Getting forest science to policy discourse: A theory-based outcome assessment of a global research programme

A. HALIMANJAYA[a,d], B. BELCHER[b,c] and D. SURYADARMA[b]

[a]*SDGs Centre, CISRAL UNPAD, Jl. Dipatiukur No. 46, Bandung, 40132, Indonesia*
[b]*Center for International Forestry Research, Jalan CIFOR, Bogor, 16000, Indonesia*
[c]*Royal Roads University, 2005 Sooke Rd, Victoria, BC V9B 5Y2, Canada*
[d]*Dala Institute, Grand Slipi Tower 9th floor (unit G), Jl. Letjen S. Parman Kav. 22-24, Palmerah, West Jakarta 11480, Indonesia*

Email: aidy.halimanjaya@fe.unpad.ac.id, brian.belcher@royalroads.ca, dsuryadarma@gmail.com

SUMMARY

This paper presents an assessment of the outcomes of research carried out under the Sustainable Wetlands Adaptation and Mitigation Programme (SWAMP). SWAMP aimed to inform national and international climate policy and practice by developing tools and methods to quantify greenhouse gas (GHG) emissions, carbon stocks and flux in tropical wetlands due to land use, land-use change and forestry (LULUCF). This assessment modelled SWAMP's intended outcomes as a theory of change (ToC) and used qualitative methods to test the ToC and to evaluate whether and how the outcomes were achieved. It found that SWAMP research has helped raise academic and policy interest in wetlands, mangroves and peat forests as carbon reservoirs, and that SWAMP's recommendations informed policy discourse and supported the development of technical guidance and strategies of sustainable wetland management. However, the research had a weak effect on international and Indonesian climate change policies compared to other factors. The Paris Agreement and Indonesia's nationally determined contribution (NDC) do not include the quantification of carbon stocks from mangroves, which are not all located in the forest areas. Knowledge translation was achieved through a variety of mechanisms, with direct engagement identified as particularly important. The outcome evaluation approach proved useful as a way of conceptualising and organising the analysis of research impact on development outcomes.

Keywords: forest science, research evaluation, theory of change, research contribution, outcome assessment

Incorporer la science forestière au discours de politique: une évaluation à base théorique du résultat d'un programme de recherche global

A. HALIMANJAYA, B. BELCHER et D. SURYADARMA

Ce papier présente une évaluation des résultats d'une recherche effectuée sous l'égide du Programme d'adaptation et d'atténuation durables des zones humides (SWAMP). Le SWAMP visait à informer la politique climatique nationale et internationale et leur pratique, en développant les outils et les méthodes utilisés pour quantifier les émissions de gaz à effet serre (GHG), les stocks de carbone et le flux dans les zones humides tropicales dus à l'utilisation de la terre, les changements de cette dernière et la foresterie (LULUCF). Cette évaluation a modelé les résultats désirés du SWAMP en tant que théorie de changements (ToC), et a utilisé des méthodes qualitatives pour tester le ToC et pour évaluer si, et comment, les résultats étaient obtenus. Elle a trouvé que la recherche du SWAMP ont aidé à éveiller l'intérêt académique et celui des politiques dans les zones humides, les mangroves et les forêts de tourbe en tant que réservoirs de carbone, et que les recommandations du SWAMP ont informé le discours des politiques et soutenu le développement d'une orientation technique et de stratégies de gestion durable des zones humides. Cependant, la recherche a eu un faible effet sur les politiques portant sur le changement climatique en Indonésie, et d'un point de vue international, comparée à d'autres facteurs. Les Accords de Paris et la contribution de l'Indonésie déterminée à l'échelle nationale (NDC) n'incluent pas la quantification des stocks de carbone dans les mangroves, lesquelles ne sont pas toutes localisées dans les zones forestières. Une traduction de tout ceci en termes de connaissance a vu le jour grâce à une variété de mécanismes, l'engagement direct ayant été identifié comme étant particulièrement important. L'approche d'évaluation du résultat s'est trouvée être utile comme moyen de conceptualiser et d'organiser l'analyse de l'impact de la recherche sur les résultats du développement.

Acercamiento de la silvicultura al discurso político: una evaluación teórica de los resultados de un programa de investigación global

A. HALIMANJAYA, B. BELCHER y D. SURYADARMA

Este artículo presenta una evaluación de los resultados de las investigaciones realizadas en el marco del Programa de Adaptación y Mitigación de Humedales Sostenibles (SWAMP, por sus siglas en inglés). El objetivo de SWAMP era informar las políticas y prácticas nacionales e internacionales relativas al clima mediante el desarrollo de herramientas y métodos para cuantificar las emisiones de gases de efecto invernadero

(GEI), las reservas y el flujo de carbono en los humedales tropicales relacionados con el uso del suelo, el cambio de uso del suelo y la silvicultura (LULUCF, por sus siglas en inglés). Esta evaluación dio forma a los resultados previstos de SWAMP como una teoría del cambio (TdC) y utilizó métodos cualitativos para probar la TdC y evaluar si se lograron los resultados y de qué forma. Se halló que la investigación del programa SWAMP ha contribuido a aumentar el interés académico y político en los humedales, los manglares y los bosques de turba como reservas de carbono, y que las recomendaciones de SWAMP han informado el discurso político y han apoyado la elaboración de pautas y estrategias técnicas para la gestión sostenible de los humedales. Sin embargo, la investigación tuvo un efecto débil en las políticas internacionales y de Indonesia sobre el cambio climático, en comparación con otros factores. El Acuerdo de París y la contribución determinada a nivel nacional (CDN) de Indonesia no incluyen la cuantificación de las reservas de carbono de los manglares, ya que no todos están ubicados en las zonas forestales. La transferencia de conocimiento se logró a través de diversos mecanismos, y se consideró que la participación directa fue particularmente importante. El enfoque de evaluación de resultados demostró ser útil para conceptualizar y organizar el análisis del impacto de la investigación en los resultados de desarrollo.

INTRODUCTION

Increasing demand for evidence based policy solutions puts pressure on scientific research programmes to create clear policy and impact targets. Researchers and research managers also need better ways to learn from their own and others' experience so that they can improve the effectiveness of research in responding to policy issues and contributing to positive change. Nonetheless policymaking is complex, and identifying research pathways that contribute effectively to policy change is challenging (Geyer 2012, Stevens and Ritter 2013), with multiple actors across scales and institutions, driven by a wide range of interests that are often entangled in a nonlinear, unmoderated and uncoordinated process (Maina *et al.* 2013). It is critical that organisations producing scientific research in the climate change arena, and also their funders, understand how scientific research contributes to policy processes, and how such contributions can be improved to better inform decision-making and accelerate climate negotiations and the reduction of greenhouse gas (GHG) emissions.

This paper presents an analyses of the policy pathways influenced by one international research programme on measuring and mitigating carbon stocks and GHG emissions from mangrove and peat forests as a way to improve understanding of the role of scientific research and related activities in the development of national policies and practices. Specifically, it assesses whether and to what extent the Sustainable Wetlands Adaptation and Mitigation Programme (SWAMP) has influenced global (i.e. United Nations Framework Convention on Climate Change (UNFCCC)) and national (Indonesia) environmental policy discourse.

The SWAMP conducted scientific studies on mangrove and peat forests, whose restoration has received little attention, despite massive degradation and the huge amount of carbon released by peat- and forest fires in Indonesia during 1997 (Page *et al*. 2002). The relationship between the sustainability of the peat ecosystem and climate change information was discussed earlier (Page *et al*. 1999). No significant action was taken by the Government of Indonesia until further forest fire incidents occurred in 2015. The 2015 haze triggered political reactions from neighbouring countries and pushed the government to take action to prevent forest and peat fires by establishing its Peat Restoration Agency. Meanwhile the mangrove ecosystem, which is mainly located in coastal areas and different from peatland ecosystem, continues to receive little attention.

The assessment of SWAMP used a theory based evaluation approach. Such approaches are increasingly used in the evaluation of development and social projects (Carvalho and White 2004) and public health programmes (Cole 1999, CAHS 2009, Banzi *et al.* 2011, Greenhalgh *et al.* 2016), but are yet to be widely implemented in the environmental science research context. The analysis uses a theory of change (ToC) as an evaluation framework (Coryn *et al.* 2011, White 2009). A ToC is an explicit articulation of the hypothesised relationships between the initiative strategies of a project/programme (the intervention) and a series of intended results, which span what the project/programme can control for (outputs), the changes that the project output aims to influence (outcomes), and the social, economic and/or environmental effects of the outcomes (impacts). Using a narrative and/or diagram, the ToC illustrates and explains the results chain from project-level activities through outputs, outcomes and impacts. The overall ToC is a set of specific hypotheses for end-of-programme outcomes that can be tested.

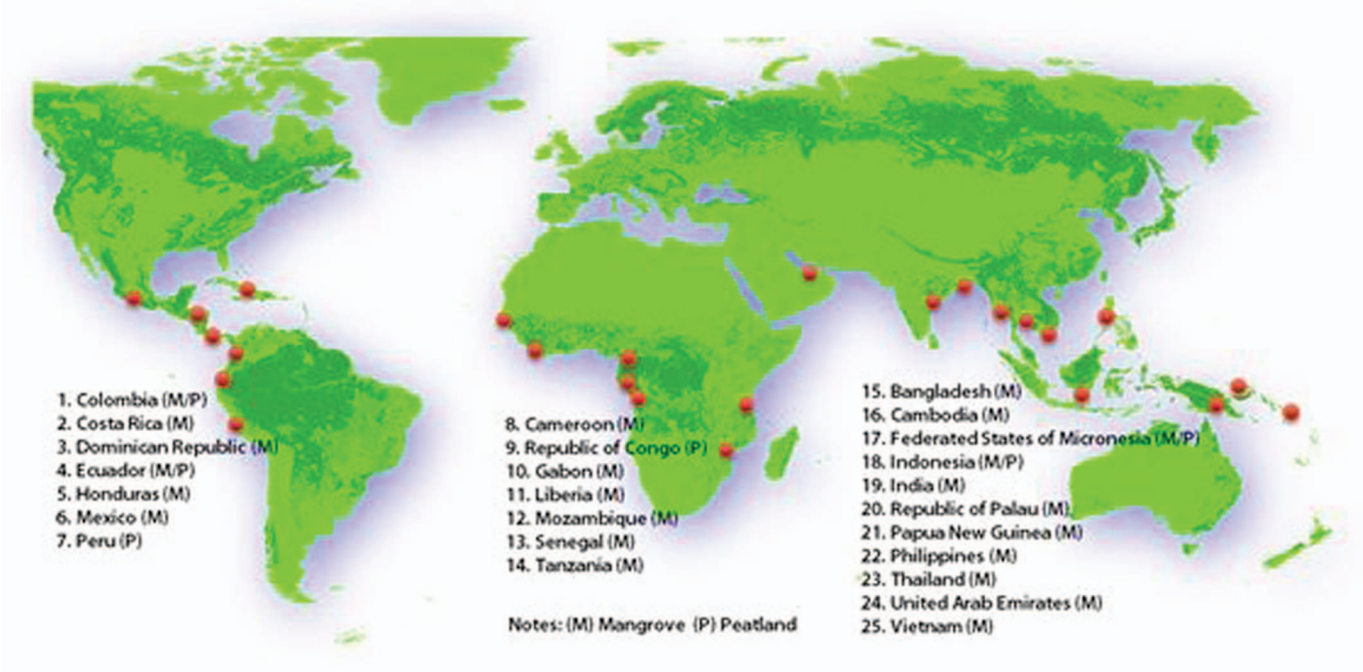
The paper sets the context with a brief overview of the SWAMP programme and the relevant national and international policy processes. It then describes the outcome assessment method, a promising approach that has not yet been widely used in research evaluation. The results are presented sequentially, following the ToC, starting with key programme activities and outputs through to the main programme outcomes. Each section provides evidence and discusses the mechanisms by which the programme contributed. The conclusion provides an assessment of the approach and a synthesis of lessons learned about how SWAMP research contributed to policy processes.

RESEARCH AND POLICY CONTEXT

SWAMP research programme

The SWAMP was established by the Centre for International Forestry Research (CIFOR) in 2009 as a collaborative research programme involving the US Department of Agriculture's Forest Service (USFS), with support from the

FIGURE 1 *SWAMP's coverage across the globe*



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US Agency for International Development (USAID). This programme started from a short multi stakeholder forum and evolved to respond to a variety of challenges in national and international wetlands policy development (CIFOR 2012b, 2012c).

With the current intense attention to climate change and global environmental challenges, most nations are engaged in international climate change negotiations and designing national and sub-national responses. The UNFCCC is one of the largest and most intricate policymaking networks in history (Keohane and Victor 2011). The overall goal of SWAMP was to provide credible scientific information on which sound decisions can be based concerning wetland (peatlands and mangrove) forests in UNFCCC policy development, and to inform national policy in 25 peatland- and mangrove-rich countries across Asia Pacific, Africa and Latin America. The programme started in Indonesia as its focal country because it holds the largest share of the world's tropical peatlands and mangrove forests (Gumbricht 2012). It then expanded to cover a number of countries, as shown in Figure 1. As Indonesia and UNFCCC received most of SWAMP's attention, this assessment focuses on these two policy arenas.

SWAMP research was organised in three work streams: (i) developing tools to quantify GHG and carbon (C) stocks in tropical wetlands; (ii) developing modelling tools for ecosystem carbon dynamics suitable for tropical forest wetlands in order to support policy relevant analyses; and (iii) building the capacity of resource management and scientific and policy communities to deal with forest wetland carbon issues (CIFOR 2012a).

Tropical forest wetlands: context and policies

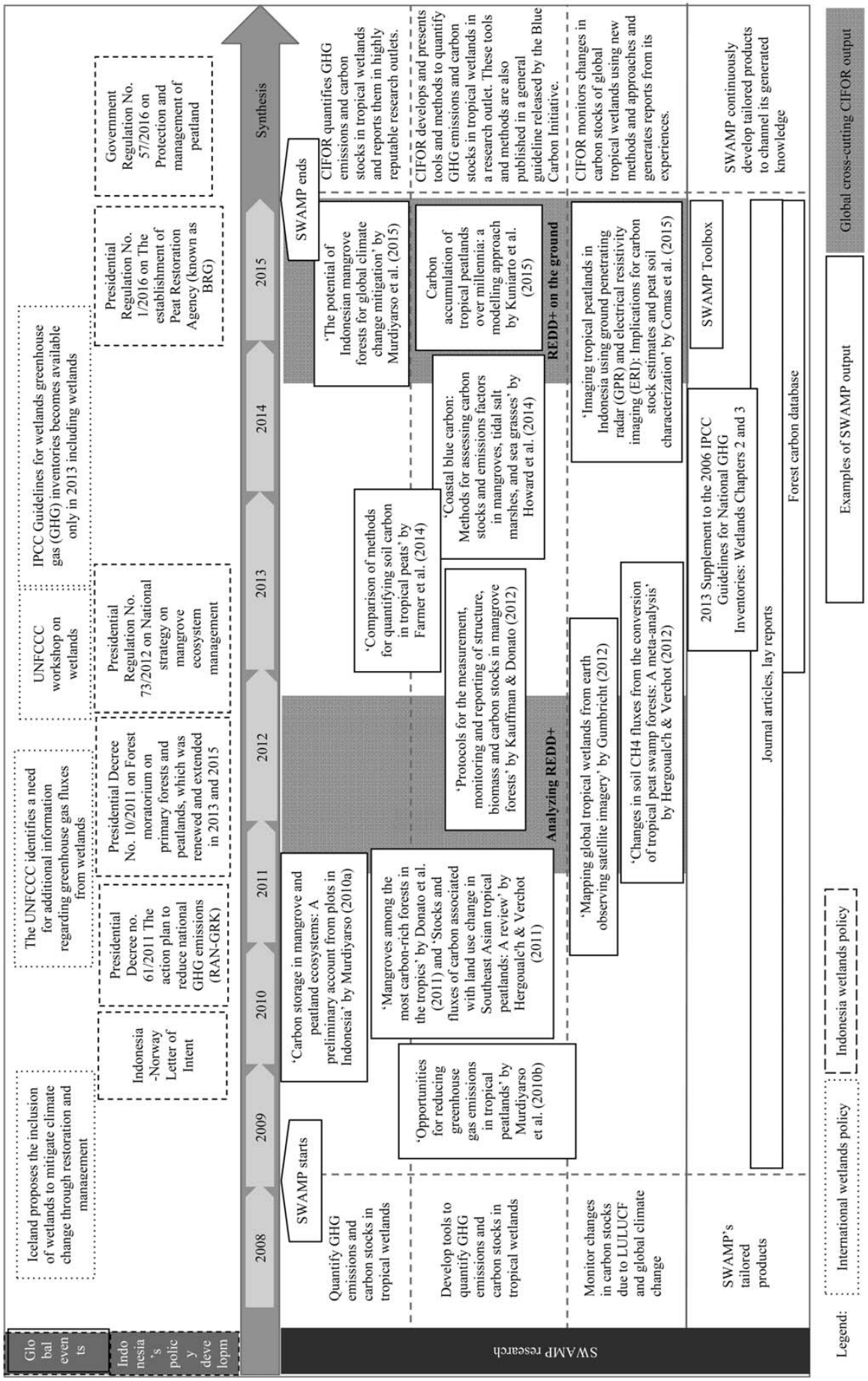
Mangrove forests, which occur along the coasts of most major oceans in 118 countries and make up 30–35% of the total global area of tropical wetland forest, have been overlooked in international climate change mitigation strategies until relatively recently (Donato *et al.* 2011); meanwhile, the extent of mangrove forests has declined by 30–50% over the past half century as a result of coastal development, aquaculture expansion and over harvesting.

Despite their high carbon content, peatlands and mangrove forests were not included in the UNFCCC agenda until late 2010s. Global wetland policy development commenced after Iceland proposed to include the restoration and management of wetlands to mitigate climate change (Figure 2). This proposition triggered policy and scientific discussions on a global scale.[1] The 2011 UNFCCC meeting in Bonn identified a need for additional information about GHG flux from wetlands. The IPCC was invited to develop methodologies specific for wetlands, which were published in 2013 as a supplement to the 2006 IPCC Guidelines for National GHG Inventories.

The development of national policy on mangrove forests and peatlands in many tropical forest rich countries including Indonesia happened concurrently with wetland policy development at the UNFCCC. Indonesia signed a Letter of Intent (LOI) with Norway in 2010 aiming for more progressive development of its land based policy, with high international expectations for reduced emissions from deforestation and forest degradation, known as REDD+ (Donato *et al.* 2012, Royal Norwegian Embassy in Jakarta 2010). Hence, we

[1] During a meeting of the ad-hoc working group of the Kyoto Protocol in 2008 in the Ad Hoc Working Group on Further Commitments for Annex I Parties under the Kyoto Protocol (AWG-KP) 6 in Accra.

FIGURE 2 *Climate change policy development and CIFOR research activity at national and global levels*



consider it as a relevant case in which a series of interventions triggered the development of national policy reforms (see Figure 2).

Policy to guide the management of forest wetlands was developed rapidly, but implementation lagged. Indonesia's peatland and above ground mangrove forest policies were mainstreamed into the national REDD+ programme in the preparation of Indonesia's forest reference emission levels (FREL). However, implementation of sustainable management of wetlands, and especially of mangroves, was sporadic due to a lack of clarity over which ministry should be responsible (Greeners.co 2014, Riski 2016).

METHODOLOGY

A mixed method theory-based evaluation approach was used to do an *ex post* assessment of whether and how the SWAMP research achieved its intended outcomes. The method builds on the tools and concepts from theory-based evaluation used in methods such as Outcome Mapping (Earl *et al.* 2001), Contribution Analysis (Mayne 2008), Outcome Harvesting (Wilson-Grau and Britt 2012), Collaborative Outcomes Reporting Technique (Dart and Roberts 2014) and RAPID Outcome Assessment method (ODI 2012). The approach used in this assessment follows the method described in Belcher *et al*. (2017).

The assessment was conducted in three main stages:

Documenting the ToC

SWAMP project documents included an implicit and partially-articulated ToC. The analysis requires a testable ToC, so the assessment team used project documents and informal interviews with SWAMP scientists to develop a well-defined, specific and detailed draft ToC. SWAMP scientists were then engaged to help to refine and improve its precision and clarity through an iterative process. The ToC was conceptualised in stages, identifying the theoretical causal links from the main research activities and outputs, tailored products (i.e. research outputs packaged and delivered for specific audiences) and engagement processes, leading to intermediate outcomes, end-of-programme outcomes, and higher-level-outcomes.

The team used the SWAMP ToC as the main conceptual and analytical tool for the assessment. It is a comprehensive description and illustration of how and why desired changes were expected to happen in this particular context (Weiss 2007, Coryn *et al.* 2011, Vogel 2012). A ToC aims to model the causal relationships between a project's activities and results, with attention to the primary pathways, actors and steps in the change process. The approach recognises and appreciates that socio-ecological systems are complex, with non-linear causal relationships. A ToC sets out testable hypotheses of a change process by working back from long-term goals to identify all the conditions that (theoretically) must be in place for the goals to occur (Belcher *et al.* 2017).

The ToC models a series of interlinked outcomes expected to occur due to actions of direct users of research and of actors and/or processes influenced by direct users. Outcomes are defined by specific actors or actor groups and their expected actions. In other words, the outcomes in the ToC answer the question "who is expected to do what differently as a result of the SWAMP project?"

The concept of "end-of-programme outcomes" is important in the analysis. These are outcomes the programme aimed to contribute to and that can be reasonably expected to be influenced by and realised within the time frame and resources of the programme. Higher level results are also represented in the ToC theoretically, but these results are expected to require more time and depend on other variables beyond the influence of the project. It would not be fair or reasonable to expect a project to produce outputs that would be sufficient to realize such high level results, and certrainly not within the time frame for this analysis.

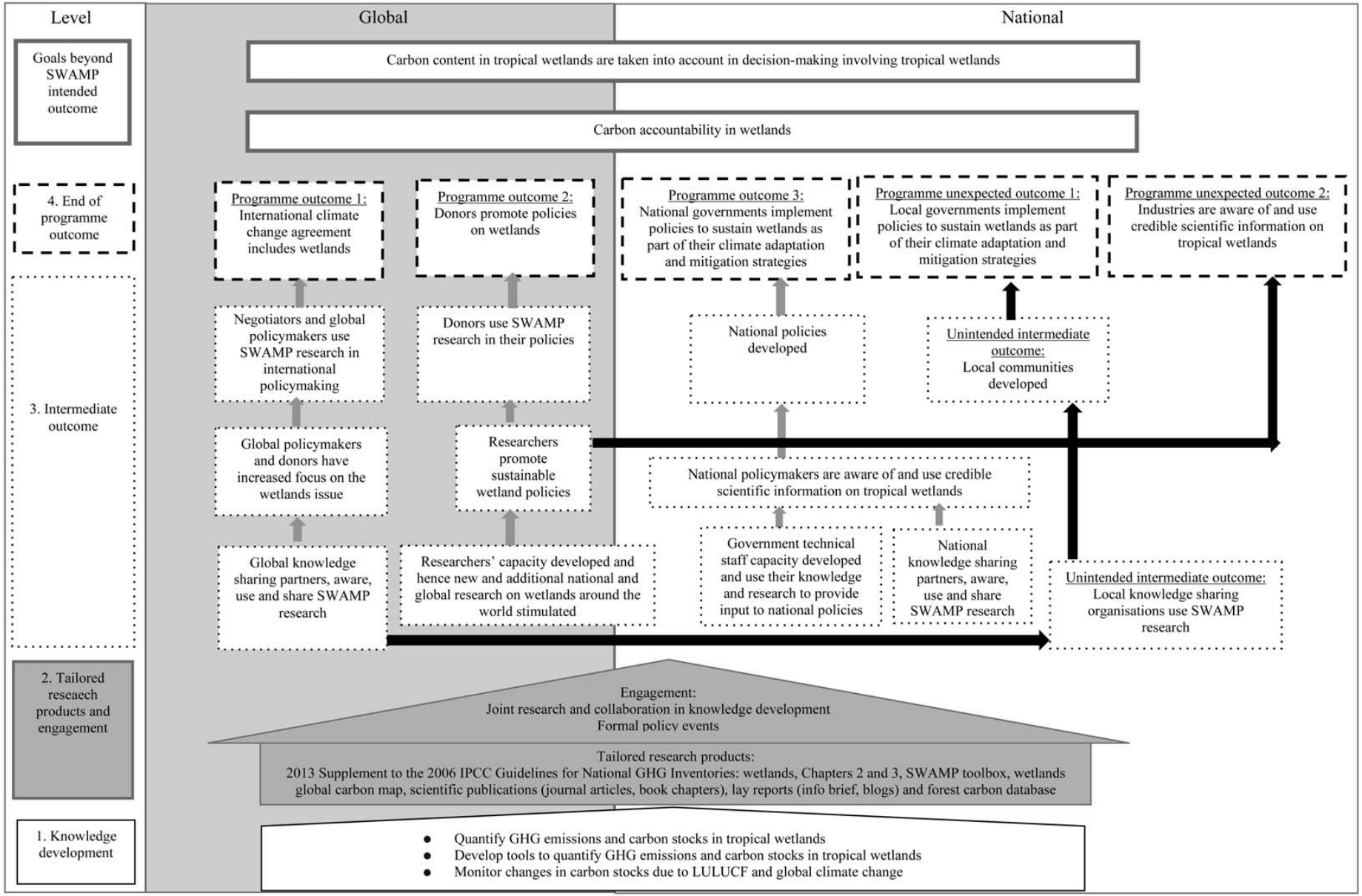
Figure 3 provides a schematic diagram of the SWAMP ToC, identifying key knowledge products and means of dissemination ('tailored products'), engagement processes, and a series of outcomes to which the research was expected to contribute. It also shows causal links that actually took place but were not included in the original ToC. The details of Figure 3 are explained in Table 1.

The outcomes shown in the SWAMP ToC were expected to result from the utilisation of SWAMP knowledge by donors and governments. The assessment team realised that other, similar activities, such as work by the University of Leicester, Wetlands International, World Resource Institute (WRI) and others, have also contributed to understanding and action in areas such as carbon accountability in wetlands. The current analysis does not attempt to disaggregate or quantify these contributions. Rather, it tests whether or not SWAMP work did make a significant contribution.

Data Collection

The ToC provides the frame to identify data needs and data sources for the analysis. The assessment considers all key steps in the process (what was expected to happen) and identifies the evidence needed to verify each step. The data collection process consisted of a document review (project documents; reports form relevant organisations; government and inter-governmental documents) and semi-structured interviews with key informants. Respondents were selected purposively to represent each of the main categories of actors in the ToC. A snowball sampling approach was used to identify additional respondents in each category. Face-to-face interviews (for Indonesia-based respondents) and telephone interviews were completed with 16 respondents from six categories: (1) global knowledge-sharing partners, (2) global policymakers and donors, including negotiators, (3) researchers, (4) national knowledge-sharing partners, (5) national policymakers, and (6) government technical staff. The availability of data from policymakers was limited; some policymakers were unavailable and therefore unable to participate due to the short amount of time available for the assessment. Interviews were recorded, transcribed and translated to English.

FIGURE 3 *SWAMP's theory of change and its actual changes*



Note: black arrows represent actual changes that were identified as unexpected causal effects

TABLE 1 *Explanation of elements in SWAMP's theory of change*

Element	Explanation
1. Programme activity: knowledge development	
1.1. Quantify GHG emissions and carbon stocks in tropical wetlands	SWAMP quantified the amount of global carbon emissions resulting from mangrove loss, particularly in below ground.
1.2. Develop tools to quantify GHG emissions and carbon stocks in tropical wetlands	SWAMP developed tools and guide to quantify GHG emissions and carbon stocks in tropical wetlands so that results are comparable across regions, countries, and territories.
1.3. Monitor changes in carbon stocks due to land use and land use change (LULUCF) and global climate change	SWAMP monitored the rapidly-changing condition of wetlands due to LULUCF on a global level using macro and micro approaches.
2. Programme output: tailoreded research products and engagement	
The 2013 Supplement to the 2006 Guidelines for National Greenhouse Gas Inventories: Wetlands, Chapters 2 and 3	Two SWAMP scientists were the lead authors of Chapters 2 and 3 of the 2013 Supplement to the 2006 IPCC Guidelines for National GHG Inventories: wetlands (IPCC, 2014), which serves as the key global reference for all climate change policymakers and scientists in making decisions on international and national levels.
SWAMP toolbox	SWAMP research partners jointly developed this online training material.
Wetlands global carbon map	Global tropical wetland maps use satellite imagery and their associated reports.
Scientific publications (journal articles, book chapters)	Up to August 2015, SWAMP has produced 44 publications in the form of peer reviewed journal articles and book chapters (see Annex 8). Some of these are available in Vietnamese and Bahasa Indonesia.
Lay reports (info brief, blogs)	Info briefs and blogs promote other tailored products such as the SWAMP Toolbox.
Forest carbon database	A web-based forest carbon database is accessible to subscribers.
Formal policy events	These events took place in the forms of forum discussions, multi-stakeholder meetings and focus discussion groups, such as discussions by the UNFCCC and Global Landscape Forum (GLF) such as 'the GLF: Wetlands matter' held in Indonesia.
Joint research and collaboration	These activities supported the development of all products tailored to the needs of audiences and were conducted with universities, research institutions think tanks, technical staff in government agencies, national and international NGOs and the media.
3. Intermediate outcomes	
Global knowledge sharing partners are aware of, use and share SWAMP research	Aimed to create high awareness of SWAMP research among the representatives of the global knowledge sharing partners, such as CI and IUCN, so that they would transfer scientific information generated by SWAMP to global policymakers.
Global policymakers and donors increase their focus on the wetlands issue	SWAMP aimed to increase focus on the wetlands issue in their policy debate, formulation and implementation by engaging with global policymakers and donors.
Researchers' capacity developed and hence new and additional national/ global research on wetlands around the world stimulated	SWAMP aimed to develop the knowledge and research skills of independent and non-independent researchers including PhD students to produce a large amount of new and additional research on wetlands around the world.
Researchers promote sustainable wetland policies	SWAMP intended that researchers with whom it worked would advocate and promote sustainable wetland policies to policy audience they engaged with.
National knowledge sharing partners are aware of, use and share SWAMP research	SWAMP aimed to increase awareness of SWAMP research on the by representatives of its national knowledge sharing partners such as in Indonesia, Vietnam, Mexico, Costa Rica and Dominican Republic so that these representatives would transfer scientific information generated by SWAMP to national policymakers and practitioners.
Government technical staff capacity developed and use their knowledge and research to provide input to national policies	SWAMP aimed to build understanding of developed and developing country government technical staff about tropical wetlands management so that they would use their knowledge and SWAMP research to provide input into national policy

TABLE 1 *Continued*

Element	Explanation
National policies developed	A number of ministerial regulations and guidelines were developed along with the improvement of local communities' understanding of sustainable wetland management.
Unexpected: intermediate outcome: local communities developed	The improvement of local communities' understanding of sustainable wetland management.
Negotiators and global policymakers use SWAMP research in international policymaking	SWAMP intended that negotiators and global policymakers would use SWAMP research in international policymaking such as in UNFCCC negotiations.
Donors use SWAMP research in their policies	SWAMP intended that donors who engaged would use SWAMP research in their policy debate and formulation, such as in their funding allocation and program development.
National policymakers are aware of and use credible scientific information on tropical wetlands	SWAMP intended that national policymakers would be aware of and use credible scientific information on tropical wetlands, including that generated from its SWAMP.
Unexpected intermediate outcome: local knowledge sharing organisations use SWAMP knowledge	NGOs working at the local level directly with communities used SWAMP output such as the SWAMP Toolbox in their presentations to such communities.
4. End of programme outcomes	
Programme outcome 1: International Climate Change Agreement includes wetlands	SWAMP intended that that the research would contribute to the inclusion of wetlands in the Paris Agreement at COP XXI.
Programme outcome 2: Donors promote policies on wetlands	SWAMP expected that donors would promote policies on wetlands and allocate more funding to support sustainable wetland management.
Programme outcome 3: National policymakers are aware of and use credible scientific information on tropical wetlands	SWAMP expected that national policymakers would be aware of and use credible scientific information on tropical wetlands, including research information developed from SWAMP.
Unexpected outcome 1: local governments implement policies to sustain wetlands as part of their climate adaptation and mitigation strategies	SWAMP partners claim that sustainable wetland management will not be successful without the involvement of local governments to implement policies aligned with sustainable wetland management.
Unexpected outcome 2: industries are aware of and use credible scientific information on tropical wetlands	Port developers received research information from SWAMP's research partner.
5. End-of-programme outcome and broader goal	
Carbon accountability in wetlands	SWAMP intended that countries involved in the UNFCCC process would be better able to account for the emissions generated from wetland ecosystems, which mainly include peatlands and mangrove ecosystems.
Carbon content in tropical wetlands is taken into account in decision-making involving tropical wetlands	SWAMP intended that end-of-program outcomes would contribute to the decision-making involving tropical wetlands. SWAMP expected that carbon content in tropical wetlands would be part of the decision-making.

Analysis and Reporting

Data were systematically extracted from all sources against the overall ToC and against key evaluation questions in a results chart (supplement 1). The results chart is a spreadsheet with a row for each node in the ToC and a corresponding cell for data (i.e. anonymised quotes, citations, policy excerpts, email exchanges, unpublished studies, briefs, research papers) that helps confirm or reject the result. A separate cell provides references for each datum. Evidence was ranked in three confidence levels. High confidence was accorded to evidence supplied in written documents by formal organisations (e.g. journals, the UNFCCC website) **and** where more than two respondents supported the evidence. Moderate confidence was ascribed to evidence in a formal text **or** supported by two respondents. Low confidence was given to evidence in an unpublished text provided by a third party and/or relying on a single respondent's claim. This evidence was used to

assess whether each step in the ToC had occurred, to assess causal relationships as claimed in the ToC, and to suggest revisions to the ToC.

Due to resource limitations, it was not possible to conduct follow-up stakeholder workshops, which might have provided valuable feedback and additional information about key policy processes. But bilateral meetings with stakeholders were used to help clarify SWAMP's contributions to some policy discussions and formal guidance documents. SWAMP senior scientists reviewed the draft report, but limited resources prevented reviews by community members and wider stakeholders.

TABLE 2 *SWAMP publications by purpose or type of publication*

Format of output	Quantity
Research article	23
Project report/research report	8
Guiding document and brief	6
CIFOR working paper	7
Total	44

Note: see Appendix 1 for a full list of the publications

RESULTS

Programme activity: knowledge generation

Between 2009 and 2015, SWAMP produced 44 publications. The lower part of Figure 2 shows the key publications and their points of influence in the policy development timeline. The seminal publication[2] 'Mangroves among the most carbon rich forests in the tropics' (Donato *et al.* 2011) presented new tools to quantify GHG emissions and carbon stocks in tropical wetlands. Gumbricht (2012) provided a global carbon map of wetlands from earth observation satellite imagery as a major contribution to the monitoring of changes in carbon stocks due to LULUCF and global climate change. One of the studies written by Murdiyarso *et al.* (2015) reveals the potential of Indonesian mangrove forests for global climate change mitigation.

It is also important to note that Indonesia's wetland policies were being developed concurrently with SWAMP research in Indonesia. Some SWAMP studies that focus on Indonesia are 'Carbon storage in mangrove and peatland ecosystems: A preliminary account from plots in Indonesia' (Murdiyarso 2010a) and 'The potential of Indonesian mangrove forests for global climate change mitigation' (Murdiyarso *et al.* 2015). It was expected that knowledge generated and shared by SWAMP, along with other supporting activities by the programme, would contribute to better informed polices at national and international levels.

Programme output: tailored research products and engagement

At the national and international levels, SWAMP knowledge was disseminated and shared through scientific publications, a series of policy briefs, and active engagement of scientists in official policy development and drafting. For example, SWAMP researchers were invited to become lead authors of Chapters 2 and 3 of the 2013 Supplement to the 2006 IPCC Guidelines for National GHG Inventories: Wetlands, which in turn informed the UNFCCC on topics such as 'Mangroves among the most carbon rich forests in the tropics' (Donato *et al.* 2011), 'Stocks and flux of carbon associated with land use change in Southeast Asian tropical peatlands: A review' (Hergoualc'h and Verchot 2011), and 'Protocols for the measurement, monitoring and reporting of structure, biomass and carbon stocks in mangrove forests' (Kauffman and Donato 2012). The Wetland Supplement is used by Indonesian policymakers in reporting their FREL to the UNFCCC.

At the national level, two SWAMP scientists were involved as lead scientists in the Task Force on National GHG Inventories (TFI).[3] This involved developing additional national level inventory methodological guidance for wetlands, including default emission factor values, with the aim of filling gaps in the coverage of wetlands and organic soils in the 2006 IPCC Guidelines. A SWAMP scientist also contributed to the development of Indonesia's REDD+ strategy and research consultants use SWAMP tailored products in Indonesia's REDD+ and FREL developments.

The interviews revealed knowledge-sharing partners' perceptions of how research results and recommendations were delivered and communicated (types of SWAMP policy engagement with stakeholders are summarised in Table 2). Formal discussions and policy events were conducted to communicate policy recommendations developed based on SWAMP research to policymakers and donor agencies. In Indonesia, SWAMPscientists were involved in policy development processes, including drafting sections of some policy and strategic documents. For example, a consultant at a multilateral bank and a SWAMP scientist were part of the team contributing to the development of Indonesia's REDD+ national strategy. This provided opportunities for direct use of SWAMP research-based knowledge and expertise.

Training, informal discussion, joint research and peer review were also identified as ways in which knowledge was transferred. For example, a scientist working for a UK based university collaborated indirectly with SWAMP through the IPCC and exchanged research papers with SWAMP scientists who were also involved in the latest wetlands division guidelines (IPCC 2014). SWAMP included a partnership with the US government research agency that compared SWAMP research methodology with alternative approaches for its assessment of carbon stocks in forested wetlands in Asia.

[2] 697 citations as of May 2017

[3] http://www.ipcc-nggip.iges.or.jp/home/docs/1308_Wetlands_ListOfAuthors.pdf

The next three sub sections present evidence on whether and how SWAMP contributed to three end of programme outcomes that were part of the original design of the SWAMP theory of change: (1) international climate change agreement includes wetlands; (2) donors promote policy on wetlands, and; (3) national governments implement policy to sustain wetlands as part of their climate adaptation and mitigation strategies. In addition, although it was not modelled in the original ToC, there is evidence that the programme contributed to a fourth end of programme outcome: 'local governments implement policy to sustain wetlands as part of their climate adaptation and mitigation strategies'.

Programme outcome 1: international climate change agreement includes wetlands

Although the Paris Agreement does not specify global interventions explicitly related to wetlands, "2013 IPCC Supplement to the 2006 IPCC Guidelines for National Greenhouse Gas Inventories: Wetlands" serves as the main global reference. The sequence of events supports the contention that SWAMP directly contributed to the Supplement as shown in the theory of change (Figure 2).

Global knowledge-sharing partners are aware, use and share SWAMP research

Coalition building improved partners' awareness of research related to wetlands and increased their use of research-based information in their global advocacy and campaigning. For example, SWAMP studies on mangrove forest adaptation and mitigation (Murdiyarso *et al.* 2010a, 2010b, Donato *et al.* 2011) were used in developing an implementation guideline by a representative of a global knowledge-sharing organisation who had been directly informed by SWAMP scientists. Another representative of a global knowledge-sharing organisation, which partnered with SWAMP to develop the SWAMP toolbox, stated that they used the toolbox in projects intended to increase the resilience of coastal communities in Kaimana Papua and also in Ecuador, Philippines, and Costa Rica. This model of co creating knowledge and tools with knowledge users has extended the application of SWAMP knowledge on how to integrate mangrove forest ecosystems and coastal infrastructure internationally. The Global Environment Facility (GEF) funded project on blue forests, for which Indonesia is one of the pilot countries, became an important channel through which the knowledge was transferred to the community level.

Global policymakers and donors increase their focus on the wetland issues

SWAMP and its research partners collaboratively influenced global policy processes in getting the wetland agenda taken up by the IPCC. The combination of interviews and meeting reports shows that SWAMP researchers were actively involved in formal discussions, activities, guidance and expert meetings on wetland issues to improve the awareness by policymakers and donors at the UNFCCC (see Evidence 4.3 in Supplement 1). Knowledge sharing by a SWAMP consultant, who also worked for donors and led a campaign for forest fire prevention in Indonesia, helped improve national policymakers' awareness and use of scientific information on tropical wetlands. At the 2013 UNFCCC Workshop in Bonn, SWAMP scientists and research partners had dialogues about technical and scientific aspects of ecosystems with high carbon reservoirs not covered by other agenda items under the Convention. The workshop note, FCCC/SBSTA/2014/INF.1 (point 54), and its website (http://www.cifor.org/swamp) refers to directly to SWAMP research (CIFOR 2016, UNFCCC 2014). A respondent who works as a representative of a UN body noted that negotiators, especially from the Rain Forest Coalition, stated that they became aware of wetland issues through presentations and submissions of wetland experts at the workshop.

Programme outcome 2: donors promote policies on wetlands

The ToC hypothesised that the research would influence donors to support and promote policies on wetlands. SWAMP improved donors' access to information on wetlands and contributed to improved capacity to understand and use technical wetland issues.. For example, a multilateral donor agency collaborated with SWAMP to publish the Blue Carbon Manual (Evidence 6.2 in Supplement 1). Mangroves and peat lands issue were then advanced in international fora and in pilot countries in a pilot project funded by Global Environment Facility (GEF).

Researchers' capacity developed

SWAMP provided funding for eight doctoral students to conduct studies on tropical peat land ecosystems. The programme aimed to improve research skills, enhance institutional leadership, change personal views and enable researchers to contribute significantly to formal Forest Reference Emission Levels (FREL) reporting. Interviews with these researchers indicated that SWAMP and other studies they were exposed to improved their understanding, and the scientists themselves indicated that SWAMP's contribution was valuable to them (Evidence 4.4. Supplement 1). For example, one scientist reported that she learned about carbon quantification methods for mangrove forest ecosystems and used the science in developing policy at the global level as well as at the national level, namely in Indonesia, Ecuador and the Philippines. Another indicated that SWAMP methods enabled him to incorporate tropical wetland carbon stock estimates in Indonesia's FREL report.

New and additional national/global research on wetlands around the world stimulated

The increased capacity of scientists supported by SWAMP contributed to increased availability of forest wetland studies. SWAMP studies, such as those of below-ground biomass, have produced key knowledge needed by the UNFCCC as acknowledged by the lead researcher at Indonesia's government Forest and Research Agency (Supplement 1, Evidence 4.5). Since the UNFCCC started to discuss wetland issues

in 2008 there has been a significant increase in the number of wetland studies. A Google Scholar search using the key words 'mangrove' and 'CIFOR' found roughly 2,510 studies published on mangrove blue carbon in 2010 to 2017, double the number of studies published in the previous three decades (1980–2009). However, these studies may not all represent CIFOR outputs but potentially include all studies which refer to CIFOR studies or use CIFOR studies as their references.

Researchers promote sustainable wetland policies

Several SWAMP research partners, in their various roles, played important roles in promoting forest wetland issues. For example, one research consultant played a significant role in channelling SWAMP research findings to key government officials. He had been leading a donor agency team preparing a fire prevention policy paper since June 2014, and was campaigning for its adoption by the Government of Indonesia (Supplement 1, Evidence 4.6). A researcher working for UNEP used SWAMP's research findings in UNEP manuals and guidelines, which were launched at the COP 20 in Peru (UNEP and CIFOR 2014). UNEP recommended using these guidelines and manuals when developing activities under a global pilot project funded by GEF.

Research partners directly and indirectly engaged with various private sector and local community actors to promote SWAMP research findings and recommendations. SWAMP research partners at the national government research agency have been influential in Indonesia's Ministry of Environment and Forestry policymaking adopting findings from SWAMP research.

Programme outcome 3: national governments implement policies to sustain wetlands as part of their climate adaptation and mitigation strategies

The research, in combination with some previous events (discussed below), supported Indonesian policymakers to use scientific information on tropical forest wetlands in developing their climate change adaptation and mitigation strategy.

National knowledge-sharing partners are aware of, use and share SWAMP research

SWAMP results and recommendations were disseminated by knowledge-sharing partners ranging from journalists to NGOs (Supplement 1, Evidence 4.7), who became aware of SWAMP research through a series of publications, training such as a capacity-building event for journalists in Vietnam, and the presentations available in the SWAMP Toolbox.[4] The journalist training aims to improve journalists' ability to articulate a clear and simple message related to forest-cover change (Young and Neil 2016). For this kind of training, SWAMP benefits from the improved external capacity built by the Global Comparative Study on REDD+ and CIFOR's Communication and Engagement team.

National knowledge-sharing partners helped deliver information and contributed to policymakers' awareness of research on sustainable wetland management. In Indonesia, SWAMP research was channelled via seconded experts, including SWAMP scientists (Supplement 1, Evidence 4.8). They were assigned to draft official documents such as the REDD+ National Strategy. A SWAMP partnership with technical staff in the FREL working group used SWAMP research as one of its references to calculate Indonesia's FREL.

SWAMP knowledge-sharing partners included national and international media and advocacy organisations. They played an influential role in shaping public and local communities' views. Newspaper articles and social media statements reported on SWAMP research. A researcher who is actively involved in conservation work, research sharing, presentations and information at the local level, used SWAMP resources for his carbon stock assessment.

Government technical staff capacity develop and use their knowledge and research to provide input to national policies

SWAMP designers understood the importance of government technical staff as key knowledge agents and intended to improve their capacity to communicate SWAMP research findings to policy audiences. Our findings show that these expectations have been met; e.g. a member of the technical staff at the government research agency reported that collaborating with SWAMP enabled her institution to conduct below ground biomass calculations using a new sampling technique/design for carbon inventory (Supplement 1, Evidence 4.9). This complemented past studies which focused on above ground biomass inventory. She argued that the collaboration added value in the development of suitable methods aligned to the government's needs.

SWAMP aimed to contribute to national forest policies. Success in this area depends on the relevance and usefulness of the information and on the willingness and ability of government technical staff to use SWAMP research and its recommendations. SWAMP worked with government technical staff at the Indonesian government's Forest Research and Development Agency, which influenced policymakers in the Ministry of Environment and Forestry via its Head of Agency presentation (Supplement 1, Evidence 4.10).

Indonesia's NDC has not included the quantification of carbon stocks from wetlands. However, the legal basis for the NDC has not yet been established and it will only be reported to the UNFCCC by 2020. Therefore, it is too early to assess SWAMP's influence on Indonesia's NDC reporting. SWAMP researchers have been requested by the National Focal Point to the UNFCCC to help revise NDC document to include blue carbon. In addition, SWAMP has been formally invited to develop a national methodology to estimate emissions from drained and burned peat land by the Peatland Restoration Agency (BRG).

[4] The SWAMP Toolbox is its user guide to understanding wetlands ecosystems as carbon reservoirs for climate change adaptation and mitigation strategies (CIFOR 2015).

Unexpected outcomes: SWAMP's influence on local communities and the private sector

SWAMP's main aim, as reflected in the ToC, was to influence national governments and UNFCCC policymaking. However, this study also found evidence of influence on local community and private sector decision-making on the management of tropical wetlands. According to a SWAMP research partner, knowledge obtained from collaborating with SWAMP researchers was used to inform climate adaptation and mitigation strategies for local community development. Another researcher who worked as a consultant for SWAMP integrated sustainable practices into private-sector approaches to building coastal infrastructure and development (Supplement 1, Evidence 4.6). Local communities and local governments have also received scientific information generated by SWAMP through an international organisation which acknowledges the importance of these actors in the management of tropical wetlands (see Supplement 1, Evidence 4.2).

The role of research and other factors contributing to policy change

There are limits to which a research programme can be expected to contribute to policy change. At the UNFCCC level, while research has provided a strong push to have forest wetlands considered more fully in climate change discussions, other factors, such as politics, may dominate. Evidence shows that the use of SWAMP research was facilitated by good and long standing relationships between the lead researchers in SWAMP and several influential institutions that helped deliver research recommendations to policymakers. But the interviews also pointed to many other factors, including political pressures, financial considerations, and time constraints, that influenced the policy process. To date, UNFCCC negotiators have not gone beyond discussing the findings of the research, likely due to these other considerations. A director at a conservation NGO explicitly mentioned that research is a weak contributing factor to policymaking compared to the other factors.

At the national level, our respondents in Indonesia noted that the main area of policy influence was through scientific advancement in measuring carbon storage and flux in wetlands. Using these new techniques, some stakeholders have begun to realise the true economic and ecosystem value of wetlands in climate change mitigation and adaptation, and the climate risks that countries face when these are converted for other uses.

THEORETICAL REFLECTION: THE SCIENCE-POLICY INTERFACE

This case study provides insight into the mechanisms by which science-based knowledge contributes to change. The default model in science communication has been a knowledge deficit model, the idea that gaps in our knowledge can be filled by science, leading to improved outcomes. van Kerkhoff and Lebel (2006) refer to this as the "trickle down" model, which holds that good research will be taken up without additional effort by researchers. The related "transfer and translate" model (van Kerkhoff and Lebel 2006) recognises that effort may be needed to translate technical knowledge for lay use. These concepts are not altogether wrong; depending on the stage or maturity of any issue, research may be needed to identify the issue, understand cause and effect mechanisms or develop responses (Tomich *et al*. 2004). The SWAMP ToC clearly made contributions of this kind, with focused effort to fill a knowledge gap by developing tools to quantify GHG emissions and carbon stocks in tropical wetlands (that others could apply) and by quantifying GHG emissions and monitoring changes in carbon stocks due to LULUCF. This knowledge was effectively shared through traditional scientific communications channels. SWAMP also employed deliberate efforts to target communications to key audiences. The assessment shows that this approach did influence the wetlands research agenda and policy discourse.

However, the linear model is increasingly challenged, with a strong recognition that the arenas of science and policy are not fully separated. New approaches posit that scientists and science organizations can increase the effectiveness of their work by changing the way they define, answer and communicate their research, with much greater emphasis in recent years on engagement, boundary crossing and knowledge brokering (Turnhout 2018, Shaxson *et al.* 2012, Belcher *et al.* 2016). The SWAMP ToC used deliberate engagement strategies to share knowledge and build capacity, with some examples of co-generation of knowledge (Schuttenberg and Guth 2015), though mainly with other scientists. As noted in the results, there was also considerable influence of scientists as experts, where the knowledge, expertise and reputation of individual SWAMP scientists, collaborating scientists, and their organizations, resulted in opportunities to engage directly in policy processes.

Some authors go further (Jasanoff 2004), challenging the truth claims of scientists and arguing for inclusion of other types of knowledge in the research process. This case did not involve that level of engagement.

CONCLUSION

The outcome assessment approach applied in this case study provided a useful framework for analysing whether and how SWAMP influenced sustainable wetland management policy discourse. The theory of change identified the main pathways and processes by which the research was expected to contribute to change. Evidence from the study shows that SWAMP influenced the development of strategies and technical methods of sustainable wetland management policy in Indonesia and in the UNFCCC. This was achieved through active engagement of SWAMP researchers in key national and global policy events and through a variety of highly cited and influential articles that are tailored to be accessible and useful to key audiences.

There is evidence that these SWAMP activities have contributed to the achievement of three programme outcomes: the inclusion of wetlands in the international climate change technical guidance but the effect is not sufficiently strong for wetlands to be included in the Paris agreement and for mangroves to be included in Indonesia's NDC; the promotion of wetland-related policies by donors; and, although there is limited evidence for this, the implementation of policies to sustain wetlands as part of Indonesia's climate adaptation and mitigation strategies.

In addition to answering whether SWAMP contributed effectively, the interviews and document reviews revealed various means and mechanisms of programme influence. Direct interactions with policy actors and policy processes proved to be particularly important. Engagement through, for example, assignments of writing formal documents on wetlands to SWAMP scientists, joint research with government technical staff, and presentations to expert meetings organised by policymaking bodies, were partly anticipated in the SWAMP ToC. However, the ToC did not anticipate the high level (and highly influential) direct involvement of SWAMP researchers in negotiating and drafting committees. Some scientists also actively engaged with audiences outside the original scope of SWAMP such as with local communities and private sector actors in coastal zones which led to unexpected positive influence of SWAMP at that scale.

Beyond the end of programme outcomes, research can, at best, influence processes. It is clear that SWAMP's efforts alone have not generated the level of change required to achieve sustainable forest wetland management. Forestry-focused research generated by SWAMP is one of many sources of information and influence.

In summary, what lessons can policy-relevant forest research projects learn from SWAMP's experience of influencing policy? Our study reinforces the importance of using a variety of mechanisms to communicate research and to engage with policy processes. Peer-reviewed journal publications remain crucial to the verification of the scientific credibility of the work, and are an important means of reaching researchers and technical staff. Policy briefs and other more popular summaries of research results and recommendations can extend the reach of research and help influence policy audiences. Materials translated into local languages help to communicate research to inform specific communities. CIFOR's media training for journalists plays an important role in translating scientific knowledge into information understood by the general public. In this case, national-level policy engagement event has helped to mainstream research findings to many key stakeholders, including government agents.

For relevant research findings that match the needs of policy development, engagement with policymakers prior to beginning the research is necessary. A research programme can also play an important convening role for stakeholders working in the field, including private sector, local government and local community actors. The SWAMP work succeeded to the degree that it did because it produced good, relevant and timely research but also because the scientists made efforts to communicate and share their results to key audiences and took active roles, in various ways, in the relevant policy development venues.

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APPENDIX 1. LIST OF SWAMP PUBLICATIONS

	Publication	Form(s)	Audience	Platform
1.	Carbon stocks of mangroves and losses arising from their conversion to cattle pastures in the Pantanos de Centla, Mexico. Publication Year: 2015. Authors: Kauffman, J.B.; Trejo, H.H.; Jesus Garcia, M. del Carmen; Heider, C.; Contreras, W.M.	Research article	Open to research community, policy and donor agencies	CIFOR website, FAO website, semantics scholar website, research gate
2.	Indonesia's blue carbon: a globally significant and vulnerable sink for seagrass and mangrove carbon. Publication Year: 2015. Authors: Alongi, D.M.; Murdiyarso, D.; Fourqurean, J.W.; Kauffman, J.B.; Hutahaean, A.; Crooks, S.; Lovelock, C.E.; Howard, J.; Herr, D.; Fortes, M.; Pidgeon, E.; Wagey, J.	Research article	Open to research community	CIFOR website, EBSCO, the blue carbon innitiative, Wetlands Ecology and Management
3.	The potential of Indonesian mangrove forests for global climate change mitigation. Publication Year: 2015. Authors: Murdiyarso, D.; Purbopuspito, J.; Kauffman, J.B.; Warren, M.W.; Sasmito, S.D.; Donato, D.C.; Manuri, S.; Krisnawati, H.; Taberina, S.; Kurnianto, S.	Research article	Open to research community	Nature, research gate, Harvard University website, Oregon State University website, CGIAR Space Repository
4.	Carbon stocks of mangroves within the Zambezi River Delta, Mozambique. Publication Year: 2015. Authors: Stringer, C.E.; Trettin, C.C.; Zarnoch, S.J.; Tang, W.	Research article	Open to research community	CIFOR wesbite, USDA, FAO, Semantic scholar, TIB library, CGIAR Space Repository
5.	Imaging tropical peatlands in Indonesia using ground penetrating radar (GPR) and electrical resistivity imaging (ERI): implications for carbon stock estimates and peat soil characterisation. Publication Year: 2015. Authors: Comas, X.; Terry, N.; Slater, L.; Warren, M.; Kolka, R.; Kristijono, A.; Sudiana, N.; Nurjaman, D.; Darusman, T.	Research article	Research community	Biogeosciences, CIFOR website, USDA, Semantic scholar
6.	Carbon accumulation of tropical peatlands over millennia: a modeling approach Publication Year: 2015. Authors: Kurnianto, S.; Warren, M.; Talbot, J.; Kauffman, B.; Murdiyarso, D.; Frolking, S.	Research article	Research community	Global Change Biology, Semantic scholar, Oregon State University Library
7.	SWAMP: Sustainable Wetlands Adaptation and Mitigation Program. Publication Year: 2014. Author: CIFOR	Project report	Donors and stakeholders	CIFOR website, climate links website

	Publication	Form(s)	Audience	Platform
8.	Guiding principles for delivering coastal wetland carbon projects. Publication Year: 2014. Authors: UNEP and CIFOR	Guiding document and brief	Project implementing agencies	CIFOR website, Europa website
9.	Coastal blue carbon: methods for assessing carbon stocks and emissions factors in mangroves, tidal salt marshes, and seagrasses. Publication Year: 2014. Authors: Howard, J.; Hoyt, S.; Isensee, K.; Telszewski, M.; Pidgeon, E.; eds	Guiding document	Project implementing agencies	CIFOR website, Blue Carbon Innitiative Website
10.	Tree biomass equations for tropical peat swamp forest ecosystems in Indonesia. Publication Year: 2014. Authors: Manuri, S.; Brack, C.; Nugroho, N.P.; Hergoualc'h, K.; Novita, N.; Dotzauer, H.; Verchot, L.V.; Putra, C.A.S.; Widyasari, E.	Research article	Research community	Forest Ecology and management, Academia.edu, research gate,
11.	Exploring the relationship between peatland net carbon balance and apparent carbon accumulation rate at century to millennial time scales. Publication Year: 2014 Authors: Frolking, S.; Talbot, J.; Subin, Z.M.	Research article	Research community	The Holocene, CGIAR Space Repository
12.	Major atmospheric emissions from peat fires in Southeast Asia during non-drought years: evidence from the 2013 Sumatran fires. Publication Year: 2014 Authors: Gaveau, D.L.A.; Salim, M.A.; Hergoualc'h, K.; Locatelli, B.; Sloan, S.; Wooster, M.; Marlier, M.E.; Molidena, E.; Yaen, H.; DeFries, R.; Verchot, L.; Murdiyarso, D.; Nasi, R.; Holmgren, P.; Sheil, D.	Research article, presentation slide	Research community	Nature, National Center for Biotechnology Information, U.S. National Library of Medicine, GOFC website, research gate, Academia.edu, Norwegian University of Life Sciences website
13.	Assessment of biomass and carbon of mangroves in West Africa: USAID Final Report. Publication Year: 2014. Authors: Tang, W.; Feng, W.; Jia, M.; Zuo, H.	Project report	Donors and stakeholders	CIFOR website, USDA, research gate
14.	Carbon accumulation of tropical peatlands over millennia: a modeling approach. Publication Year: 2014. Authors: Kurnianto, S.; Warren, M.; Talbot, J.; Kauffman, B.; Murdiyarso, D.; Frolking, S.	Research article	Research community	Global Change Biology, CIFOR website, National Center for Biotechnology Information (NCBI), research gate, semantic scholar, CGIAR Space Repository, Digital science
15.	Carbon stocks of intact mangroves and carbon emissions arising from their conversion in the Dominican Republic. Publication Year: 2014. Authors: Kauffman, J.B.; Heider, C.; Norfolk, J.; Payton, F.	Research article	Research community	Ecological Application, NCBI, research gate, UNFCCC
16.	*Protocolo para la medición, monitoreo y reporte de la estructura, biomasa y reservas de carbono de los manglares.* Publication Year: 2013. Authors: Kauffman, J.B.; Donato, D.C.; Adame, M.F.	CIFOR working paper	Spanish speaking research community	CIFOR website
17.	Changes in soil CH4 flux from the conversion of tropical peat swamp forests: a meta-analysis. Publication Year: 2012. Authors: Hergoualc'h, K.; Verchot, L.V.	Research article	Research community	Journal of Integrative Environmental Sciences, CGIAR publication,
18.	Comparison of methods for quantifying soil carbon in tropical peats. Publication Year: 2013. Authors: Farmer, J.; Matthews, R.; Smith, P.; Langan, C.; Hergoualc'h, K.; Verchot, L.; Smith, J.U.	Research article	Research community	Geoderma, GCIAR publication, research gate,
19.	Climate change mitigation strategies should include tropical wetlands. Publication Year: 2013. Authors: Murdiyarso, D.; Kauffman, J.B.; Verchot, L.V.	Research article	Research community	Carbon Management, CIFOR website, research gate, CGIAR Space Repository

Publication	Form(s)	Audience	Platform
20. Greenhouse gas emission factors for land use and land-use change in Southeast Asian peatlands. Publication Year: 2013. Authors: Hergoualc'h, K.; Verchot, L.V.	Research article	Research community	Mitigation and Adaptation Strategies for Global Change, CIFOR, research gate
21. Conversion of intact peat swamp forest to oil palm plantation: Effects on soil CO2 flux in Jambi, Sumatra. Publication Year: 2013. Authors: Comeau, L; Hergoualc'h, K.; Smith, J.U.; Verchot, L.	CIFOR working paper	Research community and stakeholders	CIFOR website, research gate, CGIAR Publication
22. Carbon Stocks of Tropical Coastal Wetlands within the Karstic Landscape of the Mexican Caribbean. Publication Year: 2013. Authors: Adame, M.F.; Kauffman, J.B.; Medina, I.; Gamboa, J.N.; Torres, O.; Caamal, J.; Reza, M.; Herrera-Silveira, J.A.	Research article	Research community	PLOS One, NCBI, biogeosciences, Climate Links
23. Mapping global tropical wetlands from earth observing satellite imagery. Publication Year: 2012. Author: Gumbricht, T.	CIFOR working paper	Research community	CIFOR website, Research gate
24. A cost-efficient method to assess carbon stocks in tropical peat soil. Publication Year: 2012. Authors: Warren, M.W.; Kauffman, J.B.; Murdiyarso, D.; Anshari, G.; Hergoualc'h, K.; Kurnianto, S.; Purbopuspito, J.; Gusmayanti, E.; Afifudin, M.; Rahajoe, J.; Alhamd, L.; Limin, S.; Iswandi, A.	Research article	Research community	CIFOR website, biogeosciences, Research gate, Penn State University,
25. Estimating Global 'Blue Carbon' Emissions from Conversion and Degradation of Vegetated Coastal Ecosystems. Publication Year: 2012. Authors: Pendleton, L.; Donato, D.C.; Murray, B.C.; Crooks, S.; Jenkins, W.A.; Sifleet, S.; Craft, C.; Fourqurean, J.W.; Kauffman, J.B.; Marbà, N.; Megonigal, P.; Pidgeon, E.; Herr, D.; Gordon, D.; Baldera, A.	Research article	Research community	PLOS One, NCBI, Smithsonian Libraries, semanticscholar, CGIAR Publication, Forest trends,
26. Tropical wetlands for climate change adaptation and mitigation: science and policy imperatives with special reference to Indonesia. Publication Year: 2012. Authors: Murdiyarso, D.; Kauffman, J.B.; Warren, M.; Pramova, E.; Hergoualc'h, K.	CIFOR working paper	Research community and stakeholders	CIFOR website, Climate Links
27. Introduction: Tropical wetlands for climate change adaptation and mitigation: Science and policy imperatives with special reference to Indonesia. Publication Year: 2012. Authors: Warren, M.; Murdiyarso, D.; Kauffman, J.B.	Research article and CIFOR working paper	Research community and stakeholders	CIFOR website, CGIAR Space Repository
28. Greenhouse gas flux and flux changes from land-use dynamics in tropical wetlands. Publication Year: 2012. Authors: Cobb, A.; Agus, F.; Warren, M.; Applegate, G.; Ryan, Z.; Engel, V.; Handayani, E.P.; Hooijer, A.; Husen, E.; Jauhiainen, J.; Kawaroe, M.; Kusmana, C.; Naito, R.; Osaki, M.	CIFOR working paper	Research community and stakeholders	CIFOR website, CGIAR Space Repository
29. Ecosystem carbon stocks and land-use and land-cover change in tropical wetlands. Publication Year: 2012. Authors: Warren, M.; Kauffman, B.; Agus, C.; Anas, I.; Anshari, G.; D'Arcy, L.; Garnier, F.; Hadriyanto, D.; Saharjo, B.H.; Husson, S.; Dharmawan, I.W.S.; Krisnawati, H.; Maswar; Matanubun, H.; Naito, R.; Persch, S.; Rahayu, N.H.; Ryan, Z.; Siran, S.A.; Solichin;	Research report	Research community	Wageningen University & Research

Publication	Form(s)	Audience	Platform
30. Ecosystem modelling of tropical wetlands. Publication Year: 2012. Authors: Hergoualc'h, K.; Frolking, S.; Canadell, P.; Crooks, S.; Harrison, M.; Joosten, H.; Kurnianto, S.; Yeager, C.	Research report	Research community	University of New Hampshire, CGIAR Space Repository
31. The use of remote sensing to monitor landuse and land-cover change in tropical wetlands. Publication Year: 2012. Authors: Herold, M.; Rahman, F.; Rossé, M.; Sugardiman, R.; Segah, H.; Rush, B.; Fatoyinbo, T.; Siegert, F.; Nursal, W.; Hirata, Y.; Romijn, E.; Hutabarat, J.; Miettinen, J.; Rumapea, M.; Fauzana; Hirose, K.; Suratno, A.; Ridarso, E.; Fisher, M.	Research report	Research community	Wageningen University & Research, CGIAR Space Repository
32. Revisiting the wetlands chapter in the 2006 IPCC Guidelines. Publication Year: 2012 Authors: Murdiyarso, D.; Swickard, N.; Crooks, S.; Emmer, I.; Ginoga, K.; Verchot, L.; Bonneau, X.	Research report	Research community	CGIAR Space Repository
33. Human dimensions and the roles of tropical wetlands in adaptation to climate change. Publication Year: 2012; Authors: Pramova, E.; Hills, T.; Widyati, E.; Santoso, H.; Purbopuspito, J.; Syaufina, L.; Sakuntaladewi, N.; Duke, N.C.; Sukardjo, S.; Adiwibowo, A.; Kholibrina, C.R.	Research report	Research community	CGIAR Space Repository
34. The way forward. Publication Year: 2012. Authors: Pramova, E.; Murdiyarso, D.	Research report	Research community	CGIAR Space Repository
35. Whole-island carbon stocks in the tropical Pacific: Implications for mangrove conservation and upland restoration. Publication Year: 2012. Authors: Donato, D.C.; Kauffman, J.B.; Mackenzie, R.A.; Ainsworth, A.; Pfleeger, A.Z.	Research article	Research community	Journal of Environmental Management
36. *Mangrove adalah salah satu hutan terkaya karbon di kawasan tropis.* Publication Year: 2012. Authors: Donato, D.; Kauffman, J.B.; Murdiyarso, D.; Kurnianto, S.; Stidham, M.; Kanninen, M.	CIFOR Info brief	Indonesian general public	CIFOR website, Universitas Sumatra Utara
37. *Rung ngap man trong nhung kieu rung giàu tru luong các-bon nhat o vùng nhiet doi.* Publication Year: 2012. Authors: Donato, D.; Kauffman, J.B.; Murdiyarso, D.; Kurnianto, S.; Stidham, M.; Kanninen, M.	CIFOR Info brief	Vietnamese general public	CIFOR website
38. Protocols for the measurement, monitoring and reporting of structure, biomass and carbon stocks in mangrove forests. Publication Year: 2012. Authors: Kauffman, J.B.; Donato, D.	CIFOR working paper	Spanish speaking research community and stakeholders	CIFOR website
39. *Giai quyet van de thích ung và giam nhe tác dong cua bien doi khí hau o các he sinh thái dam lay nhiet doi In-dô-nê-si-a.* Publication Year: 2012. Authors: Murdiyarso, D.; Kauffman, J.B.	CIFOR Info brief	Vietnamese speaking research community and stakeholders	CIFOR website
40. Addressing climate change adaptation and mitigation in tropical wetland ecosystems of Indonesia. Publication Year: 2011. Authors: Murdiyarso, D.; Kauffman, J.B.	CIFOR Info brief	Global research community and stakeholders	CIFOR website
41. Stocks and flux of carbon associated with land use change in Southeast Asian tropical peatlands: A review. Publication Year: 2011. Authors: Hergoualc'h, K.; Verchot, L.V.	Research article	Global research community	Global Biogeochemical Cycles, CIFOR website, ICBM

Publication	Form(s)	Audience	Platform
42. Mangroves among the most carbon-rich forests in the tropics. Publication Year: 2011. Authors: Donato, D.; Kauffman, J.B.; Murdiyarso, D.; Kurnianto, S.; Stidham, M.; Kanninen, M.	Research article	Global research community	Nature, CIFOR website, research gate, USDA Forest Service, Science Daily, Forest trends, Dimensions, Script.org
43. Opportunities for reducing greenhouse gas emissions in tropical peatlands. Publication Year: 2010. Authors: Murdiyarso, D.; Hergoualc'h, K.; Verchot, L.V.	Research article	Global research community	PNAS, semantic scholar
44. Carbon storage in mangrove and peatland ecosystems: a preliminary account from plots in Indonesia. Publication Year: 2010. Authors: Murdiyarso, D.; Donato, D.; Kauffman, J.B.; Kurnianto, S.; Stidham, M.; Kanninen, M.	CIFOR Working paper	Global research community and stakeholders	CIFOR website