

# A COMPARATIVE STUDY OF REFORESTATION CONCEPTS IN JAPAN: PLANTING FOR EROSION CONTROL AND PLANTING FOR TIMBER

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## Сравнительный анализ концепций лесовосстановления в Японии: посадка для борьбы с эрозией почв или искусственная посадка

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There are two kinds of thinking concerning plantation in Japan. One is based on the idea of preventing natural disasters by planting trees; virgin forests on mountains were cut recklessly over a wide area resulting in tree-less mountains, a large quantity of earth and sand flowed away, and sediment disasters occurred downstream of rivers, resulting in the loss of many human lives and properties. To prevent such natural disasters, trees have been sequentially planted in disaster-prone areas for many years to increase safety in downstream areas. The other is based on the idea of raising trees as building timber. After cutting virgin forests, saplings, selected for their usefulness are planted and cultivated for many years until they grow to a certain size suitable for cutting as building timber. Taking Mt. Tanakami in Shiga prefecture and the Kitayama area of Kyoto prefecture as representative examples of planting for erosion control and disaster prevention, and planting for timber with a commercial purpose, this study aims to compare sociological and engineering significance from the point of view of history, method, and types of tree and their effectiveness, in order to clarify the co-existence of human beings and nature from the viewpoints of nature conservation and cultural value and to shed light on the importance of nature conservation.

В Японии сосуществуют два типа мышления в отношении восстановления лесов. Одно основано на идее предотвращения природных бедствий путем посадки деревьев. Если девственные леса безрассудно вырезаны на обширной территории, большое количество земли и песка мигрирует с гор вниз по течению рек (сели), то приводит к человеческим жертвам и потере имущества. Чтобы предотвратить такие стихийные бедствия и повысить безопасность в районе ниже по течению, деревья высаживаются в угрожаемых селями районах на протяжении многих лет. Другое направление основано на идее рекультивирования лесов как строительного материала. После посадки саженцев с учетом их полезности они культивируются в течение многих лет, пока не вырастут до определенного размера. В качестве примера посадок лесов для борьбы с эрозией и предупреждению стихийных бедствий, а также посадок для культивирования и производства промышленной древесины представлен опыт лесовосстановления в горах Танаками в префектуре Сиги и район Китаями префектуры Киото. Исследование выполнено с целью анализа социальных и инженерных последствий двух стратегий лесовосстановления с учетом исторических аспектов, методов строительства, типов лесов и их эффективности. Анализируется важность сосуществования человека и окружающей природной среды в перспективе охраны природы и культурных ценностей.

### Introduction

Japan is located in the east of the Eurasian Continent and has been called the Far East from ancient times. Its land area, consisting of four rather large islands and thousands of small ones is 378,000 km<sup>2</sup> and is long in the north to south direction and thin in the east to west direction. Topographically, there are many precipitous mountains which descend to the shores, while inland basins in the mountain areas contrast with plains in the lower reaches of rivers. The climate is mild, ranging from cool temperate to subtropical zones. The average annual temperature of the Kyoto region, the study area, is around 15 degrees Celsius. As it lies in a monsoon zone, typhoons occur from summer to autumn, the moist southeast wind blowing from the Pacific Ocean brings much rain in summer and the cold northwest wind from the Eurasian

Continent causes snowfall in winter. Annual precipitation in the Kyoto region is around 1,500 mm [1, 2].

Thus, as an archipelago stretching from north to south blessed with a temperate climate, Japan is well suited for growing trees, and 66 percent of its land area is covered with various kinds of forests of broadleaf, evergreen and deciduous trees. However, typhoons and heavy rains often strike the forests causing natural disasters such as wind damage, floods, sediment flows and landslides, therefore various projects to restore and reproduce forests and to prevent disasters have been repeatedly organized.

From ancient to modern times, rich and varied forests in Japan have been important natural resources and provided the timber, fuel and fertilizer needed for people's lives. There are two kinds of symbiotic relationship between forests and human beings in Japan.

One is a symbiotic relationship between natural forests and human beings. The forests were maintained, not in a laissez faire manner, but under rules which were agreed and established among inhabitants for their use. This is because, if the forests were over-cut they would be devastated thereby destroying the symbiosis among creatures living there and the metabolic cycle of the forests, and the people could not enjoy the benefits which have periodically, cyclically and secularly been brought by them. As an instructive example between natural forests and human beings, I will introduce the planting project for erosion control on Mt. Tanakami in Shiga prefecture where, after the reckless cutting of magnificent forests, people have struggled against natural disasters and tried to regenerate greenery for hundreds of years.

The other is a symbiotic relationship between artificial planting for timber and human beings. This is based on the idea of reclaiming mountains to raise and harvest a specific kind of tree in response to the need for building timbers. I will introduce the project of artificial planting of Japanese cedar (*cryptomeria japonica*) in northern Kyoto.

This case study aims to analyze the symbiotic relationship between forests and human beings from the viewpoints of natural conservation and cultural value and to consider the importance of natural environment conservation, through a comparative study of the above-mentioned two cases.

### Planting project for erosion control on Mt. Tanakami

**History of forest devastation and erosion control.** The Tanakami mountain area is located almost in the center of Honshu, the biggest island of Japan, in the south east of Shiga prefecture, and near Lake Biwa, which has an area of 674 km<sup>2</sup>, and is the biggest lake in Japan.

One thousand and several hundred years ago, the entire area of Mt. Tanakami consisted of virgin forests, was one of the most beautiful forests in Japan and produced valuable timber. Devastation of the beautiful forests gradually advanced due to natural conditions of climate and geology as well as repeated human-induced activities, which began with massive logging, principally of Japanese cypress.

First, in the late 7<sup>th</sup> century, using building timbers logged on Mt. Tanakami, Fujiwara-kyo was built in present-day Nara prefecture. Of course there were forests in the vicinity of the Fujiwara-kyo building site, but it is estimated that the reason why the timbers of far distant Mt. Tanakami were selected lay in the fact that it produced superior high-quality building timbers. It is also estimated that in those days, as the capital of Japan was repeatedly relocated, forests were often cut to build palaces and government offices.

In the early 8<sup>th</sup> century, the capital was moved from Fujiwara-kyo to Heijo-kyo which is present-day Nara, the

ancient capital city. In those days, Buddhism was introduced to Japan via Korea and China and many huge Buddhist temples were built as symbolic representations. The still existing seven large temples and many others in the southern capital, Nara were built, and the large amount of timber needed for their construction was taken from the forests in Shiga prefecture.

In the mid-eighth century, Ishiyama temple, connected to Murasaki Shikibu, the author of the Tale of Genji was built in Shiga prefecture using timber from Mt. Tanakami. Also when Enryakuji temple was constructed on Mt. Hiei located northeast of Kyoto, timber was taken from Mt. Kohga located east of the Mt. Tanakami area.

It is estimated from ancient documents and the remaining forests that the trees massively logged on Mt. Tanakami and Mt. Kohga were Japanese cypress, cedar, oak and chinquapin.

Besides being massively logged for timber, the forests on Mt. Tanakami were used for firewood, charcoal, fertilizer and animal feed. In the Shigaraki region near Mt. Tanakami, high quality clay of weathered granite was produced, pottery production flourished through the ages, and forests were used to provide fuel for firing the Shigaraki pottery, which adopted the name of the region.

In the Edo period (1603—1868), traffic networks were developed, a commodity economy grew, and forests were reclaimed to make tea plantations and rice fields, resulting in their further devastation. Due to such devastation, sediment flow from the mountains increased, riverbeds were elevated and flood damage increased in every heavy rain. To protect forests and prevent sediment disasters, a forest policy was planned and strictly carried out. Concretely, not only cutting trees was prohibited, but also, because the forest as a recycling source was a base for life and production in the Edo period and important for erosion control, earth retaining work and reforestation were carried out on Mt. Tanakami. However, there were periods when forest protection regulation relaxed and the forest devastation and sediment flow on Mt. Tanakami continued.

With such a situation as a background, in the Meiji era (1868—1912), the so called Three Flood Control Laws were established; the River Act in 1896, and Forest Act and Sand Control Act in 1897, which have continued to today [3].

**Methods and effects of planting for erosion control.** In order to recover and regenerate the forest and to promote soil and water conservation on devastated land and tree-less mountains, fundamentally there are two kinds of construction work; one is torrent control works to prevent sediment flow and the other is hillside work to promote reforestation on hillsides. Here I will consider the latter of reforestation.

During the Edo period, in order to recover the forest and prevent sediment flow on vast devastated land and tree-less mountains on Mt. Tanakami, various methods of hillside work to prevent surface soil weathering

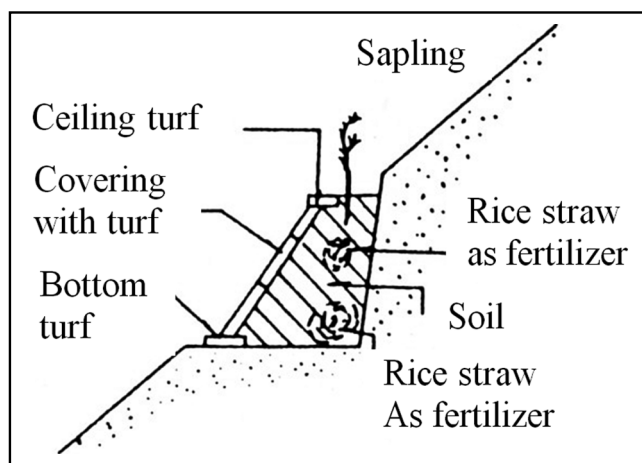


Fig. 1. Terrace work with turf. \*Reference [3].

and erosion and collapse from spreading and to control sediment occurrence and flow by tree planting were developed, in addition to the limitation and prohibition of cutting timber. The methods developed for soil retaining work and tree planting were based on agricultural production, and through a process of trial and error, were improved as effective methods and have been passed down to the present. One is the 'terrace work with turf' method by the Japanese engineer, Yoshikata Ichikawa. He devised this method taking scientific, technical and rational suggestions from Dutch engineers, Cornelis Johannes van Doorn and Johannes de Rijke who had been invited to Japan by the Meiji government. This method is based on three fundamental ideas; to provide a sufficient volume of forest floor for root system development, sufficient water for plant growth, and fertilizer to correspond with the stages of growth.

The method of 'terrace work with turf' is to reclaim mountain slopes horizontally in a staircase pattern following the contours of the land. Blocks of soil containing the roots of plants were piled up to form a retaining wall, and the terrace inside the wall was refilled using the original soil, based on the expectation that grasses and plants would grow there. However, as satisfactory results did not occur, turf was used instead of the blocks of soil. Rice straw might also be used instead of turf, being called 'terrace work with rice straw'. Figure 1 shows the terrace work with turf.

Terrace work was attempted using turf and saplings of Japanese black pine (*pinus thunbergii*), but did not yield a good result as this species did not grow well when the soil became short in nutrients. It then became clear that *alnus pendula* is well suited for denuded land and in addition, its artificial cultivation became possible. The mixed planting of black pine and *alnus pendula* was tried and found to suit the climate on Mt. Tanakami. Today these two kinds of trees are planted as saplings.

Such hillside repair work reduced the amount of sediment production, improved the growth of saplings,



Before construction



After construction

Fig. 2. Example of hillside work. \*Reference [3].

and regenerated and brought back greenery on devastated land and tree-less mountains. An example of hillside repair work is shown in Figure 2.

### Artificial planting of 'Kitayama cedar' (*Cryptomeria japonica*)

The low-mountain area north of Kyoto city is called Kitayama (northern mountain). Kitayama cedar is planted and produced in the area, which is located about eight kilometers northwest of Kyoto city. What makes it different from Japanese cedar cultivated in other areas is that, as the tree grows, almost all unnecessary branches are cut off leaving only those near the top so that the form of the tree resembles that of the decorated float 'yamaboko' of the Gion Festival. As shown in Figure 3, the scenery of Kitayama, consisting of rows of aligned cedar stretching straight to the sky is impressive and a source of aesthetic satisfaction. The village which produces the Kitayama cedar was the setting for «Koto» or «The Old Capital», a novel by Yasunari Kawabata, one of Japan's Nobel Prize winners for literature.



Fig. 3. Scenery with Kitayama Cedar. \*Reference [7].

The demand for Kitayama cedar dates back to the late 8<sup>th</sup> century. In 794 A. D. when the capital of Japan was transferred to Heian-kyo (the present-day Kyoto), Kitayama cedar on the outskirts of the city was cut as building timber for palaces. Later, along with the development of the city, the area became a supply area for firewood, charcoal and timber. In the 16<sup>th</sup> century when the tea master, Sen no Rikyu spread the tea ceremony, the demand for Kitayama cedar increased as building timber for tea-ceremony rooms, and the artificial planting of Kitayama cedar, which is said to have begun around the 14<sup>th</sup> century flourished. The reason why Kitayama cedar was used and highly appreciated as timber for tea-ceremony rooms and palaces laid in its excellent features such as straight growth, while its white wood surface consisted of fine tissues, and was shiny and fragrant.

Kitayama cedar is divided broadly into two groups; 'taruki' or roof rafter and 'maruta' or log. The roof rafter is produced from a short timber grown on a cedar stump called «Dai sugi» or parent cedar. Its shape resembles candles in a candleholder. This 'cedar stump' method is unique to the Kitayama area.

The log can be further divided into 'nami-maruta' or regular log with a smooth surface and 'shibori-maruta' or log with a gently welted surface. The latter is a local specialty of the Kitayama area, and is a log with a gently undulating welted surface forming smooth concavo-convex patterns, as shown in Figure 4. The log with an undulating welted surface is expensive and highly appreciated because no same patterns can be produced. In Japan, the log has been used since old times as a special post for the alcove in a tea-ceremony room or guest room where flower arrangements, paintings and antiques are placed to entertain guests [4].

Among logs with a welted surface, there are those that are formed naturally and others with artificially formed welts. Those with welts could be produced naturally, while a technique to artificially form them was introduced and has since been commonly used.

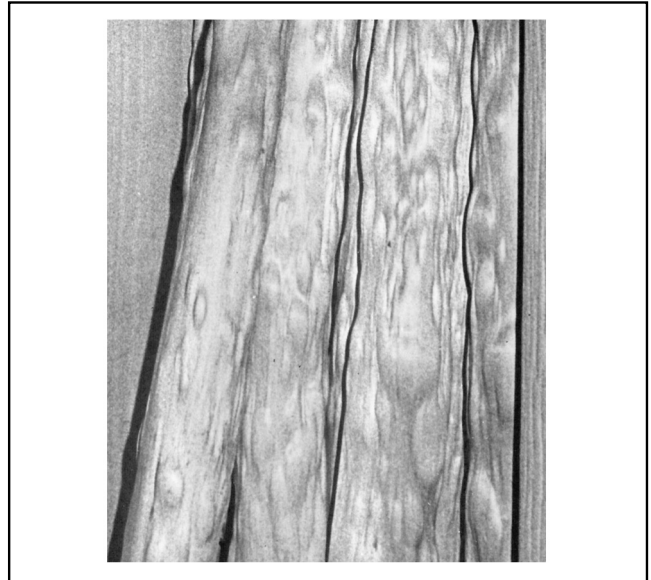


Fig. 4. Logs with softly welted surfaces. \* Reference [8].

Such a high-grade log is produced by approximately the following process. First, the sapling is planted on a mountainside at approximately two-meter intervals, and to encourage its growth, the weeding of grasses and brush is periodically carried out. After a lapse of 8—10 years following planting, branches are completely cut off leaving the treetops to produce a straight, dense, gnarl-less and full-rounded log. In a year before harvesting, branches on the treetop are trimmed leaving 3—5 cm branches from the trunk to control the growth. Mature trees are cut, dried in the shade of the forest, and conveyed to the village.

The bark of the harvested log is removed with a wooden or plastic spatula and the astringent skin scraped off with a knife. The denuded log is roughly polished with chalky clay taken from the Bodai waterfall basin and then elaborately and beautifully polished to a finished product.

In order to form artificial welts, bamboo or plastic sticks are attached vertically to the trunk to form patterns with the help of the tree's growth. In the Kitayama area, this method was introduced in the 1920's [5, 6].

In Kitayama village, taking advantage of its closeness to Kyoto city, which has a strong demand for high-grade timber, people have made their living by producing and selling high-value added logs and rafters and purchasing foods and daily commodities.

### A comparative consideration of planting for erosion control and planting for timber

So far, I have written about the planting for erosion control on Mt. Tanakami and the artificial planting of Kitayama cedar. Here I would like to compare the reforestation concepts between the two and summarize the differences in their underlying concepts and the relationship with human beings.

### 1) Differing view of nature

The reforestation for erosion control on Mt. Tanakami aims to recover and regenerate forests by the mixed planting of Japanese black pine and *alunus pendula* on a mountain which was once covered with magnificent forests and became tree-less through destructive lumbering. This is based on the concept of considering the forest as a 'stock resource', while regenerating the verdant mountain by planting trees, although their species are different from those in the original beautiful forest, in order to recreate the 'home' landscape of the region.

The artificial planting of Kitayama cedar aims to recreate forests as in the case of Mt. Tanakami, but it is a business undertaking as a part of living activities through forestation of the specific tree selected for commercial benefit. Its aim is to create economic forestry by planting, but does not expect to regenerate the natural environment of forests, and considers the forest as a flow of resources.

The reforestation concepts in these two cases differ regarding their view of nature; In the case of Mt. Tanakami, the aim is to regenerate a natural environment suitable to the climate of the area, while in the case of Kitayama cedar, the aim is to create an economic resource by means of an artificial forest.

### 2) Differing view of the symbiotic relationship

The reforestation for erosion control on Mt. Tanakami involves planting trees on the innutritious mountains, aiming not only to recover the forests through a long period of tree-care, but also to control sediment flow from the mountains, to prevent sediment disasters and to protect human lives and assets. This is a project to make disaster prevention effective and improve regional safety by reforestation for erosion control.

On the other hand, the artificial planting of Kitayama cedar is a project that expects economic effectiveness by promoting the forestry industry, for which the village, to be economically self-sustainable, produces high-value-added timber with elaborate tree-care lasting as long as approximately 30—40 years.

Planting on Mt. Tanakami has a symbiotic relationship between nature and humans with a focus on

safety, by recovering forests, preventing natural disasters and ensuring a less threatening living environment, while the planting of Kitayama cedar has a symbiotic relationship between nature and humans with a focus on economic efficiency, by taking systematic care of growing trees and producing high-quality timber to meet consumer needs.

### 3) The common reforestation effect

Planting for erosion control on Mt. Tanakami is a long-term reforestation project for all the denuded mountains, while the artificial planting of Kitayama cedar is a project to grow trees in a particular area of hillsides. The aim of these two projects is different as mentioned above; the former is permanent greening to yield the natural scenery of forests and mountains, while the latter is greening for a certain period of growing trees to yield a forest scenery with a single species of trees standing in neat rows. The latter especially, is seen in many photo albums and travel guides as well as in novels. Based on this it is estimated that the natural beauty brought by forests provides people with spiritual stability.

## Conclusion

In this study, I have introduced two representative examples of planting for erosion control and artificial planting for timber, and clarified the differences and common points between them. The results of these case studies may not be adaptable to all other such cases, but as a historical lesson from Mt. Tanakami, it is important to positively plant trees on devastated tree-less land and to make efforts to recover and regenerate the forest environment as well as to control development and conserve such environments throughout the world. The example of Kitayama cedar teaches us that the appropriate management of forests enables economic self-reliance and sustains people's livelihood. Both represent human wisdom to be inherited for generations.

From now on I would like to advance my studies through further analysis of cases related to the regeneration and recovery of the forest environment.

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