

Impacts of Forest Fires on Landscape Patches

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Abstract: The interrelationships between landscape and forest fires are synthesized by going through relevant books and reviewing related literature. Various effects of forest fires on landscape patches are described, while the interference of landscape on forest fires is illustrated, and some applications of forest fires in landscape ecology, such as firebreaks, are enumerated to provide scientific and reasonable bases for the prevention and control of forest fires.

Keywords: Forest fires; landscape patches; landscape patterns; landscape.

1. Introduction

Forest fire belongs to natural disasters, which refers to a catastrophic burning phenomenon that exhibits characteristics such as being out of people's control and bringing harm and loss [1]. With the continuous warming of the global climate, the current forest fires occur more and more frequently and are more and more harmful, which is a global problem. The term landscape first appeared in 1984, the German scholar Humboldt first used it as a scientific term in geography and explained it as "the general character of a range". Landscape ecology is a comprehensive discipline that studies the typological composition of landscape units, spatial patterns, and the interactions of ecological processes within them, and has been developing rapidly in recent years with a wide range of applications [2].

Landscape pattern is one of the core research contents of landscape ecology, and the patchiness of landscape is the most common form of landscape pattern, so analyzing the link between landscape patches and forest fires is of great significance and value. The type, shape, size, number, and spatial combination of landscape patches are affected by forest fires, and the generation and spread of forest fires are also disturbed by the landscape. Currently, forest fires are applied more and more frequently in landscape ecological construction, with their unique role.

2. Impact of Forest Fires on The Landscape

2.1. Impact of forest fires on patch types

A patch refers to a piece of surface area that is non-linear and distinctly different geomorphologically from the surrounding area, which can be categorized into four different types depending on the origin of the patch, namely: environmental resource patch, introduced patch, remnant patch, and disturbed patch [2].

The influence of forest fires on patch types is mainly reflected in the spatial scale. In a forest, if the intensity of forest fires is low, multiple fire trails are usually formed and fire-disturbed patches appear. If the intensity of forest fires is high, the overfire area is extensive, and the fire lasts for a long time, large-scale fire trails and residual patches will be created, of which if there is a small portion of the forest stand in the middle of some fire trails that have not been affected by forest

fires, such fire trails will be called the background. Landscape patches formed under the influence of forest fires are characterized by fast dissipation speed, high turnover rate, and short average retention time, and the transition between them and the background is relatively abrupt, with a narrow ecological intersection area, and the relationship between the two is dynamic [3].

2.2. Impact of forest fires on patch size

Forest fires can interfere with the formation of landscape patch sizes, e.g., by affecting the number of patches of a certain kind and the size of their area within a certain area. The number of patches refers to the total number of patches in a certain range of landscape patterns, and the area of patches refers to the size of the sum of all areas of a certain patch, which is usually described by the average patch area. The average patch area can be used to indicate the connectivity and fragmentation of the patches, the size is determined by dividing the area of the landscape elements by the number of patches, in general, the larger the average patch area the smaller the fragmentation and the higher the connectivity.

The intensity of forest fires and the spatial distribution pattern of the landscape have a great influence on the scale of landscape patches, the greater the intensity of forest fires, the wider the burning range, the smaller the scale of the patches formed, the smaller the intensity of forest fires, the narrower the burning range, and the larger the scale of the landscape patches formed by interference. The influence of landscape spatial pattern on landscape patch size is mainly caused by landscape heterogeneity and fragmentation, the degree of landscape heterogeneity and patch size are negatively correlated, when the degree of heterogeneity of a landscape is high, the size of its patches will generally be small. Fragmentation and patch size also show a negative correlation, the higher the degree of fragmentation, the smaller the size of the patch formed under the forest fire disturbance, and vice versa, the higher, such as in China's southern forested areas, the size of the landscape patch is generally small, the reason is that the landscape pattern of the region has a higher degree of fragmentation [4].

2.3. Impact of forest fires on patch shape

Patch shape refers to the geometric shape and size of a patch at a given localized scale, and can be measured by the Landscape Morphology Index, with larger values

representing more complex shapes of landscape patches. In the vast majority of cases, the shape of landscape patches affected by forest fires is very irregular, and the landscape morphology index is relatively high. In recent years, with the increased beneficial use of forest fires and the combined disturbance of other human factors, the shapes of landscape patches have become more and more regular, and the values of the Landscape Morphology Index have decreased to a great extent, e.g., human activities such as carrying out planned burns, forestation of mountain refineries, and construction of firebreaks, etc., are making the edges of many landscape patches straight, and ultimately many disturbed landscape patches affected by forest fires with a polygonal shape have been formed. disturbed landscape patches with polygonal shapes affected by forest fires.

2.4. Impact of forest fires on patch density

The density of landscape patches refers to the number of patches per unit landscape patch area and is often used to characterize the integrity and degree of fragmentation of landscape patterns. In general, the density of landscape patches in the undisturbed natural landscape is at the intermediate level, different from the negative correlation between the size of landscape patches and the impact of forest fires, the size of the density of landscape patches and the disturbance of forest fires show a positive correlation, and this connection is so close that as long as there are forest fires, it can be clearly found that the density of the landscape patches in the region will increase significantly, far beyond the intermediate level of the natural landscape [3]. Some scholars have pointed out that after mastering the special relationship between the two, it will be possible to initially determine whether forest fires have occurred in the region, the intensity of forest fires, and other related parameters based on the density level of landscape patches in a region, which opens up new paths for people to better understand, use and control forest fires.

2.5. Impact of forest fires on patch diversity

The diversity of landscape patches expresses the heterogeneity of the landscape that is realized in different aspects such as structure, function, and temporal dynamics, [5]. Heterogeneity is usually expressed in the form of gradient and mosaic, the latter mosaic is one of the basic features of the landscape, which is characterized by the aggregation of a number of different parts within a space, with clear demarcation lines between the different parts, which are both interrelated and contradictory. The heterogeneity of a landscape patch is one of the important determinants of the patch's resistance to disturbance, resilience, stability, and biodiversity, and in general, when the degree of heterogeneity of a landscape patch is high, the environment within the patch is more conducive to the symbiosis between different species.

One of the important sources of landscape patch heterogeneity is interference, interference can affect the formation of landscape patterns, and landscape patterns, in turn, react to the interference, within a certain range of influence, interference, and landscape heterogeneity are positively proportional to the degree of landscape heterogeneity will increase with the increase in the intensity of the interference, but when the interference exceeds the range or a certain value, it will reduce the degree of heterogeneity of the landscape, so it is also known as the medium interference theory Therefore, it is also called the

moderate disturbance theory. Forest fire as a common landscape disturbance factor also has the above characteristics, but because forest fire usually brings unpredictable economic losses, people often ignore the positive aspects of forest fire disturbance, focus only on its anthropogenic attributes, and focus on its hazards, not allowing any forest fire to occur. These practices actually constitute secondary human disturbances, which only result in higher fire risks, which then produce more severe forest fires, leading to a reduction in the diversity of landscape patches, and ultimately to a sharp decline in biodiversity.

We should correctly view the impacts of forest fires. Low-intensity, small-scale, and inhomogeneous fires usually form many new small patches, increase the degree of heterogeneity in the landscape, increase landscape diversity, and enhance landscape stability [6]. When forest fires are intense and widespread, they burn most of the forests, grasslands, and shrubs, turning large landscape patches into homogeneous barren landscapes, producing large, homogeneous fire trails, and drastically reducing the diversity of the landscape.

2.6. Impacts of forest fires on patch dynamics and functioning

The dynamics of landscape patches refers to the fact that the structure and function of a particular landscape patch also change after changes in the external environment, time, and space, and the reasons for the changes include that natural or anthropogenic factors have changed to varying degrees, or both have changed together, and the process of change also makes a difference, with some dynamic processes being relatively slow and the changes being inconspicuous and difficult to detect, and others being more drastic. The impact of forest fires on patch dynamics is usually the latter, as such changes are characterized by suddenness, obviousness, speed, and ease of detection. According to the different sizes of disturbances produced by forest fires, the impact of forest fires on landscape dynamics can be divided into four levels: weak impact, moderate impact, strong impact, extreme impact, and the results produced by the four types of impacts are different: weak impacts will cause fluctuations in landscape patches; moderate impacts are more serious disturbances to patches, but can be restored after a certain period of time and means; strong impacts will destroy the original landscape equilibrium state within the patch and establish a new equilibrium; extreme impacts will directly make the original landscape disappear and form a new landscape, which is the landscape replacement [7].

In the introduction to the concept of landscape patch dynamics, the structure of the landscape and the function of the landscape were mentioned, which are closely related, and it is generally recognized that the function of the landscape depends on the structure of the landscape. Landscape structure and landscape function are both affected by forest fires, but forest fires affect landscape structure before landscape function, with landscape function being affected in the following ways: forest fires greatly reduce the amount of combustible material in the forest, lowering the accumulation of combustible material and increasing the rate of species and energy flow within the forest; forest fires alter water flow paths within the forest, resulting in changes in the composition of the material in the flow; forest fires erode soils within the landscape, destroying the composition of the material in the flow; and forest fires erode soils within the landscape, destroying the structure of the landscape, resulting

in changes in the composition of the material in the flow. changes; forest fires erode the soil within the landscape, destroying habitats and sites for animals and plants; forest fires can cause the destruction of forests, resulting in natural disasters such as atmospheric pollution, soil erosion, dust storms, and droughts [3].

2.7. Impact of forest fires on patch fragmentation

The degree of fragmentation of landscape patches determines the biodiversity and the survival environment of species in the landscape, so it is of great significance to understand the relationship between the degree of fragmentation of the landscape and its disturbance factors. The degree of patch fragmentation responds differently to various disturbances, when the intensity and scale of the disturbance are small, the landscape will maintain its own stability, and the degree of fragmentation will not change significantly, only when the disturbance is too strong, the landscape will produce qualitative changes, and the fragmentation will be significantly strengthened and or weakened [8]. Forest fire is one of the disturbance factors affecting landscape fragmentation, smaller forest fires will increase the degree of fragmentation of landscape patches, and when the intensity of forest fires is large enough, the opposite of the above will occur, i.e., increase the degree of homogenization to reduce the degree of fragmentation, the reason is that high-intensity and large-scale forest fires will directly destroy the different heterogeneous landscape patches existing in the landscape so that the entire region becomes a larger area with a uniform substrate. The reason is that high-intensity and large-scale forest fires will directly destroy the various heterogeneous landscape patches in the landscape, turning the whole area into a fire burnt site with a large uniform matrix, and this change will destroy the ecological functions and characteristics of the original landscape system, causing a series of unwanted accidents, hazards, and losses.

3. Landscape Impacts on Forest Fires

3.1. Impact of landscape patterns on forest fires

The spatial distribution, relative position, and combined arrangement of patches are the connotations of the landscape patch pattern, and the differences in the spatial distribution pattern of patches in the landscape determine their impact on forest fires, which may promote the spread and development of forest fires, or slow down or even prevent the further development of fires, and even if two landscapes have the same origins, sizes, shapes, etc. of patches, ultimately, due to the differences in the spatial distribution pattern, the impacts on forest fires are different. Even if the two landscapes have the same origin, size, and shape, they will eventually have different degrees of influence on forest fires due to different spatial distribution patterns. Regions with high human activities are the most frequent areas of forest fires, and when forest patches in these regions are isolated by other landscape patches or corridors, it will slow down the spread of forest fires and reduce losses [9]. The distribution pattern and density of different patch types also affect forest fires, such as for forests as native forest areas, when agricultural patches and other land use patches in the forest area are wider in area and higher in density, it is not conducive to the spread of forest

fires, and major and mega forest fires of large area and scale generally do not occur, and vice versa, it will be conducive to the expansion of forest fires, and fires that are difficult to control from time to time will occur and bring about immeasurable losses [10].

There are many types of landscape patterns, one of which is well known for its intersection in the landscape and is called a reticulated landscape pattern, which refers to the spatial distribution pattern of a variety of corridors (linear structures that link relatively independent landscapes). When the density of corridors formed by trees on both sides of rivers and streams, firebreaks, and roads is high, forest fires can be blocked and suppressed, but when the number of corridors formed by fallen trees, logging sites, and meadows increases, the risk of forest fires increases and the spread of fires is accelerated. danger and accelerate the spread of fire [3]. The influence of the reticulated landscape pattern on forest fires depends not only on the type and density of corridors in the landscape, but also partly on the distribution location, structural orientation, width and length of the corridors, and boundary conditions.

3.2. Effects of landscape heterogeneity on forest fires

Forest fires can disturb the heterogeneity of landscape patches, and similarly, the heterogeneity of the landscape can have more or less impact on forest fires. A high degree of heterogeneity in the landscape means an adequate number of patches, a diversity of organisms, and a richness of ecosystem types in the landscape, which determines that the landscape is characterized by strong resistance to disturbance and good stability. According to this nature, people nowadays set up more biological isolation zones and avoid large areas of coniferous pure forests in natural landscapes, with the purpose of creating heterogeneous landscapes and enhancing the stability of the landscapes, which not only can effectively resist the interference of forest fires and reduce the impacts but also can prevent forest fires from occurring and spreading. However, at present, there are still many people who are bent on pursuing short-term economic benefits and do not consider the problem from a long-term perspective, planting large areas of the same tree species with fast-growing value, which drastically reduces the degree of heterogeneity of the landscape, destroys biological diversity and ecosystem stability, and seriously weakens the forest's ability to resist disturbance and impede the role of forest fires, so that once a fire breaks out in the area, the forest fire will spread rapidly, the intensity of the scale increases rapidly, the consequences are unimaginable, and in the long run there are a lot of disadvantages, which can be said to be more harmful than beneficial.

4. Application of the Relationship Between Forest Fires and Landscapes

Biological fire prevention, based on the principle that landscape heterogeneity has an impact on forest fires, utilizes the diversity of species in the landscape and their interrelationships, as well as the linkages with the environment, to increase the fire stopping capacity of the landscape, thus achieving the ability to prevent fires from occurring and to slow down the spread of fires. In addition to

the commonly understood role of forest fire in destroying forest landscapes, it actually enhances the regulatory capacity of forest ecosystems under certain conditions, maintaining and regulating the survival and function of certain populations in forests, planned burns are a good example. Planned burning refers to the renewal of forest ecosystems through man-made fires to promote, so that some as well as ecological exhaustion and can not normally carry out an ecological succession of forest landscapes renewed new vitality, the famous Yellowstone Park has been used in this way to make the park a nearly lost the function of the original forest forests of forest landscapes have been well restored, people found that after the planned burning of the trees are not only good growth, and It was found that the trees after the planned burn not only grew well but also the degree of closure quickly exceeded that before the fire, which greatly improved the diversity of the primary forest ecosystem and its ability to resist disturbances such as forest fires [11].

In forest fire prevention, the initiative of creating firebreaks, which first began in China in the 1970s, can play a role in increasing landscape diversity, forming a net-like landscape pattern, expanding the forest fire barrier network, and effectively controlling the spread of forest fires. The construction of firebreaks requires special attention to the selection of fire prevention tree species, the structure of firebreaks, and construction sites, which are of great significance in forest fire prevention projects, determining the firebreaks are very capable of realizing the desired functions. Among them, the construction of firebreaks is often the location where firebreaks can accomplish their function and effectiveness of key, if the forest belt is built at the correct control point, once the forest fire begins to gradually spread to the forest belt nearby, will be firebreaks successfully blocked, so as to protect the integrity of the forest landscape is not damaged as well as the people's lives and property safety is not harmed [3]. Firebreaks are created in the spirit of the principle of protecting all biological safety in the region, it is generally believed that the best location is the ridge, because there is a large number of reverse airflow at the ridge and forest fires will produce reverse inward airflow, etc., can effectively control forest fires, if the construction of other areas, such as the foothills, although it can be played to a certain extent to slow down the spread of fires, due to the foothills are generally a dense place of human activities, man-made sources of fires. activities, the frequency of anthropogenic fire sources is high but increases the probability of forest fire, so it is usually not worth promoting [12]. The common types of firebreaks and corresponding construction sites in the past few days are firebreaks on the national borderline, provinces, states, and municipalities on the borderline of the ridge line; firebreaks on the borderline of the townships and villages on the borderline of the ridge line; firebreaks on the ridge line on the ridge watershed; and firebreaks on the edge of the forest, the forest interior, and on both sides of the road on the edge of the forest, within the forest, and on the road [11].

5. Summary

As a common and discrete ecological factor that can disturb nature, forest fire is inextricably linked to the landscape, and

can influence the type, scale, shape, density, diversity, dynamics, function, and degree of fragmentation of landscape patches, while the structure and function of landscape elements such as landscape patterns and the degree of heterogeneity of landscapes also counteract forest fire. In recent years, the interaction and interdependence between forest fires and landscapes have been widely used in landscape ecological construction, and biological fire prevention behaviors, such as planned burns and the construction of firebreaks, have been carried out as a manifestation of this.

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