

Four steps for a strategic approach in ecosystem-centered accounting: The example of an Early Warning System against deforestation in Borneo

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SUMMARY

In order to cope with the destruction of biodiversity, private and public actors are developing a growing number of innovative conservation tools. While these tools are increasingly effective from a scientific and technical point of view, the question of their performativity and their capacity to create the expected changes in ecological, social and governance terms remains a major concern. In order to answer this question, and following on from previous work in "accounting *for* the management of ecosystems", this paper proposes a four-stage analysis approach. It illustrates it by the study of an Early Warning System for deforestation, which is part of a larger strategy for protecting Orangutan habitats, in Borneo, Indonesia. In doing so, the paper argues for the development of a field of comparative study of information tools for ecosystems, firmly rooted in accounting research and in dialogue with conservation science and socio-anthropology. To contribute to it, we propose to combine critical analysis with a more engaged strategic and design support posture at the service of actors involved in conservation action.

KEYWORDS

Social and environmental accounting, strategy, governance, landscape, biodiversity, ecosystems, NGOs, Indonesia

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DEVELOPING INFORMATION TOOLS FOR CONSERVATION: A RESPONSE TO THE DESTRUCTION OF ECOSYSTEMS?

Concerns about the future of the world's ecosystems have been growing ever since the first activists and scientists alerted us in the 1960s (Carson, 2019), the establishment of conservation sciences as a 'crisis discipline' (Soulé, 1985), and the placing of biodiversity on the international policy agenda in Rio in 1992. However, thirty years later, the levels of degradation of the biosphere's integrity are even more worrying and now exceed acceptable global limits (Steffen et al., 2015). The recent Living Planet (WWF, 2020) and IPBES (2021) reports provide a sad summary of the most recent work in this field and present us with figures to which we have already become too accustomed: a 47% decline in the extent and condition of natural ecosystems, an 82% drop in the biomass of wild mammals, 25% of species in danger of extinction in most groups of plants or animals, etc.

In parallel with this unprecedented growth in the destruction of living organisms, the last thirty years have also seen a worldwide rise in the power of scientific ecology and conservation sciences, as well as of major strategic players in environmental protection. Some of the latter's financial and intervention capacities are now equivalent to those of large international firms (Berny et Rootes, 2018).

Evolving with the times, the world of conservation has also taken the turn of new and increasingly powerful information technologies. These technologies are now being used in major efforts to produce and process knowledge and data on biodiversity. A growing number of methods and assessment systems for conservation are also being developed to structure these data for the purposes of warning, decision support, or even the management, monitoring and assessment of ecosystem protection action. For several years now, there has been a diversity of tools that vary in terms of their technology, the ecological entities targeted and their conceptualisation, their scale of application or the actors who are their main promoters and recipients (NGOs, companies, governments, etc.): provision of satellite data with *Global Forest Watch* or *Global Fishing Watch*, models for evaluating the services rendered by nature to society ("ecosystem services")

(Kareiva et al., 2011), biodiversity footprinting tools and tools for taking account of "natural capital" for businesses (WWF, 2019), accounting systems for monitoring changes in the quality of ecosystems on a territorial scale (Weber, 2014), drones for inventorying animal populations or habitats, etc.

However, feedbacks show the difficulties in generating the expected favourable changes for biodiversity *through* the use of such tools, as in the case of mapping and integrated assessment of ecosystem services (Ruckelshaus et al., 2015). Together with other works (Rabaud et al., 2020), they point out that despite the hopes raised by these tools, their users still struggle in the vast majority of cases to institute sustainable forms of management of the natural environments at stake. Recent publications also stress the need to take into account the social effects of the use of these new technologies and the ethical issues that this may raise (Sandbrook et al., 2021).

More broadly, these research demonstrate, in our opinion, the need to develop frameworks and methods of analysis in the social sciences that are capable of thinking about the relationships between the design and use of these tools on the one hand (what representation, structuring and use of information?), and the effective management of environmental problems on the other (what governance, organisation of action, attribution and control of responsibilities?), drawing on critical and interpretative research in accounting. In other words, it is a question of thinking about the tools, not only in terms of quantifying nature, but as they play a role in the "accounting" dimension of biodiversity conservation policies and strategies: who, on what, must be accountable to whom and how?

This means looking for answers to questions such as: what effects (intended or not) do the new information and assessment systems for conservation produce in terms of reorganising responsibilities, transforming social relations and power relations around a given biodiversity problem? Beyond their technical characteristics and limitations, how and to what extent can we say that they are supports and vectors of transformations that can lead to lasting and tangible ecological results? Are the performances obtained *in* terms of protection or regeneration of biodiversity equal

to the efforts invested and the promises made by their development? Furthermore, are these transformations part of governance frameworks that guarantee a certain environmental justice for the populations directly concerned and dependent on these ecosystems (Holifield, 2015) ? Our ambition is to contribute to the reflection on the role of innovative information tools in the management of change for biodiversity. More specifically, our approach is to support conservation stakeholders who, while they may be very reflective and even critical of the limits of the tools they use, work according to very constrained intervention formats that leave little room for questioning and reviewing the ways in which the tools are or are not connected to action and decision-making.

We will first recall that this reflection is a continuation of our previous work in "ecosystem-centred management accounting". We will then present at greater length an analysis and strategic support approach that we carried out as part of a study on a tool for combating illegal deforestation in Indonesia. We will conclude by stressing the need to continue structuring a field of comparative analysis of information and evaluation tools for conservation, firmly anchored and inspired by the critical and interpretative research programme in accounting, and in dialogue with other disciplines (conservation sciences, environmental management, socio-anthropology in particular).

PUTTING ACCOUNTING RESEARCH AT THE SERVICE OF CONSERVATION STRATEGIES

Within the field of social and environmental accounting research, biodiversity is a very recent topic (Jones et Solomon, 2013 ; Feger et Mermet, 2021 ; Bebbington et al., 2021). Most of the work concerns extra-financial *reporting* and the integration of biodiversity in corporate accounts (voir par exemple, Rimmel et Jonäll, 2013 ; Houdet et Germaneau, 2014; Atkins et Maroun, 2018; Addison et al., 2019). However, a certain number of recent publications are interested in the challenges of protecting ecosystems and in the emergence and use of accounting systems - understood here in the broad sense - in more unusual areas of study. These

include critical analyses of: the calculation practices associated with sustainable forest certification schemes (Borsato et al., 2014); ecological compensation procedures and so-called biodiversity market mechanisms (Tregidga, 2013 ; Khan, 2014 ; Cuckston, 2019) ; the interactions and exchanges of accounts between public and private actors in the management of a river in Scotland (Dey et Russell, 2014) ; the accounts produced in the framework of the restoration of a peat bog managed by a nature reserve (Cuckston, 2017) ; or the governance of global fisheries zones (Bebbington et al., 2019). These works enrich the fundamental reflections that animate the broader field of critical and interpretive accounting research on the definition of the boundaries of the organisational and accounting entities to be considered, their permeability, and their relations with society at large (Kurunmaki, 1999 ; Chapman et al., 2009 ; Power, 2018).

Our work in 'ecosystem-centred management accounting (Feger et Mermet, 2021) or 'accounting *for* the management of ecosystems' (Feger, 2016 ; Feger et Mermet, 2017), is part of this movement to decentralise accounting research towards the perimeters of collective governance of ecological problems. They are also in line with the recent calls by Cuckston (2018, 2021) to focus on the many ways in which accounting practices in the field of conservation can contribute to the necessary 'organisation of nature and socio-ecosystems', particularly at the scale of protected areas or territories. Their particularity, however, is that they aim to go one step further than the mere sociological and critical analysis of these new accounting practices, in order to actively place them at the service of (1) conservation strategies and the negotiation of reciprocal responsibilities ('accountability'¹) that guarantee their effectiveness; (2) a reflection on the *design of* the tools and accounting systems that can equip them (Feger et al., 2019; Bebbington et al., 2021).

¹ In our work, we have chosen to translate the English notion of *accountability* as 'acomptabilités' [rather than 'redevabilité'] in order to qualify the specificity of the relationships by which individuals hold each other accountable in a given organisational context, and perform these accountability actions through the regular exchange of accounts and information. See Feger, 2016.

More fundamentally, our research perspective considers that the issues of designing and using information and assessment tools for collective biodiversity management would benefit from being conceptualised as management accounting problems rather than technical-scientific or economic issues. Indeed, the basic problems relating to the strategic use of more conventional accounting and management control tools are found (Macintosh et Quattrone, 2010). However, they must be adapted to the specific scope, objects and contexts of strategic decision-making and management that characterise the management of environmental issues (Feger et Mermet, 2017).

In 2017 at the University of Cambridge, a first interdisciplinary dialogue was initiated between conservation scientists and critical and interpretive accounting researchers around this perspective, resulting in a collective paper (Feger et al., 2019). The former are specialised in the design and field testing of innovative tools for biodiversity, aware of their difficulties in generating the expected changes and results. The latter wish to contribute their long theoretical and methodological experience in the analysis of the multiple organisational, institutional and political implications of accounting systems 'in action' and 'in context'. (Hopwood, 1983 ; Miller et Power, 2013). This dialogue has led to the need for these two communities to work together on real field experiments using research-intervention methods (David, 2008) and according to a critical, reflective and constructive approach. On the one hand, it is a question of contributing to directly enriching the design and implementation of these tools by biodiversity protection organisations involved in action, while progressively building a portfolio of case studies useful for increasing the generality of research on these issues.

This paper reports on a first experience in this field, in the framework of a study carried out between 2019 and 2020 in Central Kalimantan (Borneo, Indonesia) with WWF-Indonesia. By using this case study as an illustration, we hope to continue the work that has been initiated to establish a theoretical and methodological framework aimed at strategic support to conservation action, rooted in critical accounting approaches (Feger et Mermet, 2017 ; Cuckston, 2018 ; Feger et al.,

2019). Such an objective is reminiscent of recent work in accounting research, which advocates a position that consists of relying on a critical approach, but also of fully accepting the performative character of any form of accounting, in order to consciously take advantage of it and favour the emergence of new pragmatic capacities to respond to the problems of our time (Busco et Quattrone, 2018).

THE CASE OF AN INNOVATIVE WARNING TOOL AGAINST THE DEGRADATION OF ORANGUTAN FOREST HABITATS IN BORNEO

The case study that serves as an illustration here was carried out as part of a two-year research and teaching collaboration with the environmental NGO WWF-Indonesia. This collaboration involved two three-week collective field missions to Jakarta and Central Kalimantan (in March 2019 and March 2020), each time involving two AgroParisTech lecturers (co-authors of this article), some fifteen students in specialised environmental management training, and members of WWF-Indonesia. During these missions, field surveys were conducted combining various methods of collecting material: documentary analysis, some 40 qualitative interviews, landscape observation and analysis of land dynamics, cartographic work, participatory mapping, etc. Structured exchange workshops took place with WWF-Indonesia teams, mainly made up of Indonesian staff, at the headquarters and in Palangkaraya (Central Kalimantan). We were also able to participate in workshops organised by WWF with local stakeholders representing local communities and government officials.

Generally speaking, the position we have adopted in this work corresponds to that of Strategic Environmental Management Analysis, particularly as applied to environmental non-governmental organisations (Guillet et Leroy, 2010 ; Guillet et al., 2016 ; Mermet, 2018b). Beyond the production of social science knowledge, our reflection also had the explicit aim of contributing to WWF-Indonesia's ongoing strategic reflections. The details of the methodological elements and in-depth findings of these field missions have been recorded in several research reports and

presentations that have served as the basis for this paper (Adam et al., 2019; Feger et al., 2019 ; Jung-Fourquez et al., 2020 ; Bourey et al., 2020).

Since 2018, the NGO has been developing an early warning system against illegal deforestation, called *Sistem Peringatan Dini-Pengendalian Kawasan Lindung* (SPD-PKL) in Indonesian, as part of its international partnership with the Boston Consulting Group, and which will eventually be deployed in different regions of the world (Von Stokkom et al., 2020). This information system belongs to a growing family of early warning tools in the field of environmental protection (Bahraminejad et al., 2018 ; Weisse et al., 2019 ; Silva et al., 2020). The SPD-PKL mobilises recent geographic information system and satellite image technologies on the one hand, and *Big Data* and artificial intelligence *on the other* (WWF and BCG, 2019 ; Van Stokkom et al., 2020). The principle is to create localised alerts indicating places with a high risk of deforestation in a relatively short timeframe (from 1 week to 12 months). Depending on the land tenure status of the alert area, if this forecast corresponds to illegal deforestation, an intervention on the ground involving various stakeholders can then be decided upon to try to prevent it from happening (reinforcing law enforcement, raising awareness and engaging local communities, influencing public and corporate policies, etc.). WWF's role here is therefore mainly to promote and support the transfer of this tool to the various administrations concerned, for areas under the authority of the Ministry of the Environment and Forests as well as for those under the authority of the Ministry of Agrarian Affairs and Land Management. For this study, we were particularly interested in forests located in so-called development zones, under the aegis of the latter ministry.

This initiative involves different teams within WWF-Indonesia. The *Conservation Science Unit* (CSU), based in Jakarta, in charge of conservation science innovation, is accompanying the design and transfer of the tool. In the pilot areas, the CSU involves the local WWF teams concerned. The participation of the latter in the testing of the tool is in addition to all the activities and initiatives they already carry out with local populations (awareness raising, ecological restoration, etc.) or in

support of government agents (for example in the management of protected areas or forests more generally), and which constitute the core of their missions.

The pilot experimentation took place in a territory facing deforestation issues, the *Katingan-Kahayan Landscape* (named after the two rivers between which it is located, near the town of Palangkaraya, in South Central Kalimantan on the island of Borneo) on which WWF-Indonesia operates. At the time of our study, the teams on site were conducting tests on different dimensions of the tool, evaluated in a quantitative manner: model accuracy, difference between the amount of deforestation measured in the areas where the model was applied and in control areas, etc. They were also reflecting on how to improve the tool's performance. They also initiated reflections on the future "governance" modalities of the tool, in order to avoid *top-down* approaches that would not take into account the particularities of local intervention contexts and the stakeholders concerned. Training sessions for the various government departments were organised, as well as consultative workshops with village and customary leaders. Various questions are addressed. What organisational structures and coordination between services should be developed? How to ensure ownership of the tool by the identified actors? What procedures should be put in place once the alert is given by the machine to guide the prioritisation, choice and implementation of interventions in the field? How to organise data sharing and communication? How to involve other local actors and in particular local communities? What protection mechanisms should be put in place to ensure that they are not harmed by the deployment of the tool?

These governance issues are already well identified in the literature on early warning tools as a key issue for their effectiveness (Weisse et al., 2019). However, a strictly technical-scientific or economic evaluation cannot claim to provide relevant answers. The implementation of these tools requires knowledge of concrete action situations by mobilising social science approaches, if it wishes to avoid a 'revenge of contexts'. (Olivier de Sardan, 2021). In this respect, critical and interpretative research in accounting proposes qualitative approaches that allow for an in-depth study of the consubstantial links between information systems and the

organisation of action (Macintosh et Quattrone, 2010 ; Naro, 2010; Miller et Power, 2013; Roslender, 2017). We transpose this type of approach to the world of biodiversity management and to the analysis of tools such as the *SPD-PKL* (Feger et Mermet, 2017 ; Feger et al., 2019). Beyond a comprehensive and critical approach, our work ultimately consisted in putting our analyses at the service of the reflection efforts already underway by WWF and its partners. The aim was to open up a space for heuristic dialogue with them, in particular through workshops, with a view to enriching their reflexivity on the institutional, organisational and social dimensions of the tool, so that it has a better chance of making a real contribution to forest protection.

The following sections report on four steps that we have identified and followed to carry out such work: re-problematise, making explicit, investigate and enrich. At each stage we show what specific stream of research from the critical accounting literature has contributed to our reflections.

REPROBLEMATIZING: AN ECOSYSTEM-CENTRIC ACCOUNTING PERSPECTIVE

How can an information and evaluation system such as the SPD-PKL and the way it is operationalised lead to better management of environmental problems or not? First of all, we need to better identify and explain the socio-organisational mechanisms at play. To this end, work in ecosystem-centric management accounting suggests that information and assessment tools for conservation should be considered as specific forms of management accounting (Feger, 2016; Feger et Mermet, 2017: 1518). They can thus be seen as "formal mechanisms for assembling and communicating data in order to assist and coordinate collective decisions in the light of an organisation's general objectives". (Horngren et Sundem, 1990: 4). However, these management accounts aim to equip organisations, or rather dynamics of organised collective action (Crozier et Friedberg, 1977), which are very specific. Indeed, these organisations are focused on the management of a given natural ecosystem or ecological concern, and are oriented towards achieving

ecological results on its scale. Moreover, they are 'in the making', since the definition of the perimeter and functioning of these ecosystem-centric organisations is most often in the process of being developed and negotiated by those who are strategically seeking to bring them into being, in alliance with other actors, and often while encountering a certain amount of resistance (Mermet et Feger, 2019). This perspective thus obliges the analyst to first ask the question of the initial state of the *organising* and accounting efforts (*accountizing*) already undertaken by the actors around a given environmental issue, before even considering the tool.

In our case, WWF-Indonesia is historically well established in Central Kalimantan, notably because of its historical involvement in the co-management of the Sebangau National Park created in 2004 by the Ministry of Environment and Forestry and which hosts in its dense peatland forests one of the largest populations of Orangutans in Borneo, estimated at around 6000 individuals (Utami-Atmoko et al., 2016 ; Hadian et al., 2019). However, this population is threatened by rising sea levels due to global warming, and may have to move to inland forests. In addition, WWF is part of a 2007 government initiative involving Indonesia, Malaysia and Brunei to protect 23 million hectares of rainforest in the heart of Borneo. The *Katingan-Kahayan Landscape* is identified as one of the six priority areas of this *Heart of Borneo Initiative* (WWF, 2017 ; Tai, 2018) particularly because protecting its forests would preserve an ecological and biodiversity habitat connection between the Sebangau Nature Park in the South and the forests of the Heart of Borneo in the North (Hadian et al., 2019).

To this end, the NGO is actively seeking to expand its activities outside Sebangau Park to contribute more broadly to the protection of the forests of the *Katingan-Kahayan Landscape*. However, it is directly confronted with the development of economic activities and infrastructures that fragment the forest habitat, according to a well-known frontier process on the island of Borneo (Tsing, 2020): forest concessions whose road infrastructures allow other legal and illegal extraction activities (Gaveau et al., 2014) ; strong development of industrial palm oil plantations, often following logging activities (Gaveau et al., 2019) ; development

of regional transport infrastructure such as the future Transkalimantan Highway (Alamgir et al., 2019) or illegal open-pit mining. Since it no longer has the means of land control that characterise the management of protected areas, WWF must also find new points of reference in order to act and deal with a highly complex social, political, economic and legal context, while its legitimacy is never fully acquired, its margins of manoeuvre limited and its alliances often fragile. To this end, WWF is mobilising the concept of the "*Landscape approach*", an avatar of the integrative management paradigm between conservation and development, as a basis for its strategic thinking in this new context. This notion is defined by Sayer et al. (2013) as a way "*to provide tools and concepts for allocating and managing land to achieve social, economic, and environmental objectives in areas where agriculture, mining, and other productive land uses compete with environmental and biodiversity goals*".

Based on its previous experience in Sumatra (Sulistiyawan et al., 2017; Sulistiyawan et al., 2019), it is the landscape ecology concept of 'ecological corridor' (Clergeau et Désirée, 1999 ; Rudnick et al., 2012) that WWF-Indonesia uses as the focal point to justify and crystallize various kinds of 'organizing' efforts to achieve forest protection performance in the *Kahayan-Katingan landscape*. These include dialogue with public and sectoral actors for the spatialised definition of key areas to be preserved and their institutionalisation through an appropriate regulatory framework (Winrock International, 2018: 63-81) ; working with local communities on social forestry and low environmental impact agricultural commodity development projects (WWF, 2018) ; or the creation of partnerships with forest concessions in monitoring and fighting fires.

These organisational efforts are inseparable from concomitant on-going efforts, to account for the ecosystems at play, which are based on complementary information and assessment tools: software for mapping the quality of the forest cover, collection of scientific field data on the Orangutan population in the area (identification and counting of nests, etc.), modelling of critical ecological connectivity points in the corridor, etc. (Utami-Atmoko et al., 2016 ; Hadian et al.,

2019). The pilot experimentation and gradual deployment of the early warning tool against deforestation in this territory is thus to be seen as one of the constitutive elements of this ongoing *accountizing* process, which is reflected in the production of additional "accounts" that can be mobilised at different moments in the organisation and decision-making processes (mapping of alerts, quantification of hectares of forest in danger, follow-up sheets for an alert and a given intervention for local agents, etc.).

What then about the initial situation for WWF and on what criteria should the role of the *SPD-PKL* be assessed? As Roberts and Scapens (1985) have shown, accounts must always be understood and studied in the context of the organised 'systems of accountability' in which they take shape and which they contribute to materialising through their very practice, i.e. precisely through the systematic use and exchange of accounts by interacting individuals or actors. Thus, in our case, we will ask ourselves to what extent the *SPD-PKL* can allow for the definition, negotiation and management over time of new commitments between the actors concerned by the degradation of the forests of the *Katingan-Kahayan landscape*, to the point of bringing about or even instituting "ecosystem-centred systems of accountability" capable of improving the targeted ecological result (here, the effective implementation of an ecological corridor for Orangutans in the territory) (Feger and Mermet, 2017; Feger et al, 2019). We will therefore consider the *SPD-PKL* as a 'proto-accounting' tool, as long as it remains at a pilot stage and does not contribute to a real and sustainable rearrangement of relations and responsibilities between actors, which is part of concrete and regular procedures and practices for exchanging accounts, and which leads to measurable ecological performance.

This theoretical proposition has strong implications for what we need to interrogate next in a more empirical way in order to continue our work of analysis of the tool.

MAKING EXPLICIT: CRITICAL ANALYSIS OF THE THEORETICAL ORGANISATIONAL MODEL UNDERLYING THE TOOL

It is no exaggeration to say that the tools developed in the world of conservation are largely based on functionalist and positivist views, reinforced by the scientific nature of the data produced. In this respect, the contribution of the critical and interpretive accounting research programme to the world of conservation is, in our view, particularly relevant and useful. Indeed, this programme was initially designed to go beyond functionalist approaches to accounting systems, insisting, among other things, on the fact that the tools carry within them a mode of problematisation, theory of change and organisation that is largely implicit (Hopwood, 1983 ; Chapman et al., 2009). The second stage of the proposed approach therefore consists of critically questioning the underlying hypotheses as to the way in which the promoters of the tool conceive of its inclusion in organisational, institutional and social dynamics in order to produce the expected changes, and of discussing the limits of this.

The envisaged use of *SPD-PKL* corresponds to the combination of two common paradigms in the field of environmental management. The first is the rational decision model (Laurans et Mermet, 2014) characteristic of functionalist and positivist approaches. The second is the 'government paradigm' as described by Mermet (2018a). The latter translates into the belief that the natural actors of change for the environment are public actors (national, local, etc.) in that they have the legitimacy, authority and a range of regulatory instruments necessary to drive and implement action. The deforestation alert tool is thus essentially conceived as a 'response machine' (Burchell et al., 1980 ; Macintosh et Quattrone, 2010, chap.7) aimed at informing the different stages of a bureaucratic decision-making and control chain at several hierarchical levels of public action. Indeed, it is expected to provide useful data to optimise the decisions of public agents and rationalise their policy and action in the fight against deforestation: prioritisation of alerts generated by the tool on the basis of automatic computations; decision to carry out a field investigation to verify the level of real risk; choice of triggering an intervention

conducted by local agents; monitoring and evaluation of the effectiveness of the interventions conducted, etc.

However, the tool's promoters are not blind to the blind spots of such an approach. The following response from the *SPD-PKL*'s designers in one of its presentation leaflets makes this clear: '*[SPD-PKL] aims at reducing the illegal conversion of forests in Borneo by 10 to 35%, **if** stakeholders can respond in a timely manner*' (emphasis added). They are thus well aware that the key to its performativity lies ultimately in the hands of 'stakeholders' at the end of the decision-making and intervention chain - whose definition and nature of interactions is left unclear. The functionalist ideal of the effectiveness of 'action at a distance' (Robson, 1992) which is the strength and attractiveness of this tool, reaches its limits when the key to its success actually lies with agents who have to go out into the field to confront 'face to face' (Roberts et Scapens, 1985) other local stakeholders with their possible responsibilities in the ongoing deforestation processes.

From this point of view, it should be added that the tool, initially invented in offices far from Borneo, poses a triple temporal problem. Firstly, its cartographic format leads to a deshistoricised representation of responsibilities in the processes of forest degradation, whereas they are first and foremost the result of a past of political and economic planning and historical actors (Casson, 2001 ; Lund et Rachman, 2018 ; Durand et Pirard, 2008). It then tends to crush the socio-political depth of the current reality on the ground, without providing a grip on the complex and eminently political work of assigning responsibility for these deforestation processes. Finally, because of its predictive technology based on machine learning of recognisable patterns of ecosystem degradation, the tool has the particularity of alerting to potential future deforestation. It therefore implies a response by agents to an event that, although localised, has not taken place, implying a completely different mode of land administration. All of these elements point to the importance of undertaking an empirical analysis of the context in which the tool is used.

INVESTIGATING AND ENRICHING: EMPIRICAL STUDY AND ANALYSIS OF THE TOOL IN CONTEXT

At this stage, we propose to focus on the contextualised uses of such proto-accounting tools for ecosystems, by relating them to a set of very concrete practices on which their real capacity to generate the expected changes will ultimately depend, i.e. to establish systems of accountabilities capable, in our case, of curbing the process of deforestation in the landscape concerned.

In order to analyse management accounting in the contexts in which it operates and how it shapes them in turn (Hopwood, 1983 ; Roberts et Scapens, 1985), the critical accounting literature emphasises the importance of combining plural theoretical analyses from sociology, organisational theory and even philosophy, with empirical research based on qualitative methods, notably from ethnography (Dey, 2002 ; Ahrens et Chapman, 2006 ; Ahrens et Chapman, 2007). Work in ecosystem-centric management accounting takes up this dual conceptual and empirical approach, but this time proposes to mobilise theoretical frameworks that are specifically relevant and designed to analyse governance and the collective handling of environmental problems (Mermet et al., 2014 ; Feger et Mermet, 2017 ; Feger et al., 2017).

In our case, as the *SPD-PKL* was still being transferred at the time of our field survey, it was impossible for us to observe its already routine use. On the other hand, the announcement of the tool's imminent arrival and the increasing number of training meetings for the actors concerned, as well as the first phases of *in situ* technical tests conducted by WWF members and public officials, enabled us to observe and question the hopes, questions or fears raised at the time during our interviews. These situations proved to be rich material for our reflection. We have identified at least two main issues: the first concerns public officials designated as future users of the *SPD-PKL*; and the second concerns local actors who will *de facto* be targeted by their activities when the *SPD-PKL* is used.

What are the conditions for the adoption of the tool by its future users?

First of all, to deal with our field material on the future users of the tool, we mobilised the sociology of translation (Callon, 1986). In particular, we structured our data and our reflection by asking ourselves under what conditions and through what transformations (of their missions, their identities, their responsibilities, their relationships, etc.) the public agents at different levels envisaged as future users of the *SPD-PKL* innovation could come to fully adopt it. In other words, under what conditions could the tool eventually become an 'obligatory passage point', beyond its pilot experimentation, and become deeply embedded in their organisational functioning? (For examples of this mode of analysis based on the Sociology of Translation for environmental management, see Mermet et al., 2014; Feger et al., 2017; Guillet et Mermet, 2020). This analysis led to several key results for understanding the context of the tool's use.

Firstly, the possible adoption of the *SPD-PKL* by these agents has to be put into the context of different modalities of governing the territory. While some of the forests in the *Kayahan-Katingan landscape* are located in areas regulated by the Ministry of Environment and Forestry and its authorities at different administrative levels, those located in the so-called development zones, on which our study focused, are under the aegis of the Ministry of Agrarian Affairs and Land Management. The latter ensures the control of land use through the establishment of spatial plans, the issuing of land use permits and the registration of property titles, the verification of the adequacy between the plan and the realities of use on the ground, the control of legality and permits, the resolution of land use conflicts, etc. Secondly, the legal and institutional pluralism that characterises Indonesian public action must be remembered (Ardiansyah et al., 2015). Despite the efforts to formalise the land tenure system, a legal dualism remains as a result of colonial and post-colonial history, with public law and customary law coexisting (Li, 2020). In addition, following the decentralisation policy implemented since the 1990s, there has been an increase in the complexity and overlap of authorities between state and elected

bodies at provincial and local levels (Casson, 2001 ; Barr et al., 2006). These realities lead to difficulties and tensions in defining the authorities and legitimate rules that regulate the use of land in a given area.

In this context, and for the specific case of the so-called development zones, our study has, for example, highlighted the interest that the tool could arouse among agents in charge of defining multi-year spatial planning at the level of the Province of Central Kalimantan, by simplifying some of their missions. Indeed, the cartographic data and predictive capacities of the tool produced could allow a better visualisation of future land use conversions and help them in their planning mission.

On the other hand, the use of the *SPD-PKL* poses a problem for the officers identified for intervention in the field. The latter are responsible for legality control activities, a task that is already difficult to carry out over a vast territory and with limited resources, as one of the officers interviewed told us: *“We don't have dedicated staff for ground checks. The position for ground investigator is vacant [...] nobody is interested by this job, it's perceived as a hard job because lots of local people dislike investigators”*. The tool would not only imply for them an increase in intervention activities, which the tool itself would track and control, but would also place them in a completely different mode of interaction with the local population. Indeed, these agents would no longer be required to intervene in the name of an observed past infraction, but rather in relation to potential future illegal deforestation identified by the tool in the form of, among other things, awareness-raising and consultation activities. This is a completely different job and mode of legitimisation in the field.

What are the challenges and risks of deploying the tool for villagers?

In addition, we sought in our survey to describe and categorise the major patterns of degradation of these forests in the study area that may or may not lead to the generation of an alert by the tool. The aim was to gain a better understanding of the

processes and social interaction logics that lead or do not lead to the generation of an alert, and to make the responsibilities of different groups of actors in these degradations more legible (villagers, palm oil or rubber companies, pulp and paper companies, etc.). We have thus identified a second major set of problems that primarily concerns villagers who practice semi-subsistence agriculture in the area and who may be involved in small-scale land clearing activities. They will indeed be *de facto* impacted in their activities and in their daily life by the deployment of the *SPD-PKL*. They would likely be the object of alerts generated by the tool and of interventions by public agents who will eventually use it.

Indeed, although the progressive extension of palm oil concessions is one of the primary historical causes of deforestation in this territory (Gaveau et al., 2019), this is most often done within the framework of the allocation of permits in planned development areas and is therefore unlikely to be the subject of interventions within the framework of the *SPD-PKL*. This is not the case for small farmers, for whom the system of land titling and land clearing and cultivation permits is difficult to access and highly complex, involving often contradictory overlaps between public and customary law, and making the boundary between legal and illegal land clearing difficult to read.

For the analysis and structuring of the data on these topics, we have mobilised the work on the governance of the commons by Ostrom (1990) and the *Environmental Entitlements Framework* proposed by Leach et al. (1999) (as synthesised in Feger et al., 2017). These two approaches provide concepts for an in-depth analysis of the systems of rules - formal and informal - that regulate access to and use of certain ecosystems and natural resources by groups or individuals. Our aim was to analyse the risks posed by the implementation of the tool with regard to the modalities of access to certain forest resources for their subsistence: subsistence agriculture, the existence of customary regulations, and the tensions that are very present in the territory between 'old residents' and 'newcomers' - the history of Borneo being marked by trans migrations of various kinds.

In particular, the tool poses a risk of criminalising small-scale semi-subsistence activities, as a local traditional chief told us: '*We are afraid that SPD-PKL will catch every move, and afraid of being blamed for not implementing governmental programs*'. The tool thus raises important issues of environmental justice when the structural historical degradation carried out by the forestry and palm oil concessions is not taken into account, or when the question of the differences in practices and the relationship to resource conservation between 'old residents' and 'newcomers' is not addressed.

What can we conclude from these field returns and analyses? At the time of our study, the tool's potential in the context was doubly limited. It is difficult to use it as a support for assigning responsibilities and for the concrete negotiation "face to face", on the ground, of new commitments that could lead to a reduction of deforestation in so-called development zones. Indeed, on the one hand, it is difficult to *translate* this innovation into the language and framework of the current missions of field control officers, which reduces its chances of adoption by the institutions and services concerned. On the other hand, the real risk to local communities and small farmers remains. In order to mitigate the risks of tension that the deployment of the tool could generate, WWF is working with local and customary authorities on the implementation of a *social safeguards* mechanism associated with its use.

CONCLUSION

At a time when the number, diversity and technical scope of innovative information and assessment tools for conservation are multiplying, there is an urgent need to set up a real research programme to study their implications in terms of transforming systems of action and governance, and defining and assigning new responsibilities. To this end, following previous work, we have defended the idea of reconceptualising these innovative tools as (proto-)management accounting systems (rather than simple technical-scientific or economic tools) established on new and evolving organisational perimeters that are socio-ecosystems.

By placing socio-ecosystems at the heart of the analysis, such a research programme must be deeply interdisciplinary and build solid bridges between conservation sciences, socio-anthropology and management sciences. Indeed, the conservation sciences provide fundamental elements of knowledge for understanding the ecological dynamics at stake and for evaluating the performance achieved, and play a leading role in the design of innovative information tools for decision-making and operational purposes. Socio-anthropology provides the empirical methods and knowledge necessary for a detailed understanding of the logic of the actors involved in the processes of degradation or protection of ecosystems, at the interface between environmental protection operators, local populations and public authorities. Finally, the management sciences make it possible (i) on the one hand, to draw inspiration from the critical research programme in accounting and to use the problematisation modes and methods that have been its strength, combining plural theoretical analyses and empirical case studies 'in context', and (ii) on the other hand, to assume a critical position in the service of the pragmatic support of stakeholders in the strategic improvement of their capacity to act in favour of biodiversity. Such a scrupulous but committed research position with the private and public actors who carry out these efforts is in line with the discipline's work on 'critical performativity' (Spicer et al., 2009; Aggeri, 2017). It requires investing in the construction of research-intervention methods that allow for this reflective, heuristic and constructive work.

Based on the approach proposed in this paper and the interdisciplinary framework it requires, we identify several complementary areas of work. Firstly, it is necessary to multiply the number of case studies taking a particular conservation information tool as an entry point, in order to progressively equip a more general and comparative discussion of tools and their governance and implementation issues in contrasting socio-ecological contexts. Secondly, it is a matter of investigating the question of how different tools and information systems (environmental, but also social, economic, etc.) relating to a given ecological concern or socio-ecosystem can be linked together, and how they can be 'assembled' in a broader accounting framework specifically dedicated to its collective

management (see for example Feger and Mermet, 2018). Finally, a third important area of work consists of considering the conditions for opening up the development of such ecosystem-centric management accounting frameworks to a diversity of stakeholders who are *de facto* concerned by this ecosystem. The challenge is then to take their concerns into account as best as possible in the new governance of the commons that these accounts can help to generate, while keeping as a primary compass the requirement to achieve environmental results. To this end, we can draw on work on 'dialogical' accounting (Brown and Dillard, 2015), on its role as an object of mediation (Jordan et al., 2013) or on the practice of accounting as a collective maieutic procedure (Busco and Quattrone, 2018b).

On this depends ultimately the capacity of these new systems of accounts for ecosystems to keep their promises in terms of both ecological performance and environmental justice, by supporting the multiple necessary recompositions of our socio-economic systems, which the preservation of our biosphere forcefully requires.

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