SIBERIAN WILDFIRE DILEMMA: CONTROLLING THE UNCONTROLLABLE?

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ABSTRACT

The intense Siberian wildfires in the summer of 2019 had devastating effects. Here the dynamics of these wildfires is described taking into consideration the legal act that determines modern forest management in Russia – the Forest Code-2006. This changed the approach to wildfire management in Russia by introducing *control zones*, where authorities can legally ignore wildfires due to their inaccessibility or remoteness from firefighting infrastructure. Remote sensing and open reports show that most wildfires (60–98%, depending on the day) in Siberia in 2019 were in control zones. Notably, the largest percentages were recorded during the crucial phases of the wildfires, including their rapid spread in June (97–98%) and during the peak from on 2 August (96%), when 3,012,082 of 3,134,128 hectares were on fire. The decision not to fight these wildfires was debatable given the considerable social concerns expressed online during the peak of the wildfires, which later resulted in civic petitions in favour of fighting wildfires more efficiently in Siberia. Based on previous reports by experts there is an urgent need to incorporate a more scientific approach in defining control zones in Siberia, to balance the current economic and socio-environmental considerations. Otherwise, the control zones of Russian forests (occupying 48% of Russia's and 11% of the global forest area, respectively) will remain a critical blind spot in climate change mitigation plans that aim to utilize Siberia's carbon sequestration potential.

Keywords: firepower; forest management; remote sensing

Introduction

With approximately half of its landmass forested, Russia is uniquely vulnerable to the adverse effects of wildfires. According to the Global Fire Emissions Database, the largest number of forest fires recorded in large countries in the Northern Hemisphere between 1997 and 2015 was recorded in Russia (Giglio et al. 2013). Nearly 80% of the wildfires recorded in Russia occur in Siberia (Vivchar et al. 2011), where 90% of summer wildfires are large-scale events covering more than 200 hectares with the potential of spreading further (Soja et al. 2004). Wildfires destroy 3.5–18 million hectares of forest each year (Tsvetkov and Buryuak 2014) in Siberia, where 20% of the total world's forests are located (Nilsson et al. 1994). Moreover, the climate-induced doubling of the fire danger has been long predicted for Russia in the 21st century (Malevskiy-Malevich et al. 2008), and some striking indications of the strongest global regional warming was recently recorded in Siberia (WMO Report 2021). These facts imply that wildfires in Russia are likely to increase the rate of global warming, as the region is one of the largest global carbon sequestration pools in the world (Forkel et al. 2016). Wildfires in Russia are unique not only because of their scale, but also because most are driven by human activities. Strikingly, from 72% (Ermoshkina 2024) to 87% (Mollicone et al. 2006) of forest fires in Russia are man-made, making national fire management exceptionally important.

Some researchers believe that not only global warming (Kim et al. 2020), but also the deterioration of the socio-economic situation (Levin 1992) after the fall of the USSR have made Siberian forests very vulnerable to frequent occurrences of extensive wildfires. To name a few reasons for this vulnerability, the low utilization and investment in forest resources (Torniainen et al. 2006), dismissal of many forest sector employees (Ulybina 2014) and creation of conditions favourable for illegal logging. Recently, many experts pointed to the Russian (Forest Code 2006) as the most significant trigger of further disruptive changes in Russian Forest Management (FM). Some researchers argue that Forest Code-2006 led to the dismantling of some traditional forest protection agencies (Isaev et al. 2013) and the introduction of so-called "control zones" (Ministry of Environment 2014). In contrast to protection zones, in control zones in Russian forests, wildfires can be legally ignored. Firefighting activities in these areas are hindered by the inaccessibility of the forests, resulting in expenditure on fire suppression that are typically ten times higher than in accessible zones (Isaev et al. 2013). As a result, nearly half of Russian forests have become unprotected de jure since the Forest Code-2006 was enacted. Indeed, as 95% of regular wildfires in Russia occur in 3–4 remote geographical areas in Siberia exposed to extreme heat in summer, the control zone approach is not unreasonable, but may cause some unpredictable socio-environmental challenges during years when there are extensive wildfires.

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In 2019, wildfires engulfed vast areas of Siberian forests. The estimates of total area destroyed during June–August 2019 in Russia varied from ~ 5.5 million hectares, according to Russia's Federal Forestry Agency (AviaLes 2019a), to ~7.2 million hectares (Voronova et al. 2020) up to 10 million hectares (Loupian et al. 2019). If the upper estimate is accurate, this would place 2019 among the top three years in terms of the area burnt (after 2003 and 2012) and the first year in 50 years when the cumulative area burnt exceeded 10 million hectares two years in a row (2018, 2019). The Siberian wildfires in 2019 were so extensive that together with those in 2020 they accounted for 44% of the total area burnt in the Siberian Arctic for nearly 30 years (1982–2020) and the resultant smoke reached Canada and Antarctica (NASA 2019). Economically, the fires in 2019 inflicted economic damage on the Russian economy amounting to ~USD 39,762,500 (Bartalev 2019). Administratively, at the height of the wildfires in 2019, 95% of the available firefighting personnel in the affected administrative regions of Russia were operative, army units were called in (Government of Russia 2019), and widespread emergency situations were declared throughout Siberia. In the aftermath there was an extensive debate about the adequacy and promptness of the administrative measures and effectiveness of the FM legal framework (Bogdanova and Wegner 2020; Porfiriev 2020), which resembled the politically charged discussions on the drivers of Australian wildfires in 2019 (Bowman et al. 2020).

In this light, this study examines the Siberian wildfires in 2019 in terms of the Forest Code-2006; the main legal act that introduced the concept of control zones and currently determines forest management in Russia. To do this, the dynamics of Siberian wildfires 2019 was studied using remote sensing and nationally reported statistics while reflecting on the extent of the wildfires in the control zones during 2019.

Materials and Methods

We analyzed Siberia as a region (see the detailed definition of the region 'Siberia' in Appendix 1), where we quantified the intensity of wildfires. To do this, remote sensing observations and official statistics about wildfires in Russia were used. Remote sensing of fire radiative power (FRP) was used to quantify wildfire intensity, as it was previously deemed efficient for determining burning emissions (Li et al. 2019) and used in fire emission (Darmenov and Silva 2015) and burn severity (Heward et al. 2013) databases. FRP from two independent sources were used: MODIS (Moderate Resolution Imaging Spectroradiometer) and VIIRS (Visible Infrared Imaging Radiometer Suite) with their C6 fire detection 1,000 m product for the years 2009–2019 (Giglio et al. 2003) and 375 m NRT product for the years 2012–2019 (Schroeder et al. 2014), respectively (see Appendix 2 for further details about remote sensing products). From a national perspective the data used came from Russia's Federal Forestry Agency, namely the Aviation Forest Protection service (AviaLes 2019b) or 'AviaLes'. This data includes the number of fires, and the total area burnt (hectares) and was accessed online (https://aviales.ru/; the date of the latest access is 31.01.2023). This is the same approach as used by Labzovskii et al. (2023), which is to summarize the trends in the results of internet searches recorded each year for the keyword combinations of interest (see details in Appendix 4). The words/word combinations were specified in both Russian and English, implying both region-sensitive and region-insensitive analyses (see Fig. 2 caption).

Results

Estimating the contribution of control zones to the Siberian wildfires in 2019

Although control zones, defined by Russian Forest Code-2006 (Forest Code 2006), have been widely criticized in the literature, previous studies on extensive wildfires have not determined the incidence of wildfires in control and protection zones. To determine this the Siberian wildfires in 2019 were used as an example. The daily dynamics of the wildfires was determined using both official reporting (AviaLes) and remote sensing data. As seen in Fig. 1, the 2019 Siberian wildfires occurred in summer, starting at the beginning of June and then quickly engulfing an ~295% larger area (from 33,094 to 130,863 ha between 1 and 13 June, respectively) according to the reports (Fig. 1, mid panel). The most extensive fires were recorded at the end of July (21–24) with a cumulative FRP of 914,987 MW at the peak on 23 July. This estimate qualitatively agrees with Bondur et al. (2020) remote sensing-based estimates, who reported the maximum fire radiative power (FRP) intensity in mid-late July 2019. The wildfires reached a second distinct (but notably weaker) FRP peak of 495,388 MW on 8 August. This annual FRP record also indicated a second peak in the area engulfed by fire (3,063,687 hectares were burning on 13 August), which is evident from the reports (Fig. 1, central panel). These peaks were not one-time events, as it is reported they continued for 6 days (1–3 August, 12–14 August) with more than three million hectares burning, 18 days (between late July and mid-August) when 2.0–2.9 million hectares were burning, and 13 days (also July and August days) when 1.0–1.9 million hectares were burning.

While remote sensing estimates indicate the overall extent of wildfires nationally reported statistics on wildfires can also be used to estimate the extent of wildfires in both control and protection zones. Strikingly, the control zones always vastly outnumbered the protection zone in terms of the area engulfed by fire (this percentage changed depending on the day from 60–98%) in summer 2019 (see the top and central panels in Fig. 1). Thus, the incidence of fires in the control zones are highly significantly correlated with area burnt (encompassing 48% of the forested area, but accounting for approximately 90% of area burnt in 2019). The dictate to firefighting agencies to allow fires in these regions to burn – combined with logistical challenges even if a response were mounted – results in a much higher fire load within these areas. Two other important aspects of the wildfires in control zones should be emphasized. First, in June, the percentage incidence of wildfires in the control zones was high (97–98% from 4 to 22 June). Second, on 2 August when the wildfires were at their annual peak in terms of area, 96% were located in control zones (3,012,082 hectares out of 3,134,128 hectares). Interestingly, the control zones concept triggered a clear difference in the total incidence of wildfires and the number brought under control during this period. In particular, during the peak on 2 August, fewer fires were fought (116) than one month earlier on 2 July (160) despite the overall area engulfed by the fires on 2 August being four times larger than on 2 July. Thus, the effect of control zones is that most of the wildfires were ignored, and this was most pronounced in two crucial periods in the 2019 Siberian wildfires.

In Fig. 1, records three important decisions regarding wildfire firefighting in Siberia in 2019, including the announcement of forestry departments to stabilize the situation (green line, 3 July), the statement of the governor of Krasnoyarsk Region that it is not worth fighting wildfires (blue line, 28 July), and an urgent meeting of the Federal Government in Krasnoyarsk calling for the dispatch of all possible resources to fight wildfires (red line, 31 July). Krasnoyarsk Region was selected as an example because it was the most affected one by wildfires during the 2019 season. The Krasnoyarsk Region was selected as an example because it was the most affected by wildfires in 2019. The timing of these decisions is important in determining the role of control zones. In particular, the forestry department meeting occurred when there were wildfires in both control and protection zones, so the wildfires could have been fought and potentially stopped according to the Forest Code-2006. However, the decisions by regional policy makers about fighting wildfires occurred when wildfires were rapidly spreading, but only in the control zones, where they could be legally ignored according to the Russian Forest Code-2006. This was reflected in the statement of the Krasnoyarsk Region Governor, who emphasized that it was not necessary to fight these wildfires. However, if the fires in the control zones posed no danger to infrastructure, why did the same decision-makers change their stance a few days later by deciding to dispatch all possible measures to fight wildfires even in control zones? Indeed, the intervention of the Federal Government on 31 July 2019 played a pivotal role in this decision, but it is also likely that the decision not to fight wildfires in such a large area without providing the public with an explanation may have caused serious social concerns, to which the federal, rather than the regional governments, had to respond.

Unforeseen nexus: control zones, wildfires and social concerns

To support the suggestion that society was concerned, social interest in wildfires in Russia was elucidated by using the analysis of data in Google. Specifically, the relative frequency of search requests in the Google search engine (points are cumulative for each month) in Russian with the keywords 'Forest fire', 'Siberia', and 'Siberian Fires' was determined. This is the same approach as used by Labzovskii et al. (2023) to determine the level of social concern over air quality in Siberia (see Appendix 4 for details). As depicted in Fig. 2 (top panel), the peak in the interest in Russia over Siberian wildfires coincided with the peak in FRP of the fires in July 2019. This indicates that by the end of July, when wildfires were spreading throughout Siberia, there was notable social interest and perhaps concern of Russians because of the size of the peak. The concerns about the adverse effects of wildfires became international as interest in the Siberian wildfires was also reported in the English-speaking part of the internet, but one month later; in August 2019 (Fig. 2, bottom panel). This concern was also manifest in more direct public action. For example, a substantial increase in wildfire-related civil petitions spurred on by the 2019 Siberian wildfires included 54 petitions in total (one had > 1,000,000 signees) (Pupkova 2021). These petitions indicate high degree of social concern over wildfires throughout Russia during the peak in the occurrence of wildfires, as most (~77 %) petitions were signed when the wildfires were most extensive between 20 July and 20 August. While Russian officials stated that the drivers of the wildfires are primarily natural, the petitions, by contrast, cited anthropogenic drivers and blamed (in descending order): the onset of "control zones" (also suggested in Section 4.1), arson and illegal logging (Pupkova 2021). However, it is difficult to support either of these claims without knowledge of the drivers of the wildfires, which is outside the scope of this study.

Google trend indicators are a good example of some of the unforeseen effects of wildfires, such as social concerns, which can result in a citizen response and even social unrest. Thus, it is important that policymakers should develop policies or guidelines, which address the reason for the social concerns. Although the reasons for these concerns should be elucidated in future studies, it is likely they are that wildfires will affect their life, health and property as many settlements in Siberia are located in forest areas. There is no scientific evidence corroborating our surmise, but some indications of this phenomenon emerged in Russian media, where people, including numerous celebrities in Russia, urged the Federal Government of Russia to focus on Siberian wildfires 2019 (RIA News, 2019). Thus, decision-making in response to extensive wildfires should consider the potential social implications of the accepted policies and measures to ensure that the actions are not causing unintended consequences that could lead to public unrest. It is clear that the reason for the dissatisfaction is a wildfire per se, however, the very concept of control zones implemented in the Forest Code may have creat-

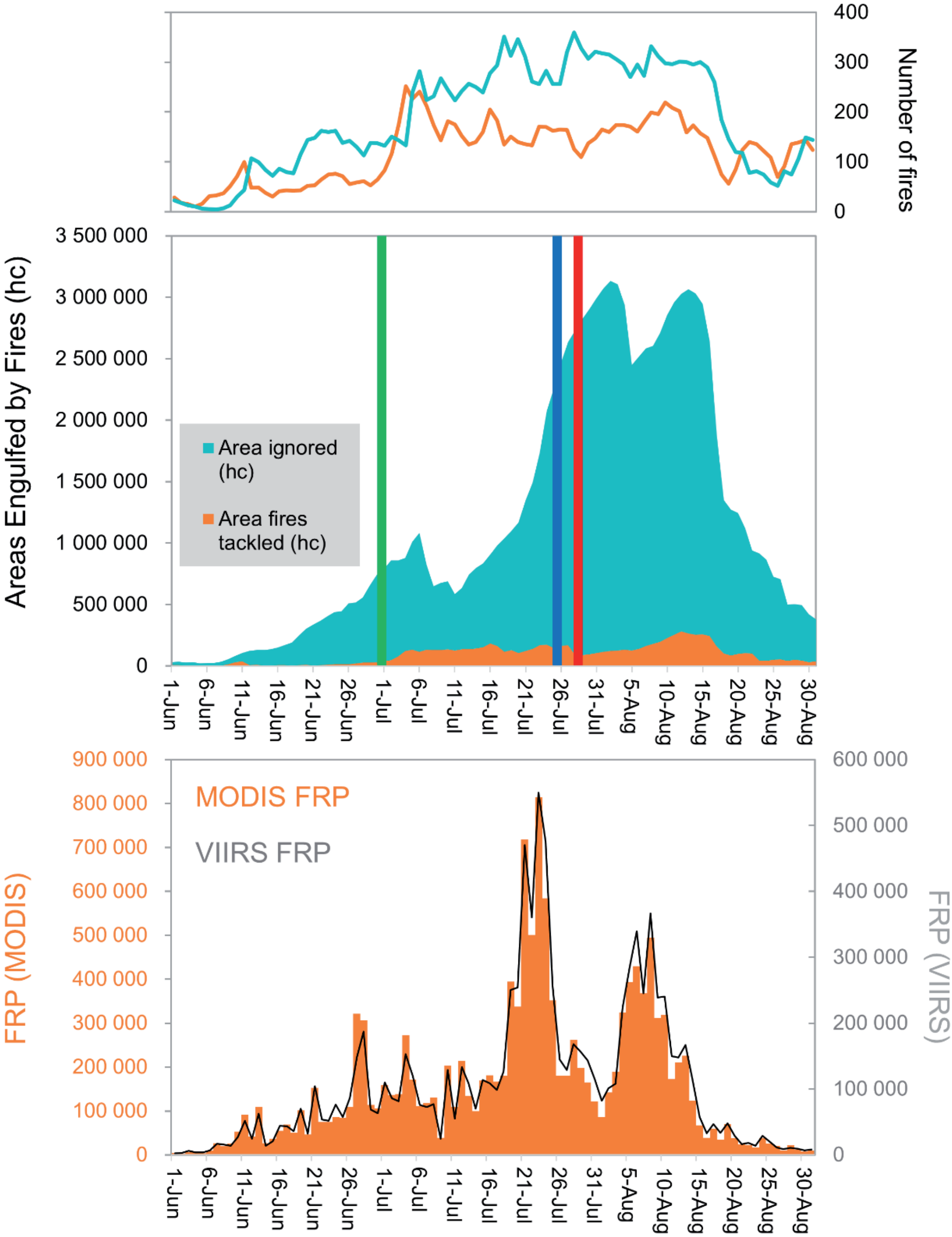

Fig. 1 Report-based Russian statistics on the number of fires tackled daily (brown) and left to burn (blue) in terms of number of fires (top panel) and hectares burnt (central panel) (it is difficult to disentangle the wildfires reported for Siberia from those for other regions using this data). Cumulative remote sensing statistics (FRP) of daily fires reported in MODIS (orange bars) and VIIRS (black line) only in Siberia (the region as defined by Fig. A1). The analysis of wildfires in control zones is based only on statistical data because there is no structured data or a digital map outlining the extent of control zones available in open access websites (Aviales 2019c). Vertical lines in the central panel denote the date the statement by LesHoz to stabilize the wildfire situation (green line, 3 July, statement only relevant to Siberia), the statement of the governor of Krasnoyarsk Region that it is not worth fighting wildfires (blue line, 28 July; statement relevant only to the Krasnoyarsk region), and the decision of the urgent meeting of the Federal Government in Krasnoyarsk to mobilize all possible resources to fight wildfires (red line, 31 July; statement applies to Siberia and nationally).

ed widespread belief that these zones were introduced to make decision-makers unaccountable for these fires (Bogdanova and Wegner 2020).

Discussion

The Russian system of FM is shaped by the Forest Code-2006, which introduced the concept of control zones. These zones make up nearly half of Russian forests (48%) and a considerable percentage (11%) of forests globally, and authorities are legally allowed to ignore wildfires in these areas. During the Siberian summer wildfires in 2019 most of the fires were in control zones (60–98% depending on the day). The percentage in control zones was highest during the crucial periods of the Siberian wildfires in 2019. Specifically, 97–98% of the fires were in control zones in June 2019, when the rate of increase in the area affected was at its highest. Even more strikingly, at the peak of the wildfire season in August 2019, 96% of the fires were in control zones, which is an astonishing 3,012,082 hectares out of a total of 3,134,128 hectares. This is likely to have hampered the decision-making over which fires should be fought and which ignored, and this was especially so during the spatially extensive wildfires in 2019.

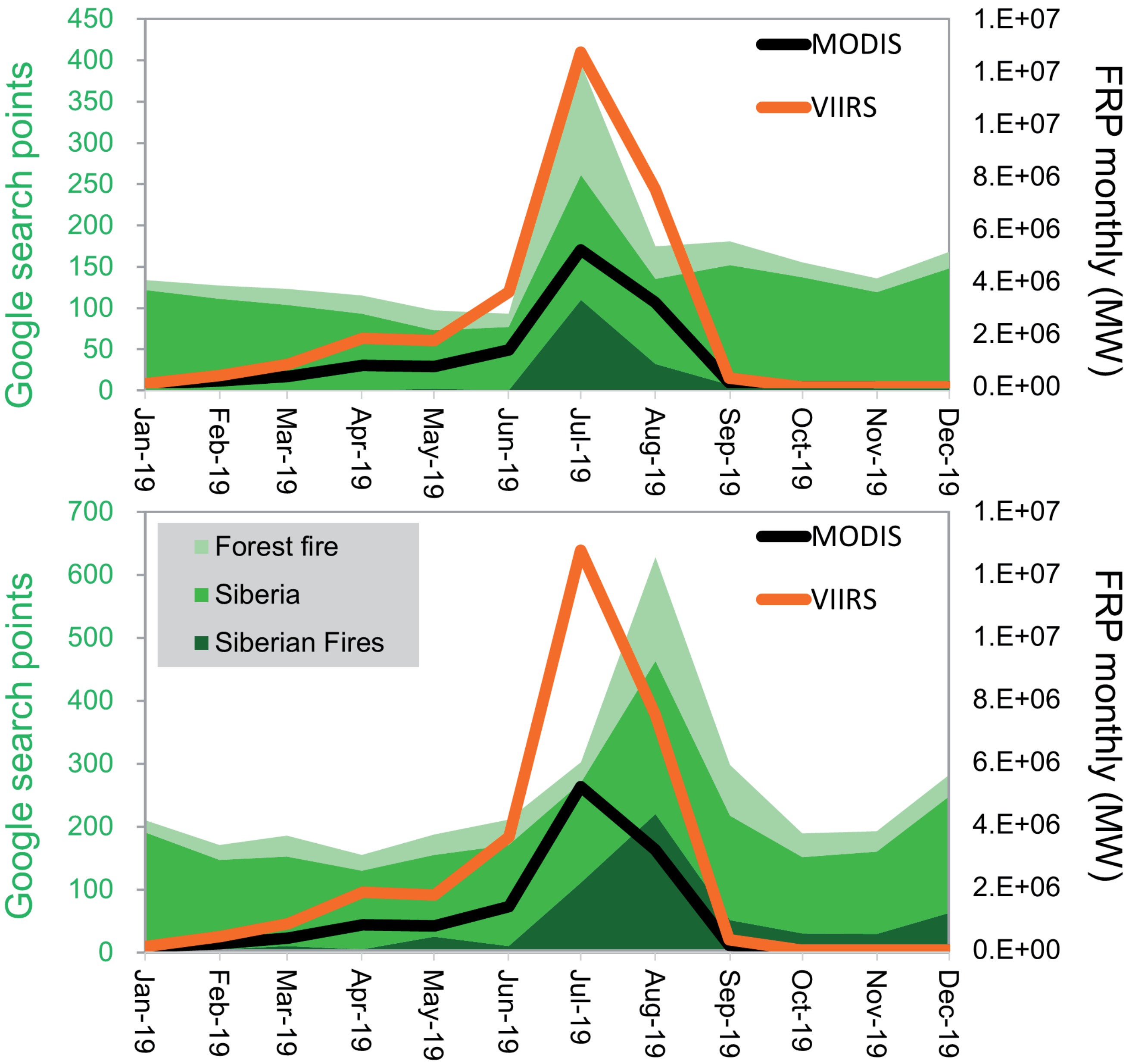

Fig. 2 Analysis of trends (green areas) in google search requests 'Forest fire', 'Siberia' and 'Siberian Fires' in both Russian (top figure) and English (bottom figure). Lines represent cumulative monthly FRP indicated by MODIS (orange) and VIIRS (black). Note that the google search points are for trends in Google data, whereas usually, the points indicate the frequency of results (from 1 to 100). The scale was extended from 1 to limitless by summarizing all google trend daily points for each month.

Despite the devastating effects of wildfires, the concept of control zones has a right to exist because there is no evidence about the increase of wildfires or the damage of the infrastructure from them at global scales despite a substantial increase in the costs related to the suppression of wildfires worldwide (Doerr and Santin 2016). Moreover, many remote fires in Russia are virtually inaccessible by firefighters. Indeed, the very idea of control zones is not detrimental per se, but rather debatable in its current form because their borders were arbitrarily outlined. If, as reported ~100% of the fires at any time can be ignored, this decision must be based on data, which takes into consideration the risk to neighbouring infrastructure.

Although this study indicates the role of "control zones" in the 2019 wildfires, it is difficult to quantify the long-term effects of these zones. This stems from the unavailability of the wildfire reporting (where clear separation between the fires in "control zones" and outside them is made) information in free-access for previous decades (the 1990s, 2000s). This can be alleviated in the future by using remote sensing analysis to calculate long-term estimates of fire occurrences (or firepower) in and outside control zones, before and after "control zones" were introduced, which is before and after 2006, respectively, if a digital map or structured dataset, describing the extent of control zones in Russia, could be published. This would facilitate a quantitative sensitivity analysis of the effect of control zones on Siberian wildfires.

Conclusions

This paper sheds light on the effects of Forest Code-2006 on wildfire protection in Siberia based on previous experience and, importantly, relying on the example of the extensive Siberian wildfires in 2019. Scepticism of Forest Code-2006 and role of "control zones", when wildfires were just reported, during the extensive wildfires in Siberia in 2019, is not new as it is expressed by many Russian experts on wildfires and forest management (Blam et al. 2011; Schvidenko and Schepaschenko 2013; Moiseev 2016; Sinkevich and Ananyev 2020) and even Russian government officials (Government of Russia 2019). This scepticism turned into a criticism after the Siberian wildfires in 2019, when the regional authorities were blamed for their *"decision not to fight the wildfires"* by experts (Bogdanova and Wegner 2020; Porfiriev 2020). As the control zones are in the largest country in the world (>50% of the area of Russia is forested), legislation of this type becomes a global climate change factor given the continental-scale of the wildfires and resultant carbon emissions from Siberia. In the absence of a scientific justification the introduction of such important legislation for forest management, Siberia risks of not being a part of any global carbon abatement plan, despite the outstanding carbon sequestration potential of its boreal ecosystems (Yin et al. 2020) and pronounced black carbon-driven warming effects of global importance (Cho et al. 2019). This paper aims to bring to the attention of the scientific community that they should in the future be involved in the decision-making procedures for forest management in Siberia.

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