Factors influencing the restoration of a vegetable cover exposed to wildfires

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Abstract. The paper is devoted to the study of factors influencing the restoration of a vegetable cover exposed to wildfires. It provides data obtained while measuring the influence of pyrogenic load on steppe vegetation. Key factors and dependence of fire consequences on contributing factors are analyzed. Types of vegetation being the most sensitive to fire are identified. The study of the influence of fires on a vegetable steppe cover resulted in identification of factors mostly contributing to restoration of a vegetable cover after wildfires.

1. Introduction
At present, the problems related to the restoration of steppe and its biodiversity are critical due to considerable release of agricultural lands. It is known that steppe ecosystems are restored rather quickly and through development tend to increase biodiversity. It is especially seen after fires since they are exposed to fast pyrogenic and demutational shift [1]. Fire as a pyrogenic factor definitely influences the vegetation throughout its lifecycle. Natural fires were primary, while intended burning was borrowed from nature by prehistoric people. Paleobotanical data confirm the influence of fires on vegetation during the period exceeding 2 million years. Ancient people used to burn vegetation to solve some problems, including clearance of lands, pasture improvement, enabling hunting or protection against wild animals and attacks of enemies [2].

2. Materials and methods
The study applied general scientific methods: analysis and comparison. The analysis of the influence of pyrogenic load on steppe vegetation was applied as a special method. Several factors were considered in the analysis of the influence of pyrogenic load on steppe vegetation (analysis of fire and post-fire conditions; it should be mentioned that the fire occurred in autumn). For objective assessment the authors monitored temperatures throughout the vegetative period, identified drought summer periods and periods characterized by normal moistening. It is a necessary condition for further development or suppression of vegetation during the post-pyrogenic period. If summer months are characterized by low rainfall, then many plant species cannot be restored after fire and generally die being replaced with drought-resistant types. Except summer rainfall it is necessary to consider the thickness of snow cover. When the snow cover is not deep the seeds of many plants that passed the entire vegetation period die in the soil and cannot be restored later, and therefore in spring the steppe lacks its typical floristic composition. On the contrary, at normal amount of moisture and depth of snow cover, all plants, according to the study, are completely restored showing practically no changes in succession. The floristic composition of control areas varies in the range of plus-minus 3-4
species.

3. Results and discussion
The following factors mainly influence the restoration of a steppe vegetable cover after wildfires: climatic factors – temperature, rainfall, depth of snow cover; edaphic conditions – soil cover, territorial relief; physical factors – wind structure, nature of fire; biotic factors – stage and time of vegetative period at the time of fire, species composition. The consequences of wildfires are defined differently depending on burning, time of fire, subsequent weather, character and degree of using burnt areas.

The change of plant association structure during post-pyrogenic period depends on the snow cover depth, which enables plant seeds to survive in low winter temperatures and increases soil moistening in spring. For example, under optimal conditions within the association of Stipa lessingiana and Achillia nobilis after fire the role of the codominant is shifted to Crinitaria villosa, while Achillia nobilis is moved back thus making the vegetable association approaching the pseudonatural condition of 1996 [3].

The species composition of explored areas did not change significantly after fire, many plant species, which occurred in single quantities before fire, simply disappeared, and new species appeared in associations. Within associations located in mound valleys the species changed as follows: after fire such types as Melampyrum arvense, Onosma simplicissima, Linaria debilis, Allium globosum (in 2003 they occurred in single quantities) were not revealed; the abundance of Euphorbia seguierana, Sedum stepposum, Verbascum phoenicum decreased. The restoration within associations located on highlands was less intensive and Galium octonarium, Scorzonera austriaca, Gypsophila paniculata, Oxytropis spicata were not found. At the same time there was an increase in abundance of Artemisia austriaca, Centaurea merschalliana, Valeriana tuberosa, Echinops ritro, Festuca valesiaca. The even lands did not suffer essential changes in species composition of associations.

Among all species there is one the most sensitive to fire – Koeleria gracilis, after fire it falls out of the composition of the majority of studied associations.

It should be noted that in some associations there are types, which did not occur before fire, including Veronica incana, Arenaria longifolia, Allium flavescens, Trinia muricata, Medicago romanica.

Relief and soil cover also play an important role in post-pyrogenic changes: as a rule the vegetation is restored much quicker in lowlands with chernozem soils of southern carbonate truncated rank lands and mound valleys than in highlands with chernozem soils of southern undeveloped stony lands characterized by continuous wind erosion and nutrient leaching from upper layers.

The condition to define the role of fire is time of its occurrence. Generally, the fire exerts the smallest impact on steppe vegetation when the fire develops in early autumn or late spring prior to the beginning or after the end of the vegetative period. The spring fires occurring on wet lands are quite easily managed by people, the summer fires are the most critical, associations are restored slowly and many species are not restored at all. Usually such fires develop when the dry grass, similar to gunpowder, flares from the smallest spark. They are difficult to suppress since quite often they cover areas of several dozens of kilometers in diameter [4].

The nature of wildfires (crown, ground) and wind structure shall also be considered. The crown fire mainly damages the top of plants, which do not play the main role in their life. The ground fire develops slowly, burns many sod grasses such as Stipa, Festuca. Bunchgrasses suffer more from fire, which only burns sod edges of coarse grass, seeds placed on surface and top soil layers are destroyed [5]. Young and middle-aged sod grasses cannot withstand fire. Stipa does not suffers much from fire since their renewal buds are located below the soil surface. The situation is different with Festuca valesiaca, its sods are closer to the surface.

Dead plant residues, namely dry grass leaves and faded parts of plants are destroyed by wildfires. The dead soil cover being rather dense and plentiful is destroyed completely in nature reserve steppes. Its restoration is very slow [6]. It should be noted that grass sods burnt along the edges gradually
increase the litter of their associations already in a year.

Thus, the plants having various life forms differently react to fire: perennial and biennial plants almost do not suffer from fire, its action on them is connected to temporary suspension of their growth and, hence, lag of development stages – blossoming and fruiting. Annuals, including ephemeral plants are mainly destroyed by fire and their restoration takes several years even provided their ovules are partly preserved in soil [7].

The analysis of the influence of pyrogenic load of steppe vegetation after fire did not detect Melampyrum arvense, Onosma simplicissima, Linaria debilis, Allium globosum (earlier they occurred in single quantities); abundance of Euphorbia seguierana, Sedum stepposum, Verbascum phoenicium decreased. Galium octonarium, Scorzonera austriaca, Gypsophila paniculata, Oxytropis spicata were not recorded in highlands. The abundance of Artemisia austriaca, Centaurea merschalliana, Valeriana tuberosa, Echinops ritro, Festuca valesiaca increased. The even lands were not marked with considerable changes in species compositions of associations.

From economic point of view, the pyrogenic factor is a very strong driving source. Besides purely mechanical treatment of soil surface from dead grass and litter, after fires the soil is enriched with ash constituents and the green phytomass stock is increased due to renovation of cenopopulation [8].

One shall be careful in using areas affected by disastrous fires as pastures. It is advisable to start pasturing only on the second or third year after fire when sod grasses suffered from fire get stronger, otherwise it is easy to destroy the pasture land.

4. Conclusions

The study of the influence of fires on steppe vegetation cover revealed factors playing a key role in restoration of vegetation cover after wildfires. Such factors include the following: climatic factors – temperature, rainfall, depth of snow cover; edaphic conditions – soil cover, territorial relief; physical factors – wind structure, nature of fire; biotic factors – stage and time of vegetative period at the time of fire, species composition.

The study also made it possible to define change patterns of floristic structure exposed to fire. The stationary sites are marked by changes in species composition of the association and quantities of some species. The most unstable species are distinguished among such associations as Poaceae (-5), Rosaceae (-3), Rubiaceae (-3); such associations as Liliaceae, Iridaceae, Brassicaceae, etc. almost did not change their quantity of species; Fabaceae (+3), Euphorbiaceae (+2), Caryophyllaceae (+2) are marked by the increase in the number of species.

Positive and negative impact of fires on steppe vegetation cover was observed. The positive aspects include: removal of dead grass, change of age structure of associations, disappearance of weed plant species, enrichment of soil layers with ash constituents. The negative factors of pyrogenic load influence on steppe vegetation are the following: some species of annual plants fall out of grass, temperature of top soil increases, underground shoots and seeds freeze in winter.

In reservation conditions and under favorable weather conditions the steppe vegetation cover is restored within 9-17 months. The fire does not drastically damage the steppe vegetation cover. After fire the degree of seed growing due to lack of dead grass is increased, the feeding quality of grass is improved, the soil layers are enriched with ash constituents.

The efficiency analysis of green plants shows lack of sharp changes. In this case the main difference was the destruction of grassland litter, dry plant stems, which are replaces which green and fresh stems. The steppe shifts from brown-yellow to lush green (May-June after fire in October). The plant cover changes in the range of 10-25%.

It is recommended to use areas affected by disastrous fires as pastures on the second or third year after fire when sod grasses, which suffered from fire, get stronger, otherwise it is easy to destroy the pasture land.
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