Peer Community In Forest & Wood Sciences

Spatio-temporal fire and forest loss patterns in the Dominican Republic

Pauline Garnier-Géré *based on peer reviews by* ***Kevin Cianfaglione*** *and 2 anonymous reviewers*

Jose Ramon Martinez Batlle (2022) Fire and forest loss in the Dominican Republic during the 21st Century. bioRxiv, ver. 4, peer-reviewed and recommended by Peer Community in Forest and Wood Sciences. https://doi.org/10.1101/2021.06.15.448604

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Fires in the Anthropocene, whether natural or human-induced, are among the main factors of deforestation, threatening forest resilience and biodiversity (Kelly et al. 2020). Fire events have also increased in occurrence and severity worldwide in the past decade (e.g. Whitman et al. 2022, Ribeiro et al. 2020). In this context, we need to better understand the links between fire occurrence and their impact on forest loss, especially in countries where such knowledge is lacking.

The work by Martinez-Batlle addresses this need as it thoroughly describes forest loss and fire patterns across the forests of the Dominican Republic (DR), and systematically tests their spatial and temporal correlations across the DR regions since 2001. To this end, the author combines two independent databases from NASA: the Global Forest Change 2000-2018 data service, and remotely sensed data on fire/hotspot occurrence. The author then provides a state-of-the-art analysis pipeline that first shows significant spatial autocorrelations in both forest loss and fire density over the whole period, and each year across the period. Detailed maps of zonal statistics across hexagonal grids also illustrate clusters of either high or low forest loss and fire points, and distinguish small or large clearings. Second, these spatial dependencies are accounted for in spatial autoregressive models, and congruent patterns of forest loss and fire density are shown across the 2001-2018 period in the DR. This is consistent with the initial working hypothesis of a link between deforestation and slash and burn agriculture. Third, detailed time-series analyses and modelling show common cyclical patterns for forest loss areas in large clearings, number of small clearings, and fire density in the first 14 years, with no increasing trends. In contrast, fire density does not predict extensive forest loss in the eastern half of the country for most years. Finally, yearly maps clearly depict uncontrolled wildfires that impacted larger areas in recent years in both the central and southern mountain ranges of the DR.

This work, therefore, provides a solid, detailed, and rigorous account of the current status of forest loss across the DR, and of its causes, either from recurrent fires due to shifting agriculture or from farming linked to

tourism expansion. These results could be very useful for designing strategies adapted to each particular zone of the DR, for preventing human-induced fires or managing wildfires, and for planning post-fire reforestation. This is true, especially for core protected areas where an increasing trend of forest loss is identified in the last 8 years (up to 25% in some mountainous and inaccessible areas of the DR). In those areas, the author suggests implementing a natural regeneration program. Indeed, recent scientists' warnings stress that fires should be accounted for when planning reforestation for climate change mitigation (Leverkus et al. 2022), with evidence in different ecosystems, that natural regeneration with local seed banks would benefit their post-fire recovery. As proposed by the author, this new knowledge for the DR should also help develop policies for managing forest fires and biodiversity, which are lacking in areas close to tourism facilities. More generally, this study offers methods and graphical representations that are likely to inspire future work with similar databases in other countries where data are scarce, on either spatial trends or temporal evolution of forest cover, or fire activities, or both.

References

Kelly LT, Giljohann KM, Duane A, Aquilué N, et al. (2020). Fire and biodiversity in the Anthropocene. Science, 370(6519), eabb0355. https://doi.org/10.1126/science.abb0355

Leverkus AB, Thorn S, Lindenmayer DB, Pausas JG (2022) Tree planting goals must account for wildfires. Science 376(6593): 588-589. https://doi.org/10.1126/science.abp8259

Martinez Batlle JR (2022) Fire and forest loss in the Dominican Republic during the 21st Century. bioRxiv, 2021.06.15.448604, ver. 4 peer-reviewed and recommended by Peer Community in Forest and Wood Science. https://doi.org/10.1101/2021.06.15.448604

Ribeiro LM, Viegas DX, Almeida M, McGee TX, et al. (2020) 2 - Extreme wildfires and disasters around the world: lessons to be learned. In F. Tedim, V. Leone, T.K. McGee (Eds.), Extreme Wildfire Events and Disasters, Elsevier Inc. 31-pp. 51. https://doi.org/10.1016/B978-0-12-815721-3.00002-3

Whitman et al. (2022) Climate-induced fire regime amplification in Alberta, Canada. Environ. Res. Lett. 17(5): 055003. https://doi.org/10.1088/1748-9326/ac60d6

Reviews

Evaluation round #2

DOI or URL of the preprint: https://www.biorxiv.org/content/10.1101/2021.06.15.448604v3
Version of the preprint: v3

Authors' reply, 28 June 2022

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Decision by Pauline Garnier-Géré, posted 14 June 2022

Editing corrections before recommendation

Dear José Ramon,
Thank you for your revised version,

We are pleased to recommend your manuscript within the PCI for Forest and Wood Science, after you have addressed the few editing comments and typos to correct for the final version of your manuscript:

Organisation of the supplementary information, Figures and tables:

The current numbering of figures is a bit confusing. I suggest that you rename the "Appendix section (usually devoted to mathematical developments or additional raw data at the end of the main text) as a "Supplementary information" section. In this section, please add a supplementary methods section (see below) where you can include the parts of the previous texts that you removed from the original methods (original end of line 94 to line 101 and 104 to 109 which are think are important to include).

Here in the methods, I think at least one of your Fig. A1 or A2 is needed in the main text. This will prevent having to go to supplementary to initially view the original or cleaned data with geographic map details on the case study. It can be renamed Fig. 2 since Fig 1 is the graphical method abstract.

Then the Figure that you did not put back in the main text (A1 or A2) becomes Fig. S1,

Fig. B1, B2 and B3 become Fig. S2, S3 and S4,

Fig. C1 and C2 become Fig. S5 and S6, and Tables C1 and C2 become Tables S1 and S2,

Fig. D1, D2, D3 and D4 become Fig. S7 to S10.

Then rename the figures in the text accordingly.

The quality of the figures is rather poor (we can't zoom in to better see the details or text within figures for example), please refer to the formatting requirements of the PCI to make sure the quality is sufficient.

Summary:

About the third point (sentence before last), I suggest to add "in fire and forest loss patterns" after "significant differences" based on your results.

Introduction:

Line 2: add "(SDG)" since you are using the abbreviation later after "Sustainable Development Goal"

Lines 5 to 8: can you please cite a reference after "in preserved areas", and another one if possible after "secondary forests".

Materials and methods

2.1 part

In Fig. 1: correct "gobal" to "global" in the top left square, replace "stats" by "statistics" the 3 times it is used, it should fit. Change "false positive" to "false positives". In the legend of Figure 1: please add "and see the Data and code availability section for provided scripts." after "details".

Lines 70: Change "Fig. A1" to "Fig. S1" or Fig. 2 (depending on which alternative you choose for or of Fig. A1 or A2 to put in the main text, see above).

Line 104: Change "Fig. A2" to "Fig. S1" or Fig. 2 (idem).

There are 2 parts of the previous text that you removed in this 2.1 part (without indicating it in tracking mode). This makes the text easier to read but as said above, please put those parts the supplementary section.

Lines 111 and 181: Replace "statistics techniques" by "statistical techniques".

Lines 127 to 132 should be relocated at the end of part 2.1, since after the consistency check (top of Figure 1), you focus now on the MODIS dataset in this revised version. Thus the VIIRS datasets should not appear in the rest of the sections as it is implicit that you are using similar approaches within the corresponding periods for consistency checks.

Lines 134 to 140: this paragraph is not edited as requested, according to the MODIS data focus only. Suggestions are to: add "noise-free" after "MODIS", add "the above defined" before "forest", add "cover" after "forest", then remove

"stands with a canopy closure equal to or greater than 25%, which I generated from the year 2000 tree cover raster layer. Then, I"

since it is redundant with what's explained above and in the Fig. 1, remove also "from both datasets".

Also please change "Last, I divided the number of points by the cell area in square kilometers, and then again by the number of years of each of the two periods of analysis, from which I obtained two data fields,

one for each period of analysis, containing the average density of fire points per square kilometer per year (hereafter, fire density)." into "Last, I divided the number of points in each cell by its area (in km2) and by the number of years, which resulted in fire density (Fig. 1)."

Lines 141 to 146: these lines can be summarized without loss of information content as follow, if you agree: "I pooled forest loss surface area representing the period 2001 to 2018, then divided it by the corresponding cell size and by 18 years to obtain the average forest loss per unit area per year."

2.2 part: some summarizing can be suggested:

Lines 154 to 156: please replace "In particular, I focused on assessing the association between those variables considering the size of the forest clearings, using both a.." just by "with..." in the text, since the details are given afterwards on how the different size of clearings is considered.

Lines 158 to 160 until "source": replace "I generated 18 maps of annual forest loss, one per each year of the study period, using the loss year raster as a source" with "I used the forest loss year raster to generate 18 annual maps".

Lines 162 to 166: replace "Afterwards...1 ha in size" with "Additionnally, annual maps of "small forest clearings" were produced with patches of less than 1 ha in size, and maps of "medium- and large-sized forest clearings" (or large clearings") with patches larger than 1 ha (Fig. 1)".

Lines 176 from "I used a regular grid...": please summarize as "This larger area than for cells used in the long-term approach was chosen to reduce the skewness of variables distributions and improve adherence to normality".

Part 2.3

Line 197: remove "the".

Line 198: remove "method".

Line 204: remove "Afterward".

Line 210: please add a reference for the Moran I statistic (suggestion: Sokal, R. R. and Oden, N. L. (1978). Spatial autocorrelation in biology. 1. Methodology. Biol J Linn Soc, 10: 199–228.).

Line 233: remove "The final stage was to produce"

Line 234: add "were produced for" after "graphics" and remove "in" before "QGIS"

Line 239: add "; see also the Data and code availability section" after 2017

Results

Line 244: replace "quite high" by "close to 1"

Line 249: replace "was good enough" by "highly correlated across time and thus appropriate".

Line 258: add "points" after 11700.

Figure 3 legend: recall what HH and LL mean.

Line 297: replace the "Spatial modelling" subtitle with "Spatial dependence between Forest loss and Fire density".

Lines 298 to 306: these lines are redundant with lines 199-200 and 221 to 223 in the methods, please combine lines 298 to 306 to those previous lines and remove from the results.

Lines : 309-310: please remove "The relevant statistics of the spatial error models fitted are summarized in Table 2" and add "; Table 2" after "(p«<0.01".

Also please refer to the formatting requirement for reporting probability for a recommended PCI manuscript format.

Line 312: add "the" before "spatial error model".

Line 335: replace "originated" with "originating"

Lines 340 and 344: remove "see" before "Figs"

Line 357: please change "analysis" to "patterns" and remove "spatial modelling" from the subtitle.

Figure 8 and Figure 9 legends: please change "Same legend as in Figure 7" with "See Figure 7 for colour legend of hexagons".

Line 426: add "was" before "significantly"

Discussion

Line 468: please replace “All in all” with “Overall”

Evaluation round #1

DOI or URL of the preprint: https://doi.org/10.1101/2021.06.15.448604

Authors’ reply, 18 May 2022

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Decision by Pauline Garnier-Géré, posted 28 December 2021

Minor revisions needed for your submitted preprint

Dear José Ramon,

Three reviewers have now assessed your work. They are overall very positive and find that both the methods using remote sensing data and the patterns described are convincing, helping the understanding of links between fire due to shifting agriculture and forest loss in Dominican Republic ecosystems. They also think that your spatio-temporal approach could inspire other studies in other countries.

They explain however that you need to address several issues before your manuscript could be recommended, and I am joining them with a few additional suggestions.

The first one concerns the methodological approach and comparison of datasets: in the long-term approach, you compare statistics and patterns from the MODIS and VIIRS datasets but use different time periods (see more details in the referees’ comments). This makes it difficult to interpret results, and the comparison should be restricted to the same periods (e.g. in Table 1). It is also proposed that after this comparison, you should focus on the longer dataset. I agree with these comments and am adding that it could also be useful, if you consider it not too redundant to the annual approach, to compare a few different multi-year periods (overlapping or not) to address your working hypothesis about an increase of association between fire and forest loss. Besides, possible benefits of one dataset compared to the other could be discussed and lead to recommending which one is more appropriate to answer the targeted questions. You may also put some of the annual approach results, using the second dataset, in supporting information.

Addressing this first issue will help address the second one that concerns mostly the form of the manuscript and the presentation of the results. I agree with the two referees who suggest restructuring part of the text (some methods being currently in the results, see details), and also reducing both methods and results, in order to clarify them (adding also sub chapters) since they are too long, and not easy to follow in some parts. I am adding one suggestion here: to please make a summarized figure of the flow of statistical analyses, to help follow the methods text, as this would greatly help to understand this part and help you summarize your text. Other comments from the referees explain specific parts that require more explanations or corrections.

The third important point is to extend the discussion a bit more, referring to your initial questions and developing more how your approach and results could be used to monitor or predict risks and prevent forest loss threats, integrating possible alternative strategies (see comments from the third referee).

Finally, all the valuable code that you have made available on your Github website for reproducing the analyses is not put forward nor referred to in your current manuscript. I suggest that you add a ”Data and code availability” paragraph at the end of the manuscript where you provide the links, explaining also how it is structured, you can also refer to it at the end of the methods.

In your revised manuscript, please provide constructive solutions to all main and detailed comments from the referees below, as well as to the additional comments above,

Thank you for considering the PCI Forest and Wood Science for submitting your work, and I am looking forward to receiving your revised version,

Yours sincerely,

Pauline Garnier-Géré

Reviewed by anonymous reviewer 1, 09 December 2021

The author assesses deforestation and fire activity (through MODIS and VIIRS data) and then assesses to what extent the latter overlaps with the former. I find the manuscript well-written and clear. The analytical methods are varied and somewhat intricated but adequate to the best of my knowledge. Likewise, the results and discussion are well presented and thorough. It's mostly descriptive work of patterns and the interest is somewhat local but I think it can provide guidance and inspiration for analyses at larger spatial scales in the frame of more ambitious projects.

Reviewed by anonymous reviewer 2, 05 December 2021

The submitted manuscript reports a study about the relationships between fires and forest losses in the Dominican Republic. The study is based on the use of several databases, built with remote sensing data.

The manuscript is fairly well-written (but see below) and the results are convincing. As a whole, I think that the study deserves being recommended, but I have a major concern about the approach that should be addressed before recommendation.

The author used for fire data two datasets: MODIS and VIIRS. The problem is that these datasets do not describe the same period (2001-2018 versus 2012-2018). The presented results are consequently not comparable and should not be compared on a multi-year basis.

Based on the presented results (Table 1, Figures 6, and Figures 10-11), it seems that the two kinds of data are well-correlated to each other, but produce values of much different magnitude. Consequently, I propose to revise the manuscript with the following approach:

(1) Build a 2012-2018 dataset for MODIS, and compare with the VIIRS dataset. These comparisons should be discussed in terms of consistency and sensitivity.

(2) Select only the MODIS dataset for further analyses as it represents a longer period than the VIIRS dataset.

(3) Present the results (as in the submitted version) but only with the MODIS data.

Other comments:

- Title: "Fire and forest loss…" instead of "Forest loss and fire…"
- Abstract:

  => first line: remove "valuable"

  => "I found no statistical association between forest loss and fire in the eastern half of the country, a region that hosts a large international tourism hub". This sentence is rather elusive in the context of the abstract. This should be removed or explained.
- line 16-17: reference format.
- Methods: in several passages of the manuscript (lines 17-19; 257-262; 279-287; 288-297), the methods are described outside the section dedicated to methods. Move them to the methods section.
- lines 43-45: merge the two questions.
- lines 85-88: indicate the proportion of missing values.
- lines 89-94: this looks like rather subjective. What were the explicit criteria?
- Figure 2: indicate that this figure presents the fires.
- lines 118-120: explain the rationale of this baseline.
- lines 319-320, 330-333, 457-458: I don't see any clear cyclical pattern in the results. Please argue.
- Figure 7: recall what the Moran's I represents.

- Figures 8-11: recall what LISA means.

Reviewed by Kevin Cianfaglione, 20 December 2021

the paper is very interesting, but there are various things that need to be improved. Some chapters are too long and difficult to read. I recommend breaking these chapters into several parts and summarizing the text to the essentials, eliminating the superfluous or redundant parts. Rewrite the text using the third person and not the first person. Also consider in the discussions the need to leave the vegetation to the free natural evolution and the forests without necessarily having to think about intervening in some way.

Please see the attached file to see more details and osservations. Hoping to be useful.

Keep in touch

Note from the MB: We removed the figures from the attached file to make it possible to upload it (do not take into account these missing figures)

Download the review