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Ecosystem Transformation
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Effect of forest fire on mercury content in soddy podburs of typical forest-steppe environments (Voronezh region, Russia)

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Received: 13.04.2018
Accepted: 14.09.2018
Published online: 17.02.2019

DOI: 10.23859/estr-180413
UDC 574.4
URL: http://www.ecosysttrans.com/publikatsii/detail_page.php?ID=100

ISSN 2619-094X Print
ISSN 2619-0931 Online

Translated by S.N. Nikolaeva

The influence of forest fire on the gross mercury content in soddy podburs formed in typical forest-steppe conditions is studied. The metal concentration in the soils of the control area not affected by the fire is 0.063 ± 0.045 mg/kg at a depth of 0–10 cm, compared to 0.041 ± 0.008 mg/kg in soils of the burnt forest area. The relationship between the content of organic carbon and the amount of mercury in the top 20 cm of the soil profile of burnt areas has not been established ($r = 0.26$; $p = 0.19$). In the soils of the control plot, on the contrary, these indicators showed a significant positive correlation ($r = 0.74$; $p \leq 0.05$). The estimated amount of mercury released from the soil during a fire is 3 mg/m^2. The area of forest affected by fires in 2010 in the Voronezh Region was 15,910 ha. Thus, the amount of mercury released into the atmosphere as a result of the combustion of the upper soil layer is estimated at 477.3 kg.

Keywords: cinder, Usman Forest, soil organic carbon, exchange cations.

Udodenko, Yu.G., Komov, V.T., Gorbunova, Yu.S., Devyatova, T.A., 2019. Effect of forest fire on mercury content in soddy podburs of typical forest-steppe environments (Voronezh region, Russia). *Ecosystem Transfromation* **2** (1), 18–27.

Introduction

Mercury is a global pollutant (Fitzgerald et al., 1998). It is highly bioaccumulative (Rice et al., 2014). Both the metal itself and its compounds are highly toxic to animals and humans (Mason and Benoit, 2003). Excessive mercury in the body leads to disruption of the nervous system and reproductive dysfunction (Mahaffey, 1999). Concentrations of mercury, greatly exceeding background values, can adversely affect both individual components of ecosystems and ecosystems as a whole (Boening, 2000).

The average abundance (Clarke) of mercury in the soils of the world is 0.01 mg/kg, in the lithosphere – 0.08 mg/kg (Vinogradov, 1962). The average mercury content in the soils of Europe is higher than the global average, and amounts to 0.04 mg/kg in the surface horizons and 0.02 mg/kg in the illuvial horizons. It is known that the mercury content in most soils is primarily determined by the amount of organic matter, fine and colloidal particles (Gruba et al., 2014; Szopka et al. 2011). The natural content of mercury in soils formed in different ecological and geographical conditions varies widely – from trace values to 0.5 mg/kg (Baidina, 2001; Gladkova and Malinina, 1999; Ivanov and Kashin, 2010; Udodenko et al., 2011a, b). In the pre-industrial era, mercury entered the environment mainly due to natural processes – weathering of rocks, evaporation from the ocean surface, emissions from volcanic eruptions (UNEP, 2013). With the development of industry, human activity became the main source of mercury in the biosphere: mining and burning of coal, metallurgical production, use of mercury in technological processes (Swain et al., 2007). Forest fires, both natural and anthropogenic, can comprise a separate category of sources of the metal (UNEP, 2013). According to various estimates, in the northern hemisphere, between 3 and 22 million hectares of forest are annually affected by fire (Conard and Ivanova, 1997; Stocks et al., 2002; Sukhinin et al., 2004). Annually, 15–50 thousand forest fires are recorded in the territory of the Russian Federation. During one fire, up to two million tons of combustion products, which include greenhouse gases, aromatic hydrocarbons, and heavy metals are released into the atmosphere (Dymov and Gabov, 2015; Valendik, 1996). They can be transferred for several thousand kilometers from the source of fire (Certini, 2005).

During ground fires, not only plants but also soils are exposed to fire (Bobrovsky, 2010). The temperature on the soil surface can reach 300–500 °C (Franklin et al., 1997). The presence of the forest litter layer prohibits heat from spreading within the soil. The temperature in the upper 5 cm of the soil rarely exceeds 150 °C, and the profile usually is not heated below 20–30 cm (DeBano, 2000). Wildfires affect the physical, chemical and biological properties of the soil (Certini, 2005). The greatest change in the properties of the upper horizons occurs in the first year after the fire. The processes of pyrogenic soil transformation are widespread, and therefore are a focus of the study of ecosystems function. In the Russian Federation, the majority of research on changes in soil properties as a result of wildfires is carried out in the taiga zone in Siberia and in the north of European Russia (Badmazhapova and Gyninova, 2014; Dymov and Gabov, 2015; Dymov et al., 2015; Krasnoshchekov and Cherednikova, 2012; Tarasov et al., 2011). At the same time, studies on the effect of wildfires on the soil cover in forest-steppe forests are extremely scarce (Gorbunova et al., 2014; Maksimova et al., 2014). Forest wildfires are recognized as an important cause of emission of mercury from terrestrial ecosystems to the atmosphere (Friedli et al., 2003; Sigler et al., 2003). The purpose of this study is to assess the differences in gross mercury content in soddy podburs of illuvial-ferruginous sand pine forests of typical forest-steppe, affected by and untouched by fire.

Materials and methods

The study was conducted in Usman Forest, a large forest located in the Voronezh and Lipetsk regions (Fig. 1). Its southern part, located in close proximity to the city of Voronezh, is a recreation area, which houses numerous tourist centers and children's health camps. Also this part of the forest houses the biological educational and "Venevitinovo" Scientific Center of Voronezh State University and the "Voronezsky" Nature Reserve. The northern part of the forest is part of the Voronezh State Natural Biosphere Reserve.

With regards to climatic conditions, the territory under study corresponds to the forest-steppe zone within which it is located. However, according to some indicators (the duration of snow cover, or its thickness) it is similar to the conditions of the forest zone. The average annual temperature is 6.2° C. The average annual rainfall is 620 mm. During the year, the least precipitation falls in March and April, the most – in June and September (Bazilskaya, 2007).

Geologically, the territory is a young plain formed in the Quaternary, composed of loose sediments lying on bedrock Devonian rocks (Drozdov and Khmelev, 1983). The soil is derived from small- and medium-grained ancient alluvial sands. The soil cover of the study area is quite diverse and does not have the zonal features of a typical forest-steppe. The floodplains are occupied by alder forests and meadows are dominated by sod-alluvial and humus-gley soils. Podburs, soddy podburs, gray and dark gray soils of various subtypes have been formed on the terraces under coniferous and broad-leaved forests (Tregubov and Solntsev, 2012).

In 2010, the undocumented part of the forest was subjected to strong fires. In order to assess the impact of fire on the soil properties, recently burnt areas near Venevitinovo, occupied by soddy podburs, were examined the year after the fire. For comparison, soddy podburs were examined next to the biological educational and scientific center and on the territory of the Voronezh Nature Reserve, unaffected by the fire. A total of 14 sections were examined on the burnt areas and six sections in non-burnt areas.

Soil samples were taken every 10 cm to a depth of 50 cm. Roots, soil macrofauna, and dead plant fragments were removed from the samples. Samples were air dried and sieved through a sieve with a mesh diameter of 1 mm. The total content of organic carbon, the content of exchangeable cations of calcium and magnesium, the pH of the medium, and the total content of mercury were determined in the samples.

Organic carbon content was determined by wet burning in chromic acid, followed by titration with Mohr's Salt (Pansu and Gautheyrou, 2006). The pH of the medium was measured in a water extract at a soil/water ratio of 1/2.5 using an I-500 microprocessor-based ionomer-pH meter ("Aquilon", Moscow). The content of exchangeable Ca^{2+} and Mg^{2+} cations was determined by the complexometric method. The content of gross mercury was determined by the atomic absorption method on a Lumex Zeeman background correction RA-915 spectrometer for equipped with a Lumex pyrolytic attachment PYRO-915 + (St Petersburg). The accuracy of the analytical

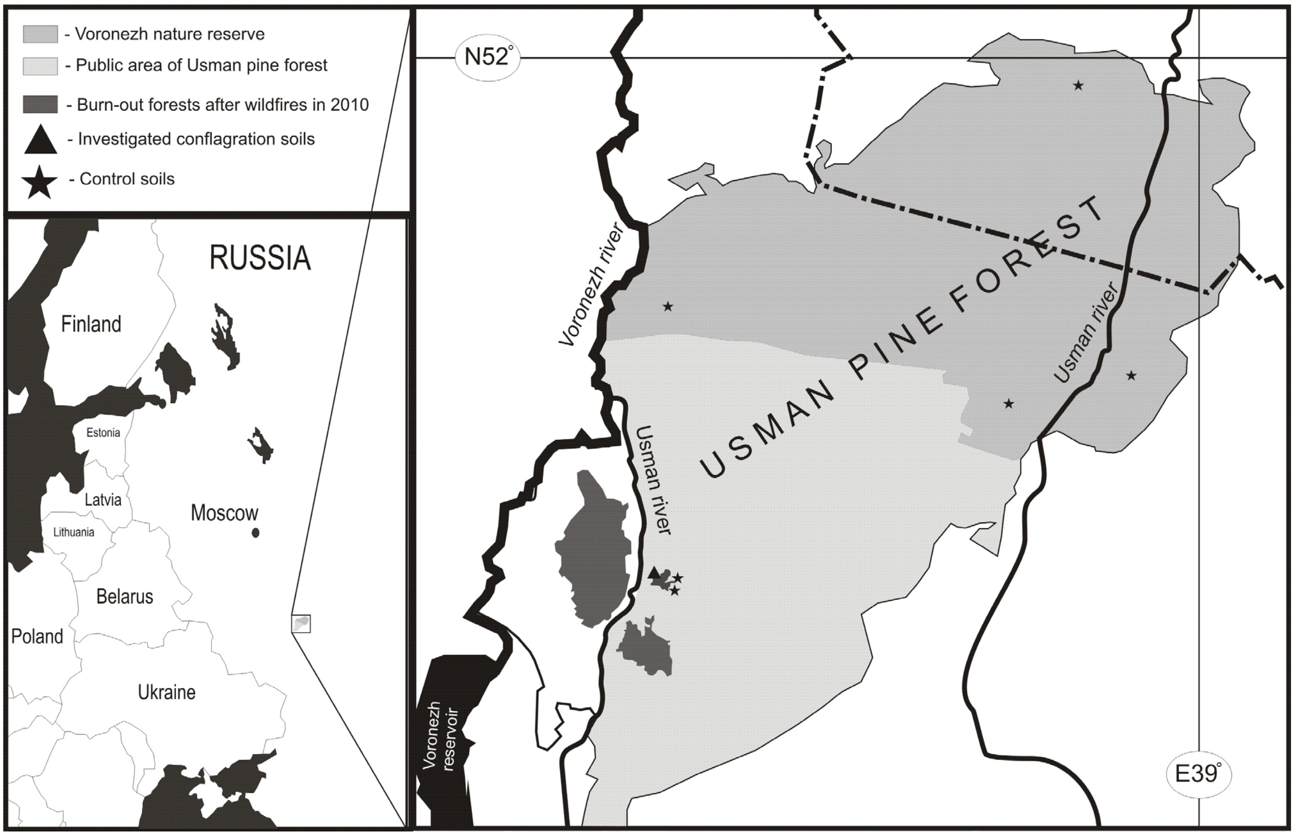

Fig. 1. Map showing the sampled sites.

measurement methods was controlled using SDPS GSO 2498-83-2500-83 certified soil samples (NPO Typhoon, Obninsk, Russia).

Statistical analysis of the results of the analysis included the calculation of the average values of the content of organic carbon, exchange cations and gross mercury in each layer of the samples for burning and control non-burnt areas. Spearman correlation coefficient was used to assess the correlation between mercury content and the amount of organic carbon. The effect of measured soil parameters on the gross mercury concentration was estimated by the method of stepwise multiple regression.

To estimate the amount of metal released into the atmosphere with products of combustion, we used the averaged values of the density of the solid phase of the soil of Usman Forest, obtained in previous studies (Doklad .., 2011). The average density of the soil in the upper part of the profile is 1.36 g/cm^3. Based on these data, it is possible to calculate the mass of mercury in one hectare of the soil profile using the standard formula for calculating the content of chemical elements with subsequent recalculation for 1 square meter (Orlov et al., 2005).

$$M = 1000 \cdot h \cdot D \cdot X, \qquad (1)$$

where M is the amount of the element, kg/ha; h is the thickness of the soil layer, cm; D is the density of the soil, g/cm^3; X is the content of the element in the bed, %.

Results

The soils of the burnt and non-burnt areas are characterized by a high content of organic carbon (Table 1). In all cases, the content decreased with depth.

The carbon content in the top 10 cm of soils of the burnt areas is lower than in soils of non-burnt areas, averages 3.11 ± 0.33% and 8.75 ± 0.54%, respectively. From a depth of greater than 20 cm, the carbon content of burnt and non-burnt soddy podburs do not show significant differences, and are comparable to one another.

Soddy podburs of Usman Forest are characterized by acidic reactions in the upper part of the profile, with a gradual shift towards neutral with the depth. Exposure to fire reduces the acidity (Table 1). The most significant difference is observed in the upper 30 cm of the profile.

The soils of the non-burnt areas and the soils of the burnt areas differed in the content of exchangeable cations of calcium and magnesium. The mean content of exchangeable calcium in fire soils is higher than in soils of non-burnt areas, and decreases from 7.22 ± 0.44 in the upper 10 cm of the profile to 4.09 ± 0.25 mmol(eq)/100 g in the underlying horizons. For soils not exposed to fire, a wider range of variation of Ca^{2+} is characteristic, from trace amounts to 8.40 mmol(eq)/100 g in the surface horizons and 4.21 mmol(eq)/100 g in the underlying. Exchange

Table 1. Analytical characteristics of the studied soils. *n* – number of samples; C_{org} – organic carbon; pH – pH of water extract; Ca^{2+} – exchange calcium; Mg^{2+} – exchangeable magnesium. Above the line is the mean ± standard error; below the line – the minimum and maximum values.

Depth, cm	*n*	C_{org},%	pH	Ca^{2+}, mmol(eq)/100 g	Mg^{2+}, mmol(eq)/100 g
	Burnt areas				
0–10	14	3.11 ± 0.33 / 2.38–3.85	4.80–5.96	7.22 ± 0.44 / 6.88–7.57	1.34 ± 0.56 / 1.24–1.45
10–20	14	3.45 ± 0.22 / 2.79–4.12	4.90–6.08	6.16 ± 0.49 / 5.77–6.57	1.31 ± 0.73 / 1.22–1.44
20–30	14	2.18 ± 0.18 / 1.84–2.51	5.77–6.60	5.06 ± 0.31 / 4.84–5.25	1.19 ± 0.05 / 1.16–1.23
30–40	14	1.20 ± 0.07 / 1.13–1.27	6.55–6.73	4.45 ± 0.25 / 4.36–4.53	1.16 ± 0.08 / 1.14–1.17
40–50	14	0.86 ± 0.08 / 0.79–0.94	6.89–6.96	4.09 ± 0.25 / 4.07–4.11	1.11 ± 0.06 / 1.09–1.14
	Control areas				
0–10	6	8.75 ± 0.54 / 3.21–28.62	4.12–5.21	4.45 ± 0.63 / 0.0005–8.40	2.90 ± 0.79 / 0.0005–11.0
10–20	6	2.57 ± 0.33 / 1.35–4.26	4.27–5.34	3.55 ± 0.69 / 0.90–8.70	2.98 ± 1.03 / 0.3–13.9
20–30	6	1.50 ± 0.27 / 0.17–2.89	4.60–6.50	2.02 ± 0.44 / 0.70–5.25	0.85 ± 0.07 / 0.3–1.28
30–40	6	0.91 ± 0.10 / 0.24–1.72	4.51–6.72	1.99 ± 0.37 / 0.0005–4.49	0.82 ± 0.11 / 0.0005–1.40
40–50	6	0.75 ± 0.12 / 0.19–1.72	4.75–6.90	1.83 ± 0.35 / 0.0005–4.21	0.71 ± 0.09 / 0.0005–1.14

magnesium is relatively evenly distributed in the burnt soil profile and decreases slightly with depth, averaging 1.34 ± 0.56 mmol(eq)/100 g in the upper 10 cm and 1.11 ± 0.06 mmol(eq)/100 g in the source bedrock. In the control soils, the Mg^{2+} content in the upper 20 cm of the profile is higher – 2.90 ± 0.79 mmol(eq)/100 g. Here, as well as for calcium ion, there is a strong variation between the limiting values, from trace amounts to 11.0 mmol(eq)/100 g. Deeper than 30 cm, the content of exchangeable magnesium is lower than in burnt soils, and is 0.71 ± 0.09 mmol(eq)/100 g in the parent rock.

The average mercury content in fire soils is lower than in unburned soils, and amounts to 0.021 ± 0.01 and 0.026 ± 0.04 mg/kg, respectively (Table 2). In all cases, there is a decrease in metal content with depth. Maximum concentrations are recorded everywhere in the upper 20 cm of the profile. In the burnt soils there is less variation in metal concentrations. The difference between the limit values to a depth of 30 cm is not more than double. In soils not affected by fire, the mercury content ranges widely. This is most pronounced in the upper 30 cm of the profile, where the difference between the lowest and the highest metal concentrations reaches 12–20 times. At depths below 30 cm, the difference between the limit values in all soils is less contrasting. Higher concentrations of mercury are characteristic of soils: 0.011 ± 0.001 and 0.006 ± 0.002 mg/kg for depths of 30–40 and 40–50 cm respectively. The mean concentrations in non-burnt soils for the same depths are 0.004 ± 0.002 and 0.003 ± 0.002 mg/kg.

The reliable correlation between the content of organic carbon and the mercury concentration in the upper 20 cm of the profile of pyrogenically modified soils has not been established (r = 0.26; p = 0.19) (Fig. 2A). Starting from a depth of 20 cm, a positive statistically significant dependence of the metal concentration on the content of organic carbon is noted (r = 0.74; $p \leq 0.05$) (Fig. 2B). In control soils, a reliable positive relationship was established both at a depth of 0–20 cm (r = 0.74; $p \leq 0.01$) and at a depth of 20–50 cm (r = 0.57; $p \leq 0.01$) (Fig. 2C, D).

Using the method of step-by-step multiple regression, we derived equations depending on the amount of mercury accumulated in soils on their properties. In soils not exposed to fire, the metal content is linearly positively associated with the

Table 2. Some statistical parameters of mercury distribution in the examined soil profiles. *n* – number of samples; $x \pm S_x$ – mean ± standard error; *lim* – concentration limits; *V* –coefficient of variation.

Depth, cm	$x \pm S_x$, mg/kg	*lim*, mg/kg	*V*, %
Burnt areas			
0–10 (*n* = 14)	0.041 ± 0.008	0.026–0.058	20.2
10–20 (*n* = 14)	0.030 ± 0.006	0.022–0.041	20.1
20–30 (*n* = 14)	0.017 ± 0.001	0.013–0.022	17.4
30–40 (*n* = 14)	0.011 ± 0.001	0.009–0.013	11.8
40–50 (*n* = 14)	0.006 ± 0.002	0.002–0.009	43.2
Control areas			
0–10 (*n* = 6)	0.063 ± 0.045	0.010–0.127	71.4
10–20 (*n* = 6)	0.022 ± 0.016	0.002–0.045	74.5
20–30 (*n* = 6)	0.008 ± 0.008	0.001–0.020	103.7
30–40 (*n* = 6)	0.004 ± 0.002	0.001–0.007	55.9
40–50 (*n* = 6)	0.003 ± 0.002	0.001–0.005	73.0

content of total carbon and exchangeable calcium:

$$[Hg] = -0.00350662 + 0.00200163[Ca^{2+}] + 0.00666087[C], \quad (2)$$

$$R^2 = 62.6;\ F = 15.0;\ p = 0.004,$$

where [Hg] – the amount of accumulated mercury, mg/kg; $[Ca^{2+}]$ – the content of exchangeable calcium, mmol(eq)/100 g; [C] – organic carbon content, %.

In soils of burning, mercury content was positively associated only with calcium content:

$$[Hg] = -0.0395419 + 0.0111677[Ca^{2+}], \quad (3)$$

$$R^2 = 58.7;\ F = 37.1;\ p < 0.001,$$

where [Hg] – amount of accumulated mercury, mg/kg; $[Ca^{2+}]$ – content of exchangeable calcium, mmol (eq)/100 g; [C] – organic carbon content, %.

Discussion

The results obtained are consistent with previously established data that fires primarily change the characteristics of surface soil horizons (Bezkorovainaya et al., 2007; Krasnoshchekov and Cherednikova, 2012). The greatest impact is experienced by litter and humus-accumulative horizons, the burning of which leads to the mineralization of organic matter and, as a result, to a decrease in carbon content. It is known that carbon content decreases most significantly in peat soils, probably as a result of the combustion of peat material (Tsibart and Gennadiev, 2008). In the rough humus podzol soils of the cedar forests of the southern Baikal region, the carbon reduction in 7–8-year burn areas is 26–34%, and for high-intensity fires it is up to 80% (Krasnoshchekov and Cherednikova, 2012). The carbon content in the brown soils of Angara Region in the upper soil horizons decreases after fire by 13.9% (Bogorodskaya et al., 2011). After fire in the soddy podburs of the Usman forest, the content of organic carbon decreases by more than 50% in the upper 10 cm of the profile, which is generally characteristic of forest soils in freshly burned areas of other regions.

At the same time, an increase in the carbon content is often observed in fire-affected soils (Gorbachev and Popova, 1996; Pshenichnikova and Pshenichnikov, 1998; Tsibart and Gennadiev, 2008). This is particularly pronounced when a crown wildfire affects the soil, when more charred fragments of wood fall onto the soil surface (Maksimova et al., 2014). An increase in carbon content at depths above 20 cm in pyrogenic soils as compared to background can be the result of decomposition of the underground organs of dead plants. An increase in the carbon content at depths above 20 cm in pyrogenic soils compared to the background can be the result of decomposition of the underground organs of dead plants. It is believed that an increase in humus content in soils after a fire is associated with accelerated decomposition resulting from the activation of biological processes and an increase in the rate of destruction of plant residues, as well as the enrichment of deep-lying horizons with fine particles of charcoal penetrating from the burnt surface horizons. No such effect was recorded in our case. The observed increased content of organic carbon in burning soils compared to non-burnt areas is most likely to result from the natural variation of organic carbon content in alpha-humus soils in the process of humus illuviation.

An increase in the response of the soil to the fires was previously recorded in the literature as a result of burning of the litter and the arrival of large amounts of ash on the soil surface (Tarabukina and Savvinov, 1990). Often, the pH of the medium, depending on the intensity of the fires, becomes alkaline. This was noted in the pyrogenic soils of the Angara region and Yakutia, in the forest soils of the city of Tolyatti (Togliatti) (Bogorodskaya et al., 2011; Gorbachev and Popova, 1996; Maksimova et al., 2014). Immediately after a fire, the pH of the medium reaches 7.9–8.0; this increase in pH is explained by the penetration of ash-soluble com-

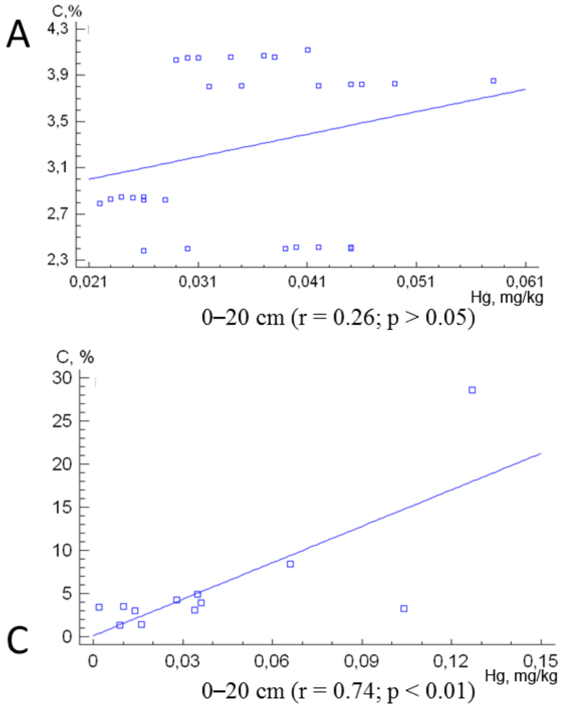

Fig. 2. Correlation of mercury content with the amount of carbon at different depths in soddy podburs (**A, B**) and control areas (**C, D**).

pounds into the soil. They saturate the soil absorbtion complex with alkaline-earth elements, shifting the soil pH towards neutral and alkaline (Badmazhapova and Gyninova, 2014). However, after a year, the pH returns to normal values as before the fires. This is because precipitation during the year washes out the products of combustion from the soil profile. Although in our case the pH of the soils of the burnt areas is alkaline, it can be assumed that in a relatively short time it will return to values typical of non-burnt soils.

The main source of mobile cations is a burnt litter layer and a dead soil layer. The uniform distribution of exchangeable calcium and magnesium in the soils of the investigated burnt areas indicates a similar intensity of the processes of their removal and influx. At the same time, soddy podburs of non-burnt areas are characterized by different rates of entry and migration of substances down the profile. This feature can be explained by the fact that soddy podburs, which were affected by fire some time ago, fell into the control group of soils picked randomly from different parts of the forest with similar ecological conditions.

In general, the mercury content in the soddy podburs of the Usman Forest is higher than the Clarke content for soil in Russia, but lower than the Clarke content for the lithosphere (Vinogradov, 1962). Values exceeding the Clarke content for the lithosphere are only recorded in the forest litter layer on the territory of the Voronezh Reserve. Since the study area is very compact, it should be assumed that the supply of mercury from natural atmospheric precipitation was fairly uniform.

Therefore, it cannot be excluded that the increased content of mercury in the litters of non-burnt soils is a consequence of the deposition of metal that has entered the atmosphere as a result of a fire. It has been shown previously that in the surface horizons of soils, the mercury content decreases as compared with the affected area and increases almost twofold in the soils of the territories that fall under the smoke plume (Shcherbov et al., 2008). The concentration of mercury in the source rock is lower than the Clarke content adopted in Russia for the lithosphere and for the soil. The reason for this is its sandy granulometric composition and, consequently, a reduced content of silt particles capable of mercury absorption.

The correlation of soil mercury accumulated in soil with the content of soil organic carbon has been identified by many authors (Koegel-Knabner et al., 1988; Obrist et al., 2009; Pant and Allen, 2007; Udodenko et al., 2011a, b). A statistically significant correlation between mercury content and organic matter was found in the polluted soils of Tennessee (r = 0.52) and for unpolluted mineral soils of Sierra Nevada (r = 0.83). However, such a connection is not always found. In the humus horizons of gray forest soils and chernozems of Transbaikalia and forest soils in Switzerland, there is a weak correlation between mercury and carbon content (Ivanov and Kashin, 2010; Rieder et al., 2011). It is unlikely that the lack of reliable correlation in this study is caused by a large number of finely dispersed fractions in the mineral part of the soddy podburs exposed to fires, but could be a product of combustion of organic matter in the upper soil layer.

Table 3. The area of forest fires in the Voronezh Region (Doklad…, 2011) and the estimated amount of mercury released into the atmosphere from the top 10 cm of the profile.

Year	2005	2006	2007	2008	2009	2010
Area, ha	352	387	1556	1530	1194	15910
Anount of mercury, kg	10.56	11.61	46.68	45.90	35.82	477.30

The results of applying the step-by-step multiple regression method show that the mercury content is related to the various properties of the soils of the fires and the soils not included in the fire. According to (2), the concentration of mercury in soddy podburs not exposed to fire is linearly positively correlated to carbon content and exchangeable calcium. According to (3), in the soils of burnt areas, mercury is positively correlated only with exchangeable calcium. The decrease in the amount of organic carbon as a result of pyrogenic exposure explains the absence of a reliable relationship between mercury and carbon in the upper 20 cm of soddy podburs for the burnt areas. In non-burnt areas in the lower part of the profile, the dependence of mercury content on the amount of carbon is statistically significant. It was previously shown that in the humus-accumulative horizon, the concentration of mercury is determined by leaching or biogenic accumulation, leading to its binding to humic acids. As a result, complex compounds are formed that hold 70–80% of gross mercury (Zvonarev and Zyrin, 1983). In the podzolic soils of the Central Forest Reserve, about 90% of mercury is represented by its organic compounds (Gladkova and Malinina, 2005).

The data obtained suggests that fires contribute to the release of mercury and its release into the atmosphere during the combustion of surface horizons. As a result of the calculations, an estimated average amount of accumulated metal in the top 10 cm of the soddy podburs profile was established. For the soils of the control plot it is 8.6 mg/m^2, for the soils of burning it is 5.6 mg/m^2. We took the difference between these values, 3.0 mg/m^2 as the average amount of metal entering the atmosphere as a result of a fire from the top 10 cm of the soil profile. Thus, during a fire, 30 g of mercury enter the atmosphere from 1 hectare of forest soil. The area of burnt forests in the Voronezh Region in 2010 amounted to 15 910 hectares and 10–50 times exceeds the values from 2005 to 2009 (Doklad…, 2011). Based on these data, the amount of mercury released into the atmosphere from the topsoil with combustion products as a result of forest fires in the Voronezh Region in 2010 is estimated at 477.3 kg (Table 3).

Previously it was assumed that the amount of mercury released into the atmosphere as a result of forest fires is 0.15 mg/m^2 (Sigler et al., 2003). Later calculations, which took into account the large amount of accumulated metal in the peat horizons of forest soils and peatlands, showed that the estimated amount of mercury entering the atmosphere as a result of forest fires in the boreal zone is 1.55–7.01 mg/m^2 (Turetsky et al., 2006). The amount of mercury obtained in this study corresponds to the latest estimates, being in the middle of the estimated range. According to the same authors, up to 340.8 tons of mercury can be released due to fires annually in the circumpolar region of the Northern Hemisphere. Thus, the proportion of mercury released into the atmosphere as a result of fires in the Voronezh Region in 2010 amounted to 0.13% of the maximum estimated value.

Conclusions

Based on the above, we can draw the following conclusions about the effect of fires on mercury content in the Usman soddy podburs:

1. There is a decrease in the content of gross mercury in the soils of the burned areas compared to the soils of the control plots. Most of the metal enters the atmosphere from the surface horizons. Fires do not affect the mercury content in the illuvial horizons and soil-source rock.

2. Soil mercury content is closely related to organic matter content. With a decrease in its amount as a result of combustion, the metal content decreases.

3. Of the considered properties of the soil, the main parameter of variation of the content of mercury in soils of the burnt areas is the amount of exchangeable calcium. In soddy podburs that are not caught in the fire, the amount of organic carbon is the main factor correlated to the mercury content.

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