Study Report

SOIL EROSION STABILIZATION IN KINARUT PROJECT

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REPORT ON SOIL EROSION STABILIZATION

Soil erosion is a process in which the soil top layer is removed or denuded by the active forces of water, wind and gravity. Water is the most damaging of the three forces. The process of soil erosion can occur gradually over centuries (geological time) and is hardly distinguishable or in an accelerated manner. The latter process mainly result from human interference and is most destructive. The outcome of soil erosion are for example floods, landslides, loss of fertile soil and soil nutrients, damaged roads and etc.

This report will presents all of the soil erosion conservation measures adopted in this project. There are two types of soil control methods implemented here. The first method is by biological work and the application (planting) of plants or vegetation to stabilize the soil and second is by engineering work which requires the construction of masonry such as retaining wall, checkdams, weirs, gabions and etc.

Sound understanding of the process of erosion is important in the prevention of soil erosion. Factors such as rainfall, soil, topography and plant cover must be considered inorder for conservation work to be effective.

Rainfall - Rainfall which is more or less evenly distributed throughout the year is less damaging when compared to rainfall concentrated on one rainy season. In the former situation, the uniform rainfall permits the growth of dense vegetation throughout the year. The vegetation is capable of protecting the soil from erosion, more rain water can infiltrate the soil. Rainfall concentrated to one season can be destructive and disastrous. In the dry season, the ground vegetation dries up and thus exposing the soil. When the rainy season comes, the ground vegetation does not have enough time to recover fully. The soil infiltration capacity will be reduced and there will be more surface runoff resulting in severe erosion.

High rainfall intensity at one time can damage the structure of the surface soil by releasing silt and clay particles that can clog the soil pores. Clogged soil pores substantially reduced the infiltration of water.

Topography - The steeper the slope the higher will the velocity and erosive power of the run-off water. On gentler and long slopes water tends to accumulate at the base. Most of the eroded soil will be deposited at this point.

Soil - Soil texture will determine the degree of soil erosion. Coarse textured soil like sand has a high infiltration capacity but it is not resistance to erosion. Fine textured soil like clay has a very low infiltration capacity and is resistance to erosion. Soil having a favorable mixture of fine and coarse textured soils like loam soil has a good infiltration capacity and it is quite resistance to erosion.

The following are soil erosion control measures undertaken in this project.

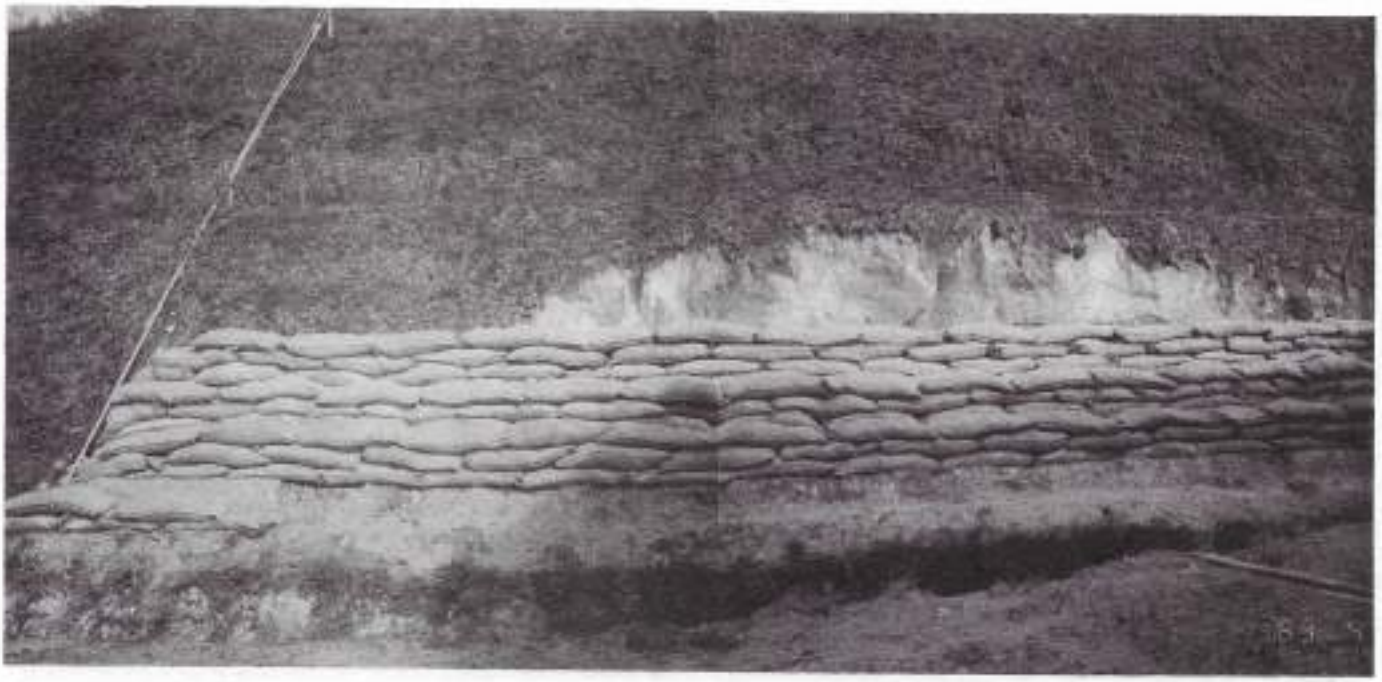
Situation 1. Landslide of a terraced cut slope. (Picture 1).

Possible cause: Gravitational erosion combined with water erosion.

The landslide area was repaired using gunny sacks filled with soil and wire for stitching. In the first stage of repair, the damaged section was levelled using handtools such as scoop and hoe. (See Picture 2)

Gunny sacks were filled with soil and the opened section of the sacks were stitched with wire. Filled gunny sacks are arranged as shown in Picture 3 (brick-wall arrangement).

Repair work completed. (Picture 4).



This method of slope repair can be carried out easily. The only draw back to this method is the lack of material durability. Gunny sacks when exposed to the forces of nature can only last for a few months. (See Picture 5).

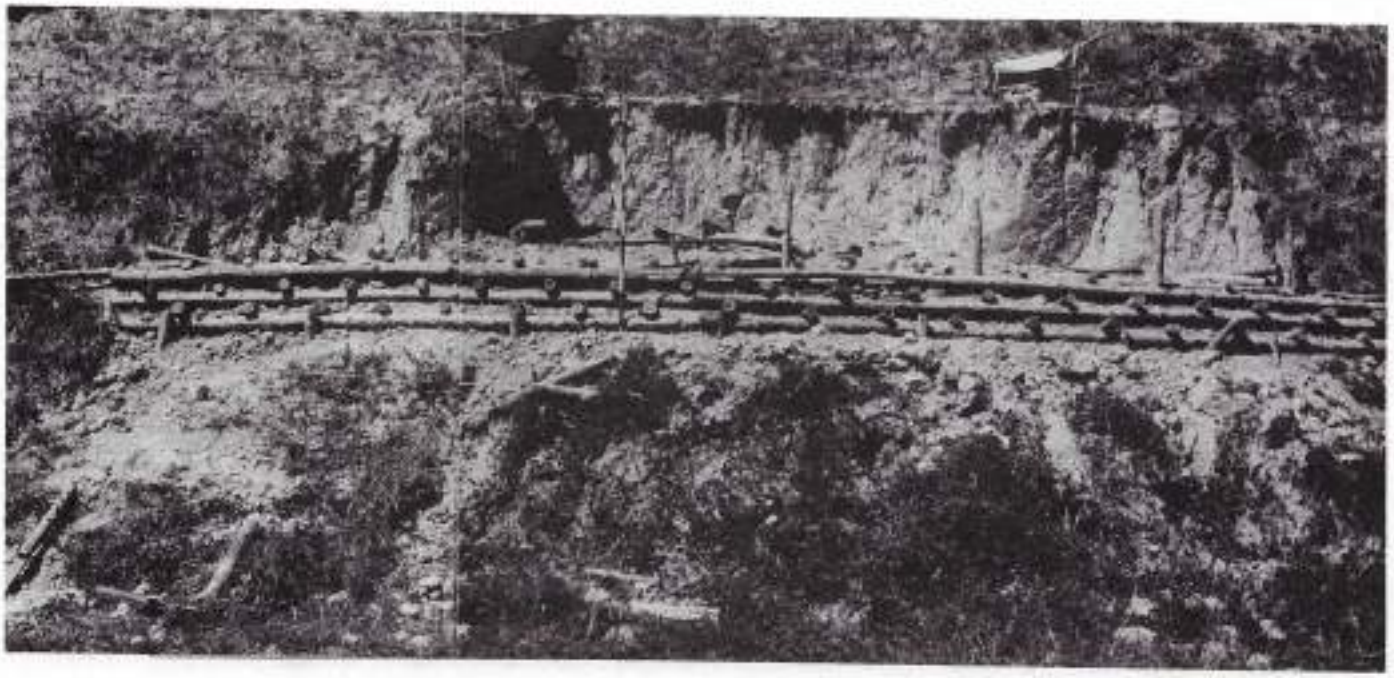
Picture 5. A few months after completion.

Note that, almost all of the sandbags have been damaged.

This area was repaired again using a much simpler method. The damaged surface was cut and filled so that the surface's finished inclination is gentler than the original surface. Wooden fence was constructed at about 2/3 the height of repaired area. This is to prevent the filled soil at the highest section from sliding and settling downwards. The finished slope surface was then turfed. (See Picture 6). This picture was taken 16 months after the second repair work.

Picture 6.

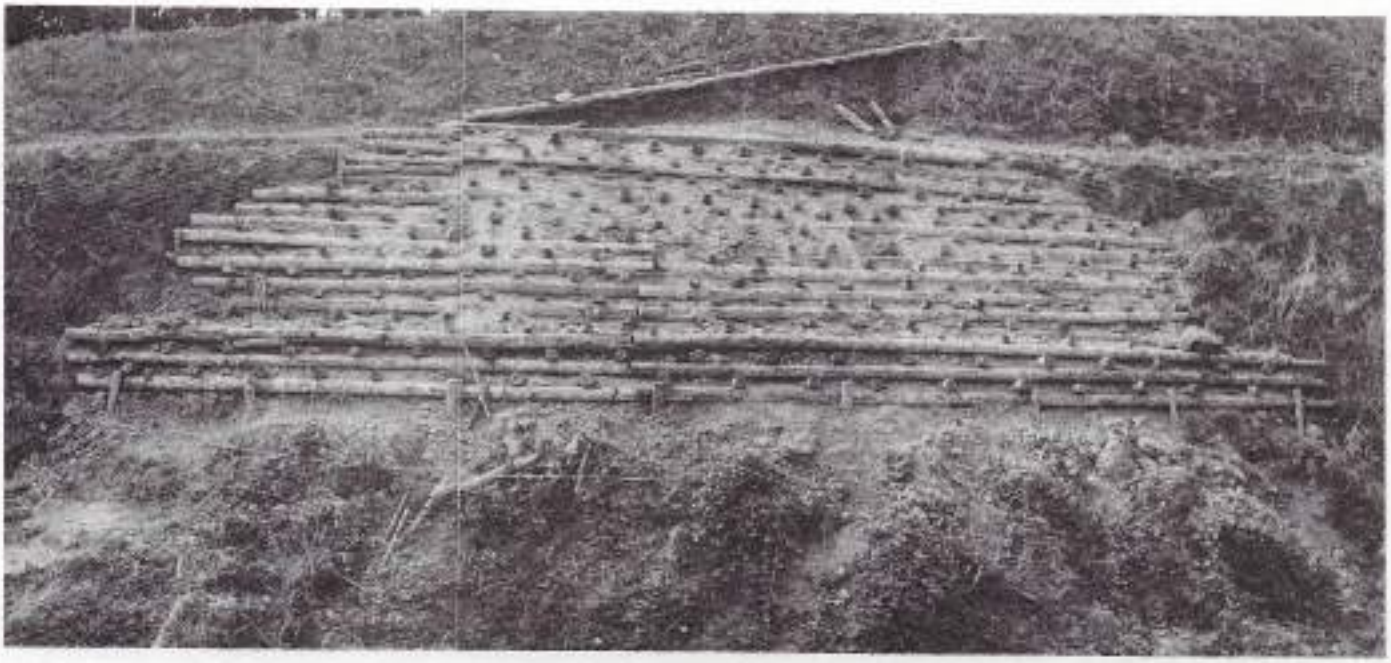
Situation 2. Landslide of a terraced cut slope. (Picture 7).



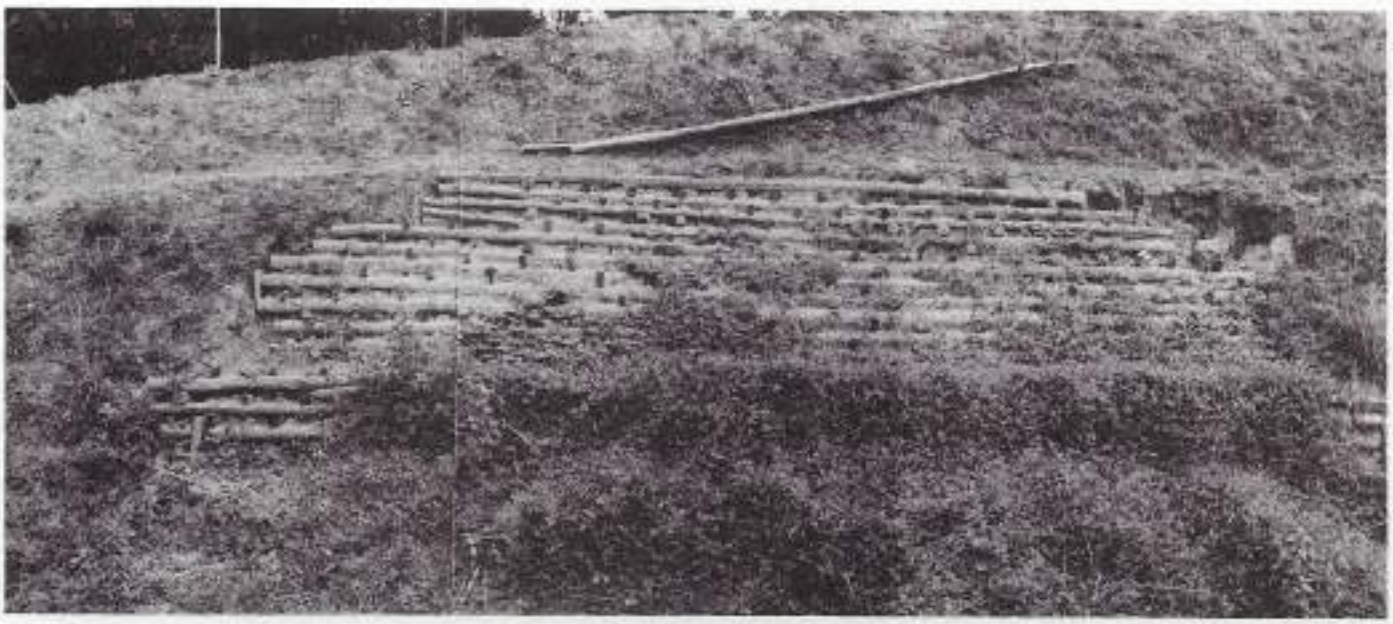
Possible causes : Gravitational erosion combine with water erosion.

This damaged area was repaired using log retaining wall. For complete information about this log retaining wall design refer to the *Manual of Forest Road Maintenance and Soil Erosion Control by Jazah Saman and Takeshi Nakamura (1991).*

Picture 8.



The above picture shows the completed design of log retaining wall. After completion the wall was seeded with *Calopagonium muconoides* to stabilized the soil.



Picture 9 was taken 3 months after seeding. Note that the lower portion of log the retaining wall is almost fully covered with the growth of *Calopagonium muconoides*. Most of the seeds seeded on the top half of the wall were washed down by rain water. This resulted in a much denser growth of *Calopagonium muconoides* on the lower section.

Situation 3. Landslide of a cut slope. (Picture 10).

Possible cause : Gravitational erosion coupled with water erosion.

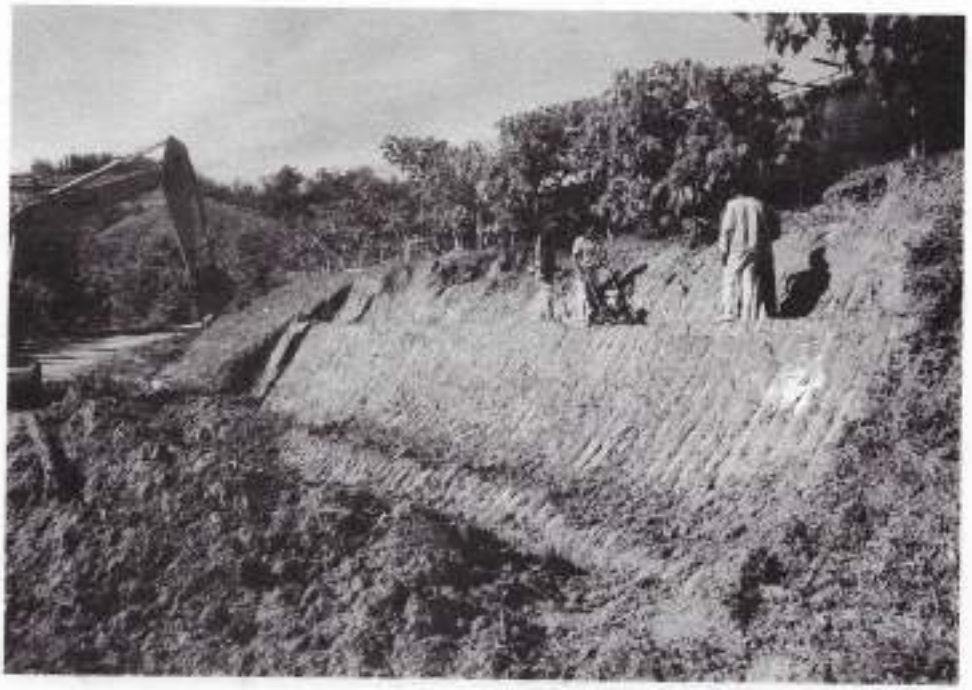
This damaged area was repaired using old tyres retaining wall. The detail of the design can be referred to the *Manual of Forest Maintenance and Soil Erosion Control by Jazah Saman and Takeshi Nakamura (1991).*

Picture 11.

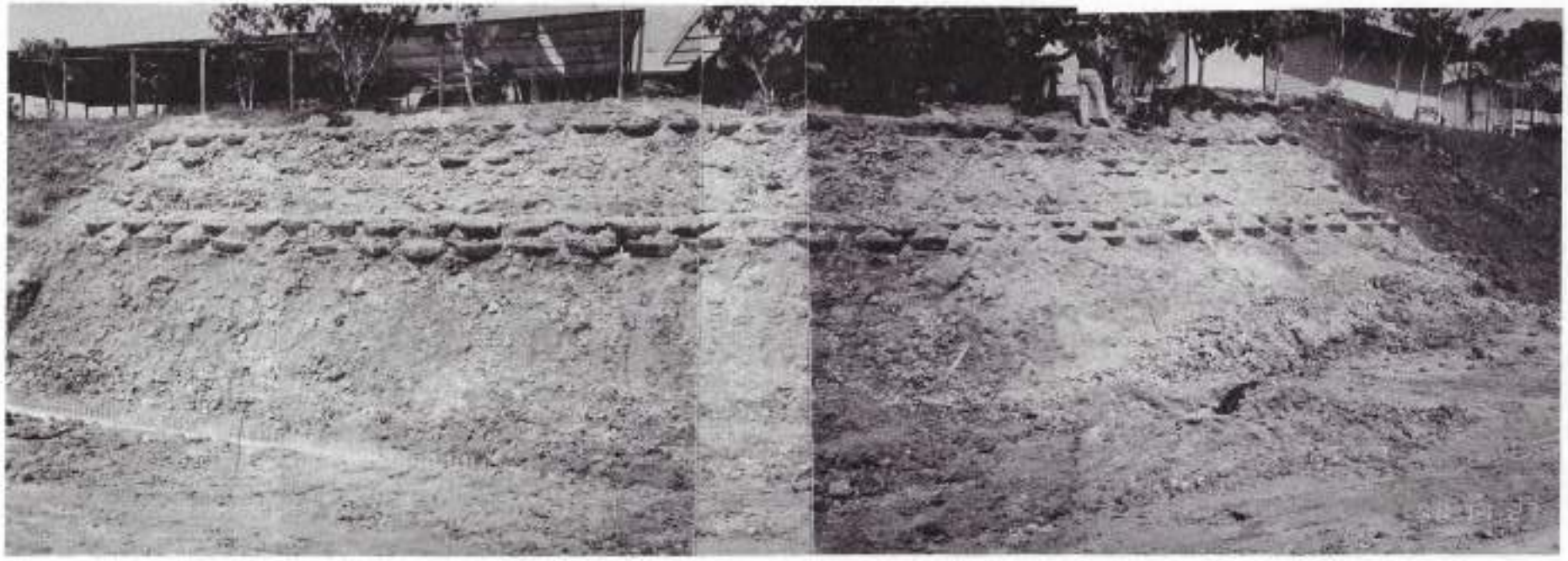
An excavator was used in reshaping and constructing of a terrace on the damaged area.

Picture 12.

The terraced section of the new slope surface was compacted with a compactor machine. Note that the slope of the cut area is steeper than the original slope.

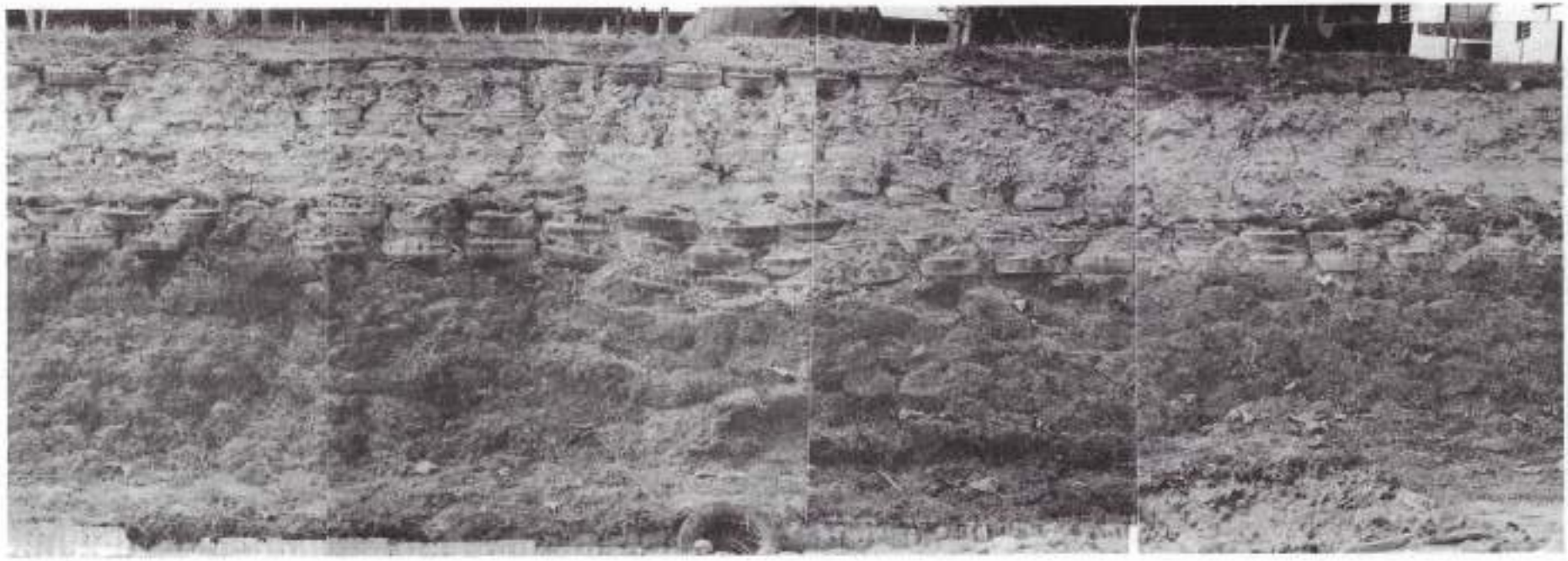


Picture 13.



This picture shows the overall arrangement of the used tyres in the retaining wall design. The tyres are arranged in such a way that they overlapped one another. Only the top half of the repaired area is covered with tyres. The lower section was turfed (See next picture).

Picture 14.

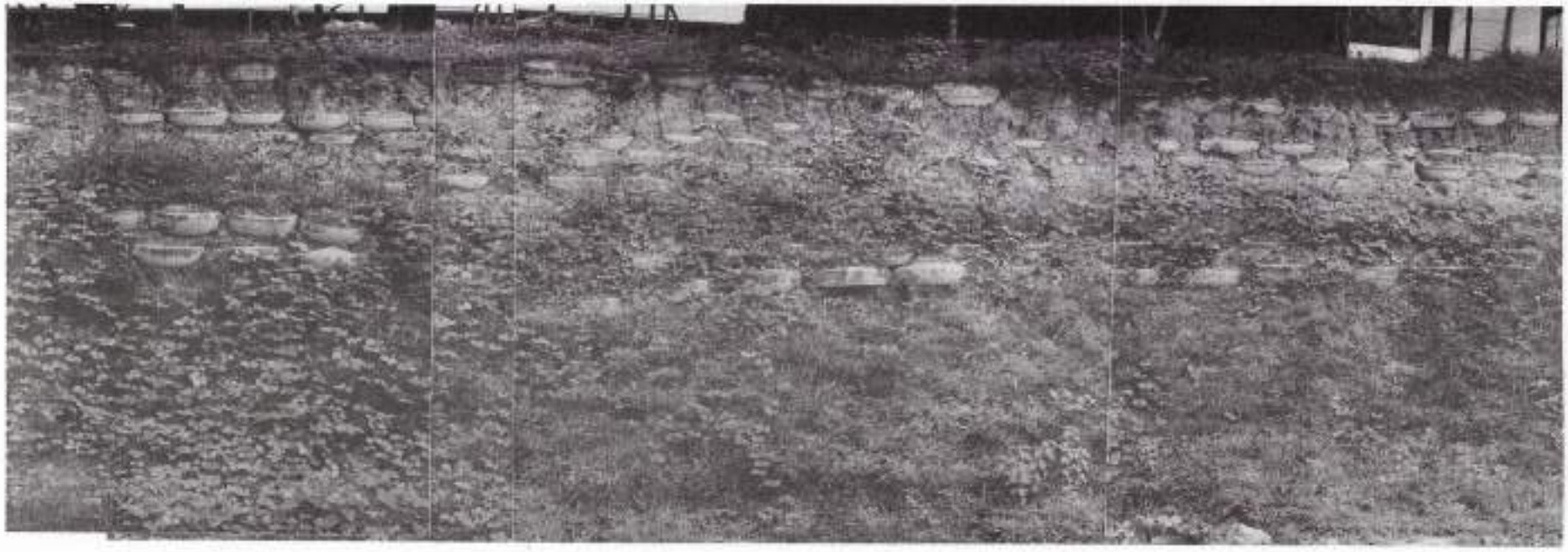


This picture shows the finished design. Top half of this area was also seeded with *Calopagonium muconoides.*

Picture 15.

This picture was taken one month after seeding. It shows the growth of *Calopagonium muconoides*.

Picture 16.



The above picture was taken four months after completion. The *Calopagonium muconoides* shows a very good growth. Apparently seeds seeded on the top section of the wall were washed down by rain water. The grass turfing also shows good growth.

Current observation: The repaired area has stabilized.

Situation 4. Gully erosion on a filled slope. (Picture 17).

Cause: Water erosion.

Heavy machinery (excavator) was used in repairing and reshaping the damaged area. Repair work was started from the top, a terrace was cut about midway of the damaged area.

Picture 18.

Picture 19 shows the new slope face with a terrace. A drain was also built at the foot of the slope. Picture 19.

After cutting operation was completed, turfing was done. Grass turfs were arranged starting from the terraced section and downwards. This is done to prevent breaking the grass turfs from pressure exerted by the worker weight. Bamboo pegs were also used to pin the grass turfs. Picture 20.

Picture 20.

Picture 21.

This picture shows how the damaged area looks like after repair.

Picture 22 of the same area was taken two years later. Note the dense growth of the grasses. This area was also planted with *Gmelina arborea* to further stabilize the soil.

Picture 22.

Current observation: The repaired area has stabilized.

Situation 5. Highly eroded side drain on steep road side.

Picture 23.

Cause: Fast flowing and highly erosive water.

This damaged drain was repaired by constructing a concrete box in the drain so as to block the flow of water. The collected water is then discharged through a culvert to the other side of the road.

Drain section downhill from the concrete box was filled with soil and sandbags were arranged so as to further reduced the flow of water.

Picture 24.

Picture 25.

Picture 26. It can be seen in this picture, the amount of water flow behind the concrete box has been highly reduced compared with the front. The concrete box greatly helped reduce the severity of water erosion on the drain.

Picture 26.

Picture 27.

Situation 6. Gully erosion on steep slope.

Picture 28.

Cause: Fast flowing and highly erosive water.

This damaged area was first repaired by filling up the gully with soil. After that a tentative drain using plastic sheet was constructed. See picture below. Filled sandbags were put on both sides of the drain's mouth to direct the flow of water into the drain.

Picture 29.

Large plastic sheet (in the picture - green colour) was used to cover the filled-up section of the gully to prevent more damages cause by rain water. Some section was turfed.

A permanent drain of corrugated pipes was installed a couple of months later. In the picture below, it shows the present situation of the area. Grasses have grown and trees had been planted. Current observation: the area has stabilized.

Picture 30.

Situation 7. Fill slope stabilization.

Picture 31.

This filled-slope was initially stabilize by planting trees (species *Gmelina arborea*). The above picture was taken 6 months after planting. Picture 32 of the same area was taken 2 years later. Most of the trees have grown over 2 meters. Grasses have also invaded the area.

Picture 32.

Situation 8. Collapse of cut slope of forest road.

Picture 33.

Possible cause(s) : Gravitational erosion combined with water erosion.

This damaged area was repaired using tyres retaining wall. Wall design can be referred to the *Manual of Forest Road Maintenance and Soil Erosion Control by Jazah Saman and Takeshi Nakamura (1991).*

Picture 34.

Picture 34 shows the completed tyres retaining wall. The retaining wall was also seeded with *Calopagonium muconoides*. Observation is still being carried out on the effectiveness of this design.

Situation 9. Gully (moderate size) erosion on road fill slope.

Picture 35.

Bamboo wattling fence was used in the stabilization of the slope. Detail of design can be referred to the *Manual of Forest Road Maintenance and Soil Erosion Control by Jazah Saman and Takeshi Nakamura (1991)*. As can be seen in the picture, sandbags were also placed along side of the fencing. The aim of these sandbags is to reduce the velocity of run off water.

The area was also planted with *Gmelina arborea* cutting. See Picture 36.

Observation on the area is still going on.

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