Case 1
Matsuki Hillside Work

The mountains upstream from the Ashio Check Dam in the highest section of the Watarase River are now reddish-brown mountains covered with exposed topsoil without grass or tree covering as a result of repeated forest fires and smoke damage caused by the large quantity of sulfite acid gas emitted by Ashiozakuran Mine and by uncontrolled cutting to obtain wood to make charcoal and for use as railway supporting materials. In these mountains, surface soil containing organic material has been washed away, eliminating their moisture and fertilizer retention capacity as a result of the intense weathering. The objective of the project is to improve the environmental conditions of the area by reforestation, rehabilitation, and land management. The project encompasses the entire area upstream from the Ashio Check Dam, including the grinding of the surface soil layer and spraying of the underlying rock surface to promote plant growth.

- Purpose of improvement: Reforestation of deforested ground
- Geology: Melancon layer zone
- Soil: Conglomeratic soil, rock
- Execution location: Tochigi Pref., Kamisouta-gun, Ashio-machi
- Work method, form: Earth moving work, Transplanting work, spraying deep layer base material
- Slope direction: SW
- Gradient: Average gradient 30°
- Jurisdiction: MLIT, Kanto Regional Development Bureau, Watarase River Office
- Execution years: 1988 to present day

Table 1: Types and density of the vegetation introduced

<table>
<thead>
<tr>
<th>Name</th>
<th>Part where deep layer base material was sprayed</th>
<th>Rejection rate of work site (winter)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Kentucky 31 fescue</td>
<td>0.02</td>
<td>2.00</td>
</tr>
<tr>
<td>Orchard grass</td>
<td>0.01</td>
<td>0.90</td>
</tr>
<tr>
<td>Creeping red fescue</td>
<td>0.02</td>
<td>0.75</td>
</tr>
<tr>
<td>Chees grass</td>
<td>0.02</td>
<td>0.75</td>
</tr>
<tr>
<td>Japanese mugwort</td>
<td>0.04</td>
<td>0.70</td>
</tr>
<tr>
<td>Shrubby lomatia</td>
<td>0.07</td>
<td></td>
</tr>
<tr>
<td>Fatigue</td>
<td>0.48</td>
<td>0.70</td>
</tr>
<tr>
<td>Alder</td>
<td>0.04</td>
<td></td>
</tr>
<tr>
<td>Total</td>
<td>0.62</td>
<td>5.22</td>
</tr>
</tbody>
</table>

Advice from Professor Ota

Concerning the soil
There was fear that heavy metals in the soil at this location would obstruct the growth of vegetation. It is assumed that soil dressing is effective in such cases, but the deep layer base material spraying method that is now used can only guarantee soil to a depth of 10cm, so that it is difficult for tall trees to take. To be sure that tall trees will take, from 30 to 50cm of soil is necessary, and considering the slope gradient, it is difficult unless terraces are cut into the slope.

Concerning rock revegetation
Revegetation of rock often creates unnatural scenery, so its use must be studied carefully. A method often used to prevent rocks from falling when performing work at the bottom of a slope is to spread net work over the exposed rock at the top of the slope, but simple revegetation to prevent this should be avoided.
Mt. Oya is the source of the Abe River and the site of the Oya Slide, one of Japan's three most massive slides. The Oya Slide, a massive mass occupying 1.8 km² with a width of 1.8 km and an elevation difference of 500 m, is estimated to have discharged 120 million m³ of collapsed soil. The geology in this zone is characterized by layers of shale and sandstone in the Paleogene period, with rockslides caused by faults and folds produced by structural movement. The area is severely cracked and landslides have advanced. The area was declared a seismic zone in 1979. In 1997, the sediment at the bottom of the slope caused a severe landslide. The 1997 landslide triggered a severe disaster by the large earthquake in 1995.

The Oya Slide work was undertaken to stabilize the unstable north-south slope on the collapsed ground. Because vegetation can be restored by artificial introduction and vegetation introduction technology is established, this is considered a model for the application of the method. The work was undertaken to stabilize the unstable north-south slope on the collapsed ground. Because vegetation can be restored by artificial introduction and vegetation introduction technology is established, this is considered a model for the application of the method. The work was undertaken to stabilize the unstable north-south slope on the collapsed ground. Because vegetation can be restored by artificial introduction and vegetation introduction technology is established, this is considered a model for the application of the method. The work was undertaken to stabilize the unstable north-south slope on the collapsed ground. Because vegetation can be restored by artificial introduction and vegetation introduction technology is established, this is considered a model for the application of the method. The work was undertaken to stabilize the unstable north-south slope on the collapsed ground. Because vegetation can be restored by artificial introduction and vegetation introduction technology is established, this is considered a model for the application of the method. The work was undertaken to stabilize the unstable north-south slope on the collapsed ground. Because vegetation can be restored by artificial introduction and vegetation introduction technology is established, this is considered a model for the application of the method. The work was undertaken to stabilize the unstable north-south slope on the collapsed ground. Because vegetation can be restored by artificial introduction and vegetation introduction technology is established, this is considered a model for the application of the method. The work was undertaken to stabilize the unstable north-south slope on the collapsed ground. Because vegetation can be restored by artificial introduction and vegetation introduction technology is established, this is considered a model for the application of the method. The work was undertaken to stabilize the unstable north-south slope on the collapsed ground. Because vegetation can be restored by artificial introduction and vegetation introduction technology is established, this is considered a model for the application of the method.
Case 3
Tanakami Hillside Work

Outline
More than one-thousand years ago, the Tanakami Mountain zone was a vast beautiful forest of Japanese cypress, Japanese cedar, and evergreen oaks. Later during the Asuka and Nara Periods (seventh century), the arrival of Buddhism and the continental culture spurred the establishment of palaces, shrines, and temples, requiring that vast numbers of Japanese cedar and other trees be cut and transported by water to locations where they were used as lumber. In this way, a primary beautiful forest of Japanese cedar and evergreen oaks was replaced by secondary forest (pines). Later as the arts and crafts advanced, pine was cut excessively to provide fuel to make ceramics. And as a key point on transportation routes, the province of Cmi was at the center of frequent wars accompanied by attackers burning the enemies' farms and setting continuous forest fires. Because the geology of the Mt. Tanakami region consists of deep layers of weathered granite, once its trees were removed by the above actions, every rainy run-off its surface soil, increasing the destruction of its land. By the sixteenth century, the sides of the mountain were so completely devastated that not one tree remained, inflicting the downstream residents with constant sediment disasters. Mt. Tanakami has been revegetated and hillside work done to stop surface erosion from running off sediment. Tanakami hillside work projects have been underway to more than 120 years beginning in the late nineteenth century. Sediment production source measures have been extremely effective, and the methods used have matured. The methods used have been earth retarding work, hillside terracing work as Mt. Iwate restoration work, and hillside terracing work, straw seeding, terracing work, sod wheeled terracing work, covering work (slope revegetation), transplanting work (black pine, Himyashahsushi adler), and as a way of encouraging the growth of dwellings after transplanting, hillside tending method A and B have been established. And to guarantee that the sediment production reduction measures continue to be effective far into the future, it is essential to transform it from a forest consisting of only pine trees to a forest physiognomy that will not cause it to return to its devastated condition.

Purpose of Improvement
- Revegetation of deforested ground

Geology
- Granite zone

Soil
- Weathered rock

Execution location
- Otsu City, Shiga Prefecture

Work method, form
- Earth retarding work
- Hillside terracing work (for details see the standard section), transplanting work

Slope
- Direction: All directions
- Gradient: -

Jurisdiction
- MLLT, Kita Regional Development Bureau, Iwashio River Office

Execution years
- 1975 to the present

Location map
- Fukui Prefecture, Kyoto Prefecture, Shiga Prefecture, Aichi Prefecture, Mie Prefecture, Kure Prefecture, Hino Prefecture, and Nara Prefecture

Standard cross section
- Black pine 1.25m - 2.5m
- Himyashahsushi adler 2.5m - 6m

Execution site (Izumi River on the Yodogawa River System)
- Transplanting work (black pine 1, Himyashahsushi adler 2)
- Transplanting work (black pine, Himyashahsushi adler)
- Transplanting work (black pine, Himyashahsushi adler 2)
- Existing seeding terracing work

Execution site 2
- After execution

Execution site 3
- Before execution

Tending method A
- After transplanting, the Himyashahsushi adler is transplanted to a height between 6.5 and 0.7m in the 4th, 7th, and 10th years to encourage sprouting and prevent them from overmatting the pines.

Tending method B
- The roots of the existing trees are transected and end fertilized.
The mountains in the Kizu River Basin were once covered with huge luxuriant forests, but the advance of civilization destroyed them as, during the Nara Period in particular, unrestricted cutting to obtain lumber to build temples and shintos desolated the land. As the deforested area expanded to 4,500 hectares, the sediment runoff from its surface caused frequent disasters in the downstream river basin. To resolve this problem, beginning in the late nineteenth century, the government undertook saba projects consisting mainly of hillside work to revegetate the deforested land. By 1969, hillside work had been completed on 2,600ha in the Kizu River Basin.

But in the upstream Kizu River Basin, torrential rainfall including that brought by the Ise Bay Typhoon in 1959 collapsed slopes at many places (2,498) because of the granite topography in the region. Many of these were extremely small with surface areas less than 0.1ha on steep mountain slopes with gradient between 30 and 45° where work conditions are poor. The Upstream Kizu River Office has executed hillside works (sabas) consisting of works to stabilize hillside slopes by using gravity concrete retaining walls and concrete secondary products etc., but it has faced cost problems and difficult execution issues. It has developed hillside work reduction methods based on the concept: stop the movement of sediment on the surface and then perform gran sabas that do not require the use of concrete. It is an economical easily executed method that prevents the movement of sediment by combining thinned Japanese cedar and Japanese cypress logs and anchoring them to the slope with wooden slat.
Rokkozan Chain Green Belt

Outline

In the late decades of the nineteenth century, the forests on the Rokkozan chain were devastated by unrestricted cutting of trees to obtain firewood. The slopes of the Rokkozan chain were naturally prone to collapse, because they consist mainly of granite and many of their slopes are extremely steep. Exposed to wind and rain, their devastation continued with every intensive rainfall causing disasters. Sabo projects that were started in 1993 to protect the city from sediment disasters have now restored their vegetation. But the trees on the Rokkozan chain include not pine and black locust (Robinia pseudo-acacia) that die very easily; a situation detrimental to sediment disaster prevention. But because the Rokkozan chain is located directly beside the city and is closely related to the lives of its residents, it is essential to not only provide protection from sediment disaster originating on its slopes, but to guarantee other functions including permitting its recreational use. The Rokkozan Chain Green Belt Project positions the slopes facing the city in urban plans as districts where particularly agricole measures are necessary, and at the same time, provide groves on the Rokkozan chain to create forests that fill four functions: (1) preventing sediment disasters, (2) preventing urban sprawl, (2) conserving and nurturing a good quality urban environment, elegant scenery, ecosystem, and biodiversity, and (4) providing suitable places for recreation. To carry out a green belt development, the first step is to undertake agricole measures utilizing civil engineering structures with top priority on preventing sediment disasters caused by the collapse of slopes. A forest consisting of only a single species of tree, katsuura kera etc., is transformed to a forest with a developed stratified structure and a mixture of various species of trees of diverse age, by providing and managing its trees. Where good quality trees are now growing, they are conserved and further improved by carrying out regular inspections of these locations and cutting weeds or thinning trees as necessary.

<table>
<thead>
<tr>
<th>Purpose of improvement</th>
<th>Replace trees that obstruct disaster prevention with trees that effectively prevent disasters.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Geology</td>
<td>Granite zone</td>
</tr>
<tr>
<td>Soil</td>
<td>Weathered rock</td>
</tr>
<tr>
<td>Execution location</td>
<td>Kobe City, Hyogo Prefecture</td>
</tr>
<tr>
<td>Slope Direction</td>
<td>SE – SW</td>
</tr>
<tr>
<td>Gradient</td>
<td>-</td>
</tr>
<tr>
<td>Jurisdiction</td>
<td>MLIT, Kinki Regional Development Bureau, Rokko Sabo Office</td>
</tr>
<tr>
<td>Execution years</td>
<td>1997 – present (Manual from 2000)</td>
</tr>
</tbody>
</table>

Need for and purpose of forest phytogonmy transformation and tree introduction

Replace trees that now harbor sediment disaster prevention (communities of Japanese cedar, Japanese cypress, communities of eucalyptus and non-native (Picea glauca var. viridis), communities of black locust (Robinia pseudo-acacia), etc.) by introducing and managing trees that effectively prevent sediment disasters.

Target forest

Forest with a developed stratified structure and a mixture of various species of trees of diverse age. The tentative target is to replace the nezaka (Picea glauca var. viridis), communities of black locust (Robinia pseudo-acacia) forest that are now introduced with a secondary forest consisting of deciduous broad-leaved trees (setting goals in stages).

Cutting

Japanese cedar and Japanese cypress groves. Thinning 20 to 30% (Picea glauca var. viridis) and black locust (Robinia pseudo-acacia) groves. Completely cutting the nezaka (Picea glauca var. viridis) and black locust (Robinia pseudo-acacia) in belts.

Forest phytogonmy transformation and tree introduction methods

Transplanting

<table>
<thead>
<tr>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Japanese zelkova</td>
<td>(transplanted bare root)</td>
</tr>
<tr>
<td>Japanese oak</td>
<td>(transplanted bare root)</td>
</tr>
<tr>
<td>Japanese larch</td>
<td>(transplanted bare root)</td>
</tr>
<tr>
<td>False larch</td>
<td>(transplanted bare root)</td>
</tr>
</tbody>
</table>

Weeding and brushing

Once or twice a year, cutting bamboo grass, cutting black locust (Robinia pseudo-acacia) sprouts.

Management method

Thinning

Done as necessary. Scheduled to be done as necessary with reference to the staged target (10 years in the future for example).

Fertilizing

Not done. Scheduled to be done as necessary with reference to the staged target (10 years in the future for example).

Follow-up survey

Done starting in 2001
- Height, branch spread, tree vigor of transplanted trees
- Starting in 2002, measurement of surface erosion of soil by tree type based on whether the forest is or not managed.
- It is important to process the sprouts of black locust (Robinia pseudo-acacia) and to cut the nezaka (Picea glauca var. viridis).
- Because locations where forest phytogonmy transformation is done are temporarily conspicuously almost completely bare of vegetation, it is necessary to explain the need and effectiveness of the project to residents to gain their understanding.
- It is necessary to establish a stable seedling supply system in the region.

Challenges

Planning forest phytogonmy transformation and tree introduction (manual, guideline, etc.)

Rokkozan Green Belt Forest Improvement Manual (Rokko Sabo Works Office, 2000)
Dashidaira Revegetation Work

Outline

Work on the Oozawa Hydroelectric Power Station was started in September, 1982 by the Kansai Electric Power Company and started full operation 3 years later on September 27, 1985 as a result of the work of 900,000 people. Developed based on the concept of integrated river system development, it is designed to control the outflow of the upstream area. The maximum output of 124,000 kilowatts is the largest in the river system following the Kurobe No. 4 Power Station. It takes in a maximum of 74m^3/sec of water from the Dashidaira Dam, a concrete gravity dam with total height of 70.7m constructed at Dashidaira on the main course of the Kurobe River, to produce power by an effective drop of 193.5m. The construction of the Oozawa Power Station created the need for reforestation work on the right bank slope of the Dashidaira Dam. Because it is in a heavy snowfall area, transplanted trees were damaged by snow avalanches and by deer and Japanese serow that ate their foliage in the winter, hampering the reforestation. The Dashidaira reforestation work was executed on the right bank slope at the Dashidaira Dam, and because it is made in a national forest and national park, it was necessary to quickly form communities as similar as possible to natural forest. Therefore, the plan stipulated that first pioneers species would be introduced to form communities followed by a later transition to natural communities. In order to transplant pioneering species of vegetation and selected species that are suited to the Dashidaira District, the pioneering species selected were Ailanthus altissima (magnolia grandiflora), Japanese maple, Katsura tree, Camphor tea, and Magnolia. The selected species were also species that have been traditionally used in the Dashidaira District. The work was completed in 1987.

Map of the surveyed district

Transplantation method by reforestation category

Revegetation category A (flat)

Revegetation category B (flat)

Revegetation category C (Longitudinal slope)
Ushibuse River Forest Physiognomy Transformation

Outline

The Ushibuse River is a first class river that originates in the Hachisuke Mountains. It is located on the eastern side of Matsumoto City, converges with the Tamesawa river into the city, then flows into the Japan Sea. As its name changes to the Hata River, Kuri River, and finally to the Shinano River. The geology in the river basin consists of sedimentary rock such as granite, diorite, and gneiss. The area is steep and the landscape is characterized by steep slopes and narrow valleys.

Need for and purpose of forest physiognomy transformation and tree introduction

The black locust (Robinia pseudo-acacia) that are now most of the tall trees in the area are aging and as they fall over, they increase the risk of disasters caused by collapsed soil and flooding. And their high fecundity prevents the invasion of natural vegetation. The forest physiognomy transformation project was undertaken to resolve these problems and to protect the river bank.

Target forest

Forest of a large variety of deciduous broad-leaved trees native to the region (broad-leaved oak, Quercus serrata, T. h. subsp. kurobe, Quercus crispula Blume, o. subsp. subª. oliveri), Robinia (Robinia pseudo-acacia), and some other exotic species. The project aims to diversify the forest composition and improve its ecological functions.

Cutting

Cutting all black locust (Robinia pseudo-acacia) in bands 15m wide.

Forest physiognomy transformation and tree introduction methods

- Cutting
- Trans-planting

Figure 2: Project Plan Diagram

Legend

- Area transplanted in 1996
- Area transplanted in 1997
- Area transplanted in 1998
- Area transplanted in 1999
- Area transplanted in 2000
- Area transplanted in 2001
- Area transplanted in 2002
- Area transplanted in 2003

Transplanted species

- Carya bituminosa
- Quercus crispula Blume
- Quercus serrata
- Robinia pseudo-acacia
- Tilia japonica
- Ulmus pumila
- Zelkova serrata

Management method

- Thinning
- Fertilizing
- Weeding and brushing

Follow-up survey

- Taint control
- Pest damage survey
- Disease survey

Challenges

- It is important to process sprouts of black locust (Robinia pseudo-acacia)
- Damage by future Japanese serow was a serious problem when the project began, but it has been almost completely resolved by installing protective nets.
- Because the mortality of saplings is high, it is necessary to find the causes and study countermeasures.
- It is necessary to establish a stable local sapling supply system.

Planning forest physiognomy transformation and tree introduction (manual, guideline, etc.)