

18 November 2025

Dear Dr. Steven Bouillon and all the editors,
Biogeosciences

5 We are sincerely grateful for the opportunity to resubmit our revised manuscript entitled
“Estimation of Particulate Organic Carbon Export to the Ocean from Lateral Degradations of Tropical Peatland
Coasts”
for further consideration in *Biogeosciences*.

10 We would like to express our deepest appreciation to you and the reviewers for your continued time, effort, and
insightful evaluations through each round of review. We are truly thankful for the opportunity to revise our manuscript
once again following the third major revision, and for the constructive comments that have greatly guided us in
improving the scientific quality and clarity of our work.

15 In this revision, we are deeply grateful to the reviewers for their specific and thoughtful comments, which have allowed
us to further refine and polish the manuscript. A detailed, point-by-point response is provided below.

We sincerely appreciate your continued consideration and the reviewers’ dedication in evaluating our work. We hope
that the revised version meets the journal’s standards and expectations, and we remain open to any further suggestions
20 that could enhance the manuscript.

With our deepest gratitude and best regards,

Hiroki Kagawa

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My point-by-point responses are as follows:

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Additional private note

35 Although the authors have invested considerable effort in revising the manuscript, it still lacks an in-depth discussion of the mechanisms underlying PMMs and the particulate organic carbon (POC) fluxes associated with these events, which are critical to understanding their role in the carbon cycle. The Results and Discussion section reads largely as a description of results, and a substantial portion of the discussion is not directly supported by the authors' own data. I believe the manuscript requires further revision before it can be accepted. In light of these concerns, I suggest that the editor review the manuscript carefully prior to reaching a final decision.

Response1.

40 To further clarify the mechanism of lateral degradations driven by coastal erosion and PMMs, we acknowledge that Sections 4.1–4.4 have collectively demonstrated how these two processes interact to produce progressive lateral retreat. Building on these results, we agree with the reviewer that a more explicit conceptual explanation of how particulate organic carbon (POC) is directly exported to the ocean would greatly strengthen the manuscript.

45 Therefore, following Figure 15 in Section 4.4, we propose to add one additional conceptual diagram as the new Figure 16, specifically designed to illustrate the stepwise mechanism leading to direct POC export from tropical coastal peatlands.

In Section 4.2, we identified the timing of peat mass movements (PMMs) and described the dominant triggering factors—namely, prolonged heavy rainfall followed by channel breaching. This sequence, which we reconstructed using field evidence and remote-sensing analyses, provides a coherent storyline for PMM initiation. However, we recognize that the detailed physical mechanisms governing PMMs in tropical coastal peatlands remain an important research question that requires further investigation. As our research team is currently conducting ongoing studies to elucidate the PMM failure processes in these systems, we refrain from presenting premature mechanistic interpretations in this manuscript.

55 Nonetheless, to contextualize the relevance of PMMs to carbon mobilization, we refer to previous findings from boreal peatlands showing that PMM events “cause substantial losses of peat and associated carbon”, which supports the interpretation that similar processes may contribute to significant POC mobilization in tropical systems as well.

Although the full mechanistic understanding of PMM initiation is outside the scope of this article, it is possible—and scientifically justified—to conceptualize the downstream process through which peat debris and POC are transported directly to the ocean following PMM occurrence. Accordingly, we have prepared a new conceptual diagram (Figure 16) that synthesizes our results together with key insights from Yamamoto et al., 2019a. A detailed explanation of the processes represented in Figure 16, as well as the proposed caption, is provided in the table below in the revised manuscript.

60 We hope that this addition will address the reviewer's concern and improve the clarity of the manuscript.

L565 Added after the second major revision

L555-L564

Peat failures in boreal peatlands are known to cause substantial losses of peat and associated carbon (Evans and Warburton, 2007). When a landslide occurs, large volumes of organic-rich peat and mineral sediments are mobilized and transported downslope or into adjacent watercourses, resulting in significant carbon export from the peatland system. These failures therefore represent an important pathway for the removal and displacement of peat materials from the landscape.

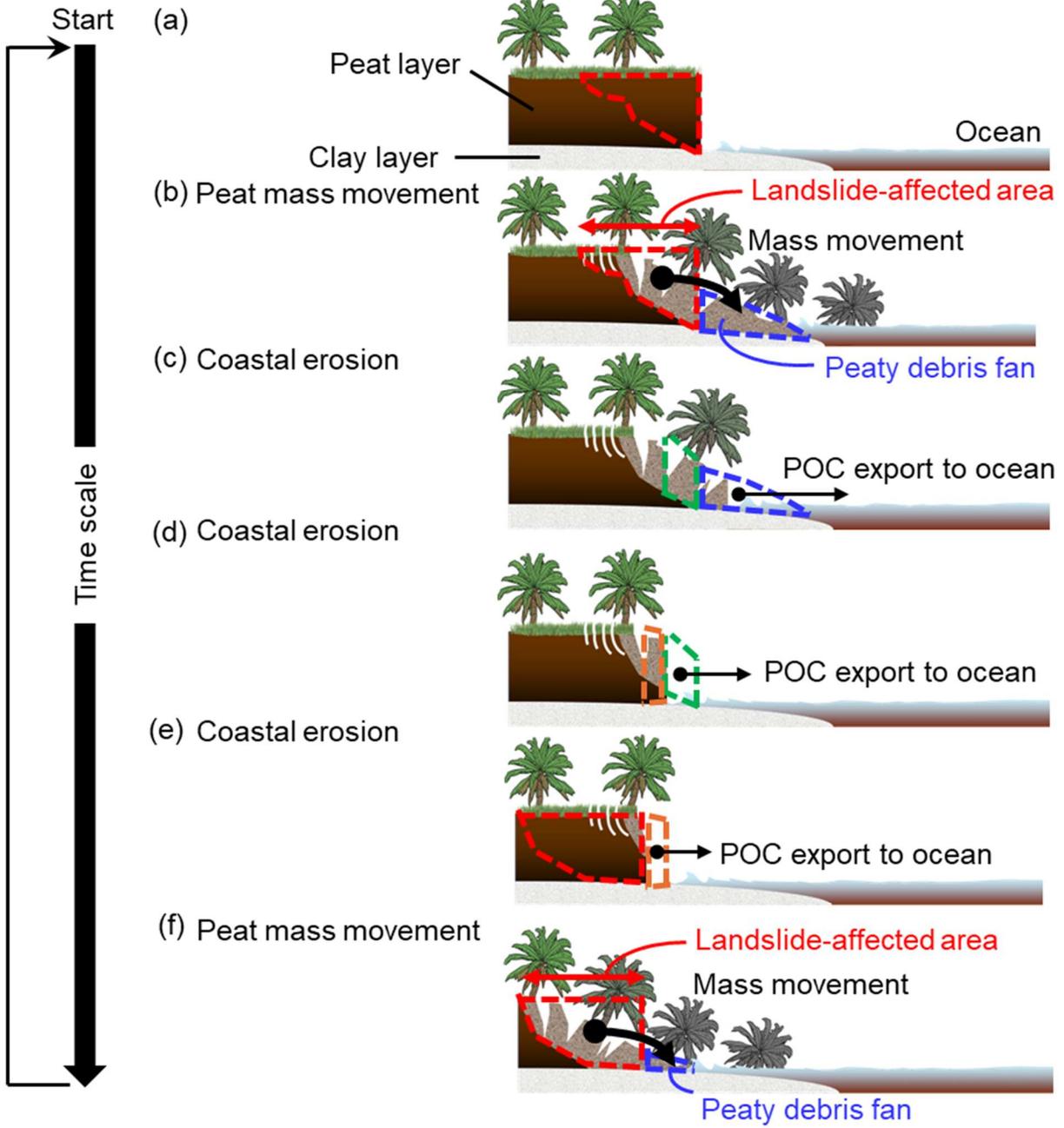
Fig. 16 summarizes the overall sequence of lateral degradation processes occurring along tropical peatland coasts. The process begins with the loss of mangrove belts, which reduces wave attenuation and promotes coastal erosion, ultimately leading to the formation of peat cliffs. Once a peat cliff develops, surface tearing at the head scarp can initiate a PMM, forming a peaty debris fan that extends seaward. Subsequent erosion of both the debris fan and the landslide-affected area results in the direct export of POC to the ocean (Yamamoto et al., 2019a). As erosion continues, the coastal peat cliff is gradually rebuilt, eventually allowing another PMM to occur and thereby completing a cyclic pattern of lateral degradation.

Caption

Figure 16: Conceptual diagram illustrating the lateral degradation processes in tropical peatlands. (a) shows the conditions around the 1960s, when the loss of mangrove belts reduced wave attenuation and initiated coastal erosion, resulting in the formation of peat cliffs. (b) illustrates a peat mass movement (PMM) triggered at the head scarp, where surface tears developed and a peaty debris fan extended seaward. Subsequent stages (c)–(e) depict the progressive erosion of the debris fan and the landslide-affected zone, leading to the direct export of particulate organic carbon (POC) to the ocean. (f) shows the stage at which the coastal peat cliff has been rebuilt by ongoing erosion, allowing a new PMM to occur and thereby completing the cyclic process of lateral degradation.

Schematic illustration of morphological changes in coastal peatlands

■ : Peat (carbon) / sediment loss



65 Figure 16

RC2 Suggestions for revision or reasons for rejection:

RC2-Suggestion1. Line 18: I noticed that the authors use ha as the land area unit throughout the manuscript. I recommend converting this to the International System of Units (SI), especially since volumes are reported in m³.

RC2-Response1.

70 Thank you very much for this constructive comment that will help improve the quality and clarity of the manuscript. As you correctly pointed out, the manuscript used both the International System of Units (SI) and hectares (ha), which resulted in inconsistencies. We sincerely apologize for not fully adhering to the SI unit recommendation stated in the author guidelines.

In the revised manuscript, all values currently expressed in hectares (ha) will be converted and standardized to square meters (m²) to ensure complete consistency with the SI system. We appreciate your careful reading of our manuscript and will

75 make these corrections throughout the text.

RC2-Suggestion2. Line 57: This paragraph should be combined with the preceding paragraph.

RC2-Response2.

Thank you very much for this constructive comment that will help improve the manuscript. As you pointed out, the sentence at line 57 was not fully consistent with the preceding paragraph. In the revised manuscript, we will revise the text to ensure

80 full coherence and consistency between line 57 and the previous paragraph. We appreciate your careful reading and will make the necessary corrections accordingly.

RC2-Suggestion3. Line 61: Please add references.

RC2-Response3.

Thank you very much for giving us the opportunity to revise the manuscript. After submission, we noticed that some references

85 had been unintentionally omitted. We sincerely appreciate your comment, which allowed us to correct this issue.

In the revised manuscript, we will add the missing references, including those cited in Appendix A, which should have been included in the main reference list. In addition to addressing your comment, we will clearly indicate in the text that these references are described in Appendix A.

Furthermore, we also confirmed that the citation of Mandanici and Bitelli (2016) in Appendix D had been omitted

90 from the reference list. We will add this reference as well to ensure completeness and consistency.

We appreciate your careful reading and will make all necessary corrections.

RC2-Suggestion4. Table 1: This table should be moved to the Supplement, as it is not well explained in the manuscript. The authors should then rephrase lines 46–48 accordingly.

RC2-Response4.

95 Thank you very much for this constructive comment aimed at improving the structure of the manuscript. We agree with your observation, and incorporating your suggestions will allow us to streamline the Introduction, which had become excessively long. In the revised manuscript, we will reorganize and condense the Introduction to enhance clarity and conciseness while maintaining all essential background information. We appreciate your thoughtful guidance and will reflect your recommendations accordingly.

100 **RC2-Suggestion5. Materials and Methods section (pages 8–20): I recommend moving parts of the Materials and Methods to the Supplementary Material. The main text could contain a concise summary of the Materials used in this study, with detailed descriptions placed in the Supplement. For example, sections 3.1.1 to 3.1.5 could be moved, along with their associated tables and figures, to avoid providing unnecessary detail in the main manuscript.**

RC2-Response5.

105 Thank you very much for this constructive comment. As you correctly pointed out, some of the materials and methods used exclusively in the appendices were inadvertently mixed with those described in the main text. In the revised manuscript, we will clearly reorganize and separate the materials and methods used in the main sections from those used in the appendices to avoid confusion and ensure a more coherent structure.

Your comment has helped us significantly improve the clarity and organization of the manuscript. Thank you again
110 for your valuable suggestion.

2 nd Major revision	3 rd Major revision
<p>L137-L211</p> <p>3.1.2 Landsat data</p> <p>In this study, multispectral Landsat series images, including Landsat 5 Thematic Mapper (TM) and Landsat 8 Operational Land Imager (OLI), were used. Landsat 5 TM images captured on 2 February 2010 were used to delineate coastal erosion and areas affected by landslides. Additionally, Landsat 5 TM imagery was used to extract bare lands. Landsat 5 TM was launched in March 1984 and carries a Multispectral Scanner Subsystem (MSS) and a TM onboard (USGS and NOAA, 1984). TM has improved the</p>	<p>L175-L246</p> <p>3.1.2 Landsat data</p> <p>In this study, multispectral Landsat series images, including Landsat 5 Thematic Mapper (TM) was used. Landsat 5 TM images captured on 2 February 2010 were used to delineate coastal erosion and areas affected by landslides. Additionally, Landsat 5 TM imagery was used to extract bare lands. Landsat 5 TM was launched in March 1984 and carries a Multispectral Scanner Subsystem (MSS) and a TM onboard (USGS and NOAA, 1984). TM has improved the spectral, radiometric, and spatial resolutions relative to</p>

<p>spectral, radiometric, and spatial resolutions relative to MSS. Landsat 8 OLI images from 9 March 2017 to 19 February 2022 were used. Landsat 8 was launched in 2013 and provides high-quality multispectral images at a resolution of 30 m and a revisiting time of 16 days. It aims to provide data continuity to the Landsat Earth observation program, started in the 1970s. These Landsat series data were downloaded from the USGS EarthExplorer (https://earthexplorer.usgs.gov/), and the cloud cover in the collected images was 0%.</p> <p>3.1.4 Sentinel-2 data</p> <p>Sentinel-2 multispectral imagery captured on 22 March 2017, was used for land cover classification. Sentinel-2B provides 13 bands of multispectral imaging at a resolution of 10 m. Sentinel-2B was launched on 7 March 2017. Part of a European fleet of satellites aimed at delivering core data to the European Commission's Copernicus programme, a programme whose services address six thematic areas: land, marine, atmospheric, climate change, emergency management, and security. In a sun-synchronous orbit at a mean altitude of 786 km above the Earth's surface, MSI samples 13 spectral bands in the visible-near infrared (VNIR) and short-wave infrared (SWIR) spectral range at three different spatial resolutions (10, 20, and 60 m) and allows for a 290 km swath width with a high revisit frequency of 10 days. Data were obtained from USGS EarthExplorer (https://earthexplorer.usgs.gov/).</p>	<p>MSS. These Landsat series data were downloaded from the USGS EarthExplorer (https://earthexplorer.usgs.gov/), and the cloud cover in the collected images was 0%.</p> <p>Move to Appendix Appearance Section 3.1.4</p>
<p>Table 3</p>	<p>Table 2</p>

Image acquisition	Data source	Resolution (m)	Bands used	Image acquisition	Data source	Resolution (m)	Bands used
22/10/2014~	Sentinel-1	5×20	C-band	22/10/2014~	Sentinel-1	5×20	C-band
30/03/2018				30/03/2018			
05/01/2018~				05/01/2018~			
08/01/2022				08/01/2022			
17/12/2014	UAV-based orthomosaic	0.494	-	17/12/2014	UAV-based orthomosaic	0.494	-
10/01/2015		0.1	-	10/01/2015		0.1	-
5/3/2016		0.086	-	5/3/2016		0.086	-
04/03/2017		0.285	-	04/03/2017		0.285	-
29/07/2018		1	-	29/07/2018		1	-
5/11/2019		0.5	-	5/11/2019		0.5	-
02/02/2010	Landsat5	30	Red/Green/Blue/NIR/SWIR1	02/02/2010	Landsat5	30	Red/Green/Blue/NIR/SWIR1
23/07/2011	Google Earth	-	Panchromatic	23/07/2011	Google Earth	-	Panchromatic
18/09/2013	SPOT-6	6	Red/Green/Blue	18/09/2013	SPOT-6	6	Red/Green/Blue
02/04/2015	WorldView-3	1.24	Red/Green/Blue	02/04/2015	WorldView-3	1.24	Red/Green/Blue
09/03/2017	Landsat8	30	Red/Green/Blue/NIR	04/03/2017	UAV DSM	0.285	-
03/10/2017~				29/07/2018		1	-
19/02/2022				2013		DEMNAS	8
03/10/2017~	Sentinel-2	10	Red/NIR/SWIR1				
19/02/2022							
04/03/2017	UAV DSM	0.285	-				
29/07/2018		1	-				
2013	DEMNAS	8	X-band/L-band				

115 **RC2-Suggestion6. Line 587: Please rephrase. I believe the intent is to point out that the environment becomes more anoxic with depth due to the saturation of seawater. Following depth from the surface downward, conditions become progressively more anoxic. Please also find a suitable reference to support this statement. I also have difficulty following the authors’ point here: according to Figure 16, OC concentration generally decreases below ~1 m depth, but OC is still present, so the cumulative OC stock should increase. Please clarify what is meant by “cumulative OC content,” as this is not reflected in the figure. In profile P02, OC concentration increases at 2 m depth, yet dry density also increases at this depth; thus, this cannot be explained solely by oxic conditions associated with water presence. The compression of soils is not reflected in other depths. Given that the paper focuses on OC stock and lateral flux rather than mechanisms of OC preservation, I recommend removing the explanation of possible mechanisms for OC variation with depth.**

RC2-Response6.

125 Thank you very much for pointing out the aspects of Figure 16 that may have caused misunderstanding. We recognize that the original presentation could unintentionally lead to misinterpretation, and we appreciate the opportunity to clarify and revise it. Below, we explain the meaning of Figure 16 and the specific revisions we will make.

130 Figure 16 shows the results of soil sampling conducted at P01–P04, corresponding to the locations shown in Figure 3(b), followed by carbon analysis. As illustrated in Figure 2, the sea-water level fluctuates around the boundary between the basal clay layer and the overlying peat layer, and the peat layer is not saturated with seawater. Therefore, the “water level” in the figure represents the depth of the groundwater table within the peat deposit, not sea-water saturation.

For this reason, we did not intend to imply that “the environment becomes more anoxic with depth due to saturation by seawater.” We understand how the current wording could be misleading and will revise the terminology accordingly.

135 We also acknowledge that the term “Carbon concentration” may have contributed to the misunderstanding. Thus, we will change it to “Carbon content per unit volume”, which more accurately reflects the measured parameter—i.e., the amount of carbon (g) contained in 1 m³ of peat, calculated from the dry bulk density and elemental carbon analysis.

Furthermore, the terms “cumulative OC content” and “Carbon stock” will be replaced with “Soil Organic Carbon Density (SOCD)”, which more precisely describes the cumulative carbon storage per unit area as a function of depth.

We believe these revisions will greatly improve the clarity and scientific accuracy of Figure 16 and its interpretation. Thank you once again for helping us strengthen the manuscript.

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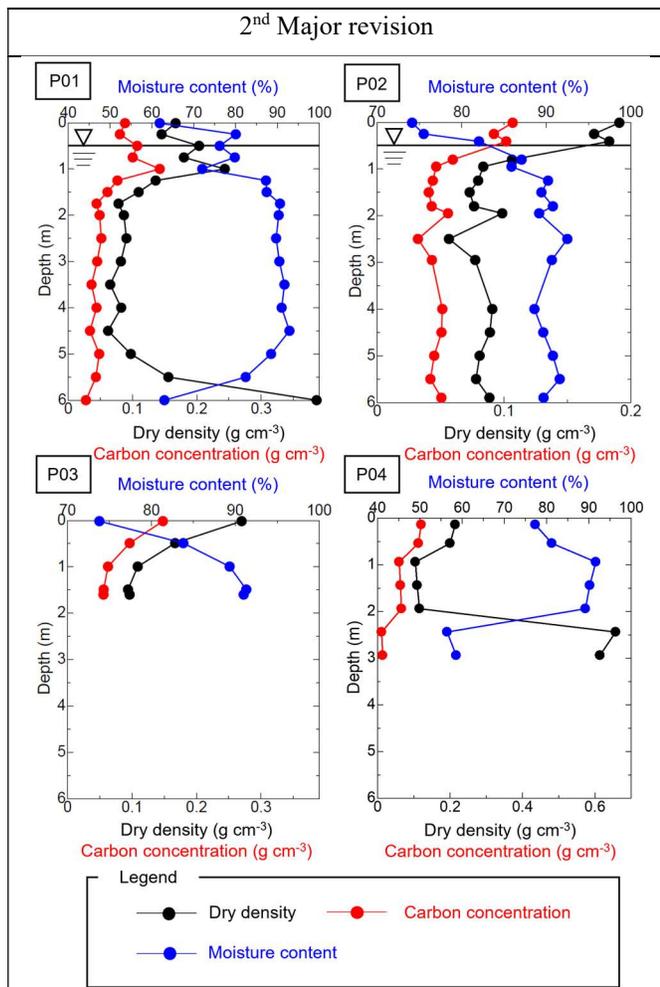


Figure 16

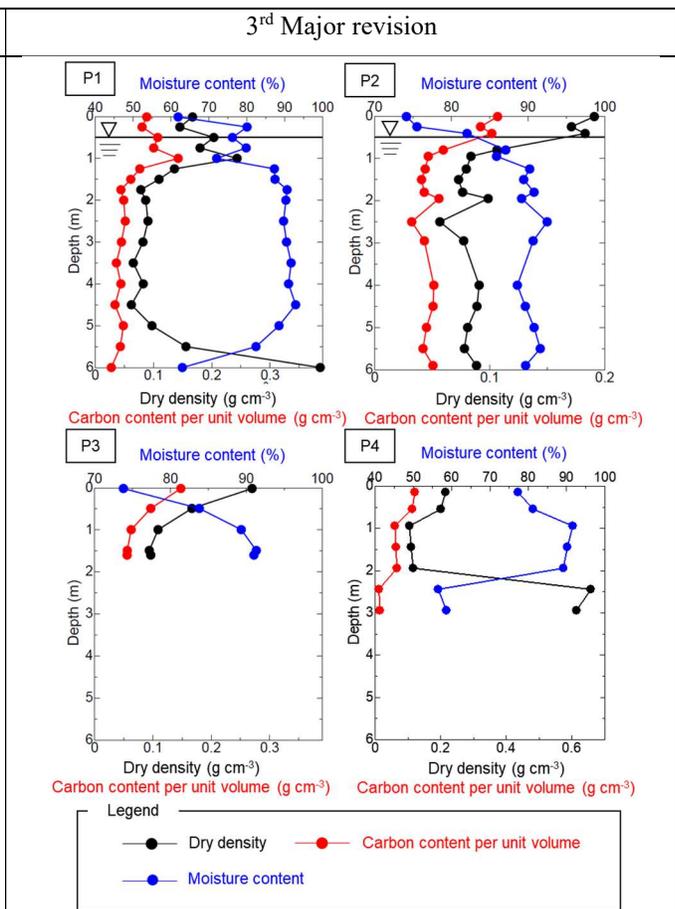


Figure 17

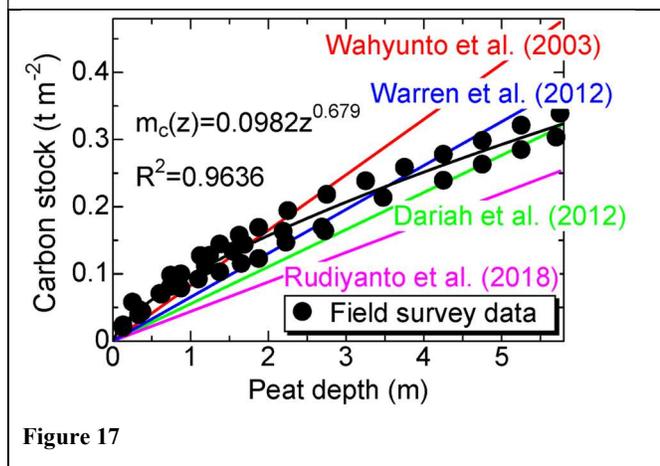


Figure 17

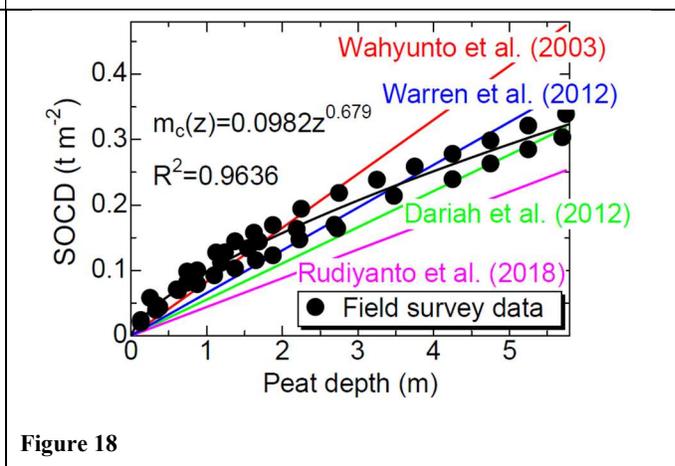


Figure 18

170 **RC2-Suggestion7.** **Statistical validation: For the regressions presented in the manuscript, please provide statistical validation measures, such as t-tests.**

RC2-Response7.

175 Thank you very much for this valuable suggestion to improve the effectiveness of presenting our analytical results. For the figures involving regression analysis, we agree that demonstrating that the relationships are not the result of random coincidence is important. Therefore, we performed a t-test to evaluate the statistical significance of each regression and confirmed that the p-values are below 0.05.

180 In the revised manuscript, we will indicate these p-values within the figures to clearly show the statistical significance of the regression relationships. We recognize that the relevant figures are Figure 13, Figure D1, and Figure H1, and we will update all of them accordingly. We appreciate your constructive comment, which has helped us improve the analytical clarity of the manuscript.

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2nd Major revision

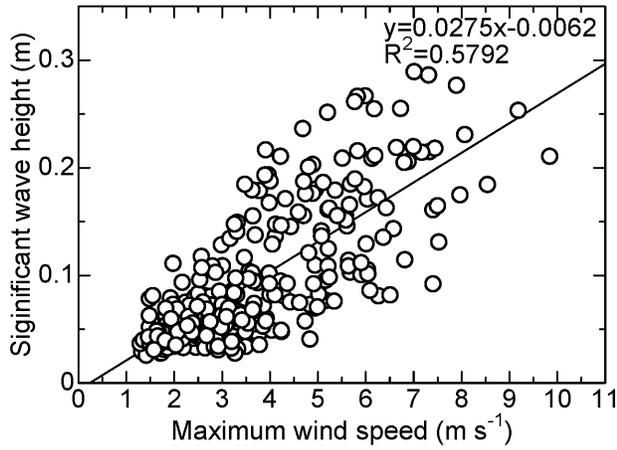


Figure 13

3rd Major revision

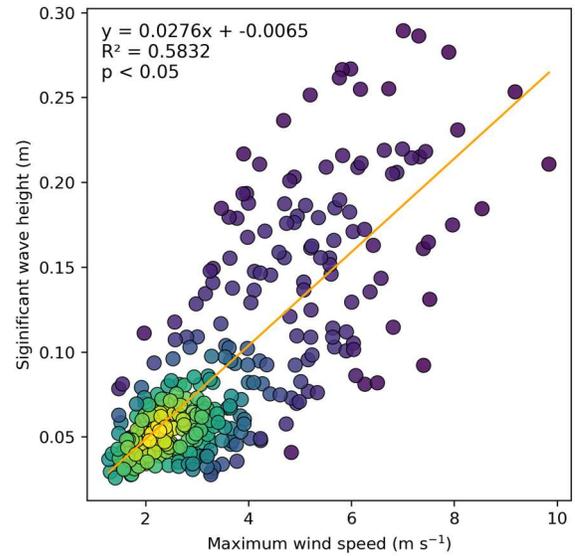


Figure 13 A significant positive relationship ($p < 0.05$, t-test) indicates that the regression is not a random coincidence.

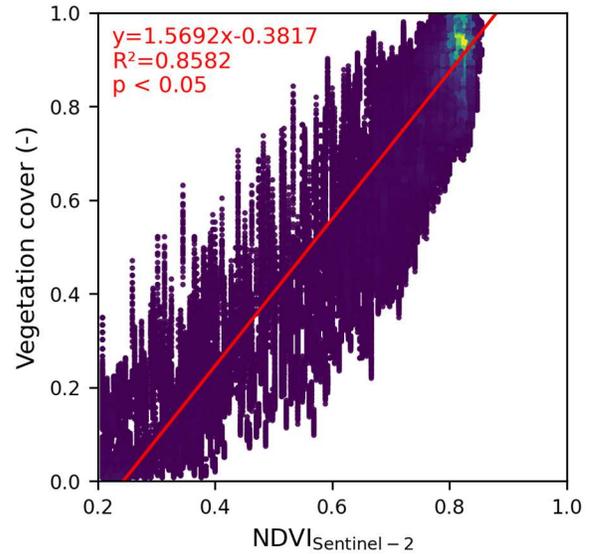
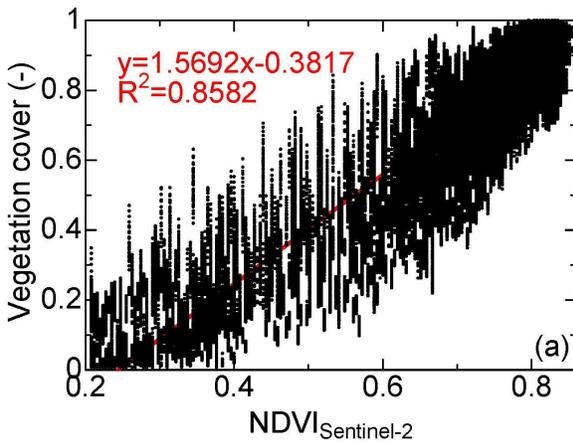


Figure C1(a) A significant positive relationship ($p < 0.05$, t-test) indicates that the regression is not a random coincidence.

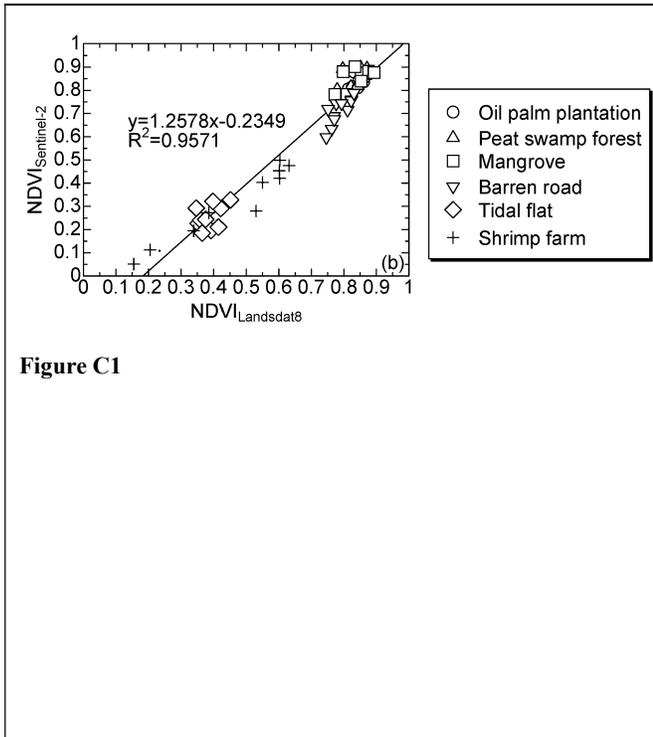


Figure C1

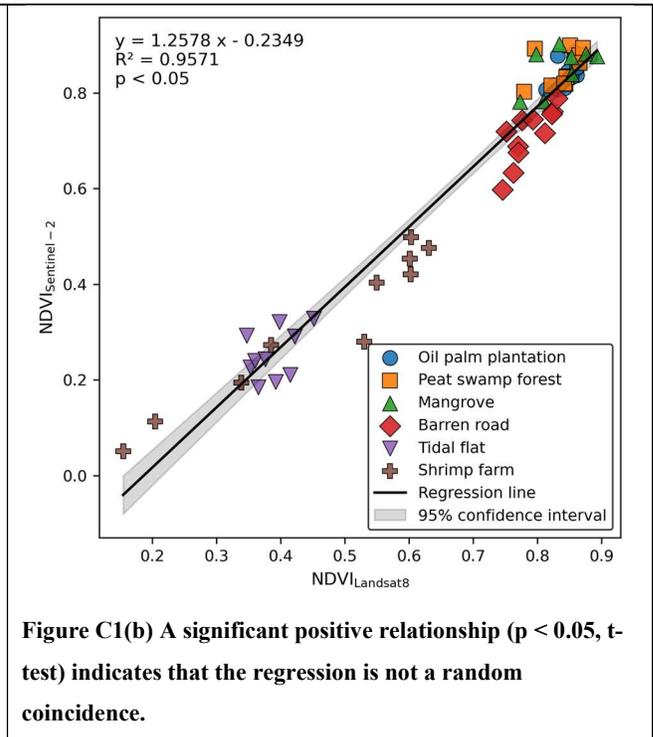


Figure C1(b) A significant positive relationship ($p < 0.05$, t-test) indicates that the regression is not a random coincidence.

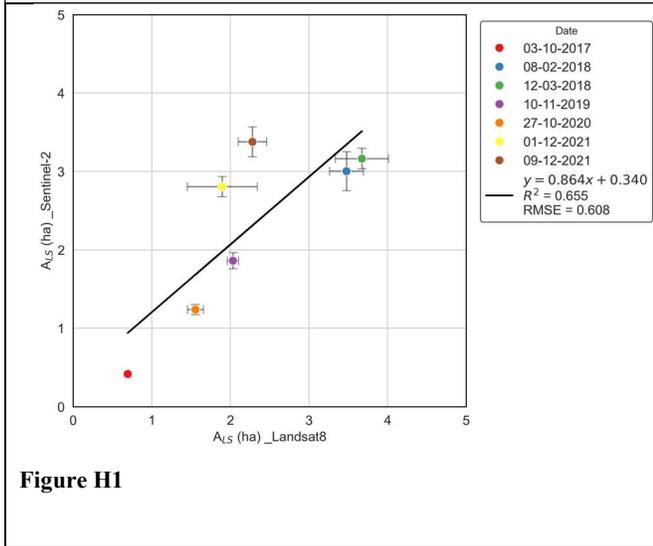


Figure H1

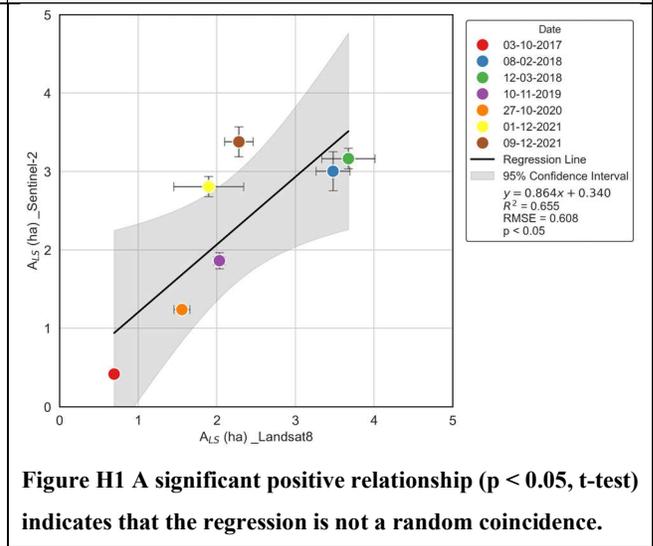


Figure H1 A significant positive relationship ($p < 0.05$, t-test) indicates that the regression is not a random coincidence.

RC2-Suggestion8. Line 624: Please delete “TOM.”

205 **RC2-Response8.**

Thank you very much for this specific comment. We agree with your observation, and we will delete the corresponding part in the revised manuscript. We appreciate your careful reading and constructive suggestion.

RC2-Suggestion9. Line 647: Please delete “blue carbon.”

RC2-Response9.

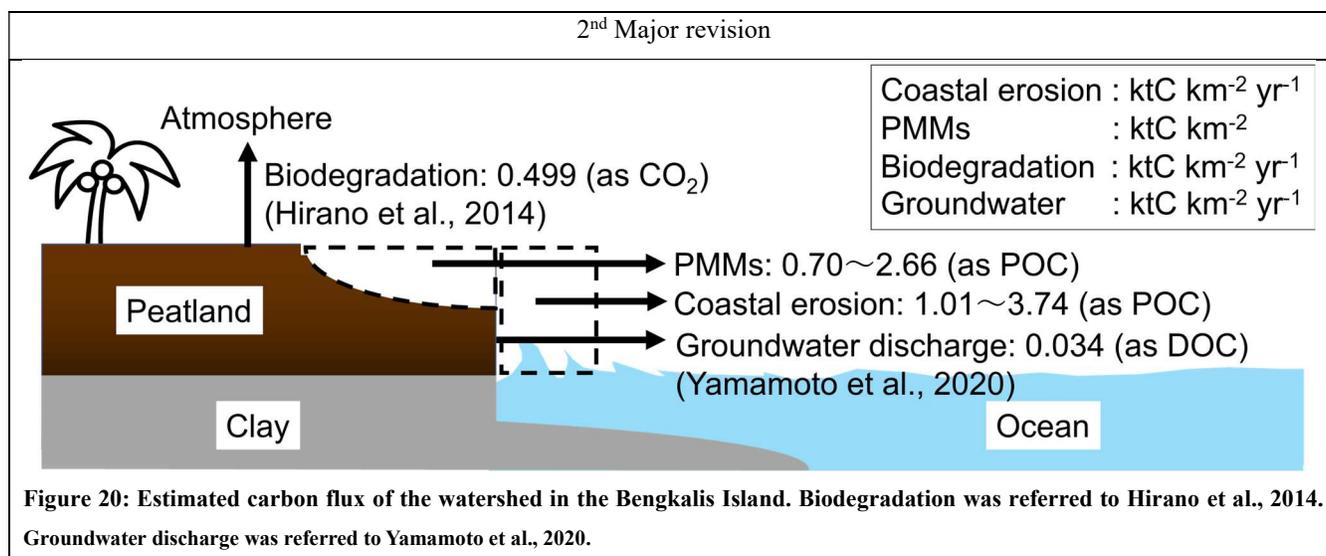
210 Thank you very much for this specific comment. We agree with your observation, and we will remove the corresponding part in the revised manuscript. We appreciate your careful reading and constructive suggestion.

RC2-Suggestion10. Lines 624–632: I do not recommend introducing DOC or comparing the fate of POC and DOC, as no data are presented to support this. Furthermore, the discussion does not sufficiently explore this aspect. Please focus instead on discussing the possible fate of POC, considering both source and sink processes.

215 **RC2-Response10.**

Thank you very much for your helpful suggestion on how to better summarize the findings of this study. Following your recommendation, we have replaced Figure 20 in the second revised manuscript with the updated version shown in the table below. In addition, the text in Lines 624–632 has been revised as indicated in the same table. We appreciate your constructive feedback, which has enabled us to improve the clarity and coherence of the manuscript.

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Lines 624–632

When terrestrial organic matter enters the ocean, its fate depends on its form. DOC is prone to oxic degradation or photolysis (Mopper et al., 1991), while POC is more likely to settle and accumulate in marine sediments, particularly under anoxic conditions. Therefore, POC exported by coastal erosion and PMMs may represent a more permanent carbon sink than DOC, especially in low-energy coastal environments with limited sediment resuspension.

The annual precipitation in the study area was 2,013 mm (from 1 January to 31 December 2018). Assuming an evapotranspiration rate of 4 mm day⁻¹, the annual discharge from groundwater and rivers was estimated at 553 mm. With an average riverine DOC concentration of 62 mg L⁻¹, the annual DOC export was estimated at approximately 34 tC km⁻² (Yamamoto et al., 2020). Approximately 1% of the POC is leached as DOC during PMMs and coastal erosion (Yamamoto et al., 2020), potentially undergoing oxidation and being released as CO₂.

3rd Major revision

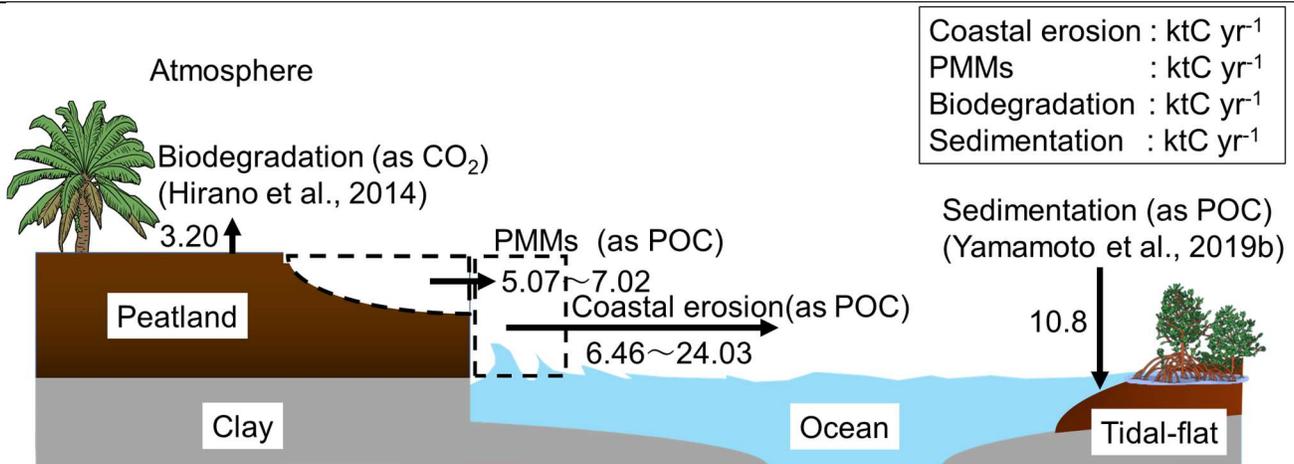


Figure 21: Estimated annual particulate organic carbon (POC) flux around the studied peatland watershed (6.41km²) in Bengkalis Island. Biodegradation was referred to Hirano et al., 2014. The coastline along the peatland watershed was 3.1 km and the area of the tidal flat in Bengkalis Island where the sedimentation happened was 1.46 km²

Lines 638–656

Fig. 21 illustrates the fate pathways of particulate organic carbon (POC) exported from the northern coastal peatlands of Bengkalis Island, representing the source-to-sink or export processes toward the adjacent ocean. In summary, our results

indicate that the coastal peatlands constitute the primary source of POC directly discharged into the Malacca Strait. Along a 3,152-m coastline, coastal-erosion processes export an estimated 6.46–24.03 ktC yr⁻¹, while peat mass movements (PMMs) contribute an additional 4.45–17.10 ktC yr⁻¹ of POC to the Strait. Following its release, the exported POC may follow three possible fate pathways. First, a portion of the POC may remain suspended in the surface ocean or eventually settle on the seafloor, functioning as a long-term carbon sink. However, this pathway remains highly uncertain, and further investigation is required to constrain the magnitude and stability of this potential sink. Second, as reported by Yamamoto et al., 2019b, part of the exported peat material may accumulate to form peat-derived tidal flats, where regenerated mangrove stands facilitate substantial carbon storage. Yamamoto et al., 2019b estimated that such tidal flats can store approximately 10.8 ktC yr⁻¹, suggesting that peat deposited in these environments may undergo reduced oxidative decomposition. Third, peat-derived beach deposits (peat beaches) may develop along the coast, where enhanced microbial activity could accelerate peat decomposition, as suggested by Matsuo et al., 2025. Collectively, these findings highlight that coastal peatlands act as major POC sources to the Strait of Malacca, while the subsequent carbon fate is partitioned among multiple pathways with varying degrees of uncertainty. Understanding the relative contributions of these pathways is essential for constraining regional carbon budgets and assessing the long-term implications of tropical peatland degradation.

225 **RC2-Suggestion11. Section 4.6: I recommend expanding the discussion of flux and comparing the estimated values to other processes. The use of OC yield is valuable, as it suggests that eroding peatlands have a high potential to release large amounts of OC. However, it is also important to present flux values in absolute terms (e.g., kg C yr⁻¹).**

RC2-Response11.

Thank you very much for this valuable comment, which helps us present the results of this study more effectively. In order to provide the flux values also in absolute terms, we have revised Figure 19 and Table 6 as shown in the table below. Correspondingly, we have added further explanation to Lines 604–608 in Section 4.6 of the second revised manuscript.

230 In addition, the captions of Figure 19 and Table 6 have been updated to reflect these modifications. The table below presents the original and revised versions for clarity. We appreciate your constructive suggestion, which has helped improve the transparency and interpretability of our results.

2 nd Major revision	3 rd Major revision
<p>L604-608</p> <p>This study quantifies the export of POC to the ocean resulting from coastal erosion and PMMs. Fig. 18 shows the annual changes in coastal erosion and landslide-affected areas. The estimated amounts of POC flux to the ocean are</p>	<p>L614-620</p> <p>This study quantifies the export of POC to the ocean resulting from coastal erosion and PMMs. Fig. 18 shows the annual changes in coastal erosion and landslide-affected areas. The estimated amounts of POC flux to the ocean are</p>

<p>shown in Fig. 19 and Table 6. The average flux of POCs to the ocean due to coastal erosion along the study area of Bengkalis Island was estimated to be in the range of 2.06 to 7.60 tC m⁻¹ yr⁻¹. The average POC from the displacement of peat mass caused by PMMs was estimated to be in the range of 1.43 to 5.41 tC m⁻¹, with an average increase of 2.23 tC m⁻¹ from 2010 to 2018.</p>	<p>shown in Fig. 19 and Table 6. The average flux of POCs to the ocean due to coastal erosion along the study area of Bengkalis Island was estimated to be in the range of 2.06 to 7.60 tC m⁻¹ yr⁻¹. The average POC from the displacement of peat mass caused by PMMs was estimated to be in the range of 1.43 to 5.41 tC m⁻¹, with an average increase of 2.23 tC m⁻¹ from 2010 to 2018. In absolute terms, the mean POC export due to coastal erosion ranged from 6.46 to 24.03 kt C yr⁻¹, while that associated with PMMs ranged from 4.45 to 17.10 kt C yr⁻¹.</p>
<p>L660–662</p> <p>Figure 19: Time series of (a) estimated POC fluxes due to coastal erosion and (b) estimated POC export due to displacement of peat mass caused by PMMs for observation moment. The average POC flux of POC to the ocean was estimated to be 2.06 to 7.60 tC m⁻¹ yr⁻¹ by coastal erosion and 1.43 to 5.41 tC m⁻¹ from PMMs. The error bars indicate the standard deviation (SD).</p>	<p>L681-686</p> <p>Figure 20: Time series of (a) estimated POC fluxes due to coastal erosion and (b) estimated POC export due to displacement of peat mass caused by PMMs for observation moment. The average POC flux of POC to the ocean was estimated to be 2.06 to 7.60 tC m⁻¹ yr⁻¹ by coastal erosion and 1.43 to 5.41 tC m⁻¹ from PMMs. The error bars indicate the standard deviation (SD). Panels (c) and (d) show the cumulative POC export derived from the time series in (a) and (b), indicating that the observed POC export is driven due to coastal erosion and PMMs.</p>
<p>L664-668</p> <p>Table 6: The landslide-affected area and the estimated volume of the eroded peat by the events of coastal erosion and peat mass movements in each period. Changes in time in the estimated amount of POC from peat mass displacement caused by PMMs and from flows due to coastal erosion. SD indicates the standard deviation of the POC flux calculated using the results of five patterns of cumulative carbon content calculations, including values from the literature. Where period (a) is 2/2/2010 to 23/7/2011, period (b) is 23/7/2011 to 18/9/2013, period (c) is 18/9/2013 to 2/4/2015, period (d) is 2/4/2015 to 4/3/2017 and period (e) is 4/3/2017 to 29/7/2018.</p>	<p>L688-L692</p> <p>Table 5: The estimated volume of the eroded peat by the events of coastal erosion in each period. Changes in time in the estimated amount of POC from flows due to coastal erosion. SD indicates the standard deviation of the specific annual POC export calculated using the results of five patterns of SOCD calculations, including values from the literature. Where period (a) is 2/2/2010 to 23/7/2011, period (b) is 23/7/2011 to 18/9/2013, period (c) is 18/9/2013 to 2/4/2015, period (d) is 2/4/2015 to 4/3/2017 and period (e) is 4/3/2017 to 29/7/2018.</p> <p>L695-L698</p>

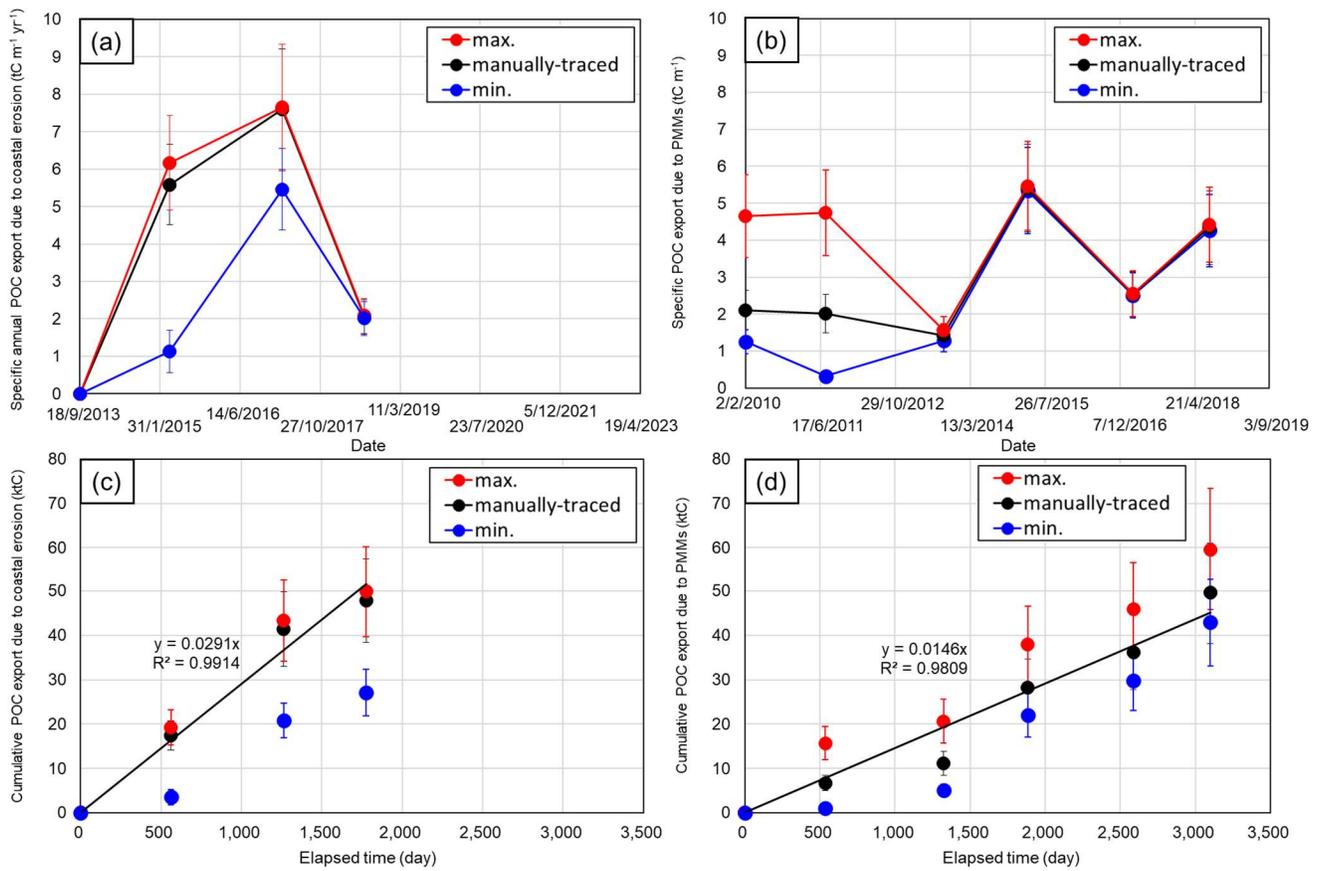
Table 6: The landslide-affected area and the estimated volume of the eroded peat by the events of peat mass movements in each period. Changes in time in the estimated amount of POC from peat mass displacement caused by PMMs. SD indicates the standard deviation of the specific POC export calculated using the results of five patterns of SOCD calculations, including values from the literature.

L701-L703

Table 7: The mean particulate organic carbon (POC) export attributable to coastal erosion ranged from 6.46 to 24.03 ktC yr⁻¹ in absolute terms. Where period (a) is 2/2/2010 to 23/7/2011, period (b) is 23/7/2011 to 18/9/2013, period (c) is 18/9/2013 to 2/4/2015, period (d) is 2/4/2015 to 4/3/2017 and period (e) is 4/3/2017 to 29/7/2018.

L706

Table 8: The mean particulate organic carbon (POC) export attributable to PMMs ranged from 4.45 to 17.10 ktC in absolute terms.



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Figure 20

Table 5

Period	Term	Coastline	Coastal erosion							Specific annual POC export		
			Area			Volume			Specific annual POC export			
			min.	manually-traced	max.	min.	manually-traced	max.	min.	manually-traced	max.	
			days	m	$\times 10^4 \text{ m}^2$	Mm^3	Mm^3	Mm^3	Average \pm SD ($n=5$)			
										$\text{tC m}^{-1} \text{ yr}^{-1}$		
(a)2010-2011	536	3,096	1.8	9.7	20.0	-	-	-	-	-	-	-
(b)2011-2013	788	3,313	8.2	13.0	18.6	-	-	-	-	-	-	-
(c)2013-2015	561	3,120	16.8	17.0	18.8	0.24	0.43	0.53	1.13 \pm 0.56	5.59 \pm 1.08	6.17 \pm 1.27	
(d)2015-2017	702	3,162	18.4	18.5	18.8	0.64	0.75	0.80	5.46 \pm 1.09	7.60 \pm 1.60	7.65 \pm 1.69	
(e)2017-2018	512	3,140	9.6	9.8	9.9	0.130	0.136	0.138	2.02 \pm 0.45	2.06 \pm 0.46	2.09 \pm 0.47	
Total	3,099		54.8	68.0	86.1	1.01	1.32	1.47				

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Table 6

Date	Coastline	PMMs								
		Area			Volume			Specific POC export		
		min.	manually-traced	max.	min.	manually-traced	max.	min.	manually-traced	max.
		m	$\times 10^4 \text{ m}^2$		Mm^3			Average \pm SD ($n=5$)		
2/2/2010	3,096	4.8	7.4	14.7	0.06	0.10	0.22	1.25 \pm 0.33	2.11 \pm 0.53	4.65 \pm 1.12
23/7/2011	3,313	3.9	11.8	24.1	0.02	0.14	0.34	0.33 \pm 0.13	2.02 \pm 0.52	4.74 \pm 1.15
18/9/2013	3,120	7.8	8.8	9.8	0.14	0.15	0.16	1.28 \pm 0.29	1.43 \pm 0.33	1.57 \pm 0.36
2/4/2015	3,162	21.0	21.3	21.6	0.395	0.400	0.404	5.34 \pm 1.17	5.41 \pm 1.18	5.47 \pm 1.20
4/3/2017	3,140	16.0	16.2	16.3	0.228	0.230	0.232	2.51 \pm 0.61	2.54 \pm 0.62	2.56 \pm 0.62
29/7/2018	3,085	16.5	16.9	17.3	0.275	0.280	0.285	4.26 \pm 0.98	4.34 \pm 1.00	4.42 \pm 1.02
Total		70.0	82.4	103.8	1.12	1.30	1.64			

Table 7

Period	Term	Coastline	Coastal erosion		
			Absolute terms (POC)		
			min.	manually-traced	max.
			Average \pm SD ($n=5$)		
	days	m	ktC yr ⁻¹		
(a)2010-2011	536	3,096	-	-	-
(b)2011-2013	788	3,313	-	-	-
(c)2013-2015	561	3,120	3.53 \pm 1.75	17.43 \pm 3.36	19.25 \pm 3.94
(d)2015-2017	702	3,162	17.26 \pm 3.44	24.03 \pm 5.07	24.17 \pm 5.36
(e)2017-2018	512	3,140	6.33 \pm 1.42	6.46 \pm 1.45	6.55 \pm 1.48
Total	3,099				

Table 8

Date	Term	Coastline	PMMs		
			Absolute terms (POC)		
			min.	manually-traced	max.
			Average \pm SD ($n=5$)		
	days	m	ktC		
2/2/2010		3,096	3.88 \pm 1.01	6.53 \pm 1.64	14.39 \pm 3.47
2/2/2010-23/7/2011	536	3,313	1.09 \pm 0.45	6.68 \pm 1.72	15.72 \pm 3.81
23/7/2011-18/9/2013	788	3,120	4.00 \pm 0.92	4.45 \pm 1.03	4.89 \pm 1.13
18/9/2013-2/4/2015	561	3,162	16.89 \pm 3.69	17.10 \pm 3.75	17.28 \pm 3.79
2/4/2015-4/3/2017	702	3,140	7.89 \pm 1.91	7.97 \pm 1.93	8.03 \pm 1.95
4/3/2017-29/7/2018	512	3,085	13.15 \pm 3.01	13.39 \pm 3.07	13.65 \pm 3.13
Total (2010-2018)	3,099		43.02 \pm 9.98	49.59 \pm 11.50	59.57 \pm 13.81
Annual (2010-2018)			5.07 \pm 1.18	5.84 \pm 1.35	7.02 \pm 1.63
(ktC yr ⁻¹)					

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