egusphere-2025-4859 – Author's response to Anonymous Referee 1

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Referee comments are written in blue italics; author's responses are written in normal font; and applied changes are highlighted in green font.

This is an interesting manuscript that describes the application and dissemination of a wildfire risk and exposure assessment in the border region between Germany and the Czech Republic. This region, like many others in Northern and Central Europe, has not been typically considered as a hub of wildfire activity (unlike Southern Europe). Consequently, both the public and government agencies lack the awareness and preparedness to address the possibility of fire becoming a more common natural hazard in the near future due to climate change. A large wildfire in 2022 which had devastating effects on both human property and local forest ecosystems has motivated the authors to study fire risk and exposure in the region. To that end, they utilized a common modelling approach based on a widely-used fire spread model, FlamMap, to create maps of burn probability and flame length across the entire region assuming three weather scenarios and three fire durations. They then intersected fire hazard maps with data on property and infrastructure to estimate potential wildfire for all settlements in the region. Finally, they created a web-based interactive map that allows stakeholders to learn about fire risk in the region; and presented this tool to a group of stakeholders, soliciting their inputs on the map.

We thank the reviewer for the detailed review and helpful suggestions. We have revised the manuscript accordingly and provide point-by-point responses below. In addition to the changes described in response to the comments, the manuscript has been carefully proofread and revised throughout to improve grammar, syntax, clarity, and the overall flow of the text. Minor textual revisions and restructuring of individual sentences and paragraphs have also been made where appropriate.

Major comments

The main strength of this manuscript is its holistic approach to addressing a growing wildfire problem in a new region. in contrast to most studies, this study did not end with the completion of the fire risk map, but continued to dissemination and accepting feedback from relevant stakeholders. This provides valuable lessons to researchers in other regions where fire problems may arise in the future, as they seek to educate stakeholders on an emerging threat. This strength of the manuscript *compensates for the fact that its scientific novelty is rather low. The methodology follows a standard approach for mapping wildfire hazard and exposure that's been around for more than a decade, so it's only novelty is the generation of a fire risk map for a region that didn't have one before. The development of the web-based map is important for dissemination but it's mostly a technical contribution. And the focus group approach to study the relevancy of the results is not novel in the context of fire risk analysis, though the insights gleaned form it may be used to improve publicly available fire risk maps in the future. I have no qualms with the risk mapping approach, as it was based on mostly standard procedures, though these had to be adapted to the particularities of the specific study region (i.e., generation of new fuel models and selection of suitable weather data). I think that the authors' approach is reasonable given data limitations, and consequently the predictions of the models under different scenarios make sense.*

We thank the reviewer for taking the time for the in-depth review. We appreciate the recognition of the study's holistic approach, particularly the combination of wildfire risk mapping, dissemination through an interactive map, and stakeholder feedback. We also acknowledge that the methodological components are based largely on established approaches. Our intention was therefore not to introduce a novel methodological framework, but to adapt these methods to a region where such assessment was previously unavailable and to extend the work toward communication and stakeholder-oriented application. We have revised the manuscript to clarify this contribution more explicitly.

In contrast, the choice of methodology for the purpose of validation was confusing to me. If the actual perimeter of the 2022 fire is known, why was the ground truth based on remote sensing data? Is it because the daily progression of the fire is unknown?

Unfortunately, no official data has been produced in relation to a day-to-day mapping of the 2022 wildfire, neither by the German nor the Czech authorities. To counter this lack of ground truth data, it was decided to employ active fire detections from MODIS and VIIRS from FIRMS as the best possible approximation for the progression of the fire. However, please note that we have revised the validation approach in order to provide a more detailed quantification of model accuracy in representing the burned area and spread of the 2022 fire as seen from the answer to the comments below.

To what extent can we trust remote sensing data as "ground truth" for validation purposes, given that RS fire products suffer from significant commission and omission errors?

We acknowledge that MODIS and VIIRS active fire products contain omission and commission errors and should not be considered strict ground truth. We have revised the manuscript to clarify that these products were used as independent remotely sensed datasets rather than absolute ground truth. We have therefore added to the Limitations "We acknowledge that our evaluation approach can only approximate the assessment of actual fire spread because active fire products contain omission and commission errors, which are caused by the limited temporal overpass of the satellites, the under-detection of low intensity and small fires, and the coarse spatial resolution, respectively. Therefore, the evaluation should be interpreted as an informed consistency check rather than strict accuracy validation."

For the validation of simulated fire spread, we now combine the timing of active fire detections from VIIRS/MODIS with the map of total burned area of the fire event. The burned area map is based on the map of the Copernicus emergency management service, which has been checked and revised by in situ mapping of the National Park administrations. We already used this map in our earlier publication (Beetz, 2023). We extracted the day of fire detection from the VIIRS and MODIS active fire observations and created a 500m buffer around each daily detected ignition, representing a compromise between the spatial resolutions of the two sensors. These buffered detections were then overlaid with the mapped burned-area perimeter to approximate when burning was first detected within different parts of the final burned area, and were compared with the modelled fire extents (Figure AC1 1, in manuscript this is Figure 8).

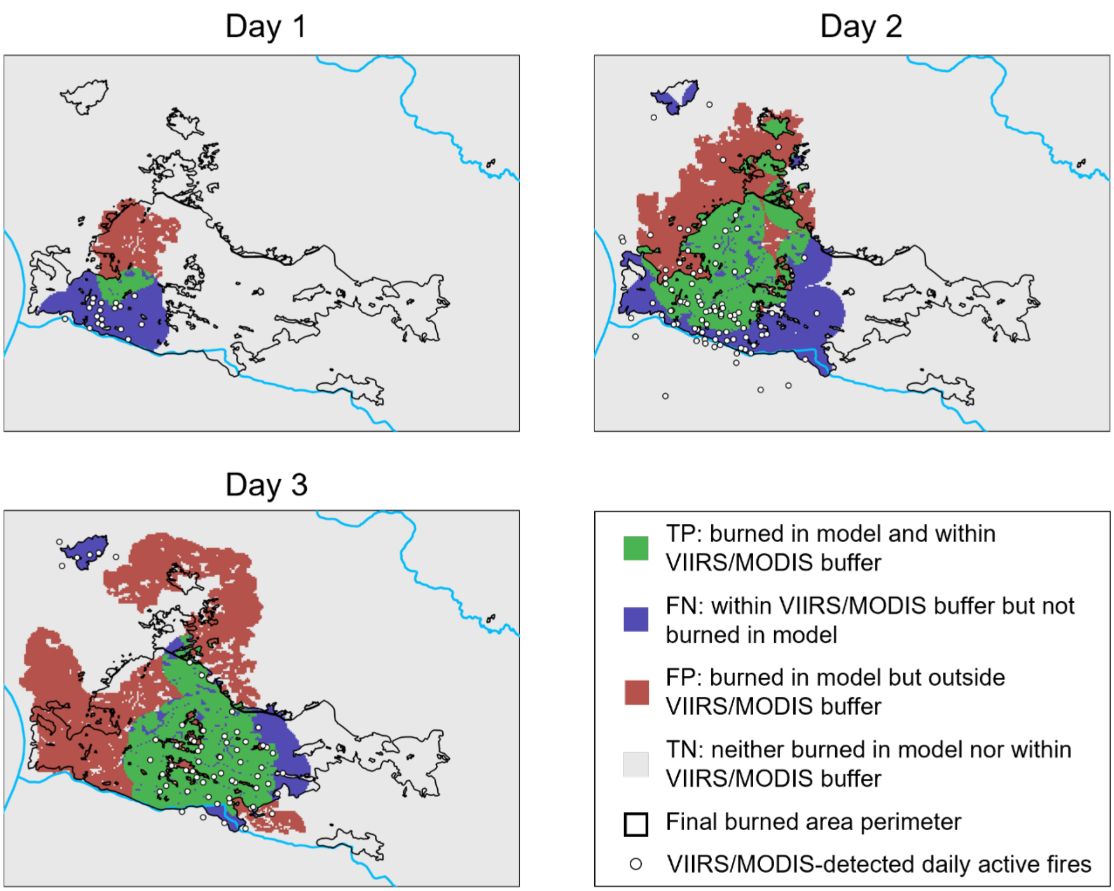

Figure AC1 1: Comparison of modelled daily fire spread with the area derived from combining 500 m buffers around VIIRS- and MODIS-detected daily active fires. TR: true positive, FN: false negative, FP: false positive, TN: true negative.

This new validation method therefore assesses spatial consistency between modelled fire spread and the day of first fire detection, restricted with the actual burned area. We describe this new approach by altering the lines 420-431 to:
"The modelled daily fire perimeters were evaluated with the dates of first fire detection. As there are no ground-observed isochrones of fire spread available for this fire event, we combined active fire detections by the Moderate Resolution Imaging Spectroradiometer (MODIS, (NASA MODIS Science Data Support Team, 2021) and the Visible Infrared Imaging Radiometer Suite (VIIRS) aboard S-NPP and NOAA 20 (formally known as JPSS-1) (NASA VIIRS Land Science Team, 2020) within the boundary of the final burned area perimeter. VIIRS and MODIS active fire data comes in 375 m and 1 km (at nadir) spatial resolutions, respectively. The final burned area perimeter is based on the map of the Copernicus emergency management service, which has been checked and revised by in situ mapping of the National Park administrations. The burned area map has been used before in Beetz et al. (2024). For the evaluation, the available satellite-detected active fires for the first three days of the 2022 wildfire (24.07.2022 – 26.07.2022), were merged and then classified into three daily layers. Each active fire point was then assigned a 500m buffer as a compromise between the spatial resolutions of the VIIRS and MODIS sensors. The resulting buffered daily active-fire detections were overlaid with the final burned-area perimeter to approximate which areas of the final burned area were burning on each day. These daily maps of fire detection were then compared with the fire perimeters derived from the three aforementioned FlamMap simulations, which were likewise produced for the first three days of the wildfire."
This text is now part of the new methodology section 2.8 "Methodology for the evaluation of wildfire modelling".

Also, I get why the validation was done on a day-by-day basis (to account for the static wind conditions in FlamMap), but constricting the prediction of fire spread to a single day (starting the actual fire perimeter at the day's start) can inflate the model's accuracy.

We agree that the use of three consecutive daily simulations reduces cumulative error and does not represent a continuous three-day fire reconstruction. However, FlamMap operates under static weather assumptions. The day-by-day implementation was therefore chosen to approximate short-term spread under quasi-static daily wind conditions, rather than to fully reconstruct the historical wildfire event. We have clarified this limitation in the revised manuscript. To address this, we changed the strong wording of lines 404-405 to: "To assess the plausibility of the wildfire modelling approach used in this study, we evaluated whether FlamMap could reproduce spatially consistent short-term fire spread patterns during the first three days of the 2022 wildfire, under daily mean fire-weather conditions."

If FlamMap cannot handle dynamic weather, perhaps we shouldn't expect it to reliably reconstruct actual fires but use it only for its intended purpose: revealing areas at risk due to existing fuel composition and configuration and prevailing fire weather conditions (typically assuming extreme weather, because these conditions results in the worst fire outcomes).

We agree that FlamMap is primarily designed to reveal areas at risk due to existing fuel composition and configuration and prevailing fire weather conditions, or to simulate potential fire behaviour under specified fuel and weather conditions rather than to reproduce historical wildfire events. Indeed, in this study the objective of the evaluation was not to replicate the wildfire precisely, which has already been undertaken by some of our co-authors (Kudláčková et al., 2024), but to assess whether the modelling framework produces spatially plausible fire spread patterns under observed daily fire weather conditions.

Another issue in the validation method is the choice of accuracy metric. The % of fire detections within the modelled fire perimeter would always be 100% if FlamMap predicts that the entire landscape burns. But this will obviously reflect a massive commission error, which cannot be accounted by the metric used here. Instead, both omission and commission errors should be reported, ideally based on actual fire perimeters (see my previous comment) rather than on remotely sensed data.

We fully agree with the reviewer. Based on the daily maps of first fire detection as described above, we now perform a complete accuracy assessment of the modelled daily fire spread maps - by keeping the limitations of the active fire detection data in mind. Therefore, we now quantify for the first three days of fire spread the area of correct and false positives and negatives, after a random sampling of 50000 points within the study area (Table AC1 1).

Table AC1 1: Confusion-matrix percentages and derived validation metrics comparing simulated fire spread with VIIRS/MODIS-based active-fire detections for the first three days of the 2022 wildfire, based on a random sample of 50,000 raster cells for each day.

Day	True Positives [%]	False positives [%]	False negatives [%]	True negatives [%]	Omission error	Commission error	Jaccard (IoU)
Day 1	0.6	2.1	2.7	94.6	0.824	0.788	0.106
Day 2	6.5	6.6	5.3	81.6	0.448	0.501	0.355
Day 3	7.3	13.3	2.7	76.7	0.269	0.644	0.315

For the interpretation of the table, we replaced lines 431-434 with the following:

"Table 3 [here, Table AC1 1] presents the confusion-matrix results and validation metrics for the comparison between simulated fire spread and satellite-based active-fire detections. Metrics utilising TN, such as overall accuracy were not considered, as they would give deceivingly large values, due to the over-prominence of TN."

The rest of section 3.4 also describes the results of Table 3:

"The simulated fire spread increasingly resembled the satellite-derived active-fire detections as the wildfire progressed (Figure 8). On Day 1, the overlap between simulated and observed fire areas was limited, with only 0.6% of sampled cells classified as true positives and a Jaccard similarity of 0.106 (Table 2). By Day 2, the correspondence improved substantially, reflected in higher true-positive values (6.5%) and a Jaccard similarity of 0.355. On Day 3, the simulated fire perimeter continued to capture a large proportion of the observed fire extent, although the increased number of false-positive cells resulted in a slightly lower Jaccard similarity (0.315) than on Day 2. Omission error decreased steadily from Day 1 (0.824) to Day 3 (0.269), whereas commission error was lowest on Day 2 (0.501) and increased again on Day 3 (0.644)."

We also added to section 4.2 of the Discussion:

"On Day 1, the model shows very limited correspondence with the areas identified from VIIRS/MODIS detections, reflected in the high omission (0.824) and commission (0.788) errors. Consequently, the Jaccard similarity is low (0.106), indicating only minor spatial overlap between modelled and detection-based fire areas. This is likely caused by the frequently changing wind directions during this day as reported by local firefighters, which is however not represented in the wind data used here. On Day 2, the model reproduces the general spatial pattern of fire spread more successfully, with substantially higher Jaccard similarity (0.355). Both omission (0.448) and commission (0.501) errors remain moderate, suggesting that while the model captures a considerable portion of the observed burning, it still both misses and overpredicts parts of the burned area. On Day 3, omission error decreases further (0.269), indicating that most of the detection-based fire areas are captured by the simulation. However, commission error increases (0.644) and FP are much higher than Day 2, reflecting a tendency of the model to overestimate the spatial extent of fire spread, which might be related to the success of firefighting operations not represented by the model. Overall, these results suggest that the model captures the general progression of the wildfire during the later stages of the event, although notable discrepancies between simulated and observed fire extents remain."

While the manuscript's presentation is really thorough, its flow can be much improved by trimming repetitive information and excessive data about some of the methods which delve too deeply in technical descriptions of well-known tools such as FlamMap and background on fuel models. Importantly, the results contain much superfluous information as each sub section tends to begin with description of methods (e.g., lines 352-353, lines 404-429, 440-445, 462-470) and/or a detailed description of the figures that should be left to the caption (e.g., lines 353-354, lines 323-326). It will be much easier to follow if results are simply described, following with a pointer to the relevant figure. Methods should not be described in the results section. Moreover, the results section contains some discussion materials which are out of place (e.g., lines 361-369). In general, a clearer distinction between the methods, results and discussion sections is needed.

The authors agree with the recommended structure and these suggestions have been implemented accordingly.

Specific comments

Line 16: " ... to create an interactive wildfire exposure map"

We changed this as suggested.

Line 24: since the map was tested with audiences, there should be a sentence that mentions the results of this test at the end of the abstract.

We have included the following to account for this:

“The interactive wildfire exposure map was tested with the general audience and local stakeholders for its usability and usefulness. Based on 50 questionnaire responses, participants generally rated the map as easy to use and were able to interpret the bivariate legend correctly in most cases, while also providing suggestions for improvements to support potential applications in monitoring and management of the national parks.”

Line 29: a reference is needed to support the claim that wildfires are increasing in the WUI. For example: Radeloff, V.C., Helmers, D.P., Kramer, H.A., Mockrin, M.H., Alexandre, P.M., Bar-Massada, A., Butsic, V., Hawbaker, T.J., Martinuzzi, S., Syphard, A.D., Stewart, S.I. (2018) Rapid growth of the U.S. Wildland Urban Interface raises wildfire risk. Proceedings of the National Academy of Sciences 115:3314-3319.

We thank the reviewer for this recommendation and have inserted the reference. We also found the Guo et al. (2024) paper which also supports this claim. Additionally, we also moved the Bowman et al. (2017) reference, as we believe it more closely supports the statement that climate change causes an increase to extreme wildfires. Further restructuring has also been implemented to better frame the Ursino and Romano (2014) paper. The first paragraph of the would thus looks as follows:

“In recent years, destructive wildfires have expanded far beyond the regions where they have traditionally occurred, becoming a global and escalating phenomenon linked to climate change (Abatzoglou et al., 2025; Bowman et al., 2017; Jones et al., 2022, 2024). At the same time, the rapid expansion of the wildland–urban interface (WUI), where human settlements are intermixed with natural vegetation, has increased the exposure of human settlements to wildfire risk (Guo et al., 2024; Radeloff et al., 2018). In addition, land-use change and the abandonment of agricultural and silvicultural practices contribute to fuel accumulation and increased wildfire activity in many regions (Ursino and Romano, 2014). The expansion of the WUI, combined with the worsening effects of climate change, render WUI wildfires even more potentially disastrous (Oliveira et al., 2020; Trnka et al., 2020). Wildfires in the WUIs can have a significant impact on both natural and human environments, and they pose unique challenges to traditional firefighting approaches due to their complexity and the interface between different land uses (Caballero and Beltrán, 2003)”

Lines 36-37: How many buildings were destroyed in these settlements? This is important for context.

More specific information was found from corresponding references and implemented as follows:

“Even temperate countries like those in Central Europe, which have historically been spared from destructive wildfires in the WUI (Heisig et al., 2022), have recently experienced wildfires with direct impacts on the built environment. In 2022, three houses burned down in Mezná, Czech Republic (Almeida et al., 2024) while in Falkenberg/Elster, Germany, a fire spread to built structures and burned part of a piglet-breeding facility; nearby single-family houses were also seriously threatened (Ministerium des Innern und für Kommunales des Landes Brandenburg, 2023).”

Accordingly, in line 97, the mention of the houses being destroyed has been removed, as now this information is provided in the Introduction.

Line 76: "we aim to provide a quantification of the" is cumbersome. Perhaps replace with: "we aimed to quantify wildfire exposure for different settlements in the region"

We have changed this as suggested.

Lines 79-81: This text is unnecessary and may be deleted.

We have deleted this text as suggested.

Lines 89-91: These two sentences can be combined and written more concisely, e.g., "The study area also includes several settlements that are not part of the conservation area of saxon switzerland but are surrounded by it (Figure 1)."

We have changed this as suggested.

Line 94: Good, but figure 1 shows many historical fire ignitions. Please describe the fire regime of the study area, i.e., how many fires per year, fire size characteristics, main ignition sources.

We agree that additional context on the local fire regime would improve the manuscript. We therefore implemented the following two changes to the manuscript.

First, to avoid confusion between historical ignitions in the study region and the expanded ignition dataset used for simulations (described later in section 2.3.1), we revised Figure 1 to display only historical wildfire ignition locations. Accordingly, we changed "Figure 1" from lines 154-155 and line 341 and replaced it with "Figure E1 of Appendix E" to point to the only figure that now contains the simulation ignition points.

Second, we added a new paragraph in section 2.1, starting right after line 93, describing the historical fire regime based on the available datasets:

"Based on the historical ignition datasets described in Sect. 2.3.1, wildfire occurrence in the study area is predominantly human-caused. For the German (Saxon) part, the most frequently reported ignition category is open fires by other persons (41.7%), followed by unknown or unclear causes (26.6% combined), while lightning accounts for 10% of cases. For the Czech part, the dominant ignition categories are setting fires in the countryside/burning grass (44.2%) and smoking (37.4%), whereas lightning represents 3.1% of cases (other natural causes <2%). Based on the available records used in this study, the Czech dataset (2016–2020) includes 163 ignitions (32.6 per year), while the German dataset (2008–2020) includes 60 ignitions (~4.6 per year). Seasonality differs between the two sides of the border: in Saxony, ignitions are strongly concentrated in late spring and summer (April to August: 80% of cases; May to June alone: 50%), whereas in Czech Republic ignitions are more broadly distributed across the year (April to August: 67.5%), with a secondary contribution in October and November (~16.6%). The available records do not include burned-area information; therefore, fire size statistics could not be derived."

Line 99: If the ignition cause of the 2022 fire is known, it should be stated.

To address this, we changed Line 96 to:

"The fire, caused by an arson, started in the Czech National Park and spread across the border into the German National Park (Beetz, 2023)."

Figure 1: The caption should mention the range of years for these ignitions.

The caption was changed to:

Figure 1: Figure 1: Study Area. The study area consists of two National Parks and two Conservation Areas at the border between the Czech Republic and Germany, and experienced a large wildfire in 2022. Historical ignitions for the period 2008 – 2020 are also shown.

Line 125: Did the model account for the potential of spotting? In principle, FlamMap can do so but was it implemented in this study? This is important because spotting is a major driver of fire spread under extreme weather conditions.

Thank you for this important comment. In this study, spotting was not simulated in FlamMap. In FlamMap/MTT, spotting requires that passive or active crown fires are modelled; without crown fire, spot-fire ignitions are not produced. In our modelling setup, crown fires were not modelled because the fire-modelling landscape lacked the required canopy layers (canopy height, canopy base height, and canopy bulk density).

We did consider incorporating these layers using the European-wide canopy/fuel dataset produced within the European Commission's FIRE-RES project (Kutchartt et al., 2024; Pirotti et al., 2023), which provides these canopy variables for our study area. However, these canopy data represent conditions around 2020, whereas the study area experienced substantial bark-beetle-related canopy degradation between 2020 and the 2022 wildfire. Without site-specific validation (e.g., field-based verification of canopy structure as in Heisig et al., 2022), using these canopy layers risked introducing uncontrolled bias in crown-fire (and hence spotting) occurrence. Given the scope of the study, we therefore did not include crown-fire/spotting and explicitly acknowledge this as a limitation on lines 542-543 of the Limitations. For better clarity, we rephrased this part to:

"As up-to-date data on canopy structure that is representative of bark-beetle-affected conditions were not available, crown fires and thus spotting were not modelled. Consequently, fire spread and intensity may be underestimated under extreme weather, especially where firebrand transport could enable rapid downwind growth or cross-barrier spread."

Lines 142-144: Random ignitions are not the standard in informed fire simulations, so there's no need to write why they weren't used. In the real world, fire ignitions are never randomly distributed. It's sufficient to start by stating that historical fire ignitions were used, and these had a clear spatial pattern in the study area.

We have changed this as suggested. Specifically, the part from line 140 now reads:

"To start fire spread simulations, ignition locations are needed. For the ignition points we first considered historical fires, which reveal clear spatial patterns of fire occurrence and ignitions in the study area, mainly along the Elbe valley and forests north of the city of Děčín and along some common hiking trails and points of interests in both National Parks (Figure 1)."

Line 144: How many years does 'historical' reflect?

We have changed this as suggested. Specifically, the corresponding parts from line 144 will be changed to:

"Historical forest fire ignition data (60 ignitions, spanning 2008-2020) for the German part of the study area were provided by the Saxon State Authority for Forestry (Staatsbetrieb Sachsenforst, 2023)." and "Ignition locations from the Czech part (163 ignitions, spanning 2016-2020) were acquired from the Fire Rescue Service of the Czech Republic (Hasičský záchranný sbor České republiky, 2023)."

Lines 152-155: Unclear. Are you balancing the total number of ignitions or ignition density (N/Area)? The former is only correct if both parts have the same area.

Thank you for pointing this out. We indeed intended to balance ignition density (N/km²), not the absolute number of ignitions, because the German and Czech parts differ in area. To clarify this, we changed lines 152-155 to:

"To balance ignition density between the German and Czech parts of the study area (i.e., number of ignitions per km²), we used the lower density Czech side as the reference and randomly subsampled the German ignition locations so that the German ignition density matched the Czech one. The final number of ignition points was 363."

Section 2.3.3: This is unrelated to the modeling stage and should be moved to the beginning of the exposure assessment section.

We thank the reviewer for this comment. While section 2.3.3 is not directly related to the fire modelling stage, section 2.3 was designed as a general "Datasets" section, covering all input data used in the study, including those for hazard modelling as well as exposure assessment and support capability indicators. For this reason, section 2.3.3 was retained within this section. We nevertheless changed its name to "Ancillary datasets" for clarity.

Line 272: How many fires were modelled overall to facilitate the calculation of burn probability per simulation? Is this the number of ignitions? In general, are all ignitions occurring in any single model run or each model run is using one ignition point? Please clarify.

Indeed, for each of the 27 scenario simulations (wind - duration - WBI), the FlamMap-MTT algorithm used the same fire list as input, containing 363 ignition locations (section 2.3.1). In this setup, each ignition location initiates a separate single-ignition fire, and burn probability was derived from the fraction of these simulated fires that burn each grid cell. To clarify this, we have added the following text to line 272:

"In each of these simulations, burn probability was computed using the same fire list containing the 363 ignition locations (Sect. 2.3.1). The 363 ignition locations were treated as independent single-ignition fires in MTT, and burn probability represents the fraction of these fires that burned each cell in each simulation."

Lines 343-344: Is the lack of fires crossing the river due to a missing spotting component in the model, or an outcome of the width of the river combined with prevailing wind directions?

As spotting was not considered in the model, this is the main reason why fires did not cross the river Elbe in the simulations. However also in reality, forest stands are separated by 200 to 400 m distance on both sides of the river and with ignitions being mostly at the eastern bank with prevailing west winds, make fires at the western bank less likely. For a more robust justification we have amended this paragraph to now state:

"Finally, a consistent pattern across the scenarios is that wildfires rarely cross the Elbe River. While high BP values can be observed along both banks, they often do not extend across the river. This can be assumed to be an outcome of the prevailing western winds and ignitions at the eastern bank as well as the lack of a spotting component in the modelling".

Figure 3: it would be clearer if WBI numbers were replaced by names, i.e., Medium, High, and Very High.

We have changed this as suggested.

Moreover, to improve the interpretability of flame-length maps throughout the manuscript (including this figure), we revised the flame-length classification used for visualisation. The suppression-based thresholds proposed by Alexander and Cruz (2018) (< 1.5 m, [1.5, 2.5) m, [2.5, 3.5) m, [3.5, 5.0) m, and ≥ 5.0 m) were not used because they resulted in limited differentiation across the range of flame-length values modelled in the study area. Instead, flame length was classified using thresholds based on the distribution of the modelled flame-length values, providing a clearer distinction between areas of low and high potential fire intensity. Accordingly, Section 2.5 was revised as follows: "Burn probability and flame length were each classified into five classes for the exposure map. The burn probability classification consisted of the intervals < 0.01, [0.01, 0.02), [0.02, 0.05), [0.05, 0.10), and ≥ 0.10. Flame length was likewise classified into five classes based on the distribution of modelled flame length values across the study area: < 0.5 m, [0.5, 1.0) m, [1.0, 1.5) m, [1.5, 2.0) m, and ≥ 2.0 m. These thresholds were selected to provide sufficient differentiation between areas with low and high potential fire intensity. To create the final exposure map, the two classifications of FL and BP were combined in a bivariate classification corresponding to 25 combinations of FL and BP. The simultaneous combination of fire intensity and probability measures to derive exposure has been applied in previous studies. For example, Sá et al. (2022) combined burn probability with fireline intensity, while Heisig et al. (2022) employed the integrated fire hazard classification scheme of the Interagency Fuels Treatment Decision Support System which gives a single fire hazard value based on both conditional flame length and conditional burn probability."

Lines 352-353: See my major comment above. This sentence belongs in the methods and not here (and if it repeats info from the methods, it can simply be deleted).

We have deleted this sentence.

Lines 353-355: There's no need to describe the contents of a figure anywhere outside its caption.

This information has been integrated into the caption.

Lines 361-369: This paragraph belongs in the discussion section.

This paragraph was moved to section 4.2 "Key Findings and Interpretations".

Figure 5. Perhaps mention in the main text the large variation around the median BP in the case of Sebnitz. Also, in the caption, mention the number of simulations from which the median and range were calculated.

Thank you, this is a good point. We agree that the large variation in burn probability within Sebnitz deserves further discussion. Accordingly, we have expanded the discussion in section 4.2 to highlight the greater within-municipality heterogeneity in exposure. Following the comments of Reviewer 2, we also revised the dead fuel moisture parameterisation, which resulted in changes to the wildfire simulations and thus BP values per municipality. As a consequence, Hohnstein now also exhibits a similarly large variation in burn probability. The following paragraph has therefore been added: "Moreover, the variation in BP across HIZs is much greater for Sebnitz and Hohnstein than for the other municipalities with high BP. This likely reflects their administrative structure, with numerous villages of different sizes and WUI configurations belonging to the same municipality, resulting in a broader distribution of exposure values."

The caption for Figure 5, which after restructuring is now Figure 7, now has caption:

"The five municipalities of the study area with the highest median burn probabilities and flame lengths, based on their residential home ignition zones, for two scenarios: an extreme scenario (WBI = 5, duration = 3 days; shown in red) and a mild scenario (WBI = 3, duration = 1 day; shown in grey). Each scenario is based on three FlamMap-MTT simulations (one per dominant wind direction) with 363 independent single-ignition fires per simulation (n = 1089 fires per scenario). Median values are indicated with points, and vertical lines show the 5th to 95th percentile range."

Lines 404-429: This is all methods

This section was moved to the new methodology section 2.8, along with Figure 7 (now Figure 3 after restructuring).

Lines 440-445: This is all methods

Lines 462-470: This is all methods

We have moved these two sections describing the methodology used for the evaluation questionnaires, to the Methodology. Along with the paragraph from lines 300-308 (description of the web map's development), they serve as the new section 2.7 "Interactive web map and questionnaire design".

Technical corrections

Lines 71-81: This paragraph should be in past tense.

We agree with the reviewer that these lines should be written in the past tense, as they describe the completed objectives and activities of the study. We therefore changed the paragraph to:

"The objective of this study was to assess wildfire exposure for the Bohemian-Saxon Switzerland trans-boundary WUI region in Central Europe, where ongoing changes in land use —such as declining forest management, increasing protection of natural processes, and increasing attractiveness for tourism— have been reinforced by the founding of two National Parks (NP Saxon Switzerland in Germany in 1990, NP Bohemian Switzerland in Czech Republic in 2000). Firstly, we aimed to produce an interactive wildfire exposure map that includes two support capability indicators, namely, the locations of fire stations and local transportation infrastructure. Secondly, we aimed to quantify wildfire exposure for different settlements in the region. Thirdly, we performed a qualitative user study to assess the usability of the map by the general audience and usefulness by local stakeholders."

Line 91: "Mio" is Million?

Yes, this was replaced with "million" for clarity.

Lines 170-171: Append to the end of the previous paragraph (a paragraph cannot contain a single sentence).

We have changed this as suggested.

Line 271: "ran FlamMap"

We have changed this as suggested.

Line 338: hazard, not exposure. The outputs of FlamMap do not consider values at risk which are required to map exposure.

We replaced "exposure" with "hazard".

Figure 3 caption: should be "wildfire hazard rasters"

We replace "exposure" with "hazard".

Figure 4 caption: The caption is in the wrong order. It should start by explaining the general purpose of the figure, e.g., "Hazard values (BP, FL) for different municipalities based on their residential home ignition zone under the extreme weather scenario. The five municipalities with the highest BP and FL are highlighted in red."

An alternative, clearer caption similar to the suggested one was implemented.

Line 491: replace exposure with hazard.

We replaced "exposure" with "hazard".

Author's response to Anonymous Referee 2

The manuscript entitled "Exposure of Settlements to Wildfires in a Transboundary Wildland-Urban-Interface Region in Central Europe" presents the application of wildfire spread modeling approaches (based on FlamMap) in a study area of Central Europe to analyze exposure to settlements to wildfires. The work also describes an interactive web-based map that was developed to inform local stakeholders about potential fire behavior and exposure in the study area.

The manuscript is overall interesting, particularly because it covers an area characterized by limited wildfire activity and low danger conditions if compared to other Southern European areas. In this sense, the manuscript informs local stakeholders about wildfire issues in a region that can be affected by more wildfires in future years due to climate and land use changes.
We thank the reviewer for the detailed review and helpful suggestions. We have revised the manuscript accordingly and provide point-by-point responses below.

Nevertheless, some sections of the study need to be improved, and some methods and results should be better explained or improved, as described more specifically in later lines. Some parts of the manuscript should be carefully re-organized, as for instance some sentences/sections of the Results should be moved to Discussions or Methods. Moreover, there is a need to reinforce the Introduction section and the state of the art, considering that the modelling approach proposed is quite common, and the results obtained are similar to a number of similar studies carried out in the US or in Southern Europe. The Discussion should also be improved.

In the following lines, the specific comments about the manuscript:

L25-80: In the Introduction section, the state of the art (particularly for the "wildfire exposure" and the "wildfire modeling" parts, which represent the key of this manuscript) is quite limited, and the review of relevant literature is not exhaustive. For instance, the model adopted for the modeling exercise (FlamMap) is not mentioned.
We thank the reviewer for this suggestion. We have expanded the Introduction to better reflect the state of the art on wildfire exposure assessment and fire modelling by adding relevant references after L66:
"Such spatially explicit approaches have been increasingly applied in wildfire exposure assessments, particularly in wildland–urban interface contexts, where the combination of fire likelihood, potential fire behaviour, and the location of assets is used to identify areas of elevated exposure (Argañaraz et al., 2017; Haas et al., 2013; Scott et al., 2013)."

We also added some information on FlamMap, to more clearly position it within the existing literature on wildfire hazard and exposure modelling with a focus on Europe. After L70:

"FlamMap is the tool chosen here for wildfire modelling. FlamMap is a fire analysis application developed by the Missoula Fire Sciences Laboratory (FlamMap - Missoula Fire Sciences Laboratory, 2026). FlamMap has the advantage of being able to visualise fire behaviour characteristics directly related to exposure such as flame length and burn probability, in the form of geolocated rasters, which facilitates the derivation of settlements' exposure (Peterson et al., 2007). It is commonly used to analyse fire behaviour in European settings. For example, Salis et al. (2009, 2012) used FlamMap to assess wildfire severity in Italy, Mitsopoulos et al. (2016) used it for a Greek landscape, Sá et al. (2022) used it in Portugal, and Alcasena et al. (2017, 2018) in Spain. For applications in Central Europe, FlamMap has been used only recently (Kudláčková et al., 2024), which is however related to the rather limited wildfire research in that region."

Additionally, the first sentence of section 2.2 was simplified to account for the previous discussion of FlamMap in the introduction:

"Wildfire exposure was quantified in terms of burn probability and potential flame length using FlamMap. It was first used in our study area by Kudláčková et al. (2024) to investigate drivers of the 2022 wildfire."

L84-89: The authors report that the study area is 700 km2 in both Germany and the Czech Republic. Please indicate the extent of the German area vs the Czech Republic area.

We have amended this as suggested, and the manuscript is now more specific about the extent of the study area. The new sentence reads as follows:

"The study area extends across a transboundary area of 720 km² on both sides of the River Elbe in Germany (322 km²) and the Czech Republic (398 km²)."

L105-109: A short description of the main topographic characteristics of the study area would be important. In addition, I would recommend adding some more information about the main land uses of the study area (e.g.: percentage of agricultural areas? Urban/anthropic areas? Main forests, apart from Picea abies?)

We agree with the reviewer that more context would benefit the better understanding of the study area. We therefore added the following text after L88:

"The area is dominated by forests (69%) and grasslands (17%), with croplands also covering a substantial share (10%) - mainly on the German side of the border (Copernicus Land Monitoring Service, 2025). Built-up areas account for 2% of the study area. These are primarily located in the south (e.g., towns of Děčín, Jílové, and Česká Kamenice) and on the German side along the Elbe River (e.g., towns of Stadt Wehlen, Königstein, and Bad Schandau; Figure 1). The study area is characterized by prominent sandstone formations, rocky outcrops, and steep cliffs. Elevations range from approximately 200 (Elbe river valley) to 723 m (Děčínský Sněžník), and this rugged topography poses substantial challenges for firefighting operations."

For a more accurate description of the local forests, we replaced the sentence on L103 with the following:

"The forested parts of the study area are largely dominated by Norway spruce (Picea abies), although pines (Pinus sp.), larch (Larix sp.), European beech (Fagus sylvatica) and silver birch (Betula pendula) are also present (Beetz et al., 2024)."

A similar consideration is valid for the fire regime (e.g.: fire season months, average area burned, and fire number per year).

We agree that additional context on the local fire regime would improve the manuscript. We therefore added the following paragraph in section 2.1:

"Based on the historical ignition datasets described in Sect. 2.3.1, wildfire occurrence in the study area is predominantly human-caused. For the German (Saxon) part, the most frequently reported ignition category is open fires by other persons (41.7%), followed by unknown or unclear causes (26.6% combined), while lightning accounts for 10% of cases. For the Czech part, the dominant ignition categories are setting fires in the countryside/burning grass (44.2%) and smoking (37.4%), whereas lightning represents 3.1% of cases (other natural causes <2%). Based on the available records used in this study, the Czech dataset (2016–2020) includes 163 ignitions (32.6 per year), while the German dataset (2008–2020) includes 60 ignitions (~4.6 per year). Seasonality differs between the two sides of the border: in Saxony, ignitions are strongly concentrated in late spring and summer (April to August: 80% of cases; May to June alone: 50%), whereas in Czech Republic ignitions are more broadly distributed across the year (April to August: 67.5%), with a secondary contribution in October and November (~16.6%). The available records do not include burned-area information; therefore, fire size statistics could not be derived".

L127-133: To produce the flame length outputs, I suppose the authors analyzed the flame length probability (FLP) file based on the MTT simulations, and then derived the conditional flame length. Please clarify.

We thank the reviewer for this important comment. We clarify that the flame length outputs used in this study were not derived from the MTT-based Flame Length Probability (FLP) output and subsequent Conditional Flame Length (CFL) calculation. Instead, we used the Basic Fire Behaviour flame length (FL) output from FlamMap.

This choice was made because our objective was not to describe fire behaviour within the simulated fire perimeters, but to characterise the potential intensity of areas across the entirety of our study area, including locations that did not burn in a given simulation run. MTT-based outputs such as FLP or burn probability are restricted to the area reached by the simulated fire spread (Finney, 2006). As a result, they are well suited to analysing the behaviour of a specific simulated wildfire event, but are less suitable for the construction of a spatially continuous exposure product intended to support comparison across the full study area.

To illustrate this, we added Figures AC2 1, AC2 2 and AC2 3. Figure AC2 1 compares burn probability outputs from one-day and three-day FlamMap simulations under the same southerly wind conditions and shows that the one-day simulation leaves substantial parts of the study area unburned. Similarly, Figure AC2 2 demonstrates the same issue for FLP-derived CFL, which like burn probability (another MTT-derived output) is only produced for areas reached by the simulated fire. In contrast, the Basic Fire Behaviour FL output, shown in Figure AC2 3, provides spatially continuous information on potential fire intensity, leaving areas unburned only where fuels are non-burnable, rather than because a simulated fire did not reach them within the modelled time frame. This distinction is particularly important in our study area because some locations, such as agricultural areas in the west, may exhibit low CFL because they are not consistently reached by simulated fires, while still showing very high potential FL (these are the large purple areas concentrated on the western part of the study area, as shown in Figure AC2 3). These areas may therefore have considerable hazard potential even if they are not frequently burned in the current simulations. This consideration is already reflected in the discussion of future development of a weighted hazard or exposure index (L559–565), where we highlight that areas with high potential flame length but low burn probability require greater attention in the context of a possible future exposure index. Finally, although Basic Fire Behaviour FL remains relatively consistent across scenarios, as also observed in Figure 3 (Figure 4 after restructuring) of the manuscript and Figure AC2 3, we consider this limitation acceptable because the alternative, CFL, would restrict the intensity assessment to only those areas reached by the simulated fire.

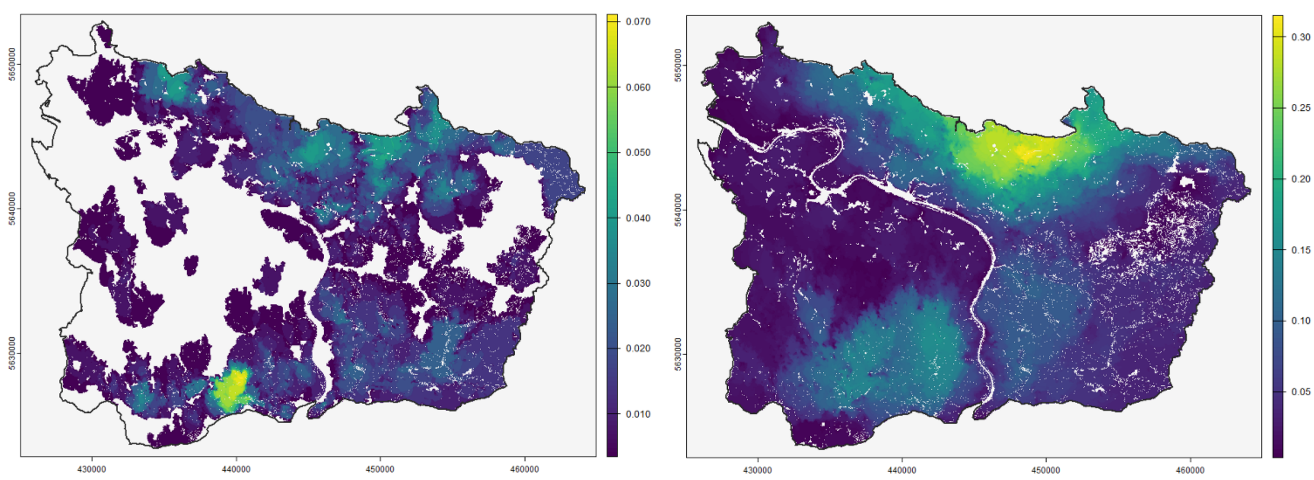

Figure AC2 1: Comparison of MTT-derived burn probability, with zero values masked, from two FlamMap simulations using the same southerly wind conditions derived from WBI = 5. The left panel shows the 1-day simulation, and the right panel the 3-day simulation.

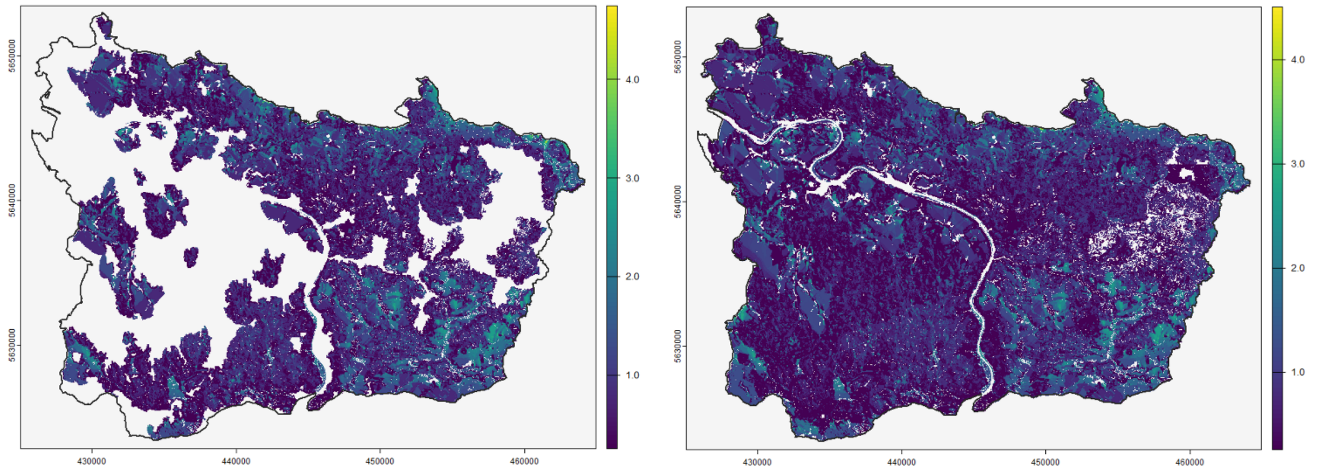

Figure AC2 2: Comparison of MTT-derived Conditional Flame Length, with zero values masked, from two FlamMap simulations using the same southerly wind conditions derived from WBI = 5. The left panel shows the 1-day simulation, and the right panel the 3-day simulation.

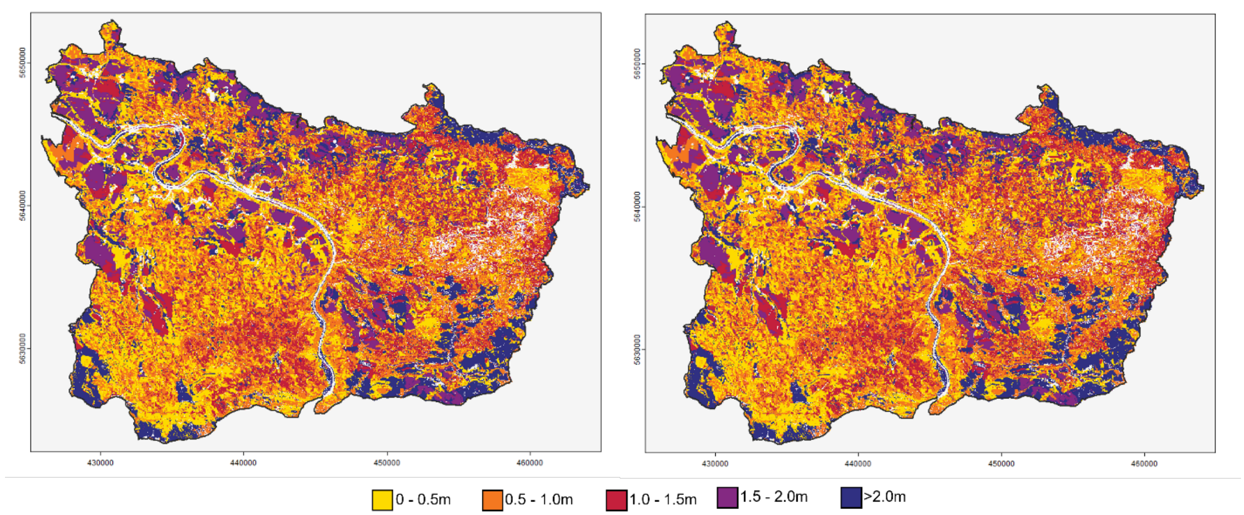

Figure AC2 3: Comparison of Basic Fire Behaviour-derived Flame Length, with zero values masked, from two FlamMap simulations using the same southerly wind conditions derived from WBI = 5. The left panel shows the 1-day simulation, and the right panel the 3-day simulation. The classes used are the same as in the main publication.

In addition, please report in the discussion why other outputs of FlamMap (e.g.: fire size; potential crown fire occurrence) were not used to analyze wildfire hazard or exposure in the study area.

We thank the reviewer for raising this point. Fire size was not included in this study, because although informative, it is not directly suited to the exposure framework adopted here. Our objective was to showcase the juxtaposition of one spatially explicit likelihood metric and one spatially explicit intensity metric with the location of exposed assets. For this purpose, burn probability and flame length were considered the most appropriate FlamMap outputs, as they illustrate these metrics and are both commonly used in wildfire hazard and exposure assessments (e.g., Sá et al., 2022).

Crown fires, as well as spotting, were not modelled because the fire-modelling landscape lacked the required canopy layers (canopy height, canopy base height, and canopy bulk density). We did consider incorporating these layers using the European-wide canopy/fuel dataset produced within the European Commission's FIRE-RES project (Kutchartt et al., 2024; Pirotti et al., 2023), which provides these canopy variables for our study area. However, these canopy data represent conditions around 2020, whereas the study area experienced substantial bark-beetle-related canopy degradation between 2020 and the 2022 wildfire. Without site-specific validation (e.g., field-based verification of canopy structure as in Heisig et al., 2022), using these canopy layers risked introducing uncontrolled bias in crown-fire (and hence spotting) occurrence. Given the scope of the study, we therefore did not include crown-fire/spotting and explicitly acknowledge this as a limitation on L542-543 of the Limitations. For better clarity, we rephrased this part to:

"As up-to-date data on canopy structure that is representative of bark-beetle-affected conditions were not available, crown fires and thus spotting were not modelled. Consequently, fire spread and intensity may be underestimated under extreme weather, especially where firebrand transport could enable rapid downwind growth or cross-barrier spread.".

L142-155: This part is quite long but needs to be improved. Please indicate the reference study period for the fire ignition data. In addition, the methods used to determine/assign fire ignitions and related probabilities for the simulations are not clear and should be presented with more details.

Thank you for this comment which is in line with Reviewer 1, who also suggested to revise this paragraph. We have changed the text in reply to both reviewers as:

"Historical forest fire ignition data (60 ignitions, spanning 2008-2020) for the German part of the study area were provided by the Saxon State Authority for Forestry (Staatsbetrieb Sachsenforst, 2023). Additionally, we also included known locations in the National Park Saxon Switzerland considered particularly susceptible to future ignitions in the German part of the study area. These comprised parking areas, viewing points, legal fire pits, and legal and illegal rock shelters ("*Boofen*" in German), totalling 697 sites. At those sites, camp fires are often ignited but did not result in a forest fire so far. Ignition locations from the Czech part (163 ignitions, spanning 2016-2020) were acquired from the Fire Rescue Service of the Czech Republic (Hasičský záchranný sbor České republiky, 2023). Neither dataset is publicly available. The ignition location of the 2022 fire was manually added to the dataset as it had not yet been included in the respective dataset. The joint datasets encompassed the locations of 921 ignition points. To balance ignition density between the German and Czech parts of the study area (i.e., number of ignitions per km²), we used the lower density Czech side as the reference and randomly subsampled the German ignition locations so that the German ignition density matched the Czech one. The final number of ignition points was 363. These can be seen in Figure E1 of Appendix E."

L163-164: The authors report that "Dead fuel moistures in non-beetle killed areas were set to 3, 4, and 5% for the 1-hr, 10-hr, and 100-hr dead fuels, respectively". Please clarify if these data were only applied to specific forest areas, or to the whole set of fuel models with dead fuels (e.g.: herbaceous fuel models). In my opinion, these values are very low, and might be observed only in days characterized by very extreme conditions, not in days with medium or high WDI values, particularly in Central Europe. As the authors know, considering that the simulations were carried out using fixed fuel moisture, these values are crucial and can heavily affect the simulated spread rate, fire intensity, and fire size of the fire simulations. Please clarify.

We thank the reviewer for this important comment and acknowledge that the previously used dead fuel moisture values of 3, 4, and 5% are very low and may be too extreme to be considered representative across all simulated scenarios, particularly for conditions corresponding to WBI classes 3 and 4. We have therefore revised the fuel moisture parameterisation. For the revised model runs, we used locally measured fuel moisture information from 10h fuel sticks and destructive samples that we took since 2023 (Kranz et al., 2025a). Two of our fuel moisture sites are located within the study area in the Saxon Switzerland National Park, one situated in a bark beetle-disturbed spruce stand, and the other in a non-disturbed beech forest. We also conducted bi-weekly to monthly 1h and 100h dead fuel moisture content from samples of litter and fine woody debris respectively. This new information, specifying the source of the dead fuel moisture data is included in the revised section 2.3.1: "Initial dead fuel moisture values were derived from the fuel moisture observations reported by Kranz et al. (2025), who established fuel moisture monitoring sites within the Saxon Switzerland National Park. To represent bark-beetle-affected forest conditions, data from the DE-SHW site, located in a disturbed spruce stand, were used. For non-disturbed forest conditions, data from the DE-BWB site, located in a beech stand, were used. Kranz et al. (2025) collected destructively sampled dead fuel moisture content (DFMC) measurements for 1-h, 10-h, and 100-h fuels from June to September 2023 and additionally operated automated 10-h fuel sticks at both sites, which recorded fuel moisture at 30-minute intervals since January of 2023."

Based on this data, we estimated typical values for 1, 10 and 100h dead fuel moisture values for bark-beetle-affected and non-affected forest stands. These values were then grouped according to the corresponding WBI classes. Because no destructive DFMC measurements were available for days classified as WBI 5 during the destructive measurement campaign, the corresponding WBI 5 fuel moisture values for 1, 10 and 100h fuels were estimated from the WBI 4 values. This estimation was based on the relative difference between WBI 4 and WBI 5 fuel-stick measurements at the respective monitoring site. The dead fuel moisture values used in the modelling are shown in Tables AC2 1 and 2. AC2 3 shows the fuel stick measurements. These tables now form the new Appendix A.

Dead Fuel Type	WBI 3	WBI 4	WBI 5 (estimated)
1h	18	17	15
10h	29	16	15
100h	23	15	14

Table AC2 1: Dead fuel moisture values (%) used for non-bark-beetle-affected (beech) stands under WBI 3-5 conditions

Dead Fuel Type	WBI 3	WBI 4	WBI 5 (estimated)
1h	14	15	13
10h	18	16	13
100h	29	19	16

Table AC2 2: Dead fuel moisture values (%) used for bark-beetle-affected stands (spruce) under WBI 3-5 conditions.

Dead Fuel Type	WBI 3	WBI 4	WBI 5
10h (beech forest)	11	9	8
10h (bark-beetle affected forest)	13	11	9

Table AC2 3: Observed 10-h fuel-stick moisture (%) for beech and bark-beetle-affected stands under WBI 3-5 conditions. Data derived from Kranz et al. (2025).

The new section 2.4.3 "Dead and live fuel moisture parameterisation" discusses this:

"To ensure consistency between the fire-weather scenarios and fuel conditions, the destructively sampled DFMC observations were grouped according to the three WBI classes, and representative values were derived separately for bark-beetle-affected and non-affected forest stands. As no destructive DFMC measurements were available for days classified as WBI 5 within the timespan of the destructive measurement campaign, the corresponding WBI 5 fuel moisture values were estimated from the WBI 4 values using the relative difference observed between WBI 4 and WBI 5 fuel-stick measurements at the respective monitoring site. The resulting fuel moisture values are presented in Appendix A (Tables A1–A3)."

Due to the new dead fuel moistures and the associated new simulations, sections 3.3 (Wildfire exposure per municipality) and 4.2 (Key Findings and Interpretations) had to be significantly revised, as the new simulations resulted in different burn probability and flame length values. This included the new Figures 6, 7, D1 and D2, and Tables E1 and E2 in the restructured manuscript, which depict the exposure of municipalities. Similarly, the online map and the Figures depicting the online map (Figures 5 and F1) were also updated. The first part of section 2.4 was also changed to account for this new setup.

L170-171: Again, the use of a constant fuel moisture value for live herbaceous vegetation and live woody fuels can be problematic, considering the range medium-high-very high conditions used for the simulations. Please clarify if these values reflect the conditions observed in very high-risk days, or if these are average fuel moisture values when WDI is above 3.

We thank the reviewer for this comment. Unlike dead fuel moisture, live fuel moisture was retained as a constant parameter across scenarios. While the WBI reflects weather conditions that strongly influence dead fuel moisture, Kranz et al. (2025) found only weak relationships between LFMC, and meteorological variables and fire weather indices in forests located in the study area. Consequently, deriving WBI-specific LFMC values would introduce additional uncertainty not supported by the available observations. We therefore retained the values of 60% for live herbaceous fuels and 90% for live woody fuels following Kudláčková et al. (2024), who applied the same parameterisation in FlamMap simulations of the 2022 Bohemian

Switzerland wildfire based on Scott and Burgan (2005) and consultation with experts from the Missoula Fire Sciences Laboratory.

Accordingly, the section describing live fuel moisture content in section 2.3.1 has been changed to: "Live fuel moisture content was set to 60% for herbaceous fuels and 90% for woody fuels. These values were adopted from Kudláčková et al. (2024), who used FlamMap to reconstruct the 2022 Bohemian Switzerland wildfire and selected the same values based on the fuel moisture scenarios of Scott and Burgan (2005) in consultation with experts from the Missoula Fire Sciences Laboratory."

We also added in section 2.4.3: "Unlike dead fuel moisture, live fuel moisture values were not varied between the WBI scenarios. Per the FlamMap modelling framework, live fuel moisture was treated as constant throughout the conditioning period of each simulation."

L203-227: It is not clear why this section is presented in this part, as it is not related to the fire spread modeling part.

We thank the reviewer for this comment. While section 2.3.3 is not directly related to the fire modelling stage, section 2.3 was designed as a general "Datasets" section, covering all input data used in the study, including those for hazard modelling as well as exposure assessment and support capability indicators. For this reason, section 2.3.3 was retained within this section. We nevertheless recommend changing its name to "Ancillary datasets" for clarity.

Moreover, how were the locations of fire stations and the local transportation infrastructure used to characterize wildfire exposure? Or were the locations of fire stations and the local transportation infrastructure only determined for visualization purposes in the web-app? Please clarify

The fire stations and the transportation network were not used as part of our exposure calculation, as was e.g., done in Oliveira et al. (2020), where proximity to fire stations via the paved road network are used to quantify coping capacity. Instead, they were included as contextual support capability layers. In the interactive web map, these layers served two purposes: Firstly, they were used in the user activity of both the usability and usefulness questionnaires, which asked participants to identify a route from a settlement to the nearest fire station under a defined wildfire scenario. Secondly, they informed the stakeholder discussion by being included among the layers evaluated for their usefulness in the stakeholders' work. We have clarified this distinction by altering the first paragraph of section 2.3.3, to avoid the impression that these layers were used to quantify exposure:

"For the assessment of wildfire exposure, we included local settlements and building infrastructure. In addition, fire stations and the local transportation network were included as contextual support-capability indicators to support user orientation and route planning in the interactive web map and to enable the task-based evaluation described in Sect. 2.7. These were not used as input variables in the exposure calculation."

L228-234: The authors state that "While ignition locations and fuel moisture were held constant based on historical observations (Sect. 2.3.1), different scenarios for fire duration and wind conditions were selected to give realistic outputs in terms of BP and FL. The different factors resulted in nine different wildfire scenarios". So they are considering 9 scenarios. But then, in L271-272, they indicate that "We then run FlamMap with the three most prominent wind directions and associated wind speeds for the three scenarios of fire duration, resulting in twenty-seven model simulations". Here, they report 27 scenarios. In my opinion, it is more correct and clearer to a reader to report, in this part of the manuscript, that the work is based on 27 simulations (3 fire duration x 3 wind speed x 3 wind directions).

We thank the reviewer for this helpful suggestion. We agree that reporting the total number of simulations more explicitly improves clarity. In the revised manuscript, we distinguish between simulations, which refer to the individual FlamMap model runs, and scenarios, which refer to the weighted average of the three most frequent wind simulations associated with a given wildfire danger level and fire duration. For example, a FlamMap run using the southern wind associated with WBI 4 and a fire duration of two days is considered a simulation, whereas the weighted average of the southern, northeastern, and northwestern wind simulations for WBI 4 and a fire duration of two days constitutes a scenario. To make this distinction clearer, the sentence in L271–272 has been revised to:

"We then ran FlamMap using the three most frequent wind direction–wind speed combinations associated with each WBI level. Each combination was simulated for fire durations of one, two, and three days, resulting in a total of 27 model simulations (3 WBI levels × 3 wind scenarios × 3 fire durations)."

We have additionally changed L228-234 to:

"While ignition locations and live fuel moisture were held constant based on historical observations (Sect. 2.3.1), varying dead fuel moisture as well as different scenarios for fire duration and wind conditions were selected to give realistic outputs in terms of BP and FL. The different factors resulted in a total of 27 wildfire simulations, comprising combinations of three fire durations (1, 2, and 3 days) and nine winds (the three most frequent wind direction–wind speed combinations for each of the three wildfire danger levels)."

We also changed the beginning of section 2.5 to:

"The exposure map simultaneously represents both burn probability (BP) and flame length (FL). Therefore, the 27 model simulations were combined into nine wildfire scenarios by calculating weighted averages of the three wind simulations associated with each combination of wildfire danger level and fire duration. The FL and BP weighted mean rasters were calculated using wind prominence percentages as weights in order to assign greater importance to wind scenarios that occur more frequently under a given wildfire danger level:"

For consistency in the manuscript, we have also replaced most instances of "modelling run" with "simulation".

L257-270: If I am right, the weather data and the danger analysis are based on the data coming from the German side, while the Czech Republic zone of the study area is not covered. Are the zones similar in terms of dominant winds, danger levels, etc.? Please provide more information on this point.

We thank the reviewer for this comment, and would like to provide clarifications on this matter. The selection of a German weather station follows from our decision to use the German fire-weather index Waldbrandgefahrenindex (WBI). WBI is an operational index available consistently for German municipalities, whereas an equivalent WBI time series is not available for the Czech part of the study area. We therefore used the municipality of Bad Schandau to derive WBI values, as it lies entirely within the study area and directly borders the Czech part (Figure D1). Hourly wind observations were taken from the nearby Lichtenhain-Mittelndorf station, which is close to Bad Schandau and also located within the study area (Figure 1).

WBI is used here solely to stratify days into fire-weather danger categories (WBI 3-5) in order to derive typical wind-direction frequencies and mean wind speeds under different fire-danger conditions, not to compare national fire-danger systems. Given the close proximity to the border and the contiguous study region with similar heterogeneity in topography, these wind statistics are expected to be representative for the cross-border study area. We amended L557-558 in the Limitations section as:

"We used weather data from a meteorological station in the centre of the study region and assume that this station is representative for the entire area. However, given the complex topography and elevation differences, micro-climatic conditions are quite different in the study region (Wild et al., 2019) which also affects fuel moisture (Kranz et al., 2025b). In addition, heat fluxes from the fire in conjunction with the small-scale complex topography cause local circulation patterns that require in future coupled fire spread-atmosphere models to accurately represent fire dynamics in this region."

L300-308: This part is not related to wildfire exposure, but is related to the web-app. This should be modified or presented in another section.

We have moved this part, to the Methodology. Along with the sections from L440-445 and L462-470, they serve as the new section 2.7 "Interactive web map and questionnaire design".

L361-369: This is not related to results and should be moved to Discussions.

This has been be moved to section 4.2 of the Discussion and modified due to the simulations resulting from the new dead fuel moisture values.

L386: This section could be moved to Methods, or after the wildfire modeling part of the results.

This section has been moved to right after section 3.1 of the Results, becoming the new section 3.2.

L403: Again, this part is not related to results and should be presented in the methods. In addition, the validation part is quite complicated to understand, and needs to be revised.

We revised the validation section in line with the suggestions of Reviewer 1. Given the emphasis placed by the reviewer on the evaluation of the fire model simulations, we prefer to retain some parts of the validation component in the Results section, but others have been moved to the new methodology section 2.8: "Methodology for the evaluation of wildfire modelling".

L439: This section merges information that should be included in the methods, and some parts that could be presented in the results. In general, I would recommend simplifying the presentation of the results obtained with the surveys

We agree that L440-445 and L462-470, which describe the design of the questionnaires, should be moved to the Methodology. They will serve as section 2.7 "Interactive web map and questionnaire design". The rest of section 3.5 has been left in the Results section, as it mostly describes the answers; a more in-depth interpretation already exists in section 4.2 of the Discussion.

L486-569: The authors are basically not discussing the results obtained in relation to those of others, in similar bio-climatic areas or elsewhere.

Thank you for this comment. We have changed the text in section 4.1 as follows:

"This methodological approach is consistent with previous wildfire exposure studies that combine burn probability and fire behaviour metrics with the spatial distribution of exposed assets (e.g., Alcasena et al., 2017, 2021; Argañaraz et al., 2017; Haas et al., 2013), but its application to a transboundary Central European landscape remains comparatively rare."

In section 4.2 we have added the following:

"The observed contrast between BP and FL is also in line with previous wildfire exposure studies, where burn probability is typically interpreted as a likelihood metric and flame length, or conditional flame length, as proxies for potential fire intensity and suppression difficulty (e.g., Alcasena et al., 2017; Sá et al., 2022). The observed relationship between BP and FL partly agrees with previous wildfire exposure studies, but also highlights differences related to the Central European setting of this study. Similarly to Alcasena et al. (2017), BP and FL did not necessarily peak in the same areas: in northern Spain, high BP was linked mainly to fast-spreading herbaceous fuels such as rangelands and cereal crops, whereas the highest Conditional Flame Length values occurred in shrublands and dense forests on slopes aligned with dominant winds. In our study, a comparable decoupling occurs, with some agricultural areas showing high potential FL but low BP due to their limited connection to ignition locations and therefore simulated fire pathways. However, unlike the Mediterranean case studies of Sá et al. (2022) and Alcasena et al. (2021), where shrublands, pine forests, and unmanaged protected areas were major contributors to high intensity or high exposure, high exposure in our study is more strongly shaped by the spatial distribution of ignition clusters, HIZs, wind direction, and cross-border forest structure. This suggests that, in this Central European WUI landscape, exposure depends on local ignition placement, fuel continuity, and the proximity of settlements to simulated fire paths."

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