HILLSIDE REPAIRS USING WIRE NETTINGS AND LIVING BRANCHES OF WILLOW IN SNOWBOUND DISTRICT

By

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ヤナギ粗だを用いた積雪地帯の金網張山腹工

東　三　郎

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Introduction

Where natural vegetation has been removed and bare soil is exposed to impact of heavy rainfall or to rapid snow melt, particles of the surface soil are loosened and moved down the slope by surface flow and snowslip. So temporary structures such as terracing (with sod, grass, wicker fence) and brush covering are used primarily to aid the establishment of vegetation by checking runoff and erosion.[5)7)]

Recently, vegetation is developing to recover whole surface in cold districts. This work is purposed not only efficiently to prevent the freezing of soil, but is appropriate for the control of sheet erosion. There are compact vegetation blocks, mulch nets, erosionnets and straw mats for this work. Jute or twisted-paper nettings are used to hold the straw elements of other mulch on the slope while seeds germinate.[3)]

But seeding and planting require bases fixed on the slopes in snowbound district. In early spring the surface soil of the slopes is moving down when the snowdrifts slip. The snowdrifts have effect to protect the slopes against freezing,[4)]

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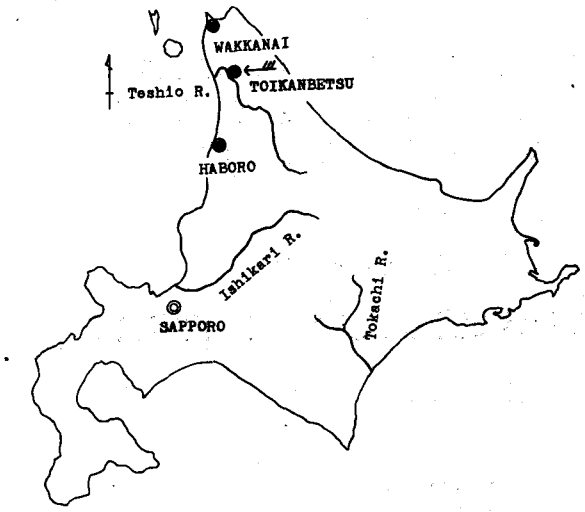


Fig. 1. Site of experiments

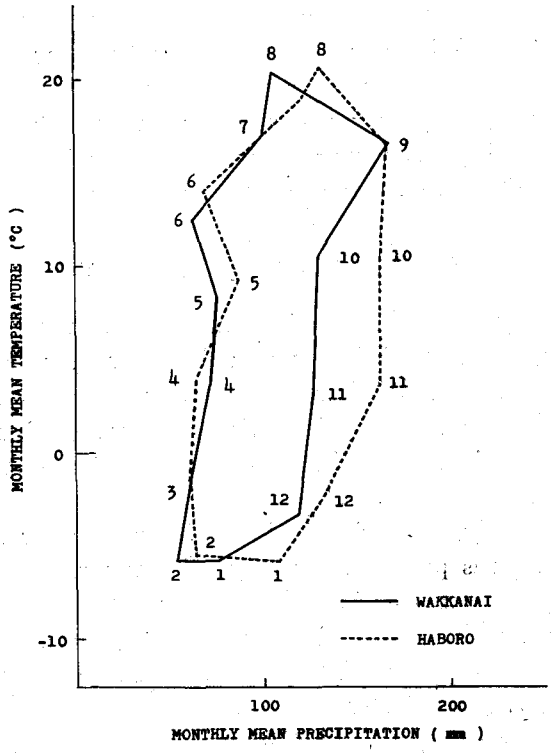


Fig. 2. Climograph of the northen part of Hokkaido.

WAKKANAI (E 141° 41′, N 44° 25′): 1937–1950
HABORO (E 141° 42′, N 44° 22′): 1921–1950

but on the other hand their down-movements denude the surfaces of the slopes. Wire nettings are used to control gully erosion as the V-type check dam and suspended-net one employed in U.S.A.[1)2)]. The writer has recognized effects of the wire nettings from a new point of view.

The writer is indebted to Dr. N. MURAI for valuable advice and encouragement, to Mr. K. FUJIWARA for helpful discussions and to Mr. Y. AIZAWA for technical assistance.

Methods and Materials

The experimental place is a part of the 2 nd Teshio experiment forest of Hokkaido university in the Teshio river basin (Fig. 1).

The climatic conditions of Wakkanai and Haboro are shown in Fig. 2[8)]. Snow depth in this place is about 1 meter every winter. Geologically this region consists of layers of tertiary materials.

The hillside employed faces toward the south-east and its surroundings are covered with Sasa (*Sasa palmata* NAKAI) since former forest fires had destroyed the trees (Plate 1–1).

The plots A and B were prepared on the 7 th of November, 1960. The surface of the plots is covered with pieces of incomplete weathering shale (Plate 1–2); its incline is at 38 degrees. Each plot is 6 meter wide and 20 meter long. Plot A was covered with poles, pegs, wire netting, living branches of willow, but plot B was without wire netting.

Materials are as follows;

1. Wire netting
   - Wire gauge: No. 22 (B.W.G.)
   - Size of mesh: 60 mm wide in hexagon
   - Width: 0.9 m
   - Length: 30 m
   - Weight: 5.5 kg (entire 30 m length)
2. Wire
   - Wire gauge: No. 10 (B.W.G.)
3. Poles
   - Species: Alder, Birch, Pine etc.
   - Length: 2.0–3.6 m
   - Diameter: 6–10 cm
4. Pegs
   - Species: hardwood
   - Length: 0.6–1.2 m
   - Diameter: 5–8 cm
5. Willow brush
   - Species: *Salix sachalinensis* FR. SCHM.
     Salix Pet-susu KIMURA

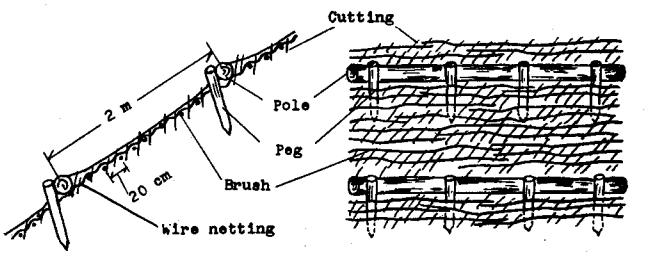
Age of branches: 1–4 years
Length: 1.5–3.0 m
Diameter: 1–2 cm

6. Willow cuttings
Species: *Salix sachalinensis* Fr. Schm.
Salix Pet-susu Kimura
Age of cuttings: 2–4 years
Length: about 30 cm
Diameter: 1–3 cm

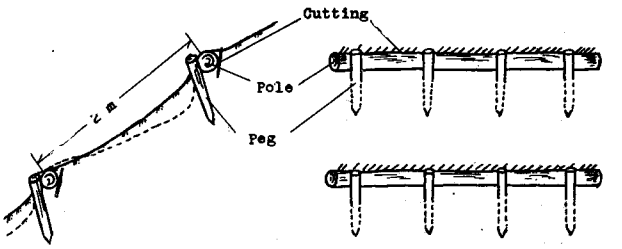
Plot A was prepared in order:

1. Wire nettings were spread over the ground surface and fixed by means of poles (Plate 2–1, 2).
2. Wire nettings were horizontally interwoven with willow brush (Plate 2–3).
3. Willow cuttings were planted as much as possible through meshes of the nettings (Fig. 3).
4. Wire nettings, brush and cuttings were all covered with soil to the depth of about 3 cm.

On plot B, the poles were horizontally fixed by means of pegs and cuttings



Plot A



Plot B

Fig. 3. Construction of the plots.

of willow were planted below the poles (Fig. 3).

Table 1. Number of sproutings about 75 days after thaw on plot A (Jun. 26, 1961)

Heights of sproutings (cm) \ Measured section (1m×1m)	a	b	c	d	e	f	g	h	i	j	Total
2			2		1						3
3			11	5	1	2	1			2	22
4			16	7	3	3	5	1	5	7	47
5	4	2	24	7	6	11	11	2	3	9	79
6	4		20	10	10	8	7	6	5	4	74
7	1	2	14	10	1	5	7	3	2	7	52
8	3	1	7	12	3	4	3	3	4	1	41
9	1		9	2	1	3	1	2	3	2	24
10	3	1	2	6	6	6	10	13	5	12	64
11	1			3	2	1	1	1		1	10
12		1	9	4	7	1	6	13	5	6	52
13		2	3		3	1	2	5	1	2	19
14		1	3	3	2		2	5	1	9	26
15		2	4	4	2	1	7	6	5	3	34
16			1		3	1	5	2	1	1	14
17		1		3	1	4	7	2	3		21
18			2	2	3		3	2	2		14
19						2			1		3
20		1	2	1	5		1	10	4	4	28
21			1								1
22		1	2	1	1	2	1	4		1	13
23				1	2		3				6
24					1				1	2	4
25	1	1			4		1			1	8
26				2	2		1	1			6
27						2	2	1	1	1	7
28						1					1
29											—
30			1	1	2	1		3	5		13
31											
32							1			1	2
33					2						2
34											—
35				1	1	3	1	2	1		9
36											—
37											—
38											—
39											—
40					1						1
41											—
42									1		1
Total	18	16	133	85	76	62	89	87	59	76	701

Table 2. Heights of sproutings on plot A (1961)

Date	Measured section / Heights of sproutings (cm)	a	b	c	d	e	f	g	h	i	j	Maximum	Average
Jun. 26	Maximum	25	25	30	35	40	35	35	35	42	32	40	33
	Average	8	13	8	10	14	11	12	14	14	11	14	12
Aug. 4	Maximum	65	110	100	95	85	85	95	65	95	80	110	88
	Average	30	50	50	50	50	35	45	30	40	40	50	42

Results

The plots were covered with snow within about 30 days after establishment. On the plots the maximum snow depth was 120 cm in the middle of February; it melted away in the middle of April, 1961. In that place the snow is likely to slip in early spring; however, snowdrifts on these plots did not slip but melted away gradually in the lower part at first (Plate 3–1.) After thaw the surface of plot A became rough as the soil on the netting had been pushed down by the snowdrifts (Plate 3–2).

In the middle of May many brushes and cuttings sprouted out about 3–5 cm in height (Plate 3–3). At the end of June the most part of plot A was covered with sproutings of willows of which the number and heights are shown in Table 1 (Plate 4–1, 2). In June the number of sproutings was 16–133 per square meter (70 on the average) and the heights were 5–40 cm (12 cm on the average). Early in August the sproutings grown up 55–110 cm (42 cm on the average) (Table 2) (Plate 5–1, 2).

On plot B, cuttings sprouted out in horizontal lines on the slope (Plate 6–1, 2).

Discussion

The poles horizontally laid on plot A had the following advantage for this work;

1. They were used for footholds during the work.
2. They held the wire nettings.
3. They prevented snowslip on the slope.

The wire nettings promoted to rooting of brush and cuttings of willows, because the netting controlled the movement of surface soil. Plate 5–1 shows plot A about 110 days after thaw. The plot with a wire netting presented an overall green appearance. On plot B the surface soil below the poles was moving down. So it is difficult to expect natural revegetation in these parts.

Used willows prefer moist soil such as river bank and swamp, but their

sproutings grow up sufficiently.

Table 3. Air temperature and soil conditions (Jun. 1961)

Observed		Air temperature (°C)	Earth temperature (°C)				Soil moisture (%)				Weather
			in depth (cm)				in depth (cm)				
date	time		0	10	20	30	0	10	20	30	
20	3 p. m.	27.0	31.8	28.0	21.4	19.2	8.1	22.5	24.5	22.3	Cloudy
21	3 "	17.5	17.2	17.2	17.2	16.8	25.0	26.5	24.4	24.4	Rainy later cloudy
22	3 "	26.0	33.6	25.1	18.8	17.0	19.2	24.4	24.4	25.9	Fine
23	3 "	26.3	34.2	29.1	23.8	19.0	16.0	22.5	24.6	23.7	Fine

June is the driest month in this region. Table 3 shows the temperature and the soil conditions on the plots at the end of June. The soil moisture was low, but sproutings of willows did not wilt away. Judging from this fact, it is possible to use willows which would naturally grow on river banks for hillside repairs.

The woven brush could prevent the washing away of the covering soil. A brush paving under old type procedures had not been expected to develop sprouts, but the wire netting interwoven with the living branches of willows has a remarkably important point in respect to the purpose to encourage sprouting from the willow branches.

Fall and spring are clearly the best seasons for this work. Fall is better than spring in cold regions, because the cuttings of willows can not root easily at once after thaw in snowbound districts. The best seasons for rooting are the flowering ones. On the other hand, cuttings and branches planted in fall can root out early in the succeeding spring[6].

Strength of the wire nettings and poles had not declined one year after establishment. One needs not to be afraid of the rotting of the nettings and poles, if only the slope is covered with green in a short term. Because their expected lives must be consistent with the expected time required to secure a permanent protection cover of vegetation.

Conclusion

The ultimate purpose of erosion control works is to make possible the restoration of natural control through the growth of vegetation. But in disintegrated lands where climatic and other conditions are unfavorable, vegetation will not easily reestablish itself without the helpful effort of human powers.

In this experiment it is proven that the branches of willows are effective materials for preventing erosion with nettings aiding recovery of vegetation cover on the slopes in snowbound district.

The willows are species suitable for swamp and moist grounds, finding their habitats from sea level to the tops of mountains. Remarkable characteristics are

their quick growth from cuttings and vigorous persistent sprouting from cut stumps at any age. So they are clearly important for erosion control works to bind shifting soil on denuded hillsides, road banks and stream banks.

When the nettings are horizontally interwoven with stems of Sasa or with straw rope and are covered with soil, seeds and fertilizers, the appearance of green cover on the slope may be expected in a short term.

(Jan. 14, 1962)

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要　　約

融雪期に裸地斜面の表土は大小のナダレによって動かされ，さらに積雪被覆のなくなった斜面では凍上による崩落土が多くなる。

この試験は積雪寒冷地帯の植生の自然侵入が困難であるとおもわれる場所で，川岸に多いヤナギ（ナガバヤナギ，エゾノキヌヤナギ）の粗だとさしきをやわらかい金網の網目にかけて斜面上に維持し，短期間に植生被覆を再現させようとしたものである。

1. 金網をおさえるために用いた横木は作業中の足場となり，融雪期のナダレを防いだ。

2. 金網と粗だは表土の流亡を防ぎ，施工面を安定させた。

3. 金網は斜面上にさしきを固定した。

4. ヤナギの粗だとさしきからのぼう芽は平均70本/m² で，1夏経過後に55～110 cmに生長し，十分に斜面を被覆した。

5. 川岸に自生しているヤナギ類といえども，この地方の山腹に使用することができる。

6. 金網に，ササや縄をあみつけ，種子と肥料を混ぜて浅く覆土すると短期間で植生被覆を期待できる。

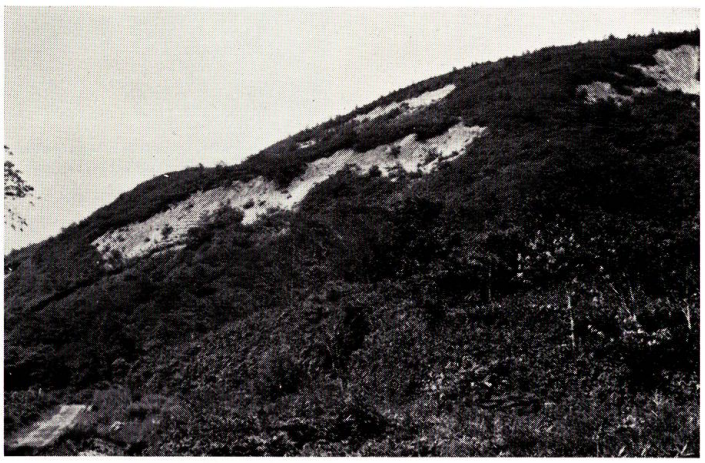

Plate 1-1. View of the hillside site.

Plate 1-2. A incomplete weathering shale on plots.

Plate 2-1. Wire netting.

Plate 2-2. Spread nettings are settled by means of poles on the slope.

Plate 2-3. Nettings are interwoven with willow brush (Nov. 7, 1960).

Plate 3–1. Spring view of the plots (Apr. 12, 1961).

Plate 3–2. Sproutings about 30 days after thaw (May 13, 1961).

Plate 3–3. Ditto.

Plate 4

Plate 4–1. Sproutings about 75 days after thaw on plot A (Jun. 26, 1961).

Plate 4–2. Ditto.

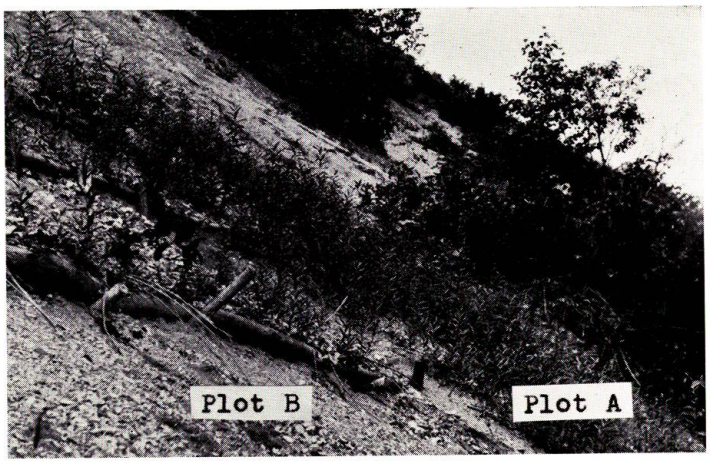

Plate 5-1. Sproutings about 110 days after thaw on plot A (Aug. 4, 1961).

Plate 5-2. Ditto.

Plato 6-1. Sproutings on plot B in summer (Aug. 4, 1961).

Plate 6-2. Roots of the cuttings below the poles on plot B (Aug. 4, 1961)