



Article

When Ice Turns to Water: Forest Fires and Indigenous Settlements in the Republic of Sakha (Yakutia)

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Abstract: In recent years, forest fires have covered many parts of the Republic of Sakha (Yakutia). The fires often threaten populated areas and Indigenous communities as well. In 2020–2021, the fires caused enormous economic and environmental damage and the exact amount is yet to be fully calculated. Concerns about the sheer scale of carbon emissions into the atmosphere were widely discussed by world media. Social scientists of the Republic of Sakha (Yakutia) raised the following questions: how do Indigenous communities live in a condition of constant threat from annual forest fires? What environmental, social, and economic challenges do they face, what do they fear, and what are their expectations? We reviewed Indigenous traditional knowledge related to fire management and firefighting techniques and analyzed Indigenous peoples' perceptions of changes in the ecological balance of water resources and permafrost. The authors also discuss the causes of forest fires, connections with industrial and transport development, and social consequences. The article is based on 2010–2021 field studies.

Keywords: forest fires; wildfires; Republic of Sakha (Yakutia); arctic; Indigenous; Siberia



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1. Introduction

An increased frequency of natural disasters in the Arctic and Subarctic territories is a part of the global climate challenge. As the World Economic Forum (2022) [1] states, “Climate action failure” is recognized as “the number one long-term threat to the world and the risk with potentially the most severe impacts over the next decade. Climate change is already manifesting rapidly in the form of droughts, fires, floods, resource scarcity, and species loss, among other impacts.” A territory of the largest Arctic region of the Russian Federation, the Republic of Sakha (Yakutia) is an example that demonstrates these global threats. In 2021, smoke from the forest fires covered the sky over the Republic's territory and reached neighboring regions and countries. The forests of Yakutia burned from May to September. However, even in the winter of 2021/2022, there was a feeling that these fires still existed. Among other vital media news, there are stories about the restoration of burned-out houses in the village of Byas-Kyuel, Gorniy Ulus, payments of reimbursement to the assistants of fire services in uluses (districts), and “zombie fires”—smoldering fires that do not extinguish even in winter [2]. Even in the middle of a snowy winter, the topic of winter forest fires has not left the socio-political and economic agenda in the Republic of Sakha (Yakutia).

The fire theme is essential for those who live in the rural settlements scattered over more than 3 million hectares of the Republic's territory with both the north-taiga landscape, rich in forest resources, and the tundra with its peat bogs, both of which are very vulnerable to fire. In the rural areas of the Sakha Republic, close to forests and water bodies that provide traditional economic management, Indigenous peoples—Sakha, Evenks, Evens, Dolgans, Yukaghirs, Chukchi—mainly live. They constitute 52.8% of the total population of the

Republic. Periodically occurring wildfires are always a direct threat to traditional livelihood activities such as animal husbandry, reindeer herding, and traditional craft. The consequences of fire have resulted in direct and indirect losses and disturbed economic livelihood cycles. Fires lead to damage of the forage base, loss of cultivated agricultural land and even livestock, damage to communications and industrial and housing infrastructure—the list of negative consequences of forest fires for rural residents is immeasurable.

In recent years, forest fires covered large areas of the Republic of Sakha (Yakutia) and often threatened Indigenous settlements and their life support facilities. Along with concerns about the scale of carbon emissions into the atmosphere due to the forest fires, the authors investigated from a social science perspective how rural Indigenous communities live in conditions where the threat of forest fires exists. Our research questions included the following: What environmental, social and economic challenges are they experiencing? Was it possible to avoid or mitigate the negative impact of forest fires on Indigenous people? How do Indigenous communities perceive changes in the ecological balance between water resources and permafrost? What natural events do they expect in the near future? What aspects of TEK of Indigenous land management practices can help reduce the extent of wildfires and better protect communities? Here, we consider Traditional Ecological Knowledge as a deep knowledge of specific plant phenological phases and a detailed understanding of climate–environment–people interconnected relations.

2. Background: The Republic of Sakha (Yakutia) as a Territory of Climate Challenges

The Republic of Sakha (Yakutia)—the largest among the ethnic republics and one of the most economically viable subjects of the Russian Federation—is located in the northeast part of the Asian continent; see Figure 1.



Figure 1. Location of the Republic of Sakha (Yakutia).

The climate is sharply continental in the greater part of the republic. Very low air temperatures characterize extremely severe, long winters, and high temperatures during the short summer. The annual temperature fluctuations can exceed 100 °C. Almost the whole territory of the Sakha Republic is a zone of continuous permafrost. The average thickness of permafrost within the territory of the republic is 300–400 m, and on the Vilui river basin, it reaches 1500 m [3].

Temperature changes noted over the past few decades throughout the territory of the Republic of Sakha (Yakutia) were emphasized by many researchers [4–7]. The temperature increase has many global and local consequences. Decreasing summer precipitation is a reason for droughts, which, for example, were observed during the spring and summer of 2021—with lack of rainfall and abnormal heat throughout the republic [8]. In May 2021,

sunny, unusually dry, windy weather led to quick snowmelt. As a result, everything dried up to a fire-hazardous state: vegetation, forest, and tundra. One of the consequences of climate change in the Republic of Sakha is frequent solid and gusty winds (Yakutia) [9]; it contributes to the rapid spread of even small fires.

In 2021, the total duration of the fire season was 140 calendar days—from 11 May to 27 September. A total of 1696 forest fires occurred. Fire extinguishing involved over 26,000 people and approximately 1400 pieces of equipment [10]. The burned area covered 8 to 9 million hectares. No one has yet calculated the total damage to wildlife, flora, and fauna. However, almost everyone understands that the great danger of recent fires relates to the safety of permafrost soils.

Sakha people call permafrost “Irbet Tong” and “Sir Muuha”, which mean “non-melting cold” and the “ice of the Earth”. It is the basis of the foundations of the entire universe of Indigenous peoples of the north. Indigenous peoples have adapted to this “non-melting ground ice” for centuries, learned to live in limiting cold conditions, and learned how to use its resources in traditional and modern life [11]. Forest fires and floods intensify the thawing processes of permafrost, and could bring on unknown, in addition to well-known, consequences. Thus, there is a possibility of releasing antibiotic-resistant bacteria and undiscovered viruses [12]. There could be outbreaks of infectious and parasitic diseases that are carried by small rodents, and their areal distribution is likely to expand [13]. One of the most worrying problems in the Sakha Republic is the decrease in permafrost bearing capacity due to the deepening of seasonal thawing. This consequence of climate change can damage the foundations of buildings, infrastructure facilities, and more [14]. Shiklomanov and his colleagues [15] have estimated the impact of climate change on the stability of Russian urban infrastructure, noting particular changes in bearing capacity and the ability of the frozen ground to support buildings. They suggest that critical climate-induced decreases in bearing capacity in the area of Yakutsk can be expected around the 2040s [15].

Indigenous people have accumulated rich observations of the process of turning ice into water. Thus, the ethnologist Nikolaev-Somoghotto described one archaic, time-extensive, and labor-intensive economic practice of Sakha people: “To expand cultural lands, they set a local fire under careful supervision and left the burnt bare area under the sun for years. Without vegetation cover, the permafrost melted in that area and settled, forming a lake. Finally, after decades, people drained the lake, and land was ready for use” [16] (p. 18). Sakha knew the power of fire, its ability to turn forests into ashes, and the “eternal ice” into water. Therefore, they carefully protected the expansive territory of their life from wildfires: the lands around their houses, pastures, and neighboring forest.

At the present stage, scientific knowledge warns of another consequence of large-scale forest fires. In addition to the release of carbon dioxide during wildfires, more greenhouse gasses can be released from the melting permafrost. As a result, it could accelerate global climate change. Therefore, forest fires in the Republic of Sakha (Yakutia) are a serious threat on local and regional levels and a global threat to the whole world’s sustainable development.

3. Materials and Methods

The theoretical framework used in our article is the Indigenous Research Framework, where the problem, purpose, research questions, and significance of the study are relevant to Indigenous people [17,18]. Within this framework, the authors raise concerns “about the questions that mattered to us” [19] (p. 68), questions that matter to Indigenous people in the Sakha Republic. We have based our article on data from a few independent projects: the HYPE-ERAS project, funded by FORMAS (DNR: 2019-02332), RFBR (project No 20-55-71005), JST (Grant No. JPMJBF2003 through the Belmont Forum Collaborative Research Action: Resilience in the Rapidly Changing Arctic), and the doctoral dissertation research in the Oymyakon region in 2015–2016, funded by NSF; the award number is #1439468.

Under the HYPE-ERAS project, we interviewed 450 people in the rural area (238 women and 212 men, where 96.5% were Indigenous peoples). We documented rural residents’

opinions about current changes in climate and environment. In Oymyakon, the authors used questionnaires, focus groups, and interviews in collecting data. There were 12 focus groups (a total of 96 people) where participants discussed changes in the environment and how these changes affect Indigenous livelihoods. In addition, there were 48 interviews where people shared more detailed personal stories about Traditional Ecological Knowledge, traditional practices, and their choices. The authors documented traditional practices during interviews, including those related to fire management. We also studied historical and anthropological, ethnographic data on using ice and water in Sakha Indigenous livelihood, natural and climatic conditions, and the Sakha Republic's water resources.

The authors accumulated field research materials from different uluses of the Republic, carried out during 2010–2021, and studied perceptions, evaluations, and experiences of confronting natural disasters, including forest fires in rural communities. They also analyzed the content of forest fires in social networks and regional media in Russian and Sakha languages.

The authors, being in the city of Yakutsk, directly experienced the impacts of forest fires in the summer of 2021 in the Republic of Sakha (Yakutia). In addition, they interviewed the forest firefighters and Indigenous peoples who were directly or indirectly affected by the forest fires. At the same time, the authors tried to avoid personal bias in evaluating the ongoing processes of transformation of ice into water.

4. Results and Discussion

In June 2021, the authors worked in the Ust-Aldan ulus, the Republic of Sakha (Yakutia). The weather was dry and hot, and there was a slight smell of smoke near the settlements in the morning. We questioned residents about the source of the smoke and when they would put out the fire.

They answered, “It burns far from our municipal borders. We did signal to the regional firefighters’ services (which subordinate to the Federal Center). However, they answered that it was a landscape fire, and it is inexpedient to extinguish it because it is very expensive—too much expense. We will take firefighting measures when it threatens the lives and safety of the people . . .” [Field materials, Ust-Aldan, 2021].

At the same time, the media noted that there was no threat to settlements and economic facilities [20]. After four days, officials recognized almost 30 outbreaks, where 444 people with 64 pieces of equipment were trying to extinguish the fire. In the second half of May, a head of the Republic of Sakha (Yakutia) introduced a special fire regime in the Tompo, Tatta, Oymyakon, and Nyurba districts [21] (Figure 2).

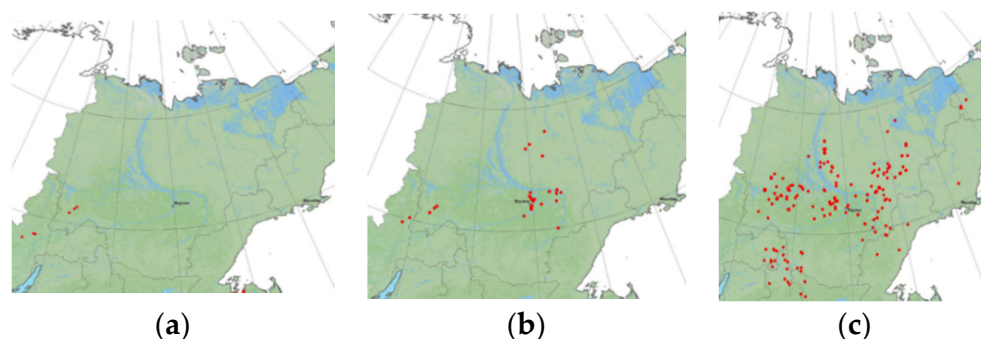


Figure 2. A map of wildfires in the Republic of Sakha (Yakutia) in the time period May–September 2021. (a) Wildfires on 14 May 2021; (b) Wildfires on 27 June 2021; (c) Wildfires on 9 September 2021. <http://www.meteorf.ru/press/news/24584/> (accessed on 8 April 2022), Reprinted with permission from ref. [20]. Copyright 2021, Planeta, Far East Region, Russia.

In early July 2021, the Sakha government suspended the section of 129–132 km of the Federal Highway “Vilui” for all types of transportation due to the forest fire. On July 13, 2021, the local authorities declared a non-working day for the city of Yakutsk—the capital of the Republic—and for several municipalities due to thick smoke. The authorities warned people to stay indoors to avoid breathing in heavily polluted air. The toxic smoke in Yakutsk was one of the world’s worst ever air pollution events [22]. On 18 July 2021, the capital’s airport was closed because of poor visibility due to heavy smoke and the ferries and passenger ships were unable to operate on the Lena River as well. Thus, the city was isolated due to the forest fires [23] (Figure 3).



Figure 3. Smoke in the city of Yakutsk. August, 2021. Photo by Vera Solovyeva.

By August 2021, the wildfires had become even more dangerous. Forest fires threatened the populations of dozens of settlements in Verkhnevilyuisk, Suntar, Tatta, Gorniy, and other uluses. In some places, the wildfire came critically close. For example, the village of Bes Kuel of the Gorniy Ulus was a tragic fire victim. On 7 August, the fire broke through the fire defense line and destroyed 31 residential buildings and eight outbuildings [24]. On 8 August 2021, by Decree, the head of the Republic announced a regional emergency throughout the Republic of Sakha (Yakutia) [25] (Figure 4).

Before 2021, the public discussions on forest fires were always stentorian. However, in 2021, the reactions of the Republic of Sakha (Yakutia) residents were incredibly harsh and involved many more people. People were outraged that the government did not take adequate measures to extinguish forest fires. Heated debates on social media such as WhatsApp, Facebook, Instagram, VKontakte, and others were about the causes of forest fires, the difference between the officially announced and the actual scale of the area of flames, the effectiveness of firefighting measures, the situation of rural communities under the threat of forest fires, and the position of the federal government on the issue of wildfires in the Republic of Sakha (Yakutia).

Large-scale fires occurred sequentially in 2020 and 2021, and the scale of the forest fires was massive, with millions of hectares burned. Very often, people vigorously discussed versions of the causes of forest fires and other fire-related issues. Our analysis of social media and the results of focus group discussions and interviews revealed that Indigenous peoples of the Sakha Republic most frequently mention the following reasons for forest fires and their increased scaling: (1) natural cycle; (2) climate change; (3) unusual and strong winds; (4) dry thunderstorms; (5) arson; (6) punishment by mystical higher powers.

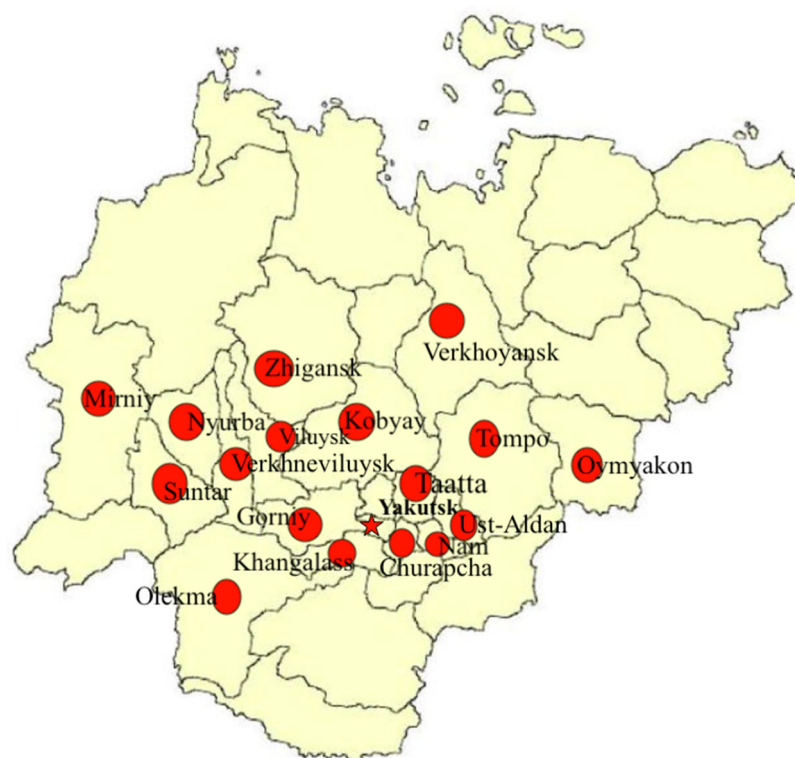


Figure 4. A map of wildfires in the Republic of Sakha (Yakutia).

We systematized and analyzed the most common causes of forest fires mentioned by Indigenous peoples during our interviews and social media analyses. We also discussed the social consequences of wildfires for the society of the Sakha Republic, miscalculations on a federal level that led to the catastrophic scaling of the forest fires in 2021, and social activism during this natural disaster.

4.1. Causes of Forest Fire: Versions and Facts

Natural cycle. Many scientific sources argue that, overall, fires historically were quite common in the Sakha Republic and even have a certain cycle of recurrence. A study of 300-year-old trees revealed that up to a dozen fires tended to occur naturally within 10 to 22 years [26]. The natural features of the Sakha region—boreal forests, permafrost, a relative lack of summer and winter precipitation, rapidly melting snow cover, and a dry climate—combine to create conditions conducive to natural causes for the occurrence and spread of forest fires [13,26–29]. Typically, forest fires happen mainly in summer, with maximum activity occurring in the second half of summer. Observers note that the periods of high flammability with the largest forest fire areas coincide with periods of less cloud cover and higher temperatures [13,26] (Figure 5).

As seen in the graphs (Figure 5), the area of cloud cover over the territory of Sakha Republic decreases from April to July and increases from August to October. The change in the cloud cover leads to changes in humidity in the forest area and changes in fire vulnerability. Thus, minimum cloudiness and maximum temperature are typically observed in July. This is coincident with the forest fire peak, which also falls in July [26]. Often, the cause of forest fires is lightning during dry thunderstorms. In June 2019, 75% of the forest fires that occurred within Sakha Republic territory were due to dry thunderstorms, as the Russian Agriculture Center specialists have stated [19]. However, some informants do not believe in such a high proportion of dry thunderstorms among the causes of forest fires. Other arguments are as follows: (a) the cause of large-scale wildfires is complex; it includes the collapse of the Soviet forest protection system with clearly defined rights and responsibilities of regions versus current ill-founded forest protection in the Russian

Federation; (b) there is a hostile human factor—negligence in handling fires, cigarettes, and private uncontrolled agricultural burning.

Correlation of the cloud cover values and the total area of forest fires in the period from May to September.

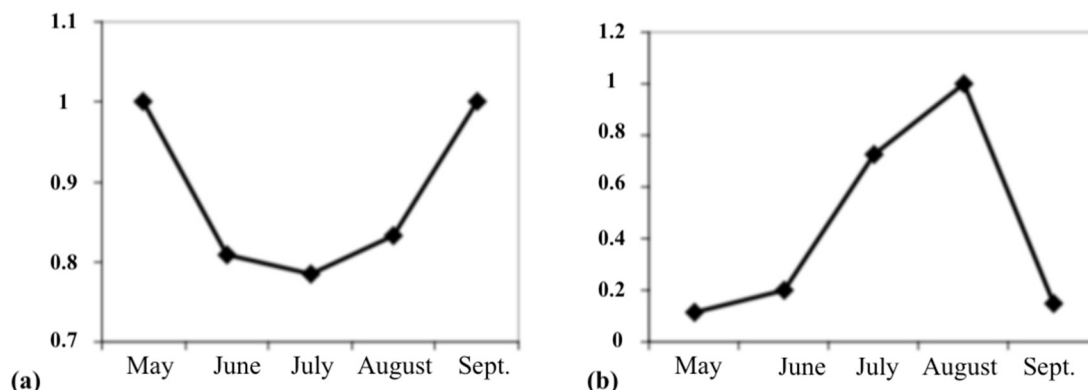


Figure 5. Correlation of the cloud cover values and the total area of forest fires in the period from May to September. (a) Change in the cloudiness area over the territory of Sakha Republic by month; (b) Change in the total area of the forest fires within the territory of the Republic of Sakha (Yakutia) by month [26].

Climate change. Climate change directly affects the intensity and size of forest fires in the Republic of Sakha (Yakutia). It is an increase in temperature, a decrease in precipitation in the warm season, followed by dry weather over some (not all) regions of the republic, and an increase in wind. The most dangerous factors that amplify the size and intensity of fires are a decrease in rainfall and an increase in temperature [30–32].

In the last few years, in the Republic of Sakha (Yakutia), as many sources indicate, temperatures have increased throughout the whole territory [4–7]. In 2019, heat records hit the Arctic regions. In Verkhoyansk, on 20 June, the daily temperature reached +38 °C, which became a triple record: day (previous record +31.4 °C, 1993), month (previous +34.0 °C, 16 June 1990), and summer (previous record +37.3°, 25 July 1988). Now, Verkhoyansk will also be known as the hottest place in the Arctic. Central regions experienced drought until September [33]. Over the past few years, unusually high temperatures and dry weather in the Arctic and Subarctic regions have caused plants, mosses, and peatlands to dry out, making them extremely fire-hazardous.

The authors compared the official data with sociological surveys and interviews of different ulus residents. Indigenous observations of environmental change generally supported science data. Rural residents in four uluses of the Sakha Republic—Ust-Aldan, Nam, Khangalass, and Oymyakon—argued that climate change is happening and expressed their concerns. The proportion of respondents who, without doubt, perceive climate change as a threat to well-being is high (Figure 6).

Question: Is climate change a threat to you and your close ones' wellbeing?

As seen from Figure 5, 70.1% of respondents in the Nam ulus, 78.6% in Khangalass, 78% in Ust-Aldan, and 74% in Oymyakon perceived climate change as a threat. Survey respondents emphasized the danger of regular droughts and abnormally high summer temperatures. Moreover, 82.1% of the respondents in the Ust-Aldan ulus, 46.6% of respondents in the Nam ulus, and 45.8% in Khangalass were concerned about the drought. In addition, 46.6% of the survey participants in the Nam ulus think that the drought has been brought on due to climate change; almost the same number of responders in the Khangalass ulus believe this as well (Figure 7).

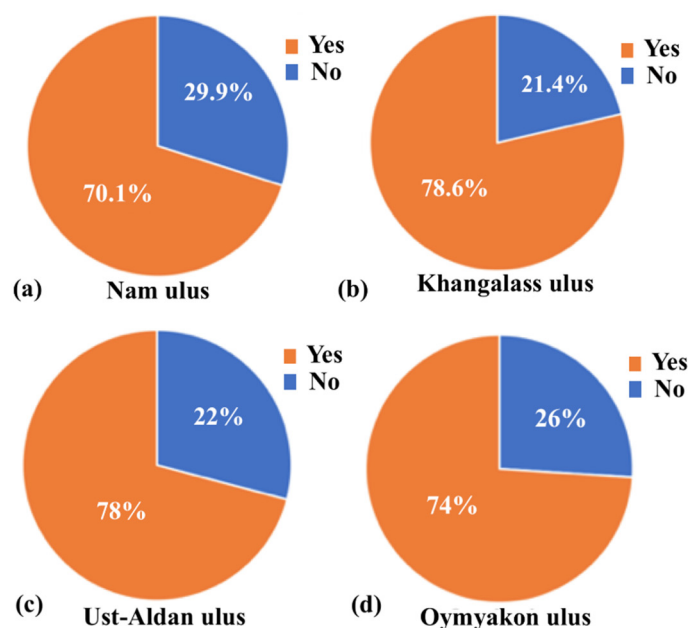


Figure 6. Level of concerns about climate change as a threat to well-being. (a–c) 2021 survey results from the HYPE-ERAS project, and (d) 2016 survey results from the Solovyeva dissertation research.

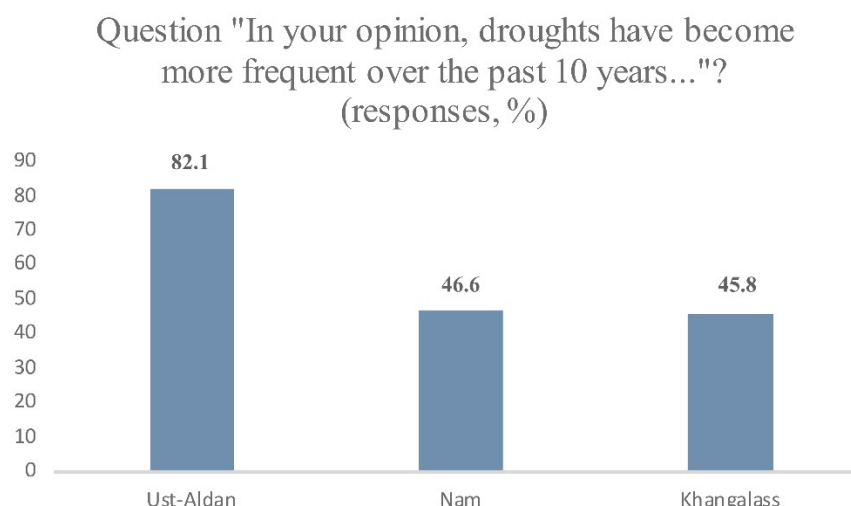


Figure 7. The level of concern about droughts in Ust-Aldan, Nam, and Khangalass uluses, the Republic of Sakha (Yakutia).

However, in Oymyakon, people worried more about flooding (87%). This is because the precipitation level changed unevenly over the territory of the Sakha Republic. While, in northern territories (tundra area), the amount of precipitation decreased by 52 mm on the eastern side and by 73 mm on the western side over 50 years, in the southern part of the republic, the amount of precipitation increased by 80 mm for the period of consideration. In Oymyakon, the level of precipitation increased by 20–40 mm from 1966 to 2016 [34]. However, 2020–2021 summers were characterized by a precipitation deficit, particularly over the whole territory of the Sakha Republic.

Overall, Indigenous peoples perceive natural disasters—forest fires and floods—as consequences of climate change. Other consequences of climate change are unusual and include intense winds and thunderstorms, which have happened more often in recent years.

Unusual and strong winds. Another major factor affecting the scale and intensity of fires is stronger than usual winds. Increased winds can quickly spread even small fires that grow into catastrophic events [35]. As our studies have shown, residents of different uluses

perceive changes in the strength and the direction of the winds as one of the consequences of climate change [9]. They argue that unexpected squalls often catalyze forest fires (Field materials, 2021). Thus, residents of the Verkhoyansk ulus noted that the recent strong winds and dry thunderstorms played a prominent role in the spread of fires that hit the Verkhoyansk district in force. For example, at the end of June 2019, 10 natural fires blazed in the Verkhoyansk ulus, covering 292,970 hectares [36]. Fires burned until the fall rains began in August, which extinguished only a part of the fires [37].

Dry thunderstorms. Recently, scientists and Indigenous people have more often referred to dry thunderstorms as a reason for the forest fires in the Republic of Sakha (Yakutia). A dry thunderstorm is an atmospheric event wherein discharges of atmospheric electricity between clouds and the Earth and are not accompanied by rainfall. In combination with hot, dry weather and gusts of wind up to 30 m per second, they are often responsible for forest fires [38]. In June 2019, 75% of the forest fires that occurred within Sakha Republic territory were due to dry thunderstorms, as the Russian Agriculture Center specialists have stated [19]. The same factors caused wildfires in the tundra [39].

Arson. According to many Indigenous informants, forest fires in the Republic of Sakha (Yakutia) may be preparation for the future exploitation of natural resources instead of costly deforestation on the territory of future mining enterprises. As one respondent shared his thoughts in 2021:

“The Verkhoyansk region was on fire in 2019 and in 2020 . . . However, the media practically hushed up this topic . . . The Tompo ulus greatly suffer from the fire in the second season. Strangely, there are many fires in the *uluses* with industrial sites, where it is potentially possible to expand mining.” (Informant, male, Sakha, born in 1950).

The basis for such suspicions is that mining development is costly: building roads, laying communications, deforestation. Developers also must pay compensation for the damage to natural resources, fauna, and the flora of the developed areas, along with the economic activities of Indigenous peoples during transport and industrial development.

People also believe that developers can use targeted arson to force Indigenous people to migrate from the resource region. Despite the controversy of these points of view, we assess them as symptoms of painful, hidden conflicts in legal relations between mining organizations and the Indigenous population. We also need to note that, in 2013, authorities made corrections in the “Government reports on the state of the environment” list of reasons for the forest fire ignitions. Thus, two reasons were highlighted among others, namely due to the fault of loggers and the fault of expeditions (mainly exploration). However, the authorities removed these two reasons. As a result, other reasons for igniting forest fires are now recorded, such as spontaneous thermal combustion, repeated fire, peatlands, arson, and spontaneous combustion (lens effect).

There were also cases of fires caused by unprepared people using agricultural burning. However, the number of such cases is small. Agricultural burning has been officially banned since 2015 on the Republic of Sakha (Yakutia) territory for fire safety reasons [40]. However, Sakha natural scientists argued that only approximately 7% of forest fires were provoked by agricultural burning in 2017 [41]. Using fire as a land management tool, clearing and burning forests from deadwood, branches, fallen needles, and leaves should be considered fire-fighting measures. Moreover, in the traditional cultures, fire management meant compliance with all fire regulations of Traditional Ecological Knowledge. Thus, fire was used as a pervasive management tool by many Indigenous peoples for centuries. Prior to European contact, native hunter–gatherers widely used fire in their traditional burning practices for various purposes in what became America. For example, they saw burning as a spiritual responsibility to the land or as a tool to promote world renewal, clearing meadows and village sites, pest and crop management, and more [42–48]. They used fire as a vegetation (shrub) management tool to bring out young shoots, which they used for basketry fibers [49,50] or to increase the number of wild plants to attract wild animals, on which they depended [42]. Intentional fire setting was also used to create prairies—habitats

for elk, deer, and other game—on which Native Americans rely [43,51]. Thus, culturally prescribed burning most importantly created a mosaic of natural habitats, which increased animal biodiversity and edible and medicinal plants [42,43,51,52].

In the Republic of Sakha (Yakutia), using fire as a land management tool was a part of the traditional economic culture, particularly in horse breeding, where semi-wild horses were kept free all year round outside the barn. Therefore, preparing quality pastures for winter grazing using fire management was extremely important in northern conditions. As one of our responders in Sakha, an elderly horse breeder in Ust-Aldan, shared:

“In the old days, people walked around the territories where horses graze in winter and looked after it: they mowed the grass there and burned the remnants of last year’s grass. At present, no one cares for the outlying lands. In addition, we cannot (by law) carry agricultural fires now. So, the horses were forced to eat last year grass that is low in nutrition and even dangerous (because it is rotten)” [Field material, Ust Aldan, 2021].

Indigenous people in the Sakha Republic stressed that it is extremely important to choose the right timing for setting the intended fire because every fire-prone ecosystem has season-related conditions that foster or reduce ignited fire. According to their Traditional Ecology Knowledge (TEK), they set the fire on the hay gathering fields and pastures only in early spring—when the snow melts on the fields, but still remains under the trees. In this case, it is safe to burn overwintered dry grass. Indigenous people use other timing and methods to protect their houses and communities from wildfires. They remove all branches, vegetative debris, dead trees, and shrubs around their houses and communities and collect them in an open place. Indigenous peoples burn this pile after the snow falls, when it is safe to ignite the fire.

A punishment by mystical higher powers. Initially, the notion of the origin of forest fires as a punishment of the inhabitants of Yakutia by mystical higher powers for various moral and spiritual offenses appears exceptionally fantastic. However, the background of this statement is deeply rooted in the spirituality of the Sakha people and other Indigenous peoples of the Republic and has good reasons for appearing in serious discussions of the causes of forest fires. The Indigenous peoples of the Republic consider themselves an integral part of nature. Thus, the well-being of human life is inextricably linked to the well-being of natural components. Violation of the natural balance leads to a breach of the harmony of the relationship between people and nature. The current climate change is, in particular, a consequence of peoples’ greedy attitude towards nature, and their thoughtless actions that increase the emission of greenhouse gasses into the atmosphere. These are the moral and spiritual misdeeds of humankind before nature. Such sentiments among the Indigenous population could be generated by a series of incidents related to environmental pollution in the Republic of Sakha (Yakutia)—for example, the significant release of industrial effluents into the rivers Vilui, Iryalakh, and Malaya Botuobuya by the diamond mining company ALROSA in 2018.

Indigenous peoples are concerned for their habitat, similar to other people worldwide, who live on land rich in natural resources. In the Republic of Sakha (Yakutia), the social activity of the Indigenous peoples throughout the post-Soviet period is closely intertwined with the environmental movement [53,54]. The practices of turning to mystical forces or the owners of psychic abilities from time to time appear in many ethnic regions of Russia due to the critical situations associated with natural disasters. Public expectations of any radical measures to distinguish fires were so high that, even at the level of the Republic’s government, there was an expression of the idea of turning to the mystical abilities of shamans. Thus, Andrei Tarasenko, head of the government of the Republic, commenting on the problematic situation with fires in 2021, said “We must return to the folk methods and find a shaman who will make it rain” [55].

4.2. Reflection of Flame in Society

The flame traveled through not only the forests and fields of the Sakha Republic. The wildfires hit the economy and ecology, social well-being, and consciousness. The damage, caused only to the forest fund of the Republic in 2021, was estimated by the prosecutor's office of the Republic as exceeding 3.7 billion rubles [56]. Among the social consequences, residents incur material costs during the forest fire seasons. There were direct losses of homes, outbuildings, livestock, and land. The most obvious of indirect losses was the impact on human health, fodder for animal husbandry, and fisheries due to drought and fires. The damage to the agrarian sector of the Republic has not been finally calculated yet, but market prices for vegetables, potatoes, berries, meat, and dairy products have risen as expected.

Due to the COVID-19 restrictions, regional businesses suffered many losses. In addition, during forest fires, some entrepreneurs, such as the taxi and transportation services, were doubly affected by the consequences of forest fires. Forest fires also bring invisible indirect damage at additional costs. Participating in municipal fire protection work required rural families to spend money from the family budget on clothing, food, and transportation for the mobilized men. In addition, people spent money on personal protective equipment and food. Another example of unplanned financial expenses is buying out of the additional equipment. Thus, in the summer of 2021, the urgent installation of air conditioners led to the selling out of expensive air purifiers. At the same time, people were unable to purchase high-quality masks, respirators, and special respiratory protection equipment.

Citizens of the Republic of Sakha (Yakutia) have been under pandemic restrictions since March 2020. They awaited the change in their daily spring and summer 2021 routine to include the outdoors because they mostly stayed indoors during the long cold winter from September to May. For city dwellers, spring provides an opportunity to travel to country homes (dachas), and arrange family and corporate trips to nature and the banks of rivers. However, in spring 2021, nature trips were prohibited due to the forest fires, which started as early as May.

All these events undoubtedly increased the stress level for the Republic's citizens. For city residents, forced isolation in cramped, stuffy rooms during the summer heat of over 30–35 degrees Celsius, often without air conditioners, and the inability to go anywhere due to the COVID-19 restrictions and forest fires, could affect their health. Rural residents, some of whom ended up living in a "ring of fire", were forced to breathe and live in conditions of permanent toxic smog. However, for a long time, data about air quality were at least questionable. For a long time, Rospotrebnadzor in the Republic of Sakha (Yakutia) published air quality data that were slightly higher than the maximum allowable amount. Only in August, when smoke from the forest fires in the Sakha Republic covered other countries, authorities began to publish data from the international air quality monitoring system IQ Air. According to this, the air pollution index in the capital city of Yakutsk was, on average, 878 AQI, and the PM2.5 concentration was 107 times higher than the recommended parameters of the World Health Organization and the average [57]. These indicators on the IQ Air scale correspond to the level of "dangerous for life". Among our informants, there is dissatisfaction with the authorities' attitude towards the victims of the fires. People complain that there is no recording and monitoring system of the health impacts among the rural population. This concerns the violation of people's right to health, as some villagers expressed:

"No one considers invisible damage . . . Damage to health. I came to the city to treat my eyes in the hospital. The doctors say: "You have complex conjunctivitis, micro trauma. It happens due to burning. It is because of the fire, to which I was too close, and the burnt particles flew in the face (and eyes). And I probably registered as just a patient with vision problems. Here in this department, there are a few people like me—mostly from those who participated in extinguishing fires near villages, who worked on the line of fire . . ."" (Informant, male, Sakha, born in 1965).

Unfortunately, we only have data on air pollution in the capital and its surrounding environment. Statistics cannot reflect the real picture of the health (lung) problems because the forest fire smoke occurred alongside a pandemic. Thus, there were many similar respiratory diseases. For the past two years, medical services have primarily assisted patients with COVID-19. Unfortunately, there is no clear information about medical monitoring or telic work with the population, which would consider the double (due to the pandemic) pressure on health during the months of the forest fires. No special attention has yet been paid to the physical and psychological health of the people who found themselves victims to two social challenges combined in time and space—COVID-19 and forest fires—nor a Center for Rehabilitation and Psychological Support. This is a challenge for all regions worldwide that have survived large-scale forest fires.

In these difficult conditions, the topic of the migration of Indigenous peoples outside the Republic, connected with the climate, is constantly discussed. Before this topic appeared in the late 20th and early 21st centuries, it was related to major floods. People who suffered from housing damage and significant losses considered the possibility of changing their place of residence. It is an alarming ethnocultural indicator.

4.3. Firefighting on the Local Level

We observed how the organization of extinguishing fires occurs at the level of rural settlements in the Tatta, Gorniy, Ust-Aldan, and Viluisk uluses. The organizational scheme was approximately the same, so we can give an example based on the Viluysk ulus—the volunteers carried out the firefighting work according to the adopted scheme of the actions of the Republican Public Volunteer Headquarters to combat the forest fires. Together with volunteers from other settlements, local volunteers were sent to the settlements directly threatened by fires. The local municipal administration managed all activities based on the local situation. Fire trucks with firefighters arrived to help, mostly staying in the villages if the fire entered the settlement. Settlement residents provided transportation to the volunteers to reach the areas with forest fires, and the settlement's administration provided fuel for transport. Volunteers have been digging trenches around their settlements in an attempt to stop the fires (Figure 8).



Figure 8. Volunteers on duty. Photo from the archive of Nikolai Chemezov (Gorniy ulus, the Republic of Sakha (Yakutia)).

At the borders of fires, a sentry monitored the fire situation. The distance from the village determined their duty time. If the flame was far away, they were on duty for one day. Other residents, mostly women, prepared provisions. Then, they delivered the food to the people who were busy extinguishing fires. The equipment for extinguishing fires came from the Republican General Staff for Extinguishing Fires or their compatriots, who lived in Yakutsk and purchased them.

There were also firefighters from different parts of Russia: Moscow, Ufa, the Krasnoyarsk Territory, Kamchatka, Chita, Perm, and other cities. They provided professional but targeted assistance. However, compared to the professionals, the lack of locally trained people prepared to fight fires was visible, especially at the level of uluses (districts). As the head of the fire department of Greenpeace in Russia, G. Kuksin, commented, “There is simply no fire equipment in the Sakha Republic”. One of the petitions on Change.ru stressed, “At the moment, a couple of hundred men with buckets and shovels, on old tractors and UAZs, are resisting the fiery hell. Volunteers travel on personal vehicles, but most are on their feet. Village budgets are small. They cannot buy observation drones, walkie-talkies, GPS navigators, fire ammunition and gas masks” [58].

4.4. Social Activism in Summer 2021

Previous studies have discussed the ability of Indigenous communities in the Sakha Republic to be promptly mobilized in the event of natural and technocratic disasters, often on the basis of well-preserved traditions of sharing and mutual support [54,59]. During the forest fires in 2021, in the face of a catastrophic shortage of people, equipment, and funds, social activists living in the Sakha Republic made a significant contribution from the organization and coordination of firefighting actions to media coverage of the people’s participation in the fight against the forest fires. One of the first persons who started gathering groups of volunteers in Yakutsk and traveling to the most critical places with fires was Gulnara Alekseeva, a retired employee of the Ministry of Internal Affairs of the Republic of Sakha (Yakutia). Gulnara, together with the ecologist Aiya Dyulurga and the chairman of the public organization for large families, “Big Family”, Albert Vasilyev, issued a call on social networks to consolidate volunteers and collect financial assistance. Like-minded people, such as the locally well-known businessman Afanasy Alekseev, and social activist Alexander Zhurakovsky, supported them and formed a Public Volunteer Center. This Volunteer Center became a collecting center of necessary supplies for extinguishing fires, food for volunteers, and for the collection of funds required to purchase fire extinguishing equipment and fuel for transport. At this Center, volunteers received information, instructions, and the most necessary practical advice since the vast majority of volunteers from Yakutsk went to fight forest fires for the first time in their lives [60]. This Volunteer Center operated entirely with the help of volunteers: firefighters, organizations, and others. The citizens of the city of Yakutsk were trying to provide all their assistance—from milk bags to shovels. One of these volunteers, who brought two large packages with supplies to the Center, provided the following response when asked why he did this:

“I occupy a senior position in our production. So, the company doesn’t let me volunteer in firefighting. I know for sure that firefighting requires many consumables—food, water, soap, masks, gloves, and shoes that burn first. I bought paramilitary boots. They are more safe than ordinary. Soap. Household respirators. I bought as much as I could. There is no extra money—family, children, mortgage loans, like everyone else . . . But it’s impossible not to help in any way!” [Field materials 2021, Yakutsk, Sakha man, 35 years].

The Public Volunteer Center interacted with the Republican Headquarters for fighting forest fires to synchronize the information on the fire situation and coordinate the volunteers’ work. In addition, the Center sent volunteers to the threatened villages and critical areas of fires because there was an acute shortage of people. By fall, people with legal agreements for firefighting were paid cash rewards. Finally, local administrations made sure to honor

active participants who stood at the borders of the fire for days with moral encouragement in the form of commemorative signs (Figure 9).



Figure 9. A memorial sign in the Republic of Sakha (Yakutia), which reads “Participant in extinguishing forest fires in 2021”. Photo by Viktoria Filippova.

The topic of volunteering in extreme situations requires a special study. Unlike typical social volunteering, a person in a forest fire faces a direct risk to their health and life. Nonetheless, in 2021, the scale and composition of volunteer firefighting were impressive. The residents of the Sakha Indigenous villages and the townspeople who joined them showed rare civic cohesion and human courage.

Deficiencies in fire protection in the Republic of Sakha (Yakutia).

Catastrophic fires revealed severe miscalculations in forest fire protection in the Republic of Sakha (Yakutia). Out of the 254.7 million hectares of forest growing on the territory of the Republic of Sakha (Yakutia), only 37 million hectares (14.5%) are protected [8]. In other words, 85.5% of forests remain without any fire protection. According to the federal methodology, the distribution of subventions among regions for forest conservation and firefighting is based on the region’s population. In 2021, the Republic of Sakha (Yakutia), where there are more than 250 million hectares of forest and the population is approximately 965 thousand, residents received only 6.1 rubles per 1 ha, versus the national average of 200 rubles for firefighting [61]. This money ended in June 2021. After that, the Republican budget paid for all fire extinguishing activities. With meager funding, if the estimated damage from a fire is lower than the cost of putting the fire out, fires are not extinguished. Under such conditions, unextinguished fires quickly scale up, turning into catastrophic ones.

In addition, there is an acute shortage of helicopters and An-2 aircraft that provide an early response to fires. Thus, in summer 2021, the region received federal assistance to fight forest fires. The federal aircraft of the FBU “Avialesookhrana”, consisting of planes and helicopters, arrived at Mirny’s airport (the airport of Yakutsk could not receive them due to technical reasons). However, the firefighting planes could not fly for three days due to heavy smoke [62].

Furthermore, the Republic of Sakha (Yakutia) does not have a well-equipped emergency monitoring system. This absence has negative consequences, especially in a time of climate change. For example, in summer 2020, an abnormal heat wave with a temperature of +38 °C degrees was established in Verkhoyansk. That summer, an unexpected dry thunderstorm with strong hurricane winds hit the village of Stolby. The hurricane knocked down trees, tore off the roofs of houses and outbuildings, and killed a resident [63]. Unfortunately, neither the regional meteorological service nor the Ministry of Emergency Situations warned of the likelihood of this disaster, which shows that the Center “Antis-

tikhia” of the Russian Emergencies Ministry, created to observe and predict emergencies, is not perfect. A possible reason is that the centers for monitoring and predicting emergencies are distributed unevenly within Russia’s territory. The majority of these monitoring centers are located in the south and south-west parts of the Russian Federation. Only a few of them are located in the eastern parts of Russia, and almost none are in the northern part of the country. This is despite the well-known findings that climate change in the Arctic and Subarctic areas has been advancing at a faster rate compared to the southern part of the Russian Federation. Subsequently, the number of emergencies induced by climate change is growing faster in northern territories—for example, fires.

The fire situation exposed vulnerabilities in the firefighting infrastructure of the Republic. Moreover, the stress of living in conditions of poor health and safety has exacerbated a distrust of official sources of information. Opinions were circulating on the Internet and social networks about the discrepancy between official data and the actual picture of the fire situation, and the desire to underestimate or hide the number of outbreaks. Thus, people were outraged by the words of Deputy Prime Minister and Presidential Plenipotentiary Envoy to the Far Eastern Federal District (FEFD) Yury Trutnev about the scale and consequences of the forest fires in the Sakha Republic: “Mostly grass and small shrubs burned down . . . and the forest will recover quite quickly” [64].

In the Republic of Sakha (Yakutia), wildfires are becoming a regular and increasing phenomenon—the area of burning forests in 2021 was 20 times more extensive than in 2020 [65]. It places a heavy burden on the Republican budget that compensates for material damage from forest fires. In the Byas Kuel village of the Gorniy ulus, all those who lost their houses received new housing. In addition, the Republican government assisted in the revival of their households and organized mass visits of forest fire victims to medical and rehabilitation sanatoriums in Russia [66]. A policy of compensation and material support serves as a mitigating factor for rural communities—as our 2021 polls showed, the level of trust in municipal and regional authorities in the villages of the Sakha Republic is relatively high.

However, Indigenous people fear the recurrence of forest fires. The public consciousness is severely traumatized by the scale and duration of the fires in 2021, the size and consequences of which can hardly be overestimated. On 19 January 2022, at a meeting with the Minister of Natural Resources and Ecology of the Russian Federation Alexander Kozlov, the head of the Sakha Republic, Aisen Nikolaev, said that the total area covered by the forest fire exceeded 9 million hectares or 90% of the total area of forest fires in Russia [67]. Considering that “zombie fires” remained and large areas were left uncovered after forest fires, the tragedy could be repeated when dry and hot weather sets in in the summer of 2022.

5. Conclusions

To date, all studies on the forest fires in the Republic of Sakha (Yakutia) have been conducted only by natural scientists [68–71], and they do not include the human dimension. This article is a pioneering study of the reflection of forest fires in recent years on Indigenous peoples of the Republic of Sakha (Yakutia). The social dimension of the recent forest fires and their consequences in the Republic of Sakha (Yakutia), without a doubt, needs a deep interdisciplinary study. We performed a primary analysis of the social consequences of the latest fires in the Republic of Sakha (Yakutia) because of their severity for the people’s future.

For a historically long time, the territory of the Sakha Republic was perceived as a zone of natural stability, where there were practically no dramatic events due to the presence of the permafrost and relatively low anthropological pressure on the environment. However, times have changed. The global processes of climate warming have led to the rapid thawing of the permafrost, turning the “eternal ice” into water. As a result, the world’s coldest inhabited region has become vulnerable to global climate change challenges.

The increased frequency of large-scale fires in recent years, caused by drought and unusually hot weather, has led to further natural extreme situations, including the release

large amounts of carbon dioxide into the planet's atmosphere. The Arctic "lungs of the planet" are affected by the "fire COVID"—forest fires—and the restoration of the taiga in the Arctic and northern zone will be slow. The society of the Republic of Sakha (Yakutia) has not fully recovered from the shock and stress caused by the prolonged and destructive forest fires. It is in a state of permanent experience now: the forest fire gestalt has settled in the minds of many residents of the Republic and is often reflected in public anxiety, fear, anger, regret, compassion, or hope. The climate-related migration of Indigenous peoples is increasing. It was highly uncommon in previous historical periods and appeared only recently. Thus, the topic of migration outside the Republic appeared at the end of the 20th and beginning of the 21st centuries in connection with major floods, when people who suffered from housing damage and significant losses considered the possibility of changing their place of residence.

The main social lessons of the wildfires in 2020–2021 can be summarized as follows:

- First, there is a need for fundamentally different funding and material equipment for protecting the forests of the Republic of Sakha (Yakutia). Leaders of the Republic reached an agreement between the Republic and the Federal center about increasing funding for fire protection. In 2022, funding for forest fire protection in the Republic of Sakha (Yakutia) was increased by 5.5 times at the expense of the federal budget. There are also plans to increase the number of aviation staff and ground forest protection service staff. It took 140 days of fire on 9 million hectares of land to make these long-needed changes.
- Second is the training of personnel for the protection of forests from fires. As the head of the firefighting department of Greenpeace, G. Kuksin, argued, an effective step in the fight against fires would be to provide "the region with enough resources to recruit and train people on the spot—from among those who know the area, and who will not need to be transferred. So, they can begin to fight fires at the earliest stages, when it is still possible to turn the tide" [72]. In this case, the Indigenous peoples' employment should be considered a priority.
- Moreover, there is expected to be a diversification of activities to prepare for extreme situations. It is necessary to increase civic responsibility; the ideal model would imply social responsibility from the bottom to the top—from private households and local communities to the level of municipalities and the Republic.

In order to understand and act on forest fire protection, biologists' approaches combined with modern technologies should be integrated with methodologies of traditional environmental cultural knowledge. It should consider science together with traditional environmental culture. It is necessary to include Indigenous peoples in the process of developing climate change adaptation strategies and introduce the practice of agricultural burning as a mandatory preventive firefighting measure. Safely burning combustible material accumulated due to the harsh northern conditions in the spring and late fall is an essential practice for fire prevention (Field materials, Oymyakon, 2016).

Summarizing the social consequences of forest fires for society, we need to emphasize the regional cohesion of the Republic of Sakha (Yakutia) citizens—the potential for self-mobilization of rural and urban communities still persists. The people have shown that they can unite in difficult times of natural disasters and survive through the difficult times with dignity. The high penetration of mobile communications and social networks has enabled the Sakha Republic's population to be informed about the progress of fighting the fires, volunteers' participation, and the scope of the work being carried out. By virtue of social networks, people saw that they were not alone in their troubles—society supported them.

Overall, the forest fires highlighted significant social and ethnocultural changes in response to the natural disaster. The fire hazard situation for Indigenous settlements was exacerbated by the limited communications, reducing the quality of life through the impact of COVID-19. Current climatic processes that result in large-scale forest fires have led to alarming social changes that may negatively affect the lives of the Indigenous peoples in the Republic of Sakha (Yakutia).

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