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JRATUNSELUNA BASIN UPDATED DEVELOPMENT PLAN

PART I

TUNTANG/JRAGUNG RIVERS BASINS
INTEGRATED DEVELOPMENT PLAN

PART II

TUNTANG AND RELATED RIVERS BASINS
DEVELOPMENT PLAN.

(SEPARATE BINDING)

APPENDIX F

SOIL AND WATER CONSERVATION

MAY 1980

SUBMITTED BY

PRC ENGINEERING CONSULTANTS, INC.
ENGLEWOOD, COLORADO, U.S.A. SEMARANG, INDONESIA

DIRECTORATE GENERAL OF WATER RESOURCES DEVELOPMENT
MINISTRY OF PUBLIC WORKS
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PREFACE

The Directorate General of Water Resources Development (DGWRD) of the Ministry of Public Works, Government of Indonesia (GOI) contracted PRC Engineering Consultants, Inc. (PRC/ECI) to provide consulting engineering service for preparing an integrated development plan for the Tuntang/Jragung Rivers in the Jratunseluna Basin. In the contract it was stipulated that the plan should include recommendations on water and soil conservation in the Tuntang Subbasin which had not been studied in the past. The study for the preparation of the plan started on May 16, 1979 and was originally scheduled to be completed on November 30, 1979.

As interim report on the study was submitted by PRC/ECI on August 15, 1979 which was reviewed by all the concerned agencies and later discussed on September 24, 1979 in a meeting held by the DGWRD at Jakarta. In that meeting, it was decided that the study on the Tuntang/ Jragung Rivers should be modified by including the entire Jratunseluna Basin in certain aspects of the study. In that modified study the interrelationships of the existing, proposed and the potential development works of the Tuntang/Jragung subbasins and those of the adjoining subbasins within the Jratunseluna Basin should be examined. Also, problems and needs of water and soil conservation in the entire Jratunseluna Basin would be identified and a conceptual plan to start conservation measures including design of a pilot demonstration farm would be prepared. The original contract between GOI and PRC/ECI for the engineering services was, therefore, amended to include the revised scope of work for the modified study.

A report on water and soil conservation in the Tuntang Basin, as contemplated originally, was prepared and is presented in the document titled "Jratunseluna Basin - Updated Development Plan. Appendix F. Part I."

The above mentioned modified study for the entire Jratunseluna Basin was started in December 1979 and completed in May 1980. The results of that study have been presented in a separate document titled "Jratunseluna Basin - Updated Development Plan. Appendix F. Part II".

Semarang, May 1980 PRC Engineering Consultants, Inc.

PART I

TUNTANG/JRAGUNG RIVERS BASINS INTEGRATED DEVELOPMENT PLAN

APPENDIX F

SOIL AND WATER CONSERVATION

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APPENDIX F.- PART I

SOIL AND WATER CONSERVATION

F.1. PHYSICAL CONDITIONS

F.1.1. General

The modern concept of soil erosion and water conservation is not directed merely toward maintenance of the status quo. It is dynamic and progressive. It should be designed to control erosion and lead to lasting increased productivity of the land thereby promoting and raising the common welfare of the participants in the program. Modern soil conservation does much more than safeguard the land and water resources. It directly results in a wide variety of benefits, which accrue in the form of increased yields per hectare of production on most farm lands. It results in large savings in damages such as reduced siltation of canals and reservoirs. It helps to alleviate damage to soils by providing better methods of soil and crop management. It encourages a more flexible and diversified type of agriculture on a sound basis and makes adjustments according to the farmer's needs and requirements for his family.

The wisdom of proceeding with the complete development of the land and water resources in an orderly way is that it will help to relieve some of the population pressure and provide a better living for the farm family.

Soil and water conservation practices are designed to keep land permanently productive and to make efficient use of precipitation.

There are some sixty or more soil and water management practices and conservation measures now being used throughout the world to control erosion, conserve rainfall and improve soil and water resources. Soil losses from upland erosion can be reduced by using a system of conservation farming practices, bench terracing and other structural measures, together with an improved vegetation program. Usually combinations of several measures are essential in mutual support of each other to develop a conservation plan. Single practice soil and water conservation has never been too successful on agricultural land, because it only considers part of the problem.

Land users are interested in reducing soil erosion and its accompanying problems only if their net income is increased along with reducing soil losses. If the farmer can expect no gain from his conservation program he can not be forced to put the program on his land, no matter how good the plan. The farmer must also have a voice in preparing and implementation of the plan, and he must be able to afford the program.

Evaluation of a coordinated soil and water conservation program for the hillslopes of the Tuntang River Basin above the Gunung Wulan proposed damsite appear to be technically feasible, economically justifiable and institutionally and socioculturally acceptable. In other words a quick review of the problems, and conditions of the farmers and village needs indicate the situation could be improved with a well planned and developed soil and water conservation program. It should be made clear that in the initial stages a soil and water conservation program will not achieve dramatic changes in erosion. Over a period of years a conservation program will improve the economic situation for the upland farmer and help check the rapid deterioration of the soil and water resources. Implementation of the plan can begin as soon as funds and basic physical data are available. Each hectare of conservation formed land should be made to produce a profit to the farmer. This is the main incentive to carry forward a coordinated well planned conservation plan.

F.1.2. Land Forms

The Tuntang River and its tributaries drain the south slopes of the extinct volcanoes, Gunung Ungaran (2,050 m), Telomoyo (2,100 m), and Merbabu (3,145 m). The catchment area can be divided into two major parts. The streams originating above the Rawa Pening lake drain on area of 282 km^2 and the streams originating below the out-let of the Jelok Weir up to the Glapan Weir in the flood plain drain 514 km^2.

There are 19 major streams above the Rawa Pening lake. These tributaries originate on the 3 old volcanoes. They are on very steep slopes and are generally incised into the volcanic deposits and lava flows. Sediment is carried from the steep slopes, to the broad flat cones and fans at the base of the volcanoes. The finer sediments are caught in the rice paddies or carried into the lake proper. Because of the steep slopes, the soils are very susceptable to sheet and gully erosion. The soils are generally lighter in texture and more subject to the gravitation forces of erosion.

For Jragung River land form, see Reference [2].

F.1.2.a. Mountain Areas

Forests are found on the higher slopes of Gunung Merbabu, Telomoyo, and Ungaran. Where the forests are largely undisturbed little accelerated erosion is taking place. However, signs of the system of clearing forest land prior to planting to trees on the back slopes of Telomoyo shows evidence of heavy erosion before the trees and other vegetation provided a vegetal cover to protect the soil. Soils are very shallow on the steep slopes and any disturbance can cause land slipping and deep gully erosion.

F.1.2.b. Lower Basin Areas

The lower basin below Rawa Pening can be further divided into 3 subbasins. The Tuntang catchment (514 km^2) is joined upstream of the Gunung Wulan damsite by the Kali Senjoyo with a catchment area of 120 km^2 and the Kali Bancak or Ngromo with a catchment of 140 km^2 The upper reaches of these streams are relatively flat with deep channels cutting through the volcanic capping materials and down into the old sedimentary clastic sediments and alluvium. Each subbasin has different erosion problems closely associated with the land use.

The soils of the lower valley areas are developed from sedimentary sandstone and mudstones and do not erode like the upper volcanic soils which are on steeper slopes above Rawa Pening. The soils on the lower portions of the valleys are heavy black clay soils that crack badly on drying. On the steeper slopes many sandy soils are found which are very fragile and have a high erodibility index. They are highly eroded because of improper land use. The paddy areas are darker in color and have a higher Ph value with high erosion potential when dry. These soils generally occur below the 50 m contourline.

F.1.3. Soil and Water Erosion Conditions

All cultivated slopes with above 10 percent slope are eroding and require protection of the soil by vegetation to control erosion. The steeper the slope the higher the potential for erosion and the more difficult it is to control to an acceptable rate.

The success of mechanical methods of control, described in the Jragung Report Appendix VI [1] must be fitted into the upland farming operation. The failure, or lack of success of the greening and other soil and water programs being carried out in Java, is the result of that not being coordinated with the farmers needs and desires. The farmer has not had an active part in the construction of the control measures. The success of these control measures and maintenance rests with the private land user with some help from the Government.

F.1.4. Land Pressures

The major land condition in the Tuntang catchment is a "People Problem" with technical and physical limitations, to the economic solutions. The upland farmer's present production and the size of his farm are so limited that neither the physical nor the economic conditions exist for the farmer to carry out a multiple use conservation plan to control erosion and runoff and to make a reasonable profit for his efforts. Figure F-2 shows the present generalized Land Use in the project area.

Critical areas have been designated by the R3RPDAS program. Unfortunately these critical areas are poorly defined because the base maps and photographic coverage are inadequate for quality planning of an erosion control program.

F.1.5. Erosion on Roads and Trials

Erosion on roads, trails, exposed cut banks, and slide areas must be recognized as a major source of sediment. This often makes roads and trails impassible, thereby causing transportation problems and increased costs of maintenance.

F.1.6. Forest Land

Generally it can be said the upland forest and plantation problems can be blamed on encroachment by the people. Forest practices could be improved for both harvesting and reforestation. Much erosion is caused during timber harvesting. The present system of allowing farmers to grow two years of food crops, causes severe soil losses during the planting of a new forest stand. Gullies are started that not only produce large volumes of sediment, but require years to control by the increasing forest vegetation. Generally the forest and plantation areas have some improvement plans and budgets to implement improved conservation programs. Tighter control is a major factor in a good erosion control program. Generally forests are stable. Some head cutting is found but they will stabilize over time if no harvesting is permitted.

F.2. LAND MANAGEMENT

The amount of soil erosion which is occurring on the steep dry farm areas is caused by the shallow soil and steep slopes and the treatment or management the lands receive. Some of the soils examined may be losing as much as 400 t/ha when farmed in row crops up and down the slope. While these same soils under well planned and managed cover crops and terracing would only lose small amounts of fertile soil. The difference in erosion rates can generally be explained by differences in management of the soils. In fact soil erosion is influenced more by management than any other factor. If the upland soils are to be preserved and the sediment rates reduced it will require an intensive system of land management. The best land management to control erosion, within acceptable limits is to provide a system of conservation farming that maximizes vegetative ground cover and provides structural measures where needed. Conservation policies and measures must be positive and encouraging not restrictive. Land is valuable but there is no reason for the farmer to conserve the soil if he cannot farm it to provide a better standard of living for his family.

F.2.1. Land Inventory

The best aid to planning efficient land use is a sound land inventory of the physical conditions. This is called the land capability system. It provides the basic essential features and facts about a piece of land. There facts include items like soil type, erodibility, depth, water holding capacity and slope of the land, which all can be assessed in the field on the basis of measured physical characteristics. The land can be classified into groups that reflect the risk of soil erosion and so indicate the combination of management practices which will be required if the land is to be used efficiently and productively.

The present land capability map available will provide a starting point for planning. A more detailed description of the land factors will be needed for planning an effective soil erosion and conservation plan considered necessary in controlling the individual farmers soil resources from excess runoff and erosion. A more detailed capability system will need to be developed, based on detailed soil surveys, slopes and type of erosion. The capability map is the link between land use and mechanical control. Each class spells out both the recommended cropping system and the kind of protection required to use the land effectively. See Land Capability Map in Referece [2]. A similar map should be prepared for the Tuntang Basin.

F.2.2. Multiple-Use Plan

The two aspects of erosion control, mechanical protection and measures to create an economic uplift in the area must be integrated into a multiple use plan for each hydrologic unit of land. Mechanical protection, such as terraces, drop structures and other control measures are only the first line of defence and very necessary to prevent further damage. But control based on mechanical structures will not control the problems of soil on water erosion. The task of creating an improved agricultural industry that will raise the farmers' capacity to earn a better living is the only solution. Mechanical works in themselves are not productive or constructive. They are necessary for the most seriously eroded land, and where they are required must come first; later, they must be followed with correct land use and techniques of scientific agronomy, which can be applied to reduce and control erosion and at the same time increase production. The two kinds of controls are not alternatives but are complementary and must be used together, each serving its separate purpose.

F.2.3. Demonstration Farms

The most important function of the demonstration farm is to provide a system of communication between the technician and the farmer. The farmer is the principal land user and has the most to gain from an erosion and water development program.

Around the demonstration farm the total educational program can be organized and implemented at the local level. It is important to recognize that the technicians can show and demonstrate the soil erosion and water management ideas to the farmer. It will show the farmer and village people how a soil conservation multiple use plan can be oriented to the people's problem and how to use their soil and water to increase farm yield and at the same time protect the soil from erosion.

The demonstration farm can demonstrate how the soil survey, resource planning, engineering designs and proper construction of structural measures must be applied. Improved crop varieties, fertilizer use, and conservation farming techniques can be explained and demonstrated.

The demonstration farm will introduce to the group of farmers in the mini hydrologic units how they have to work together to carry out a coordinated program, particularly the necessity for maintenance and planning ahead of how farm development must work. It will help to soften the impact of having to change the farming practices on the steep slopes and show how a tree grass practice can produce an adequate income through animal, fish and other products. The demonstrations can show the farmers how erosion robs them of their soil resources and fertility and why the planting of cassava on steep slopes without conservation measures is making the yields of their crops smaller each year.

The size of the demonstration farms is important. Experience at Solo and Panawangan Pilot Projects and other watersheds in Java indicates that demonstrations should be small 5-10 ha hydrologic units. They should have no more than 10 farmers who are willing to work together as a unit. They should not have the idea that this is another government project. They must be made to understand that the demonstration is their project and the government is willing to work with them to show and help them develop an erosion and water conservation program for their units.

F.3. FACTORS AFFECTING EROSION

F.3.1. Rainfall and Climate Conditions

There is obviously an association between the amount and intensity of rainfall and the amount of soil erosion. The more rainfall on bare soil the higher the erosion rate. Less rain and low intensity storms cause less erosion. In statistical terms however, the correlation between the two is poor. The same total quantity of rain can on different occasions result in widely differing amounts of erosion. Consequently, more specific measurements are required to understand the more specific events that describe the ability of rainfall to cause erosion.

There is considerable evidence of close association between erosion and intensity of rainfall. Data on the occurrence and frequency of intensities is recorded on recording raingages. The project has established a system of these gages in the Tuntang watershed. The present recording gages are on a weekly or monthly basis. These records are of little value to the erosion researchers because he must look at the intensity of rain in 15 and 30 minute intervals. In developing any erosivity index it should be based on some function of rainfall intensity. The intensity is computed from the rate of rainfall recorded (see Figure F-4) during a 15 or 30 minute intervals. Because rain drop causes detaching of soil particles on bare soil, the knowledge of the intensity of rainfall becomes a very important factor in designing any erosion control program. An Iso-Erodent map has been developed for all Java of Reference [3]. This is described in detail on pages 23 - 28 of Reference [2]. The long time records and location of the recording raingages are presented in Appendix A Part I - Hydrology [4] of this report.

F.3.2. Hillslope Erosion Processes

Hillslopes cover virtually the entire landscape in the Tuntang. The upland crop areas are the primary lands that must be better managed. This is the place where erosion and water losses are the greatest. On these sites forestry, agriculture, village gardens, and other human activities must be carried on in harmony with natural processes. How these hillslopes are used, by the farmers and people, controls the longterm productivity of the land for cultivation or long term suitability for villages or other use. Failure of hillslopes or other disruptions have caused many hectares of the land to become virtually worthless because of improper land management. Sediment released by these activities can also have damaging effects to lower lands, canals and irrigation facilities.

Almost all geomorphic processes on hillslopes are concerened with the action of water on the soil. For this reason it may be useful to look at the processes taking place on the hillslopes.

In this natural forested state with a good vegetation cover, soil on a hillslope remains in a state of approximate balance for long periods of time. The physical and geochemical processes that break down the rock minerals and decompose them are called weathering. Weathering produces a layer of sand, silt and clay which covers the solid rock. The clay particles are particularly important because they are able to hold on their surfaces, plant nutrient ions, such as calcium, potassium, phosphorus, iron, etc. The soil is also able to hold water and air in its pores. Soil achieves an equilibrium state that depends on the climate, geology, vegetation, and topography conditions. These processes are generally in balance unless disturbed by man. Man's activities almost always increase the hillside erosion by significant, and sometimes catastrophic amounts. The term accelerated erosion is often used to emphasize this increase.

Good soil and water management for long term productivity requires that accelerated erosion be minimized so the soil will not degrade. Controlling the accelerated erosion in the Tuntang will be difficult and expensive, both in money and labor, and will require the coordination and cooperation of all the agencies concerned or the battle will be lost. In all the critical land areas, the erosion rates have greatly exceeded the acceptable rates of erosion.

The task of reversing this condition requires a close look at the raindrops composing a storm of moderate size. The raindrops possess tremendous amount of Kinetic energy by virtue of their mass and velocity of fall. Studies have shown that the impact of the drop on the land generates a small explosition of soil and water. Large soil aggregates are dispersed and smaller particles are splashed over several feet. The soil particles splashed down the hillslopes travel further than those up hill causing a net down hill transport which is called raindrop splash erosion. After each major rain storm each area of soil protected by a rock pebble can be seen standing up on a small pillar of soil, indicating the depth of soil moved by rain drop splash. Raindrop splash erosion becomes extremely important on steep slopes devoid of vegetation. On the other hand a good cover of vegetation intercepts almost all of the kinetic energy of the rainfall and very little erosion occurs. Here lies the critical and dominant role of vegetation in reducing soil erosion. When the hillslopes are cleared of forest and the vegetative cover and planted to crops without proper conservation measures, accelerated erosion occurs. There are other factors controlling the resistance of the soil to splash erosion but they also need good vegetation cover and fertilizer.

F.3.3. Infiltration Process

Infiltration is the movement of water into the soil surface. There is a maximum rate at which the soil, in a given condition, can absorb water; this upper limit is called the infiltration capacity. If the rainfall intensity is less than this capacity, the infiltration rate will be equal to the rainfall rate. Likewise if rainfall intensity exceeds the ability of the soil to absorb water the excess becomes runoff. The excess of rainfall over infiltration collects on the soil surface and runs over the surface as sheet flow or concentrated flow which collects into the low places and generates streamflow.

Infiltration rates are expressed in units of depth per unit of time, the same as rainfall intensities. Water that does not infiltrate runs off quickly and causes erosion when the soil is not protected. On the other hand water that infiltrates into the soil is mostly used by vegetation which helps to increase infiltration rates and the balance rechanges the groundwater aquifers. The surface soil, plays a major part in determining the volume of storm runoff, its timing, and then its peak rate of flow. (Figure F-5).

Water running over the soil surface is capable of eroding topsoil and the important organic residues from the land surface. The soil erosion technician is concerned with either inducing the precipitation to infiltrate into the soil or conducting it safely away from the farmer's fields by control structures that pass it into the streams in a non-erosive manner.

Water movement in soil involves three independent processes that must be considered in developing a soil and water erosion program.

1. Infiltration or entry through the soil surface.

2. Storage within the soil.

3. Percolation downward through the soil, and underlying geologic materials.

Limitation on any of these processes can reduce infiltration rates. When this occurs erosion can take place by the flow of water over the soil surface.

When farmers and land users do not consider these processes, the ability to produce an economic return to the farmer is greatly reduced and erosiom becomes a critical problem.

F.4. EROSION CONTROL MEASURES

An important factor in a good soil erosion control program is the selection of the most appropriate agricultural use of the farm land. Different ways of cropping the land have major effects on the amount of soil erosion. Therefore, to control erosion on the critical lands in the Tuntang catchment area, detailed studies and cropping systems will need to be developed to fit the soils and physical conditions of the land. Considerable work has been done by agricultural technicians on this problem both in Indonesia and abroad. This research work however will need to be centered more directly on the farmers problems and needs in the critical areas. It is a specific problem that will require special consideration of the local soil problems. There is a vast amount of data around the world on the subject which can be helpful but must be applied to the specific erosion problems in the area. This will require a concentrated program of all people working together if this erosion rate is to be controlled.

F.5. PROBLEMS AND NEEDS OF THE TUNTANG WATERSHED

F.5.1. General

It is the purpose of this report to focus attention on some of the more obvious problems and conditions in the Tuntang catchment area. Considering the short time that has been available for the study only some overall indications and the actions to be taken can be given.

1. Any effective resource and development soil and water conservation program should focus on the private land owners problems and how the various types of assistance provided by the government can help them approach a cooperative soil and water management program to control erosion on their land. The farmer is responsible for accelerated erosion so he is the logical man to control it. The soil erosion and water conservation program should develope and improve resources and at the same time provide a flexibility to accomodate the economic and social demands of the farmer's family.

2. Under present conditions, the land pressures are so great, because of the continually growing population, that farmers are forced to seek additional land higher and higher on the steep slope where the soils are shallow and potentially erodible. Table F-1 shows the heavy population density in the watershed and Table F-2 shows the pattern of private land use. Note the large hectarage of dry crop land and home gardens where much of the erosion is occuring. Table F-3 shows the soil units and the petrographic units in the watershed. The common agricultural practices are such that even with the best agronomic and conservation practices (terraces, drop structures, etc.), it is not going to be easy to slow down the high soil losses and the losses in productivity.

3. The regional productivity of the dry crop land is extremely low because of past accelerated erosion and the farmers are now using subsoil which has little or no fertility. Because of these conditions it is questionable if the land can be improved without a large assistance program and incentives. As farmers move higher on the slopes the steep forest land can only produce for a short period of time before the farmer is forced to abandon the land because excessive erosion rates will destroy the capacity of the soil to produce any kind of a living.

   The upland farmer's present farm productivity and size of operation are so limited that neither the physical nor the economic conditions will permit him to construct an effective soil and water conservation program on his land. What is not generally recognized is that the soil erosion and water control conditions that exist on these critical lands are the "People's Problems" which require a much different approach than is generally considered for their solution.

4. Roads and trails if not properly built and maintained greatly add to the surface erosion. The nature of the exposed soil and rock material and the steepness of the slopes govern the requirements for treating roads and cut slopes. Erosion of deep cuts through soil in steep road sections are especially hard to control because sloping them to 1.5H : 1V may require excavating and extensive back sloping of the hill which creates a more serious condition. Lack of adequate drainage is a common condition on many of the roads. Control of runoff and erosion from road surfaces is an engineering problem that can be solved largely by preventive location, design and construction. Adequate drainage must be planned for and erosion control structures placed at critical sloping areas. Some accelerated erosion and runoff on cut slopes, over-hangs and fill slopes are unavoidable. The most economical and effective permanent control is vegetation. It can also hide some of land scars of road construction.

Protection of road shoulders, gully treatment, cross dip and shallow crossings designed to keep the water spread out are only some of the control measures needed on most roads in the catchment area. Constant inspection and maintenance of erosion control structures is very important and can be done by the villages with some technical help. This will permit immediate repair where failures occur and slump and slides cover roads and cause additional erosion.

Figures from Solo and Panawangan indicate it costs approximately 3,252,000 Rp/km for road maintenance. The villagers would be expected to provide 1,084,000 Rp. in the form of labor and the government will provide the remaining part.

F.5.2. Channel Stabilization and Detention Dam Stabilization

Generally there are not enough benefits to justify stabilizing long sections of a stream by channel improvement. This can some times be accomplished by providing detention dams. Each river problem must be assessed individually. Small detention dams can provide not only some sediment storage but can also provide additional water during the dry season for home gardens and village use. Any release valves provided should be well shielded and easy to operate. Adequate spillways must provide for large expected flows.

Maintenance must also be given due consideration. Maintenance problems usually grow into larger, costlier problems. If maintenance cannot be organized in such a manner that the people can do the required monthly or yearly maintenance, the structures should not be built.

It will require detailed designs and plans for control measures of this type. No estimates of costs are available at this time.

F.5.3. Forest Roads and Trails

The roads and trails on the forest lands present considerable erosion problems for several reasons. The land is usually steep and rainfall heavy. Many of the roads are not used much so expensive roads with superior construction are not justified. Road use during harvesting operation is very damaging and bound to be associated with a high risk of erosion. One serious question that must be decided is at what stage in the forest development and management should the road system be constructed. Economics and erosion hazzards must be taken into account. If road systems are to built at planting time, there is a lot of unproductive capital lying idle, and a long time for erosion to occur on the roads and banks. On the other hand if road construction is delayed until harvest time it means struggling with inadequate access for fire protection, pruning, policing and other forest management responsibilities. These are management decisions that will effect erosion and sediment control. Table F-4 shows an estimate of forestry transportation conditions in the project area.

During the planting, establishment, and growth of a forest, the management practices required to minimize erosion are generally known. These practices include a foundation of mechanical protection works followed by management aimed at maintaining a complete vegetative cover. The most serious problem in the Tuntang area forests is during harvesting. The choice of clear cutting and allowing farmers to grow food crops for two years, while planting the new forest trees has created serious erosion problems. Erosion removes many tons of fertile soil that may never be replaced.

It is recognized that clear cutting is necessary for some species or may be the most economic method. A steep hillside badly damaged and scarred by clear cutting is liable to continue to erode for years afterwards, with log roads and skid trails turning into gullies, and damage being done before a protective mantle of vegetation is re-established. Good forest husbandry practices and principles coincide with good erosion control practices.

F.5.4. Plantations

There are 2 major plantations in the project area. Getas which is to be a rubber plantation, 1,420 ha and Assinan which is to be all planted to cofee, 425 ha. Tables F-5 and F-6 show some of the production and labor force statistics for these plantations.

A general review of the soil and water conservation practices in these plantations was generally satisfactory. In laying out of new plantation the land is cleared and planted to a cover crop of Colopogonimum calebrium and Centarasirium klumare. These are grown singularly and in combination as a cover top. These legumes provide a quick cover to protect the soil and serves also to provide some Nitrogen for the young trees. When the tree canopy shades out the legumes, a grass cover is planted in between the tree rows. Small basins are dug around each tree to hold all the rain. The basin also provides a place to place the fertilizer to keep it in close contact with the tree.

The plantation officials have expressed a desire to cooperate in any way they can to help farmers apply soil erosion practices.

TABLE F-1

NUMBER OF POPULATION IN THE TUNTANG CATCHMENT AREA BY SUBDISTRICTS

Regency	Sub-district	Population		Total
		Male	Female	
I Semarang	1. Tuntang	24,721	25,539	50,260
	2. Salatiga	17,704	18,740	36,444
	3. Salatiga Kota	33,643	38,877	72,520
	4. Beringin	25,714	26,942	52,656
	5. Getasan	19,150	20,429	39,579
	6. Tengaran	15,705	15,143	30,848
	7. Ambarawa	28,714	31,366	60,080
	8. Banyubiru	15,677	16,599	32,276
	9. Jambu	16,148	17,054	33,202
	10. Bawen	16,617	17,884	34,501
II Purwodadi	11. Kedungjati	17,836	19,337	37,173
III Boyolali	12. Wonosegoro	4,612	5,766	10,378
	Total:	236,241	2,536,676	489,917

TABLE F-2

THE PATTERN OF PRIVATE LAND USE IN THE TUNTANG CATCHMENT AREA BY SUBDISTRICTS

Regency	Sub-districts	Rice Fields: Technically Irrigated (ha)	Rice Fields: Semi Technically Irrigated (ha)	Rice Fields: Wildly Irrigated (ha)	Rice Fields: Rain Dependent (ha)	Rice Fields: Total (ha)	Dry Fields (ha)	Home Yards (ha)	Others (ha)	Total (ha)
I Semarang	1. Tuntang	421.0	179.0	1,143.0	-	1,743.0	1,158.6	1,425.8	204.2	4,531.6
	2. Salatiga	1,451.0	166.0	1,163.0	17.0	2,797.0	676.6	1,635.6	45.2	5,154.4
	3. Salatiga Kota	202.8	-	-	-	202.8	1,407.6	982.6	58.5	2,651.5
	4. Bringin	493.2	552.4	293.7	1,852.2	3,191.5	2,671.9	2,054.9	401.9	8,320.2
	5. Getasan	-	35.0	21.2	40.6	96.8	4,318.4	1,192.1	248.4	5,855.7
	6. Tengaran	213.3	27.4	186.0	137.0	563.7	1,374.4	4,040.7	43.2	6,022.0
	7. Ambarawa	310.0	125.0	1,193.9	477.0	2,105.9	1,315.2	975.5	185.1	4,581.7
	8. Banyubiru	40.0	206.0	709.0	123.0	1,078.0	2,123.4	503.0	13.0	3,717.4
	9. Jambu	205.0	-	648.0	140.0	993.0	3,718.0	740.0	150.0	5,601.0
	10. Bawen	53.0	58.0	648.0	1,065.0	1,824.0	1,771.0	1,074.0	11.0	4,680.0
II Purwodadi	11. Kedungjati	-	-	139.0	406.0	545.0	1,080.0	1,138.0	-	2,763.0
III Boyolali	12. Wonosegoro	-	83.8	156.6	67.0	307.4	782.1	197.7	26.5	1,313.7
	Total:	3,389.3	1,432.6	6,301.4	4,324.8	15,448.1	22,397.2	15,959.2	1,387.0	55,192.2

TABLE F-3

SOIL UNIT AND PETROGRAPHIC UNIT IN THE TUNTANG CATCHMENT AREA

No.	Soil Unit	Petrographic Unit	Area (ha)	Percent
1.	Young grey or brownish grey margalitic soils	Alluvial loam or clay	3,570.5	4.5
2.	Dark-brown alluvial	Alluvial loam or clay	3,270.3	4.1
3.	Grey regosol and dark-grey grumusol complex	Limestone and marl	21,363.5	27.0
4.	Brown andosol	Volcanic ash and other products	6,833.6	8.6
5.	Brown andosol and reddish brown latosol	Volcanic products	5,493.5	6.9
6.	Dark-grey andosol and lithosol complex	Volcanic ash and sand	1,070.0	1.4
7.	Dark-brown mediterranean	Volcanic products	11,602.9	14.7
8.	Reddish brown latosol	Volcanic products	5,555.6	7.0
9.	Brown latosol	Volcanic products	14,956.3	18.9
10.	Reddish dark-brown latosol	Volcanic products	543.5	0.7
11.	Red latosol	Tephrite volcanic	4,415.1	5.6
12.	Yellowish red, dark-brown Latosol and lithosol complex	Rough stony volcanic deposits	498.5	0.6
			79,164.3	100.0

According to Soil research Institute, Bogor 1964.

TABLE F-4

FORESTRY TRANSPORTATION FACILITIES (Km)

K.P.H. (Subdistrict of Forestry)	Area (ha)	Railway		Roads		Total	Belong to Others (km)	Needed (km)	Existing (km)	Less
		Good Condition	Bad Condition	Good Condition	Bad Condition					
1. Semarang	29,099	38.40	62	83.90	17.50	201.80	20	387.98	221.80	166.18
2. Telawa	19,871	-	31.40	51.40	70.50	153.50	45	264.95	198.30	66.65
3. Purwodadi	19,621	65.80	56.30	93.70	47.4	263.20	6	261.61	26.20	-

TABLE F-5

GETAS RUBBER PLANTATION DATA

Area

- Total Area of Getas Rubber Plantation	:	1,420 ha
- Production Area	:	1,051 ha
- Not producing	:	193 ha
- Preparation new planting	:	37 ha
- For research on rubber	:	17 ha
- Others (Remainder of total): include reserve 31 ha of 6-years age trees	:	122 ha

Production

- 1978: Cured Rubber Production	:	1,277 tons
- 1979: (till September): Cured Rubber Production	:	1,400 tons

Officials

- Government Officials (from Department of Agriculture)	:	10 persons
- Monthly Salary Plantation Officials	:	59 persons
- Labour no (average)	:	± 1,130 persons

Wages of labour : Rp. 350/day.

Fertilizer

1.2 kg/tree. Consist of C.F. = 15 : 15 fertilizer
Extra Urea 330 gram per tree
Stimulation system = Ethrel (2 cc/tree)
(2½ % combined with 2 cc water)

TABLE F-6

ASSINAN COFFEE PLANTATION DATA

Present Condition

Total Areas Assinan Plantation	:	424 ha
Present Area of Coffee	:	200 ha

Production

Cured Rubber Production	:	till September 1979	:	50 tons	:	50 tons
Coffee Production	:	till September 1979	:	12 tons	:	12 tons
Estimate Future Production of Coffee (for 400 ha)					:	±222 tons

Officials

Government Officials (from Department of Agriculture)	:	8 persons
Monthly Payroll/Plantations	:	70 persons
Labour (Wages: Rp. 280 up to Rp. 1,000)	:	± 720 persons

Diseases of Coffee

- Bourder
- Pseudocacuscitric

Production Time of Coffee: 35 - 40 years.

Note: Assinan Crop Plantation consist of rubber: Cocoa and Coffee Planning for the next year: all will be changed to coffee.

F.6. SOIL AND WATER CONSERVATION PLAN OF ACTION

F.6.1. General

Any soil erosion and water plan of action must be designed to integrate human needs into a system of land use that will maximize the production from the land and at the same time protect the soil and water resources from erosion and destruction.

To accomplish these objectives it becomes necessary to break the problem into several parts.

1. The condition of the land, its slope, soil, vegetation cover and drainage patterns dictate how the land must be used. In some cases it may be necessary to place the land in permanent vegetation. This means the physical conditions of the land are so fragile that the surface soil should not be disturbed by cultivation. Other conditions, such as slope and soil depth require some type of supporting structures to use the land safely. Still other conditions place less restrictions on use, such as the rice paddies.

2. The "people's problems" must then be fitted to these physical requirements. It should be investigated that with these restraints how can the farmer produce the highest economic value to sustain his family and still conserve his resources.

3. An assessment must be made of the tools the farmer has to work with such as labor, land, technical help, facilities and credit to carry out a profitable farming operation. The farmer has to profit from the change or the best plan will fail.

4. Coordination of all resources together with cooperation from all the assisting agencies must be focused on the problem of maintaining the resources and still allow a profit for the farmer. This is the major goal of a sound soil and water erosion control and development plan.

The farmer because of his small farm unit must seek the assistance of his neighbors to provide a well planned water disposal program for his land. He can have the best crop rotation or vegetative cover but he also needs an adequate water-way to dispose off surplus runoff from his land. He has to cooperate with his neighbor in building the water disposal system. He and his other neighbors can best accomplish their erosion control by working together in a coordinated plan so to produce the best results for the community.

F.6.2. Mini Hydrologic Unit

The mini hydrologic unit of land has been shown to be the best and most economical unit of land upon which to build a sound soil erosion control and water management system. The mini hydrologic watershed is a small piece of land having a common drainage pattern. It can be one large farm or several small farms that can be planned to operate as a conservation unit.

F.6.3. Using the Multiple Use Plan

The available resources for accomplishing the desired changes must be looked at and fitted to the physical requirements of the land and the ability of the farmers to make the desired changes. Last but not the least, the existing social structure and infrastructure must complement the physical resources. The social factors may at times be more of a problem than the lack or knowledge of the technical problems. These integrated factors are called the multiple use plan in action.

A major problem in planning a program of integrated soil erosion and water management is to design, with the farmer's help, a program for improving the production and net returns to the farmers in a small hydrologic unit. The individual farmers must have the resources, or have them provided through government assistance, to carry out the technical improvements before they can be incorporated into a multiple use plan. This is particularly true because many soil conservation measures applied to the land actually reduce net crop area.

To obtain improvements in the productively of the land, requires a total integrated program of incentives, credit, increased availability of seeds, fertilizers, pesticides, and technical assistance in all aspects of crop, livestock, fisheries, and forestry production.

F.6.4. Education at the Farmer Level

The low education level of the farmer and the lack of trained personnel to assist him present a difficult problem. Training and educating these people is a massive job for the Extension and Education people, and it is the first step in developing a conservation program. People must know what the program is about and what they will be expected to do. It can be achieved, by training programs and demonstrations for all farmers involved in the erosion control program.

The concept of the program for soil and water conservation is centered on, and developed by the proper use of vegetation. All management efforts should be directed to providing a vegetal cover on the soil to control soil and water erosion. Conservation practices should be designed to help increase and improve the vegetation cover and to protect the soil from raindrop splash. It is important in this phase of the program that the technicians realize that the farmer must understand what is being proposed and he should agree to the plan. The final decision on what is to be done on his land should rest with the farmer.

Village development must go hand in hand with the farmer's understanding of the erosion control program. Existing group farm leaders at the village level should work together on a cooperative basis. With regard to soil and water development it is essential that a bottom-up program should gradually replace the now prevailing top-down method of INPRES funding and planning. The farmer will only truly cooperate with the program when it is his idea.

Extension and guidance from the government are essential ingredients of a training program, together with adequate budgetting. The program will differ basically from present Inpres program because the village and farmer should be brought into the design and planning so that it will be tailored to local conditions and requirements. They would also be responsible for the execution and maintenance of the program. It is of prime importance that precise methods of rehabilitation be worked out and recorded with the farmer and farmer groups.

F.6.5. Basic Research

Basic and applied research upon which new procedures and practices can be designed are very limited in Indonesia. While there is a great deal of research data in other countries that could be used in Indonesia it is always open to some question under tropical conditions. This problem can only be corrected by establishing a research program with one of the major research institutes. Despite all research activities it must be considered that progress has been slow. Research in the various phases of dry land crop production is badly needed and must be included in any plan of action. Demonstrations must go hand in hand with latest research findings to show farmers how to improve their conservation practices. A procedure to carry research findings to the farmer is the responsibility of the provincial level of government.

F.6.6. Initiating Soil Erosion and Water Control Practices

In examining the many complex problems in the Tuntang catchment area it is obvious that the present governmental organizations and programs are not solving the soil and water conservation problems. There are several reasons that could be cited for this condition. Probably the most difficult is the coordination and implementation of available assistance to serve the farmer. For example the technical knowledge and potential benefits of the greening DAS program are not passed on to the farmers. Farmers are encouraged to participate in the terracing program and are given incentives to help ease the cost for construction of the terraces or water conveyances. But there is not enough technical guidance, engineering, agronomic and other conservation measures, to help the farmer with his land once he has built the contour furrows or terraces. There are no water disposal measures to convey off excess rain water. Educating and advising the farmer on the crops to grow on the newly constructed terraces is left to the Department of Agriculture. That department does not have the plans or funds to provide the necessary service required to develop effective soil erosion control practices. Its program has not kept up with the DAS program. Also the other water management programs are not coordinated with the farmer's needs. It can be argued that farmers would not understand the plans because they lack the technical and other incentratives to use them on their lands. A plan of action to overcome some of these problems are detailed on page 40 of the Jragung Report [2]. This is only suggestive and some modifications will be necessary to meet on the ground problems. Figure F-2 shows the proposed organization for a soil and water resources development program in the Tuntang River Basin.

F.6.7. Coordination of Soil and Water Conservation Activities

Sincere efforts have been put forward by the Government to develop and execute an effective soil and water conservation program. The Department of Agriculture's program of "Greening" and Reforestration (P3RPDAS) has had limited success. The Department of Home Affairs through its Administrative channels, from the provincial level down to the village and farmer level have taken part in implementing soil and water activities with the farmer. The Department of Agriculture has through its Extension Service spent time trying to educate farmers so they know what soil erosion is and what causes its devastating results. Many farmers and officials have seen demonstrations and attended training courses on how to stop the tremendous losses of soil erosion. Some farmers have tried to use recommended erosion practices on their farms with mixed results. Land use planning has been tried with half-hearted acceptance or outright rejection. Development of a multiple use plan seems impossible because of the farmer's low educational level. Too often these plans were developed for the farmer not with the farmer. As a result the plans developed conform to the planners perscription of needs and how to achieve the end results. The private land owner, the farmer has not had a chance to express his needs and desires about the plan. He also generally does not have the resources to carry out the plan. Even if alternatives and needs of the farmer. In reviewing the DAS (Greening) program, the crucial issue has been that the farmers were not involved and did not understand the goals and objectives developed by the planner.

Before a multiple use planning and implementation program of soil and water conservation can be carried out it must be understood by the farmer, who has created the problem. He must be shown how to correct it. In short, coordination and cooperation of all types of assistance are the first essentials for an effective program of erosion control to be accomplished.

F.6.7.a. Use of Regular Organization Channels of Government

Development of a cooperative coordinated soil conservation program requires that several regular levels of government be strengthened in order to focus all assistance on one objective i.e., to help the farmer do a better conservation job. To accomplish this it is necessary to review how assistance has been provided to the farmer and where the failures have occuring.

It must also be recognized that an organization created to deal with downstream irrigation and water problems does not understand, nor can they help in solving the problems facing the upstream farmer. Their problems are not the same, therefore, the methods for achieving the upstream management objectives must be developed along entirely different lines. The upstream farmers do not have the resources (human, physical and economic) necessary to accomplish the needed conservation measures or farming methods. They have no control over the amount of water that falls on the land nor do they have any control on it before it falls. The problem faced by the upstream farmer is that he has to undertake soil conservation program with the limited resources at his disposal.

How well the Government is able to assist the farmer in doing this job will depend on how the Government organization is structured to do the job. An effective organization should provide efficient use of soil and water resources and technical advice on how an effective soil and water development program can be achieved.

A strengthening of the existing Government organizations is suggested using the regular channels of administration. Several new positions for coordination of planning and implementation are needed to develop an effective program. A discussion on this approach is detailed on page 40 of Reference [2]. Some changes in the suggested organization have been made as shown in Figure F-2 in this report.

The Minister of Home Affairs through his administrative channels from the Provincial level on down through the Kabupaten, Keçamatan and Kelurahan provides the overall guidance and coordination of all the assistance and technical services with the people. In the basic law no. 5/1960 of the Government, provision is made for control over soil conservation development. These rights are centered in the Governors, at the first level, and the Bupati at the second level for implementing soil and water conservation program with INPRES funds.

Because of the complexity of coordination it is recommended that the present administration organization or "control line" be strengthened from the farmer organizations to the Kepala Desa, Camat, Bupati, Governor and on to the Minister. Rather than create a new organization to accomplish the management objectives.it is strongly suggested that the existing authorities be given staff and funds necessary to accomplish the soil erosion control and water management objectives. This approach has the advantage of not creating a new agency to direct the soil conservation activities.

Another difficulty that must be recognized in initiating the soil erosion control and water development program is the fact that the various independent government agencies have seldom, if ever worked together as a coordinated team on an integrated project that has many multidiscipline problems. Some of the agencies tend to resent what appears to them to be loss of independence for technical guidance and expertise.

The specific functions of the various levels of government are briefly discussed from the farmer level to the Minister level. The reason for starting from the bottom up is because all assistance to control erosion and its many integrated problems should start with the farmer who owns the land and must develop and apply the conservation plan of action for his farm.

Examples of the formations and duties of the personnel associated with a coordinated program are:

1. Group Leader. Farmer organizations, such as the mini hydrologic unit group, select a leader to represent their interests with the key farmer organization at the desa or village level. The Kepala Desa serves as the coordinator of all farmer activities.

2. Kecamatan (Camat). This is the planning level of all hydrologic unit plans. Here the multiple use plan is developed and the staff members coordinate supervise and give assistance to the farmer groups in implementing the conservation unit plans. Technical services labor and incentive requirements such as fertilizer, seed and planting stock are arranged for assistance in laying out erosion control structural measures under the supervision of the conserva-

tionist. Their responsibilities also include providing back up data, arranging for needed credit to finance the farmers part of the erosion control program, and preparing reports on all progress of farmer units.

3. Kabupaten (Bupati). The jobs assigned at this level are: recruit and train all staff personnel in the district, plan and arrange for the soil surveys, land use maps and land capability maps and data for use at the farmer level, supervise work programs, provide general liaison with provincial officials, assist in program coordination, budget preparation and provide training for all staff and farmer's groups, work with credit agencies, marketing, transmigration, trade and transportation groups to increase and coordinate all assistance below this level.

4. Provincial Government (Governor). This office is charged with the responsibility to coordinate and supervise the collection of all physical data such as soil, aerial photographs, land capability, land use and vegetation and erosion information for planning evaluation, with BAPPEDA coordinate all conservation budgets; coordinate research and demonstrations for training purposes, dessimate all types of training material and arrange for specialists to train lower level staff, carry out periodic field inspections to insure compliance with program objectives, and conduct seminars for all personnel for all lower levels of government.

5. Central Government (Minister and Director General). General direction and high level coordination of policy, review decisions budget preparation and supervision and control are carried out at this top level. The additional functions are to coordinate and manage research on soil erosion and water conservation problems at all levels of government and arrange for different Universities to assist in the research activities, and dessimate all types of data and information and supervise training for Provincial staff.

F.6.8. Physical Surveys and Data Collection

There is considerable technical knowledge available in Indonesia on agriculture, soils, hydrology, engineering, forestry and other disciplines needed for river basin planning. The big challenge is to apply this knowledge to the solutions of the environmental, soil erosion and water problems. One action that should be taken is to secure adequate aerial photographs and other planning maps in sufficient detail that inter-disciplinary plans and courses of action can be developed. Physical and social conditions should be adequately recorded. Hillslope stability, water quality, and other plans cannot be designed without an inventory and data of the many complex physical conditions.

F.6.9. Understanding Climatic Conditions

Adequate climatic data on evapotranspiration and intensities of rainfall, sunshine and other climatic conditions are not adequately measured and need to be studied to permit detailed development of vegetation and other mechanical measures to control erosion and improve the economic problems on the dry land and forest areas. These facilities need to be expanded and improved. As has been pointed out, the rainfall intensities for short periods of rain are required for good erosion control plans. There are recording raingages in the watershed but they do not have daily records. These should be converted to daily recording.

F.6.10. Vegetation Control of Erosion and Crop Management

The management specifications for good soil and water erosion control are generally the same as for maximum production and maximum profits from crops and related agricultural commodities. Higher applications of fertilizer mean a higher investment cost. These higher costs are well repaid by higher crop yields and more return on the investment. Experiments conducted at Bogor by the Soil Research Institute and discussed under "Conservation Research" page 68 Reference [2] show the results of vegetation and crop management.

To maintain fertility with continuous monoculture cropping requires a high level of management and incurs higher capital recurrent costs. A farmer can increase his crop yields by using multiple cropping with fertilizer application. This practice maintains a vegetation cover that protects the soil and reduces the energy from raindrop splash. This in turn increases the infiltration rate of the soil and helps control the excess runoff.

These improved methods of farming must be applied on the critical lands of the watershed if soil erosion and water conservation are to succeed. How these measures can be applied and used by the farmer will require demonstrations and well developed educational and technical assistance together with interdisciplinary coordination at all levels of government. The importance of vegetation cover cannot be over emphasized for controlling damaging erosion problems.

F.6.11. Erosion Control on Roads and Trails

The surprising thing about the problems concerned with farm roads and trails is that most of the conditions do not need to be problems. Putting it another way these problems could have been avoided with adequate design and supervision of maintenance. The first rule of good road construction is to place roads on the hill crests where possible. This presents one of the most troublesome problems, drainage. A road along the crest has little or no catchment to shed water onto the road. The water from the runoff can easily be controlled and discharged on both sides of the road.

Many roads and trails are heavy producers of sediment to the streams. They are located in the valley bottoms where critical road conditions exist. Most roads and trails require better drainage and location. Vegetation lined drainage ways must be maintained instead of removing the grass cover. This problem is one of proper design and vegetation control. Here again coordination and funding need to be balanced with demand for better transportation to get increased production to markets.

F.6.12. Mechanical Protection of the Steep Lands

When surface run-off is allowed to flow unimpeded down a slope of arable land there is danger that its volume or velocity or both, may build to a point where it carries away soil dislodged by rain drop impact. This has a scouring action of its own. To avoid this problem some form of earth work at right angles to the steepest slopes is used to intercept this runoff. There are a variety of techniques and host of names for these structures. They are constructed with a slight gradient with the intention that the surplus water can be safely disposed off by controlled water courses and channel control. Frequently there is no suitable natural water courses and one must be artificially made. Another purpose of these structures is to increase the infiltration rate of the soil. Many of the structures are discussed in Reference [2]. Several other types are used in other countries and research should be made to determine the types best suited to the Tuntang and similar drainage basins.

F.6.13. Proposed Integrated Procedure for Conducting a Soil and Water Program

Time does not permit a detailed examination of all the specific soil and water conditions in the Tuntang River Basin. The data used in this study was largely from the Jragung Report [2] and the NEDECO Glapan Dam Study [6]. However, some new data were obtained on the critical land areas, and the Greening program accomplishments and are recorded for future reference in Tables F-7 thru F-13.

It should be stressed that the development program suggested is a very minimum. To make any noticable improvement in impeding the overall basin sediment rates will require long periods of time. Also, it will require a great effort on the part of the private land owners and operators, and the Government and the credit agencies to reverse the soil erosion conditions before they become much worse.

It is impossible to develop a complete program of development at this time. The most urgent need is to make a coordinated start to define the problems and procedures to correct the erosion condition.

The first prerequisite that must be considered in any program of development must be the farmers resources and how he can change and improve his farming operations, to meet the requirements of water conservation and erosion control, and still provide an improved standard of living for his family. Government cooperation, both technical and administrative personnel, together with an intensive educational program that is oriented to the farmer's needs will be required. It will also require credit and incentives to be available in the form of seeds, fertilizers, livestock, fish and other aids, to help the farmer make the initial investment to carry out a unified and coordinated erosion control and water development plan.

F.6.14. <u>Conservation Procedures</u>

The following conservation activities are listed in the general order that they should be undertaken.

F.6.14.a. <u>Critical Area Surveys</u>

There is a serious shortage of information to permit interdisciplinary planning. Aerial photographs on a scale 1:5,000 should be available. The Forest Service (P3RPDAS) should include these pictures in the maps and statistical data that defines the extent of the critical areas. Discussions with the Reforestation and Greening people indicate they will have all the critical land treated by the end of 1980. This should not leave the impression that the soil erosion problem is under control. On the ground inspection shows that it is a long way from being completed, and it is a matter of definition as to what critical erosion includes.

F.6.14.b. Detail Soil Surveys and Land Capability Map

As soon as aerial photographs are available detailed soil survey should be made showing soil type, texture and depth along with slopes, erosion condition and vegetal cover.

The development of a detailed soils map and land capability map from aerial photographs is a very necessary tool for planning erosion control measures. The soils map will give such features as soil texture, percent slope, climatic factors, drainage, fertility, stonyness and erosion. These features help the conservation farm planner to make the best use of each hectare of land. It also helps locate the best terrace position relative to soil, slope, and drainage, trees or areas for grass and other types of conservation practices. It also provides essential data for vegetative practices and alternatives for a cropping system can be determined for each farmer's personal needs and desires.

A land capability map has been developed for the Tuntang catchment but it is not on an appropriate scale to be of much value for the more intensive erosion control measures. A new map will be required when soils data are available.

This information will also provide the basis for developing the multiple use plan of action prepared by the conservationist. These plans are not limited to hydrologic or soil resources, or the agronomic needs but should include animal husbandary, fishing, bee keeping and forest data and analysis. All of these major aspects of the general physical potential for each small hydrologic unit should be considered for developing the farmers land and water resources. Studies of social behavior, internal and external markets for agricultural products grown under the intensive farming conditions and alternate solutions must be coordinated. No single resource can be managed without the knowledge of its relation to the other resources. Much of these data are recorded by the soil scientist when he prepares the soil map.

F.6.14.c. Upland Demonstration Areas

Demonstration farms of 10-25 ha are probably the best way of showing and educating farmers on how to conduct a soil and water conservation program. These should be established in each of the subbasins shown on the Tuntang subbasin Area map (Figure F-1). The most critical areas are shown on the land use map (Figure F-3). Farmers should be associated in the demonstrations so they will begin to understand what is required to control the soil problem. There are good examples of these areas in the Solo and Citanduy watersheds. The schedule for starting these demonstrations should depend on the professional staff to prepare the plans and implementation schedule.

F.6.14.d. Bench Terracing, Gully Control and Grass Waterways

Bench terracing is very effective in reducing erosion if properly constructed and maintained. The improved productive capacity of the soil with fertilization and improved cropping systems can reduce erosion on bench terraces areas to very low rates.

Bench terracing is accomplished by converting a steep sloping surface into a series of steps with horizontal ledges of widths, and steep drops of heights determined by the stability of the material to stand between the ledges. The soil erosion is controlled on the bench terraces where the energy of flow is dissipated at controlled drops between the ledges and racing of flow on the slopes does not take place. The terraces afford level areas which can be bunded to store water up to the desired extent for crop production. The bench terraces, therefore, not only help in controlling erosion but also provide land for agriculture which otherwise may not be fully productive.

Costs of bench terracing are largely the function of the vertical interval, and the slope of area terraced. In the critical areas of the project, soils are shallow and highly susceptable to erosion so it is very important that bench terracing is properly designed to fit each slope and soil condition.

Unit costs per hectare are given on pages 63-64 and the types of structures used is shown in Appendix VI of Reference [2].

F. 6.14.e. Gully Control

Gully erosion is widespread in the Tuntang River catchment, both in the area above Rawa Pening and the lower watersheds. It is often seen as the symptom of erosion. In terms of damage to the agricultural lands or reduction in agricultural production it is not as important as sheet and other types of erosion because most land that is subject to gully erosion should not be used for agriculture. Also gully erosion control is always difficult and expensive. The cost of reclamation usually exceeds the value of the land. However, in the sense of reducing the amount of sediment going into the streams, choking the dams and irrigation systems, it seems highly desirable to do something about the excessive gully problems in the watersheds. Prevention is better than cure, however. With sound agricultural policies of controlling soil erosion and runoff much of the gully problem will be reduced. Farmers with limited resources can usually be taught to prevent future gullies and cure existing ones.

When the timber is logged and the land is farmed to reestablish the stand the land is not in equilibrium and many gullies begin to cut deep gashes in the soil profile that will require many years to correct and bring back to equilibrium not to mention the tons of sediment carried to the streams.

F.6.14.f. Other Conservation Measures

Essentially no help is available to the dry land farmer's where the greatest erosion hazard exists. Lack of technical help, improved varieties of seeds fertilizers, fruit trees, grasses and other types of vegetal cover have not been available for farmer's use. However dryland farms have a wide range of crops, e.g. trees for fruit, timber, nuts, fuel wood, etc. Also they can produce livestock by growing forage where farmers are required to convert the steep land above 50 percent slopes to permanent vegetation. Good returns can be had from these areas if farmers are shown how to harvest a profitable crop rather than let the land grow up to worthless weeds.

F.6.14.g. Training Program

The training of the farmers and the professional and non-professional staff to carry forward a soil and water conservation program is one of the most urgent problems of planning and implementation. It is a requirement that the technical staff understand the processes of erosion and agronomic techniques and the proper structural and other conservation techniques for protecting the land resources. Without these people to guide and develop the program, it cannot go forward. In the field of upland soil and water conservation there are very few trained people. In fact there are only a few courses in the Universities that can be directly recognized as essential to producing the professionals required to lead a large scale program. Several years will be required to train and develop a staff that can carry forward a large coordinated and integrated program.

There is a real need for training managers and technical staff as supervisors to train those who will carry out the implementation of the many technical recommendations involved in an integrated soil and water conservation program. Local institutions have not been able to satisfy the demand for trained specialists in upland agronomists, soil conservationists, agricultural engineers, and resource economists. It is in these fields that foreign training could help meet the increased demand for specialized development technical staff.

It must be emphasized that all the assistance provided by the Government will be of little value if the assistance and cooperation of the villages, district and provincial authorities, and farmers themselves, is not understood and agreed upon. Demonstrations in Solo and Panawangan Pilot Watershed projects have shown that for an erosion control program to be successful the program must be adopted by the farmers as their own program and not just a program of the Government.

A review of the problems and needs for the improvement of the erosion control program discloses that the present governmental organization and programs for solving these problems do not provide a coordinated implementation program to the farmer. This is explained on page 40, Chapter II of the Jragung Report Ref. [2]. A slightly modified organization proposal (Figure F-2) is included in this report but it must be recognized this is only a recommendation, and further modifications may be required. It does provide at the various levels of government a coordinator for soil and water development and soil conservation technicians at several different government levels to carry forward a technically sound program.

F.6.14.h. <u>Use of Forest and Plantation Lands for Fuel and Livestock Feed</u>

The traditional use of wood for fuel in the homes and industries is wide spread in the Tuntang area, and requires a significant amount of wood from the forests and plantations. There is a real need for a program to develop fast growing fuelwood species for regulation control on some of the steeper eroded lands. Also grasses and legumes could be grown under the trees that could provide fodder for livestock in areas where crops cannot grow. Actually dry land farmers have wider choices of crops than the irrigated farmers. However, much land is wasted because farmers fail to use, or do not understand the use of vegetation conservation practices. Knowledge gained at Solo and Panawangan Pilot Watersheds can be very helpful in training technical help to apply these practices. The Agricultural Components consists of:

Agronomic practices
Grass Regulation
Trees for Cash Crop, lumber, fuel and Silvopasture
Livestock
Beehives, fish ponds.

F.6.14.i. Nursery Plantings and Seed

Large amounts of plant materials are needed for revegetation to stabilize and protect the soil from raindrop impact and erosion. Nurseries are an essential part of the program to provide adequate supplies of plant material when needed close to the planting site. Nurseries should supply all grasses trees, shrubs suitable for the environment of the farmer's fields. They should be developed on rented land, with deep soil and good irrigation supply so plants and seeds can be produced year around. As the program moves from one area to another the nurseries can be moved and new ones established as needed. These will be very important to the success of the program. The Forest Service and Agriculture have had considerable experience with nurseries.

F.6.14.j. Road and Trail Erosion and Water Management

Considerable damage is being done to roads and trails by erosion and improper drainage. The damage is considerable and is a major source of sediment to streams. Without adequate surveys it is not possible to actually assess the damage. The villages should provide most of the labor for this work with engineering and technical help coming from the project.

F.6.14.k. Research

A research program is very essential to an active soil and water development program. Rain-fed agriculture has not been studied so that accurate soil erosion and water conservation data are not available to provide background data to the implementation technician. For example severe alterations in soil and microclimate often bring on serious soil deficiencies and vegetation problems. New information is required on these and many other problems associated with a developing program.

The current program, although it is improving does not provide data needed to expand to a large scale development for soil conservation program. Some of limited information is given on page 68 of the Jragung Report Reference [2].

The agricultural productivity of much of the land is so low because farmers are farming subsoil which has little or no fertility. Because of these conditions it is questionable if the land can ever be used without an initial large assistance program and incentives. As farmers move higher on the slopes the steep forest land can only produce for a short period before the farmer is forced to abandon the land because of excessive erosion and lack of proper conservation measures. A sound research program can point the direction for correcting some of these problems.

F.6.15. Soil and Water Conservation Plan of Action

An integrated soil and water conservation plan of action should be designed for each small hydrologic unit area for the entire Tuntang River Basin. This integration and the development of a multiple use plan for each small catchment area is the key to coordinated use of the limited funds and manpower; gaining acceptance of the farmer and the local people for a better use of the land, and obtaining higher production while protecting the soil and water resources. This is the integration of the human needs into a system of land conservation for the protection and use of the soil and water resources.

To provide a development program to reach these objectives we must start with the condition of the land and its ability to produce crops under strict conservation measures. In some cases this may require that the land be placed in a permanent cover of grass and trees, or by building structural measures to reduce the heavy soil losses through erosion.

The available resources for accomplishing the desired changes must be looked at and fitted to the physical requirements of the land and the ability of the farmer to make the desired changes. Last but not the least the existing social structure and infrastructure must complement the physical resources. The social factors may at times be more of a problem than the lack of knowledge of the technical problems.

In planning a program of integrated soil erosion and water management with the farmer's help, a program for improving the production and net returns to the farmers in a small hydrologic unit is required. The individual farmers must have the resources, or have them provided through government assisatnce, to carry out the technical improvements before they can be incorporated into a multiple use plan. This is particularly true because many soil erosion conservation measures applied to the land actually reduce net crop area.

These improvements designed to improve the productive capacity of the land require a total integrated program of incentives, credit, increased availability of seeds, fertilizers, pesticides, and technical assistance in all aspects of crop, livestock, fisheries, and forestry production.

The low level of education of the farmer and the lack of trained personnel to assist him also create difficult problems. How you train and educate these people is a massive job for the extension and education people. It must start in the early school years and be carried by training programs and demonstrations to all individuals involved in the program.

The concept of the program in controlling soil and water is centered on, and developed by the proper use of vegetation. All the efforts at management should be directed ot the problem of providing a vegetal cover on the soil to control soil and water erosion. Land treatment practices should be designed to help increase and improve the vegetation cover and to protect the soil from raindrop splash. It is important in this phase of the program that the technicians realize that the farmer must understand what is being proposed and he should agree to the plan. The decision should rest with the farmer as to the crops he grows.

Village development must go hand in hand with farmer's understanding of the erosion control program. Existing bodies, economic and social, at the village level should be working together on a cooperative basis. With regard to soil and water development it is required that a bottom up program should gradually replace the now prevailing top-down method of INPRES funding. Extension and guidance from the government are essential ingredients, together with adequate budgetting. The program will differ basically from present INPRES program in that the village and farmer will have been brought into the design and planning so that it will be taylored to local conditions and requirements. They would also be responsible for the execution and maintenance of the program. It is essential that precise methods of rehabilitattion be worked out and recorded with the farmer and farmer groups.

F.6.16. Demonstrations

The demonstration of the results is one of best ways to teach unschooled people the value of well planned and coordinated soil and water conservation program. A great deal of farm management data can be passed on to farmers about specific production practices to improve crop yields such as fertilizer applications improved seeds and planting stock. Erosion conditions that require retiring badly eroded land from cultivation offer the farmer a way to use his land for his profit and control his soil loss. Information can be demonstrated on the best use of mechanical structures and also some of the hazzards involved. Demonstration farms should preferably be 10-15 ha in size.

A schedule for developing the demonstration farms must be based on the availability of trained technicians to implement the program with an assurance of success. It is far better to have one good demonstration than several which are not effective. Also production incentives must be available to allow a wide variety of improved agronomic practices for demonstration. Only one in each subwatershed in the basin should be started to get the program in operation. These can then be expanded as farmer's interest and comprehension of the erosion problem develop.

F.6.17. Incentives

Participation incentives must be recognized as being essential to securing cooperation in the application of many conservation practices, and in some cases the adoption of new crop varieties and cropping systems. They can easily be justified if we are asking the farmer to adopt something he is not acquainted with or for any losses he may incur. His costs are sure to rise as he gets the conservation program going, however, his immediate and ultimate gains will also increase manyfold.

Participation incentatives should be kept to a minimal level that will encourage the farmer to participate. The farmer must not decide that the program is the government's program or it will be the government's responsibility to perform the maintenance and operation of the recommended practices. Farmers should provide as much as thay can afford to start the program and the program be tapered off when the production increases.

TABLE F-7

GREENING PROGRAM DURING PELITA I

(1969/1970 to 1973/1974)

AT TUNTANG RIVER BASIN

No.	District/ Subdistrict	Critical Area (ha)	1969/1970		1970/1971		1971/1972		1972/1973		1973/1974		1974/1975		Remarks
			Culti-vated (ha)	Ter-raced (ha)	Culti-vated (ha)	Ter-raced (ha)	Culti-vated (ha)	Ter-raced (ha)	Culti-vated (ha)	Ter-raced (ha)	Culti-vated (ha)	Ter-raced (ha)	Culti-vated (ha)	Ter-raced (ha)	
1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
I.	SEMARANG:														
1.	Bawen	887	140	130	167	-	100	-	-	350	-	-	-	-	
2.	Tuntang	-	-	-	-	-	-	-	-	100	-	-	-	-	
3.	Banyubiru	339	40	50	140	109	-	-	-	-	-	-	-	-	
4.	Salatiga	-	-	-	-	-	-	-	-	-	-	-	-	-	
5.	Jambu	1,122	-	-	147	-	-	-	-	-	975	-	-	-	
6.	Ambarawa	21	-	-	21	-	-	-	-	-	-	-	-	-	
7.	Bringin	450	-	-	-	-	200	-	-	250	-	-	-	-	
	Total:	2,919	180	180	475	109	300	-	-	700	975	-	-	-	

TABLE F-8

GREENING PROGRAM DURING PELITA II
(1974/1975 to 1978/1979)
AT TUNTANG RIVER BASIN

No.	District/ Subdistrict	Critical Area (ha)	1974/1975		1975/1976		1976/1977		1977/1978		1978/1979		1979/1980		Remarks
			Culti- vated (ha)	Ter- raced (ha)	Culti- vated (ha)	Ter- raced (ha)	Culti- vated (ha)	Ter- raced (ha)	Culti- vated (ha)	Ter- raced (ha)	Culti- vated (ha)	Ter- raced (ha)	Culti- vated (ha)	Ter- raced (ha)	
1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
I.	SEMARANG:														
1.	Bawen	1,325	-	-	-	-	-	-	-	-	520	195	460	150	
2.	Tuntang	1,560	-	-	-	-	500	-	620	-	-	-	240	200	
3.	Banyubiru	1,139	-	-	-	-	-	500	489	150	-	-	-	-	
4.	Salatiga	415	-	-	-	-	-	-	250	-	-	-	165	-	
5.	Jambu	1,630	-	-	-	-	1,000	-	250	-	-	-	200	180	
6.	Ambarawa	940	-	-	-	-	-	-	615	100	-	-	225	-	
7.	Bringin	2,930	-	-	500	-	1,800	200	285	-	-	-	145	-	
	Total:	9,939	-	-	500	-	3,300	700	2,509	250	520	195	1,435	530	

TABLE F-9

EXECUTION REFORESTATION DURING PELITA II

(1974/1975 to 1978/1979)

AT TUNTANG RIVER BASIN

No.	Forest District	Board of Forest Administration Unit/Resort	Stage of Execution (Year) 1974/1975 (ha)	1975/1976 (ha)	1976/1977 (ha)	1977/1978 (ha)	1978/1979 (ha)	Remark
1	2	3	4	5	6	7	8	9
I	MAGELANG	Ambarawa:						
		1. Kopeng	-	-	30	-	-	
		2. Gempol	-	-	30.5	-	-	
II	SEMARANG	Tempuran: (Forest Distr.)						
		1. Kalimaro	-	-	2.2	-	-	
		2. Tempuran	-	-	18.7	89.8	-	
		3. Perigi	-	-	5.5	-	-	
		4. Kalikurmo	-	-	25.6	28.9	-	
		5. Bantal	-	-	19.5	-	-	
		6. Nyemah	-	-	-	65.8	-	
		Total	-	-	132	184.5	-	

TABLE F-10

SUMMARY PLANTING REALIZATION

Year 1975 - 1978

UNIT I STATE'S FORESTRY - CENTRAL JAVA

No.	Forest Administration Unit (Forest District)	1975		1976		1977		1978			Total			Remark
		Routine	Special Budget	Routine	Special Budget	Routine	Special Budget	Routine	Special Budget	Fill in Stand	Routine	Special Budget	Fill in Stand	
		Ha	Ha	Ha	Ha	Ha	Ha	Ha	Ha	Ha	Ha	Ha	Ha	
1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
1.	Semarang	123	801.3	137	1,159.9	164	3,022.7	260.6	-	1,113.3	684.6	4,983.9	1,113.1	
2.	Telawa	35	957.51	-	1,620.75	29	2,997.1	27.7	-	2,560	91.7	5,575.36	2,560	
		158	1,759	137	2,781	193	6,020	287	-	3,673	777	10,559	3,673	

TABLE F-11

SUMMARY DESIGN REFORESTATION

Year 1979 - 1983

UNIT I STATE'S FORESTRY - CENTRAL JAVA

No.	Forest Administration Unit (Forest District)	1979		1980		1981		1982		1983		Total		Remark
		Routine	Special Budget	Routine	Special Budget	Routine	Special Budget	Routine	Special Budget	Routine	Special Budget	Routine	Special Budget	
		ha	ha	ha	ha	ha	ha	ha	ha	ha	ha	ha	ha	
1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
1.	Semarang	115	1,344.9*)	117	270.5	105	-	97	-	94	-	528	1,615.4	*) 150 ha Rumput Gajah (Grass)
2.	Telawa	28	1,314.4	37.2	2,013	24	-	24	-	24	-	137.2	3,327.4	
	Total	143	2,659	154	2,284	129	-	121	-	118	-	665	4,943	

TABLE F-12

ESTIMATED NORMAL CUTTING OF FOREST WOOD

District/ Subdistrict	1980	1981	1982	1983	1984	Total
Semarang Timur (ha)	35	27	33	22	30	147
Fire-wood m^3	1,754	1,985	2,511	2,567	3,141	11,958 m^3

Total wood production for all years 11,958 m^3

Areas thinned total 2,391 ha

Fuelwood cut 23,916 m^3

Semarang forest district reforested 1,094 ha

Telawa forest district reforested 5,667 ha

TABLE F-13

SCHEDULE AND REALIZATION OF GREENING IN THE TUNTANG RIVER BASIN

FOREST SERVICE PLANNING

No.	Residency/ Subdistrict	Critical Land Area	Greening 78/79	Greening Planned	Remained Planned	Remarks
I.	SEMARANG:					
1.	Bawen	1,585	715	610	260	
2.	Tuntang	440	-	440	-	
3.	Banyubiru	1,000	-	548	452	
4.	Salatiga	374	-	165	209	
5.	Jambu	360	-	-	360	
6.	Sumowono	1,660	1,250	110	300	
7.	Ambarawa	225	-	225	-	
8.	Bringin	366	-	145	221	
9.	Getasan	1,975	-	655	1,320	
	Total:	7,985	1,965	2,898	3,122	

F.7. UNIT COSTS OF SOME MAJOR CONSERVATION ACTIVITIES

Because sufficient time was not available for this study, unit costs for soil conservation activities could not be developed for the Tuntang River basin. However, to provide some information on the probable costs involved in soil conservation, the costs established for the related activities in other parts of Java are given in this section. It should be noted that these costs may not be totally applicable in the Tuntang Basin for which costs should be established taking all the relevant factors into consideration.

F.7.1. Demonstration

Demonstration of research results is very important in getting new ideas accepted. There is also need for a great deal of farm manage ment information on specific costs involved and returns to be expected. The demonstration farm is also required to develop the relations of climate, natural and land use conditions to runoff and erosion as well as demonstrating the best methods of reducing damages to the environ- ment.

The costs of demonstration will depend upon the size of the area and the specific measures needed thereon for soil conservation.

F.7.2. Terracing and Structures

The financial outlay per hectare of bench terracing based on the cost estimates of Solo Project are tabulated below.

Elevation Range (m)	State of Erosion			
	Moderate		Severe	
	First yr	Full Benefit	First yr	Full Benefit
	31,500	41,000	24,000	41,000
	26,000	27,000	25,000	27,000
	26,000	21,000	2,500	
	26,000	25,000	2,500	

F.7.3. Vegetation Erosion Protection Nurseries

To give full protection to the risers and lips of terraces the Government should provide seed, seddlings for planting bushes on the lip of the terrace and fodder grass for the risers to improve the protection. Fodder grass on the risers will provide riser protection as well as fodder for livestock. Grass should be fertilized for good establishment. Also insect control is very necessary. This should be provided as an incentive for the establishment period. Thereafter, the farmer should be encouraged to carry the work forward at his own expense.

Seed and other planting stock can be supplied by the project nursery. Costs should be developed for the particular cases as applicable.

F.7.4. Organization Costs

It must be recognized that the present organizations were created to deal with downstream irrigation water management problems. Those organizations do not meet the requirements or needs of the upstream farmers. Their problems are not the same type and the methods for achieving the upstream management objectives are entirely different. The upstream farmer has to develop a program of conserving his soil resource as well as increasing his food supply without an assured water supply for irrigation. The farmer must think of all his resources because the soil erosion and water conservation program is only government assistance.

The suggested organization chart is presented in Figure F-2. It requires the active participation of private land holders and or operators, various technical professions and the participation of all existing levels of Government from the Ministry's level to the Bupati and the Camat.

The Goverment has set up a specific program called "Program Penyelamatan Hutan, Tanah dan Air" for safeguarding forest land and water. The Directorate of Reforestation and Land Rehabilitation is in charge of planning, guidance, and evaluation of the program representing the Central Government. The implementation or execution is given to the Provincial and local administrative bodies. On paper it can be said that the first priority areas of afforestration are fully planned so that new priorities could be established.

The organization can be made effective by using the existing government structure for administration business and by strengthening key positions to coordinate and integrate the existing programs. The suggested budget for new positions and training has been developed for a 5-year period based on experience from Panawangan and the Solo project and is presented in Tables F-17 and F-18.

F.7.5. Research Program Costs

It is recognized that it is impractical to have research stations in each river basin. But the urgent nature of the problems in the

Tuntang River Basin and the Jragung River Basin justifies an extension of the research being done at Bogor and elsewhere on the specific problems existing in this area. The specific charge would be to work on the urgent problem of soil and water conservation.

An extension of the experimental program from Gadjah Mada University located in the Tuntang Basin could be used to train students and other scientists in solving the problems of upland agriculture and the accompaying problems of soil erosion and water conservation. Further justification can be found on page 68 of the Jragung Report Reference [2]

The reason for having at the national level is so the research people and talents can be used from all available sources. Gajah Mada University has a direct interest in such a program for this watershed and should be encouraged to participate in any research studies. Also Satya Wacana Christian University has a direct interest in the soil, water and farmer related social and economic problems, and should be called on to participate.

An estimate of cost for a 5-year research program is presented in Table F-19.

TABLE F-14

ESTIMATED UNIT COSTS FOR 3 ha DEMONSTRATION FARM WITH 2 ha TERRACED 1/

(Rupiah)

Item	Project	Farmer	Total
First Year Cost			
Preparation and Assistance Cost			
Organization of Watershed Development Committee	25,000		25,000
Meeting Place for each Village	100,000		100,000
Desa Conservation Technician 10,000 Rp/month for part time position	120,000		120,000
Record keeping costs	7,000		7,000
Soil surveys 3.27 ha @ 3,060 Rp/ha	10,000		10,000
Maps and Aerial Photographs (6,000 Rp/ha)	18,000		18,000
Sub total:	280,000		280,000
Terracing Costs (with Waterways)			
Surveying & Staking	72,000		72,000
Terrace Construction		455,000	455,000
Constructing Waterways and Diversions	5,000	50,000	55,000
Constructing drop structures	5,000	60,000	65,000
Revegetating waterways and terrace risers		73,000	73,000
Materials (bamboo, stone and grass sod)	183,800		183,800
Sub total:	265,800	638,000	903,800
Other Conservation Structure 2/	50,000	122,000	172,000
Agricultural Inputs (based on 1.28 ha cropped bench)			
Improved Seeds (25,516 Rp/ha x 1.28 ha)	32,660		32,660
Fertilizer (550 kg/ha @ 70 Rp/kg x 1.28 ha)	49,280		49,280
Insecticides (3 liters @ 1,500 Rp/l x 1.28 ha)	5,760		5,760
Sprayer @ 50,000 Rp.	50,000		50,000
Honeybee Hives (2 @ Rp. 17,000)	34,000		34,000
Livestock (sheep) 16,000 Rp each x 5	80,000		80,000
Fingerlings 100 kg @ Rp 925/kg	92,500		92,500
Sub total:	344,200		344,820
Total first year cost:	940,000	760,000	1,700,000
Second through Fifth Year Cost			
Desa Conservation Technician (10,000 Rp/month)	120,000		120,000
Record keeping costs	5,000		5,000
Watershed Development Committee Costs	10,000		10,000
Farmer Tour and education costs	23,000		23,000
Improved seeds (26,000 Rp/ha x ½ x 1.28 ha)	16,280		16,280
Fertilizer (300 kg/ha @ 70 Rp/kg x 1.28 ha)	26,880		26,880
Insecticides (2 liters @ 1,500 Rp. x 1.28 ha)	3,840		3,840
Total per year:	205,000		205,000

1/ Reference [6].

2/ May include fishponds, diversions and gully control structures.

TABLE F-15

ESTIMATED COST OF STRUCTURAL MEASURES 1/

(1979 Rupiah Values)

Structure	Unit	Estimated Cost	Contin-gencies	Engineering Design	Engineering Supv.&Adm.	Total Cost
Bench Terraces 2/	ha	451,900	22,600	23,700	49,800	548,000
Conservation Terraces 2/	ha	219,700	10,985	11,535	24,220	266,440
Critical Area Planting	ha	501,000	25,050	5,260	10,630	541,940
Diversions	km	231,000	11,550	12,100	25,450	280,100
Gully Control Structures:						
Ruble masonry (7.0 m^3 average	no	103,940	5,200	5,450	11,500	126,100
Loose Rock Drop/Checks (4.5 m^3 ave)	no	28,000	1,400	1,470	3,090	33,960
Loose Rock Drop/Checks (1.0 m^3)	no	6,350	320	330	700	7,700
Gabions (7.0 m^3 ave)	no	74,350	3,700	3,900	8,200	90,150
Bamboo Wattle Checks	no	5,400	270	280	595	6,545
Bamboo Wattle Checks with stone dissipators	no	7,500	375	390	825	9,090

1/ Reference [6]

2/ Includes the cost of waterways and drop structures but not the cost of incentive agricultural inputs.

TABLE F-16

CONSERVATION TERRACE COST ESTIMATE

15 PERCENT SLOPE AND 2 METER VERTICAL INTERVAL 1/

Structure	Unit	Unit Cost	Quantity	Total Cost Rp/ha	Project Rp/ha	Farmer Rp/ha
Field Preparation-surveying	md	500	30	15,000	15,000	
Staking Fields	md	500	5	2,500	2,500	
Terrace Construction 2/	md	500	250	125,000		125,000
Constructing waterways and diversions	md	500	30	15,000	1,000	14,000
Construction Drop Structures	md	500	45	22,500	1,500	21,000
Revegetating Terrace Channels	md	500	5	2,500		2,500
Total Labor:		500	365	182,500	20,000	162,500
Materials						
Bamboo for drop and staking	pc	200	100	20,000	20,000	
Stone 3/	m^3	3,700	4	14,800	14,800	
Grass for sodding and sprigging	m^2	12	200	2,400	2,400	
Total Materials:				37,200	37,200	
Total Estimated Cost				219,700	57,200	162,500
Contingencies (5%)				10,985	10,985	
Engineering Design (5%)				11,535	11,535	
Engineering Supervision & Adm.(10%)				24,220	24,220	
Total Structural Cost:				266,440	103,940	162,500
Incentive Agricultural Inputs						
Improved seeds or plants				16,000	16,000	
Fertilizer 200 kg @ 70 Rp/kg				14,000	14,000	
Insecticides 1 liter @ Rp 1,500/1				1,500	1,500	
Subtotal:				31,500	31,500	
Total Cost of Conservation Terracing:				297,940	135,440	162,500

1/ Reference [6]

2/ Based on 750 m^3/ha and a production rate of 3.0 m^3/md

3/ Stone cost estimated at Rp. 1,200/m^3, plus hauling 10 km @ Rp. 250/km/m^3

TABLE F-16A

BENCH TERRACING COST ESTIMATE

(25% slope and 120 cm vertical interval) 1/

Item	Unit	Unit Cost Rp	Quantity	Total Cost Rp/ha	Project Rp/ha	Farmer Rp/ha
Labor						
Field Preparation-Surveying						
Staking Fields	md	500	64	32,000	32,000	
Terrace Construction 2/	md	500	8	4,000	4,000	
Constructing Waterways and Diversions		500	455	227,500		227,500
Constructing Drop Structures	md	500	55	27,500	2,500	25,000
Revegetating Waterways and Terrace Risers	md	500	65	32,500	2,500	30,000
	md	500	73	36,500		36,500
Total Labor:			720	360,000	41,000	319,000
Materials						
Bamboo for Drops and Staking	pc	200	150	30,000	30,000	
Stone 3/	m^3	3,700	7	25,900	25,900	
Grass for Sodding Risers and Waterways	m^2	12	3,000	36,000	36,000	
Total Materials:				91,900	91,900	
Total Estimated Cost				451,900	132,900	
Contingencies (5%)				22,600	22,600	
Engineering Design (5%)				23,700	23,700	
Engineering Supervision and Administration (10%)				49,800	49,800	
Total Structural Cost				548,000	229,000	319,000
Incentive Agricultural Inputs						
Improved seeds (25,000 Rp/ha x 0.64)				16,000	16,000	
Fertilizer (300 kg @ 70 Rp/kg)				21,000	21,000	
Insecticides (2 liters @ 1,500 Rp/1)				3,000	3,000	
Subtotal:				40,000	40,000	
Total Cost/ha of Bench Terracing:				588,000	269,000	319,000

1/ Reference [6]
2/ Based on Panawangan experience of 455 md/ha, or a production rate of 3.0 m^3/md and 1,356 m^3/ha
3/ Stone cost estimated at 1,200 Rp/m^3, plus hauling 10 km @ 250 R/km/m^3

TABLE F-17

ESTIMATED COST OF NEW POSITION AND TRAINING CENTER 1/
AS SHOWN ON ORGANIZATION CHART ABOVE KABUPATEN LEVEL
(Thousand Rupiah)

Position	Year 1	2	3	4	5	Total
Personnel Cost						
Soil and Water Development						
Coordinator @ 100,000 Rp/mo	1,200	1,200	1,200	1,200	1,200	6,000
Conservationist @ 75,000 Rp/mo	900	900	900	900	900	4,500
Senior Training Officer @ 75,000 Rp/mo	900	900	900	900	900	4,500
Training Officer @ 50,000 Rp/mo	600	1,200	1,200	1,200	1,200	5,400
Administrative Officer @ 28,000 Rp/mo	335	335	335	335	335	1,675
Secretarial and Typing	276	552	552	552	552	2,484
Drivers @ 20,000 Rp/mo	480	960	960	960	960	4,320
Sub-Total:	4,691	6,047	6,047	6,047	6,047	28,879
Capital Cost						
Land 2 ha @ 225 Rp/m²	4,500					4,500
Training Center 500m² @ 80,000 Rp/m²	30,000	10,000				40,000
Furnishing and Equipment	15,000	12,000				27,000
Office Equipment	5,000	5,000				10,000
Audio-Visual Equipment	9,000	6,095				15,095
Library	1,250	1,250	250	250		3,000
Supplies and visual aid materials	1,225	2,400	3,125	3,125	3,125	13,000
Jeeps @ 5,000,000 Rp	10,000	10,000				20,000
Motor Cycles @ 800,000 Rp	2,400					2,400
Sub-Total:	78,375	46,745	3,375	3,375	3,125	134,995
Other Cost						
Training Center Costs						
Lodging and meals	1,050	4,200	7,000	7,000	7,000	26,250
Sancks and pocket money	225	900	1,500	1,500	1,500	5,625
Travel expenses	30	120	200	200	200	750
Field Trip Expenses	90	360	600	600	600	2,250
Miscellaneous Training Expenses	300	1,200	2,000	2,000	2,000	7,500
Staff travel expenses	500	600	600	600	600	8,900
Operation, maintenance, replacement and travel costs	5,580	10,080	10,080	10,080	10,080	45,900
Allowances @ 25% of Personnel Costs	1,172	1,512	1,512	1,512	1,512	7,220
Sub-Total:	8,947	18,972	23,492	23,492	23,492	98,395
TOTAL COST:	92,013	71,764	32,914	32,914	32,664	262,269

1/ Reference [6].

TABLE F-18

ESTIMATED COST FOR NEW POSITIONS AND OPERATIONS COST FOR KABUPATEN 1/

(Thousand Rupiah)

Position	Yearly Cost per Staff Member	Year 1	Year 2	Year 3	Year 4	Year 5	Total 5 year Project
Personnel Cost							
Soil and Water Resources Coordination @ 85,000 Rp/mo	1,020	1,020	1,020	1,020	1,020	1,020	5,100
Training Officer @ 50,000 Rp/mo	600	600	600	600	600	600	3,000
Assistant Training Officer @ 35,000 Rp/mo	420	420	840	840	1,260	1,260	4,620
Conservation Supervisor @ 45,000 Rp/mo	540	540	540	540	540	540	2,700
Assistant Soil and Water Coordinator @ 60,000 Rp/mo	720	1,440	2,880	5,040	7,920	13,680	30,960
Soil Conservation Officer @ 35,000 Rp/mo	420	840	1,680	2,940	4,620	7,980	18,060
Spot Workers or PLP @ 23,000 Rp/mo	276	2,208	4,416	7,728	12,144	20,976	47,472
Administrative Officer	335	335	335	335	335	335	1,675
Secretarial and Typing	276	480	960	960	960	960	4,320
Drivers	240	240	720	720	720	720	3,120
Sub-Total:		8,123	13,991	20,723	30,119	48,071	121,027

1/ Reference [6]

TABLE F-18 (Cont.)

ESTIMATED COST FOR NEW POSITIONS AND OPERATIONS COST FOR KABUPATEN

(Thousand Rupiah)

Position	Year 1	2	3	4	5	Total 5 year Project
Capital Cost						
Motor Cycle @ 800,000 Rp/ca	4,000	8,000	12,000	8,000		32,000
Jeeps @ 5,000,000 Rp/ca	5,000	10,000	10,000			25,000
Bicycles @ 30,000 Rp/ca	240	360	360	840		1,800
Office Equipment	4,000	4,000				8,000
Supplies and Visual Aid Materials	2,000	2,250	2,250	2,400	2,500	11,400
Sub-Total:	15,240	24,610	24,610	11,240	2,500	78,200
Other Costs						
Operation, Maintenance and Replacement Cost	2,700	8,100	14,700	17,100	17,100	59,700
Allowance at 25% of Personnel Cost	2,031	3,498	5,181	7,530	12,018	30,258
Training and Education	450	1,700	2,800	2,800	2,800	10,550
Field Demonstration and Meeting Costs	1,000	1,500	2,500	2,500	2,500	10,000
Miscellaneous equipment and tools	655	1,430	3,000	5,342	2,607	13,034
Sub-Total:	6,836	16,228	28,181	35,272	37,025	123,542
TOTAL:	30,199	54,829	73,514	76,631	87,596	322,769

F.8. TRAINING PROGRAMS

The training of Professional and non-Professional staff is one of the most critical items for the development of an upstream soil erosion and water conservation program. If the professional staff do not understand the causes and effects of soil loss and erosion, the proper use of bench terraces, and other conservation measures they can not teach the farmers correct principles. The agronomic techniques for increasing dryland crop production while protecting the soil will not be integrated with the proposed soil erosion and water development program. Only when all the staff are really interested in the farmer and his problems can the program succeed. They must work with the farmer and train and motivate him so he wants to do something about his problem.

It must be recognized that local educational institutions have not been able to satisfy the demand for highly trained specialists in some fields. Also there is no program to specifically train erosion control specialists, watershed managers, water resources engineers and or agronomists for solving the special problems of the upper watersheds.

F.8.1. Staff Training

The provincial level should be the first level of training. The staff training would be the responsibility of the day to day coordinator and the senior training office. After the provincial staff has been budgeted and trained the same problem will be faced by the district staff. However, they will have the provincial training program to guide them. In general the staff will need the interdisciplinary approach method explained and how the program is to be coordinated. They will all need to acquire a knowledge of the specific causes of erosion and the available methods of reducing erosion rates. This training will have to be done by the trained available technical staff, any consultants available, individual specialists from research and by the University specialists. Staff training is a continuing need in the development of trained technicians. Replacement of staff promoted to positions of greater responsibility and the need to train new staff members that are required to step up the program will require a highly skilled group of people.

F.8.2. Farmer Training

The demonstration farm and larger demonstration projects similar to the Panawangan and Solo projects are the most direct way to train farmers and others with little education. It is a direct way of showing and telling what the most desirable conservation tools are and how they are used. How to terrace the land, install controled water ways and use agronomic practices to improve the soil and reduce rain drop splash erosion are only a few of the items to be shown. A demonstration farm must be successful to be effective. It requires constant attention and guidance for the application of conservation practices for the different conditions that will be encountered by the farmer. New techniques and fertilizer and seeds can be tried and evaluated.

The Figure F-2 and Table F-18 indicate that the program will need additional specialists as the program expands. By the fifth year it is estimated that a district would require from a 100 to 120 new technical and semi technical people. The program should peak out as farmers become trained and know more of the methods required to maintain and improve their farms. These positions range from the day to day coordinator down to the village technicians assigned directly to help the mini hydrologic units.

F.8.3. Consultants and Foreign Training

It would be desirable to employ some foreign consultants to help train and advise on the program until the Government employees develop a competence in the soil and water conservation. Foreign training is also a quick way to expanding the Indonesian technicians knowledge of the problem.

F.9. SIGNIFICANCE OF SOIL EROSION AND WATER CONSERVATION

The total cost of accelerated soil erosion, either in monetary terms, or in human suffering, has not been calculated and probably never could be. Soil erosion has been recognized as a threat to the continued productivity of the land and a great deal of investment and research have already gone into the program. More recently concern has shifted toward viewing the problem as a source of pollution and high sediment rates to reservoirs and downstream irrigation facilities.

Growing populations are creating land pressure and every available piece of land is used to produce food or cash crops or to generate foreign exchange such as the timber industry. There are many examples where cassava and maize are planted on highly eroded hillslopes and production does not even pay for the seed. The steep forest lands on the sides of the old volcanoes are being broken out of the fragile vegetation and planted to crops. Sheet erosion soon causes gully erosion and the shallow soils are no longer able to provide crop to the farmer and he is forced to move to other areas. Farmers simply have no option but to clear new areas because families have to be fed. Until the concept of population control or transmigration gains more popularity and surplus farm labor is used in other industries or diverted to other types of production these steep lands will continue to be under pressure. In the meantime, the needs can be met by reclaiming the eroded lands for productive forestry or grass for livestock feed.

In the past many mistakes have been made in forcing people to use conservation practices that were not only unpopular but did not work. As more and more research and educational facilities are founded in these critical areas better data can be provided to both soil conservations and agriculturists who will learn more effective ways to control the problem with local farmers.

F.10. MAINTENANCE

After the initial construction period, thorough maintenance program is essential and required. Ideally this should be done willingly by the farmers and land owners. If the farmer is educated and is shown the value of the conservation improvement he should carry the responsibility of maintaining his personal developments. However, if the Government technicians oversell the value of terraces and other erosion control measures before their need or purpose has been understood and accepted by local people, there is danger that maintenance will not be done when the government help is withdrawn. It is easy for the Government to send in technicians to design and build terraces and other structures, but the subsequent maintenance can be a problem. Any element of compulsion may cause resistance and so reduce the chance of the erosion works of improvement being accepted. On the other hand if they are left unmaintained they will certainly fail. Many examples of this can be seen with greening program.

The short term answers to these problems is that when funds are set aside for implementation, a portion must be set aside for follow up and maintenance work, also.

F.11. RECOMMENDATIONS

F.11.1. General

The development of a soil erosion and water conservation program involves an integrated multidiscipline system of management. This is in line with "One River One Plan" concept put forward by Dr. Emil Salim, Minister for Living Environment and Nature Preservation, Government of Indonesia. The suggested action plan consists of the organization changes and soil erosion and water development practices required to accomplish the objectives. This would include the following:

1. The farmers and Government technicians should be made aware of the problem and they should appreciate the serious damages that are occuring in many critical areas in the upper watersheds. The Tuntang River catchment has many of these critical areas.

2. The plan suggested emphasizes "better farming for improved living" idea. It attempts to demonstrate to the farmer or land owner why soil and water conservation and improved cultural practices can enable him to make maximum use of his land resource and still improve his family living standards.

3. The approach involves cooperation and coordination of all agencies and government political subdivisions down to the village level. It will point out that the individual areas will require different components and forms of assistance to develop their special requirements and needs to correct the erosion damage.

4. It must be recognized that important social and economically viable projects can support the soil and water conservative objectives through increasing living standards.

   Livestock, fish, poultry and bee culture can fit well into a conservation program and help to relieve the land pressures. Livestock can use grass and fodder that grows on land taken out of cultivation.

5. The integrated coordinated approach for soil conservation practices and structural works have been previously demonstrated. Existing terraces that do not come up to standards should be used where possible by modifying those sections that do not meet conservation requirements. Participation by the farmer in the conservation measures on his fields has proven to be effective. His wishes and desires must be incorporated in the plan to gain his support.

F.11.2. Organizational Improvements

Some organization modifications are required to effectively develop a soil and water conservation program. This can be done with the existing government system, with some modification and strengthening. A new overall ministerial organization is not required to carry out an effective soil and water conservation program. There is no need for a single government agency to direct the soil and water erosion program. It only needs strengthening to coordinate and focus on getting aid directly to the farmer. The farmer must be shown and helped to do the conservation job on his land. Some other types of assistance such as incentives can be made available to farmers and others through the same system. The development plan suggests an organization and costs to implement the plan at the various levels of government.

F.11.3. Conservation Works

Conservation activities that should be planned and carried out are detailed in the Jragung Report, Reference [2].

F.11.4. Vegetation

The plan does not attempt to solve all the peoples problems in the upper watershed. It emphasises peoples management and use of the available resources to control erosion through the use of vegetative cover and soil conservation practices. Vegetation is the basis for all sound conservation programs.

F.11.5. Research

Research is required to provide the data for an active soils and water conservation program. It is recommended that research stations should be set up in the Jratunseluna Basin.

TABLE F-19

RESEARCH EXPERIMENTAL STATION COSTS 1/

(Thousand Rupiah)

Position	Yearly Cost Per Staff Member	Year 1	2	3	4	5	Total for 5Years
Personnel Costs							
Research Director @ 225,000 Rp/mo	2,700	2,700	2,700	2,700	2,700	2,700	13,500
Assistant Director @ 175,000 Rp/mo	2,100	2,100	2,100	2,100	2,100	2,100	10,500
Student Assistant		4,680	6,240	7,800	9,360	9,360	37,440
Laboratory Assistant @ 85,000 Rp/mo	1,020	1,020	2,040	3,060	3,060	3,060	12,240
Secretarial, Administrative, Farm Labor and Miscellaneous		1,500	3,000	4,500	4,500	4,500	18,000
Sub-Total:		12,000	16,080	20,160	21,720	21,720	91,680
Capital Costs							
Land 10 ha @ 150 Rp/m^2		15,000					15,000
Buildings and Laboratory 15 x 50 = 750 m^2 @ 80,000 Rp/m^2		20,000	40,000				60,000
Furnishing and Equipment		15,000	22,500				37,500
Laboratory Instruments		5,000 1/	5,000	2,500	2,500		15,000
Farm Tools and Equipment		2,000	3,000				5,000
Automatic Absorption Spectrophotometer					4,375		4,375
Library 1,250,000/yr		1,250	2,500	1,250	1,250	1,250	7,500
Visual Aids 1,250,000/yr			1,250	1,250	1,250	1,250	5,000
Cars and Jeeps @ 5,000,000 Rp		10,000	5,000				15,000
3 ton trucks @ 7,000,000 Rp		7,000	7,000				14,000
Small tractors @ 1,875,000 Rp		1,875	3,750				5,625
Sub-Total:		77,125	90,000	5,000	9,375	2,500	184,000

1/ Reference [6].

TABLE F-19 (Cont.)

RESEARCH EXPERIMENT STATION COSTS

(Thousand Rupiah)

Position	Yearly Cost Per Staff Member	Year 1	2	3	4	5	for 5 years
Other Cost							
Staff Travel Expenses		1,200	1,600	2,000	2,100	2,100	9,000
Operation, Maintenance, replacement and travel cost		5,100	8,700	8,700	8,700	8,700	39,900
Materials, Seeds and Planting Stock		4,000	4,000	4,000	4,000	4,000	20,000
Allowance 25% of Peronnel Costs		3,000	4,020	5,040	5,430	5,430	22,920
Miscellaneous and Contingencies		2,000	2,000	2,000	2,000	2,000	10,000
Sub-Total:		15,300	20,320	21,740	22,230	22,230	101,820
Total Cost:		104,425	126,400	46,900	53,325	46,450	377,500 1/

1/ Includes Cost of Meteorological Station of 3,485,882 Rp.

F.12. ESSENTIAL REQUIREMENTS FOR A SOIL EROSION AND WATER CONSERVATION PROGRAM

F.12.1. General

Massive Government expenditures will not solve the soil erosion and water conservation problems. Instead it will tend to create a subsidized agricultural system.

Experience of the greening program, and other agricultural program in Indonesia have shown that to have an effective soil and water erosion control program in the upstream watersheds the farmer must understand what the government technician is planning for him to accomplish to control the erosion on his farm. It requires more than just making a plan and giving incentives to carry out the program. The farmer must not only understand what and how the program is to be carried out, he must participate and put his resources into the conservation plan.

Demonstrations have proven to be one of the best ways to shown farmers, who have little education, that their steep and shallow soils can be made to produce if these are properly managed and protected. Well planned and executed demonstration farms have shown that erosion can be controlled and the land made to produce much more under a conservation system of management. Small demonstrations placed in the subbasins will show the farmers and technicians that it is better to adopt correct methods on a small unit of land than to carry out a massive crash government programs. This is not to say that the Government should not be heavily involved in farm credit, technical help, supplies of improved varieties of seed, fertilizers insecticides; and other forms of assistance.

A start should be made by the Government by providing funds to help start a demonstration on road stabilization, proper ditch design, channel control, small storage ponds and other works of improvement in which the farmer can participate. They must be made aware of the fact that the soil and water conservation program is a self help program with some government assistance to help with costs. The Government cannot do the job alone. It is too far reaching and complicated. Local people must be made aware that they have largely created the erosion problems themselves.

F.12.2. Management of Agricultural Lands

The objective of conservation land management is to protect the land against all forms of soil deterioration; to rebuild eroded and depleted soils; to build soil fertility, to stabilize critical runoff and sediment producing areas; improve contour terraces, and grassed waterways on land too steep for cultivation; to provide supplemental irrigation; and reduce flood and sediment damage.

These objectives can be attained by the application of land treatment practices and water control structures on individual private farms and upstream drainages through both individual and group action. A complete soil and water conservation management plan of a small mini-hydrologic unit may not be as complex as for larger subwatershed and large river basins, but the principles of management are the same.

F.12.3. Water Control

The efficient control and use of water on the farm requires the application of various techniques. Cropland vegetation provides some protection against soil erosion. However, it is necessary to increase the protection against runoff from high intensity rains. This is done by terracing, and controlled waterways. A structural system may be required to convey surface runoff at non-erosive velocities to a disposal system; or diversions, grassed waterways, and grade stabilization structures may be needed. Where rain is infrequent or poorly distributed, as in the dry season, the supply or demand for irrigation water could often be helped by small irrigation developments that the villages and groups of farmers could develop with technical help. Although projects of this type are small they require adequate consideration of hydrologic and hydraulic design features.

F.12.4. Extent of Hydrologic Data

Generally speaking, a soil and water conservation program may not require extensive and costly hydrologic investigations. Basic maps of runoff, soils and topography with intensity rainfall records can be used and standard designs modified, as necessary, to meet the specific needs of the situation. However, when high cost structures are necessary, field investigations are justified to achieve economy in design and construction. Watershed soil and water erosion control structures and practices use a wide and varied range of control measures and the extent of the hydrologic investigations necessary vary accordingly. High cost projects will require special designs and hydrologic studies, including field investigations to attain economy of design and to avoid unecessary risk of failure.

F.12.5. Channel Improvement

For small-size channel improvements and subsequent maintenance, assistance should be provided by the Government to the farmers. It is advisable that the Government should construct all major works needed for channel improvement and should also maintain them.

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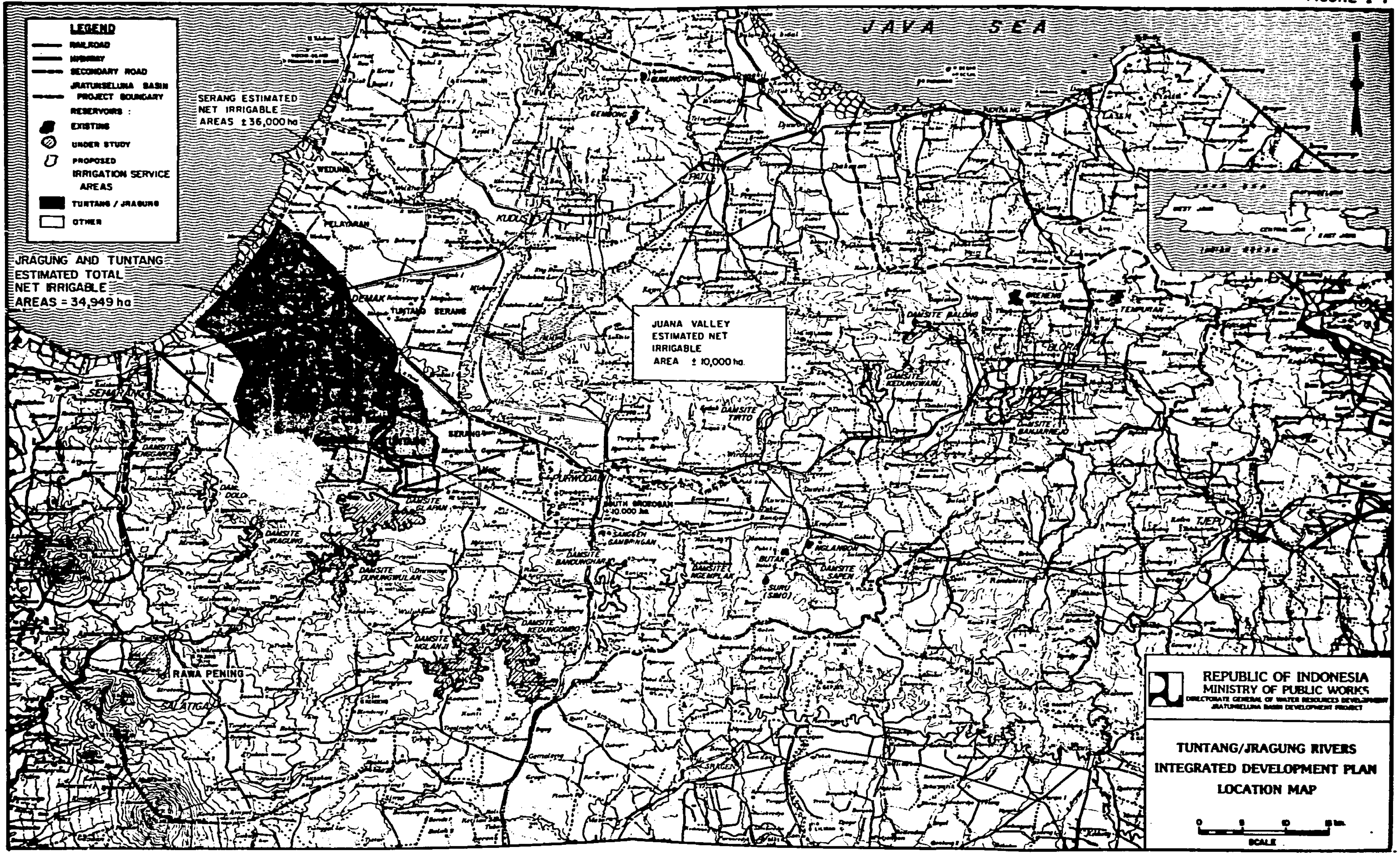
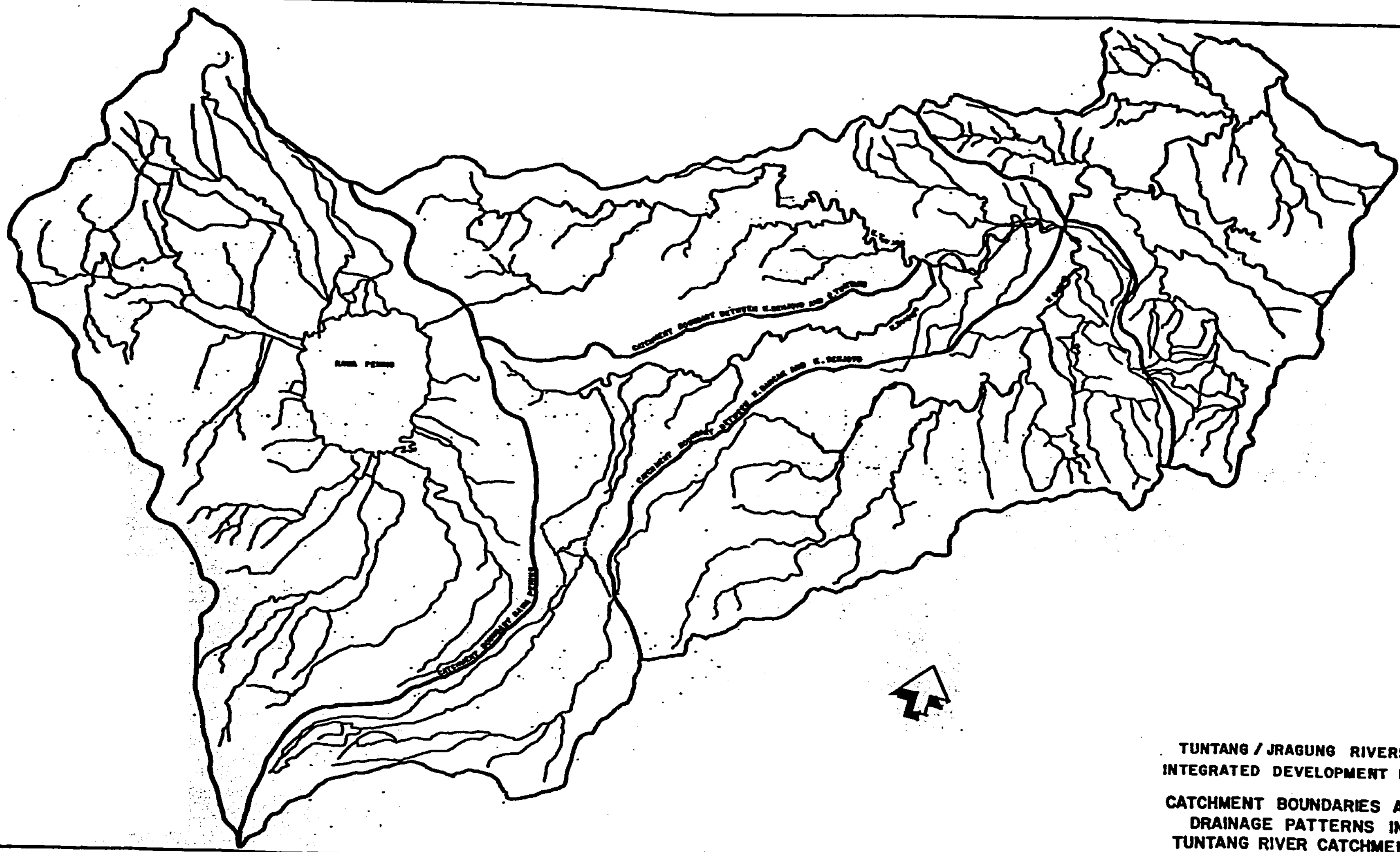
5	NEDECO. Jratunseluna Basin Development Plan. Glapan Dam Irrigation, Flood Control and Hydropower Project July 1975.
6.	PRC Engineering Consultants, Inc. Citanduy Upper Watershed Management Project Feasibility Report. October 1979.


LEGEND
RAILROAD
HIGHWAY
SECONDARY ROAD
JRATUNSELUNA BASIN PROJECT BOUNDARY
RESERVOIRS :
EXISTING
UNDER STUDY
PROPOSED
IRRIGATION SERVICE AREAS
TUNTANG / JRAGUNG
OTHER
JAVA SEA
SERANG ESTIMATED NET IRRIGABLE AREAS ±36,000 ha
JRAGUNG AND TUNTANG ESTIMATED TOTAL NET IRRIGABLE AREAS = 34,949 ha
JUANA VALLEY ESTIMATED NET IRRIGABLE AREA ± 10,000 ha.
KUDUS
PATI
DEMAK
SEMARANG
SERANG
PURWODADI
DAMSITE GLAPAN
DAMSITE JRAGUNG
DAMSITE DUNUNGWULAN
DAMSITE KEDUNGOMBO
DAMSITE MGLANJI
DAMSITE TIRTO
DAMSITE KEDUNGWARU
DAMSITE BANJARREJO
DAMSITE BALONG
DAMSITE SAPEN
DAMSITE NGEMPLAK
DAMSITE BANDUNGHARJO
SOUTH GROBOGAN ±10,000 ha
RAWA PENING
SALATIGA
SRAGEN
BLORA
TJEPU
TEMPURAN
GRENENG
GEMBONG
LASEM
REMBANG
WEDUNG
PELAYARAN
BUTAK
SURU (SIMO)
NGLANGON
REPUBLIC OF INDONESIA
MINISTRY OF PUBLIC WORKS
DIRECTORATE GENERAL OF WATER RESOURCES DEVELOPMENT
JRATUNSELUNA BASIN DEVELOPMENT PROJECT
TUNTANG/JRAGUNG RIVERS
INTEGRATED DEVELOPMENT PLAN
LOCATION MAP
0 5 10 15 km.
SCALE

PRC ENGINEERING CONSULTANTS, INC

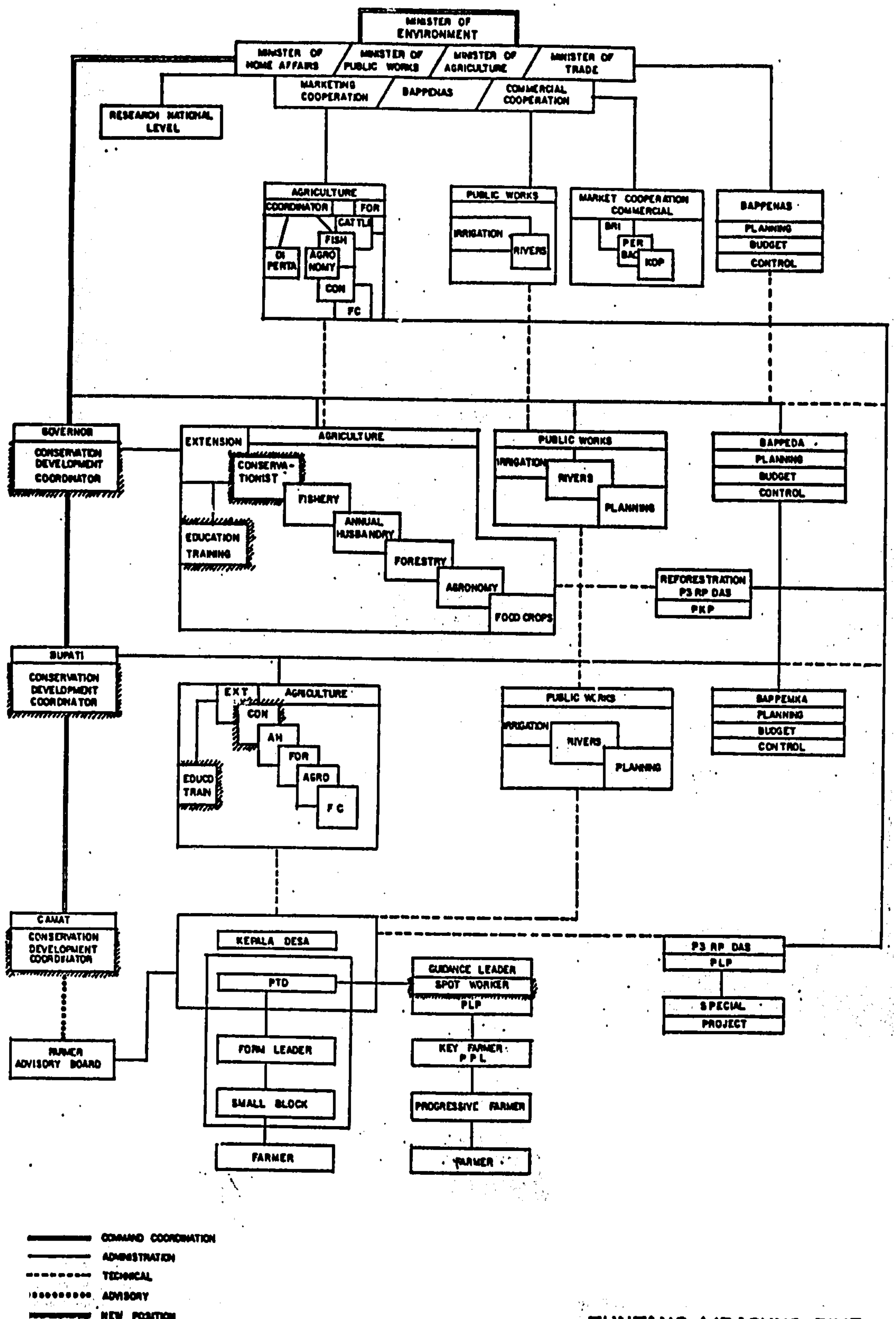
FIGURE F-1



TUNTANG / JRAGUNG RIVERS
INTEGRATED DEVELOPMENT PLAN

CATCHMENT BOUNDARIES AND DRAINAGE PATTERNS IN TUNTANG RIVER CATCHMENT

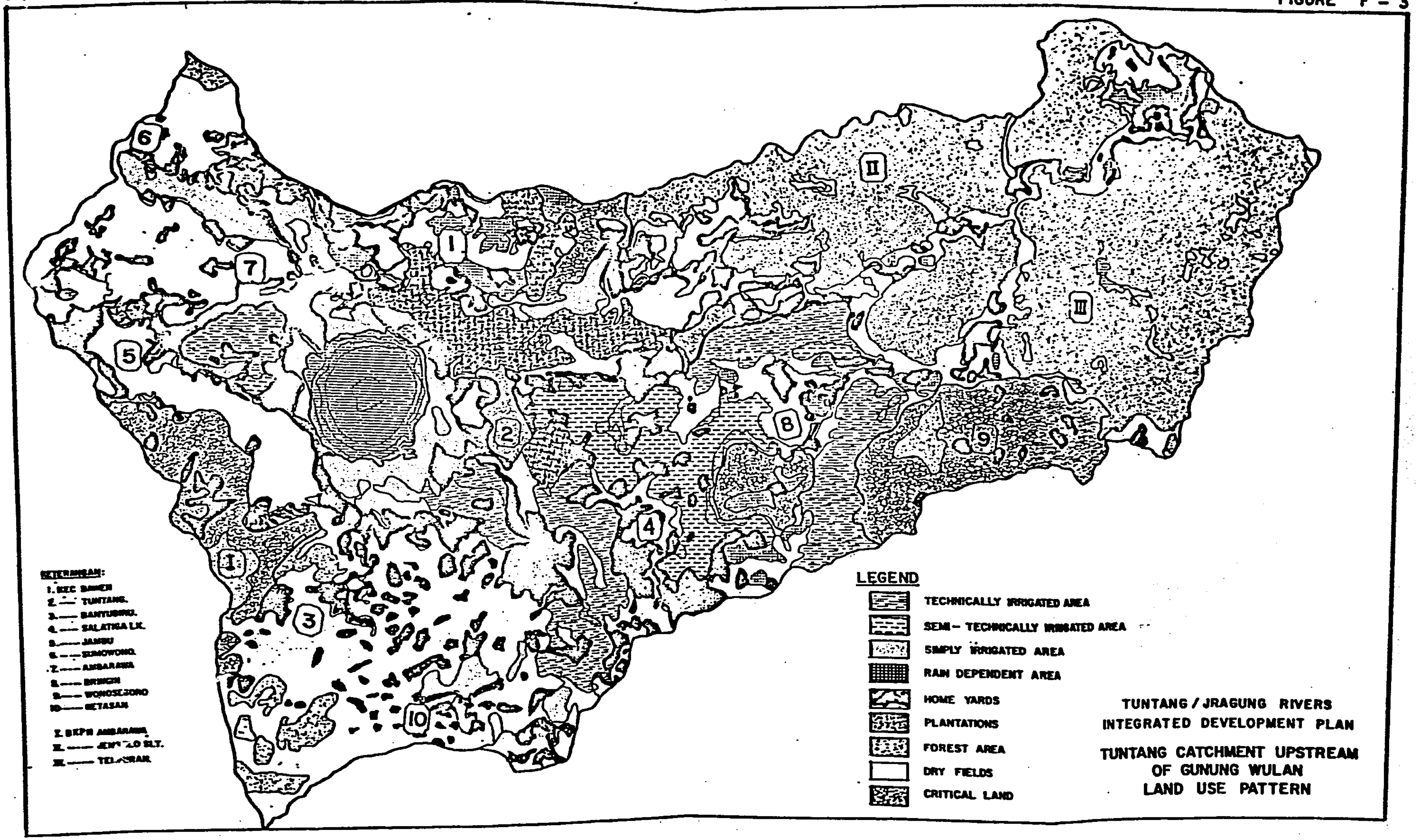
SOIL AND WATER RESOURCES DEVELOPMENT PROGRAM

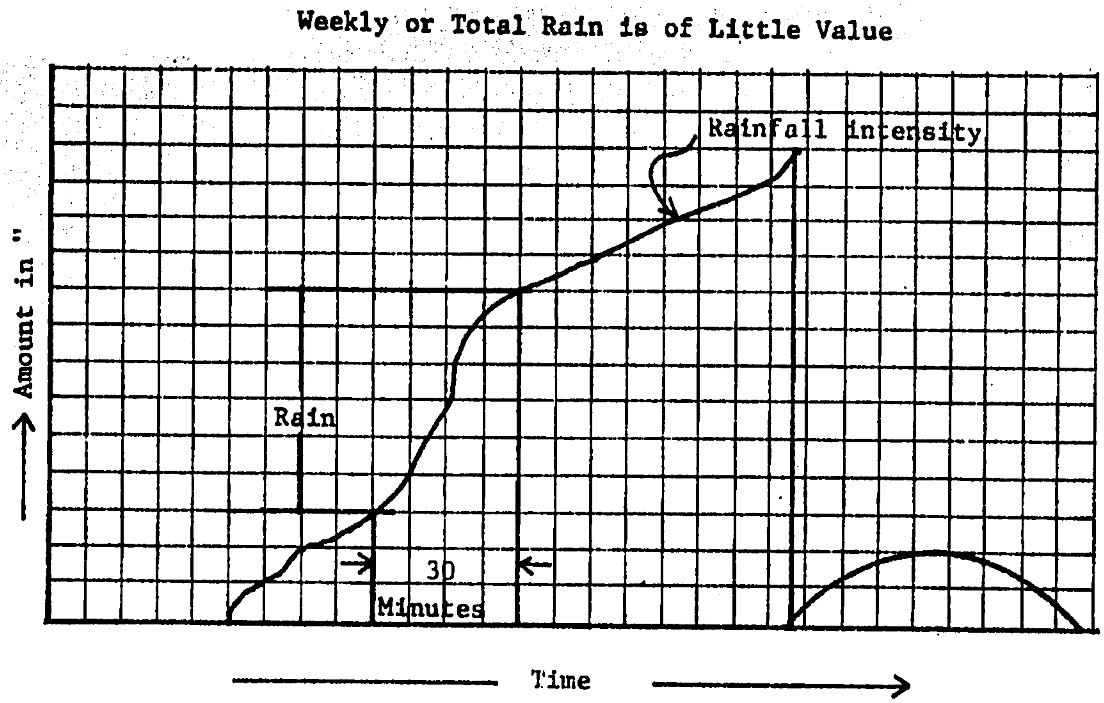


TUNTANG / JRAGUNG RIVERS
INTEGRATED DEVELOPMENT PLAN

ORGANIZATION CHART

FIGURE F - 3

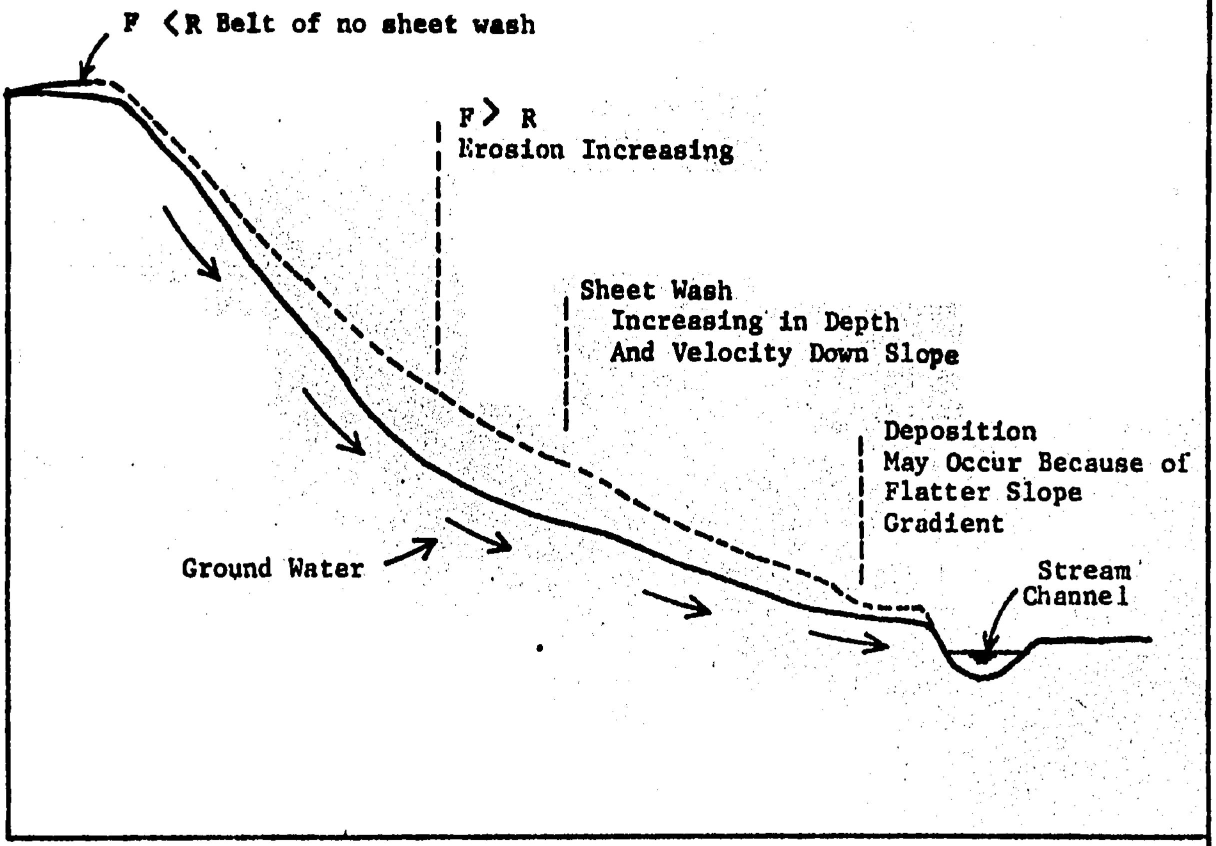

LEGEND
TECHNICALLY IRRIGATED AREA
SEMI - TECHNICALLY IRRIGATED AREA
SIMPLY IRRIGATED AREA
RAIN DEPENDENT AREA
HOME YARDS
PLANTATIONS
FOREST AREA
DRY FIELDS
CRITICAL LAND
TUNTANG / JRAGUNG RIVERS
INTEGRATED DEVELOPMENT PLAN
TUNTANG CATCHMENT UPSTREAM
OF GUNUNG WULAN
LAND USE PATTERN



Method of obtaining 30 minute Intensity. The 30 minute period with greatest amount of R is found from the daily rain gage Chart twice this amount is the 30 minute intensity.

JRAGUNG / TUNTANG RIVERS
INTEGRATED DEVELOPMENT PLAN

DAILY RAIN GAGE CHART



The relative Magnitudes of eroding forces of Sheet erosion (F) and the resistance (R) of the soil to erosion. Erosion determines the width of a belt of no sheet erosion near the top of hill. Below this belt the intensity of sheet erosion depends on the erosive force F (which is proportional to the product of hill slope gradient and water depth) note that rain drop splash erosion does occur in the belt of no sheet erosion.

The intensity of erosion depends on the product of water depth and hillslope gradient. It may increase or decrease with distance down slope depending on the combination of water depth and hillslope gradient along the hill profile. A common situation for erosion to increase with distance as the gradient steepens down slope and then for erosion to decrease or even for some deposition to take place on the gentle bottom slope.

JRAGUNG / TUNTANG RIVERS
INTEGRATED DEVELOPMENT PLAN

RESISTANCE TO EROSION DECREASING OR DEPOSITION OCCURING