**Dataset derived from a literature review on soil greenhouse gas emissions after forest fires in upland boreal forests**

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**Abstract**

This article describes the dataset acquired during a literature review on soil greenhouse gas (GHG) emissions after forest fires in upland boreal forests [1]. It comprises 142 observations from 32 studies that met our search criteria, which included the terms (wildfire or fire) and (boreal forest) and (soil respiration or carbon dioxide or methane or nitrous oxide or CO2 or CH4 or N2O). The extracted parameters were carbon dioxide (CO2), methane (CH4) and nitrous oxide (N2O) fluxes per age class (time after fire), along with supporting information such as fire severity, presence or absence of permafrost layer, geographical location of experiments and dominant tree species. Soil CO2 fluxes included soil heterotrophic respiration (Rh), soil autotrophic respiration (Ra) and soil respiration (Rs = Rh + Ra). Articles with at least one extractable GHG were incorporated into this dataset, regardless of availability of supporting information. Mean fluxes were extracted manually from each article and data processing consisted of limiting flux mean to growing season and converting flux unit to a unique standard per GHG. Additionally, the script used to analyse and create each figure present in our review article is available as individual files [2], so the graphs are reproduceable once the processed data is loaded into the statistical software.

**Keywords**

Fire disturbance, greenhouse gas, systematic review, boreal forest

**Specifications Table**

|  |  |
| --- | --- |
| **Subject** | Forestry |
| **Specific subject area** | Fire disturbance and ecosystem processes |
| **Type of data** | Table  Code |
| **How data were acquired** | Systematic literature review.  WebPlotDigitizer, version 4.2. |
| **Data format** | Raw  Analyzed  Filtered |
| **Parameters for data collection** | Electronic searches using Helka-libraries, which is a shared collection of libraries administrated by the University of Helsinki Library that searches through main databases such as Web of Science, Scopus and SpringerLink.  Search terms: (wildfire or fire) and (boreal forest) and (soil respiration or carbon dioxide or methane or nitrous oxide or CO2 or CH4 or N2O). |
| **Description of data collection** | We extracted mean soil CO2 (including autotrophic and heterotrophic respiration when available), CH4 and N2O fluxes from the selected articles, along with supporting data regarding age class (time after fire), class of fire severity and presence or absence of permafrost. WebPlotDigitizer was used to extract mean fluxes from figures when not promptly available throughout the text, tables or as supplementary materials. |
| **Data source location** | Published peer-reviewed articles identified from searches according to described parameters. |
| **Data accessibility** | Repository name: Mendeley Data  Data identification number: v1  Direct URL to data: <https://data.mendeley.com/datasets/v7gxtvv9z3/draft?a=b85f3cc2-168b-45d2-8f00-ed874a9e2d5c>  Direct URL to JMP code: <https://github.com/c-riku/datainbrief-repo>  Direct URL to R code: <https://github.com/c-riku/datainbrief-binder> |
| **Related research article** | Ribeiro-Kumara, C., et al. How do forest fires affect soil greenhouse gas emissions in upland boreal forests? A review, Environmental Research. <https://doi.org/10.1016/j.envres.2020.109328> |

**Value of the Data**

* This database consists of 142 observations from 32 *in-situ* experiments, while it only includes mean values as summary statistics, it might be useful for future meta-analyses.
* Scholars in fire disturbance may benefit from these data to identify soil GHG emissions gaps in relation to time after fire, geographical region, fire severity and presence or absence of permafrost during the fire succession of boreal forests.
* Possible patterns identified through this dataset might be useful in developing new hypothesis regarding soil GHG fluxes after fire.
* This dataset helps to validate and improve global C circulation models.

**Data Description**

This dataset [3] comprises mean soil GHG (CO2, CH4 and N2O) fluxes and supporting information (age class, fire severity class, presence or absence of permafrost and region) extracted from peer-reviewed articles that met the inclusion criteria for our literature review. In total, 142 observations from 32 studies were included. Table 1 shows the summary of the studies reviewed. The dataset is split into “raw-data” and “processed-data” folders. Within the raw files, there is i) a data table (via-typing.xlsx) including mean GHG fluxes and supporting information directly extracted from reviewed articles and their supplemental materials and ii) references to source articles (sources.txt) including page and figure number used as input for data extraction, and their numerical output as data tables (.csv). Within the processed files, there are: i) modified numerical output data tables (.csv) to include, for example, mean flux and column heads; ii) data tables (.xlsx) for each GHG used to convert original units to desirable units; iii) data tables (.xlsx and .jmp) comprising all observations from compiled studies used to generate the graphs available in our review article. Within the code files [2], there are scripts (.jsl) used to filter outliers and to generate the graphs used to aid visualization and identification of trends of the expected value of the distribution of CO2, CH4 and N2O mean fluxes over time.

Table 1. Summary of articles reviewed.

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| GHG | Region | Time after fire | Fire severity | Permafrost | Sources |
| CO2 | Alaska | 7, 8, 9 years | High-severity | No | [4] |
| CO2 | Alaska | 3 years | High- and low-severity | No | [5] |
| CO2 | Alaska | 7 years | High-severity | Present in some plots | [6] |
| CO2 | Alaska | 1, 3, 7, 10, 80, 140 years | High- and low-severity | Yes | [7] |
| CO2 | Canada | 1, 9, 72 years | High-severity | No | [8] |
| CO2 | Canada | 6, 15, 27 years | High-severity | No | [9] |
| CO2 | Canada | <1, 16, 59 years | NA | No | [10] |
| CO2 | Canada | 2, 3, 9, 17, 34, 68, 128 years | NA | Yes | [11] |
| CO2 | China | <1 year | Low-severity | No | [12] |
| CO2 | China | 5 years | High- and low-severity | No | [13] |
| CO2 | Northern Europe | 2, 42, 60, 152 years | Low-severity | No | [14]\* |
| CO2 | Northern Europe | 7, 18, 33, 64, 75, 178 years | High-severity | No | [15] |
| CO2 | Siberia | 1, 5 years | High- and low-severity | Yes | [16] |
| CO2 (Ra/Rh) | Alaska | 2 years | NA | Yes | [17] |
| CO2 (Ra/Rh) | Alaska | 1, 3, 7, 10, 80, 140 years | High- and low-severity | Yes | [18] |
| CO2 (Ra/Rh) | Canada | 4, 7, 13, 21, 38, 72, 152 years | High-severity | Present in some plots | [19] |
| CO2 (Ra/Rh) | Canada | <1, 5, 14, 39, 73 years | High-severity | Yes | [20] |
| CO2 (Ra/Rh) | Canada | 1, 6, 15, 23, 40, 74, 154 years | High-severity | Present in some plots | [21] |
| CO2 (Ra/Rh) | China | 4, 5, 6 years | High- and low-severity | No | [22] |
| CO2 (Ra/Rh) | China | <1 year | Low-severity | No | [23] |
| CO2 (Ra/Rh) | Northern Europe | 2, 42, 60, 152 years | Low-severity | No | [24]\* |
| CO2/CH4 | Canada | <1, 2, 5, 7, 80 years | High-severity | No | [25] |
| CO2/CH4 | China | 7, 8, 117 years | High-severity | Yes | [26] |
| CO2/CH4 | China | 7, 8, 117 years | High-severity | Yes | [27] |
| CO2/CH4 | Northern Europe | <1, 1, 2 years | NA | No | [28] |
| CO2/CH4 | Siberia | 1, 23, 56, 100 years | High-severity | Yes | [29] |
| CO2/CH4/N2O | Alaska | <1, 1, 2 years | NA | Yes | [30] |
| CO2/CH4/N2O | Alaska | 6, 11, 90 years | High- and low-severity | Yes | [31] |
| CO2/CH4/N2O | Canada | 3, 25, 46, 100 years | High-severity | Yes | [32] |
| CO2/CH4/N2O | Northern Europe | 5, 45, 75, 155 years | Low-severity | No | [33] |
| CO2/CH4/N2O | Northern Europe | 8, 19, 34, 65, 76, 179 years | High-severity | No | [34] |
| CO2/CH4/N2O | Siberia | 1, 5, 24 years | High- and low-severity | Yes | [35] |
| CO2/CH4/N2O | Siberia | 4 years | High-severity | Yes | [36] |
|  |  |  |  |  |  |

References marked with asterisk (\*) report the same soil respiration data.

**Experimental Design, Materials, and Methods**

This dataset was acquired through a systematic literature view. We used the Helka electronic libraries, a shared collection of libraries including collections of Helsinki University Library, Institute for the Languages of Finland, The Finnish Heritage Agency Library, Finnish Literature Society, Library of the Labour Movement and Baltia-kirjasto, which searches through major databases (e.g. Scopus, Web of Science, SpringerLink etc), to gather published peer-reviewed articles. The search parameters included the terms: (wildfire or fire) and (boreal forest) and (soil respiration or carbon dioxide or methane or nitrous oxide or CO2 or CH4 or N2O). We manually went through each of the total 38 peer-reviewed articles that met our search criteria to extract mean soil GHG (CO2, CH4 and N2O) fluxes per age class. Age classes reported as lower than 12 months were considered as zero. The maximum age class of the control forests was set to 100 years to match the average fire return interval in boreal forests. A web-based tool (WebPlotDigitizer v. 4.2; Ankit Rohatgi, San Francisco, CA, USA) [37], was used to extract numerical values from figures in which mean GHG fluxes were only graphically available. We only extracted mean GHG fluxes measured during the growing season, thus when we had to manually calculate mean GHG fluxes from supplementary materials or numerical output from figures, we limited the calculation of the mean to measurements carried out between April and September. Moreover, we disregarded mean GHG fluxes related to additional treatments other than time after fire, for example warming and drying experiments. Rather, we extracted their mean control values assigned to the age class defined on the source article. Only articles with at least one extractable GHG was incorporated into this dataset. When available, we extracted the fire severity class (high-, low-severity) and physical environment (permafrost, nonpermafrost soil). The degree of fire severity was determined as follows — reported (highly) intense or severe fires, crown fires and stand-replacing fires were considered of high severity, whereas reported weakly and moderately severe fires and surface fires were considered of low severity. When none of these terms was reported, the severity degree was set as not available. Soil CO2 fluxes include soil heterotrophic respiration (Rh), soil autotrophic respiration (Ra) and soil respiration (Rs = Rh + Ra). When studies provided two of these components, the third component was manually calculated using the equation above. Mean soil CO2, CH4 and N2O observations were converted to g CO2 m-2 d-1, mg CH4 m-2 d-1 and mg N2O m-2 d-1, respectively, and combined into a unique dataset. We used the JMP statistical software (JMP v. 14.3; SAS Institute Inc., Cary, NC, USA) [38] to filter outliers and generate graphs out of this dataset.

In our review paper, we screened all independent variables (Rs, Ra, Rh, CH4, N2O) for outliers, and decided to filter them only for Rs and CH4 mean fluxes due to the low number of observations in the other variables. Since there were several Rs outliers grouped within only 3 studies, we decided to filter all Rs observations from these studies, else we only filtered the screened CH4 outliers. The script to screen outliers and create each figure present in our review article is available as individual files [2] so the graphs are reproduceable once the processed data is loaded into JMP. The underlying method used by JMP to generate the GHG trend during the fire succession is cubic smoothing splines based on Eubank [39]. By using the additional script files for figure 2 and 3, it is possible to access the R-Square and Sum of Squares Error as well as change the smoothing parameter.

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**Competing Interests**

The authors declare that they have no known competing financial interests or personal relationships which have, or could be perceived to have, influenced the work reported in this article.

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