SHORT TERM SCIENTIFIC MISSION (STSM) SCIENTIFIC REPORT

This report is submitted for approval by the STSM applicant to the STSM coordinator

Action number: CA18135
STSM title: Burned area, weather, landscape and socioeconomic spatial interaction analysis case study in Sweden
STSM start and end date: 21/07/2021 to 27/08/2021
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PURPOSE OF THE STSM:

My STSMS aimed at collaboration and knowledge dissemination about the factors influencing recent wildfires in Europe with particular emphasis on Sweden. Within this period I gained experience from the IIASA colleagues about fire risk modelling approaches and data processing methods. STSM was a great opportunity to evaluate and improve my skills on fire related modelling tasks. Period was used to strengthen my contacts within the climate change related science community, including presentation at the internal IIASA seminar and international conference IBFRA'21.

The motivation for our study is to identify the reasons of wildfires in Sweden, particularly, in 2018 (around 20 thousand ha burned). We developed the database using remote sensing products and national datasets to represent possible factors explaining fire ignition, spread, and areas burned. We analyzed sources of ignition, weather impacts, as well as socio-economic factors reflecting human activities and suppression efficiency. Ultimately the analysis will allow to identify forest areas in Sweden that are most vulnerable in terms of wildfire risks in terms of future climate conditions. We also informed the research community about our finding at the IBFRA 2021 conference and mass media through Twitter.

DESCRIPTION OF WORK CARRIED OUT DURING THE STSMS

During STSM I was able to establish a 1x1 km^2 resolution gridded spatial database covering the entirety of Sweden, which consists of multiple fire-related variables from 2012 to 2018. Each grid cell contains information on dynamic variables: monthly Fine Fuel Moisture Code (FFMC) calculated from daily weather, burned area (based on MODIS data from the Fire_CCI project), ground observation of lightning strikes (acquired from the Swedish meteorological institute). Static variables include socioeconomic factors: the population, road and lake densities, number of camping places, forest management intensity; biophysical indicators: total forest volume and deciduous tree volume, forest age structure; landscape information: mean elevation, slope, aspect and information about vegetation zones in Sweden. These variables were plotted in different combinations to understand the pattern and relations between them, and statistical analysis has been carried out.

Within my STSM I was participating in IIASA Young Scientists Summer Program activities and their presentation seminars to present my study. I was able to meet other students and take a part in social events at IIASA, including weekly football and volleyball matches. New contacts with upcoming scientists from all around the world is an extremely valuable outcome from my STSM project.

DESCRIPTION OF THE MAIN RESULTS OBTAINED

According to recent studies weather impact is one of the most important influential factor in fire risk modelling in the Fennoscandia region. FFMC is a widely used fire-weather indicator to evaluate the weather caused fire hazards around the world and it takes into account temperature, relative humidity, wind speed and precipitation. Weather also has a significant explanatory power in our project, because MODIS burned area data correlated with the FFMC, having a weather index and burned area value peaks in July and August. It is assumed that significant fire risk occurs when FFMC reaches 78, but during the most extensive fires in 2018 most parts of Sweden (except Scandinavian mountains) mean monthly FFMC values were above 82, but in two main fire areas mean monthly FFMC values were 85-86.

Analysis revealed that most of the fire events took place in grid cells with population density below 1 inhabitant per km^2. Within such sparsely populated areas there is still some probability of anthropogenic ignition, but at the same time distance to settlements and people's awareness of forest condition are relatively low, making fire identification and suppression more challenging.

According to Swedish meteorological institute statistics in 2018 the dominant share of burned area (65 %) occurred because of fires that were ignited by lightning strikes. Lightning unlike other anthropogenic ignition sources can occur in remote areas, where fire suppression is problematic and therefore fire potentially can develop and spread over larger areas making more serious economical, social and environmental problems. The most lightning strikes in Sweden usually are recorded in July, but especially large numbers were recorded in summer of 2014 and 2018 matching the time with two most devastating forest fire events in recent Swedish firefighting history. This information should be investigated further to evaluate the lightning strike importance on forest fires in Sweden.

Within the last decade Sweden has suffered from a couple of serious and awareness raising forest fires, but nevertheless they are not so common and disastrous as in Siberia, Spain or Portugal therefore the database has meaningful influence from two main forest fires in 2014 and 2018 potentially giving misleading impression about actual fire predictability. Would be worthy to request national level spatial fire statistics and compare it with MODIS burned area because incorrect fire periods and areas lead to bias FFMC, landscape, socioeconomic factor relation in fire probability models. It is important to develop an approach which is able to quantify and include forest management related variables (thinning intensity, felling residual management, risk of ignition from heavy forest machinery during rocky soil preparation) in the fire prediction models, because it might have a significant explanatory power to understand the fire hazards and create more fire resilient landscapes in the future.

Sweden because of its elongate shape has a significant latitude difference of 1 500 km from south to north and Scandinavian mountain ridge is forming even larger climate, landscape, vegetation and population distribution differences within the country. This diversity is also causing various fire hazard regimes, therefore in the modeling phase the country will be divided in six biogeographical zones to develop more adaptive fire probability models.

Project database and preliminary graphs were shown in a remotely organized International Boreal Forest Research Association (IBFRA) 2021 conference, where I gave an oral presentation about this project (16.08.21).

FUTURE COLLABORATIONS (if applicable)

STSM project will be continued with more detailed modelling to calculate fire probability and compare the model accuracy in different vegetation zones in Sweden. Later database could be adjusted and used to compare the fire probability in Sweden with FLAM (developed by IIASA) fire model predictions. Created database has potential to be used to support other forest fire related studies in Sweden, therefore it might be documented with scripts and specifications to publish it and create a freely available source for other scientists. We hope to publish a paper and corresponding database in the nearest future with aknoledgement of FireLinks Cost Action.