

## F-2.2 Studies on Analysis of Biological Diversity and Effects of Forest Disturbance on Symbiosis in Russian Boreal Forest

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**Abstract** A history of forest disturbance, institutional and economic analysis of forestry in the Russian Far East, and influences of forest disturbance on ecosystem were surveyed in the boreal forest, near Khabarovsk. Forest disturbances occurred on the lowland in 1980's, while on the backland in 1990's. Forest cutting seemed to be the main cause of the disturbance. Although timber export had increased in 1990's, the profit was rarely reinvested with both forest production and industry sector. Although methane was taken up by the soil in natural forest, methane emission was observed at a high moist area in the felling site.  $\text{SO}_4^{2-}$  fluxes indicates that there was much input of artificial acidic deposition at forest ecosystems at Khabarovsk, Russia. A kind of fungus, *Patella scutella*, could be an indicator of disturbance of forest floor. Soil animal population increased in felling site due to an addition of organic matter supplied by the residue of wood litter. In contrast, rodents contributing seed dispersal were not recorded in the center of disturbed areas. Methane uptake was significantly related to soil temperature and moisture.

**Key Words:** Biological Diversity, Russian Boreal Forest, Forest Disturbance, LANDSAT Image, Biogeochemical fluxes

### 1. Introduction

After the UNCED, the United Nations Conference on Environment and Development, taken place in 1992, conservation of biological diversity and prevention of global warming have become the major criteria to evaluate sustainable forest management.

The forest of the Russian Far East was once characterized by huge stock volume and high biological diversity. Recently, there are statistics of the forestry activities in the Russian Far East, which reports the decreasing trend of production. This may show the degradation of the forest expands rapidly. It is critical to elucidate the requisites of sustainable resource management in the forest of Russian Far East.

### 2. Research Objective

Although the conservation of the forest is critical, available information on the forest disturbance is limited. Therefore, we focus the purposes of the study on the transition of forest disturbance and influence of forest disturbance, and employed the following approaches.

- 1) Transition of forest disturbance
  - a) rebuilding the the history of forest disturbance using satellite images
  - b) institutional and economic analysis of forestry
- 2) Influence of forest disturbance
  - a) influence of forest disturbance on biogeochemical fluxes

## b) influence of forest disturbance on biotic community

### 3. Research Method

#### 1) rebuilding the the history of forest disturbance using satellite images

The images used in the study are five scenes of LANDSAT TM and MSS of a same path/row (121/026), taken about every five years from 1980 to 1999. An initial forest in 1980 whose reflectance jumps up only once afterward is regarded as a forest canopy removal. A threshold of DN (digital number) to select the initial forest distribution in 1980 and another threshold of DN difference to detect the jump between continuous two images are set from the interpretation of histogram as 100 and 30, respectively. The thresholds are subjectively set from interpretation so that the commission error can be minimized.

#### 2) institutional and economic analysis of forestry

We collected the information on recent status of forestry. These are analysed from the view point of policy framework and federal-local relationship.

#### 3) influence of forest disturbance on biogeochemical fluxes

To characterize the influence of forest cutting of biogeochemical fluxes, we measured methane, nutrient elements for atmospheric deposition, throughfall, stemflow, discharge from soil, litterfall, and nutrient uptake by vegetation from September 1999 to September 2000. Study was conducted in mature forest, coniferous-deciduous mixed forest (CS) and felling site (FS) at Khekhtsy Experimental Forest, about 40 km south of Khabarovsk.

#### 4) influence of forest disturbance on biotic community

Ground vegetation and fungi indicate environmental condition. Also, soil animals and small rodents are good indicators of vegetational condition. We compared species composition and abundance of these organisms between the different types of forests to evaluate the influence of forest disturbance on biotic community. Study was also conducted in Khekhtsy Experimental Forest.

### 4. Result

#### 1) rebuilding the the history of forest disturbance using satellite images

A history of forest disturbance in 1980-1999 in a part of Khabarovsk State, Russia, is mapped using a time series of LANDSAT images (Fig. 1). Winter images with snow cover are used for the analysis due to the high contrast between woods and open areas and the more availability of images than summer, the cloudy season.

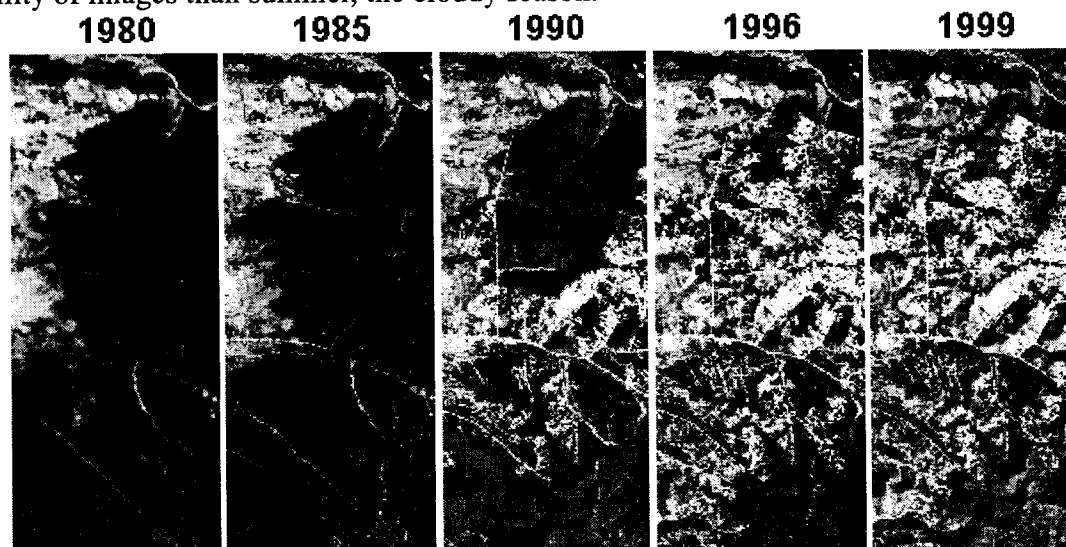


Fig.1 Expanding forest disturbance observed from LANDSAT.  
Each rectangle represents a 10 km by 24 km area.

## 2) institutional and economic analysis of forestry

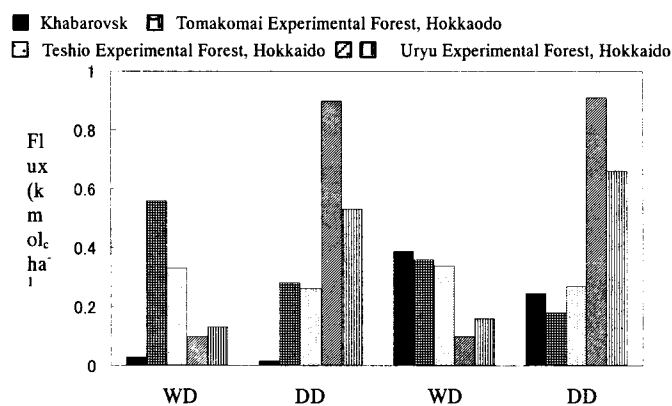
The decentralization of forests policy has been realized under the ambiguous provision of joint jurisdiction and the weak political background of President Yeltsin, and the Khabarovsk Krai government succeeded to formulate a progressive forest policy framework. The forest lease system which has been developed, not only assigns the right of forest use to users based on competition, but also serves as a strong policy tool to control forest users. The krai government also established a Local Code, which set concrete guidelines for forest institutions of the krai. However, this locally dominated policy framework has a weak foundation, because there exists the imbalance of resources between the federal and local governments. So, as President Putin has developed policies to establish strong federal authority, the authority of local governments has started shrinking. Without changing framework of ownership of forests and allocation of resources between federal and local governments, forest policy framework would continue to unstable.

Forest policy development of Khabarovsk Krai indicate that local based policy development has advantages to develop forest policy which reflect local condition and to contribute to sustainable forest use. It is important for the local governments to enhancement their ability to develop their own policy and prepare for chance to change federal-local relationship.

## 3) influence of forest disturbance on biogeochemical fluxes

At the mature forest, methane was taken up by the soil, while emitted at the border of grassland and forest. Methane uptake was related to soil temperature and moisture at 99% level of significance. Methane uptake in the mature forest was higher than in most of the ecosystem.

Proton ( $\text{kmol}_e \text{ ha}^{-1} \text{ y}^{-1}$ ) loaded through atmospheric deposition at FS and CS were 0.05, 0.03, respectively. These values at our study sites were much lower than values at Hokkaido, Japan. On the other hand, fluxes ( $\text{kmol}_e \text{ ha}^{-1} \text{ y}^{-1}$ ) of  $\text{NH}_4^+$  by atmospheric deposition at FS and CS were 0.63, 0.39 respectively. These values were equal to or larger than the values at Hokkaido, Japan (Fig. 2).  $\text{SO}_4^{2-}$  fluxes ( $\text{kmol}_e \text{ ha}^{-1} \text{ y}^{-1}$ ) by sea salt and non-sea salt origins in wet deposition were 0.01, 0.23, respectively indicating that there was much input of artificial acidic deposition at forest ecosystems at Khabarovsk, Russia.



**Fig. 2**  $\text{H}^+$  and  $\text{NH}_4^+$  fluxes by wet and dry deposition at Khabarovsk and Hokkaido  
WD; wet deposition, DD; dry deposition

## 4) influence of forest disturbance on biotic community

There was similarity in species composition of forest floor between mature forest and unfelling forest. Felling site was dominated by *Calamagrostis canadensis* and the number of species decreased. A kind of fungus, *Patella scutella*, was collected only in the mature

forest and could be an indicator of disturbance of forest floor.

The density of total macro-fauna was 400 to 500 / m<sup>2</sup>. The density in felling site was relatively large in 1999, but in 2000 the density in unfelling was larger than in felling site. The density of meso-fauna in felling site tended to be larger than that in the other sites in 1999. However, in 2000 the density of Collembola in unfelling site was larger than in felling site (fig.3 ). The Pianka's similarity index of Oribatid community was very high in 1999( 0.999), but it decreased in 2000 (0.969).

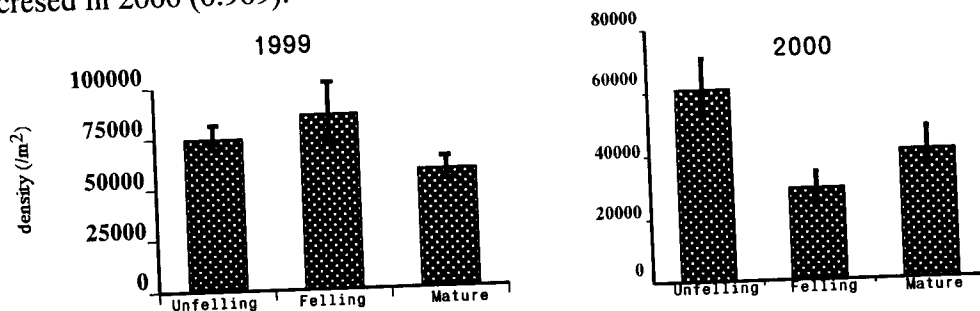


Fig. 3 The density of Collembola in each site

Infrared-triggered camera recorded chipmunks and Korean field mice were contributing the seed dispersal of Korean pine. These animals were abundant in mature forest, while scarce in cut-over area.

## 5. Discussion

1) rebuilding the the history of forest disturbance using satellite images  
Cutting seems the main cause of disturbance in the area. Annual disturbance area dropped in the latter decade, which support a statistics of timber production in Russia. The result will enable us to select stands of varied ages after disturbance for further studies of forest recoveries.

2) institutional and economic analysis of forestry

It could also be pointed out that concept of participatory approach to forest management and community based forestry are quite important for the sustainable management of Russian forest. Forest industry in the Russian Far East is controlled by timber export companies, which seeks for hard currency, and lead to destructive forest development and poverty in rural society. To change these situation, introduction of community based forest management, which seeks both sustainable society. Economy and ecosystem are required.

3) influence of forest disturbance on biogeochemical fluxes

There was little proton output from soil systems at both FS and CS, but base cations leached with NO<sub>3</sub><sup>-</sup> suggesting that proton generated by nitrification exchanged with exchangeable base cation in soils. NO<sub>3</sub><sup>-</sup> fluxes (kmol<sub>c</sub> ha<sup>-1</sup> y<sup>-1</sup>) by discharge from soil at FS and CS wret 0.11, 0.43, respectively. CS accumulated proton in soils indicating the tendency of soil acidification. There was NO<sub>3</sub><sup>-</sup> leaching also at FS suggested that soils at FS might be not only soil acidification but also nitrogen saturation. In the future, it will be necessary to evaluate the degree of soil acidification and nitrogen saturation.

4) influence of forest disturbance on biotic community

In conclusion, after 1 year from the tree felling (in 1999), the desnsity of soil fauna was larger in the felling site probably because of the extra supply of organic matter through leaving needles and twigs on the site. After 2 years from the tree felling (in 2000), the effect of the extra supply was lost, and the severity of climate and loss of new resorces in the felling site might lead to the decrease of the density of soil animals and change of the community structure of Oribatida.

The results of this study are limited to the small-scale tree cutting site on the wet soil. In order to generalize the influence of tree cutting in Khabarovsk area, the research for the large-scale tree-cutting site or the research on dry soil is needed.