EROSION CONTROL WORKS IN KOREA

IICA/JAMAICA

1981

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Bo-Myeong Woo, Ph. D.

IICA in Jamaica

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F O R E W O R D

In June 1977, the IICA Office Director after his presentation of credentials, visited the different diplomatic representatives accredited in the country. Among these was the Embassy of the Republic of Korea.

Dr. Woonsong Choi, Korean Ambassador indicated that "the Koreans were the masters of hillside farming" and that Korea would be happy to cooperate with the Government of Jamaica and IICA. Further conversations and contacts led to the signature of a tripartite agreement between the Government of Jamaica, the Government of Korea and IICA in August 1979.

Based on the above agreement, Dr. Bo-Myeong Woo was brought to work with IICA and he was asked by IICA to monitor the Olive River/Jamaica Experimental Station.

Dr. Woo is professor of Forestry and Soil Conservation at the Seoul National University. He finishes his contract with IICA in February 1982 and returns to teaching.

Dr. Woo has demonstrated ability, capacity and resilience in dealing with the day to day problems. All the staff of IICA/Jamaica have great personal and professional regard for him.

It is with great pleasure that IICA/Jamaica supports the seminar of Dr. Bo-Myeong Woo.

Percy Aitken-Soux
Director

EROSION CONTROL WORKS IN KOREA

EROSION CONTROL WORKS IN KOREA [1/]

Bo-Myeong Woo, Ph.D.[2/]

ABSTRACT

This paper attempts to present some major information on the erosion control works in Korea and reviews briefly the environmental problems associated with soil erosion.

Korea is a peninsular country located in east Asia, having an area of about 221,000 km² including the northern part of Korea. Average annual precipitation is about 1,200 mm. About 67% of the total land belongs to forest-land of which more than 10% had been denuded by the 1950's. As a result of continuous efforts on the part of the Korean Government to rehabilitate the denuded land, it now occupies only about 1.5% of forest-land area.

The Village Association of "Saemaul Undong" (New Community Movement), has been participating as a core organization in carrying out erosion control projects from 1970, and contributed remarkably to the successful completion of the projects.

1. Environmental Factors in relation to Forest Denudation

The Korean peninsula is approximately 1,000 km in total north-south length, and 216 km wide at its narrowest point. The peninsula and all of its associated islands lie between 124°11' and 131°53' east longitude, and between 33°06' and 43°01' north latitude, having an area of 221,325 km², or about 86,000 square miles including the northern part of Korea.

1/ This will be presented by using colour slides.

2/ The author is an Associate Professor, College of Agriculture, Seoul National University in Korea, and has been assigned as an Associate Personnel of IICA/Jamaica's Soil Conservation Project under a tripartite agreement between the Inter-American Institute for Co-operation on Agriculture, the Republic of Korea and the Government of Jamaica since August 1979.

Geological distribution in Korea consists of 66 per cent of Paleozoic strata and 34 per cent of the Cenozoic strata. Distribution of the main bedrocks is as follows: 37 per cent igneous, 43 per cent metamorphic, and 20 per cent sedimentary rocks. Granite and gneiss occupy as wide as 55 per cent of all land area and the remainder is covered by igneous rocks such as basalt, porphyry, tuff, etc., and also such sedimentary rocks as limestone, shale, argillite, sandstone.

Korea belongs to the temperate zone which is in the middle latitude region. During the summer time, it is hot and humid having much rainfall, while it is cold and dry in the winter season. Average annual precipitation is about 1,156 mm, ranging from 800 mm to 1,500 mm.

Major forest soil is the "brown soil", which is largely unsaturated. "Yellow soil" is distributed along the west and south coasts. Podozolic soil is found in high mountain areas.

Forest-land as of the end of 1979 is about 6.6 million hectares or 67% of a total land area of about 10 million hectares. Forest-land can be subdivided into 6,120,000 hectares (92.6%) of stocked and 480,000 hectares (7.4%) of unstocked forest land. Average growing stock volume per hectare is estimated at 17.33 m^3. Forest-land area by ownership shows that national forest accounts for about 20%, and privately owned forest and public forest accounts for the balance.

Mainly because of the interaction of steep slope and climatic conditions, i.e. great difference in temperature during summer and winter, and concentrated rainfall in July and August, forest lands have been subject to soil erosion resulting in the denudation of land. Concentrated rainfall during July and August amounts to almost 2/3 of the annual precipitation, and it has frequently created severe surface run-off and soil erosion, including mass soil erosion such as landslides and debris avalanches.

Much of the top soil has been continuously lost creating sedimentation along the streams, and this sediment has also resulted in the formation of an elevated stream bed which leads to serious flood damages. Once the top soil is lost the revegetation and restoration of the deteriorated forest-land is quite impossible within a short time. Devastated forest-lands can no longer perform their water-holding function and become one of the main reasons for severe drought damages. Along the coast-line the damages have been worsened by the drifting and moving of sand which causes much damage to houses, crop fields, fishing areas, livestock, and even loss of human lives.

2. Principal Policy for the Erosion Control Projects

The erosion control works are aimed at preventing soil erosion including landslides as well as rehabilitating eroded lands by putting various kinds of soil conservation measures such as some engineering structures in place, and planting soil conserving plants. The necessity and urgency for the erosion control projects have always been reflected in forest policy in Korea.

The areas in need of treatment for control of soil erosion were divided into fourteen (14) "wide-eroded regions" and nine (9) "peculiar-eroded regions", based mainly on the geographical situations. All available information for planning and executing the projects should be concisely recorded on a regional basis on the Erosion Control File, including the relevant Erosion Control Map.

The lands to be treated with erosion control measures within a given region were classified into four categories: (a) general erosion control project area, (b) special erosion control project area, (c) barren-land revegetation project area, and (d) erosion control planting project area. The criteria for classification are primarily based on the characteristics of severity and topography of the eroded land, and also consequently on the erosion control measures to be adopted.

Erosion control projects have always been undertaken under the principle of the "complete rehabilitation of denuded land regions through the erosion control project itself" according to the priority given to each region. To accomplish the successful completion of erosion control projects, every stage of the works from land survey for planning to final execution of the works has always been done with the combined exercise of training for the personnel and improvement of erosion control techniques.

For organizing a more efficient office system, in terms of strong administrative channels among the offices of government organizations concerned with the erosion control projects, the "stairway system" has been developed and mobilized from the Office of Forestry to the Erosion Control Station at the field level including Forest Offices at city and county level.

As a result, the Government has successfully completed the rehabilitation of about 42,000 hectares of eroded lands through the erosion control projects during the first 10-year Forest Development Plan. The Government has again established another 10-year plan for erosion control projects for the rehabilitation of 78,400 hectares of denuded lands in the second 10-year Forest Development Plan (1979-1988), and this plan is operating at present.

In field operations and practices for execution of erosion control projects, the Village Association of "Saemaul Undong" (New Community Movement) has been participating as a core-organization from 1970. The "Saemaul Undong" based on the spirit of diligence, self-reliance and co-operation is the movement for better life. Saemaul Undong aiming at the modernization of Korean society, was started in 1970, and has been instituting encouragement and self-confidence in the minds of the rural people, as well as those in the urban area, and has resulted in great changes and improvements of living standards and environments in the society.

In the field of erosion control projects, the people particularly in the rural areas have been, at their best, working very hard for the rehabilitation of the denuded lands with the Saemaul Undong spirit, and has resulted in the completion of the first 10-year project.

3. Main Erosion Control Measures

(1) Erosion Control Measures in the Denuded Forest-lands

Main measures for control of soil erosion in denuded forest-lands are: slope-grading, stepped mini-terrace sodding, (serrated cut-slope) terracings, underground-laying, stone masonry, strip-sodding, terrace-sodding, straw-mat matting (mulching), soil arresting structures, erosion check dam, hill-side drain improvement works, and direct seeding and planting practices.

Main tree species for soil conservation planting are: *Pinus rigida*, *Alnus tinctoria* var. *sibirica*, *Alnus firma*, *Lespedeza cyrtobotrya*, *Lespedeza bicolor*, and *Robinia pseudoacacia*. Main native grasses and legumes used for soil conservation by direct seeding on denuded hillsides are: *Arundinella hirta* var. *ciliata*, *Themeda japonica*, *Cymbopogon georgingii*, *Miscanthus purpurascens*, *Miscanthus sinensis*, *Zoysia japonica*, *Carex lanceolata* var. *nana*, *Casia nomame*, *Lespedeza cuneata*, *Lespedeza striata*.

Main exotic grasses introduced mostly from the United States of America are bahia grass (*Raspalum notatum*), Bermuda grass (*Cynodon dactylon*), Kentucky bluegrass (*Poa pratensis*), creeping red fescue (*Festuca rubra*), weeping love grass (*Eragrostis curvula*), orchard grass (*Dactylis glomerata*), red top (*Agrostis alba*), perennial ryegrass (*Lolium perenne*), switch grass (*Panicum vergatum*), and timothy (*Phleum pratense*).

One of the most peculiar characteristics of the Korean erosion control measures is the use of the sods, mostly naturally established with the dominant Zoysia japonica for stabilizing the terraces and waterways.

(2) Sand-dune Stabilization Measures in the Sea-coast Lands

The main measures for sand-dune fixation and stabilization consists of: sand accumulating fences, sand-dune stabilizing fences, sand-dune mulchings, planting of trees and grasses, and establishment of wind-breaks. These facilities act as a barrier to prevent the drifting of sand from the sea-coast sand-dunes.

In case of vegetation measures, tree seedlings are planted with the aid of erosion-resistant structures described above. The plantations established along the sea-coast serve as a wind-break barrier and protect farming lands and livestock and even human lives from strong winds and tidal wave damages.

Erosion control projects in coast areas are generally performed through the following two procedures:

(a) Along the coastal sand-dune lines, the sand accumulating fences (with mostly wooden planks) are set up to induce artificial sand-dunes. The front side of the dune is generally fixed with anti-wind structures and is also planted with tree seedlings of soil conserving species for sand-dune fixation.

(b) At the back side of the artificial dune; sand-dune stabilizing fences (with mostly rice straws and reeds), are set up to stabilize the drifting sands within the fence cells.

Main tree species for sand-dune planting: black pine (Pinus thunbergii), pitch pine (Pinus rigida), black locust (Robinia pseudoacacia), and Elaeagnus glabra. In case of direct seeding practices, mixed seeds of black locust, native woody lespedeza,

native grasses, and some exotic grasses are directly sown on dune beds with a good amount of soil dressing. Generally, bunches of native grasses are transplanted for sand-dune stabilization.

The important native grasses used include: Pennisetum japonicum, Aster hayatae, Carex kobomugi, Carex oahuensis, and also grasses which are used for erosion control works in hillsides. Main exotic grasses are weeping love grass (Eragrostis curvula) and switch grass (Panicum vergatum).

(3) Torrent Stabilization Works

In stream and channel stabilization projects, the first priority is given to denuded streams (wild torrent) adjacent to forest-lands. Those wild torrents are becoming dry with continuous production and transportation of soil sediment, including sand which has drifted from the denuded upper-streams and inflicts severe damage causing floods down stream, and erosion up in the mountains whenever it rains.

To stabilize and improve these torrents, such engineering measures as the check dam, revetment and spurs, drop structures, channel grade stabilizing structures, and dike embankments have been successfully adopted.

4. Maintenance of the Lands Treated

(1) Fertilization of the Lands Treated

Most lands treated with erosion control measures are still very poor in soil fertility. The application of fertilizers to the treated lands are needed to assist and accelerate the growth of vegetation, so that rehabilitation of the denuded lands can be successfully completed.

The Government established a new forest policy in 1975 for applying fertilizers to the forest lands treated for at least two

consecutive years after the erosion control works. The total area fertilized reaches to about 100,000 hectares since then. The Government has recently developed some solid types of compound fertilizers, particularly for the forest fertilization.

(2) Designation for the "Protection Forests"

In order to maximize the intangible as well as tangible benefits from the forests, a total of 625,996 hectares of "protection forests" (or reserves) have been designated by the Government.

The important protection forests consist of protection forests for: water resources conservation (276,787 ha), soil erosion control (219,254 ha), landscaping (118,939 ha), fishery resources conservation (7,792 ha), sand drifting control (2,646 ha), public health improvement (532 ha), falling stone prevention (384 ha), wind-break (35 ha), navigation target (27 ha), and tidal wave-break (9 ha).

(3) Tending for young Forest Trees

Until recent years, tree tending was under the responsibility of the person and/or organization who established the plantation, and the Office of Forestry as a central government organization provided technical aid. That is because the Government was primarily, able to concentrate its efforts on the fast restoration of forest lands through extensive reforestation. However, the Government's principal target - "greenification of the national land" - was accomplished through the successful completion of the first 10-year Forest Development Plan, and the Government began to emphasize new reforestation practices with timber species and also intensive tending for the plantations. The Government also planned to allocate a more expanded budget for this project.

The solid compound fertilizer exclusively for forest-lands has been produced since 1977 and applied to young plantations.

At the same time, the Government set up a "Forest Tending Day" to emphasize the importance of tree tending as much as tree planting to the people.

References

1. Office of Forestry, Republic of Korea. 1970. Forestry in Korea. P. 98, Seoul, Korea

2. Office of Forestry, Republic of Korea. 1974. Forestry in Korea. P. 110, Seoul, Korea.

3. Office of Forestry, Republic of Korea. 1979. Forestry in Korea. P. 118, Seoul, Korea.

4. Office of Forestry, Republic of Korea. 1979. Shifting Cultivation Resettlement in Korea. P. 240, Seoul, Korea.

5. Woo, Bo-Myeong. 1969. Erosion Control Works in Korea. P. 34, Seoul, Korea.

APPENDIX I

SHIFTING CULTIVATION RESETTLEMENT IN KOREA

Shifting cultivation in which all vegetation in forest-land was felled and burnt out illegally for crop cultivation is a primitive farming method practised exceptionally in the remote mountainous areas from tens of decades ago in Korea.

According to the statistics of 1973, shifting cultivation in Korea was estimated to be 124,643 ha with 300,796 households. The uncontrolled forest openings resulted in: (1) loss and ruin of forest resources, (2) devastation of the forest land, incurring drought and flood disaster and difficulties in stream management due to high sedimentation of river beds, (3) hurting the naturally beautiful landscape, (4) besides forestry problems, social problems of the poor with primitive living standards, and who were scattered in the remote and inaccessable mountains.

The government, therefore, enacted the Law on Resettlement of Shifting Cultivation and the resettlement projects were carried out under the basis of the national land utilization and development plan.

The five-year plan of shifting cultivation resettlement (1974-1978) has been successfully accomplished along with the first 10-year Forest Development Plan. The term "shifting cultivation" no longer exists in Korea.

Therefore, all the problems caused by shifting cultivation could have been substantially alleviated. The only thing the Government has to do in the future is to prevent the farmers from getting again into the forest-land for shifting cultivation.

The project implementation of shifting cultivation resettlement is explained in the following chapter.

1. Resettlement Direction

(a) Reorganization of Land Utilization

The affected lands of more than 20 degrees in slope are restored to forests by planting trees and the lands less than 20 degrees of slope are rearranged into permanent and modernized farming lands.

However, the lands affected by shifting cultivation which are more than five hectares in size, located collectively, and with more than 20 degrees of slope are left for continued farming land. In this case, adequate facilities are made to prevent excessive run-off and soil erosion through out the land.

TABLE 1. - Accomplishment of Shifting Cultivation Resettlement

Category	Target	Accomplishment		
		1973 - 1978	1979	Total
Land rearrangement (ha)	124,643	123,834	819	124,643
- Restoration into forest	86,073	85,254	819	-
- Conversion into farmland	38,570	38,570	-	38,570
Household resettlement	300,796	300,796	-	300,796
- Removal to other village	25,857	25,857	-	25,857
- House removal to near village	2,349	2,349	-	2,349
- Settlement at the place	272,590	272,590	-	272,590

(b) Resettlement of Shifting Cultivation Households

The farmers who can have farmland of less than about 2,000 square meters (600 pyong) after the completion of rearrangement projects, the government subsidizes with US$1,000 (500,000 won) (cost price in 1974) in each household for moving to the other village or town.

In case of the farmers who can have more than 2,000 square meters of farmland other than the land under shifting cultivation which is quite enough to support their livelihood and have their houses located in the forest, they receive a government subsidy of US$500 (250,000 won) in cash each for the construction of their houses in the near villages, so that they live together with neighbours.

(c) Postmanagement

Due to the fact that shifting cultivation resettlement projects involve numerous difficulties of not only social, but also technical aspects, the forest administrative authorities have to take careful measures from the very beginning.

Prevention against the recultivation of the rearranged shifting cultivation is the responsibility of the head of cities, counties and towns. Forestry officials in local government inspect periodically the rearranged lands of shifting cultivation.

On the other hand, the aerial inspection is made by helicopters especially at the time of sowing season. The helicopters use a loudspeaker and leaflets.

In order to establish a postmanagement system in which the farmers participate voluntarily in connection with their profit, firstly, the owner of the forest and villagers make a profit-sharing contract on the rearranged land of the private forest by the labour mobilization of the villagers; secondly, the villagers

[illegible]

[illegible]

[illegible]

[illegible]

[illegible]

[illegible]

can receive a benefit of the forest by-products from the rearranged land of the National Forest under the order of protection. Thirdly, the owners and managers are informed to take precautions against recultivation.

2. Measures for Livelihood

One of the objectives of the Law on Resettlement of Shifting Cultivation is stabilization of the farmers' life. It is very important for the government to support the farmers' livelihood, particularly former cultivators moved to other places, and hence the government supports business for farmers' income such as loan arrangement for cattle, joint nursery stock raising, establishment of mulberry field and gives priority to the farmers in employment and utilization of idle man-power.

Shifting cultivation resettlement projects in Korea have been successfully completed, particularly under the Saemaul Undong spirits and practices.

Shifting cultivation may be defined as the whole series of techniques used by those farmers who have only the most primitive tools at their disposal, and who cannot invest any capital in the work which essentially is intended to provide food for themselves and their families. It is carried out on soils whose fertility is depleted very rapidly, owing to prevalent climatic conditions and poor parent materials. Such farmers, therefore, have to rely on relatively long natural fallows; these are usually forest fallows. The area needed to ensure provision of food for the family depends on the time taken by the natural fallow to replenish the fertility of the soil or to eliminate invading weeds. The longer the time, the larger must be the area available to the farmer. Thus, shifting cultivation is a waste of land. In any event, it is irreconcilable with any situation, whether it be economic, social or institutional, which limits the farmer to ever-smaller areas in relation to his needs. The use of primitive tools, which is one of

the characteristics of shifting cultivation was, at the dawn of history, the lot of every farmer. Each one also doubtless secured his first bit of land by clearing strips of primeval forest with axe and fire, leaving to pastoral tribes those areas where climatic or soil conditions had prevented forest from developing.

In general, shifting cultivation techniques are similar everywhere: the felling and burning of the woody vegetation, followed by one, two or three years of cultivation of the cleared ground, and the return for a long period to forest or bush cover. In spite of this similarity, there are many types of shifting cultivation throughout the world; and the life types of the shifting cultivators are also very different from one locality to another. There are indeed all the intermediate stages, on the one hand between shifting cultivation and the much more primitive methods of subsistence by hunting and gathering of food and, on the other, between shifting and sedentary agriculture.

APPENDIX II

EROSION CONTROL WORKS IN KOREA

PART A: Soil Erosion, Landslides and their Rehabilitation Measures

Slide No.	Subject
1	Landslips:* two small-sized landslips caused by heavy storm from devastated forest land creating soil and mud flows.
2	Landslide:* large-sized landslide caused by heavy storm at the young (15-year) pitch-pine plantation, rooted up trees and resulted in debris slides.
3	Landslide: a narrow-sized landslide which exposed the bed-rock was created by a heavy storm and avalanches of mostly debris occurred.
4	Creeping type landslides:* creeping-type landslides along the highway up-slopes were mostly a result of soil fluctuation. This resulted frequently in mass soil movement to the highway downslopes.
5	Denuded forest-land: severely denuded forest-land (upper-part) due to numerous landslides and site under-rehabilitation works (lower part).
6	Run-off experiment plots: one for the direct seeding and mulching measures and the other for semi-terrace sodding and grassed waterway.
7	Stone masonry: continuous contour stone masonry with sodding along the hillsides, for rehabilitation of landslides.
8	Wattles:* continuous contour wattles (weaved-pole structures) across the hillside slopes, for rehabilitation of landslides.
9	Bare land: very severely denuded forest-land due to continuous collection of fuel woods which resulted in sand sedimentation.
10	Stepped terracing: stepped continuous contour terracing with cut-and-fill operation on the site of hillside slopes, for rehabilitation of bare land. This is the foundation work for the "stepped terrace-sodding" works.

Slide No.	Subject
11	Sod soil-arresting works: soil-arresting structures were made by using sods at the upper-slope gully head, and terrace-sodding measures on the slopes.
12	Straw-mat matting: matting with coarse straw-mats on devastated hillslopes, and should be directly seeded before and/or after matting.
13	Erosion-net netting: netting with the "erosion-net" on bare fill-slopes.
14	Hydroseeding:* revegetation by hydroseeding included grasses, seeds, fiber, organic matter, fertilizer, green staffs, etc. (hydromulching).
15	Mine-spoil rehabilitation:* revegetation by direct seeding (*) after grading, shaping, compacting and top-soiling on surface slopes for rehabilitation of mined land.
16	Mined-land reclamation: same as no. 15
17	Experiment for mined-land reclamation: same as no. 15
18	Gully-bed grade stabilizing structures:* large-sized gully-bed grade stabilization structures by stone masonry across the gully (torrent control measure).
19	Drop structures:* stepped drop structures by stone dry-masonry for stabilizing eroded gully-bed (torrent control measure).
20	Revetment:* revetment construction with gabion structures (*) along the embankment for protection of stream banks.
21	Stream channel stabilization:* large-sized stream channel stabilization structures with energy dissipators across the stream by wet-masonry.
22	Check dam:* small-sized stone check dam by dry-masonry, in mountainside gully-bed.
23	Check dam: medium-sized stone check dam by wet-masonry, built in 1944.
24	Mini-debris dam: small-sized debris checking dam with pipe-outlet.

Slide No.	Subject
25	Erosion control dam: large-sized concrete erosion control dam; under construction work.
26	Erosion control dam: large-sized concrete erosion control dam; after construction work.

PART B: Road-side, Cut slopes and Sand-dune Rehabilitation Measures

27	Latticed structures: latticed structures with long-sized concrete blocks, immediately after construction for rehabilitation of road-side cut slopes (1:1).
28	Latticed structures: short-sized concrete block latticed structures filled completely with sods (*Zoysia* spp.), and supported by ornamental tree plantations.
29	Latticed structures: latticed structures for stabilizing unstable cut-slopes.
30	Stepped terrace-sodding:* stepped terrace-sodding measures for rehabilitation of road-side cut-slopes newly constructed and supported by strip planting of *Forsythia koreana*. It is developed as a peculiarly Korean measure.
31	Straw-mat matting: road-side cut-slope rehabilitation by rough straw-mat mulching between terraces supported by direct seeding of woody lespedeza and local grasses.
32	Terrace-sodding and planting: stepped terrace-sodding measures supported by tree planting and rip-rap waterways (*) on road-side cut-slope.
33	Terrace-sodding and planting: fully rehabilitated slope one year after construction.
34	Continuous contour concrete rib-barriers construction: well stabilized road-side cut-slope by the continuous contour concrete rib construction measures supported by sod planting.
35	Cement mortar spraying measures: under construction work for road-side cut-slope stabilization (volcanic geology) by the cement motar spraying measures.

36 Stone falling prevention net: protection for highway driving by the stone-falling prevention net construction (synthetic fiber).

37 Synthetic wood utilization: road-side landscape conservation by synthetic wood utilization of concrete-made wood and weaved-pole formations.

38 Synthetic wood utilization: synthetic wood made of concrete had been used for urban and park landscape conservation including roadside cut-slope rehabilitation.

39 Road-side pergola: highway rest facilities with synthetic wood pergola for conservation of highway roadside environment.

40 Roadside rock gardening: roadside rock gardening for roadside landscape conservation (flowering Forsythia).

41 Living environment conservation: establishment of sod garden supported by azalea (Rhododendron mucronulatum) for living environment conservation (Seoul National University campus).

42 Green environment establishment on buildings in urban areas using perennial climbing plants (Parthenocissus thunbergii).

43 Sea coast sand-dune stabilization: well stabilized sand-dune along sea coast by planting with Korean black pine (Pinus thunbergii) and bunchgrass supported by sand-dune stabilizing fences (after 6 years).

44 Sea coast sand-dune stabilization: well stabilized sand-dune along sea coast by planting with Korean black pine supported by sand-dune stabilizing fences. In sand-dune planting, needs soil amendment (*).

45 Same as No. 44

Note: (*) have a brief description on the following page.

APPENDIX III

TERMINOLOGY IN EROSION CONTROL MEASURES

(Terminology mostly related to the colour slides)

Amendment:- Any material such as lime, gypsum, saw dust, or synthetic conditioners, that is worked into the soil to make it more productive. Technically, a fertilizer is also an amendment, but the term is used most commonly for added material other than fertilizer.

Apron (dam):- A device to protect a stream or river bed against scour; a shield. A strong non-erosive, usually horizontal surface on which the kinetic energy of a jet or stream of water is dissipated and the velocity of flow reduced to a safe value for downstream conditions. Bottom part of inside trim on windows. A floor or lining of concrete, timber, etc. to protect a surface from erosion, such as the pavement below chutes or spillways, or at the toes of dams.

Backfill:- Any material used to fill an excavation such as around footings or foundations of buildings. (see Backup Material).

Backup Material:- Any type of material used to fill in behind or give a backing to a facing material.

Barrier, temporary:- Impedes surface run-off and stops the movement of sediment, mulch or other surface protectors. Brush and hay bales used on medium slopes or at the toes of steep slopes. Fence used on slopes. Made by piling or staking on or near a contour along the surface to be protected. Also serves as filter on berm.

Bench terrace:- A step-like embankment of earth with a flat top and a steep or vertical downhill face. Construction is along the contour of sloping land to control run-off and erosion.

Bench terracing:- The development of level or nearly level benches across the slope with steep risers between. The risers are usually protected with vegetation, loose rock or masonry.

Buffer strip:- Strips of grass or other erosion-resisting vegetation between or below surface or auger mining disturbance of land for cultivation.

Bunchgrass:- A grass that does not have rhizomes or stolons and forms a bunch or tuft.

Channel stabilization:- Erosion prevention and stabilization of velocity distribution in a channel, using jetties, drops, revetments, vegetation and other measures.

Check dam:- Small dam, constructed in a gully or other small water course to decrease the stream flow velocity, minimize channel scour, and promote deposition of sediment. Dam height is dictated by flow amount and channel slope.

Chute:- Used to convey water down slopes and can be either temporary or permanent. Chutes generally require energy dissipators at the downstream end.

Conservation:- The protection, improvement, and use of natural resources according to principles that will assure their highest economic or social benefits.

Contour:- An imaginary line connecting points of equal height above sea level as they follow the relief of the terrain.

Core wall:- A wall of masonry, sheet piling or puddled clay built inside an earth dam or embankment, the purpose of which is to reduce percolation.

Crib:- A retainer for a bank of earth.

Crib-dam:- A barrier which is made of timber forming bays or cells filled with stone or other suitable material for stream bank protection.

Cut-and-fill:- Process of earth-moving by excavating part of an area and using the excavated material for adjacent embankments or fill areas.

Dam:- 1) An artificial structure which obstructs a stream of water for the purpose of water storage, for conservation, recreation, water power, flood control, irrigation, etc. A dam may be used for one or more of these purposes. 2) A barrier to confine or raise water for storage or diversion to create a hydraulic head.

Debris dam:- A barrier which is built across a stream channel to store debris, such as sand, silt, driftwood, etc.

Dike:- 1) A ridge of earth which is thrown up to impound water, as in irrigation; or to divert water, as in soil erosion. 2) An embankment or level which is constructed to prevent inundation of low land, as on the sea-coast or in the flood-plain of a river valley. Also called dyke. (see: levee)

Direct seeding:- A method of establishing a stand of vegetation by sowing seed on the ground surface.

Diversion: Channel constructed across the slope for the purpose of inter-cepting surface runoff. Changing the accustomed course of all or part of a stream.

Diversion ditch (cut slope):- Constructed at the upper edges of cut slopes to collect water from adjacent properties and divert it around the cut. Materials used to construct these ditches are determined by the slope of the ditch but include sod, gravel, stone, asphalt, and concrete. Ditches may be temporary or permanent.

Diversion dam:- A barrier which is built to divert part or all the water from a stream into a different course; for example, into an irrigation ditch.

Drain, down:- Used to conduct run-off down a slope. May be open channel or closed conduit, temporary or permanent. (See also Chutes).

Drain, slope: Placed horizontally at vertical intervals on long slopes to reduce the effective slope length. These drains can be of any open channel cross-section and must be lined. Usually function both as temporary and permanent structures (see also Interceptor drains).

Drop-box culvert:- Consists of a culvert inlet-box with vertical sides. Acts as an energy dissipator and reduces the velocity in the culvert. This type of structure is usually permanent except in temporary sediment basins, and is constructed of steel, wood or concrete.

Dry masonry:- Stone work laid without mortar.

Energy dissipator:- Converts high-velocity flows from paved channels and/or conduits to lower velocity flows. Materials are frequently gabions, concrete or large boulders.

Gabion:- A mesh container used to confine rocks or stones. Used as energy dissipators, channel liners, steep-slope protectors, and retaining walls. Construction of gabions is accomplished by placing wire-mesh baskets at the desired location, filling them with gravel and tying them together. The size of the basket and the diameter of the gravel are determined by the amount of protection required.

Grading (Land):- The surface smoothening practice of changing the topography of a field by making cuts and fills according to a predetermined plan so that each row of place is graded without any depressions throughout its length to a field drain.

Grade stabilization structure:- A structure for the purpose of stabilizing the grade of a gully or other watercourse, thereby preventing further headcutting or lowering of the channel grade.

Grassed waterway:- A grassed waterway is a natural or man-made drainage way of parabolic or trapezoidal cross-section that is below adjacent ground level and is stabilized by suitable vegetation. The flow is normally wide and shallow and conveys the run-off down the slope. The purpose of the structure is to convey run-off without causing damage by erosion. Grassed waterways are used where added channel capacity and/or stabilization is required to control erosion resulting from concentrated run-off, and where such control can be achieved by this practice along or in combination with others.

Gully control structure:- A structure designed to lessen soil erosion by water.

Gully erosion:- That type of accelerated erosion by water that produces definite channels too deep to be obliterated by normal tillage.

Hydroseeding:- Dissemination of seed hydraulically in a water medium. Mulch, lime, and fertilizer can be incorporated into the sprayed mixture. (hydromulching)

Interceptor dike:- Directs overland flow to a desired collection or run-off point. Constructed with any material that will withstand the anticipated flows.

Interceptor ditch or drain:- Ditches and drains, like the dike, change the course of flow of surface run-off and direct it to a desirable collection or run-off point. Construction of ditches and drains is similar to that of most eater channels and they must be protected to withstand the flow velocities anticipated.

Jetties:- Used to deflect water currents away from selected sections of a stream-bank or shore.

Landslide:- The failure of a slope on which the movement of the mass takes place along interior surface of sliding.

Levee:- An earthen dam which is placed at varying distances from the banks of a river to serve as a containing protective barrier to adjacent low land during flood periods.

Mass Movement:- Mass movement include falls, slides, flows, creeps and subsidence. The identification depends on their material, speed of movement, water content and other relevant phenomena. Mass movement usually occurs on steep mountains. It is a kind of geological erosion or hillslope evolution. It can be triggered by human activities such as highway construction, mining and logging.

Matting:- Matting is used as a surface and channel protector. In most cases it requires staking to the ground. It is usually used in conjunction with seeding and protects the surface until vegetation becomes established.

Mulch:- Natural or artificial materials used to provide more desirable moisture and temperature relationships for plant growth. It is also used to control unwanted vegetation. Used to increase infiltration, decrease run-off, protect soil surface from erosive action of raindrops and to enhance seedbed for vegetative growth. Mulch is applied with machinery or by hand, using either water or air as the carrying agent. Proper application rates are important.

Reclamation (land):- The process of reconverting denuded, devastated, eroded, and mined land to its former or other productive use.

Rehabilitation (land):- Implies that the land will be returned to a form and productivity in conformity with a prior land use plan, including a stable ecological state that does not contribute substantially to environmental deterioration and is consistent with surrounding aesthetic values.

Retaining wall:- Used for stabilizing steep slopes and to prevent earth slides. They can serve as either temporary or permanent structures and are commonly constructed of brush mats, rock, concrete rubble, log jacks, car bodies, etc., and are normally quite large.

Revegetation:- Plants or growth that replace original ground cover following land disturbance.

Revetment:- A facing of stone or other material, either permanent or temporary, placed along the edge of a stream, to stabilize the bank and protect it from the erosive action of the stream.

Riprap:- Broken rock, cobbles, or boulders placed on earth surfaces such as the face of a dam or the bank of a stream, for protection against the action of water (waves). Also applied to brush or pole mattresses, or brush and stone, or other similar materials used for soil erosion control.

Roadside erosion control:- Any system for controlling and preventing erosion along roadways. Methods used will vary from elaborate structural control to simple vegetative control.

Sand-dune erosion control:- The application of various mechanical and vegetative measures which are designed to stabilize permanently coastal and inland sand-dune or low-sand areas (beach erosion control).

Scour:- In soil and water conservation it pertains to the removal of sand or earth from the bottom or banks of a stream by erosive action of flowing water.

Sediment:- Material that settles in quiet or less turbulent liquid.

Sedimentation basin:- Any structure or reservoir that provides for sediment accumulation. Sediment basins control or stop sediment after it has eroded. Basins are quite large, as compared to traps, and receive run-off from large areas. Each consists of a dam, an outlet structure, and water storage space. Most sediment inflowing water will settle out in a sediment basin if the detention time is long enough. They must be cleaned regularly.

Sediment control structure:- A control structure in open channel water flow to slow its movement and cause settlement of excessive amounts of soil particles.

Sediment trap:- A manhole or catch basin providing for a storage volume below the tile line grade for collecting the sediment.

Sediment trap:- Sediment traps are small sediment basins. They are constructed as simply as possible and should be used extensively during construction. They are made by digging holes in medians and other drainage ways and by building small dams of wood, stone, bales, etc., across channels, culvert inlets, and other low areas. They must be cleaned regularly.

Seeding:- Seeding is done to establish vegetative erosion control. Stage seeding, both temporary and permanent, is generally very effective in controlling erosion on construction sites, mined lands, cut-and-fill slopes and denuded lands.

Serrated cuts:- Increase infiltration and reduce water velocities down cut slopes. They also provide a better seedbed for establishing vegetation and help to retain moisture. Horizontal steps are constructed with a grader as cut is made.

Slumping:- The action of water erosion on valley slopes along main streams, side streams and tributaries causing the slopes to slide into the stream.

Sod:- A closely knit ground-cover growth, primarily of grasses.

Sodding:- Used for surface and channel protection. Sod may be hand-laid over the entire surface or in narrow strips along the contour of a slope. On steep slopes it may need to be staked to prevent slippage. Another effective use of sod in areas of high rainfall is a 40-50 cm wide strip laid along the edges of the pavement of highway, to prevent the shoulder from eroding.

Sod flume:- Water channel sections lined with sod for stabilization.

Sod strip:- 1) A band or narrow strip of sod which is used for checking erosion in waterways. 2) A narrow band of grass or other close-rooted crop which is placed across the channel of a gully to spread and retard the flow of water. 3) In strip cropping, a strip that is in sod.

Soil erosion:- Removal of soil material from a land surface by water or wind, including normal soil erosion and accelerated soil erosion.

Soil and water conservation:- The application of practices on the land that reduce soil erosion and increase water retention.

Soil conservation:- Protection of the soil against physical loss by erosion or against chemical deterioration; that is, excessive loss of fertility by either natural or artificial means.

Soil-saving dam:- A dam of earth, concrete or other material which is placed across a gully or natural watercourse to impound run-off water and to collect eroded soil.

Spillway:- Any of several types of hydraulic structures used to convey water supply from an upper level to a lower level. It may be an overfall dam, an open channel chute, or a drop inlet tube.

Spur dike:- A disk of rock or other material which is built from the bank into the channel for bank protection or for channel improvement. Also called jetty. Spur dikes provide funnels and expansion sections for streams flowing beneath bridges. They are similar to jetties and must have substantial surface protection to the high water line.

Stepped terrace-sodding:- The rate of run-off, thus, the rate of soil erosion can be controlled by manipulating the gradient and length of slopes. The stepped terrace-sodding measure is converting a steep slope into a series of steps, with horizontal or nearly horizontal (reversed) ledges, and vertical or almost vertical (naked face) walls between the ledges. To hold up the vertical face and to prepare the planting base, some structural wall is necessary, usually of sods, or sods with stone or less frequently, sods with brick or timber. In very stable soils the walls may be held up only be vegetation. This measure is particularly important in steep-cut slopes and mountain top steep slopes, and developed in Korea as a peculiarly Korean measure.

Stream bank protection:- This protection requires large material masses or smaller anchored structures such as large boulders, brush mats, log jacks, concrete rubble or special concrete and/or steel structures.

Streambank erosion control:- Vegetative or mechnical protection of erodible stream banks which is frequently used where valuable farm land or a highway is or may be affected.

Streambank stabilization:- The construction of desirable side slopes and the establishment of cover on riverbank.

Stream erosion:- The erosion which occurs when the waterflow of a river or stream cuts into the natural banks of the stream. It is usually the result of excess volume or shift in stream current.

Strip sodding:- The laying of sod in strips separated by spaces not sodded.

Terracing:- A practice of constructing a ditch or channel, with a ridge below, across the slope at various vertical intervals to intercept run-off. The channel and ridge are usually constructed to a cross-section which will permit contour operations with farm equipment.

Topsoiling:- Stockpiling and subsequent spreading of top soil on cut and fill slopes aid greatly in the establishment of vegetation. Fertilizer may not be required if topsoiling is done. Topsoil may also be brought from an outside area depending on cost.

Vegetated channel:- A natural or artificially constructed waterway having a grass bottom, which is used to conduct the accumulated run-off from cultivated land, terraced land, diversion, or from fields in a countour strip crop system.

Vegetative stabilization:- Vegetative stabilization is accomplished by planting imported or native vegetation on cut and fill slopes and other areas needing erosion protection.

Wattles:- Early method used for stabilizing fill slopes. Hand labour required. (One example: leafy brush, straw or both are packed into a "cable" about 30 cm wide and 25 cm thick and laid in trenches dug into the slope-face along the contours. 3 x 5 x 60 cm stakes are driven in on 60 cm centres below the wattles to hold them in place). Live cuttings are planted between the wattle rows and the entire area is seeded.

Weir:- A notch of regular form through which water flows when stream flows are being measured.

Windbreak:- Windbreaks are often in the form of fences - log, lath, plank, board, etc., which reduce wind velocity near the ground. Trees, shrubs, and other types of vegetation are also effective windbreaks.

Wire dam:- A temporary type of gully control dam which has a head wall constructed of woven wire.

REFERENCES

1. Farrall, Arthur W., and Carl F. Albrecht. 1965. Agricultural Engineering, a Dictionary and Handbook. The Interstate Printers & Publishers Inc. P. 434.

2. Frevert, R. K., Schwab, G. O., T. W. Edmonster and K. K. Barnes. 1966. Soil and Water Conservation Engineering (2nd edition). Wiley, New York.

3. Hudson, Norman. 1971. Soil Conservation. B. T. Batsford Limited. P. 320

4. U. S. Environmental Protection Agency. 1976. Erosion and Sediment Control, (1) Planning (2) Design.

5. U. S. Transportation Research Board. 1980. Erosion Control during Highway Construction. P. 23.

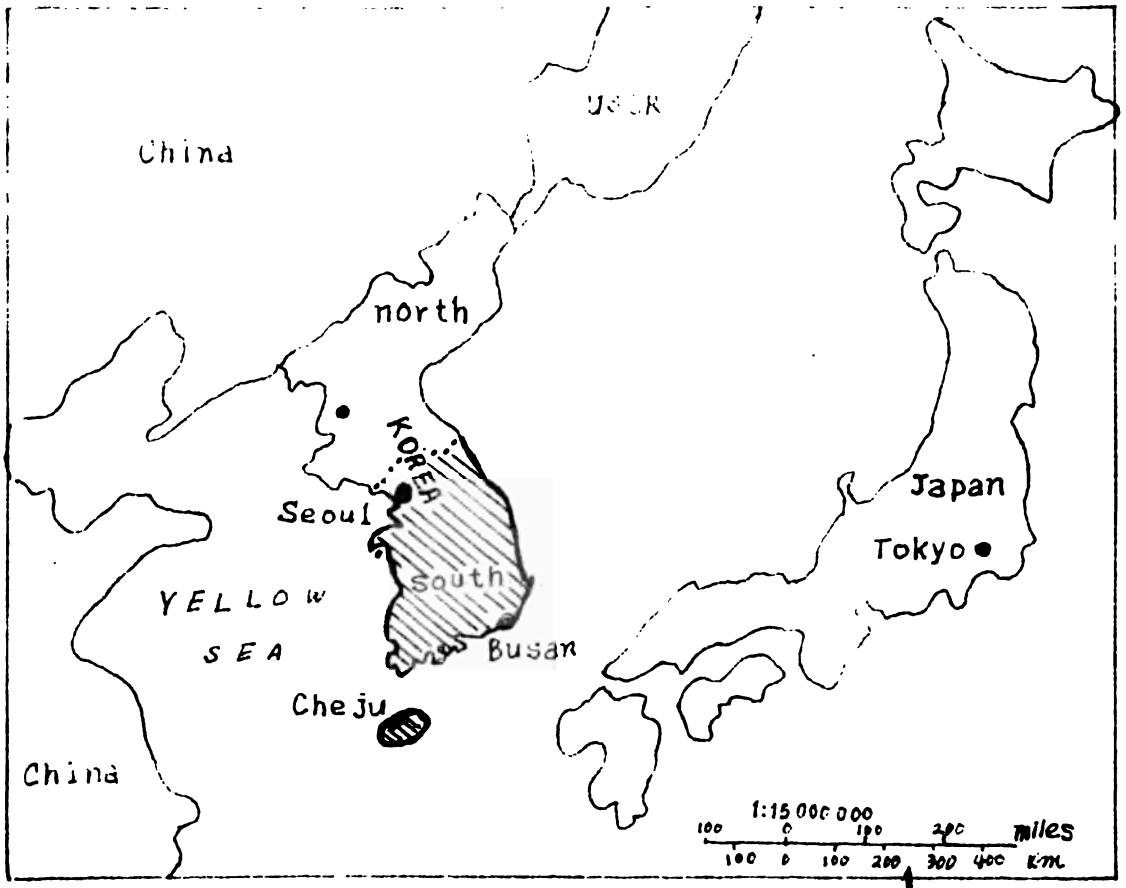
6. Woo, Bo-Myeong. 1969. Erosion Control Works in Korea. Seoul National University, Korea. P. 34.

7. Woo, Bo-Myeong. 1974. Terms in the Erosion Control Measures in Korea. The Journal of the Korean Forestry Society. No. 26:1-22.

APPENDIX IV

FIGURES IN RELATION TO THE EROSION CONTROL WORKS IN KOREA

Fig.1 Map of the Republic of Korea



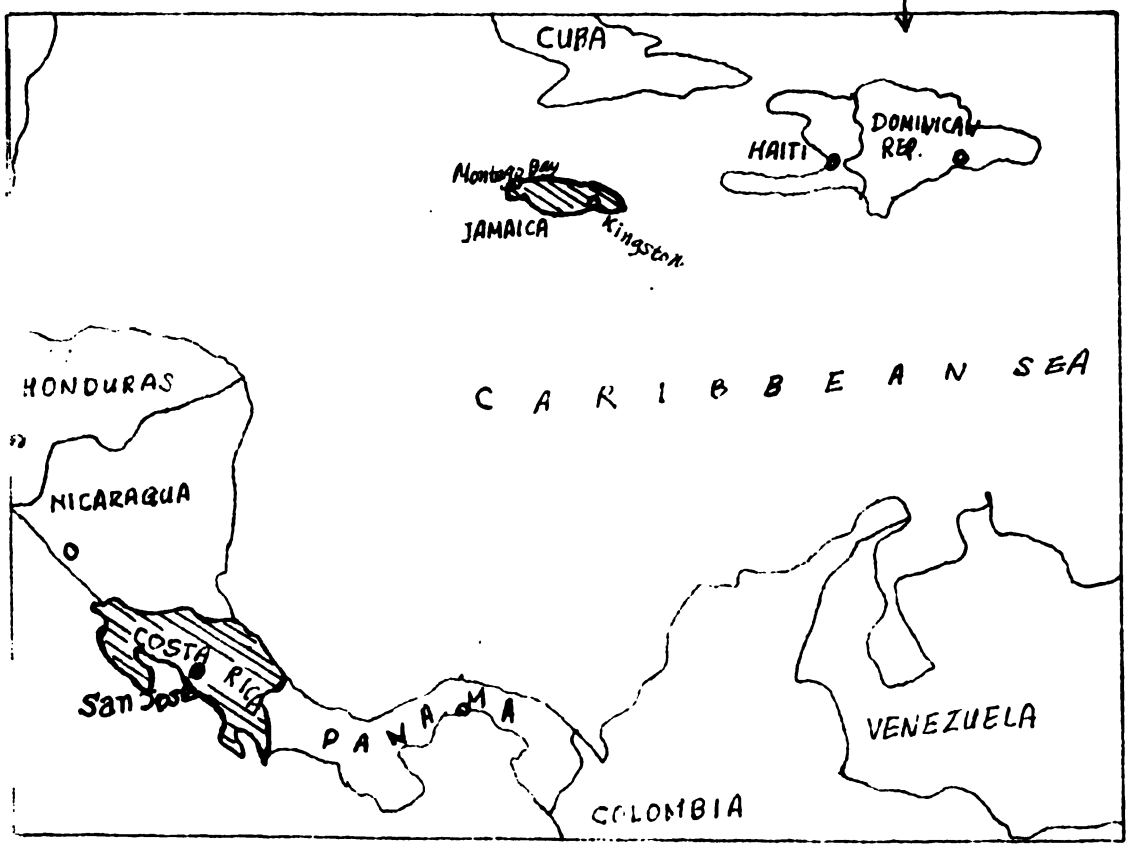
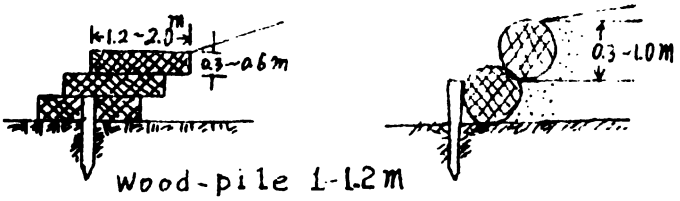
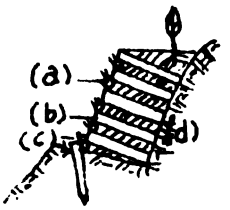


Fig.2 Map of Jamaica and Costa Rica



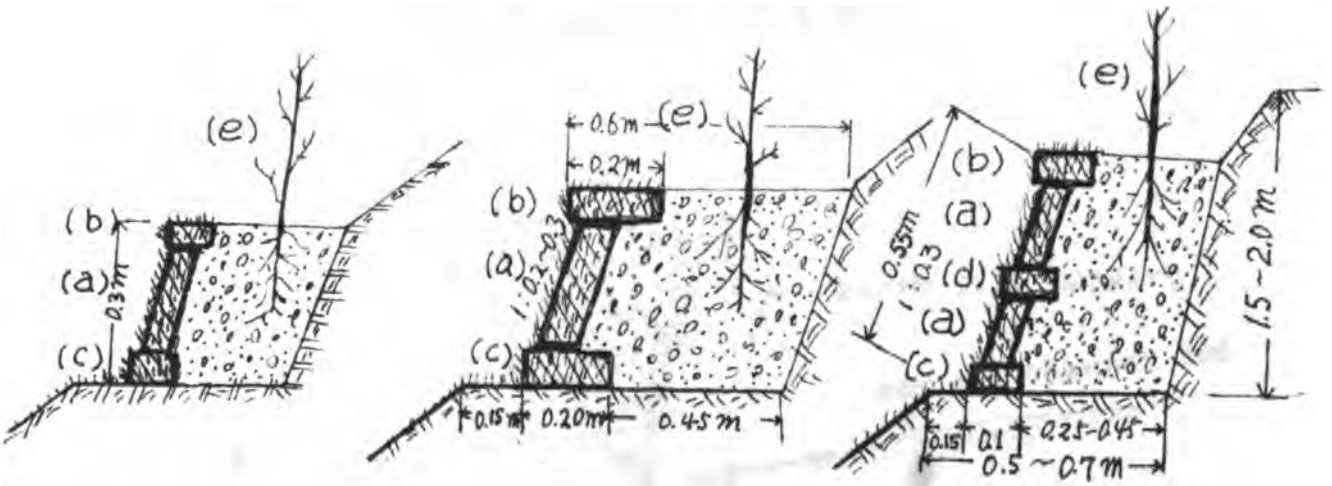
(A) Gabion soil-arresting structures



(a) Length-timber
(b) Cross-timber
(c) weeds
(d) original ground

(B) Timber soil-arresting

Fig.3 Soil arresting structures

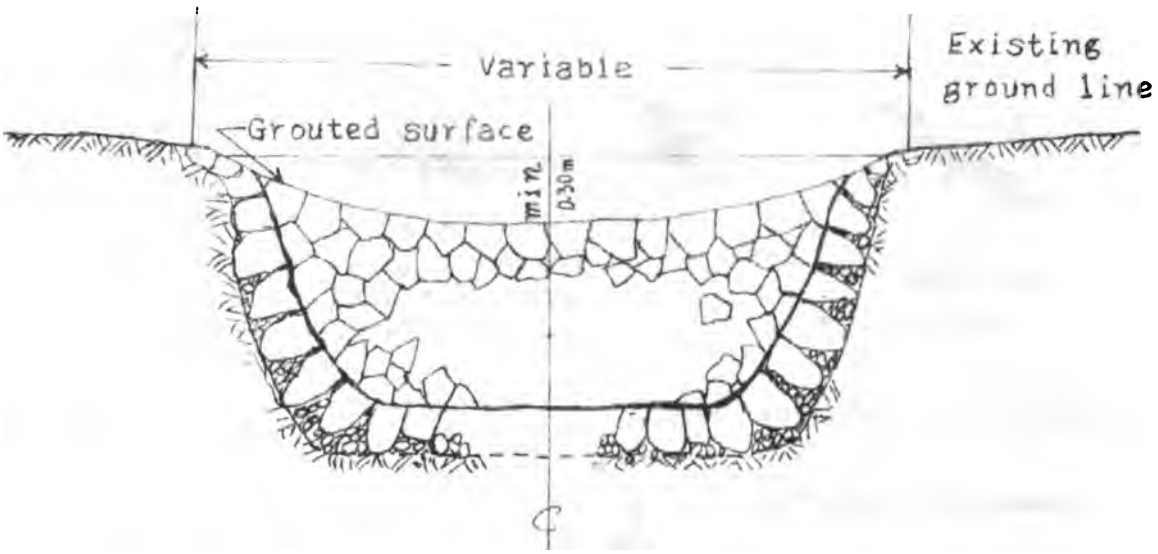


Terrace-sodding using 2 sods on cross section:
(b)&(c) used half-sized sod
(e) Seedling planted

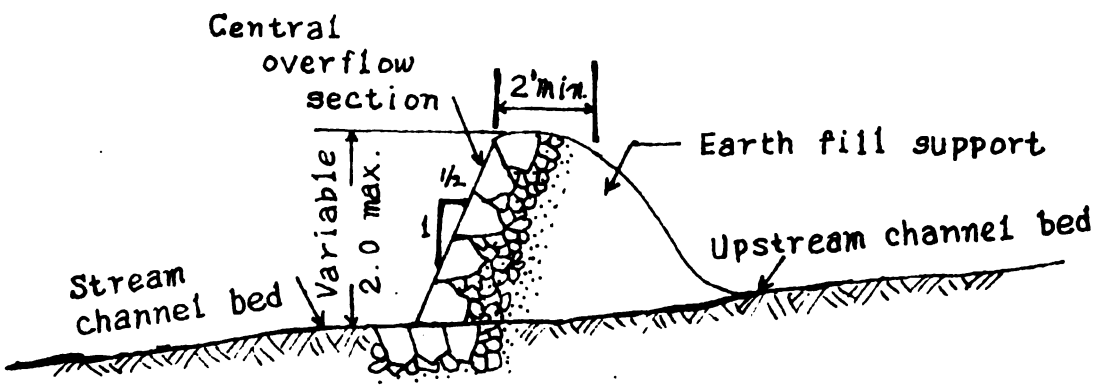
Terrace-sodding using 3 sods on cross section:
(a), (b), (c) used whole-sized sod

Terrace-sodding using 3 1/2 sods on cross section:
(b), (c), (d) used half-sized sod

Fig.4 Stepped terrace-sodding works



Typical section check dam



Vertical section through center

Fig.5 Typical grouted rock riprap check dam

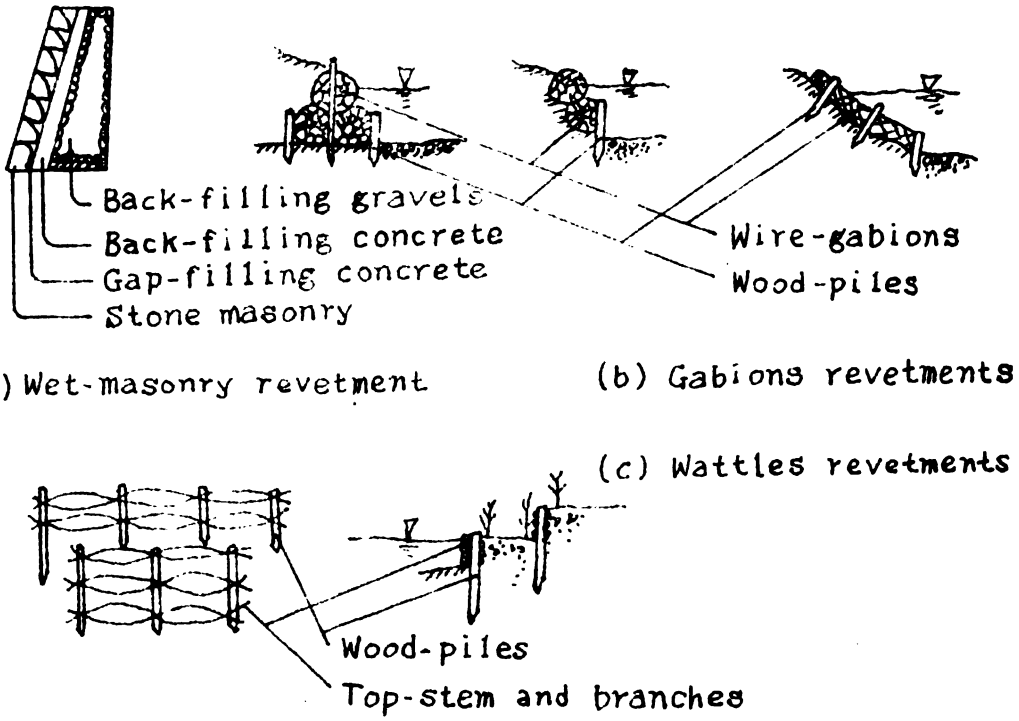


Fig.6 Revetments for stream bank stabilization

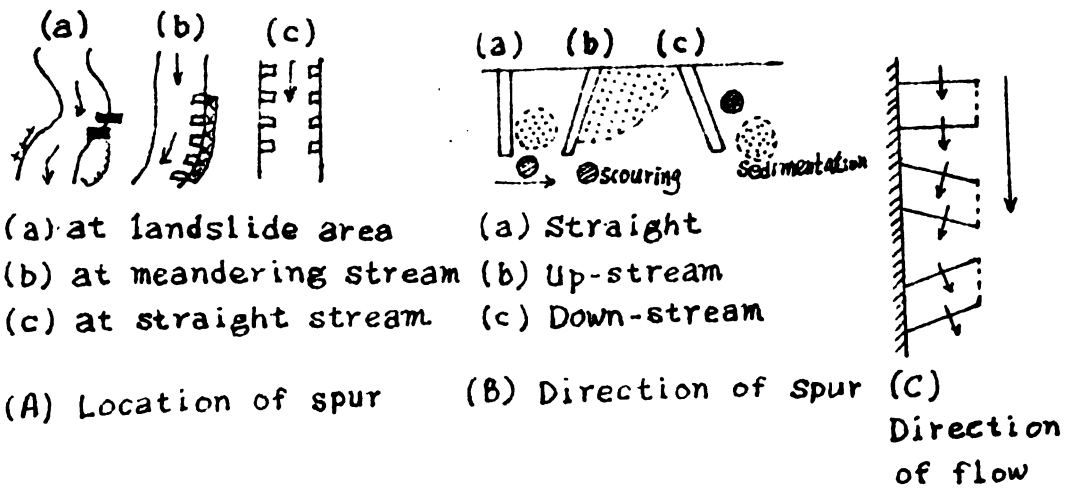


Fig.7 Location of spurs and direction of flow

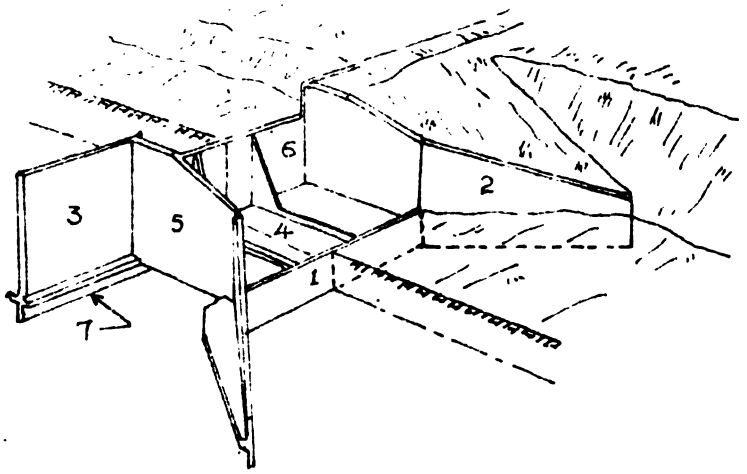


Fig.8 Drop spillway showing structural components. (1) Toe wall, (2) Wing wall, (3) Head wall extension, (4) Apron, (5) Side wall, (6) Head wall, (7) Cutoff wall.

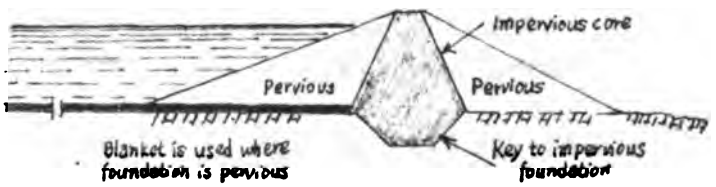


Fig.9 Embankment utilizing a central core and key of impermeable materials extending from above the water line to the foundation.

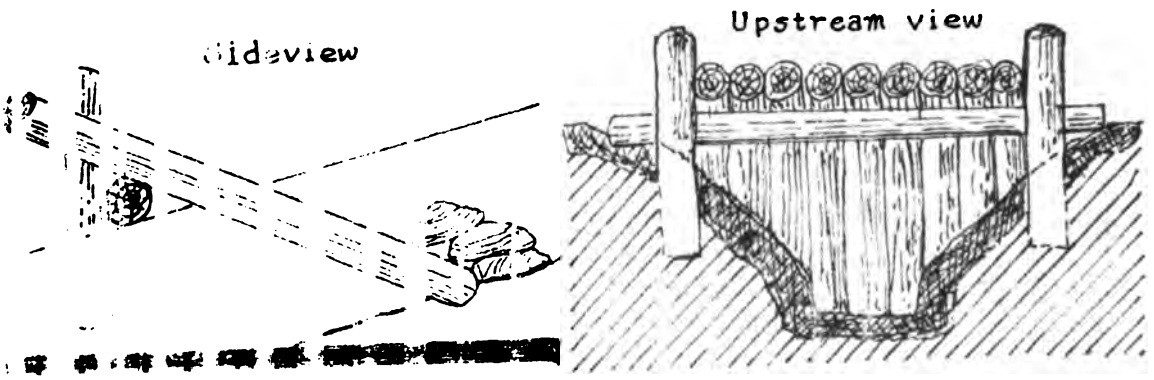


Fig 10 Sediment basin (log-and-pole structure)

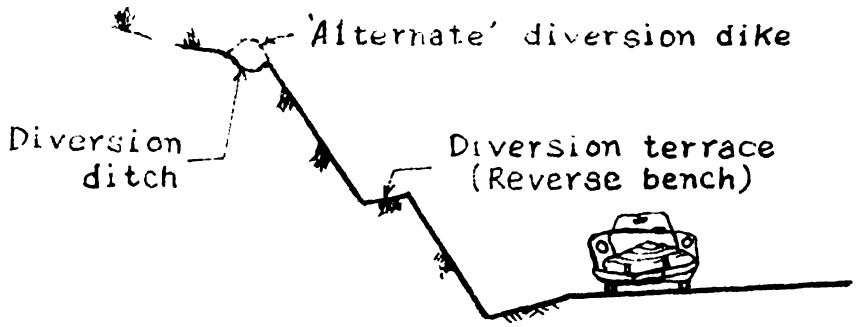


Fig.11 Typical diversion structures on roadway cut

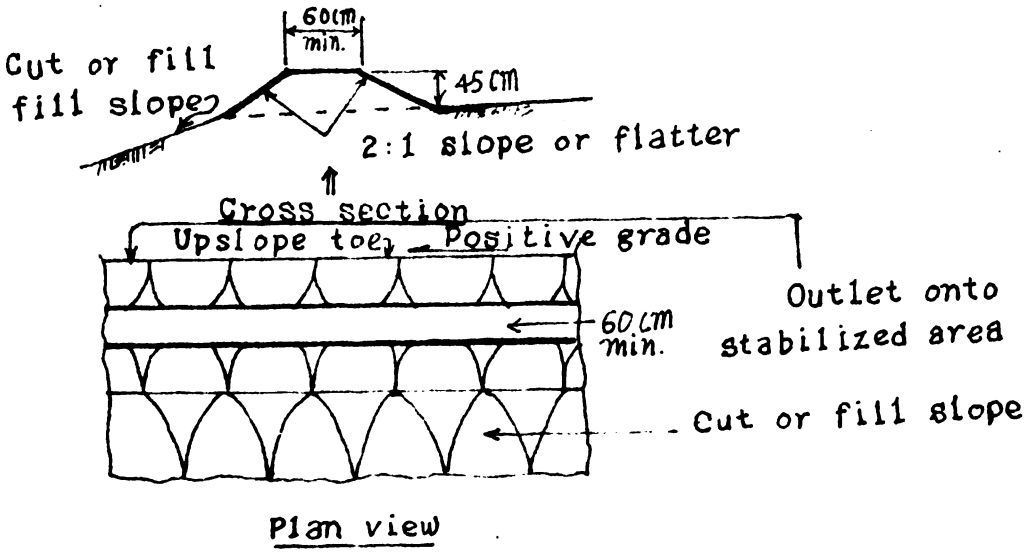


Fig.12 Diversion dike

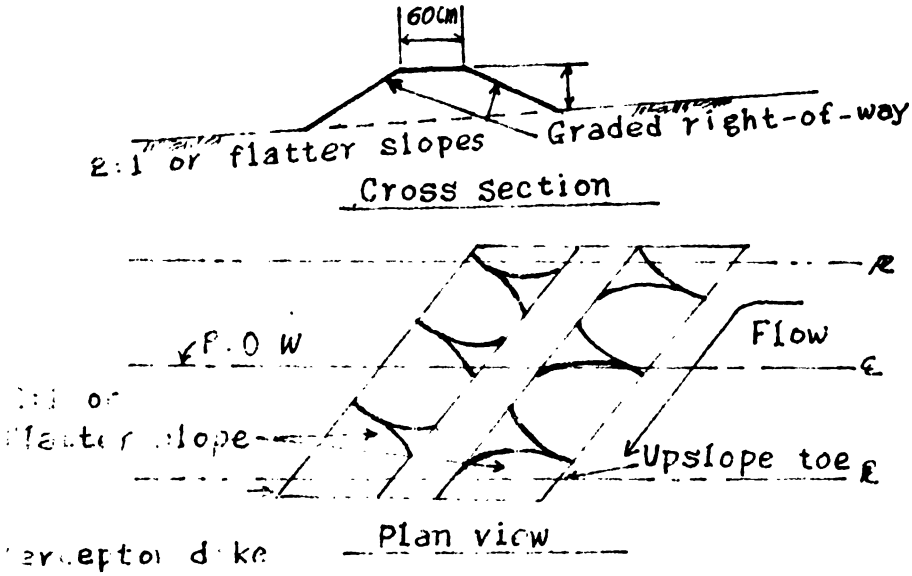


Fig 13 Interceptor dike

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