Stud. Mater. Ośr. Kult. Leśn. 16, 2017, s. 81–107

CONSERVATION OF THE MIXED CONIFER-BROADLEAF FORESTS OF HOKKAIDO UNIVERSITY FORESTS IN NORTHERN JAPAN FOR EDUCATIONAL DEVELOPMENT

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1. INTRODUCTION

Hokkaido University Forests (HUF), located mainly in northern Japan, are internal units of Hokkaido University. Their primary role was to produce timber to provide financial resources for the establishment of Hokkaido Imperial University from 1901 as well as Hokkaido University from 1945, but at the same time, they are also essential as locations for field training of undergraduate and postgraduate students [Yokota *et al*. 2016].

The forest management goal of HUF has been oriented to creating a kupa „Normal Forest" in terms of subject „Forest Management" for producing a constant amount of timber per year. However, the principal idea of forest conservation in HUF is characterized by the consideration of subject „Forest Aesthetics" [Niijima and Murayama 1918]. Indeed, the degradation of natural forests in HUF has been accelerating annually, which may be due to not only anthropogenic activities, such as over-harvesting

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and air pollution but also heavy snowfall, extreme cold and typhoon damage [e.g. Ito 1987; Matsuda *et al.* 2002]. Despite our advancements in the area of Forestry Science [Sato 1929, Taniguchi *et al.* 1968, Matsuda *et al.* 2002], the quality and quantity of natural forest resources are declining.

Of course, we also preserve several forests (including primeval forests), not only for current research projects, but as sources for the „seeds" of future researches. Forest management for HUF has been carried out based on the concept of sustainable use of natural resources [Niijima and Murayama 1918]. However, we occasionally have overused forest resources, mainly in timber production related to wars [Yokota *et al.* 2016]. In an attempt to preserve the mixed forests as a viable natural resource, we should seek sustainable methods in forest management, which encourage the conservation of biodiversity and forest productivity [Yoshida *et al.* 2005, 2006]. Naturally, we should try harder to conserve our precious forest resources and to rehabilitate the degraded areas of natural forests in Hokkaido by way of practical forestry techniques [e.g. Kikuzawa 1983, Samejima 1985, Sakagami and Ishida 1987, Watanabe and Sasaki 1994, Matsuda *et al.* 2002]. Based on these studies, we should improve forestry technology in Hokkaido, aiming at the conservation of mixed conifer-broadleaved forests as well as developing the new concept of „Landscape Ecology" as discussed by Takeuchi [1994, 2006] and Forest Aesthetics.

During these decades, a new approach of forest aesthetics has been proposed as a part of forest ecosystem management in Germany, i.e. „Waldästhetik" [Stölb 2005]. Here, „Wald" means natural forests, including the term of forest ecosystem. We will try to create a forest management system according to the proposal of „Waldästhetik". Process of forest management and land use affect usually water resources [Schlesinger 1997, Hatano *et al.* 2005, Woli *et al.* 2007]. Because of the recent increase in both public and scientific concern about the sustainability of the quality and quantities of water resources in Japan, we should study the essential role forest management plays in water resource conservation and how it will be influenced by global climate change [Shibata *et al.* 2004, Stölb 2005]. Since 1998, the education staff of HUF has opened graduate schools based on our experience in forest management in HUF (theory and practices). However, the orientation has been shifted to more pure biology but not for practical forestry [Yokota et al. 2016].

We hope to contribute all aspects of individual science into an integrated education system to support the idea of sustainability [e.g. Takeuchi 1991, 1994, Washitani *et al.* 2005, Komiyama 2007].

In this report, we summarize the methods for the conservation and rehabilitation of natural forests after several types of disturbance and how to build new concept for sustainable management in a forest ecosystem involving a catchment area. To do this, we first show the ecological studies of HUF, then the land use procedures accompanied by the University's financial requirements [Yokota *et al.* 2016], and finally give examples of educational trials for both Japanese and overseas' students as a part of the Sustainability Governance Project (SGP) of Hokkaido University [Osaki 2007]. The final goal of SGP in forest science is to make a new educational system on the basis of our on-going research projects in environmental and natural resources.

We followed the nomenclature of Latin names of both tree species and disease names established by Ohwi [1978] and Hayashi *et al.* [1985], respectively.

2. ECOLOGY OF MIXED FORESTS

Hokkaido University Forests (HUF) are mainly located in mixed conifer-broadleaf forests which were named by Prof. Misao Tatewaki (1955–1957, 1958) as the Pan-Mixed Conifer-Broadleaved Forest. This type of forest region is located between the Kuromatsunai-lowland in southern Hokkaido, and the southern limit of the Schmidt Line stretches across Sakhalin Island and northeast China. The Pan Mixed Forest is regarded as the transition zone between cool temperate broadleaf forests and sub-arctic coniferous forests. This transition has also been recognized in Western Europe and northeast America [Tatewaki 1958] (fig. 1). Three forest regions are characterized by similar composition of trees at genus level with different number of species: total numbers of woody species are estimated in Europe, North America (west~east), Asia and 115, 176~373, 676, respectively [e.g. Koike and Koike 2012]. However, the soil conditions are quite different among the three regions; Western Europe has fertile black soil, northeast America is characterized by the Canadian Shield, the most infertile soil and northern Japan has immature volcanic ash soil, i.e. fertile soil [Koike *et al.* 2002].

We should consider the mixed forests as a transient „climax" (but not the same meaning as Tansley's climax) between coniferous forests and broadleaf forest because they are a floristic mosaic created by a variety of disturbances and natural regeneration [Pickett and White 1985, Ishizuka and Sugawara 1986, 1989, Hiura *et al.* 1998, Yoshida *et al.* 2006]. We should recognize the instability and vulnerability of the mixed forest. From the late 1980s to the present, conservation studies on hedgerows in central Europe have been carried out from the viewpoint of biodiversity and physiological ecology [Scherer-Lorenzen *et al.* 2005]. They introduced the idea of zone and landscape management based on the linkage between function of each species and their habitat as noted by Washitani *et al.* [2005]. The main concern of ecotone studies in Europe is how to apply the idea of a man-made disturbance as a key factor in maintaining a forest ecosystem. How can we conserve forest ecosystems in HUF?

Generally speaking, the forest floors in heavy snow regions of Japan are usually covered by dwarf bamboo (*Sasa* sp.) [e.g. Ito 1987, Lei and Koike 1998, Uemura 1994, Koike *et al.* 2001]. The successful growth of trees in these areas will surely increase after selective cutting or natural disturbance of the dwarf bamboo [Matsuda and Yajima 1979, Noguchi and Yoshida 2004, 2005]. However, if the light conditions of the harvested area are advantageous for the growth of dwarf bamboos (relative light intensity is more than 5%), the area will be immediately occupied by them [e.g. Lei and Koike 1998, Koike *et al.* 2001]. As a result, the number of regenerated seedlings does not increase rapidly because the natural regeneration on the forest floor is inhibited by the invasion of dwarf bamboo [e.g. Hijii 2016] and snow blight disease [Sakamoto and Miyamoto 2005] (fig. 2). The only places that are safe sites for natural regeneration of Ezo spruce (*Picea jezoensis* Carr.) and fir (*Abies sachalinensis* (Fr. Schm.) Masters) are on fallen logs and the bottom part of standing trees where no *Sasa* sp. invasion by subterranean stem due to high density of tree root [Yajima 1982, Yoshida *et al.* 2005].

3. LAND USE PROCESSES AND SOCIAL CONDITIONS

We had been managing HUF based on the idea of forest aesthetics („Forstästhetik" in German) [Niijima and Murayama 1918, Konda 1934], which meant we should make highly productive man-made forests instead of keeping natural forests. The original idea of „Forstästhetik" was to maximize the profitability of forested land with well-arranged plantations, „Forst" means man-made forests or plantation. However, we have overused the forests that have resulted in having many degraded forests. In this section, we show again the basic idea of forest management of HUF and an historical overview of land use of HUF.

3.1. BASIC IDEA OF FOREST MANAGEMENT

The principal idea of forest conservation in HUF is characterized by the idea of forest aesthetics [Niijima and Murayama 1918]. Recently, the concept of forest aesthetic as a field of study has been developing as „Forest Aesthetics and Landscape Management" [Koseki 1990]. However, the concept of forest aesthetics has been strongly influenced by „Forstästhetik" published by von Salisch [1885, 1902], a German forester. They proposed a reasonable method for a well-organized structure of forest stands made in through the process of forest management. However, the original idea of Niijima and Murayama [1918] in Forest Aesthetics was different from the proposed idea of von Salisch [1885], i.e. simply to say that all activities devoted to improving the condition of beautiful, scenic forests was regarded as a part of „forest aesthetics" [Konda 1934, Akasaka 1991]. The idea is similar to that proposed in „Waldästhetik" by Stölb [2005].

Nowadays, one of the most important ideas in regional resource management for the assurance of human survival [Takeuchi 2006] is the conservation of forest resources, i.e. sustainable management of forest resources. Implementing this idea, we have been managing Uryu Experimental Forest in the vicinity of Lake „Shumarinai" (formed with the construction of a hydroelectric dam) not only for timber production, but also for wildlife habitat including fresh water fish [Tamate and Maekawa 2000, 2004] (fig. 3).

3.2. FORESTRY PRACTICES AND THE ECOLOGICAL IMPACT OF DISTURBANCES ON MIXED FORESTS

We had mainly employed a selective cutting method for harvesting timber from HUF until World War II [Yoshida *et al*. 2006, Yokota *et al*. 2016, Yoshida 2016]. As a result, mixed forests were able to maintain a high level of biodiversity and functional activities [e.g. Tatewaki 1958, Ito 1987]. However, with the strong influence from the political orientation by the Meiji Restoration, forests of Japan except Hokkaido Island changed from natural mixed forests to conifer plantations [Ono 2005, Koike and Koike 2012]. During the Edo period (1603–1868: Togugawa shogun family governed most part of Japan) after the Age of Provincial Wars around 1467–1591, Japan had closed the country for 265 years, except The Netherlands, China and Russia due to prevent Christianity from invading. In this sense, the Edo period banned maritime

activities. However, the arrival of the „Black Ships" from America to the Uraga port in 1853 was more than enough to make the bigoted conservatives realize that their closed-door policy was long out of date. Immediately after opening up the country to the world, the Meiji government tried to follow up Europe and America, sending many young people to study there so they could construct a „Modern Country". They made the Sino-Japanese War (of 1894–1895) and the Russo-Japanese War (of 1904–1905). The Imperial Rescript of 1908 ordered most of the Japanese forest stands except Hokkaido to be changed to productive conifer plantations, so they could help recover the economy after those 2 wars [Ono 2005, Yokota et al. 2016].

The SATOYAMA region has also been modified from stands dominated with broadleaved tress to productive conifer stands in Honshu, Kyushu and Shikoku Islands. The idea of SATOYAMA means a very special type of natural environment (secondary natural environment) that cannot exist without moderate intervention of human beings [e.g. Takeuchi *et al.* 2003, Osaki 2007]. After several small harvests, the creation of plantations was attempted, however, it resulted in many poor, even-aged uniform stands and even some dead forests which were killed by frost in a „cold air lake" (basin land form). Furthermore, unfortunately, stands were also not properly managed (improper timing of thinning and pruning). This was partly due to the rapid increase in labor costs and the decrease in the commercial value of conifer timber.

Many studies have been conducted on the transition from natural forests to production forests specifically for timber since the 1950s, especially after the „Toyamaru" typhoon in 1954. However, many man-made forests could not be established because of the harsh physical environment as well as damage caused by biological stress (e.g. shoot blight diseases and grazing by voles) [Taniguchi *et al.* 1968, Matsuda and Takikawa 1985, Matsuda *et al.* 2002]. Moreover, market prices of conifer species per volume have been lower than those of deciduous broadleaf tree species. The commercial value of broadleaf trees, such as ash (*Fraxinus mandschurica* Rupr. var. *japonica* Maxim.), Japanese elm (*Ulmus davidiana* Planch. var. *japonica* Nakai), Castor aralia (*Kalopanax septemlobus* (Thunb. ex A. Murray.) Koidz.), Monarch birch and oak [e.g. Matsuda *et al.* 2002], maintains relatively high level, but it is still difficult to produce these broadleaf trees from commercial plantations because of few knowledge of their growth traits [Koike 2013].

It is quite important for us to harvest timber accompanied by maintaining secondary forests. Ecological studies have revealed that mosaic and patch structures are major components of mixed forests [Pickett and White 1985]. While it is true that harvested forests will return to their original condition after an extended period of time, it is important to keep some secondary forest activity as close to normal as possible. To apply the idea of disturbances, we should evaluate the role of pattern and degree of disturbances on the recycling processes in the mixed forests. Even though we have several permanent plots in HUF for estimating the growth increment of mixed forests, we still cannot obtain a reliable value. We can, however, harvest a small quantity of timber from the total volume of the mixed forests in central Hokkaido [Shibata 1988, Yamamoto 1990, Watanabe and Sasaki 1994]. Despite this fact, we cannot directly apply these methods to forests in northern Hokkaido because of the differences in topographic, edaphic and biotic conditions. However, recently we employ airborne LiDAR (Laser Imaging Detection and Ranging) method in order to

estimate growth and stock of large forest area [Takagi *et al.* 2015]. Based on LiDAR data, they can estimate biomass acute and quickly. We overcome many difficulties in the previous methods.

In 1997, the Japanese government signed the International Agreement of Biodiversity Conservation Program. To achieve the goals of this program, we have been establishing species-rich deciduous broadleaf forests in abandoned larch and pine plantations, as well as monitoring the changes in species richness and productivity accompanied by physical environmental changes. Even though people's expectations of multiple aspects of forest resources are large, the quality and quantity of mixed forests in HUF are still declining partly due to typhoons [e.g. Matsuda *et al.* 2002].

4. CONSERVATION OF FOREST ECOSYSTEM

One of the most important roles of forests is to conserve water resources in the regional ecosystem and watershed or catchment [e.g. Takeuchi 2006, Nakamura 2007]. We are facing serious problems of water management on a regional to global scale [e.g. Kuraji 2008]. We have been using high levels of technology of our water resources for 100 years, however, water resources per person in Japan are lower than those in Saudi Arabia because water is easy to run off on steep slopes of land of Japan. Therefore, we must pay attention to water resource management of a catchment area as an essential part of forest management. We show firstly the forest management in HUF, and then summarize an on-going research project on water quality in the Teshio River catchment.

4.1. MAINTENANCE AND REHABILITATION OF THE FORESTS

If we want to develop methods to rehabilitate disturbed forests, we should know more about the mechanisms of forest succession [Bazzaz 1979, 1983] as well as the interactions among species, in regard to the existence of dwarf bamboo [Hiura *et al.* 1996, Lei and Koike 1998] and the differences in shade tolerance traits [Koike 1988]. Mixed forests are characterized by a mosaic structure in space, time and species composition [e.g. Hiura *et al.* 1996, 1998, Matsuda *et al.* 2002]. To effectively predict the growth of each species, we should know the responses of species in the mixed forests to the timing and severity of natural and anthropogenic disturbances [Bazzaz 1996]. Moreover, the ecological role of birds and mammals on reproduction [e.g. Mizui 1993, Hayashida 1989] and seed dispersals in natural forests [Yagihashi 2001] should be analyzed to maintain the mixed forests. Based on these findings, we have tentatively proposed afforestation methods for decaying mixed forests.

The key points of sustainable forest management of mixed forests are how many trees can be harvested, the interval between harvests and finally how to manage the forests. However, the serious problem of afforestation is the inhibition of regeneration by dense vegetation cover and brown rot fungi as mentioned before. How can we eliminate dense vegetation cover of *Sasa* sp. for providing space of natural regeneration? At first, we introduced big forestry machines, such as a bulldozer with the expectation of natural regeneration on flatlands [Shibuya *et al.* 2000, Matsuda *et al.* 2002]

(fig. 4). It is quite effective to use a bulldozer fitted with upward-warped rakes to eliminate rhizomes and culms of dwarf bamboo, i.e. *Sasa* sp. and eliminate the „damping off" or brown rot fungi disease in seedlings caused by the fungi *Rhacodium therryanum* or *Phasciduim* sp. [Hayashi *et al.* 1985, Sakamoto and Miyamoto 2005] (fig. 5). The thickness of the soil layer with organic matter under dwarf bamboo is thicker than other sites [Ujiie 1985], which allows us to use bulldozers in the *Sasa* sp. dominated forests. However, this technique has not been well established because we still cannot overcome the danger of erosion that may occur after using a bulldozer on steep slopes. Therefore, we apply this technique for site preparation at locations that are either flat or have only gentle slopes. Of course, a forest management system for conserving the mixed forests should be based on the growth traits of the representative tree species [Satoh 2016]. The methods are summarized by Matsuda et al. [2002] as shown in fig. 6.

4.2. MANAGEMENT IN CATCHMENT

4.2.1. ESSENTIAL ROLE OF A CATCHMENT FOR BIO-PRODUCTIVITY IN A MARINE ECOSYSTEM

As a result of biogeochemical processes in catchment areas, many kinds of elements are transported to estuary and marine ecosystems through rivers [Nagumo and Hatano 2001, Ducklow *et al.* 2003, Woli *et al.* 2007]. Water quality and quantity in rivers are strongly influenced by vegetation, soil, geology, climate and land use in the catchment [Schlesinger 1997, Hatano *et al.* 2005]. In certain climatic conditions, vegetation patterns and related gradients of the soil characteristics in the catchment can be important environmental drivers for the spatial distribution of dissolved elements in a river [Nakamura 2007]. In addition, land use changes and/or forest practices in a catchment area also have the potential to affect the transfer of elements from terrestrial to aquatic ecosystems, which usually induce an outbreak of shellfish poison [Hayakawa *et al.* 2003, Hatano *et al.* 2005]. Therefore, it is important to understand the natural and anthropogenic drivers of river water quality to develop better catchment management systems associated with the sustainable utilization of natural resources.

Since the leaching processes of iron from soil to stream were closely related to hydrological dynamics and land use (development of agriculture, industry, forest harvesting, fires etc.) in a catchment have the potential to affect iron transport from terrestrial ecosystem [Nagumo and Hatano 2001, Shibata *et al.* 2003]. Here, we will focus on the transfer of dissolved iron and the related solute (mainly dissolved organic carbon; DOC) from a terrestrial to a stream ecosystem of HUF in northern Japan.

4.2.2. TOPOGRAPHIC CONTROL OF SOLUTE CONCENTRATION IN STREAM WATER IN A FORESTED CATCHMENT

In a cool temperate and boreal region, topographic characteristics create several gradients of ecosystem functions and processes associated with the differences in the soil moisture regimes in a forested basin. Some soil processes (mineralization and immobilization of organic matter) associated with microbial activities in the soil closely related to the soil moisture condition [Ito *et al.* 2004]. In anaerobic conditions, decomposition velocities of the organic matter decreased more than those in aerobic conditions. Topography of the catchment also affects the ground-water flow.

Iron and the related solute concentration in stream water were investigated in Uryu Experimental Forest, Hokkaido University to clarify the relationships between topographic characteristics of a catchment and the stream chemistry in a forested catchment [Ogawa *et al.* 2006]. Our results indicate that the riparian wetland has a significant amount of dissolved iron and conjugated DOC because the stream ecosystem of this catchment has deposited it there. Nitrate retention of the riparian wetland was very important in the formation of the spatial differences in nitrate concentrations in stream water [Shibata *et al.* 2004]. These results suggest that the topographic features and the related soil moisture regime might be the primary drivers in dissolving and transporting iron in forest catchments in this region (fig. 7).

4.2.3. SPATIAL CHANGE OF SOLUTE CONCENTRATION IN RIVER UNDER LAND USE CHANGE IN REGIONAL SCALE

To understand the mechanisms of solute exports from terrestrial to aquatic ecosystem on a wider and regional scale it is necessary to look at some land use and human activities involved in the catchment environment [Nagumo and Hatano 2001, Shibata *et al.* 2003, Woli *et al.* 2007]. Regional observation of solute concentrations in river water was conducted in the Teshio River to clarify the regional spatial pattern of river quality. There was significant positive relationship between iron and DOC concentration in river water. In the Teshio River catchment area, human activities mainly occur in the middle part of the river. Therefore, iron release associated with dissolved organic materials from the terrestrial ecosystem to the river seemed to be released from a combined source of peat soil (natural processes), and/or land use changes (urbanization and agriculture) by anthropogenic processes.

5. EDUCATION

HFU was managed on the basis of the idea of sustainability in forest aesthetics as proposed by Niijima and Murayama [1918] and Konda [1934] until the 1940s. However, between 1950 and 1990 we were required by the government and university administration to harvest timber intensively from HUF for financial reasons [Yokota *et al.* 2016] and this was the same situation in Germany which lead to the development of the forest aesthetic [Stölb 2005]. In 1995, we declared that our forest management system would cover all aspects of HUF, from timber production to conservation, in an attempt to rehabilitate the HUF [Hokkaido University Forests 1995, 2006]. Since 1998, we open the lecture course in the graduate school by teaching staff of HUF.

To integrate four research divisions in HUF (i.e. Ecosystem Function, Forest Dynamics, Wildlife Conservation, and Regional Resources Management), we have employed the idea of „ecological service" proposed by the Millennium Ecosystem Assessment of the United Nations from 2001 [UN 2001]. At the same time, we have established the Field Science Center for Northern Biosphere to manage our University Forests to develop further the idea of „ecosystem service" as a basis for human survival [e.g. Washitani *et al.* 2005]. Based on these activities, we hope to dedicate

our trials to creating a new education system for overseas' students as well as Japanese students. With these lectures, we would like to make clear our goal for forest management in the conservation movement.

5.1. JAPANESE PROGRAMS

5.1.1. TRAINING COURSE FOR JAPANESE STUDENTS

It takes at least 40 years to grow a tree and produce lumber, and forest maintenance and management cannot be supported by only one person. In order to maintain the functions of forests under a changing environment and pass them to the next generation, it is indispensable to pass the ideas and skills of sustainable forest maintenance. For that purpose, we have been conducting the „Field Symposium for Forest Research" since the summer of 1998, as a part of HUF's education.

The „Field Symposium" is a five-day technical education program for college students through Japan who have an interest in forest and environmental studies [Uemura and Shibata 2000, Uemura 2010]. The basic components of the symposium are field sessions: poster sessions, and panel discussions in a forest (fig. 8). There are representative three themes for the symposium:

1) „The function of the environment and ecosystems", under which we examine the functions of forest ecosystems, such as carbon balance and the cycle of nitrogen,
2) „The sturdy lives of creatures", under which we examine the roles of forests in maintaining the biodiversity of creatures based on the characteristics of the life cycle and relationships between creatures,
3) „Creating productive forests", under which we examine how humans should coexist with forests through the production of biological resources such as timer, berries, mushroom, games etc. and river basin maintenance.

Ten to fifteen studies are introduced in every year. Studies introduced in the sessions are by young faculty members and Ph.D. candidates in ecology, biogeochemistry, forest dynamics, soil science, hydrology, erosion control, plant physiology, dendrochronology, and forest policy, who are conducting field studies in HUF and its peripheral areas.

In addition, the technical staffs, who are in charge of field maintenance, observation, and analysis of organized studies, serve as the administrative staff. The participation of the technical staff in discussions about field sessions is expected to improve field maintenance that will advance research activities. Many of them have visited the experimental forests of overseas institutions based on MOU over the past 20 years and have studied many examples of forest management. What they have learned has been reported in the bulletin of „The Technical Report for Boreal Forest Conservation" issued by HUF.

5.1.2. TRAIT OF PARTICIPANTS

In previous field symposiums, we conducted a drawing to select the participants because two or three times as many people applied for the 25 openings in each year. The applicants were from around the nation, from Hokkaido to Okinawa (southernmost islands) but the number of women always exceeded men, namely more than 80% of the applicants were women in some years. Most of the applicants

belonged to departments of agriculture or science but others majored in various subjects such as liberal arts, medicine and pharmacy [Uemura and Shibata 2000, Uemura 2010].

Many of the participants were fascinated by forest science and decided to go to a graduate school. They entered their studies with their own interests and themes and presented their research results to younger students. This symbolically expresses the success of the „Field Symposium". It can be said that the field symposium created a stir in the present situation of university education, which lacks field studies and is apt to fall into one-way information distribution in passive classrooms (fig. 9).

Moreover, Japanese forestry agency had changed finance system from the special account by trade of timber to general accounting from the fiscal year of 2013. Therefore we should educate to our students more on the topics of forest ecological services as people are expecting.

5.2. INTERNATIONAL PROGRAMS

The Asia Europe Foundation (ASEF) was established at the Asia-Europe Meeting (ASEM) of foreign ministers held in Singapore in 1997 [ASEF 2008]. Its purpose is to organize and assist activities of intellectual, cultural and human exchanges in order to deepen understanding between Asia and Europe. The symposium that established the project „People-to-People Exchange for Sustainable Forest Management" was held in University of Joensuu (currently University of Eastern Finland) in July 1999 [Koike and Akibayashi 2001]. Since then, a secretariat has been set up, together with SILVA-NETWOK of Europe, at the Department of Forestry, University of Joensuu (now Joensuu campus of The Univ. of Eastern Finland), and permanent secretariat members reside there. From 2004, the ASEF project had opened a summer school instead of exchanging students because of a limitation in education funds, especially in Munich Technological University (via Dr. Markus Schaller; now Basel, Switzerland). Although this program was closed by 2005, most of the participants and HU have been collaborating together to offer the chance to younger generation.

We believe that the exchange and education of people from different countries with different cultural and social backgrounds will raise awareness of global citizenship and that it is, although time-consuming, the shortest way to solve environmental problems in the long run. We are also convinced that the increased number of people with global awareness correlates to the quicker solution of environmental problems.

5.2.1. PARTICIPANTS AND INSTRUCTORS

At the symposium that established the project in ASEF, it was confirmed that researchers younger than 35 years old would be exchanged and educated for a maximum of six months. The universities in Asian region that were designated when the project was established were the University of Philippines-LosBanos, University Putra Malaysia, Northeast Forestry University, China, and Hokkaido University Forests. The designated universities in Europe were the University of Joensuu, Austria National Agriculture University, Lleida University, Catalonia-Span and Florence University, Italy. The project has supported four researchers so far.

In Japan, the Field Science Center for the Northern Biosphere (FSC) of Hokkaido University has cooperated with the ASEF project and has been an accepting institution for researchers since 2000. We choose an adviser according to the specialty of the ASEF researcher. We also hope to expand the activities of the technical staff who have been engaged in natural conservation in Japan, a country which has been harmed by pollution (mostly air pollution) but now is a leader in environmental issues. Based on past achievements, we hope to develop our Forest Research Station as a place to train both international and domestic students.

5.2.2. ORIENTATION OF EDUCATION

Generally speaking, no one would object to the restoration and sustainable use of rich forest resources. However, neither solutions nor improvements can be made even though developed nations vociferously discuss global environmental issues or the necessity of restoration of tropical rain forests. A fundamental solution is necessary. After all, in order to restore tropical forests and conserve the biodiversity of creatures, we cannot simply rely on the self-help efforts of the countries wherein these forests and creatures exist. Developed nations are responsible for supporting these self-help efforts. Japan is importing a large amount of lumber, which temporarily improves some people's lives in the exporting nations. However, it does not mean that Japan is free from giving support.

Although many scientific fields have been departmentalized as they have developed, we try to integrate most aspects of forest science on the basis of practical and theoretical forestry in HUF [Uemura and Shibata 2000, Matsuda *et al.* 2002, Koike *et al.* 2006, 2007, Uemura 2010] including concept of SATOYAMA (see 3.2). We have been constructing many field laboratories and monitoring stations in HUF as well as on the university campus (Eco-Campus Project) to promote field science. As an example, we made name plates for the shade trees around the International Student Center of Hokkaido University and FSC so both International and Japanese students can recognize the species-rich forests in East Asia. The name plates show the origin of Japanese name, „Aynu itak" (Ainu name), ecological traits of trees and how they are utilized. For making the name plates, we referred to ordinary plates of plants as well as books on the Ainu and how they used wood [Koike *et al.* 2006].

5.3. RESULTS AND DEDICATION

The results of these studies will certainly contribute to building the foundation of research on conservation, restoration and reproduction of tropical rain forests, which in turn will widely profit the world. Researchers are required to achieve „results" such as papers. In fact, the most important thing is how these „results" are locally understood and established. We believe that the results of research based on field studies are the quickest way to contribute to the maintenance and sustainable use of forest resources.

Based on these international collaborations in education, we also provide two international lecture courses for overseas students of HUSTEP (Hokkaido University Short-Term Exchange Program). As we have shown, we have been creating and improving shade-trees on campus to use as education materials (Eco-Campus) [Koike *et al.* 2006, 2007, Watanabe *et al.* 2007]. The shade-trees with name plates are also useful for the subjects of Dendrology of department of forest science and landscape architecture.

6. CONCLUSION AND SCOPE

In conclusion, forest management had been focused on creating a „normal forest" in term of subject „Forest management", however we have been unable to realize this goal. The value of forests has changed from being the function of their timber production to the aspect of „Forstästhetik" proposed by von Salisch [through Niijima and Murayama 1918, Konda 1934] to the real value of the existence of forests as proposed in „Waldästhetik" by Stölb [2005] including the idea of „Landscape Ecology" [e.g. Takeuchi 2006]. Stölb [2005] insists on the idea of triangular among forest aesthetics, ecology and economy as for the establishment of forest management. We should employ his idea of „Waldästhetik" in our attempts to achieve sustainable forest management. A multidisciplinary approach, including the linkage between nutrient cycling and conserving biodiversity in forested areas, will also be an important aspect of using a forest ecosystem as a sustainable tool to provide enough water resources for human beings [Shibata *et al.* 2004, Stölb 2005].

Disturbed mixed forests cannot usually rehabilitate themselves through natural regeneration in Hokkaido [Matsuda *et al.* 2002, Yoshida *et al.* 2005, 2006, Satoh 2010]. However, it is still unclear how many seedlings and what kinds of species we shall use for rehabilitating disturbed forests. Therefore, we should establish a new practical system for restoring disturbed and degraded mixed forests including catchments and river basins because forest management directly affects water quality and quantity [Hatano *et al.* 2005, Nakamura 2007]. In order to make this system as efficient as possible, it is important to analyze the growth characteristics of individual species of the mixed forests [Yokota *et al.* 2016] as well as the interactions between them in order to establish a new education system for sustainability of forest ecosystems.

ACKNOWLEDGEMENTS

We would like to thank the technical staff of Hokkaido University Forests and graduate students for their work on several mixed forest afforestation and rehabilitation projects, and Prof. R. Hatano and Dr. T. Yoshida for collecting references and Prof. T. Marutani and Prof. F. Nakamura for the discussion on water management in forested ecosystem. Ms. Saki Fujita of Hokkaido University improved partly in English. Financial support in part by the Japanese MEXT is greatly acknowledged. This study is a contribution to the Sustainability Governance Project (SGP) of Hokkaido University.

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* Title in parenthesis is the translation by first author.

CONSERVATION OF THE MIXED CONIFER-BROADLEAF FORESTS OF HOKKAIDO UNIVERSITY FORESTS IN NORTHERN JAPAN FOR EDUCATIONAL DEVELOPMENT

S u m m a r y

We have carried out several forestry and ecological studies on the regeneration mechanism of mixed conifer-deciduous broadleaf forests in Hokkaido University Forests (HUF), northern Japan to conserve natural resources as well as for education in forestry and environmental science. The principal idea of subject „Forest Aesthetic" has been discussed when we would make any types of forestry use decision, especially in harvesting timber from HUF for the financial benefit of the university. We reviewed several studies on the mixed forests of HUF that concerned ecosystem and catchment management as a part of sustainability. Forestry Sections of HUF have been damaged by over cutting for timber production, typhoons and forest fires, and are being rehabilitated. During this process, we are trying to make lecture courses related to the growth characteristics of representative tree species under changing environments. Based on our forestry practices on woodland ecosystem studies, we have developed a new educational system for Japanese and overseas' students that includes the new subject of „Field Science" on forest ecosystem management.

Keywords: Sustainable management, forest aesthetic, mixed conifer-broadleaf forests, catchment and river basin, educational development

OCHRONA IGLASTO-LIŚCIASTYCH LASÓW MIESZANYCH UNIWERSYTETU HOKKAIDO W PÓŁNOCNEJ JAPONII DLA ROZWOJU EDUKACJI

S t r e s z c z e n i e

Przeprowadziliśmy kilka leśnych i ekologicznych prac badawczych poświęconych mechanizmowi regeneracji iglasto-liściastego lasu mieszanego w Lasach Uniwersytetu Hokkaido (HUF), w północnej Japonii. Celem prac była ochrona naturalnych zasobów, jak również edukacja w zakresie leśnictwa i nauki o środowisku. Zasadnicze idee „estetyki lasu" są podejmowane przy każdej decyzji dotyczącej użytkowania lasu, szczególnie pozyskania drewna z HUF w celu uzyskania przychodów przez uniwersytet. Dokonaliśmy przeglądu literatury poświęconej lasom mieszanym HUF, która dotyczyła zarządzania ekosystemem i zasobami wodnymi jako składnikami zrównoważonego rozwoju. Lasy HUF zostały uszkodzone przez nadmierne cięcia, tajfuny i pożary, a obecnie są odtwarzane. W czasie tego procesu przygotowujemy kursy wykładowe dotyczące charakterystyki najważniejszych gatunków drzew poddanych wpływom zmieniającego się środowiska. Na podstawie naszej praktyki i badań w ekosystemach leśnych rozwinęliśmy nowy program edukacyjny dla japońskich i zagranicznych studentów, który zawiera nowe zagadnienia realizowane w terenie dotyczące urządzenia ekosystemu leśnego.

Słowa kluczowe: trwałe i zrównoważone zarządzanie, estetyka lasu, iglasto-liściaste lasy mieszane, zasoby wodne i dorzecze, rozwój edukacyjny

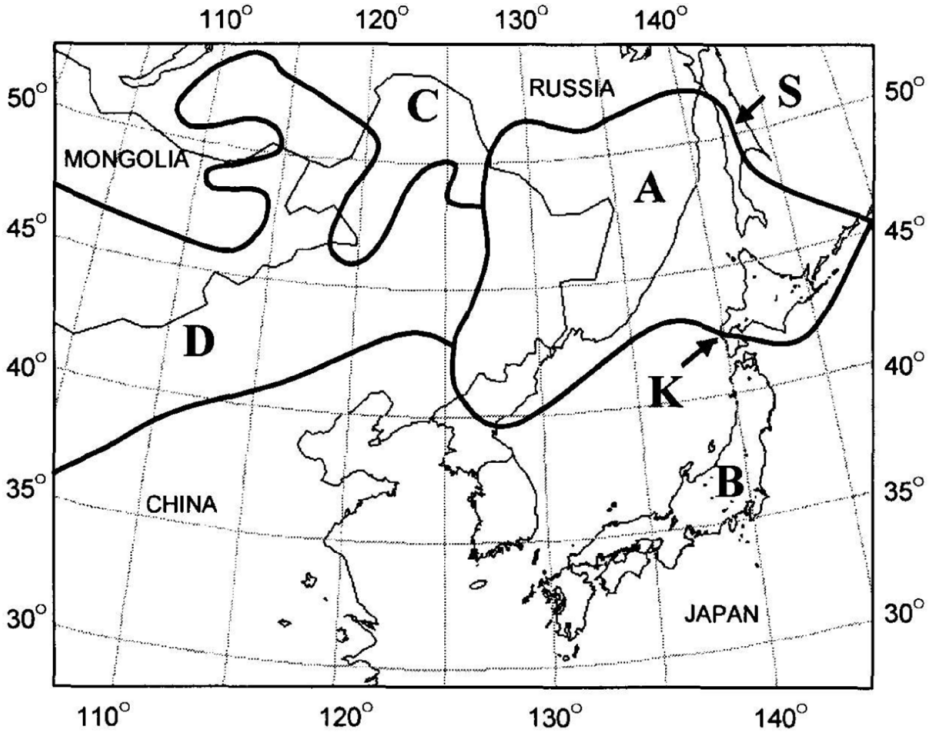

Fig. 1. Pan-mixed conifer broad-leaved forest zone in northeast Asia. A – Pan-mixed conifer-broad-leaved forests, B – Temperate forests, C – Siberia sub frigid forest, D – Steppe in central Asia, K – The Koromatsunai low land [after Matsuda *et al.* 2002]
Ryc. 1. Strefa mieszanego lasu iglasto-liściastego w północno-wschodniej Azji. A – mieszane lasy iglasto-liściaste, B – lasy umiarkowane, C – subpolarny las syberyjski, D – step w Azji centralnej, K – nizina Koromatsunai [Matsuda i in. 2002]

Fig. 2. Dense *Sasa* bamboo in a mixed fir-bass wood stand. Height of the researcher is 172 cm (photo by K. Takagi)
Ryc. 2. Gęste zarośla bambusowe *Sasa* w mieszanym drzewostanie jodłowo-lipowym. Wysokość badacza wynosi 172 cm (fot. K. Takagi)

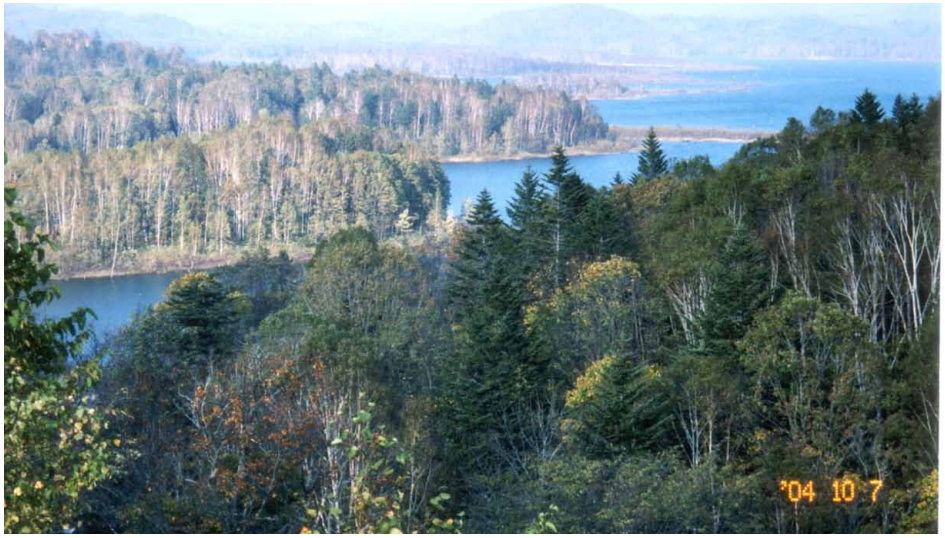

Fig. 3. A view of Lake Shumarinai and Uryu Experimental forest of Hokkaido University as a result of management based on forest aesthetics (photo by T. Koike)
Ryc. 3. Widok na Jezioro Shumarinai i Las Doświadczalny Uryu Uniwersytetu Hokkaido jako rezultat zagospodarowania opartego na estetyce lasu (fot. T. Koike)

Fig. 4. A bulldozer eliminates the dwarf bamboo of *Sasa* sp. and fungi of shoot blight disease from forest floor for accelerating regeneration of trees (photo by staff of The Uryu Exp. Forest)
Ryc. 4. Buldożer usuwający karłowate bambusy *Sasa* sp. i grzyby powodujące rdzę pędów z dna lasu, aby przyspieszyć odnowienie drzew (fot. pracownicy Lasu Doświadczalnego Uryu)

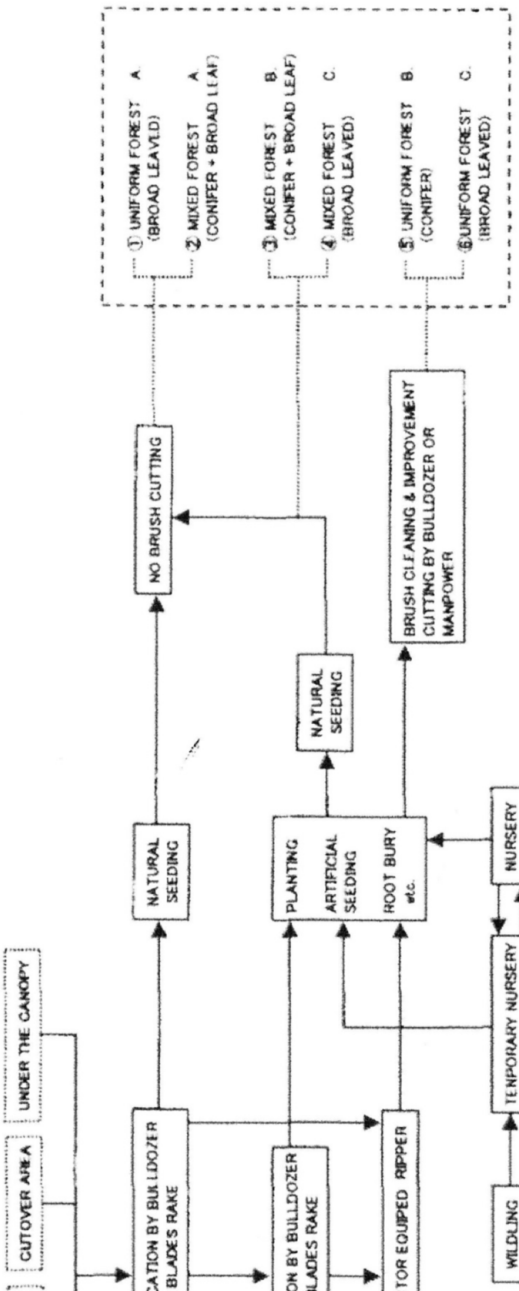

Fig. 5. Silviculture system of Hokkaido University Forests in Hokkaido Island. We use a bulldozer with rakes for site preparation to eliminating *Sasa* sp. A bulldozer is again used to press roots and sprouts of invading birches and brush to reduce competition between species, especially between lines of fir planting. We expect the recovery of small dwarf bamboo to avoid brushes before planted spruce will reach the height of surrounding plants. [after Matsuda et al. 2002]

Ryc. 5. Zagospodarowanie Lasu Uniwersytetu Hokkaido na Wyspie Hokkaido. Używamy buldożera z grabiami do przygotowania powierzchni i wyeliminowania *Sasa* sp. Buldożer jest ponownie stosowany w celu zgniecenia korzeni i pędów inwazyjnych brzóz i krzewów, aby zmniejszyć konkurencję międzygatunkową, przede wszystkim między rzędami sadzonej jodły. Spodziewamy się niewielkiego odnowienia karłowatych bambusów, co pozwoli uniknąć zakrzaczenia przed osiągnięciem przez świerk wysokości otaczających roślin [Matsuda i in. 2002]

Fig. 6. Typical example of natural regeneration of spruce in a secondary forest in deep snow region of Hokkaido (photo by T. Koike). The damping off disease in seedlings caused by the fungi *Rhacodium therryanum* (by courtesy of K. Tanaka)
Ryc. 6. Typowy przykład naturalnego odnowienia świerka w śnieżnym regionie Hokkaido (fot. T. Koike). Zamieranie siewek spowodowane przez patogena *Rhacodium therryanum* (dzięki uprzejmości K. Tanaka)

Fig. 7. Overview of a new plantation of *Sasa* sp. dominate secondary stand with hybrid larch F_1 (yellow). We remain trees growing on slopes for the trap of absorbing extra-nitrogen in order to stop nitrogen contamination to stream (photo taken from a 40 m flux monitoring tower by T. Koike).
Ryc. 7. Widok na nową plantację *Sasa* sp. dominującą wtórny drzewostan modrzewiowy (hybryda F_1, żółty). Pozostawiamy drzewa rosnące na zboczu jako pochłaniacze nadmiernej ilości azotu, aby zatrzymać zanieczyszczenie azotowe strumienia (zdjęcie zrobione z 40-metrowej wierzy monitorującej przepływ, fot. T. Koike)

Fig. 8. Lectures in a forest using field notes. A view of summer course of field symposium (photo by K. Takagi)
Ryc. 8. Wykłady i notatki w lesie. Sympozjum i kurs letni (fot. K. Takagi)

Fig. 9. Discussion in front of name plates of trees for international students as a part of establishing „Eco-Campus" project (photo by T. Koike)
Ryc. 9. Dyskusja naprzeciwko tabliczek z nazwami drzew dla studentów zagranicznych w ramach projektu „Eco-Campus" (fot. T. Koike)