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THE UNIVERSITY OF OKLAHOMA

GRADUATE COLLEGE

A LAND USE REGIONALIZATION OF THE REPUBLIC OF KOREA

A DISSERTATION

SUBMITTED TO THE GRADUATE FACULTY

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BY

BALLARD MICHAEL BARKER

Norman, Oklahoma

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APPROVED BY

DISSERTATION COMMITTEE

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CHAPTER I

THE PROBLEM

Statement of the Problem

Land use studies in one form or another have been conducted with increasing frequency in nearly every part of the world in the last fifty years as man's concern for one of his most fundamental activities --the use of the land--becomes evermore critical. This has especially been the case in many of the technologically advanced countries where the problems of economic and national development provided early impetus for investigation. The situation, however, is significantly different in those areas of the world which have traditionally been considered underdeveloped. It is considered essential that every country produce a general reconnaissance overview of its environment in order to do intelligent development planning, yet because of various obstacles to research, there is still a chronic shortage of land use information on a very large part of the developing world.[1]

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[1]NASA, Earth Resources Survey Systems, Vol. I, NASA SP-283 (Washington, D.C.: U.S. Government Printing Office, 1972), pp. 181-182.

The Republic of Korea is one of the rapidly developing countries where there is insufficient knowledge of regional land use patterns during an important period of its economic take-off. Contemporary studies which are extant deal exclusively with agricultural characteristics of land use and give the impression that agriculture dominates the country's landscapes. On the contrary, despite the fact that approximately 50 percent of the Korean population is engaged in primary agricultural activities which comprise nearly 30 percent of the GNP, only about 23 percent of the land area is involved in agriculture.[2] Further, these studies tend to use rather arbitrary and convenient regional boundaries of questionable validity and precision.

The problem, then, is to develop and apply techniques that enable rapid, but objective and precise, delimitation of integrated land use regions in the Republic of Korea which have a complexity and scale consistent with current needs for a national environmental overview.

Background of the Problem

Man's use of the earth has progressed in the last few thousand years from a point of negligible or minimal disruption of the environment to a point where environmental impact is a major issue and concern for man's living space is becoming urgent. Land use studies have become a major vehicle for determining the nature and present scope of

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[2] Facts About Korea (Seoul: Ministry of Culture and Information, 1971), p. 69.

land use activities, as well as, for planning and monitoring future change and growth.

Studies in Developed Areas

Land use studies in developed countries have been conducted for a wide variety of reasons and with a considerable range in method, scale and result. They are commonly conducted at the local or regional level as a prelude for land use planning and zoning, and less frequently, on the national level for general informational purposes. One of the earliest and best known studies of this type was the Land Utilisation Study of Britain founded by L. Dudley Stamp in 1930. It was a prerequisite for rational planning for the use of Britain's extremely restricted land resources, with special emphasis on its agricultural future. Specifically, it had as its objective the remedying of what Stamp considered as a major defect--the "...lack of knowledge of existing land use...."[3] An updated and more detailed version of that survey was conducted in the 1960's.

Stamp went on to become one of the great proponents of land use mapping, classification and planning. He very early sensed the need for an understanding of land use patterns in both modern industrialized states such as those of Europe and in the less developed countries of Asia and Africa. Stamp also encouraged the establishment of the

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[3]L. Dudley Stamp, Man and the Land (London: Collins, 1964), p. 241.

World Land Use Survey in 1950 under the sponsorship of the United Nations Educational, Scientific, and Cultural Organization (UNESCO).

The World Land Use Survey had the twin objectives of: (1) testing methods of survey with emphasis on aerial photography, and (2) stimulating an international land use study effort using compatible procedures.[4] Although the commission and its survey have made only sporadic and marginal advances in the intervening years, it has encouraged inventories and mapping projects in several countries and has raised the general level of consciousness of the problem.

Until recently land has not been a scarce resource in the United States and interest in land use mapping and policy grew more slowly. There has been little coordination and the land use study effort has been fragmented among a host of federal agencies, state and local governments and agencies, and educational institutions. Probably the best small-scale land use map and study of the entire United States yet published is that by Marschner which is almost entirely agricultural in orientation.[5] The first nationwide study and mapping of land use at large and medium scales is being conducted by the Land Use Data and Analysis Program of the U.S. Geological Survey (USGS). This long-term effort

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[4]L. Dudley Stamp, Applied Geography (Baltimore: Penguin Books, 1963), pp. 46-47,

[5]Francis J. Marschner, Land Use and Its Patterns in the United States. Agriculture Handbook No. 153. (Washington, D.C.: U.S. Department of Agriculture, 1959).

which began in the 1970's is systematically mapping and analyzing land use and cover data at Level II of the USGS classification system discussed in Chapter III.[6]

Some of the earliest formal land use mapping in the United States was conducted during the 1920's and 1930's by Michigan's Land Economic Survey using conventional surveying techniques, although the cartographic use of aerial photography had been experimented with in the state as early as 1920.[7] Those early efforts were followed in 1935 by the extensive rural land classification program of the Tennessee Valley Authority's Division of Land Planning and Housing.[8] Since that time the TVA has remained active in mapping and the development of improved techniques.

Hawaii was the first state to initiate a modern statewide land use study in response to its State Planning Act of 1957. This act required that all land be classified as to its current and potential use. The results were used as a planning and zoning guide whose purpose

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[6]U.S. Geological Survey, "Land Use Data and Analysis Program," Reston, Virginia, 1975, p. 1. (Mimeographed.)

[7]Preston E. James, All Possible Worlds: A History of Geographical Ideas (Indianapolis: The Odyssey Press, Division of Bobbs-Merrill Company, 1972), p. 491; and Willis T. Lee, The Face of the Earth As Seen from the Air. American Geographical Society Special Pub. No. 4. (New York: American Geographical Society, 1922), p. 56.

[8]Robert G. Reeves, ed., Manual of Remote Sensing (Falls Church, Virginia: American Society of Photogrammetry), pp. 1990-1991.

was similar to that of Britain's Land Utilisation Survey.[9] In the mid-1960's New York and Minnesota began long term programs for statewide, large-scale land use surveys. The New York State Land Use and Natural Resources Inventory (LUNR) was designed to compile the first comprehensive land use map in the state's history and to build a living data base for future management. It uses 50 land use classifications to record both present activity and intensity of use.[10] The Minnesota Land Management Information System Study uses 9 land use classes to map the state in 40 acre cells. Like LUNR, this is a pioneering attempt at environmental planning, but neither program directly encompasses any significant spatial analysis.[11]

On the regional level the California Urban-Metropolitan Area Open Space Study of 1968-69 was an example of a tailored practical program. In this case the concern was the rapid loss of open space around several population centers. Although designed to provide a basis for local governments' open space preservation policies, it had as a further objective the development of methods and criteria for the

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[9]Derek Lovejoy, ed., Land Use and Landscape Planning (New York: Barnes and Noble, 1973), pp. 240-241.

[10]Ernest J. Cole, A Review of the New York State Land Use and Natural Resources Inventory (Ithaca N.Y.: The Center for Aerial Photographic Studies, Cornell University, 1970), pp. 2-4.

[11]George W. Orning and Leslie W. Maki, "The Minnesota Land Management System Study," Proceedings of Seminar on Operational Remote Sensing (Falls Church, Va.: American Society of Photogrammetry, 1972), pp. 171-173.

systematic analysis of land use.[12]

The onset of massive federal funding of highway and urban development programs also encouraged a multitude of studies dealing with specific developmental impacts on localities. The literature abounds with cases such as the Puget Sound Regional Transportation Study, the Atlanta Region Metropolitan Planning Study, and the Detroit Regional Transportation and Land Use Study, all of which were completed before 1970.[13]

More recently the increased public interest in environmental affairs and the novelty and interest generated by space imagery have stimulated a large number of state and local projects involving some aspects of land use study in the broadest sense. Among these are statewide inventories in Alaska, Connecticut, Massachusetts, Michigan, Minnesota, Rhode Island, Wisconsin, and Wyoming, and regional projects in resources and urban growth in several other states such as Arizona, California, Pennsylvania, and Texas.[14]

Other examples of national land use classification and mapping

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[12]Lovejoy, Land Use and Landscape Planning, p. 236.

[13]H. James Brown, et al., Empirical Models of Urban Land Use: Suggestions on Research Objectives and Organization. Exploratory Report 6 to the National Bureau of Economic Research (New York: Columbia University Press, 1972).

[14]Stanley C. Freden and Enrico P. Mercanti, eds., Symposium on Significant Results Obtained from Earth Resources Technology Satellite-1, Volume III-Discipline Summary Reports (Greenbelt, Md.: Goddard Space Flight Center, 1973), pp. 20-23.

programs which have been conducted in technologically advanced countries in recent years are those of Japan, Australia, and Canada. All of these are ongoing projects with multiple purposes. About 60 percent of Japan has been classified and mapped at small and medium scales as a part of its post-war reconstruction program.[15] The Canada Land Inventory's objective is the small scale mapping of land occupance and use in the settled portions of the national territory.[16]

In addition to practical studies there are several examples of academic exercises in the literature which have served to satisfy curiosity, develop land use classification techniques, or serve as teaching vehicles. The majority of the early studies dealt with rural or agricultural uses and several attempted some sort of regionalization scheme. First generation studies by Whittlesey, Baker, Jonasson, and Cressey[17] were followed by early quantitative attempts such as Weaver's,[18]

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[15]Inter-Agency Steering Committee on Land Use Information and Classification. Proceedings of the Conference on Land Use Information and Classification (Washington, D.C.: U.S. Geological Survey, 1972), pp. 147-148.

[16]Ibid., p. 28.

[17]Derwent Whittlesey, "Major Agricultural Regions of the Earth," Annals of the Association of American Geographers, XXVI (1936), pp. 199-240; O.E. Baker, "Agricultural Regions of North America," Economic Geography, II (1926), pp. 459-493; O. Jonasson, "Agricultural Regions of Europe," Economic Geography, I (1925), pp. 277-314; and George B. Cressey, "Agricultural Regions of Asia," Economic Geography, X (1934), pp. 109-142.

[18]J. C. Weaver, "Crop-Combination Regions in the Middle West," Geographical Review, XLIV (1954), pp. 175-211.

and in the 1960's and 1970's by a host of studies using aerial and space imagery as major data inputs.[19] Large-scale urban land use studies for both theoretical and practical purposes have become increasingly common since the 1930's.

All of these efforts suffer from the lack of uniformity of method and result which prevents any meaningful temporal or spatial analysis so necessary if complete global land use is ever to be effectively inventoried and monitored. Nevertheless, both the practical and the academic studies in developed nations continue to be encouraged by programs such as the UNESCO World Land Use Survey, the International Geographical Union's Commission for Agricultural Typology, the U.S. Geological Survey's Census Cities Project and Land Use Data and Analysis Program, and Congressional proposals for the establishment of a national land use policy for the United States.[20]

The Developing World

Developing countries of the world have, for the most part, lagged behind in the acquisition of land use information. Academic case studies of small areas are fairly common, but large area studies

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[19]Numerous examples are referenced in Nelson R. Nunnally, "Interpreting Land Use From Remote Sensor Imagery," in Remote Sensing: Techniques For Environmental Analysis, ed. John E. Estes and Leslie W. Senger (Santa Barbara, Calif.: Hamilton Publishing Co., 1973), pp. 177-187.

[20]Proceedings of the Conference on Land Use Information and Classification, p. 16.

and mapping have generally been done only to such an extent as was needed by some of the more advanced nations in attaining goals of national interest to the latter. Several agencies of the U.S. Government have been especially active in this regard, and the spurt of interest in Southeast Asian landscapes and land uses in the 1960's was particularly obvious.[21] Even academic studies of underdeveloped areas have been significantly retarded because of political, economic or physical restrictions. Specific problems frequently facing the researcher are shortfalls in time and funding, incomplete physical and cultural accessibility, an inadequate or nonexistent data base, and the lack of an indigenous technical infrastructure.

Despite the difficulties there have been many small descriptive land use studies in underdeveloped areas, including a few notable attempts. One of the greatest monuments to organization and perseverance is Buck's classic study of traditional land use processes and patterns in Republican China.[22] Another was the Rural Land Classification Program conducted during 1949-51 by the Commonwealth of Puerto Rico. Its objective was a comprehensive classification of

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[21]U.S. Department of the Army, Advanced Projects Research Agency, Resources Atlas Project-Thailand (Bangkok: U.S. Army Engineer Agency for Resources inventories and Applied Research Corporation of Thailand, 1969); and Nafis Ahmad, Economic Resources of the Union of Burma (Natick, Mass: Earth Resources Laboratory, U.S. Army Natick Laboratories, 1971) are examples.

[22]John L. Buck, Land Utilization in China (Shanghai: Commercial Press, 1937).

nearly all land use on the island so that natural resources could be managed better despite high population pressures on the land.[23]

More recently, first generation land use inventories have been completed in a number of emergent countries, to include Sri Lanka, Cyprus, Malawi, and Tanzania. But, there is still a chronic shortage of geographical land use information in that part of the developing world where there are "...large numbers of peasant farmers, operating on small scale in an environment with few external links and a relatively simple economic climate and yet subject to radical and rapid change."[24] Many scientists would seem to agree with one commission's findings that when adequate resources become available, the "...highest priority should be assigned to inventory of arable land in the non-Western world."[25]

The Republic of Korea

The Republic of Korea is one of the less developed nations where there is a dearth of information on either local or regional land

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[23]Clarence F. Jones and Rafael Pico, eds., Symposium on the Geography of Puerto Rico (Rio Piedras, P.R.: University of Puerto Rico Press, 1955), p. v.

[24]M.F. Thomas and G.W. Whittington, eds., Environment and Land Use in Africa (London: Methuen & Co., 1969), pp. 9-10.

[25]Committee on Geography, Division of Earth Sciences, National Academy of Sciences-National Research Council. Report of the Committee. Spacecraft in Geographic Research (Washington, D.C.: National Academy of Sciences, 1966), p. 64.

use. Korea only emerged into the modern world during the first decade of this century with the occupation and subsequent annexation of the peninsula by Japan. The colonial period fostered the growth of an infrastructure which, although staffed largely by Japanese colonists or nationals, began the ordering of the traditional landscape and the collection of a land use data base. During this period the Japanese codified land ownership practices, accomplished extensive and high quality topographic surveys, and initiated data collection and recording procedures necessary for the economic integration of the Korean colony.

The end of World War Two brought about the dissolution of the Japanese Empire and, at the same time, a period of severe political, economic, and social turbulence in Korea. That was followed from 1950 to 1953 by the massive destruction and partition of the Korean War and further political and economic problems. Until the early 1960's nearly all of Korea's resources were applied toward physical reconstruction of wartime losses and maintenance of military security. Since then some resources have been allocated for rapid industrial development and for general improvement in the national standard of living. The limited resources available and political realities have, however, largely precluded substantial public or private involvement in such "luxuries" as land use studies until recently.

The only modern inventory of land use in Korea extended from 1908 to 1918, first under the supervision of the Korean Department of

Finance, and later under the Japanese colonial government. Land was placed in one of 19 land use classes primarily for taxation purposes.[26] The earliest scholarly studies dealing with any aspects of land use were done by Japanese during the colonial period. Kato, Nagai, and Nakakawa attempted to define agricultural regions on the basis of predominant crop growing areas.[27] During the 1930's there was a worldwide flurry of agricultural and land use studies and Korea was not forgotten. In 1934 Coulter and Kim used 1928-29 data from the Japanese colonial governor's office to depict Korea's "land utilization" in a series of seven dot maps of crop and population distribution.[28] The thesis was that crop production coincided closely with population distribution, a point of little surprise in a rural subsistence economy.

The use of physical environmental regimes to delimit land use and agricultural regions has been common throughout the world, and in 1935 Hall relied almost entirely upon climatic characteristics to divide the entire Korean peninsula into just three agricultural regions.[29]

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[26]Lee Hoon Koo, Land Utilization and Rural Economy in Korea (Chicago: University of Chicago Press, 1936), pp. 102-106.

[27]Lee Chung Myun, "A Study of Agricultural Regions in South Korea," Geographia Polonica, XIX (1970), p. 150, citing I. Nagai and Y. Nakakawa, "Major Species and Its Distribution," Agricultural Expermental Station Report, V (No. 1, 1924).

[28]John W. Coulter and Bernice B.H. Kim, "Land Utilization Maps of Korea," Geographical Review, XXIV (July, 1934), pp. 418-422.

[29]R.B. Hall "Agricultural Regions of Asia, Part VII," Economic Geography, XI (January, 1935), pp. 44-52.

The most comprehensive and detailed land use study to date, despite its shortcomings by comtemporary standards, is the widely cited study by Lee.[30] This study, which was similar in style to Buck's work on China, was sponsored by the Institute of Pacific Relations and it was the first and only attempt to incorporate agriculture, forestry, urban, and mineral land use, as well as numerous other economic and functional characteristics. Data for the study were almost entirely obtained from field surveys, household samples, and from records of the Japanese Governor-General's office. In consonance with the times, the data and findings were presented descriptively using dot maps and tables of provincial level statistics. Lee struck down all previous attempts to define agricultural regions as being based on convenience, arbitrariness, or other nonscientific grounds which did not reflect any marked diversity of agriculture.[31]

A number of geographers published Korea studies during the period from the middle 1930's through the 1950's, the most prominent being Grajdanzev, Lautensach, McCune, and Zaichikov. Both Lautensach and McCune published several articles and monographs, some of which dealt with regionalizations of various elements of the environment. Some of Lautensach's papers discussed agricultural types and their distribution, and McCune's research and publication focused on a delineation of Korea's

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[30]Lee, Land Utilization and Rural Economy in Korea.

[31]Ibid., p. 83.

climatic regions and their associated landscapes and economies.[32] All four also published general geographies which included various regional schemes, but all of them were descriptive approaches based largely upon personal observation and subjective evaluation. None dealt directly with integrated land use classification or regionalization.[33]

During the Korean War the Canadian government published a monograph on Korea's geography which received wide distribution. It included two apparently new maps depicting agricultural and industrial regionalizations of the peninsula, but unfortunately there were no supporting data, rationale, or sources given.[34]

Perhaps the most detailed and comprehensive land use map of

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[32]Hermann Lautensach, "Zur Geographie der Kunstlischen Bewasserung in Korea," Petermanns Geographische Mitteilungen, LXXXVI (September, 1940), pp. 289-303; and "Uber den Brandrodung-sfeldbau in Korea mit Bemerkungen zur Urlandscaftsforschung," Petermann's Geographische Mitteilungen, LXXXVII (February, 1941), pp. 41-54 are examples which are available in the USA as cited in Shannon McCune, "Geographic Publications of Hermann Lautensach on Korea," The Far Eastern Quarterly, V (May, 1946), pp. 330-332; Shannon McCune, "Climatic Regions of Korea and Their Economy," Geographical Review, XXI (January, 1941), pp. 95-99; and Shannon McCune, "Climatic Regions," Research Monographs on Korea, Series E. Nos. 1-9 (June, 1945).

[33]Representative general works were: Andrew J. Grajdanzev, Modern Korea (New York: Institute of Pacific Relations, 1944); Hermann Lautensach, Korea, Eine Landeskunde auf Grund Eigener Reisen und der Litteratur (Leipzig: K.F. Kohler Verlag, 1945); Shannon McCune, Korea's Heritage: A Regional and Social Geography (Tokyo: Charles E. Tuttle Company, Inc., 1956); V.T. Zaichikov, Geography of Korea, trans. by Albert Parry (New York: Institute of Pacific Relations, 1952).

[34]Korea: A Geographical Appreciation (Ottawa: Canada Department of Mines and Technical Surveys, 1951, pp. 46-56.

the peninsula yet published appeared in a Korean language atlas in 1957. The map is titled "Land Use" and places all of Korea's land area into one of five categories of predominant surface occupance. An inset map also depicts areas of substantial crop concentration.[35] Unfortunately, this interesting effort is also without further documentation.

In 1967 Koo published a detailed and broad scope study which used 1965-66 governmental estimates and sample data to examine several aspects of agriculture. Its purposes were to better document then existing conditions, contribute to the development of regional planning in agriculture, and to assist other scholars interested in Korean agriculture.[36] In one of five parts of the study Koo classified and delineated 31 agricultural regions. While acknowledging that both "natural and economic" factors played a role, and indeed, were the major determinants of agricultural regions, only three attributes were used in the classification: (1) ratio of arable to nonarable land, (2) ratio of arable to paddy cropped land, and (3) the location of provincial boundaries which were, "...naturally established during a long course of history in accordance with natural environments and cultural characteristics."[37]

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[35]Lee Sang Man, ed., Saeroun Urinara Chido [New Atlas of Our Country] (Seoul: Hong Ji Sa, 1957), pp. 10-11.

[36]Koo Jae Suh, A Study of the Regional Characteristics of Korean Agriculture, Study for the International Agricultural Research Institute (Seoul: Korea University, 1967).

[37]Ibid., pp. 333-338.

Throughout the past half-century there has been considerable interest in the classification or division of Korea into "agricultural management" regions. Some of this interest was manifested in Japanese and Korean language studies by Ihn, Seoh, and Hisama which used land use information.[38] The most recent research, and the most available to Western scholars, was Lee's study which used 1960 census data and other annual statistical reports to define "agricultural regions."[39] Fifteen attributes were considered in the study, and all but one were indices of agricultural management and economics. Although there is little documentation and no explanation of procedures used in the regionalization, Lee apparently mapped the various attributes for each minor political subdivision and then superimposed and subjectively evaluated the compage. The resulting 17 different categories of agricultural regions were applied to some 1,520 study units without any contiguity constraints and produced several hundred specific regions.[40] Of interest is Lee's concluding paragraph which states:

> Most of the research [projects] in this field have hitherto concentrated on qualitative classification. They suffer the weakness of subjectivity: there is little computible [sic] basis for establishing

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[38]Ihn Chung Shick, Agricultural Regions in Korea (Seoul: 1937); Seoh Chang Kee, A Classification of Agricultural Regions in Korea (Unpublished thesis, Kyungbuk University, 1962); K. Hisama, A Study of Agricultural Management in Korea (Tokyo: 1950) all cited in Lee, "A Study of Agricultural Regions in South Korea," pp. 150-155.

[39]Lee, "A Study of Agricultural Regions in South Korea."

[40]Ibid., p. 170.

> comparable agricultural regions by independent scholars. Some measureable, yet manageable criteria should be prepared as objective standards to build on. Perhaps, further studies will employ a much needed quantative [sic] approach.[41]

The same might be said for the broader class of land use studies.

The Korean government itself became interested in land use studies, planning, and management after 1961 when President Park Chung Hee decided to break free from the developmental lethargy which had characterized the nation since its independence. Passage of the Comprehensive National Land Construction Planning Law of 1963 was the first step in a chain of governmental and social consciousness of the problem.[42] Its purpose was the enhancement of the national government's economic development programs, and it focused on several areas of public works capital investment. The utility of that new action was immediately apparent because, as one economist observed earlier:

> At practically every stage in the evolving development program, Korea has been handicapped by the fact that it did not have a firm factual basis for this program--that the planners were forced to rely upon statistics in which they had little or no confidence.[43]

In 1968 a set of National Physical Planning Guidelines evolved which led directly to the formulation and approval in October, 1971 of

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[41] Ibid.

[42] National Land Development Plan: 1972-1981 (Seoul: Government of the Republic of Korea, 1971), p. 6.

[43] Nam Kyu Chung and Heung Keun Oh, An Introduction to Korea Agriculture (Seoul: The American-Korean Foundation, 1962), p. 139.

the National Land Development Plan: 1972-1981.[44] The basic objectives of the plan are fourfold: (1) enhancement of efficiency in land use management, (2) expansion of the economic development foundation, (3) development of the land resources and the conservation and protection of nature, and (4) the improvement of people's living environment.[45] One of the first prerequisites for meeting those objectives is the gathering of basic information about what conditions exist at the present. As one of its steps, the plan requires the classification of the entire national area into one of the five functional categories: (1) agricultural, (2) forest, (3) urban, (4) natural, and cultural assets conservation areas, and (5) continental shelf areas.[46] The study and action groups must accomplish the tasks set forth in the plan under severe constraints. They must be done under the pressure of substantial historical residual, rapid industrialization and urbanization, and in the midst of extremely high population density.[47]

Korea's Setting for Development

The Republic of Korea occupies the southern half of the Korean Peninsula which extends southward from the East Asian mainland to within 200 kilometers of the Japanese islands of Honshu and Kyushu. It encompasses slightly under 100,000 square kilometers of contiguous

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[44] Ibid., p. 7. [45] Ibid., pp. 11-12. [46] Ibid., pp. 15-16.

[47] Ibid., p. i.

land area and several hundred islands clustered along the southern and western coastlines (Figure 1).

The Korean landscape is dominated by a mountainous cordillera along the eastern coast and several ranges of lower mountains and hills extending to the southern and western coasts. Collectively, these mountainous areas occupy over 70 percent of the country's land area. Maximum elevations are commonly only 1,000 to 2,000 meters, but because of recent uplifting and the geologic structure, the uplands exhibit extremes of ruggedness and local relief. In the east a mature landscape of V-shaped valleys, steep stream gradients, and an emergent coastline have developed. Along the western coast there is a more mature landscape of fairly broad alluvial plains separated by worn remnants of ancient mountain roots. These plains constitute the largest and most productive agricultural area on the peninsula but include less than 15 percent of the national area. It is a well drained landscape in which there are virtually no natural lakes or marshes, and where all rivers are short, rapid flowing, and possess distinct seasonal flow regimes.

The peninsula has a humid-continental climate which is under the influence of the very strong Asian monsoon system. Winters are cold and dry with strong northerly wind flows. Temperatures in January range from -10°C along the 38th Parallel to 0°C along the southern coast. Summers are everywhere warm and humid, with temperatures

KOREA'S SETTING

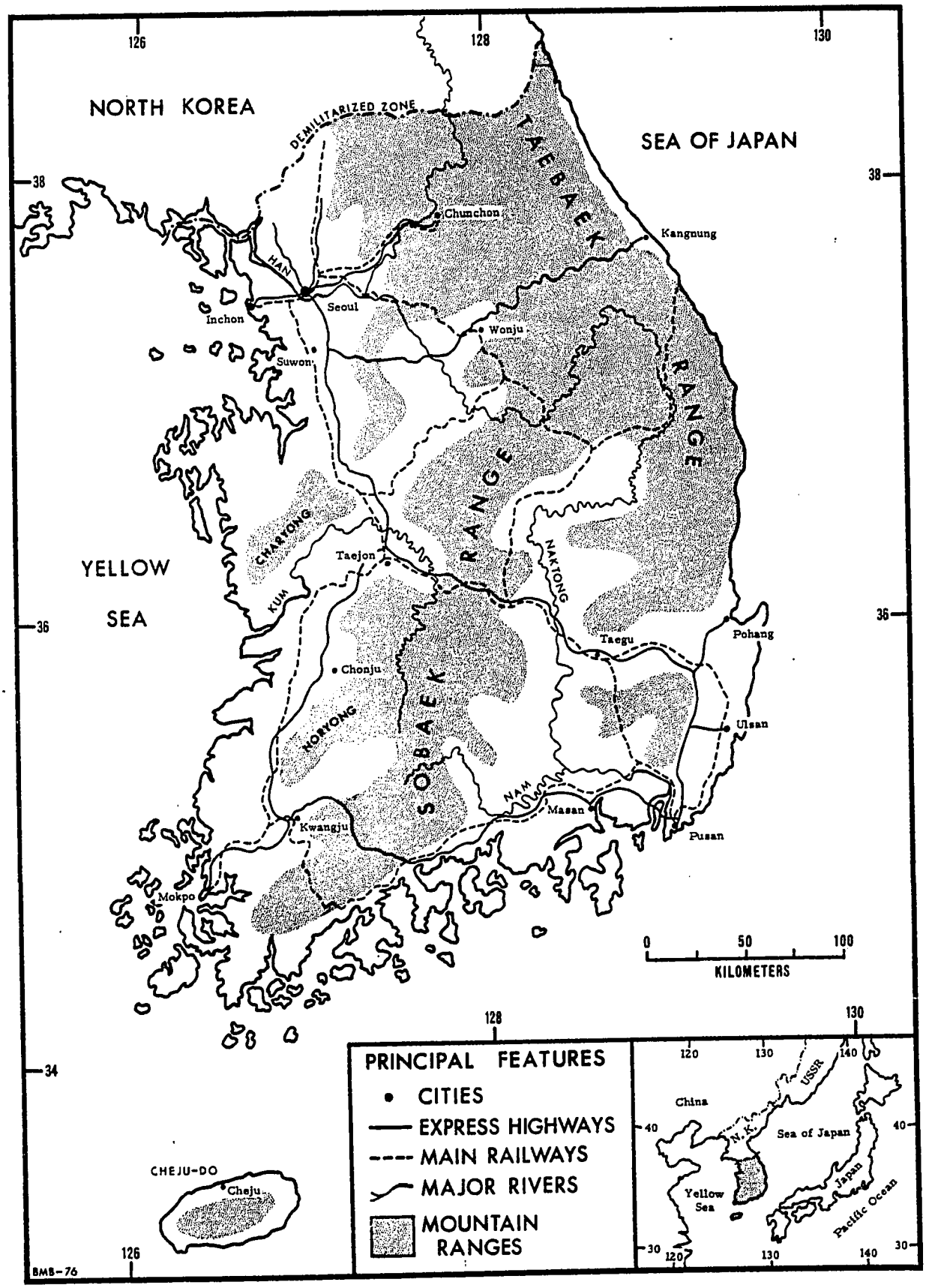

Figure 1

averaging 26°C in August. Over 50 percent of the average annual precipitation of 1,000 to 1,500 millimeters occurs in July and August, and only 15 percent falls in the six winter months.[48] Agriculturally, no area is deficient in precipitation. The growing season ranges from about 175 days in northern inland areas to over 220 days in the south.[49]

The population of Korea in 1970 was 31.5 million with an annual growth rate of just under 2 percent, down from nearly 3 percent in 1960.[50] The government estimates that despite expected further decreases in the annual growth rate, the total population will reach 37 million by 1981.[51] The low degree of urbanization, large subsistence sector in the economy, and tolerable physical environment allow the population to be more evenly distributed than might be expected. Nevertheless, in 1970 about 52 percent of the population was found in the western and southern lowland areas which constituted less than 22 percent of the national area.[52]

Korea has made spectacular economic advances since 1961 and

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[48]Korea Statistical Yearbook: 1971 (Seoul: Bureau of Statistics, Economic Planning Board, ROK, 1971), pp. 28-33.

[49]Kenneth G. Clare, et al., Area Handbook for the Republic of Korea. Department of the Army Pamphlet 55-041 (Washington, D.C.: U.S. Government Printing Office, 1969), p. 13.

[50]Korea Statistical Yearbook: 1971, p. 37.

[51]National Land Development Plan: 1972-1981, p. 30.

[52]Ibid., p. 14.

there were reflected in an increase in the GNP of 240 percent by 1970. Modernization of the economy is illustrated by changes in the composition of contributions to the GNP between 1965 and 1970. During that period the primary sector (agriculture, forestry, and fishing) declined from 38.7 to 25.8 percent while the secondary sector (mining and manufacturing) increased from 19.5 to 28 percent and the tertiary sector from 41.8 to 46.2 percent.[53]

It is this industrialization, with its inevitable urbanization, increase in standard of living, and steady population growth which is creating intense competition for the use of the land. Korea has been a food deficit nation since the Korean War, and being an intensive grain farming culture, nearly all land with slopes less than 15 percent has long been cultivated. In such an area the rising expectations and demands of non-agricultural sectors for housing, industry, transportation and public facilities will precipitate immediate dilemmas and beg equally urgent solutions. Already the meager gains of tidal lands reclamation, farm field consolidation, and erosion control have been offset by urban and industrial development which is expected to increase even more dramatically in the next decade.[54]

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[53] Korean Statistical Yearbook: 1971, p. 661.

[54] Jin Hwan Park, An Economic Analysis of Land Development Activities in Korea, Study for the Ministry of Agriculture and Forestry and the U.S. Agency for International Development in Korea (Seoul: Seoul National University, 1969), pp. 7-8.

Objectives of the Research

The objectives of this research are threefold. The first, and perhaps that of widest interest and significance, is one of developing an improved technique for the regionalization of land use attributes. Methodologies focused on mathematical "factoring" and grouping techniques are well established in the literature, having generally replaced traditional descriptive regionalizations as the normative model.[55] Although widely used, these methodologies all suffer the weakness of using a single data point to represent areal data collection units of variable sizes and configurations. That is the case even though the actual distribution of the attributes being regionalized is unknown and is frequently constrained to a fraction of the data unit by physical, economic, or social forces. Consequently, the representation of an entire data unit by a given class, and the establishment of regional boundaries around aggregated data units virtually insures imprecision in the presentation of results.

In recent years since hyper-altitude aircraft and satellites have made very small-scale imagery generally available there has been considerable interest in regionalizing directly from the image. Many of these efforts have involved the manual bounding of areas on the image

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[55]James, All Possible Worlds: A History of Geographical Ideas, p. 522; some of the prominent studies illustrating this contention are listed in Bryn Greer-Wooten, A Bibliography of Statistical Applications in Geography. Technical Paper No. 9 (Washington, D.C.: Association of American Geographers, 1972), pp. 57-67 and 86-90.

displaying visually distinct signatures representing a compage of surface attributes.[56] This technique is rapid and more flexible in boundary placement than mathematical techniques, but it too has problems. The principal disadvantages are the determination of what surface attributes are spatially associated with the photomorphic signatures, and the degree to which a particular attribute affects the signature. This is a major problem when dealing with single factor regions and landscapes exhibiting diverse yet integrated land uses and covers. Because of its subjectivity, manual bounding produces regions which have a low degree of replicability and creates a greater obligation for validity testing of the resulting regional composition and structure. Finally, description of the regions delimited by this technique must rely on indirect evidence from imagery or alternate sources.

The methodology proposed in this study seeks to combine the advantages of each of the two techniques to improve the objectivity, precision, and validity in regionalization. The success of the technique and its application will enchance the speed, economy, and utility of land use studies in all areas of the world, but it will be incrementally most useful to developing countries.

The second objective is concerned with at least partially satisfying a need in the body of regional literature on Korea. The regional

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[56]Reeves, ed., Manual of Remote Sensing, pp. 1961-1975.

concept has long been a principal theme of geographic study,[57] and according to one distinguished committee of the Association of American Geographers, "Geographers are in general agreement that regional study is an essential part of their craft."[58] James was even more adamant in stating that, "The regional concept constitutes the core of geography."[59]

The Republic of Korea is currently experiencing rapid social change and economic development in the face of severe environmental restraints and a body of inadequately organized and managed land use information. Many of the development problems have been recognized and planned for in the National Land Development Plan, but a requirement for its success would seem to be an overview of integrated land use regions within the country. At least some development specialists believe that the most efficient development proceeds in orderly phases from the broad environmental overview to detailed studies of small

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[57]William D. Pattison, "The Four Traditions of Geography," The Journal of Geography, LXIII (1964), pp. 211-216; Preston E. James and Clarence F. Jones, eds., American Geography: Inventory and Prospect (Syracuse, N.Y.: Association of American Geographers by Syracuse University Press, 1954), pp. 21-32.

[58]Ibid., p. 21.

[59]Preston E. James, "Toward a Further Understanding of the Regional Concept," Annals of the Association of American Geographers, XLII (September, 1952), p. 195.

areas,[60] and that specialized knowledge of complex problems must be accompanied by a "composite regional analysis."[61] Richardson was even more specific:

> Consideration of what constitutes a region and of how the economy may be sub-divided into a system of regions would appear to be an essential prerequisite for the analysis of regional economic phenomena.[62]

That such a regional structure is not merely an academic device, but can contribute to the understanding and success of development plans is indicated by the assertion that, "...spatial structure and spatial process are circularly causal. Structure is a determinant of process as much as process is a determinant of structure."[63]

The last objective is to satisfy a scholarly curiosity as to the composition and distribution of major land use associations in the Republic of Korea. This is the "academic" mode of regional study about which the Committee on American Geography agreed:

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[60]Kirk P. Rogers, "Some Criteria for Making Decisions to Invest in Resource Surveys with Special Emphasis on Developing Countries," in Earth Resources Survey Systems, Vol. I, NASA SP-283 (Washington, D.C.: National Aernautics and Space Administration, 1972), pp. 181-182.

[61]Reeves, ed., Manual of Remote Sensing, p. 1949.

[62]Harry W. R ichardson, Regional Economics: Location Theory, Urban Structure and Regional Change (New York: Praeger Publishers, 1969), p. 233.

[63]Ronald Abler, John S. Adams and Peter Gould, Spatial Organization (Englewood Cliffs, N.J.: Prentice-Hall, Inc., 1971), p. 60.

> Scientific curiosity prompts such a study.... The conclusions permit or lead to diagnosis of the meaning and import of the discovered relationships. The investigation and presentation of the findings serve to increase knowledge of the earth for the general public, for teaching, and for transfer to cognate disciplines.[64]

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[64]James and Jones, eds., American Geography: Inventory and Prospect, p. 57.

CHAPTER II

RESEARCH DESIGN

The research design used in defining, delimiting and describing the land use regions of Korea is comprised of four parts: (1) the use of statistical data and quantitative computation techniques to define dominant land use factors and regional concentrations or core areas of those factors, (2) the use of satellite imagery to accurately delimit regional boundaries for the core areas defined in step one, (3) the use of ground truth sampling to verify the final boundaries from step two, and (4) a statistical and narrative description of each of the final land use regions.

Definition of Regional Core Areas

The definition of regional core areas is essentially the construction and use of an observation model. It is what Harvey calls "cognitive description," and consists of the collection, ordering and classification of data.[1] Specifically, it is a problem of inductive classification and requires two operational steps.

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[1] Harvey, Explanation in Geography, p. 79.

The Factor Model

The first step is concerned with finding and describing a relatively small number of "composite variables," or factors, which adequately represent a larger body of diverse land use attributes about whose underlying structure and interrelationships one can only hypothesize. A multivariate technique is obviously required, and of the several suitable for analyzing these data, the general factor analysis model was chosen because of computational limitations. This model originated in the behavioral sciences and its use rapidly spread to the social and earth sciences. Its acceptance as a valid tool, or at least its experimental interest in geography, is evidenced by the large and rapidly growing body of literature in which it is used in some form for a wide variety of research purposes. Discussions of the model, techniques for its use, and a large number of applied examples in social and geographic studies are included in standard works by Rummel, Harvey, King, and Greer-Wooten, among others.[2]

The general factor analysis model includes several variant forms, of which, principal components analysis and common factor

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[2]R.J. Rummel, Applied Factor Analysis (Evanston, Ill.: Northwestern University Press, 1970); Harvey, Explanation in Geography; Leslie J. King, Statistical Analysis in Geography (Englewood Cliffs, N.J.: Prentice-Hall, Inc., 1968); Bryn Greer-Wooten, A Bibliography of Statistical Applications in Geography. Technical Paper No. 9 (Washington, D.C.: Association of American Geographers, 1972).

analysis are most extensively used and most relevant to this research design. The consideration of which variant to employ was subject to a host of theoretical and practical factors. The reasons for employing both principal components and common factor variants are adequately discussed in the works cited above.

Principal components analysis is used primarily to determine the minimum number of "factors" or "principal components" which will represent a data matrix, thus facilitating its interpretation. The use of the common factor analysis model, however, requires specification of communality terms in the matrix, an act which presupposes the existance of a priori theory on which to base the specification. Consequently, this model is most suitable for hypothesis testing and other experimental work in instances where there is some knowledge of interrelationships in the data matrix.

Tempering those strict interpretations of the respective variants is the fact that applications of the factor analysis model do not reflect any marked divisions along theoretical grounds. Indeed, even King, who adamantly voices the strict theoretical distinctions and seems to agree with Harvey that common factor analysis may not be the best choice for most geographical problems, cites the actual interchange of the principal components and common factor models in a large portion of the literature which is frequently cited as representative

examples of factor analytic studies.[3] Greer-Wooten reinforces the lack of practical distinction in model roles by stating of the body of common factor analysis applications in geography: "...most of the studies are descriptive, rather than fulfilling the role that factor analytic models are presumed to have in the testing of theory."[4] Others such as Adelman and Morris agree with Thurstone that common factor analysis belongs on the "border line of science" where well defined domains and theory do not necessarily exist.[5] They recognize that on "advanced fields of scientific inquiry" one normally formulates hypotheses to test with factor analysis, but in fields where knowledge is insufficient to prepare a priori models,

> ...it becomes desirable to make only very general specifications and to try to use the data as a guide in the formulation of hypotheses concerning the relative importance of different sources of variation. It is the latter approach that underlies the use of factor analysis.[6]

A common factor analysis model was used for this research because it was the most effective computerized model available to this

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[3]Harvey, Explanation in Geography, pp. 344-345; King, Statistical Analysis in Geography, pp. 182-184.

[4]Greer-Wooten, A Bibliography of Statistical Applications in Geography, p. 64.

[5]Irma Adelman and Cynthia T. Morris, Society, Politics and Economic Development: A Quantitative Approach, (Baltimore: The John Hopkins Press, 1967), pp. 132-133; L.L. Thurstone, Multiple Factor Analysis (Chicago: University of Chicago Press, 1961), p. 56.

[6]Adelman and Morris, Society, Politics and Economic Development, p. 133.

researcher which would accept the required data matrix. There have been too few land use studies which used factor analyzed data to determine the basic factor structures, and no a priori considerations were included here. The specific program used was the UCLA BMDX72 General Factor Analysis program which performs a principal axes solution and an orthogonal rotation of the factor matrix. Since the purpose of the factor analysis was the determination of significant land use factors of an area and its nested sub-areas in 1970, the R-mode of analysis (a cross-section of cases and their attributes at a single point in time) was conducted. The cases studied were 141 county-sized political subdivisions in the Republic of Korea. The 31 variables analyzed largely reflect agricultural uses; but include forest, builtup, barren and water uses of the landscape. The selection of the cases and variables that comprise the data slice are discussed in detail in Chapter III.

The Grouping Step

The second step of the regional definition involved the inductive classification, or grouping, of those cases with similar attributes such that within-group variance or "difference" was minimized while variance between groups was maximized. Factor scores were used to compute paired distances among the 141 cases using the generalized distance of Mahalanobis which is an extension of the Pythagorean Theorem.

The grouping algorithm used was that developed by Ward to form hierarchical groups of a large number ($n > 100$) of mutually exclusive subsets.[7] The grouping process continues by stages until all cases are included in one general class in which 100 percent of the information which originally differentiated the cases is "lost."

For research purposes, however, the grouping process may be stopped at any number of groups between n-1 and 1, and the amount of original information lost can be calculated. This allows the researcher the alternative of stopping the classification when a certain number of classes have been reached or after a predetermined amount of information loss. The decision as to which criterion to apply, and at what level is, along with the choice of initial variables, one of the most critical decisions in the classification process. It has been suggested that the "best" stage to stop is where the graphed incremental loss of detail reaches a minimum, but Johnston found that point difficult to detect and was inconclusive in his recommendation of criteria.[8]

Another alternative is to seek the most stable number of groups, and presumably the strongest group structure, by finding a

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[7] J.H. Ward, "Hierarchical Grouping to Optimize an Objective Function," Journal of the American Statistical Association, LVIII (January, 1963), p. 236.

[8] R.J. Johnston, "Choice in Classification: The Subjectivity of Objective Methods," Annals of the Association of American Geographers, LVIII (September, 1968), p. 587.

plateau in the graphed number of groups per step. Such a plateau will frequently occur fairly high in the step order. It is preceded by a steadily decreasing number of groups as single cases rapidly cluster and recluster to form the basic groups. Once the basic groups are formed they tend to resist collapse. Instead, they attract unattached cases for several steps and form a plateau before the basic groups begin to collapse into each other. It was this procedure which was used in this study.

The purpose of the hierarchical grouping is to produce logical and realistic clusters of areas with similar land use characteristics. Grouping without a contiguity constraint maximizes between group differences and yields the "purest" groups and, in the geographical context, produces what Grigg and others have termed "generic" regions.[9] Such classes or generic regions include cases or observations whose attributes resemble each other, but which may be separated in space. This situation creates no problems in most disciplines, but in geography where the "regional concept" is a part of the philosophical foundation some objections are raised. The argument is that regionalization is a special case of classification in which location is an attribute, therefore cases which are grouped to form these unique specific regions must be contiguous to each other.[10]

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[9]David Grigg, "The Logic of Regional Systems," Annals of the Association of American Geographers, LV (September, 1965), p. 477.

[10]Ibid., pp. 476-477; Johnston, "Choice in Classification," p. 588.

Ignoring the philosophical consideration for the moment, one must also weigh the inevitable loss of detail and "purity" which results when contiguity constraints are applied. In many cases this loss of detail may be excessive, but in some cases it may be acceptable in return for the added benefits of a more compact and less complex pattern of regions.[11]

Delimitation of Regional Boundaries

The inductive classification described in part one of the research design adequately identified fundamental relationships in the land use attributes and grouped those political subdivisions with similar characteristics into clusters. Each of the counties in a cluster was more or less like some hypothetical core area which epitomizes the particular land use associations. There is no reason to assume, however, that land use is uniform within each political unit or within the cluster. Neither is there necessarily any "core" in each cluster where the group attributes are the purest and from which the purity or similarity decreases with distance

Indeed, when the attributes being regionalized are largely cultural in nature and are constrained by the physical environment to a substantial extent, one would not expect regions to have intense

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[11] Ronald Abler, John S. Adams, and Peter Gould, Spatial Organization (Englewood Cliffs, N.J.: Prentice-Hall, Inc., 1971) p. 186.

cores and radially decreasing similarity. This would seem especially true in areas of great local physical diversity such as Korea, where interrupted alluvial plains, rugged mountains and intermontane valleys comprise most of the surface area.

In most of Korea political boundaries have traditionally been physiographic in nature, having been established along drainage divides for the most part, and along stream channels less frequently. The combination of county or province size and the pattern of physical landscapes seldom allows the two to coincide, and political subdivisions will frequently contain portions of two or more radically different landscapes. This suggests, then, that the best approximation of land use region boundaries is not simply the outer bounds of grouped political units.

Many geographers have treated the methodologies and philosophies of establishing boundaries between regions when there is a continuum of values and points to classify or bound. But, the practical problem of where to draw a boundary through an areally large data unit which is represented by a single "spatially anonymous" set of values such as a set of several factor scores has been neglected.[12] Use of the county-sized data units in this research would result in boundary zones tens of kilometers wide and demarcated by rather

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[12] Peter Haggett, Locational Analysis in Human Geography (New York: St. Martin's Press, 1966), pp. 214-227; Roger Minshull, Regional Geography (Chicago: Aldine Publishing Co., 1967), pp. 108-110.

arbitrary political boundaries. Consequently, in order to approach the desired precision in regional boundary placement, interpretation of remotely sensed imagery was used to establish land use boundaries for each cluster of counties.

The use of large scale aerial photographs to identify and map land use and other attributes of the earth's surface was well established in fact and in the literature during the 1930's and 1940's. It has continued to expand as a product of the rapidly changing technology of the aerospace and photographic industries. The utility of conventional aerial photography has traditionally been restricted by high acquisition and dissemination costs, physical or political inaccessibility of many areas, varying quality and scale of the photographs, and photographs which were "...too detailed in scale to be used directly in regional geographic synthesis."[13]

With the implementation of the manned orbital missions of the United States' space program, it became apparent that satellite imagery similar in scale and resolution to that produced by the Gemini and Apollo missions could become a valuable aid to earth science investigations. In 1966 the Conference on the Use of Orbiting Spacecraft in Geographic Research outlined several broad interdisciplinary areas in which this type of imagery could best be used. Among the most important program

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[13]National Aeronautics and Space Administration, A Survey of Space Applications. NASA SP-142 (Washington, D.C.: U.S. Government Printing Office, 1967), p. 50.

objectives agreed upon for orbiting spacecraft was the regional or chorographic scale mapping of world land use.[14] A large number of studies followed in the literature which indicated that very small scale satellite imagery would alleviate many of the acquisition and scale problems associated with large scale photography.[15]

The earliest published experiments with space photography involved conventional recognition of surface features and patterns. Among these were a number of successes with interpreting and mapping broad categories of land use.[16] One of the earliest demonstrated advantages of the relatively low resolution, small scale imagery was the apparent sharpening of diffuse edges of cultural patterns on the landscape which facilitated mapping of the patterns.[17] Later studies, primarily by geographers, dealt specifically with the problem of delimiting and classifying land use at the chorographic scale, and several investigators have successfully demonstrated methods of

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[14]National Academy of Sciences, Spacecraft in Geographic Research, p. 73.

[15]Stanley C. Freden, Enrico P. Mercanti and Donald E. Witten, eds., Symposium on Significant Results Obtained from Earth Resources Technology Satellite-1. Vol. II-Summary of Results (Greenbelt, Md.: NASA Goodard Space Flight Center, 1973).

[16]W.A. Radlinski, "Applications of Remote Sensing To Earth Resources Surveys." (Paper presented at the U.N. Conference on the Human Environment, Stockholm, Sweden, June 6, 1972), p. 4.

[17]Ibid., p. 2.

determining gross land use boundaries on very small scale imagery.[18]

Since 1972 much of the data collection effort has focused on the Earth Resources Survey Program of the USGS which is responsible for the development and application of remote sensing techniques to resource management. One of its constituent elements is the LANDSAT earth resources survey satellite project which produces detailed, repetitive synoptic coverage of the entire surface of the earth.[19] Its specific mission is to "...demonstrate the feasibility of remote sensing from space for use in practical earth resources management applications."[20] One of those applications is the acquisition, inventory, and mapping of land use information sufficient to extend our knowledge of all parts of the earth.

Significant results of the LANDSAT program which have already been substantiated are the multispectral imaging of surface water, snow

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[18]Donald D. MacPhail, "Photomorphic Mapping in Chile," Photogrammetric Engineering, XXXVII (November, 1971), pp. 1139-1148; Nelson R. Nunnally, "Integrated Landscape Analysis with Radar Imagery," Remote Sensing of Environment, I (1969), pp. 1-6; Robert D. Rudd, "Macro Land-Use Mapping with Simulated Space Photos," Photogrammetric Engineering, XXXVII (April, 1971), pp. 365-372; Andris Viksne, Thomas C. Liston, and Cecil D. Sapp, "SLR Reconnaissance of Panama," Photogrammetric Engineering, XXXVI (March, 1970), pp. 253-259.

[19]LANDSAT is the new designation of the Earth Resources Technology Satellite (ERTS) program. It was adopted in 1974 and is used interchangeably in much of the literature.

[20]Photo Mosaics from Space (Valley Forge, Pa.: General Electric Company, Space Division, 1973).

and ice cover, landforms, geologic structure, natural vegetation, agricultural land use, patterns of urban development, and other forms of human activity which can generally be mapped at a scale of 1:250,000 without substantial losses in detail.[21] The mapping and planning of land use is one of the principal applications, and several states and local governments have completed or initiated operational programs.[22]

In past investigations several different types and scales of imagery have been used to study the earth's surface. The objectives varied widely from landform analysis to timber resource management, but in all cases the image interpretation procedure was the primary tool for both recognition (definition) and delimitation of areas or regions. Several of the studies have demonstrated that "varying associations of physical and cultural phenomena" could be delimited by outlining the composite variation in tone, texture, pattern and shape.[23] In most of the early reports those variations were detected and outlined simply by using a human interpreter as a qualitative assessor to draw boundaries between areas which visually appeared to be significantly

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[21]Freden, Mercanti and Witten, Symposium on Significant Results, Vol II, p. 15.

[22]Freden and Mercanti, Symposium on Significant Results, Vol. III, pp. 20-21.

[23]Nunnally, "Integrated Landscape Analysis with Radar Imagery," p. 1; and others cited in Nunnally, "Interpreting Land Use from Remote Sensor Imagery," p. 174.

different. Nunnally referred to such areas as "integrated landscape types" and MacPhail, using small scale aerial photography, named them "photomorphic areas." The danger in this approach is obvious in the question as to what attribute, or combination of attributes, is visually dominant and is therefore unintentionally weighting the regionalization. This is another of the weaknesses that result from subjectivity in the objective method, but it can be tempered by the investigator's technical and regional experience and judgment.

In this study the major deviation from previous efforts was the use of factor analysis and hierarchical grouping to define important land use factors and to cluster counties with similar attributes. The mapped clusters of counties produced tentative regions of predominant land use associations whose boundaries could be more closely approximated by image reading. Political boundaries were then disregarded and the final regional boundaries delimited land use regions which were both exhaustive and mutually exclusive with respect to the total area within the Republic of Korea.

Verification of Regional Boundaries

In order to determine if the derived regional boundaries adequately delimited areas of similar land use associations it was necessary to compare the hypothesized regions with some form of ground truth and evaluate the results. Ideally such evaluations are statistical in nature and tend to indicate the confidence one can place

in the validity of the hypothesis. Such techniques have not been successfully applied to earlier image analyses, however, even though most studies have dealt with single-factor regions or areas only.

In MacPhail's original study large scale photographs and photomaps were used to verify that sample points "...typified the image patterns of the photomorphic areas...."[24] Nunnally recognized the need for statistically valid testing, but the supporting evidence for his preliminary study with radar imagery was obtained from aerial photographs, other studies and field investigations.[25] Most recently, Nichol used the photomorphic technique to map portions of Colorado, and the validity of the mapped areas was "...substantiated by field observations, interviews and census information, as well as by the available maps."[26]

Even when only a single mapped attribute need be compared with a single interpreted attribute there is a derogation of statistical techniques which is caused by differing data bases and the inherent subjectivity in all interpretation procedures. These problems are dramatically increased when dealing with multiple factor regions and,

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[24]MacPhail, "Photomorphic Mapping in Chile," p. 1142.

[25]Nunnally, "Integrated Landscape Analysis With Radar Imagery," p. 2.

[26]Janet E. Nichol, "Photomorphic Mapping for Land-Use Planning," Photogrammetric Engineering and Remote Sensing, XLI (October, 1975), p. 1254.

consequently, only a qualitative evaluation was feasible for this study.

Large-scale aerial photographs and topographic maps were used as a surrogate for ground truth because of the impracticality of actual field sampling. The validity of the surrogates was enhanced by their timeliness, both having been compiled in 1969. Together they adequately recorded surface occupance patterns existing immediately prior to the 1970 censuses which were the principal data sources for the factor analysis.

At irregular intervals across each region, but with greatest frequency near borders, either topographic maps or aerial photographs were examined in context to detect any obvious anomolies or inconsistencies between the mapped regions and the apparent or probable land use associations. Minor adjustments to boundaries were made where necessary in order to increase the consistency of the final regional scheme.

Regional Descriptions

The final step of the research was a statistical and narrative description of each of the final land use regions. Its purpose was to assist in the characterization and visualization of each of the regions, as well as lend some insight into the background of regional development and interrelationships in Korea. The factor analysis solution was discussed and amplified with additional statistical data as appropriate. The narrative additionally draws upon field work of the researcher in

1967, 1971, and 1974, as well as large scale photographs, thematic maps, and other published materials. Whenever practical, terrestrial and aerial oblique photographs were used to supplement the regional descriptions.

CHAPTER III

DATA SELECTION AND PREPARATION

In some investigations the amount of information available and the freedom of access are so great in relation to requirements as to make the choice of cases and attributes one of computational convenience and optimization. At other times, however, the researcher is constrained to use data which have already been assembled by political subdivisions for entirely different purposes than the problem at hand. In those instances one must exercise cybernetic model building such that the model, the research question, and the available data are at last wed for an optimal solution under the given constraints. Such is the case in this study where a breadth of detailed information was required for a nation whose technological and bureaucratic traditions have not developed to the point where comprehensive data are routinely collected at all levels of industry and government.

Selection of Cases

In the Republic of Korea the political units which routinely collect and compile basic information are the nine provinces and two

special cities (province-level status) at the highest level. At the second level are 140 gun (counties) and 30 provincial cities, and to a much lesser extent there is a third level of approximately 1,500 township equivalent units.

The most comprehensive, standardized, and reliable information is compiled and published by the first order political units, but they are so large that their use in this study would likely yield results that are no more meaningful than might be suggested by inspection. At the other extreme the body of information available for the several hundred third order units was rejected for two major reasons. The first was the sheer size of any data cube slice and the difficulty associated with its manipulation. The second was the inconsistent character of this data base. Specifically, identical data are not collected for uniform periods, there is little standardization of collection or compilation procedures, data are occasionally distorted for expedient reasons, and it is virtually impossible to assemble a set for each political unit.

For these reasons, the second order units, with some modification, were selected as the cases to be examined. The bulk of this slice is comprised of 139 of the 140 counties of the Republic, which range in size from 72 to 1,946 square kilometers, and together, include over 95 percent of the national area. All of these units publish fairly standard statistics at regular intervals. They are also of sufficiently small size to preserve detail, yet not so small as to tax practicality.

The one excluded county is the island of Ullung-do (72 square kilometers) which is located 130 kilometers east of the central coast in the Sea of Japan. Its inclusion would have no practical affect on the regionalization, and would cause the number of cases to exceed the limits (141) of the contiguity program used in a later step.

The other component of the second-order political hierarchy is the body of 30 "provincial cities" which, because of their size and activities, enjoy equal political status and statistical responsibilities. Their small areal dimensions (average size is 83 square kilometers) and nested positions within the counties suggested that these cities would best be integrated with their traditionally associated counties for purposes of computation and mapping. A second modification was the inclusion of the first-order "special cities" of Seoul and Pusan at this level because of their similarity in size (613 and 373 square kilometers), and to provide 100 percent areal coverage of the country. These modifications yielded 141 areal data units; a small enough number to allow analysis of the complete universe of cases (Figure 2).

Selection of Variables

The selection of attributes to be studied is, along with the choice of cases, one of the critical steps in the research design. Rummel discusses no less than 11 considerations in this step: (1) theoretical importance, (2) hypothetical relevance, (3) catholicity, (4) substantive and statistical sufficiency, (5) replication, (6) data

DATA CASES

(Listed in Appendix A)

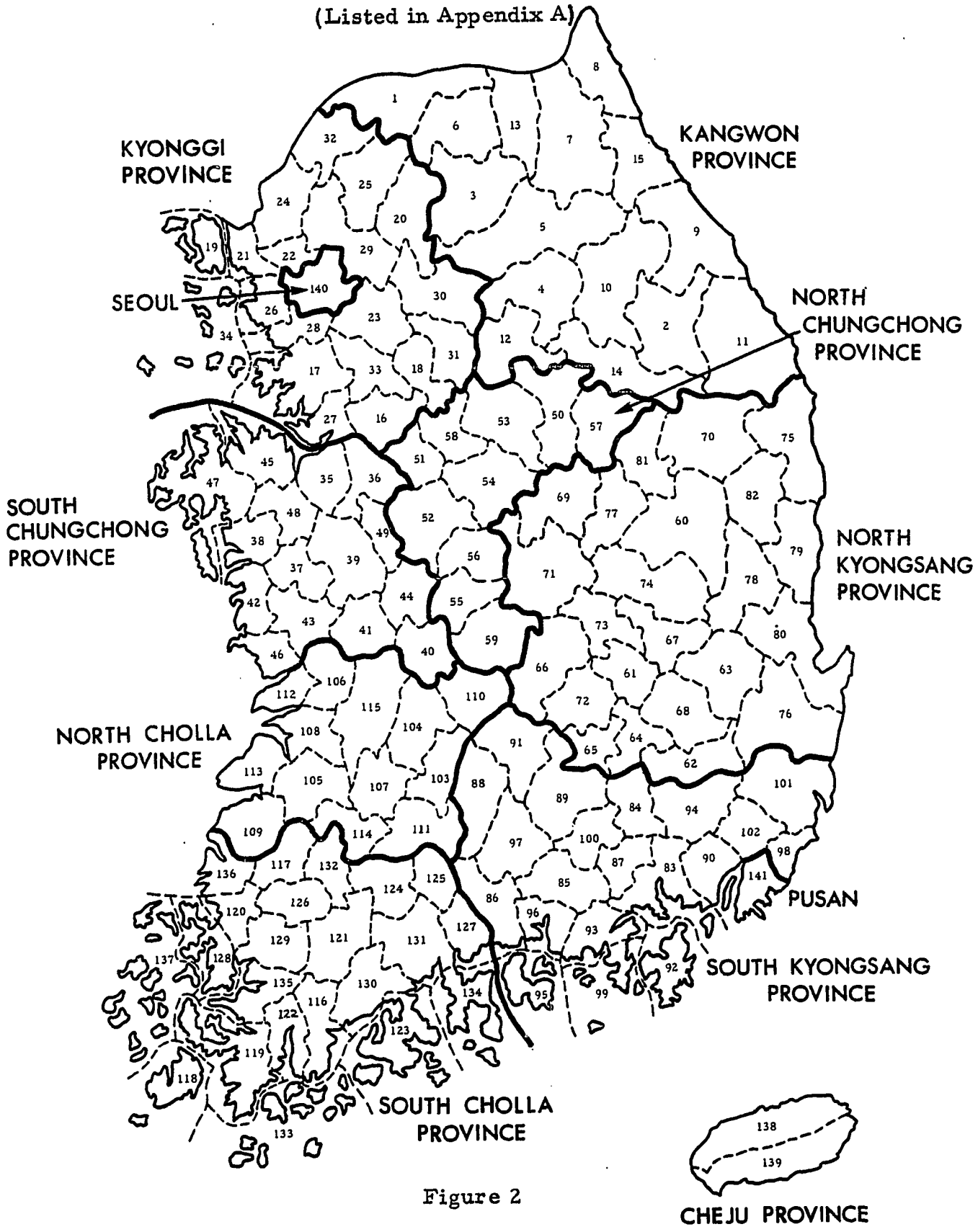

Figure 2

availability, (7) data reliability, (8) resources with which to conduct the research, (9) arithmetic independence, (10) frequency distribution of the data, and (11) number of variables in relation to the number of cases.[1] It is also necessary to consider specific objectives of the investigation and other interrelated steps of the methodology. Implicit in the objectives of this study is the requirement for a fairly broad spectrum of land use or occupance information to adequately serve the descriptive role, and an array whose landscape effects could be detected on small-scale satellite imagery.

The year 1970 was established as the base date of the data slice because in that year the Korean government conducted the most recent and extensive census in that nation's history. Included were the 1970 Population and Housing Census and the 1970 Agricultural Census which were heavy contributors to the data base employed in this study. The choice of that year was reinforced by the fact that the most recent large-scale topographic map and full-country, large-scale aerial photography coverages were completed in 1969. The only complete and timely LANDSAT-1 imagery of Korea was obtained in 1972. The 1970 time frame was also useful since it reflected many of the dramatic physical and economic changes which have occurred in Korea since its modernization drive began in the early 1960's.

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[1]Rummel, Applied Factor Analysis, pp. 209-220.

One of the first steps in the selection of variables is usually an examination of existing literature to determine which class of attributes might be of theoretical significance. It was found, however, that despite the long-standing interest of geographers and others in land use, there is an astonishing dearth of general land use theory. Harvey attributes this situation to the general preoccupation of geographers (with a few noted exceptions) with empirical studies at the micro-scale, and their perceived lack of responsibility or disciplinary role in developing general theories.[2]

Much of the general land use theory has been developed by agricultural economists and rural sociologists and understandably focuses on models of agricultural activity.[3] As a result, there is a very large gap in the literature between the general micro-analytic studies and the specialized studies of other disciplines. It is only partly filled by the large number of descriptive studies which have contributed little to broadening the theoretical base of land use study. This study of Korea also has a descriptive goal and did profit from an examination of land use categories and specific variables used in earlier research.

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[2]David W. Harvey, "Theoretical Concepts and the Analysis of Agricultural Land-Use Patterns in Geography," Annals of the Association of American Geographers, LVI (June, 1966), p. 361.

[3]Ibid., p. 362.

Agricultural studies generally fall into one of three data categories: (1) those that use crop acreages or production only, (2) those which focus on a combination of crops and management methods, and (3) those which draw upon diverse inputs such as crops, management methods, socio-economic conditions, and physical environmental regimes.[4] These studies offered little guidance on the structure of a land use data matrix, but did suggest a number of specific and general agricultural land uses traditionally considered important.

Regional and national scale general land use studies, however, did suggest a broad framework of land uses or occupance modes which have traditionally been examined and which tend to insure catholicity of variables. Some of these are shown in Table 1.

Another consideration in the establishment of data categories dealt with the remote sensing aspects of the methodology. A significant part of it involves the use of satellite imagery to refine regional boundaries. There is no evidence that this specific use of satellite imagery has been considered before, but there is a growing body of literature relating the potential of orbital scale imagery for land use mapping.

One of the early tasks of satellite land use studies was the determination of what surface attributes could be identified and the

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[4]David Grigg, "The Agricultural Regions of the World: Review and Reflections," Economic Geography, XLV (April, 1969), pp. 96-132 discusses and compares criteria used in the best known regionalizations of world agriculture.

TABLE 1

SMALL-SCALE LAND USE CLASSIFICATIONS

Land Utilization Survey of Great Britain[a]

1. Intensive arable (gardens and orchards-separate subclass)
2. Arable (farm crops)
3. Grassland (permanent)
4. Heath, moor, and rough grazing land
5. Forest and woodland
6. Agriculturally unproductive land (built-up areas and waste land)

World Land Use Survey[b]

1. Settlements and associated non-agricultural lands
2. Horticulture
3. Trees and other perennial crops (includes orchards and plantations)
4. Cropland
5. Improved permanent pasture
6. Unimproved grazing land
7. Woodlands
8. Swamps and marshes
9. Unproductive land

Marschner's Land Use Patterns in the United States[c]

1. Metropolitan cities
2. Cropland and pasture land
3. Cropland, woodland, and grazing land
4. Irrigated land
5. Grazed forest and woodland
6. Ungrazed forest and woodland
7. Subhumid grassland and semiarid grazing land
8. Grazed open woodland
9. Grazed desert shrubland
10. Ungrazed desert
11. Alpine meadows and peaks above the timber line
12. Swamps
13. Marshland

[a] Stamp, Applied Geography, pp. 41-42.

[b] Ibid., pp. 46-47.

[c] Marschner, Land Use and Its Patterns in the United States, map insert.

appropriate classifications and scales for mapping. Rudd experimented with the simple recognition of surface occupance, and the classification and bounding of "similar" areas on simulated space imagery. He was able to distinguish and map categories of: (1) agriculture, (2) forest, (3) mixed forest and agriculture, (4) urban, (5) nonused, and (6) undetermined land use. With additional experience he was able to identify two or three subclasses for each of the major categories.[5]

Perhaps the most comprehensive discussion of land use classification schemes employing orbital imagery was done by Anderson. He emphasized the apparent impossibility of devising a single classification system to serve all needs, but stressed the importance of attempts such as that of Nunnally and Witmer to encourage universality.[6] Three of Anderson's conclusions regarding further research activity were especially relevant to this study:

> (1)...it is quite apparent that it will not be possible to duplicate categories generally used for the classification of land use from surveys involving enumeration, grould observation, large-scale aerial photographs or a combination of these data-gathering approaches.
> (2) Inasmuch as it is improbable that a complete, well balanced land-use classification scheme can be developed in the near future which places sole reliance upon orbital imagery, it is

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[5]Rudd, "Macro Land-Use Mapping with Simulated Space Photos," pp. 366-367.

[6]James R. Anderson, "Land-Use Classification Schemes," Photogrammetric Engineering, XXXVII (April, 1971), p. 384; Nelson R. Nunnally and Richard W. Witmer, "Remote Sensing for Land Use Studies," Photogrammetric Engineering, XXXVI (May, 1970), pp. 449-453.

strongly suggested that a scheme be adopted which will be adaptable to supplementing orbital imagery with other readily available information about land use in order to avoid difficult gaps in the categories that will be needed for an acceptable classification system.
(3) The more basic the categorization is in a classification scheme, the more variable the uses that can be made of the classification.[7]

Anderson proposed a double-tiered classification system which, with some modification, has been adopted for test purposes by the U.S. Geological Survey. This system reflects the feeling that satellite imagery alone of the type produced by LANDSAT-1 and LANDSAT-2 will be useful for determining no more that nine general categories of land use based largely on major differences in ground cover. Used in conjunction with supplemental information from ground enumeration and topographic maps, however, it is felt that substantially more discrimination can be made within each major category. The USGS proposal therefore has two levels of sophistication depending upon both image quality and scale, and the availability of supplemental data (Table 2).[8]

The USGS system is reasonably compatible with the several classification systems currently being used by federal agencies in the United States. It serves the primary objective of providing researchers with a vehicle for immediate testing of satellite imagery in the land use

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[7]Anderson, "Land-Use Classification Schemes," p. 385.

[8]James R. Anderson, Ernest E. Hardy, and John T. Roach, A Land-Use Classification System for Use With Remote-Sensor Data, Geological Survey Circular 671 (Washington, D.C.: Department of the Interior, 1972), pp. 3-4.

TABLE 2

U.S. GEOLOGICAL SURVEY LAND USE CLASSIFICATION SYSTEM[a]

Urban and Builtup Land	
1. Residental	6. Institutional
2. Commercial and services	7. Strip and clustered settlement
3. Industrial	8. Mixed
4. Extractive	9. Open and other
5. Transport and utilities	
Agricultural Land	
1. Cropland and pasture	3. Feeding operations
2. Orchards, groves, and horticultural areas	4. Other
Rangeland	
1. Grass	3. Chaparral
2. Savannas	4. Desert shrub
Forest Land	
1. Deciduous	3. Mixed
2. Evergreen (coniferous and other)	
Water	
1. Streams and water ways	4. Bays and estuaries
2. Lakes	5. Other
3. Reservoirs	
Nonforested Wetland	
1. Vegetated	2. Bare
Barren Land	
1. Salt flats	4. Bare exposed rock
2. Beaches	5. Other
3. Sand, other than beaches	
Tundra	
Permanent Snow and Ice Fields	

[a]Anderson, Hardy, and Roach, Land Use Classification System, p. 6. A slightly modified version of this system is published in USGS Interagency Report 253 (July, 1974).

classification mode. It also has sufficient flexibility to permit the integration of conventional data.[9]

The categories of land use established for this study were essentially the same as those in the level I USGS scheme except for four categories of land use or occupance not found in Korea (nonforested wetland, rangeland, tundra, and permanent snow and ice fields). They also coincided closely with those currently being used in the Canada Land Inventory (urban, agricultural, woodland, wetland, unproductive land, and water) which is also based largely on aerial photography.[10] Specific variables selected and assigned to the categories are listed in Table 3.

Discussion of the Variables

Urban and Builtup Land Category

The variables selected as indicators of this category are those which represent intensive human activity in some role other than direct agricultural production. They normally are associated with high population densities and extensive modification of the landscape through construction.

Korea's role as a source of raw material and agricultural

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[9]Ibid., p. 6.

[10]Proceedings of the Conference on Land Use Information and Classification, p. 166.

TABLE 3

KOREAN LAND USE CATEGORIES AND INDICATORS

Urban and builtup land	Source[a]	Date
1. Area in contiguous urban development	Series 1501 Maps	1969
2. Number of agglomerated villages	Statistical Yearbook	1970
3. Number of households	Pop. -Housing Census	1970
4. Total population	Pop. -Housing Census	1970
5. Length of paved roadway	Series 1501 Maps	1969
6. Length of railway	Series 1501 Maps	1969
Agricultural land		
7. Area of paddy fields	Agricultural Census (items 7-25)	1970
8. Area of upland fields		
9. Area of permanent crops		
10. Area of pasture		
11. Area of fully irrigated paddy field		
12. Area of tree fruit (orchards)		
13. Area of vinyl houses		
14. Area of burnt-field farming		
15. Number of dairy and beef cattle		
16. Number of draft cattle		
17. Number of farm households		
18. Harvested area of paddy rice		
19. Harvested area of common barley		
20. Harvested area of naked barley		
21. Harvested area of wheat		
22. Harvested area of millet		
23. Harvested area of corn		
24. Harvested area of red beans		
25. Harvested area of Chinese cabbage		
Forest land		
26. Area of coniferous forest	Forestry Statistics (items 26-28)	1972
27. Area of mixed forest		
28. Area of nonstocked forest		
Water		
29. Number of lakes and reservoirs	Series 1501 Maps	1969
Barren land		
30. Area of reclaimed land	Forestry Statistics	1972
31. Area of nonforested forest land	Forestry Statistics	1972

[a]Short titles.

products in the Japanese colonial structure from 1910 to 1945, and the subsequent years of warfare, precluded the development of more than a minimal skeleton of industrial and transportation facilities. That situation has been aggravated by the military-political partition of the peninsula which eliminated intercourse of any kind between the North and South. As a consequence the industrial, commercial and transportational facilities are unnaturally stunted and are focused toward maritime import-export trade.

Large-scale urbanization is a recent phenomenon in Korea, and it is restricted to a few major industrial foci. Traditionally, the bulk of the population has lived in the nearly 60,000 small, agglomerated villages of less than 100 families which are dispersed across the peninsula.[11] That distribution is reflected in an estimated total urbanized and builtup area of 6.9 percent of the national area.[12]

Since Korea publishes no statistics on areas actually occupied by urban, industrial, transportation, and other related activities, a number of surrogates were selected from published sources. All of the urban-builtup indicators are expected to be concentrated in the western plains, enclaves of coastal development in the South, and along the lowland corridors that connect them.

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[11]Patricia M. Bartz, South Korea (London: Oxford University Press, 1972), p. 54; Eui Young Yu, "Seoul Metropolitan Development: 1960-1973," Journal of Korean Affairs, IV (July, 1974), p. 24.

[12]National Land Development Plan: 1972-1981, p. 13.

The total population or population density is directly related to the productivity of the area. Some portion of the population increase from one region to another may represent nothing more than an increase in agricultural productivity or suitability of the physical environment, but at some point it begins to reflect the concentration of labor around secondary and tertiary economic activities and the associated urban environment. The multiplier effects of higher order economic activities on underdeveloped areas such as exist in Korea are especially pronounced.[13]

The number of households is both a physical manifestation of urbanization and an indicator of the degree of urban or rural orientation of the region's population. As modernization has come to Korea the family (household) has shrunk from a pre-modern size of 8 to 10 persons per conjugal family to well under 6 per family. That trend is further indicated by the 1970 census which revealed that the average family size for rural households was 5.57 persons and for urban families just 5.12 persons. In Seoul, the primate city, families averaged only 5.04 persons.[14]

The number of farm households is a further indicator of the urban-rural dichotomy since the percentage of farm to total households

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[13]Harvey S. Perloff, et al., Regions, Resources, and Economic Growth (Lincoln: University of Nebraska Press, 1960), p. 94.

[14]Korea Statistical Yearbook: 1971, p. 52.

has been shown to vary inversely with the population of urbanized areas. Seoul and Pusan with 1970 populations of 5.5 and 1.9 million, respectively, have 2 and 3 percent farm households compared with a national urban average of 18.5 percent and extremes of over 40 percent.[15]

The area in contiguous urban development is the most direct and obvious indicator of urbanization, but represents only the largest several hundred agglomerations. This variable is complemented by published figures on the number of agglomerated villages. The latter is an indicator of builtup area in rural areas which may have many small and noncontiguous villages with substantial total area, but which are not necessarily large enough to be mapped to scale or classified as urban. Isard has indicated that one should expect the density of settlements to be greater near major urban centers than in remote areas.[16] Skinner's study of rural China found the number and closeness of rural towns increased directly with the density of rural population.[17] Further, the highest densities of settlements and population occurred, "...only on plains of exceptional fertility, situated in the typical case near

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[15]Bartz, South Korea, p. 53.

[16]Walter Isard, Location and Space-Economy (New York: John Wiley & Sons, 1956), pp. 271-273.

[17]G. William Skinner, "Marketing and Social Structure in Rural China," Journal of Asian Studies, XXIV (November, 1964-August, 1965), pp. 590-591.

major urban center."[18]

Transportation aspects of land use are important because of the large amounts of land occupied by transport facilities, especially in urbanized areas. The nodal function of the facilities also stimulates more intensive activity in both the rural and urban sectors. Transportation routes are therefore indicators of a variety of land use activities, many of which are visually significant on satellite imagery only when spatially associated with transportation facilities. In Korea, transport construction is a strong indication of urban development and its fringe areas. In the past the constraints of scarce capital prevented more that minimal road construction even in urban-industrial zones, and it was almost totally ignored in rural areas where neither social nor economic needs demanded it.

The indicators used to represent the transportation sector of land use were the length of railway and the length of paved roadway. Railways have formed the backbone of Korea's modern transportation system since they were introduced late in the nineteenth century, but their primacy is being challenged. A recent government program of transportation route expansion and improvement is emphasizing highways because of their flexibility and a new set of social and economic needs.[19] The length of railway in 1970 was 3,194 kilometers and was

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[18] Ibid., p. 592.

[19] National Land Development Plan: 1972-1981, pp. 68-69.

closely associated with the 3,894 kilometers of paved roadway.[20] The preponderence of both is in the major lowland corridors that connect southern and western urban centers, as well as in the urban zones, themselves.

Agricultural Land Category

Agricultural activities occupy about 23 percent of Korea's land area, and of that amount perhaps 99 percent is actually cultivated. Because of its size, its importance to all aspects of Korean culture, and its impact on the landscape this category was heavily represented in the total list of variables. The attributes measured were selected because of: (1) their overall share of total acreage, (2) strong regional concentrations, (3) representation of, or association with, a group of corps or land use pattern, and (4) their traditional employment in agricultural and land use studies.

Land in actual cultivation is traditionally divided into two major categories in Korea. Fields which are capable of holding water on their surface are designated paddy fields and those that are not so constructed, even though they may be irrigated in some manner are called upland fields.[21] That distinction further indicates the physical

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[20] Ibid., pp. 77 and 86.

[21] Park Jin Hwan, An Economic Analysis of Land Development Activities in Korea, Study for the Ministry of Science and Technology (ROK) and the U.S. Agency for International Development to Korea, (Seoul: Seoul National University, 1969), p. 7.

organization of the landscape, the general intensity of cultivation and associated activities, and the types of crops most likely grown. In Korea paddy fields are located almost exclusively on valley bottoms and coastal plains and tend to predominate there. Upland fields may be located in valley and plains locations where there are inadequate or unreliable water resources, but they tend to be concentrated on lower hillsides of slight to moderate slope. Both of these land use classes have been included in almost every study conducted in Korea. In 1970 paddy field occupied almost 57 percent of all agricultural land and 12 percent of the national area, while upland fields occupied 38 and 9 percent, respectively.[22]

Permanent crops is a class which includes a broad range of perennial row, vine, and tree crops. Prior to recent improvements in the marketing and transportation systems and the promotion of a governmental policy of crop diversification, most crops in this category were grown in close proximity to large population centers where both demand and capital were present. The pattern is still present to a degree, but is starting to blur as permanent crops increasingly expand into reclaimed land and marginal forest land throughout the peninsula under the impetus of rural income expansion programs.[23]

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[22] 1970 Agricultrual Census Advance Report (Seoul: Ministry of Agriculture and Forestry, 1971); p. 130.

[23] Industry, Korea Background Series (Seoul: Korean Overseas Information Service, 1973), pp. 23-24.

The same is generally true for the area of tree fruit. Data on this class are frequently included in the total figure for permanent crops at the national level, but its area is considered separately in this study because it is comprised solely of orchards with site and situation attributes somewhat different from the larger category. In 1965 there were only six zones of significant fruit production in Korea and four of them were compactly centered on cities standing first, third, fifth, and sixth in the population hierarchy. The other two were centered on cities which are major transportation hubs and currently rank tenth and nineteenth in population.[24] As these areas have prospered, the market for fruit and the production acreage has expanded dramatically. Between 1962 and 1970 tree fruit acreage increased nearly 150 percent;[25] and together with the other permanent crops, now occupies 5 percent of the national agricultural area.[26]

The pasture land variable used in this study represents grassland used for hay gathering and grazing exclusive of land which is incidentally grass covered.[27] Koreans have used draft cattle for

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[24]Koo, Regional Characteristics of Korean Agriculture, p. 233.

[25]Agricultural Yearbook: 1970 (Seoul: Ministry of Agriculture and Forestry, 1970), p. 40.

[26]1970 Agricultural Census Advance Report, p. 130.

[27]1970 Agricultural Census (Seoul: Ministry of Agriculture and Forestry, 1972), p. 25.

hundreds of years, but livestock other than farmstead scavengers have not been readily adopted. Consequently, an animal husbandry tradition has not flourished. Husbandry expenses have kept the average number of draft cattle per farm household to less than one. With these low densities cattle have traditionally been kept in the rural farmstead and grazed along local pathways and stream banks.

A true commercial livestock tradition began in the 1960's with the introduction of limited numbers of beef and dairy cattle operations in response to the government diversification policies mentioned earlier. The higher densities and qualitative requirements of these two sectors have required the establishment of permanent or seasonal pasture.[28] At this stage in their development the livestock operations and their related pasturage have been restricted to narrow rings around major population centers which have demand, are the foci of efficient transportation, and are centers of innovation in all aspects of economic and social change. Like permanent crops, livestock operations are expanding largely at the expense of forest land of marginal potential. These livestock variables which occupy perhaps 1 percent of the agricultural area are therefore thought to be indicators of urbanization, marginal forest land, and vegetable production.

The number of draft cattle may be an opposite indicator since

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[28]Park, Land Development Activities in Korea, pp. 23-24.

recent studies have shown them to exist in greater numbers in mountainous areas.[29] The greater availability of natural forage, a cropping pattern less suited to tractor use, and distance from centers of innovation may be reasons.

Burnt-field cultivation still exists on a limited scale in Korea. In some parts of the world shifting cultivation represents a common, if not the highest, niche of cultural development. This is not the case in Korea, however, where it is primarily an expedient economic form. Many of those involved in it follow the same pattern observed by Spencer in Southeast Asia.[30] Suffering severe disruptions and exploitation, most burnt-field cultivators have been forced to leave areas of conventional sedentary cultivation and gravitate to remote highland areas. In Korea today, most are refugees of the Korean War who live in small, sedentary villages or dispersed farmsteads. In that vicinity they clear and farm scattered plots using rudimentary, but conventional techniques with a declining frequency of field relocation. Since the government has taken active steps in the last few years to resettle these farmers, their presence is generally an indication of remoteness from urban areas and lowland agricultural forms.[31] Burnt-field cultivation

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[29] Ibid., pp. 37-38.

[30] J.E. Spencer, Shifting Cultivation in Southeastern Asia, University of California Publications in Geography, Vol. 19 (Berkeley: University of California Press, 1966), p. 5.

[31] Forestry in Korea (Seoul: Bureau of Forestry Administration, 1970), p. 65.

has historically been most prominent in the mountains of the eastern cordillera.

The area of fully irrigated paddy field is an indicator of strong rice producing areas and the most intensively used and valuable agricultural land. This is land which is provided with year-round irrigation by means of wells, stream pumping stations, canals, and reservoirs. This body of land use is focused on the more extensive alluvial plains of the southern and western coastal areas. It includes traditionally arranged fields with irregular shapes and local irrigation systems and the newer "reclaimed" fields which have been consolidated, rearranged into a grid system, and benefit from a regional or corporate type irrigation system.

Vinyl houses are a recent addition to Korea's agricultural technology which occupy a fraction of a percent of the land in cultivation but are probably strong indicators of several other aspects of land use. They are inexpensive greenhouses of permanent or semi-permanent construction, often using expedient framing and rolls of plastic sheeting, which extend and intensify the vegetable growing season. They have appeared in response to the same factors that encourage dairy and beef cattle operations.

As with other recent technology imports the use of vinyl houses is diffusing from the urban centers or innovation.[32] The perishable

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[32]Man-Gap Lee and Herbert R. Barringer, eds., A City in Transition: Urbanization in Taegu, Korea (Seoul: Hollym Corporation, 1971), p. 149.

nature of their produce demands that the vegetable farms employing vinyl houses be located in areas of dense urban population and modern transportation networks.[33] A 1970 study of the densely populated western plains found that farms in close proximity to highways devoted five times as much area to vegetable production as did those in areas with only foot or cart trail service.[34] Even in the sparsely populated mountain areas of the east coast which have small local market potential, farms with reasonable access to secondary roads had 75 percent more land in vegetable crops than less accessible areas nearby.[35]

The density of farm households was discussed earlier as an indicator of the urban-rural distinction and it is additionally seen as a useful indicator of the boundary, or at least the transition zone, between the more intensively farmed lowlands and the forest oriented rural uplands. This indicator may be especially useful in the northeastern and central provinces of the peninsula.

Several of the variables in the agricultural category are food crops which are dominant in their extent and in their importance to Korea and many other countries. The seven leading crops by area in

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[33]Kim Chung Ho, Influence of Class and Means of Transportation on Farm Enterprise Distribution, Hwasung Gun, Kyonggi Province, Republic of Korea, Study for the Ministry of Agriculture and Forestry (ROK) and the U.S. Agency of International Development to Korea (Seoul: U.S. Overseas Mission to Korea, 1970), pp. 19-20.

[34]Ibid., p. 8.

[35]Ibid., p. 11.

Korea for the past several years have been rice, barley, corn, soybeans, beans, millet, and wheat in descending rank order.[36] The same crops, with the exception of both beans, also constitute five of the six leading crops of India, for example.[37]

Paddy rice is probably the most conspicuous and important agricultural variable because it is the staple food, is the most productive grain crop, earns a much higher income than other grains, and occupies far more people and more area than any other agricultural activity. Because of its value, its production has long been pressed near environmental limits, but improved farming methods and landscape engineering have allowed its area to expand about 7 percent between 1962 and 1969.[38] It is grown to some extent in nearly every stream valley, but is dominant on the larger plains of the west and south.

The harvested area of common barley and of naked barley are significant components of land occupance on the alluvial plains and lower slopes of Korea where the climate is warm and moist in all seasons. Both are frequently double-cropped on paddies. Naked barley is a popular food crop which requires the warmest seasonal temperature,

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[36]Chen Cheng-siang, Agricultural Geography of Korea (Hong Kong: The Chinese University of Hong Kong, 1970), p. 43.

[37]J.E. Crawford, "India," in Agricultural Development in Asia, ed. by Richard T. Shand (Berkeley: University of California Press, 1969), p. 59.

[38]Agricultural Yearbook: 1970, p. 36.

and it consequently predominates as a double-crop with rice in the extreme southwestern coastal zone. Common barley is somewhat more tolerant and has become the dominant secondary crop across all of southeast Korea except in immediate coastal zones where rice is unchallenged.[39]

Wheat is not a popular food crop but its tolerance of drought, cold, and minimal care has caused it to be cultivated over a substantial and distinct portion of Korea's central upland where it occupies dry hill slopes.[40] Like wheat, millet is another crop of declining popularity and distribution, but its tolerance of a wide range of environmental conditions made it a traditional insurance and subsistence crop in the mountainous northeastern counties.[41] In most of that region it occupies 10 to 40 percent of all cultivated land.[42]

Corn occupies a similar niche in the economic structure and environment as millet, except it is concentrated even further north where the northeasternmost province of Kangwon includes 60 percent

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[39]Koo, Regional Characteristics of Korean Agriculture, pp. 171-183.

[40]An Economic Analysis of Upland Cropping Patterns, Study for the Ministry of Science and Technology (ROK) and the U.S. Agency for International Development to Korea (Seoul: Seoul Municipal College of Agriculture, 1969), p. 48.

[41]Ibid., pp. 78-79

[42]Koo, Regional Characteristics of Korean Agriculture, p. 205.

of the national acreage. Corn demands more soil nutrients than most crops, and requires large inputs of green and animal manures which are readily available in the forested mountain areas.

The area of red bean production was included as a further indicator of the millet and corn regions because it is the most common intercropped plant and shows a distinct spatial concentration in the mountainous interior of the northeast.[43]

Vegetables are, with rice and other secondary grains, the largest dietary input of the Korean family, and their importance to the economy as judged from planted area is frequently underestimated.[44] Most important in their diets is a pickled relish composed largely of Chinese cabbage and radishes. As a result these two crops are grown to some extent in every region of the peninsula, although simple environmental constraints make the northeast substantially less suitable. Chinese cabbage was selected as a variable becuase it appears in all quarters of the land and is a general indicator of agricultural use as opposed to forest or other less intense land uses. This crop also shows marked increases in density in zones of urban influence and probably serves as an indicator of that family of attributes.

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[43]An Economic Analysis of Upland Cropping Patterns, p. 98.

[44]Nam Kyu Chung and Heung Keun Oh, An Introduction to Korean Agriculture (Seoul: The American-Korean Foundation, 1962), p. 44.

Forest Land Category

Traditionally only three types of landscapes or land uses have been recognized in Korea. Builtup areas of villages and cities and cultivated fields were exclusively lowland activities and, together, were the foci of the farmer's daily life. Everything else in the environment, that is to say the upland, was called "forest" and was of little interest or conscious value to the individual. That tradition is still evident today in the official classification of all non-cultivated upland, regardless of its vegetative cover, as forest land. This procedure results in 67.9 percent of the national area being loosely classified as forest, although much of it is little more than scrub or coarse grassland.[45] During the later years of the colonial administration, Japanese statistics showed that only 10 percent of Korea was actually covered with trees. Another 50 percent was brush and scrub, and about 5 percent was grass covered or bare.[46] More recent estimates of the amount of true forest range from 45 to 82 percent of the forest land, but include large expanses of small or newly reforested stands.[47]

The total forested area is further classified by generic type

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[45] National Land Development Plan: 1972-1981, p. 13.

[46] Chen, Agricultural Geography of Korea, p. 34.

[47] Chung and Oh, An Introduction to Korean Agriculture, p. 68 and Clare, et al., Area Handbook, p. 15.

and quality. Coniferous forest of all species covers 56.8 percent of the forest land.[48] The best developed forest zone is the narrow band of pine, fir, larch and spruce which dominates the higher altitudes of the peninsula's cordillera. Low stature pine species are dominant in the hills and low mountains of the west and southwest. Because of excessive harvesting and wartime destruction, virtually none of this forest is more than 20 years old.

Homogeneous deciduous forest occupies about 20 percent of the total forest area according to official figures, but it exists solely in scattered patches in the low mountains, and is not regionally prominent. The deciduous species are represented in the extensive areas of mixed forest which cover 21.7 percent of the forest land.[49] These forests of oak, elm, pine and several other temperate species cover nearly all of the mountains of moderate elevation in central Korea.

The last forest variable is the 6.1 percent of forest land classified as nonstocked.[50] It represents areas of perpetual scrub growth which is usually caused by heavy and continual harvesting of fuel and compost from accessible forests adjacent to populated lowlands. It is probably a good indicator of the transitional zone between intensive agricultural regions and extensively managed forest lands.

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[48] Forestry in Korea, p. 7.

[49] Ibid.

[50] Ibid.

Water Category

In most classification systems this category includes all areas covered by inland water bodies, estuaries, and coastal bays included within census enumerations and the national "land" area. In this study coastal areas were not considered because they are not normally included in Korea's statistics. Rivers and an insignificant number of small lakes are the only naturally occurring inland water bodies on the peninsula, and the area they occupy is not published for the political units. Neither has there been any compilation of data on the rapidly growing number of artifical reservoirs.

The number of lakes and reservoirs is seen as a useful land use indicator because, with the exception of a few large hydroelectric reservoirs, the remainder are small irrigation system components. They appear to be concentrated in and near the major lowland plains where they partially ameliorate the effects of high seasonality in precipitation and stream flow on the areas of rice, lowland cultivation, and high population densities. A count of water bodies was used as input because no figures on area were available, most lie in the same general size range and their total surface area is not substantial.

Barren Land Category

Barren lands are those which have no substantial potential for agricultural or forestry production, and are at most only peripherally used for some other activity. The natural landscape of Korea has

little land of that kind, with the exception of the many wide, sand and gravel choked stream channels and some locally extensive areas of lightly vegetated or exposed regolith. Areal statistics have been compiled only for the latter area which is classified as nonforested forest land, and they were included in this study.

Reclaimed land is a surrogate representing areas which were recently barren and are still not fully productive or useful. Tidal flats and areas suffering from sheet or stream erosion which have recently undergone some stabilization program such as erosion control construction or the planting of hardy vegetation are in this class. Because it requires both capital and a stimulus, reclaimed land is most common in areas of agricultural innovation.

Collection and Preparation of Data

Factor Analysis Matrix

The data used in the factor analysis were collected during the period from 1972 and 1974 from the sources listed in Table 3. The largest number came from the 1970 Agricultural Census which recorded data effective December 1, 1970 by means of complete field enumeration for all categories of information included in this study. It is comprised of nine province oriented volumes published between December, 1972 and December, 1973, and a summary volume. The census was undertaken as a part of the United Nations' FAO 1970 World Census of

Agriculture and was conducted in accordance with FAO guidelines. Considerable planning and rehearsal took place before the census-date and the information gathered by this second major census of Korean agriculture is thought to have high reliability. Processing error was kept to a minimum by computer processing of the data after initial enumeration.

The 1970 Census of Population and Housing from which some items were extracted also reflects December, 1970 conditions. Its modern design, and enumeration and compilation methods likewise indicate satisfactory reliability. The enumeration districts of both censuses were kept identical to promote simplicity, quantitative analysis, and generality of use.

The other major source of data was the annual statistical summary of forestry, which recorded the status of all forest land on December 31, 1972. This volume is compiled annually from administrative reports rendered by lower order political units. These data are probably the least reliable of those collected for three reasons: (1) the difficulty of accurately surveying the extensive areas of rugged upland, (2) the traditional Korean indifference toward forest lands, and (3) the intentional and accidental errors that are perpetuated in the reporting of statistics by many local agencies. Field interviews reveal a tendency for local officials to portray forest land conditions and improvements in an overly favorable light because of intense national

government interest and pressure in this sector of regional development in the last several years.

Other desired data on urban areas, transportation, and water bodies are either not compiled in a format suitable for this study, or were simply not available at the national level. Railroad statistics, for example, are compiled only for five regional railroad bureaus and there is no way to extrapolate data for the counties or provinces. These data therefore had to be manually extracted from medium-scale topographic maps which were based on 1969 aerial photography.

The length of all railway in the nation was measured to the nearest kilometer with a linemeter and double-tracked lines were given double weight. All paved roads outside of urban areas were similarly measured with no allowance made between two and four-laned roadway. Unpaved roadway, however, is so extensive and diverse in quality and function, that it could not be practically measured. Attempts to define, measure and include nominal values for unpaved roadway proved unsatisfactory.

Areas of urban development large enough to be mapped in correct scale were planimetrically measured to the nearest tenth of a square kilometer. That measurement generally included all settlements with an area greater than one-half square kilometer. Smaller villages were already included in the "number of agglomerated villages" from tabular data.

Most of the lakes and reservoirs in Korea are so small and their shapes so irregular that it was impossible to obtain a meaningful measure of area for any except a few of the largest. Consequently a simple count of all mapped water bodies in each county was accepted as input despite obvious shortcomings. The counties which suffer most under this procedure are those few in mountainous areas which contain only a single large hydroelectric reservoir and are statistically outweighed by lowland areas with several very small irrigation ponds. This bias toward lowland areas is probably less serious that it might appear because it is in the lowlands that the water bodies feed extensive distribution systems that are not recorded in any way. It is also in the lowlands that the water bodies interact most extensively with other aspects of the environment to create distinctive land use patterns.

Random accidental measurement error is to be expected in these manual measurements, but it should be insignificant in absolute magnitude and occur proportionally in all areas. A potentially more serious form of error is that which was built into the mapped data. It is not known what threshold size or other quality was used as a criterion for the scaled portrayal of builtup areas and water bodies. It is assumed that the criteria were consistently applied.

All of the publications and maps from which data were collected were published in both Korean and English, as are most statistical and planning documents in Korea. Language did not prove to be a direct

problem, but indirectly it was somewhat troublesome. Statistical publications frequently used excessively loose, or in other instances, excessively literal translations which required further investigation to determine accurate and precise meanings. This was an especially important step in the selection and true representation of variables.

The data from all sources were manually recorded directly onto coded collection sheets from which computer cards were punched and printed. The entire raw data deck was then checked against the collection sheets and a page print-out to detect possible processing errors. The raw data matrix contained all ratio scaled elements and there were no missing data. The elements of the matrix were then machine converted into density values (frequency of the attribute per unit area of each political subdivision) for each case in order to make measurement scales uniform. That converted data deck was the input for all subsequent factor analysis.

Small-Scale Satellite Imagery

Imagery used in the refinement of regional boundaries was produced by LANDSAT-1 which was launched on July 23, 1972. It was placed in a sun-synchronous polar orbit which allowed it to image on command every point on the earth's surface every 18 days. The sensor on the platform was a multi-spectral scanner which imaged a 100 nautical mile square in the green, red, and near-infrared portions of the electromagnetic spectrum.

For this research design it was necessary to assemble a set of imagery which met four requirements: (1) was recorded as near as possible to the collection date of the tabular data used in the factor analysis, (2) covered the entire country, (3) had a very low percentage of area obscured by clouds, and (4) was spectrally useful in distinguishing various land use patterns. Since a very large number of images with different attributes were available, it was necessary to develop both desired image criteria and a selection methodology.

The selection of the best imagery was facilitated by a locally produced computer program and graphics system.[51] The relevant attributes of all possible images were placed in a data file from which the program selected and displayed a scaled outline of those images which met specified criteria. The criteria were image quality of at least 8 on a 1 to 9 scale, maximum cloud cover of 20 percent, and acquisition dates in September and October. The visual display of image outlines superimposed on a map of Korea also allowed the selection of a minimum number of images to cover the area. Nine image scenes acquired in September and October, 1972 were found to cover all of the country except Cheju Island with only about 2 percent of the area obscured by clouds. The only suitable imagery of Cheju was a cloud-free scene acquired in February, 1973 (Figure 3).

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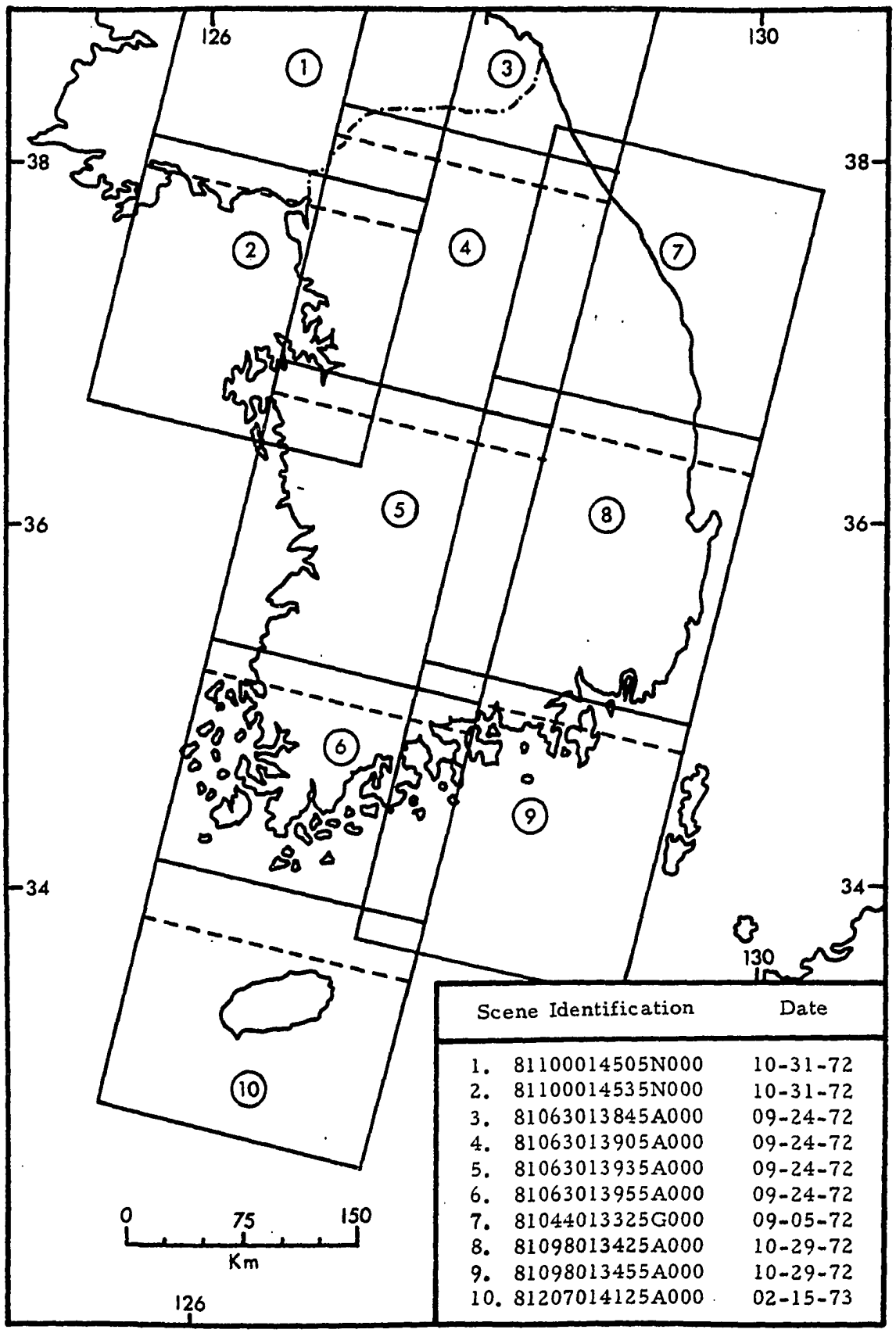
[51]Stanley E. Whitmore, Jr., "Computer-Aided Selection of ERTS Imagery," The Professional Geographer, XXVI (August, 1974), pp. 314-317.

LANDSAT MOSAIC IMAGES



Scene Identification	Date
1. 81100014505N000	10-31-72
2. 81100014535N000	10-31-72
3. 81063013845A000	09-24-72
4. 81063013905A000	09-24-72
5. 81063013935A000	09-24-72
6. 81063013955A000	09-24-72
7. 81044013325G000	09-05-72
8. 81098013425A000	10-29-72
9. 81098013455A000	10-29-72
10. 81207014125A000	02-15-73

Figure 3

The basic image vehicle for delimiting major associations of land use was an uncontrolled mosaic constructed from black and white prints enlarged to a nominal scale of 1:500,000. The result had a satisfactory degree of planimetric accuracy because of the high altitude of the sensor and geometric corrections integrated in the image processing system. Since black and white LANDSAT prints record only a single spectral band, the red band (0.6-0.7 micrometers) was used. Earlier experience had shown it to record the greatest amount of cultural and natural detail and give the best integrated landscape image.

The spectral signature of an area is largely a product of ground cover and the season of acquisition. In Korea manmade structures appear nearly uniform throughout the year, but the mosaic of temperate forests, dry cultivation, and wet rice farming is most distinctive during the late spring or fall. Since frequent spring weather systems prevented coverage during that season, the autumn criterion was established.

The same image frames were also used to make a set of false color enhancements to supplement the mosaic. The red and near infrared (0.6-0.7 and 0.8-1.1 micrometers) band positive transparencies were combined to form a rendition of color infrared photography. That technique produced very different visual signatures for most kinds of land cover, and substantially increased the discrimination potential of the human eye.

Large Scale Photographs

Vertical aerial photographs with a nominal scale of 1:25,000 were produced for all of South Korea in March, 1969 to provide a high quality and recent data base for topographic mapping. From that coverage, strips of panchromatic imagery were obtained to provide a surrogate ground truth sample for regional evaluation and description. A large proportion of the selected photographs imaged boundary zones between the proposed land use regions.

Other large scale aerial photographs were taken during field research in June, 1974. Five aerial transects which averaged 200 kilometers in length and spanned major portions of the peninsula were flown at a nominal altitude of 1,500 meters. A hand-held 35 millimeter camera was used to take color oblique landscape photographs for use in the regional descriptions. These were complemented by a series of terrestrial landscape photographs and field notes taken on road trips during the same month.

CHAPTER IV

DATA ANALYSIS

The Factor Analysis

The full data matrix discussed in Chapter III was factor analyzed using the BMDX72 program with a varimax rotation of extracted factors. The factor results were not compared with any previous analyses, so it was not necessary to transform the data distribution. The only matrix transformation employed was the simple reduction of all variable input to density values to standardize measurement scales.

The Estimate of Communality

The BMDX72 program, like most modern factor analysis programs, allows the user to specify the value to be placed in the principal diagonal of the correlation matrix. Communality estimates usually range from an upper bound of unity down to the squared multiple correlation (SMC) of each variable. Rummel discusses four considerations in the specification of the estimate: (1) the estimate used in comparable studies, (2) available computation facilities, (3) the size of off-diagonal values in the correlation matrix, and (4) the number of

variables in the study.[1]

In this study unity was used as the communality estimate primarily because of the large number of variables (31) included in the matrix. As the number of variables exceeds 10, the estimate not only has a rapidly decreasing effect on the analysis, but the SMC, which is the lower-bound estimate, also approaches unity.[2] Both unity and the SMC are the prevalent estimates used in geographical analyses, but since there were no known land use analyses with which this study might be compared, comparability was not a factor in the choice of an estimate. Neither were there any computational constraints.

Determination of the Number of Factors

The determination of the number of factors to be rotated is one of the crucial steps in the research design and there are no fixed guidelines or rules of general applicability. There are several favored criteria, however, and the retention of all factors with eigenvalues greater than unity is the most frequently used.[3] Kaiser and others have shown the unity criterion, together with estimated communalities of unity, to be the best mathematical solution.[4] That criterion was used in this study although it was not adopted without consideration of the zone of discontinuity in the graphed eigenvalues and the meaningfulness of all remaining factors.

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[1]Rummel, Applied Factor Analysis, pp. 318-319.

[2]Ibid. [3]Ibid., p. 362. [4]Ibid.

The graph of variance accounted for by each factor (Cattell's scree test) indicated that the variance accounted for by factors 10 and above tended to be fairly constant. That constancy indicates a likelihood that those factors are primarily reflecting random error and are largely meaningless to the analysis.[5] The nine extracted factors accounted for 77.8 percent of the total variance. Factor 9 very conveniently had an eigenvalue of 1.004 and, as the last factor, accounted for 3.2 percent of the total variance. Additionally, each of the nine factors was a meaningful association of variables to the investigator.

Discussion of the Factors[6]

Factor 1. --The first extracted factor accounts for 20.8 percent of the total variance, and probably represents the foundation of Korea's commercial agricultural sector. The attributes which most strongly load on this factor are harvested area of rice, area of paddy field, area of fully irrigated paddy, and the number of farm households. Each of these variables is an indicator of lowland agriculture, and the significant bipolar loading of the area of corn clearly indicates a dissociation from mountainous areas of the northern interior (Figure 4).

Of significantly less importance to the composition of the factor, but reinforcing lowland agriculture indications are the minor

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[5]Ibid.

[6]See Appendix B-Loading Order of Variables on Orthogonal Factors.

FACTOR I

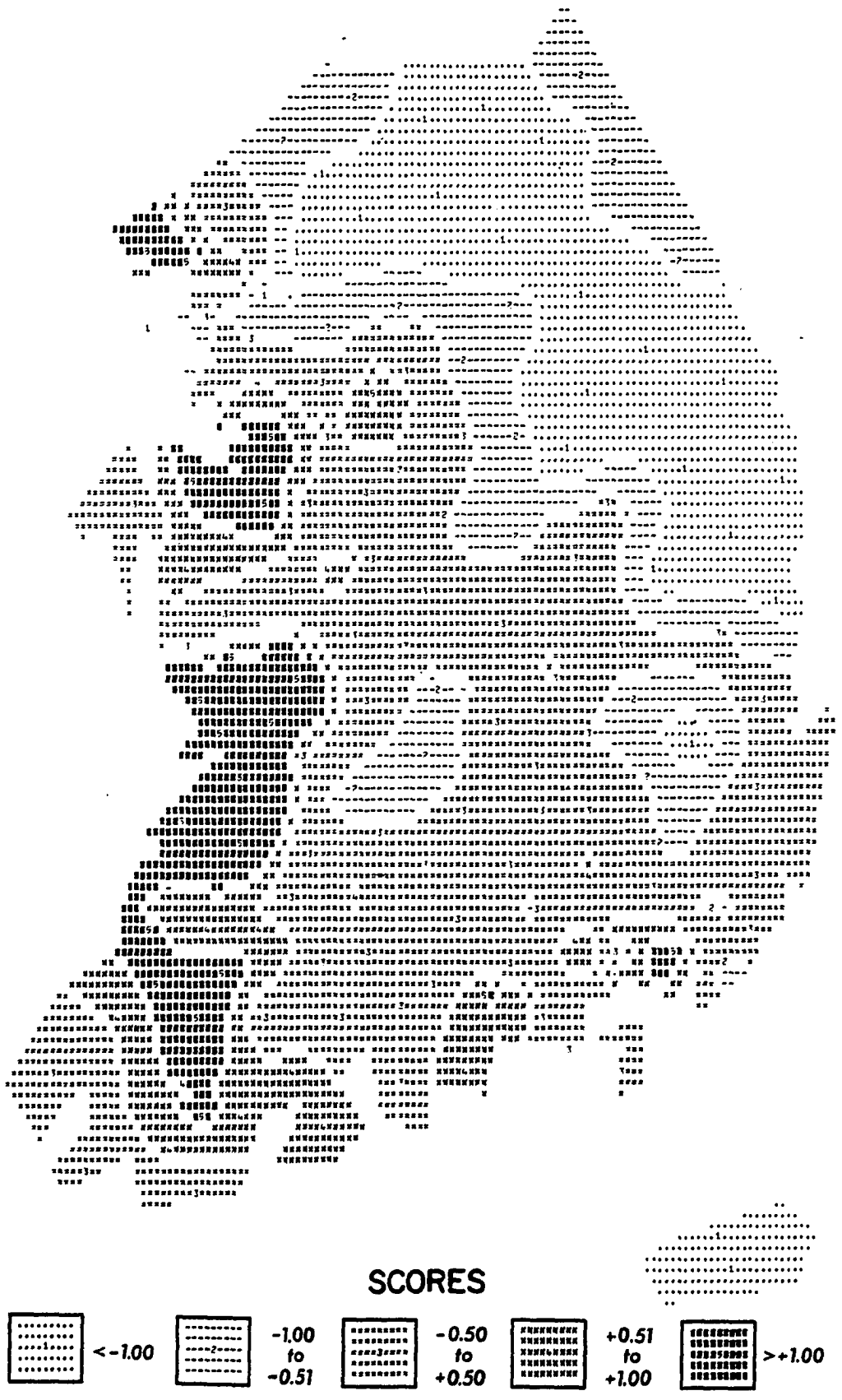


Figure 4

loadings of water bodies and the harvested area of Chinese cabbage. Reservoirs seem to be prevalent in the low hills adjacent to many of the more intensely farmed lowlands. In some areas of the country small holding ponds occupy the heads of nearly every small tributary valley along major river valleys or coastal plains. Chinese cabbage is usually grown on low hill slopes adjacent to paddy, and occupies significantly high acreages only in areas of intense farming or high population densities.

The strength of the loading of fully irrigated paddy on this factor depicts use of that land with the greatest productive potential and value in the rural sector. It also indicates that the land lies within the sphere of agricultural innovation where paddy field consolidation and the development of formal water distribution systems is commonplace. Naked barley, almost exclusively a winter crop after rice in areas of mild climate, also loads strongly. All of these qualities predominate on the larger plains along the western and southern coasts.

Factor 2. --The second factor accounts for 16.3 percent of the variance and clearly represents the urban-builtup land use sector. The highest variable loadings on this factor are number of agglomerated villages, population density, and the number of households. In the process of selecting variables it was felt that all of these would be manifested in construction on the landscape. The validity of that

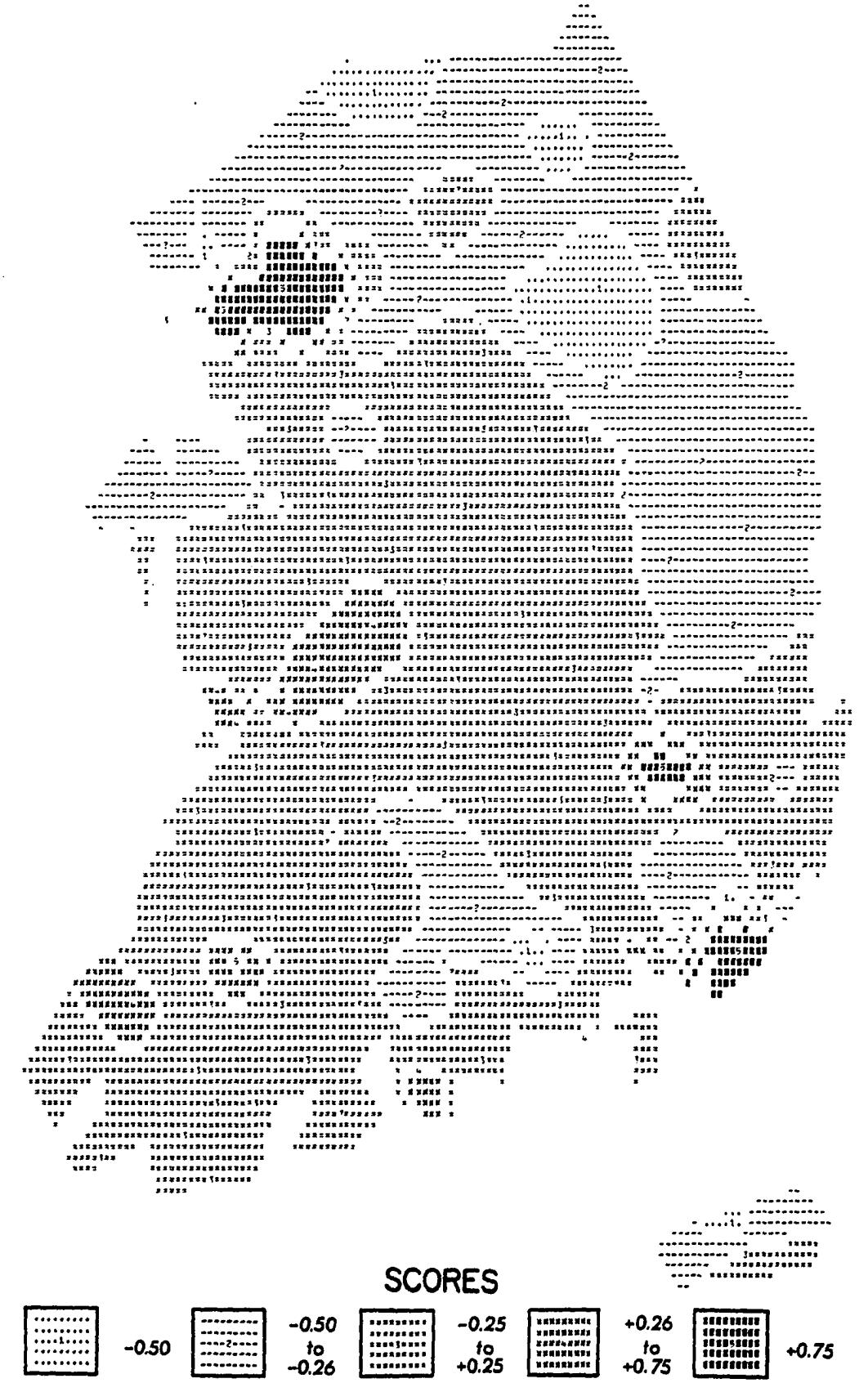
assumption is indicated by the equally high loading of the variable representing the area of contiguous urbanization in each political unit.

The significant loadings of length of paved road, dairy and beef cattle, and length of railroad reinforce the complexion of the factor. As mentioned in Chapter III, the dairy and beef cattle activities are directly attributable to the urban markets and are clustered in close proximity. Both paved roads and railroads stimulate and, in turn, are stimulated by urbanization and this affinity was also expected. Likewise, it is logical that the loadings of the transport variables might be relatively low. Transport routes focus on urban areas and exist there in greatest densities, but much of their length obviously serves the internodal connectivity function. Consequently, the transport variable loadings are somewhat diffused.

The only areas having extraordinarily high scores for this factor contain the three largest cities in the country. The remaining cases having positive scores include portions of the lowland corridor between the three principal cities and the densely populated counties of the western and southern coasts (Figure 5).

Factor 3. --Factor 3 accounts for 10.4 percent of the variance and establishes dry field farming as a major land use association. The highest variable loading is the area of upland fields, followed by the areas of millet, reclaimed land, and naked barley. The usual lowland occupants of rice, paddy, and irrigated acreage have essentially neutral

FACTOR 2



SCORES

Figure 5

loadings which strengthen the upland character of the factor, but imply agricultural diversity.

The factor has two areas of concentration in the country (Figure 6). The strongest orientation is toward the extreme southwest where millet and naked barley have the highest acreages in the country. It is also along the submergent coastline that extensive tidal flat reclamation work has been accomplished. A weaker tie exists to the central interior and northwestern coast. The former is another major millet growing area, while the latter includes large areas of upland fields devoted to commercial row crops. The moderately negative loadings of common barley acreage and the area in vinyl houses further suggest little association with the southeastern quarter of the country and the urban fringe zones.

A comparison of mapped scores for Factors 1 and 3 shows the same general group of counties in the west and south to have high scores for both factors, although the highest scoring areas are complementary. This indicates balanced agricultural strength along those coasts and their value to Korea's economy.

Factor 4. --The fourth extracted factor accounts for 7.1 percent of the variance and seems to represent a specialized upland crop association. The two strongest loadings are made by the areas of tree fruit and permanent crops. These are commonly represented in large-scale classification schemes as separate categories, but they

FACTOR 3

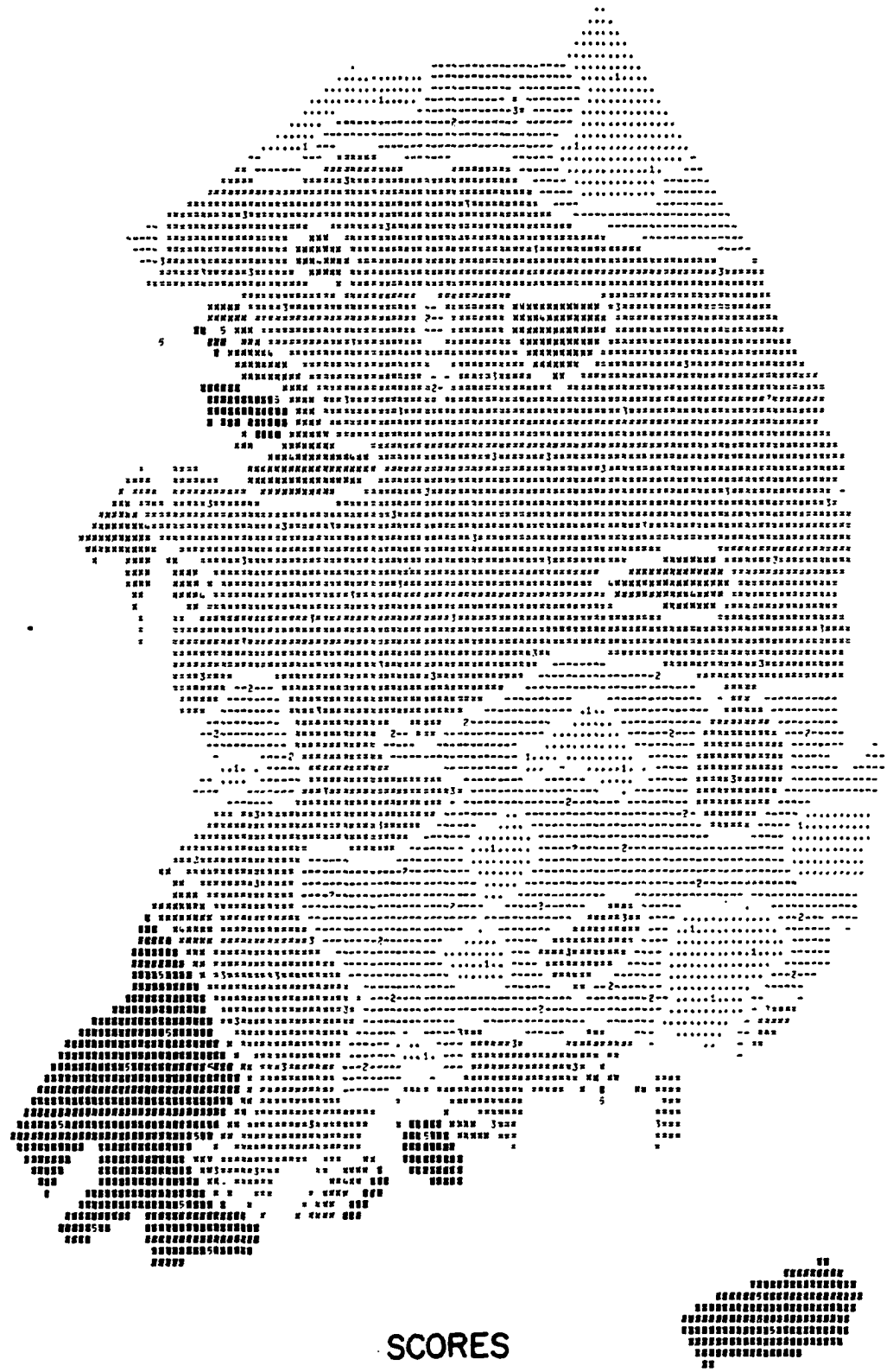


Figure 6

are combined in the USGS remote-sensor scheme under the unwieldy label of "orchards, groves, vineyards, bush-fruit and horticultural areas."

The tree fruit variable represents all commercial-size orchards which, in Korea, grow mostly apples, pears, peaches, and persimmons. These crops have grown up in response to increasingly affluent urban and export markets, and are stimulated by agricultural and marketing innovations which are diffusing from several of the largest cities. These crops typically occupy a previously unproductive environmental niche along sandy river floodplains or barren uplands with easy access to urban markets.

The other high loading is the area of permanent crops, a variable which includes the traditional mulberry and bamboo plots, as well as other crops also associated with a more modern agricultural sector. These include orchards, vineyards, nursery operations, tree plantations, and other minor activities. All are upland activities which do not compete with the intensive agricultural forms which are able to earn the highest economic rents.

The importance of the modern sector crops in shaping the factor's character is revealed by a comparison of the factor map and the distribution of mulberry and bamboo acreages. Mulberry plantations are prominent in the northeastern quarter of the country and in the south-central uplands, while bamboo is restricted to the southern

coastal tier of counties.[7] None of these areas coincide with the areas having significantly positive scores for Factor 4 (Figure 7).

Another significant, though not dominant, variable loading is the number of water bodies. Virtually all of these are reservoirs which are typically situated in small upland valleys from which they supply the lowland fields. This variable, along with the minor loadings of common barley, further reinforces the noncompetitive nature and hill land situation of the land use associations represented by this factor. Lastly, the moderate loading of paved road length on this factor is a reminder of the market orientation of land uses represented.

Factor 5. --This factor, which accounts for 6.4 percent of the variance, focuses on land use in the forest and agriculture categories. It specifically seems to represent a coniferous forest-upland farming association with a semisubsistence-semicommercial orientation. Evidence of this association's transitional qualities between intensively farmed lowlands and extensively managed mountainous areas is provided by the pattern of variable loadings.

The two variables with the highest and nearly equal loadings are the number of draft cattle and the area of coniferous forest. That is an expected combination because it is only in the mountains that substantial forests exist, where those forests are able to provide abundant forage, and where a less prosperous or innovative population still

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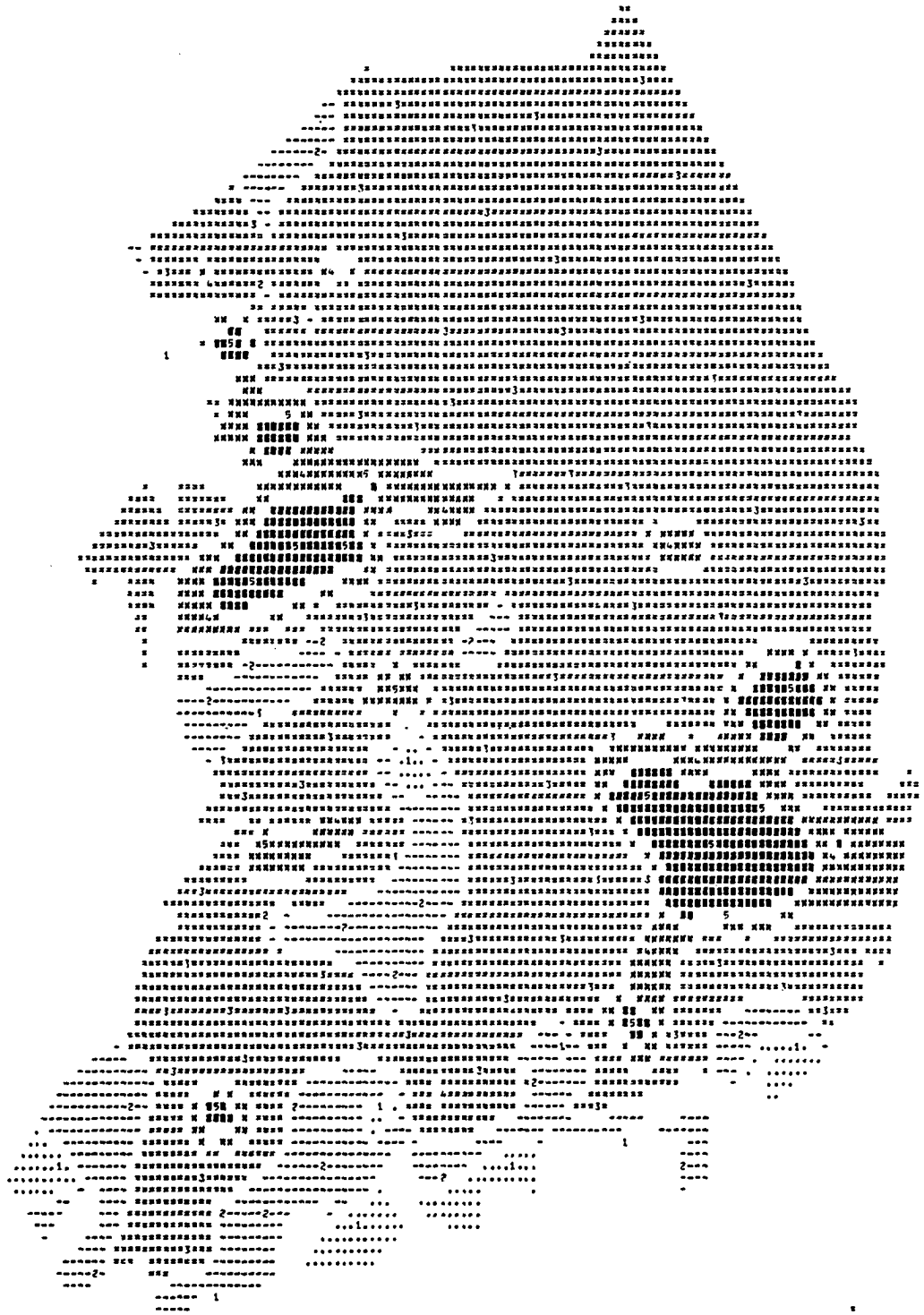
[7]Koo, Regional Characteristics of Korean Agriculture, p. 285.

FACTOR 4



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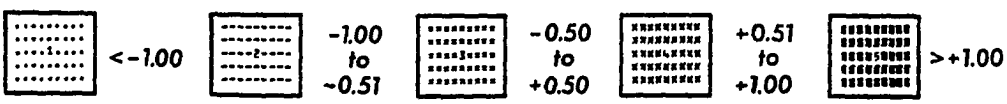


Figure 7

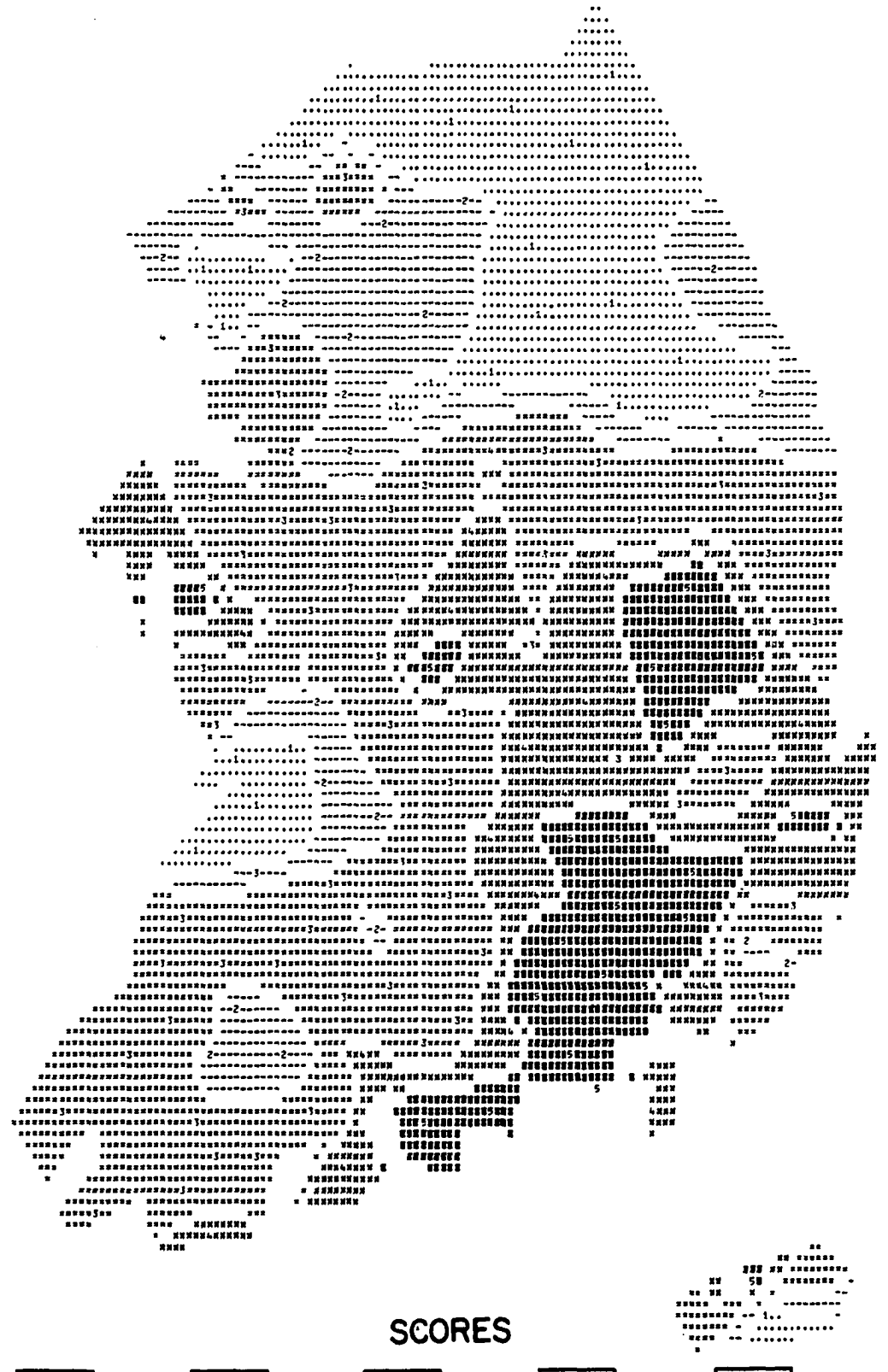
relies on traditional draft animals.

A substantial agricultural element is indicated by the strong positive loadings of common barley and wheat, and the low but relatively strong loading of farm households. A hint of innovation is even present in the low positive loadings of vinyl houses and water bodies. At the same time the limited productivity and extent of this element is indicated by the low loadings of paddy, upland fields, and the population variables.

Factor 5 gains a distinct spatial orientation from the loadings of the food grains (Figure 8). Barley is the dominant dry field crop in at least 35 percent of the country, including the southeastern one-quarter and a band across the central interior. The central band also includes the majority of the nation's wheat acreage. The strength of corn's negative loading shows a clear dissociation from the mountainous northeast.

Factor 6. --This factor has a rather specific mixed forest-upland subsistence agriculture identity which is normally associated most strongly with the hills and low mountains of western and central Korea. The factor structure is quite similar to that of Factor 5, and its neutral or extremely low loadings for all variables except mixed forest and the harvested areas of red beans, naked barley and wheat also indicate the transitional nature of this factor in the physical and economic sense. Only the strength of the negative loading of naked barley

FACTOR 5



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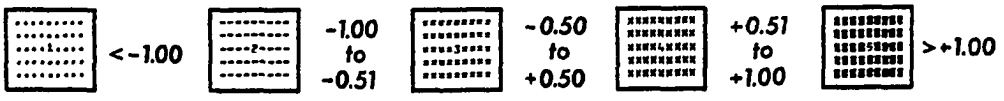


Figure 8

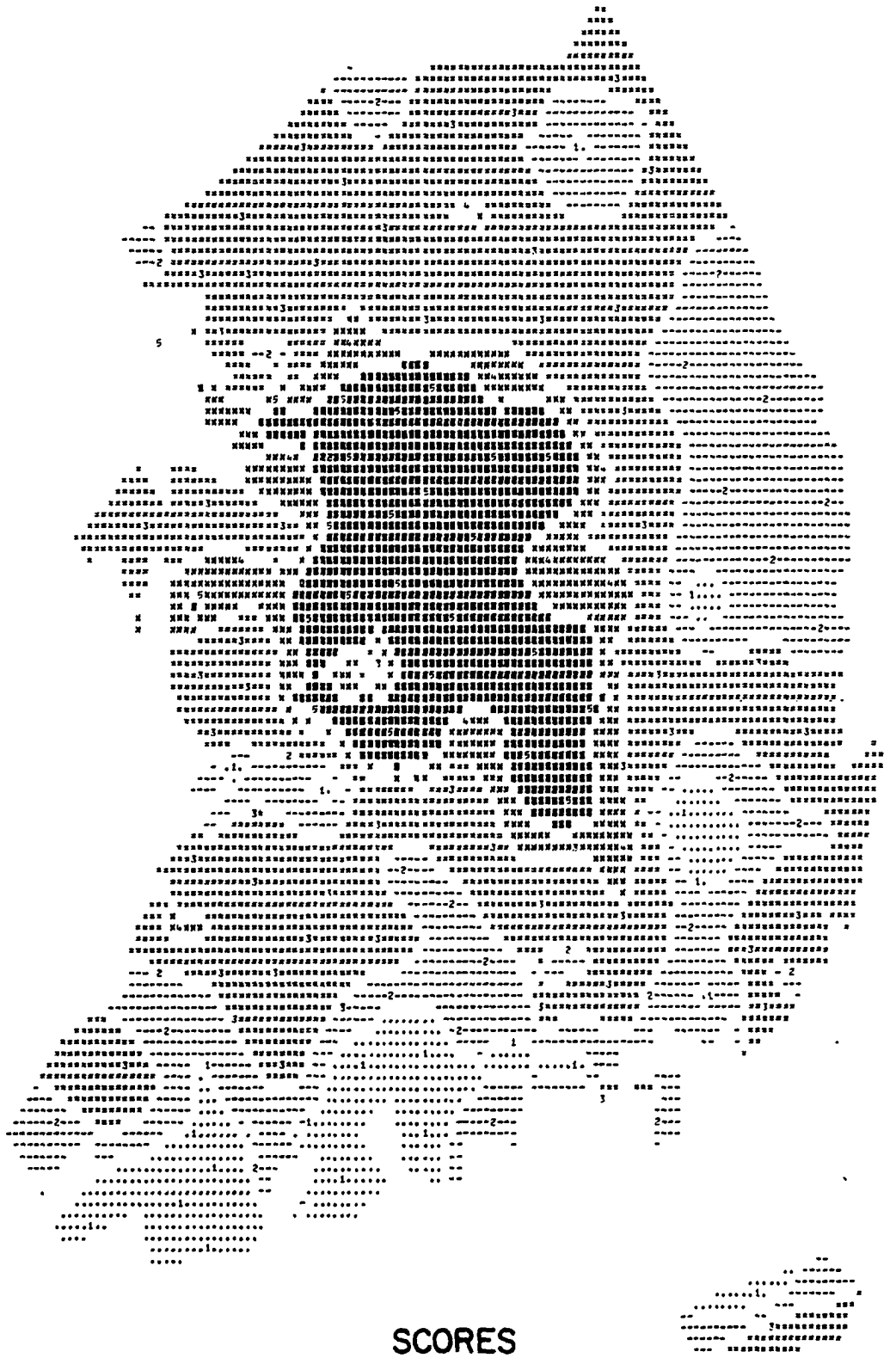
is evidence that although this factor probably occupies a similar environmental niche as Factor 5, it does so in a more northerly zone (Figure 9).

The surprisingly low impact which the urban-builtup and intensive agriculture variables have on this factor, despite its probable spatial association with areas having those strengths, suggests a significant potential for economic development. It is in such historically stagnant areas with little utility for traditional agriculture, yet not too distant from populous areas, that there has been a recent surge in commercial tree crops and livestock activities. These are all livelihoods which produce high incomes and encourage both agricultural innovation and rapid change in the region's cultural landscape.

Factor 7. --This specific factor accounts for 4.2 percent of the total variance and has a very simple and clear structure. It represents neglect or remoteness in the physical or politico-economic sense as indicated by the loading of burnt-field farming. That interpretation is strengthened by the positive loading of corn and the negative loading of the area of reclaimed land. Corn is a major subsistence crop in the interior mountains as it is in many rudimentary agricultural societies. The low impact of reclamation activities is specific evidence of the low level of government involvement at a time when cultivation is being pushed to environmental limits.

In Korea burnt-field farming is most frequently found in the

FACTOR 6



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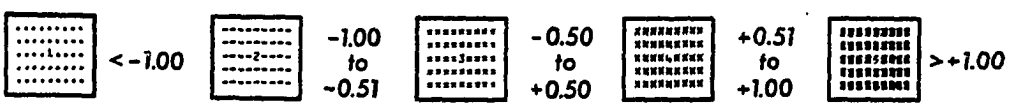

Figure 9

interior mountains where its area expanded rapidly during the 1930's, but there are now prominent enclaves in the publicly owned highlands around some of the larger urban centers and densely populated lowlands[7] (Figure 10). The bulk of the burnt-field farmers are refugees from the Korean War and economically displaced families. Many of the areas they have settled are obviously in or near the economic or administrative mainstream, but for expedient reasons the government takes only token measures against their presence.

The factor is significant in that it represents a dilemma of the Korean government. Burnt-field farming is a problem because it is an uncontrolled and destructive land use, and at the same time, an interim solution to some population and economic pressures. It survives essentially because it is a low intensity and noncompetitive land use which occupies what would otherwise be largely unproductive upland.

Factor 8. --This factor identifies a complex of lowland activities found within the urban-fringe zone. The areas of vinyl houses and cabbage cultivation load equally high, and are followed by the logical set of dairy and beef cattle and pasture area. This strong association of urban market oriented commercial agriculture is supported by significant loadings in the modern transportation sector. All of these variables not only complement those of Factor 4 (specialized upland agriculture), but are capable of earning higher economic rents. Consequently,

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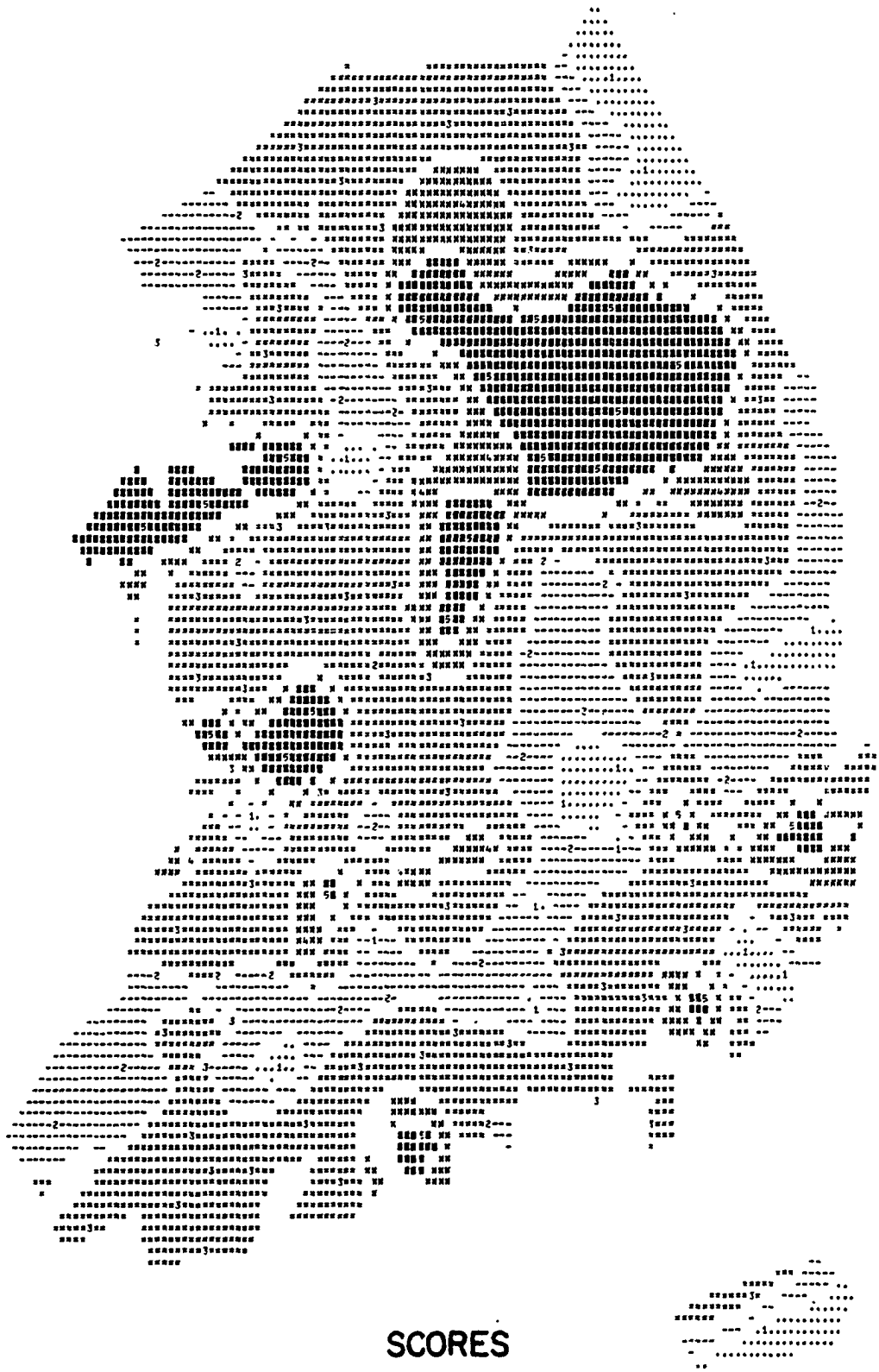
[8]McCune, Korea's Heritage, p. 89.

FACTOR 7



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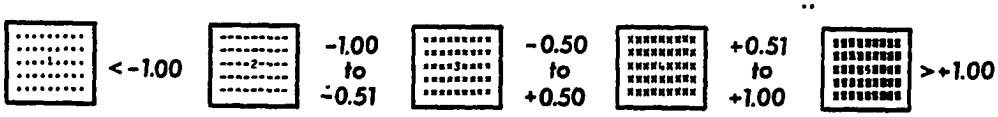


Figure 10

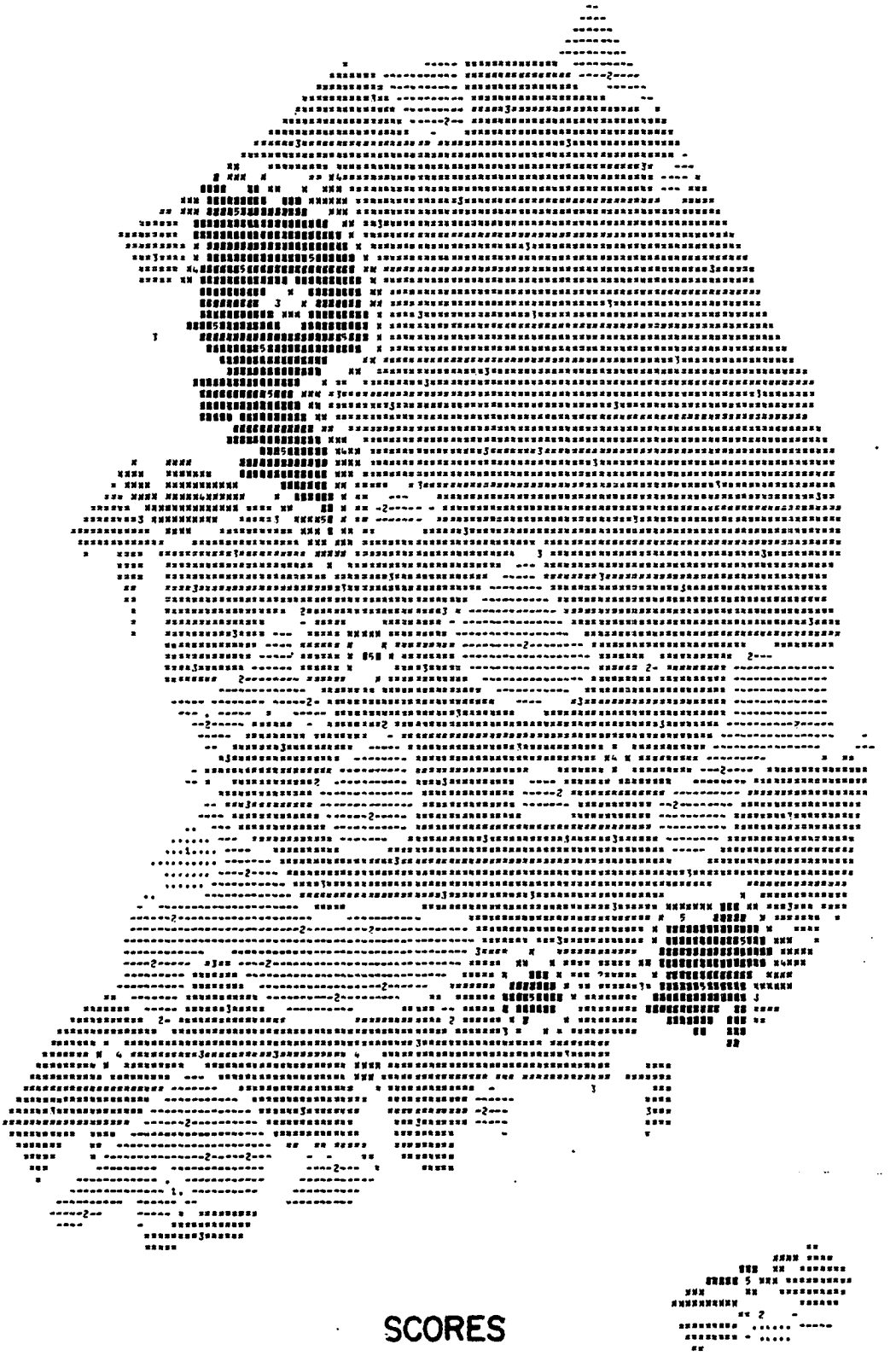
they are found still closer to the urban centers.

The variables with meaningful loadings on this factor have traditionally occupied land with site characteristics which were unsuitable for paddy. They were typically located along the paddy-upland margins and on sandy or otherwise unsuitable soils. Increasingly, however, vegetable growing as represented by cabbage and vinyl houses earns higher income than the traditionally dominant rice. Modern transportation facilities also "earn" some of the highest rents and, together with high volume cash crops such as vegetables, are displacing rice in lowland areas within major urban market spheres (Figure 11).

With the possible exception of some progressive rice farming areas, Factor 8 identifies the most intensively managed and occupied rural land use association in Korea. The nature of its products and its role in agricultural diversification and rural income expansion programs clearly make this factor prominent around centers of innovation and policy implementation. Despite its local or regional importance, the small amount of variance (4.0 percent) accounted for by this factor largely reflects the embryonic state of commercial agriculture in Korea and the large percentage of the population still engaged in subsistence farming.

Factor 9. --The final factor accounts for slightly over 3 percent of the total variance. It clearly identifies the least intensively managed and least productive land covers and uses; and the areas of

FACTOR 8



SCORES

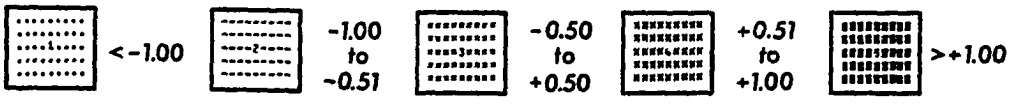


Figure 11

nonstocked forest, nonforested forest land, and pasture being the only substantial loadings. This factor most closely approximates the barren or nonproductive land use associations frequently identified in studies. It also substantiates the earlier hypothesis that the newly introduced livestock industry is establishing itself largely in the environmental niche of marginal forest land and eroded upland.

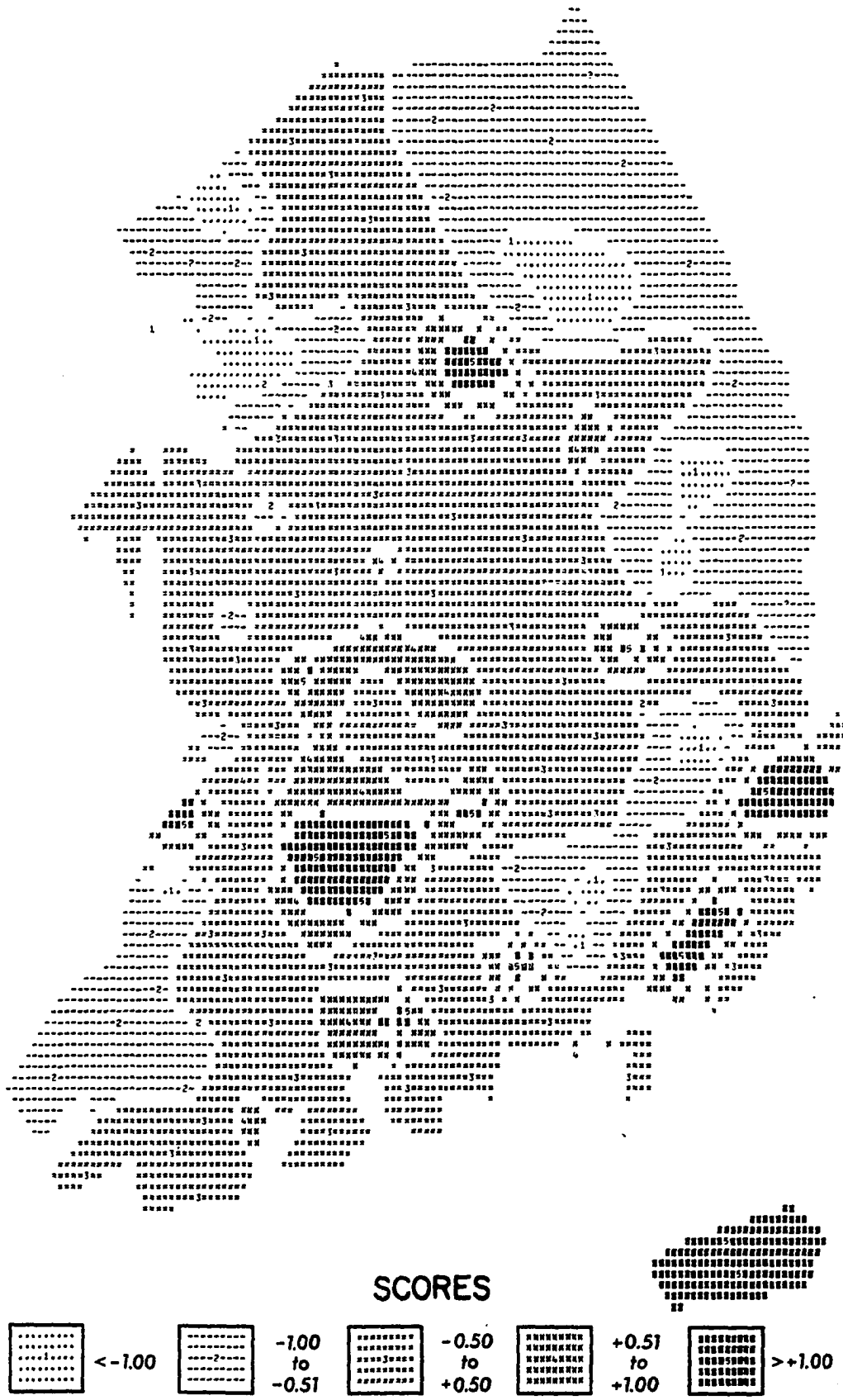
The absence of any other significant loadings on Factor 9 raises the implication that it is not related to any extremes in location or environment. It appears to represent another aspect of the transitional upland zone that exists nearly everywhere between the intensively used lowlands and the more remote and protected mountainous areas. The distribution of factor scores (Figure 12) tends to confirm this assertion, and further, suggest that this factor might reflect areas of greatest deforestation during the colonial period.

Of all the land use factors, this one identifies the sector in greatest need of rural development attention, especially in terms of developing alternate forms of agricultureal production and reforestation. The existence of this factor to any large degree within the reach of urban markets should be considered a sign of livestock and tree fruit production potential.

The Grouping Operation

The grouping operation was performed by a computer using Ward's algorithm. The criterion for grouping was the minimum

FACTOR 9



SCORES

Figure 12

increment to the pooled within group sum of squares between groups of one or more counties. A contiguity matrix was constructed using the criteria that: (1) counties which touch at any point are contiguous, (2) counties which are comprised largely or entirely of offshore islands are contiguous to each other or to peninsular counties if they share a water boundary, and (3) the two counties of the major offshore island province of Cheju are considered noncontiguous to any other counties because of their distance (80 kilometers) from the peninsula.

The objective of the grouping procedure was to identify regions which preserved as much of the information contained in the factor score matrix as possible, yet simple enough in pattern and few enough in number to serve as a useful generalizing and planning vehicle.

Grouping was initially performed without a contiguity constraint, but it did not produce the desired level of generalization until very high in the clustering step sequence, and even then there were two or more specific regions of each generic type. There were also too many small, distant outliers of the major generic regions for utility. The noncontiguous grouping trials, however, did indicate a basic structure of 13 to 15 groups and fairly constant boundary zones which were useful clues to an acceptable product using the contiguity constraint.

When the contiguity constraint was applied 15 groups were developed at step 118, and for the next six steps the number of groups alternated between 13 and 14. That plateau on the scree curve, in

conjunction with indications from the noncontiguous grouping, showed this to be the strongest group structure. At each step subsequent to 118 the groups retained their identities and merely added single hold-outs until step 125. At that point the basic group structure and identities started to collapse into a small number very rapidly.

The groups identified at step 124 were accepted as the tentative land use regions of Korea. At that point the 139 counties and 2 special cities had been reduced to 13 specific regions and 4 single, unassigned political units. Each of the ungrouped units was recognized as having a unique identity of sufficient importance to stand alone as an additional specific region. The 17 specific land use regions which resulted (Figure 13) constituted a tentative solution, subject to subsequent modification after image analysis.

The Image Analysis

The image analysis served to better delimit the basic land use regions defined in earlier steps. The black and white (MSS band 5) LANDSAT-1 mosaic was used as a base over which the regional clusters of counties were demarcated on a transparent overlay. Each regional cluster was then qualitatively examined to determine the dominant image signature, or photomorphic image, that most likely reflected or represented the composite land use present in the cluster.

The photomorphic image is essentially composed of contiguous areas with respect to continuity, uniformity, outstanding tonal qualities

PRELIMINARY REGIONS

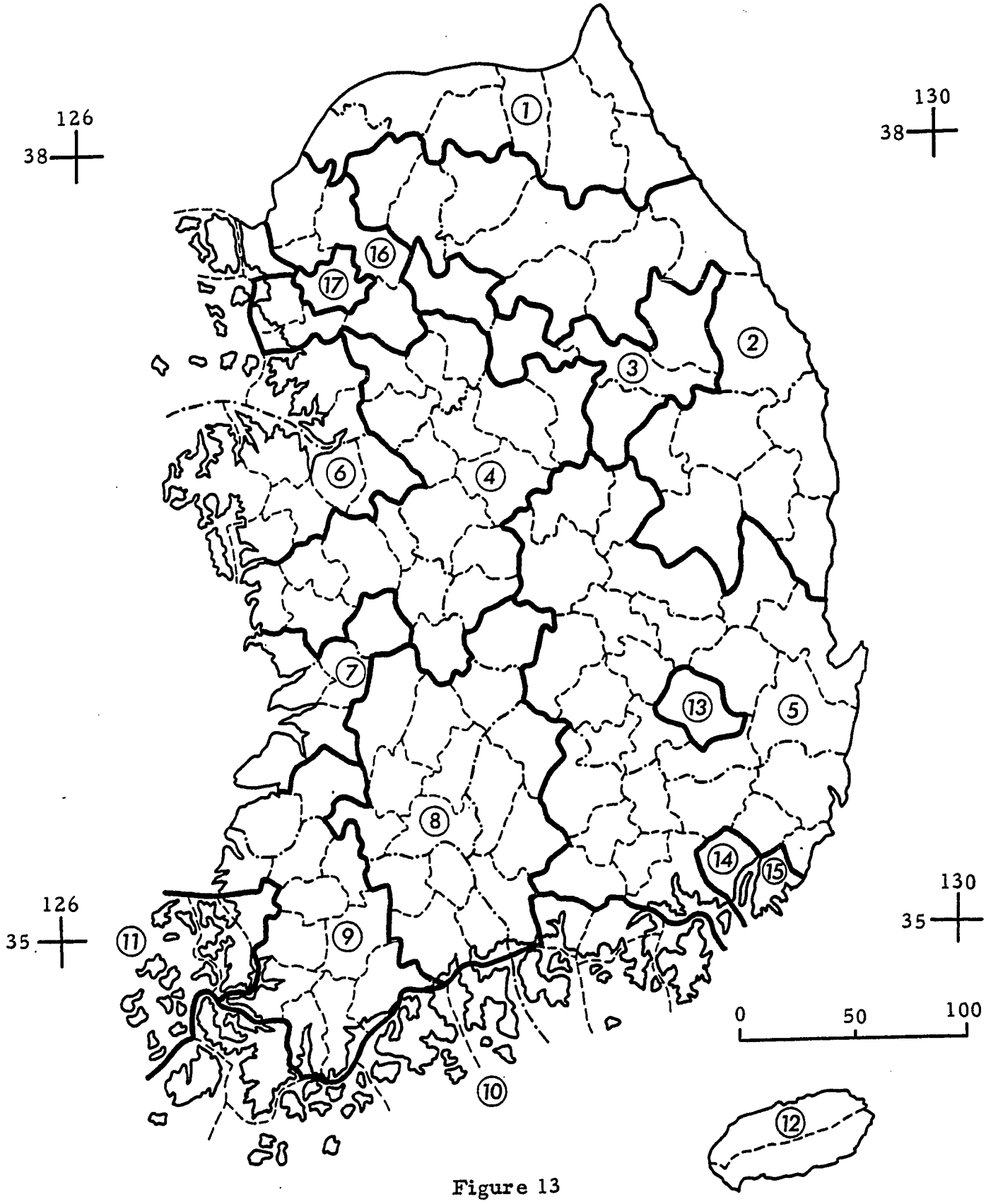


Figure 13

and characteristics of apparent form of a wide variety of surficial attributes such as landforms, drainage pattern, natural vegetation, agricultural patterns, and settlement features.[9] To aid in understanding and bounding the photomorphic areas, the factor structure of each regional cluster was examined and characteristic signatures of component land uses were evaluated.

Consider, for example, a regional cluster which had universally high factor scores for the lowland agriculture association and strongly negative scores for several of the upland and forest associations. The dominant image signature element would be expected to display a minimum of topographic control, a minimal drainage pattern because of man's usurpation of natural drainage for irrigation, relatively large areas of light gray tones characteristic of many short cultivated crops, and no apparent texture in the light gray tones because of the density, uniformity, and continuity of crops and fields. A general absence of very dark gray textured areas would indicate the lack of forests, while light toned lineaments and clusters would certainly reflect cultural features such as highways and settlements.

Further understanding of the signatures was gained through the evaluation of both fall and spring season composite color infrared images. Spring imagery was dramatically effective in conclusively distinguishing between flooded rice paddy and other lowland and upland

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[9]MacPhail, "Photomorphic Mapping in Chile," p. 1141.

fields. It likewise clearly resolved the questionable distinction on black and white imagery between upland crops such as dry grains and pasture or scrub vegetation. During either season it was especially useful for emphasizing generic differences in forest vegetation, forest density, and cultural features. With both black and white and color imagery each of the more or less distinctive signatures was identified or substantiated by reference to surrogate ground truth, other examples in the body of literature, and the investigator's interpretation experience.

Once recognized, the characteristic signatures of regional clusters were bounded without regard for political boundaries. In order not to disregard the findings of the factor analysis or to unnecessarily distort the mathematically correct results of the contiguity grouping, no county was allowed to be bounded entirely within a second region. In a few instances, however, a county with fairly evenly divided attributes whose sum caused it to be grouped with hypothetical cluster A, was divided between regions B and C, which each part more closely resembled, to the exclusion of region A.

Surprisingly few boundary problems developed, nevertheless most regions were substantially altered in shape and area. Some regions changed little in total area, but exchanged considerable area with adjacent regions. The final regional scheme (Figure 14) is felt to be a considerable improvement in regional homogeneity, if not in administrative tidiness.

MODIFIED REGIONS

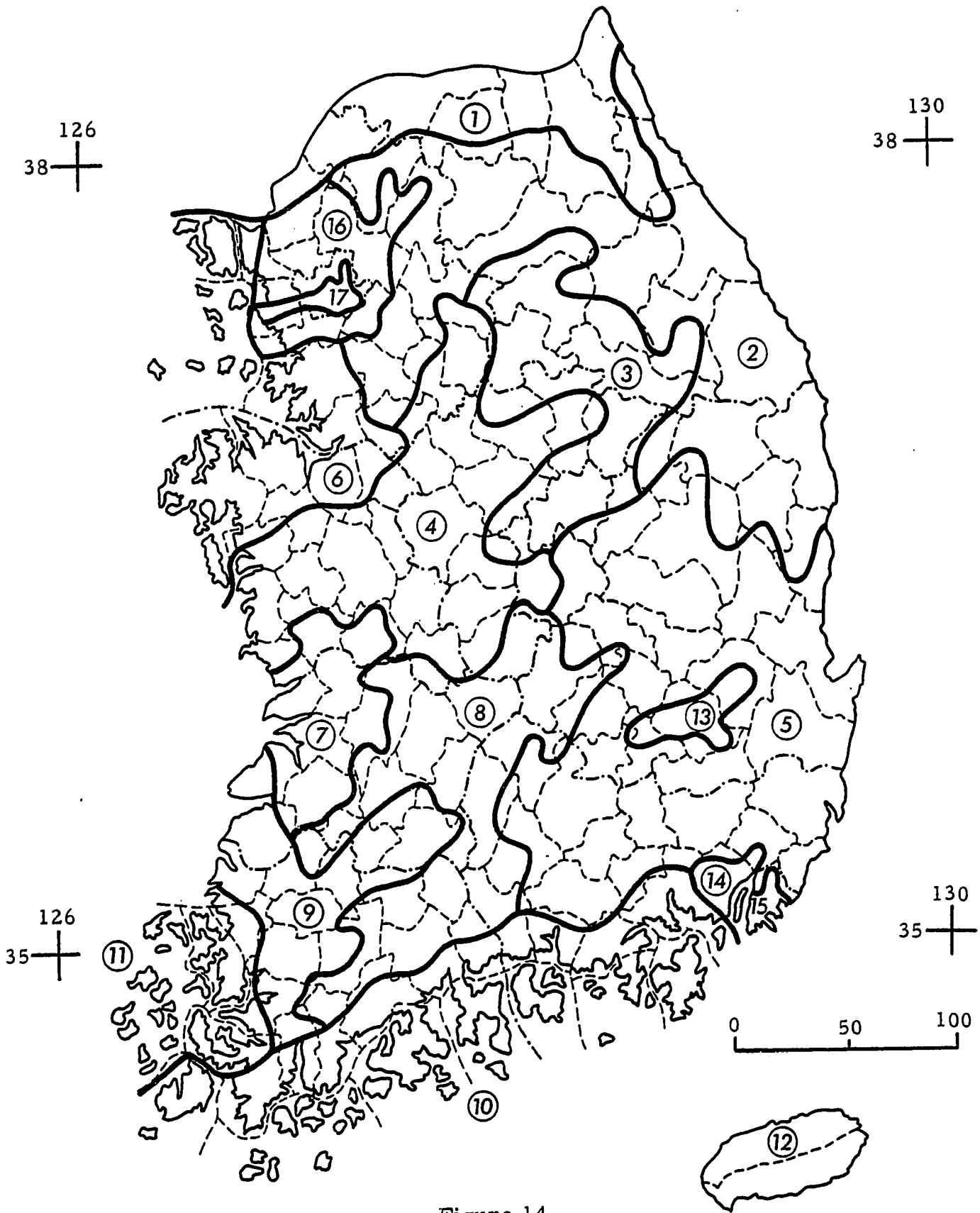

Figure 14

Description of Regional Signatures

The photomorphic signature of each region as imaged on the band 5 (black and white) imagery is described in a style compatible with that used by MacPhail, Nunnally, and Rudd. The purpose of the descriptions is to "fix" the image and its interpretation, and to illustrate fundamental differences that exist between regional signatures. It might also be of interest to compare the signatures from imagery of this scale, type, and environs with those described in other studies.

Region 1. --The dominant characteristic of this signature is the large area with dark gray tones and the almost total absence of contrasting light tones. Topographic control of the signature is obvious, and it produces a coarse faceted or angular appearance of alternating dark and somewhat lighter tones. Within each of those tonal elements there is a coarse texture probably caused by local changes in the topography and vegetation. The only interruptions in this pattern are linear and dendritic patterned areas of light gray tones which appear to be sparsely vegetated drainage divides and stream channels. There are no apparent cultural elements in the landscape, and the total signature appears to be indicative of relatively high mountains with a frequently dense and nearly continuous forest cover (Figure 15).

Region 2. --This region has the same dark toned, faceted appearance seen in Region 1 as a basic signature, but the topographically related linear and dendritic shaped areas of light tones are more intense

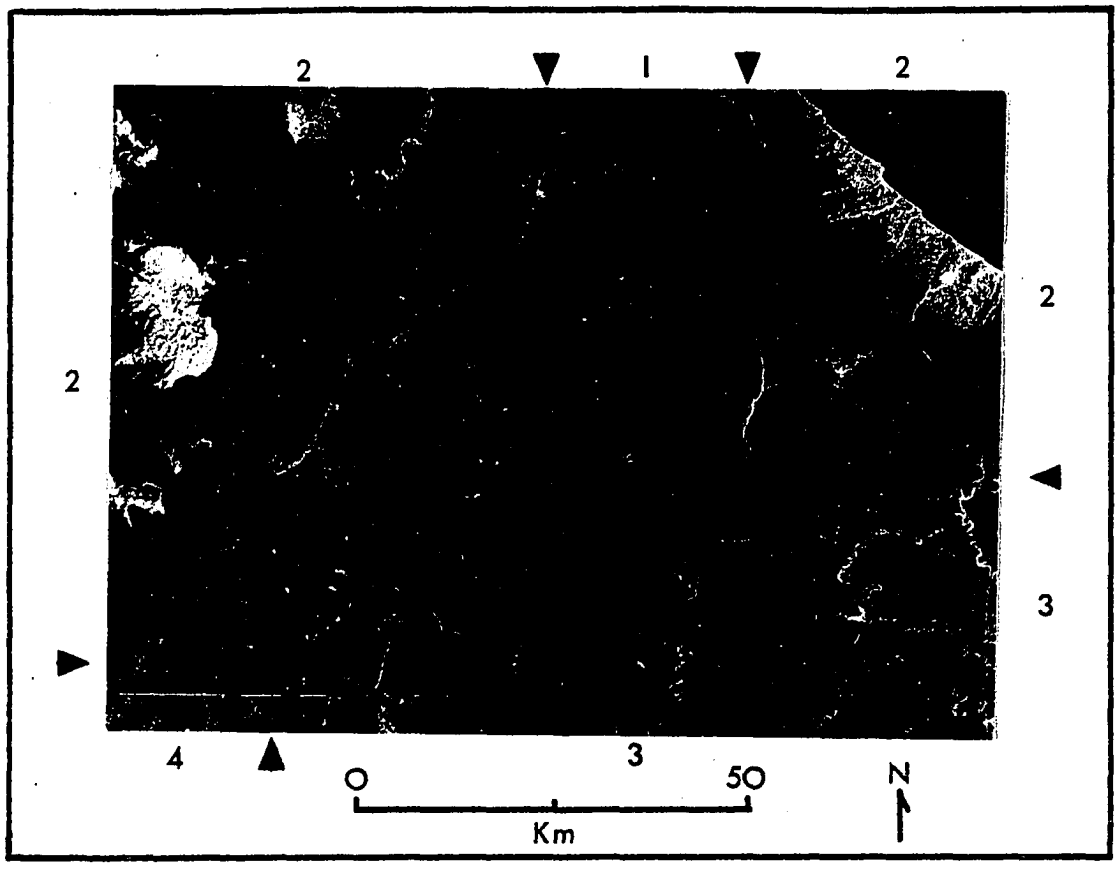

Figure 15. --Portion of LANDSAT mosaic scene 4 for Regions 1, 2 and 3.[a] The decrease in topographic and vegetative expression, and the increased extent of light gray tones from Region 1 to Regions 2 and 3 are clearly evident. The coastal enclave of Kangnung shows the vivid contrast of a densely settled coastal plain. Clouds are conspicuous along the western edge of the image.

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[a]Figures 15 through 20 are all multispectral scanner (MSS) band 5 images printed at a scale of 1;1,000,000. They are printed on paper at this scale for illustrative purposes only. Analysis was done on third generation film transparencies using a 70-power zoom stereoscope.

and frequent in occurrence. Medium gray tones with a coarse mottled texture occur irregularly along stream valleys, and in some localized areas that appearance extends over the interfluves. Along the coastline the mottled medium gray includes occassional patches of nearly white gray tones, and is nearly continuous in the north but is restricted to small enclaves along the southern coastal portion of the region (Figure 15).

Essentially the same topography and natural vegetation as exists in Region 1 forms the basic signature, however, in this region the stream channels and valleys are somewhat wider and are frequently occupied by small settlements and farming activities. That mixture of distinctly different land uses probably yields the mottled texture. Larger areas along the coast indicate the nearly universal clearance of natural vegetation and widespread cultivation. The nearly white patches have such a shape and orientation as to indicate relatively large and dense urban agglomerations.

Region 3. --Region 3 is marked by great contrasts in tone, texture, and shape of constituent elements. The dominant appearance is is still one of very dark toned and substantially smaller angular facets than are seen in the first two regions. Perhaps 25 percent of the total area, however, is occupied by a medium gray tone with a coarse texture which is interspersed with a high density of small dot-like dark spots. These medium gray elements are largely feather-shaped areas

along the smaller stream valleys, but they coalesce in several places to form large irregularly shaped and ragged-edged patches. These larger areas are marked by occassional small, nearly white areas (Figure 16).

The signature seems to represent denser settlement and land use on a more mature fluvial landscape than that of Regions 1 and 2. The almost salt-and-pepper pattern superimposed on the medium gray toned areas probably results from discontinuous mountain slope clearings and small settlements thoroughly mixed throughout the region. The very light toned patches are all in stream valleys and are undoubtedly larger agglomerated settlements.

Region 4. --This region is marked by contrasts between two major signature elements. The first is comprised of ragged-edged, irregularly shaped areas of dark gray tones incised by light gray along minor drainage lines of very high density such that both tones are nearly equal in area. The second element is comprised of several large, elongated, or generally oval areas of light to medium gray tone. These areas have a moderately coarse texture dominated by a high density of very light gray speckles. Within these areas the only apparent drainage channels are quite wide and appear to be the highest two orders. Throughout the region there are several compact, but irregularly outlined areas that appear nearly white (Figure 16).

The primary influences on the signature are a mature fluvial

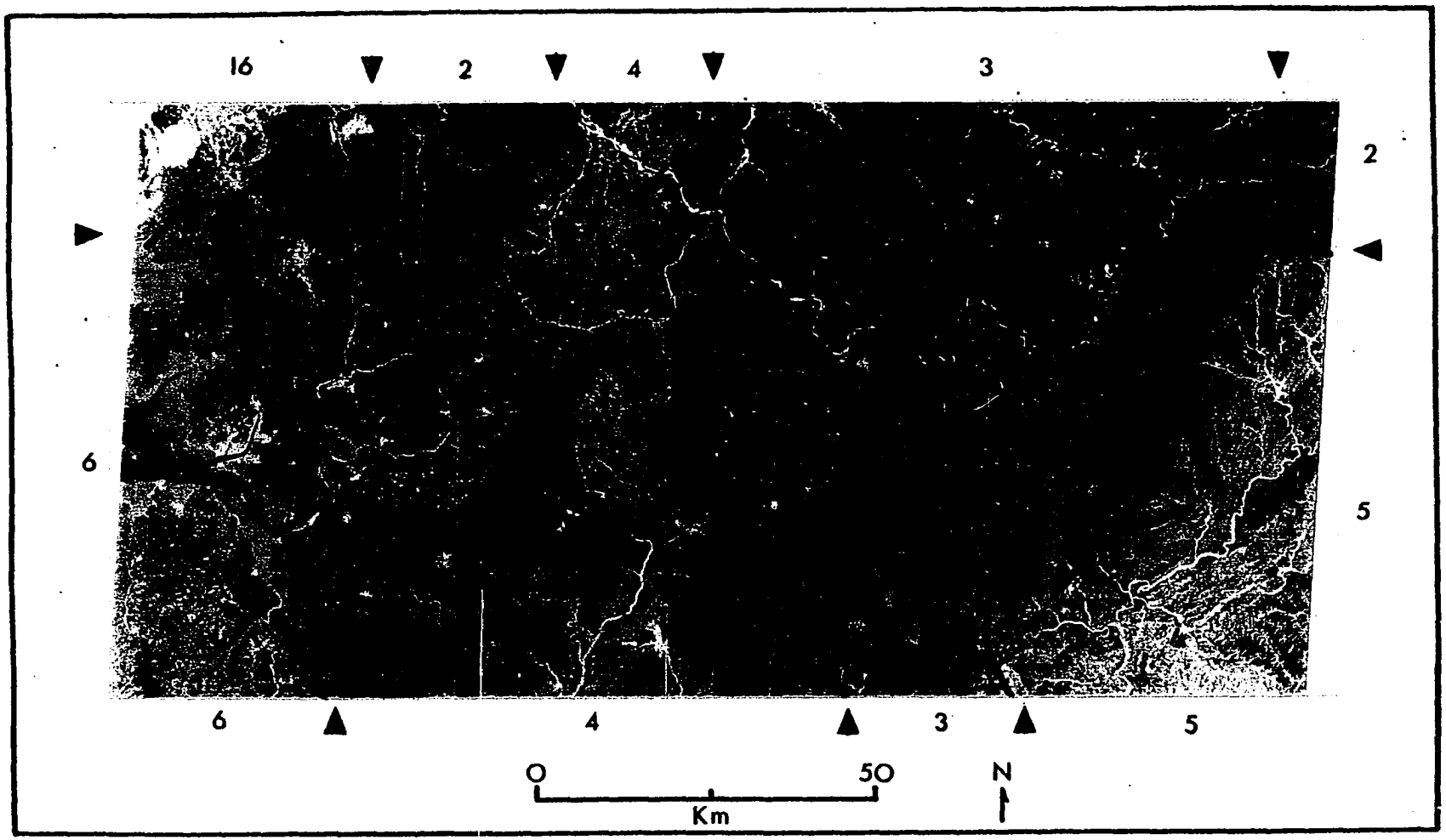

Figure 16. --Portion of LANDSAT mosaic scene 4 for Regions 3, 4, 5 and 6. The dark gray tones and coarse texture of Region 3 contrast sharply with Regions 4, 5 and 6 where light tones and finer textures are increasingly dominant. The darkest areas represent continuous forest cover, and the lighter tones indicate increasingly dense agricultural and builtup land covers.

landscape on which clearing and settlement appears to have fully occupied all areas except the highest and most rugged interfluvial slopes. The light speckles probably reflect a combination of dry cultivated land and small settlements distributed across the large lowlands. Large urban places with dense construction are imaged as nearly white areas.

Region 5. --This region presents essentially the same signature as Region 4 except that areas of light to medium gray tone are much smaller and are elongate or sinuous in form. The difference appears to be a result of the same cultural processes working on a more dissected landscape having smaller uninterrupted valleys for development, and exhibiting substantially less cultural impact (Figures 16, 17 and 19).

Region 6.--Region 6 presents a signature with a light gray matrix on which a spatter pattern of nearly white, medium and dark gray tones is rather evenly distributed. In some small areas there are greater densities of either dark or light spots. The overall texture is moderately fine and the apparent drainage is dendritic and relatively coarse. Along the coastline which forms the western boundary of the region there are extensive areas of very light gray tones with no apparent texture (Figure 16).

The signature suggests that the area has little relief and is almost totally occupied by cultivated agriculture and other settlement features. The spattering effect probably represents a great variety of small, discrete and well integrated land occupance modes. Several

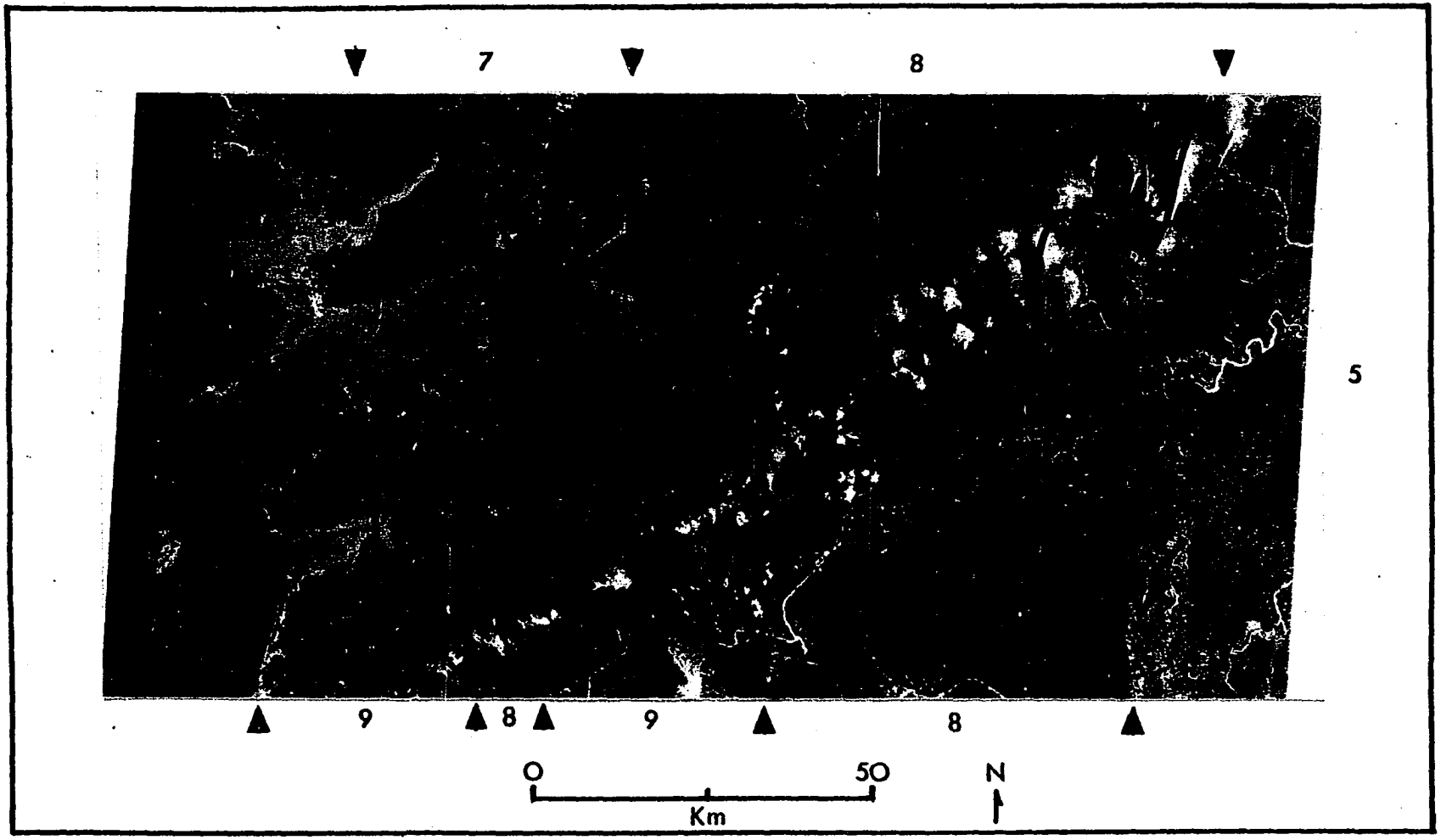

Figure 17. --Portion of LANDSAT mosaic scene 5 for Regions 5, 7, 8 and 9. The dark tones, incompletely cleared valleys and coarse drainage texture of Region 8 are characteristic of sparsely settled mountains. The light gray matrix of Region 7 shows little relief, but extraordinary settlement impact. Notable are the urban agglomerations and highways.

nearly white patches appear to be agglomerated settlements, but none are very large.

Region 7. --The signature of this region has a light gray matrix with negligible texture and no apparent drainage pattern. Superimposed on the matrix are a few localized dark gray areas of irregular shape and fine texture, and a patchy, but distinct salt-and-pepper pattern. Several star-like clusters of very light gray spots are prominent across the region, and they are interconnected by a faint network of light toned lineaments (Figure 17).

The various signature elements clearly indicate a region of negligible relief which is almost completely occupied by cultivated fields and settlements. Patches of salt-and-pepper appearance probably reflect local changes in soils or topography which cause a slight variance in land use. The high density of population and urban-builtup activities is responsible for the very light toned clusters and lineaments.

Region 8. --This region presents a photomorphic image similar to that of Region 2 in most respects. A notable difference is the greater range in size and gray tone of the faceted elements. Larger facets remain very dark, but smaller facets have medium gray tones. There is also a marked decrease in the prominence of light toned drainage lines standing out in contrast. These differences are probably the result of a greater range in local relief and the extensive clearing or cultivation of lower mountain and hill slopes in this region (Figure 17).

Region 9. --This area resembles Region 4 except that all aspects of the signature are reduced in size by as much as one-half. The impression is one of similar cultural processes and patterns to those of Region 4 working on a landscape in the same stage of fluvial morphology, but having more subdued relief (Figure 18).

Region 10. --This region is largely shaped by a coastal belt of mountains, islands, and irregular peninsulas characteristic of submergent shorelines. The dominant element is a medium gray area having very small angular facets and a fine drainage density which occupies about 80 percent of the region. It is set in a matrix of light gray with no discernible texture which is restricted to narrow strips along stream valleys and to semicircular areas along many embayments. Isolated areas of very light gray tone having discrete boundaries and small size are widely separated in the light toned coastal areas (Figure 18).

The photomorphic image indicates low but rugged topography with negligible clearing. The medium gray tone of the uplands indicates only a sparse forest cover. Cultivation appears to cause the minor areas of light tone, while small urban areas produced the discrete areas along the coast.

Region 11. --This small region is adjacent to Region 10 and is distinguished from it by a reversal in the dominant elements of the photomorphic image. Here the majority of the area is occupied by light gray tones with a fine tecture. It is interrupted by very small, isolated

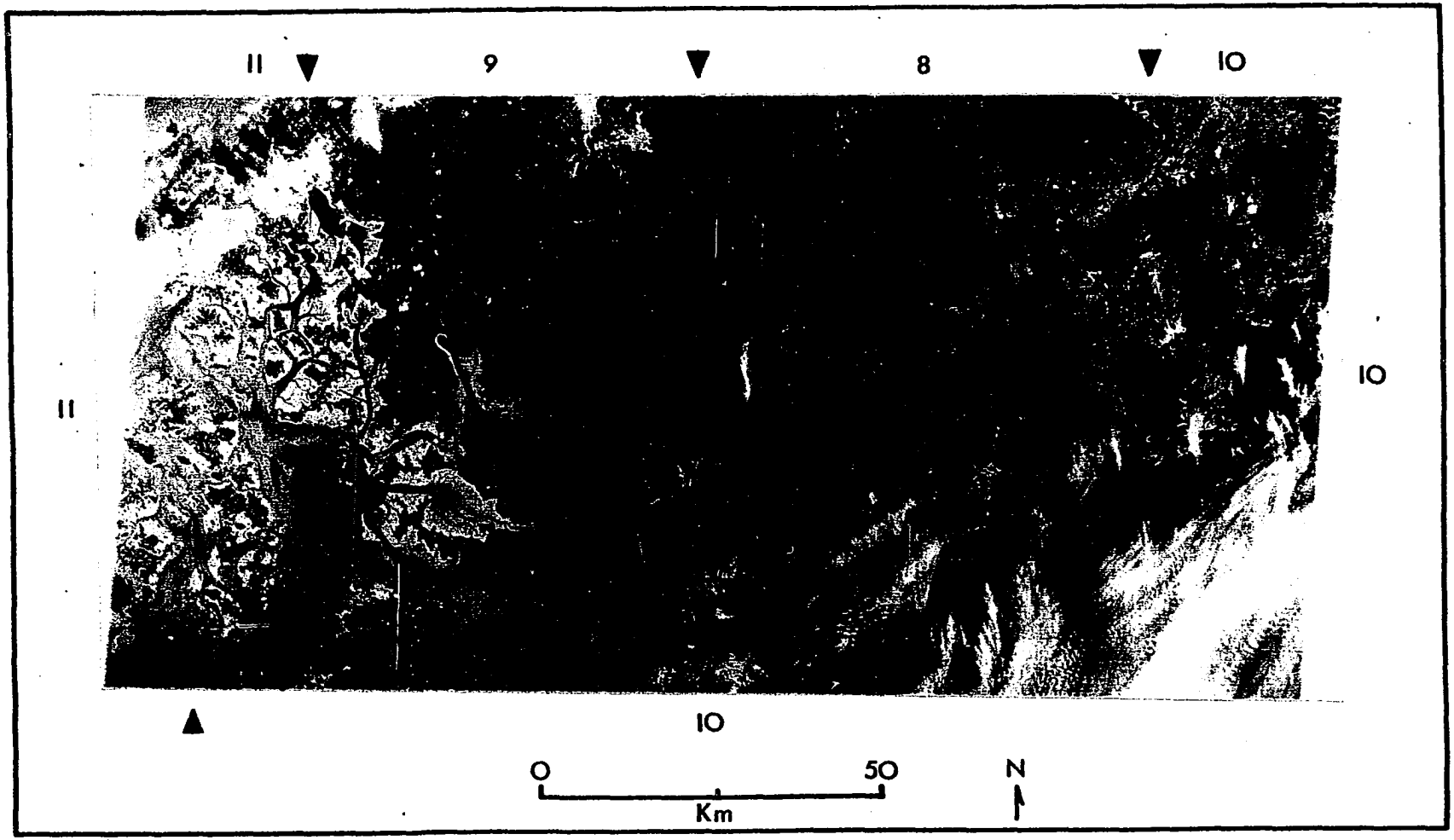

Figure 18. --Portion of LANDSAT mosaic scene 6 for Regions 8, 9, 10 and 11. Prominent on this image are the contrasting tones and textures between the regions. Most distinctive are the expanses of textureless light gray in Region 11. They are mud tidal flats. Region 10 has a high frequency of textural and tonal change, and is marked by isolated pockets of settlement.

patches of dark gray which occur at the highest elevations of the apparent relief. The many small islands and narrow peninsulas are surrounded by broad areas of textureless very light gray tone which are incised by a dendritic network of dark gray (Figure 18).

The composite signature appears to represent a simple combination of intense cultivation on all surfaces except mountain peaks where remnants of natural vegetation remain. The large expanses of smooth textured light gray indicate flat areas of unvegetated earth material and are unquestionably tidal flats.

Region 12. --Region 12 is a large elliptical island whose photomorphic image appears to vary with elevation. A ragged-edged band of medium gray with a fine pin-point pattern of light spots and no apparent drainage pattern occupies the outer one-third of the radius.

The first zone bleeds into a zone of light gray which is interrupted by dark gray radial lines and several large patches of dark gray with very distinct outlines. The inner one-third of the radius is occupied by very finely textured dark gray tones except where incised by light gray along obvious drainage lines.

The principal contributors to the photomorphic image from the coast to the interior appear to be cultivated fields in the outer lowland zone, grass or short scrub growth in the middle, and lava fields or forest in the inner zone. The only cultural elements evident are some small settlements along the northern coast.

Region 13. --The signature of this small region is distinguished from that of the surrounding region by substantially less topographic control and by the inclusion of several different elements of nearly equal prominence. A principal element characteristic of urbanization is an oval area of light gray tone which exhibits no relief or regular texture, but contains many small, diffused dark spots and several lineaments of obvious cultural origin (Figure 19).

The bulk of the region is characterized by elongate areas of light gray tone interspersed with irregular segments of medium gray extending inward from the boundary. A large number of small, irregularly shaped dark gray spots with discrete edges are distributed throughout the medium gray areas. These signature elements appear to represent intensively farmed lowlands flanked by low hills containing standing water bodies.

Region 14. --This is a small region which appears as a rather compact zone of light gray without any apparent relief, texture, or local drainage pattern. The homogeneity of this element indicates a preponderance of high density cultivation. The only deviations from the basic signature are major river channels and minor peripheral and angular intrusions of medium dark tones which appear to be forested uplands (Figure 19).

Region 15. --The photomorphic image of this region has two elements. Dominant is an irregular, but continuous area of light gray

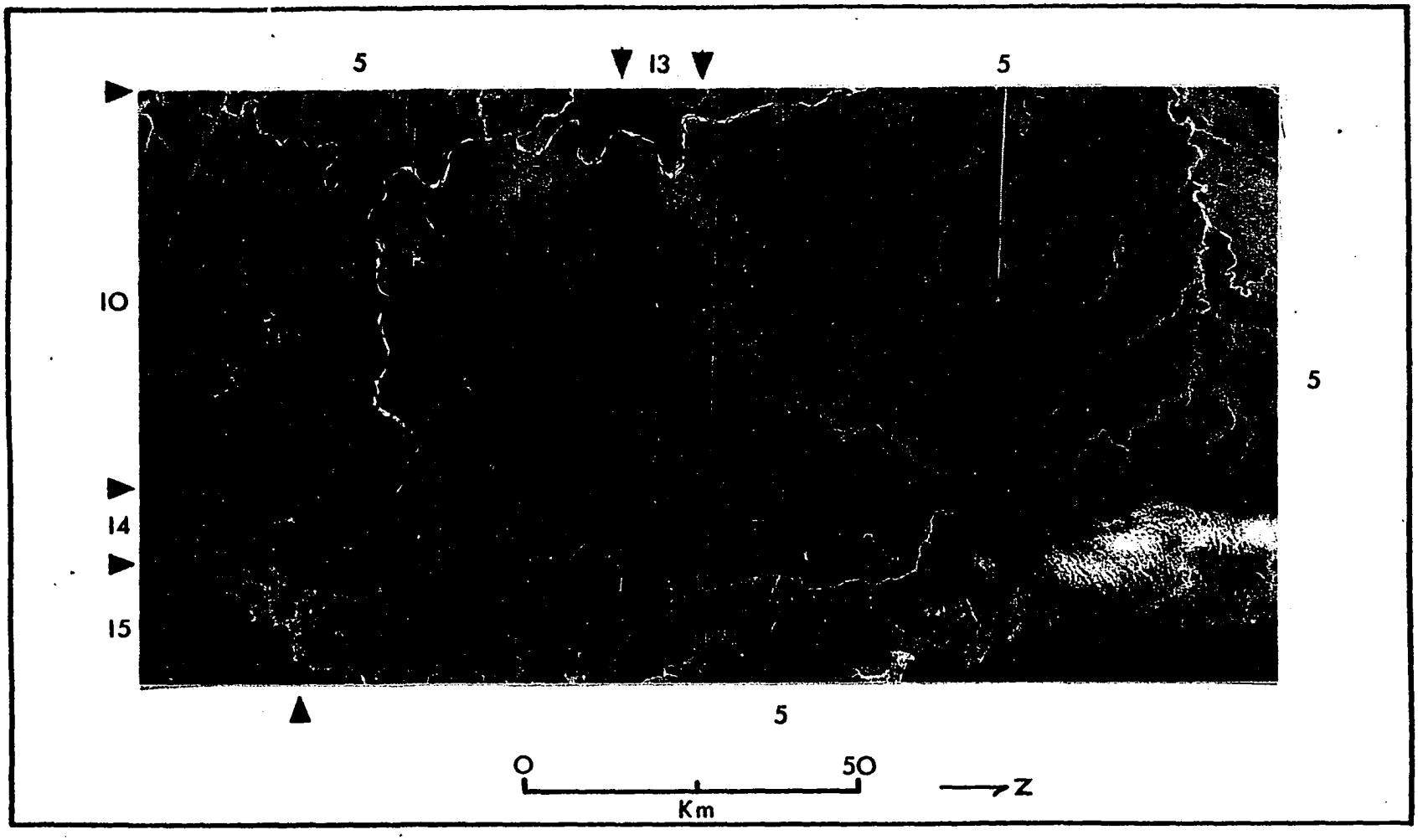

Figure 19. --Portion of LANDSAT mosaic scene 8 for Regions 5, 13, 14 and 15. Region 13 is an area of predominantly light tones and subtle textures surrounded by Region 5's more conspicuous topographic control and tonal contrasts. The homogeneous texture of Region 14 contrasts with the white spattered appearance of urban Region 15.

which is speckled with a high density of nearly white flecks. Some nearly white lineaments and regular shapes are apparent in several places. That element is interrupted by a few compact intrusions of faceted medium gray tones. The boundary is distinct and irregular. The composite signature indicates a dense urban agglomeration which is bounded and perforated by severe topographic barriers (Figure 19).

Region 16. --The photomorphic image of this region, like Region 13, is distinguished from adjacent regions by substantially less topographic control and by the inclusion of a wide variety of different elements. Among the elements present around most of the land boundary is an area of medium and dark gray tones which are mixed together in a tweedy combination of medium to fine texture. Generally paralleling those areas is a zone of medium gray tone which exhibits minimal topographic control and drainage. It is speckled with light spots and appears to occupy intermediate elevations on the local relief. Next are areas of light gray with no apparent texture, relief or drainage systems which clearly intrude up all major stream valleys and occupy extensive areas along the Han River. Lastly, there are many irregularly shaped white or very light gray areas of varying size distributed across the region (Figures 16 and 20).

The spectrum of occupance modes imaged in this region includes low forested hills incised by upland farming, large valleys of nearly continuous paddy cropping, and several major urban agglomerations. The

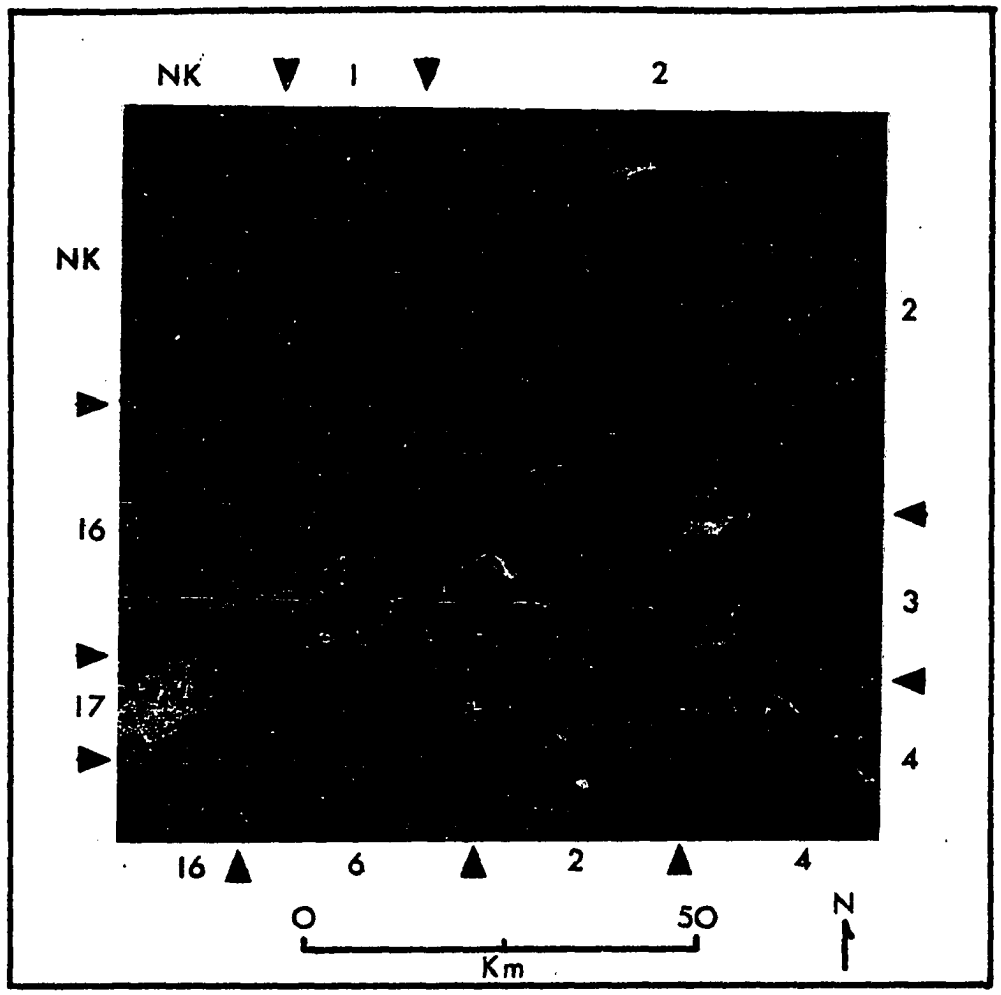

Figure 20. --Portion of LANDSAT scene for Regions 16 and 17. This high density frame partially masks topographic and textural changes in the signatures, but accentuates the tonal contrasts that mark the boundaries of urbanized areas. Note the conspicuous signature of the artificial harbor in Inchon at the lower left.

tweedy texture of the higher relief indicates discontinuous vegetation and high settlement impact.

Region 17. --This photomorphic image is similar to that of Region 15 except for the mix of signature elements. In this region topographic expression is less pronounced, and each element has a more compact area of dominance (Figure 20).

CHAPTER V

REGIONAL DESCRIPTIONS[1]

Forested-Subsistence Agriculture Regions

Region 1

Region 1 is an intermediate sized region of about 4,100 square kilometers which includes major portions of seven counties in Kyonggi and Kangwon provinces. It forms a narrow belt from the east coast nearly to the west and is truncated on the north by the Demilitarized Zone (DMZ). Its boundary follows lines of marked change in landforms and land use in the west where it abuts Region 16 and on the east where it adjoins the coastal belt of Region 2. Everywhere else the landscape change is more gradual and the boundary zone is less distinct.

The region lies just north of the 38th Parallel and is comprised of rugged mountainous terrain for the most part. It is underlain with granite, granite gneiss, and schist rock of Tertiary or Cretaceous age.[2]

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[1]See map in Appendix D--Land Use Regions of the Republic of Korea.

[2]Geologic Map of Korea (Seoul: Geological Survey and the Geological Society of Korea, 1956).

The landscape has the configuration of early maturity characterized by narrow interfluves, deep V-shaped valleys, great local relief, and a complex drainage pattern of entrenched dendritic and meandering streams.[3] Mountain tops and ridges range from 700 meters elevation in the west to 1,700 meters or more in the east, and local relief is 600 to 1,000 meters. Slopes commonly exceed 30 percent and have boulder or exposed bedrock surfaces. In the west the terrain is more subdued and areas of locally mature landscape are found.

The entire region lies in a zone classified by McCune as having a Köppen Dwa climate which receives less than 1,000 millimeters of precipitation annually.[4] The soils are shallow and frequently stoney residual podzols which are locally sandy or clayey, depending upon the parent material. The natural vegetation has undergone considerable disturbance, but the climax form is probably a spruce-fir association at the very highest elevations and a mixed forest of pine, oak, elm and maple everywhere else.[5]

All but the western extreme of the region is poorly integrated with the rest of the country because of severe topographic barriers and

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[3]Davisian geomorphic terms in this chapter are used to describe the landscape rather than to represent a particular stage in a cyclical process.

[4]Shannon McCune, Climatic Regions: Delineation, Research Monographs on Korea, Series E, No. 1 (Columbus, Ohio: Korean Research Associates, 1945), p. 15.

[5]Zaichikov, Geography of Korea, pp. 32-33.

a primitive transportation network. There are no paved roads in the region, and most routes have single-laned dirt or gravel surfaces. The few all-weather roads were built for defense purposes, and they form an adequate network only in the western third of the region astride traditional invasion routes. The only railway extends northward from Seoul to near Chorwon where it is severed by the DMZ.

A major cultural characteristic of Region 1 is its low population density of about 50 persons per square kilometer. Even those few people are found clustered in small villages along the bottoms of major stream valleys. There are no large cities in this region, and only Chorwon and Kumhwa have sufficiently large agglomerations (20,000 persons) to be considered towns. Both of them were regional transportation hubs whose hinterlands were truncated by the DMZ. Their major function now is serving as foci for military activity in the area.

Economically, this region has always been a part of the backwater or frontier where one found the lowest percentages of arable land, the greatest percentage of land above 1,000 meters, and the largest share of burnt-field farming.[6] Most of the population is engaged in subsistence farming, although forest harvesting and small mining operations employ a small percent. Greater development of the region is hampered by its isolation and defense policies. Severe security restrictions have been placed on the migration, settlement, and daily

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[6]Bartz, South Korea, p. 144.

activities of persons in this area because of the threat of North Korean infiltration and terrorism. One result has been the forced migration of most burnt-field farmers to areas further south, and to the localization of settlement activities.[7]

Agricultural activities occupy less than 10 percent of the region's area, and they are largely restricted to the narrow valley floors and lower slopes adjacent to settlements. The principal crops are paddy rice, corn, soybeans, and white potatoes in close, but descending rank order. A host of other dry grains and subsistence crops complete the list. Low intensity agriculture and a preoccupation with subsistence crops to a degree approached no where else in the country are the region's most notable agricultural characteristics. Both characteristics result from isolation from markets and innovative techniques, and from a harsh interior climate that makes the harvesting of more than a single crop per year very infrequent.[8] Only in the far west is this situation tempered.

The dominant land cover in Region 1 is forest and barren or nonstocked upland. Most of the region was razed during the Korean War and most vegetation is consequently less than 25 years old. The oak-pine association mentioned earlier is dominant, although scrub oak and coarse grasses prevail over large areas of thin or eroded soils

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[7]Forestry in Korea, p. 64.

[8]Koo, Regional Characteristics of Korean Agriculture, pp. 371-373.

and in areas easily accessible for fuel foraging. Despite low or negative scores for all forest oriented factors, large and small scale image analysis indicates that over 75 percent of the region is "forest" land of some quality.

Region 2

This region is the second largest in the country with an area of about 17,000 square kilometers. It spans 210 kilometers from the 38th Parallel southward and reaches 170 kilometers westward from the east coast at its widest point. The boundary with Region 1 on the north and Region 3 in the south-center is broadly transitional and ill-defined, but it is marked by obvious and fairly abrupt landscape change elsewhere.

Physiographically this region is the same as Region 1 except that in the northwestern portions of Region 2 there is more extensive river valley development, and along the Sea of Japan there is a very narrow and discontinuous coastal plain. The Taebaek Range, which is the peninsula's cordillera and east-west drainage divide, dominates the landscape. It also constitutes a climatic barrier which separates the coastal Cfa climate from the Dwa dominated area west of the range.[9] Geologic materials are also similar except in the southeastern extension where massive sedimentary and metamorphosed sedimentary strata are found.[10]

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[9]McCune, Climatic Regions: Delineation, p. 14.

[10]Geologic Map of Korea.

The most rugged and isolated portion of the region, which comprises perhaps one-half of the total area, has a population density of less than 50 persons per square kilometer. Substantial areas in the south and west where there is more lowland have densities of over 100 or 200 per square kilometer. Settlement in the higher mountains of the east is concentrated along all of the larger stream valleys where there is relatively level land or where the slopes are less than about 30 degrees. With increasing distance from the DMZ a dispersed settlement form which was once common in all the highlands occurs more frequently. These settlements are typically single or double farmsteads of a related family located on a small pocket of land with cultivable slopes and a perennial stream. In the west the more traditional and preferred settlement form of agglomerated lowland villages prevails.

Settlements throughout the region are generally limited in areal extent and population by the topography and the low overall productivity of the landscape. Large villages and small towns of several hundred households are located along valley transportation routes and nodes, and with greater frequency in the more amenable west. There are two large cities in the region which perform the full range of urban functions. The largest in Chunchon (1970 population 123,000), a major north-south and east-west highway junction and the northern terminus of the Kyongchon railway line from Seoul. Economically it benefits from its nearness to the resources of the Taebaek Range and its location between

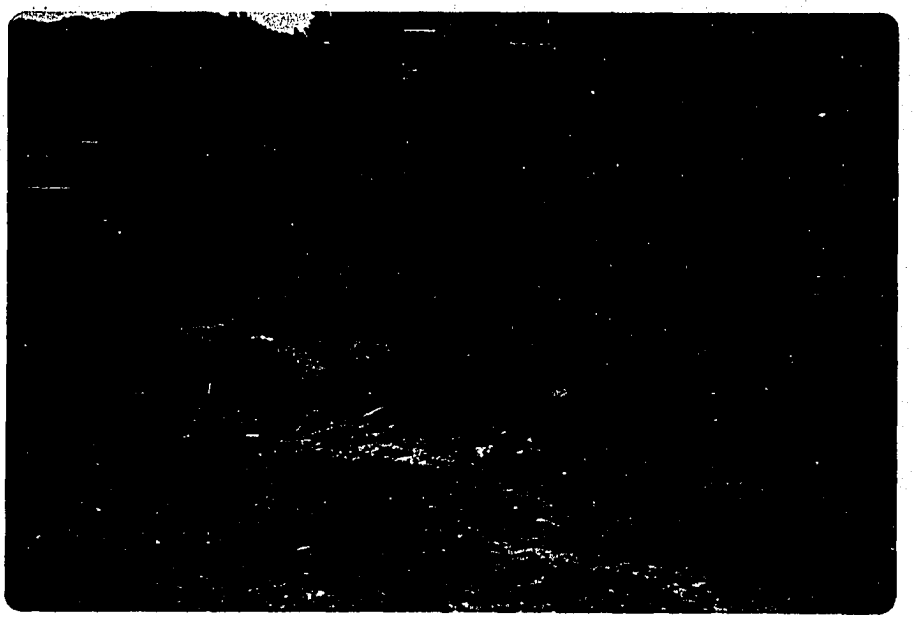

Figure 21. --Farmstead in the Taebaek Mountains of Region 2. The isolated situation, site characteristics and rudimentary nature seen here are illustrative of the dispersed subsistence farms in many remote mountain areas, especially in Regions 1, 2 and 3.

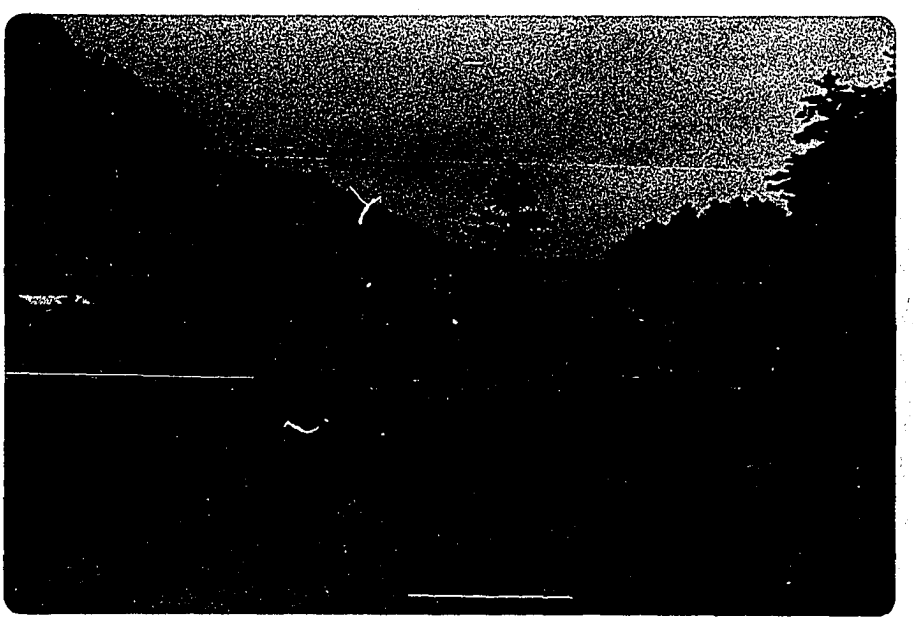

Figure 22. --Settlement along the Wonju-Kangnung highway. This valley in the Taebaek Range provides a suitable site for a small village. Corn and beans are the principal crops in view, and conifers are the dominant slope cover. This was the best trans-Taebaek route until 1975.

several of Korea's largest hydroelectric reservoirs. The other city is Kangnung (1970 population 75,000) which owes its standing primarily to its site characteristics. It is situated on the largest pocket of coastal plain (about 100 square kilometers) between Wonsan in North Korea and Pohang some 200 kilometers to the south, and is growing as a regional administrative and transportation center.

The economic integration and interconnectivity of Region 2 with the rest of South Korea varies considerably. As could be expected, connectivity is poor in the long mountainous belt which has only two roads crossing it to the east coast. One of these is the Wonju-Kangnung highway whose upgrading and paving were completed in 1975. The western extension of the region has about as complete a transportation network as the terrain will allow and is reasonably well connected to the population centers of the western lowlands. Modern economic development of the region was ignored by the Japanese colonial government because of the difficult terrain and the availability of better resources farther north in what is now North Korea. Recently developed government plans, however, call for the grafting of this region with its power, mineral and timber resources to the industrializing areas around Seoul and Taegu.[11]

It is not surprising that land occupance patterns in this region reflect the influence or control of terrain more than any other factor.

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[11] National Land Development Plan: 1972-1981, p. 202.

Urban and builtup uses are understandably small in view of the sparse population, and the bulk of the area is devoted to less intensive uses. Forest of all types, which undoubtedly includes a substantial amount of statistically unreported barren land, is the predominant cover. Agriculture occupies a minor, but always important fraction of the region, with all other categories of use being negligible.

The interpolation of county statistics and the analysis of imagery indicate that forest occupies from 65 to 80 percent of the area as one moves from west to east.[12] Theoretically there are stands of mixed forest of the pine-oak association, but much of that cover was destroyed during the Korean War. It has been replaced by a natural succession of herbs and scrub growth, faster growing pine species, and in some cases, reforestation with pure stands.

About 75 percent of the region is included in a nationally administered forest system that has been established to preserve watersheds and manage economically valuable timber land to meet long term needs.[13] Currently there are some major stands of dense, mature timber of significant value located in several national forest preserves in the Taebaek Mountains, but much of the region is still being reforested with economically useful trees. Most commonly planted are hybrid pine on lower slopes and native pine, fir and larch at higher elevations.[14] Several

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[12] Forestry Statistics: 1973, Table II-4.

[13] Forestry in Korea, pp. 44-45. [14] Ibid., p. 43.

thousand hectares are being reforested each year in a long term government plan which is expected to take a generation to complete.[15]

Agricultural land in this region is almost exclusively cultivated, although several experimental cattle farms have been established on nonforested upland in recent years. The amount of farmland varies from a high of about 15 percent of the area in the south and west to a low of 10 percent in the northeast.[16] Without notable exception the spatial and temporal patterns of cropping are identical to those described for Region 1, and vary little from those of any mountainous area in Korea. Koo's study of Korean agriculture found the common characteristics of those regions to be: (1) the low percentage of arable land, (2) the low percentage of cultivated area in paddy, (3) an absolute concentration on food crops, and (4) the growing of a wide variety of crops.[17]

Even in this region wet rice is the favored crop and, as elsewhere, paddy occupies the best land situated astride or immediately adjacent to drainage lines of reasonably reliable flow. Dry or upland crops are normally planted in long, narrow fields paralleling drainage lines. They are usually localized, but where slopes are gentle enough they frequently extend several hundred meters up slopes having the greatest sun exposure. The drainage oriented pattern of cultivation is

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[15] Ibid., p. 45.

[16] Koo, Regional Characteristics of Korean Agriculture, p. 769.

[17] Ibid., pp. 371-373.

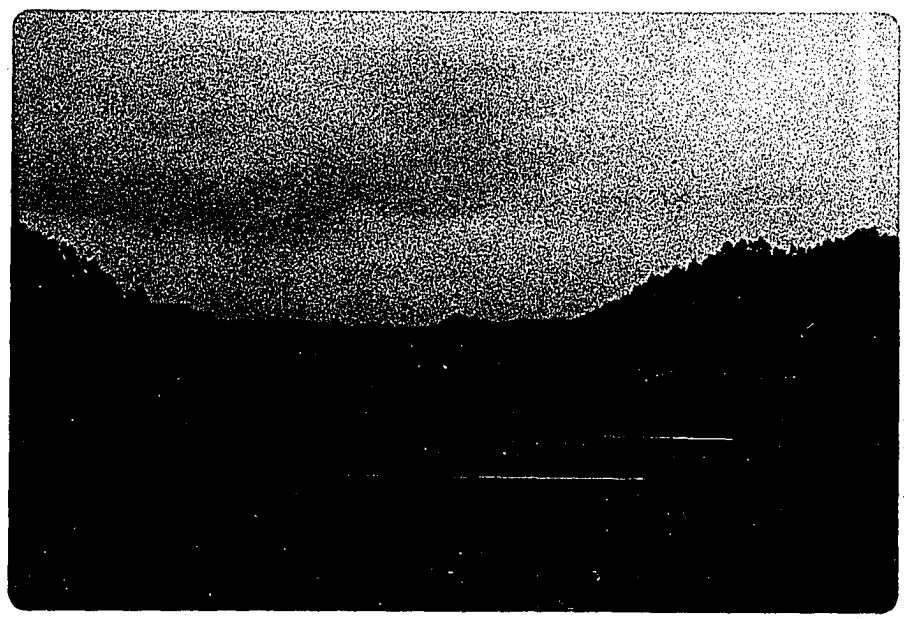

Figure 23. --Cultivated valley in the Taebaek Mountains. This steeply descending valley at about 1, 000 meters elevation and 40 kilometers from the Sea of Japan is typical of the larger cultivated areas of Region 2 away from the coast. A perennial stream irrigates the string of rice paddies, and corn and vegetables are grown on the wide margins of the floor. The mountain slope on the right shows evidence of timber harvesting within the last two or three years. The relief and natural vegetation are similar to that seen throughout most of Region 2.

what produces the linear light tones in the dark faceted areas on LANDSAT imagery of the region.

Region 3

The third land use region sits near the center of South Korea, much like a keystone astride the interior juncture of four provincial boundaries. It includes five large counties and major portions of two others for a total area of about 7,300 square kilometers. The northwestern lobe of the region extends up the western flank of the Taebaek Range and includes two major spurs of the Taebaek and the interdicting lowlands of the Som River basin around the city of Wonju. The southwestern lobe runs down the backbone of the Sobaek Range for 125 kilometers and includes some of the highest and most formidable mountains on the peninsula. The physical environment is otherwise essentially the same as that described for Regions 1 and 2.

The population density for the entire region is about 130 persons per square kilometer, but when the locally dense population around Wonju is excluded, the regional density drops to under 100. The increasing suitablility of the terrain for agriculture and urbanization in the southern and western portions of the region is indicated by the presence of larger and more numerous towns and cities. Region 3 contains three cities of substantial population and area. The largest is Wonju (1970 population 120,000), located in a large intermontane valley having favorable growing conditions. Like most of the large

cities of Korea, its early growth and present status are largely a result of its transportation hub function. Three national highways and a major railway pass through it.

The economy of this region has subsistence farming as its broad foundation, but locally it has major strengths in mining and related industrial activities. Three of the four largest concentrations of mining employment in Korea are located in the Sobaek Range.[18] The majority of the country's coal and iron ore production, large copper deposits, and the world's third largest tungsten mine are clustered in this region. The mineral resources have also served as an attraction to transportation, and this region has been tied to other regions very effectively despite some locally inaccessible areas. As a consequence, the central portion of the region has one of the densest rail and all-weather road nets in the country.

The land use association which clearly distinguishes Region 3 from all others is the large amount of barren uplands and the high percentage of land occupied by burnt-field farming. The exact area of these two categories is unknown, but map and imagery analysis reveals hundreds of square kilometers of mountainous terrain which is devoid of any substantial vegetation, and many hundreds more which are cloaked in no more than low scrub growth. Some of the individual barrens occupy contiguous areas of nearly a hundred square kilometers. The

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[18]Bartz, South Korea, p. 87.

lack of adequate surveys and the illicit nature of burnt-field farming have also worked to keep the extent of this activity questionable, although it is believed to have doubled in area between 1924 and 1964.[19]

The focus of burnt-field farming is in the large tracts of publicly owned mountain land in this region and is partially a consequence of recent displacements from near the DMZ. The site characteristics sought by these farmers are no different from those desired by conventional farmers, but terrain constraints usually force them to adopt different spatial patterns. Their fields are typically located on slopes which were by-passed by earlier generations of farmers because they were too steep or lacked perennial streams. Some small, rudimentary terracing may be done along drainage lines to take advantage of periodic runoff and precipitation. Dry crop fields are usually no larger than a few tens of square meters, are irregular in shape, and are widely dispersed to the most advantageous sites on the mountain slopes. Once established in a location, the farmers seldom move farmsteads or fields unless forced out by the government. Subsequent damage to the "forest" vegetation, then, is largely in the form of conventional fuel and green manure foraging.

The distinctive speckled or salt-and-pepper signature of this region on satellite imagery can be attributed to this land use association. The generally vegetated uplands present a dark matrix which is interrupted

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[19]Koo, Regional Characteristics of Korean Agriculture, p. 396.

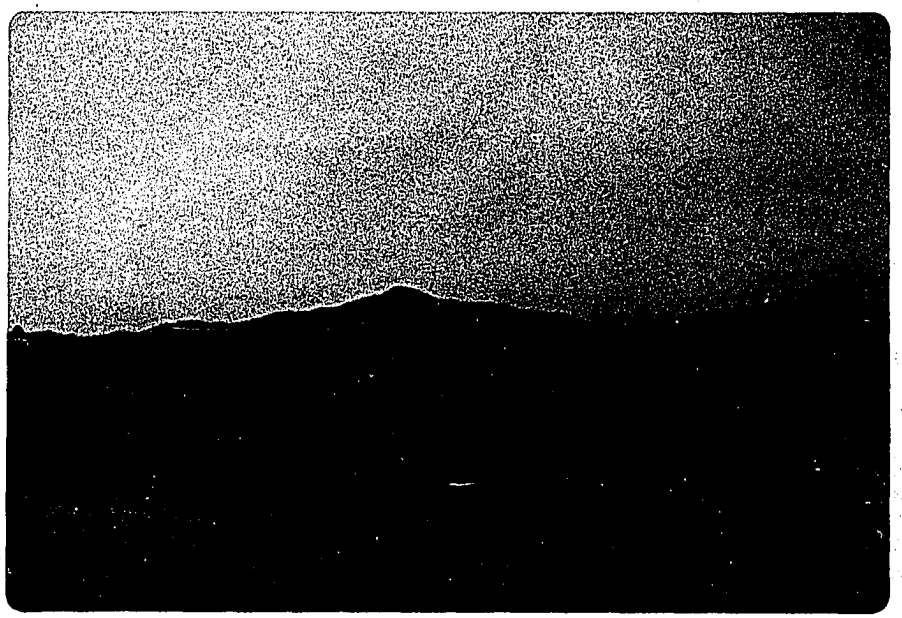

Figure 24. --Agriculture and settlement near Wonju. The intense pressure on the cultivable portions of Region 3, such as the Som River lowlands shown here, is illustrated by the mosaic of fields extending to the summits of the lower hills.

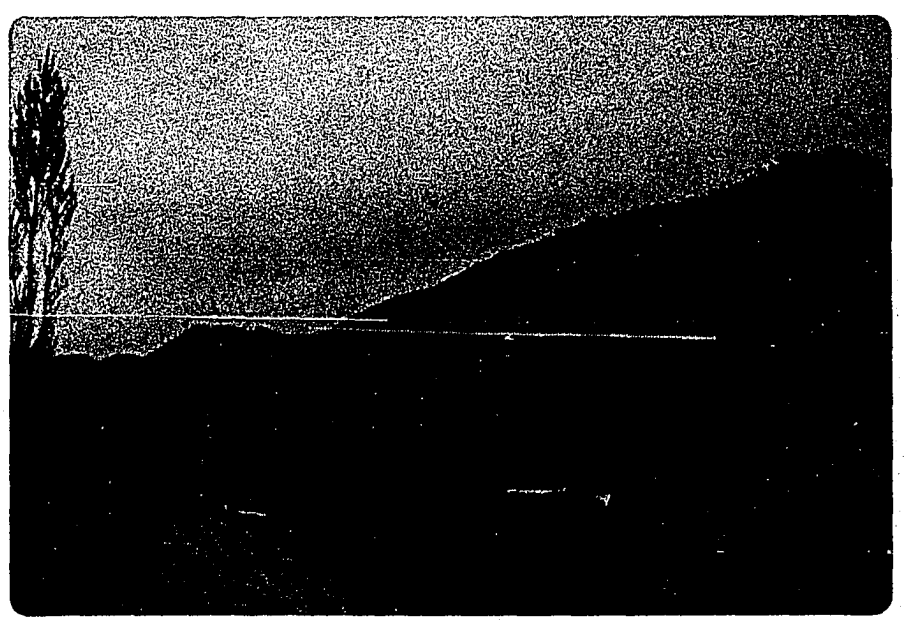

Figure 25. --Upland agriculture east of Wonju. This is the kind of extensive subsistence farming which has razed the upland forests of Region 3. These are sedentary farmsteads, but they exhibit few differences in site or quality from the region's burnt-field farms.

by large barrens, the extensive clearing of forest and brush, and the scars of forest fires that result from clearing attempts. Finer patterns are caused by the dispersed pattern of the burnt-field farmsteads and fields.

Burnt-field farming and the large amount of barrens are usually linked in discussions of this part of Korea, but the question of which was present first and what causal relationships exist might be argued. Nonetheless, the government policy is to sedentarize this segment of the population and restrict them to the less damaging traditional forms of agriculture. The national government is also sponsoring a long term program to reforest the region.[20]

In terms of conventional agriculture the region differs little from the two previously described. Only in the large river valley around Wonju does the multi-crop subsistence pattern fade in favor of the traditional rice-based semisubsistence-semicommercial lowland farm. Region-wide no more than 13 percent of the land is involved in all types of agriculture.

Region 8

From a point 30 kilometers southwest of the boundary of Region 3, this region juts southwestward in two prongs along the parallel axes of the Sobaek and Noryong Ranges. It reaches 175 kilometers to the coastal plains and includes the highest and some of the most spectacular

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[20] Forestry in Korea, pp. 44-45

terrain in South Korea. Geologically and physiographically it is identical to Region 3 for most purposes of comparison. Only the intermontane basins and stream valleys are somewhat less expansive. It also has a much milder climate because of its lower latitude and proximity to coastlines. The northern half of the region extends from the Dwa through the Cwa climate zone, while the southern half is entirely Cfa.[21]

Region 8 is a large area of over 9,000 square kilometers which sits astride the mountainous boundaries of six of the eight peninsular provinces and vividly illustrates the physiographic nature of traditional Korean political boundaries. Its boundary is abrupt in the west where it meets the broad erosional plains, somewhat less obvious along the hilly eastern side, and visually subtle along the northern and southern mountain boundaries.

The similarity of all four of the mountainous regions is reflected in the factor score matrix, but the likeness is especially strong between this region and Region 3. They are both interior regions sharing the same mountain range in close proximity, and their remarkably similar gross land use patterns were not unexpected. Hidden within the factor structure, however, is a basic difference which impacts heavily on this region's development. That difference is the absence of any major mining centers in Region 8 to serve as the nuclei for urban agglomeration, agricultural stimulation, or the attraction of modern transportation

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[21]McCune, Climatic Regions: Delineation, p. 14.

connections with the rest of the country. As a result, this large region is largely bypassed and neglected by the nation's traffic. The only paved roadway in the region is a short, recently paved segment connecting Kwangju with the southern coast. Limited dirt roads through narrow valleys complete the coarse transportation net.

The population is settled in small villages of a few dozen families along the valleys which provide water and road or trail service, but the settlements are dispersed greater than anywhere else in the country. Over much of the region there are ten or more kilometers separating settlements, including those along valley transportation routes. There are no proper cities in the region, and only Muju and Kurye would be classified as large towns. Neither of them has any notable regional function or situation.

The spatial patterns of agricultural land use are consistent with the other mountainous areas. The ratio of cultivated to total area averages 18 percent, with 25 to 35 percent in rice, 30 percent in barley, and about 20 percent in soybeans and wheat. The northernmost counties of the region where conditions dictate a strict subsistence economy split their acreage fairly evenly between four or five crops, while in the south the two-crop rice-naked barley association occupies 75 percent of the cultivated area.[22]

Forest land by official definition occupies 67 percent of the

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[22]Koo, Regional Characteristics of Korean Agriculture, p. 480.

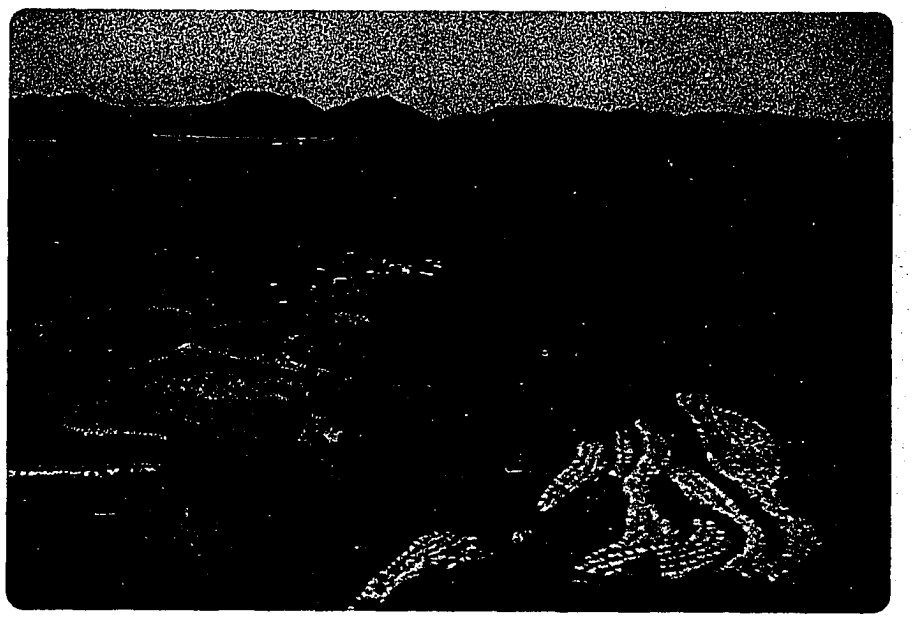

Figure 26. --Land use in the southern Sobaek Range. This view illustrates the physical landscape of Region 8 and the more intensive agricultural activity than is generally seen in the northern mountainous regions. In this June scene barley is being harvested, and will be followed by the rice already several centimeters tall in the seedbeds seen in the foreground. The climate of southern Region 8 encourages multiple cropping and hill slope terracing seldom seen in Regions 1, 2 or 3. Note the sparseness and stunted stature of the "forest" cover.

regional area, a somewhat smaller amount than in the more northerly mountainous regions.[23] The quality of the forest cover appears to be the lowest of any region previously discussed even though burnt-field farming is not a significant problem. The bulk of the cover is very sparse, stunted native pine and scrub oak, with occassional patches of bamboo, black locust and other fast growing deciduous species at lower elevations. As a remedy the government has included this entire region in the same reforestation program being applied to Region 3.

Transitional Agriculture Regions

Region 4

This fourth region presents a greater variety and balance of land use than have any of the three mountainous regions previously discussed and serves as a transition to the largely agricultural west. It includes the majority of both North and South Chungchon provinces with an area of approximately 12,000 square kilometers, and closely approximates the Kum River drainage basin. The landscape can be characterized as low mountains of complex pattern which are interrupted by many small, elongated stream valleys with typical areas of a few square kilometers. There are also a few large intermontane valleys, apparently formed by differential erosion, whose areas of up to about a hundred square kilometers of level land and deep soils make them

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[23] Forestry Statistics: 1973, Table II-4.

agricultural and population centers of the region.

The uplands, which form a sort of frame or matrix for the region, are covered with stands of mixed forest with some harvesting potential in the sparsely populated east. The lower and more discontinuous hills around the western lowlands, on the other hand, have long since had their natural forest removed. Many of these lower "forests" are still used for fuel and compost foraging by lowland settlements and are covered with nothing but scrub oak and stunted pine. Increasing government action and public education, however, has produced large areas of homogeneous pine plantations in recent years. Across the region the ratio of forest land to total area varies from 50 to 76 percent in accordance with the terrain. The generic composition averages 46 percent coniferous, 35 percent mixed, and 8 percent deciduous.[24]

The amount of land under cultivation is also constrained by the topography and covers an average of 27 percent of the regional area. Subsistence farming occupies all of the smaller valleys throughout the mountains where the land use and cropping patterns are little changed from previous descriptions.

As one moves westward into the area of more extensive valleys and plains the area of rice cultivation continues to increase to nearly 60 percent of the acreage at the expense of the common barley acreage. Near the west coast where the climate changes into a Cwa type, naked

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[24]Ibid.

Figure 27.--The landscape of Region 4. This aerial view southwest of Chonan illustrates the mix of low forested mountains, cultivated valleys, agglomerated settlements, and transportation routes which exists in most of the region.

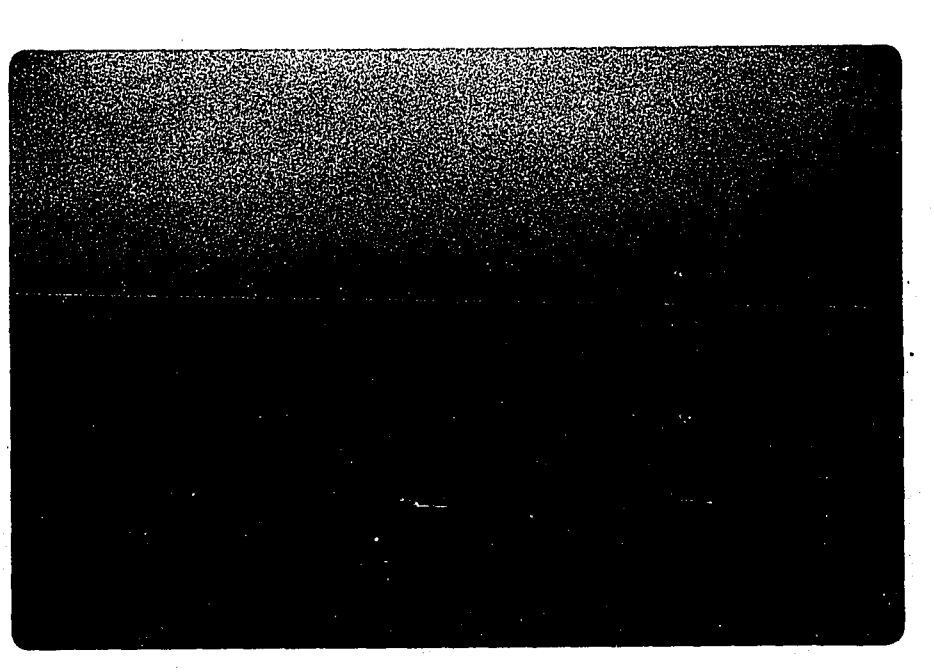

Figure 28.--Cultivation in the South Han drainage basin. This scene containing modern consolidated rice paddies in the north-central portion of Region 4 illustrates the predominant landscape of the larger river valleys.

barley starts to replace the less desirable common variety. There is also a dramatic increase in the amount of land which is fully irrigated and double-cropped with barley or some other crop after rice harvesting. The availability of water and the longer growing season allow as much as 85 percent of the upland and 35 percent of the paddy to be double-cropped.[25]

The agricultural productivity of Region 4 and its situation astride the logical lines of movement between Seoul and the other major population centers in South Korea have contributed to the region's economic development and national integration. Most of the nation's major transportation arteries pass through this region, and they have had a substantial impact on the expansion of the urban-builtup association of land uses. The completion of an express highway between Seoul, Taejon, and Pusan has led to the rapid expansion of secondary sector economic activities along that corridor.

The population density ranges from 200 to 350 persons per square kilometer, and the region has several large towns and cities regularly distributed across its area. The largest is Taejon (1970 population 415,000), the sixth ranking city in the country and the major north-south transportation focus for crossing the Sobaek Range to all of southern Korea. Most of the other urban areas also have transportation and administrative functions, but very little industrial development. All of the urban places are reasonably well connected with surface routes.

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[25]Koo, Regional Characteristics of Korean Agriculture, p. 532.

Region 5

The largest land use region in Korea occupies the great Naktong River basin of the southeast. It has an east to west span which averages 150 kilometers, and it extends from the 35th to the 37th parallel of latitude to encompass an area of nearly 20,000 square kilometers. Its northern and western boundaries are marked by the Taebaek and Sobaek Mountains where the landscape change is obvious. The boundaries with coastal Region 10 and nested Region 13 are less distinct visually and require reference to tabular data to justify. Most of North and South Kyongsang provinces are included in the region, and it contains a wide diversity of physical and cultural landscapes.

The physical foundation of the region is unique in Korea in that it is entirely underlain by sedimentary strata. Massive beds of sandstone, shale, mudstone, and conglomerate have been gradually elevated in the east and warped by tectonic activity.[26] The Naktong River and its major tributaries are antecedant streams which have worked on these beds to produce a new iteration of a fully mature fluvial landscape. Although several areas of high peaks remain, most of the region has been reduced to a monotonous sea of low, rounded, hills and mountains, and narrow stream valleys. The drainage density is very high, but the pattern varies from entrenched meanders on many of the major streams to structurally controlled trellis patterns for many of the lower order

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[26] An Outline of the Geology of Korea (Seoul: Geological Survey of Korea, 1956), p. 17.

stream systems. As a result, there is still very little level land in this region. Even the valley floor of the meandering Naktong River, the longest in South Korea, is seldom more than a few hundred meters wide. The region has a Cfa climate along the coast and much of the south, Cwa in a broad belt across the center, and a Dwa climate in the northern interior.

Because of the size of Region 5, its land use patterns are somewhat more difficult to characterize than those of other regions. Consequently, generalizations are less precise and descriptive of any small facet of the area than might be desirable. The region's complexion results more from what is not in the region than from what is. The most likely "core" of the region would have to be the lowland along the Naktong River and one or two of its major tributaries. The remainder of the region exhibits transitional land uses from adjacent mountainous and coastal zones.

The Naktong valley stretches some 180 kilometers from the northern mountainous fringe of the region to the southern coast. It has been a focal point of Korean settlement and civilization since the fourth century B. C.[27] It is a strong agricultural area with a moderate population density of about 220 persons per square kilometer. As a consequence, the predominant settlement pattern is one of large numbers of evenly spaced, small farming villages, and occasionally, large service

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[27]Zaichikov, Geography of Korea, p. 127.

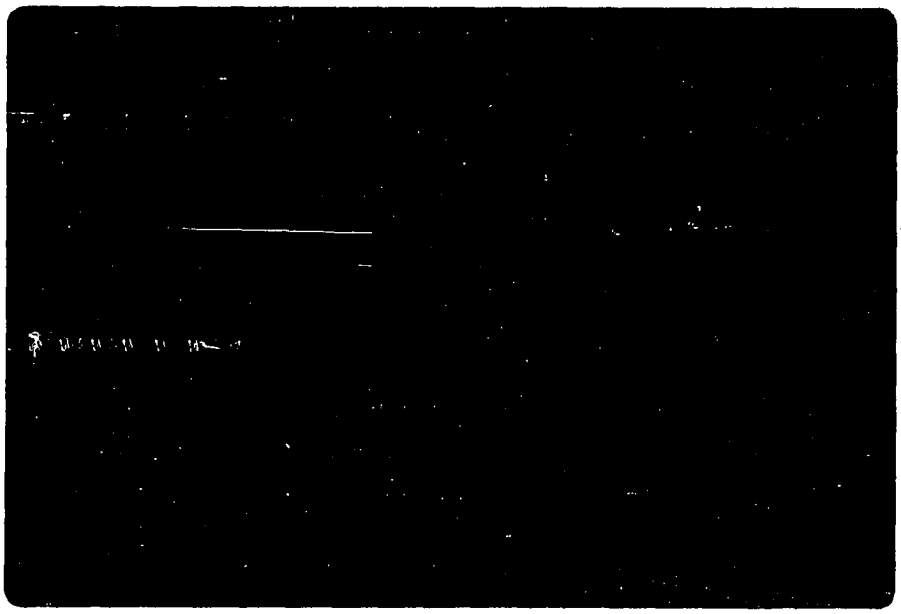

Figure 29. --The middle Naktong basin. This portion of the basin about 60 kilometers north of Taegu illustrates the "core" of Region 5. The landforms are subdued, covered with thin vegetation, and have a high drainage density. Man's presence and severe impact on the landscape are obvious. Agricultural improvements in the form of canals, reservoirs and rectangular fields can be seen on the floodplain in the foreground.

centers. These are connected to each other by a network of unpaved roads.

The few modern transportation links which cross or pass near the Naktong are either interregional routes or connect interior service centers. Neither the Naktong nor any of its tributaries are navigable to any type of vessel because of their seasonal flow and shifting, sand-choked channels. It is not surprising, then, that there is only one large town or city along the entire course of the river, and it is the land transportation node and administrative center of Andong on the upper reaches.

Elsewhere in the region urbanization has progressed little farther and there are still only six cities with populations in excess of 50,000 in this region of 4.3 million persons. All of the cities are regional transportation and market centers, but only two are more than 25 kilometers from the coast. The largest city is Ulsan (1970 population 160,000) with a newly expanded port facility and heavy industrial base. Taegu (1970 population 1.1 million) and its immediate surroundings lie at the very center of the region, but for the purposes of this study that industrial city was classified as a separate highly urbanized region There is no other appreciable manufacturing activity or employment in the region except in Pohang and the immediate sphere of Pusan. That situation is responsible for the consistently negative scores for Factors 2 and 8 except around the Pusan urban region where the latter factor is locally strong.

One-fifth of the land in this region is cultivated and agriculture is the economic mainstay. The entire region is noted for its emphasis on food grains, and the Naktong River valley is also a leading fruit growing area. Rice naturally forms the foundation of the food grain association, but its dominance is challenged by barley more than anywhere else on the peninsula. The mountainous terrain around the region blocks the prevailing moisture bearing winds and causes the Naktong basin to receive one-third less precipitation than the national average.[28] The precipitation regime and the poorly forested watersheds have helped make this one of the least irrigated regions in South Korea. Barley is therefore the primary crop with wheat or soybeans over large areas of undependable water supply, and it is widely double-cropped behind rice in drained paddies. The harvested areas of the two crops are nearly equal, and each occupies between 35 and 45 percent of the cultivated land area in the region. These conditions are reflected in the high scores for Factor 5 and the mixed, but rather low scores for the lowland agriculture association represented by Factor 2. The upland specialization on barley is substantiated by the low scores for Factor 3.

The other distinctive component of agricultural land use in Region 5 is the tree fruit sector which specializes in apple growing, but also ranks high in pear orchards. More than 60 percent of the

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[28] Ibid.

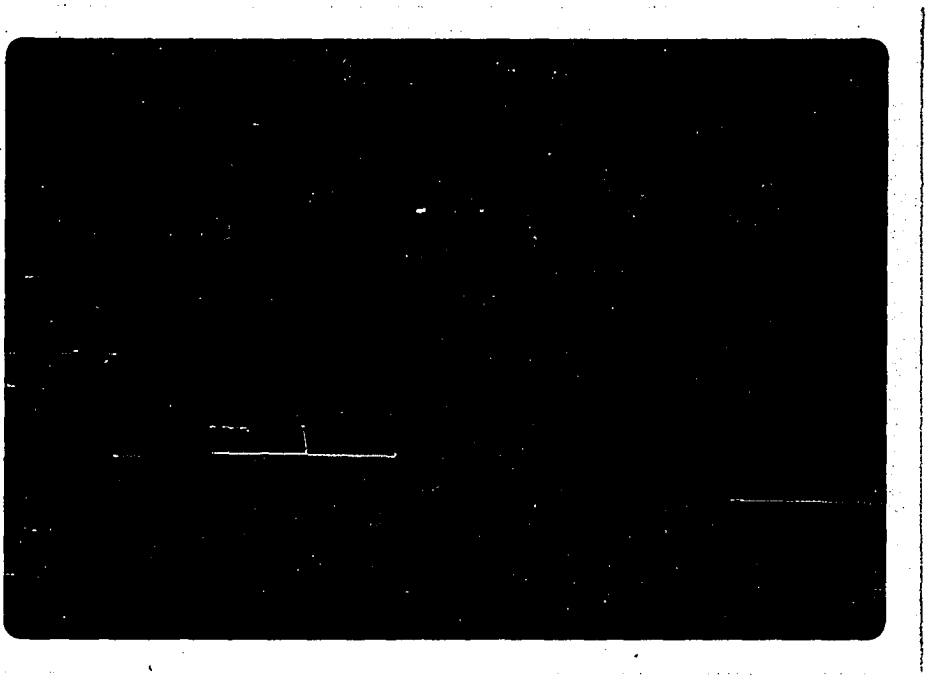

Figure 30.--Nam River valley landscape. This is one of the largest tributary valleys in the southern Naktong basin. Barley is being harvested and the rice seedbeds will soon be transplanted. Note the poor appearance of the uplands.

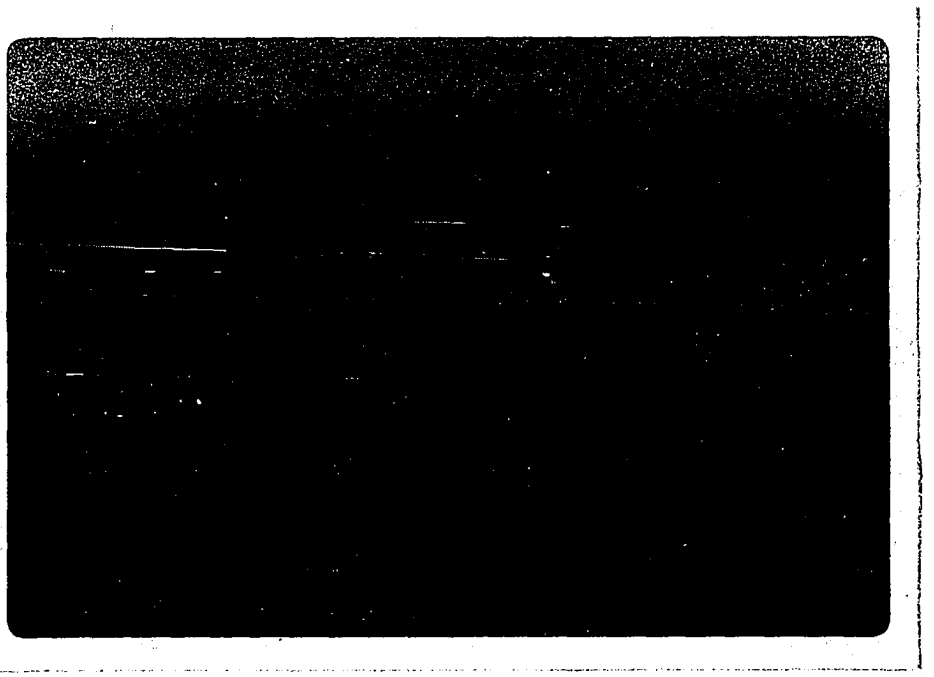

Figure 31.--The southern Taebaek Range. Low, thinly clad mountains of low utility and population density comprise much of northeastern Region 5. This area is adjacent to the east coast near Pohang.

apples and pears of Korea are grown on the sandy banks of the Naktong's middle course.[29] The reasons for this distribution are as much historical as economic or physical, and they date from the introduction of Western varieties of fruit trees to the area around the turn of the twentieth century.[30] Despite their very small share of the regional area, the orchards are the most conspicuous element of land use on color infrared imagery of the area.

Nominal forest is the most extensive land cover in the region, occupying the national average of 66 percent of the area. The higher mountains along the interior boundary and in the northeast have modest covers of mixed forest which are reflected in the pattern of scores for Factor 6. The remainder of the region's uplands are covered with the same thin native pines and herbaceous plants seen elsewhere. The official classification of 95 percent of this cover as true forest results in some locally prominent scores for Factors 5, 6 and 9, but visits to the region confirm its rightful place in the barren land cover category.

The future holds little change in store for Region 5 except in the coastal zone. Everywhere else the National Land Development Plan for the next decade calls for the continued improvement of the food grain production base. Fundamental improvements in irrigation facilities, farmland consolidation, mechanization, and farm road

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[29]Koo, Regional Characteristics of Korean Agriculture, p. 231.

[30]Bartz, South Korea, p. 166.

construction are expected to increase crop yields and rural income levels. Along the coast, however, action has already been initiated to develop several major international trade and industrial centers in a 100 kilometer long arc centered on Pusan.[31] Although only Ulsan is included in that zone, the development of the zone will make major and fundamental changes in the southern half of the region not unlike those that have occurred in the region surrounding Seoul.

Region 12

Lying 80 kilometers south of the Korean peninsula's southwestern tip is the island region of Cheju whose land use patterns are transitional, yet in marked contrast with the rest of the country. The island is a geologically youthful, but inactive composite volcano with an area of 1,830 square kilometers. It has a concave upward profile which rises to an elevation of 1,950 meters. Except for the central cone and a few minor eruptive features near the base there is very little relief. The surface drainage is conducted by a dense, radial network of low order streams of unreliable flow. The island is swept by the warm Tsushima Current which strongly influences the Cfa climate shared by Cheju and the peninsula's southern coast.

The factor score matrix for the region shows some contrasting extremes in land use associations between the northern and southern halves of the island. Some of these can be explained by the presence

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[31] National Land Development Plan: 1972-1981, pp. 207-211.

of a large urban area on the northern coast, while others are thought to be consequences of historical accident rather than subregional physical or cultural differences. The set of common qualities, however, which distinguishes the region is the weakness of the lowland agricultural association and great strength in the upland agricultural and barren uplands associations.

Although the island has a nearly perfect climate for the Korean complex of rice centered lowland agriculture, it is of negligible importance because the volcanic rock and soils cannot retain sufficient surface water. As a consequence just 2 percent of the island's cultivated land (20 percent of the region) is occupied by paddy. As in Region 11, upland crops fill much of the void in rice productivity. The nature of those crops is affected by the region's isolation as much as the physiological aridity, and what are elsewhere known as "insurance crops" are staples on Cheju Island. Naked and common barley comprise 51 percent of the harvested area, sweet potatoes around 20 percent and millet 16 percent. Only the generally low state of agriculture and its small share of the regional area prevent this from being the leading upland crop region.

The spatial pattern of cultivated land use on Cheju differs radically from elsewhere in the country because the constraints of topography and the attraction of drainage lines are virtually absent. The result in a quilt-like pattern of compact, interlocking polygons completely covering the gently sloping margin of the island below the

200 meter contour line. Above that elevation there is little settlement or cultivated land use.

In the absence of a strong agricultural land use sector it would seem that in Korea one would find a strong forest sector but that is not the case on Cheju Island. Although 64 percent of the region, including most of the center, has been classified as "forest land," only 34 percent is tree covered. The climax broadleaf community which once existed below 500 meters elevation has been completely removed, leaving some discontinuous stands of mixed and coniferous forest in a conspicuous band around the summit between 500 and 1,500 meters elevation. The strong showing of Factor 5 on the northern side of the island is apparently a result of the exceptionally high contribution of draft cattle rather than the coniferous forest area.

Almost one-third of the island could be classified as nominally barren land, although much is otherwise listed as eroded or nonstocked forest in official publications. These euphemisms include volcanic rock from the 1,500 meter level to the summit and around some of the lesser vents. It also includes a wide band of abandoned farmland in a 200 to 500 meter elevation band around the cone which has largely reverted to scrub and thorn thickets. The abandonment was caused by the forced evacuation of settlers in 1948 while Communist insurgent activity was being suppressed. These areas have recently been reintegrated into the conomy for livestock grazing and for recreational

purposes.[32]

Urban-builtup land uses are of little significance on the island because of a region-wide population density of only 165 persons per square kilometer and the lack of any growth stimulating industrial activity. The only urban area is the city of Cheju (1970 population 106,000) on the north-central coast which is the provincial capital and the sea and air node for transportation to the peninsula. The tempo of life in Cheju city is reflected in the fact that 48 percent of its families are full-time farmers. Another several dozen villages and small towns are evenly spaced on the level ground in a narrow coastal ring. The only modern surface transportation on the island is a recently paved two-lane road around the circumference and a narrow tourist route across the eastern slope of Mount Halla.

The government's long range plans for the economic development of this region seem to properly draw on the strengths identified in this study. Planning is focused on: (1) the expansion of domestic and foreign tourism to the Mount Halla volcano and hunting preserves on its slopes, (2) the expansion of the grazing livestock sector, (3) the creation of subtropical fruit tree orchards on Mount Halla's slopes, and (4) the expansion of fishing industries.[33] None of these activities will drastically change the balance of land use on the island, but they

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[32]Bartz, South Korea, p. 194.

[33]National Land Development Plan: 1972-1981, pp. 213-214.

should dramatically improve the productivity of the land and the standard of living of its inhabitants.

Intensive Commercial Agriculture Regions

Region 6

Region 6 is a rural agricultural belt of coastal lowlands and hills extending southward from the Han River mouth some 140 kilometers to include the Sosan Peninsula. It is comprised of a series of small, discontinuous stream basins which are separated by low hills and mountains. No point in the region is more than 25 kilometers from the Yellow Sea coast, but Korea's weak maritime tradition has had little effect on the region's complexion. A large part of the region's area is comprised of many islands of every size which are, in turn, surrounded by expansive mud tidal flats. The islands are mostly remnants of drowned mountains along this submergent coast, and they range in size from mere rocks to the 421 square kilometers of mountainous Kanghwa-do on the DMZ.

The region has an area of about 4,800 square kilometers which includes all or part of eleven counties. Its land boundary is visually apparent on the south and east where it abuts the forested hills of Region 4, but its narrow juncture with Seoul's urban fringe zone (Region 16) requires statistical definition. Hills of low relief (less than 150 meters) dominate the landscape of the northern half while the

southwestern half has larger plains and several isolated groups of mountains of more than 200 or 300 meters elevation.

Land use within the region is still highly traditional and, as indicated by the factor score matrix, the relative strengths of the agricultural land use associations are what distinguishes this region. Cultivated land occupies nearly 40 percent of the region, substantially more than in Region 4 and three times that of the mountainous regions. Forest occupies a relatively low 45 percent of the region, leaving just over 10 percent of the area to all other uses and covers such as water bodies and builtup areas.

The forest cover in this region is especially poor in quality and spotty in its distribution. Only in the northern hills and the more rugged portions of the Sosan Peninsula are there somewhat continuous and homogeneous stands of thin native pines which account for the region's mixed scores for Factor 5. The factor score matrix also indicates considerable strength for the mixed forest association, but it is misleading. It reflects large areas of mixed forest in the mountains of the eastern fringe of the grouped counties which were truncated by the modified regional boundary and included in Region 4. Elsewhere there is no notable forest cover nor forest centered economic activity, and there are no plans to develop the area's forests.

Agricultural land use is fairly constant in areal extent, ranging from 49 percent of the area in the east to 34 percent on the Sosan

Peninsula. The traditional three-crop association of rice, common barley and soybeans dominates the region.[34] It is seen in its most austere form on the Sosan Peninsula where surface water is not abundant, much of the area is isolated by coastal irregularities, and the road network is primitive. Consequently, commerce outside the local village is severely limited. However, with decreasing distance from the modern transportation corridor containing the Seoul-Pusan expressway, a national railway, and a paved national highway there is a greater variety and area of upland crops such as fruits and vegetables. Livestock is also becoming nationally important, if not yet spatially significant, in this zone of rapid access to the major urban markets such as Seoul and Taejon.[35] The same area also generates a strong score for Factor 4 with the large number of irrigation reservoirs which have been constructed in the southern half of the region.

The urban-builtup land uses are close to the national norm in extent and character. The population density averages 330 per square kilometer, but it increases steadily from 270 to 430 per square kilometer along a line from the coast to the inland transportation corridor. Most of the population is rural and there are only six urbanized places in the region, and none of them are located on the coast. Three would be classified as large towns and three as cities, the two largest being

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[34]Koo, Regional Characteristics of Korean Agriculture, Map 22.

[35]Bartz, South Korea, p. 138.

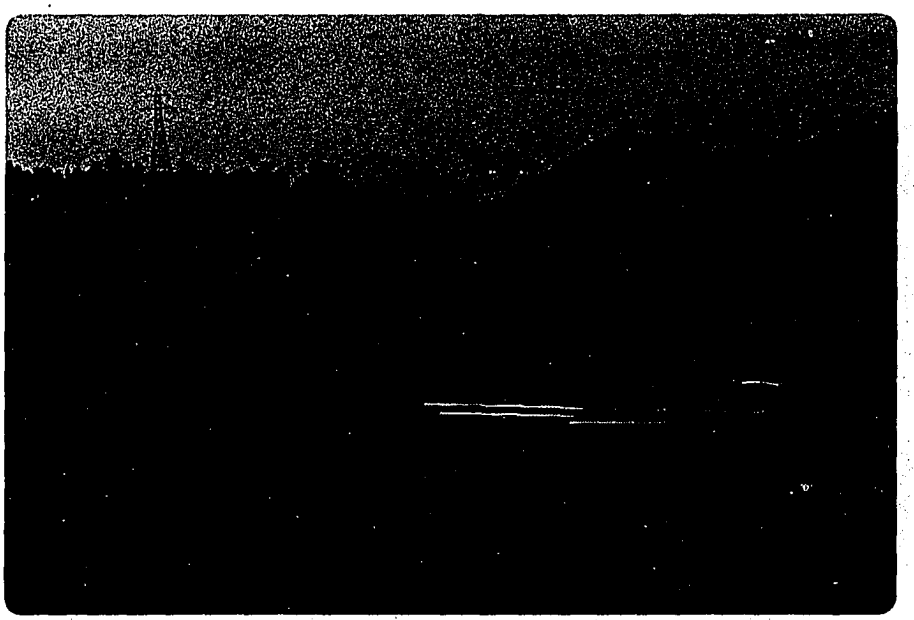

Figure 32.--Traditional landscape near Suwon. The threesome of rice paddy, flanking dry fields and upland forest are dominant in Region 6, but modern influences are seen in the commercial vegetable fields and erosion control plantings on some slopes.

Figure 33.--The changing landscape of Region 6. The increased scope of agricultural activities and greater variety of land uses near the region's transportation corridors can be seen in this view. Several orchards are situated on upland around the town.

Suwon (1970 population 171,000) and Chonan (1970 population 78,000). All of the large towns and cities have land transportation as a major function and the four largest urban places are on the Seoul-Pusan highway and rail axis. Suwon also serves a major administrative function as the Kyonggi provincial capital, a military headquarters, and the center of agricultural research in Korea.

Region 7

Region 7 is a compact area astride the 36th parallel on the southwestern coast of the peninsula. It includes the extensive erosional plains and deltas around the estuaries of the Kum and Man'gyong Rivers. The highest parts of the plain are only about 100 meters in elevation, and are found around the region's mountainous perimeter. It slopes gently westward to sea level everywhere except where penetrated by a few low, rounded, and isolated hill remnants. The climate of the region is borderline Cfa-Cwa and has been described by McCune as, "...the most suitable for agriculture of the Korean type in the peninsula."[36] Major portions of eight counties in South Chungchong and North Cholla provinces having an area of some 3,500 square kilometers comprise the region.

The agricultural potential of the region has long been recognized. The vicinity of Region 7 was one of the first areas of the peninsula to be

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[36]Shannon McCune, Climatic Regions: South Korea, Research Monographs on Korea, Series E., No 7 (Columbus, Ohio: Korean Research Associates, 1945), p. 1.

settled, and it was here that the Japanese developed a major food grain production base for its expanding empire prior to the Second World War. In order to maximize production and distribution, the Japanese made a number of significant and lasting changes to the area. One of the first and most fundamental was the consolidation of traditional, irregularly shaped paddies, and their subsequent reorganization into large rectangular fields. To increase harvests and the potential for double cropping, they also constructed irrigation reservoirs in the hills surrounding the plains and a network of concrete lined distribution canals.[37] Those changes continue to give this region a distinctive appearance and to contribute to its agricultural productivity. Unfortunately, most of the country had to wait until the 1970's for equivalent rural capital improvements.

The Japanese also constructed a transportation network by which they could move the grain harvest out of Korea. Consequently, the seacoast town of Kunsan was expanded into an important grain shipping port and was connected with the rest of the region by major rail and road connections. The road net continues to be one of the most complete, if not the most modern, in the country.

The rural rice bowl complexion of the area has remained to the present and will likely be the region's role in the forseeable future. It lies at the heart of the recently established Chonju development region

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[37] Ibid., p. 7.

whose long-term development goals are: (1) the improvement of the food grain production base, (2) the initiation of minor coastal activities such as shellfish farming, and (3) the development of agriculturally oriented light industries in urban areas such as Kunsan and Ili.[38]

The importance of this region to the nation's economic well-being is apparent from a glance at agricultural data. It has the highest share of cultivated land in the country at 46 percent. Seventy-five percent of the cultivated land is paddy, and 77 percent of the paddy is fully irrigated by reliable systems. Throughout the region between 45 and 55 percent of the cultivated land is planted in rice, 30 percent in naked barley and the remainder in several lesser crops. The effective areas of these crops are further increased by double-cropping on about 11 percent of the paddy and 75 percent of the dry fields.[39] Neither specialized cash crops nor livestock raising have made any inroads here, nor are they likely to, considering the low level of urban specialization.

For the last several decades this has been the most densely settled rural area in Korea, with well over 450 persons per square kilometer. The uniformly positive Factor 2 scores for all counties reflect the general impact of man on this region. Region 7 scored significantly higher on this factor than any except the purely urban regions of Seoul, Pusan, and Taegu. The predominant form of settlement

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[38]National Land Development Plan: 1972-1981, pp. 205-207.

[39]Koo, Regional Characteristics of Korean Agriculture, p. 644.

Figure 34. --The Honam Plain of southwest Korea. This view illustrates the low relief and high percentage of cultivated land in Region 7. The investment in consolidated paddies and water distribution systems indicate the value of this food grain base.

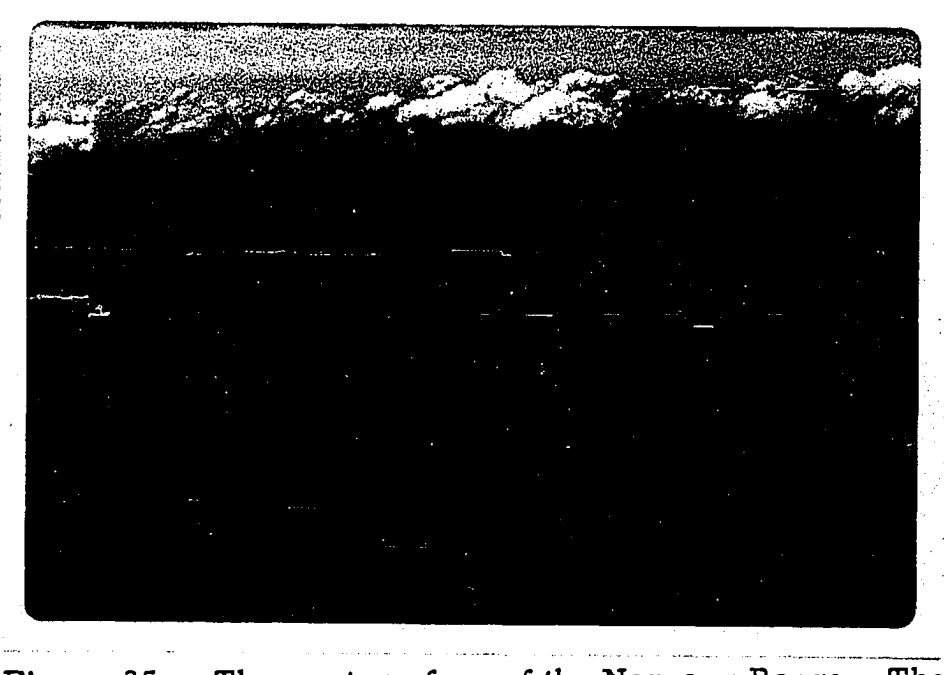

Figure 35. --The western face of the Noryong Range. The abrupt change in physical landscape and land use between the southern margin of Region 7 and the rugged mountains of Region 8 is seen here. Note the reservoir and canal in the central valley.

is the large agglomeration of up to several thousand households distributed fairly regularly across the plain. There are 14 especially expansive towns in this one region, including the city of Chonju which ranks seventh in the nation with a population of 263,000. Despite the size of the urban areas, substantially less than 20,000 persons in the entire region (population 1.4 million) are employed in any form of manufacturing.[40] The urban areas are therefore little more than overgrown farm villages in the Chinese tradition, and many of the residents are full or part-time farmers.

The overall land use of the region is summarized fairly well by the factor score matrix. It shows the highest scores for the lowland agriculture association (Factor 1) of any region in the country while most upland associations (Factors 3, 4, 5, and 6) have generally weak or negative scores. The one case with a strongly positive score for Factor 4 is the county in which Chonju is located, and as the most specialized city in the region, it does generate a market for some cash crops. Otherwise the urban oriented agricultural land uses are not significant.

The only other remarkable pattern shown in the factor score matrix is the totally unexpected and strong showing of the burnt-field and unproductive upland associations (Factors 7 and 9). The combination occurs largely outside the modified regional boundary, but its

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[40]Bartz, South Korea, p. 184.

presence is still in striking contrast to the remainder of the region and begs explanation. Briefly, the uplands which surround the plain and occupy major portions of some of the counties have long been denuded by the incessant harvesting of fuel and manure already mentioned. The same population pressure which caused the hills to be denuded has forced otherwise landless and economically displaced families to squat on these hills in an attempt to eke out a marginal living. Since the government has until recently had difficulty providing a viable alternative to this settlement, the large numbers of quasi burnt-field farmers have persisted.

Region 9

Immediately south of the expansive Honam Plain of Region 7 the Soebaek Range and a lesser range known as the Noryong Mountains thrust toward the Yellow Sea and interrupt the coastal plains and river valleys. The resulting mix of mountains and broad, but discontinuous valleys produces a physical landscape very similar to that of Region 4. The only significant differences are the even more pronounced dearth of "natural" vegetation here in the southwest, and the markedly better agricultural climate. Nearly 6,500 square kilometers of that landscape in 12 counties of North and South Cholla provinces comprise the region.

Although the physical landscape resembles a distant area, the land use qualities are similar to adjacent Region 7. The large plains and moderate Cfa climate allow the widespread development of intensive

lowland agriculture of the kind seen on the Honam Plain to the north, and like that region, this area fell within the Japanese sphere of rural development. Many of those improvements remain, but the more mountainous terrain has limited the area's growth.

The share of land available for cultivation in this region is only 36 percent and only 64 percent of that is in paddy. While these figures are about 10 percent lower than those of Region 7, they still allow this region to generate the second highest Factor 1 scores in the country. The lower potential for rice is partly balanced by a corresponding increase in dry crops such a naked barley, wheat, millet and vegetables; and by an increased rate of double-cropping to over 17 percent for paddy and 90 percent for dry fields.[41] It is this upland crop strength which results in some strongly positive scores for Factor 3 and most clearly distinguishes this region from its northern neighbor.

Forest land uses occupy half again as much land in this more mountainous region, but that 48 percent of the area is still well below the national average. As in much of the densely populated peninsula, the steep slopes, fragile soils, and torrential rains have made the retention of any respectable natural vegetation difficult in this region. Large areas of barrens scar the surface of the mountains and further contribute to the solidly negative factor scores for all forest land use associations.

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[41]Koo, Regional Characteristics of Korean Agriculture, p. 578.

Figure 36.--Landscape change between Regions 8 and 9. Here 25 kilometers northeast of Kwangju the broad, efficiently farmed plains of Region 9 abruptly meet the extensively used Sobaek Range of Region 8.

Figure 37.--Kwangju and vicinity. This June view illustrates the expansive plains and encircling mountains in the heart of Region 9. Fields are between barley harvesting and rice transplanting in the annual cycle.

The other notable change from the previous region is the decline in the urban-builtup land use sector. In Region 9 the somewhat less productive landscape has dampened man's impact, and only one county has a strongly positive score for Factor 2 despite a regional population density of 350 persons per square kilometer. There are 15 urban areas in the region, but only the provincial capital city of Kwangju (1970 population 503,000) exceeds 50,000 in population. This sprawling city has been the regional center for distribution and administration since the Japanese colonial period despite a lack of adequate transportation links. Indeed, the entire region's urban and economic growth are still seriously handicapped by the distances from other growth centers in Korea and the difficulty of interregional transportation across the enclosing Sobaek Mountains. In 1975 there was still only one paved road penetrating the region.

Future development in the region will hinge on the success of the National Land Development Plan which is grooming the Kwangju Development Region as another specialized food grain production base. Region 9 lies at the heart of that development region and should benefit enormously. Specific objectives include attacks on weaknesses specifically noted in this discussion and include: (1) the improvement and expansion of irrigation works, (2) continued farmland consolidation, (3) construction of farm roads, (4) expansion of the cultivated area through reclamation works, (5) the expansion of paved interregional

highways, and (6) a high priority program of erosion control and reforestation. Kwangju will also be nurtured as a light industrial center.[42]

Region 10

This southern coastal region occupies a narrow belt of islands, rocky peninsulas and abruptly rising hills characteristic of a submergent coastline. Mountains of 400 to 700 meters elevation frequently extend to the sea to form alternating rocky headlands and narrow sandy bays reminiscent of the Maine coast of the United States. The ruggedness of the landforms can be attributed to the resistant Cretaceous sandstones and conglomerates which underlie the region. The climate is a moist and mild Cfa which is punctuated by regular incursions by typhoons during the summer and by infrequent freezes during the winter.[43] The region has an area of roughly 6,200 square kilometers and extends nearly 275 kilometers on a northeast-southwest line between the 34th and 35th parallels.

The land use strengths of this region are surprisingly well balanced between lowland agriculture, upland agriculture and some of the forest associations. Cultivated agriculture is able to occupy an unexpectedly high 27 percent of the region of which fully 57 percent is in paddy. Rice is grown as a summer crop on the two-thirds of the paddy

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[42]National Land Development Plan: 1972-1981, pp. 212-213.

[43]McCune, Climatic Regions: South Korea, p. 3.

with reliable irrigation and the rest is sown to upland crops. Between 25 and 50 percent of the paddy has sufficiently good drainage that it can be double-cropped during the winter or spring with barley or wheat.[44] A prominent element of land use in the western half of the region which is closely associated with agriculture is water conservation. Image examination reveals that the larger islands and the peninsular valleys have one of the greatest densities of irrigation reservoirs in Korea.

The strength of the upland agriculture association is probably a response to the region's population pressure (335 persons per square kilometer) and the favorable climate. The mild winters and more evenly distributed rainfall throughout all seasons affords greater success with upland crops which, by definition, are not normally irrigated. Not only is it possible to get two or more crops, but the area of cultivation can be expanded to locations which would be unsuitable in more northerly regions.

Nowhere along the coast is there forest in the Western meaning of the term, despite the relatively strong factor scores for some associations and having 54 percent of the area officially classified as forest. The trees are generally sparse and the true ground cover is coarse grass and herbaceous plants. Even where there are locally dense stands the trees seldom exceed five meters in height and ten centimeters in trunk diameter. Large upland areas are barren and even

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[44]Koo, Regional Characteristics of Korean Agriculture, p. 555.

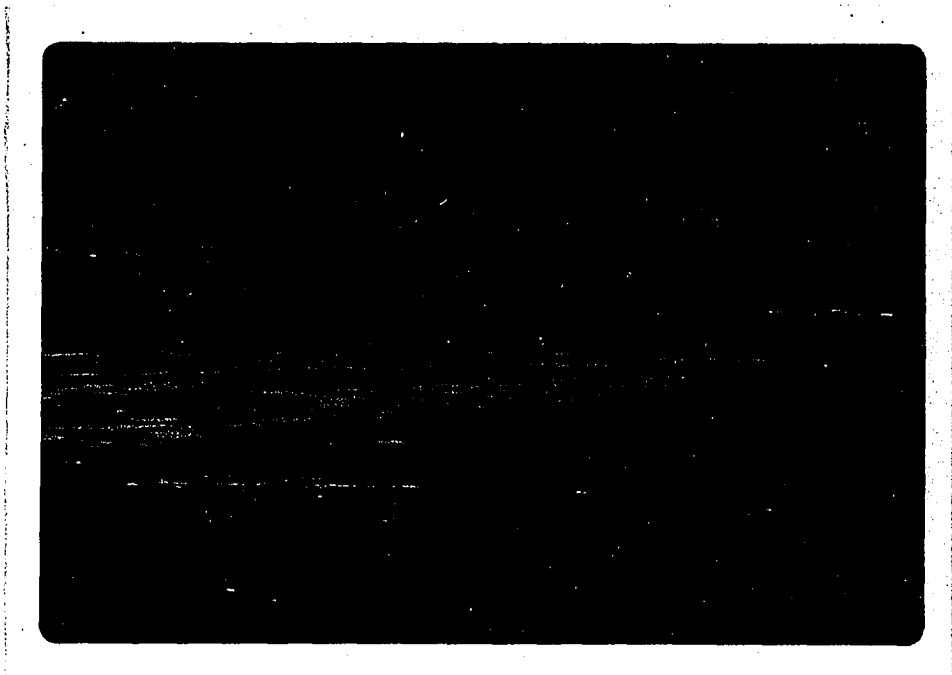

Figure 38. --Somjin River near its mouth on the southern coast. In Region 10 nearly barren uplands alternate with broad sand-choked stream channels and embayments along the entire coast.

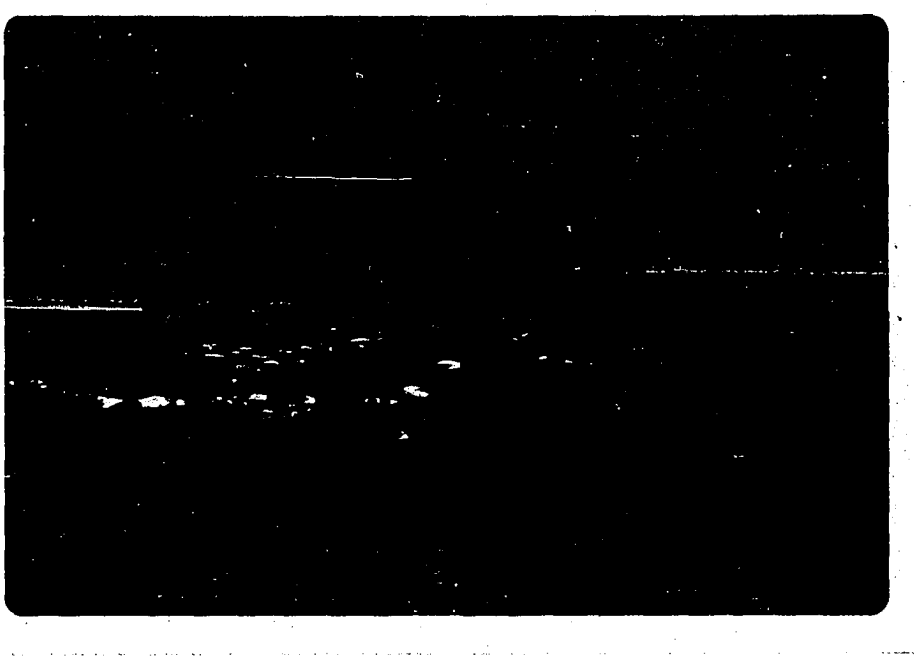

Figure 39. --Land use along the southern coast. This landscape of isolated villages, double-cropped valleys and nearly barren uplands prevails over most of Region 10 a few kilometers inland from the coast.

official sources report 7 percent of the region as eroded, nonvegetated, or otherwise lacking trees. Included in this figure is some land affected by the prominent burnt-field farming in the hills.

The strong showing of the coniferous forest association (Factor 5) can easily be explained despite the overall forest complexion. Contrary to most of the peninsula, the climax vegetation formation for the coastal strip from Pusan to the southwestern port city of Mokpo is nearly pure pine, and even where razed by seasonal harvesting and erosion, the pines seem to be the most resistant and dominant species.[45] So, although the percentage of total forest is almost exactly the national average, the area of coniferous stands is a very high 44 percent of the regional area.

As in many of the more remote areas of Korea today, agriculture is the only economic activity which noticeably affects gross land use patterns. The geology of the area is not conducive to mining activity, and the coastal towns have not yet generated much fishing or transportation oriented development. Of the dozen urban places in the region, about half are coastal towns and the remainder are market centers and land transportation nodes located a few kilometers inland where trunk roads to the interior intersect the coastal railway and recently completed paved highway. Five of the six cities with populations

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[45]FAO. Rehabilitation and Development of Agriculture, Forestry, and Fisheries in South Korea. Report for U.N. Korean Reconstruction Agency (New York: Columbia University Press, 1954), p. 321.

over 50,000 are minor port cities, the largest being Masan (population 191,000).

Planning for the economic development of Region 10 is split between the Kwangju and Pusan economic development regions of the National Land Development Plan. Few changes are planned in the west except for the improvement of coastal communications, while in the east the government is attempting to build upon the embryonic industrial bases and natural harbors of cities such as Masan and Samchonpo. There they hope to establish a zone of heavy industrial cities using imported raw materials.[46] Such developments would, in turn, spur widespread changes in the agricultural and builtup sectors of land use.

Region 11

Adjacent to the northwestern boundary of Region 10 is a three county area of 1,800 square kilometers which consistently formed the core of a distinct and resistant region during all of the factoring and grouping trials. The region physically differs from neighboring Region 10 only in the extent of landscape fragmentation. Here there are more small islands and narrow peninsulas whose surface areas are nearly doubled at low tide by the exposure of extensive sand and mud tidal flats.

As one would expect, the land use patterns of these two regions

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[46]National Land Development Plan: 1972-1981, pp. 210-212.

are very similar, but there are two associations which clearly distinguish Region 11. The first is the sharp drop in the importance of forest land use associations as indicated by Factors 5, 6, 7 and 9 and as detected on LANDSAT imagery comparisions. Only 50 percent of the region is classified as forest land and only 44 percent has any kind of tree cover. In both relative and absolute terms the forest land associations are not very significant. The coniferous forest association is marginally positive only because the percentage of forest classified as pure coniferous is a very high 79 percent.

The second land use which clearly identifies the region is the upland agriculture association represented by Factor 3. The scores for the three counties in this region are unapproached in magnitude except by Region 12 with its permeable volcanic soils. The heavy emphasis on the upland crop association (area of upland fields, millet, naked barley and reclaimed land) is probably an economic response to the physical landscape. Only 18 percent of the region is suitable for paddy and the local ratio varies from 24 to 13 percent from the peninsula coastward. Even that amount is threatened by periodic water shortages because the narrow peninsulas and small, hilly islands which comprise the region have neither the area nor the forest cover necessary to provide adequate watersheds. However, the climate is moderate enough and the rainfall is usually sufficient to support dry crops such as barley, millet, soybeans, and sweet potatoes. The diminished

ability to grow rice, with its high productivity per unit of area and its relatively high price, makes it necessary for the farmer to compensate with increased acreages of the less desirable crops.[47]

The strength of Factor 3 is reinforced by the large amount of land reclamation work which has been done to expand the agricultural area. The acreage which has been reclaimed from severely eroded upland has been small in absolute terms, but it is well above the national average. More important has been the coastal reclamation work which has caused dozens of shallow coves and bays to be diked and drained or allowed to fill with sediment. They are difficult and expensive projects, but the national government has a continuing program for their expansion in this region and adjacent areas of the southwestern coast. Between 1965 and 1967, 190 tidal reclamation projects were started along this coast and the National Land Development Plan calls for the reclamation of 157 kilometers of tidal flats by 1981.[48]

The exceptionally high population density of over 430 persons per square kilometer is probably another factor in the intensity of agriculture, but it has little impact on the urban-builtup land uses. The physical isolation of the area and its distance from modernizing centers has allowed the population and economy to remain rural and agricultural. The only city in the region is Makpo (1970 population 178,000) which

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[47]Park, Land Development Activities in Korea, p. 18.

[48]National Land Development Plan: 1972-1981, p. 22.

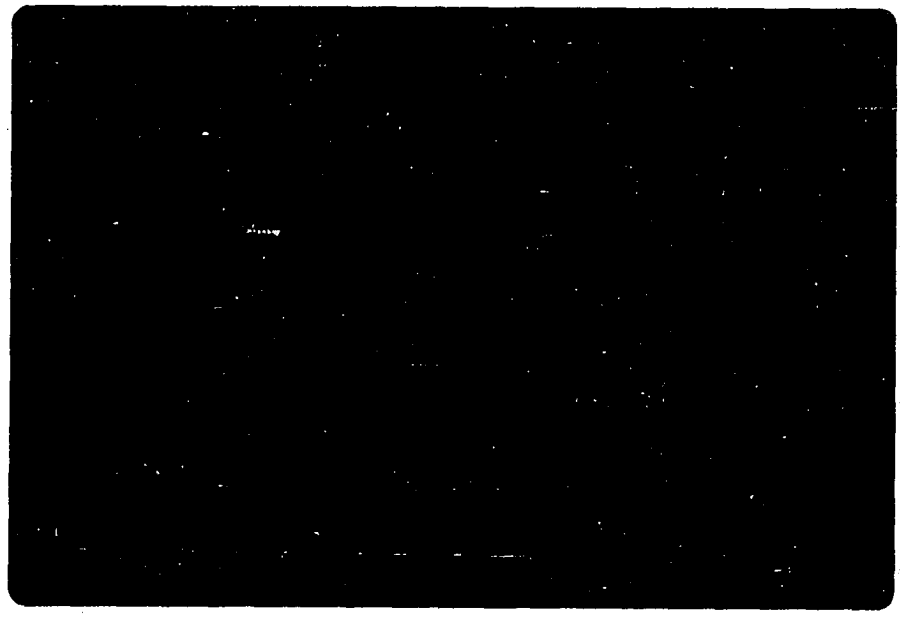

Figure 40.--The southwestern coast. This aerial view of an estuary and tidal flats on the Yellow Sea coast is just north of Region 11, but it illustrates several characteristics of the region. The great tidal range and low relief create thousands of square kilometers of tidal flats, make communications difficult, and inhibit economic growth of the area. Further south the land is even more fragmented, the hills are less prominent, and less land is suitable for irrigated paddy (also see Figure 19).

serves as the regional port for coastal shipping and fishing.

Urban-Fringe Regions

Region 14

This small land use region is adjacent to the Pusan urban region (Region 16) on the west, and has strong functional links to it. The region spatially coincides closely with the Kimhae Plain physiographic region. It is a 350 square kilometer area of the Naktong River delta and small adjoining erosional plains which is nestled between, and bounded by, coastal mountains rising 400 to 800 meters above the lowlands. Almost three quarters of the region is delta with less than five meters of relief which is highly dissected by distributaries, tidal channels, canalized streams, and irrigation and drainage canals. Most of the area has been stabilized and under cultivation for several decades, and there is no natural or wild vegetation community of note. The only upland in the region is found on the slopes of the mountains which form the region's boundary everywhere except at the river's mouth.

The overwhelming land use in the region is cultivated agriculture, as one would expect from the physical characteristics. Nearly 75 percent of the land area is in cultivation, and 83 percent of that is in irrigated paddy fields. Until the 1960's a traditional agricultural economy and near rice monoculture prevailed because of the favorable terrain, water supply, climate, and limited markets.[49] In the last

[49]Koo, Regional Characteristics of Korean Agriculture, p. 619.

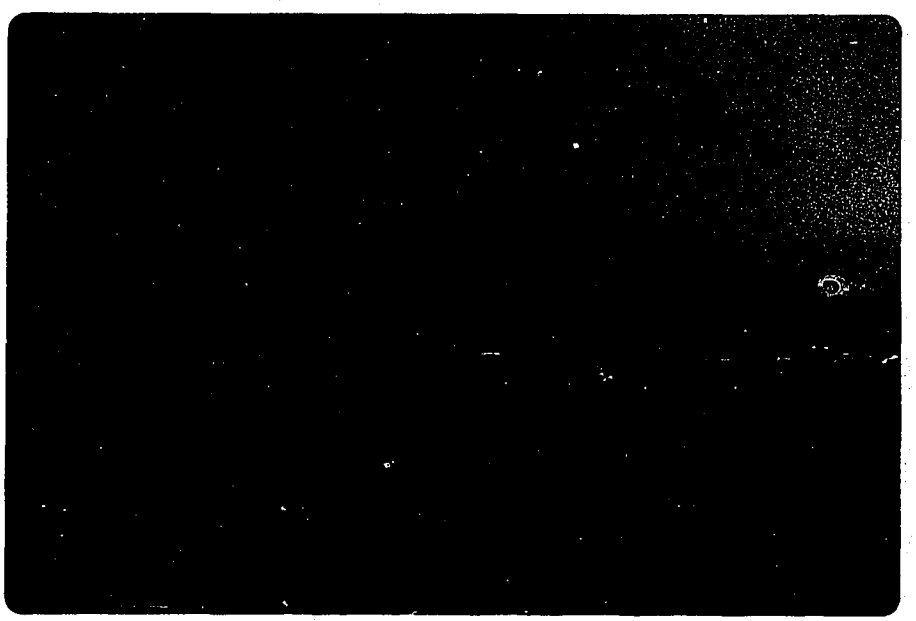

Figure 41. --Agriculture on the Kimhae Plain. This northward view from the center of Region 14 illustrates the intensive commercial nature of the region. Several vinyl houses are seen on the right. The mountains in the background lie on the region's boundary.

decade, however, the region has responded to the rising urban incomes and changing markets in Pusan to become that city's market garden.

The Kimhae Plain is still a leading rice producer, but it is now even more noted for its intense commercial vegetable and fruit production which goes across the Naktong River to Pusan. The most important "truck farming" zones are lobes which extend some 15 kilometers from Pusan along major highways.[50] Rice no longer earns the highest economic rents in those areas and has been replaced by a variety of vegetable crops whose production is increased with the use of vinyl houses. The vinyl houses allow farmers to get several vegetable crops a year in a nonstop cycle. The density of vinyl houses in the Kimhae Plain region is at least five times greater than all but two of the counties in the country and is exceeded by none. The region's fruit orchards and vineyards are mostly found on the sandier soils of the delta's northern side.

The prominence of these highly productive and profitable agricultural activities is indicated in the factor score matrix where Factor 1 is strongly positive, and the score for Factor 8 is the highest in the nation. Upland agricultural activities logically score negatively except for burnt-field farming (Factor 7). Sendentary burnt-field farming is found in the bordering uplands which are largely outside the modified regional boundary. This is to be expected of any zone

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[50]Bartz, South Korea, p. 175.

near a large urban area such as Pusan, which acts as a magnet for poor rural families seeking economic advancement. The high positive score for Factor 9 indicates the characteristically poor quality of upland cover on the mountain slopes adjacent to densely populated lowlands. Again, however, most of the forest land lies outside the modified boundary.

The region has a fairly dense population (315 persons per square kilometer), but like the agricultural plains of southwestern Korea there is a very low degree of urbanization. There is no major economic activity other than agriculture even though the center of the region is only 15 kilometers from Pusan and it is traversed by two major highways and a rail line. The only builtup place is the regional market city of Kimhae which has a population of about 25,000 and is located on the northwestern edge of the delta. Uncharacteristically of Korea, much of the settlement is comprised of dispersed farmsteads rather evenly distributed throughout the cultivated lowlands.

The Kimhae Plain lies at the heart of the Pusan Development Region which is experiencing rapid industrialization, but precautions have been taken to retain and improve it as a food production base. No industry is projected for the area, but here will be incremental improvements to irrigation and road networks and further reclamation of tidelands.[51] The most important land use changes in the next few years

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[51] National Land Development Plan: 1972-1981, pp. 209-210.

will probably result from further agricultural restructuring in response to the modernizing markets of the emerging coastal industrial zone.

Region 16

Land use region 16 envelopes the Seoul-Inchon urbanized region in a band of diverse and highly mixed activities. It is a rapidly expanding region which, more than any other in the country, represents and is shaped by the shock waves of modernization that are originating in Seoul. Outside of this zone and the urban complexes of Pusan and Taegu, the patterns of life have undergone accelerating evolutionary change over the last decade as impetus for such change filtered through the countryside. Within Region 16, however, revolutionary change has affected nearly every element of the cultural landscape. Most marked are the modernization of transportation systems and the commercialization of agriculture.

The region is centered on the lower Han River basin and includes about 2,600 square kilometers of small, discontinuous erosional plains interspersed with forested hills and low mountains. The greatest expanse of plain is found along the Han west of Seoul, while a 10 kilometer wide belt of rugged mountains up to 850 meters in elevation trends north to south through the middle of the region. The boundary of the region is conspicuous throughout a 180 degree arc east of Seoul where the highly modified cultural landscape abruptly changes to mountain dominated regions. The west is bounded by the DMZ, the Imjin River

and the Yellow Sea. Only in the southwest where it abuts Region 6, with its increasing land use diversification and physical similarity, is the boundary zone not visually apparent.

All of the major categories of land use are present in this region and have substantial areal representation even though they may not be strongly reflected in the factor score matrix. The two largest categories are forest land, whose "stocked" component occupies about 47 percent of the region, and cultivated land which covers 28 percent. The builtup area of towns, transportation, and military facilities probably exceeds 15 percent, although exact figures are not available. The remaining 10 percent of the region is divided between water bodies such as the Han River and its tributaries, irrigation reservoirs, coastal salterns, and barrens. Barren land is found in limited amounts along the sandy flood plain of the Han system and in several places in the mountains north of Seoul.

Forest of all types covers nearly one-half of this region, but compared to most regions the percentage is low. The quality of that forest is somewhat better than average, however, because the national government's attention to the area has stimulated greater local reforestation and tighter harvesting controls. Immature pine stands and scrub oak are the dominant cover except in protected mountain valleys where some small tracts of mixed forest survived the Korean War. The former are harvested for fuel and green manure for rice paddies

and are economically important despite appearances. Few forest areas are remote enough for burnt-field farming to become significant because competition for the land is too great and most refugees or migrants to the region have settled in the vast squatter suburbs of Seoul where the opportunity for non-farm employment is perceived. Scores for Factors 5, 7, and 9 are therefore strongly negative while Factor 6 has mixed scores.

The most interesting facet of land use in the region is agricultural, because it shows the impact of recent commercialization and specialization. Until the early 1960's the traditional agricultural pattern of irrigated rice growing in all suitable paddies and supplemental row crops sited on sandy soils and dry hill slopes prevailed in the region. Rice is still grown on about 50 percent of the cultivated land, but in wide sectors extending outward from the Seoul-Inchon urbanized region vegetables and other truck crops are encroaching on both paddy and subsistence upland acreage. That trend is largely responsible for the generally negative scores for Factor 1 in this region.

Rice is still dominant over a large expanse of lowland along the Han River east of Seoul and on the gently rolling Kimpo Peninsula west of the city where soil and water conditions are near optimum. The low hills northeast and southwest of Seoul comprise one of the country's major fruit growing zones, specializing in peaches, pears, grapes, and persimmons.[52] Northwest of Seoul the Paju Plain has become the

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[52]Koo, Regional Characteristics of Korean Agriculture, p. 232.

Figure 42.--The Paju Plain north of Seoul. This erosional plain was once one of Korea's rice bowls, but it is rapidly being converted to more specialized uses as modern transportation penetrates all of Region 16.

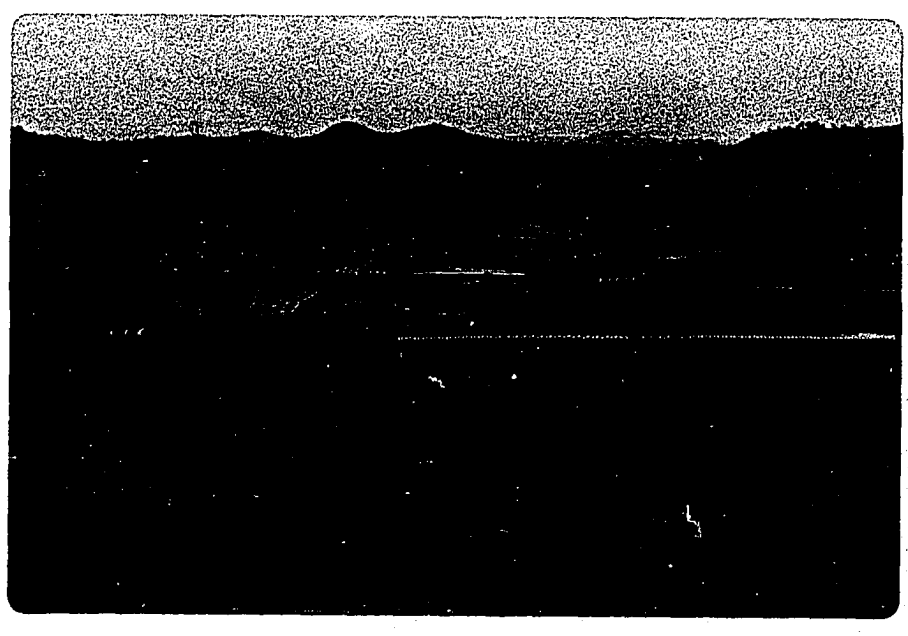

Figure 43.--Changing land use in Region 16. These hills 20 kilometers north of Seoul have recently been cleared of the stunted forest seen in the background. They are now in very profitable commercial vegetable production in response to urban stimuli.

dominant vegetable growing sector for the metropolitan region, and ranks as one of the three leading vegetable producing areas in the country. In the Paju sector and similar areas paddy is rapidly being converted to nearly year-round vegetable growing by the use of densely packed vinyl-houses. Farm income is dramatically increased because greater productivity per unit of area is achieved, vegetable prices can seek a market level which is usually higher than the controlled price of rice, and farmers have greater production flexibility with cash crops. Double-cropping of paddy is otherwise precluded for most of the region by the shortness of the growing season.[53]

Another new and rapidly growing land use in the region is dairying. Increased nutritional standards, changing tastes in metropolitan areas, and modern processing facilities have created a market for dairy products. The government has responded by subsidizing the conversion of some areas of poorly forested hills and barrens into improved pasture as a means of improving the land's productivity. Such pasture currently occupies a miniscule area, but it has great growth potential. Currently nearly 28 percent of the nation's 24,000 dairy cattle are located in this region. Together with truck farming the dairy sector is responsible for the extraordinarily high scores for Factor 8.

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[53]Young Kun Shim, Economic Analysis of Double Cropping in Paddy Fields, Report for the Ministry of Science and Technology and the U.S. Agency for International Development to Korea (Seoul: Seoul National University, 1967), p. 34.

The urban-builtup association of land uses shows surprisingly little strength in Region 16 despite the region's envelopment of the nation's primate city and a population density of 365 persons per square kilometer. The region also contains one of the densest transportation nets in the country, and the northern third has a significant portion devoted to military installations. Nevertheless there are only two cities in the region and it is questionable whether their proximity to Seoul stimulated or retarded their functional scope and size. Uijongbu (1970 population, 95,000) is a light industrial and administrative center 20 kilometers north of Seoul which also has a major military garrison function. Anyang is less than one-half as large and serves local commercial needs in the southern part of the region. Outside those cities there is no other mining or manufacturing activity.

Under new economic planning guidelines both Uijongbu and Anyang are scheduled to become industrial satellites of Seoul in an attempt to better balance the regional and national distribution of population and industry. The remainder of Region 16 is to be formally developed as an urban market oriented commercial agriculture zone which will also serve as a massive greenbelt for Seoul. The emphasis will be on the growing of fruits and vegetables, horticultural activities, and dairy farming. These will be facilitated by increasing the degree of farm mechanization and the density of farm-to-market roads. As in the Pusan region, an expected beneficial side effect is the lessening

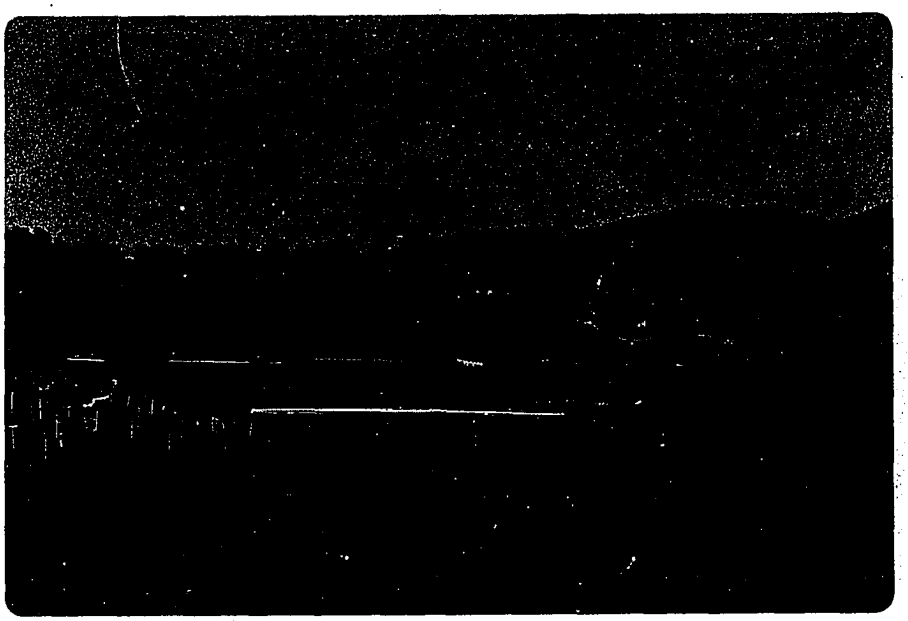

Figure 44. --Farm village south of Seoul. This small prosperous village about 20 kilometers south of Seoul illustrates the agricultural diversity and commercial specialization which is becoming the trademark of Region 16.

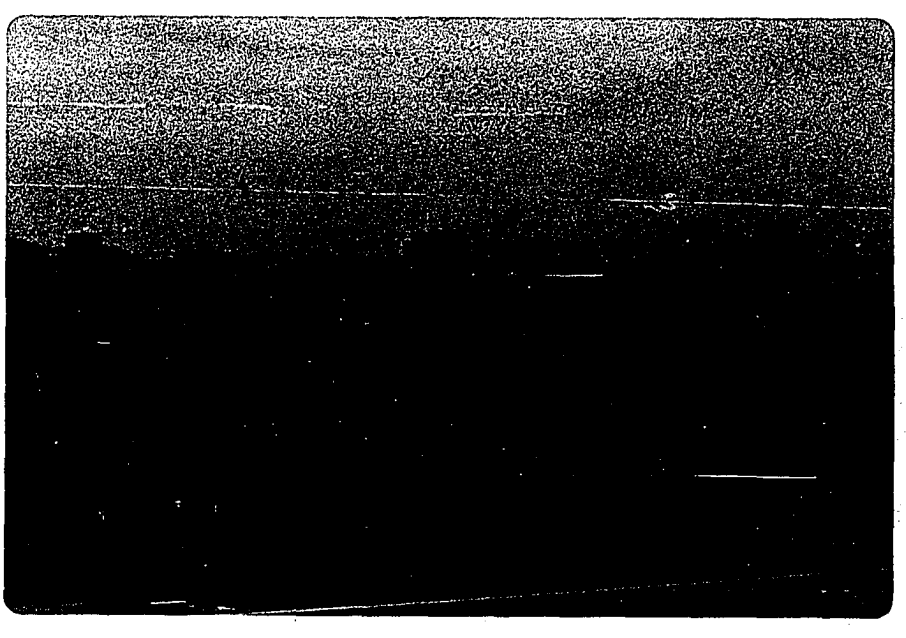

Figure 45. --Suburban expansion around Seoul. This area south of the Han River illustrates the rapid encroachment of the urban area on the surrounding farmland and hills and the need for land use planning and control.

of the rural-urban income gap and a resultant slowing in the farm-to-city migration rate.[54]

Urban-Builtup Regions

Region 13

This region is a small nested enclave of 700 square kilometers in the heart of Region 5 which encompasses the city of Taegu and its immediate hinterland. It occupies the valley of the Kumho River from its junction with the Naktong River west of Taegu eastward some 55 kilometers to the vicinity of Yongchon. The general physical setting is the same as that of Region 5, but the landscape of this region is almost entirely comprised of erosional lowlands ringed by low mountains.

This is a region of widespread urbanization and specialized or urban oriented agriculture, although it is clearly just emerging as an urban zone. Taegu (1970 population 1.1 million) is the highest order central place in the eastern interior and ranks third in population in the country behind Seoul and Pusan. In areal coverage, however, it is second and its immediate environs are well suited for further urban expansion. The two land use associations which shape the complexion of the region and clearly distinguish it from the surrounding region are urban-builtup and specialized upland crops (Factors 2 and 4).

The builtup area is centered on the city of Taegu whose

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[54] National Land Development Plan: 1972-1981, pp. 190-201.

contiguous urban area is approximately 100 square kilometers. The city has a compact shape and there is little radial expansion of the urban area along transportation arteries. This compactness can be attributed to the shortage of private and public transportation as much as to master planning which has been largely dormant since the Japanese colonial period.[55] The densities of structures and population are greatest in a five kilometer diameter zone near the city's center where there are 25,000 residents per square kilometer. The intensity of the urban environment declines rapidly with distance, and about five kilometers from the city center there are numerous remnants of agricultural land still in production.[56] The population density also drops abruptly to a modest 300 to 350 per square kilometer.

Taegu has a large industrial sector which includes nearly 25 percent of the nation's textile industry and significant portions of the rubber, basic machinery, and basic metal products capacity of Korea.[57] The small size of most of the plants and the absence of effective governmental control of the locational process has resulted in the plants being widely distributed throughout the builtup area, and no true industrial zone can be identified.[58]

Yongchon is a secondary marketing and transportation node in

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[55]Man-gap Lee and Herbert R. Barringer, A City in Transition: Urbanization in Taegu, Korea (Seoul: Hollym Corp., 1971), p. 480.

[56]Ibid., p. 469. [57]Ibid., pp. 168-169. [58]Ibid., p. 412.

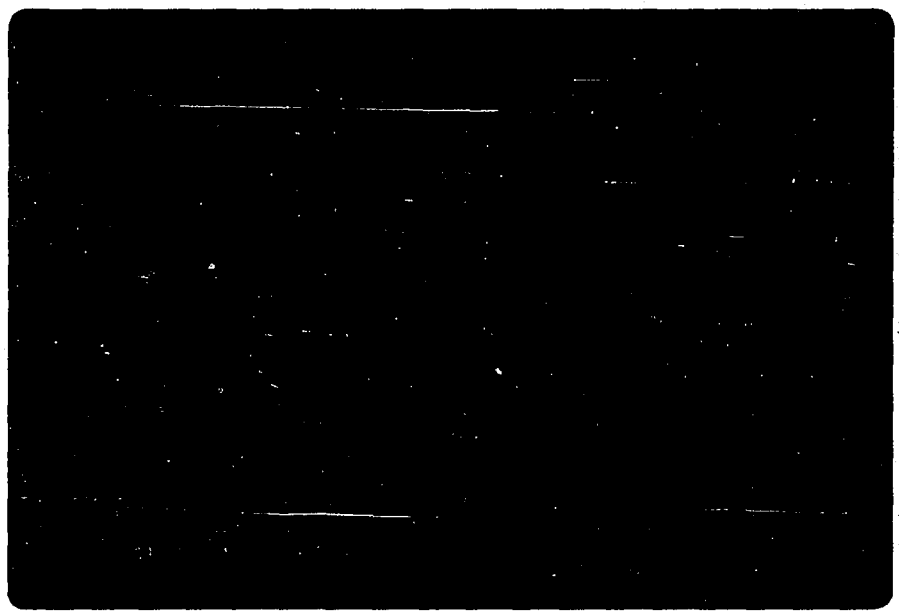

Figure 46. --Aerial view of Taegu. This view includes the Kumho River, the center of the sprawling urban area, and an indication of the density of modern transportation development in Region 13. A portion of the low mountains which bound the region can be seen at the upper left.

the eastern end of the region with a population of about 40,000 which contributes to the urban-builtup complexion of the landscape. It links Pusan, the eastern coastal ports, and the northern Naktong basin with Taegu and the western plains by railroad and national highway. Three major rail lines and several major highways, including the Seoul-Pusan four-laned expressway, traverse the region and make the Taegu-Yongchon axis one of the best developed transportation zones in the country.

The specialized agricultural sector of land use is of extraordinary importance in distinguishing this region. All of the major urban areas of Korea have adjacent zones of urban oriented activities which include concentrations of vegetable farming and livestock raising. Several are also at the center of a local zone of tree fruit production, but none of them are as large or as nationally prominent as the Taegu area. Twenty-five percent of the total cultivated land in the surrounding county is devoted to orchards, and in 1970 some 50 percent of the upland area around Taegu was covered with apple orchards alone.[59]

Orchards currently form an almost continuous belt averaging two kilometers in width up the center of the Kumho River valley. Associated with them is the greatest concentration of irrigation reservoirs in the nation even though the primary source of water is the Kumho River. Mulberry plantations and other lesser commercial crops are widespread on many of the uplands adjacent to the river valley which are

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[59]Ibid., p. 142.

less accessible or are not benefitted by a reliable water supply.

The strengths of the region are adequately reflected in the factor score matrix where Factors 2 and 4 register extremely high positive scores, but the positive scores of Factors 5 and 7 representing the coniferous forest and burnt-field associations are misleading. Both reflect the conditions present within the politically bounded region, but subsequently excluded from the modified region.

Current government planning calls for few changes for the Taegu region over the next several years. Urbanization and the centralization of industry have reached desirable upper limits and the government now plans to stimulate more growth in the smaller cities of the Naktong basin. The most significant changes will be qualitative in nature and include urban planning and renewal in Taegu, expansion of rural roads, and major new steps in water management for both agricultural and industrial needs.[60]

Region 15

The smallest of all regions and the easiest to describe without resorting to a microscale study is the Pusan metropolitan area (1970 population 1.9 million). Pusan was nothing more than a medium sized fishing village until late in the nineteenth century when the Japanese and other foreign interests began to open Korea to trade, and it did not

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[60] National Land Development Plan: 1972-1981, pp. 207-209.

begin to expand as an industrial and port city until the Japanese annexation in 1910.[61] It continued to grow throughout the colonial period and its organization was patterned after Western cities. Its size and status were further enhanced during the Korean War when it was the principal port outside the sphere of combat action. After the war it languished briefly until normal relations were reestablished with Japan and a high volume of industry and commerce resumed.[62]

In 1963 Pusan annexed its suburban fringe and adjacent urban areas and was given the provincial level status of "special city" and domain over nearly 375 square kilometers of Korea's mountainous southeastern tip. The contiguous urban area has continued to expand northward and westward wherever the terrain permitted, and the Pusan urbanized area is now prorupt and perforated like few other major cities. All together, some 200 square kilometers of the administrative area of Pusan are sufficiently urbanized to be included in this urban-builtup land use region.

Within this small region only two of the major categories of land use are present. Urban-builtup attributes cover approximately 65 percent of the area, including just about all land that is suitable for construction. The remainder of the area is occupied by a half dozen steep mountains reaching to heights of 400 to 600 meters. Their

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[61]Bartz, South Korea, p. 128.

[62]Ibid., p. 130.

vegetative cover is so thin that they are essentially barren and are not even effective as watersheds. The only agriculture which remains is gardening and some small-scale farming in isolated remnants of now-urbanized valleys.

The functional center of the region is downtown Pusan which focuses on the harbor at the southern end of the region. The downtown area includes much residential and commercial construction of modest means and it has expanded to its limit up the surrounding mountain slopes. Most of the recent urban growth has been in a two kilometer wide strip extending northward some 18 kilometers along the harbor front and in a low corridor through the 200 to 500 meter high mountains which surround the city. Newer and somewhat less ordered expansion has incorporated 10 kilometers of waterfront northeast of the harbor and several smaller lowland areas north of Pusan proper.

A large portion of Pusan's area is occupied by all of the transportation facilities one expects to find in a modern industrial port city with a substantial hinterland. Port facilities occupy several square kilometers of waterfront. They handled 32 percent of the national ocean tonnage in 1970, and are being modernized and expanded to triple current capacity by 1989.[63] Pusan is also the terminus of the bulk of the nation's railway and it includes two major rail marshalling yards and many kilometers of enroute track. A regional airport and several

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[63] National Land Development Plan: 1972-1981, p. 93.

Figure 47.--Downtown Pusan. This view illustrates the manner in which Pusan has expanded to fill all the lowland around the harbor. A northward belt of contiguous urbanization extends around the harbor and over the low pass on the horizon just left of center.

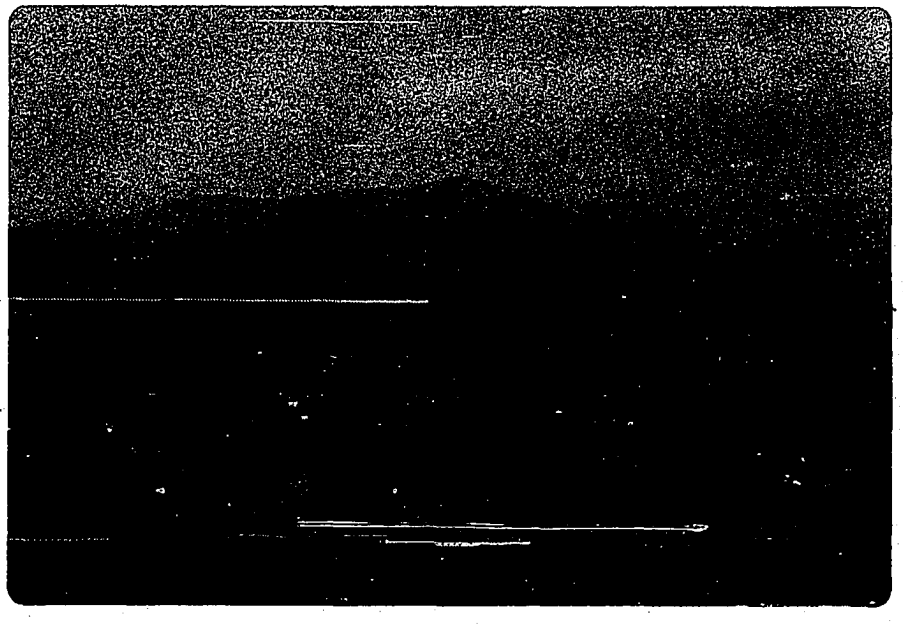

Figure 48.--Urban expansion north of Pusan. This is a part of the industrial and residential expansion about 10 kilometers north of Pusan Harbor. The mountains in the background lie along the boundary of Region 5.

major highways complete the transportation sector.

The Pusan urban region is already a major industrial area which includes nearly 9 percent of Korea's manufacturing plants and 17 percent of the manufacturing workers.[64] The composition of the region's industry is well balanced and includes textiles, chemicals, basic metal goods, plywood, food processing, and ship building among the many. As in Taegu, the plants are distributed throughout the urbanized area.[65]

Further expansion of the industrial base and the urbanized area will be minimized under the provisions of new government guidelines. Under these constraints the population growth rate is expected to average only 2.6 percent a year in the decade prior to 1981, while that of the smaller regional cities should approach 10 percent.[66] The concentration of industry and population in a few cities is seen by the government as a strategic weakness in the present political environment of northeast Asia.[67] It is also an obvious force perpetuating the severe and politically troublesome rural-urban income gap. As a consequence, emphasis is being given to the development of outlying areas. Pusan's economic strength will still continue to grow as the city becomes the pivot of a planned heavy industrial belt which is to include the coastal cities

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[64]Korea Statistical Yearbook: 1971, p. 179.

[65]Bartz, South Korea, p. 131.

[66]National Land Development Plan: 1972-1981, p. 115.

[67]Ibid., p. 110.

of Ulsan, Chinhae, Masan, and Samchonpo.[68] It will certainly remain the second most populous and powerful urban area in South Korea as long as healthy economic ties exist with Japan.

Region 17

The largest and most imposing urban area in the Republic of Korea centers on Seoul, its primate city, located in the northwestern corner of the country just 30 kilometers south of the DMZ. The region includes about four-fifths of the 613 square kilometer administrative area of the special city plus a lobe of some 200 square kilometers extending westward to include Inchon and the considerable urbanization in the intervening 20 kilometers.

Though small, the region has a jumbled landscape which is essentially a rolling erosional surface interrupted by resistant uplands. Hill remnants are separated by wide stream valleys except in the central part of the region where some prominent mountains thrust up to 700 meters above Seoul and its surroundings. The broad sand and gravel choked channel of the Han River traverses the region for nearly 30 kilometers and is an effective hindrance to north-south intercourse.

Seoul has been the site of Korea's capital since late in the fourteenth century and it has retained its importance largely because of its situation and the inertia of institutions. It is located midway down

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[68] Ibid., pp. 40-41.

the western coast of the peninsula astride the junction of the only north south and east-west lowland corridors on the peninsula. Its site offered early inhabitants amenable living conditions and defensible terrain.

The city remained a small administrative center in the Chinese tradition until the Japanese annexation when revolutionary modernization and expansion began. Japan rapidly converted Seoul into the primate city by establishing and centralizing administrative functions, transportation facilities, schools, hospitals, commercial activities and western-style industry. Since the channel of the Han River has always been too shallow and variable for commercial navigation, Inchon became the capital region's port and it has been closely linked to Seoul for many decades.

By 1949, the last census before the Korean War showed the population of Seoul to be almost 1.5 million, and it was the first city to be given the special province-level political status.[69] Today Seoul is one of the world's largest cities, having a 1970 population of over 5.5 million and an extremely high growth rate which has caused the population to treble since 1955.[70] Inchon has grown along with Seoul and it had a population of 650,000 in 1970. Together this one region accounts for 20 percent of the national population.

As one would expect, urban-builtup land uses are predominant

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[69]McCune, Korea's Heritage, pp. 168-169.

[70]Korea Statistical Yearbook: 1971, p. 40.

in this small region and they occupy about 60 percent of the area. Significant urban expansion of both Seoul and Inchon did not occur until the twentieth century when the Japanese began economic integration of the colony.[71] The early growth took place within compact bounds, but as further growth engulfed various terrain obstacles Seoul became increasingly fragmented and perforated. Most land within about seven kilometers of central Seoul which is suitable for urban growth is now builtup and expansion is accelerating along transportation arteries.

The furthest contiguous urbanization is about 15 kilometers from downtown Seoul, and it is most advanced in the north. To the south the Han's unruly channel was an absolute barrier until the 1917 when it was first bridged, and it still retards growth in that direction.[72] On the west the relationship with the port of Inchon and the attraction of Kimpo International Airport have resulted in rapid expansion along that axis and with the establishment of a number of large industrial estates and depot-type activities. The only barrier to the complete urbanization of a several kilometer wide zone between Seoul and Inchon is the Capital Region Development Plan which has made provisions for a narrow greenbelt of forested hills and rice land between the cities.[73]

The contiguous builtup area of the city of Seoul reflects largely

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[71]McCune, Korea's Heritage, pp. 167-169.

[72]Bartz, South Korea, p. 122.

[73]National Land Development Plan: 1972-1981, p. 201; and Eui, "Seoul Metropolitan Development: 1960-1973," p. 29.

unplanned growth in terms of spatial organization and functional distribution. Nevertheless, there are four relatively well defined zones of urban activity within the city. The first is the core of modern commercial and administrative activities which is located within two kilometers of the original walled city's center. Included in this core are most of the modern high rise buildings and modern transportation facilities, international commercial activities, national government buildings, industrial headquarters, and many hotels and historic sites.

About four kilometers south of the city's center on an expanse of lowland along the Han River is a concentration of light industrial activities, military compounds and transportation facilities. Across the Han River some six or seven kilometers southwest of central Seoul is the industrial suburb of Yongdungpo. Its oldest and densest portion of some 20 square kilometers contains nearly every kind of industrial plant found in Korea and is the greatest heavy industrial zone in the country. Lastly, there are the remaining areas of the city which are occupied largely by residential and local service activities. These are most expansive along the north bank of the Han River and the northern suburbs of the metropolitan area.

Agricultural activities are still prominent and important to the economy of the region, and they occupy 16 percent of the area. Most of the farm land is on lowland along the Han River and the broad plain between Seoul and Inchon. The acreage is about evenly divided between

Figure 49.--Industrial estate west of Seoul. Most industrial growth is occurring along the Seoul-Inchon axis where transportation, level land and development plans have encouraged the establishment of dozens of industrial estates such as this.

Figure 50.--Downtown Seoul. This is an eastward view across a portion of Seoul's core from near the capital. The city has expanded to cover nearly all the area to the base of the mountains faintly visible on the horizon.

rice and commercial vegetable growing. Like the surrounding region, this area has adopted vinyl houses to increase production efficiency and has the fourth ranking concentration in the country.

Incongruous as it may seem, forest is found on nearly 15 percent of the area as strictly an upland cover where no higher economic rent can be earned. Young, fairly dense,and closely managed pine stands are most apparent on the northern mountains of the city and in large tracts on hills between Seoul and Inchon. They are maintained as an example of forest management for the rest of the nation and as a major component of Seoul's greenbelt. Another 5 percent of the region is barren land and water.

The rapid growth of the metropolitan area and a serious imbalance in the national distribution of population, industry, and public institutions has alerted the government to the need for remedial action. As a consequence, strict limits have been placed on the physical growth of the Seoul-Inchon area and positive measures are being taken to decentralize many functions. The goal is to eliminate all industry from the center of the Seoul urban area and to foster its development along the Seoul-Inchon corridor and in satellite cities such as Uijongbu. Residential areas are to expanded along the Han River, and all remaining suitable land is to be developed for truck farming.[74] The port of Inchon is being enlarged and modernized so that it can better support the

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[74]National Land Development Plan: 1972-1981, pp. 189-192.

industrialization of all of northwest Korea. It appears, then, that growth in this region will continue in a more orderly fashion, but that no dramatic changes in land use patterns will take place in the next decade.

CHAPTER VI

SUMMARY AND CONCLUSIONS

The Problem and Research Objectives

A knowledge of contemporary land use patterns and environmental resources is important for any country today, but it is in remote areas and underdeveloped countries that the information void is greatest and the means of accomplishment are least. The need to fill that void becomes critical when the decision is made to develop a modern, integrated economy in the region and little reliable information is available for a planning foundation.

The Republic of Korea is a good example. Integration of the rural sector with a rapidly expanding industrial economy is the major goal of existing development plans. Implicit in this scheme is the complete and efficient use of land areas and other productive resources. However, in the past little attention was paid to the collection of reliable land use data, and land use mapping and regionalization have been based almost entirely on a variety of uncoordinated academic studies and tabular data from several agencies and administrative levels of the government. They have produced a series of regional maps which are

antiquated, overly simplistic, imprecise, or too narrow in scope to be of much value. Consequently, South Korea lacks a general reconnaissance overview of its land resources and an understanding of integrated regional land use.

This study has sought to develop an improved methodology for the regionalization of integrated land use attributes and to apply that methodology to the Republic of Korea. Specific regional objectives were the determination of the dominant land use associations presently shaping Korea's landscapes, and the definition and realistic delimitation of small-scale integrated land use regions consistent with the need for an environmental overview as a prelude to national land use planning.

The Research Design

The research design used in this study has combined the advantages of using mathematical techniques to define dominant land use associations and regions with the use of synoptic space imagery to realistically delimit boundaries. The major elements of the design were: (1) the factor analysis of selected land use attributes from each of the major categories of land use present in Korea to establish predominant land use associations; (2) the use of factor scores and Ward's grouping algorithm to cluster data cases to reveal a preliminary regional structure; and (3) the use of a modified photomorphic mapping technique on LANDSAT images of Korea to adjust preliminary regional boundaries and establish final boundaries.

This methodology was successful in this study and appears to have several advantages over either the mathematical or photomorphic mapping techniques used alone. Significant advantages over the photomorphic mapping technique are: (1) it objectively identifies those land use associations most important on the landscape; (2) it establishes a tentative regional structure for the image interpreter to compare with his visually derived organization, and at the same time, identifies the dominant land use associations impacting on the photomorphic signature; and (3) there is a reduced need to statistically test the validity of regional composition and structure since the preliminary regions are mathematically defined and classification error can occur only within the adjustment range of the modified (photomorphic) boundaries.

Advantages over a purely mathematical classification and grouping methodology are: (1) regions are more representative of the totality of surface attributes; (2) there is greater precision and realism in boundary placement; and (3) regions are defined and bounded in a more realistic context (the image) which allows greater understanding of the patterns and processes shaping the landscape.

A major problem with this methodology, as it is with any technique involving a mathematical solution, is the acquisition of an adequate data base. This problem would probably occur most frequently in developing countries or remote areas of economically developed countries where censuses are not regularly conducted. Most of the

specific problems encountered in this study of Korea were previously discussed in Chapter III, but they can be generally summarized as ones of completeness, compatibility, and reliability of the input data. Incomplete information about some land use attributes forced the inclusion of some possibly weak surrogates in an attempt at catholicity. As a consequence of that and the apparent inaccuracies in some of the data, the communalities of several variables were lower than desireable and weakened the factor results. The suspected poor reliability of some data is also thought to be responsible for some surprising and misleading factor scores such as those showing the mountainous counties of Regions 1 and 2 to be very weak in forest land use associations.

Another weakness is the subjectivity involved at several points of the methodology. These include the selection of variables for the factor analysis, the use of a contiguity constraint and the selection of a cut-off point in the grouping process, the evaluation of image signatures, and the bounding of photomorphic areas. These last two problems also exist in most machine (computer) analyses of imagery because of the need for the operator to establish initial tonal identifications and algorithms for the machine's reference.

Lastly, there appears to be a requirement that the researcher have a familiarity with the study area. A knowledge of land use associations, spatial and temporal patterns, and the physiography is essential if the researcher is to properly select variables, judge the meaningfulness of extracted factors, and rationally bound photomorphic areas.

Despite the shortcomings of the methodology used in this study, it is seen as a rapid and economical means to effectively identify, map, and regionalize gross land covers and uses at small scale. Its generalizing characteristic makes it most suitable for the level of detail defined by Level I of the USGS Land-Use Classification System for Use with Remote-Sensor Data. The assured availability of extremely low cost LANDSAT imagery for any land surface on the earth, and the modest requirements for computer processing and conventional image interpretation equipment make this methodology especially suitable for developing countries or regions doing land use, economic development, or environmental management planning. Its proper role appears to be thematic mapping or multifactor regionalization in the reconnaissance or overview mode, rather than as a final planning vehicle. It was in such an overview mode that MacPhail's photomorphic technique was used in the Regional Land Systems of Chile Project and again in a study of northern Colorado in 1972.[1]

This methodology also has potential uses in areas of developed countries where there is a coarse set of data collection points, or where physical access is restricted or large-scale imagery is unavailable. In that context this combination of the mathematical and photomorphic techniques would seem to be an advantageous means of updating the information base on countries such as the USSR and the Peoples' Republic of China.

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[1]Reeves, ed., Manual of Remote Sensing, p. 1962.

Land Use Associations

The fundamental finding of this study was that 9 basic dimensions effectively represent 31 land use variables in the Republic of Korea, and they account for 77.8 percent of the total variance (Table 4). From this it is clear that the three categories of land use traditionally recognized by the Korean culture (lowland, upland, forest land) are reasonable approximations of the dominant land use associations established by this study.

TABLE 4

DOMINANT LAND USE ASSOCIATIONS

Factor	Interpretation	% Variance
1	Lowland agriculture	20.8
2	Urban-builtup	16.3
3	Upland agriculture	10.4
4	Specialized upland agriculture	7.1
5	Coniferous forest-upland subsistence farming	6.4
6	Mixed forest-upland subsistence farming	5.4
7	Upland burnt-field agriculture	4.2
8	Lowland urban-fringe agriculture	4.0
9	Marginally productive upland	3.2

Not surprisingly, traditional forms of lowland and upland agriculture (Factors 1 and 3) are two of the most important associations in regional definition although together they occupy less than one-fifth of the country's surface. That situation is not likely to change as long as Korea relies upon its food grain production base for such a large share of its GNP and promotes the improvement and expansion of traditional

agricultural forms. Numerous physical and economic constraints also retard changes to the traditional patterns in much of the country.

Specialized agricultural associations represented by Factors 4 and 8 indicate a growing diversification and commercialization in Korean agriculture. The strength of these two factors is considered a sign of favorable trends in economic development and land use efficiency. Both associations have existed in limited scope for several decades, but recent expansion into "luxury" and industrial crops has increased their influence to the point that they are becoming prominent in regional land use dynamics.

The strength of the urban-builtup association (Factor 1) was not expected in a country where so much of the population is in the primary sector of the economy and where there are so few large cities. Apparently the aggregate of moderate population densities, large numbers of sprawling villages, a few regional cities, and the array of associated land uses is becoming a sector of considerable importance. The research for this study indicated that agencies at all levels have a poor grasp of the qualitative and quantitative aspects of the urban-builtup land use association and that it should be more closely monitored.

Despite the prominence of forest covers on the Korean landscape, no single forest land use association was found to be especially useful for differentiating regions. This unexpected outcome is thought to result from the poor reliability and imprecision of government data on

forest covers. They report nearly constant percentages of forest land in all parts of the country despite obvious qualitative differences. The importance of forest covers to the various regions is consequently masked. Two of the nine extracted factors (Factors 5 and 6) clearly represent forest associations, and their variable loadings suggest that forested areas are spatially and economically integrated with the subsistence farming sector. Despite the areal dominance of forest land in most regions, forestry is everywhere subsidiary to subsistence farming in an economic sense.

Upland burnt-field farming and marginally productive upland (Factors 7 and 9) emerged as unexpectedly important associations. Burnt-field activities, in particular, show greater prominence and wider distribution than is reported in any literature. This indicates that these inefficient and counterproductive land uses which the government has historically tried to ignore or downplay are, in effect, problems of consequence in several regions.

Each of the land use factors represents a facet of the total cultural landscape of Korea, and each occupies a rather predictable niche in the spatial order. In a representative landscape transect from the mountains to a lowland or coastal plain, one sees a progression of dominant land use associations very similar to those described by Geddes in the American South. Geddes' hypothesis that there tends to be a "natural sequence of regions" following the physiographic profile of the

land has been bolstered by other accounts of sequential landscape patterns.[2] This model may be too simplistic or deterministic for much of the world, but it still appears to be reasonable in much of Korea where a low resource-low technology culture long ago reached a kind of stable and harmonious adjustment with the physical landscape.

The Korean sequence starts with forests and burnt-field farming (Factor 7) in the remote mountains. In lower and more accessible mountains traditional sedentary upland subsistence farming (Factors 5 and 6) becomes prevalent in a broad vertical zone. Along upland margins to lowlands conventional upland agriculture (Factor 3) is prominent, although specialized upland agriculture (Factor 4) may be locally dominant. Urban and other builtup uses typically occupy lowland fringes and may themselves be flanked by the urban related association of Factor 8. The lowest physiographic niche is reserved almost exclusively for the intensive lowland agriculture of Factor 1.

The Regions

This research identified 17 specific land use regions within the Republic of Korea, and they ranged in size from the 200 square

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[2]Rupert B. Vance, Human Geography of the South, 2d ed. (New York: Russell & Russell, 1968), pp. 29-31 citing Geddes from an unidentified source. A more recent and analytical discussion is provided by Philip W. Porter, "Environmental Potentials and Economic Opportunities-A Background for Cultural Adaptation," in People and Land in Africa South of the Sahara, ed. by R. M. Prothero (London: Oxford University Press, 1972).

kilometers of Pusan to the nearly 20,000 square kilometers of Region 5. Five generic groups of land use regions can be identified from the data set used in this research. Although each group contains regional diversity, sufficiently deep or broad similarities exist for this subjective classification. Included as generic groups are: (1) forested-subsistence agriculture, (2) transitional agriculture, (3) intensive commercial agriculture, (4) urban-fringe zones, and (5) urban-builtup. There are no substantial similarities between either these generic classes or this regional organization and those single-factor schemes which are extant. Logically, the most similarities are seen with recent agricultural regionalizations. The least commonality exists with the great number of regionalizations which were based on presumed climatic limitations on agriculture and natural vegetation. The single physical attribute which appears to have the greatest correspondence to these regional boundaries is physiographic change.

Despite the ubiquity of forest covers in South Korea, there are only four regions where forests have a principal role in land use economics. Only in mountainous Regions 1, 2, 3 and 8 are the forest covers well developed, and do provisions exist for the current or projected integration of the forests in a commercial sense. Elsewhere in the country the predominant forest land covers are new planatations, scrub forest, and essentially barren lands which have no active role in the economic system. These "forests" make their

TABLE 5

SUMMARY OF MAJOR LAND USES BY REGION[a]
(Percent)

Region	Area (km^2)	Urban-Builtup	Agriculture			Forest	Barren	Water Bodies
			Cultivated	Paddy	Upland			
1	4,100	3	8	4	4	80	5	-
2	17,100	4	13	5	8	77	3	2
3	7,300	5	13	2	11	68	12	1
4	11,900	7	27	15	12	52	6	3
5	19,700	5	20	13	7	56	10	3
6	4,800	6	37	23	14	45	6	4
7	3,500	12	46	34	12	29	4	4
8	9,100	4	18	8	10	67	10	-
9	6,500	8	36	24	12	48	5	2
10	6,200	8	27	15	12	54	7	2
11	1,850	9	40	18	22	44	6	-
12	1,830	5	20	1	19	34	36	-
13	700	20	40	22	18	20	8	5
14	350	5	74	62	12	10	5	4
15	200	65	5	3	2	20	10	-
16	2,600	15	28	17	11	47	4	2
17	600	60	16	9	7	15	5	1

[a]These are approximate figures for the modified regional organization. They are based on extrapolations from sources listed in Table 3 and map and image examination. Row sums do not equal 100 percent of each regional area.

contributions in the form of conservation, foraged green manures, fuel, and herbs. Those products are not calculated in the GNP and their value has become a point of contention between some agronomists.

Even in the mountainous regions the youth of much of the forest cover and the time-distance costs of communications insure that subsistence agriculture remains the predominant economic activity. These four forested-subsistence agriculture regions therefore remain the most traditional regions in the country. They are currently able to contribute little to the national development program and should probably be treated as deficit areas for economic development for the next several years.

The next class up the scale of land use intensity is represented by Regions 4, 5 and 12 with their transitional agricultural characteristics. These regions are to some extent spatial buffer zones between the forested-subsistence agriculture regions and the intensively settled and farmed coastal lowlands. They reflect both intermediate environments and intermediate accessibility, yet each contains subregional extremes representing adjacent classes. These regions have remarkable diversity and self-sufficiency in land use practices, and not surprisingly, occupy 33 percent of the national area in a broad diagonal belt across the peninsula.

It is in the transitional regions that the bulk of the nation's barren or marginally productive upland is found. Its extent is so great that little economic development can take place until the land has been

reclaimed or reforested and a generation of trees matured. This means that the government's rather leisurely reforestation schedule which extends over the next decades will probably delay the economic integration of those regions for another half-century. Indeed, it appears that the large share of forest land cover in every county and region poses substantially larger developmental problems and potential than current land and economic development plans are prepared to manage.

Regions 6, 7, 9, 10 and 11 form the heart of Korea's intensive commercial agriculture sector with a specialization in food grains. They occupy exclusively coastal lowlands in the west and south where Korea's most suitable agricultural soils and climates fortuitously coexist. Their role and spatial extent has remained virtually unchanged for at least a half-century, and with the exception of improved accessibility and the development of light industry in selected regional cities, they will remain largely unchanged for another fifty years. Despite Korea being one of the oldest settled countries and being settled by an intensive grain farming society in the Chinese tradition, these are the only regions (except Region 14) where agricultural land uses even approach areal dominance. Even so, the 23 percent of the national area represented by this group of regions alone should insure South Korea's agricultural sufficiency using available management resources.

Some of the most rapid economic and social changes in South Korea are occurring in the urban-fringe regions where intensively

managed, specialized agriculture is the dominant land use. Included in this group are Regions 14 and 16, each of which is contiguous and responsive to one of the country's two principal cities, and has a high degree of interconnectivity.[3] They both specialize in the growing of high priced, non-staple foods for the adjacent markets, but they are relatively small regions because of the still limited per capita incomes of urban residents.

The appearance of these urban-fringe regions in this study is significant because it clearly illustrates that strong forces for modernization are present in the country, and that the often criticized Korean farmer is quite responsive to genuine economic stimuli. This regionalization also suggests that a system of Thünian rings are beginning to appear around the three major cities of Taegu, Pusan, and Seoul. The link between the mapped factor scores, the regions, and von Thünen's model might seem tenuous, but it seems justified in light of the formidable physical factors of distortion and the land use changes which have occurred since moderization began. Suburban vegetable and fruit growing have been important activities for decades, but there is no previous evidence in the literature that traditional land uses were not dominant to the edge of the urban areas. Recent literature has remarked on the accelerating change around urban places, but this

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[3]A similar zone appears to be forming around Taegu, but the configuration of political units, and consequent data cells, may have prevented its definition in this study.

study is the first to suggest spatial dimensions.

Urban-builtup regions are predictably small and sparse, and currently include only the political units containing South Korea's three largest cities. These will probably be the only urban areas for at least a decade because they are the only growth poles in Korea and are currently absorbing most of the capital investment and the rural-to-urban population migration.[4] Although these cities are stimuli to their respective sections of the country, recent policy decisions and planning measures have been directed toward abrupt limitation of growth in those areas, and the stimulation of growth in medium-sized regional cities. Growth will also tend to remain localized because of the lag time between growth pole stimulus and regional response. Rural regions around the three urban regions appear to be experiencing the "backwash effect" which has been observed in other rapidly developing countries.[5]

Only Region 17, the Seoul-Inchon complex, shows promise of considerable expansion in the near future. Absolute growth of that urban zone will probably continue despite a substantial decline relative to smaller cities. The likely result, regardless of substantial green belts and other zoning measures, will be the expansion of the conurbation toward Uijongbu to the north and Anyang and Suwon to the south. Growth

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[4]Eui, "Seoul Metropolitan Development: 1960-1973," pp. 24-25.

[5]M.I. Logan, "The Spatial System and Planning Strategies in Developing Countries," Geographical Review, LXII (April, 1972), p. 237.

of the urban center will absorb portions of Region 16 which will, in turn, expand its outer perimeter in response to the conomic situation.

The successful implementation of the National Land Development Plan: 1972-1981 will impact substantially on the regions of this study. The greatest effect will be to increase similarities within the regional groups while maximizing between group differences. For example, the mountainous regions of the northeast and southwest are to undergo an extensive program of reforestation and the elimination of burnt-field farming which will practically eliminate internal differences. At the same time the plan calls for the continued and almost singular advancement of intensive agriculture in the regions of the western hills and plains, largely at the expense of marginal forest land and barrens. This specialization, complementarity and interdependence in the land use regions will place far greater demands on government planning, control and transportation development than have existed previously.

The National Land Development Plan appears to recognize many of the regional strengths discussed in this study, but it does not employ the same regional structure. It divides the country into 17 "sub-regions" which have the potential for becoming functional "economic spheres," and which are further grouped to form eight named regions which are the bases of current development planning. Each region is organized to achieve functional balance and logically includes a wide range of

uses. The development regions are divided along provincial and traditional sub-provincial boundaries and bear no spatial resemblance to the land use regions proposed by this study (Figure 51).

Although this study made no attempt to name the regions nor to apply rigid labels to their composite land use attributes, the descriptions of the regions and an examination of the factor score matrix reveal their character. The research clearly indicates that despite the seemingly limited range in primary and secondary sector economic activities and the monotony of the rural landscape, there is substantial diversity in the regional land use characteristics. It also supports an earlier contention that past studies describing regions defined by single attributes, groups of closely associated attributes defined as "agriculture", or "climatic potential" were not representative of the regional complexities in Korea.

As such, this study presents an alternative to the various Korean regionalizations in existence, most of which did not have the benefit of comprehensive data and quantification techniques, nor of the synoptic view of space imagery. It is a first step toward the achievement of Korea's environmental overview, and it brings to mind a comment by Grigg that, "...the measure of success of a regional system is not the exactness of the boundaries delimited but the stimulus which the system provides in explaining the regional differences revealed by the system."[6]

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[6]David Grigg, "Regions, Models and Classes," in Models in Geography, ed. by Richard J. Chorley and Peter Haggett (London: Methuen & Co. Ltd., 1967), p. 495.

DEVELOPMENT PLAN REGIONS

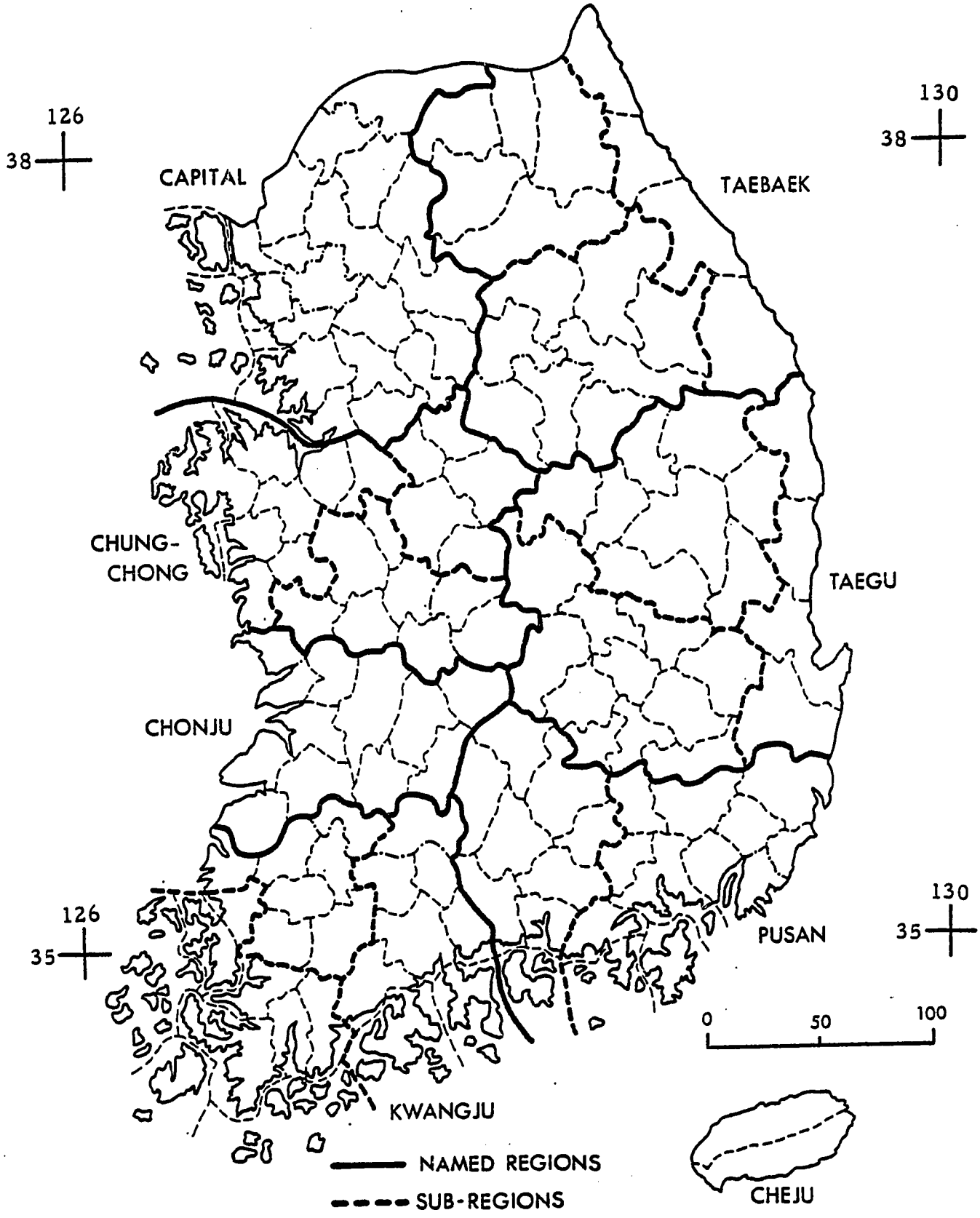

Figure 51

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APPENDIXES

APPENDIX A

LIST OF DATA CASES

Kangwon Province

1 Chorwon
2 Chongson
3 Chunsong
4 Hoengsong
5 Hongchon
6 Hwachon
7 Imje
8 Kosong
9 Myongju
10 Pyongchang
11 Samchok
12 Wonsong
13 Yanggu
14 Yongwol
15 Yangyang

Kyonggi Province

16 Ansong
17 Hwasong
18 Ichon
19 Kanghwa
20 Kapyong
21 Kimpo
22 Koyang
23 Kwangju
24 Paju
25 Pochon
26 Puchon
27 Pyongtaek
28 Sihung
29 Yangju
30 Yangpyong
31 Yoju
32 Yonchon
33 Yongin
34 Ongjin

South Chungchong Province

35 Asan
36 Chonwon
37 Chongyang
38 Hongsong
39 Kongju
40 Kumsan
41 Nonsan
42 Poryong
43 Puyo
44 Taedok
45 Tangjin
46 Sochon
47 Sosan
48 Yesan
49 Yongi

North Chungchong Province

50 Chechon
51 Chinchon
52 Chongwon
53 Chungwon
54 Koesan
55 Okchon

APPENDIX A--Continued

56 Poun
57 Tanyang
58 Umsong
59 Yongdong

North Kyongsang Province

60 Andong
61 Chilgok
62 Chongdo
63 Chongsong
64 Dalsong
65 Koryong
66 Kumryung
67 Kunwi
68 Kyongsan
69 Mungyong
70 Ponghwa
71 Sangju
72 Songju
73 Sonsan
74 Uisong
75 Ulchin
76 Wolsong
77 Yechon
78 Yongchon
79 Yongdok
80 Yongil
81 Yongju
82 Yongyang

South Kyongsang Province

83 Changwon
84 Changyong
85 Chinyang
86 Hadong
87 Haman
88 Hamyang
89 Hapchon
90 Kimhae
91 Kochang
92 Koje
93 Kosong
94 Milyang
95 Namhae
96 Sachon
97 Sanchong
98 Tongnae
99 Tongyong
100 Uiryong
101 Ulchu
102 Yangsan

North Cholla Province

103 Changsu
104 Chinan
105 Chongup
106 Iksan
107 Imsil
108 Kimje
109 Kochang
110 Muju
111 Namwon
112 Okku
113 Puan
114 Sunchang
115 Wanju

South Cholla Province

116 Changhung
117 Changsong
118 Chindo
119 Haenam
120 Hampyong
121 Hwasun
122 Kangjin
123 Kohung
124 Koksong
125 Kurye
126 Kwangsan
127 Kwangyang
128 Muan
129 Naju
130 Posong
131 Sungju

APPENDIX A--Continued

132 Tamyang
133 Wando
134 Yochon
135 Yongam
136 Yonggwang
137 Sinan

Cheju Province

138 Puk Cheju
139 Nam Cheju

Special Cities

140 Seoul
141 Pusan

APPENDIX B

LOADING ORDER OF VARIABLES ON ORTHOGONAL FACTORS

	Variables[a]	Orthogonally Rotated Factors									
		F1	F2	F3	F4	F5	F6	F7	F8	F9	h^2
18.	Rice	.95	.00	.05	.13	-.05	.03	.01	.17	-.11	.96
7.	Paddy field	.95	.00	.05	.13	-.04	.03	.01	.18	-.12	.96
11.	Irrigated paddy	.94	-.02	-.06	.16	-.07	-.04	.03	.15	-.07	.95
17.	Farm households	.85	.07	.36	.06	.22	-.11	.03	.07	.06	.93
21.	Wheat	.49	-.09	-.08	.14	.48	.38	.14	-.10	-.02	.69
23.	Corn	-.48	-.14	.06	-.05	-.33	.04	.45	-.03	-.12	.59
20.	Naked barley	.47	.02	.46	-.27	.05	-.47	-.06	-.22	.16	.81
4.	Population	-.02	.98	-.02	.02	-.03	-.05	.00	.10	-.01	.98
3.	Households	-.03	.98	-.02	.03	-.03	-.05	.00	.10	-.01	.98
1.	Urban area	-.05	.97	-.03	.12	-.04	-.06	.00	.10	.00	.97
2.	Villages	.19	.92	.06	-.10	-.08	-.02	.02	.06	-.03	.91
5.	Paved road	-.14	.55	-.06	.45	-.09	.06	-.03	.42	.01	.72
8.	Upland field	.30	-.07	.84	-.01	.16	.21	.17	.05	.04	.91
21.	Millet	-.09	-.04	.75	-.12	.05	-.24	-.10	-.11	.04	.67
30.	Reclaimed	.18	.08	.54	.20	-.31	.00	-.43	.09	.19	.70
12.	Tree fruit	.12	.11	-.02	.86	.12	.01	-.04	.23	.14	.85
9.	Permanent crops	.25	.04	-.06	.82	.08	.15	-.04	.14	.17	.82
29.	Water bodies	.44	.04	.05	.59	.14	-.12	.13	-.17	-.20	.66
26.	Coniferous forest	-.13	-.03	.15	-.07	.73	-.25	-.07	-.08	-.19	.69
16.	Draft cattle	.25	-.19	.21	.18	.73	.15	-.07	.00	.25	.80
19.	Common barley	-.03	-.09	-.29	.39	.66	.22	-.05	.09	-.08	.75
27.	Mixed forest	-.03	-.02	-.25	.03	.16	.81	-.11	-.06	.01	.76

APPENDIX B--Continued

Variables[a]	Orthogonally Rotated Factors									
	F1	F2	F3	F4	F5	F6	F7	F8	F9	h^2
24. Red beans	-.03	-.11	.23	.02	-.12	.69	.26	.03	-.10	.64
14. Burnt-field	.14	.06	-.03	.02	-.06	.09	.83	.01	.11	.74
13. Vinyl houses	.23	.15	-.22	-.05	.14	-.16	.04	.74	.11	.74
25. Cabbage	.32	.17	.14	.23	-.11	.12	.05	.74	-.20	.82
15. Dairy-beef	-.04	.51	.11	.13	-.15	.04	-.12	.61	-.07	.70
6. Railroad	.17	.50	-.20	.19	-.01	.03	.10	.54	.04	.66
28. Nonstocked forest	-.24	-.14	-.07	-.04	.04	-.18	.21	.01	.72	.68
31. Nonforested	-.04	.11	.33	.19	-.11	.04	-.04	-.11	.60	.55
10. Pasture	.06	-.04	.05	.14	-.02	.02	-.19	.47	.48	.52

[a]Short names.

APPENDIX C

FACTOR SCORES

Region/ Cases	F1	F2	F3	F4	F5	F6	F7	F8	F9
REGION 1									
1	-0.78	-0.58	-1.07	-0.23	-2.23	-0.79	-0.46	-0.48	-0.43
6	-1.26	-0.46	-0.88	-0.39	-2.03	0.18	0.40	-0.53	-0.71
7	-1.37	-0.54	-1.15	-0.30	-1.96	-1.01	-0.38	-0.46	-0.80
8	-0.70	-0.43	-1.18	-0.32	-1.80	-0.43	-1.36	-0.64	-0.59
13	-1.30	-0.44	-0.49	-0.31	-1.52	-0.33	0.12	-0.37	-0.90
15	-0.83	-0.34	-1.01	-0.40	-1.30	-0.38	-1.18	-0.46	-0.56
32	-0.73	-0.39	-1.12	-0.65	-1.44	0.07	0.12	-0.18	0.05
REGION 2									
3	-1.47	-0.15	0.31	0.14	-0.91	0.51	0.95	0.01	-0.55
4	-0.71	-0.58	0.95	0.25	-1.32	0.20	1.09	0.03	-0.86
5	-1.51	-0.39	-0.06	-0.01	-1.20	0.00	0.35	-0.26	-1.02
9	-0.97	-0.16	-0.45	-0.22	-0.58	-0.55	-0.03	-0.20	-0.75
10	-2.00	-0.74	0.44	-0.01	-1.61	-0.31	1.33	0.08	-1.25
11	-1.42	-0.30	-0.11	-0.29	-0.99	-0.73	-0.34	-0.18	-0.57
20	-1.34	-0.29	-0.38	-0.06	-0.69	-0.05	0.48	-0.14	-0.26
25	-1.09	-0.28	0.29	0.02	-0.07	-0.24	0.08	0.54	0.08
60	-1.14	-0.32	0.65	-0.16	1.52	-1.17	-0.22	0.02	-1.08
70	-1.25	-0.30	0.41	-0.27	0.34	-0.67	0.81	-0.01	-1.09
75	-1.05	-0.34	-0.43	-0.48	-0.40	-0.61	-0.70	-0.45	-0.85
79	-1.05	-0.26	-0.18	0.02	0.19	-0.69	-1.06	-0.47	-0.88
81	-0.40	-0.26	0.37	0.88	-0.02	-0.37	-0.34	-0.07	-0.62
82	-1.32	-0.30	0.24	-0.40	0.19	-0.51	-0.42	-0.31	-0.65

APPENDIX C--Continued

Region/ Cases	F1	F2	F3	F4	F5	F6	F7	F8	F9
REGION 3									
2	-1.80	-0.46	0.11	-0.13	-1.33	-0.72	3.36	0.01	-0.32
12	-0.90	-0.03	0.01	0.43	-1.12	0.84	1.31	-0.30	1.77
14	-1.82	-0.48	0.02	-0.30	-1.04	-0.33	2.86	0.03	0.46
30	-0.59	-0.29	-0.53	-0.14	-0.81	-0.17	1.70	-0.06	0.35
57	-1.36	-0.14	0.20	-0.44	0.00	0.56	2.81	-0.24	0.81
REGION 4									
16	0.46	-0.37	0.65	1.05	-0.78	1.59	-1.73	0.88	0.44
18	1.04	-0.15	0.23	0.41	-1.15	2.09	-0.76	-0.13	-0.25
31	0.35	-0.11	-0.54	-0.34	-1.01	1.82	-0.04	-0.40	0.58
33	0.04	-0.18	0.06	-0.03	-0.57	1.18	-0.61	0.17	-0.46
37	-0.01	-0.03	-0.29	-0.73	0.66	-0.01	-0.34	-0.42	-0.62
39	-0.05	0.03	-0.34	-0.70	0.34	1.26	-0.48	-0.51	-0.15
40	-0.11	0.11	-0.56	-1.29	-0.06	2.38	-0.49	-0.51	0.24
42	0.31	0.19	-0.28	-0.73	0.22	-0.05	-0.15	-0.31	-0.38
43	1.14	-0.09	-0.70	-0.46	-0.42	0.39	-0.44	-0.53	-0.29
44	-0.32	0.70	-0.24	1.02	0.40	0.25	-0.52	1.29	0.53
49	0.62	0.20	-0.28	-0.07	0.02	2.74	-0.46	0.33	0.11
50	-0.92	-0.08	0.41	-0.28	0.15	1.94	1.17	-0.26	-0.26
51	0.46	-0.05	0.13	0.02	-0.29	2.72	0.01	-0.88	-0.22
52	0.42	0.13	0.39	0.31	0.28	2.94	0.34	0.26	0.60
53	-0.45	-0.17	0.23	0.50	0.53	1.50	0.78	-0.33	-0.19
54	-0.53	-0.10	0.47	-0.45	0.60	2.03	1.64	-0.44	-0.14
55	-0.21	0.16	0.11	0.44	1.29	1.92	0.48	-0.47	0.71
56	-0.32	-0.07	0.43	-0.63	0.95	2.20	1.14	-0.48	-0.01
58	0.32	-0.14	0.45	0.73	0.08	1.64	0.93	-0.47	-0.37

Region/ Cases	F1	F2	F3	F4	F5	F6	F7	F8	F9
REGION 5									
61	-0.50	-0.02	-1.12	2.16	0.40	0.45	-1.25	0.67	0.46
62	-0.58	-0.30	-0.81	1.16	1.44	-1.04	0.24	-0.43	-0.31
63	-1.18	-0.07	0.15	1.06	0.18	-0.79	-0.89	-0.58	-1.23
64	0.36	-0.16	-0.74	0.44	1.58	0.77	-1.02	-0.20	-0.41
65	0.06	-0.20	-0.77	-0.26	1.55	0.39	-0.88	-0.21	-0.31
66	-0.02	0.02	-1.03	0.29	0.74	1.32	-0.91	-0.44	0.08
67	-0.82	-0.30	-0.71	0.61	1.31	-0.40	-0.53	-0.19	-0.53
69	-0.59	-0.09	-0.30	-0.42	0.38	0.51	-0.72	-0.50	0.11
71	0.35	-0.06	-0.43	-0.13	0.49	1.51	-0.60	-0.73	-0.16
72	0.31	-0.14	-0.82	0.09	0.84	1.48	-1.04	-0.65	0.39
73	0.46	-0.07	-1.05	0.47	0.67	1.06	-0.94	-0.45	0.11
74	-0.18	-0.20	-0.61	0.32	1.11	-0.06	-0.03	-0.51	1.25
76	-0.14	-0.25	-1.09	0.99	1.06	-0.56	1.14	-0.05	1.59
77	0.16	-0.12	0.55	-0.46	0.97	0.90	-0.53	-0.21	-0.28
78	-0.46	-0.37	-0.47	1.67	1.08	-0.36	-1.05	-0.52	0.05
80	-0.17	-0.10	-0.77	-0.21	0.58	0.43	-0.67	-0.60	-0.32
83	0.42	0.38	-0.86	0.02	1.06	-0.57	0.14	0.39	-0.03
84	0.50	-0.16	-0.35	0.67	2.33	0.44	0.40	-0.38	-1.08
85	0.32	-0.63	-0.87	-1.10	1.90	-0.33	-1.08	3.07	1.71
87	0.60	-0.21	-0.61	1.49	2.28	-0.18	0.44	-0.56	-1.10
89	-0.32	-0.17	-0.83	-0.49	1.52	0.26	-1.07	-0.43	-0.84
94	0.24	-0.39	-1.22	0.00	2.19	-0.80	0.42	1.28	-0.17
98	-0.08	-0.20	-0.73	-0.19	-0.56	-0.61	-1.13	0.78	0.16
100	-0.49	-0.22	-0.16	-0.01	2.64	-0.66	-0.38	-0.08	-0.86
101	-0.32	-0.02	-0.89	0.16	0.48	-0.03	0.13	-0.01	-0.27
102	-0.54	-0.51	-1.28	-0.45	-0.80	-0.02	-1.91	1.98	1.73

APPENDIX C--Continued

Region/ Cases	F1	F2	F3	F4	F5	F6	F7	F8	F9
REGION 6									
17	0.67	-0.11	1.17	1.20	0.03	1.09	-0.19	1.37	-0.94
19	1.19	-0.35	-0.49	-0.40	-0.82	-0.57	-0.70	-0.11	-0.68
21	1.31	-0.57	0.07	0.57	-1.33	0.15	-0.69	0.62	-0.76
27	1.45	-0.06	0.88	0.86	-0.53	0.88	2.67	2.12	-0.24
34	-1.49	-0.23	1.86	-1.09	0.58	2.19	0.46	0.21	-1.70
35	1.23	-0.24	0.16	1.78	0.43	0.20	0.32	0.09	-0.60
36	-0.02	0.09	0.20	1.21	0.02	1.23	-0.09	1.20	0.03
38	0.64	-0.19	0.54	0.82	1.27	1.03	0.08	0.38	-0.13
45	1.26	-0.30	0.35	0.35	-0.03	0.36	1.83	0.79	-0.06
47	0.16	-0.25	0.51	0.23	0.79	-0.22	1.15	0.47	-0.20
48	0.86	-0.19	0.43	2.03	-0.05	0.60	-0.68	0.03	-0.07
REGION 7									
41	1.94	0.60	-0.06	-0.23	-0.70	1.24	1.84	-0.63	1.04
46	2.63	0.34	-0.65	-0.49	-0.26	-0.10	1.40	-0.98	-0.26
106	3.17	0.30	-0.52	-0.15	-1.11	-0.54	4.09	-0.13	0.10
108	3.39	-0.22	-0.33	1.05	-2.59	-0.25	-1.31	-0.32	0.50
112	2.88	0.27	-1.37	-0.29	-2.14	-1.21	0.12	-0.13	-0.96
113	1.90	0.18	0.44	0.14	-1.34	-0.41	0.54	-1.55	1.28
REGION 8									
59	-0.73	0.05	-0.67	-0.06	0.23	0.72	0.12	-0.34	0.94
86	0.13	-0.22	-0.48	-0.13	0.38	-0.72	-0.48	-0.53	-0.19
88	-0.41	-0.30	-0.88	-0.19	0.48	-0.70	0.31	-0.48	0.37
91	-0.28	-0.21	-1.21	-0.32	0.63	0.43	0.64	-0.45	1.18
97	-0.47	-0.37	-1.16	-0.08	0.32	-0.68	-0.79	-0.49	0.38
103	-0.43	-0.27	-0.75	-0.72	0.04	-0.83	0.70	-0.41	1.61

APPENDIX C--Continued

Region/ Cases	F1	F2	F3	F4	F5	F6	F7	F8	F9
REGION 8									
104	-0.63	-0.21	-0.19	-0.49	-0.68	-0.01	-0.87	-0.63	0.63
107	-0.12	-0.24	-0.93	-0.79	-0.41	-0.16	1.15	-0.31	2.35
110	-0.87	-0.20	-0.45	-0.48	-0.16	-0.00	0.29	-0.45	0.04
111	0.53	-0.06	-0.69	-0.61	-0.60	0.05	-1.01	-0.61	1.15
114	0.08	-0.14	-0.40	-0.09	0.05	-0.24	0.69	-0.73	0.84
115	0.23	0.01	-0.43	0.73	-0.73	-1.01	0.30	-0.51	0.65
124	0.16	-0.08	-0.32	-0.45	0.13	-0.50	-0.84	-0.73	0.46
125	0.02	-0.22	-0.88	-0.45	-0.31	-0.93	-0.53	-0.71	-0.00
127	0.11	-0.46	-1.21	0.57	0.23	-2.08	0.17	0.21	1.16
131	0.17	-0.14	-0.77	-1.08	0.68	-1.81	0.34	0.63	0.95
REGION 9									
105	1.61	0.14	-0.16	-0.54	-0.47	0.22	-0.16	-0.62	-0.28
109	0.99	0.07	0.94	0.04	0.00	-0.83	0.31	-0.77	-1.11
116	0.55	-0.06	-0.29	-0.89	-0.28	-0.91	-0.14	-0.76	0.82
117	0.62	-0.01	-0.05	-0.27	-0.25	-0.49	-0.51	-0.39	-0.16
121	0.01	-0.11	0.22	-0.59	-0.99	-0.27	-1.20	-0.40	0.18
122	1.19	-0.10	0.25	-0.72	-0.01	-1.27	-0.47	-0.77	-0.08
126	1.34	0.76	0.02	0.09	-0.87	-0.41	-0.48	0.38	0.27
129	1.55	-0.01	1.74	1.33	-0.59	-1.01	-0.50	-0.46	-0.62
130	0.78	0.01	-0.46	-0.75	-0.01	-1.04	0.16	-0.12	-0.01
132	0.95	-0.02	-0.14	-0.45	-0.31	0.00	-0.96	-0.89	0.09
135	0.98	-0.05	1.45	0.18	-0.47	-1.03	-0.32	-0.95	-0.73
136	1.05	0.05	1.71	-0.29	-0.45	-0.82	-0.84	-0.82	-0.72
REGION 10									
92	0.09	-0.03	-0.13	-0.97	0.81	-0.58	0.13	-0.36	0.24
93	0.42	-0.15	-0.01	-0.45	1.57	-1.15	-0.40	-0.45	-0.10

APPENDIX C--Continued

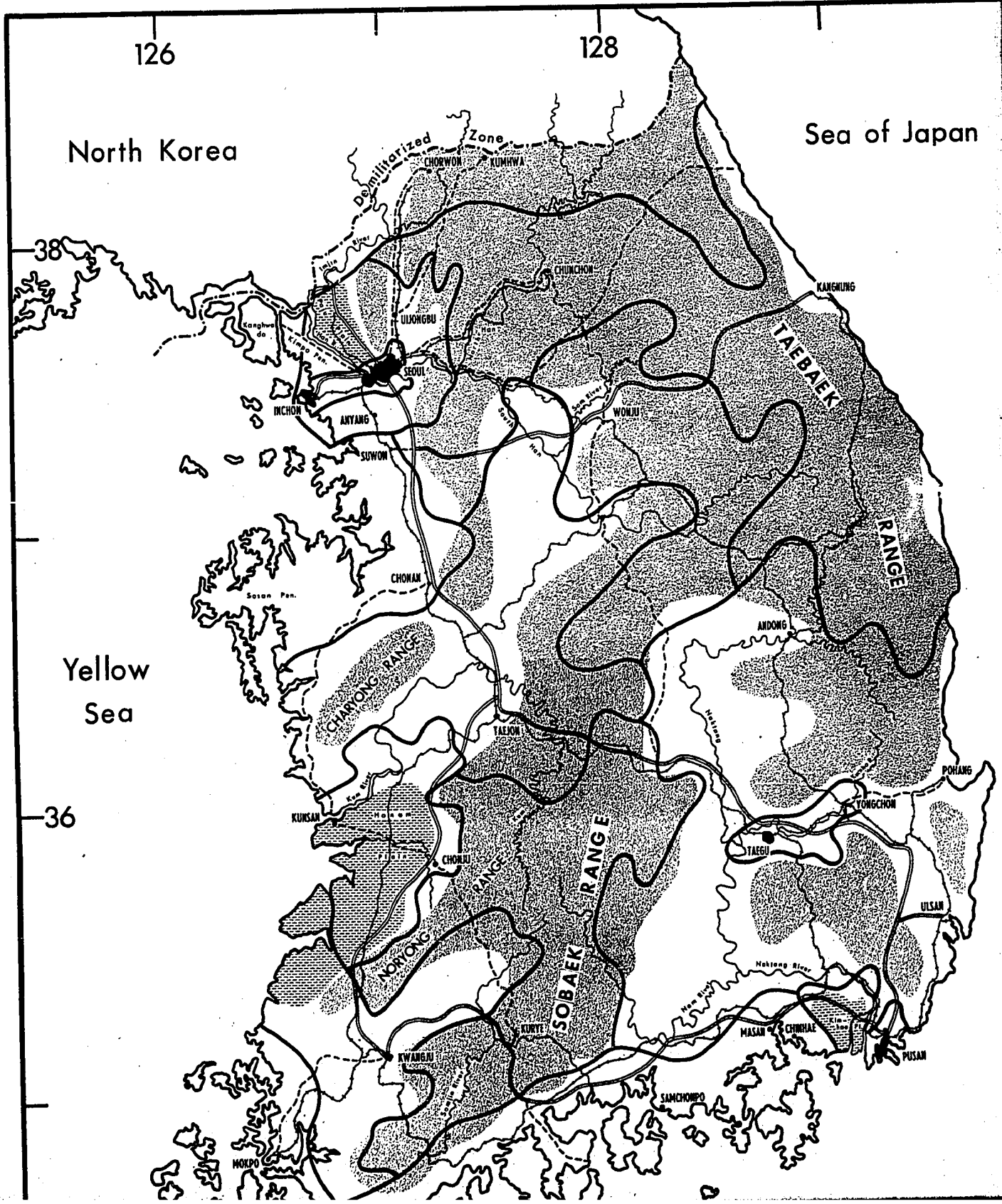
Region/ Cases	F1	F2	F3	F4	F5	F6	F7	F8	F9
REGION 10									
95	0.82	0.12	0.45	-1.29	1.27	-0.62	-0.60	-0.64	0.24
96	1.04	-0.06	-0.31	-0.52	0.80	-1.15	0.10	-0.24	0.15
99	0.03	0.32	1.54	-1.07	1.18	-0.21	0.33	-0.27	0.80
118	-0.28	-0.08	1.96	-0.52	0.22	-1.40	-0.04	-0.57	-0.32
119	0.58	0.08	1.97	-0.25	0.06	-1.22	0.23	-1.04	0.15
123	0.62	0.05	0.91	-1.10	0.86	-1.04	0.40	-0.67	-0.27
133	-0.30	0.18	2.43	-1.06	0.91	-1.16	0.36	0.43	-0.45
134	0.27	0.29	1.51	-0.99	1.54	-1.13	1.20	0.13	0.12
REGION 11									
120	1.20	0.13	3.53	-0.48	0.33	-0.93	-0.31	-0.61	-0.52
128	0.56	0.40	4.12	-0.72	0.07	0.04	-0.84	0.52	-0.67
137	-0.12	-0.02	2.94	-1.03	0.19	-0.68	-0.68	-0.26	-0.66
REGION 12									
138	-1.49	-0.51	2.28	-0.50	1.17	-1.27	0.23	1.20	4.52
139	-1.28	-0.10	3.25	2.44	-1.64	0.02	-2.15	-0.94	6.53
REGION 13									
68	-0.54	1.42	-0.60	8.08	0.41	-1.92	1.34	-0.74	-0.87
REGION 14									
90	1.47	-0.42	-2.13	-0.88	0.78	-1.05	1.52	5.15	1.39
REGION 15									
141	-0.74	5.40	-0.04	-1.67	0.37	-0.27	-0.76	0.19	0.10

APPENDIX C--Continued

Region/ Cases	F1	F2	F3	F4	F5	F6	F7	F8	F9
REGION 16									
22	0.80	-0.46	0.40	-0.53	-1.55	0.02	-0.42	5.19	-0.69
23	-0.63	-0.33	0.30	-0.45	-0.78	0.79	-0.97	1.41	-0.91
24	-0.13	-0.28	0.06	-0.49	-0.38	0.18	-0.52	1.38	-1.20
26	-0.49	1.31	1.04	1.60	-1.10	-0.13	-1.31	2.65	-0.96
28	-0.43	0.11	0.65	0.20	0.10	-0.83	-0.24	3.37	-1.78
29	-1.15	0.07	0.83	0.65	-0.94	0.44	-0.79	2.53	0.13
REGION 17									
140	-1.06	9.72	-0.37	-0.48	-0.62	-0.04	0.25	0.19	0.09

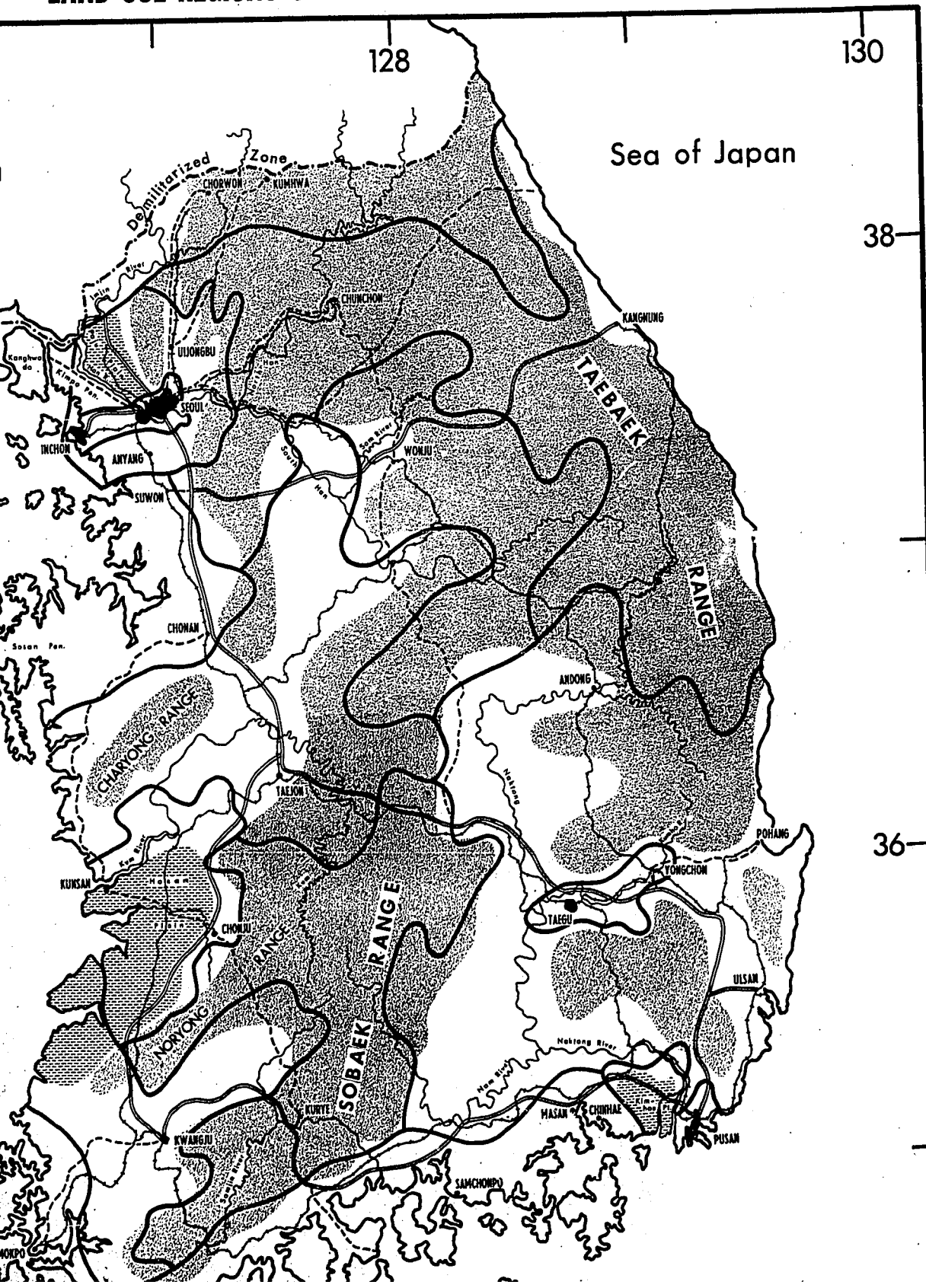
APPENDIX D

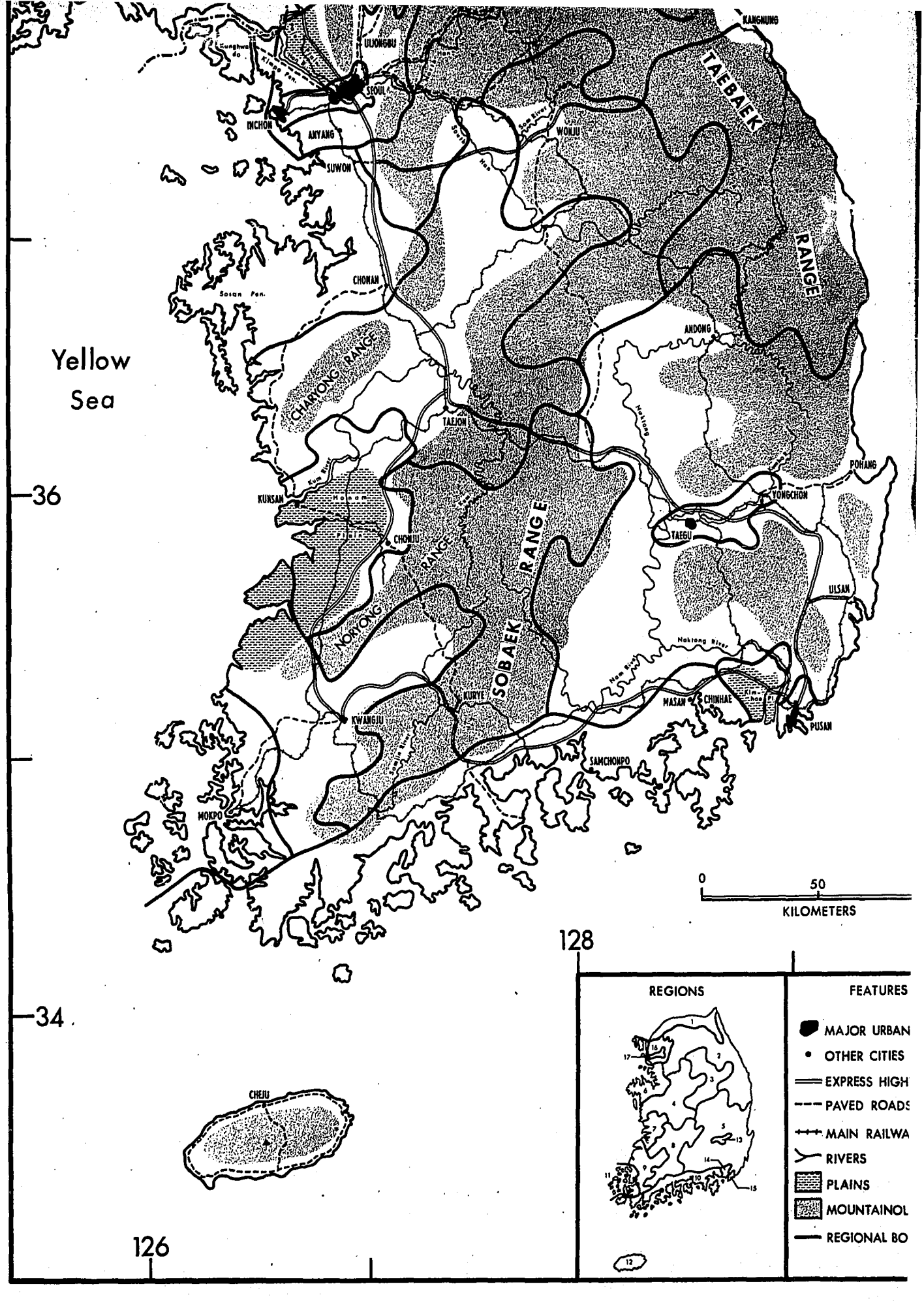
LAND USE REGIONS OF THE REPUBLIC OF KOREA



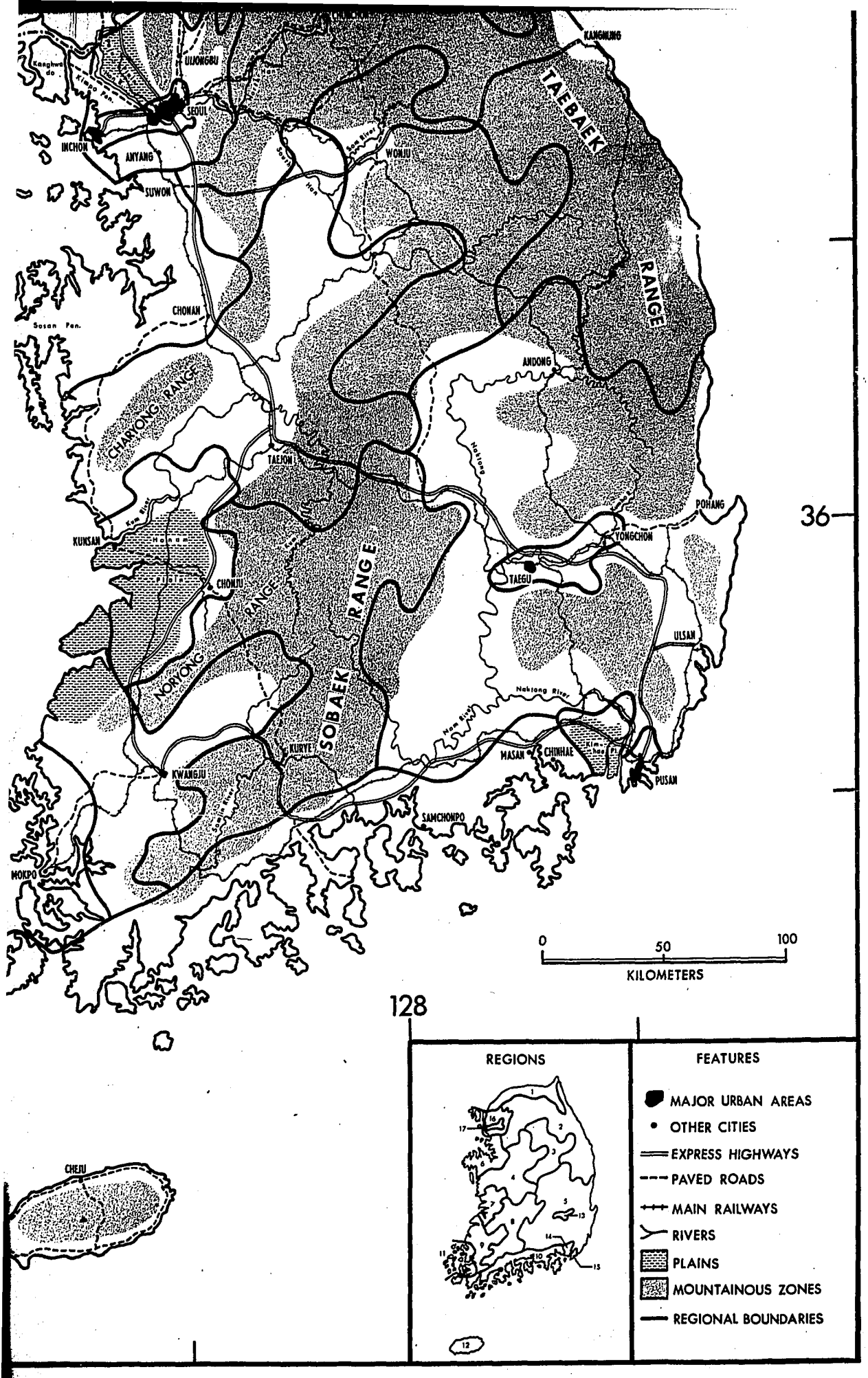
APPENDIX D

LAND USE REGIONS OF THE REPUBLIC OF KOREA





7L7-0166-25-27 Oct. 1976


KANGNUNG
TAEBAEK RANGE
ULJONGBU
SEOUL
INCHON
ANYANG
SUWON
WONJU
Han River
CHONAN
Sosan Pen.
ANDONG
CHARYONG RANGE
TAEJON
Naktong
POHANG
YONGCHON
KUNSAN
Geum River
CHONJU
TAEGU
ULSAN
NORYONG RANGE
SOBAEK RANGE
Nakiang River
Nam River
MASAN
CHINHAE
KURYE
PUSAN
KWANGJU
Yosan River
SAMCHONPO
MOKPO
CHEJU
0
50
100
KILOMETERS
36
128
REGIONS
FEATURES
MAJOR URBAN AREAS
OTHER CITIES
EXPRESS HIGHWAYS
PAVED ROADS
MAIN RAILWAYS
RIVERS
PLAINS
MOUNTAINOUS ZONES
REGIONAL BOUNDARIES