Reviewer #1:

General Comments:

Comment #1

It is useful to have maps of world distribution of different forest disturbance types and the authors provide a higher-resolution data set. The results appear reliable and mark a significant contribution to the state of the world's forests. 13 situations are recognised (Table 1); of these, two 'weak disturbances' (drought, pests&diseases) are not considered, so 11 are mapped in Fig.5, including 'undisturbed' and 'newly added forest'. Excluding undisturbed and new leaves 9 types of disturbance, of which 7 are covered in Fig.3 and Table 4 (accuracy of flood and oil palm not being evaluated).

Response #1

Thanks for your recognition and constructive suggestions, which make our manuscript stronger. In this version, we have further revised the manuscript and addressed all your concerns. Please see the detailed point-by-point responses below.

Comment #2

My criticisms are essentially confined to details of presentation and wording. It might be good to have more information on how the types are defined and how time series permit recognition of e.g. recovered areas. (**Revised**)

Response #2

Thanks for your constructive comments. We have supplemented the manuscript with further details regarding the definition of forest disturbance types (Page 2-3, Line 62-81). The identification of each type relies on time-series characteristics, including pre-disturbance conditions, the disturbance process, and post-disturbance recovery patterns.

"The global forest disturbance classification framework is established through a comprehensive synthesis of key disturbance characteristics, including disturbance intensity, disturbance source, forest types affected, disturbance processes, and recovery type. Based primarily on disturbance intensity, disturbances are categorized into negative disturbance (newly added forest, 22), positive strong disturbance, and positive weak disturbance. According to the differences in disturbance sources, such as human activities, natural wildfires, climatic factors, insect and disease outbreaks, and flooding, weak disturbances are further differentiated into drought-induced disturbances (16) and forest pest and disease disturbances (17). Similarly, strong disturbances are subdivided into forest fires (15), flood disasters (19),

and human-induced forest disturbances. Depending on post-disturbance recovery status and land use type, human-induced disturbances are further distinguished into built-up area expansion (18) and cropland occupation (19), where forests are not restored. Taking into account the forest type disturbed, human-induced disturbances are also classified into renewal plantation (13) and oil palm expansion (21), both of which involve manual reversion. Based on the presence of short-term agricultural activities during the disturbance process, natural recovery secondary forests are categorized into natural forest deforestation (14) and shifting cultivation (11). Meanwhile, natural forest areas that were logged and then actively restored by humans are identified as forestry replanting (12).”

Table 1: Global forest disturbance classification framework

Code	Disturbance type	Disturbance intensity	Disturbance source	Forest type	Disturbance process	Recovery type
0	Undisturbed	Undisturbed	-	Natural forests	Undisturbed between 2000 and 2020.	-
11	Shifting cultivation	Strong	Human disturbance	Natural forests	Residents randomly cut down forests on a small scale and plant crops, then abandon cultivation after 1-2 years.	Natural recovery
12	Forestry replanting	Strong	Human disturbance	Natural forests	To obtain wood, natural forests were cut down, and later manual planted them.	Manual reversion
13	Plantation disturbance	Strong	Human disturbance	Plantation	Regular logging and renewal of plantations.	Manual reversion
14	Deforestation of natural forests	Strong	Human disturbance	Natural forests	To obtain wood, natural forests were cut down, and later natural recovery.	Natural recovery
15	Forest fire disturbance	Strong	Natural fire	All forests	The destruction of forests by wildfires.	Natural recovery
16 *	Drought	Weak	Natural climate	All forests	Forest degradation caused by drought.	-
17 *	Forest pests and diseases	Weak	Natural pests and diseases	All forests	Forest degradation caused by pests and diseases.	-
18	Built-up area expansion	Strong	Human disturbance	All forests	Expansion of built-up areas encroach on forests.	No recovery
19	Cropland occupation	Strong	Human disturbance	All forests	Expansion of cropland encroach on forests.	No recovery
20	Flood disaster	Strong	Natural flood	All forests	Flood disasters encroach on forests.	Natural recovery
21	Oil palm	Strong	Human disturbance	All forests	Expansion of oil palm plantations encroach on forests	Manual reversion
22	Newly added forest	Negative	Human disturbance	Non forest	Artificially planting forests on non-forest land.	Manual planting

*Note: * indicates weak disturbance type. Due to the spatial overlap between weak and strong disturbance types, this study did not consider weak disturbances.*

For the identification of recovery areas, the line segments fitted by CCDC provide trend information on forest changes over each time period. In particular, the trend information during the post-disturbance phase can effectively indicate whether forest recovery has occurred.

Utilizing multi-temporal Landsat data in 2000-2020 and ancillary datasets (Section 2.2.5), we constructed a comprehensive feature set comprising 18 disturbance indicators (Table 2). These features were systematically derived from both temporal and spatial dimensions, including: Overall characteristics of forest disturbance (OC), pre-disturbance forest conditions (PDC), post-disturbance recovery patterns (PDP), disturbance potential metrics (DP), land use/cover features (LUC), spatial contextual attributes (SC).

Table 2 Global Forest Disturbance Characteristics Indicator

Indicator type	Forest disturbance characteristic indicators		
OC	Disturbance frequency	Average disturbance period	Number of segments
PDC	Linear intercept before disturbance	Internal fluctuations before disturbance	Interannual trend before disturbance
PDP	Linear intercept after disturbance	Internal fluctuations after disturbance	Interannual trend after disturbance
DP	Forest fire area	Plantation area	Intensity of population
LUC	2020 Land Use /Cover	Forest cover in 2000	Forest cover in 2020
SC	Longitude	Latitude	Disturbance partition

Comment #3

On line133 the treatment of 'vacant areas' is worrying: more information on this is needed, how big an area is affected? (**Revised**)

Response #3

Thanks for your constructive comments. For the "vacant areas," we have provided additional clarification. These areas actually represent missing areas that were not covered by the existing CCDC dataset. We have replaced the term "vacant areas" with "missing areas".

The supplementary manuscript content is as follows (Page 7, Line 147-149):

"The dataset provides extensive coverage of global forest areas, but small number of missing areas occur along the edges of some images, accounting for approximately 6% of the total global forest area. For the missing areas in the dataset,……"

Minor Comments

Comment #1

101 '… America, South …' comma missing (**Revised**)

Response #1

Thanks for your suggestion. We have revised the expression here (Page 6, Line 114-115):

"…four major clusters: Africa, Southeast Asia and Australia, Central America and South America, and the Northern Forest Region."

Comment #2

132 Insert space before 'in' (**Revised**)

Response #2

Thanks for your suggestion. We have revised the expression here (Page 7, Line 147):

[ee.ImageCollection("GOOGLE/GLOBAL_CCDC/V1")] in GEE.

Comment #3

140 'Considering …' -this sentence is incomplete, it is just a clause introducing something that is missing. (**Revised**)

Response #3

Thanks for your suggestion. We have revised the expression here (Page 8, Line 159-161):

"Generally, a high spatial consistency is typically observed between disturbance types such as forest fires and plantation expansion and global fire and plantation distribution."

Comment #4

156 'Meanwhile …' is an incomplete sentence – just a clause. I suggest replacing with 'Weak disturbances in forest cover are highly time-bound.' (**Revised**)

Response #4

Thanks for your suggestion. We have revised the manuscript according to your suggestion (Page 9, Line 191-192):

"Meanwhile, weak disturbances in forest cover are highly time-bound."

Comment #5

160 Delete 'are not considered' - duplication. (**Revised**)

Response #5

Thanks for your suggestion. We have revised the manuscript according to your suggestion (Page 9, Line 194-195):

"Therefore, this study did not consider these two weak disturbance types of drought disturbance and pest disturbance."

Comment #6

166-169 This sentence misuses punctuation (: and ; are repeated). Please re-write. (**Revised**)

Response #6

Thanks for your suggestion. We have revised the expression here (Page 9, Line 201-204):

"The specific process consists of two steps: decision tree generation and pruning. During the

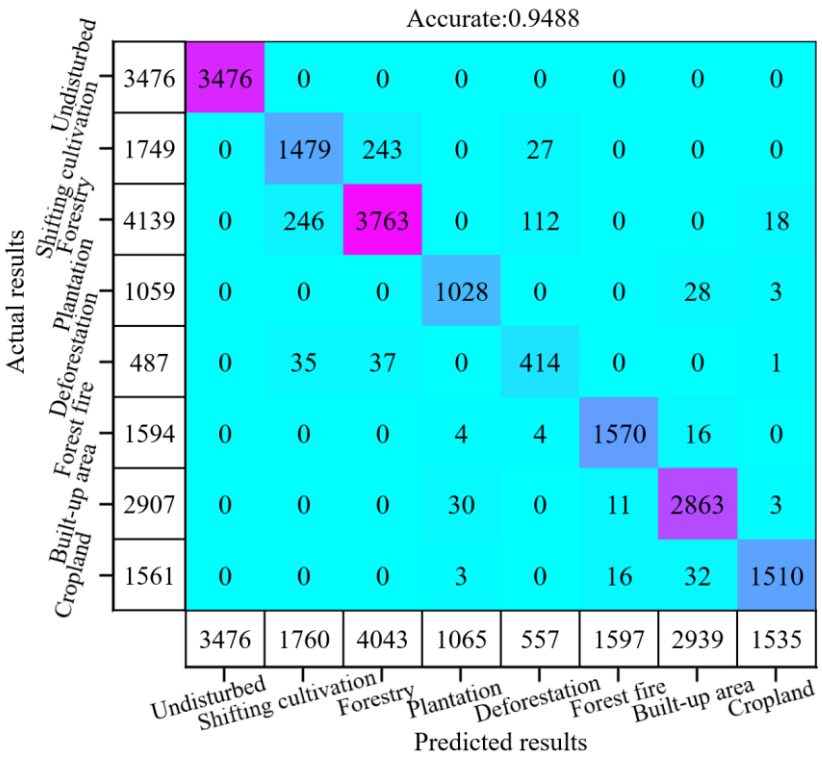
decision tree generation phase, a tree is constructed from the training dataset and is grown to its maximum possible size. Subsequently, pruning is performed using the validation dataset to select the optimal subtree, with the minimization of the loss function serving as the criterion for pruning."

Comment #7

Fig.3 There is space to replace codes with brief versions of types – e.g. 'plantation'. **(Revised)**

Response #7

Thanks for your suggestion. We have revised the Fig.3 according to your suggestion (Page 12, Figure 3):



"Figure 3 Confusion Matrix of Global Forest Disturbance Classification"

Comment #8

Table 4 118 should be 18 **(Revised)**

Response #8

Thanks for your suggestion. We have revised the expression here (Page 13, Table 4):

Table 4 Accuracy Evaluation of GFD Mapping Results

Type	User 's Accuracy	Uncertainty (±)	Producer's Accuracy	Uncertainty (±)	Overall Accuracy
11	84.03%	0.87%	84.56%	0.86%	94.88%± 0.17%
12	93.07%	0.40%	90.92%	0.45%	
13	96.53%	0.56%	97.07%	0.52%	
14	74.33%	1.85%	85.01%	1.62%	
15	98.31%	0.32%	98.49%	0.31%	
18	97.41%	0.29%	98.49%	0.23%	
19	98.37%	0.32%	96.73%	0.45%	

Comment #9

254-260 There should be a space before ± (**Revised**)

Response #9

Thanks for your suggestion. We have revised the manuscript according to your suggestion (Page 13, Line 277-284):

"The overall accuracy reaches 94.88% (±0.17%), indicating robust model performance at the aggregate level (Table 4). Forest fire disturbance (98.31% ±0.32% user's accuracy, 98.49% ±0.31% producer's accuracy) and cropland occupation (98.37% ±0.32%, 96.73% ±0.45%) demonstrate the highest classification reliability. Forestry replanting shows strong(93.07% ± 0.40%, 90.92% ±0.45%), while shifting cultivation achieves moderate performance and slightly more variable accuracy (84.03% ±0.87%, 84.56% ±0.86%). Deforestation of natural forests exhibits the lowest user's accuracy (74.33% ±1.85%), suggesting significant confusion with other disturbance types, despite its relatively higher producer's accuracy (85.01% ±1.62%). Built-up area expansion shows nominally high accuracy (97.41% ±0.29%). These results highlight the model's effectiveness for dominant disturbance types.."

Comment #10

260 Not a sentence: 'both …' implies ' …and' (**Revised**)

Response #10

Thanks for your suggestion. We have revised the expression here (Page 13, Line 284):

"These results highlight the model's effectiveness for dominant disturbance types."

Comment #11

268 'Western Siberian Plain in North America' ?? (**Revised**)

Response #11

Thanks for your comments. We have revised the expression here (Page 13, Line 290-291):

"The evergreen coniferous forest exhibits significant disturbance in the central Cordillera Mountains, southern Labrador Plateau, Eastern European Plain, and Western Siberian Plain."

Comment #12

Fig.4 As each small symbol represents an area (grid square?), the colours must represent density. So ha per … ? Up to 1500 ha, so per at least 39 x 39 km. Please state resolution of this & Fig.5. (**Revised**)

Response #12

Thanks for your suggestion. We have added the resolution to the legend in Figure 4 &5. The spatial resolution of Figure 4 is 5.5km. The maximum value of our statistical results is 1500ha, which is 15km^2, less than half of a grid area.

"Figure 4 Global Forest Disturbance Distribution Map in 5.5km resolution."

"Figure 5 Global Forest Disturbance Classification Map in 30 m resolution."

Comment #13

Fig.5 'Forestry replanting ' is inconsistent with text (lines 284, 288 etc.), other Figures (8 & 9) and Table 1 ('Forestry disturbance') and does not seem to be used elsewhere. Actually 'forestry disturbance' is an unfortunate term for just one type of forest disturbance – disturbance as a disturbance type. Could it be replaced throughout by 'forestry replanting', 'recovered disturbance' or just 'replanted' ? (**Revised**)

Response #13

Thanks for your suggestion. We have replaced all 'forestry disturbance' in the manuscript with 'forestry replanting'. (Page 3, Line 74-75; Page 8, Line 168-169; Page 14, Line 297-298):

"Meanwhile, natural forest areas that were logged and then actively restored by humans are identified as forestry replanting (12)."

"……have been preliminarily identified through research: undisturbed (0), shifting cultivation disturbance (11), forestry replanting (12), plantation disturbance……"

"The main types of global forest disturbance are forestry replanting (43.79%), shifting

cultivation (24.32%), and forest fires (11.45%) (Fig. 5).”

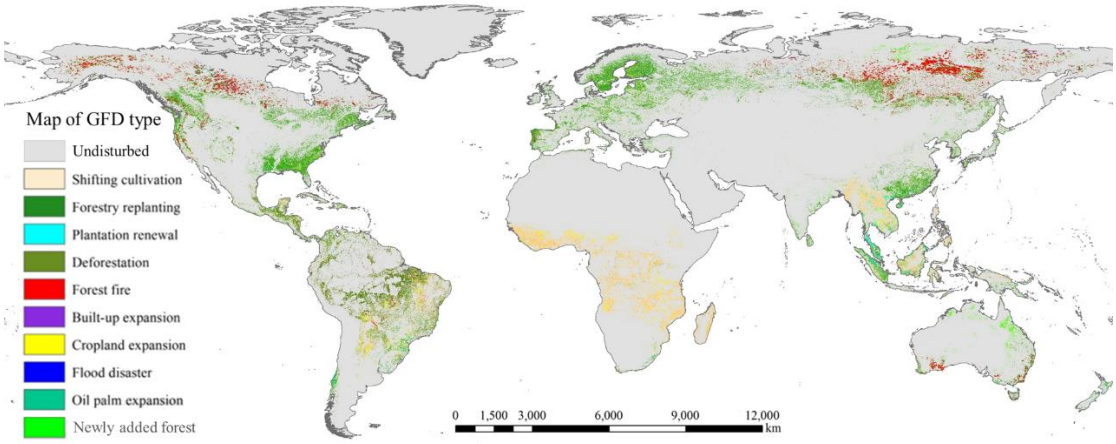


Figure 5 Global Forest Disturbance Classification Map in 30 m resolution.

Comment #14

284-293 Presumably Mha should be M ha (**Revised**)

Response #14

Thanks for your suggestion. Yes, we agree with your suggestion. However, based on the opinions of other reviewers, we have removed unnecessary statements here.

Comment #15

Fig. 6 caption Insert 'Note varying scales.' (**Revised**)

Response #15

Thanks for your suggestion. We have added “note varying scales” to the legend of Figure 6 as per your suggestion (Page 15, Line 314-316).

“Figure 6: Global Typical Forest Disturbance Statistics. a. is the cropland occupation on forests; b. is the disturbance caused by forest fires; c. is the disturbance of shifting cultivation; d. is the disturbance of plantations (excluding oil palm). These results are presented on a grid of 1.5° × 2.5°, and note varying scales.”

Comment #16

Fisg.6 & 7 maps show density, so it is necessary to state the unit area and (as these are rectangular) its dimensions. (**Revised**)

Response #16

Thanks for your suggestion. We have supplemented the unit area and its dimensions in Figures

6 and 7 as per your suggestion (Page 15, Figure 6; Page 16, Figure 7).

"Figure 6: Global Typical Forest Disturbance Statistics. a. is the cropland occupation on forests; b. is the disturbance caused by forest fires; c. is the disturbance of shifting cultivation; d. is the disturbance of plantations (excluding oil palm). These results are presented on a grid of 1.5° × 2.5°, and note varying scales."

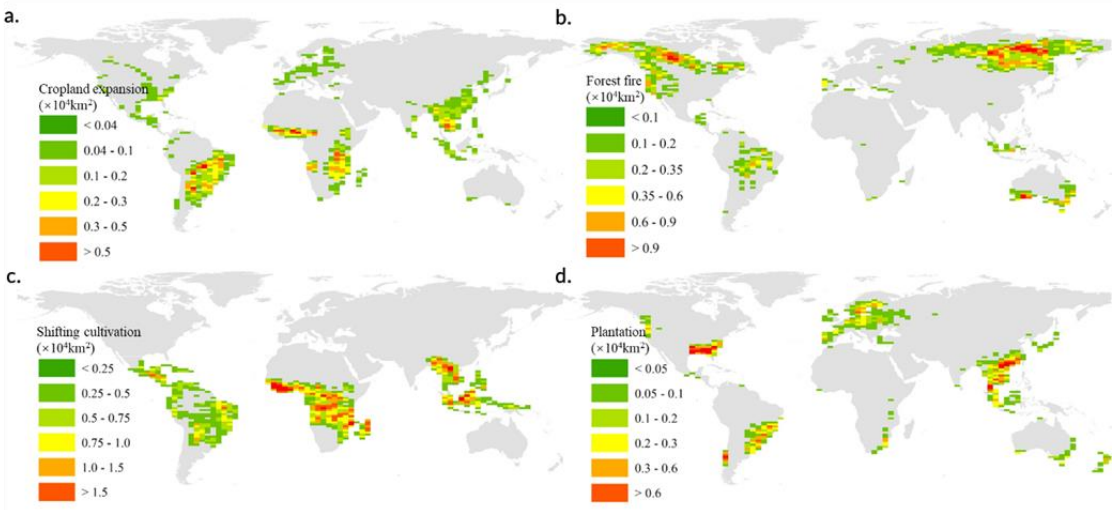
"Figure 7 Global Forest Disturbance Characteristics. a is recovered forest area; b is unrecovered disturbed area; c is undisturbed forest area; d is newly added forest area. These results are presented on a grid of 1.5° × 2.5°, and note varying scales."

Comment #17

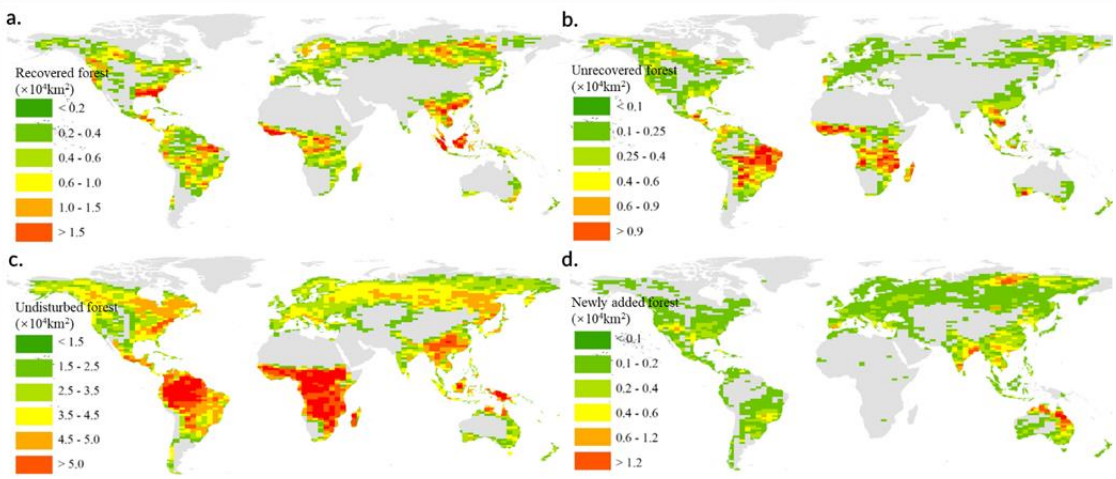
Fig.7 What is the rationale of having red = most in a & b, but red= least in c and d? (For me, a, c and d might be considered 'good'; b is 'bad'.). Fig. 6 was consistent with red = most, so readers are going to be confused here. (**Revised**)

Response #17

Thanks for your suggestion. We have standardized the legends for all subgraphs. All subgraphs are 'red=most' (Page 15, Figure 6; Page 16, Figure 7).



"Figure 6: Global Typical Forest Disturbance Statistics. a. is the cropland occupation on forests; b. is the disturbance caused by forest fires; c. is the disturbance of shifting cultivation; d. is the disturbance of plantations (excluding oil palm). These results are presented on a grid of 1.5° × 2.5°, and note varying scales."



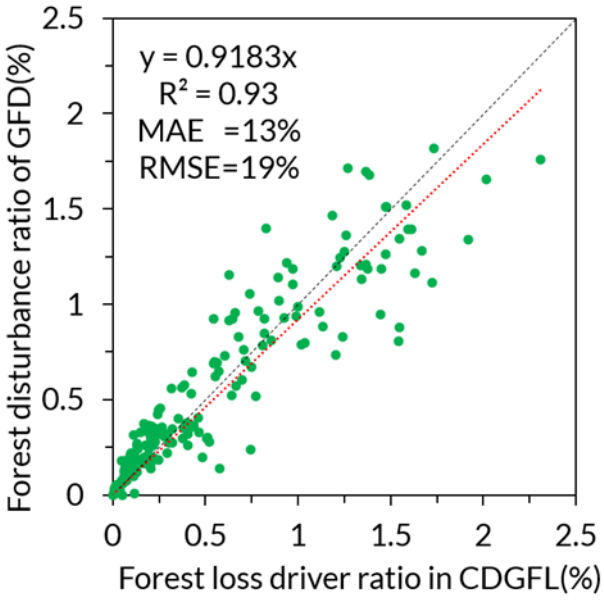
"Figure 7 Global Forest Disturbance Characteristics. a is recovered forest area; b is unrecovered disturbed area; c is undisturbed forest area; d is newly added forest area. These results are presented on a grid of 1.5° × 2.5°, and note varying scales."

Comment #18

328-330 This is misleading, based on the inclusion of 'all' in Fig.8b. That should be replotted excluding 'All'. Consistency over the 5 types is thus much less, and the big deviation for Forest fire requires comment. (**Revised**)

Response #18

Thanks for your suggestion. We have revised Figure 8 and, taking into account the opinions of other reviewers, we have removed unnecessary Figure 8b.



"Figure 8 Overall spatial consistency comparison with CDGFL."

Comment #19

Figs. 8a, and 9a-d: Note that all show highly skewed distributions of both x and y variables. Calculating regressions on logarithmic scales would reduce the influence of the few high values. It would, however , increase the leverage of the numerous small values: a choice has to be made based on the absolute error margins of small versus large values. Perhaps both types of regression should be presented. (**Revised**)

Response #19

Thanks for your suggestion. We strongly agree with the viewpoint. We have added logarithmic scale scatter plots in the Appendix B. In fact, the logarithmic scale fitting results are better, which also highlights the accuracy of our conclusion (Page 20-22, Line 391-409).

"Appendix B

We compared the logarithmic proportional characteristics of forest cover under the same drivers and disturbance types across different global regions. To highlight the consistency of a large number of smaller values between GFD and CDGFL, we performed logarithmic operations on all indicators. According to 200 grids covering a wide range of forest areas worldwide, the proportion of GFD in each grid has a high consistency with the proportion of CDGFL, with a consistency coefficient of 0.81 (R2=0.83) (Fig. B1).

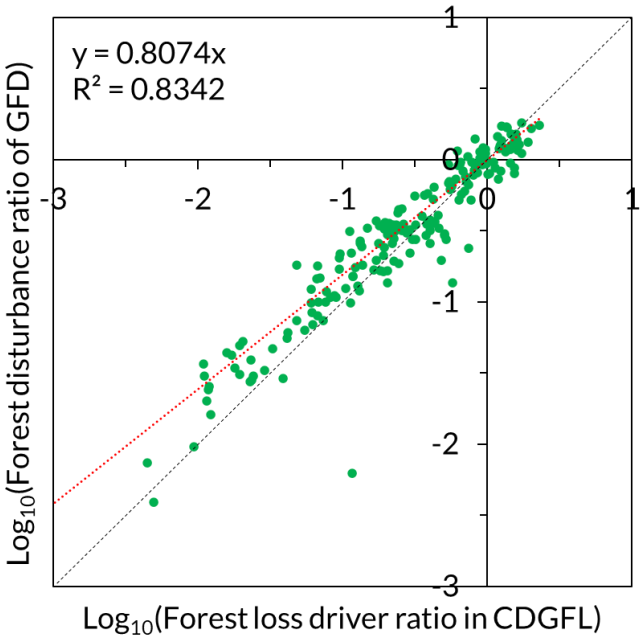


Figure B1 Overall spatial consistency comparison with CDGFL under logarithmic scale.

Under logarithmic scale, all GFD categories also exhibit strong spatial consistency with the existing CDGFL dataset (Fig. 9). We quantified the four dominant disturbance types with the largest proportions: forestry replanting, shifting cultivation, forest fire, and deforestation of natural forests (Fig. B2). The comparative analysis reveals that these four major disturbance types display high spatial agreement with the existing low-resolution CDGFL dataset, with the following metrics: shifting cultivation (R^2=0.80), forestry replanting (R^2=0.77), forest fire (R^2=0.90), and

deforestation of natural forest (R^2=0.80). The spatial consistency fitting of various disturbance types at logarithmic scale is higher, which further supports the main conclusion of section 3.4.

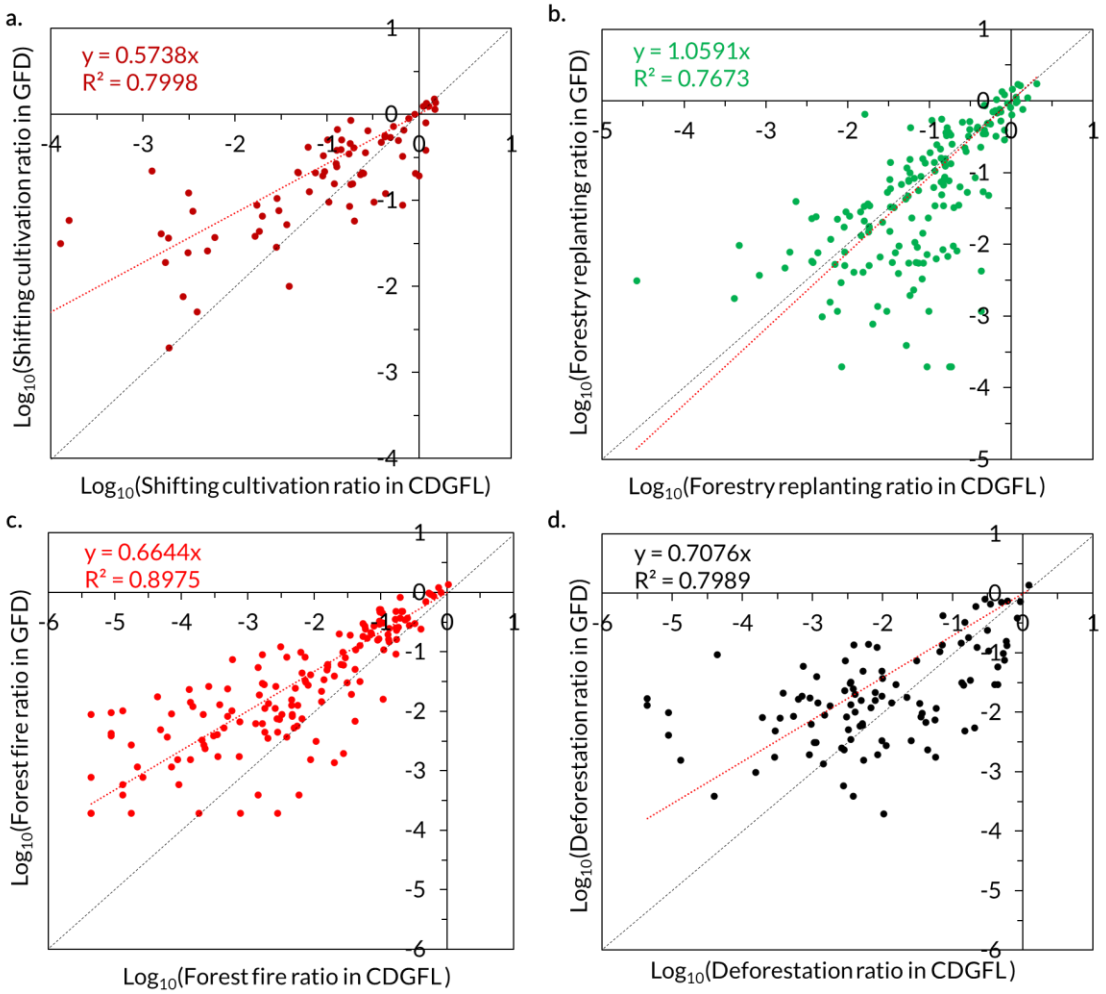


Figure B2 Spatial consistency under different forest disturbance types under logarithmic scale. *a-d represent the spatial consistency of between the GFD and the CDGFL in shifting cultivation, forestry replanting, forest fire, and deforestation of natural forest, respectively."*