FOREST FIRE CONTROL AND FUELS MANAGEMENT

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ABSTRACT

According to the theories of ecology, forest fire management and systems engineering, considering forest fuels as a controllable and adjustable parameter, this article theoretically expounds that the increase of its inner's controlment and adjustment ability by introducing a negative entropy into the ecological system resist the external interference; In order to decreasing the fuel sufficiently for achieving the goal of efficiently preventing and control forest fires, this article practically suggest the comprehensive measures through the monitoring the growth and decline of the fuels.

Key Words: fuel, negative entropy, management.

PREFACE

Forest fire bring the harm and loss to the forests, economics and environment. Forest fires occurrence needs three factors coming together, fuels, fire sources and fire enviroments. For these three factors, Fire sources can be controlled by man. Although fire environment is diffcult controlled by man. Although fire environment is diffcult controlled, up to now, it can be predicted and monitoried. Fuels which is a important factor in the forest fire can be controlled by scientific and technical measures according to mankind's willings. Therefore, fuels managemnet is quite an effective technical way to prevent and control forest fires. This article brings up detailed methods of fuels management based on expounding the relationships between forest fire prevention and fuels, and analysing the energy current of forest ecology system.

1. SCIENTIFICALLY MANAGING FUELS IS THE BASE OF FOREST FIRES PREVENTION

The forest fuel is the material base of forest fire starting. Consequently, konwing the pattern of fuel's growth and decline, to plan, design and take technical methods for adjusting and controlling fuels quantity, type and structure pattern is a engineering measure. It must be done during the whole process of the forest growing. It is a year around work of forest fires prevention.

In a broad sense, we concept all flammable organic materials as fuels, but this study emphasize on

dead fuels, such as leaves, needles on the ground, logging slash, dead trees and logs laying on the ground. The fuel quantity, fuel size, fuel bed structure and their physical and chemical characteristics quite affect whether fires will start, how they will spread and what damage they will do. However, the degree of fires is also directly determined by fire environments.

The fuel is a kind of compound material. It has compacted in shape, gradation and with dynamic characterristics. The dead fuels in forest have close relations with forest fires. They can be classified into four size classes, the timelag grades are:

Class A: < 0.6 cm – 1 hour
Class B: 0.6 ~ 2.5 cm – 10 hour
Class C: 2.5 ~ 7.5 cm – 100 hour
Class D: > 7.5 cm – 1000 hour

The timlag is refer to that the deferrence of moisture content between fuels and surounding squal to 1 / e. In the real fire, class A contains easily burned fuels which can be totaly burned in the fire. Class D are those large and heavy fuels, which are not easily burned in the fire wind. Class B and Class Care the fuels between Class A and Class D, which can be burned when they face the fire wind. Accordingly, the effective burning degree is decreasing while the timlag is increasing. In the Inner Mongloia and Northeastern part of China, it is easily to find through the research of forest fires that the fuels, such as Deyenxia Iangsdoxffil and Carex sp are belong to timlag class A. Fires on those are low intensity (< 700kw / m) surface fires. Their effective burning degree can reach 100%; The fuels, such as small twigs and cones, belong to timlag class B and class C, the effective burning degrees are ranged in 60~70% . The large and heavy fuels which belong to timlag class D can generally give effective burning degrees lower than 20% . However in the extreme weather conditions, such as Daxingling "May 6" big fire in 1987, Although the large and heavy fuels of which timlag value equal to 1000h, their effective burning degrees can also reach 100% . Therefore, scientific fuels management plan can be done according to the research of the timlag value. For an example, the fuel moisture content is a featural parameter of forest fires management. We can predict mositure content of various forest fuels, such as grass, dead trees and logs by measuring thee wet and dry bars. Then we can take different technical actions to prevent forests from fires through the forecasting the fire hazard. In the process of reducing fuels, we mainly clear the fine fuels, such as grass, leaves, needles and small twigs. The prescribed burning under the forest is a very important way to reduce the fuel load. In eastern part of Heilongjiang province, China, the fine fuel can be burned up 70~ 80% of total by one prescribed burn under the forest. After 7~8 years, those fuels can be reloaded around 90% .

2. THE ANALYSIS OF ENERGY CURRENT IN FOREST ECOLOGY SYSTEM

Forest ecology is an opening system. It continuously exchanges materials and energy with surrounding environment. It is a typical disspation structure. This system can keep its structure and energy, the materials in and out, also the balance and stable in thermodynamics, in a certain period of time under the relative stable conditions by its own abilities of feedback, adjustment and controllment. The accumulation of fuels in the forest ecology system is increasing following the days. In order to avoid the explosive release of energy and the occurrence of big fires, the nagative

entropy is intruduced into the system according to the theory of thermodynamics, it can be described as:

ds = des + dis

ds — exchange of entropy

des — entropy current, or negative entropy (burn)

dis — entropy productive (fuels) dis $>$ 0

Above equation shows the dynamical balance of materials currrent and energy current in the forest ecological system. Introducing the negative entropy is to increase the ability of system's adujstment and cotrollment. If the system is interfered, such as fires, ecological system can gradually recover to normal, and maintain its own dynamical balance; if the negative entropy is not introduced for a long period of time, the inner abilities of adjustment and controllment would drop. If the value of disturbance is higher than the ability of adjustment and controllment, the system would not return to begining conditions, and the balance would be broken, the system would have qualitative change. So, we need continuously bring in negative entropy to increase system's abilities of feedback, adjustment and controllment, for resisting the interfere from outside of system. If the weather conditions like the one at Daxinganling in " May 6 ", 1987, the disturbance is more higher than the elastic limit of the system, it will break the system into aparts.

3. THE PRACTICAL MEASURES OF FUELS MANAGEMENT

System engineering should be used in managing fuels. Combining various traditional and the high, new technologies, according to the different conditions in such a area, we can monitor or take actions on it according to the survey and plan to the forest fuels. Many years surveies to the Northeast virgin forest in China, shows the fuel load:

20～30 T / ha. in over cut forest

10～15 T / ha. in man-made forest.

If the fuel can be reduced 50～60% of the total amount, the fine fuels could be below 1T / ha. from 4T / ha. at present. It will reduce forest fires and lower the damage which the fire would cost. Therefore, the following works need be done. :

(1). Much more surevies should be done, including site conditions, forest types, organic cover types, ground fuel types and load. Then those datas should be input into computers. So, we can make the forest fuel type map for furtherr uses.

(2). Monitor system of fuels growth and decline should be established. Regular checking is necessary following the various change. So, it can provide the updated informations to the forest fire decision making procedure of dynamical management.

(3). The practical steps need be token for reduce the fuel load. It should include presicribed burning for silvicultural purpose, industrial utilization (chip, paper pulp), living utilization (fire wood), mechanical compacting, chemical killing weeds, man clearing (selected cut) and planting mixed forest. For an example, in inner Mongolia and Northeast of China, accoreing to the characteristics of various seasons, the prescribed burning could be done at the time when the snow is melting in the Spring, or the time of dry frost in the Fall, of warm days after snowfall in the Winter. All those ways to reduce fuels in the forest, or outside the forest are well planed. They are Chinese characteristical methods to clear fuels.

(4). Keeping the seedlings and young trees can be done by breaking down the fuels continuity. The

area of young trees planted in China is gradely increasing, and quite concentrated on state owned forest land. So, it is very significant to break fuels continuity by making break line around forests.

4. SUMMARY

The fuel is a kind of material base for forest burning. According to the theories of Forest Ecology and Systems Engineering, considering forest fuel as a controllable and adjustable parameter, theoretically analysing energy current and practically taking the management actions are the basic works of forest fires management.

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