for Practice

- National-level policymakers, NGOs (non-governmental organizations), and researchers involved in peatland restoration agree on its importance and the many benefits it can provide, yet differ in their views on how peatland restoration should be achieved, the progress that can be made, and the end point that is sought.
- Respondents across our interviewed groups agreed that peatland restoration offers many potential benefits (including reducing carbon emissions and improving health), but further research is needed to ensure that the costs of restoration are equitably shared.
- Local community involvement was highlighted as key to project success by policymakers, NGOs, and researchers involved in peatland restoration, yet there were a wide range of opinions on how well it is currently being implemented. Further research and resources are needed to understand how local communities perceived their involvement in restoration, as well as its impacts.
- Respondents showed greatest consensus that raising water levels in degraded peatlands can be used as a measurement of progress towards restoring peatlands.

Introduction

The United Nations (UN) declared 2021–2030 the decade of ecosystem restoration, aiming to "scale up the restoration of degraded and destroyed ecosystems as a proven measure to fight climate change, and enhance food security, water supply and biodiversity" (UN Environment Programme 2019). This sits alongside recent reports which underscore that avoiding, reducing, and reversing land degradation is essential for meeting the UN sustainable development goals (SDGs) by 2030 (Cowie et al. 2018; IPBES 2018; IPCC 2019). Despite widespread agreement that restoration is important, little research has

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considered who decides what restoration is aiming to achieve, how we should go about achieving that, and when there are multiple perspectives, how perceptions may differ leading to different approaches and priorities. This study targets that gap.

The starting point for restoration is determined by how degradation is defined. The Society for Ecological Restoration (SER) primer states: "Ecological restoration is the process of assisting the recovery of an ecosystem that has been degraded, damaged, or destroyed" (Society for Ecological Restoration International Science & Policy Working Group 2004). However, Hobbs (2016) shows that definitions of degradation vary considerably and relate to different ecosystem features depending on the policy and management context. Ecosystem changes are perceived through different value-based filters, and changes may be valued by some people but not others (Hobbs 2016). Restoration goals are also dependent on historical information regarding the ecosystem before human disturbance, but often this is unavailable or limited (Higgs et al. 2014). Furthermore, restoration goals are shaped by the interaction of historical information, current conditions, and other practical considerations (Higgs et al. 2014). Yet, few studies assess whose values and histories are prioritized.

Given the diversity of views and goals of ecological restoration, social dimensions are central to restoration success, yet are often underreported (Wyborn et al. 2012; Martin 2017). There are multiple ideas about restoration and how to identify the end point as "restored." Shifting baseline syndrome, where human perceptions change due to loss of knowledge of past conditions, also affects the restoration "end point" (Papworth et al. 2009). It can lead to reduced public support for restoration (it is seen as unnecessary) and cause policymakers to set inappropriate targets, leading to reduced chances of intervention success (Soga & Gaston 2018).

Sustainable tropical peatland management is a key focus for the UN decade of ecosystem restoration (UN Environment Programme 2019), due to its importance in reducing global carbon emissions. Intact tropical peatlands act as a carbon sink, but emit more carbon dioxide when degraded (Page et al. 2011; Jauhiainen et al. 2016). Degraded peatland is also fire-prone, leading to even greater carbon emissions, alongside health issues, destruction of crops and houses, and disruption of infrastructure (Page & Hooijer 2016; Green & Page 2017; Marlier et al. 2019; Uda et al. 2019). Indonesia contains 15 million hectares of tropical peatland (Ritung et al. 2011), more than half of which are degraded due to drainage and conversion to cropland (Dohong et al. 2018). Peatland fires in 2015 were estimated to have contributed to over 100,000 deaths (Koplitz et al. 2016) at a cost of USD16.1 billion in Indonesia alone (The World Bank 2016). In 2016, the Indonesian government committed to restoring over 2 million hectares of tropical peatland by 2020. While the remit of environmental restoration cross-cuts the interests of multiple ministries, the Peatlands Restoration Agency (Badan Restorasi Gambut, BRG) was established to oversee the restoration in line with the policy target, via a "3Rs" approach. The 3Rs include rewetting through canal blocking and backfilling, revegetation, and revitalization of livelihoods to offer alternative, more sustainable options (Dohong 2017; Dohong et al. 2018). Additional restoration activities are dispersed across Indonesia's peatlands and involve a range of different organizations and institutions, and receive support from different donors, ministries, and other groups.

Recent publications and policy changes highlight multiple ideas around what peatland restoration in Indonesia should be, and how it should be achieved. For example, some researchers have called for peatland agriculture to end (Evers et al. 2017; Wijedasa et al. 2017; Murdiyarso et al. 2019), whereas the Indonesian government has mandated that peatlands under agriculture must maintain a maximum water table depth of 40 cm. The Roundtable on Sustainable Palm Oil updated their guidelines in 2018 to recommend an average water table depth of 50 cm, ranging between 40 and 60 cm (RSPO 2018). For successful restoration, agreement is needed on the aim and most appropriate methods (Reed et al. 2019). Yet, limited research explores the range of perspectives on ecological restoration in tropical peatlands. We address this gap, focusing on a national level to ask: (1) What are the drivers and motivations for restoring Indonesia's tropical peatlands? (2) What are the perceived benefits and costs of tropical peatland restoration? (3) What is peatland restoration aiming to achieve in Indonesia? (4) How has peatland restoration progressed so far? (5) How have local communities been engaged in the peatland restoration process?

Methods

As restoration stems from ecology, the majority of research (including peatland restoration) has been based on quantitative data collection, although this is now changing with important recent research findings published utilizing a qualitative approach (e.g. Carmenta et al. 2017; Uda et al. 2018; Harrison et al. 2019; Langston et al. 2019; Puspitaloka et al. 2019). Qualitative approaches enable exploration of in-depth issues, and can better represent diversity of study groups or populations (Drury et al. 2011; Newing et al. 2011). This is crucial in understanding processes, motivations, and drivers of certain behaviors or policies relating to restoration. Although quantitative data can help us understand trends in a numerical form, qualitative data can help us to explore the "how" and "why" of those trends and add greater explanatory power, as well as more comprehensively contextualizing the situation.

Stakeholder perceptions of restoration, and environmental management more generally, are critical to improving design and on-the-ground implementation of interventions (Reed et al. 2016; Tschakert et al. 2016). Perceptions can provide greater understanding at both ends of the policy structure, in exploring perceptions of how policies are created, implemented, and how they are perceived on the ground. They can point towards areas of agreement and disagreement and be an important determining factor in the establishment of partnerships. Processes of transparent dialogue can enable points of consensus and controversy to be identified, building trust to facilitate negotiation when addressing inevitable trade-offs and differences between perceptions (Reed et al. 2016; Stringer et al. 2017). Furthermore, perceptions are particularly useful where there is a lack of objective data on the impact of restoration activities (Higgs et al. 2014), as is the case in Indonesia. Despite these strengths, perceptions are often

criticized as being an unreliable source of evidence, as they are subjective, cannot be used to determine causality, may be purposefully inaccurate, and cannot be generalized to a wider population (Bennett 2016). This is because perceptions are dependent on past experiences, personal motivations. and individual knowledge and understanding. However, this is also where their strength as a form of evidence lies.

We focused on three pragmatically selected groups: policymakers, NGOs, and researchers (Table 1). We initially began with a fourth group too (the private sector) but despite identifying and contacting a number of potential respondents, they either did not respond or did not want to be interviewed, so this group was later removed. The purpose of the groups was primarily for ease of sampling, although in reality their roles in peatland restoration often overlapped, and each group is not uniform and homogeneous. We also use these groups to assign interviewees anonymity, upholding commitments in the ethical approval given for the research. For this reason, we do not specify the government ministries, NGOs, or research institutes that our respondents worked for. Before each interview took place, respondents were asked to explain how their role related to peatland restoration. Policymakers and researchers were often involved in projects on the ground alongside setting policies and targets and monitoring progress towards these. NGO employees were involved in advising policymakers, collecting and analyzing data to monitor their own restoration projects, and implementing restoration projects on the ground. Nevertheless, by sampling from these three groups we were able to get a range of perspectives from those involved in peatland restoration. As Indonesia has a highly decentralized governance system, we chose to focus on those working at the national level within government and NGOs. This meant that most of our respondents had experience in a range of different districts and were able to comment on the wider trends nationally, giving specific examples where appropriate. This is also useful as peatlands in Indonesia are found on three different islands (Sumatra, Kalimantan—Indonesian Borneo, and West Papua) which differ in cultures, livelihoods, and traditional peatland management, although the 3Rs approach of BRG is designed to be applied to all peatland areas within Indonesia. Due to the focus on the national level, we decided not to include local community representatives as they were likely to only have been able to discuss individual restoration projects rather than drawing on knowledge of the wider picture across Indonesia. Local communities are an important stakeholder in peatland restoration, playing useful roles in informing design, implementation, and the success of the restoration outcome, which is why our questions also focused on this aspect. Our findings on how local communities are involved in and affected by peatland restoration are therefore based on perceptions of policymakers, NGOs, and researchers and we make no claims about the perceptions of local communities, which themselves are likely to be highly heterogeneous (Ward et al. 2020). As we discuss above, perceptions can be unreliable for many reasons, but also offer a useful insight into what these stakeholders, who are often the decision-makers or evaluators of restoration projects, see as being important issues relating to restoration processes. Further comparative research is needed to understand the impact of peatland restoration on local communities, but this is outside the scope of this study.

Twenty-five semi-structured interviews were conducted in English. All participants were offered the choice of conducting interviews in either English or Bahasa Indonesia but all selected English. Data were collected during July 2018–January 2019, either face-to-face or via video conferencing (Table 2). Taking a semi-structured approach meant that we were able to follow-

Table 1. Definition and justification of the groups selected for interviews.

Group	*Definition for This Research*	*Reason for Choosing*
Policymakers	Government employees working in a range of national-level ministries and departments involved in peatland restoration (including BRG) All members of this group were involved in making policy decisions or setting policy goals at a national level	Responsible for setting restoration targets, monitoring peatland fires, and establishing trial and full restoration projects
NGO	Employees working for NGOs involved in peatland restoration. The NGOs varied in their overall aim, including environmental protection and sustainable development. All NGOs included were involved with executing restoration work on the ground, alongside other roles in some cases. Interviewees were either directly involved in these projects or responsible for designing or managing them. The NGO restoration projects were both those set up by BRG or by other organizations The NGOs included were both national and international in reach, but all NGO respondents were based in Indonesian national offices	Involved in on-the-ground restoration projects, both with government departments and other partners
Researchers	A range of academic researchers from universities and other research institutions in Indonesia and other countries involved in researching any aspects of peatland restoration. Their range of disciplines included soil science, social science, hydrology, botany, and forestry	Many publications stress both the urgency and importance of restoring tropical peatlands, with many researchers also collaborating with policymakers and NGOs

Table 2. Summary of interviews conducted

Stakeholder Group	*Number of Interviews*
NGO (national and international)	11
Government	7
Academic researcher	7
Total	25

up on interesting points, and that the conversations were allowed to flow rather than following a list of questions in a set order. Participants were identified via a snowball sampling approach, starting with two key stakeholders (both of whom were researchers and also involved in government restoration work) involved in a wider research project on peatland restoration. We asked each of our key stakeholders and interview participants to recommend any national-level policymakers, NGO employees, or researchers involved in peatland restoration that they knew through their networks, to ensure we had a wide range of expertise. We found that all of our key stakeholders and most interview participants were able to recommend people from each group, meaning that we were able to traverse wider networks. Starting from multiple points in each group helped address some of the reported biases in snowball sampling approaches (Newing et al. 2011; Young et al. 2018). We were not aiming for a representative sample, but one that could provide an idea of the variety of perspectives within and between groups. Policymakers were all Indonesian, while NGOs and researchers were from several countries including Indonesia. Interviews lasted 30–60 minutes, encompassing topics that mapped onto our overall research questions (Data S1). Although our questions were about peatland restoration generally in Indonesia, we found that the responses tended to focus on the BRG's restoration efforts.

Respondents were contacted via email or WhatsApp before the interview, in order to explain the study aim and processes of anonymity, confidentiality, and informed consent. Ethical approval was gained from the lead author's institution prior to data collection and research approval was given by the Indonesian government, permit number: 199/SIP/FRP/E5/Dit.KI/VII/2018.

Interviews were transcribed then analyzed following thematic coding using NVIVO software (QSR 2012), first being coded into question topic themes, then recoded following emerging themes. Answers for "why it is important to restore peatlands" and "what the benefits are" were subsequently grouped together, due to their similarity. We make no judgment about the scientific accuracy of respondents' understandings of how peatlands function in our analysis given our focus is on reporting their perceptions.

Results

What Are the Drivers/Motivations for Restoring Indonesia's Tropical Peatlands, and What Are the Benefits?

Most (21/25) respondents identified multiple drivers and benefits of restoration, including environmental, economic, and social factors. Most (15/25) of the respondents also noted the environmental motivations and benefits of restoration, for example: "It's very important for an environmental issue and the biodiversity and the water storage and for the climate change" (Government 2); "*There are many. First that we can restore the ecosystem, meaning that we can restore the habitat for the wildlife and the trees itself, because there is lot of diversity in the peatland ecosystem. And the second is of course for the carbon sequestration this will become the global issue. It is not only for Indonesia but the world and also for the local communities or people—we believe that if we restore the peatlands we can also involve the local people surrounding the area for the labor but also as the agents for the restoration activities*" (Government 3).

Most (22/25) respondents emphasized the benefits of restoration for reducing fire risks. This was justified as important both for local reasons, including health issues due to haze, and international reasons relating to reducing global carbon emissions: "*It was shocking to us in 2015 where there was a lot of haze: people, kids could not go to school, traffic stranded and many more bad stories on that*" (NGO 8); "*Given the scale of the carbon emissions from South East Asian peatlands, anything that we can do to reduce emissions, particularly if we can do that at scale, is actually going to make quite a difference to Indonesia, in particular to their carbon emissions but also to global emissions*" (Researcher 3).

Respondents' views diverged more as to whether restoring peatlands will bring livelihood benefits, and if peatlands can be sustainably used for livelihoods (particularly for agriculture). Policymakers tended to state that peatland restoration would bring livelihood benefits: "*We have to also consider about the sustainability and livelihoods of the communities and the prosperity of them. And then we believe that restoration should be addressed for the local livelihoods' sustainability so something like that and then the livelihood can get better for the future, that's the point*" (Government 6). NGOs and researchers were more cautious about the assumption that livelihoods would automatically benefit: "*people have really adapted to the current situation, so people are benefitting now and we need to find ways they can benefit from the re-wetted peatland. That's going to take some changing*" (Researcher 2).

When considering benefits for local communities, respondents highlighted the reduced fire risk and income generation, via involvement in restoration activities and improved livelihoods: "*The expected benefits are because that area still has fire happening, and what we expect most actually here is to reduce the fire. If the fire reduced I think that the health of the communities will improve, the kids can go to school again and… it would make them more confident to plant something in the area*" (NGO 8). However, there were extremely polarized views on whether paludiculture (crops growing on undrained peatlands) is feasible: "*What is this paludiculture answer, what is the crop that grows at a water table at or very close to the surface and yet delivers a livelihood? And it needs to compete with palm oil*" (Researcher 3), while others highlighted concerns: "*I'm not going to give an opinion on whether paludiculture works or not. I have dear valued colleagues who say it's great and it can restore the peatlands … and others who say it's a total waste of time, once you've removed the forest it's the beginning of the end. That's beyond my scientific expertise if you will, I'm not even sure if we know for sure*" (NGO 9).

What Are the Challenges/Negatives to Restoring Peatlands?

Some (10/25) respondents either stated there were no downsides to Indonesia's peatland restoration, or were unsure. This was particularly the case for policymakers: "I *think mostly it's on the positive side*" (Government 4); "*for the negatives I don't think there really are any*" (Government 3). Researchers and NGOs were more critical, citing local and short-term costs (including reducing access via canals and raising water tables), high financial costs involved in restoration activities, and issues of high expectations over what restoration activities could really achieve in the short/medium term: "*People have really adapted to the current situation, so people are benefitting from the current situation and we need to find ways they can benefit from the re-wetted peatland. That's going to take some changing*" (Researcher 2); "*Given the level of degradation in the peatlands, that you could completely get rid of fire by restoration in a short to medium time frame is overly optimistic*" (NGO 3).

When asked specifically about local communities, again, policymakers tended not to identify negatives, while NGOs and researchers reiterated challenges of reduced access from canal blocks: "*Of course there are, look if you start raising water tables then it will have negative impacts on certain parts of life. As I said there is no choice and so that is where the state needs to start compensating people. I mean there's no way that it will only have positive impacts*" (NGO 3).

Some (8/25) respondents highlighted that costs had to be faced as there was no alternative: "*I think we have to restore the peatlands whatever the cost or negative impact*" (Government 3).

What Is Peatland Restoration Aiming to Achieve?

Recognizing Degraded Peatland. All respondents agreed on a range of biophysical degradation indicators including: recent fire, loss of natural vegetation, lowering of water table depth (although no respondents gave a specific depth), and subsidence: "*Biophysical ones, the obvious ones are water table depth and fire hotspots, and if you're looking at satellite data it's easy stuff to measure as well. You could collect land cover data, because you know as soon as it's degraded; as soon as the water table drops you're switching from forest to ferns and sedges very quickly, even if there's no logging going on or no burning*" (NGO 6).

NGOs and researchers were unsure about how peatlands used as a source of livelihood fitted into recognizing degradation: "*I didn't put the social aspects into the indicators of degradation because I would say that they don't necessarily always line up, in that, when, for example, the economy of the village is low, it doesn't always feed in that the ecosystem would be degraded*" (NGO 6); "*Then there's a question as to whether you lump in with the degraded peatland, peatlands which are under some economic use. Some people do and some people make a separation. I try not to make that separation because I don't think it's particularly helpful to describe peatlands which are under economic use as degraded. I mean, they are degrading but are they degraded? Because, you know, they are supporting livelihoods so it depends whether you take a socio-economic viewpoint or a biological one*" (Researcher 3).

Recognizing Restored Peatland. All respondents stated the inverse of the range of biophysical indicators described for recognizing degraded peatland when it comes to recognizing restored peatland. Most (14/25) respondents highlighted that hydrology (or raising water tables) is the most important factor in restoring peatlands: "*if we are talking about the peat soil itself, it means that we can maintain the water level at the certain level to avoid subsidence… if we are talking about the restoration of the ecosystem of course we have to find the native tree species already starting to establish in the areas, and then there is also wildlife which will come later*" (Government 3).

A few (9/25) respondents also noted a lack of knowledge about whether peatlands can be fully restored and what happens when you try to restore them, for example: "*We actually have very little understanding of how peat operates, from healthy peat to degraded peat to restored peat. And people are just kind of assuming that you raise the water table depth and you improve the situation for the local communities and you have fire management and bing, there's your peatland back with a forest on top of it, sequestering carbon like it's meant to. We have no baseline data, no understanding how the peat is going to operate*" (NGO 6). Other respondents noted that full restoration of peatlands could take decades.

NGOs and researchers were more critical than policymakers as to how to include people within definitions of restored peatlands: "*The problem area would be what would you say about livelihoods, because if you were really restoring these landscapes and they've got people in them, then what would you say from the perspective of livelihoods. I suppose you would want to say that people who lived in that landscape had some adequate economic support for their livelihood, but quite what that looks like I don't know*" (Researcher 3). No respondents mentioned cultural or spiritual aspects or values of peatlands.

How Has Peatland Restoration Progressed in Indonesia?. Most (15/25) respondents were aware of the multiple restoration activities taking place in Indonesia. Some elaborated on this, saying that considering the lack of evidence to build upon, and very short timeframe since the focus on restoration, progress had been good: "*I think the progress that we've made [since I became involved in peatland restoration] has been huge, but also compared to other ecosystems, there was no starting point knowledge base*" (NGO 6). Other respondents felt that despite considerable activity, overall there had been limited progress: "*There's been a lot going on for quite a long time, but unfortunately … there's not been a lot of great outcomes*" (Researcher 2).

Concerns about progress were that the activities so far tended to be small scale: "*I don't really know what there is in the way of really large-scale restoration taking place in Indonesia at the moment. There's very small-scale stuff—it really is quite small scale. These landscapes are vast, so people are blocking channels, building dams, people are trying to rewet. I don't know where these big-scale restoration projects really are happening*" (Researcher 3); and that there needed to be more focus on evaluating impacts of the restoration activities: "*For example,*

you cannot do canal blocking just around one canal, what is the impact of that? Like, how many metres of peatland would be wet again from that one canal block? Are they effective or not? And I think we still need a lot of discussion in this country about that. So whether it is a success or not, you know, it's a bit confusing because the minister of environment and forest he claims that we already restored. But actually ecologically not, but we did like the re-wetting yes, like how many percent is already re-wetted" (NGO 5).

Policymakers linked the reduced fire frequency since 2015 to restoration activities: "*You see now in 2017 and 2016 that there has not been as many fires"* (Government 2); but NGO and researchers recognized that these years had been wetter than 2015, and restoration progress would be tested in the next dry year: "*Over the last two years it's rained a lot; we haven't really had a significant dry season. The claims of the government of Indonesia that it's in control of the forest fires over the last two years should be moderated with a little bit of modesty vis-a-vis the role that the heavy rains have played during the dry seasons over the last two years, although this year is a bit drier and we're seeing more fires*" (NGO 9).

Are There Any Lessons That Can Be Learnws From the Restoration Process So Far?. Most (13/25) respondents spoke about a need to focus on hydrology, and re-wetting needing to be the first step: "*If you don't get the hydrology improved then everything else you do is going to be sort of Sisyphean struggle of pushing the rock up the hill and then seeing it roll back down the hill before you've got to the top*" (NGO 9); and also needing to focus on a hydrological unit for scale of restoration projects: "*It's scientifically flawed because in a sense what you do, is you have your peat dome, your hydrological unit, but you consider a different decision within this unit, which means what you do is at different operation levels, you will build up levels of peat to get outflow. So, you need to work at hydrological units and you need to adjust your land use management and your land use decision making at the hydrological unit, which is, of course, a different scale, so the system has to be used to that*" (NGO 3).

Another frequently (15/25) mentioned aspect was that improved integration was needed between stakeholders, academic disciplines, and restoration activities: "*I think for me one of the realisations …, if I've started to convert someone to the challenges of tropical peat restoration, is that there's this knowledge management base. But even if you're in a single spot and you've got all the sources of knowledge from the social, biophysical, political, economic and even if you get them all understood, lining them up, it's like building a house of cards. Because tropical peatlands are … an in-equilibrium ecosystem, and that is not just the biophysical stuff or the ecology. [Tropical peatlands] are so anthropogenic and you have to consider where people are in terms of social, health and education and economics and the political situation*" (NGO 6).

How Have Local Communities Been Involved in Peatland Restoration?. Most (22/25) respondents mentioned the importance of community involvement. All respondents described community participation in restoration as continuous, from the beginning, and following Free Prior Informed Consent (FPIC): *"Because we know that every intervention will have positives and negatives, so that's why from the beginning we have the social safeguard policy in order to mitigate against the negative impacts and also in order to resolve if that impact cannot be avoided from happening*" (Government 1); "*So basically everything is done as a big community consultation, that's not where the problem is. That's all going pretty well let's be honest*" (NGO 3); "*I think that's where BRG have been really successful is actually integrating their work with local communities. So, actually giving local communities some control over their landscapes. I haven't been to very many of the pilot project sites so I don't speak from great experience but if we put to one side the whole idea of what restoration actually should look like, but we focus on the side of revitalisation, then some of their activities are good*" (Researcher 3).

All respondents also justified the importance of community involvement, both for ethical and instrumental reasons: "*I think the awareness of the community is the most important one in the first step of the peatland restoration. If the people are not aware or they don't want it … if they are not aware they don't want to take part in the peatland restoration. For the rest, lessons learnt like revegetation or building up blocking canals can be done after, only if the awareness of people has improved*" (Government 5); "*Wherever you're doing backfilling or some kind of water restriction flow, it's our experience … that it's of fundamental importance to do FPIC, free prior informed consent. And the reason is not just because it's touchy feely romantic and nice to involve people rather than just go in and do it for the greater social good, it's that if you do it without their consent and if you use compacted peat, be it peat alone or peat mixed with wood, they will destroy the dams or find other ways to get around*" (NGO 9).

Despite agreement that community participation was necessary, respondents had differing opinions on whether this has been the case in reality. Policymakers were more likely to state that community involvement has been implemented successfully via FPIC: "*When we work in the field, especially for rehabilitation or building up canal blocking, we need to also involve the community there and make them first aware of the importance of peatlands. And so far, only some projects are doing FPIC properly but maybe many other projects don't use FPIC properly*" (Government 5). NGOs and researchers were more critical of whether FPIC was always fully implemented: "*Beware lip service being paid to FPIC which is not FPIC. Well, the principles of FPIC at a high level are very clear … And that's just super important, but often, all sorts of shortcuts are taken because we don't have the budget and so on and so forth"* (NGO 9).

Differences Between Groups. NGOs and researchers had fairly similar views on most of the questions. The main differences were between policymakers and NGOs/academic researchers. Differences were most obvious in perceptions of negatives to peatland restoration, progress of restoration activities, and success of community involvement. NGOs and researchers were more critical towards these aspects than policymakers, who in

general did not identify any negatives to restoration and tended to be more optimistic about the impact of restoration activities so far (Table 3). By identifying areas of consensus and disagreement, our analysis provides an entry point to improve dialogue between stakeholders (Lopez Porras et al. 2019) and find restoration strategies that are more likely to have buy-in from a wider range of stakeholders. This is key to the long-term success and sustainability of peatland restoration 3.

Discussion

What Does Restoration Mean, and How Can It Be Achieved?

We found that respondents had somewhat differing opinions on what a restored peatland landscape might look like. Although they all mentioned the importance of hydrology and other biophysical factors, there were markedly varied perceptions of how human activity could fit into a restored peatland landscape. This echoes a wider debate in restoration and conservation, with differing views on relationships between humans and nature, and social and ecological system components (Liu et al. 2007; Leslie et al. 2015; Okpara et al. 2018). Respondents who had greater expertise in biodiversity or environmental protection stated that a fully restored peatland landscape could not include agriculture in its current form. Yet other respondents highlighted concerns about what this meant for the communities living in these areas. Policymakers may need to take a more pragmatic viewpoint as many households across Indonesia reply on peatland areas for largely market-based agricultural activities which have helped to reduce poverty levels (Luskin et al. 2014; Wildayana & Armanto 2018; Wildayana et al. 2019). Other peatland livelihood activities may offer alternatives to agriculture, such as fishing which is particularly prevalent in Kalimantan, yet there is also evidence that this is becoming unsustainable due to increased human pressures (Thornton 2017). Given the large area of peatland under agriculture across Indonesia, the continued increase in demand for oil palm and established markets and supply chains, and a rapidly growing human population of 267 million (The World Bank 2019), it is unrealistic to imagine a restored peatland system that excludes people. However, our respondents (and previous research) argued that there is currently no known crop that can both provide an income for households and prevent peatland degradation (Evers et al. 2017; Green & Page 2017; Wijedasa et al. 2017). Paludiculture (agriculture on wet peatland soil) was mentioned as a solution by a few of our respondents, and is listed as a BRG strategy, would reduce emissions and further degradation of these peatland areas (Gunawan 2018). However, as other respondents highlighted, until agronomic knowledge has advanced and markets and prices have been established that match supply and demand, paludiculture's potential appears limited. It may also be difficult to encourage households to shift livelihood activities, or grow different crops (Wright et al. 2016), depending on the context. For example, households with a range of seasonally variable livelihood activities are likely to be more open to new livelihood activities than those who rely on one major activity to provide their income. For Indonesian peatlands, oil palm has provided some smallholder farmers in Sumatra with a substantial rise in income and well-being (Feintrenie et al. 2010; Euler et al. 2017), although in Kalimantan, the benefits from the introduction of oil palm for smallholder farmers are less clear, and have led to a decrease in well-being for those living near to large plantations (Santika et al. 2019). This shows that there is unlikely to be a single solution to change livelihoods across peatlands in Indonesia, and highlights the differences in culture, livelihoods, and peatland management within Indonesia.

There may be other reasons for why our respondents had different views on what a restored peatland landscape could look like. Restoration goals depend on available historical

Table 3. Summary of the similarities and differences between groups of respondents

	Policymakers	*NGOs*	*Academic Researchers*
Motivations/ drivers/benefits	• Many benefits	• Many benefits	• Many benefits
Challenges/ negatives	• None	• Local/short-term costs	• Local/short-term costs
Identifying degraded/ restored peatland	• Biophysical indicators	• Knowledge gap • Biophysical indicators • Unsure how livelihood use of peatlands fits	• Biophysical indicators • Unsure how livelihood use of peatlands fits
Progress	• Good progress • Reduced fire frequency since 2015	• Many activities • Need to focus more on impact evaluation	• Many small-scale activities but not necessarily leading to positive outcomes • Need larger scale projects
Lessons learned	• Community involvement is key • Activities need to be integrated	• Inter/multi/trans-disciplinary approaches are needed to bring in all relevant stakeholder groups	• Inter/multi/trans-disciplinary approaches are needed to bring in all relevant stakeholder groups • Hydrology is key
Community involvement	• Important for ethical/ instrumental reasons • Successful so far	• Important for ethical/instrumental reasons • Better implementation of FPIC needed	• Important for ethical/instrumental reasons • Mixed views on whether FPIC is being fully implemented

information, specific parts of ecosystems that are valued, and available resources (Higgs et al. 2014; Martin 2017; Dallimer & Stringer 2018). Some of our respondents mentioned that there was a lack of a knowledge base underlying peatland restoration. This could be attributed to tropical peatland research starting much later than that in tropical forests, giving a limited historical data to set a baseline for restoration (Page et al. 2009). Reference models used for restoration projects should be informed by native ecosystems, including traditional cultural ecosystems (Gann et al. 2019). However, if understanding may be incomplete as to how different activities impact peatland and how peat soil naturally functions, it will be difficult to build a consensus for what a reference model should look like. This risks a shifting baseline scenario where the "norm" for functioning peatlands changes depending on the memory of what it used to be like (Soga & Gaston 2018). This may be why so many of our respondents highlighted a need for interdisciplinary methods, particularly to improve understanding of human–environment interactions. Where historical environmental data are sparse, interviews with people who have been living in and alongside peatlands (particularly where there is limited or more recent degradation) could be combined with existing scientific and paleoecological data to give a better understanding of what a functioning peatland environment looks like in a particular location (Reyes-García et al. 2019).

All respondents stated that addressing the hydrology needed to be the first step towards restoring peatland, or at least reducing the fire risk. This is echoed in the existing literature, and the government and RSPO guidelines on water table levels for agriculture on peatland (Dohong & Lilia 2008; Dohong et al. 2018; RSPO 2018; Harrison et al. 2019). Many of our respondents went further with this, discussing the importance of considering peatland hydrological units. Land management across the hydrological unit will affect restoration success. This is where the complexities of Indonesia's decentralized government, and land tenure and property rights challenges will impact restoration. One peatland hydrological unit may contain, e.g. land managed by smallholder farmers, private companies, NGOs, and the Ministry of Environment and Forestry. In some cases, land tenure is not clear and different parties may both have claims to land. The large number of stakeholders involved in one peatland hydrological unit could make it exceedingly difficult for larger landscape restoration projects to be created, and also reduces the likelihood of smaller restoration projects being successful. The One Map Policy aims to reduce land-use conflicts by standardizing to one map used by all decentralized departments across Indonesia. This policy may be able to relieve some of the land tenure tensions, but has had difficulties in getting started (Wibowo & Giessen 2015). Perspectives on peatland restoration from private companies would be interesting to consider in this regard too, but unfortunately we were unable to find any willing participants.

Local Community Participation

Although we were not interviewing local community representatives in this study, all our respondents perceived community involvement as key to successful peatland restoration. Substantial literature evidences that environmental interventions are more likely to be successful and sustainable when local communities are involved (De Vente et al. 2016; Sterling et al. 2017). Local participation is important for pragmatic reasons and because it is a more democratic approach, and can yield benefits including: improved decision making, increased support, reduced costs, increased representation, empowerment of marginalized groups, increased trust, and promoting social learning (Reed 2008; Dyer et al. 2014; Sterling et al. 2017; Ward et al. 2018). The SER states that "stakeholders can make or break a project" and highlights the importance of directly involving local communities in ensuring that nature and society mutually benefit (Gann et al. 2019). However, we also found that some NGOs and researchers had concerns about the effectiveness of some of the community engagement work in peatland restoration. Effective participation can pose challenges, being time-consuming, expensive, and susceptible to elite capture (where benefits are captured by the wealthiest or most powerful; Stringer et al. 2006; De Vente et al. 2016; Orchard & Stringer 2016). Some Indonesian studies observed peatland canal blocks being destroyed by local people who were not aware of their purpose and advantages (Dohong & Lilia 2008; Dohong et al. 2018). Free prior and informed consent is an underlying part of the BRG's strategy, yet many of our respondents raised concerns that some projects were taking shortcuts and not fully implementing it. We also found that policymakers were less likely to report any concerns with how FPIC and community participation were being implemented compared to NGOs and researchers. This could be because policymakers are less likely to experience projects happening on-the-ground, although many of our policy interviewees gave examples from where they had visited restoration projects. Policymakers could also be more concerned about reporting negative impacts from government policies, highlighting the importance of NGOs and researchers in evaluating restoration policies and progress. Considering that all our respondents stated that community involvement was crucial to the success of peatland restoration, our results support others calling for more resources and funding to be directed into community engagement aspects of peatland restoration (Dohong 2017; Harrison et al. 2019), and monitoring set up to ensure that it is implemented correctly, sharing lessons where there have been issues. The aim of our research here was to gain a range of perspectives from a national level of peatland restoration, but it is clear that much more research is needed on the local community side. Further research could focus on repeating these questions with explicit consideration of intersectionality, interviewing local community representatives in a variety of different locations across Indonesia to see how their perceptions differ within and between communities and compared to the national-level stakeholders who we have interviewed. This is where qualitative research and investigating perceptions of local communities could help to strengthen restoration projects or understand why they may not have succeeded.

Distribution of Benefits and Costs of Peatland Restoration

All respondents agreed that peatland restoration is important and offers many benefits, both locally and globally. This is well

established in the literature (Graham et al. 2017; Leifeld & Menichetti 2018; Marlier et al. 2019). Addressing peatland restoration thus offers scope for Indonesia and other countries to meet multiple SDGs. However, it is fundamental to consider how the benefits and costs of any ecological restoration project are distributed, both spatially and temporally (Dallimer & Stringer 2018), yet detailed analyses of these aspects are lacking in the literature, particularly for peatlands. The majority of benefits mentioned by respondents would be shared globally, such as reducing carbon emissions (Leifeld & Menichetti 2018) and protecting biodiversity, while even the benefits from reducing haze from fires would be shared with neighboring countries (Koplitz et al. 2016). Yet, the challenges or costs mentioned by respondents were mostly felt locally, impacting local livelihoods and access to farms.

Benefit sharing challenges across scales have been raised relating to conservation and other environmental issues (Oldekop et al. 2016). Research shows that more equitable approaches are more likely to succeed (Pascual et al. 2014; Schreckenberg et al. 2016; Law et al. 2017). Payments for ecosystem services (PES) projects have aimed to reduce uneven distributions of benefits and costs, providing economic incentives for people to protect environments, paid for by those who benefit (Redford & Adams 2009). However, mixed results have ensued. In Madagascar, payments were susceptible to elite capture, and did not reach the right people, with households with sociopolitical power or road access more likely to receive payments than those most impacted by the intervention (Poudyal et al. 2016). Another obstacle is that for any economic incentive to be successful, someone has to provide the funds. Currently, there is no fully functioning market for carbon or biodiversity conservation or many successful PES schemes, which could address some of the economic equity concerns associated with restoration. For any ecological restoration project to be sustainable in the long term, greater consideration needs to be given to the distribution of related benefits and costs and methods found to equitably compensate those who bear the costs (both economic and non-economic).

Measuring Success

Respondents highlighted concerns about whether restoration activities were successful, and how best to measure the impact of restoration projects. This is a common problem across other ecosystems beyond peatlands, where it may be difficult to find suitable indicators to measure progress. The SER guidelines state that full recovery is defined as "the state or condition whereby all key ecosystem attributes closely resemble those of the reference model" (Gann et al. 2019). Without consensus around what a restored landscape should look like, it is difficult to agree on indicators to measure progress towards restoration.

All of our respondents were very easily able to list a range of biophysical attributes that could be measured to track restoration progress. Yet, there were few mentions of any socio-economic measures that could be used. This is despite the fact that most respondents perceived that community involvement in peatland restoration are critical to its success. Respondents who did mention the social side of restoration were concerned that social indicators might be the inverse of biophysical ones, that is, degraded peatlands are more able to support economic development than restored ones. Restoration has traditionally focused on ecological indicators, but for areas where there are large populations living within these landscapes it is important to consider people. While the SER has a list of ecosystem attributes to be considered when defining indicators, there is less guidance on the selection of social indicators. Restoration projects need to work with local communities in order to co-produce indicators which can measure progress towards a mutually beneficial goal. Lessons from other systems could provide useful insights here (Stringer et al. 2017). In the case of tropical peatland restoration where some areas being restored are likely to remain under agricultural use in the near term, ecological attributes are less likely to be applicable. In terms of reducing fires, which was most frequently raised as a benefit our respondents, raising the water table was suggested to be the most important factor. This implies that water table levels could act as a useful indicator of restoration progress in tropical peatland, recognizing their natural fluctuations. However, water tables can naturally vary strongly within local areas and are seasonally dynamic, so ongoing monitoring may needed to ensure appropriate water table ranges are identified (Wösten et al. 2008).

Indicators too can be interpreted in different ways by different groups. We found that policymakers stated that decreasing fires each year after 2015 provided evidence that restoration projects were having the desired impact. However, other respondents mentioned that these years were wetter than 2015. In 2019, another drier year, increased numbers of fires and issues with haze were reported across Indonesia, Malaysia, and Singapore (Haniy et al. 2019; Lo Bue 2019; Normile 2019), with 66,000 fire alerts from January to the end of September 2019. Although this is lower than fire levels in 2015, it is much higher than 2016–2018 (Haniy et al. 2019). This shows the importance of selecting the appropriate indicators to measure restoration, so that a true representation of progress is achieved, across both environmental and human aspects.

Based on our respondents' perceptions about peatland restoration, we suggest that further dialogue is needed between policymakers, NGOs, and researchers to move forward on addressing the challenge of restoring Indonesia's peatlands, and to better understand each other's perspectives. Areas of consensus, particularly regarding the importance and benefits of restoring peatland, represent important aspects of common ground that could be used as a useful starting point to bring stakeholders together.

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LITERATURE CITED

Bennett NJ (2016) Using perceptions as evidence to improve conservation and environmental management. Conservation Biology 30:582–592

Carmenta R, Zabala A, Daeli W, Phelps J (2017) Perceptions across scales of governance and the Indonesian peatland fires. Global Environmental Change 46:50–59

Cowie AL, Orr BJ, Castillo Sanchez VM, Chasek P, Crossman ND, Erlewien A, et al. (2018) Land in balance: the scientific conceptual framework for land degradation neutrality. Environmental Science & Policy 79:25–35

Dallimer M, Stringer LC (2018) Informing investments in land degradation neutrality efforts: a triage approach to decision making. Environmental Science and Policy 89:198–205

De Vente J, Reed MS, Stringer L, Valente S, Newig J (2016) How does the context and design of participatory decision-making processes affect their outcomes? Evidence from sustainable land management in global drylands. Ecology and Society 21:24

Dohong A (2017) Bolstering peatlands restoration in Indonesia through 3Rs approach. *Proceedings of the Conference on Developing International Collaborations to Address Fire and Other Conservation Issues in Central Kalimantan, Indonesia*. University of Exeter, Cornwall, U.K.

Dohong A, Lilia (2008) Hydrology restoration of ex mega rice project Central Kalimantan through canal blocking techniques: lessons learned and steps forward. In: Wösten JHM, Rieley JO, Page SE (eds) *Restoration of tropical peatlands*. Alterra–Wageningen University and Research Centre and the EU INCO –RESTORPEAT Partnership. Available in PDF as *Tropical Peatland Restoration Report: the Indonesian case*, from: https://www.researchgate.net/publication/323676663_Tropical_Peatland_Restoration_Report_the_Indonesian_case

Dohong A, Abdul Aziz A, Dargusch P (2018) A review of techniques for effective tropical peatland restoration. Wetlands 38:275–292

Drury R, Homewood K, Randall S (2011) Less is more: the potential of qualitative approaches in conservation research. Animal Conservation 14:18–24

Dyer J, Stringer L, Dougill A, Leventon J, Nshimbi M, Chama F, et al. (2014) Assessing participatory practices in community-based natural resource management: experiences in community engagement from southern Africa. Journal of Environmental Management 137:137–145

Euler M, Krishna V, Schwarze S, Siregar H, Qaim M (2017) Oil palm adoption, household welfare, and nutrition among smallholder farmers in Indonesia. World Development 93:219–235

Evers S, Yule CM, Padfield R, O'Reilly P, Varkkey H (2017) Keep wetlands wet: the myth of sustainable development of tropical peatlands—implications for policies and management. Global Change Biology 23:534–549

Feintrenie L, Chong WK, Levang P (2010) Why do farmers prefer oil palm? Lessons learnt from Bungo District, Indonesia. Small-scale Forestry 9:379–396

Gann GD, McDonald T, Walder B, Aronson J, Nelson CR, Jonson J, et al. (2019) International principles and standards for the practice of ecological restoration. Second edition. Restoration Ecology 27:S1–S46

Graham LLB, Giesen W, Page SE (2017) A common-sense approach to tropical peat swamp forest restoration in Southeast Asia. Restoration Ecology 25:312–321

Green SM, Page S (2017) Tropical peatlands: current plight and the need for responsible management. Geology Today 33:174–179

Gunawan H (2018) Indonesian peatland functions: Initiated peatland restoration and responsible management of peatland for the benefit of the local community, case in Riau and West Kalimantan Provinces. Pages 117–138. In: Lopez M, Suryomenggolo J (eds) Environmental resources use and challenges in contemporary Southeast Asia. Vol 7. Springer, Singapore

Haniy SU, Hamza H, Hanifa M (2019) Intense forest fires threaten to derail Indonesia's progress in reducing deforestation. World Resources Institute, Washington D.C.

Harrison ME, Ottay JB, D'Arcy L, Cheyne SM, Anggodo Belcher C, et al. (2019) Tropical forest and peatland conservation in Indonesia: challenges and directions. People and Nature **2**:4–28

Higgs E, Falk DA, Guerrini A, Hall M, Harris J, Hobbs RJ, et al. (2014) The changing role of history in restoration ecology. Frontiers in Ecology and the Environment 12:499–506

Hobbs RJ (2016) Degraded or just different? Perceptions and value judgements in restoration decisions. Restoration Ecology 24:153–158

IPBES (2018) The IPBES assessment report on land degradation and restoration. IPBES, Bonn, Germany

IPCC (2019) *Climate change and land: an IPCC special report on climate change, desertification, land degradation, sustainable land management, food security, and greenhouse gas fluxes in terrestrial ecosystems*. https://www.ipcc.ch/report/SRCCL/

Jauhiainen J, Page SE, Vasander H (2016) Greenhouse gas dynamics in degraded and restored tropical peatlands. Mires and Peat 17:1–12

Koplitz SN, Mickley LJ, Marlier ME, Buonocore JJ, Kim PS, Liu T, et al. (2016) Public health impacts of the severe haze in equatorial Asia in September–October 2015: demonstration of a new framework for informing fire management strategies to reduce downwind smoke exposure. Environmental Research Letters 11:094023

Langston JD, McIntyre R, Falconer K, Sunderland T, van Noordwijk M (2019) Discourses mapped by Q-method shows governance constraints motivate landscape approaches in Indonesia. PLos One 14:e0211221

Law EA, Bennett NJ, Ives CD, Friedman R, Davis KJ, Archibald C, Wilson KA (2017) Equity trade-offs in conservation decision making. Conservation Biology **32**:294–303

Leifeld J, Menichetti L (2018) The underappreciated potential of peatlands in global climate change mitigation strategies. Nature Communications 9:1071

Leslie HM, Basurto X, Nenadovic M, Sievanen L, Cavanaugh KC, Cota-Nieto JJ, et al. (2015) Operationalizing the social-ecological systems framework to assess sustainability. Proceedings of the National Academy of Sciences of the United States of America 112:5979–5984

Liu J, Dietz T, Carpenter SR, Alberti M, Folke C, Moran E, et al. (2007) Complexity of coupled human and natural systems. Science 317:1513–1516

Lo Bue MC (2019) Indonesia's huge fires and toxic haze will cause health problems for years to come. *The Conversation*. UK. https://theconversation.com/indonesias-huge-fires-and-toxic-haze-will-cause-health-problems-for-years-to-come-124556

Lopez Porras G, Stringer LC, Quinn CH (2019) Corruption and conflicts as barriers to adaptive governance: water governance in dryland systems in the Rio del Carmen watershed. Science of the Total Environment 660:519–530

Luskin MS, Christina ED, Kelley LC, Potts MD (2014) Modern hunting practices and wild meat trade in the oil palm plantation-dominated landscapes of Sumatra, Indonesia. Human Ecology 42:35–45

Marlier ME, Liu T, Yu K, Buonocore JJ, Koplitz SN, DeFries RS, et al. (2019) Fires, smoke exposure, and public health: an integrative framework to maximize health benefits from peatland restoration. GeoHealth 3:1–12

Martin DM (2017) Ecological restoration should be redefined for the twenty-first century. Restoration Ecology 25:668–673

Murdiyarso D, Lilleskov E, Kolka R (2019) Tropical peatlands under siege: the need for evidence-based policies and strategies. Mitigation and Adaptation Strategies for Global Change 24:493–505

Newing H, Eagle CM, Puri RK, Watson CW (2011) Conducting research in conservation: a social science perspective. Routledge, Oxford, United Kingdom

Normile D (2019) Indonesia's fires are bad, but new measures prevented them from becoming worse. Science, https://www.sciencemag.org/news/2019/10/indonesias-fires-are-bad-new-measures-prevented-them-becoming-worse#

Okpara UT, Stringer LC, Akhtar-Schuster M, Metternicht GI, Dallimer M, Requier-Desjardins M (2018) A social-ecological systems approach is necessary to achieve land degradation neutrality. Environmental Science and Policy 89:59–66

Oldekop JA, Holmes G, Harris WE, Evans KL (2016) A global assessment of the social and conservation outcomes of protected areas. Conservation Biology 30:133–141

Orchard SE, Stringer LC (2016) Challenges to polycentric governance of an international development project tackling land degradation in Swaziland. Ambio 45:796–807

Page SE, Hooijer A (2016) In the line of fire: the peatlands of Southeast Asia. Philosophical Transactions of the Royal Society, B: Biological Sciences 371:20150176

Page S, Hosciło A, Wösten H, Jauhiainen J, Silvius M, Rieley J, et al. (2009) Restoration ecology of lowland tropical peatlands in Southeast Asia: current knowledge and future research directions. Ecosystems 12:888–905

Page SE, Rieley JO, Banks CJ (2011) Global and regional importance of the tropical peatland carbon pool. Global Change Biology 17:798–818

Papworth SK, Rist J, Coad L, Milner-Gulland EJ (2009) Evidence for shifting baseline syndrome in conservation. Conservation Letters 2:93–100

Pascual U, Phelps J, Garmendia E, Brown K, Corbera E, Martin A, Gomez-Baggethun E, Muradian R (2014) Social equity matters in payments for ecosystem services. BioScience 64:1027–1036

Poudyal M, Ramamonjisoa BS, Hockley N, Rakotonarivo OS, Gibbons JM, Mandimbiniaina R, Rasoamanana A, Jones JPG (2016) Can REDD+ social safeguards reach the 'right' people? Lessons from Madagascar. Global Environmental Change 37:31–42

Puspitaloka D, Kim Y, Purnomo H, Fulé PZ (2019) Defining ecological restoration of peatlands in Central Kalimantan, Indonesia. Restoration Ecology **28**:435–446

QSR (2012) NVivo Qualitative Data Analysis Software

Redford KH, Adams WM (2009) Payment for ecosystem services and the challenge of saving nature. Conservation Biology 23:785–787

Reed MS (2008) Stakeholder participation for environmental management: a literature review. Biological Conservation 141:2417–2431

Reed J, Van Vianen J, Deakin EL, Barlow J, Sunderland T (2016) Integrated landscape approaches to managing social and environmental issues in the tropics: learning from the past to guide the future. Global Change Biology 22:2540–2554

Reed J, Barlow J, Carmenta R, van Vianen J, Sunderland T (2019) Engaging multiple stakeholders to reconcile climate, conservation and development objectives in tropical landscapes. Biological Conservation 238:108229

Reyes-García V, Fernández-Llamazares Á, McElwee P, Molnár Z, Öllerer K, Wilson SJ, Brondizio ES (2019) The contributions of Indigenous peoples and local communities to ecological restoration. Restoration Ecology 27:3–8

Ritung S, Wahyunto W, Nugroho K, Sukarman, Hikmatullah, Suparto, Tafakresnanto C (2011) Peta Lahan Gambut Indonesia Skala1:250.000 (Indonesian peatland map at the scale 1:250,000). Indonesian Center for Agricultural Land Resources Research and Development, Bogor, Indonesia. Available in PDF as *Indonesian peatland map: method, certainty, and uses,* from: https://www.researchgate.net/publication/293821145_INDONESIA

RSPO (2018) Principles and criteria for the production of sustainable palm oil. RSPO, Kuala Lumpur, Malaysia

Santika T, Wilson KA, Budiharta S, Law EA, Poh TM, Ancrenaz M, Struebig MJ, Meijaard E (2019) Does oil palm agriculture help alleviate poverty? A multidimensional counterfactual assessment of oil palm development in Indonesia. World Development 120:105–117

Schreckenberg K, Franks P, Martin A, Lang B (2016) Unpacking equity for protected area conservation. Parks 22:11–26

Society for Ecological Restoration International Science & Policy Working Group (2004) *The SER international primer on ecological restoration*. SER, Tucson, Arizona

Soga M, Gaston KJ (2018) Shifting baseline syndrome: causes, consequences, and implications. Frontiers in Ecology and the Environment 16:222–230

Sterling EJ, Betley E, Sigouin A, Gomez A, Toomey A, Cullman G, et al. (2017) Assessing the evidence for stakeholder engagement in biodiversity conservation. Biological Conservation 209:159–171

Stringer LC, Dougill AJ, Fraser E, Hubacek K, Prell C, Reed MS (2006) Unpacking "Participation" in the adaptive management of social–ecological systems: a critical review. Ecology and Society 11:39

Stringer LC, Reed MS, Fleskens L, Thomas RJ, Le QB, Lala-pritchard T (2017) A new dryland dvelopment paradigm grounded in empirical analysis of fryland systems science. Land Degradation and Development 28:1952–1961

The World Bank (2016) The cost of fire. An economic analysis of Indonesia's 2015 fire crisis. The World Bank, Jakarta, Indonesia

The World Bank (2019) Indonesia data. The World Bank data

Thornton SA (2017) (Un)tangling the net, tackling the scales and learning to fish: an interdisciplinary xtudy in Indonesian Borneo. PhD thesis. University of Leicester, Leicester, United Kingdom

Tschakert P, Das PJ, Shrestha Pradhan N, Machado M, Lamadrid A, Buragohain M, Hazarika MA (2016) Micropolitics in collective learning spaces for adaptive decision making. Global Environmental Change 40:182–194

Uda SK, Schouten G, Hein L (2018) The institutional fit of peatland governance in Indonesia. Land Use Policy, https://doi.org/10.1016/j.landusepol.2018.03.031

Uda SK, Hein L, Atmoko D (2019) Assessing the health impacts of peatland fires: a case study for Central Kalimantan, Indonesia. Environmental Science and Pollution Research 26:31315–31327

UN Environment Programme (2019) New UN decade on ecosystem restoration to inspire bold UN environment assembly decisions. https://www.unenvironment.org/news-and-stories/story/new-un-decade-ecosystem-restoration-inspire-bold-un-environment-assembly#:~:text=New%20UN%20Decade%20on%20Ecosystem%20Restoration%20to%20inspire%20bold%20UN%20Environment%20Assembly%20decisions,-Photo%20by%20Pexels&text=Restoration%20of%20350%20million%20hectares,gases%20out%20of%20the%20atmosphere.

Ward C, Stringer LC, Holmes G (2018) Protected area co-management and perceived livelihood impacts. Journal of Environmental Management 228:1–12

Ward C, Stringer LS, Warren-Thomas E, Agus F, Crowson M, Hamer K, et al. (2020) Smallholder perceptions of land restoration activities: rewetting tropical peatland oil palm areas in Sumatra, Indonesia, under review

Wibowo A, Giessen L (2015) Absolute and relative power gains among state agencies in forest-related land use politics: the Ministry of Forestry and its competitors in the REDD+ Programme and the One Map Policy in Indonesia. Land Use Policy 49:131–141

Wijedasa LS, Jauhiainen J, Könönen M, Lampela M, Vasander H, Leblanc MC, et al. (2017) Denial of long-term issues with agriculture on tropical peatlands will have devastating consequences. Global Change Biology 23:977–982

Wildayana E, Armanto ME (2018) Formulating popular policies for peat restoration based on livelihoods of local farmers. Journal of Sustainable Development 11: 85–95

Wildayana E, Armanto ME, Zahri I, Adriani D, Syakina B (2019) Socio-economic factors causing rapid peatlands degradation in South Sumatra. Sriwijaya Journal of Environment 3:87–95

Wösten JHM, Clymans E, Page SE, Rieley JO, Limin SH (2008) Peat–water interrelationships in a tropical peatland ecosystem in Southeast Asia. Catena 73:212–224

Wright JH, Hill NAO, Roe D, Rowcliffe JM, Kümpel NF, Day M, Booker F, Milner-Gulland EJ (2016) Reframing the concept of alternative livelihoods. Conservation Biology 30:7–13

Wyborn C, Jellinek S, Cooke B (2012) Negotiating multiple motivations in the science and practice of ecological restoration. Ecological Management and Restoration 13:249–253

Young JC, Rose DC, Mumby HS, Benitez-Capistros F, Derrick CJ, Finch T, et al. (2018) A methodological guide to using and reporting on interviews in conservation science research. Methods in Ecology and Evolution 9: 10–19

Supporting Information

The following information may be found in the online version of this article:

Data S1. Interview questions.

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