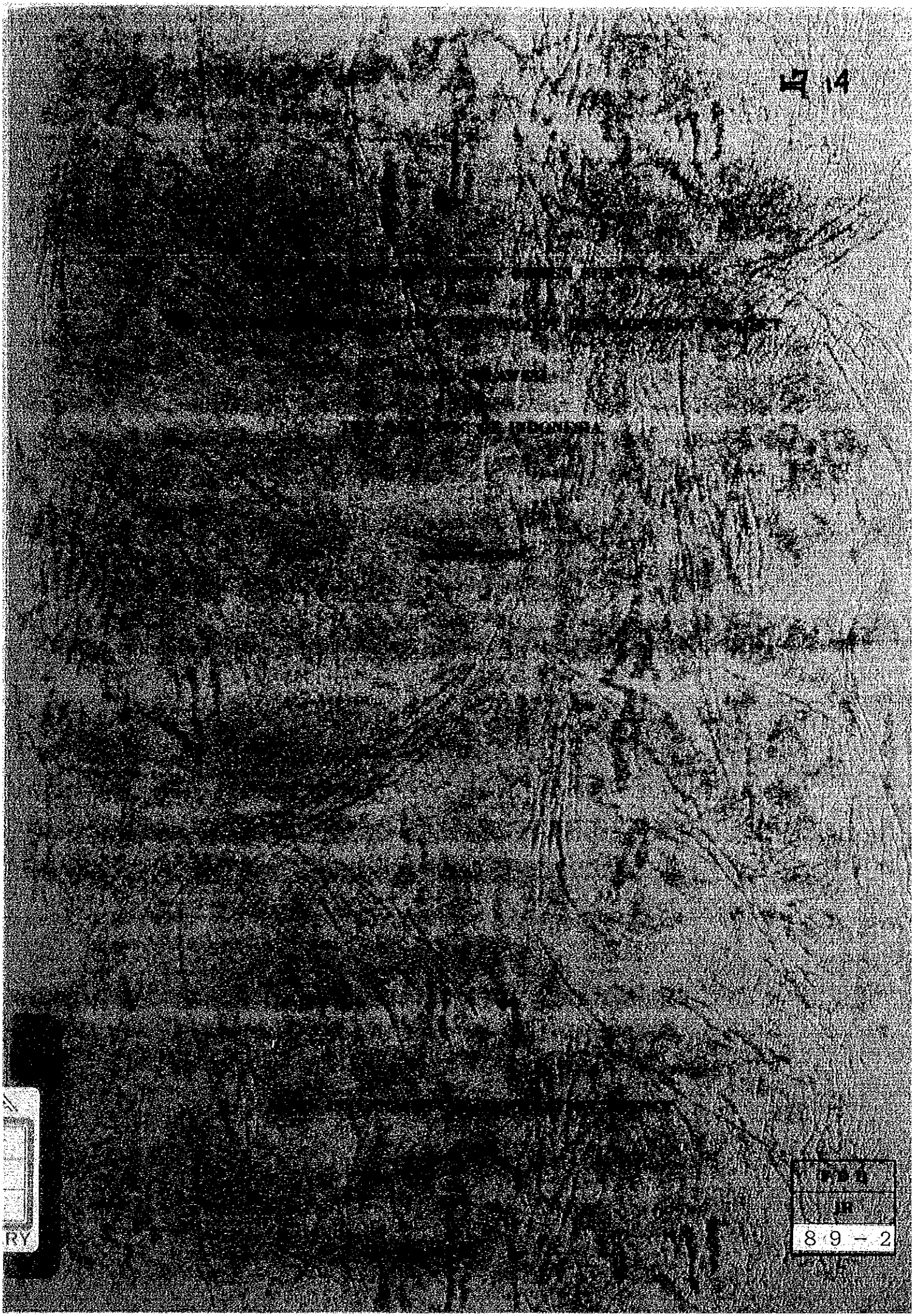

# REPORT ON IMPLEMENTATION DESIGN SURVEY TEAM
# FOR
# THE WATERSHED MANAGEMENT TECHNOLOGY DEVELOPMENT PROJECT
# IN
# SOUTH SULAWESI
# IN
# THE REPUBLIC OF INDONESIA

Preface

In the Republic of Indonesia, shifting cultivation and excessive pasturage has resulted in denudation of forests.

Restoration of the devastated land and prevention of another devastation are the urgent and important problems in the policy on forestry of the country. Thus, dividing the country into six districts, the country is going to establish a basin control technologies adapted to the natural and social conditions of the respective districts.

Under such a background, the Republic of Indonesia requested our technical cooperation in JFY 1985 for development and improvement of the watershed management technology in the South Sulawesi District and training of engineers.

For the request, the Japan International Cooperation Agency took a steps to initiate a forestry conservation technical cooperation project in July 1988. The project was intended for the transfer of forestry and hydrologic technology, development and improvement of the forestry conservation technology and flood control and afforestation technology and training of the required engineers.

Thus, from October 20 to December 3, 1988, the Agency dispatched a survey team for implementation design of the facilities required for execution of the project, including hydrometer and other forestry and hydrological facilities, stream works, hillside works and other flood control facilities, buildings such as laboratories, warehouses and garages, nurseries and bridges.

This report presents a summary of the survey, and I am convinced that it will serve as valuable information for promotion of the project.

I would like to express my thanks for the support and cooperation of the personnel of the Republic of Indonesia as well as the agencies concerned in our country and those who participated in the survey, without which this survey would have been impossible.

January 1989

Katsuyuki Ohmi
Director, Forestry and Fisheries Cooperation Dept.,
Japan International Cooperation Agency

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# I. PURPOSE AND OUTLINE OF SURVEY

## 1. Purpose

This survey was undertaken to conduct execution design of the various facilities needed to implement the South Sulawesi Erosion Control Project in accordance with the R/D concluded on July 21, 1988.

The land surveyed was divided into the field station in Malino Village and the model area in the upper reaches of the Malino River. In the former area, design of buildings will be undertaken. In the latter area, gauging facilities, stream work, hillside work, nurseries, nursery facilities, bridges including access roads, and other work and facilities will be designed. The work also included framing of an overall plan, such as building layout plans, trial aforestation plans and tree garden plans embracing the buildings, nursery facilities and other facilities which the Government of the Republic of Indonesia is scheduled to build.

## 2. List of Persons Concerned and Survey Schedule

### (1) List of persons concerned

#### 1) Composition of execution design team

Members of Survey Team for Execution Design of Model Infrastructure Improvement Project for Erosion Control Program of South Sulawesi, Republic of Indonesia

| Name and Responsibility | Organization |
|---|---|
| Shunji KUDO<br>(Coordination, erosion control) | Erosion Control Section Chief,<br>Japan, Forest Civil Engineering Consultants Foundation |
| Hiroyuki TERAYA<br>(Forest roads) | Technical advisor,<br>Japan, Forest Civil Engineering Consultants Foundation |
| Yotaro HIROSE<br>(Buildings) | Technical advisor<br>Japan, Forest Civil Engineering Consultants Foundation |

2) Indonesian Officials

| | |
|---|---|
| Ir. Banbang SUKARUTIKO | Director of Soil Conservation, Department of Forestry |
| Ir. Dwiatmo SISWOMARTONO | Directorate of Soil Conservation, Department of Forestry |
| Ir. Widji SANTOSA | Foreign Cooperation and Technical Assistant, Bureau of Planning, Ministry |
| Ir. Soenardi SETYODARMODJO | Secretary of Directorate General for Reforestation and Land Rehabilitation, Department of Forestry |
| Ir. MOMONG (Kepala BRLKT IX) | Balai Rehabilitasi Lahan dan Konservasi Tanah IX (BRLKT) |
| Ir. Paulos KADANG | Same as above |
| Ir. SUMIJARTO | Same as above |
| Dr. Ir. Marthen L. LANDE | Universitas Hasanuddin |

3) Japanese Officials

| | |
|---|---|
| Atsushi IOGI | First Secretary, Japanese Embassy in Indonesia |
| Mitsuo WATANABE | Consul General, Japanese Consulate General in Ugung Pandang |
| TANIUCHI | Vice Consul, Japanese Consulate General in Ujung Pandang |
| Yasuyuki SUZUKI | Advisor (Programming and Project Planning) of Department of Forestry (JICA) |
| Yasuo KITANO | Director, Indonesia Office, JICA |
| Manabu AIBA | Staff member, Indonesia Office, JICA |
| Masayoshi SHINAGAWA | Expert, South Sulawesi Watershed Management Project (Team Leader, JICA) |
| Akira SATO | Expert, South Sulawesi Watershed Management Project (Aforestation, JICA) |
| Satoshi KUTSUZAWA | Same as above (Nurseries) |
| OSHIMA | Same as above (Machinery) |
| UEDA | Same as above (Forestry and hydrology) |
| TANIGUCHI | Same as above (Project coordinator) |

(2) Survey schedule

The survey was undertaken for 45 days between October 20 and Cecember 3, 1988.

Work Report

| | | |
|---|---|---|
| October | 20 (Thurs.) | Left Tokyo, arrived Jakarta. |
| | 21 (Fri.) | Courtesy calls and discussions at Japanese Embassy and JICA office. |
| | 22 (Sat.) | Studied field books. |
| | 23 (Sun.) | Studied field books. |
| | 24 (Mon.) | Courtesy call to Ministry of Forestry. |
| | Afternoon | Arrived Ujung Pandang via GA flight 732. |
| | 25 (Tue.) | Courtesy calls to Japanese Consulate General in Ujung Pandang and Land Rehabilitation and Soil Conservation Center I Discussed work schedule. |
| | 26 (Wed.) | Surveyed land at scheduled building construction site in the field station (Malino Village). Some buildings must be removed. Viewed Malino River catchment basin. Visited the Japan Black Tea Co. plant and toured its nursery facilities, buildings and other facilities. Stayed at the Malino Hotel. Accompanied by Director Kadang of Juneberang Sub-center, Leader Shinagawa, Mr. Teraya and Mr. Hirose. |
| | 27 (Thurs.) | Inspected the four proposed bridge construction sites and head-waters for water flow to nurseries in the model area. |
| | 28 (Fri.) | Inspected the site scheduled for gauging facilities. Toured the lysimeter and meteorological observation field to be provided by the Indonesian side. |
| | 29 (Sat.) | Revisited Japan Black Tea Co. plant and borrowed data related to buildings such as contracts and design drawings. |
| | 30 (Sun.) | Compiled data for discussion with JICA HQ. |
| | 31 (Mon.) | Meeting. After telephoning JICA HQ., tried to go up to hills. However, the road condition was |

| | | |
|---|---|---|
| | | poor and abandoned the plan to stay in Sanggiringan. Stayed in Malino instead. Accompanied by Messrs. Sumijarto, Taniguchi and Teraya. |
| November | 1 (Tues.) | Arrived in Sanggiringan. Inspected the site scheduled for nurseries with Mr. Kadang, Leader Shinagawa and Messrs. Kutsuzawa, Sato and Teraya. Selected the site. Stayed in Sanggiringan. |
| | 2 (Wed.) | Conducted longitudinal leveling and planimetric surveying of the scheduled site for the gauging facilities. (Both processed and non-processed blocks) Conducted planimetric and center line surveying of land near the four bridges. Stayed in Sanggiringan. |
| | 3 (Thurs.) | Conducted cross-leveling of the dam in uppper area of gauging facilities in the non-processed block. Met vendors interested in undertaking construction in Malino in the afternoon. Stayed in Malino. |
| | 4 (Fri.) | Showed the vendors the sites up to the second bridge. Left Malino for Ujung Pandang. Stayed in Ujung Pandang. |
| | 5 (Sat.) | Prepared "Progress of Survey on Execution Design of Model Infrastructure Improvement Project for South Sulawesi Erosion Control Program and design Problems" at the Land Rehabilitation and Soil Conservation Center IX and submitted the report to the JICA Indonesian office director. Stayed in Ujung Pandang. |
| | 6 (Sun.) | Studied field-books. Stayed in Ujung Pandang. |
| | 7 (Mon.) | Proceeded to Sanggiringan. Accompanied by Messrs. Lahaman, Kutsuzawa and Teraya. Stayed in Sanggiringan. |
| | 8 (Tues.) | Decided directions of the gauging dam for gauging facilities in the non-processed block, waterway work, gauging dam in the processing block, |

| | |
|---|---|
| | waterway work, and upper dam. Conducted cross-leveling. Conducted planimetric and center line leveling around the fourth bridge. Stayed in Sanggiringan. |
| 9 (Wed.) | Conducted leveling of the foregoing sites and planimetric and center line leveling around the fourth bridge. Stayed in Sanggiringan. |
| 10 (Thurs.) | After deciding directions for two erosion control dams (torrential work), conducted cross-leveling, BM setting, and leveling around the fourth bridge. Stopped work in the afternoon due to rainfall. Stayed in Sanggiringan. |
| 11 (Fri.) | Went down the hills and proceeded to Ujung Pandang. Stayed in Ujung Pandang. |
| 12 (Sat.) | Discussed intermediate progress report at the Land Rehabilitation and Solid Conservation Center IX. Studied field-books in the afternoon. Stayed in Ujung Pandang. |
| 13 (Sun.) | Prepared a draft document on intermediate progress report in English and submitted it to Specialist Taniguchi for necessary corrections. Stayed in Ujung Pandang. |
| 14 (Mon.) | Went up the hills and proceeded to Sanggiringan. Due to rain, stayed in Malino. Accompanied by Messrs. Teraya and Sato. |
| 15 (Tues.) | Proceeded to Sanggiringan. The car was unable to proceed farther at 250 m before the fourth bridge. Abandoned the vehicle and walked to Sanggiringan. Due to rain, work was not possible. Kudo stayed in Sanggiringan. Messrs. Teraya and Sato stayed in Malino. |
| 16 (Wed.) | Conducted longitudinal leveling from headwaters and planimetric surveying and center line leveling around the third bridge. Kudo stayed in Sanggiringan. Messrs. Sato and Teraya stayed in Malino. |

17 (Thurs.) Conducted longitudinal leveling (waterway) and leveling around the third bridge. Kudo stayed in Sanggiringan. Messrs. Sato and Teraya stayed in Malino.

18 (Fri.) Conducted longitudinal leveling (waterway). Kudo stayed in Sanggiringan. Messrs. Teraya and Sato went down the hills.

19 (Sat.) Same as above.

20 (Sun.) Same as above.

21 (Mon.) Conducted longitudinal leveling (waterway) connecting to the scheduled nursery site. Leveled land around hillside land collapse (processed block). Met the Director of Erosion Control Bureau, Ministry of Forestry, at the site. Leader Shinagawa and Specialist Kutsuzawa joined. Kudo stayed in Sanggiringan. Mr. Teraya proceeded to the hills and stayed in Malino.

22 (Tues.) Kudo set lysimeters in the non-processed and processed blocks. Conducted leveling of two erosion control dams and went down the hills. Stayed in Ujung Pandang. Teraya conducted planimetric surveying and center line leveling around the second bridge. Stayed in Malino.

23 (Wed.) Teraya conducted leveling around the second bridge and stayed in Malino. Kudo studied field-books and stayed in Ujung Pandang.

24 (Thurs.) Teraya conducted planimetric surveying and center line leveling around the first bridge. Kudo went up to the hills with Mr. Kadang, Leader Shinagawa and Mr. Hirose and conducted leveling of area around slided land along roads at Lembangpanai. All members stayed in Malino.

25 (Fri.) Kudo conducted planimetric surveying, longitudinal leveling, and leveling of gauging facilities in the forest block. Traya conducted leveling around the first bridge.

| | | |
|---|---|---|
| | | All members went down the hills and stayed in Ujung Pandang. |
| | 26 (Sat.) | Mr. Kadang, Leader Shinagawa, Mr. Kutsuzawa and Kudo called on Dr. Marthen L. Lande at Universitas Hasanuddin and asked for his cooperation in supplying various data. Stayed in Ujung Pandang. |
| | 27 (Sun.) | Studied field books. |
| | 28 (Mon.) | Final discussion at the Land Rehabilitation and Soil Conservation Center IX. Stayed in Ujung Pandang. |
| | 29 (Tues.) | Visited Japanese consulate general in Ujung Pandang to report completion of survey and departure to Japan. Arrived in Jakarta in the afternoon. Stayed in Jakarta. |
| | 30 (Wed.) | Visited Japanese Embassy and JICA Jakarta office for discussion and to report completion of survey and departure to Japan |
| December | 1 (Thurs.) | Visited Ministry of Forestry to report completion of survey and departure to Japan And discussion schedule after going back. |
| | 2 (Fri.) | Departed Jakarta. |
| | 3 (Sat.) | Arrived Tokyo. |

* Mr. Hirose in charge of buildings stayed in Ujung Pandang for building design except for the work activities mentioned in the above work report.

## II. NATURAL CONDITIONS OF SURVEYED LAND

### 1. Topography

The field station is located on a plateau sandwiched by the Jeneberang and Malino Rivers. Located approximately 67 km from Ujung Pandang, the elevation of the land is 720 m and the site is in an optimal environment for building field offices and other facilities.

The model area has an area of 500 ha in the upper reaches of the Malino River. Unlike the land where the field station is scheduled to be built, the terrain centering on both sides of the Malino River is complex, mixed with steep land advanced in diffraction, undiffracted plateau and other types of land.

The undiffracted plateau terrain is used as paddy fields and is prominent on the left side of the middle and lower reaches of the Malino River.

### 2. Geological Features

The soil in the surveyed area is mainly sedimentary rocks of the Neogene and igneous rocks. The igneous rock layer contains mainly tuff, volcanic tuff and breccia. The sedimentary rocks of the Tertiary period contains in part limestone, calcareous sandstone and calcareous mudstone. A distribution of mud-flow sediments caused by flowing of Lompobatang igneous rocks is also slightly present.

### 3. Meteorology

#### (1) Rainfall

According to the rainfall data of the surveyed area (Malino Observation Station) and of observation stations around the surveyed area (Monthly and Annual Mean Rainfall, see Table 1 and Fig. 1), the annual rainfall recorded by the Malino Observation Station shows the greatest value (3,867 mm). Judging from Fig. 1, Malino is located deepest, which means that the elevation is also highest. Therefore, it can be said that rainfall is proportional to elevation.

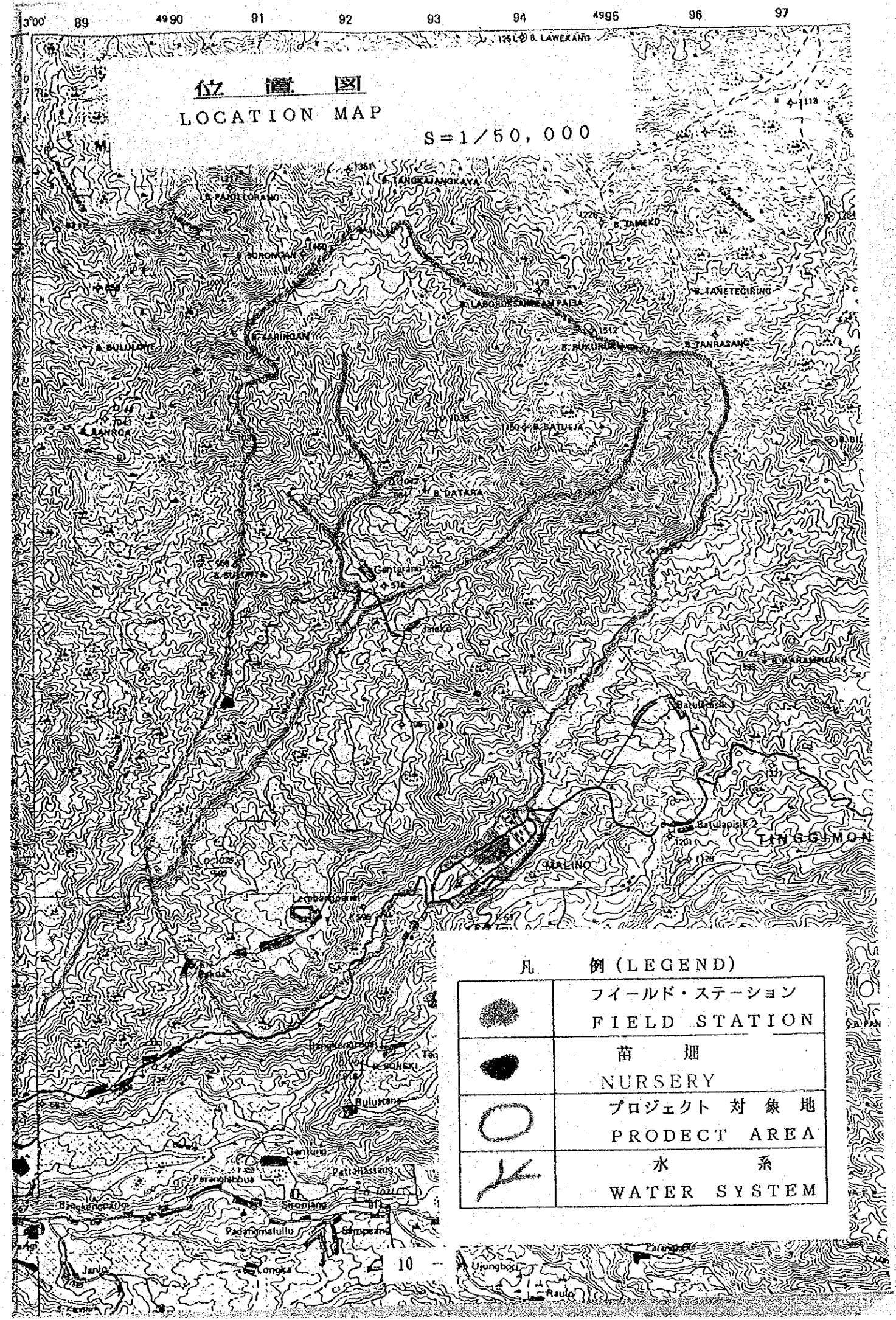

位置図
LOCATION MAP
S=1/50,000
凡　例（LEGEND）
フィールド・ステーション
FIELD STATION
苗　畑
NURSERY
プロジェクト対象地
PRODECT AREA
水　系
WATER SYSTEM
B. TANGKAJANGKAYA
B. PAKULORANG
B. SURONGAN
B. TAMEKO
B. TANETEGIRING
B. LABORUSAMBEAN PAITA
B. KARINGAN
B. BULUKOMBO
B. RUKUNDUA
B. TANRASANG
B. LANROA
B. BATUEJA
B. DATARA
B. BUSUNTA
Gantgrang
Jaleko
Batulapisik
Batulapisik 2
TINGGIMON
MALINO
Lembakapeta
Pakuli
Jalo
Bangkeangkang
Bulukang
Gantung
Pattallassang
Parangtabbua
Bangkeangkang
Sikonang
Padangmalullu
Gampeang
Janlo
Longka
Ujungbokl
Raulo

Table 2 presents the annual maximum one-day rainfall in the past. This survey includes design of gauging facilities to analyze the relationship between rainfall and discharge, and calculations of a 100-year probable one-day rainfall in accordance with the above-mentioned data.

TABLE 1 MEAN MONTHLY RAINFALL

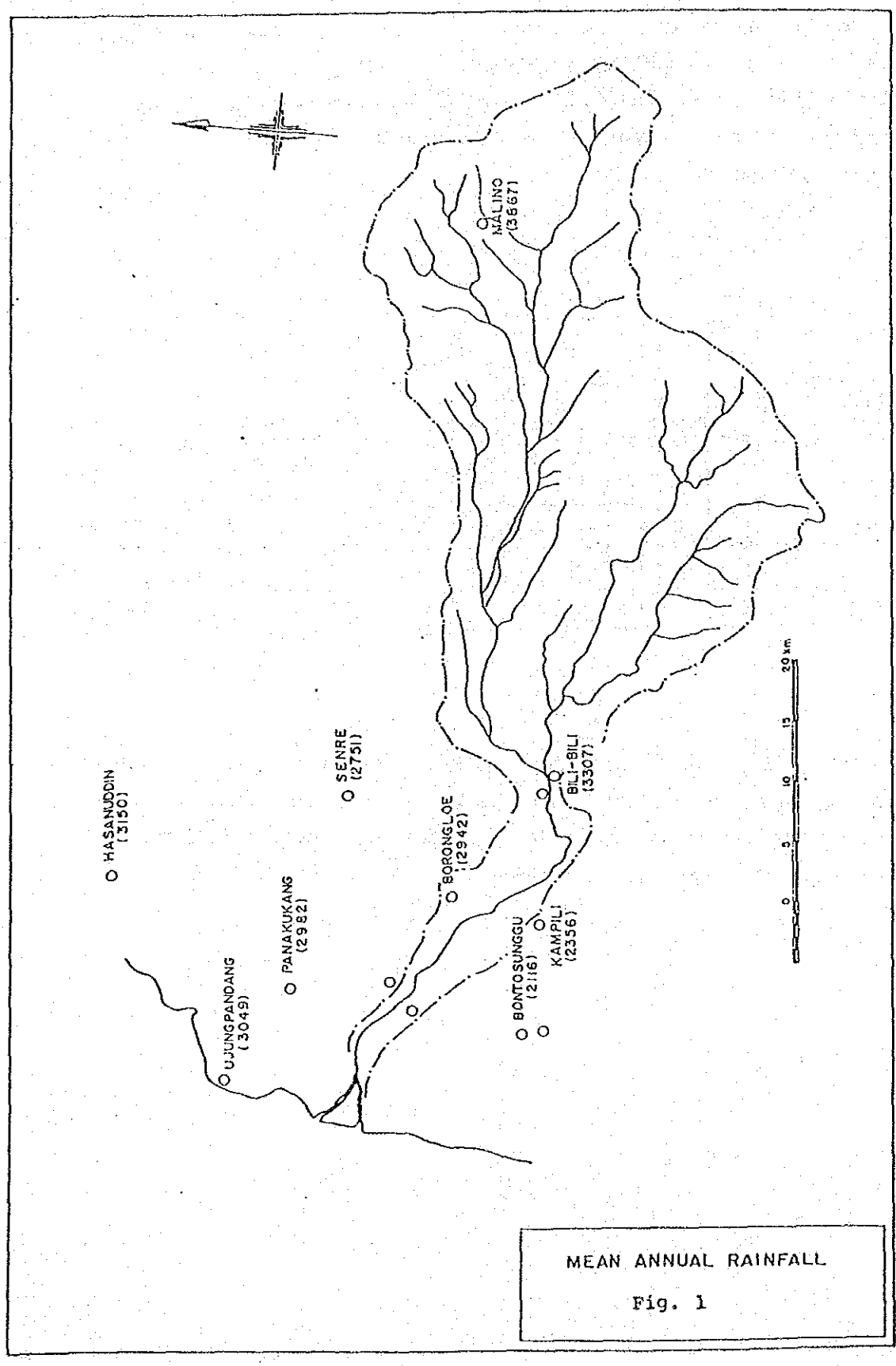
(Unit: mm)

| Observation Station \ Month | Jan | Feb | Mar | Apr | May | Jun | Jul | Aug | Sep | Oct | Nov | Dec | Year (Total) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Ujung Pandang | 758 | 595 | 433 | 177 | 95 | 56 | 46 | 8 | 32 | 66 | 227 | 547 | 3,049 |
| Panakukang | 727 | 619 | 310 | 217 | 108 | 86 | 47 | 17 | 42 | 77 | 192 | 486 | 2,982 |
| Bili-bili | 652 | 609 | 374 | 323 | 151 | 73 | 63 | 16 | 51 | 79 | 318 | 616 | 3,307 |
| Malino | 619 | 599 | 441 | 433 | 249 | 155 | 87 | 29 | 67 | 131 | 285 | 644 | 3,867 |
| Hasanuddin | 646 | 59 | 419 | 202 | 129 | 90 | 57 | 18 | 66 | 110 | 338 | 577 | 3,150 |

(2) Mean Monthly Climatology Data

Table 3 presents the mean monthly climatology data. The annual mean temperature is 26.3°C. Unlike Japan, the mean values for the various months are nearly identical. However, one-day differences are great, and the temperature becomes very low during the night.

The annual mean temperature is 15.3°C in Tokyo.




MEAN ANNUAL RAINFALL

Fig. 1

TABLE 2 ANNUAL MAXIMUM ONE-DAY RAINFALL

(Unit: mm/day)

| Year | Malino | Bili-bili | Year | Manlino | Bili-bili |
|---|---|---|---|---|---|
| 1923 | - | 97 | 1955 | - | 182 |
| 1924 | - | 98 | 1956 | 193 | 145 |
| 1925 | - | 235 | 1957 | - | 143 |
| 1926 | - | 113 | 1958 | - | 143 |
| 1927 | - | 143 | 1959 | 150 | 200 |
| 1928 | - | 113 | 1960 | 235 | - |
| 1929 | - | 182 | 1961 | 201 | - |
| 1930 | - | 152 | 1962 | 169 | - |
| 1931 | 117 | 125 | 1963 | 119 | - |
| 1932 | 115 | 217 | 1964 | - | - |
| 1933 | 202 | 156 | 1965 | 200 | - |
| 1934 | 150 | 210 | 1966 | 111 | 147 |
| 1935 | 252 | 210 | 1967 | 190 | 172 |
| 1936 | 118 | 97 | 1968 | 127 | 87 |
| 1937 | 154 | 139 | 1969 | 88 | 213 |
| 1938 | 225 | 165 | 1970 | 130 | 131 |
| 1939 | 181 | 138 | 1971 | 150 | 151 |
| 1940 | 143 | 117 | 1972 | 205 | 249 |
| 1941 | 216 | - | 1973 | 105 | 271 |
| 1942 | - | - | 1974 | 294 | 194 |
| 1943 | - | - | 1975 | 86 | 264 |
| 1944 | - | - | 1976 | 134 | 160 |
| 1945 | - | - | 1977 | 208 | 235 |
| 1946 | - | - | 1978 | 160 | 114 |
| 1947 | - | - | 1979 | 152 | 211 |
| 1948 | - | - | 1980 | 138 | 108 |
| 1949 | - | - | 1981 | 135 | 118 |
| 1950 | - | - | 1982 | 135 | 147 |
| 1951 | - | - | 1983 | 130 | 206 |
| 1952 | - | - | 1984 | 125 | 129 |
| 1953 | 225 | 157 | 1985 | 105 | 121 |
| 1954 | 225 | 102 | 1986 | 193 | 161 |

TABLE 3 MEAN MONTHLY CLIMATOLOGY DATA

| | Jan. | Feb. | Mar. | Apr. | May | Jun. | Jul. | Aug. | Sep. | Oct. | Nov. | Dec. | Mean |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1. Temperature (°C) | 25.5 | 25.8 | 26.1 | 26.2 | 26.5 | 26.2 | 25.8 | 26.1 | 26.7 | 27.2 | 26.8 | 26.0 | 26.3 |
| 2. Relative Humidity (%) | 86.4 | 87.0 | 85.1 | 83.5 | 81.9 | 79.3 | 73.5 | 69.3 | 67.7 | 71.3 | 79.6 | 86.3 | 78.3 |
| 3. Wind Velocity (Knot) | 3.1 | 3.2 | 2.8 | 2.4 | 2.1 | 2.3 | 2.9 | 3.7 | 3.7 | 3.6 | 3.3 | 2.9 | 3.0 |
| 4. Sunshine Duration (%) | 47.7 | 47.6 | 59.5 | 72.5 | 74.5 | 72.2 | 86.9 | 92.2 | 89.0 | 85.1 | 70.0 | 47.8 | 71.9 |
| 5. Evaporation (mm/day) | 4.3 | 3.6 | 4.2 | 4.6 | 3.8 | 3.6 | 3.6 | 4.1 | 5.5 | 6.0 | 5.9 | 4.4 | 4.5 |

## III. NECESSITY FOR WATERSHED MANAGEMENT

The approach to watershed management naturally differs between Indonesia, where farmland is developed under the name of forest development, and Japan where every corner of narrow land has been developed from early on.

In Indonesia, forests that are utilized positively for timber production are relatively small and are rather designated as protection and natural reserve forests, or as reserve forests for undefined utilization purposes.

The emphasis of forestry policies is placed in Indonesia on silviculture and erosion control. These policies are carried out divided into reforestation and afforestation. The forest type in afforestation is converted into ordinary forests by converting shrub thin stands of Alang-Alang land and secondly forests into ordinary forests as erosion control afforestation combining purposes as farmland and dwelling land conservation.

Under the circumstances, instead of promoting watershed management technology as a result of excessive felling and development as in Japan, in Indonesia, improvements in watershed management technology have been advocated primarily to meet changes in natural conditions (increases in bare land, Alang-Alang land, and land changing to denudation).

The following can be considered as watershed management technology to meet these circumstances. This survey, however, does not refer to the construction of multi-purpose dams aimed at flood control, water supply and power generation, or of debris barriers.

Watershed Management Technology Preconditioned on Forest Conservation

1. Improvements in forest soil water-holding property and permeability (increase in base flow)

1) Development and maintenance of forests high in total yield to achieve quantitative and qualitative improvements of forest soil. Forest type improvement and afforestation of infertile forest land.

2) Restoration and afforestation of denuted land.

2. Prevention of soil wash-out

1) Prohibition of land clearing of moderate land (generally 20° or more). Limitation of moderate land (building terrace, drainage and other facilities).

2) Seeding and planting of unstocked forest land and development and maintenance of forests.

3. Restoration and afforestation of slided land
Hillside work (sheathing, drainage and replanting)

4. Prevention of stream erosion

Prevention of longitudinal erosion: Erosion control dam (bed sill work).

Prevention of side corrosion: Erosion control dam, revetment, spur jetty

Prevention of valley head corrosion: Erosion control dams (simple dam), sheathing, waterway work

5. Reinforcement of water-holding capacity of deposit soil horizon such as stream beds and spurs colluvial soils and talus cones (quantitative and qualitative improvements: erosion control dams, sheathing, underdrainage and others)

By arranging the above-mentioned work types case by case, a contribution to forests can be made and forest effects can be demonstrated 100% as a result.

However, of the above-mentioned work types, effects and safety of civil engineering structures can already be anticipated at the time of design, while effects of replanting cannot be decided at an early stage. The introduction of vegetation in the tropical area requires the development of grass and tree species that can stand meteorological conditions (high short-time rainfall intensity) and soil conditions (root system development will be difficult because of high soil hardness).

The South Sulawesi watershed management project has been established to analyze and solve these problems. Basic analysis by building gauging facilities and providing slope plots and other facilities will be important and urgent particularly in the initial stage.

## IV. GAUGING FACILITIES AND SLOPE PLOT

### 1. Section of flood control channel of gauging dam

The section of the flood control channel of the gauging dam generally has a double section construction, setting inverse triangle or rectangular notches for a flood flow of a medium degree in the bottom part and floor control channel section for a maximum flood flow in the top part. Normally, the bottom notches arrange a sharp-crested contracted weir, which allows complete overflow, immediately on it. If the flow is small (less than 30 ha in catchment area), inverse triangle notches are used while rectangular notches are used if the flow is relatively large. The water level overflowing on the notches is measured, a water level flow curve formula is calculated, and the flow is calculated. When the inverse triangle and rectangular notches are compared, the overflow water depth of the former is large and the measurement accuracy is high. The catchment areas in the locations where gauging facilities are scheduled to be built in the survey site are less than 30 ha in the processed, non-processed and forest blocks. For this reason, the inverse triangle notches will be built.

The processed block is grassland or land changing to denuded land. This is the block in which erosion control work such as ravine and hillside work will be undertaken in the future as part of watershed management. The unprocessed block is grassland or land changing to denuded land. By leaving it as it is, the run-off of water and earth of it can be compared with that of the processed block. The forest block is a watershed whose catchment area is covered nearly entirely by forests. This block is compared with the foregoing two watersheds.

(1) Calculation of maximum estimated high water flow

The section of a flood control waterway of a gauging dam must have a construction that assures safe flowing of the calculated peak flow and that allows measurement of low-water, low, normal water level and high water flows as accurately as possible.

The maximum estimated high water flow was calculated using the rational formula. The maximum one-hour rainfall in the past was not

known, and the section of the flood control channel cannot be changed after building the gauging dam. For these and other reasons, the stochastic hydro flow was obtained as an element in deciding the notches and the section of the entire flood control channel to decide the rainfall intensity (mm/h).

The stochastic hydro flow was obtained by calculating 100-year probable one-day rainfall and mode one-day rainfall based on the data contained in Table 2 of paragraph (1) Rainfall, 3. Meteorology in II.

When the section of a flood control channel based on a probable hydro flow is decided, 100-year probable one-day rainfall is calculated. the mode one-day rainfall (most-frequent one-day rainfall in one year) based on it must flow safely over inverse triangle or rectangular notches (bottom section). The 100-year probable one-day rainfall must flow safely over the notches and top section (double section surface).

1) Calculatios of 100-year probable one-day and mode one-day rainfalls

100-year probable one-day rainfall

$$P = \frac{\Sigma Pi}{N} = 150 \text{ mm}$$

where $\overline{P}$: mean value of maximum one-day rainfall in the observation history (mm)

Pi: maximum one-day rainfall of each year (mm)

N: observation history (1965 ∿ 1986)

$$Cv = \sqrt{\frac{\Sigma(Pi - \overline{P})^2}{N - 1}} = 48.55$$

where Cv: standard deviation

$$Cs = \frac{\Sigma(Pi - \overline{P})^3}{(N - 1)(Cv)^3} = 1.17285$$

where Cs: strain coefficient

$$\hat{Cs} = Cs\left(1 + \frac{8.5}{N}\right) = 1.63$$

where $\hat{Cs}$: strain coefficient of population

$$P_T = K_T \cdot C_V + \overline{P} = 314 \text{ mm}$$

where $P_T$: 100-year probable one-day rainfall

$K_T$: standard probable variable matching $\hat{C}S$

$$P_M = \overline{P} - \frac{\hat{C}_S \cdot C_V}{2} = 110 \text{ mm}$$

where $P_M$: mode one-day rainfall (mm)

2) Calculations of high water flow matching 100-year probable one-day rainfall and mode one-day rainfall (rational formula)

$$Q = 1/360 \cdot f \cdot r \cdot A$$

where Q: high water flow ($m^3$/sec)

f: coefficient of run-off (processed and non-processed blocks 0.80, forest block 0.55)

r: rainfall intensity within time of concentration for flood (314 or 110 mm/h).

A: catchment area (processed block 15.47, non-processed block 17.72, forest block 15.00 ha)

(Processed block): 100-year probable one-day rainfall

$Q = 1/360 \times 0.80 \times 314 \times 15.47 = 10.8$ $m^3$ sec

(Non-processed block): 100-year probable one-day rainfall

$Q = 1/360 \times 0.80 \times 314 \times 17.72 = 12.4$ $m^3$/sec

(Forest block): 100-year probable one-day rainfall

$Q = 1/360 \times 0.55 \times 314 \times 15.00 = 7.2$ $m^3$/sec

(Processed block): Mode one-day rainfall

$Q = 1/360 \times 0.80 \times 110 \times 15.47 = 3.8$ $m^3$/sec

(Non-processed block): Mode one-day rainfall

$Q = 1/360 \times 0.80 \times 110 \times 17.72 = 4.3$ $m^3$/sec

(Forest block): Mode one-day rainfall

$Q = 1/360 \times 0.55 \times 110 \times 15.00 = 2.5$ $m^3$/sec

3) Scale of triangular notch (See the gauging dam construction diagram)

The triangular notch flow is calculated as follows:

$$Q = K \cdot \left\{ 2(H + h)^{5/2} - (5H + 2h)^{5/2} \right\}$$

$$K = \frac{4}{15} C \sqrt{2g} \tan\frac{\theta}{2}$$

The following formula will apply if the weir has a flooding pond, which is sufficiently large, in its upstream, and if the approaching velocity can be neglected:

$$Q = 2 \cdot K \cdot H^{5/2}$$

where Q: flow ($m^3$/sec)

H: measured water level (m)

c: flow coefficient decided by contraction of a water vein at the weir.

g: gravity acceleration ($m/sec^2$)

$\theta$: vertical angle of triangular notch (°)

h: velocity head of approaching velocity V ($h = V^2/2g$)

Therefore, a flooding pond can be set immediately above the triangular notch in the site scheduled for a gauging dam in the survey area, and the foregoing formula will become:

$$Q_{(1)} = 2 \times 0.732 \cdot H^{5/2} = 1.46 \cdot H^{5/2}$$

assuming the flow coefficient C to be 0.62 and vertical angle of the triangular notch, 90°.

Table 3 shows a trial calculation of the gauging dam water level by the flow matching the 100-year probable one-day and mode one-day rainfalls of the various areas using the section of the tentative flood control channel. Therefore, the section of the tentative flood control channel is considered as the final section.

TABLE 3 TRIAL CALCULATIONS OF FLOOD FLOW AND GAUGING DAM FLOW

| Dam Location | Catchment Area | Rainfall Intensity | Coefficient of Run-off | Flood Discharge |
|---|---|---|---|---|
| Grassland (Processed Block) | 15.47 ha | 314 | 0.80 | 10.8 $m^3/s$ |
| Grassland (Non-processed Block) | 17.72 | 314 | 0.80 | 12.4 |
| Forest Block | 15.00 | 314 | 0.55 | 7.2 |

Trial Calculations of Gauging Dam Water Level by Mode One-day Rainfall (110 mm) and 150 mm Rainfall Intensity

| Dam Location | 110 m (Flow) | Notch Water Level | 150 mm (Flow) | Double Section Water Level |
|---|---|---|---|---|
| Grassland (Processed Block) | 3.8 $m^3/s$ | 1.5 m | 5.2 $m^3/s$ | 1.73 m |
| Grassland (Non-processed Land) | 4.3 | 1.5 | 5.9 | 1.82 |
| Forest Block | | | | |

| Notch Height | Notch flow | Double Section Width x Height | Flood Control Channel Total Flow | Total Flow/ Flood Flow |
|---|---|---|---|---|
| 1.5 (90°) | 4.0 $m^3/s$ | $\frac{7\ m}{5\ m}$ x 1.0 | 14.6 $m^3/s$ | 1.35 |
| 1.5 (90°) | 4.0 | $\frac{7\ m}{5\ m}$ x 1.0 | 14.6 | 1.18 |
| 1.5 (90°) | 4.0 | $\frac{7\ m}{5\ m}$ x 1.0 | 14.6 | 2.03 |

Calculation formula used in trial calculation of flow

Triangle $Q = \frac{8}{15} C \cdot \tan\frac{\theta}{2} \sqrt{2g} \cdot h^{\frac{5}{2}}$

$C = 0.62 \qquad Q = 1.46 \cdot \tan\frac{\theta}{2} \cdot h^{\frac{5}{2}}$

## 2. Incidental Facilities of Gauging Dam

As an incidental facility of the gauging dam, a water level observation room will be built in the upperstream of the apron (right or left bank) of the gauging dam to calculate the correlation formula between water level and flow, as required, in addition to a flooding pond, sand settling basin, erosion control dam and other facilities shown below. (See DRAWING-1 16)

The water level will be measured through vertical motion f the float lowered to the water level of the observation room from the water level gauge.

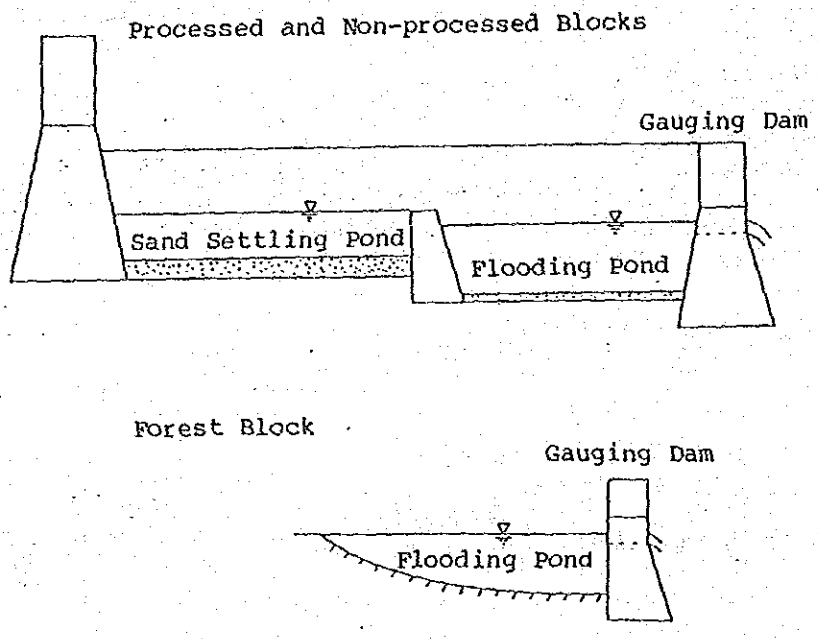



Fig. 2 Gauging dam and water level measuring room

## 3. Slope Plots

Slope plots are installed in forests land, grassland, bare land, land changing to denudement in positions where the surface conditions differ by dividing the areas into some segments to measure surface run-off water discharge, surface run-off earth volume and other data during rainfall to gather basic data regarding the forest water and earth conservation functions.

As illustrated below, a block 20 m in length and in width is set on a slope of a hillside, and receiving tanks will be installed in the bottom

part of the slope (observation and sand settling tanks) to measure flowing surface water and run-off earth volume. The slope plots will be installed on the hillside slope in the processed and non-processed blocks.

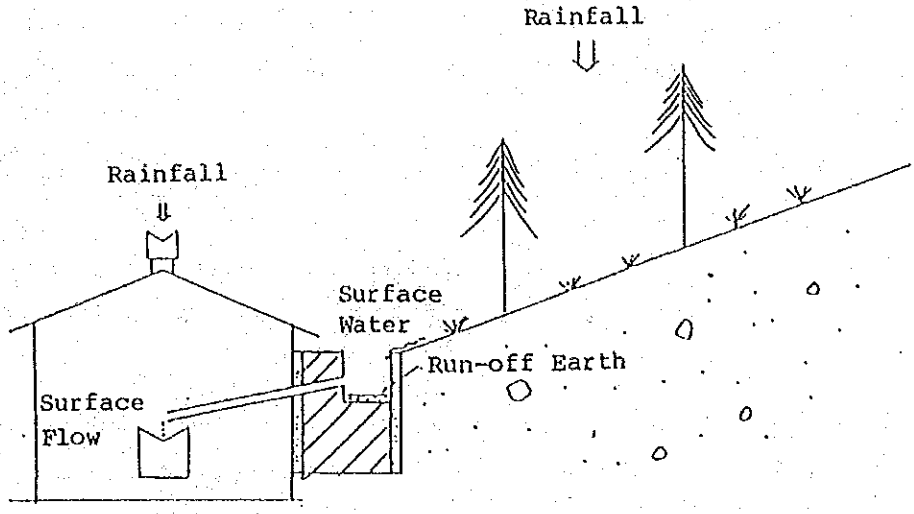



Fig. 3

## V. MODEL EROSION CONTROL DESIGN

As mentioned earlier, this project is designed to develop and improve various erosion control technologies for conservation of forests applicable to the South Sulawesi area as part of watershed management technology.

The meteorological condition of the survey area is 3,867 mm in mean annual rainfall, 517 hours un mean monthly duration of sunshine, and 1,620 in mean annual amount of evaporation. The problem of conservation of water and soil is one of the most important challenges in watershed management.

The establishment of the erosion control and afforestation technology covering very large grassland areas will witness concrete plans and construction methods based only on the results of survey research in each sector.

Therefore, this survey will undertake design of experimental and model stream and hillside work as a result of water and soil conservation in the site area, as well as forest conservation as a result, in finding the basic direction for the erosion control and afforestation technologies.

### 1. Factors and Countermeasures for Denudement

#### (1) Factors for Denudement

Denuded land as defined in the survey can be divided into land changing to denudement including grassland, treeless hills and mountains and slided land.

Land changing to denuded land is caused by a loss of humus of soil due to mountain fires, to excessive felling, to excessive grazing fire and destructive cultivation, causing deteriorated physical properties such as water-holding property and pH. If the situation is left as it is, soil erosion starts and treeless hills and mountains will result.

Generally, the denuded land in the surveyed area is mostly land changing to denuded land showing a grassland condition as mentioned above. At present, the proportion of treeless hills and mountains and

of slided land is small. However, once the condition changes to treeless hills and mountains, surface soil layer is washed away and B or C layer exposes. Surface and rain ditch erosion caused by rainfall, as well as rill erosion caused by torrential rain, are feared in the future.

The soil in the survey area is cohesive soil and appears to resist erosion by overland flow. If an appropriate amount of water is maintained, the soil has a strong cohesion. If it is for a short time, a nearly vertical cut surface can be maintained.

However, when it dries and solidifies, disabling penetration of vegetation, violent erosion is caused by torrential rain as mentioned above. Earth runs off, sometimes causing gully and rill erosion. However, compared with sandy soils, the erosion depth of it is shallow.

The deterioration speed of soil physical properties with grassland is considered several stages faster than that of secondary stands and brushland.

If grassland recedes, bare land advances and the soil structure further deteriorates to form a cluster of denuded land, presenting serious problems for land utilization, as well as for water and soil conservation.

The grassland being denuded (land changing to denuded land) requires urgent soil improvements by the power of the nature through erosion control and afforestation using humus, or improvements of physical properties of soils artificially using peat moss, bark compost, or other fertilizers, or soil conditioners. Or, some other method must be employed.

(2) Restoration countermeasures

As restoration countermeasures, model and experimental design was tried in the processed block.

1) Stream work

As mentioned earlier, the principal mode of denudation in the surveyed area is soil run-off, namely, sheet erosion. In some limited locations, gully and rill erosion can be found. Therefore, the necessity for ravine work to prevent blocky land sliding, to fix spurs, or to control unstable earth in ravines is small. However,

erosion control dam work to ease stream bed gradient is necessary. For this reason, two units of stream work (erosion control dams) are provided in the upstream of the gauging facilities in the processed block. (See the DRAWING-1 1, 12~14)

(3) Hillside work

Normally, minimum civil engineering structures are needed to restore and replant denuded land on hillsides.

The process for denuded land is that the weathering horizon in the surface horizon is lost to expose B and C horizons, causing the gradient to be acute, or surface water flows down concentratedly during torrential rainfall to cause gully erosion or gully, thus repeating violent erosion.

For the moment, prevention of earth moving of the very surface horizon only can be expected by grass of the rice family even if revegetation work is undertaken. Thus, sheathing work or other means will be needed for dynamic stability of soil horizon. Waterway work to safely flow for erosion caused by surface run-off and foundation work such as terracing and terrance work to prevent concentrated run-off in order to weaken the eroding power will be needed.

Terracing and drilling work to build foundations for revegetation will be needed for very hard cohesive soil and weathered stone. Covering work will be needed to shield direct sunshine and to prevent sheet erosion by rainfall. Judging from the rainfall intensity of the surveyed area, covering, seeding and seed spraying work causes run-off of materials and particularly seeds. Therefore, these types of work are not recommended.

Thus, the land to be used in hillside work (5.00 ha) designed for demonstration purposes must be limited to quarry stone work sheathing, stone-paved channel (dry pitching), and sodding waterway work as foundation work. Hillside revegetation must be limited to stone terracing, wooden fence, pot seedling planting and other work. (See DRAWING-1 18, 19)

## VI. NURSERY

### 1. Seedling Production Plan

| Planting Area [ha] | | Seedling Production [pieces] |
|---|---|---|
| 1988 | 0 | 0 |
| 1989 | 55 | 150,000 |
| 1990 | 100 | 300,000 max |
| 1991 | 80 | 250,000 |
| 1992 | 30 | 100,000 |
| Total | 265 | 800,000 |

Assuming 1,800 seedlings are planted per ha, 75% of produced seedlings are planted out, and 90% of seedlings for planting are planted.

The actual quantity produced shall be 1.5 times the number of actually planted seedlings.

### 2. Nursery Development Plan

Based on the foregoing seedling production plan, nursery land for 12,525 $m^2$ in total shall be secured and developed. This land is broken down into 8,000 $m^2$ as pure fields and 4,525 $m^2$ as building and other purposes.

Assuming a nursery bed land utilization ratio of pure fields to be approximately 50% and the number of seedlings to be cultivated per $m^2$ to be 100, areas were set for 3,000 $m^2$ as maximum annual nursery bed land and 1,000 $m^2$ as reserve land.

(1) Nursery land preparation

Land for nurseries is leveled by a bulldozer for grading and is finished in accordance with the land features.

Ponds located in the lower part of the land shall be reclaimed for use as field.

(2) Development of nursery bed

Nursery beds are arranged horizontal to the inclination direction to prevent washing down of surface soil by rainwater.

Nursery beds are made by laying bricks in wooden fences measuring 1.0 x 20.0 m for protection of pot seedlings.

As sun-shade, the entire fields are covered with victoria lawn. Steel pipes will be used as posts, and wire is stretched above them longitudinally and laterally to support the victoria lawn.

(3) Germination chamber

Sunshine must evenly emit the germination bed in the germination chamber. Therefore, victoria lawn will be covered as sun-shade, instead of roofing it.

(4) Soil management yard

Bricks will be laid on the floor, and a roof will not be provided.

(5) Water supply facilities

Water received from the outside of the field will be supplied to various location of the field through water pipes buried in the ground to evenly supply water to the field.

Fifteen water faucets will be installed in the field. Two water tanks will be installed for temporary-use water, the one at the entrance to the field and the other in the center of the field.

(6) Roads

Vehicle roads and footpaths to differentiate them from the field will be blocked, but will not be prepared as roads. Roads will not be covered with gravel either.

# VII. ROADS AND BRIDGES

Of the road extending roughly 16 km from the junction of the national highway to Sanggringan, design was conducted for four bridges and access roads to them, as well as for correction of steep grades and curves with a small radius on the existing roads to allow easy traffic.

## 1. Overall Design Policy

### (1) Constructions and Design Conditions of Bridges to be Built

| | |
|---|---|
| Design load | 14 tons |
| Effective width | 4.0 m |
| Construction | H-beam bridge construction (HBBC) |

### (2) Constructions and Design Conditions of Abutments and Side Walls

| | |
|---|---|
| Construction | Gravity-type cobble stone concrete |
| Topographical feature of back | Banking |
| Internal friction angle of back soil | 35° |
| Foundation ground | Bedrock foundation |

Quarry stone or miscellaneous stone available at the site will be used as cobble stone.

### (3) Road Construction

| | |
|---|---|
| Width | 4.0 m |
| Shoulder | 0.5 m |
| Side ditch | Triangular side ditch 1.0 m in width and 0.3 m in depth. |
| Course bed | Graveled to 0.2 m in average thickness. |
| Slope gradient | Cutting method 3%, 8% in some blocks only in slided land near SP25 m near the No. 1 bridge. Banking method 10% |
| Steepest gradient of route | 10% |
| Minimum curve radius of route | 18 m |
| Type of ditch | CMP for easy carrying |

The details of bridge replacement and road correction are described below. The roads not included in the scope of design require additional graveling to reinforce the road surfaces, minor repairs to maintain the road body, and repairs to be performed from time to time as the soil of road surfaces is cohesive soil special to the tropical zone.

2. No. 1 Bridge, Access Road and Corrected Route

(1) The No. 1 bridge is located approximately 6.3 km from the junction. A simple bridge built with bamboo and lumber is existing at present. It is, however, unable to stand a heavy load.

The bridge to be built will be a reinforced concrete slab bridge measuring 20.0 m in length and 4.0 m in effective width. The beames and slabs are integrated to support the load. It will be a compound-beam bridge that will use two steel beams.

One steel beam will be divided into two 6.0 m beams and one 8.4 m beam for easy transportation and will be assembled at the site after moving them to the site.

The abutment and side walls will be made of gravity-type cobble-stone concrete. To minimize carrying aggregate to the site, the design allows the use of quarry stone or miscellaneous stone, which can be obtained abundantly at the site.

(2) Access Road and Corrected Route

The route to be corrected beginning a point near 4.8 km from the junction has the steepest gradient of 22% and a minimum curve radius of 5 m. Long or heavy articles cannot be carried through it. Therefore, SP0 to 610 m of 1,757 m sandwitching the No. 1 bridge will have gradients and curves corrected and SP610 to 1,260 will have a road surface repair and a curvey correction in some parts of it. The portion after SP1,260 m is the bridge access block, and the gradient and curve for it match the bridge position and height.

After the correction, the steepest gradient will be 10% and minimum curve radius will be 18 m.

As a transient measure for the lower part of slided land in SP25 m, a retaining wall measuring 45 m in total length and 2.0 m in

height will be built as cutting work by laying quarry stone on the right side of the road shoulder to protect the road. A concrete side ditch will be provided in the lower front part of the retaining wall to prevent scouring of the legs by flowing water during rainfall.

Open channels using logs and other materials are installed over small streams scattered in various partrs of the block. They are unable to stand a heavy load, and CMPs will be installed. The diameters of the open channels were decided based on the existing traces of running water spotted at the site.

(3) Temporary bridges and roads will have to be built for work during the construction period and for use by the residents in the area. The cost for them has been included as temporary works cost.

3. No. 2 Bridge, Access Roads and Corrected Route

(1) The No. 2 bridge is located approximately 9.2 km from the junction. A simple log bridge exists at present, but is unable to stand a heavy load. The No. 2 bridge will be built on a river-bed route. Cobble-stone concrete retaining walls will be built on both sides of the roadside. The road surfaces will be paved using miscellaneous broken stone. Normal running water up to 1 $m^3$/sec is passed by installing CMPs of 1.0 m. Rainfall and running water in excess CMPs of 1.0 m. Rainfall and running water in excess of this level will flow over the road surface.

(2) Access Road and Corrected Route

The existing route in this block is a series of steep gradients. Sections exceeding 20% in maximum gradient total 300 to 500 m. The design for this block from the start point to SP575 m is 10% in maximum gradient and 18 m in minimum curve radius. The section between SP575 and 785 m will utilize the existing road surfaces and will be paved with miscellaneous broken stone. Stone will be obtained in the site area and will be mixed in concretes.

Three ditches will be provided using 1.0 mø CMPs. The diameters of them were decided based on the existing traces of running water spotted at the site.

(3) There is no necessity for temporary bridges or roads to be built for the No. 2 bridge.

4. No. 3 and 4 Bridges, Access Roads and Corrected Routes

In this block, routes requiring corrections exist here and there between the No. 3 and 4 bridges. The cost estimate combines the two bridges and routes.

(1) The No. 3 bridge is located 11.4 km from the junction.

The present structure is simple using bamboo and logs and cannot stand a heavy load.

The bridge to be built will be a slab bridge 14.0 m in length and 4.0 m in effective width. It will be a compound-beam bridge with the same construction as that of the No. 1 bridge.

One steel beam will be divided into one 6.0 m and one 8.0 m beams for easy transportation. The beam segments will be assembled at the site after moving them to the site.

The abutment and side walls will have the same construction as that of the No. 1 bridge, namely, gravity-type cobble-stone concrete. The design allows the use of quarry stone or miscellaneous stone, which can be obtained at the site. The height of the bridge execution base level was decided by surveying and confirming the maximum flood stage at the site and by adding the clear headway under beams.

(2) The No. 4 bridge is located 12.4 km from the junction.

At present, it is a simple bridge built using bamboo and lumber and is not able to bear a heavy load.

The bridge construction will be a compound beam bridge, as is the case with the No. 1 and 3 bridges. The bridge length and effective width will be 20.0 m and 4.0 m. The abutment and side walls will be made of gravity-type cobble-stone concrete as in the No. 1 and 3 bridges.

The height of the bridge execution base level was decided by surveying and confirming the maximum flood stage at the site and by adding the clear headway under beams as in the No. 3 bridge.

(3) Access road and corrected route

This block of the existing road also has a series of steep gradients and a large number of sections with small curve radii. Therefore, heavy or long articles cannot be carried through it. To improve this and to allow passing of heavy and long articles, the route will be changed toward the valley and will have the steepest gradient of 10% and minimum curve radii of 18 m.

Two ditches using 1.0 mø CMPs and four ditches using 0.6 mø CMPs will be provided. The diameters were decided based on the existing traces of running water spotted at the site.

(4) No. 3 temporary bridge and road have been included in the estimate for use during the construction work and for passing by local residents. The No. 4 bridge does not require a temporary bridge judging from the site condition. The cost estimate is based on a river bed road. In any event, the temporary roads and bridges for the bridges cannot be used during the rainy season, and the construction should preferably be finished during the dry season.

## VIII. BUILDINGS

The design documents for the buildings referred to in Tables 1 and 2 were prepared after conducting a local survey of the field station and model area site. The design documents of the existing buildings in the neighborhood and similar buildings in Japan were used in the design as a reference. The local weather and climate, as well as materials that can be procured locally, were taken into consideration in preparing the design documents.

The design work involved the following items.

1) Construction site.
2) Preparation of plans and other drawings.
3) Preparation of layout and other drawings.
4) Rough estimation of works cost.
5) Construction period.

### 1. Construction Site

As mentioned above.

### 2. Preparation of Plans and Other Drawings

The facilities are based on the Work Instructions and the drawings were prepared after discussing with long-term specialists and consultants, as well as the counterparts.

#### (1) Office Building 510 $m^2$ (Field Station)

The building will contain the following facilities:

| | |
|---|---|
| 2 laboratories (forest, hydrology and erosion control), @100 $m^2$ | 200 $m^2$ |
| 2 laboratories (afforestation, nursery practice), @50 $m^2$ | 100 $m^2$ |
| Computer room @50 $m^2$ | 50 $m^2$ |
| Drafting room, @30 $m^2$, storage room @25 $m^2$, corridors, toilets and other facilities | 355 $m^2$ |

The number of partition walls was minimized to allow the rooms to be used for multi purposes.

(2) Machine Work Room 30 $m^2$

A work pit measuring 2,000 x 900 x 1,200 mm is provided in the floor.

(3) Warehouse 200 $m^2$

The warehouse scale is two rooms, each for 100 $m^2$, total 200 $m^2$. 20 draining boards measuring 1,800 x 850 mm will be provided to prevent dampness.

(4) Garage 200 $m^2$

The height and width of the entrance are designed to allow storing of various heavy machines. A movable parts storage box measuring 1,800 x 1,200 x 600 mm is provided in the design.

(5) Seed Storage Room 10 $m^2$

Shelves to store seeds are provided in the design.

(6) Oil Storage 10 $m^2$

Shelves to storage parts are provided in the design.

(7) Power Generation Building 30 $m^2$

The building has two foundations to install private power generators, allowing changes in generator models.

(8) Model Areas

The model area building will use the construction of the building to be built as a field station, as a reference. An opening measuring 3,500 W x 2,800 H (mm) is provided to store machines such as back hoes.

3. Preparation of Layout Drawings

Layout drawings were prepared for the offices, boarding quarters and custodian rooms and for the garage, oil storage, machine work room and warehouse in accordance with the foregoing plans by grouping them into two groups. Due consideration was given for effective utilization of passages and corridors inside the premises and buildings and for functions of them.

4. Project Cost Estimation

The project cost was estimated after preparing a unit price list based on surveys on the current market prices.

5. Construction Period

Approximately 150 days is estimated.

Annex 1 Field Station

| Building Facilities | Area | No. of Storeys | Remarks |
|---|---|---|---|
| 1 Office | 537m² | 2 | Team Leader's room, Field Manager's room, Counterpart's room, Administration Office |
| (2) Office | 492 | 2 | Laboratory (4), computer room, drafting room |
| 3 Living Quarters | 587 | 2 | 14 rooms, 2 guest's rooms, maid's room, dining room |
| (4) Garage | 200 | 1 | |
| (5) Machine Workshop | 100 | 1 | |
| (6) Warehouse | 200 | 1 | |
| 7 Janitor's Room | 42 | 1 | |
| (8) Seed Storage Room | 10 | 1 | |
| (9) Oil Bunker | 10 | 1 | |
| (10) Electric Generator | 30 | 1 | |
| 11 Water Tank | 1 | 1 | |
| 12 Outward Structure | | | |

( ): Japanese side

Annex 2 Model Area

| Building Facilities | Area | No. of Storeys | Remarks |
|---|---|---|---|
| (1) Nursery Work Shop | 4 X 100 400m² | 1 | |
| (2) Compost Area | 48 | 1 | |
| (3) Garage | 200 | 1 | |
| (4) Warehouse | 50 | 1 | |
| (5) Oil Bunker | 10 | 1 | |
| (6) Electric Generator | 30 | 1 | |
| (7) Soil Placing | 50 | 1 | |
| 8 Janitor's Room | 30 | 1 | 1 living quarter |
| 9 Germination Room | 50 | 1 | |
| 10 Observation Tower | 1 | | |
| 11 Water Tank | 1 | | |
| 12 Outside Construction | 1 | | |

( ): Japanese side

# Ⅸ. TRIAL AFFORESTATION PLANNING

Planting wii be conducted between 1989 and 1992 in the 500 ha scheduled for this project without specifying the location as the trial afforestation project as described below.

## 1. Planting Specification

Nursery-line (dense) 2 m × 2 m = 2,500 seedlings/ha
Nursery-line (sparse) 3 m × 3 m = 1,111 seedlings/ha
Based on planting densely and sparsely on a 50/50 basis,average 1,800 pieces/ha.

The trial afforestation for this project will not aim saw-timber forest (long felling season) as well as pulp wood (short felling season. It will be planted to decrease surface run-off and to prevent flow-out of surface soil.

Accordingly extremely sparse planting is not effective to attain the above mentioned aims. And extremely close planting leads imbalance growth of trees especialy in soil of tropical zone where is lacking nutrition because of competition in growing among them. this project has decided to adopt such moderate planting intervals as 2 m× 2 m and 3 m × 3 m.

## 2. Planting Tree Species

The following two tree species were found to be suitable for erosion afforestation as a result of the studies:

○ Acacia auriculiformis (Suitable to stabilize soil on barren slope land.

○ Intsia palembanica (prominent taproots)

The following five tree species grow fast with established nursery practice and afforestation technologies.

○ Acacia Mangium
○ Albizzia Lebbek
○ Albizzia Falcataria
○ Eucalyptus Deglupta
○ Anthocepallus Cadamba

3. Establishment of Trial Afforestation Block and Planting Area

Establishment of trial afforestation block for erosin control will be adopted 2 type with dense and sparse seedling-line pich in accordance with planting specification every above mentioned seven species. And a long term yearly plan of planting including others are as follows.

| | Erosion Control Trial Planting Inside Model Area | Planting Work Inside Processing Block | Arboretum (Display) | Replanting | Yearly Total |
|---|---|---|---|---|---|
| 1988 | - | - | - | - | - |
| 1989 | 28 | 15 | 10 | - | 53 |
| 1990 | 70 | - | - | 25 | 95 |
| 1991 | 42 | - | - | 35 | 77 |
| 1992 | - | - | - | 30 | 30 |
| Total | 140 | 15 | 10 | 90 | 255 |

Unit:ha

Besides plans of basical area each year, species, dense and sparse are asfollows.

1989 2 ha ( 2 ha × 2 block × 7 species = 28 ha )
1990 5 ha ( 5 ha × 2 block × 7 species = 70 ha )
1991 3 ha ( 3 ha × 2 block × 7 species = 42 ha )

## X. ARBORETUM

An arboretum has been planned for 10 ha flat land centering on the ridge tops in the bottom part of Sanggirigun village. The display effects of the planned site are large because it is near the proposed nursery and because it can be viewed from Malino Village located on the other side of the river.

The following tree species are scheduled to be planted in the arboretum for nursery practice after the nursery facilities are completed.

1. Fast-growing tree species with established nursery practice and afforestation technologies:

   - o Acasia mangium
   - o Albizzia Lebbek
   - o Albizzia Falcateria
   - o Cucalyptus deglupta
   - o Authocepallus cadamba

2. Tree species suitable for erosion control afforestation

   - o Acacia auriculiformis (Suitable to stabilize soil on barren slope land)
   - o Intsia palembanica (Prominent taproots)

3. Fertilizer and fuel wood timber

   - o Cassia siamea (fuel wood)
   - o Gmelina arborea (fuel wood)
   - o Leucaena leucocephala (fuel wood + fertilizer)
   - o Sesbania grandiflora (fertilizer)

4. Long felling-period tree species

   - o Pterocarpus indicus
   - o Diospyros celebica
   - o Dalbegia latifolia
   - o Peronema Canesens
   - o Swietenia Macrophylla
   - o Tectona Grandis

5. Other

   - o Pinus merkusii
   - o Samanea samman
   - o Schima Wallich

## XI. CONSTRUCTION PERIOD

Tables 5 (road, bridge and nursery works), 6 (building works) and 7 (gauging facility, erosion control and pipe culvert works) present rough works process charts. The entire processes will require approximately seven months.

In order to shorten the construction period, the foregoing process charts show the heavy machines procured for each project to start these jobs simultaneously as much as possible. The machines will move to the individual sites from the national highway junction by themselves.

Table 5 Construction of Road, Bridge and Nursery

Outline of Works Progresses Schedule

| | | | 10 20 30 40 50 60 70 80 90 100 110 120 130 140 150 160 170 180 190 200 |
|---|---|---|---|
| No. 1 Bridge | Soil Removal | 212 | |
| | Banking | (35) | |
| | | 212 | |
| | Retaining wall and Concrete Side Ditch | 20 | |
| | Culvert (CMP) | 12 | |
| | Levelling | 10 | |
| | Grave Paving | 25 | |
| | No. 1 Bridge | 83 | |
| | Bridge River Road | 10 | |
| No. 2 Bridge | Soil Removal | 50 | |
| | Banking | (13) | |
| | | 50 | |
| | Paving | 18 | |
| | Grave Paving | 9 | |
| | Culvert (CMP) | 4 | |
| | Bridge River Road | 17 | |
| No. 3, No. 4 Bridge | Soil Removal | 80 | |
| | Banking | (21) | |
| | | 80 | |
| | Grave Paving | 17 | |
| | Culvert (CMP) | 9 | |
| | No. 3 Bridge | 56 | |
| | No. 4 Bridge | 80 | |
| | No. 3 Temporary Bridge and Road | 10 | |
| | No. 4 Temporary Bridge and Road | 10 | |
| Nursery | Soil Preparation for Nursery | 5 | |
| | Seed Bed Preparation | 25 | |
| | Germination Room and Soil Mixing Side | 3 | |
| | Water Channel and Water Tank | 7 | |
| | Sun-Shade | 33 | |

Table 6 Outline of Works Progress Schedule

Building Construction

| Item | | Type | Quantity | Unit | Progress |
|---|---|---|---|---|---|
| Field Station | Building | Office | 492 | $m^2$ | |
| | | Garage | 200 | $m^2$ | |
| | | Machine Workshop | 100 | $m^2$ | |
| | | Warehouse | 200 | $m^2$ | |
| | | Seed Storage Room | 10 | $m^2$ | |
| | | Oil Bunker | 10 | $m^2$ | |
| | | Electric Generator | 30 | $m^2$ | |
| Model Area | Building | Nursery Work Area | 400 | $m^2$ | |
| | | Compost Area | 48 | $m^2$ | |
| | | Garage | 200 | $m^2$ | |
| | | Warehouse | 50 | $m^2$ | |
| | | Oil Bunker | 10 | $m^2$ | |
| | | Electric Generator | 30 | $m^2$ | |
| | | Soil Placing | 50 | $m^2$ | |

10 20 30 40 50 60 70 80 90 100 110 120 130 140 150

Table 7 Gauging Facilities, Stream Dams, Pipe Culverts

Outline of Works Progress Schedule

| | | 10 20 30 40 50 60 70 80 90 100 110 120 130 140 150 160 170 180 190 200 210 |
|---|---|---|
| Gauging Facilities, Stream Dam and Lysimeter | 210 | |
| Pipe Culvert, Intake Dam and Farm Pond | 120 | |
| Hill Side Work | 170 | |

# XII. EXECUTION SUPERVISION

The entire construction period will last seven months, the amount of work is large, there are many different work types, and some aspects require special technologies. For these reasons, it will be necessary and indispensable to send an execution supervisor to accomplish the entire project.

Gauging facilities (Japanese-style facilities) and erosion control works, particularly, are project types that are not experienced by Indonesia. Execution planning requires prudence and meticulousness. Execution planning and methods employed in road and bridge works will greatly affect the entire project.

Under the circumstances, sending an execution supervisor for the supervision and management of the entire project will be essential.

## XIII. CONTRACTOR

This survey team contacted three construction contractor during staying in the spot and investigated necessary matters about them .

Each of the companies have efficient ability to perform infra-structure construction in Field Station and Model Area . They are as follows.

HAZAMA-GUMI,LTD

This is one of the biggest general contractor in Japan . HAZAMA has huge achievements in the field of engineer building works not only in Indonesia but also in the South East Asia Countries and is especialy taking interest in doings of the Project watching for an opportunity to extend to its business to South Sulawesi. And it is a matter of couurse HAZAMA has many branch offices in Jakarta and other district in Indonesia.

PT.TAIYO SINAR RAYA TEKNIK

This company is local contractor with head office in Jakarta and recently extending to its business even in the field of trading as well as engineering and building works taking cooperation system together with Japanese companies. As the result of that TAIYO SINAR is valued highly both at home and abroad. And also the company is taking interest in doings of the Project.

C , LTD

This company is also one of the biggest general contractor in Japan and has large achievements in the South East Asia and the Middle East.In South Slawesi it has local partner but is not interested in the Project and does not want to perform works in the out-of-the-way place.