1.1 IMPACTS OF WEATHER AND GROWING SEASON ON THE OCCURRENCE OF FIRES IN FINLAND

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1. INTRODUCTION

Weather is a strong driving factor behind wildland fire occurrence, especially in terms of fuel moisture. Dead fuel moisture dynamics are mainly regulated by relative humidity, air temperature, wind, solar radiation, and precipitation (e.g. Nelson 2001), and these weather variables have been incorporated into most systems that are being used to predict fuel moisture. Because live fuels usually exhibit fairly steady remarkably higher moisture contents than dead fuels the impact of ample live fuel load is often considered as an ignition retardant. Boreal forests in Finland receive precipitation at fairly regular intervals throughout the year (Drebs et al. 2002). Extreme fire conditions resulting of prolonged drought occur only as isolated events in both space and time. In these mild fire weather conditions, seasonal dead-live fuel dynamics may play a very important role in the determination of fire occurrence.

There are several seasonal fuel quality processes that potentially influence burning susceptibility and may override the impact of short-term weather. At the beginning of fire season, right after the snowmelt, fuel material consists in large part of dead or dormant vegetation that has relatively low moisture content and loses that moisture fast in favorable weather conditions. As the growing season proceeds, the accumulation of new vegetation is likely to start suppressing fire activity due to the higher moisture content of live herbs and shrubs. The slowing down of growth processes and the wilting of vegetation may later on again ease the occurrence of fires.

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So far, there has not been clear understanding of the effects of seasonal vegetation development on fire dynamics in Finland. In this study, we examine general trends of forest fire occurrence during fire season and the combined effect of season advancement and fire weather. The work will aid the further development of Finnish Fire Risk Index and fire management practices.

2. METHODOLOGY

Data consist of national fire statistics 1996-2002, effective temperature sum, and Finnish Fire Risk Index (hereafter referred to as the FFI).

In fire statistics provided by the Rescue Service, information reported on each fire consisted of time, location, type of event, and fire size. Seasonal time span of the records ranged from the beginning of April to the end of October. Reported fires occurred within 59º90'-69º10' N and 21°20'-31°00'E. The events had been classified as forest fires, clearing and other open area fires, and peatland fires. Reported fire sizes ranged from 0 to 200 hectares. The reports did not include information on fire weather, fire behavior, or the intensity of suppression actions. In the analysis, we assumed that all fires get the same effort of fire suppression (i.e. they will be put out as soon as possible following the current fire policy in Finland) and as a result, the reported burned areas reflect the "goodness" of burning conditions. There is naturally some case-to-case variation in accessibility to fire events but generally topography and infrastructure do not impose remarkable obstacles to fire-fighting in Finnish landscape.

Effective temperature sum is the cumulative sum of daily mean air temperature of above +5 ºC, generally used to evaluate the advancement of growing season e.g. for agricultural purposes. The values of temperature sum for the time and place of each fire event were provided by Finnish Meteorological Institute.

The FFI has been designed to estimate the volumetric moisture content of organic layer (consisting of litter, moss, and humus) in clear-cut areas as a function of precipitation and evaporation (Heikinheimo et al. 1998, Venäläinen and Heikinheimo 2003). Weather data needed for the FFI calculation were interpolated for the regions of Kauhava (63º23' N, 24º02' E) and Sodankylä (67º22' N, 26º38' E) from the meteorological station network of Finnish Meteorological Institute.

Average daily temperature sum, number of fires, and daily burned area during were calculated to all forest fires reported in Finland during fire seasons 1996-2002. The co-variation of fires, seasonal vegetation development, and Finnish Fire Risk Index (FFI) was examined in Kauhava and Sodankylä (Fig. 1).

3. RESULTS

The number of forest fires reported in the whole country presented two seasonal peaks. The first of the peaks occurred during early fire season, from May 12 through June 8, at the average effective temperature sum of below 230 and the second in September 16-26, roughly at the temperature sum of 1200 (Fig. 2). When average fire frequency was 4.4 fires per day for the total fire season, during the peaks number of reported ignitions was at the highest 12.9 per day (September 28) (Fig. 2).

Daily burned area, calculated as a product of average size of fire event and number of daily fire events, reached its highest value at the temperature sum of 150-250 and began to decline from there on. The seasonal average of daily burned area was 1.7 ha for the total period of April-October. Daily burned area was highest (36.6 ha) from May 8 through June 15 and peaked again slightly (16.6 ha) later in the fire season, from August 27 through September 22 (Fig. 3).

Likely due to the far north location of Sodankylä fires there were generally scarcer than in Kauhava (Fig. 4). The number of fires at high fire risk index values was usually but not always lower during late than early fire season. In terms of burned area, the late season effect was more pronounced: in these two locations the burned area of the late season fires remained close to zero despite the level of the fire risk index and high number of fire events (Fig. 4). Occasionally high fire occurrences at the very end of the season in the south of Finland were poorly connected with the FFI. The minimal burned areas of the period, however, were in line with the model's low fire risk predictions.

4. CONCLUSIONS

The examination of the reported fires largely supported the expectations concerning the impacts of seasonal vegetation development on fire activity. The most active fire season in our dataset took place from early May through mid-June, then declining due to the accumulation of new-growth, and picking up during autumn after the new vegetation has started to wither. The number of the reported ignitions followed closely the proposed effect of seasonal vegetation development but showed for the most part of season a strong connection to changing fire weather conditions. Daily burned area on the other hand diminished drastically after the early season peak and showed little dependence on the prevailing fire weather from then on.

The highest values in the number of fire events and burned area in May and in September were unexpected since these months have been considered marginal parts of fire season. According to earlier fire occurrence studies (mainly years 1900-1950), the three most active fire months in Finland have been July, June, and August, in this order. It is, however, difficult to draw conclusions about climate-induced seasonal shifts in fire activity because yearly burned area is nowadays only a fraction of that at the beginning of the 20th century.

The findings of this study indicate that the accuracy of the FFI would greatly benefit from the incorporation of the seasonal vegetation development factor because conditions for fire spread seem to weaken radically at a fairly early stage of average fire season. Further work is needed to specify the exact nature of the co-effect of seasonal vegetation development and prevailing weather on fire occurrence in Finland.

5. ACKNOWLEDGEMENTS

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6. REFERENCES

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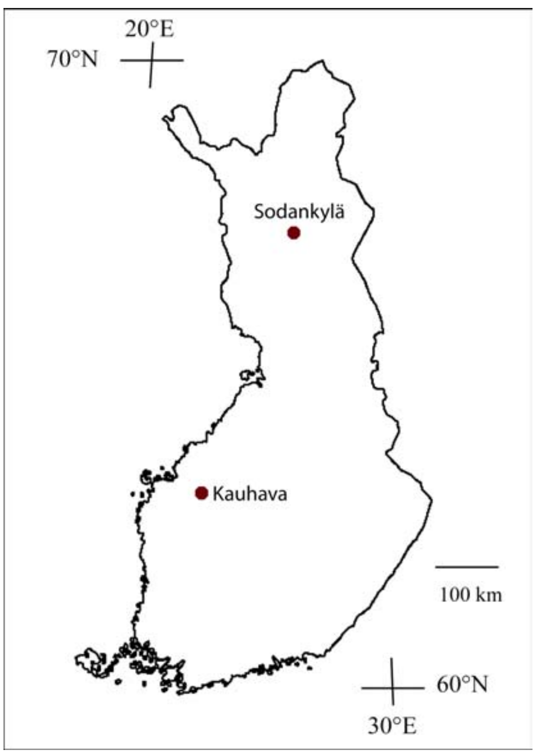

Figure 1. Map of Finland and locations of Finnish Fire Risk Index study areas Kauhava and Sodankylä.

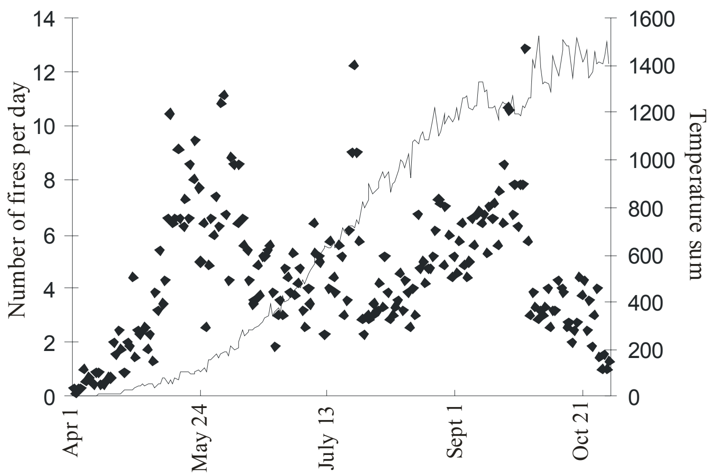

Figure 2. Average daily number of reported forest fire events (left axis) and the average accumulation of effective temperature sum (right axis) in Finland during fire seasons 1996-2002.

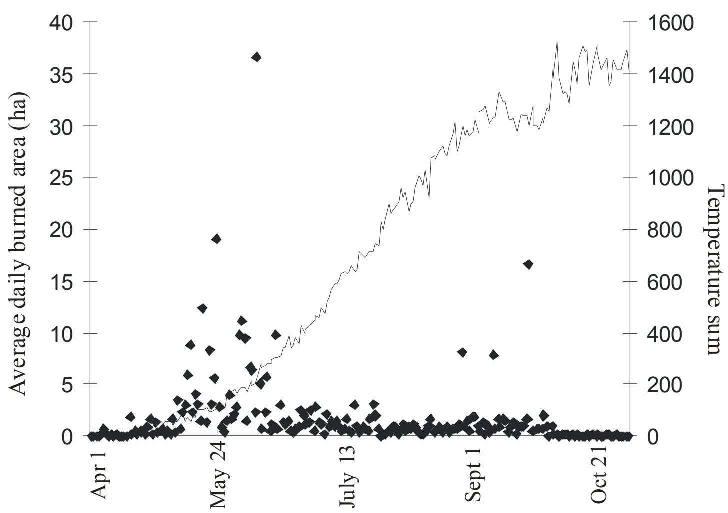

Figure 3. Average daily burned area (left axis) and the average effective temperature sum (right axis) in Finland during fire seasons 1996-2002.

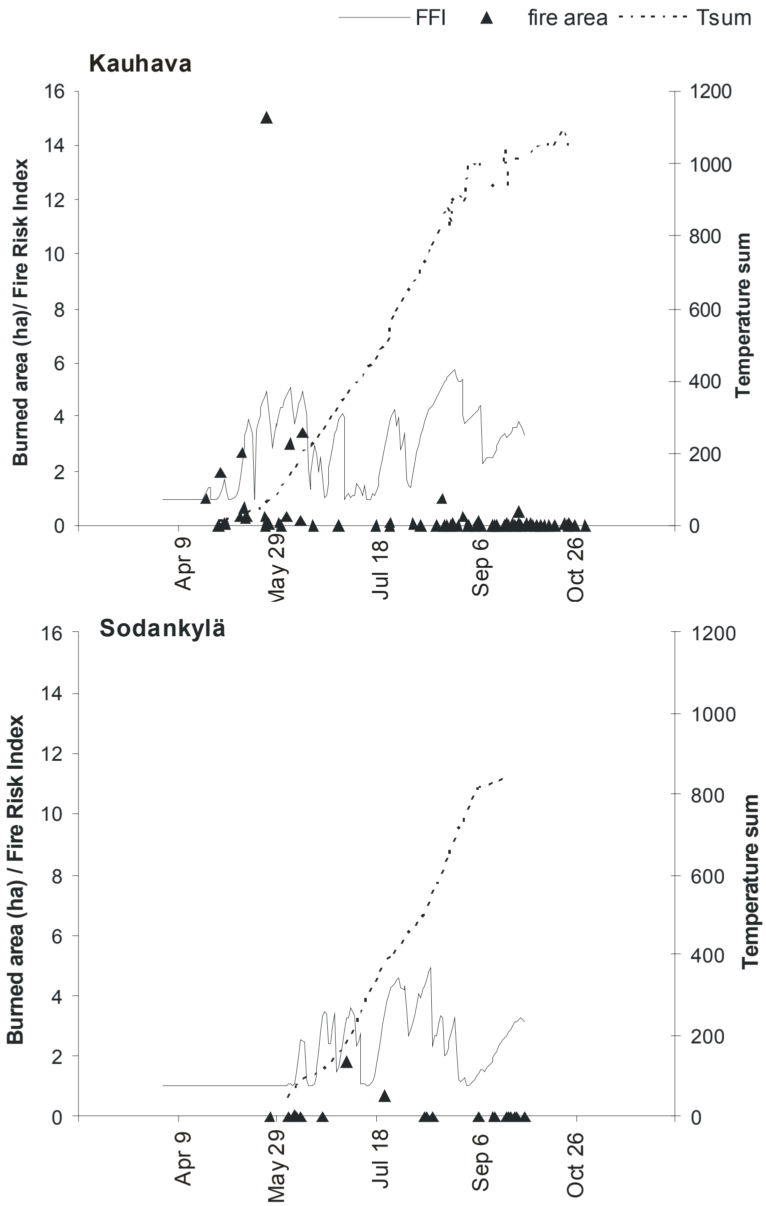

Figure 4. Average daily burned area (left axis), value of the FFI (left axis) and effective temperature sum (right axis) in Kauhava and Sodankylä during fire season 1996.