

EROSION CONTROL AND TORRENTIAL IMPROVEMENT FOR SETA RIVER HILLSIDE PLANTING OF MT. TANAKAMI



*Preserve the Nature
and
Conserve Green*

建設省近畿地方建設局
琵琶湖工事事務所

Lake Biwa Works Office
Kinki Regional Construction Bureau
Ministry of Construction

The History for Erosion Control and Torrential Improvement (Sabo)

Year	Contents
694	The "Fujiwara-no-miya" (Fujiwara Palace) was built. Japanese cypress from Mt. Tanakami was brought to Nara along the Seta River, the Uji River and the Kizu River.
733	Konsho Temple was built.
752	Timber from Mt. Tanakami was used when Todai-ji Temple and other seven large temples were built.
761	Ishiyama Temple was built.
788	Enryaku-ji Temple was built.
859	Fudo-ji Temple was built.
1660	A decree was issued by the shogunate to prohibit uprooting of trees and plant young trees.
1666	An ordinance was enacted by the shogunate to maintain rivers and mountains of the provinces.
1670	Dredging of Seta River
1683	Occurrence of flood disaster in the upper stream of Yodo River. Mr. Juiken Kawamura on behalf of the research board of the shogunate discussed how to control such disaster.
1684	An ordinance was re-issued by the shogunate to maintain rivers and mountains of the provinces.
1686	Construction of soil retaining work.
1708	A serious flood broke through most of the defenses along the Daido River on July 19 th . Houses in Nakano and Shibahara Villages were washed away, and the villages were later rebuilt on their present sites.
1736	Dredging of Seta River
1868	The junction of the three rivers in the Yodo River became clogged with silt, and the Seta River was dredged (1868-1870).
1871	Sabo Law with five articles was enacted. A survey of the mountains forming the catchment area for the Yodo River was begun.
1872	Shiga Prefecture launched an Sabo project in the basins of the Yasu River and the Seta River.
1873	A Sabo Law for the Water Source Areas of the Yodo River was enacted.
1878	Carried out a Sabo project under the auspices of the Ministry of Domestic Affairs in accordance with the plans prepared by Derehk. Installation of Sabo factory in Fukuen-ji Temple of Tanakami Haguri Village.
1888	Sabo projects were launched under the direct control of the Ministry in the basins of the Yasu River and Kusatsu River.
1889	Completion of Yoroi (armor) dams in the basins of Tenjin River, Yasu River and Kusatsu River by the plans of Mr. Tanabe, civil engineer.
1890	A trial cultivation of alnus was successfully carried out in Iwane Village.
1893	Both alnus and black pine were planted.
1897	A Sabo Law and a Forestry Law were enacted.
1897	The budget for the Yodo River Sabo project with ¥30 million yen over ten years was approved.
1910	The Sabo project in the basin of the Kusatsu River was transferred to the Ministry of Agriculture and Commerce.
1924	Completion of Sabo project in the basin of Yasu River under the direct control of the Ministry of Domestic Affairs.
1936	Completion of Sabo projects in the districts of Ishiyama and Seta in Otsu city under the direct control of the Ministry of Domestic Affairs.
1943	Construction of the erosion control dam on the Tenjin River, a tributary of the Seta River, was begun. (The 1 st period:1932-1946, the 2 nd period:1958-1959, additional height = 2.3m)
1962	A survey was undertaken to promote growth in poor trees as part of a general cultivation test (B).
1963	Hillside and slope works in the Tanakami District were opened to public from direct construction.
1964	The Seta Sabo Works Office was unified into the Lake Biwa Works Office.
1966	Commencement of road construction to transport materials in Tanakami (1966-)
1967	The tree cultivation project (A) was launched. Chemical fertilizer at the rate of 1ton/ha was sprayed by helicopters in the districts concerned in 4, 7, 10 years after respectively, and cutting off alnus in summertime was a sort of maintenance work to dissipate pressure from pine trees.
1974	With the implementation of a centennial project on the Yodo River, a commemorative monument for sabo works was erected, and a memorial forest was set and planted by primary school pupils.
1977	Commencement of river bed improvement works of Tenjin River in Tanakami District (1977-)
1979	A tree cultivation project denoted as B was begun in the Wakame Valley, around the mid stream area of the Tenjin river.
1985	A tenth anniversary celebration of planting was held by the pupils again, which awarded the prize from the Minister of Construction during the disaster prevention campaign under the auspices of Mt. Tanakami Sabo Association, in Otsu City.
1986	The Tanakami Sabo association was awarded the Prime Minister Prize as the best promoter of green and planting.
1990	At the first nationwide campaign "Preserve Green", the pupils in planting in commemoration of their graduation were awarded the prize from the Minister of Construction.



Sabo Centennial Commemorative Monument

This Monument is made of granite. Its exterior is a sapling bed. A stone ball of 30cm dia. on the top features young planting tree. Commemorative words are written by Priest Takateru Washio of Ishiyama Temple. The works history is shown in the back.



Memorial Forest of Centennial Project for Yodo River

This memorial forest was started to be formed in Wakamedani, Tanakami Haguri Town, Otsu City in 1974. Lots of green can be seen at present in this area through execution of hillside works.



Commemorative Planting at Mt. Tanakami

The commemorative planting was started by local school pupils in their graduation in 1974. The number of schools participated increased at present. This planting is executed in February and March annually. The schools were awarded the prize from the Minister of Construction in 1990 at the 1st nationwide campaign, "Preserve Green"

1. Forest in the past

Mt. Tanakami and its surrounding areas were beautiful forests of cypress, cryptomeria, oak, etc. in over one thousand years ago. The evidences for the above are as follows:-

1. A natural forest is remained near the temples on the summit of the mountain since this area was not deforested,
2. A poem, titled "Construction of the Fujiwara Palace" in the Japanese famous anthology "Man-Yo-Shu" describes the process of cypress transportation from Mt. Tanakami to Yamato (Nara) through Seta River, Uji River and Kizu River by use of rafts as shown below,
3. A construction memorandum of utilizing the timber (cypress) is remained in the Shosoin when seven large temples in Nara were built such as Todaiji Temple, Saidaiji Temple, etc.,
4. And many roots of cypress and oak have been found when the hillside work was being carried out.

「藤原宮之役民作歌」

(万葉集卷1の50番)

いねほしる おうみのくにのこゝろのたのやまのまきさきくしのついでき
 磐走 淡海乃国^の衣手能 田上山之 真木佐苦 桧之端手乎
ものゆのやそじがわにたまもなすうかへながれ
 物乃布能 八十氏河爾 玉藻成 浮倍流礼



Forest Condition of Mt. Taishin near Fudo Temple

This area is remained as the same condition as the past since it was not deforested.



Forest Condition of Mt. Sasamagadake

A natural forest is remained on the summit area of Mt. Sasamagadake (over the dotted line). Because holy temple and shrine are located. This photo was taken in 1908.

Mt. Tanakami was full of beauty and covered with lots of green in the past.

2. Causes of Forest Denudation

Mt. Tanakami was a beautiful mountain in the ancient age. But the forest denudation was progressed by the causes below:-

1. Through the introduction of Buddhism and continental culture to Japan, many palaces and temples were being built such as Fujiwara Palace, Todaiji Temple, Saidaiji Temple, etc. by using a lot of cypress and oak timber materials from Mt. Tanakami through rivers,
2. The forest of cypress and oak was transformed to pine forest. However, the pine trees were also deforested as a fuel for making ceramics or china as an artistic handicraft was developed,
3. Wars were frequently occurred in this area since the Omi District was a key point in terms of nationwide traffic and transportation. The forests had been fired many times,
4. The granite in this area is seriously weathered from the geological points of views, so that the surface soil is easily washed away by floods once trees are deforested.

In the Edo Era, Mt. Tanakami was deforested completely like snow covering, and people living in the downstream were frequently suffered from sediment and flood disasters.



Junction of Daido River and Seta River

The flow of Seta River is damaged by the sediment from Daido River.



Todaiji Temple

This temple was built in 752 by use of timber material from Mt. Tanakami.



Condition of Forest Denudation of Mt. Tanakami in Meiji Era

The evidence of hillside works can be found in the end of Edo Era and the first of Meiji Era. Planting was successful only for valley portions. This photograph was taken in 1908.

Natural corruption is terrible.

Design of Hillside Work

3. Hillside Work

In designing hillside work, it shall be done to materialize its function namely its purpose, and to consider its safety and maintenance performances at the same time.

[Notes]

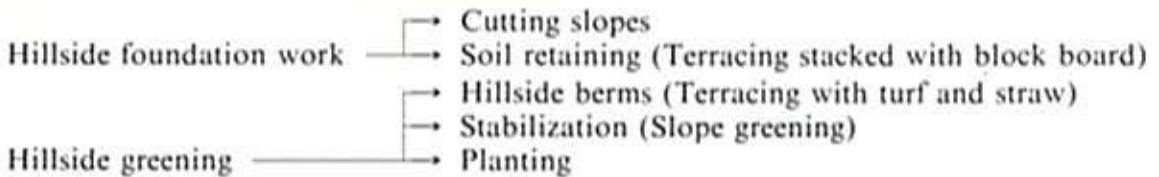
Hillside work is applied to control the production of sediments, and to prevent the weathering of surface soil, and magnification of erosion and corruption for the slopes.

Hillside work can be classified into two categories i.e. hillside foundation work and hillside greening.

1. Hillside foundation work is to make firm foundation for forests by stabilizing cutting slopes and prevent their erosion from precipitation.

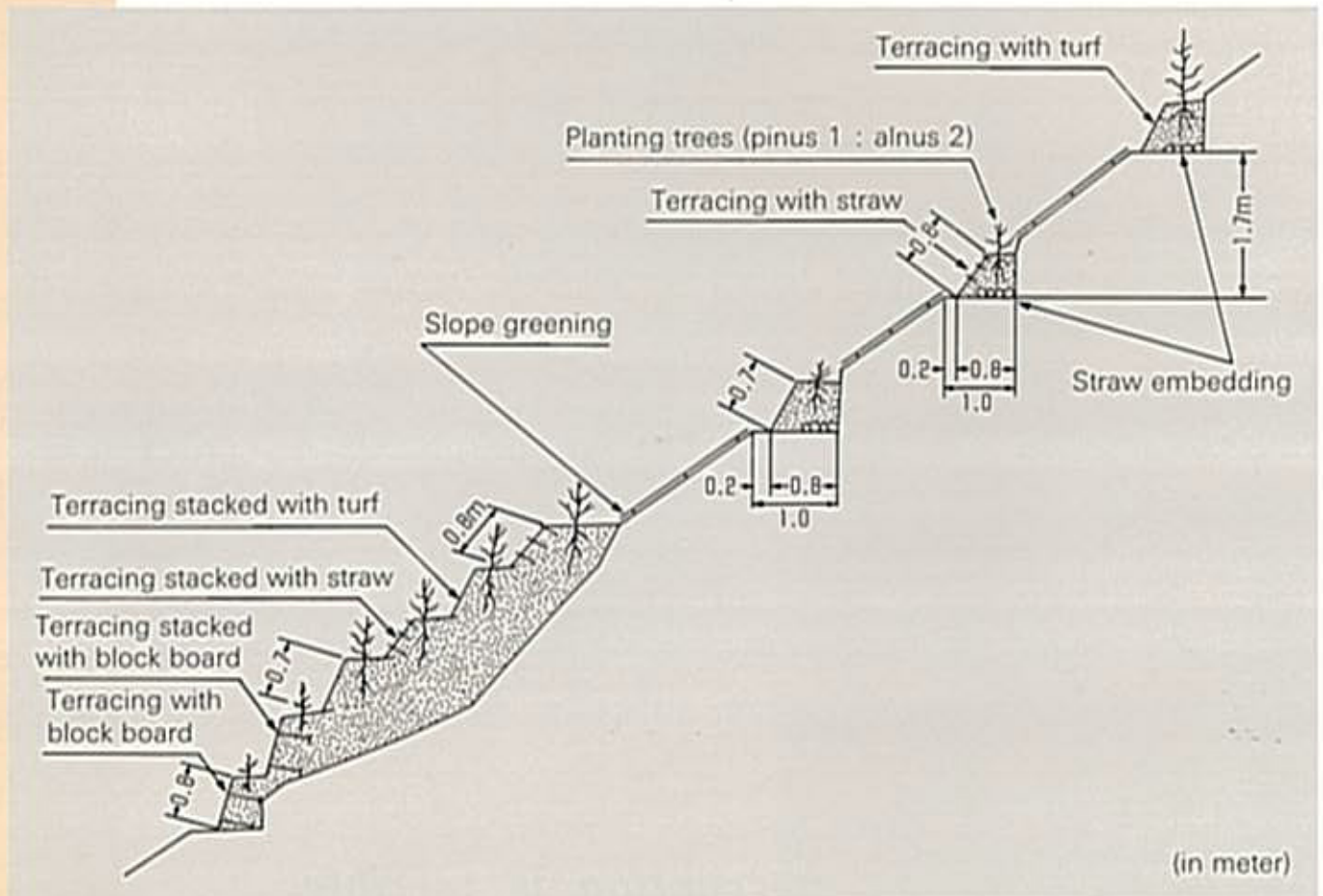
2. Hillside greening is to plant trees on the foundation.

Typical construction items included in the above categories are as follows.



Hillside work is carried out in the following sequence.

Soil retaining → Slope cutting → Terracing with block board → Hillside berms → Stabilization → Planting



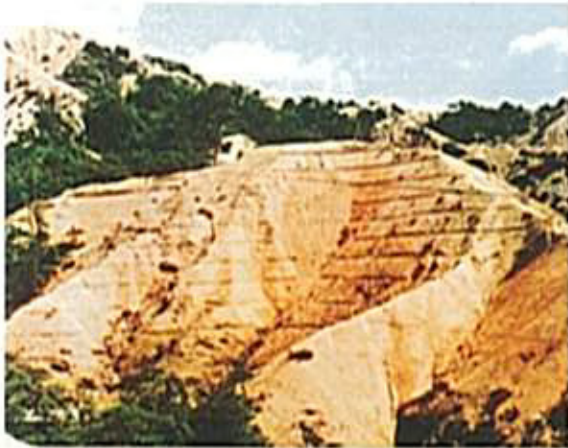
(1) Hillside Foundation Work

1) Slope cutting

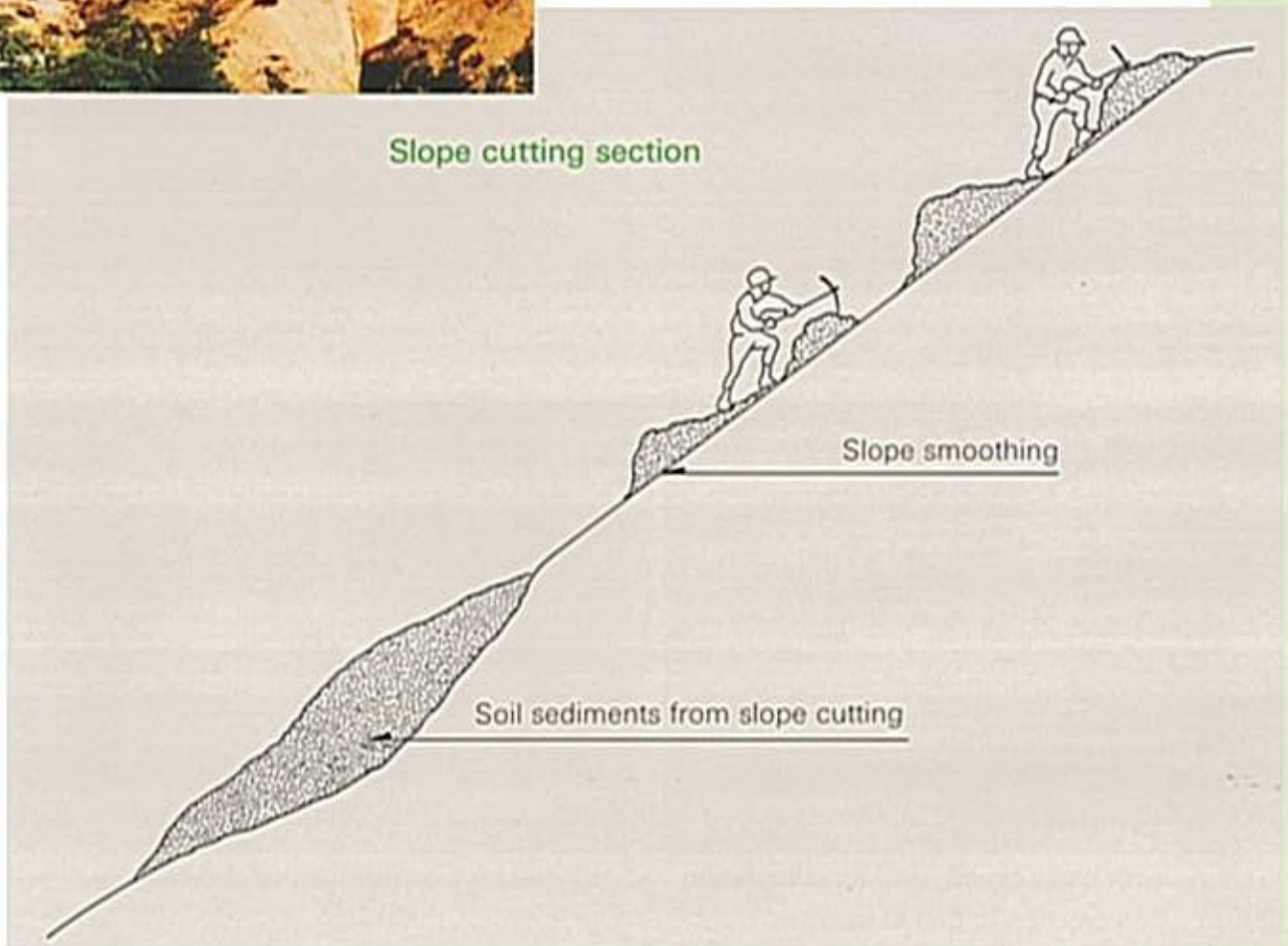
The existing slopes have irregular undulations, in cases that slopes are very steep. Therefore, it is impossible to construct hillside berms on them. Hillside berms are constructed after such undulations have been treated properly and such steep slopes have been mitigated.

Completion of Traces

Traces are to be horizontally set after the undulations have been treated.



Slope cutting and surface smoothing

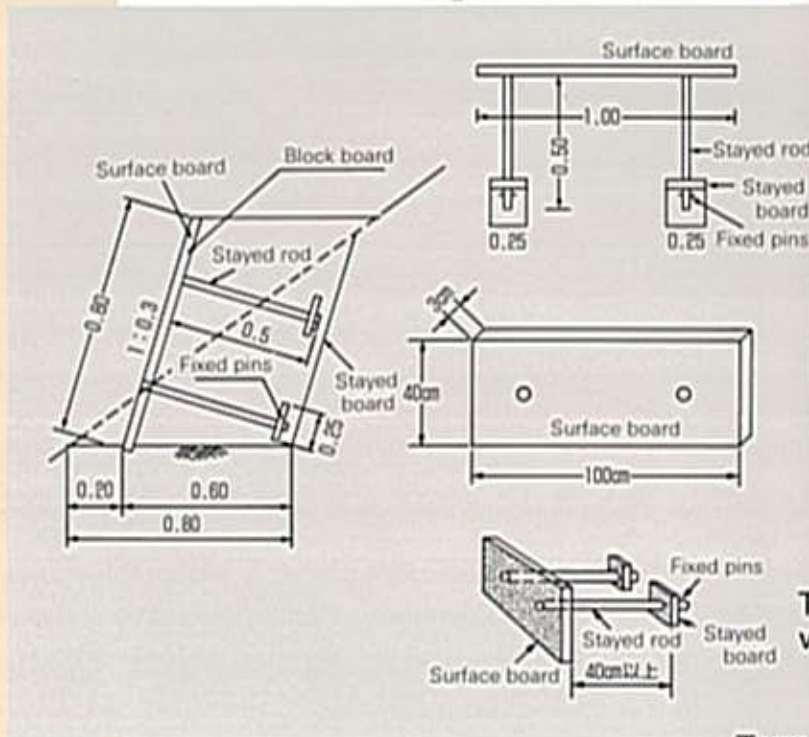


2) Soil retaining work

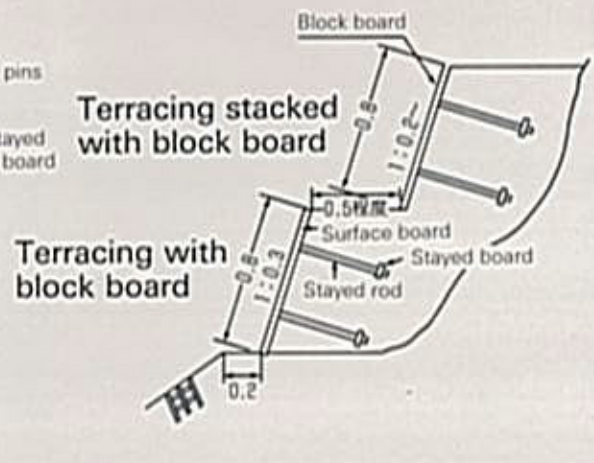
Terracing stacked with block board : Residual soil, which comes out from slope cutting and hillside step work, should be stabilized by terracing stacked with block board, otherwise it must be washed away by rainfall easily.

Terracing stacked with block board consists of three members ; surface board, stayed board and stayed pipe. These three members can be transported separately and assembled at the site, which facilitates its construction. But this method is not appropriate if large earth pressure is acting.

Structural Drawings



Completion of Excavation Bed



Quantities of materials used per 10 m

Materials	Specification	Unit	Qty	Remarks
Block board	Dimension : 1.0*0.4 m Thickness : 3 cm	(m ²) set	(8) 20	Stayed board, Stayed pipe and pins



Terracing with block board, and its completion

Stacking : Construction of bed excavation
Step stacking : For residual soil without excavation



Completion of 1st block

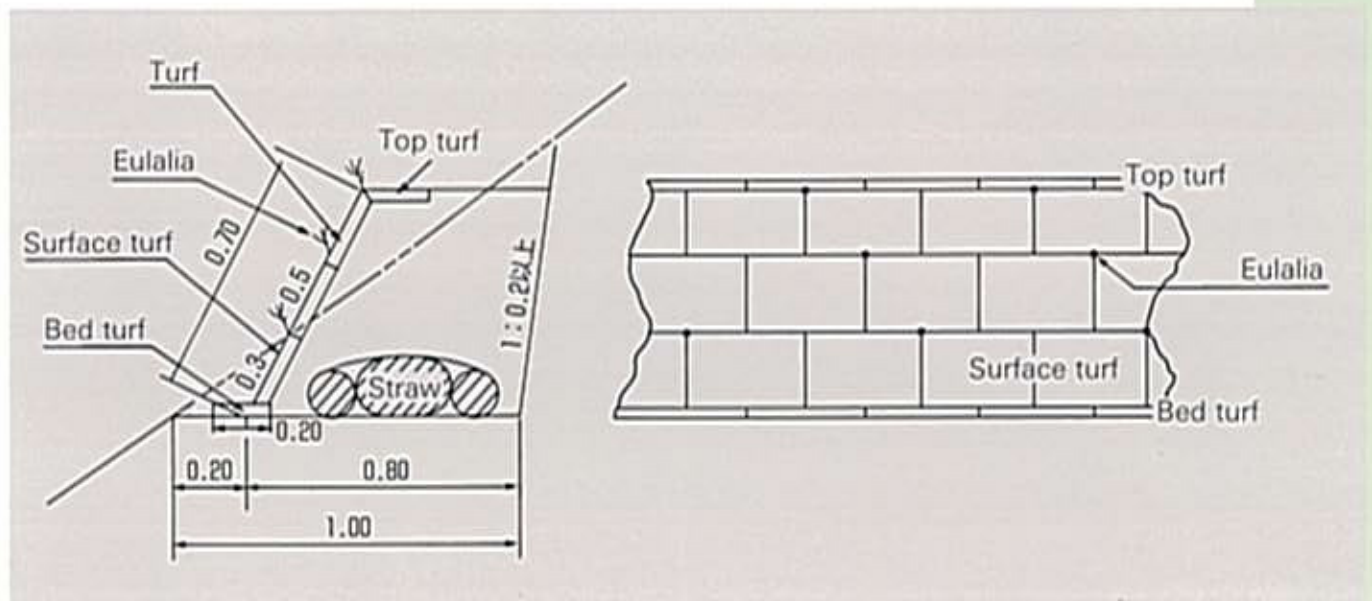
(2) Hillside Step Work

1) Terracing stacked with turf

This work constructs planting beds by making horizontal steps on the hillside to prevent erosion by rainfall and preserve wetness. A typical item is stacking seedling by use of turf or straw. Straw seedling is a supplement of turf.

Materials quantities for terracing stacked with turf

Items	Specification	Unit	Qty	Remarks
turf	over 20 cm in one direction	m ²	10	wild turf
eulalia	30 cm in length, bundled in 1 m	bundles	1	
straw	rice straw	kg	40	



Completion of slope cutting and under making steps

When slope cutting has been completed, steps with 20cm in width and around 1.7m spacing in height are being made horizontally by use of 2 poles and levelling device.



← Under bed excavation for steps

Excavation is carried out horizontally from the bottom to the top on the prescribed lines by use of breakers and picks. When bed excavation has been completed, the surplus soil is removed to the lower part.

The remained soil on the slopes is utilized as finishers.

Under bed excavation→

Excavation is being done by breakers. The width is about 1 m.



← Completion of bed excavation

When the bed excavation has been completed, their dimensions are measured and inspected by Engineer, or their pictures are submitted for inspection.

Fitting of bundles of straw→

Just after the completion of the bed excavation, bundles of straw weighing 4kg per meter are fitted to preserve water and supply organic substances.





2) Turf covering

←Under construction of bed turf

Construction of terracing stacked with turf is done from the higher step to the lower. Turf covering starts with covering of bed turf as shown in the drawing.

Under construction of 1st layer of surface turf→

Residual soil from bed excavation is filled on the back of the surface turf which stands and covers on the bed turf. And the compaction is carried out by foots and tamping tools.



←Under construction of 3rd layer of surface turf

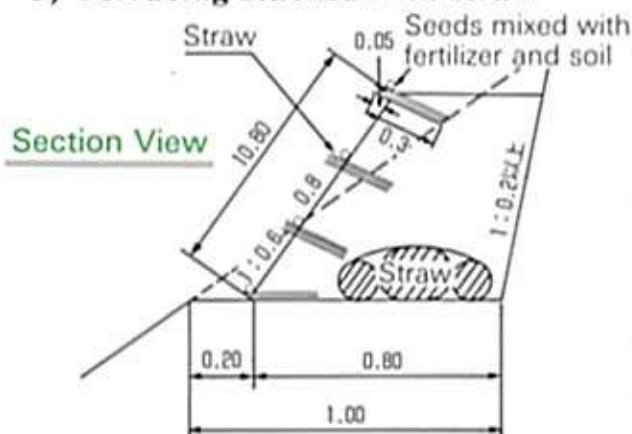
When the back-up soil is short for 2nd and 3rd layers of surface turf, residual soil of upper steps or additional excavation is utilized. Proper compaction needs skills. Besides, a bundle of eulalia per 10m is planted among the surface turf. And the top layer of turf is covered and compacted properly in the end.

Completion of terracing stacked with turf→

[Notes] It should be careful that the slope might be corrupted in spring when the turf covering is conducted in winter because of frost heave.



3) Terracing stacked with straw



Materials quantities per 10 m

Materials	Specification	Unit	Qty	Remarks
straw	rice straw	kg	60	
break-down	finishing fertilizer	kg	20	
	fertilizer	kg	40	

Seeds mixed with fertilizer and soil per 10 m

Materials	Specification	Unit	Qty	Remarks
seeds	weaving grass Kentucky.31	g	26	mix proportion 1:1
fertilizer	N:P:K 15:10:7	kg	0.66	



← Under construction of 1st step

Terracing stacked with straw is constructed from the upper steps to the lower steps as the same manner as that of the terracing stacked with turf as shown in the drawing.

Under construction of 2nd step →

The bundles of straw are cut around their root portion at about 30cm, and spread with put-out of 5 cm, which are compacted by feet and compacting tools. The direction of straw is perpendicular to the finished surface with 3 layers.

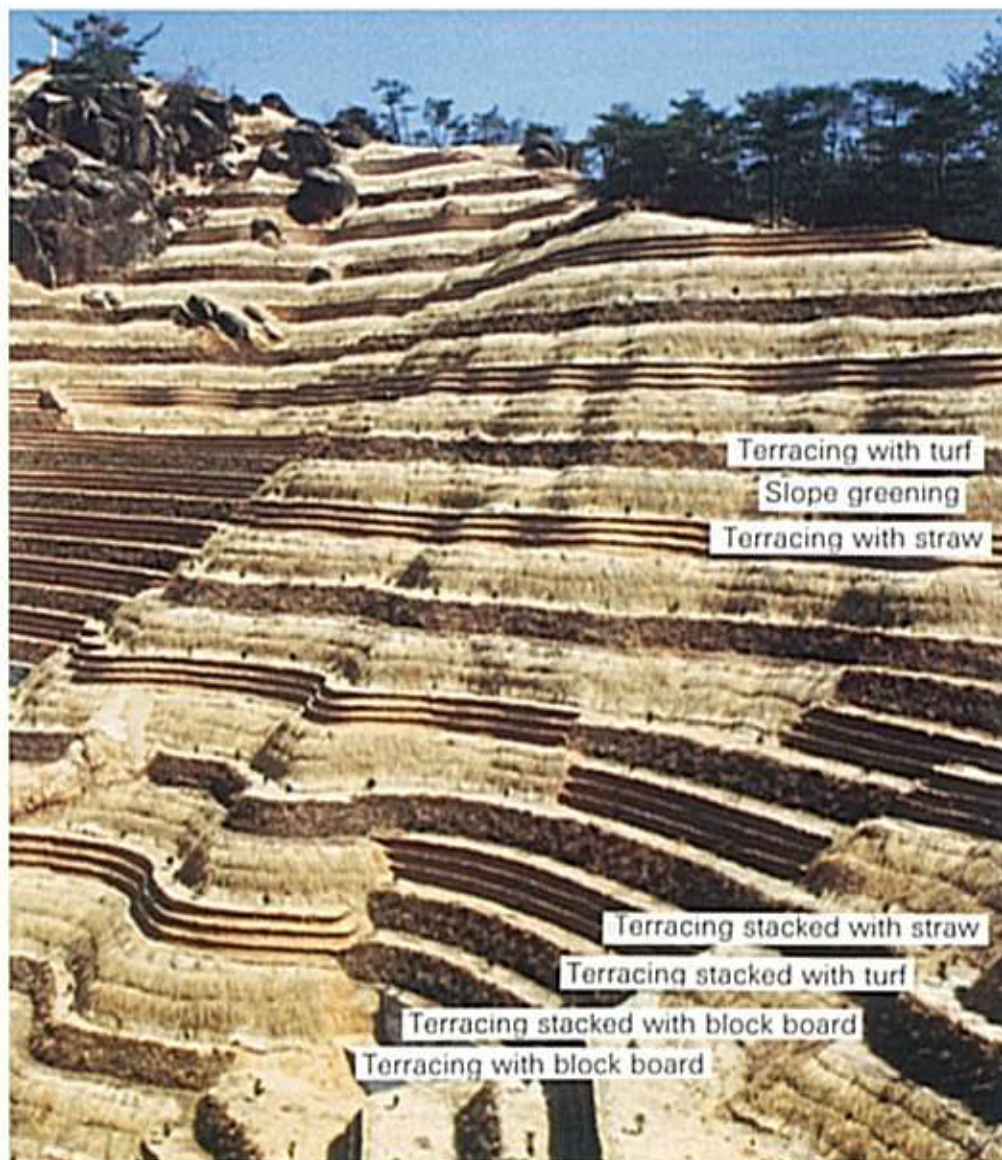
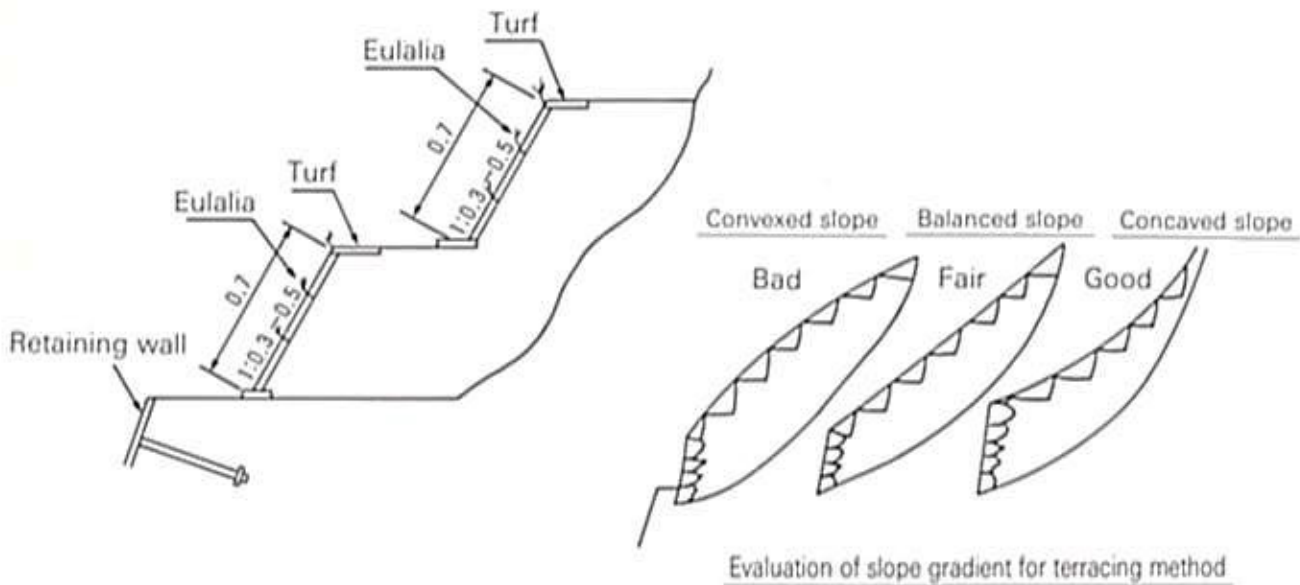


← Completion of terracing stacked with straw, seeds mixed with fertilizer and soil and seeding

Generally, the finished surface is deteriorated in 6 months, seeds mixed with fertilizer and soil are placed on the straw to make green. This method is applied where the turf is shortage, and alternately adopted with turf.

It would be desirable that the turf method be adopted all over.

4) Terracing method

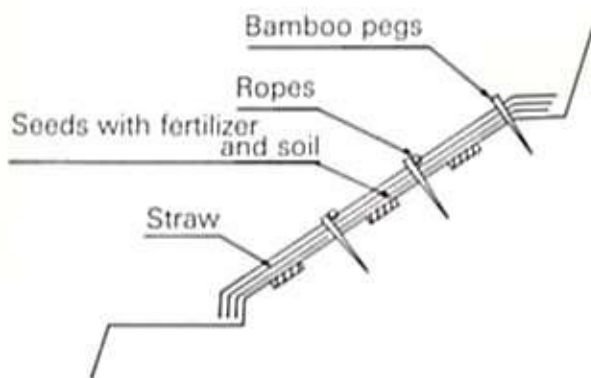


The terracing method consists of block boards as retaining walls, turf and straw walls from the lower to the upper portions, to treat sediments and minimize residual soil. If the residual soil would become large, the width of the top should be narrower, and vice versa. This method is principally the same as stacked seedling method, where no bed excavation. In addition, straw layers into the soil are not employed to prevent the deterioration of the slopes.

Slope Greening

The slope greening is conducted to prevent the erosion due to heavy rainfall in summertime, frost heave in wintertime and evaporation from the ground by covering of straw and plantings for the exposed portions between hillside slope steps.

Slope Greening and Covering



Materials quantities for slope greening

Items	Specification	Unit	Qty	Remarks
turf	20cm in length	m ²	30	wild turf
straw	rice straw	kg	20	
rope	straw rope ϕ 0.8cm	unit	1	
bamboo peg		unit	1	

Materials quantities for seeds with fertilizer and soil

Items	Specification	Unit	Qty	Remarks
seed	fern	g	13	
straw	bush clover	g	13	
fertilizer	N15:P10:K7	kg	0.66	



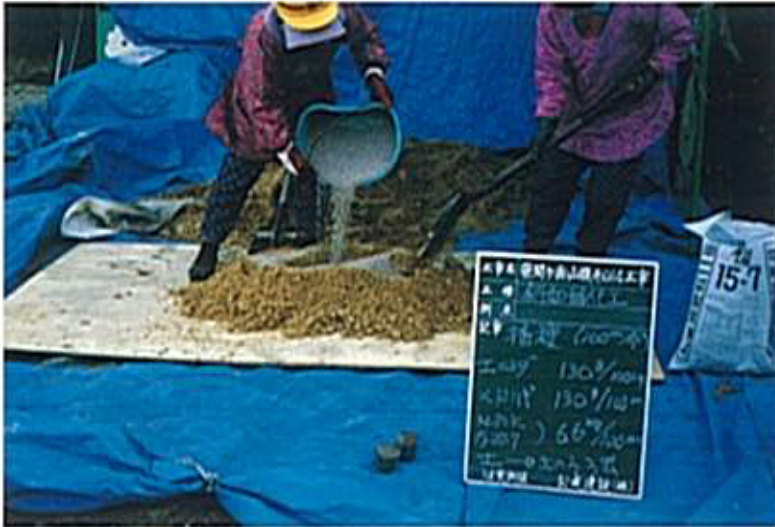
Application of lines

Three layers of lines with 10cm in width and 5cm in depth are applied on the slope between hillside steps in parallel, which becomes for bed excavation.

Turf is planted in the excavated beds on which seeds with fertilizer and soil are applied.



Turf planting and seeding with fertilizer and soil



Seeds, Fertilizer and Soil
Materials quantities per 10m :-

- 1) Seeds :
fern 13g,
bush clover 13g
- 2) Fertilizer :
N15:P10:K7 = 0.66kg
- 3) Soil :
local soil

Mixing of seeds, fertilizer and soil

When turf planting and application of seeds with fertilizer and soil have been completed, bundles of straw are set from the top and the bottom simultaneously. This straw mat is fixed with straw ropes and bamboo pegs.



Application of straw mat



Completion of slope greening and covering

Planting

Saplings are planted to make formation of forests faster where the hillside step works have been finished.

Planting is desirably conducted from the end of February to the first of April.

Trees to be planted

Female flower



Male flower of pinus thunbergii



Alnus pendula



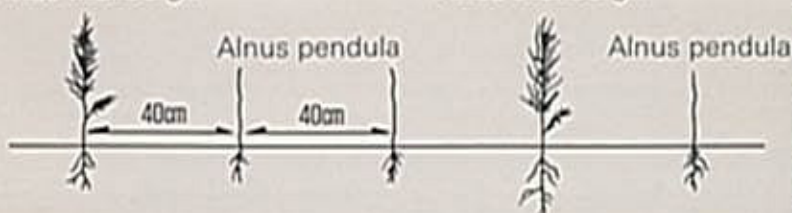
Alnus pendula

deciduous tree, low height tree, High strength of growing with slender branches, a several flowers are blooming, nationwide tree

Items	Saplings	
	pinus thunbergii	alnus pendula
Type of tree	pinus thunbergii	alnus pendula
Specification	two-year old bottom diameter : over 7mm height : over 25cm be confirmed for sound growing	one-year old bottom diameter : over 3mm height : over 20cm be confirmed for sound growing
Spacing of planting	Terracing with block board, Terracing with turf and straw : 80cm Excavated bottom : 40cm	Terracing with block board, Terracing with turf and straw : 80cm Excavated bottom : 40cm
Planting ratio	1	2
Fertilizer	N13:P17:K8 = 30g/tree	N6:P12:K8 = 30g/tree

Pinus thunbergii

Pinus thunbergii





←Temporary planting of saplings

- (1) Purchased saplings should be transported speedily to the temporary planting site to avoid damages and death.
- (2) The number of saplings should be limited to be done in a day. If some saplings are remained, proper care must be needed.

Planting and fertilizing→

- (1) Saplings of *alnus pendula* are to be cut at 1/3, or 20cm when they are taken from the temporary planting site.
- (2) Planting beds are 20cm both in diameter and depth. But, it should be cared that those bed be prevented in a dry condition.
- (3) Planting should be conducted not to be too shallow, to make slender roots scatter, and to fill the soil with proper compaction.
- (4) Fertilizers are buried in 20cm depth, 10cm apart from the planted trees. Direct contact should be avoided



Completion of Hillside Works



Before construction



After construction

Maintenance Work

Thinning and fertilizing as a maintenance work are conducted after planting in 4,7 and 10 years later.

1) Thinning

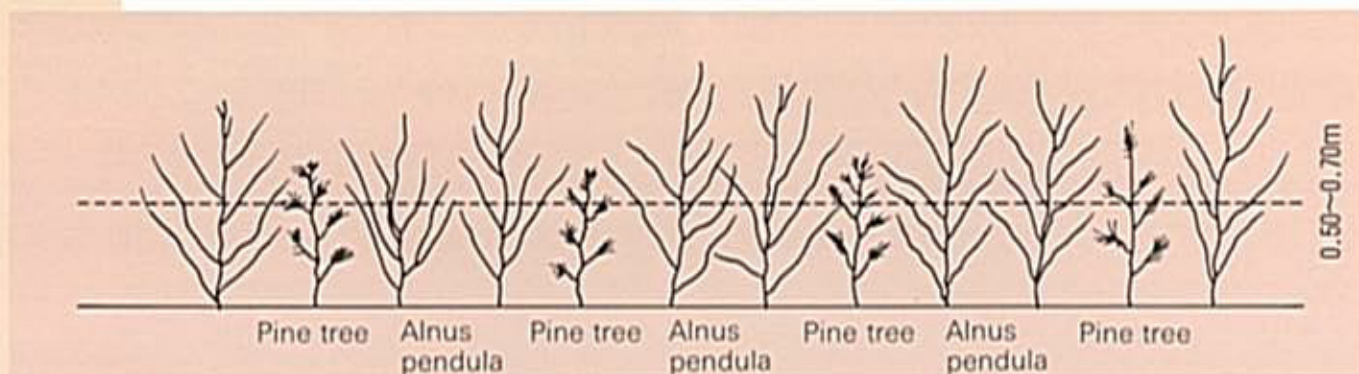
Pine trees (main trees) and alnus pendula (fertilizer trees) are mixed to be planted. The growing speed of alnus pendula is faster than that of pine trees, resulting in pressure occurred to pine trees. Thus, alnus pendula is to be cut at 0.5-0.7m height as shown below. Debris of alnus pendula is utilized as a fertilizer for pine trees.

2) Additional fertilizing

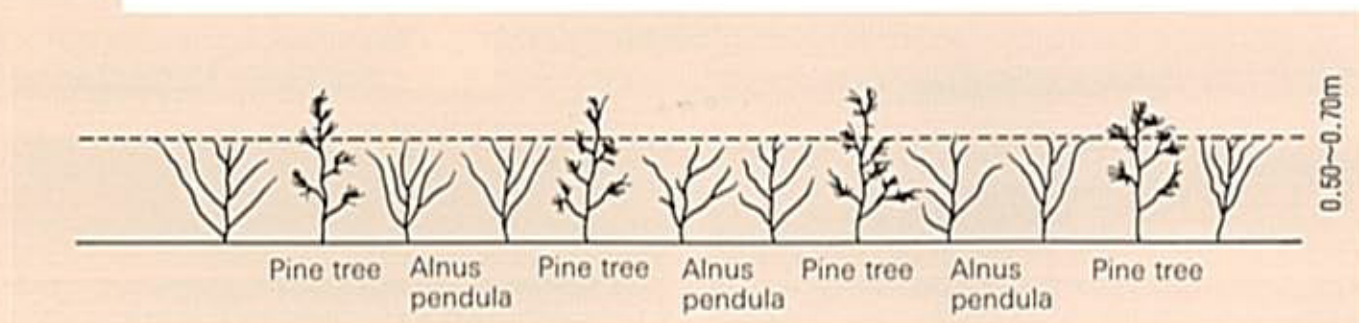
As to the poor mountains in terms of nutrition, the growing speed of pine trees will be decreasing due to the lack of fertilizers. Thus, additional chemical fertilizing is conducted at the rate of 1 ton/ha of (N13:P17:K12). As for Mt. Tanakami, additional fertilizing is conducted by helicopters.

Typical Drawing for Maintenance Work (Thinning)

Before work



After work



[Notes] This hillside work in this brochure is a construction method appropriate for mountains to be covered with decomposed granite.

Comparison of Mt. Tanakami between Meiji Era and Present

Meiji Era (taken in 1908)



Poor land can be seen, even though hillside work was conducted from the end of Edo Era to the first of Meiji Era.

Present (taken in 1994)



Basin of Kichijoji River, Tanakami-Nakano Town, Otsu-City



Poor land can be seen, even though hillside work was conducted from the end of Edo Era to the first of Meiji Era.



**Armor type of dam completed in 1889, (H=6.8m, L=42.0m)
Basin of Tenjin River, Tanakami-Sato Town, Otsu-City**

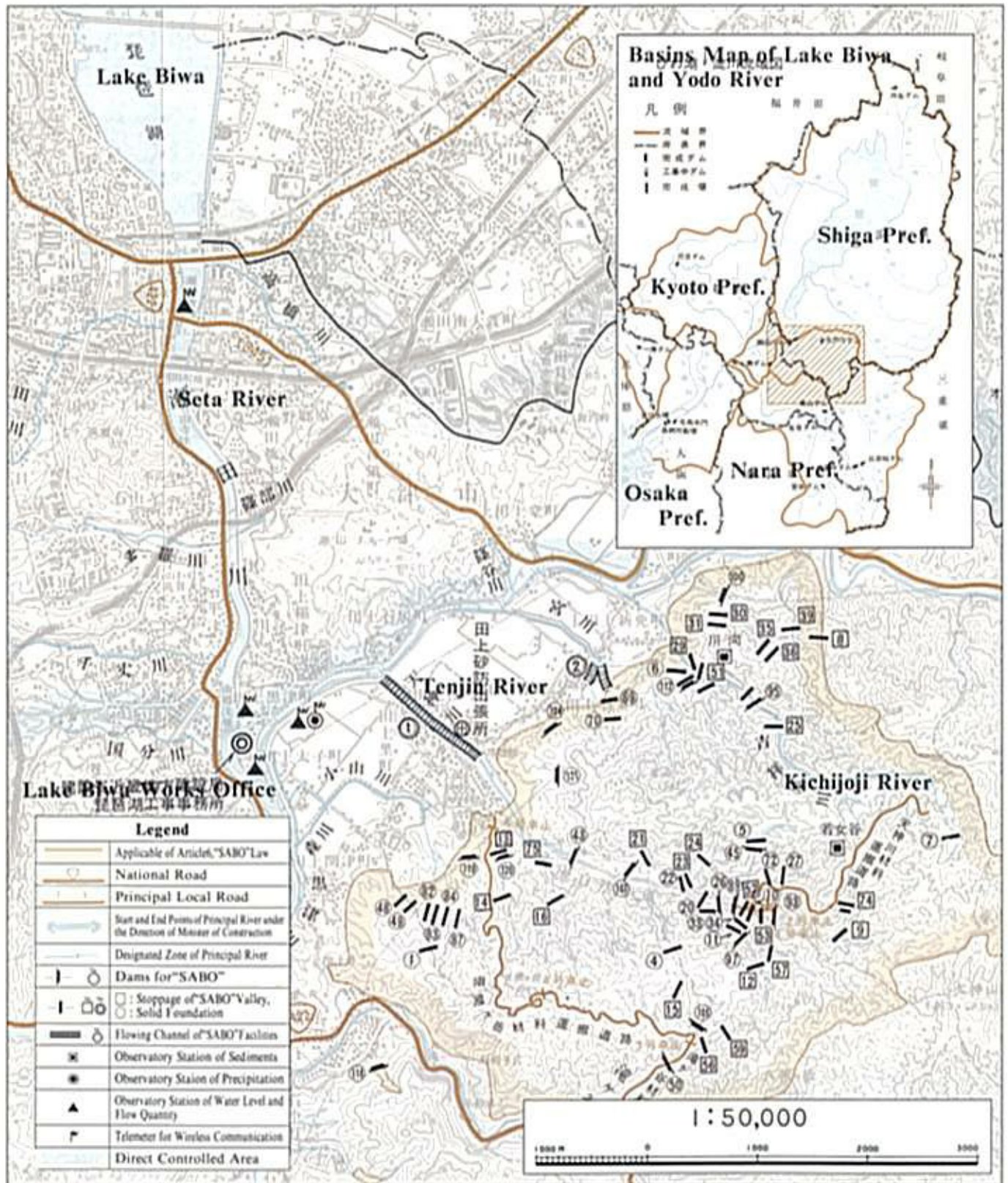


Poor land can be seen, even though hillside work was conducted from the end of Edo Era to the first to Meiji Era.



Mt. Sasamagatake, Tanakami-Sekitsu Town, Otsu-City

It would take more than 100 years and a great amount of money to recover beautiful mountains with lots of green.



***Integrated efforts
to prevent
Sediment Disasters***

**Lake Biwa Works Office
Kinki Regional Construction Bureau,
Ministry of Construction**

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