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AGRICULTURAL SURVEY AND DEMONSTRATION IN SELECTED WATERSHEDS

REPUBLIC OF KOREA

FINAL REPORT

Volume II

SOILS AND LAND CLASSIFICATION

FOOD AND AGRICULTURE ORGANIZATION OF THE UNITED NATIONS

This Final Report consists of the following volum

Volume I: General Report

(Published by the Food and Agri e Organization of the United Nations, Rome)

Volume II: Soils and Land Classification

(Prepared by Uniconsult ! porated, Lafayette, California)

Volume III: Agronomy, Forestry and Pa re Improvement

(Prepared by Uniconsult corporated, Lafayette, California)

Volume IV: Hydrology and Engineering

(Prepared by Uniconsult corporated, Lafayette, California)

Volume V: Economic Appraisal

(Prepared by Uniconsult orporated, Lafayette, California)

AO/SF : 47/KOR 7

AGRICULTURAL SURVEY AND DEMONSTRATION IN SELECTED WATERSHEDS

REPUBLIC OF KOREA

FINAL REPORT

VOLUME II
Soils and Land Classification

Report prepared for the
Food and Agriculture Organization of the United Nations

by

UNICONSULT INCORPORATED
Lafayette, California

FOOD AND AGRICULTURE ORGANIZATION OF THE UNITED NATIONS
Rome, 1968

PROJECT SUMMARY

PROJECT:

United Nations Special Fund Project-----Agricultural Survey and Demonstration in Selected Watersheds in Korea. (United Nations Korean Uplands Project - 'UNKUP')

PURPOSES:

To determine the kinds of land use treatment, and soil and water conservation practices, which are technically and economically feasible in Korea for the conversion of under-utilized hilly and mountainous lands into more productive farm and forest lands.

To demonstrate to farmers the latest techniques of upland conversion and utilization.

To train Korean technicians in the conception, planning, and execution of such work.

GENERAL SCOPE:

In two separate drainage basins, the Ansong Chon and the Tongjin Gang, of approximately 100,000 hectares each in size, soil and land use surveys, hydrological and meteorological data collection and studies, ground water investigations, agronomic, agricultural economic, and flood damage studies, and forestry and vegetation inventories, were completed. Development plans were drafted for each watershed, and Detailed Work Plans were prepared and executed in Pilot Demonstration Areas of about 1,000 hectares each in size in each watershed.

BUDGET:

Slightly more than U.S. $1,000,000

TIME:

Inception: December 1961
Completion: October 1967

PERSONNEL:

Maximum Korean Staff; approximately 70 persons.
Maximum Foreign Staff; 7 persons.

PRINCIPAL RESULTS:

Technical and economic feasibility demonstrated in Pilot Areas.

Korean Government considered results successful, and adopted principles and practices of Pilot Demonstration Areas for a 7-year Nation-Wide Uplands Conversion Program, whereby some 400,000 hectares are being converted into farm lands. They also initiated other United Nations projects for complete uplands development in three drainage basins based on these same principles and practices.

More than 750 Korean technicians trained in one or more facets of Upland Conversion Technology.

'NOTE'

IN THE PREPARATION OF THIS VOLUME, AN EFFORT HAS BEEN MADE TO USE THE SAME SPELLING OF PLACE AND FEATURE NAMES. WHERE POSSIBLE THOSE USED ON THE UNITED STATES ARMY TOPOGRAPHIC MAPS, 'ROMANIZED' IN ACCORDANCE WITH THE MCCUNE-REISCHEUR SYSTEM, HAVE BEEN FOLLOWED.

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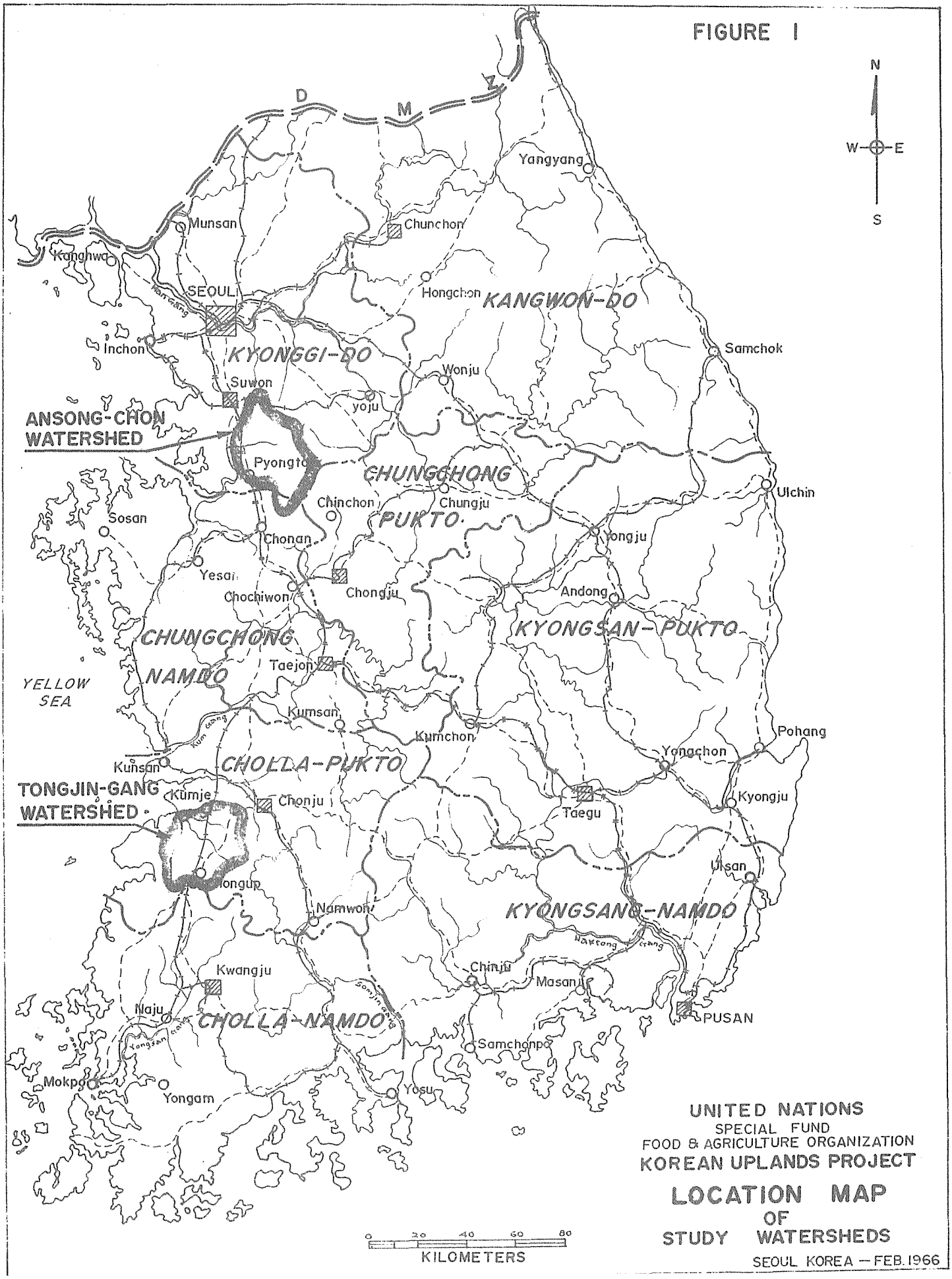
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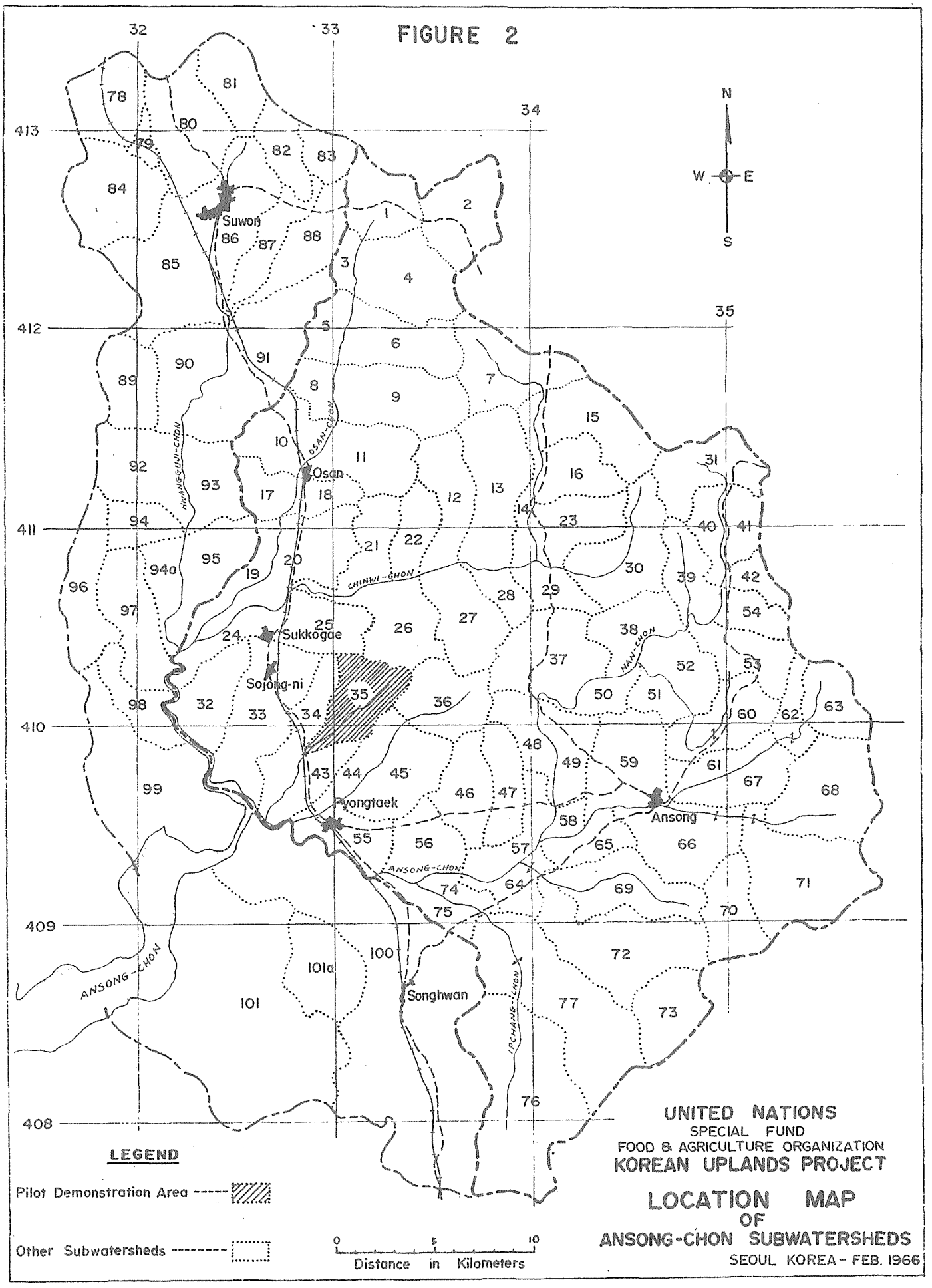
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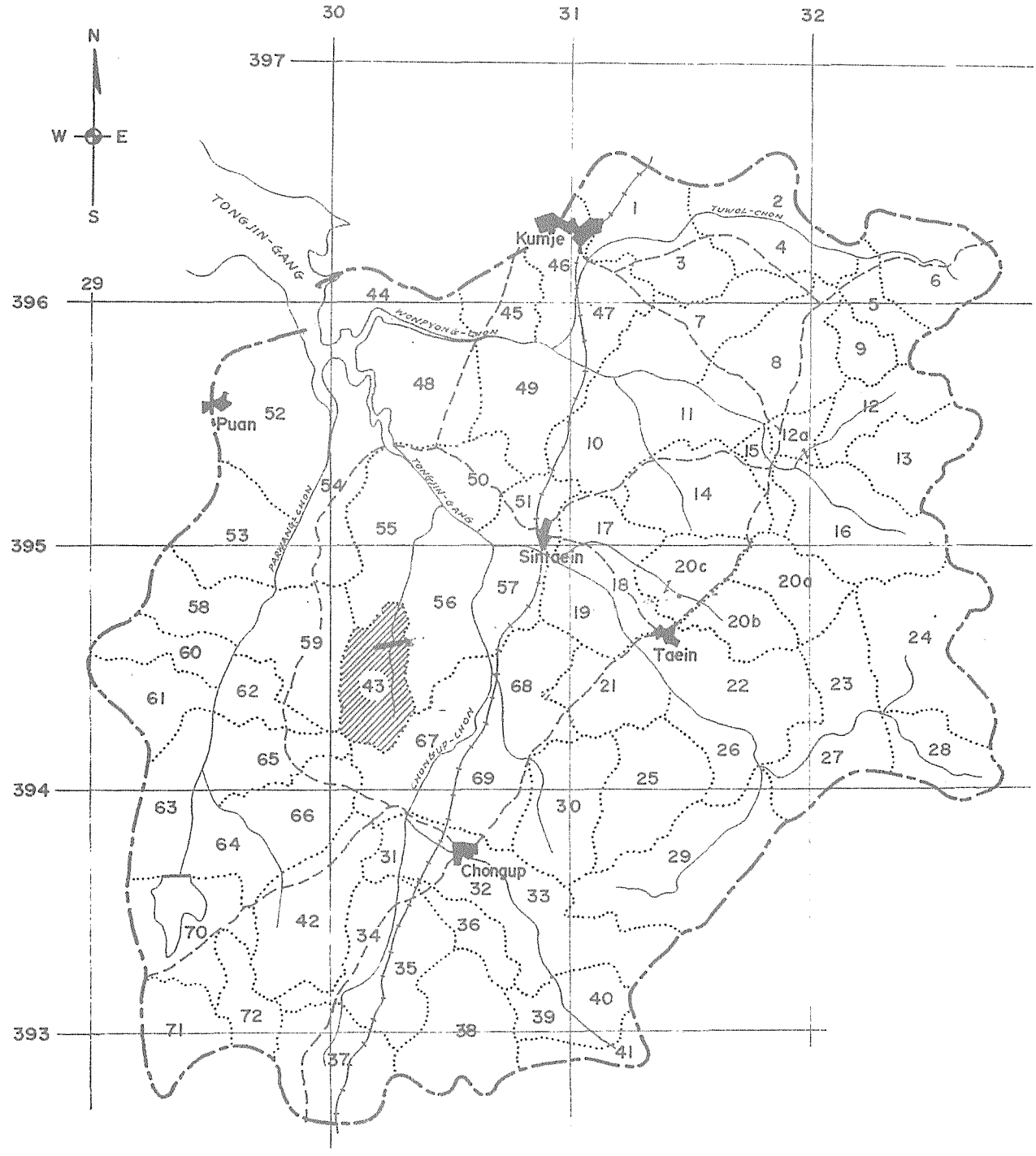

LEGEND

Pilot Demonstration Area----

Other Subwatersheds ------

0 5 10

Distance in Kilometers

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KOREAN UPLANDS PROJECT

LOCATION MAP
OF
TONGJIN-GANG SUBWATERSHEDS

SEOUL KOREA – FEB. 1966

VOLUME II

SOILS AND LAND CLASSIFICATIONS

CHAPTER 1 - INTRODUCTION

1.1 Scope of Report

This report summarizes and updates the 1964 Interim Report on Soil Survey and Land Classification. Essentially it emphasizes results and procedures, with data included being limited to representative examples and summaries which will enhance understanding of the physical problems and limitations of the Project areas as regards soils and land classification.

The soil survey and land classification work initially begun and carried out in the project uplands and later adopted by the Korean Government for application to similar areas, for similar purposes, throughout South Korea, is also included as part of this report.

1.2 Purpose of Studies

The main purpose was to classify the uplands in sufficient details to determine the highest economic use of each classified tract of the entire project area, and to locate and map the lands suitable for conversion to upland crop producing lands.

1.3 Previous Studies

Soil surveys conducted in the past have largely been limited to the rice paddy lands of Korea. Between the years of 1936 and 1945 soil surveys of these areas were carried out by the Japanese. As far as can be ascertained, the classification of soils were made on a series and type level. Complete reports of this work are not available, and those which are have much of their meaning lost in the course of being translated.

In 1961, the Soil Survey Section of the Office of Rural Development carried out a soil survey in the uplands of Taeduk Myon in Chong Chung Nam Province. The technicians engaged in this survey received prior training in soil survey work at Suwon in 1959-1960 under a training program established and administered by U.S. ICA advisory personnel. The report covering this work is very sketchy. It does mention however, that the work was patterned after USDA methods and that soil classification was based on series, types and phases. An area of approximately 34,000 hectares was covered by this survey. For the reasons stated or implied, neither of these previous surveys were of value in the soils and land classification work of the project uplands.

1.4 Standards Used

The standards used for the soil survey were based on the U.S. Department of Agriculture, Soil Conservation Service method, modified to meet local Korean conditions. The land classification scheme in the two watersheds was patterned after the national land capability system used by the U.S. Soil Conservation Service. Hence field and laboratory data obtained during this survey can be used for other interpretive soil groupings.

The Soil Survey Manual, U.S.D.A. Handbook No. 18 was used as the standard text in the Training Program.

Major characteristics of the soil profile and related site features significantly affecting its performance and influencing land use, were recorded by means of fractional code symbols made up of a combination of letters and numbers. These are explained in Table 2. These major soil characteristics were used in conjunction with Tables 13 and 14 as the basis for determining land capability classifications. Table 13 is a guide for placing soils in land capability classes, and Table 14 the guide for placing soils in land capability sub-classes.

Twelve provisional soil series were established for the Project lands. These provisional series were established primarily on differences in degree of profile development and type of underlying parent materials. Several types and phases in each series were also established.

The work described in this report, although incomplete from a strict soils classification standpoint, does represent the first attempt in Korea to provide a functional system of land classification based on an evaluation and interpretation of land and soil characteristics mapped in the Project lands. Soils now placed in respective Land Capability Units may change as more knowledge is gained about the behavior and response of the soils to different uses and treatments than is presently known about them.

1.5 Areas Covered

The area surveyed consisted of all the uplands in the two Study Watersheds of Ansong Chon and Tongjin Gang, comprising a total of approximately 200,000 hectares. Two types of surveys were carried out in each of the Study Watersheds, namely, "detailed" and "detailed reconnaissance". The "detailed" survey was made on the two Pilot Demonstration Areas, comprising a total of approximately 2600 hectares, to provide detail soils information and basic data for specific upland development and watershed management practices, both vegetative and structural, for demonstration work. The "detailed reconnaissance" type survey was carried out on all the remaining lands in these watersheds, primarily as a means for locating land areas potentially suitable for agricultural purposes. All of the surveyed lands were subsequently classified into Land Capability Units.

Total areas surveyed and classified in both study watersheds were determined planimetrically. The total area surveyed, exclusive of rice paddies and stream area lands, in each watershed basin by type of survey is as follows:

A. Detailed Soil Survey

1) Ansong Chon	882.7	Hectares
2) Tongjin Gang	792.4	Hectares

B. Detailed Reconnaissance Soil Survey

1) Ansong Chon	60,406.5	Hectares
2) Tongjin Gang	57,897.7	Hectares

1.6 Procedures

Field work was preceeded by a training program for Korean technicians in various phases of soils survey work. This training is described in section 1.8.

Field surveys conducted in the study watersheds consisted of the examination, classification, and mapping of the soils.

Numerous soil samples were collected in the course of the field work. These samples were analyzed at the soils laboratory of the Office of Rural Development in Suwon under a joint-use agreement between UNKUP and ORD.

An inventory of native plant cover was carried on concurrently with the soil survey. Densities of total vegetation and total woody cover were estimated. The detailed plant inventory is described in Volume III Part B - "Agronomy - Forestry and Pasture Development".

On completion of the field work, the field photo sheets were checked for correct symbolization and matching. All pertinent field data was inked directly on individual field sheets. The various soil mapping units appearing on the sheets were grouped into land capability units in accordance with criteria established for the watershed lands. Detailed soil survey, land capability unit maps, and land ownership maps were subsequently prepared for each of the Pilot Demonstration Areas.

1.7 Personnel and Work

The soil survey and land classification studies described in this report for the period June 1962 through May 1964, were performed under the direction of Soil Scientist Expert, Timothy R. Maestas. This work

included the preparation of "The Preliminary Draft of the Interim Report on Soil Survey and Land Classification, dated June 1964. The Nation Wide Soil Survey work was carried out by the UNKUP soil technicians under the administration of the UNKUP Project Manager. All field, laboratory and office data required for the study and report were prepared in cooperation with Korean counterpart technicians, headed by Kee Seung Park, project co-manager and Vice President of the Union of Land Improvement Associations.

"The Interim Report of Soil Survey and Land Classification - United Nations Korean Uplands Project", contained complete soil survey procedures and technical data for the reconnaissance soil survey of Ansong Chon and Tongjin Gang Study Watershed Areas and for the detailed surveys of the two Pilot Demonstration Areas. The report, which includes detailed tables, tabulations of land classification data, and survey maps of the demonstration areas, was reproduced and distributed to the Food and Agriculture Organization of the United Nations and to the Ministry of Agriculture and Forestry officials of the Republic of Korea. Original data were retained in the files of The Farm Lands Bureau - MAF.

1.8 Training

Field work was preceeded by an intensive training program of two months duration. During this period, local technicians were given classroom instructions and-on-the job training in various phases of soil surveying, photo interpretation, and methods of land classification. The Soil Survey Manual, USDA Handbook No. 18 was used as a standard reference text. Supplemental training material, in the form of seven training memorandums, were also prepared and used by all trainees. Since the on-the-job training was considered an invaluable part of the overall program, it was given special emphasis and was carried on throughout the course of field work. Duplicate copies of the training memorandums were also distributed to Ministry of Agriculture and Forestry Officials and Soil Technicians of Agencies.

1.9 Acknowledgements

Acknowledgements are made to Mr. Kim Young Sup, Director of the Plant Environmental Office of Rural Development, Suwon, and to General Ko Kil Hoon, President of the Korean Union of Land Improvement Association for making available their laboratory facilities to UNKUP for the processing of soil samples.

CHAPTER 2 - GENERAL DESCRIPTION OF THE PROJECT AREA

2.1 Location and Extent

The Ansong Chon and Tongjin Gang Watershed basins are located in Kyonggi and Cholla Pukto Provinces, respectively. These two watershed areas were selected from among several considered, on the basis as outlined in Section II, paragraph A, 3 of the UNKUP Inception Report, and in Volume I, General Report, Chapter 3.

The Ansong Chon basin is located south of the capital city of Seoul and can be reached by automobile from Seoul in 2 hours driving time. The basin encompasses a total area of 98,200 hectares. The northernmost point of the basin lies east of the important university and agricultural city of Suwon. From here, the northern boundary trends south-eastward along the Kwang-ju mountain range as far as Toksong-ni, a village located northeast of the town of Ansong. In the vicinity of Toksong-ni, the Kwang-ju range merges with the higher and more rugged Charyang mountains. This latter mountain divide forms the eastern and southern boundaries of the watershed basin. The western boundary is formed by a ridge of low-lying hills that form the drainage divide between the Osan and Hwang-gu-je streams.

Pyongtaek, gun headquarters (county seat), is the largest city in this area with an estimated population of 30,000 inhabitants. Aside from its political importance, it is also an important transportation and agricultural center.

The Tongjin Gang basin, located near the southwestern coast of Korea, has a total area of 104,380 hectares. Of this total area, approximately 45,000 hectares are in rice paddies. Its eastern and southern boundaries are formed by the Yarong mountain divide that rises to over 600 meters in elevation in many places. The northern and western boundaries consist of a combination of well defined hills and rolling uplands that seldom exceed 100 meters in elevation. The county seat for the area is Chong-up. It is the largest and most populated city in the basin (250,000).

Figure 1 shows the location of the study watershed basins in relation to Provinces and major cities of Korea.

2.2 Division or Units of the Project

In order to facilitate the collection of field data, the study watershed basins were subdivided into subwatershed areas. Seventy-seven were delineated in the Ansong Chon and seventy-two in the Tongjin Gang. The subwatersheds are in themselves separate entities, each being delineated on the basis of hydrological boundaries. Thus, they represent small tributary drainage basins. In the Ansong Chon basin, the size of these units vary from 375 to 3890 hectares and in the Tongjin Gang basin from 285 to 3255 hectares.

One subwatershed was selected in each study watershed to serve as a pilot demonstration area. These were established to demonstrate the kind of land use conversions that are feasible from the standpoint of adequate soil and water conservation, prevention of erosion, and the economic feasibility of dry land farming on various degrees of land slope.

Figures 2 and 3 show the subdivision of each study watershed basin by subwatershed units and designates the pilot demonstration areas, which are subwatershed No. 35 in Ansong Chon and No. 43 in Tongjin Gang.

2.3 Physiography of the Study Watersheds

The physical land features of both study watersheds are quite similar. Descriptions that apply to one also apply to the other, unless otherwise stated.

Like most of the Korean peninsula, the terrain of the watershed basins is hilly to mountainous with numerous connecting valleys formed by main and tributary streams.

Physiographically, the basins consist of two major land forms, the alluvial bottomlands and the uplands. In the Ansong Chon, the upland areas make up approximately 63% of the total land area; in the Tongjin Gang 56% of the basin consists of uplands.

The bottom alluvial lands vary from vast broad valleys to narrow terraced valleys that often extend almost to the top of the drainage divides. In contrast to the alluvial lands, the upland areas are characterized by having wide variations in relief, from gently undulating to very steep. The gently undulating to gently sloping lands are generally located along the hill footslopes and represent a zone of transition between the bottom alluvial lands and steeper uplands. Beyond this zone, the relief often becomes hilly to very steep.

The chain of low hills that extend from the main and secondary drainage divides are usually less than 100 meters high. Most of the potential conversion land is located on these low ridges. The hills are characterized by having short, broken, and complex slopes and are denuded of much of their native vegetation. The scanty vegetation consists primarily of scrubby pine

(Pinus densiflora and Pinus rigida), black locust, occasional alder, bushy type oak, and scattered clumps of summer active annual and perennial grasses.

The complex nature of slopes above 10% precludes the use of cultural practices normally used on similar uniform slope gradients. Thus the majority of the lands on slopes greater than 10% will require bench type terraces before these lands can be intensively used for agriculture and for maximum conservation of soil and water.

Most of the lands in the study basins have suffered erosion damage of one degree or another. Steep slopes, coarse soils, inadequate vegetative cover, and detrimental farming practices, have singly or in combination contributed to the severe erosion problem found on the watershed lands. Erosion damage to the lands has been mainly of the sheet erosion type although large areas of gullied lands also occur.

The impact of high intensity summer rains on unprotected soils on sloping lands results in dislodgment of the surface soil material and its subsequent downslope removal by surface runoff. This type of sheet erosion is common in the watershed lands. Removal of the surface material has resulted in the formation of "stools" around tree crowns and other clumps of vegetation.

Lack of vegetative cover is the chief factor responsible for the severe erosion found on the project lands. Traditional use of the uplands as a source of fuel and compost material -- with no policy of protection or replacement has resulted in denudation of the uplands. The enactment of the law forbidding the cutting of trees has had very little effect on improving the upland soils. Farmers, of necessity, still continue to 'glean' the uplands ground surface of all organic litter.

Erosion damage is not confined to the virgin uplands. Presently cultivated upland areas have also been affected but to a lesser degree. Detrimental cultural practices such as downslope cultivation and disregard for close growing cover crops to protect the land during the summer rains has ruined many a hectare of land. In the vicinity of Taen of the Tongjin Gang basin, large tracts of once productive lands have now been reduced to a level where they are now practically worthless.

The Erosion Control Section under the Bureau of Forestry has engaged in controlling erosion damage to existing eroded scarred lands. The method employed consists of building a series of narrow benches (or V-trenches) on the contour with two to three meter spacings between the benches. The benches are in turn seeded and/or sodded while the area between the benches is sometimes grass pitted or planted to pitch pine. Commonly, though, the areas between the benches are left bare.

This method of erosion control has not met with the measure of success hoped for due in part to poorly constructed benches, lack of/or

inadequate drainage outlets, and the lack or regard for adequate vegetative cover in the areas between the benches. More elaborate and costly methods of erosion control have been used in the past - check dams built of concrete and masonry in gullied areas - but these have given way to the less expensive method described above.

2.4 Geology and Soil Derivation

The principal rocks underlying the soils of the Ansong Chon and Tongjin Gang Study Watersheds are gneisses and granites. Schist and porphyry occur in much lesser amounts and, collectively, occupy less than 10% of the overall area. Figures 4 and 5 show the distribution area and extent of the different rock types for each watershed basin.

Schists, equivalents of metamorphosed sediments, are considered the oldest rocks in Korea and are of Archaeozic age. In the Ansong basin - the schist occurs as a small wedge type body in the northeastern part of the watershed. Its mineral composition is mostly biotite which is commonly golden in color. Occasional seams of white quartzite are found associated with it.

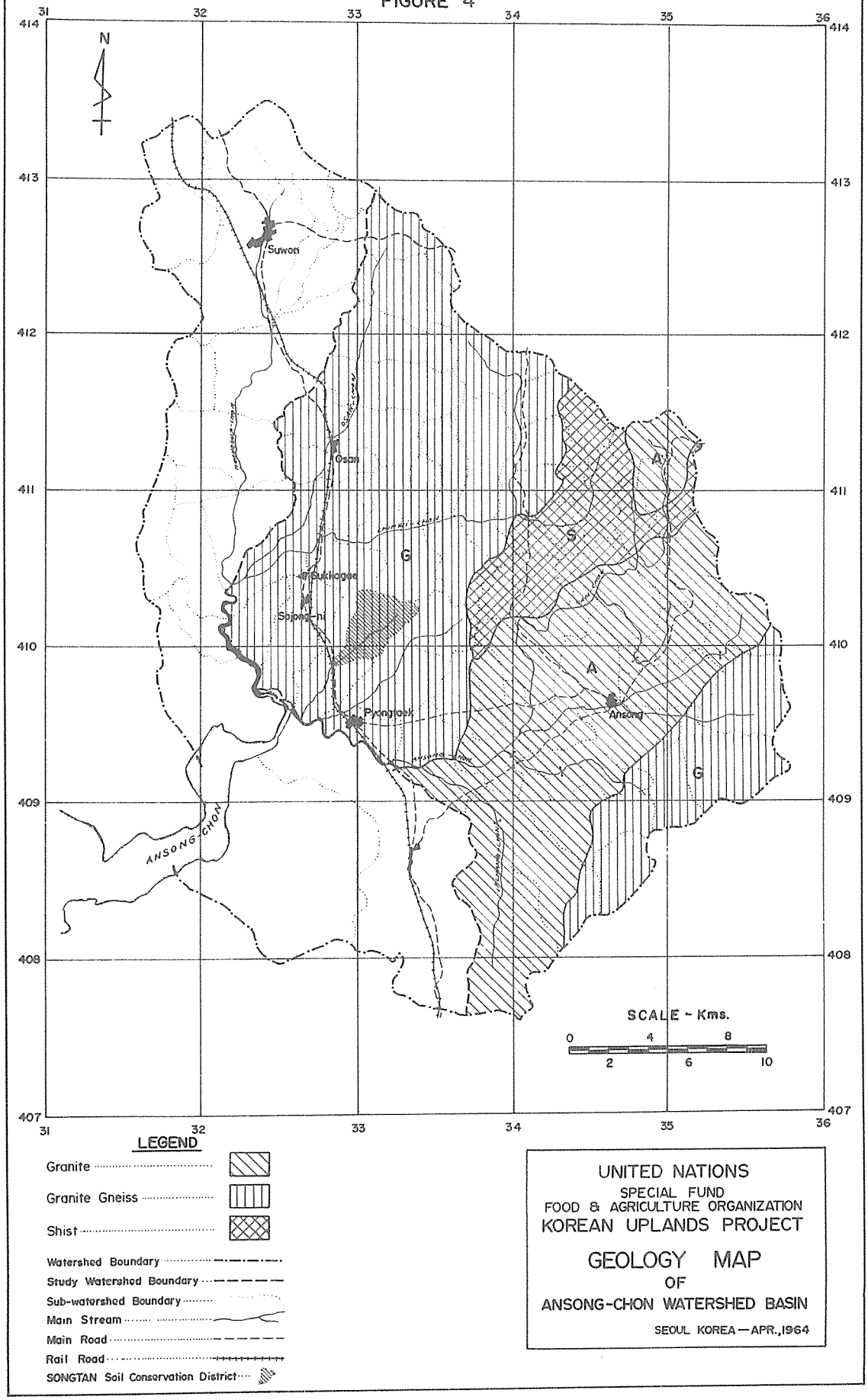
Gneiss, mostly granitic and also of archaeozic age, is again found only in the Ansong Chon watershed and occupies about one half of the total basin area. It is generally referred to as gray gneiss or gray granite gneiss due to its resemblance to granite and also because of the color of its predominant constituents. Mineralogically, it is composed of gray feldspars, quartz, and biotite. In places, the biotite is grouped and aligned in parallel streaks that alternate with streaks of the felsic materials giving the rock a banded structure. Seams of quartzite are commonly found associated with it.

Granite, of mesozoic age, and commonly called "young granite" to distinguish it from the older pre-cambrian granite of Korea, underlies about one-half of the area in the Ansong Chon and nearly two thirds of the area of the Tongjin Gang. It is composed chiefly of pink and gray-white feldspars, quartz, and biotite.

Schistose granite is found only in the Tongjin Gang basin and underlies approximately one third of the watershed area. In composition and texture, it resembles the granite occurring in both areas but in structure is similar to the granite gneiss of the Ansong Chon. The age of the formation is doubtful but is generally thought to be of Mesozoic age. Due to similarities in age, structure, and composition, it has been grouped with the granite system in both areas. The distinguishing feature, and one that makes separation between it and the large body of granite that lies contiguous to it, is the pronounced schistose structure which includes the grouping and alternation of the biotite and felsic minerals into bands and/or streaks.

Porphyry and associated porphyrite is found in the steep Noryang mountain range that forms the southern boundary of the Tongjin Gang basin.

FIGURE 4



LEGEND

- Granite
- Granite Gneiss
- Shist
- Watershed Boundary
- Study Watershed Boundary
- Sub-watershed Boundary
- Main Stream
- Main Road
- Rail Road
- SONGTAN Soil Conservation District

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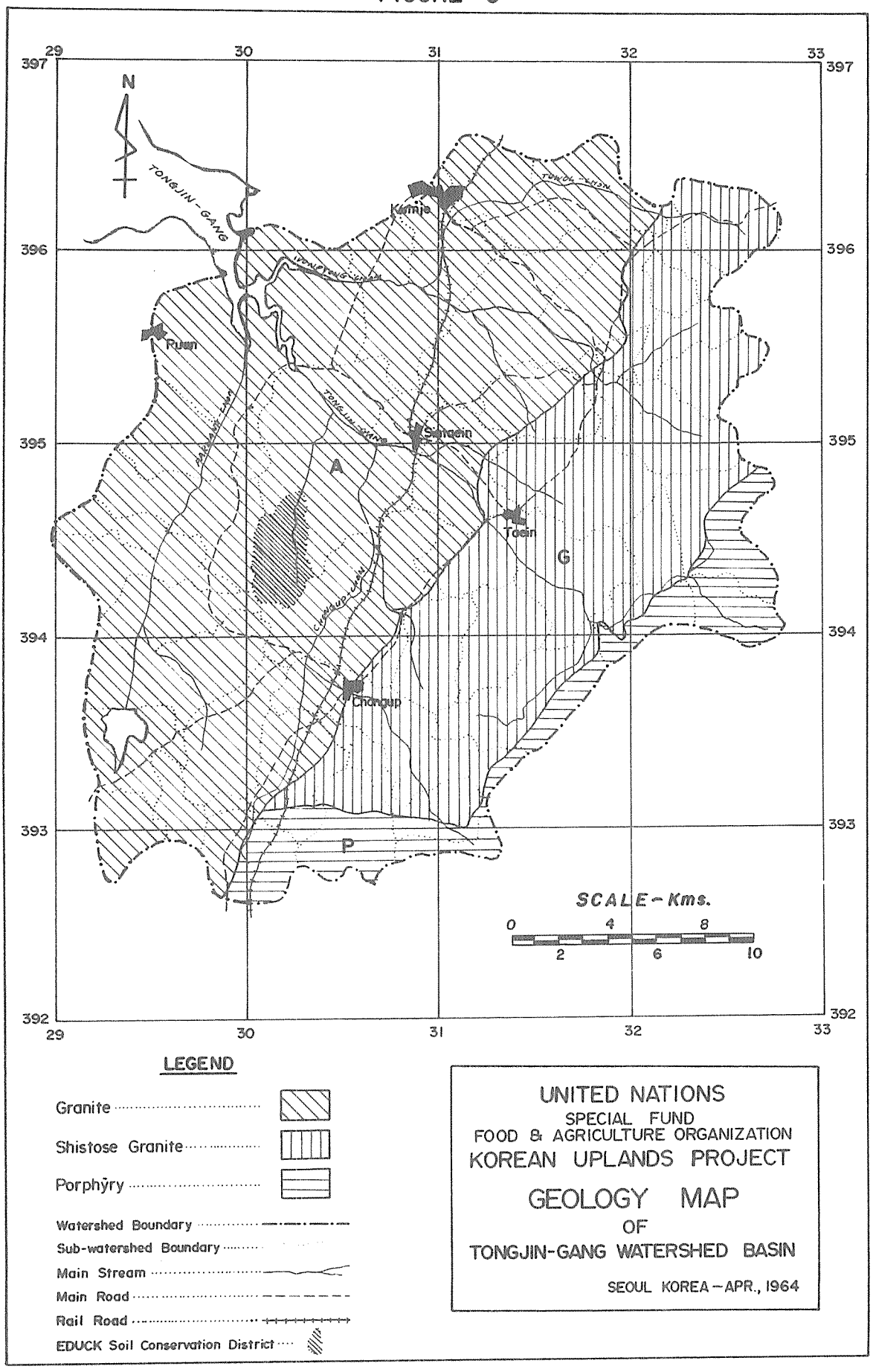
GEOLOGY MAP
OF
ANSONG-CHON WATERSHED BASIN

SEOUL KOREA — APR., 1964

FIGURE 5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Songcain
Toein
Chongup
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LEGEND
Granite
Shistose Granite
Porphyry
Watershed Boundary
Sub-watershed Boundary
Main Stream
Main Road
Rail Road
EDUCK Soil Conservation District
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KOREAN UPLANDS PROJECT
GEOLOGY MAP
OF
TONGJIN-GANG WATERSHED BASIN
SEOUL KOREA - APR., 1964

Minor amounts of other sedimentary rock types belonging to the Silla Series are included with this group. The latter are scattered in small areas and are so inter-mixed with the porphyry that separation was not attempted. Basically, the porphyrys are dense, fine textured rocks, and are fairly resistant to weathering. Mineral composition and color of the rocks varies widely. The age of the formation is Mesozoic.

With exception of the porphyrys, the schists, gneisses, and granites weather easily, resulting in the development of a mantle of decomposed rock that exceeds 8 meters in many places. Soils derived from these geological materials are generally medium-fine to course textured. The porphyrys on the other hand, are fairly resistant to weathering. Consequently, thickness of the weathered mantle seldom exceeds one meter above the hard rock. Shallow, dark colored, medium textured soils are formed from this material.

2.5 Climate and Its Relation to Soil Formation & Agriculture

The data presented in Table 1 summarizes the climatic conditions in both study watersheds. The values are applicable to areas below 200 meters in both areas since long-term rainfall records for stations above 200 meters are non-existant.

Examination of the data in Table 1 shows that the general climatic conditions of both study watersheds are quite similar. The climate is humid with warm summers and moderately cold winters.

Normal annual rainfall and monthly distribution of precipitation is similar for both watersheds. Sixty-five to seventy percent of the annual precipitation falls between the months of June and September, thus making definite dry and wet seasons. Winter - December through February - are dry with less than ten percent of the annual precipitation during these months.

Annual minimum and maximum temperatures occur in January and August, respectively. Annual maximum temperatures in late July or early August seldom exceed 35°C following the peak of the rainy season.

The first frost generally occurs during late October to mid November. Average length of the frost free season, that is, between the first and last killing frost, is 190 days in the Ansong Chon and 220 days in the Tongjin Gang.

Relative humidity averages seventy percent during the year and commonly exceeds 80% during July and August. Winds are generally light and from the Southwest during the summer. Wind velocities seldom exceed 20 meters per second except during summer typhoons.

Moisture supply is often critical during the early part of the growing season - April through early June. During an average year, evaporation potential exceeds rainfall during this period. Maximum moisture deficit occurs in May and averages about 70 millimeters.

TABLE 1

AVERAGE CLIMATIC CONDITIONS*
OF
ANSONG CHON AND TONGJIN GANG BASINS

MONTH	NORMAL MONTHLY PRECIPITATION IN m.m.		NORMAL MONTHLY TEMPERATURES IN °C.	
	ANSONG CHON	TONGJIN GANG	ANSONG CHON	TONGJIN GANG
January	17	26	-5	-1
February	22	28	-1	0
March	58	58	+3	+5
April	72	75	11	12
May	85	82	17	17
June	167	168	22	22
July	365	272	25	25
August	220	234	26	27
September	144	156	20	21
October	49	51	13	14
November	38	42	6	8
December	33	34	-1	+1
ANNUAL	1270	1226	11.5	12.5
Max.	1370 (Suwon-1940) (July)	936 (Iri - 1940) (July)	Mean Max. (July) 29	31
Min.	15 (Suwon-1959) (June)	33 (Iri - 1939) (June)	Mean Min. (Jan.) -10	-5
Min. (ANNUAL)	620 (Suwon-1949)	535 (Iri - 1939)	Growing Season (days) 190	220

*Values presented are estimates of average conditions for each drainage basin, based on data from the Central Meteorological Office, Republic of Korea, Central Meteorological Observatory in Japan, and United States Air Force, Korea; as compiled and analyzed by W. D. McMillan, UNKUP Hydrologist.

Due to the fact that moisture supply is often critical during the spring and early summer months, a study was undertaken by the Project Hydrologist to establish a tentative relationship between magnitude and frequency of droughts for these periods in the two study watersheds. Thirty-two year records of rainfall and evaporation data from three stations proximate to the study watersheds were used in his analysis. The results of his study indicate that crop failure could be expected in one out of four or five years on soils having an available water holding capacity of 100 m.m. Frequency of crop failure for soils having available water holding capacities greater than 100 m.m. would necessarily be lower than for those having A.W.C's less than 100 m.m. Factors, other than those used in the analysis, must be considered when applying the results of this study to the capability classification of the non-irrigated uplands of the study watersheds.

Although minor variations in climate between both watershed areas has left no recognizable imprints on soils or in agriculture, the broader conditions of climate are reflected in both. The warm, humid, and high rainfall summers have promoted the development of soils which in general belong to the Red-Yellow-Podzolic great soil group. The soils are acid in reaction, deficient in available plant nutrients, and have low organic matter contents in both the topsoil and subsoil.

The growing season coincides with the rainy season in Korea. Irrigation of the uplands is generally not practiced. Summer precipitation and distribution of precipitation is usually sufficient - except during drought years - to meet the minimum moisture requirements of most upland crops. Bottom alluvial lands, on the other hand, located downstream of existing reservoirs, are the only lands which receive supplemental irrigation water. These latter areas are, for the most part, cropped to rice. Some bottom alluvial lands in the Ansong Chon are irrigated by pump irrigation from wells.

CHAPTER 3 - SOIL SURVEY AND SOIL CLASSIFICATION

3.1 Standard Used and Basis for Same

A soil-vegetation survey and land capability classification was made of the study watershed lands following national standards and procedures established and currently employed by the Soil Conservation Service, U.S.D.A., and the Pacific Southwest Forest and Range Experiment Station of the U.S. Forest Service. Both were modified to fit local Korean conditions. The Soil Survey Manual, U.S.D.A. Agricultural Handbook No. 18, was also used in conjunction with the above as a standard work of reference.

The use of standards and references cited above were in accordance with the provisions of the UNKUP Inception Report, Chapter II, paragraph B, subparagraph 1.

3.2 Survey Methods and Procedures

The soil surveys conducted on the study watershed lands consisted of the examination, classification, and mapping of soils in the field. Auger borings were made in numerous locations and exposed road cuts and stream banks were studied. At each location, the soil profile was examined to the depth of the parent material. Careful observations were made and noted of the color, structure, consistance, texture, roots, gravels, stones, depth to and kind of parent material, and thickness of the soil horizons. Other site features of the surrounding land, such as, slope, native vegetation, present land use, and degree of erosion, were also noted.

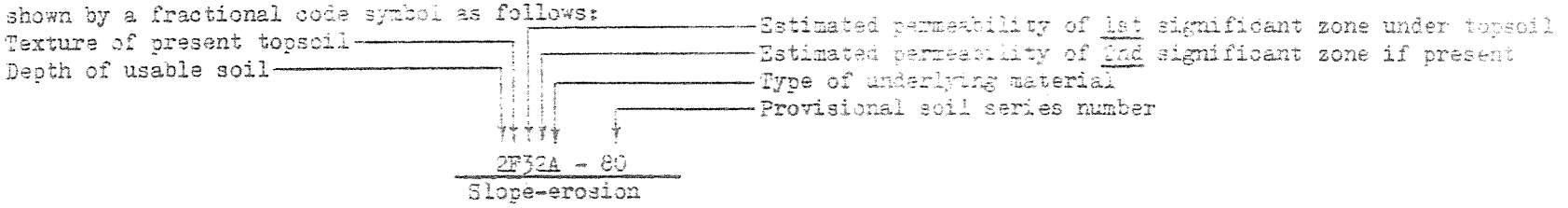
The major characteristics of the soil profile and related site features significantly affecting its performance and influencing land use and management, were recorded directly on the field photo maps by means of a fractional code symbol made up of a combination of letters and numbers. Characteristics considered significant were: (1) effective soil depth (2) texture of the present topsoil (3) permeability of the soil material determining effective soil depth (4) slope and (5) degree of present erosion. Standard code symbols for the above soil characteristics, their range in conditions, and placement in the fractional symbol are shown in Table 2.

TABLE 2

STANDARD SYMBOLS OF MAJOR SOIL CHARACTERISTICS

Effective soil depth	Texture of Topsoil	Texture Modifiers	Subsoil Permeability (cms./hour)	Type of Underlying Mat'l	Class & Degree of Slope	Erosion	Provisional Series No's.
1-Deep (>122 cms.)	H-Fine (very heavy)	g-gravelly	1 - V. Slow (<0.125)	A - Granite	A-Nearly level (0-2%)	1-None to slight	60 Series - Weakly developed profiles
2-Mod. deep (91-122 cms.)	F-Fine (light)	c-cobbly	2 - Slow (0.125-0.50)	E - Shale	B-Gently Sloping (2-9%)	2-Mod. severe	
3-Mod. Shallow (61-91 cms.)	M-Medium	vg-V. gravelly	3 - Mod. slow (0.50 - 2.0)	F - Sandstone	C1-Moderately Sloping (9-16%)	3-Severe	70 Series - Moderately developed profiles
4-Shallow (25-61 cms.)	L-Coarse (light)	vc-V. cobbly	4 - Moderate (2.0 - 6.25)	G - Gneiss	C2-Strongly Sloping (16-27%)	4-Very Severe	80 Series - Strongly developed profiles
5-V. Shallow (< 25 cms.)	C-V.Coarse (very light)	S-Stony	5 - Mod. rapid (6.25-12.5)	H - Slate	D1-Moderately Steep (27-45%)	GL-Gully land	
		R-Rocky	6 - Rapid (12.5-25.0)	P - Porphry	D2-Steep (45-58%)	EPM-Exposed Parent Material	
			7 - V. Rapid (>25.0)	Q - Quartzite	E-Very Steep (plus 58%)		
				S - Schist			

For easy and early direct use of the survey data on soil maps, the major soil characteristics for individual soil mapping units are shown by a fractional code symbol as follows:



3.3 Laboratory Testing of Samples

Many of the profiles examined were sampled, and the soil samples sent to the laboratory for physical and chemical analysis. The samples were analyzed for:

1) Texture (hydrometer method)

2) pH (glass-electrode method using 1:1 soil water ratios)

3) Available phosphorous - P_2O_5 in ppm (Landcaster's modified extraction method)

4) Available potassium - K_2O in ppm (Extraction by normal ammonium acetate)

5) Exchangeable acidity (Okuhara method involving the titration of leachate with normal KCL)

6) Humus in % (Oxidation of Organic Matter with Chromic Acid)

7) Cation Exchange Capacity (Nesselerization of absorbed ammonia after extraction with sodium chloride)

8) Exchangeable cations including potassium, sodium, calcium, and magnesium extracted by normal ammonium acetate (Complexometric titration and flame spectrophotometric methods)

The test methods employed were those in use by the laboratory at the time the samples were analyzed. More detailed information on the analytical methods adopted including bibliographical references, can be obtained by interested persons through the laboratory at Suwon.

Moisture retention studies and bulk density determinations were made on a number of selected samples. The results of these tests, however, fell considerably outside the range of values normal for individual soil classes, and therefore are not included in this report. Difficulties with pressure regulation, air leaks, and errors in core sampling contributed to making the data unreliable.

A summary of data based on average values for soils by textural class, type of underlying parent material and depth of sampling of the analysis of 2456 soil samples collected in the study watersheds and the analytical data for all soil samples collected from the Pilot Demonstration Areas are presented in the Soil Survey and Land Classification Interim Report of June, 1964.

Table 3 is presented to show one representative page of the analytical data for all soil samples collected in the Pilot Demonstration Areas.

Several discrepancies in the analytical data have been recognized. These discrepancies can be attributed partly to errors in sampling, laboratory technique, contaminated chemicals, and calculation of data, to name but a few. Because of the mass of samples involved, no attempt was made to reconcile them.

TABLE 3

Representative Page

Average Values of Analytical Data for Soils Derived from Granite

Ansong Chon Watershed (0-25 cms. soil depth)

(Complete tables are presented in Interim Technical Report)

SOIL TEXTURE	Number of Samples	Parent Material: GRANITE Soil Depth: 0-25 cms.								
		pH	Avail. P205 ppm	Avail. K ppm	Exch. Acidity m.e./100g	Humus %	Exch. K m.e./100g	Exch. Na m.e./100g	Exch. Ca m.e./100g	Exch. Mg m.e./100g
Sand	None	-	-	-	-	-	-	-	-	-
Loamy Sand	4	5.1	35.65	84.8	0.53	1.13	0.40	0.30	2.95	1.80
Sandy Loam	105	5.3	16.86	67.7	1.09	0.98	0.29	0.40	3.64	2.13
Loam	76	5.3	7.15	64.8	1.68	1.23	0.27	0.38	2.88	2.20
Silt Loam	None	-	-	-	-	-	-	-	-	-
Sandy Clay Loam	38	5.1	10.63	55.4	2.10	0.91	0.26	0.36	2.29	1.84
Clay Loam	65	5.4	6.82	57.4	1.86	1.15	1.01	0.52	2.54	2.06
Silty Clay Loam	17	5.4	6.44	60.3	1.92	1.65	0.28	0.48	2.61	2.02
Sandy Clay	None	-	-	-	-	-	-	-	-	-
Silty Clay	4	5.7	0.92	49.7	2.93	0.73	0.16	0.39	2.55	1.78
Clay	4	5.2	4.75	58.6	1.42	0.82	0.25	0.41	3.27	2.75

3.4 Land Use

The kind of use being made of the land or the nature of the vegetal cover, in the case of non-cultivated land, was denoted on the aerial survey sheets during the course of the field surveys. On the basis of early reconnaissance of the project areas, broad land use categories were initially established. As the soil survey of the areas progressed, these categories were refined and others added to give a fairly comprehensive picture of the land use conditions then existing in the project lands.

Tables 4 and 5 show the area in hectares surveyed in each sub-watershed of the Ansong Chon and Tongjin Gang study watersheds. The data is also arranged to show the area in hectares by land use categories in each subwatershed. A more detailed differentiation of these land use categories was not deemed necessary nor practical. The total area of potential conversion land in each watershed is given in the last vertical column. These include lands in land capability classes II, III, IV, and VIsu.

Tables 6 and 7 are a summary of the land capability units in the Ansong Chon and Tongjin Gang Study Watershed Basins. The data is arranged to show the hectares of present land use and potential conversion land of these areas. Tables 8 and 9 are a similar summary of the two Pilot Demonstration Areas: subwatershed No. 35 in Ansong Chon and subwatershed No. 43 in Tongjin Gang.

3.5 Classification of Mapping Units into Series, Types, and Phases

On the basis of their characteristics, the soils were provisionally classified into series, types, and phases. The series includes soils having the same genetic horizons, similar in their characteristics and arrangement in the soil profile, and developed from a particular type of parent material. On the project soil maps, the series (provisional) is shown by a number following the parent material symbol and separated from it by a dash.

The type is a sub-division of the series and is defined according to the texture of the upper part of the soil. It is the principal unit in mapping and because of its specific character is usually the soil unit to which agronomic data are definitely related.

A phase, on the other hand, is a variation within the soil type and differs from it in minor soil characteristics that may have practical significance in making land use decisions. Differences in slope, depth of soil, stoniness, relief, and erosion are commonly used to show phases.

Twelve provisional series were established in the study watersheds. These were established primarily on differences in degree of profile development and on type of underlying parent material. Several types and phases within each series were also established.

On completion of the field work, the field sheets were checked for complete symbolization, matching, and for closure of all soil delineations.

All penciled survey data was then inked directly onto the field survey photo sheets. The individual field sheets were subsequently planimetered by subwatershed areas and total area surveyed was then determined.

Detailed Soil Survey Maps for both Pilot Demonstration Areas are shown on Plates I and II. These detailed maps were prepared from data collected and mapped in the field, and show the location and distribution of soil types and phases in relation to existing cultural and natural features of the landscape. The detailed information from these maps was used as a basis for preparing the Land Capability Maps also included with this report.

Table 4

SUMMARY OF
PRESENT LAND USE AND POTENTIAL CONVERSION LAND
AREAS FOR TONGJIN GANG BASIN BY SUBWATERSHEDS.

S.W. No.	Present Land Use - 1963							Total	PCL [9]
	L[2]	O[3]	W[4]	X[5]	H[6]	Cem.[7]	Forest[8]	Ha.	Ha.
1	216.1	11.3	254.0		50.1	11.7	5.7	548.9	233.0
2	68.6	1.4	263.3		50.5	1.9	6.9	392.6	238.1
3	167.3	8.0	194.1		36.4	9.3	50.7	471.8	79.6
4	219.3		145.7		35.7	2.4	31.2	434.3	100.3
5	16.4		42.1	37.9	8.5	0.4	427.9	533.2	36.5
6	45.2	12.0	32.7	2.4	26.6	2.0	892.4	1013.3	16.2
7	295.5	0.9	204.1	0.5	53.5	5.7	41.6	601.8	102.9
8	188.5	2.6	162.2		35.8	21.4	340.1	750.6	104.1
9	11.0		57.4	3.4	11.8		370.5	454.1	54.5
10	323.2	1.9	339.5	4.2	50.9	9.1	17.0	745.8	238.5
11	232.3		126.2	0.8	52.9	29.4		440.6	124.3
12	69.7		74.5	10.8	29.2	3.3	1012.7	1200.2	74.5
13	38.9	1.2	22.6	12.1	27.4		1355.9	1458.1	27.9
14	377.3	5.5	472.4	11.6	65.4	12.1	363.7	1308.0	443.9
15	51.7		19.1		15.7	8.6	203.7	298.8	7.0
16	69.9		30.3	28.5	21.0	1.4	1861.0	2008.1	49.9
17	131.4	3.3	109.6	13.0	19.3	6.5	41.2	324.3	118.1
18	57.0	2.0	21.7	2.6	33.8	6.8	73.8	197.7	23.4
19	160.3	2.6	36.1		28.5		102.0	329.5	45.5
20	148.7	1.2	178.8	44.0	52.6	12.8	1777.2	2215.3	92.2
21	230.6	4.1	324.8	10.7	42.5	7.7	50.8	671.2	219.8
22	178.6	5.4	112.8	4.6	53.5	7.8	801.4	1164.1	37.1
23	53.1	0.7	26.0	1.9	19.2	1.6	837.9	940.4	7.1
24	194.5	1.0	20.9	12.7	12.2		2202.3	2443.6	17.3
25	213.8		169.9	3.9	39.8	2.3	1049.6	1479.3	92.4
26	29.4		34.6	0.5	2.8	1.3	241.7	310.3	16.3
27	50.0	5.0	110.7	.	39.0	1.8	889.7	1096.2	110.7
28	228.4	1.8	6.3	448.9	18.3	34.0	913.3	1651.0	56.7
29	87.0		2.5	5.3	12.6		2242.0	2356.4	23.0
30	162.2	4.5	228.7	42.7	34.1		732.9	1205.1	135.0
31	30.1		44.5	6.8	15.1		132.5	229.0	36.4
32	17.1	2.0	16.7	22.4	21.9	6.0	619.3	712.4	3.8
33	74.2	1.6	29.7	43.9	29.9	3.9	1213.1	1396.3	31.4
34	60.6	0.6	89.0	14.6	32.9	3.8	411.1	612.6	93.9
35	195.9	12.3	133.6	4.8	32.0	6.1	571.9	956.6	111.5
36	15.9		87.9	23.1	8.1	3.2	801.4	939.6	89.5
37	186.2		97.9	9.3	48.8		1088.9	1431.1	241.6
38	24.5	1.7	61.4	26.0	8.0	3.8	1569.2	1694.6	76.2
39	24.6		20.2	17.4	5.6		757.9	825.7	47.1
40	13.0		18.8	10.9	4.7		473.2	520.6	18.8
41	20.5				6.4		1202.9	1229.8	
42	280.7		547.2	25.1	91.0	7.1	524.0	1475.1	524.9
43*	191.01		210.03		31.79	5.53	354.06	792.42	201.64
44	118.6	0.5	27.4	0.8	72.5	10.8	5.4	236.0	26.3
45	122.0	0.3	122.8		35.7	18.2		299.0	107.1
46	144.0	3.4	74.9		46.6	15.0		283.9	74.9
47	154.1		78.6		43.5	4.4	70.3	350.9	57.5
48	46.4		0.2		37.1	8.2		91.9	0.2
49	165.7		135.3	1.7	33.1	12.0	13.1	360.9	90.3
50	188.7		96.7	0.6	34.0	18.2		338.2	85.6
51	148.0	5.8	67.7	6.0	61.3	10.2	2.7	301.7	59.3
52	239.8	0.9	64.4	1.5	108.7	24.7	52.5	492.5	66.5
53	151.0	2.0	254.1	3.6	48.9	11.6	34.2	505.4	230.5
54	284.2	1.7	274.8	0.5	69.4	26.0	3.7	660.3	274.8
55	182.8		190.7	3.6	38.0	14.7	12.5	442.3	190.7
56	311.5	1.0	204.2	20.9	72.3	23.3	74.3	707.5	189.1
57	44.1		35.4	1.9	17.2	5.4	4.7	108.7	33.8
58	213.1	1.6	298.8	11.3	61.0	9.4	99.2	694.4	289.4
59	192.6	0.6	189.2	53.5	45.8	3.9	357.6	849.2	197.2
60	86.1		127.4	0.7	24.0	1.7	151.6	392.1	131.2
61	308.7	0.4	436.1	1.9	67.9	3.0	94.5	914.5	437.8
62	152.4	6.0	103.1	17.6	45.8	10.7	129.4	465.0	106.5
63	195.8		381.4	10.3	57.7	5.3	2.1	652.6	330.0
64	180.7		312.0	9.1	40.4	2.6	59.9	604.7	253.6
65	184.9	0.8	211.8	6.3	52.8	8.7	126.2	591.5	210.8
66	261.9	0.0	682.0	11.0	58.0	3.6	224.9	1240.0	620.9
67	133.8		122.5	16.6	55.2	10.5	479.6	855.2	154.8
68	244.9	13.0	401.4	25.9	51.4	5.6	106.0	848.2	243.0
69	175.4	17.7	235.2	34.5	42.4	11.7	277.3	797.2	172.6
70	305.3	0.2	673.2	3.5	70.7	12.0	43.9	1108.8	654.8
71	221.0		367.2	2.8	50.0	1.4	274.2	916.6	386.1
72	69.5	1.2	157.9	6.8	36.9		440.2	712.5	204.7
Total	10673.21	164.30	11514.93	1167.20	2804.69	533.53	31802.26	58690.12	10282.54

1 - Sub-watershed number
2 - Land presently cultivated
3 - Deciduous orchards
4 - Woodland - grass
5 - Undifferentiated
6 - Area occupied by villages
7 - Area occupied by mass graves
8 - Scrub type forest vegetation
9 - Potential Conversion Land
* - Detailed data from Pilot Area

Table 2

SUMMARY OF
PRESENT LAND USE AND POTENTIAL CONVERSION LAND
AREAS FOR AMONG CHOM BASIN BY SUBWATERSHEDS

S.W.[1]	Present Land Use - 1963							Total	PCL[9]
No.	L[2]	O.[3]	U[4]	X[5]	H[6]	Cem.[7]	Forest[8]	Ha.	Ha.
1	52.6		170.2		12.0	3.1	640.3	878.2	238.4
2	129.3		51.0	2.7	24.7	0.5	1118.8	1327.0	117.2
3	2.1		8.7		1.9	1.0	228.6	242.3	13.9
4	117.9		58.1		19.9	1.2	1294.9	1492.0	234.5
5	20.8		35.4	29.7	10.1	0.9	310.3	407.2	87.3
6	153.5		102.9		15.7	3.7	962.8	1238.6	230.2
7	160.5		28.6	20.0	18.1	1.3	1526.3	1754.8	58.0
8	61.3	0.3	118.6		10.0		131.0	321.2	122.4
9	161.9		142.0	1.5	20.8	4.9	1024.7	1356.8	312.5
10	131.1	3.6	186.3	2.9	26.7	2.7	233.2	596.5	138.5
11	98.3	1.4	137.1	12.9	28.7	10.2	557.3	848.9	205.8
12	60.7	2.4	120.1	82.5	14.3		608.8	908.8	296.9
13	144.0		140.7	2.0	25.1	4.7	1434.5	1751.0	252.4
14	15.2		13.5	1.9	5.0	2.0	400.3	437.9	34.1
15	116.0		54.6		24.7	0.7	1294.7	1499.7	72.5
16	103.8		45.2		13.3	0.9	597.3	762.5	80.1
17	78.5	2.0	85.2	0.5	21.0	10.7	208.4	406.3	111.3
18	68.0	52.9	50.0		21.0	7.6	107.5	307.0	49.3
19	62.2		40.1	0.4	22.6	13.6	92.5	231.4	71.6
20	143.0	31.3	156.1	0.6	31.5	12.3	164.6	549.4	142.5
21	50.5		71.2	0.2	22.0	3.5	622.2	781.6	80.2
22	30.1	1.5	168.0	50.8	14.1	0.2	301.6	566.9	231.3
23	36.8		92.1	3.2	10.7	1.8	730.7	842.3	109.3
24	44.7		37.5		4.7	5.4	1.5	93.8	12.0
25	90.7	3.5	68.9	3.4	51.8	2.7	519.0	740.0	96.8
26	58.3	5.2	74.8	7.7	13.7	1.2	718.3	881.8	133.2
27	22.1		32.9	11.4	11.8		828.9	907.1	222.5
28	20.6	0.8	10.2	5.1	2.2	1.0	428.2	474.1	20.6
29	17.0		24.8	1.1	4.1	11.9	343.1	402.0	54.6
30	113.1	2.0	7.9	8.5	19.0	0.8	1310.0	1461.3	19.4
31	163.4	1.2	242.8	1.2	26.2	6.4	984.6	1426.5	180.3
32	208.7	22.1	244.0		18.5	24.2	23.2	578.4	124.7
33	467.9	34.5	372.8	1.0	66.1	19.7	163.6	1125.6	301.2
34	228.4	12.8	153.9	0.2	32.8	9.4	176.2	613.7	144.0
35*	218.1	1.5	189.4	21.0	23.1	18.6	405.0	882.7	262.8
36	27.9		140.1	3.0	20.7		884.6	1076.3	318.2
37	33.6		101.2	28.8	25.6	0.7	1291.4	1487.3	352.6
38	60.0	2.0	83.4	14.6	27.3	2.7	640.0	830.0	130.2
39	82.5		66.7	10.1	14.6		763.2	937.1	72.7
40	68.7		73.1	27.6	7.8		406.2	583.4	58.7
41	157.9	1.0	72.3		8.5	17.0	351.8	608.5	103.3
42	35.2		32.4	10.2	3.4		530.4	611.6	35.3
43	147.7	17.9	84.5	0.1	15.1	7.1	27.9	300.3	86.8
44	118.9	23.3	153.2		15.6	7.7	85.6	404.3	136.9
45	148.1	201.4	182.2	3.3	29.1	1.6	80.6	646.3	161.8
46	262.0	19.7	170.4	0.6	39.2	0.4	241.2	731.1	195.5
47	241.0	44.6	282.1		28.0	4.0	88.5	688.2	274.0
48	111.5	18.4	183.4	3.5	31.3	1.8	208.5	558.4	156.5
49	84.8		26.2		14.0	2.6	284.6	412.0	63.8
50	39.0		32.7	13.9	11.6	1.9	215.7	314.8	67.8
51	41.9	1.4	36.1	3.3	13.0		214.9	310.6	42.8
52	114.6		128.8	10.1	26.0		452.9	732.4	194.8
53	121.9		52.3	9.7	15.5		548.9	755.3	78.3
54	52.2		44.6	3.2	4.9		280.5	385.4	38.9
55	58.4	9.9	20.7		72.6	3.3	17.6	182.5	24.8
56	154.4	23.9	149.3		23.0	3.4	45.1	395.1	151.3
57	99.6	27.8	163.4		19.6	1.1	2.2	313.7	156.9
58	34.7	0.6	18.8		12.3	6.5	81.4	154.3	16.5
59	210.0	16.8	192.7	23.8	43.4	10.7	464.6	962.0	195.1
60	81.9	4.5	117.8	4.2	16.9	1.9	670.5	897.7	223.8
61	85.1		49.3	3.6	15.2	2.1	263.4	418.7	37.1
62	51.8		29.2	25.1	3.2		573.9	683.2	27.9
63	69.0		27.1	19.2	8.2		831.9	955.4	55.0
64	123.8	6.3	66.2	1.1	12.7	4.1		214.2	53.3
65	55.6	16.0	107.3		16.0	6.5	156.7	358.1	100.0
66	121.6	32.1	169.5	29.8	26.6	12.3	485.6	877.5	188.7
67	22.1	9.6	63.1	1.2	1.0	0.9	237.5	335.4	63.1
68	61.8		24.4	0.9	8.7		1715.3	1811.1	24.4
69	93.7	25.0	417.1	16.6	27.2	5.1	502.6	1087.3	390.7
70	18.7		29.7	7.8	9.1		1112.6	1177.9	29.7
71	37.9		16.7	8.8	6.8		2488.2	2558.4	28.1
72	319.3	28.0	426.1	21.2	45.5	14.8	843.4	1698.3	502.1
73	30.0		11.0		3.3	0.4	1024.7	1069.4	11.0
74				Restricted Area					
75				Restricted Area					
76	335.6	11.1	219.8	8.1	29.3	9.1	686.0	1299.0	252.8
77	360.6	2.3	402.7	96.8	39.7	27.0	1321.3	2320.4	506.2
Totals	8039.1	732.6	8190.2	691.6	1492.7	346.2	41796.8	61289.2	10751.0

1 - Sub-watershed Number
2 - Land presently cultivated
3 - Deciduous orchards
4 - Woodland - grass
5 - Undifferentiated
6 - Area occupied by villages
7 - Area occupied by mass graves
8 - Scrub type forest vegetation
9 - Potential conversion land
* - Pilot Demonstration Area data.

TABLE 6

SUMMARY OF
LAND CAPABILITY UNIT AREAS IN HECTARES
ANSONG CHON STUDY WATERSHED BASIN

LCU	Present Land Use - 1963							Total Ha.	PCL 8 Ha.
	L[1]	O[2]	W[3]	X[4]	H[5]	Cem.[6]	Forest[7]		
IIe1	1976.9	43.2	107.6	5.0	263.2	11.8		2407.7	112.6
IIe2	586.3	137.3	90.3		141.6	5.4		960.9	90.3
IIIe1	1285.6	121.4	639.3	12.1	187.6	31.5		2277.5	651.0
IIIe2	258.1	5.9	162.8	1.5	16.2	9.9		454.4	164.3
IIIe5	941.6	157.2	680.0	0.3	122.9	56.2		1958.2	680.3
IIIs4	42.2		12.0		5.6			59.8	12.0
IVe1	468.0	34.5	821.6	11.3	107.9	16.4		1459.7	832.9
IVe2	77.5	12.3	178.4		9.4	1.2		278.8	178.4
IVe3	583.5	27.1	682.2	3.4	102.9	13.1		1412.2	685.6
IVe5	719.3	100.6	2452.0	29.7	167.8	40.9		3510.3	2482.2
IVs4	60.0		2.6		8.4			71.0	2.6
VIe1	41.1	0.7	29.5		14.4	2.3	342.1	430.1	
VIe3	285.3	14.8	676.9	10.4	89.0	40.5	3619.7	4736.6	
VIe5	92.6	11.2	15.5	18.1	74.2	21.1	9397.7	9630.4	
VIs4	6.6	1.6	2.5	1.0	5.9		502.9	520.5	
VIsu	521.1	61.5	1477.1	11.6	148.4	57.3	3370.1	5647.1	4858.8
VIIe1				6.7			418.0	424.7	
VIIe3	83.1	0.6	109.5	19.5	2.1	5.7	3567.0	3787.5	
VIIe5	7.5	1.1	47.9	23.7	10.3	15.8	9565.0	9671.3	
VIIs4	0.6	1.6	2.5	4.7	0.3	0.3	1420.3	1430.3	
VIIIe1	2.2			504.0	8.7	16.3	4621.1	5152.3	
VIIIs4				28.6	5.9	0.5	4972.9	5007.9	
Totals	8039.1	732.6	8190.2	691.6	1492.7	346.2	41796.8	61289.2	10751.0

1 - Land presently cultivated
2 - Deciduous orchards
3 - Woodland - grass
4 - Undifferentiated
5 - Area occupied by villages
6 - Area occupied by mass graves
7 - Scrub type forest vegetation
8 - Potential Conversion land

TABLE 7

SUMMARY OF
LAND CAPABILITY UNIT AREAS IN HECTARES
TONGJIN GANG STUDY WATERSHED BASIN

LCU	Present Land Use - 1963							Total Ha.	PCL[8] Ha.
	L[1]	O[2]	W[3]	X[4]	H[5]	Cem[6]	Forest[7]		
IIe1	708.98	3.90	186.10	2.80	202.20	27.30		1,131.28	188.90
IIe2	1,318.80	11.90	218.11	0.80	190.61	12.20		1,752.42	218.91
IIIe1	1,125.53	12.10	958.42	-	249.55	48.70		2,394.30	958.42
IIIe2	2,202.15	20.40	2,409.12	1.20	522.20	68.35		5,223.42	2,410.32
IIIe5	1,456.98	15.70	1,778.66	12.70	375.15	80.83		3,720.02	1,791.36
IIIs4	276.00	1.00	7.00	-	42.50	-		326.50	7.00
IVe1	180.58	5.60	280.31	0.50	71.00	10.20		548.19	280.81
IVe2	193.90	-	399.25	63.45	5.20	-		661.80	462.70
IVe3	276.30	8.60	514.38	4.00	108.80	6.70		918.78	518.38
IVe5	450.02	14.00	1,193.08	-	163.10	17.75		1,837.95	1,193.08
IVs4	54.80	0.40	114.74	-	13.90	-		183.84	114.74
VIe1	12.20	3.80	-	4.20	18.50	3.20	159.02	200.92	
VIe3	632.35	24.50	690.51	40.60	231.00	56.85	4,690.52	6,366.33	
VIe5	28.10	1.70	22.50	10.40	14.70	9.60	918.35	1,005.35	
VIs4	51.70	2.20	2.90	-	3.40	0.80	360.49	421.49	
VIsu	955.72	14.80	1,354.76	4.30	325.75	82.45	7,780.06	3,516.64	2,137.92
VIIe1				7.80			13.60	21.40	
VIIe3	458.80	19.40	1,003.80	39.80	178.73	29.30	6,646.33	8,376.16	
VIIe5	133.90	2.30	317.15	2.50	45.40	9.30	815.64	1,326.19	
VIIs4	80.30		37.00	20.60	9.60	54.00	1,393.90	1,595,40	
VIIIe1	49.70		57.14	442.30	15.20	10.00	4,044.09	4,618.43	
VIIs4	26.40	2.00	-	509.25	18.20	6.00	11,981.46	12,543.31	
Total	10,673.21	164.30	11,544.93	1,167.20	2,804.69	533.53	31,802.26	58,690.12	10,282.54

1 - Land presently cultivated
2 - Deciduous Orchards
3 - Woodland Grass
4 - Undifferentiated
5 - Area occupied by villages
6 - Area occupied by mass graves
7 - Scrub type forest vegetation
8 - Potential conversion land

TABLE 8

LAND CAPABILITY UNIT HECTARES
FOR
ANSONG CHON SUB-WATERSHED NO.35
(PILOT DEMONSTRATION AREA)

LCU	Present Land Use - 1963							Total Ha.	PCL[8] Ha.
	L[1]	O[2]	W[3]	X[4]	H[5]	Cem[6]	Forest[7]		
IIe1	95.69	-	5.18	1.12	11.12	0.45	-	113.56	6.30
IIe2	43.80	-	0.30	-	2.05	-	-	46.15	0.30
IIIe1	29.82	0.90	38.72	2.53	0.90	0.85	-	73.72	41.25
IIIe2	2.10	-	4.10	1.45	-	0.20	-	7.85	5.55
IIIe5	22.50	-	12.02	-	3.57	1.80	-	39.89	12.02
IIIs4	-	-	-	-	-	-	-	-	-
IVe1	5.33	0.60	50.35	5.48	0.10	1.73	-	63.59	55.83
IVe2	0.25	-	3.85	-	1.20	0.15	-	5.45	3.85
IVe3	0.82	-	-	-	-	-	-	0.82	-
IVe5	0.48	-	24.13	-	0.70	1.60	-	26.91	24.13
IVs4	-	-	-	-	-	-	-	-	-
VIe1	-	-	-	-	-	-	2.25	2.25	-
VIe3	5.63	-	10.40	-	0.70	0.70	18.90	36.33	-
VIe5	0.39	-	-	-	-	1.60	44.87	46.86	-
VIs4	-	-	-	-	-	-	7.74	7.74	-
VIsu	10.25	-	31.15	7.00	3.15	6.85	75.31	133.71	113.46
VIIe1	-	-	-	-	-	-	4.88	4.88	-
VIIe3	1.05	-	9.15	1.55	-	0.45	15.74	27.94	-
VIIe5	-	-	-	-	-	0.15	63.28	63.43	-
VIIs4	-	-	-	-	-	0.25	28.98	29.23	-
VIIIe1	-	-	-	1.90	-	1.75	71.91	75.56	-
VIIIs4	-	-	-	-	5.65	0.05	71.14	76.84	-
Totals	218.11	1.50	189.35	21.03	29.14	18.58	405.00	882.71	262.69

1 - Land presently cultivated
2 - Deciduous orchards
3 - Woodland - grass
4 - Undifferentiated
5 - Area occupied by villages
6 - Area occupied by mass graves
7 - Scrub type forest vegetation
8 - Potential Conversion land

TABLE 9
LAND CAPABILITY UNIT HECTARES
FOR
TONGJIN GANG SUB-WATERSHED NO. 43

(PILOT DEMONSTRATION AREA)

LCU	Present Land Use - 1963							Total Ha.	PCL[8] Ha.
	L[1]	O[2]	W[3]	X[4]	H[5]	Cem.[6]	Forest[7]		
IIe1	20.28		12.00					32.28	12.00
IIe2	80.20		2.01		5.39			87.60	2.01
IIIe1	12.93		17.02		3.15	0.10		33.20	17.02
IIIe2	42.45		40.22		8.50	0.25		91.42	40.22
IIIe5	4.58		14.26		3.15	0.83		22.82	14.26
IIIs4									
IVe1	4.48		32.91			0.90		38.29	32.01
IVe2	1.70		12.65		0.75			15.10	12.65
IVe3			2.18					2.18	2.18
IVe5	4.22		18.18		6.90	0.55		29.85	18.18
IVs4	1.90		0.24					2.14	0.24
VIe1							6.22	6.22	
VIe3	5.75		18.65		1.40	0.55	43.22	69.57	
VIe5							13.25	13.25	
VIs4			2.90			0.80	17.29	20.99	
VIsu	12.52		33.86		2.55	1.55	16.11	66.59	49.97
VIIe1							2.50	2.50	
VIIe3			2.20				32.88	35.08	
VIIe5			0.75				3.74	4.49	
VIIs4									
VIIIe1							78.19	78.19	
VIIIs4							140.66	140.66	
Totals	191.01		210.03		31.79	5.53	354.06	792.42	201.64

1 - Land presently cultivated
2 - Deciduous orchards
3 - Woodland - grass
4 - Undifferentiated
5 - Area occupied by villages
6 - Area occupied by mass graves
7 - Scrub type forest vegetation
8 - Potential Conversion land

CHAPTER 4 - SOILS

4.1 Soil Formation

Soils are the products of the forces of the environment acting upon soil materials deposited or accumulated by geologic agencies. The nature of these environmental processes and the kinds of soils formed depend upon the following five factors: (1) the physical and mineralogical composition of the parent material; (2) the climate acting on the soil material since its accumulation; (3) the relief of the land influencing the internal soil climate such as its drainage, aeration, moisture content, and etc.; (4) the biologic forces - plant and animal life living on and within the soil, and (5) the length of time the climatic and biologic forces have acted on the soil material. These factors vary from place to place and produce a variety of soils, each with special characteristics that expresses each factor in various degrees of dominance. The manner in which these factors are expressed serves as a basis for distinguishing one kind of soil from another.

4.2 General Characteristics of the Soils in the Project Areas

The upland soils in the watersheds display many common characteristics and bear close resemblance to each other. Therefore, the separation of soils into series was made primarily on the basis of two factors, (1) the kind of parent material from which the soil was formed and (2) the degree of profile development as evidenced by the relative accumulation of clay in the lower solum. Based on these two considerations, the soils developed from each type of parent material were separated into three broad series categories as follows: 60 series, 70 series, and 80 series. A total of twelve provisional series was thus established for the project lands.

The 60 series includes soils that show none to slight development in the profile. Textures are generally uniform throughout the entire solum and range from loamy sands to clay loams. Coarse textures, including loamy sands and sandy loams, predominate. These soils are usually moderately shallow to shallow and occupy slopes having wide ranges in gradients.

The soils included in the 70 series show more development in the lower solum than do the soils in the 60 series. Clay content is generally higher in the subsoil, even among soils having uniform textures throughout. These soils are, for the most part, shallow to moderately deep and are found inter-mixed with the 60 and 80 series. Like the 60 series, they occur on a wide range of slopes.

The soils in the 80 series are characterized by having strongly developed profiles. Surface textures are predominantly clay loams and silty clay loams. Subsoil textures consist of silty clays and clays. The peds in the lower part of the solum are often clay coated with a continuous, reddish color clay film. These soils occupy a narrower range in slope than

the 60 and 70 series, from nearly level to strongly sloping topography. They are moderately deep to deep.

In table 9a, the numerical designations assigned to the provisional series mapped in the two study watersheds are presented. The same sequence of numbers, namely, 61, 71, and 81 for the Ansong Chon and 60, 70 and 80 for the Tongjin Gang, were used to separate the soils into series, irrespective of the parent material from which the soils were derived. As mentioned previously, parent material and apparent degree of profile development were the major factors used in placing the project soils into provisional soil series. In order to distinguish the soils between the two study watersheds, an odd numbered series was assigned the soils of the Ansong Chon and even numbered series to the soils of the Tongjin Gang, not-with-standing the occurrence of similar or same parent material in both areas as was the case with the granite in the Ansong Chon and the schistose granite in the Tongjin Gang which were considered for all practical purposes the same.

TABLE 9a

Numerical Designations for Soil Series Mapped

in the Ansong Chon and Tongjin Gang Study Watersheds

AREA	GRANITE (A)			GNEISS (G)			SCHIST (S)			PORPHYRY (P)		
	ND*	MD	SD	ND	MD	SD	ND	MD	SD	ND	MD	SD
Ansong Chon	61	71	81	61	71	81	61	71	81	- None -		
Tongjin Gang	60	70	80	- None -			- None-			60	70	80

* ND = None to slight development; MD = Moderate development; SD = Strong development.

The soils in the project uplands have been developed from residual material, with the exception of the soils found in the small, narrow upland valleys. These latter soils have been developed from transported material. Swale areas and soils on moderate to gentle slopes are superposed with a mantle of alluvial material originating from the erosion of higher lying lands. This alluvial mantle varies in thickness from a few centimeters to over 25 centimeters in many places.

All of the soils are strongly to medium acid in reaction in the surface and subsoils. The range in soil pH for all of the samples analyzed from the project areas is from 4.8 to 6.7 with average of 5.3 for all soils.

As a result of the denudation of the upland vegetation and the gleaning of surface organic litter, the organic matter level for the majority of soils is very low.

Soils developed from granite, gneiss, and schist parent rocks display colors that range in hues from 10YR to 10R. Reddish browns, yellowish reds, reddish yellows, and red colors are common. Brown and dark brown colors are associated with the soils derived from porphyry parent rock. To a large extent, color is related to degree of erosion. Severe erosion has exposed new soil layers with colors that differ from the original surface soil.

Structure for the surface soils is primarily crumb or granular. Coarse textured soils generally have single grain structure. Subsoil structures range from angular to subangular blocky. Except for the 80 series, the soils have good permeability and internal drainage.

4.3 General Descriptions of Provisional Soil Series

60 and 61 Series Developed from Granite - These are moderately shallow to shallow upland soils developed from coarse textured granite parent rock. They are extensive in both watershed basins and are found occupying a wide range of slope gradients. A large portion of these soils are found at the tops of ridges, sides of steep slopes and on gentle slopes where past erosion has been severe. The profiles of these soils are generally uniform throughout and show little or no evidence of genetic development. They are predominantely light textured soils with textures ranging from loamy sands to clay loams. Coarse textures, including loamy sands and sandy loams, predominate. Surface colors vary considerably and depend largely upon the degree of surface erosion whereby new soil material is exposed having colors that differ from the original surface. In general, surface colors are light yellowish browns with pale browns in the subsoil. The soils are well drained, are medium to strongly acid in reaction in both topsoil and subsoil, deficient in available plant nutrients and very low in organic matter content. The 60 and 61 soils represent the same soil, but were numbered differently to indicate the area in which they were mapped, namely, 60 in the Tongjin Gang Watershed and 61 in the Ansong Chon. The same applies to the soils in the 70 and 80 series.

70 and 71 Series Developed from Granite - The soils in this group differ from those above in that they show slight to moderate development in the lower solum. They range in depth from shallow to moderately deep. Surface textures to a depth of 15 to 30 cms. range from sandy loams to clay loams with sandy loams and loams predominating. Subsoil textures are generally loams, clay loams and sandy clay loams. The color of the surface soils are largely yellowish red with brown and yellowish red colors in the subsoil. These soils, like their 60 series counterparts occur on a wide range of slopes but slopes are less steep than those of the former group. Internal and surface drainage is good. Structure of the surface soils is crumb to granular and subangular blocky in the subsoil. Surface and subsoil reaction is medium to strongly acid. Available plant nutrients and level of organic matter are low.

80 and 81 Series Developed from Granite - These soils are characterized by having strongly developed profiles. They are moderately deep to deep with moderately fine textured surface soils and fine textured subsoils. They are found on nearly level to strongly sloping relief. Surface textures, to a depth of around 30 cms., consist generally of yellowish red or reddish yellow colored clay loams or sandy clay loams over yellowish red to red clay. The peds, in the lower part of the clay horizon, are often coated with a continuous, thick reddish color clay film. The structure of the surface soil is usually granular and massive to subangular blocky in the subsoil. Internal drainage is slow. These soils have high water holding capacity and because of generally favorable topography, a large percentage of them are under cultivation.

61 Series Developed from Gneiss - These soils display profile characteristics common to the 60 and 61 series developed from granite parent rock. They were therefore separated solely on the basis of the parent material from which they were formed, namely, coarse crystalline gneiss which could be easily identified and mapped in the field.

71 Series Developed from Gneiss - Except for differences in parent material, the soils within this series closely resemble the moderately developed soils derived from granite. Thus parent material was the major factor used in separating these soils from their granite counterparts.

81 Series Developed from Gneiss - As in the previous two cases mentioned above, parent material was the primary criterion for separating these soils from similar soils developed from granite.

61 Series Developed from Schist - These immature upland soils differ from those developed from granite and gneiss parent rock in that soil textures are generally finer textured and consist mostly of either loams, clay loams or sandy clay loams. Soil colors are also more reddish in hue throughout the solum.

71 Series Developed from Schist - General profile characteristics are basically the same as described for the moderately developed soils formed from granite and gneiss. The major difference is that these soils are generally more reddish in color.

81 Series Developed from Schist - The basic difference between these soils and similar soils derived from granite and gneiss parent material is that both surface and subsoils are darker red in color. These soils are less extensive as their granite and gneiss counterparts and occur on similar type relief.

60 Series Developed from Porphyry - These young, upland soils consist primarily of loams and clay loams. They are shallow in depth over hard porphyry rock. They are found on a wide range of slopes but generally on moderately steep to very steep terrain. Surface and subsoil colors are mostly pale browns or light browns. They are acid in reaction throughout. Due to steep topography, most are in native grass and scrub timber.

70 Series Developed from Porphyry - Moderately developed soils with pale brown or brown surface soils and dark brown subsoils. Surface horizon comprised chiefly of loams and clay loams with heavy clay loams and silty clay loams in the subsoil. Structure of the surface soil is granular to crumb and subangular blocky in the subsoil. Well drained soils.

80 Series Developed from Porphyry - Moderately deep to deep strongly developed soils on nearly level to gently sloping terrain. Similar to the moderately developed 70 soils, described above, except that subsoils are finer textured and darker brown in color and are not as well drained.

4.4 Typical Profiles

Profile descriptions and analytical data are presented for three soil profiles from the project areas in Tables 10, 11, and 12. They are representative of the soils placed within each of the three broad series categories mentioned in the preceeding pages.

TABLE 10

60 Series Profile
(Colors for moist soil unless otherwise stated)

Vegetation : Red pine (Pinus densiflora) and grass
Parent Material: Granite
Topography : 55% slope facing east, very steep upland

0-29 cms. Light yellowish brown (10YR 6/4) sandy loam, pale brown (10YR 8/3) when dry; medium granular; very friable; abundant fine roots; diffuse boundary

29-86 cms. Brown (7.5YR 5/4) coarse sandy loam, pale brown (10YR 8/3) when dry; very coarse granular; friable; very few fine roots; abrupt, irregular boundary

+86 Moderately hard, slightly weathered, coarse crystalline granite parent rock

Analytical data for profile

Depth cms.	Gravel >2mm	Mechanical analysis**			Texture	pH	Avail P_2O_5 ppm
		Sand	Silt	Clay			
0-8	13	53.5	26.5	20.0	SL	4.85	23.92
15-25	15	55.5	24.6	19.9	SL	5.15	29.44
35-45	12	60.8	21.2	18.0	SL	5.50	18.40
63-75	9	68.0	18.6	13.4	SL	5.25	21.16

Avail K ppm	Humus %	CEC me/100g	Exchangeable Cations me/100gms				
			H*	K	Na	Ca	Mg
44.5	1.44	12.5	3.90	0.15	0.42	0.47	0.44
22.5	0.73	10.2	2.85	0.09	0.43	0.31	0.15
17.5	0.59	10.2	3.10	0.07	0.43	0.47	0.26
25.0	0.50	10.2	3.85	0.12	0.48	0.47	0.10

* Exchange Acidity
** Hydrometer method

TABLE 11

70 Series Profile
(Colors for moist soil unless otherwise stated)

Vegetation : Red pine (Pinus densiflora) and grass
Parent Material: Granite
Topography : 11% slope facing southwest, moderately sloping upland

0-25 cms. Yellowish red (5YR 5/8) clay loam; medium crumb to granular; very friable; plentiful fine roots; clear, wavy boundary

25-47 cms. Strong brown (7.5YR 5/6) loam; coarse granular; friable; few fine roots; abrupt, smooth boundary.

47-76 cms. Yellowish red (5YR 4/6) clay loam/sandy clay loam; medium subangular blocky; firm; few very fine roots; gradual and smooth boundary.

76-120 cms. Yellowish red (5YR 5/6) clay loam; medium subangular blocky; firm; very few fine roots; few quartz grains; gradual smooth boundary.

120-152 cms. Strong Brown (7.5YR 5/6) clay loam; medium subangular blocky; firm; very few fine roots; few quartz grains; clear smooth boundary.

152 + Highly weathered granite parent material

Analytical data for profile

Depth	Gravel	Mechanical analysis			Texture	pH	Avail P_2O_5
cms.	>2mm	Sand	Silt	Clay			ppm
7-19	6	32.4	32.4	35.2	CL	5.10	17.48
30-41	5	40.0	35.0	25.0	L	5.35	16.56
59-70	8	45.0	27.0	28.0	CL/SCL	4.90	20.24
91-102	6	36.8	28.2	35.0	CL	5.25	17.48
124-132	7	42.8	26.2	31.0	CL	5.30	18.40

Avail K	Humus	CEC	Exchangeable Cations me/100gm				
ppm	%	me/100g	H	K	Na	Ca	Mg
49.0	1.61	22.8	5.60	0.15	0.40	0.81	0.78
27.0	0.84	18.0	2.60	0.07	0.32	0.39	0.26
25.0	0.67	15.4	2.90	0.11	0.42	0.44	0.36
32.5	0.62	14.8	4.40	0.11	0.43	0.99	0.70
44.5	0.62	20.1	7.60	0.18	0.47	1.83	0.73

TABLE 12

80 Series Profile
(Colors for moist soil unless otherwise stated)

Vegetation : Red pine, alder, and grass
Parent Material: Granite
Topography : 15% slope facing southwest; gently rolling upland

0-8 cms. Reddish yellow (7.5YR 7/6) sandy clay loam when dry; medium crumb; very friable; abundant fine roots; common, fine continuous, random, simple pores; clear smooth boundary

8-26 cms. Yellowish red (5YR 5/6) clay loam; reddish yellow (7.5YR 6/6) when dry; coarse granular; very friable; plentiful fine vertical roots; common, fine pores; abrupt smooth boundary

26-36 cms. Yellowish red (5YR 4/8) clay; reddish yellow (5YR 6/6) when dry; medium sub-angular blocky; firm; few very fine roots; few, fine, discontinuous, random, simple pores; abrupt, smooth boundary

36-89 cms. Red (2.5YR 4/6) clay; weak red (10R 4/4)when dry; medium angular blocky structure; very firm; very few fine vertical roots; reddish brown (2.5YR 4/4) and weak red (10R 4/4) when dry, continuous, thick clay film on ped faces; quartz grains and black staining on ped faces; gradual smooth boundary

89+ cms. Highly weathered granite parent material

Analytical data for profile

Depth cms.	Gravel >2mm	Mechanical Analysis			Texture	pH	Avail. P_2O_5 ppm
		Sand	Silt	Clay			
0-8	6	53.2	25.8	21.0	SCL	5.35	13.80
12-23	1	28.4	36.4	35.2	CL	5.35	19.32
27-35	3	25.6	31.4	43.0	C	5.10	17.48
40-55	5	29.0	27.8	43.2	C	5.20	18.40
66-79	2	31.0	26.0	43.0	C	5.30	15.64

Avail. K ppm	Humus %	CEC me/100g	Exchangeable cations me/100gms				
			H	K	Na	Ca	Mg
51.0	0.92	12.5	2.55	0.19	0.40	0.78	0.60
30.5	0.95	14.5	3.60	0.09	0.40	0.54	0.52
35.0	0.62	14.5	4.70	0.12	0.47	0.75	0.54
30.5	0.42	17.4	4.10	0.19	0.47	1.25	0.68
32.5	0.50	16.8	3.95	0.12	0.67	2.06	0.70

CHAPTER 5 - LAND CAPABILITY CLASSIFICATION

5.1 Type of Classification and Basis for Same

The basis for using the Capability Classification as a means of classifying the project lands is given under Section II, paragraph B-1-a(1), of the United Nations Korean Uplands Project Inception Report. In brief, the Inception Report states that for present and potential agricultural areas, "The individual mapping unit will be the soil type which is a subdivision of the soil series. The units will be grouped into capability units, these units into subclasses and the subclasses into classes, I-IV, inclusive. The land treatment and conversion recommendations will be based upon these delineations." Although no mention is made regarding the classification of the nonagricultural lands, these too were classified by the land capability system.

5.2 Capability Classification and Its Categories

The capability classification is basically an interpretive classification involving the grouping of soils that behave alike in their responses to management and treatment. It is based on the inter-action of combinations of climate and permanent soil characteristics as they affect risks of soil damage, limitations in use, productive capacity, and soil management requirements. It consists of three major categories, namely, capability unit, subclass, and class.

The individual soil mapping units are the building stones of the system. The soil mapping units are first grouped into capability units; these units, in turn, are grouped into subclasses and the subclasses into classes.

The capability unit is a grouping of soils that are similar enough to require about the same degree of management and to grow similar kinds and amounts of crops. Thus, soils within a capability unit are or should be sufficiently uniform in the combination of soil characteristics that influences their qualities to have similar potentialities and continuing limitations or hazards. Capability units, in combination with class and subclass, furnish information about the degree of limitation, kind of limitation or problem, and the treatment and management practices required for the land. It is designated by an arabic number following the subclass letter. The unit numbers are used to either modify the limitation represented by the subclass or to indicate a secondary limitation or soil quality. The latter concept was used in connection with the classification of the project lands.

Subclasses are groups of capability units within classes that have the same kinds of dominant limitations for agricultural use. Four kinds of dominant limitations are recognized at the subclass level. These are:

(1) erosion damage and or hazard to erosion, (2) limitations resulting from wetness, drainage, or overflow, (3) root zone limitations, (4) and, limitations due to climate. The subclasses are denoted by the symbols (e), (w), (s), and (c). Subclasses are not recognized in capability class I.

Subclass (e) is made up of soils where susceptibility to erosion and past erosion damage are the major soil factors, whereas subclass (w) consists of soils where excess water in the soil or damage from overflow is the dominant hazard or limitation in their use. Soils with root zone limitations such as, stones, low moisture holding capacity, shallow soil depth, coarse textures, are placed in subclass (s). Subclass (c) includes soils where climate is the major limitation; that is, temperature and precipitation.

The class is the broadest category in the capability classification and expresses the degree of hazard and/or limitation in use. All soils in the capability classification are placed into one of eight capability classes. Limitations or hazards in use become progressively greater from class I through class VIII. Soils in classes I through IV are considered suitable for cultivation and other uses and under good management are capable of producing adapted agricultural crops, trees, and range plants. Soils in class V through VII are considered best suited to the use of adapted native plants. Due to very severe limitations, soils in class VIII generally do not return on-site benefits for inputs of management and, therefore, are best suited to uses other than those specified for soils in class I through class VII above.

5.3 Description of Land Capability Classes and Special Use Class

Class I - Soils in class I have few limitations that restrict their use. They are suited to a wide range of plants and may be used safely for cultivated crops, pasture, range, woodland, and wildlife. The soils are nearly level and erosion hazard is low. They are deep and very deep, are well drained and easily worked. They hold water well and are either fairly well supplied with plant nutrients or highly responsive to inputs of fertilizer.

Class II - Soils in class II have limitations that reduce the choice of plants or require moderate conservation practices. Soils in this class require careful soil management and conservation practices to prevent deterioration or to improve air and water relations when the soils are cultivated. The limitations are few and easy to apply. The soils may be used for cultivated crops, pasture, range, woodland, or wildlife. Limitations of soils may include singly or in combination the effects of gentle slopes, moderate susceptibility to erosion, less than ideal soil depths, unfavorable soil structure and workability, and slight climatic limitations on soil use or management.

Class III - Soils in class III have more restrictions than those in class II and when used for cultivated crops the conservation practices are usually more difficult to apply and to maintain. The soils may be used for cultivated crops, pasture, woodland, range, or wildlife. Limitations of soils restrict the amount of clean cultivation, time of planting, tillage, harvesting, choice of crops or a combination of these items. The limitations may result from one or more of the following: moderately steep slopes, high susceptibility to erosion or adverse effects of past erosion, very slow permeability of the subsoil, shallow depths that limit the rooting zone and water storage, low moisture holding capacity, low fertility not easily corrected, and moderate climatic limitations.

Class IV - Soils in this class have very severe limitations that restrict the choice of plants and require very careful management. The restrictions in use for these soils are greater than those in class III and the choice of plants is more limited. When these soils are cultivated more careful management is required and conservation practices are more difficult to apply and maintain. These soils may be used for crops, pasture, woodland, range, or wildlife. Use for cultivated crops is limited as the result of the effects of one or more of the following features: steep slopes, severe susceptibility to erosion or severe effects of past erosion, shallow soils, low moisture holding capacity, or moderately adverse climate.

Class V - Soils in class V generally have limitations that are impractical to remove and that limit their use largely to pasture, range, woodland, or wildlife. Limitations of soils in this class restrict the kind of plants that can be grown and that prevent normal tillage of cultivated crops. They are nearly level but some are wet, are frequently overflowed by streams, are stony, have climatic limitations, or have some combination of these limitations. Because of one or more of these limitations, the cultivation of the common crops is not feasible but pastures can be improved and benefits from proper management can be expected.

Class VI - Physical conditions of soils placed in class VI are such that it is practical to apply range or pasture improvements, such as seeding, liming, fertilizing and water control with contour furrows, diversions, or water spreaders. Soils in this class have continuing limitations that cannot be corrected, such as steep slope, severe erosion hazard, effects of past erosion, stoniness, shallow rooting zone, low-moisture capacity, or severe climate. Due to one or more of these limitations the soils in class VI are not

generally suited for cultivated crops but may be used for pasture, range, woodland, wildlife cover, or some combination of these.

Class VII - The physical conditions of soils in this class are such that it is impractical to apply such pasture or range improvements as seeding, liming, fertilizing, and water-control measures such as contour furrows, ditches, diversions, or water spreaders. Soil restrictions are more severe than those in class VI because one or more of the continuing limitations cannot be corrected, such as very steep slopes, erosion, shallow soil, stones, unfavorable climate, or other limitations that make them unsuited for common cultivated crops. They can, however, be used safely for grazing, woodland, or wildlife food and cover, or some combination of these under proper management. Depending on the soil characteristics and local climate, soils in class VII may be well or poorly suited to woodland. They are not suited for any of the common cultivated crops. Some areas in this class may require seeding or planting to protect the soil and prevent damage to adjoining areas.

Class VIII - Soils and land forms in class VIII have limitations that preclude their use for commercial plant production and restrict their use to recreation, wildlife, water supply, or aesthetic purposes. Gully land, rock outcrops, mine tailings, and other nearly barren lands are included in class VIII. It may be necessary to give protection and management for plant growth to soils and land forms in class VIII in order to protect other more valuable soils.

Class VI Special Use (su) - Continuing limitations as specified for class VI lands generally precludes the use of lands in class VI for cultivation of adapted farm crops. In Korea, however, the dire need for additional land to help meet the food needs of an expanding population necessitates the use of a portion of these lands for the production of adapted agricultural crops. Thus, class VI was subdivided into a "special use class" to include lands that could be safely used for this purpose and at the same time provide maximum conservation of soil and water through the use of bench type terraces constructed on the contour.

Lands falling into this special use class are extensive in the project study watersheds. And their conversion to agricultural use will do much to help alleviate the present and future food shortage in the country. In the Ansong Chon basin, 4859 hectares of class VI special use land was mapped while 2138 hectares was mapped in the Tongjin Gang.

The criteria used in establishing this specia use land is given in Table 13.

5.4 Land Capability Classification Criteria

Specific information normally used in developing criteria for land capability groupings is for the most part unavailable in the study watersheds. Reliable yield data for upland crops, response of soils and plants to different levels and kinds of management, and the effect of climate and soil on crops grown is generally lacking. Consequently, the criteria developed for classifying the watershed lands was based on an evaluation and interpretation of the following combinations of soil characteristics and qualities as they affect the use, management, and productivity of the soils. These are:

1) Ability of the soil to give plant response to use and management as evidenced by organic matter content, percentage base saturation, base exchange capacity, type of parent material, available water-holding capacity, and response to balanced applications of commercial fertilizers.

2) Texture and structure of the soil to depths influencing the environment of roots and the movement of air and water.

3) Susceptibility to erosion as influenced by kind of soil, slope, and the effect of erosion on use and management.

4) Depth of soil material to layers inhibiting root penetration.

5) Physical limitations such as deep gully's and rocks.

6) Climate (temperature and effective moisture)

Based on the preceeding factors the criteria used in establishing classes, subclasses, and capability unit numbers for the project lands is presented in Tables 13, 14 and 15 respectively. In Table 13 the criteria and ranges in characteristics assumes that the effects of other soil characteristics are favorable and are not limiting. Moreover, the table is arranged to indicate the most extreme condition of each soil limitation allowable in each class.

5.5 Description of Land Capability Units

On the basis of the established criteria, twenty-two land capability units were developed for the project lands. A brief description of each follows:

TABLE 13

Guide for Placing Soils into Land Capability Classes

Capab. Class	Depth cms.	Surface Texture and Workability	Subsoil Permeability	Slope %	Erosion and Erosion Hazard	AWC (inches)
I	120+	visL - SicL (E-F)	3 - 4	0 - 2	1	8
II	90+	SL - C (L - H)	2 - 5	< 9	2	6
III	60+	SL - C (L - H)	1 - 5	< 16	3	5
IV	60+	g., cob., st., r. (C - H)	1 - 6	< 27	3	4
V	60+	any cob., st., r.	1 - 5	< 27	2	3
VI**su	45+	SL - C (L - H) g., cob., st., r.	1 - 4	< 35	3	3
VI	25+	any vcob., vst., vr.	1 - 5	< 45	3	2
VII	any	any	1 - 6	< 58	any	1
VIII	any	any	1 - 6	any	any	any level

** Special Use (su) class.

TABLE 14

GUIDE FOR PLACING SOILS IN LAND CAPABILITY SUBCLASSES

	Groups of Soils defined by the following Selected Features	Subclasses by Slope Classes						
		A	B	C1	C2	D1	D2	E
1)	Moderately well to excessively drained soils over 25 cms. deep:							
	a) Coarse textured soils with less than 8" AWC, without textural B; substrata mod. rapid to rapid.	s	s	s	s	s	s	s
	b) Coarse textured soils with less than 8" AWC, with textured B or substrata moderately to slowly permeable	s	s	e	e	e	e	e
	c) Moderately coarse textured; AWC over 8".	s	e	e	e	e	e	e
	d) Medium and moderately fine textured; AWC over 8".	s	e	e	e	e	e	e
	e) Fine textured soils; AWC over 8".	s	e	e	e	e	e	e
*	f) Moderately coarse textured; AWC less than 8".	s	e	e	e	e	e	e
*	g) Medium to fine textured; AWC less than 8".	s	e	e	e	e	e	e
2)	Slowly permeable, well and moderately well drained soils over 25 cms. deep	s	e	e	e	e	e	e
**	3) All soils less than 25 cms. deep; all stony and rocky soil classes	s	s	s	s	s	s	s

* Over bedrock or other relatively impermeable or excessively permeable soil material.

** Soils deeper than 25 cms. and containing stones and/or rocks may be placed in subclass "e" on slopes greater than C2 if erosion is the dominant limitation.

TABLE 15

CRITERIA FOR CAPABILITY UNIT NUMBERS

1. Erosion, slope, or both. Used to indicate a problem resulting from past erosion or a problem of erosion hazard.

2. Soils with limitations because of slow and very slow subsoil permeability. Internal drainage is slow.

3. Coarse textured soils that have low water holding capacity.

4. Cobbly, rocky or stony conditions. Available moisture capacity is not significantly reduced.

5. Soils with limitations due to less than ideal soil depths. Includes moderately shallow and shallow depth soils.

Land Capability Unit IIe1 - Deep to moderately deep, well-drained upland soils on gentle slopes.

The soils in this unit are deeper than 90 centimeters and have slight to moderate profile development. They are permeable and well drained and occur on slopes from 2 to 10 percent. Surface soil textures range from sandy loams to clay loams while subsoil textures are sandy loams, loams, sandy clay loams, and clay loams. These residual soils are formed in place from a variety of parent rocks consisting of granite, gneiss, schist, and porphyry. Intense weathering of the parent rock has resulted in the development of a deep mantle of soft, decomposed parent material that is easily penetrated by roots and moisture. The available water capacity (AWC) for the effective depth of profile exceeds 6 inches. Past erosion has been slight to moderate.

The soils are very strongly to strongly acid through-out. In general, soil acidity (pH) is highest at the surface and decreases slightly with depth. Organic matter content and fertility level of these soils is also low.

These upland soils occur for the most part on gently sloping to gently undulating land which, physiographically, represents the transition zone between the bottom alluvial paddy lands and steep uplands. Because of favorable physical soil properties and gentle topography, the majority of these lands are presently under cultivation. Crops respond to balanced applications of phosphorous, nitrogen, and lime.

Land Capability Unit IIe2 - Moderately deep to deep, slowly permeable, upland soils on nearly level to gentle slopes.

The soils in this unit are found on slopes ranging from 2 to 10 percent. They are at least 90 centimeters in depth to parent material that has been highly weathered in place from parent rocks consisting chiefly of granite, metamorphosed gneiss, and to a lesser extent schist and phorphyry. Unlike the soils in unit IIe1, these soils show strong profile development and are characterized by having slowly permeable subsoils. Physiographical position for the soils in this unit is the same as for the soils in Unit IIe1 except that slopes are slightly concave and gently sloping. Surface textures range from sandy loams to clay loams. Subsoil textures vary from clay loams to slowly permeable clays. Although internal drainage is slow, the soils are never-the-less well drained as evidenced by lack of water table and/or lack of pronounced mottling. Some "stacking up" of soil moisture above the slowly permeable horizon has been observed during the rainy season. This "stacking up", however, is of short duration as the moisture tends to percolate gradually through the slowly permeable layer while some moves downslope along the top of the layer and emerges as "seeps" at lower

lying paddy lands. Because of its short duration, there are no aparent ill effects to growing crops. The lands in this unit are intensively farmed and well managed. Consequently, past erosion on these soils has been slight. The AWC exceeds 6 inches for the effective profile.

Like most soils in the project watershed areas, these soils are very strongly to strongly acid through-out. They are deficient in organic matter as well as available crop nutrients. The results of fertility trials conducted on lands in this unit show crops to be highly responsive to balanced applications of nitrogen, phosphorous, and lime.

Land Capability Unit IIIe1 - Deep to moderately deep, well drained upland soils on moderately sloping to rolling topography.

This unit consists of soils that are 90 to over 120 centimeters deep to highly weathered parent materials derived from the weathering in place of parent rocks geologically classified as granites, phorphyrys, schists and gneisses. These upland soils occupy slopes that range in gradient from 10 to 16 percent. Surface textures vary from sandy loams, loams, sandy clay loams, and clay loams. The soils are permeable and well drained. The water holding capacity for the soils exceeds 5 inches for the effective soil depth. Soil slopes in this unit are oftentimes short, uneven, and broken and will require bench type terraces as a maximum conservation treatment for safe and intensive use of these lands. Much of the land in this unit is presently farmed. Past erosion has been slight to moderate. Erosion can become a problem on these soils if mismanaged and/or left bare. They are acid in reaction, are low in organic matter, and are deficient in plant nutrients. Crop response to applications of nitrogen, phosphorous, and lime, is high.

In non-cultivated area, where past erosion has been slight, the native vegetation generally consists of scrub pine (red pine) and hardwood trees (Oak, Alder, and Black Locust) with a moderately dense under story of summer active annual and perennial grasses and forbs. On the more highly eroded sites, the under story consists primarily of scattered standards of rhizominous grasses and lespedeza. These soils are similar to those in Unit IIe1 except that they are found on steeper slopes and have a greater erosion hazard.

Land Capability Unit IIIe2 - Moderately deep to deep, slowly permeable upland soils on moderately sloping to gently rolling topography.

Soil depth for soils in this unit exceeds 90 centimeters. The soils are underlain by a mantle of highly weathered parent material derived from the weathering in place of either granite, gneiss, schist, and phorphyrys parent rocks. Thickness of the weathered

mantle varies from a few feet to over 25 feet in some places. Surface textures range from sandy loams to clay loams while subsoil textures vary from clay loams to slowly permeable clays. These soils have water holding capacities exceeding 6 inches for the profile. Slopes are in the range of 10 to 16 percent. In general, past erosion for lands in this unit has been slight to moderate. Few isolated area showing severe erosion have been mapped. The combined effects of slope and shallow depth to the slowly permeable subsoil layer makes these soils susceptible to erosion under clean cultivation.

Water movement through the subsoil is somewhat restricted. Water has been observed to accumulate above the slowly permeable horizon during the rainy season. This accumulation of moisture, however, is of short duration and has no observable adverse effect on growing crops.

These soils are similar to those in Unit IIe2 except that they occupy steeper slopes and have a greater erosion hazard.

Most of the lands in this unit are presently under cultivation. Base saturation and organic matter content are low. They respond well to applications of nitrogen, phosphorous, and lime.

Native vegetation in non-cultivated areas consists primarily of open stands of scrub pines and hardwood trees with semi-dense under-stories of summer active annual and perennial grasses and forbs.

Land Capability Unit IIIe5 - Moderately shallow, well drained upland soils on gently sloping to rolling topography.

These residual soils are 60 to 90 centimeters in depth to highly weathered parent material derived from the weathering in place of parent rocks consisting of either granite, gneiss, schist, and phorphyry. They are moderately permeable and well drained and occupy slopes from 3 to 16 percent. Surface textures vary from sandy loams to clay loams while subsoil textures range from loams to clay loams. They are generally non-rocky and have available water holding capacities of at least 5 inches for the effective depth of soil. The soils are strongly acid throughout their entire depth. Organic matter content and available plant nutrients are also low.

The effect of past erosion varies from slight to severe. These soils generally occupy the low lying foothills that extend fingerlike in varied directions from the main mountain ridges. Slopes, in general, are short and complex. Due to the complex array of slopes, the high susceptibility to erosion, and the severe effects of past erosion, many of the lands in this unit will require terracing as a maximum conservation treatment for safe utilization and maximum conservation of soil and water.

This unit differs from IIIe1 by having shallower soils.

A large percentage of the lands in this unit are in cultivation. In non-cultivated areas, the native vegetation consists mostly of open stands of scrub pine and hardwood trees. The under story in the better non-eroded sites is made up primarily of summer active annual and perennial grasses and forbs.

Land Capability Unit IIIs4 - Moderately deep to deep, gravelly coarse textured upland soils on nearly level to gently sloping topography.

Included in this unit are coarse textured, gravelly soils that make up less than one percent of the total lands in the watershed basins. They are 90 to over 120 centimeters deep and occupy slopes ranging in gradient from 1 to 10 percent. Surface and subsoil textures are sandy loams. Coarse sub-rounded and rounded fragments of colluvial and alluvial origin are for the most part concentrated below the soil surface and make up from 20 to 50 percent of the soil mass by volume. These soils are not extensive and usually are found occupying positions adjacent to and below the steep, shallow, rocky uplands. They are permeable and well drained. Erosion damage to these lands has been slight. Organic matter content and levels of available plant nutrients is low.

All lands in this unit are under cultivation. Crops respond to applications of nitrogen, phosphorous, and lime.

Land Capability Unit IVe1 - Deep to moderately deep, well drained, moderately coarse to moderately fine textured upland soils on strongly sloping to hilly topography.

The soils in this unit occur on slopes from 16 to 27 percent. They are 90 to over 120 centimeters deep to highly weathered parent material. Surface textures vary from sandy loams to clay loams while subsoil textures are sandy loams, loams, sandy clay loams, and clay loams. These soils show weak to moderate profile development, are moderately permeable, and are well drained. Available water holding capacity for the effective depth of soil exceeds 5 inches. Most of the soils in this unit are slightly to moderately eroded. They are unstable and will erode when clean tilled or when left without a protective vegetative cover. These soils are similar to those in Unit IIIe1 except for steeper slopes.

Deciduous orchards, cereal, and vegetable crops, are grown in areas that are presently under cultivation. The soils are acid in reaction throughout their entire depth and show a high response to applications of phosphorous, lime, and nitrogenous fertilizers. Organic matter is also deficient along with low levels of other necessary plant elements. The native vegetation in areas that are not under cultivation consist mainly of very open stands of mixed

scrub pine and hardwood trees. The density of understory is quite variable and includes summer active annual and perennial grasses and forbs.

Land Capability Unit IVe2 - Moderately deep to deep, slowly permeable upland soils on strongly sloping to hilly topography.

The soils included in this unit are residual and are formed in place by the weathering of parent rocks consisting either of granite, gneiss, schist, or phorphyry. They range in depth from 60 to over 120 centimeters to highly weathered parent material that varies in thickness from a few feet to well over 25 feet in some places. Depth and degree of weathering is greater for the granites, gneisses, and schists, and is less pronounced for the fine grained phorphyrys. These soils are found on slopes from 16 to 27 percent. Surface textures are predominantly loams, sandy clay loams, and clay loams. Subsoil textures range from sandy clay loams to slowly permeable clays. The soils in this unit have AWC's ranging from 4 to 7 inches. Although the degree of past erosion has been slight to moderate, these soils are highly susceptible to erosion when left bare. They are highly leached. Consequently, the soils are very strongly to strongly acid in reaction and deficient in available plant nutrients. Organic matter content is also low.

Some of the lands in this unit are in cultivation. Where the lands are not in cultivation, the native vegetation consists mainly of scattered scrub pine and hardwood trees. Understories consist chiefly of summer active annual and perennial grasses that vary in density of cover.

Land Capability Unit IVe3 - Moderately shallow, coarse textured upland soils on gently sloping to hilly topography.

The soils included in this unit are 60 to 90 centimeters deep. They are underlain by a mantle of highly weathered material that varies in thickness and texture and derived from the weathering in place of parent rocks consisting either of granite, metamorphosed gneiss or schist, and porphyry. The degree and depth of weathering is greatest for the granites, gneisses and schists and is less pronounced in the denser and finer textured porphyrys. These soils are generally non-rocky with surface and subsoil textures consisting of sandy loams. The permeability of the soil material above the weathered parent material is moderately rapid to rapid. Available water holding capacity for the effective depth of soil is around 3 to 4 inches. Slopes range from 3 to 27 percent. Past erosion varies from moderate to severe. These soils erode readily and must be protected at all times with an adequate vegetative cover. Soil profiles are acid throughout and are deficient in available plant nutrients. Organic matter content is also low.

Past efforts at arresting soil erosion on some of these severely eroded sites by the Government Erosion Control Section have proven ineffective due in part to the sparseness of vegetative plantings (tree and shrub types) and the undue regard for a close-growing understory (grasses).

Some of the lands in this unit are in cultivation. Because of coarse textures and high hazard to drought, these soils should not be terraced. Land treatment practices other than terracing should be applied to these lands for protection against further erosion damage and conservation of soil and water.

Land Capability Unit IVe5 - Moderately shallow, well drained upland soils with sandy loam to clay loam surface textures on strongly sloping to hilly slopes.

The soils in this unit are similar to those in Unit IIIe5 except that they are found on steeper slopes. They range in depth from 60 to 90 centimeters and are underlain by a weathered mantle of parent material formed in place by the physical and chemical weathering of granite, gneiss, schist, and phorphyry parent rocks. Surface textures vary from sandy loams to clay loams. Subsoil textures are predominately loams, sandy clay loams, and clay loams. Soils in this unit are for the most part non-rocky, permeable, well drained, and have an AWC of at least 5 inches for the effective depth of soil. Slope gradient for the soils is from 16 to 27 percent. Effects of past erosion have been slight to severe. Surface and subsurface soils are strongly acid. Available plant elements and organic matter levels are low.

Some of these lands are cultivated to grain and vegetable crops. The nature and steepness of slopes, coupled with soil depletion farming practices, will require bench terracing a large portion of these lands for safe utilization and maximum conservation of soil and water.

Land Capability Unit IVs4 - Land having stony, moderately deep to deep, well drained, permeable soils on moderately sloping to gently rolling slopes.

The soils in this unit are over 90 centimeters deep to weathered parent material. They contain within the profile, coarse, stony, fragments of colluvial origin which originated from higher lying areas containing appreciable surface rock outcroppings. Surface and subsoil textures are coarse and consist mainly of sandy loams. The soils are well drained, with moderately rapid permeability, and occupy slopes from 10 to 16 percent. Erosion damage to lands in this unit has been slight. Available plant nutrients and organic matter are low.

All of the soil areas included in this unit are in cultivation. Crops respond to applications of nitrogen, phosphorous and lime.

These soils are similar to those in Unit IIIs4 but differ by having steeper slopes.

Land Capability Unit VIe1 - Moderately deep to deep, well drained upland soils on moderately steep to steep slopes.

This unit contains soils that are more than 90 centimeters deep to decomposed, unconsolidated parent material having variable thickness and derived in place by the weathering of a variety of geological rocks. The soils are, for the most part, free of rock fragments, are well drained, and are found occupying slopes from 35 to 45 percent. Surface textures are primarily sandy loams, loams, sandy clay loams and clay loams. The range of subsoil textures is from sandy loams to clay loams. These soils have available water holding capacities exceeding 5 inches for the effective soil depth. They are strongly acid in reaction and have low levels of available plant nutrients and organic matter. Past erosion on these lands has been slight to severe.

This unit differs from IVe1 by having steeper slopes. Most of the lands in this unit are in native vegetation consisting of mixed scrub pine - hardwood trees with understories consisting of summer active annual and perennial grasses and forbs. These lands should be considered for orchards and/or fuelwood production.

Land Capability Unit VIe3 - Moderately shallow to shallow, well drained, coarse textured upland soils on gently undulating to steep slopes.

Included in this unit are soils that are 25 to 90 centimeters deep to weathered parent material. They are generally non-rocky and have surface and subsoil textures consisting of sandy loams. The permeability of the soil material overlying the weathered mantle of parent material is moderately rapid to rapid. Due to coarse textures and rock fragments, these soils have low available moisture holding capacities. Slopes range from 3 to 45 percent. Past erosion damage varies from slight to severe. These soils are highly erosive and must be protected by adequate conservation treatment practices. Because of shallow depths, coarse textures, and low AWC, these soils are not recommended for terracing. Organic matter levels and available plant nutrients are low.

Land Capability Unit VIe5 - Moderately shallow to shallow, well drained, moderately coarse to moderately fine textured residual soils on steep slopes.

These upland soils occupy slopes from 35 to 45 percent and are 25 to 90 centimeters deep to weathered parent material. They are

for the most part rock free. Surface textures vary from sandy loams to clay loams while subsoil textures range from loams to permeable clay loams. The soils are permeable and well drained and have available moisture-holding capacities from 2 to 5 inches. Past erosion, for lands in this unit, varies from slight to severe. Erosion is usually greater on west and south aspects and is also associated with areas that have been denuded of vegetation by the rural people in their quest for fuelwood and compost material.

The majority of the lands in this unit are in native vegetation consisting mostly of scattered stands of mixed scrub pine and hardwood trees. Understories consist of summer active annual and perennial grasses and forbs.

Land Capability Unit VIs4 - Moderately shallow to shallow, well drained, moderately coarse to moderately fine textured rocky upland soils on steep slopes.

The soils in this unit are similar to those in Unit VIe5 except that they are rocky and/or stony. They are developed in place from a variety of parent rocks consisting chiefly of either granite, gneiss, or schist. They are 25 to 90 centimeters deep to highly weathered, unconsolidated material formed by the weathering in place of the parent rocks. Slopes range in gradient from 35 to 45 percent. Surface and subsoil textures are predominantly sandy loams and loams. The degree of past erosion for most of the lands in this unit has been moderate to severe. Content of organic matter for surface and subsoils is low. Available plant nutrient levels are also low. Soil pH's are in the acid range.

The majority of these lands are in native vegetation consisting of scattered scrub pine and hardwood trees with grass and forb understories of varying densities.

Land Capability Unit VIsu - Special use land capability unit consisting of soils meeting the following criteria.

Included in this unit are soils that are at least 45 centimeters in depth to deep, highly decomposed, parent material. Permissible range in surface textures for all soil depths included in this unit are sandy loams to clay loams. Subsoil textures for one and two depth soils may also vary within this range. However, subsoil textures for three and four depth soils must be no coarser than a loam. Maximum slope gradient for all soils is 35 percent.

The soils in this unit are extensive in the project watershed areas. They are slightly to severely eroded. Most are in native vegetation, the density of the latter varying according to the degree of past erosion. The major land treatment practice for these

lands will be the construction of bench type terraces for maximum land use and conservation of soil and water.

Land Capability Unit VIIe1 - Deep to moderately deep, well drained, moderately fine to moderately coarse textured upland soils on very steep slopes.

The soils in this unit are formed in place from the weathering of parent rocks consisting either of granite, gneiss, schist, or phorphyry. They are generally non-rocky, well to excessively drained, and occupy slopes from 45 to 58 percent. Surface textures consist of sandy loams to clay loams. Subsoil textures are in the same range as surface textures. They are deeper than 90 centimeters to weathered parent material.

This unit differs from VIe1 by having steeper slopes.

The lands in this unit occur in very steep mountainous areas where erosion hazard is severe. The usual mixed open stands of scrub pine and hardwood trees is the predominant vegetation.

Land Capability Unit VIIe3 - Shallow and very shallow, coarse textured soils with very low available water holding capacities.

These residual upland soils are derived from granite, gneiss, schist, and porphyry parent rocks. They are 10 to 90 centimeters deep to weathered parent material. The degree of weathering and the thickness of the weathered mantle is relativity shallow and incomplete on the steep slopes that occur in this unit. The soils are coarse textured, the predominant textures for surface and subsoils being loamy sands and sandy loams. The available AWC does not exceed 3 inches for the deepest soil included in this unit. These soils are generally non-rocky but may contain small areas of rock too small to delineate and areas of exposed weathered parent material. Slopes range from 3 to 58 percent. Past erosion varies from moderate to very severe.

These soils are similar to those in Unit VIe3 except for steeper slopes and greater erosion damage.

Many of the soil areas in this unit have little or no vegetation. Some areas have been vegetated by the ROK government as part of their program of erosion control. In these latter areas, the lands support very open stands of pine and hardwood trees with almost no understory cover.

Land Capability Unit VIIe5 - Moderately shallow to shallow moderately coarse to medium textured upland soils on very steep slopes.

The soils included in this unit are 25 to 90 centimeters deep

to weathered parent material and are formed from a variety of parent rocks consisting either of granite, gneiss, schist, or porphyry. They are well drained, permeable, residual soils with surface textures consisting of sandy loams, loams, and clay loams. Subsoil textures range from loams to clay loams. These soils are found occupying slopes from 45 to 58 percent. Due to steep slopes, erosion hazard is high for these soils. Past erosion for most of the lands has been moderate to very severe.

The soils in this unit are similar to those in Unit VIe5 but differ by having steeper slopes.

These soils support mixed stands of pine and hardwood trees.

Land Capability Unit VIIIe1 - Very steep watershed lands.

Included in this unit are shallow soils and miscellaneous land types on slopes exceeding 58 percent. Erosion hazard is extreme and severe erosion occurs where the cover is disturbed. Many of the lands in this unit are very severely eroded and devoid of vegetation. Stabilization of these areas by vegetative plantings and/or other necessary works is necessary in order to protect lower lying productive lands.

These lands are suited for watershed and wildlife.

Land Capability Unit VIIIs4 - Extremely rocky, very shallow watershed land.

Lands in this unit are extremely rocky and occur on slopes exceeding 58 percent. Moderately shallow to very shallow soils containing appreciable rock detritus in the profile and on slopes exceeding 58 percent are included in this unit. Also included are rock outcrops and slopes covered with talus material. These lands support some vegetation, the amount varying with depth of soil material.

Lands in this unit are suited to watershed and wildlife uses.

Land Capability Classification Maps for both Pilot Demonstration Areas are shown on Plates III and IV.

CHAPTER 6 - NATION WIDE UPLANDS SOIL SURVEY PROGRAM

6.1 Introduction

The bench terrace system of land conversion first developed by UNKUP for use in the Pilot Demonstration Areas was, in 1964, expanded and applied to other upland areas in the southern provinces of South Korea. This demonstrational work was performed under a joint-venture agreement between FAO, USOM and MAF. The success of this expanded program together with positive results obtained from the upland development work in the Pilot Demonstration Areas, led to the adoption of a National Soil Survey Program by the South Korean Government to provide basic soils information needed for development of the uplands in accordance with criteria established by UNKUP.

In order for this program to be carried out in an orderly and technical manner, UNKUP undertook the responsibility of supervising the program as part of its regular project through 1966.

6.2 Purpose and Scope

A) Purpose

The primary purpose of this program was to locate and convert to agricultural use all the potential farm lands in the presently under utilized and eroded uplands. It is estimated that there are some 400,000 hectares of this land in Korea which could be used for dry land farming if properly converted and farmed. This would increase the present cultivated uplands by almost 50 per cent and would help attain the food requirements of the present and expanding population. To attain this goal the Government of Korea planned a Seven-Year Nation Wide Development Program to carry out the practices and recommendations of the United Nations Korean Upland Project. These recommendations, which provide for development of the Uplands for maximum production of food crops, grass and trees, also provide benefits for the lowlands, by reducing damage to reservoirs, land and crops resulting from annual flooding and siltation.

B) Scope of Project

The program provides for development of all South Korea including the off-shore islands and Chejudo. The area involved is approximately 98,430 square Kilometers:in all 8 provinces including Chejudo Island.

6.3 Nation Wide Soil Survey Program

The phase of this program was confined to field work consisting of the examination and mapping of soils to provide the necessary soils data

for classification of all the uplands to determine the most beneficial use of all areas and the selection of all lands suitable for conversion by the Bench Terrace Method. The activities required the selection of qualified technical personnel, training of key personnel for specialized work necessary to carry out development phases of the project and the actual execution of the work program which consisted of the soil survey, ownership mapping, laboratory analysis of soil samples taken by the soil survey crews, and preparation of Land Capability Classification Maps of each sub-watershed and the tabulation of all areas classified.

6.4 Execution of Soil Survey Program

A general plan for the survey of all the uplands in Korea provided for the implementation of the Soil Survey work in 1964 on 6 watersheds and expanding the work during the next 3 years so as to complete all soil survey work one year ahead of the 7 year development program.

6.5 Phases of Work

Three phases of work were scheduled and completed under the supervision of Upland Project Officials. The period for each phase, the amount of won budgeted and the area surveyed are as follows:

Phase	Period	Budget-Won	Survey Area
First	Sep. 1964-Apr. 1965	27,463,845	447,000 ha
Second	May 1965-Dec. 1965	46,300,000	897,330 ha
Third	Jan. 1966-Dec. 1966	63,900,000	2,251,030 ha
	Total:	₩ 137,663,845	3,595,360 ha

6.6 Scope of Work

This additional activity required recruiting and training new employees, purchasing new soil survey and laboratory equipment, and procurement of aerial photos for all of South Korea.

A) Recruiting and Training Personnel

Recruitment and selection of new personnel required the interviewing of several hundred applicants for each phase of the program. A four week training course of selected key personnel was given at the Agricultural Training Center at Suwon for the first phase and at the Agricultural College in Seoul for the second phase. This training was given by UNKUP Senior Technicians. Technicians of the FAO Soil Survey Project, both foreign and Korean, also assisted in this training. For the third phase of the program, new key personnel were

selected by promoting employed Assistant Technicians trained on the job and by on the job training for new Assistants.

The number of soil survey teams engaged in field surveys and the number of trained key personnel are:

	Soil Survey	Training Program		
Phase	Teams	Key Personnel	Period	Location
1	49	51	Sep. - Oct. 1964	Agriculture Training Center At Suwon
2	82	30	July 1965	Seoul City Agricultural College
3	85	10	On the Job Training	

B) Purchasing Soil Survey and Laboratory Equipment

All of the soil survey equipment including soil sampling augers, color charts, field testing kits, abney hand levels, and drafting equipment was procurred in Tokyo. An initial purchase was made in October, 1964, for equipping 50 soil survey crews and a subsequent purchase made in 1965 for an additional 35 soil survey crews. In September, 1965, complete mechanical and chemical laboratory soil testing equipment was purchased.

C) Procurement of Aerial Photos

All aerial photographs required for South Korea to execute this project were obtained by UN-FAO Engineer A. W. Redman. A total of 52,160 photos, mainly 1:10,000 scale were obtained for soil survey mapping. A total of 47,860 photos were obtained from the U.S. Army Map Service in Japan, of which about 10 percent were 1:40,000 scale for steroscopic study and 90 percent 1:10,000 scale for soil survey mapping. An additional 2,892 photos were enlarged from 1:40,000 scale photos to 1:10,000 scale by the Korean Army Map Service in Pusan, Korea, by joint agreement with U.S. Army Advisors, the Korean Army Map Service and the Ministry of Defense. Formerly 172 photos were enlarged in Japan by the Fuji Film Company. The balance of coverage, consisting of 1,177 photos, were obtained from the Korean Army Air Force.

6.7 Soil Sampling and Testing

A total of 9,646 soil samples were collected by the soil survey crews. These samples were analyzed by the Nation Wide Soil Laboratory in Suwon.

Mechanical and chemical analyses were made of each sample. Samples taken and analyzed for each phase are:

Period	No. samples analyzed
Aug. 1964 to Apr. 1965	2,371
May 1965 to Dec. 1965	4,236
Jan. 1966 to Dec. 1966	3,039
Total	9,646

6.8 Completion of Soil Survey Program

The soil survey program was originally planned to locate and map a specific amount of conversion land each year. This was based on an estimate of the amount of convertible lands that were in the different areas. The work schedule was based on the number of soil surveyors and the amount of land they could survey in a specific period.

The area in hectares actually surveyed and the hectares of selected conversion land for each phase are:

Phase	Period	Area in Hectares	
		Survey Area	Conversion Land
1	Sep. 1964 - Apr. 1965	450,750	33,009
2	May 1965 - Dec. 1966	1,313,850	65,813
3	Jan. 1966 - Dec. 1966	2,251,030	55,532
	Totals:	4,014,630	154,354

6.9 Additional Soil Survey Work

Following completion of the UN-FAO, UNKUP supervised program which ended December 31, 1966, all maps, photos and soil survey equipment was delivered to the Union of Land Improvement Association as instructed by the Minister of Agriculture and Forestry.

This nation wide uplands soil survey work, following the procedure established by UNKUP and using the soil surveyors trained by UNKUP is continuing as a Korean project under the administration of the Korean Union of Land Improvement Association.

GLOSSARY

I Abbreviations used

A. Organizations:

UNKUP United Nations Korean Uplands Project
The name adopted and used for the United Nations Special Fund Project. (Agricultural Survey and Demonstration in Selected Watersheds in Korea.)

KULIA or ULIA Korean Union of Land Improvement Association

MAF Ministry of Agriculture and Forestry, Republic of Korea

NACF National Agricultural and Cooperative Federation

ORD Office of Rural Development

ROK Republic of Korea

USOM or ICA United States Operation Mission - Korea

B. Soil and Land Use

1. Fertilizer

N - Nitrogen

P - Phosphate

K - Potash

Ca - Lime

2. Other

Ha. - Hectare

LCU - Land Capability Units

PCL - Potential Convertible Land

P.D.A. - Project Demonstration Area

II Technical Terms

Watershed The area within the high ground boundary line between two or more adjacent drainage divides. A drainage area.

Subwatershed A small drainage area - a separate entity delineated on basis of hydrological boundaries.

III Korean Political Divisions -- English equivalent

Burak - Village

Ri - Township

Myon - A political grouping of townships

Gun - County

Province - State

IV Land Measurements

PYONG area equivalent to 0.033058 Are

TANBO " " " 9.91736 Are
(approximately 1/10 of a hectare - also listed as 'Tan')

CHUNGBO area equivalent to 99.1736 Are or 0.991736 hectare

V Volume

SUK 180.39 Liters or 5.119 bushels

VI Weight

KWAN 3.75 Kilograms or 8.2672 pounds

VII Money

WON also written '₩' - Present Value ₩ 270 = $1.00