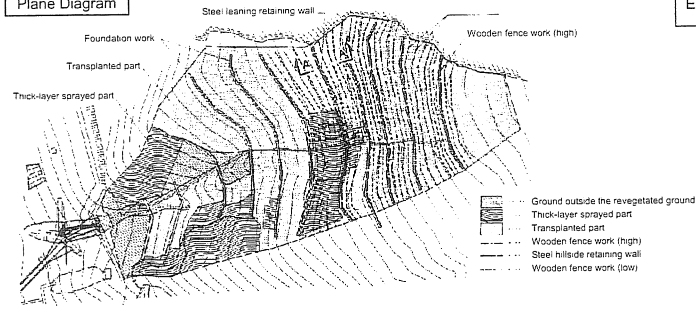
Case 1 Matsuki Hillside Work

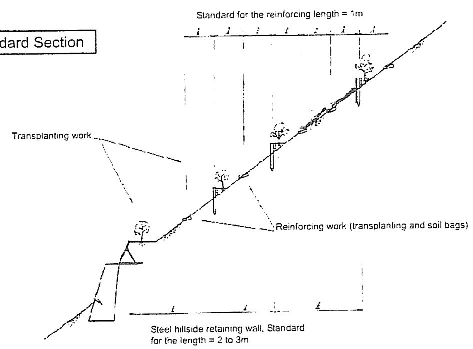
The mountains upstream from the Ashio Check Dam in the highest section of the Watarase River are now reddish brown mountains covered with exposed topsoil without grass or tree covering as a result of repeated forest fires and smoke damage caused by the large quantity of sulfuric acid gas emitted by Ashiodozan Mountain 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 brittle geology consisting mainly of Metazoan layers and severe climatic conditions such as repeated freezing and thawing during the winter. Additionally, whenever heavy rain falls, more soil is washed away. Public revegetation projects conducted as part of mountainside erosion control work and flood control work have been underway for more than a century since they were begun in 1897. Since the nineteen-fifties, the smoke damage has ended and full scale projects have been undertaken. Revegetation projects carried out by the Ministry of Land, Infrastructure and Transport, Forestry Agency, and Tochigi Prefecture have restored greenery to about 50% of the mountainsides. Residents have taken part in extensive reforestation projects, with the Restore Trees to Ashio Society carrying out its first tree planting in May of 1996 as a citizens activity. Revegetation projects were carried out 9 times from that year until 2004. In addition, tree planting was incorporated as part of educational tours and open-air schools that appeared gradually after 1993, and the increase in repeat visits by schools and word-of-mouth expanded into hands-on environmental education activities. Part of the tree planting was performed as revegetation by volunteer groups sponsored by the NPO, Restore Trees to Ashio Society, but in recent years, it has become increasingly difficult to obtain transplanting locations where volunteers can work safely.

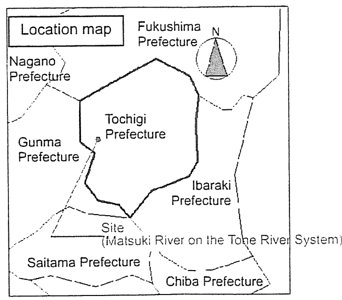
Purpose of improvement		Revegetation of deforested ground
Geology		Metazoan layer zone
Soil		Conglomeratic soil, rock
Execution location		Tochigi Pref., Kamitsuga-gun, Ashiomachi
Work method, form		Earth retaining work Transplanting work, spraying deep layer base material
Slope	Direction	SW
	Gradient	Average gradient 30°
Jurisdiction		MLIT, Kanto Regional Development Bureau, Watarase River Office
Execution years		1988 to present day

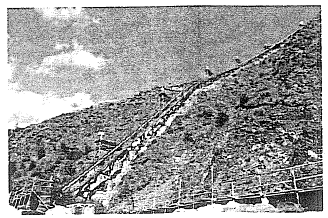
Plane Diagram



Standard Section







Construction of a large scale materials reception facility (Super carrier system: labor-saving and increased efficiency)

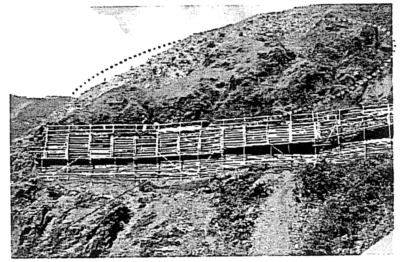
Types and density of the vegetation introduced * Density/m²

Name	Part where deep layer base material was sprayed	Reinforcing work g/bag
Kentucky 31 fescue	0.026	2.84
Orchard grass	0.012	0.50
Creeping red fescue	0.012	0.76
Chinese lespedeza	0.042	0.57
Japanese mugwort	0.018	0.16
Shrubby lespedeza	-	0.07
False indigo	0.488	0.32
Alder	0.064	-
Total	0.662	5.22

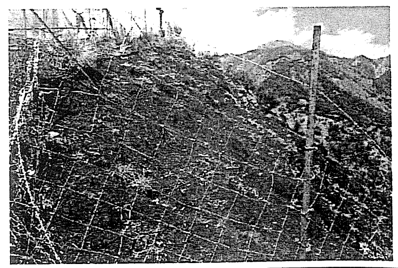
Types and density of the vegetation initially introduced * Done at 10m intervals

Name	Tree height
Black pine	H=0.5 – 0.8m
Alder	"
Manchurian alder	"
Japanese kerria	"
Chinese redbud	"
Weeping forsythia	"
Japanese spirea	"

(Photo 1) State of vegetation on the slope:
Recovery of vegetation caused by natural invasion is seen at the location where sediment movement is controlled above small check dam work.



(Photo 2) Revegetation of rock:
On the Matsuki hillside work, rock revegetation was done as a measure to prevent erosion of the surface of weathered rock under harsh climatic conditions including freezing/thawing and cold wind damage during the winter.



(Photo 3) Measure to prevent damage by deer:
A protective net installed to prevent damage by Japanese serow and Japanese deer.

(Reference photo 1) Ohatazawa Green Sabo Zone
Actively revegetated by volunteers

The Ministry of Land, Infrastructure and Transport (Watarase River Office) formed a committee of scholars and representatives of concerned organizations to compile the Guideline to Matsuki Hillside Work Revegetation (Draft). It is working to restore greenery through links with the local residents according to the Guideline. The following are the major features of the Guideline.

- Its major goal is to revegetate the hillside slopes to control of the runoff in order to guarantee the safety of the region and its aim is to restore nature by forming zones of forested land suited to the Matsuki District.
- It calls for regular monitoring surveys to increase the effectiveness of the revegetation methods under harsh revegetation conditions. It also offer guidelines to carrying out revegetation project while revising them based on the results of the monitoring.
- In the future, links with volunteers will be strengthened to perform revegetation while maintaining a cooperative organization.
- The successful results of revegetation projects will be used as opportunities for sabo and environmental education and as a tourist resource in order to contribute to the region.

Advice from Professor Ote

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.

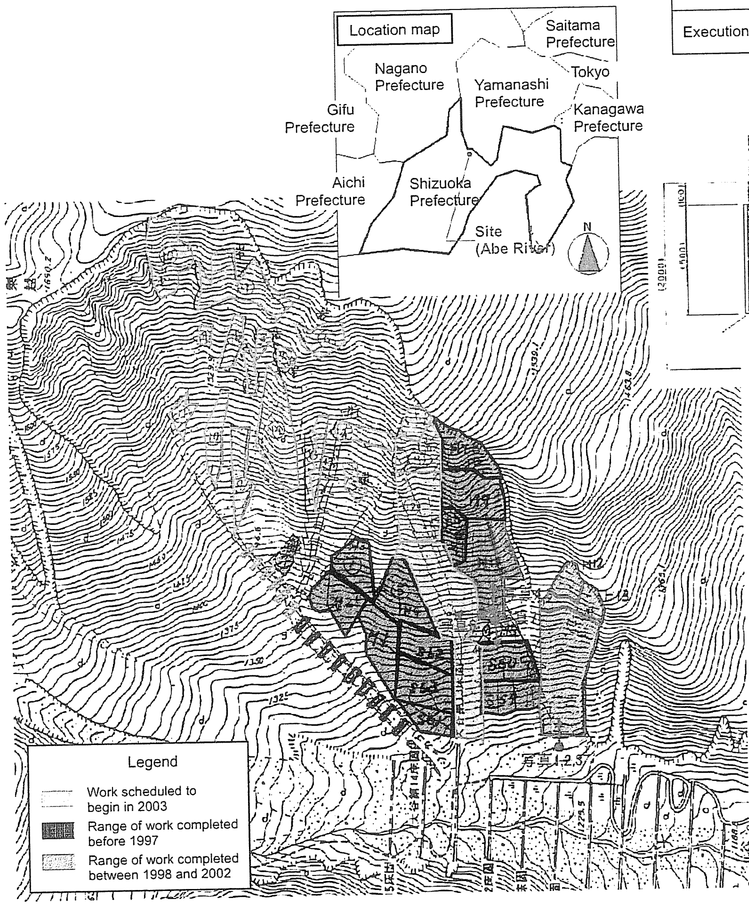
Concerning rock revegetation
Revegetation of rock often creates unnatural scenery, so its use must be studied carefully. A method often used to prevent rocks from falling when performing work at the bottom of a slope is to spread net work over the exposed rock at the top of the slope, but simple revegetation to prevent this should be avoided.

Case 2 Oya Hillside Work

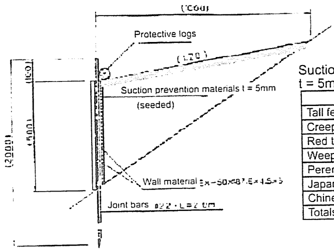
Outline

Mt. Oyarei that is the source of the Abe River is the site of the Oya Slide, one of Japan's three most massive slides. The Oya Slide, a massive event occupying 1.8km^2 with width of 1.0km and an elevation difference of 800m, is estimated to have discharged 120 million m^3 of collapsed soil. The geology in this zone is alternating layers of shale and sandstone in the Palaeogene period, includes remarkable crushing caused by faults and folds produced by structural movement, is severely cracked, and bedrock separation has advanced. Fan-shaped slide topography exists at the bottoms of slopes. The Oya Slide was triggered by a large earthquake in 1707 and the sediment it produced triggered a severe disaster caused by later intensive rainfall. Therefore, hillside revegetation was done to stabilize the unstable north-south slope on the collapsed ground. Because vegetation can be restored by artificial introduction and a vegetation introduction technology is established, this is considered a model for the application of the method in other locations in the jurisdiction. The hillside work on the Oya Slide was undertaken to (1) form stabilized scenery by revegetation, (2) control sediment production from hillsides, and (3) supply the unstable sediment to the river. The characteristics of the work method were terracing work executed on the talus and spraying special mortar (Rock-ment) on broken parts of exposed rock. As a result of the hillside work, between 40% and 70% of the trees have taken thanks to the use of this method.

Purpose of improvement		Prevent expansion of the collapsed ground
Geology		Tertiary zone
Soil		Conglomeratic soil
Execution location		Shizuoka City, Shizuoka Prefecture
Work method, form		Hillside terracing work (steel fence work), transplanting, spraying special mortar
Slope	Direction	SE
	Gradient	30°
Jurisdiction		MLIT, Chubu Regional Development Bureau, Shizuoka River Office
Execution years		1986 to present day



Section Diagram



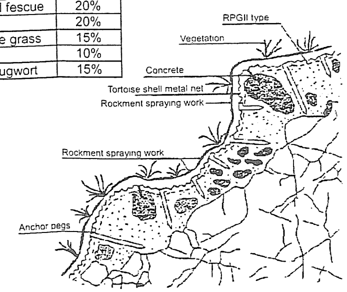
Suction prevention material t = 5mm (seeding)

	Per 1m²
Tall fescue	10g
Creeping red fescue	3g
Red top	1g
Weeping love grass	1g
Perennial rye grass	4g
Japanese mugwort	1g
Chinese lespedeza	1g
Totals	20g

Rockment spraying (sprayed 6kg/m^2) Standard execution diagram

S = 1 : 20

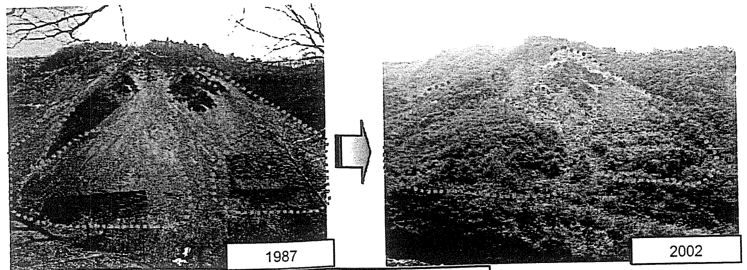
	Seed mix
Tall fescue	20%
Creeping red fescue	20%
Red top	20%
Weeping love grass	15%
White clover	10%
Japanese mugwort	15%



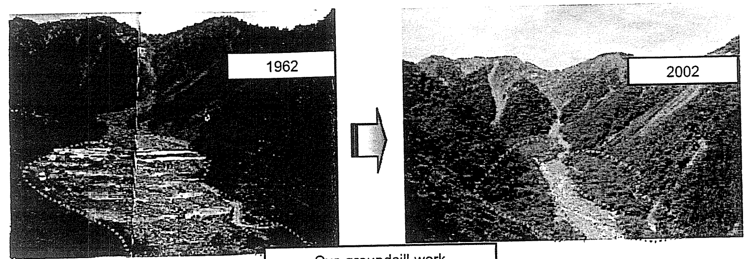
Rockment Spraying Work (sprayed 6kg/m^2) Materials Table

Per 100m²

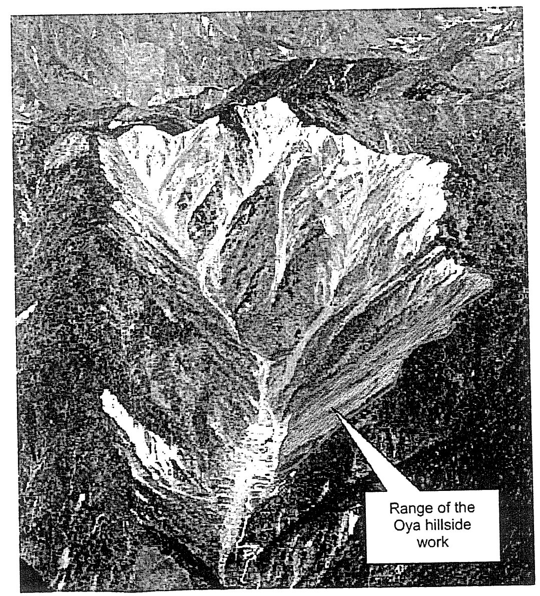
	Standard	Unit	Quantity	Remarks
Rockment	Mix: 1:3:5	kg	600	
Tortoise shell metal net	Wire diam. 1.2mm, meshes 10mm	m²	140	
RPB (type II)	Thickness 1.0mm, palm-net	m²	110	
Anchor pegs	Diameter 13mm X 600mm	-	60	
Anchor pegs	Diameter 13mm X 400mm	-	50	
Anchor pegs	Diameter 9mm X 200mm	-	300	



Oya hillside work
(Change of the work locations)



Oya groundsill work
(Change of the work locations)

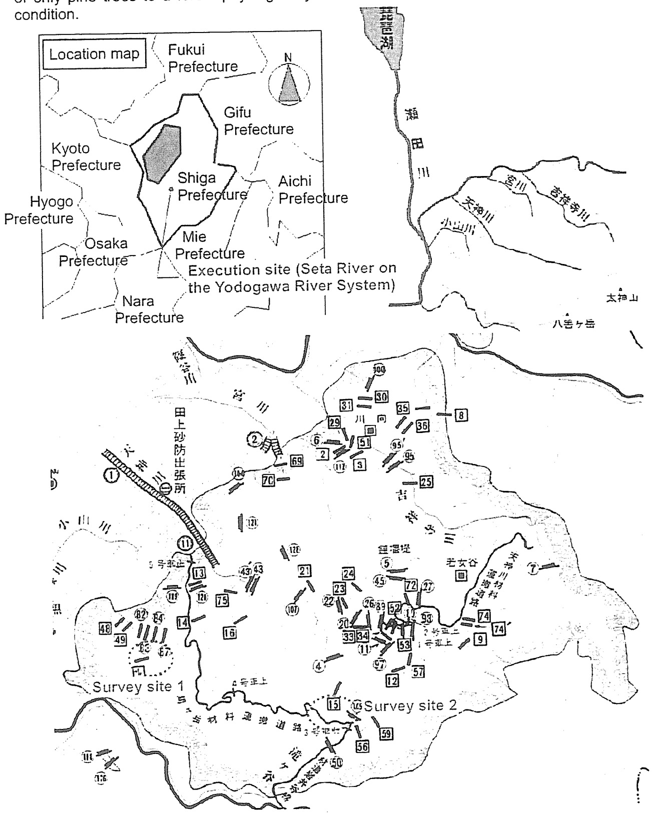


Case 3

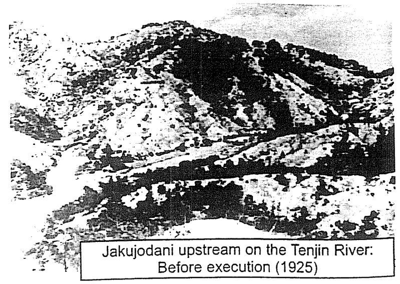
Tanakami Hillside Work

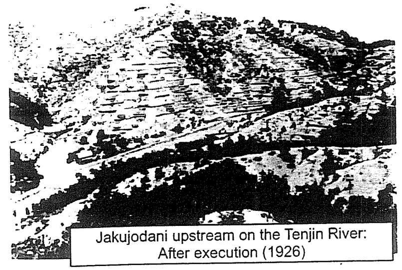
Outline

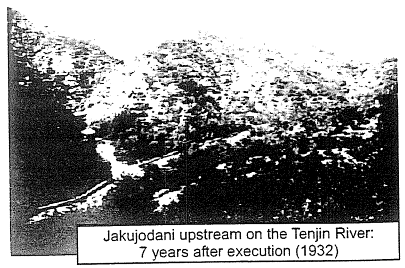
More than one-thousand years ago, the Tanakami Mountain zone was a vast beautiful of luxuriant Japanese cypress, Japanese cedar, and evergreen oaks. Later during the Asuka and Nara Periods (seventh century), the arrival of Buddhism and the continental culture spurred the establishment of palaces, shrines, 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 Omi was at the center of frequent wars accompanied by attackers burning their enemies' towns 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 rainfall ran off its surface soil, increasing the destruction of its land. By the seventeenth 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 works done to stop surface erosion from running off sediment. Tanakami hillside work projects have been underway for 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 retaining work as hillside foundation work (block panel terracing work and block panel stepped terracing work), hillside terracing work as hillside revegetation (sod seedling terracing work, straw seedling terracing work, sod stepped seedling terracing work), covering work (slope revegetation), transplanting work (black pine, *himeyashabushi* alder). And as a way of encouraging the growth of seedlings after transplanting, hillside tending method A and hillside tending method 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.

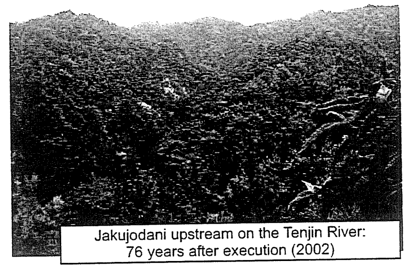


Purpose of improvement		Revegetation of deforested ground
Geology		Granite zone
Soil		Weathered rock
Execution location		Otsu City in Shiga Prefecture
Work method, form		Earth retaining work Hillside terracing work (for details see the standard section), transplanting work
Slope	Direction	All directions
	Gradient	-
Jurisdiction		MLIT, Kinki Regional Development Bureau, Biwako River Office
Execution years		1878 to the present

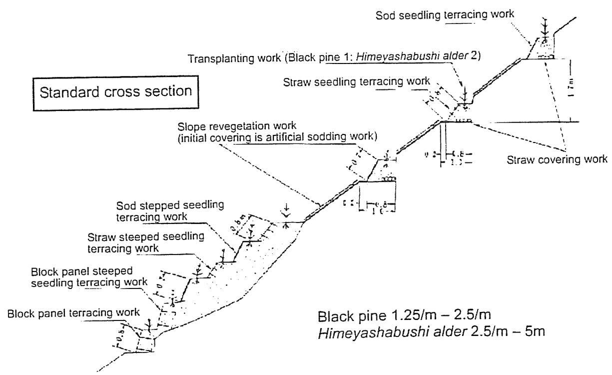

Jakujodani upstream on the Tenjin River: Before execution (1925)


Jakujodani upstream on the Tenjin River: After execution (1926)

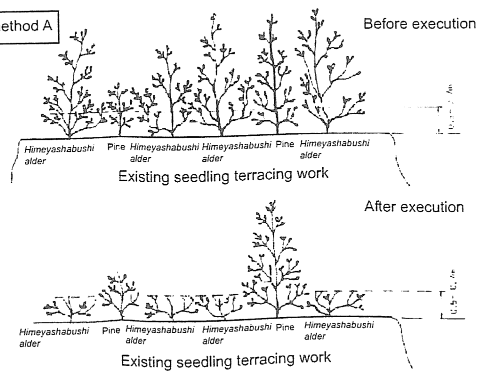

Jakujodani upstream on the Tenjin River: 7 years after execution (1932)


Jakujodani upstream on the Tenjin River: 76 years after execution (2002)

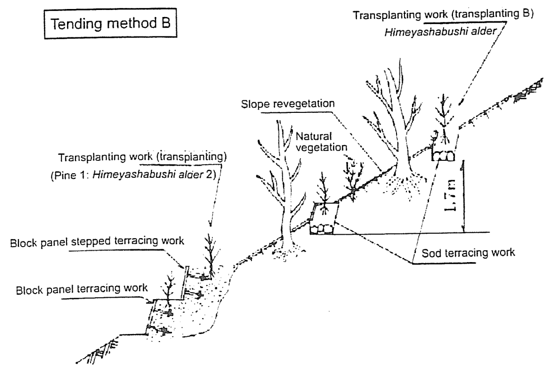
Standard cross section



Tending method A



Tending method B



Tending pattern A: After transplanting, the *Himeyashabushi alder* are truncated to height between 0.5 and 0.7m in the 4th, 7th, and 10th years to encourage sprouting and prevent them from overwhelming the pines.

Tending method B: The roots of the existing trees are trenched and and fertilized.

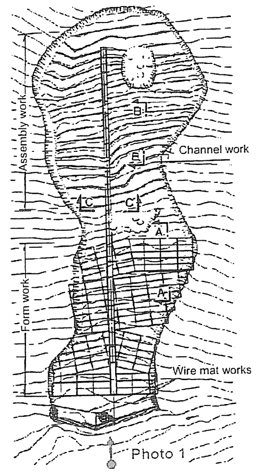
Case 4 Tsuchiyabara Hillside Work (Shorenji River Hillside Work)

Outline

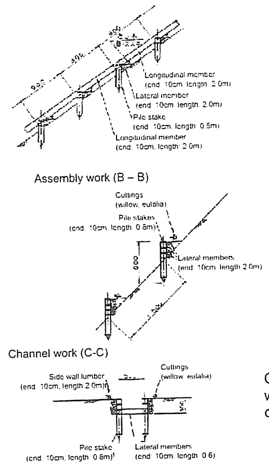
The mountains in the Kizu River Basin were once covered with huge luxuriant forests, but the advance of civilization destroyed them as, during the Nara Period in particular, unrestricted cutting to obtain lumber to build temples and shrines deforested the land. As the deforested area expanded to 4,500 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 sabo projects consisting mainly of hillside work to revegetate the deforested land. By 1959, 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 of 1959 collapsed slopes at many places (2,490) 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 40° where work conditions are poor. The Upstream Kizu River Office has executed hillside works (earth retaining work) to stabilize hillsides by using gravity concrete retaining walls and concrete secondary products etc., but it has faced cost problems and difficult executions. It has developed hillside work reduction methods based on the concept: stop the movement of sediment on the surface and then perform green sabo that does 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 stakes.

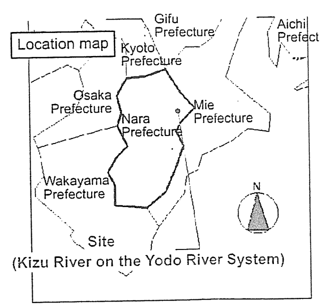
Purpose of improvement		Prevention of the expansion of collapsed ground
Geology		Granite zone
Soil		Rock pebbles
Execution location		Uda-gun, Nara Prefecture
Work method, form		Slope cutting, earth retaining work, hillside drainage channel work, peaked roof form work, wooden form work, transplanting work (cuttings)
Slope	Direction	-
	Gradient	-
Jurisdiction		MLIT, Kinki Regional Development Bureau, Upstream Kizu River Office
Execution years		1989 to 1991

Survey Location 1 Plane diagram



Standard section





Cuttings (Willow, eulalia, azalea, and other fascine) brushwood were placed at lateral intervals of 30cm and longitudinal intervals of 90cm.

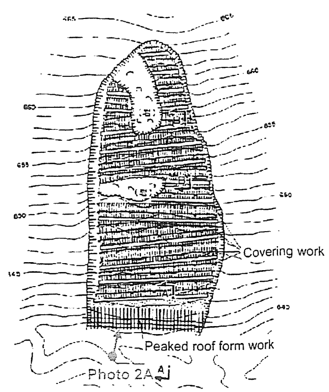
Immediately after completion (1989)

One year after completion (1990)

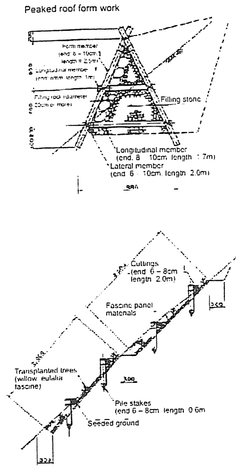
Three years after completion (1993)

Twelve years after completion (2002)

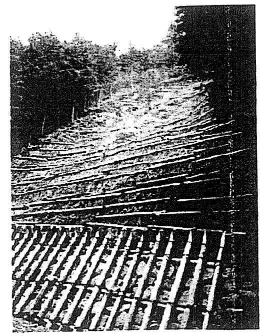
Survey Location 2 Plane diagram



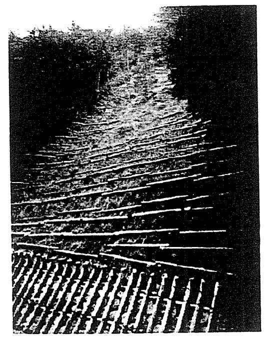
Standard section



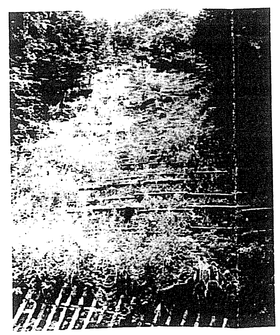
Fascines were inserted at lateral intervals of 30cm and longitudinal intervals of 0.66 cm.



Immediately after completion (1991)



Six months after completion (1991)



One year after completion (1992)

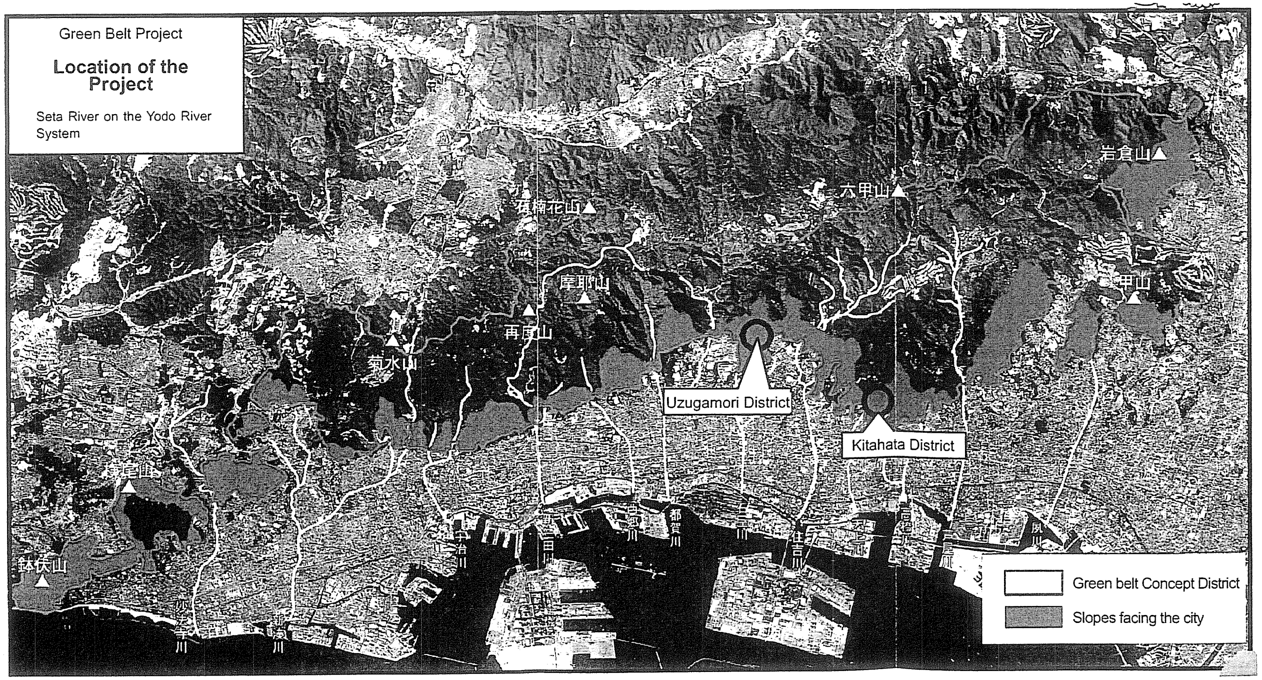
2002

Case 5 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 1893 to protect the city from sediment disasters have now restored their vegetation. But the trees on the Rokkozan chain include red pine and black locust (Robinia pseudo-acacia) that die very easily; a situation detrimental to sediment disaster prevention. But because the Rokkazan 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 aggressive measures are necessary, and at the same time, provides groves on the Rokkozan chain to create forests that fill four functions: (1) preventing sediment disasters, (2) preventing urban sprawl, (3) 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 aggressive 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, toppled trees 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.

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



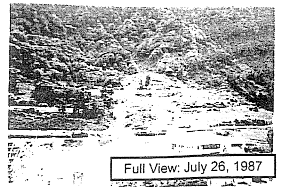
Need for and purpose of forest physiognomy transformation and tree introduction		Replace trees that now hamper sediment disaster prevention (communities of Japanese cedar, Japanese cypress, communities of eulalia and *nezasa* (*Pleioblastus chino var. viridis*), communities of black locust (*Robinia 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 *nezasa* (*Pleioblastus chino 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)
Forest physiognomy transformation and tree introduction methods	Cutting	(Planted Japanese cedar and Japanese cypress groves) Thinning 20 to 30% (*nezasa* (*Pleioblastus chino var. viridis*) and black locust (*Robinia pseudo-acacia*) groves) Completely cutting the *nezasa* (*Pleioblastus chino var. viridis*) and black locust (*Robinia pseudo-acacia*) in belts
	Transplanting	(Transplanted tree species) *Konara oak (Quercus serrata Thunb. ex. Murray)*, hornbeam, Korean hornbeam, fagaceae, *Yamazakura* (*Prunus jamasakura Sieb. ex Koidz*), Japanese oak, Japanese zelkova (*Ulmaceae Zelkova serrata (Thunb.*), *Mukunoki* (*Aphananthe aspera*), etc. Transplanted density (2,500 trees/ha)
Management method	Weeding and brushing	Once or twice a year, cutting bamboo grass, cutting black locust (*Robinia pseudo-acacia*) sprouts
	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.
Challenges		• It is important to process the sprouts of black locust (*Robinia pseudo-acacia*) and to cut the *nezasa* (*Pleioblastus chino var. viridis*) • Because locations where forest physiognomy 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.
Planning forest physiognomy transformation and tree introduction (manual, guideline, etc.)		Rokkozan Green Belt Forest Improvement Manual (Rokko Sabo Works Office, 2000)

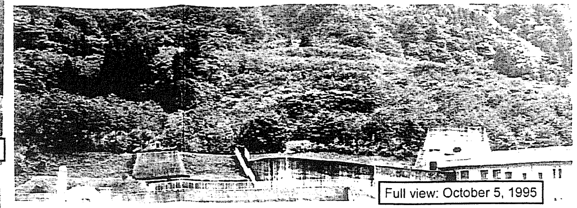
Case 6 Dashidaira Revegetation Work

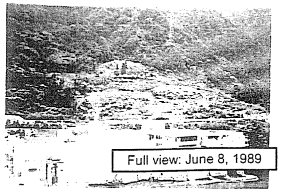
Outline

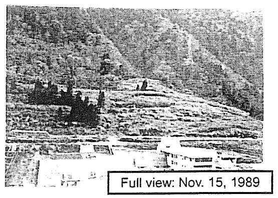
Work on the Otozawa Hydroelectric Power Station was started in September, 1982 by the Kansai Electric Power Company and started full operation 3 years later on September 27, 1985 as a result of the work of 900,000 people. Developed based on the concept of integrated river system development in order that it use the abundant flow volume regulated and discharged by the upstream Kurobe Dam, its 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 76.7m 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 Otozawa Power Station created the need for revegetation work on the right bank slope at the Dashidaira Dam. Because it is in a heavy snowfall zone, transplanted trees were damaged by snow avalanches and by deer and Japanese serow that ate their foliage in the winter, hampering the revegetation. The Dashidaira revegetation work was executed on the right bank slope at the Dashidaira Dam, and because it is inside 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 pioneer 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 Alder (*Alnus sieboldiana matsumura*) and Manchurian alder (*Alnus hirsuta*), and the selected species were *Itayakaede* (*Acer mono Maxim. var. marmoratum*), Japanese maple, *Katsura* tree (*Cercidiphyllum japonicum*), *Mizunara* (*Quercus mongolica var.grosserserrata*), *sawagurumi* (*Pterocarya rhoifolia*), *konara oak* (*Quercus serrata Thunb. ex. Murray*), Siebold's beech, and Cardinal red. The work was completed in 1987.

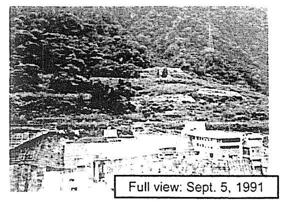
Purpose of improvement		Revegetation of a slope as part of an electric power plant construction project
Geology		Granite zone
Soil		Weathered rock
Execution location		Kurobe City in Toyama Prefecture
Work method, form		Flat ground A: complete soil dressing and plowing Flat ground B, slope: soil dressing, spraying, and plowing
Slope	Direction	W
	Gradient	-
Jurisdiction		Kansai Electric Power Company
Execution years		1986 - 1987

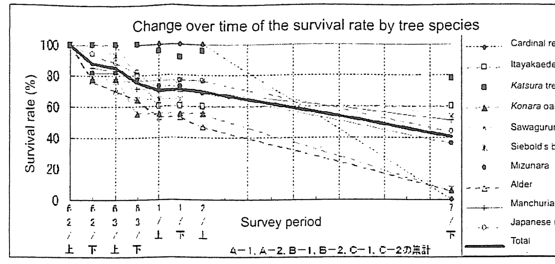


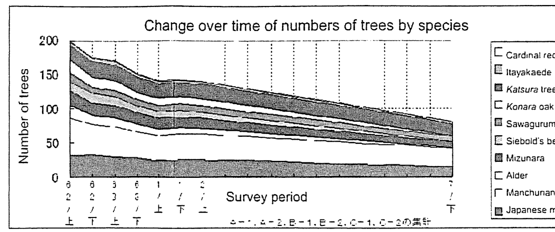




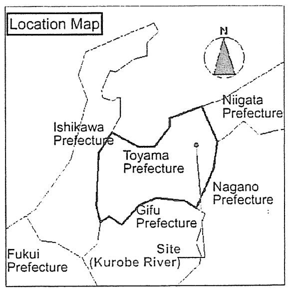


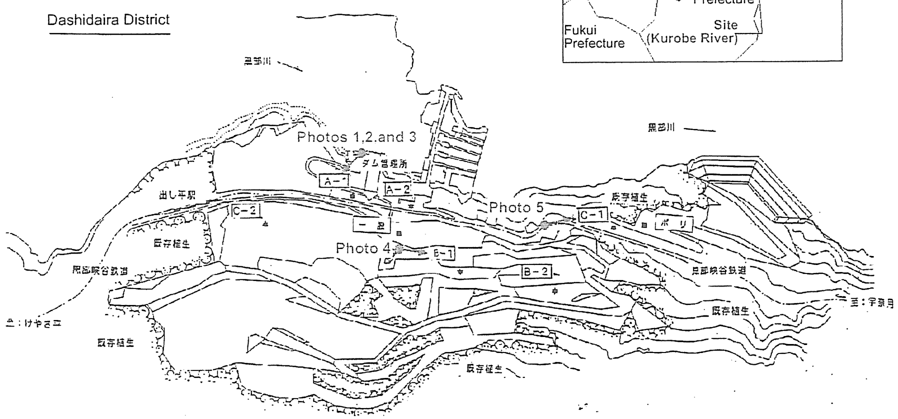






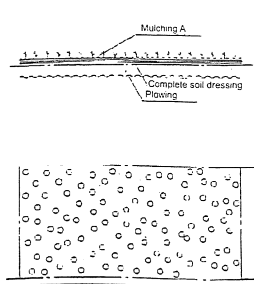
Map of the surveyed district





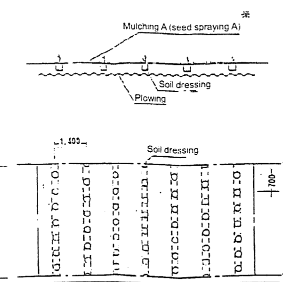
Transplantation method by revegetation category

Revegetation category A (flat)



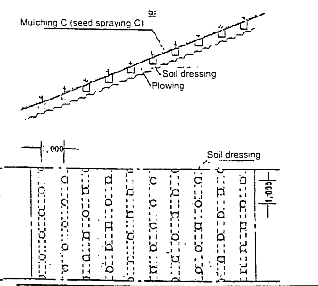
Planting	2 trees/m^2, Tree A: Tree B 2:8
Soil dressing	Complete soil dressing: depth 30cm
Soil improvement	Peat moss: 30 liters/m^2
	Keifun 3kg/m^2 or solid fertilizer 3.25kg/tree
Plowing	Depth 50cm
Mulching	Mulching A (straw mulch 3kg)

Revegetation category B (flat)



Planting	1 tree/m^2, Tree A: Tree B 8:2
Soil dressing	Soil dressing: width 30cm, depth 30cm, 0.004m^3/m^2
Soil improvement	Peat moss: 35 liters/m^2
	Solid fertilizer 0.25kg/tree
Plowing	Depth 50cm
Mulching	Mulching B (Seed spraying: A)

Revegetation category C (Longitudinal slope)



Planting	1 tree/m^2, Tree A: Tree B 4:6
Soil dressing	Soil dressing: width 30cm, depth 30cm, 0.09m^3/m^2
Soil improvement	Peat moss: 3.25 liters/m^2
	Solid fertilizer 0.25kg/tree
Plowing	Depth 50cm
Mulching	Mulching C (Seed spraying: B)

Seed spraying A, B: Comparison of Quantity Sprayed per m^2

		Seed spraying A	Seed spraying B
Curing agent (bark fertilizer)	Kg	0.2	2.0
Adhesive	"	0.003	0.3
Seeds	"	0.028	0.028
Fertilizer	"	0.2	0.15

General spraying is the same as seed spraying

Note
Tree A: Ratio of alder/Manchurian alder
Tree B: Equal numbers of *Itayakaede* (*Acer mono Maxim. var. marmoratum*), Japanese maple, *Katsura tree* (*Cercidiphyllum japonicum*), *mizunara* (*Quercus crispula Blume*), *sawagurumi* (*Pterocarya rhoifolia*), and konara oak (*Quercus serrata Thunb. ex. Murray*)

Case 7 Ushibuse River Forest Physiognomy Transformation

Outline

The Ushibuse River is a first class river that originates in the Hachibuse Mountain Yokomine to the east of Matsumoto City, converges with the Tagawa River inside the city, then flows into the Japan Sea as its name changes to the Narai River, Kuzu River, and finally to the Shinano River. The geology in the river basin is detritus of sandstone, mudstone, conglomerate etc. above an elevation of 1,300m, while below that elevation, it consists of volcanic rock such as fragile quartz diorite and granite diorite that are easily weathered and eroded. And because of its steep topography, the area has a long history of frequent sediment disasters. In particular, by the late nineteenth century most slopes in the water resource zone of the main course of the Ushibuse River, mainly those in around the Hikage Marsh and the Jigoku Gorge, were deforested and devastated. In response, the Sabo Division of the Home Ministry carried out Sabo works along the Ushibuse River for a five year period beginning in 1885. Then beginning in 1898, Nagano Prefecture took over Sabo works on the Ushibuse River with financial assistance from the national government, finally completing a series of projects in 1918. To restore the greenery on the devastated slopes along the Ushibuse River, red pine, black locust (*Robinia pseudo-acacia*) etc. were planted. Of these, the black locust, being a dominant species, are now distributed widely, but the black locust are near the end of their lifetime, and toppled trees have caused disaster prevention problems. And because they mature quickly, obstructing the germination and growth of other native species, they have been completely cut in order to transform the forest physiognomy to a forest of deciduous broad-leaved trees native to the region. Since 1996, forest physiognomy transformation work has been completed on about 32ha of the upstream region.

Purpose of improvement		Forest physiognomy transformation from the existing black locust (*Robinia pseudo-acacia*) to a forest of native deciduous broad-leaved trees
Geology		Granite zone
Soil		Weathered rock
Execution location		Matsumoto City, Nagano Prefecture
Slope	Direction	All directions
	Gradient	-
Jurisdiction		Nagano Prefecture, Matsumoto Construction Office
Execution years		1996 to present day

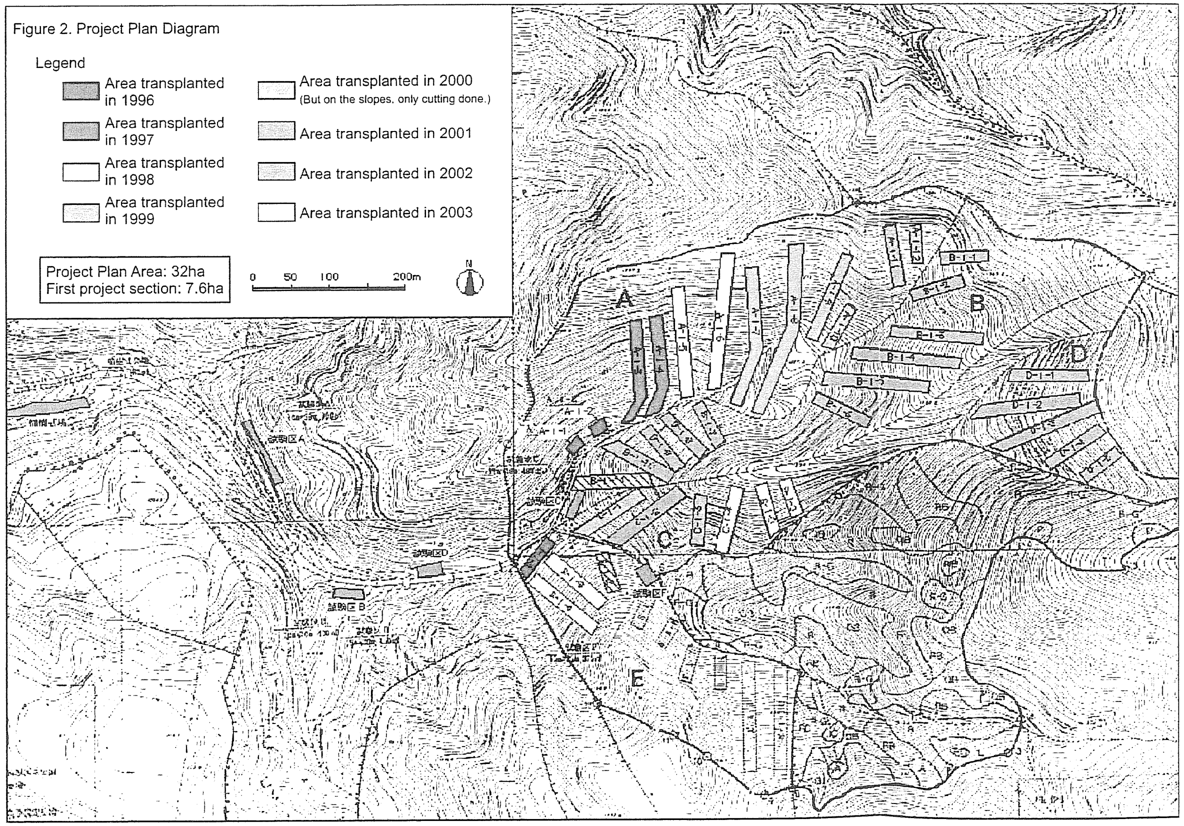


Figure 2. Project Plan Diagram

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 region are aging and as they fall over, they increase the risk of disasters caused by collapsed soil and floating logs. And their high fecundity prevents the invasion of natural vegetation. The forest physiognomy transformation project was undertaken to resolve disaster problems and to protect the region's ecosystem
Target forest		Forest of a large variety of deciduous broad-leaved trees nature to the region (*konara* oak (*Quercus serrata Thunb. ex. Murray*), *mizunara* (*Quercus crispula Blume*), *sawagurumi* (*Pterocarya rhoifolia*), *Katsura* tree (*Cercidiphyllum japonicum*), etc.) (Secondary deciduous broad-leaved forest)
Forest physiognomy transformation and tree introduction methods	Cutting	Cutting all black locust (*Robinia pseudo-acacia*) in bands 15m in width
	Trans- planting	(Transplanted tree species) [torrent banks] *sawagurumi* (*Pterocarya rhoifolia*), *Katsura* tree (*Cercidiphyllum japonicum*), *tochinoki* (*Aesculus turbinata*), *ohyo* (*Ulmus laciniata*), *onigurumi* (*Juglans mandshurica var. sachalinensis*), *ezoenoki* (*Celtis jessoensis*), Japanese zelkova (*Ulmaceae Zelkova serrata (Thunb.)*, and giant dogwood (*Cornus controversa*). (slope area) *konara* oak (*Quercus serrata Thunb. ex. Murray*), *mizunara* (*Quercus crispula Blume*), Japanese chestnut (*Castanea crenata Castanea*), Japanese linden (*Tilia japonica*), *mizume* (*Betula grossa Sieb. et Zucc*), Japanese hornbeam (*Carpinus japonica*), *Yamazakura* (*Prunus jamasakura Sieb. ex Koidz*) etc. Transplanted density (1,600 trees/ha)
Management method	Weeding and brushing	Cutting black locust (*Robinia pseudo-acacia*) sprouts once a year (summer) and cutting grasses
	Thinning	In principle, it is not done. It is expected that natural thinning will maintain the correct density.
	Fertilizing	Not done.
Follow-up survey		Are performed annually beginning in 1996. • Taking rate and growth of trees • Pest damage survey • Toppled trees and transition in areas where execution has not been done
Challenges		• It is important to process sprouts of black locust (*Robinia pseudo-acacia*) • Damage by foraging 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.)		Guideline to Forest Physiognomy Transformation of Black Locust (*Robinia pseudo-acacia*) on the Ushibuse River (Revised Edition) (Nagano Prefecture, Matsumoto Construction Office, 2003)

(Photo 1)
Black locust (*Robinia pseudo-acacia*) grove near a French type terracing work
Only about 3% of the trees were black locust at the time of the hillside work, but because of its high fecundity and because secondary cutting was repeated before the war, it is now mostly black locust

(Photo 2) Toppled black locust (*Robinia pseudo-acacia*)
Black locust have short roots and topple easily. The black locust in the Ushibuse area are aging, and as shown in the photograph, their toppled trunks are seen at various places in the river basin.