1   **Supplementary information**

2   Global trends in mangrove forest fragmentation

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10   **Supplementary materials 1**

11   All following equations and explanations are derived from the Fragstats (version 4.2) help

12   manual.

13   **The clumpiness index**

14
$$Gi = \left(\frac{g_{ii}}{\sum_{k=1}^{m} g_{ik}} \right)$$

15
$$CLUMPY = \left[\begin{array}{l} \dfrac{G_i - P_i}{1 - P_i} \ for \ G_i \geq \ P_i \\ \dfrac{G_i - P_i}{1 - P_i} \ for \ G_i < \ P_i \ ; \ P_i \geq 0.5 \\ \dfrac{G_i - P_i}{-P_i} \ for \ G_i < \ P_i \ ; \ P_i < 0.5 \end{array} \right]$$

16   Where g_{ii} = number of adjacencies between focal habitat and focal habitat, g_{ik} = number of

17   adjacencies between focal habitat and non-focal habitat (m), P_i = percentage of landscape

18   occupied by the habitat

19   CLUMPY ranges from -1 to1

20   CLUMPY = -1 is a maximally disaggregated habitat;

21   CLUMPY = 0 is a randomly distributed habitat;

22   CLUMPY = 1 is a maximally aggregated habitat;

23   This is a metric of like adjacencies (contagion) which is normalised by quantity of habitat in

24   the landscape.

25   **Perimeter-Area fractal dimension**

26
$$PAFRAC = \frac{2}{\dfrac{\left[n_i \sum_{j=1}^{n} \left(\sum_{j=1}^{n} \ln p_{ij} \cdot \sum_{j=1}^{n} \ln a_{ij} \right) \right] - \left[\left(\sum_{j=1}^{n} \ln p_{ij} \right) \left(\sum_{j=1}^{n} \ln a_{ij} \right) \right]}{\left(n_i \sum_{j=1}^{n} \ln p_{ij}^2 \right) - \left(\sum_{j=1}^{n} \ln p_{ij} \right)}}$$

27   Where n_i is the number of patches in the landscape of habitat type i, p_{ij} and a_{ij} are the

28   perimeter and area of patch ij, respectively.

29   PAFRAC ranges from 1 (patches are simple geometric shapes) and tends to 2

30   PAFRAC = 1; patch shape is simple

31   PAFRAC = 2; patch has theoretical maximal convolution

32   PAFRAC employs regression analysis on landscapes, accordingly only landscapes with

33   NP>20 were considered when mapping and modelling PAFRAC in mangroves
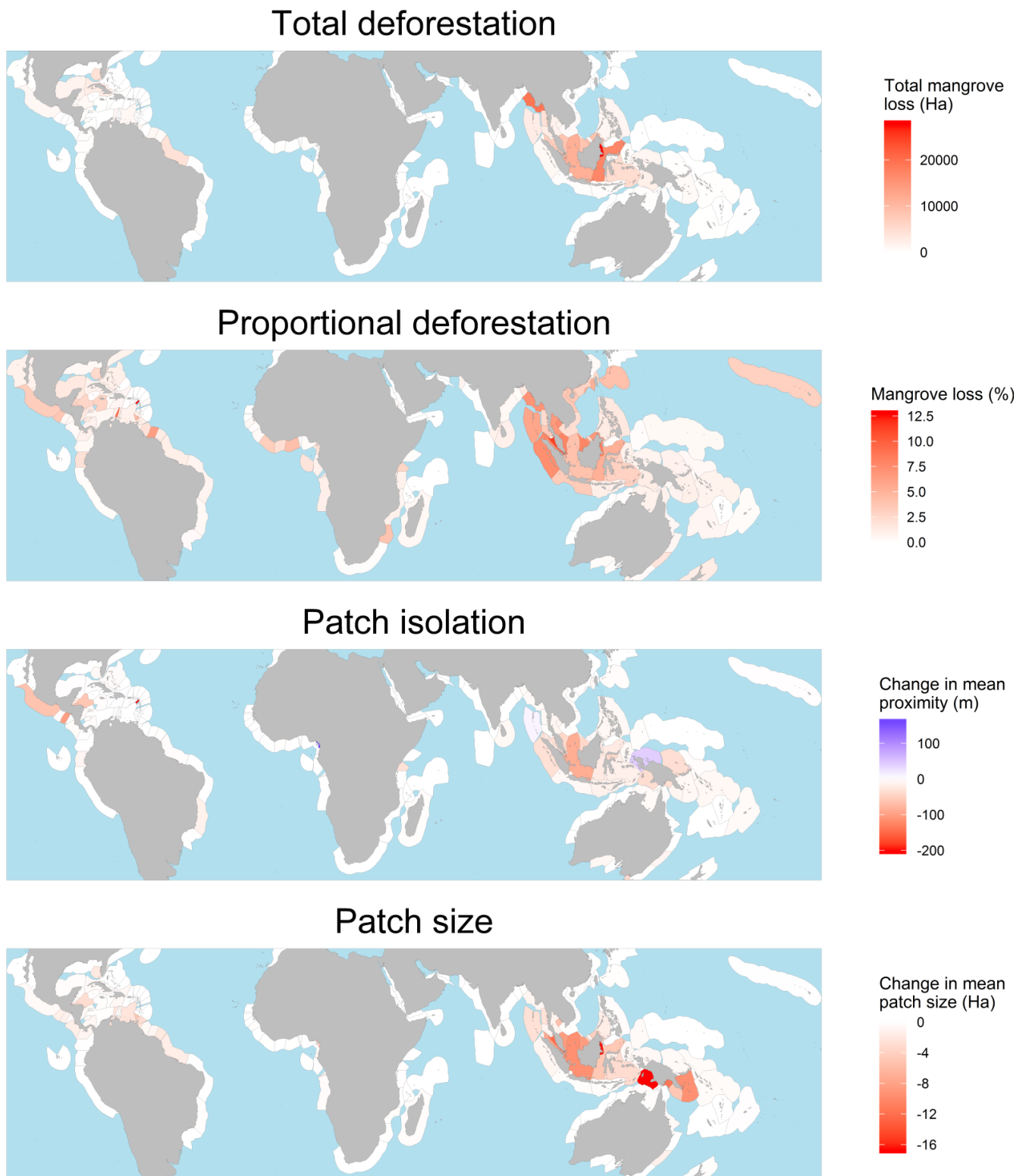
34   **Mean patch area**

35
$$AREA\_MN = \frac{\sum a_{ij}}{n}$$

36   Where a_i is the area of patch i of habitat j (in hectares) and n is number of patches.

37   **Mean Euclidean nearest neighbour**

38
$$ENN\_MN = \frac{\sum \min(h_{ij})}{n}$$

39   Where h_{ij} is the distance in metres between patch i and j, and n is the number of patches in the

40   landscape

Supplementary Figure S1

Total deforestation

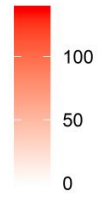## Proportional deforestation

Patch isolation

Patch size

42 Supplementary Figure S2(a): The global distribution of shifts in the four metrics reported in

43 the paper. Panel A) Total mangrove loss, B) Proportional mangrove loss, C) shift in the

44 distance to nearest mangrove patch and, D) change in average size of mangrove patches.
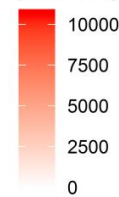
Mean number of patches

Total number of patches

Patch shape - PAFRAC
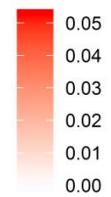
Patch shape - clumpiness
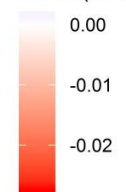
45   Supplementary Figure S1(b): The global distribution of shifts in the three metrics unreported

46   in the paper. Panel A) and B) show the mean and total shift in number of patches,

47   respectively. Panel C) and D) shows the distribution of shifts in average patch shape, as

48   measured by PAFRAC and the clumpiness index, respectively.

49 **Supplementary Table S1**

50 The Spearman rank correlations (mangrove fragmentation as a function of mangrove loss) for

51 different fragmentation metrics. Correlation coefficients are given with p-values in

52 parentheses. Table A shows the relationship between fragmentation and loss for each land-

53 use transition. Table B shows the relationship between fragmentation and loss without

54 considering the dominant land-use transition of the landscapes.

55 Table A:

	Clumpiness index	PAFRAC	Mean patch size	Mean Euclidean nearest neighbouring patch
Aquaculture	0.53509 $(p < 0.00001)$	0.58419 $(p < 0.00001)$	0.73112 $(p < 0.00001)$	0.49822 $(p < 0.00001)$
Rice plantations	0.55937 $(p < 0.00001)$	0.68847 $(p < 0.00001)$	0.63448 $(p < 0.00001)$	0.43210 $(p = 0.00003)$
Oil palm plantations	0.25241 $(p < 0.00001)$	0.32181 $(p < 0.00001)$	0.67644 $(p < 0.00001)$	0.30532 $(p < 0.00001)$
Mangrove regrowth	0.33155 $(p = 0.00001)$	0.37602 $(p < 0.00001)$	0.72454 $(p < 0.00001)$	0.31218 $(p = 0.00005)$
Urban developments	0.34229 $(p = 0.00068)$	0.56971 $(p < 0.00001)$	0.53678 $(p < 0.00001)$	0.24801 $(p = 0.01713)$
Other	0.35591 $(p < 0.00001)$	0.37341 $(p < 0.00001)$	0.59747 $(p < 0.00001)$	0.34039 $(p < 0.00001)$

56

57 Table B

	Clumpiness index	PAFRAC	Mean patch size	Mean Euclidean nearest neighbour
All landscapes	0.38260 (1.77 E-49)	0.44830 (8.90 E-63)	0.66359 (2.08 E-176)	0.37191 (3.47 E-46)

58