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Philippine Geographical Journal, Vol. 36, Nos. 3 & 4
(July-December, 1992)

EDITORIAL

REMOTE SENSING AND GEOGRAPHIC INFORMATION SYSTEM TECHNOLOGIES IN THE PHILIPPINES

Resource information systems involve the inventory, mapping and monitoring of the earth's atmosphere and land and water surfaces. Such systems provide information that will facilitate better management of resources as well as improve the long-term maintenance of the environment. The information gathered have become increasingly more significant in modern society. They are particularly relevant to government policy-makers who are constantly faced with the dynamics of change and the urgent need for better prediction, planning and management of the environment and scarce resources of their country. The increasing importance of information as a production factor supports the observation that the demand for spatially referenced information will increase.

The sciences involved in the acquisition, processing and interpretation of these information include Remote Sensing (RS) and Geographic Information Systems (GIS). These technologies themselves depend mainly on the physical, mathematical and statistical sciences; however, their application is dependent on the different biological, geographic and environmental sciences. RS is concerned with the collection of data using sensing devices (censors) that are not in contact with the object being sensed. The sensors include radar, multispectral scanners, or radiometers mounted on platforms such as aircrafts and satellites. The quantum leap in the development of satellite technology and digital image processing techniques has made RS a highly efficient means of collecting information on the terrain of an area, the availability and status of its natural resources, and the extent to which the environment has been altered by human activity. On the other hand, the growing demand for increasingly complex spatial data requires an appropriate management system, or GIS, for their collection, processing, manipulation and presentation for users such as planners, researchers and administrators. GIS integrates attributes or textual data with geographic or spatial information from various sources into a computer-based system. In computer science jargon RS and GIS would refer respectively to the hardware and software components of a resource information system.

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try to be innovative at least in the creation of software, if not in the production of hardware. The advanced countries should help in establishing high quality facilities and in providing high quality training that will allow the adaptation of the new technology in developing countries. After all, helping protect and manage the resources and environment of Third World countries will go a long way towards creating an ecologically sound global environment to which the First World countries also belong.

MELITON B. JUANICO

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Philippine Geographical Journal, Vol. 36, Nos. 3 & 4
(July-December, 1992)

ARTICLES

THE AURORA COMPUTERIZED ENVIRONMENTAL INFORMATION SYSTEM*

Trevor M. Dibb**

ABSTRACT. Aurora Province is one of the few remaining thickly forested provinces in the Philippines with 78 percent of its total land area of 313,800 hectares occupied by woodlands with abundant natural resources. However, these resources are actively threatened by deforestation and consequential degradation due to illegal logging, swidden agriculture, charcoal making and other destructive human activities. The sustainable development of this province, therefore, lies in the implementation of programs that involve the rational and efficient management of its rich natural resources. Relative to this is the need for the establishment of a comprehensive, low-cost and manageable environmental information system as a necessary tool to ensure that all development programs in the province operate within the acceptable limits of the available resources and environment. The experience of Aurora Province in establishing and maintaining such environmental information system is hereby presented to serve as basis for other provinces bearing similarities with the Aurora environment.

BACKGROUND OF DEVELOPMENT

The Aurora Computerized Environmental Information System (ACEIS) was commissioned by the Aurora Integrated Area Development Project (AIADP), a project funded by the Philippine government and the Delegation of the European Communities, in its pursuit of its goals of promoting socioeconomic development through the rational use and sustainable management of the natural resources and environment of Aurora Province. The system is loosely based on the principles of a Geographic Information System of presenting spatially related data in tabular and map forms. To date, ACEIS is used by the Aurora IAD (Integrated Area Development) Project as a tool in decision making, planning and monitoring activities for the development, protection and/or rehabilitation of Aurora's 303 watershed sub-groups in the context of sustained economic growth of the province.

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* Condensed report of a two-month consultancy with the Aurora Integrated Area Development Project for the establishment of a computerized environmental information system for Aurora.

** Trevor M. Dibb, (BSc Geology and Cartography, Oxford Polytechnic, UK) is an Information System Specialist developing appropriate level information management systems for earth science-related studies and integrated area development projects. His fields of expertise include systems for watershed management and planning, monitoring resource and environmental change using remote sensing techniques and GIS applications.

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Prior to the development of the system, a series of surveys was carried out by the AIADP in order to gain an overall appreciation of the natural resources within Aurora and to identify the current levels of environmental degradation in the province. These surveys included the identification of the following:

i) the hydrology of the province (including identification of watershed boundaries)
ii) the total forest cover (and constituent forest types)
iii) other land areas, e.g., grassland, shrubland, paddy
iv) areas of soil erosion and landsliding
v) topography
vi) infrastructure (e.g., roads, irrigation schemes, reservoir schemes) including an assessment of watersheds which have impact on structures
vii) terrain units
viii) existing land use
ix) legal land status

These data were derived from extensive field survey programmes, interpretations of aerial photographs[1] and 1987 SPOT satellite images, and derivations from previous studies. The end result has been the creation of a large amount of information pertaining to the current environmental status of Aurora.

The overall objective of the Aurora IAD Project was to assimilate these data into policy recommendations, both on a provincial and individual watershed basis. This involves analyzing provincial trends as well as identifying individual watersheds where environmental degradation through inappropriate land management techniques has become serious enough to warrant the implementation of remedial rehabilitation schemes. Since manual assimilation of voluminous data is slow, cumbersome and in many cases simply not possible especially for map overlaps and temporal data analysis, there was a felt need for the establishment of an easy-to-use computerized environmental information system to allow the storage, retrieval, analysis and display of the wealth of environmental information collected by AIADP. In effect, the Aurora computerized environmental information was devised in order to:

i) provide an easy-to-use management tool as an aid to the decision making process regarding environmental protection within Aurora Province;

ii) provide a rapid implementation of the system to allow management decisions regarding environmental protection to be made in the short term;

[1] The AIADP employed the services of the Philippine Airforce in 1989 to conduct aerial photography of Aurora at a cost of ₱320,000, the output of which are photos of monochrome vertical stereoscopic cover at scales of 1:24,000-1:27,000.

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iii) provide a temporal monitoring facility allowing the input of updated data as well as the facility to monitor the rate of degradation or rehabilitation; and

iv) provide visual aids in the form of tabulated and map output for the effective demonstration of trends identified in the data.

OVERVIEW OF THE SYSTEM'S DEVELOPMENT AND DESIGN

Overall, the Aurora computerized environmental information system was developed in a period of nine months and involved the following stages and methodologies:

Stages	Methodologies	Duration (man months)
— Data collection	Manual	1 month
— Data compilation	Manual	5 months
— Data entry	Computerized	1 month
— System development	Low-level GIS	2 months

Data classification on a watershed or grid square basis was carried out manually, with data entered on tally sheets for subsequent keyboard entry to the database system. This basis for data entry is perhaps the most time and cost effective method in the context of Aurora where there is no shortage of staff to carry out the manual data collection and entry. It also obviates the need for expensive digitizing tables, good quality base maps (for digitizing off) and the time required for the development of digitizing software.

Although the system cannot be described as a Geographic Information System, sensu stricto, it does contain much of the functionality of a GIS without the high investment cost and implementation delays traditionally associated with GIS developments. Furthermore, the system has been designed for effective use by non-specialists; users can make effective use of the system with only a week's training.

SYSTEM'S ATTRIBUTES AND FUNCTIONS

The ACEIS stores georeferenced environmental data for the Province on either a watershed or 1sq.km. grid square basis. The data are stored using the dBASE IV database management software package and are mapped using either Info-Map or Autocad mapping software. Figure 1 provides an overview of the system. A set of dBASE IV application programs have been written which provide user-friendly, menu driven access to the system allowing search, retrieval, analysis and mapping of the data by non-specialists. Also included are data editing facilities and system management routines. The following software has been used to develop the system:

Database management	dBASE IV

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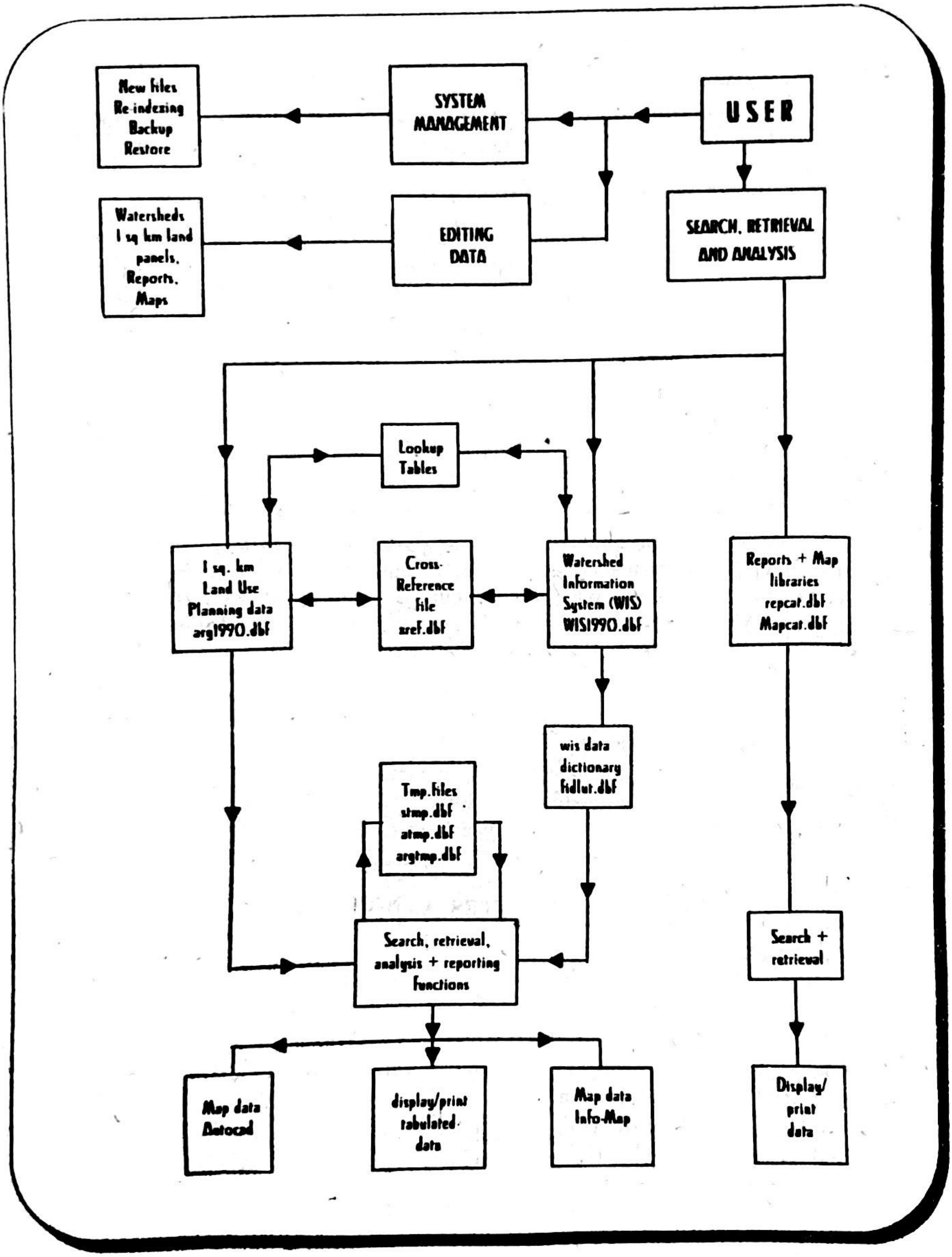

FIG. 1. OVERVIEW OF AURORA COMPUTERIZED INFORMATION SYSTEM

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Mapping/plotting of watershed data	Info-Map/Pizzaz Plus
Mapping/plotting of 1sq.km. grid data	Autocad

Together with the Watershed based information system (WIS) and the 1sq.km. grid cell based information system (LUPPIS), ACEIS also incorporates inventories of the report and map libraries (MAPCAT, REPCAT) at the Watershed Office in Baler. It has also a system for tabulating socioeconomic data for the conduct of watershed resource profiling.

The major system functions are as follows:

1. Allows a convenient and practical method of integrating, storing and revising the large amount of environmental data gathered by the Watershed Component Study.
2. Search, retrieval and analysis of data on a watershed or 1sq.km. grid cell basis.
3. Mapping and plotting of data in colour or monochrome.
4. Editing of data as improved information is gathered.
5. The facility to create and edit new data files from existing data. This allows a temporal monitoring facility with data for individual years being stored in separate data files.

SYSTEM'S COST

The total capital cost for the hardware and software for the ACEIS varies on the speed of computer systems used and the desired level of sophistication. At present, the information system is installed in a high speed and a low speed AT-type desktop computer systems with the following configurations, costs and attributes:

PARTICULARS	HIGH SPEED		LOW SPEED	
	Item description/attributes	COST (P)	Item description/attributes	COST (P)*
Computer System Attributes	IBM-AT Type -803865 MHz processor -80387 co-processor 640kb + 3072kb extended memory -EGA-VGA monitor -LQ 2550 dot matrix printer -Uninterruptible power supply & tape back-up facility -Automatic Voltage Regulator	159,000	IBM-XT(Turbo) Type -80286 16 MHz processor -80287 co-processor 640kb memory -EGA-VGA monitor -LQ 2550 dot matrix printer -Automatic Voltage regulator	86,600
Digitizer (Optional)	Model GT 1812	26,500		
Plotter (Optional)	Model DXY-1100	28,000		
Software	Info-Map/Pizzaz Plus	37,000	Info-Map/Pizzaz Plus	37,000
TOTAL		250,500		123,600

* Based on 1991 prices.

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It should be noted that the cost for the dBASE IV and Autocad software package is not included in the above computation as these were included in the computer hardware package.

THE SYSTEM'S COMPONENTS

The Aurora computerized environmental information system has four components, viz:

— Watershed Information System (WIS)
— Landuse Planning and Policy Information System (LUPPIS)
— Socio-Economic Tabulation System (SETS)
— Reports and Maps databases (REPCAT and MAPCAT)

THE WATERSHED INFORMATION SYSTEM (WIS)

The basic mapping unit for this system is a watershed as defined in the Hydrological report for Aurora Province (AIADP, 1989a). These are deemed the most suitable planning untis for which environmental protection and land use management policies can be formulated. Three hundred three (303) watersheds are contained within Aurora, consequently, there are 303 records in the database. There are 12 watersheds in the extreme southern part of the Province, whose affiliations are in dispute with the adjoining Quezon Province. Because of the sparseness of data held for these watersheds they are currently excluded from the database.

Basically, the WIS has the following capabilities:

— Stores bio-physical and resource data on a watershed sub-group basis.
— Allows easy access to that information by a wide variety of uses.
— Identify and ranks watershed sub-groups containing specified bio-physical and resource attributes.
— Models susceptibility of watershed sub-groups to environmental degradation and resource depletion.
— Displays and prints watershed sub-group information in a variety of tabular formats.
— Displays and prints maps showing the spatial variability of specified watershed attributes.
— Allows the easy update of watershed parameters as new and improved data become available.

Figure 2 shows the information stored by the WIS on a watershed sub-group basis.

Searches can be carried out on any data item combination (Figure 2) and results displayed, printed or mapped through the Info-Map mapping package. Data transferred into Info-Map can also be combined by numerous mathematical and statistical means and mapped accordingly.

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For the project and the province, the WIS has been useful, among others, in determining watershed sub-groups with high to low score of criticality measured in terms of land degradation, forest cover, hill farming density and logging road density, definite log ban areas and watershed reservations. Figures 3-5 are samples of map outputs from the WIS.

1990 DATA

GENERAL INFORMATION
1 Watershed number
2 Area (ha) within Aurora
3 Watershed map number
4 Municipalities
5 Cultural minority groups

GROUND CONDITIONS
6 Watershed classification
7 Watershed discharge classification
8 Percentage of slopes > 50%
9 Percentage of moderate-high erosion
10 Number of landslides in watershed
11 Area of landsliding in watershed

INFRA-STRUCTURE
12 Watershed impact on structures
13 Irrigated area within watershed
14 Provincial road density
15 Existing logging road density
16 Proposed logging road density

LEGAL LAND STATUS
17-28 to see descriptions

LANDFORM MAPPING UNITS
29-40 to see descriptions

CURRENT LAND USE
41-49 to see descriptions

RECOMMENDED LAND USE
50-67 to see descriptions

CHANGE OF LAND USE
68-69 to see descriptions

LAND COVER
70 Total forest cover BSWM study
71 Total forest cover RP-German Study
72 Mossy forest cover (RP-German)
73 Old growth cover (RP-German)
74 Mangrove cover (RP-German)
75 Residual forest cover (RP-German)
76 Total forest cover NAMRIA study
77 Mossy forest cover (NAMRIA)
78 Old growth cover (NAMRIA)
79 Mangrove cover (NAMRIA)
80 Residual forest cover (NAMRIA)
81 Grassland cover (BSWM study)
82 Grassland cover (NAMRIA study)
83 Shrubland cover (BSWM study)
84 Shrubland cover (NAMRIA study)
85 Hill Farming cover

CRITICAL WATERSHED INDEX
86 Critical watershed index score
87 Critical watershed index class

Enter a category to search on
(99 to quit)

FIGURE 2. INFORMATION STORED IN WIS DATABASE

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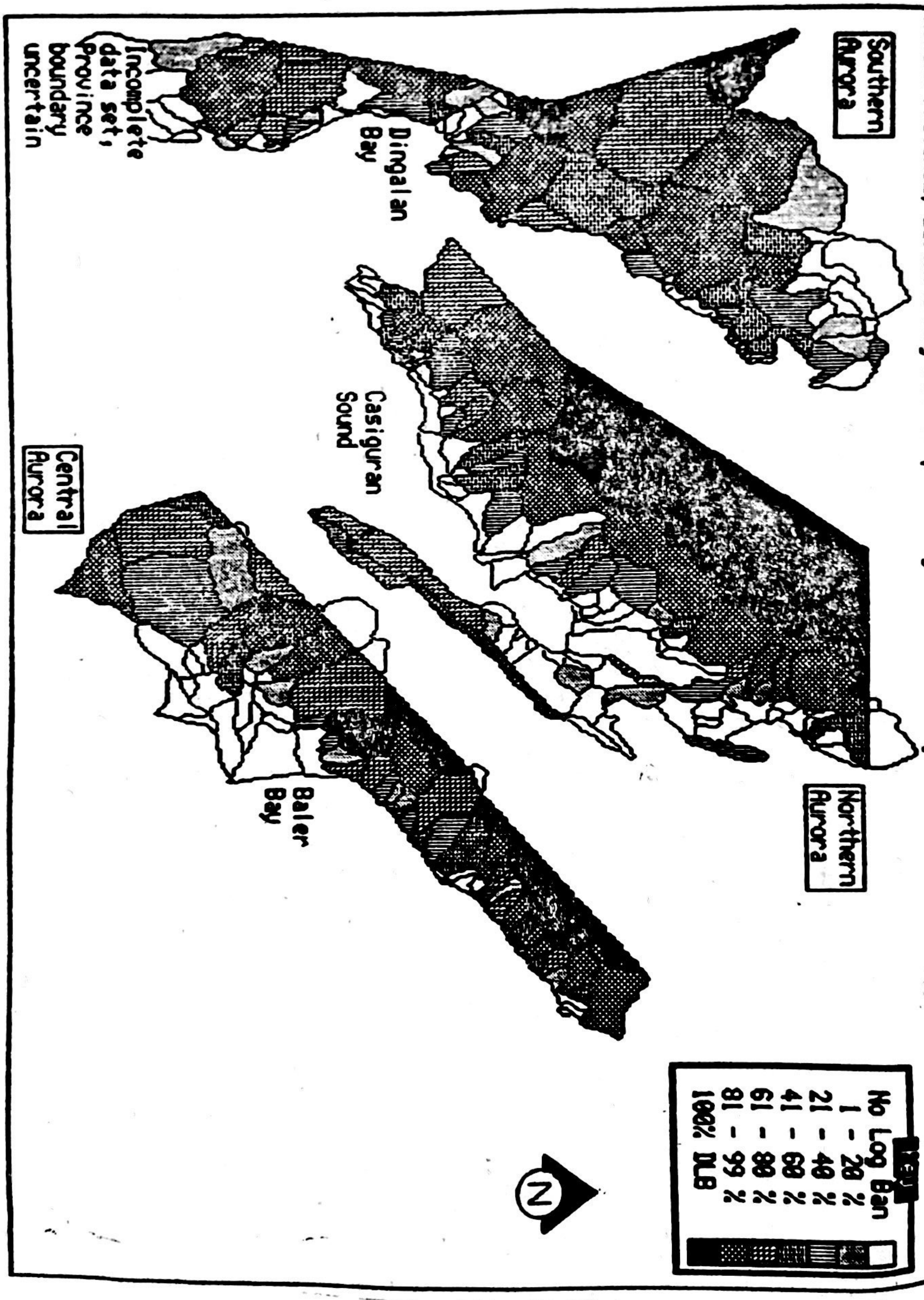
AURORA PROVINCE: Definite Log Ban (as percentage area cover) by Watershed Sub-Groups
Southerm Aurora
Northerm Aurora
Central Aurora
Dingalan Bay
Casiguran Sound
Baler Bay
Incomplete data set; Province boundary uncertain
KEY
No Log Ban
1 - 20 %
21 - 40 %
41 - 60 %
61 - 80 %
81 - 99 %
100% DLB
N

FIGURE 8

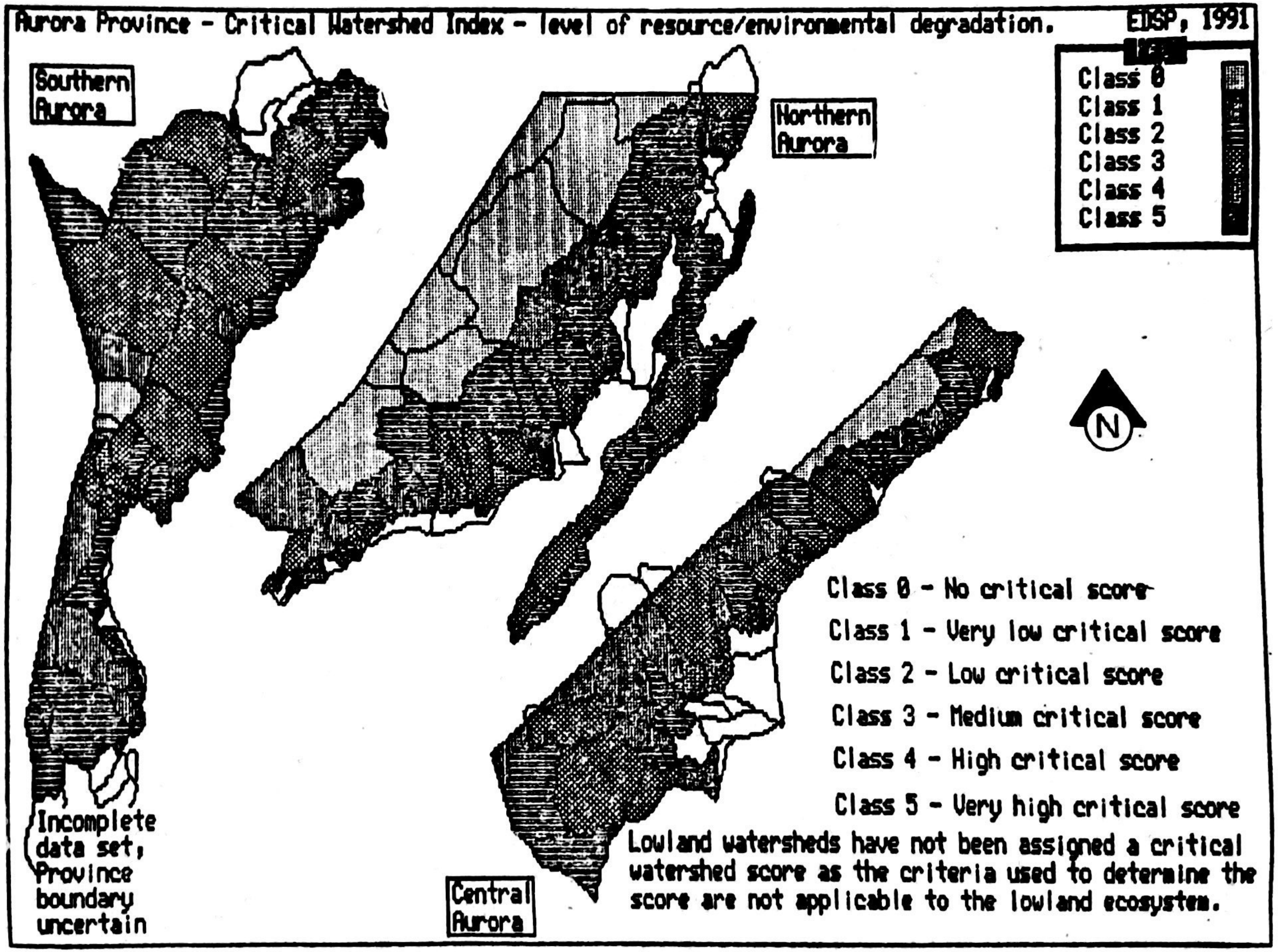
Aurora Province - Critical Watershed Index - level of resource/environmental degradation.
EDSP, 1991
Southern Aurora
Northern Aurora
Central Aurora
Incomplete data set, Province boundary uncertain
Class 0
Class 1
Class 2
Class 3
Class 4
Class 5
Class 0 - No critical score
Class 1 - Very low critical score
Class 2 - Low critical score
Class 3 - Medium critical score
Class 4 - High critical score
Class 5 - Very high critical score
Lowland watersheds have not been assigned a critical watershed score as the criteria used to determine the score are not applicable to the lowland ecosystem.
N

FIGURE 4

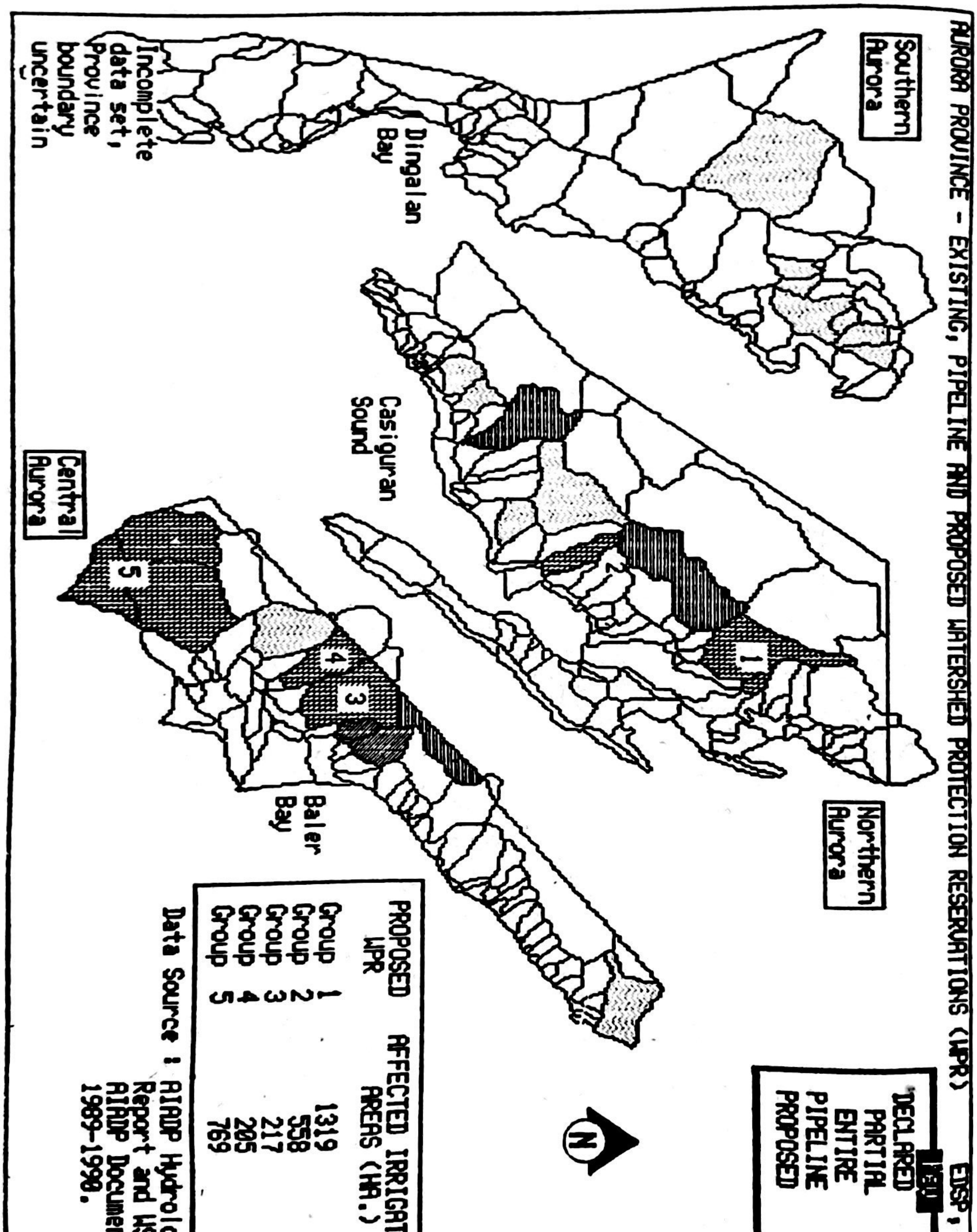
AURORA PROVINCE - EXISTING, PIPELINE AND PROPOSED WATERSHED PROTECTION RESERVATIONS (WPR)
EDSP, 1991
Southern Aurora
Northern Aurora
Central Aurora
Dingalan Bay
Casiguran Sound
Baler Bay
Incomplete data set, Province boundary uncertain
WPR
DECLARED
PARTIAL
ENTIRE
PIPELINE
PROPOSED
N
PROPOSED WPR
AFFECTED IRRIGATED AREAS (HA.)
Group 1 1319
Group 2 558
Group 3 217
Group 4 205
Group 5 769
Data Source : AIADP Hydrology Report and WST-AIADP Documents, 1989-1990.

FIGURE 5

THE AURORA LAND USE PLANNING AND POLICY INFORMATION SYSTEM (LUPPIS)

The basic mapping unit for this database is a 1sq.km. ground area identified from the 1:50,000 topographic maps of Aurora. Each grid square is stored as a pixel in a raster database structure. This provides, on the whole, a finer ground resolution than the WIS database and consequently contains a great deal more database records (c.3,400 compared to 303). The tenfold increase in the size of the dataset imposes speed restrictions, however, on the searching.

The dataset can be searched on any of the data fields and the results of searches displayed, printed or mapped through the Autocad mapping package.

The following data are contained in the LUPPIS database:

* Location. Data records are located either by a row and column coordinate or by a grid reference relating to the 1:50,000 topographic map series grid projection.

* Landform mapping unit. Data adapted from AIADP-BSWM survey (1989). Each pixel is classified with one of the following descriptions:

  — Active tidal flat,
  — Swamp,
  — Beach ridge/swale,
  — Broad alluvial plain, none to moderate flooding,
  — Broad alluvial plain, severe flooding,
  — River terrace, stream valley, colluvial and alluvial fan,
  — Undulating to slightly rolling, moderately dissected, metamorphic and volcanic hills,
  — Rolling to very steep high limestone hills,
  — Rolling to very steep high metamorphic and volcanic hills,
  — Steep and very steep limestone, metamorphic or volcanic mountains,
  — Other, e.g., reservoir, built-up area,
  — Beach sand and riverwash.

* Current land cover. Data adapted from AIADP-BSWM survey (1989). Each pixel is classified with one of the following descriptions:

  — Paddy,
  — Annual field crop,
  — Perennial tree crop,
  — Grassland,
  — Shrubland,

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— Degraded forest or replanted forest,
— Primary forest,
— Mangrove or Nipa forest,
— Wetlands,
— Other, mainly riverwash, built-up areas, reservoir, etc.

* Legal land status. Prepared by the Watershed Component of AIADP in 1989 from various sources. Each pixel is classified with one of the following descriptions:

— National Park,
— Wilderness area,
— Watershed reservation,
— Timberland with timber license agreement,
— Timberland with no timber license agreement,
— Industrial tree plantation,
— Rattan gathering area,
— Alienable and disposable land,
— Military reservation,
— Integrated social forestry area,
— Land reform area,
— Private titled land.

* Existing land use. Prepared by the Watershed Component of AIADP in 1989 from several sources. Each pixel is classified with one of the following descriptions.

— Agriculture,
— Natural production forest,
— Plantation production forest,
— Agroforestry,
— Watershed reservation,
— National Park,
— Military area,
— Special protection area.

* Recommended land use. By an examination of the landform mapping unit, current land cover, legal land status and existing land use, it is possible to establish an optimum land use for every pixel (AIADP, 1990b).
Each pixel can be classified with one of the following recommended land uses:

— Agricultural intensification,
— Agricultural intensification after changing legal land status,
— Agricultural extensification,
— Agricultural extensification after changing legal land status,
— Agroforestry intensification,

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— Agroforestry intensification after changing legal land status,
— Agroforestry extensification,
— Agroforestry extensification after changing legal land status,
— Natural production forest,
— Natural production forest after changing legal land status,
— Plantation production forest,
— Plantation production forest after changing legal land status,
— Watershed reservation,
— Watershed reservation with reforestation,
— Watershed reservation after changing legal land status,
— Watershed reservation with reforestation after changing legal land status,
— National Park,
— Military area,
— Special protection areas.

A comparison of existing land use with recommended land use identifies those areas which are currently under suitable cover, assuming correct land management techniques and those areas in which a land change is recommended. Figures 6-7 present the existing and recommended land use of Aurora Province with the use of the LUPPIS.

THE SOCIOECONOMIC TABULATION SYSTEM (SETS)

The socioeconomic tabulation system (SETS) is a tool used for the computerized processing of the socioeconomic data specific for the resource profiling of a particular watershed area. The system is developed using the dBASE IV software package and is designed to generate data such as the demographic features, income level, resource extraction and usage and economic activities of a particular watershed being surveyed and studied. These processed data are then validated and used as bases for the preparation of strategic zonation plans for the integrated development of a specific watershed area.

THE REPORTS AND MAPS DATABASES (REPCAT and MAPCAT)

An inventory of the reports held in the library at the AIADP Office in Baler is contained within the computerized information system allowing rapid access to archival data. The inventory can be searched on author (plus data), title or subject code. A similar system exists for the map library whereby searches can be performed on map source (plus data), scale, map subject code, map number or area covered by the map.

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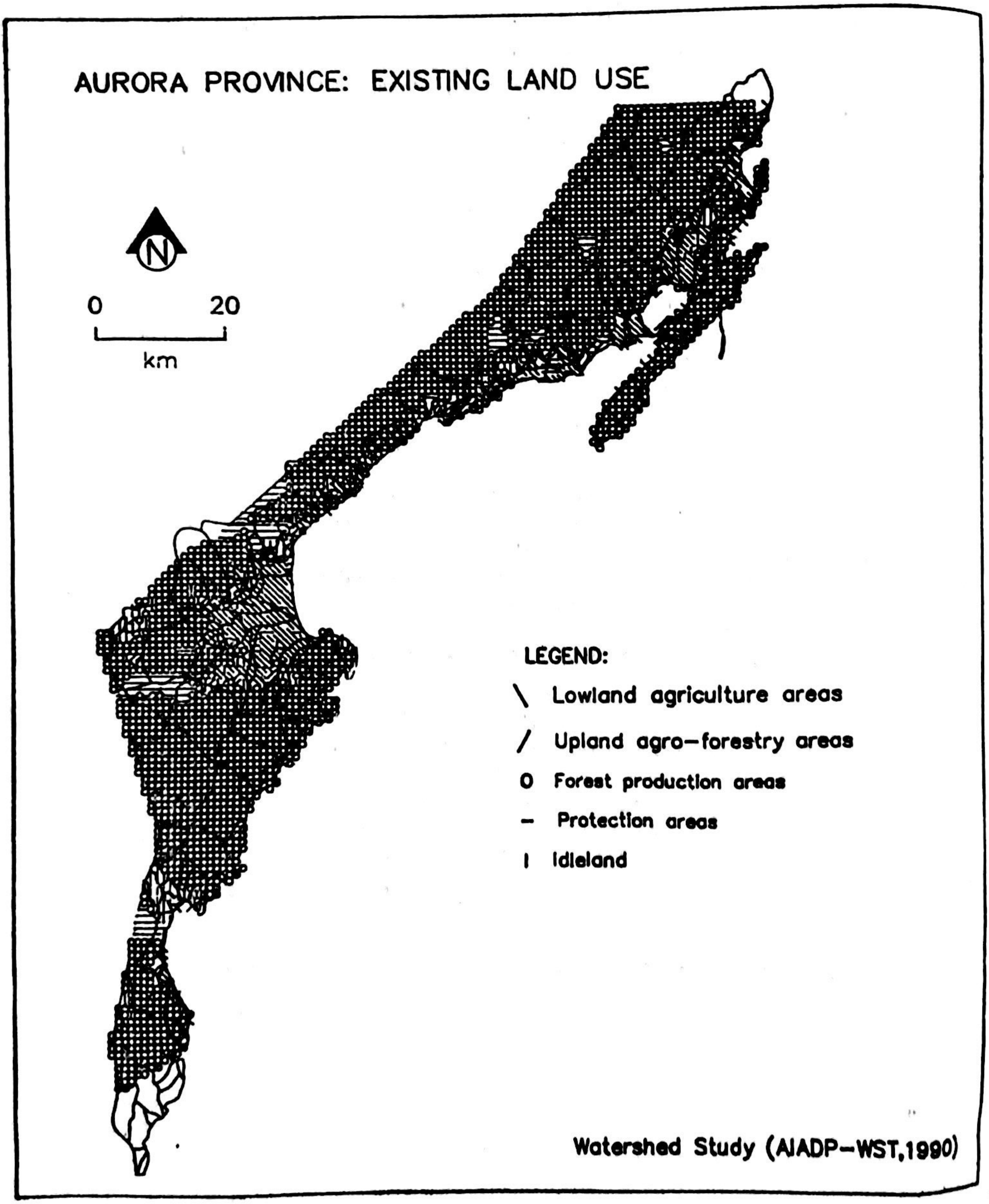
AURORA PROVINCE: EXISTING LAND USE
N
0
20
km
LEGEND:
\ Lowland agriculture areas
/ Upland agro-forestry areas
O Forest production areas
– Protection areas
I Idleland
Watershed Study (AIADP-WST,1990)

FIGURE 6

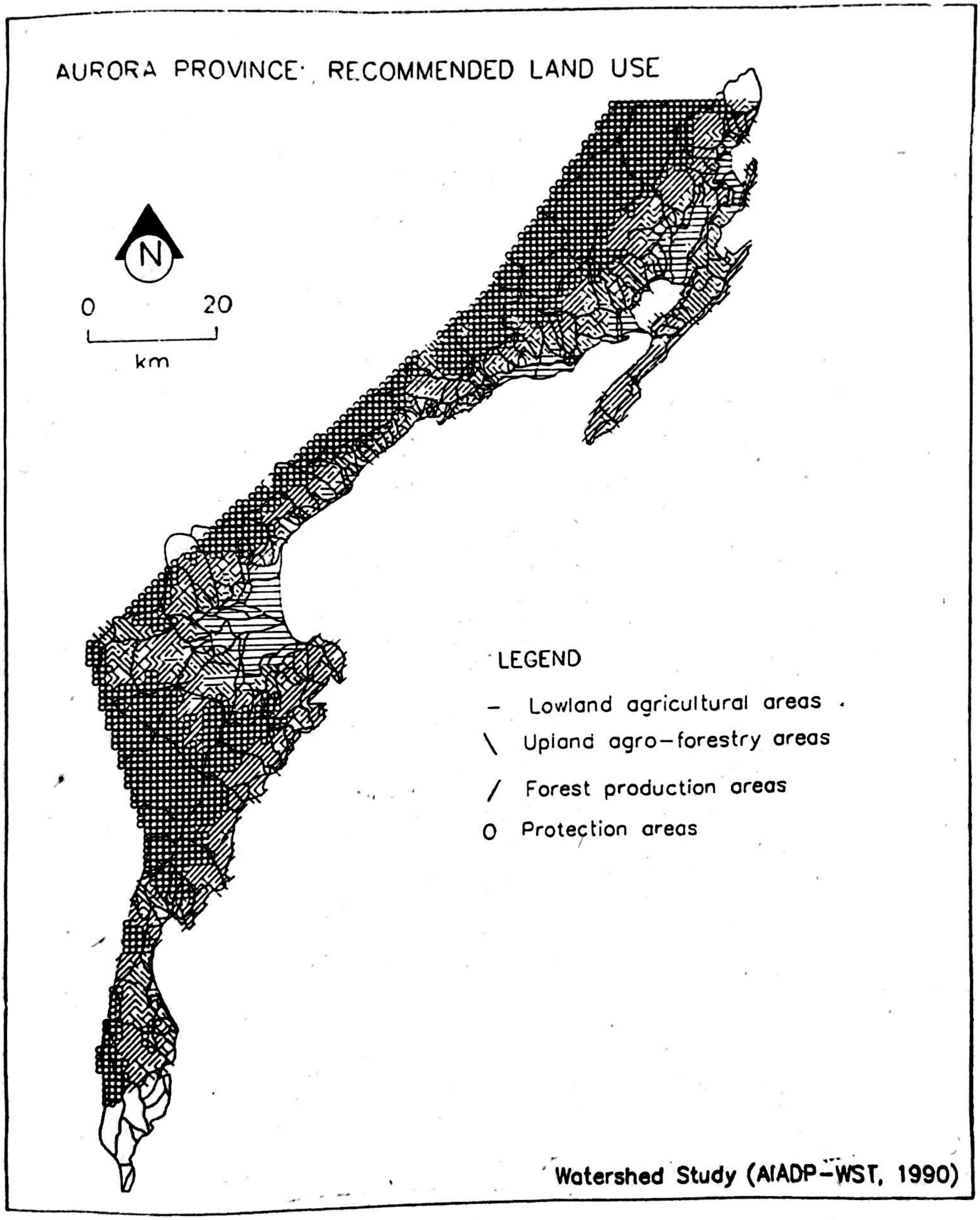

FIGURE 7

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INTEGRATION OF THE WIS AND LUPPIS DATABASES

It is possible to integrate the data stored within the LUPPIS database, stored on a 1sq.km grid square basis, with the WIS database, whose data are stored on a watershed basis. This permits analysis of the LUPPIS database using selected watersheds from the WIS as template. It also permits data from the LUPPIS database to be incorporated into WIS and mapped on a subwatershed.

The integration cannot be wholly accurate, however, as certain assumptions made, although not significantly prejudicing the whole dataset, can lean to erroneous attribute estimates within individual watersheds. This means that values quoted on a watershed basis (in WIS) for attributes stored on a raster basis (LUPPIS) can only be estimates and must be viewed as such. Large watersheds containing a low perimeter to area ratio are less prone to error whereas watersheds with a high perimeter to area ratio (small and/or linear shaped watersheds) are more prone to errors in the integration process.

FUTURE DEVELOPMENTS

As it is, the Aurora computerized environmental information system still lacks the flexibility and facility to be called a true management and environmental information system. However, plans to strengthen its capabilities are underway and these will include the incorporation of the following attributes and/or information:

* Activity status monitoring, e.g., check dams, gully plugs, project status,
* Distribution and size of resource users, e.g., saw mills, furniture makers,
* Environmental management factors, e.g.:
  — where are the nurseries, what are their stocks, species, etc.,
  — where are the upland stabilization schemes,
  — provide a check on new schemes — e.g., if a lowland agriculture improvement project is planned, use the information system to check back which upland areas affect the lowlands in question and ensure that proper measures are being taken in those watersheds to preserve water supply and quality in the agricultural scheme,
  — more socioeconomic data.

Whether the Aurora information system become truly sustainable only time will tell, however, given that a large proportion of the development will be taken on by local staff employed by AIADP, the signs are promising.

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CONCLUSIONS

The successful development and implementation of a low-level GIS within a two-month time scale highlights the suitability of this type of system for the storage and analysis of the large amounts of data collected by the Aurora IAD Project. Although not providing full "high-level" GIS functionality, the system does provide a very effective decision-making tool for macro-level development of environmental protection and management policies within a province.

In addition, the easy to use nature of the system negates the need for specialist system training. This allows the use of the system by a number of personnel and does not place reliance on highly trained staff.

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PLANNING AGROFORESTRY DISSEMINATION FOR SUSTAINABLE ENVIRONMENTAL USE: LESSONS FROM AN NGO PROJECT IN GHANA

E.A. Gyasi*

ABSTRACT. Agroforestry holds promise for sustaining land use. How to disseminate it constitutes a challenge to development planning especially among peasant communities in the fragile tropical environment. Recently, Ghana Rural Reconstruction Movement, a non-governmental organization, introduced agroforestry as a component of its integrated rural development experiment in the Mampong Valley Social Laboratory. The project experience suggests that agroforestry might most effectively be popularized by improving rural capital, countering rural labour emigration, securing land holding, and improving agroforestry project management training and the incentives for the propagators. But above all, agroforestry dissemination would be enhanced by a grassroots bottom-up approach involving local adaptive trials, demonstrations, and training; service points; popular participation including more women; and stationing of the extension officials right in the field among the peasants.

INTRODUCTION

Ghana is predominantly an agricultural country inhabited by 14.2 million people (Republic of Ghana, 1990). There, as in the rest of Sub-Saharan Africa, population has been growing rapidly at a yearly rate of about three percent against a background of generally declining, stagnating or, at best, marginally increasing agricultural output with adverse effects upon food supplies, nutrition, health, incomes and general welfare (Food and Agriculture Organization, 1990A and 1990B; Ministry of Agriculture, 1987; Population Reference Bureau, 1990; Republic of Ghana, 1984; United States, 1990).

Among the multiplicity of factors underlying the growing food insecurity are:

a) adverse weather, especially increasingly low and unreliable rainfall;
b) land tenure and other socio-cultural barriers,
c) outmoded technology,
d) deteriorating infrastructure,
e) inappropriate agricultural policy and lack of farm incentives as

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reflected by storage and marketing limitations and high post-harvest losses,

f) emigration of the rural youth,
g) civil war and general political instability, and
h) land degradation, the most insidious threat to food security.

Land degradation may be defined as the progressive loss of the intrinsic quality of land or biosphere. Alternatively, it may be defined as the loss of biodiversity and of the aesthetic quality and productive capacity of land. It is basically man-induced (Benneh and Agyepong, 1990; Blaike and Brookfield, 1987; Dorm-Adzobu, et al., 1991; Environmental Protection Council — No date).

In Ghana, land degradation assumes various forms, including:

a) deforestation estimated at 7.5 percent per annum since 1977, and other forms of vegetation degradation,
b) soil erosion,
c) declining soil fertility,
d) wildlife loss,
e) watertable reduction,
f) environmental pollution,
g) coastal degradation,
h) desertification, and
i) micro-climatic changes and other forms of ecology disturbance.

It occurs with varying degrees of severity in the four major agroecological zones: the humid forest; coastal savanna; interior savanna; and the derived savanna, the forest-savanna transition zone. The major causes have been identified as: overfarming, timber exploitation, overstocking, the spread of mono-culture, bush burning, urbanization, and other forms of stress on the land associated with population growth, greed, rising economic expectations, and resource mismanagement (Benneh and Agyepong, 1990; Dorm-Adzobu, et al., 1991; Environmental Protection Council — No date).

Humanity survives upon the plant and animal species, air, water, soils, and other biotic and abiotic phenomena associated with the land. This being the case, it then follows that land degradation amounts to erosion of the basis of human livelihood, as reflected by decreasing agricultural yields (Ministry of Agriculture, 1987; Republic of Ghana, 1990) whose cost together with other costs of environmental degradation has been estimated at four percent of the Gross Domestic Product in Ghana (Environmental Protection Council — No date).

It was against this backround that the Ghana Government, in 1988, initiated, as part of the World Bank and IMF — assisted national economic recovery programme (ERP), the Environmental Action Plan (EAP)

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embodying a national environmental policy "to improve the surroundings, living conditions and the guilty of life . . . (and) ensure reconciliation between economic development and natural resources conservation, . . . (and) make a high quality environment a key element supporting the country's economic and social development" (Environmental Protection Council — No date: 12) through optimum sustainable environmental use and management.

Agroforestry is widely seen as an ecologically sound method of sustainable land use (Egger, 1988; Milner, 1989; Okigpo — No date), hence its growing promotion by governmental agencies as well as non-governmental organizations [NGOs]) which provide a flexible medium for mobilizing resources for development through collective individual enterprise unencumbered by the bureaucracy characteristic of government organizations.

In 1987, Ghana Rural Reconstruction Movement, a charitable non-governmental rural development organization (NGO), introduced agroforestry in the Mampong or river Yensi valley in Ghana. This paper examines the diffusion and impact of this innovation, with a view to drawing lessons for sustainable land use.

Agroforestry Defined

Agroforestry has been defined as "sustainable land management system which increases the yield of land, combines the production of crop (including tree crops) and forest plants and/or animals simultaneously or sequentially on the same unit of land and applies management practices that are compatible with the cultural practices of the local population" (Okigbo — No date: 75). It is a low external input basically self-regenerating agricultural system that seeks to maximize land use and maintain ecological stability through permanent diversified floristic cover sometimes incorporating selected fauna in the manner of the natural ecosystem. It involves the cultivation of selected woody species, trees or shrubs in combination with crops, livestock, or with both. The woody plants commonly recommended are those characterized by fast growth, ability to fix nitrogen and loosen the soil, and a capacity to rapidly produce poles and foliage. They include *Leucaena leucocephala, Gliricidia sepium, Calliandra calothyrsus, Flamingia conjesta,* and *Sesbania sesban* introduced under the Mampong valley agroforestry project.

The three basic agroforestry systems commonly distinguished are agri-silviculture, which involves the cultivation of the selected woody plants in combination with ordinary field crops, silvipasture involving the raising of the woody plants in association with livestock, and agri-silvipasture involving the raising of the woody plants in combination with both crops and livestock. Often, silviculture or woodlot farming, which involves the cultivation of selected trees in isolation is classified as agroforestry.

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Any of the agroforestry systems may be carried out in the form of contour farming, alley farming, or bio-intensive farming which involves composting and is most conveniently carried out in the backyard.

Agroforestry has one or more advantages, including the advantage of:

a) enriching the soil through the nitrogen-fixing woody plants and decomposing leaves, twigs, etc.,
b) providing material for mulch through coppicing,
c) loosening the soil through the deep-rooted woody plants,
d) checking soil erosion through contour farming and continuous vegetative cover,
e) providing protection for the crops and soil against wind, since the trees/shrubs serve as windbreak,
f) providing wood and forage or fodder,
g) providing other economic by-products and additional income from sales of fruit, poles, etc.,
h) minimizing deforestation,
i) sparing the farmer the cost, inconveniences and, often, hazards of applying artificial inorganic chemical fertilizer, since agroforestry is essentially an organic or ecofarming system based on the principles of low external input and self-regeneration,
j) enhancing the security of the farmer through diversified ecofarming, and
k) providing, under conditions of growing land scarcity, a more sustainable alternative to the traditional land-and-labour-wasting shifting cultivation, and land rotation systems of farming practised in tropical Africa.

The virtues of agroforestry, both exotic and autochthonous, have been demonstrated in tropical Africa environments (Benneh and Gyasi, 1991; Gyasi, 1990A). How to encourage its spread constitutes a challenge to sustainable land use planning.

The Agroforestry Project and Setting

In October 1989, the Ghana Rural Reconstruction Movement (GhRRM) started an agroforestry project in the 65 km² Mampong Valley Social Laboratory (MVSL) "where specialists live with farmers and assist them through participation to identify their problems with a view to finding solutions to them" (Unpublished Ghana Rural Reconstruction Movement records). The externally-funded project had the basic aims of regenerating degraded soils, encouraging sustainable farming, and improving vegetation for fodder, mulch, and fuelwood. These arrangements were in line with the GhRRM's fundamental objective of promoting rural development through grassroots experimentation in an 'action-research setting' within which various programme inputs aimed at alleviating the interrelated problems of poverty, disease, illiteracy, and civic inertia could

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be introduced in an integrated manner, and their impacts on the target community assessed (Ghana Rural Reconstruction Movement — No date).

The MVSL is inhabited by 4,500 people, and is located in the Akuapem district at the southern fringes of the interior forest, 70 km north of Accra, the national capital (Fig. 1). Akuapem district comprises a densely populated highland, and the less densely settled Mampong or Yensi valley, site of the MVSL, a food crop farming area characterized by severe deforestation and soil erosion, and growing collapse of the traditional bush fallow or land rotation system of farming reflected by the reduction in fallow length observed during a 1989 survey (Gyasi, 1990A and 1990B). Aerial photographs of 1974 showed that only 27 percent of the MVSL's original semi-deciduous tropical forest cover remained, the other 73 percent having been cleared for various human uses, most especially agriculture. Out of the total number of land parcels under cover or usage along selected motor-roads and footpaths ground-surveyed during 1989, forest land comprised only three percent, the remaining 97 percent being agricultural land, 61 percent in active cultivation and 36 percent under fallow, which suggests that the natural forest cover near the access roads was on the verge of extinction. The farmers' assessment of the condition of the vegetation, wood supplies, fallow lengths, and agricultural yields in the past compared to the contemporary situation, provides further indication of the ecological deterioration. Nearly 99 percent of a sample of them reported that the state of vegetation was worse in 1989 than 20 years before 1989. The 165 sample farmers unanimously expressed the view that the wood supply situation had worsened, reflected by growing scarcity of fuel and constructional wood. According to most of the farmers, 20 years before 1989, land was so abundant that the fallow length extended up to 10 years and beyond, compared to the situation in 1989 when the fallow length rarely exceeded five years as contrasted to the up to eight years cultivation period, which implies increase in the frequently of cropping or change towards permanent cultivation, and increasingly insufficient time for the land to regenerate its fertility naturally. Since these changes were, on account of poverty and ignorance, not generally accompanied by artificial soil improvement measures, it hsould not come as a surprise that the farmers characterized nearly 40 percent of their farm land as marginal to poor in terms of soil fertility, and also, almost to a person, reported agricultural yield decline.

Thus, the evidence strongly points to an agroecological crisis which the agroforestry project was designed to counter through:

a) silviculture or woodlot farming,

b) agri-silviculture,

c) agri-silvipasture, and

d) contour and alley farming and bio-intensive gardening.

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The main operational base is Yensi Centre which has various agroforestry adaptive-trial and demonstration plots. It is from Yensi Centre that the agroforestry method are disseminated through training programmes, demonstrations, the nine sub-centres (Fig. 1 & 2) and the GhRRM — trained local propagators including farmer scholars. The field staff, comprising various specialists or technical men, is headed by a Field Director who is responsible through the Executive Director to the Accrabased Board of Trustees which holds overall responsibility for the project.

Diffusion, Impact, Constraints and Planning Implications

The number of farmers who had received the agroforestry training was, in mid-1989, 136 comprising mostly of men from 36 or so villages in nine localities, with one locality, Adawso/Kabu, falling outside the MVSL (Fig. 3). The highest proportion (29.4 percent) was at Addo Nkwanta, located very near Yensi Centre.

In the initial stage, the last quarter of 1987, there were eight trainees, representing 5.9 percent of the total number of the trained farmers in mid-1989; 36 farmers, representing 26.5 percent of the cumulative total, joined in 1988, followed by another 92-set of trainees, representing 67.6 percent of the cumulative total.

A graphical representation of these figures in the form of a cumulative growth curve shows a typical innovation-response trend, as does the curve representing the growth in the three time phases involved, namely the initial or early innovators phase (last quarter of 1987), late innovators phase (1987-88), and early majority phase (about the first half of 1989; Fig. 4; Ablar, et al., 1971). This finding implies a normal response by the farmers to the training programme, and reflects the responsiveness of the local peasants to innovations (Jones, 1957; Miracle and Fetter, 1970). Also the normal response finding, together with the successful training of 136 out of a total of about 1,500 often illiterate or barely literate peasants within only two years is something as novel as modern agroforestry methods, underlines the effectiveness of the GhRRM's grassroots bottom-up approach involving field-based full-time specialists and part-time propagators, a network of service centres, and the farmer-scholar arrangement whereby a GhRRM trainee is required to impart the acquired knowledge to other persons who, in turn, are required to do similarly. A further reflection of the effectiveness of the strategy was the finding that out of a sample of 111 farmers who had not been involved in the agroforestry programme, 55 percent had at least heard of it, and mostly through the GhRRM field staff and the participant farmers.

Only 44 percent of the 136 trainees were actually practising the agroforestry methods. The percentage of females was only 4.4 percent, despite the fact that over 50 percent of the farming population were

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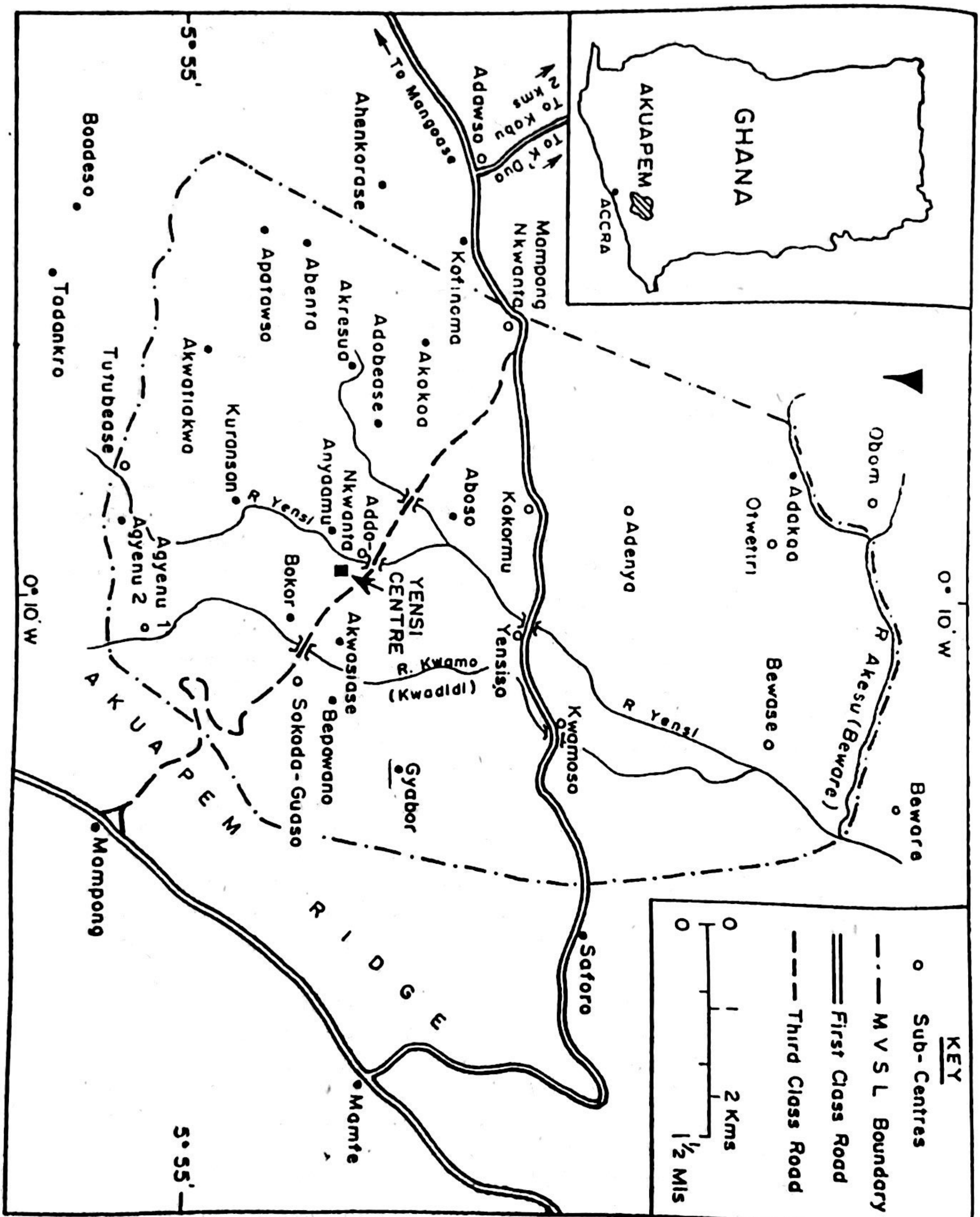

FIG. 1. MAMPONG VALLEY SOCIAL LABORATORY

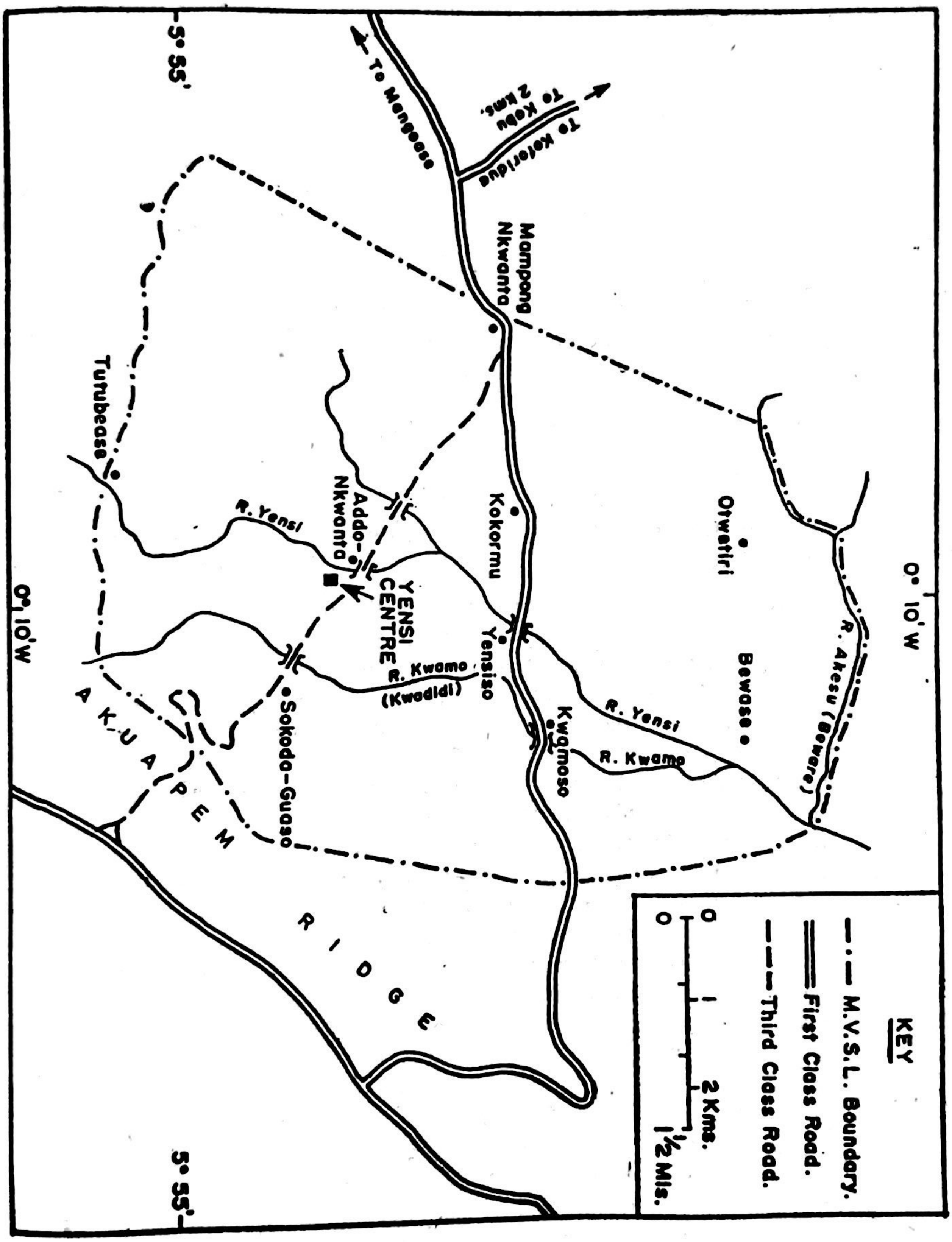

FIG. 2. MAP OF THE AGROFORESTRY OPERATIONAL CENTRES

female. This, most probably, reflects the male domination of leadership, and reinforces the need for rural modernization and general development planning to focus more on the women (Oppong, 1987). Alley farming was the most popular agroforestry practice, followed by woodlot farming, contour farming, and bio-intensive farming.

Despite its promise as a cost-effective method of encouraging the production of ruminants, especially sheep and goats, silvipasture had barely caught on as only two percent of the farmers were practising it. Although alley farming was the most popular, it also was the one about whose practice the farmers complained the most because of the tedium and labour difficulties involved in the lining and pegging and the frequent pruning required. Significantly the temporal pattern of the agroforestry practice adoption appears similar to the typical logistic pattern exhibited by the training programs participation as nine percent started practising in 1987, followed by 42 percent in 1988, and 49 percent in 1989.

The practising farmers were distributed among 13 villages of which two, Kofi Noma and Adawso, were located outside the MVSL (Fig. 5). The concentration was highest at Bewase, six km. from Wensi Centre, and lowest at Agyenu one and two and Aboso located near Yensi Centre.

As noted, only 60 (44 percent) out of the 136 trainees were actually practising the newly learnt agroforestry methods. This big gap between training and practice might be related to capital constraints as poverty appeared to be endemic in the MVSL, to labour shortage associated with the emigration of the youth, and to population-induced land shortage, which underscore the need to intensify integrated or multi-faceted developmental measures. A more serious constraint, according to the GhRRM field staff and a substantial number of the sample peasants, had been the communal land tenure system which, in their view, did not encourage the large number of migrant farmers (about 50 percent of the total number of farmers) to plant perennial agroforestry trees as they did not own the land, but were operating it only temporarily on rental or sharecropping basis at the pleasure of the native Akuapem communal owners. Among the land owners, there appeared to be some apprehension that the migrant farmers might lay permanent claim to the land on the basis of the agroforestry trees whose economic value was, at any rate, yet to be convincingly demonstrated to the target group (Gyasi, 1991). It might also be argued that a substantial number of the trainees were not putting the 'theory' into practice simply because they had not had ample time to organize themselves for that purpose as they had undergone the training only recently. Some time lag between theory and practice, or between knowledge acquisition and application of that knowledge, should be expected in any innovation introduction situation (Gyasi, 1990C).

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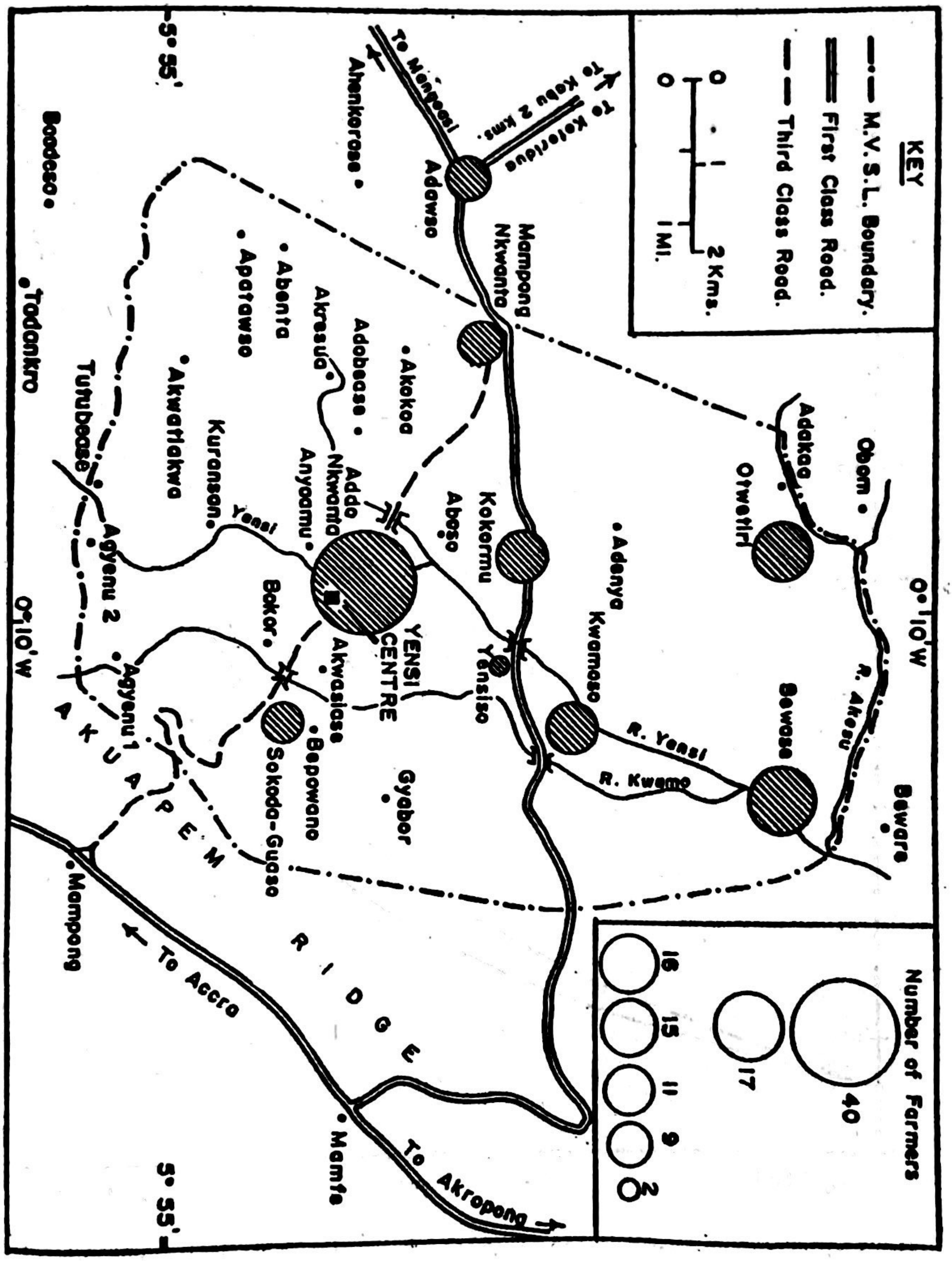

FIG. 3. MAP OF FARMERS TRAINED IN AGROFORESTRY BY LOCALITY

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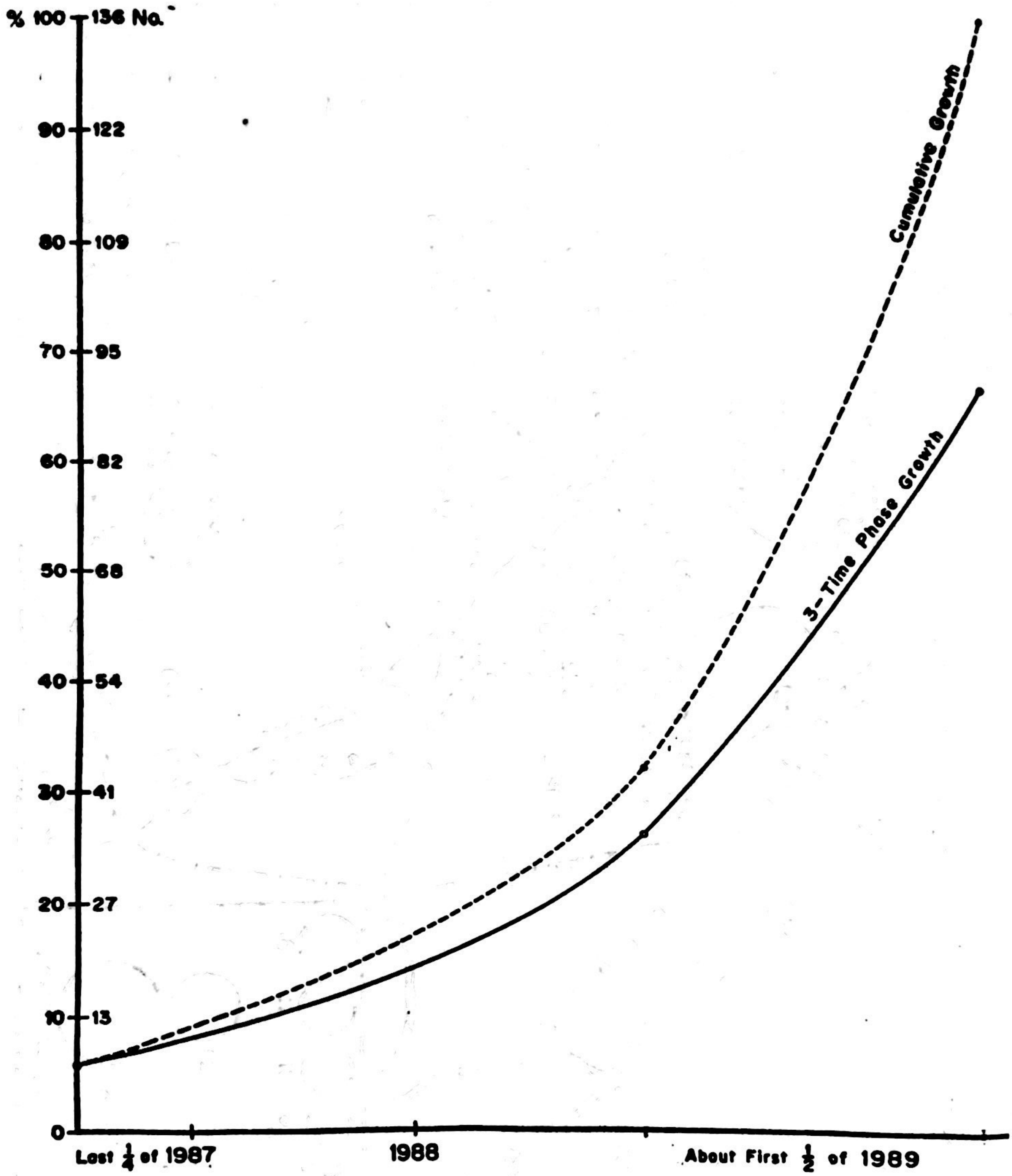

FIG. 4. TEMPORAL PATTERN OF AGROFORESTRY TRAINEES

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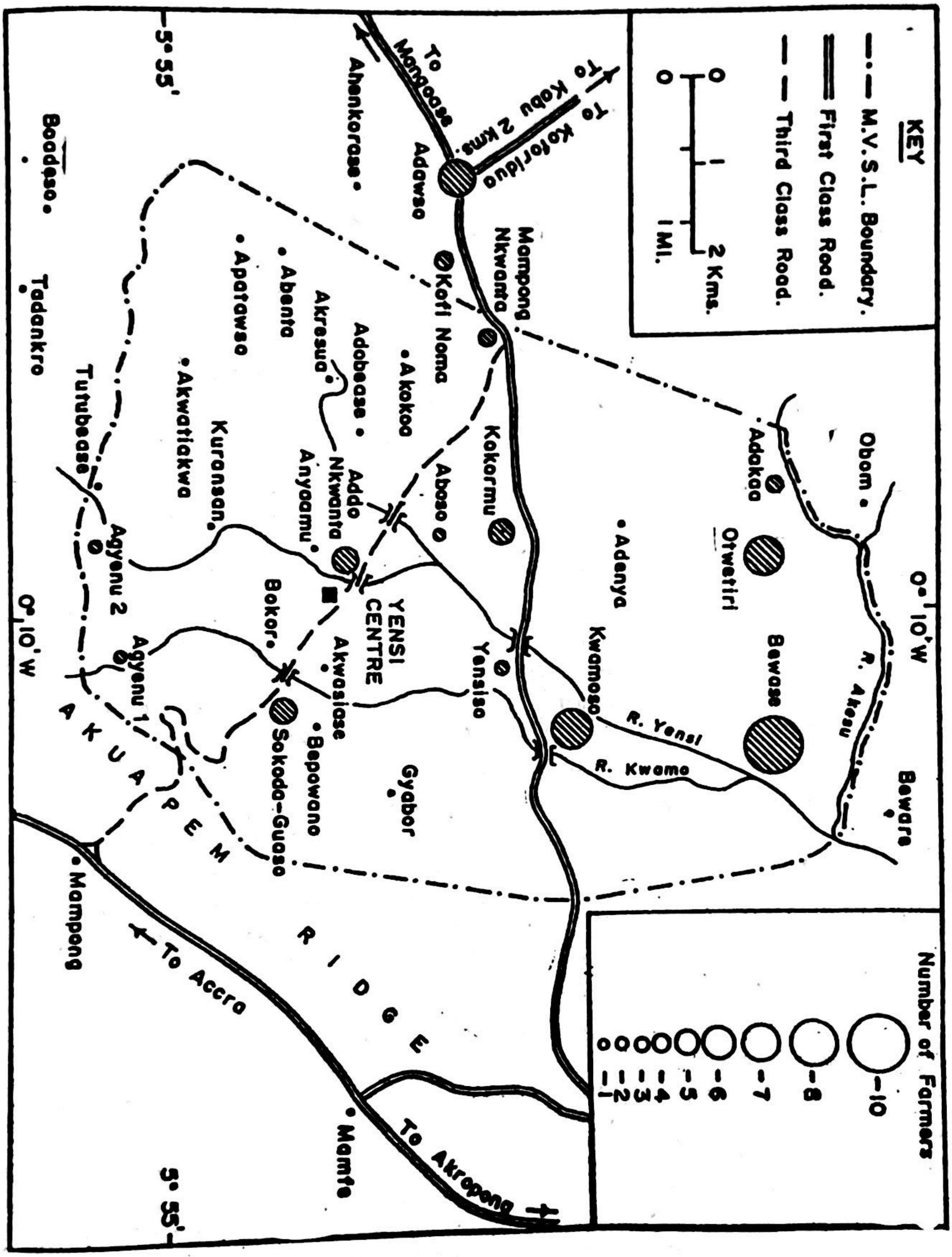

FIG. 5. MAP OF FARMERS PRACTISING AGROFORESTRY BY VILLAGE

A 0.47 correlation coefficient was found between population size of the practising villages and the number of those practising in each corresponding practising village expressed as a percentage of the gross total of the practising agroforestry farmers. This implies that generally as the absolute population size increases, so does the absolute number of agroforestry adoption, which appears normal. However, expressed as a percentage of the population in each village, the magnitude of the agroforestry practice showed a negative correlation of 0.89 with the village population size, which suggests that generally the greater the population of a village, the smaller the proportion of agroforestry practice, or that the proportion of acceptance tends to be significantly greater among the smaller villages. This finding probably reflects the less difficulty or cost involved in information dissemination within smaller communities because of closer social interaction through the neighborhood effect (Hagerstrand, 1965) in such small communities. If so, then it amounts to an enccuraging finding because it reinforces the view that agroforestry and other methods of promoting rural development would succeed, especially among the smaller rural communities which development planning tends to ignore, if the grassroots bottom-up approach centered on the local opinion leaders and those most favorably disposed towards innovations, is followed.

The rate of adoption correlated inversely with distance from Yensi Centre, the hub of the agroforestry project. Although the correlation coefficient was only -0.35, it nevertheless underscores the importance of proximity or access to service points in the innovation dissemination and general socioeconomic development processes (Hansen, 1972).

The majority (62 percent) had adopted agroforestry methods to check soil erosion, while the rest did so to enhance firewood supplies (11 percent), increase crop yield (four percent), improve soil fertility (two percent),, improve animal feed supplies (two percent), or achieve some purposes (19 percent). These responses are significant because they indicate that, generally, the peasant farmers appreciated the basic rationale behind agroforestry, which bodes well for the future of the project, and for agroforestry dissemination among the peasantry in general.

The agroforestry methods appeared to be making a modest but significant impact on the socioeconomic situation including the ecological base. In the view of the GhRRM field staff, although the methods had not had a readily discernible positive effect on the soils, they had started generating a fair amount of firewood and animal feed, two important resources in short supply. The agroforestry farmers assessment stressed increases in crop yield and animal fodder, improved soil fertility and fuelwood supplies, and a miscellany of other benefits including increase in the number of certain wild ruminants attracted by the browse provided by the agroforestry trees and shrubs.

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Thus, it becomes evident that, on the whole, not only had the agroforestry methods diffused in a manner consistent with theory, but also, they had started impacting positively on agriculture, fuelwood supplies, and the land or ecological base. That this had been so, may be attributed primarily to the GhRRM's grassroots bottom-up strategy involving the dissemination of the new methods through specialists resident in the operational area, a network of fairly closely spaced and readily accessible service centres, GhRRM-trained local propagators recruited from the target villages, and the farmer scholar arrangement whereby a farmer trained in agroforestry methods by the GhRRM is expected to impart the new knowledge to others. Another factor might be that as a private charitable non-governmental organization, the GhRRM has enjoyed greater freedom to mobilize and apply resources for the propagation of the agroforestry methods.

The diffusion process would have been faster and registered greater impact but for the low involvement of the women, the pivot of farming and other rural economic activities, capital and land tenure constraints, population-induced land shortage, labour shortage associated with emigration, project management difficulties, and inadequate incentives and logistical support for the field staff (Gyasi, 1990C).

CONCLUSION

The findings of this paper suggest that agroforestry practising among the peasantry would be enhanced by:

a) improving rural capital supply through modern credit system,

b) improving rural labour supply by curbing rural out-migration through appropriate incentives,

c) countering land shortage by population control and more efficient intensive land use methods,

d) clarifying the land tenure situation and strengthening the security of title to land,

e) motivating the propagators through better logistical support and incentives, and

f) improving agroforestry project management training.

But, above all, the findings suggest that agroforestry practising would be enhanced by a grassroots bottom-up approach involving more local women, opinion leaders, innovators or pace-setters, a network of local trial, demonstration and service centres, and stationing of the extension officials right in the field among the peasants in the spirit of the GhRRM's motto:

Go to the people
Live among them
Learn from them

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Serve them
Start with what they know
Build on what they have.

Note:

This paper is a revised version of a paper presented at a Seminar on Monitoring Geosystems organized by the International Geographical Union Commission on Geographical Monitoring and Forecasting, in December 1991, at the University of Delhi, Delhi, India.

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Philippine Geographical Journal, Vol. 36, Nos. 3 & 4
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IDENTIFICATION OF SERVICE CENTRES IN KASHMIR DIVISION — AN APPROACH TOWARDS MICRO LEVEL URBAN PLANNING IN JAMMU AND KASHMIR STATE

Ishtiaq A. Mayer

ABSTRACT. Identification of service centres in a backward and less developed region has got tremendous potential value, as these centres act in promoting and developing linkages between rural and urban people. In the present paper, the Kashmir Division of Jammu and Kashmir State is chosen for such a study. Hierarchy of service centres and their distribution (tehsil wise) has been depicted after making a quantitative assessment of the settlements with the help of some selected variables chosen from the Census data of India.

INTRODUCTION

A striking feature of the Indian economy in the recent past has been the large increase in urban industrialism. The urbanization of rural areas at the periphery of towns or cities is becoming widespread as people migrate more and more to urban areas for industrial work. Thus majority of the urban population live in large cities of more than 100,000 population. The planners have been wrestling with the problems which the Indian urbanization produces. The accumulation of people at some selected urban areas, particularly in metropolitan cities, has created socio-economic and cultural tensions. Same is true with Jammu and Kashmir State with only a few urban centres have over-grown in the whole state. The level of urbanization in Jammu and Kashmir State stands at 21 percent which is lower than the National level of 23 percent.[1]

The Jammu and Kashmir State which is divided into three political and administrative divisions namely: Jammu, Kashmir and Ladakh, has fifty-eight (58) urban centres of different population size groups. Majority of these centres fall in the lower population size of Indian census scheme (Fig. 1).

The Kashmir and Jammu Divisions are the most populous regions and have more urbanized areas in comparison to Ladakh Division which has only two urban centres although it is the largest division of the state as far as area is concerned. (Table 1).

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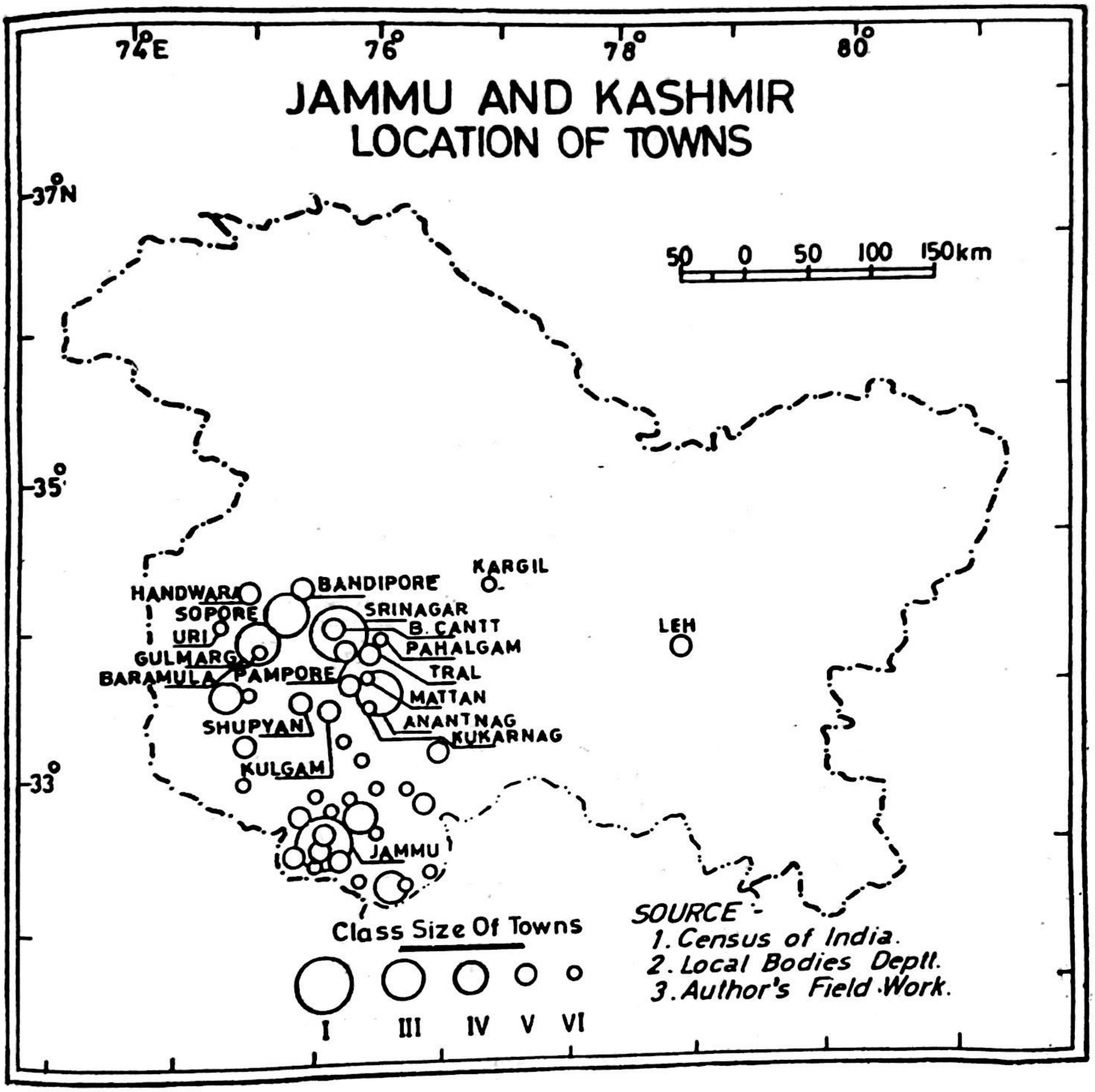

FIGURE 1

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Srinagar and Jammu cities combined absorb about seventy percent of the total urban features and have maximum accumulation of wealth and infra-structural facilities with localization of most of the business and industrial establishments in these areas; whereas, other towns and urban areas are smaller ones and have less and inadequate facilities.

This unequal distribution of towns have created unbalanced economic growth of the state and have been producing hindrance one or the other way in the regional planning of the state. Some urban centres are closely knitted up, thus their catchment areas are over-lapping, and some urban centres are located at far distances that in between them many rural areas remain unserved by them. The present paper deals here only with the distributional pattern of the urban centres of the Kashmir Division as a case study.

TABLE 1. DISTRIBUTION OF URBAN POPULATION IN JAMMU AND KASHMIR STATE. (By District, 1981)

S. No.	District	Total district population	Percentage of population to total state population	Urban population	Percentage of urban population to total state urban population	Number of urban centres	Percentage of urban centres to total urban centres of the state
1.	Anantnag	656,351	10.96	70,286	5.57	8	13.79
2.	Baramulla	670,142	11.19	89,766	7.12	6	10.34
3.	Badgam	367,262	6.13	51,885	4.11	1	1.72
4.	Pulwama	404,078	6.74	36,279	2,87	4	6.89
5.	Kupwara	328,743	5.49	9,688	0.76	2	3.44
6.	Srinagar	708,328	11.83	570,195	45.23	3	5.17
	Kashmir Division.	3,134,904	52.34	828,099	65.66	24	41.35
7.	Doda	425,262	7.10	25,174	1.99	6	10.34
8.	Udhampur	453,636	7.57	43,247	3.43	6	10.34
9.	Kathua	369,123	6.16	41,990	3.33	6	10.34
10.	Jammu	943,395	15.75	279,644	22.18	9	15.51
11.	Rajouri	302,500	5.05	15,833	1.25	4	6.89
12.	Poonch	224,197	3.74	14,171	1.12	1	1.72
	Jammu Division.	2,718,113	45.37	420,059	33.30	32	55.14
13.	Kargil	65,992	1.10	3,527	0.27	1	1.72
14.	Leh	68,380	1.14	8,718	0.69	1	1.72
	Ladakh Division.	134,372	2.24	12,245	0.96	2	3.44
	Jammu and Kashmir State.	5,987,389	99.95 (100%)	1,260,403	99.92 (100%)	58	99.93 (100%)

Source: — Compiled from the census data, series 8, 1981.

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The Kashmir Division, the most populous region of Jammu and Kashmir State, contains about 53 percent of the total population with only 15 percent of the total land area. Its share of urban population stands at about 66 percent but has only 41 percent of the total urban area. Although urban centres and urban population of Kashmir Division contribute its best to the total urban phenomena of the state, their size and distribution in the Division are very haphazard and do not follow any hierarchy. Some areas are large and closely spaced with higher population size and some are very low in smaller towns. Srinagar is the largest urban area spreading over 200 square kilometres and has about 0.65 million resident population. It has thus gained primate city status in the state. The smallest town is Tral with only 0.5 square kilometre of areal extension. Out of a total of 24 (twenty-four) urban centres in the Kashmir Division eighteen (18) are very small and infact are "overgrown glorified villages."[2] Their urban status exists only in name as their predominant functions are agricultural pursuits. What the Division needs is that the process of urbanization gains momentum and acceleration so that the level of urbanization boosts up the productive and secondary activities that contribute more to the economy of the Division as well as the State.

One approach to achieve the target is to create and to locate service centres in rural areas which have better potentialities and can serve their surrounding areas and may shape urban demography and other urban features of the state. For finding out and to locate such areas a simple methodology is here suggested.

Methodology

In the first phase, all those villages of Kashmir Division are taken into consideration whose population is equal to or more than 2,000. Let us denote the population by PI, again let P denote the percentage of population taking 2000 as base, that is P = 2000 = 100 percent. Let p be the excess percentage in population with respect to P. For socio-economic analysis, we select indicators like percentage of literates and workers to total population and percentage of non-agricultural workers to total workers. Let these be denoted by a, b, and c. The sum of these is denoted by Sd, so that $Sd = a + b + c$. The Sd has been computed for rural Kashmir Division level at 61.6 percent. This is the determining factor in the socioeconomic study of villages.

Now if any village has $a + b + c$ less than Sd, it is not taken into consideration for study despite how large its P may be, and if $a + b + c$ is greater than Sd, we use a new symbol D, so that

$$D = dI \times i + Sd + P$$

Where dI stands for excess value in Sd, i stands for 5, the incentive

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given to percentage for any such village in whatsoever respect its exceeds the Sd, P already defined. This represents the value of socioeconomic indicators. Graphically we can show it as follows:

Settlement	P	p	a	b	c	Sd	dI	D
Kashmir Division								
Rural level	...	...	12	32	17.6	61.6	...	...
"A" village	3,000	50	14	35	20.0	69.0	7.4	148.6
"B" village	2,000	5	10	31	15.5	56.6	...	...

where 2,000 is taken as base value that is 2,000 = 100%.

The "essential services and amenities" constitute the indicators with their values as higher education 4, junior higher education 3, primary education 2; higher medical facilities 4, moderate and low medical facilities as 3 and 2 respectively. Metalled and unmetalled roads as 4, and 2 respectively. Power (electric) supply 4, and posts and telegraphs with phone facility 4, telegraph 3, and post office 2. The value of a particular function is multiplied by its occurrence and the value thus derived are summed up that avails a village. The value is only added to those villages which satisfy the equation $D = dI \times i + Sd + p$. By adopting this strategy we give certain values to villages which number sixty-nine (69) out of two thousand nine hundred and forty (2,940) in Kashmir Division and are recognized as service centres. The index value of these centres range from eighty (80) to four hundred seventy-five (475). This range has been divided into three classes; (a) less than 150 group has been recognized as Village Service Centres, (b) group between (150-300) as Growth Potential Service Centres, and (c) group between (300-475) is recognized as Growth Generating Service Centres.

SUGGESTIONS AND CONCLUSION

In achieving balanced regional and urban development a major obstacle is produced by the developmental and planning policies which give their full attention and put stress on sectoral planning while neglecting the spatial and functional aspects of the region. This is not only creating polarization of socioeconomic activities and accumulation of "wealth" at some selected places, but in some cases it has already created social and economic tensions among masses. In Kashmir Division there has been extreme polarization of socioeconomic activities within a few established urban centres, keeping the multitude of settlements in perpetual backwardness. Under such a gloomy scene it is felt that unless these rural areas are given proper attention in respect of their needs and their developmental abilities and are not provided with the means of exploitation of their resources and are not provided with the functions in accordance with their resource bases, they will not be able to contribute

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towards the prosperity of the macro region in which they fall. A few large urban centres particularly Srinagar city in the Kashmir Division has overgrown in size and in absorbing greater share of inputs and people thronging in everywhere thus has become over-urbanized. Settlements a little far away from the city do not enjoy in most cases even the basic and essential amenities.

Therefore for regional and balanced urban development in Kashmir Division the creation of service centres in rural areas is needed which will help in diffusing functions and services so that the whole Division in one way or the other brought under the catchment area of various service centres. Each of the service centres can also promote inter-village complementary functions among constituent villages in obtaining job opportunities for each other and much of the labour will get jobs locally. The rush to create larger urban units may reduce Srinagar and those who are highly skilled will leave their home towns. This will lead to division of labour slowly, but steadily.

In Kashmir Division rural areas are highly underdeveloped, the range of their social and economic linkages are extremely narrow. Therefore every village is not a feasible unit for comprehensive development. So the idea of making each village self-contained has to be abandoned. But at the same time villages must change and the change must come from its people who inhabit it and they must be in contact with urban centres — the points at which ideas turn into realities, realities lead to success, success to prosperity, and prosperity to overall development.[3] In an area like Kashmir Division the problem is how to utilize manual resources and not to spare them and replaced by machines. Therefore at service centres those activities have to be furnished which are positively correlated with the resource base of the centre. Once these centres are selected they will function like nodes in the state's infrastructural networks (economic, social, institutional, and psychological, etc.), which form the activity system of next level of region — a meso region centred around the service centre.

In Kashmir Division sixty-nine (69) such centres have been recognized out of two thousand nine hundred forty (2,940) inhabited villages on the basis of methodology discussed earlier.

The distribution of these centres have been shown by Fig. 2 and Tables a, b, c. These service centres have been given scores based on their qualities. Those which range from 0-150 are called "Service Centres". These areas have more potential resources than other rural areas in the surrounding. The other group varies from 150-300 and has been called as "Growth Potential Service Centre". These centres have more central functions than the service centres. Finally, that group which ranges

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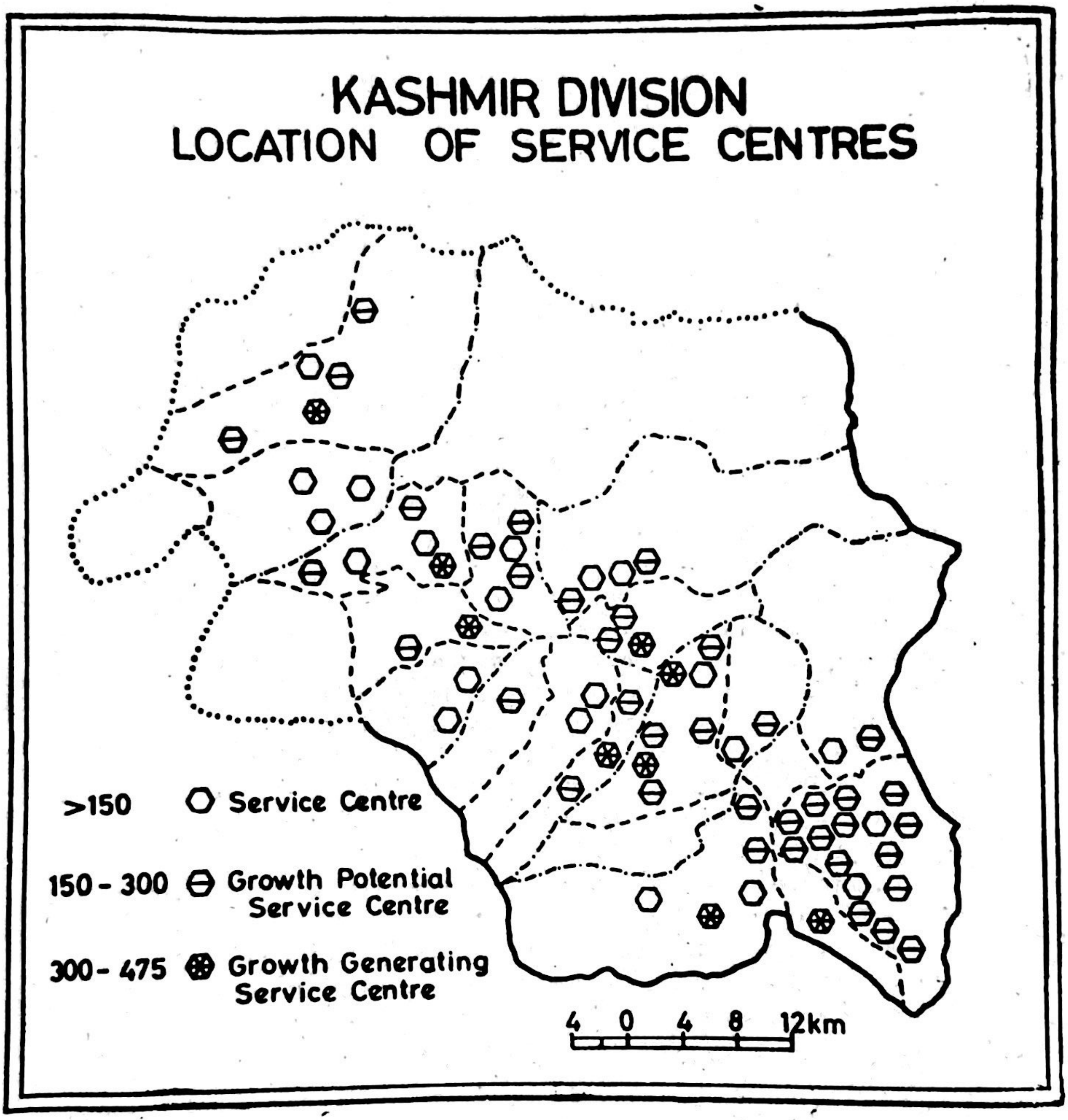

FIGURE 2

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from 300-475 has been called as "Growth Generating Service Centre" and are nine (9) in number. These have infact more or less urban characters.

These service centres will bring about homogeneity in the process of urbanization and in the level of urbanization at a micro-level. Also socially it is not possible to shift the population of Srinagar city to other areas so that the hierarchy is maintained in accordance with rank size rule. In such a condition the service centres can play a great role in the movement of people.

NOTES

1. Director Census Operations (1981), Census of India, Series 8, Jammu and Kashmir, Part II.
2. Mayer, I.A., (1984) Srinagar Primacy in Relation to Other Towns of Kashmir Vlaaey, unpublished M. Phil Dissertation, University of Kashmir, Srinagar, pp. 107-110.
3. Ibid., p. 116.

ACKNOWLEDGMENT

Thanks are due to Prof. Bais Akhtar for his guidance in writing this paper.

Table a. **Service Centres with their scores.**

Settlements	Scores
I. *Ganderbal Tehsil:*	
1. Gutli Bagh.	148.4
2. Manigam.	106.9
II. *Badgam Tehsil:*	
1. Rawal Pora.	102.4
2. Ompora.	128.1
3. Own.	141.1
III. *Sonawari Tehsil:*	
1. Gund Sadar Kot.	134.9
2. Ashern.	88.9
IV. *Sopore Tehsil:*	
1. Tujar Pakhar.	136.3
2. Hardu Shou.	142.8
V. *Gulmarg Tehsil:*	
1. Lal Pora.	102.8
2. Feroz Pora.	103.3
VI. *Handwar Tehsil:*	
1. Kandi Khas.	131.0
2. Langet.	135.9
3. Magam.	135.8
VII. *Kupwara Tehsil:*	
1. Drugmula.	139.3

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VIII. *Pahalgam Tehsil:*	
1. Salar.	144.1
2. Dadsar.	149.6
IX. *Anantnag Tehsil:*	
1. Solia Ponchal Pora.	112.3
2. Sofa Shali.	86.8
X. *Kulgam Tehsil:*	
1. Kulgam Lozga.	126.0
2. Mazgam.	116.8
3. Frisal.	148.4

Table b. **Growth Potential Service Centres.**

Settlements	**Scores**
I. *Ganderbal Tehsil:*	
1. Tulmula.	205.8
2. Saloora.	256.8
3. Moran.	244.8
II. *Srinagar Tehsil:*	
1. Khanmoh.	208.0
2. Gupta Ganga.	260.1
3. Tokne.	156.0
III. *Chadura Tehsil:*	
1. Kral Pora.	246.2
2. Nagam.	170.6
3. Giru.	180.0
IV. *Beerwah Tehsil:*	
1. Beerwah.	191.2
V. *Sonawari Tehsil:*	
1. Ajas.	256.1
2. Safa Pora.	255.6
3. Naid Khai.	169.4
VI. *Sopore Tehsil:*	
1. Achabal.	280.0
2. Trega Pora.	185.8
VII. *Baramulla Tehsil:*	
1. Delina.	243.7
VIII. *Kupwara Tehsil:*	
1. Sogam.	170.0
2. Trehgam.	232.4
3. Panzgam.	178.8
IX. *Kulgam Tehsil:*	
1. Kurigam.	195.0
2. Grand Aish.	222.0
3. Awantipora.	198.7
4. Rathi Pora.	246.6

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X. *Pulwame Tehsil:*	
1. Keriam.	168.4
2. Seer Kandi Gund.	284.3
3. Ranbir Pora.	157.3
4. Uttarsoo.	220.1
XI. *Anantnag Tehsil:*	
1. Shangas.	191.6
2. Nowgam Kother.	219.8
3. Sahib Abad.	252.0
4. Akiem Gom.	204.6
5. Devil Gom.	180.1
6. Bata Gund.	180.5
7. Veerinag.	251.6
8. Sogam.	173.9
9. Fateh Pora.	203.9
10. Navilgam.	207.7

Table c. **Growth Generating Service Centres.**

Settlements	Scores
I. *Srinagar Tehsil:*	
1. Barzalla.	426.4
II. *Chadura Tehsil:*	
1. Char-i-Sharief.	436.7
III. *Sopore Tehsil:*	
1. Seer Jagir.	474.6
IV. *Baramulla Tehsil:*	
1. Pattan.	390.6
V. *Kupwara Tehsil:*	
1. Kupwara.	358.0
VI. *Anantnag Tehsil:*	
1. Duru.	370.7
VII. *Kulgam Tehsil:*	
1. Chowgam.	374.7
VIII. *Pulwama Tehsil:*	
1. Pulwama.	373.0
2. Khrew.	346.0

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REGIONAL VARIATIONS OF AGRICULTURAL PRODUCTIVITY IN JAMMU AND KASHMIR

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and Shafat Ali Khan

ABSTRACT. *Jammu and Kashmir is primarily an agricultural state of India with 85 percent of the total population engaged in this occupation. There are marked differences in the production of different crops in aggregate production in the districts as well as per unit of area in the state. Cereal crops account for 75.41 percent, pulse crops 5.41 percent, oilseeds with 4.35 percent, and cash crops 0.32 percent accounting for 85.91 percent of the total cropped area of the state. The irrigation facilities are inadequate and only 30.02 percent of the cropped area is irrigated.*

In this paper, an attempt has been made to analyze the spatial variations in agricultural productivity in Jammu and Kashmir by considering ten crops grouped into four categories as cereal crops, pulse crops, oilseeds and cash crops. The study is based on districtwise data collected from official records of the Jammu and Kashmir Government. According to the methodology as given by "Yang" the productivity indices of crops considered for ten districts have been computed for the year 1985-86.

The overall picture of agriculture productivity as emerged by using composite yield index shows that two districts fall in high category, four districts in medium category, two in low category and two districts fall in very low productivity regions. Further, an attempt has also been made to evaluate diverse factors responsible for regional variations of agricultural productivity in the entire state.

Variations in the level of agricultural development have attributed considerable attention of planners and researchers and many studies have come out relating to the position of agriculture in the various states like Uttar Pradesh, Rajasthan, Punjab and Tamil Nadu. But no attempt as such has been made to study the problem of agricultural development in Jammu and Kashmir which is also agricultural important, with about 85 percent population of the State directly or indirectly dependent on agriculture. Therefore, the main objective of the study is to find out the variations in agricultural productivity in Jammu and Kashmir State.

The State of Jammu and Kashmir lies between 32°17′ and 37°5′ North latitudes and 72°40′ and 80°30′ East longitudes and occupies a strategic position in India, with its border touching Afganistan in the northwest, Pakistan in the west and China and Tibet in the north and east. The State as a whole covers an area of 222,236 sq. km. (Fig. 1).

The situation and physiography of the State are mainly responsible for the varying climatic conditions in its three regions — the outer plains and outer hills of Jammu, the vale of Kashmir and the frontier region of Ladakh and Gilgit. The variations in temperature and rainfall are related to their altitude.

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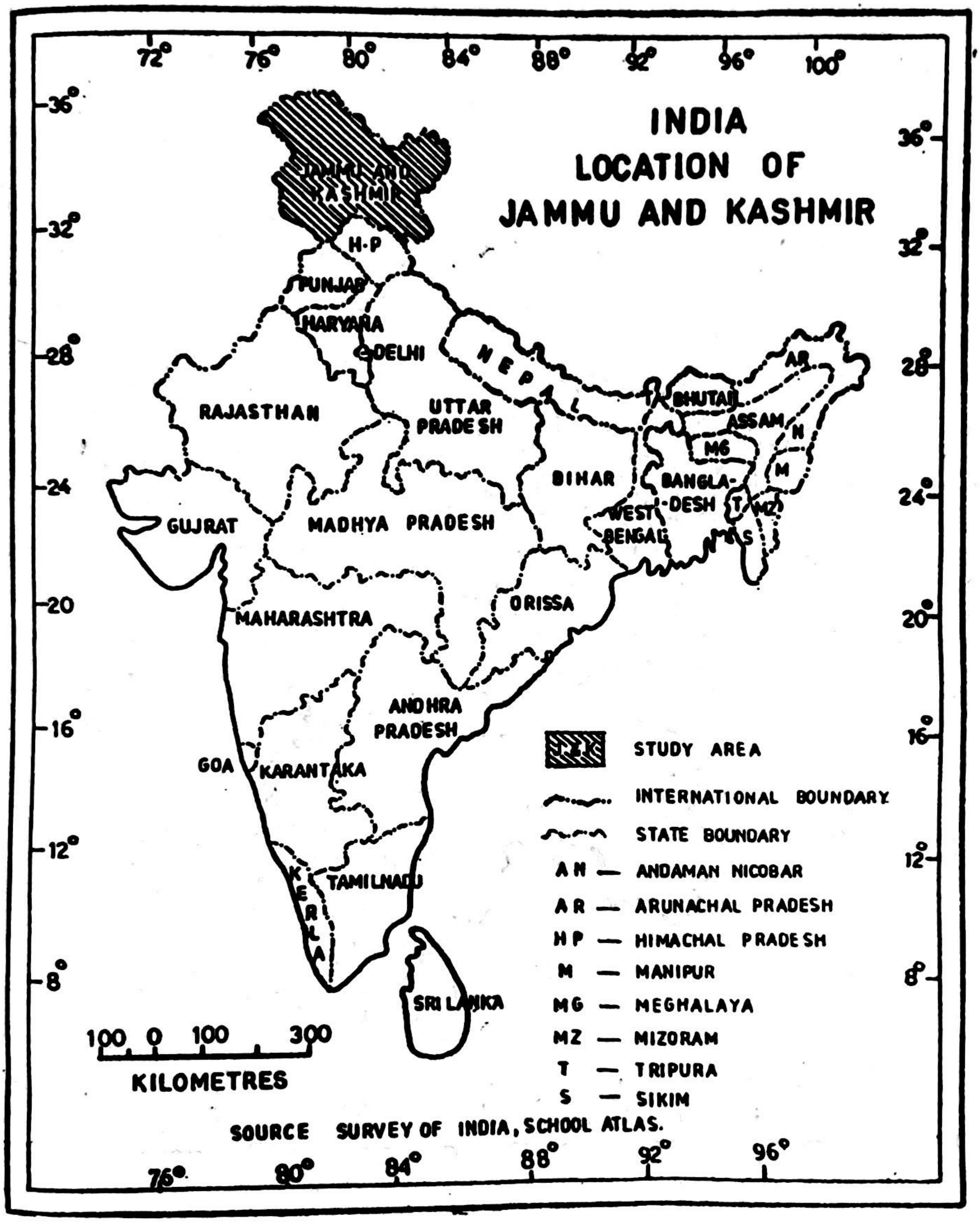

FIGURE 1. INDIA LOCATION OF JAMMU AND KASHMIR

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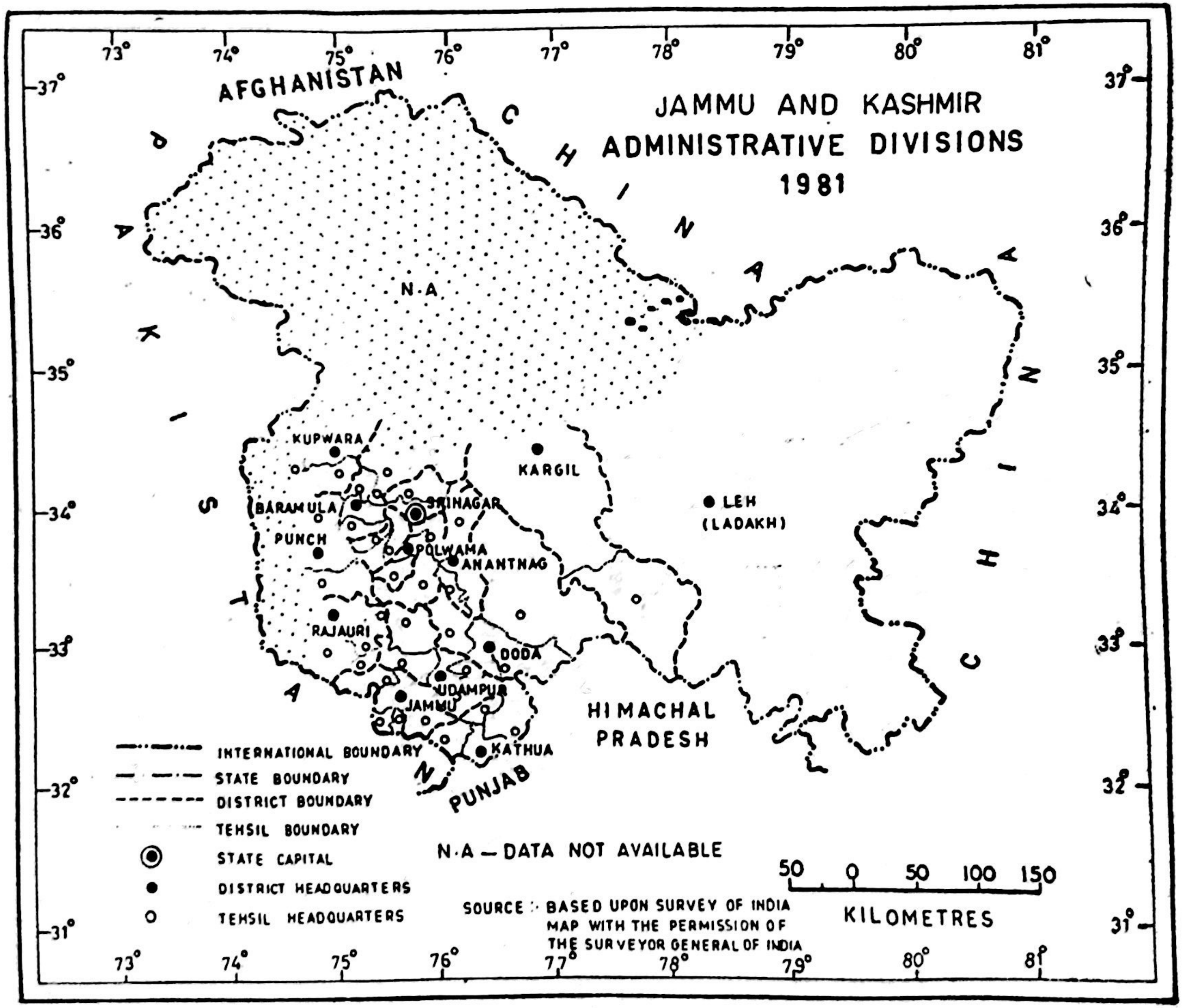

FIGURE 2. JAMMU AND KASHMIR ADMINISTRATIVE DIVISIONS 1981

The formation of the soil in the State is the result of climatic factors and geomorphic process. In the middle mountain region, the soil is fairly thick, rich and capable of supporting the oak, pine, fir and deodar trees. There are patches of alluvial soils in the areas of stream flow and where crops are grown. There is a large area of alluvial soil in the state.

In order to assess the crop productivity in each of ten districts of the Jammu and Kashmir State for the year 1985-86, these were computed according to the crop yield index method initiated by "Yang". Ten leading crops were considered which all together accounted for 85.91 percent of the total cropped area of the State for the year 1985-86. For computing productivity, these crops were grouped into four distinct categories, viz., cereal crops (rice, maize, wheat and barley), accounting for 75.41 percent of the cropped area; pulse crops (gram and urd), 5.41 percent, oilseeds, (mustard and sesamum), with 4.35 percent and cash crops, (potatoes and chillies) which account 0.32 percent of the total cropped area of the State for the year 1985-86.

The study is based on districtwise data collected from official records of the Directorate of Economics and Statistics Planning and Development of Jammu and Kashmir. The productivity indices of crops considered for each district were computed according to the methodology as given by "Yang" and as explained by the author with an example of district A (Table 1).

TABLE 1. METHODS OF CALCULATING CROP PRODUCTIVITY INDEX FOR THE DISTRICT 'A'

Name of the crops	Yield in Quintal per hectare		Area of crop in the district in hectares	Crop yield in the district as percentage of the State (Col. 3/Col. 2 x 100)	Percentage multiplied by area in hectares (Col. 5 x Col. 4)
	Average yield in the State	Yield in the district			
1	2	3	4	5	6
Rice	12.24	18.29	3,570	149.42	533,458.3
Maize	14.25	22.56	20,360	158.31	3,223,309.5
Wheat	10.95	16.25	7,000	148.40	1,038,812.8
Barley	8.22	7.39	23	89.90	2,067.7
Total	—	—	30,953	—	4,797,648.3

$$\text{Crop Yield Index for district 'A'} = \frac{4,797,648.3}{30,953} = 154.99$$

This index represents the yield of all crops in a district compared with the average yield of the crop in the State. The method is to divide the average yield per hectare of a crop on a particular farm by the average yield of the crop in the entire region. A percentage thus obtained multiplying with 100, gives the index number as shown in column 5 of the Table 1. By considering the area devoted to each crop as a weight and multiplying this percentage index, the products are obtained as shown in column 6 of the Table 1. By adding the products and dividing the sum of the products by the total cropped area in the district (the sum of column 4), the average index obtained is the desired crop yield index for the particular district, using the cropped area as weight.

Productivity patterns in Jammu and Kashmir

To identify agricultural productivity patterns in Jammu and Kashmir, the crop productivity was computed in accordance with the methodology discussed earlier for the ten districts for the years 1985-86.

To classify the districts with reference to the magnitude of spatial variations, a statistical method for regional demarcation was applied to work out to get the mean value of agricultural productivity indices. Table 2 helps to demarcate the different productivity regions. Uniform class of magnitude of distribution of crop productivity were decided. In order to classify districts into four classes on the basis of variation of districts around the mean value of the productivity index, following system was adopted to determine the ranges of class.

TABLE 2

Productivity Rank	Index Range
High	Above 130
Medium	115 — 130
Low	100 — 115
Very low	Below 100

This system of regional demarcation was applied to the State on the basis of productivity indices computed for each district and with a view to maintain uniformity. In order to assess the crop intensity and patterns in each district during the period under study, the area under major ten crops were added into four distinct broad categories; cereal crops, pulse crops, oilseeds and cash crops.

(1). Productivity regions, on the basis of cereal crops

Cereal crops acquire an important position in the agriculture of Jammu and Kashmir with 75.83 percent of the total cropped area of the State. Among the cereal crops, rice, maize, wheat and barley are the important crops. Out of the four, maize being the most dominating cereal crop, covers an area of about 29.08 percent of the total cropped area of the State.

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(i). *High productivity region*

On the basis of cereal crops high productivity is designated to the district of Poonch with the index value of more than 130. This district covers an area of about 30,953 hectares (4.55 percent) of the total area under cereal crops in the State in 1985-86. Rice, maize and wheat are the dominating crops of high productivity region. The high productivity of cereal crops in this district is mainly due to the high percentage of irrigation and favorable climatic conditions. The district belongs to the dark green belt, where the average annual rainfall invariably exceeds 1270 mm. As a result of sufficient moisture available, the crops do not suffer with that of non-availability of water. Agricultural lands are also benefitted with the presence of numerous springs the waters of which are usually used for irrigation. Most of the rivers are perennial, therefore, they constitute an important source of irrigation.

(ii). *Medium productivity region*

Medium productivity regions based on cereal crops with the index ranging between 115 and 130, are confined to the districts of Baramulla and Doda. These districts cover 15,476 hectares (22.26 percent) of total cropped area under the cereal crops. In the medium productivity regions, district Doda lies in the outer hill region with an altitude of 609 m to 1219.2 m above the sea level. In this district cultivation is scarce and is carried on over small scattered fields. The soil is having medium range of nutrients like nitrogen, phosphates and potash. In Baramulla, the crops are very oftenly destroyed by the unprecedented floods and the top layers of the soil are washed keeping the soil with marginal fertility.

(iii). *Low productivity region*

The low productivity in this region characterized by the index value ranging from 100 to 115, includes the districts of Udhampur and Jammu. There are 182,908 hectares of land characterized by low productivity. Low productivity region accounts for 26.88 percent of the total cropped area of the State, Table 3. The area devoted to cereal crops in these districts recorded as 7.97 and 18.91 percent respectively.

TABLE 3. AREA UNDER DIFFERENT PRODUCTIVITY REGIONS CEREAL CROPS, 1985-86

Productivity Rank	Range index	Area under cereals in hectares	Percentage	Number of districts
High	Above 130	30,953	4.55	1
Medium	115 — 130	15,476	22.26	2
Low	100 — 115	182,908	26.88	2
Very low	Below 100	314,898	46.29	5

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The soils of Jammu district show a great heterogeneity. They are characterized with low proportion of nitrogen and medium quantities of phosphorus and potash. Jammu region of the state is having a relatively low altitude and some parts adjacent to Punjab plain experience warm climatic conditions and annual rainfall is generally inadequate. A few patches of agricultural fields are irrigated by canals. The Udhampur district falls in the region of outer hills lying to the south of Pir Panjal range of Himalayas which separates it from Kashmir region. The district is mountainous in character, therefore, cultivation of crops is confined mainly to terraces at the hill sides.

(iv). *Very low productivity region*

The productivity of this region is characterized with the index value below 100, and spreads over the districts of Anantnag, Srinagar, Ladakh, Kathua and Rajouri. All these districts have the area under cereal crops as percentage of the total area of cereal crops are 15.48, 9.27, 0.63, 11.38 and 9.5 percent, respectively.

(2). **Productivity regions, based on pulse crops**

The cultivation of pulse crops is very significant in Jammu and Kashmir agriculture. In the cultivation of crops they constitute second place. Cultivation of pulse crops spreads over an area of 48,600 hectares (5.41 percent) out of the total cropped area of the State. But the productivity varies in different parts of the State. Table 4 and Table 5 show the variations in productivity of pulse crops and the state, as the entire districts have been grouped into high, medium, low and very low productivity.

TABLE 4. DISTRICTWISE CEREAL CROPS PRODUCTIVITY INDEX, AREA, PERCENTAGE IN JAMMU AND KASHMIR

Name of the districts	Productivity index value of cereal crops	Total area of cereal crops	Percentage of area under cereal crops in districts
Anantnag	88.25	105,302	15.48
Srinagar	95.59	63,063	9.27
Baramulla	119.46	101,658	14.94
Ladakh	69.46	4,727	0.63
Udhampur	110.15	54,238	7.97
Jammu	113.42	128,670	18.91
Kathua	96.88	77,460	11.38
Doda	115.37	49,818	7.32
Poonch	154.99	30,953	4.55
Rajouri	88.69	64,746	9.51

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TABLE 5. AREA UNDER DIFFERENT PRODUCTIVITY REGIONS — PULSE CROPS, 1985-86

Productivity Rank	Range Index	Area under pulse crops in hectares	Percentage	Number of districts
High	Above 130	3,900	8.02	4
Medium	115 — 130	2,000	4.11	1
Low	100 — 115	700	1.44	1
Very low	Below 100	42,000	86.41	4

(i). *High productivity region*

High productivity in pulse crops with indices above 130, occupies 3,900 hectares (8.02 percent) of the total area under pulse crops spreads over the districts of Anantnag, Baramulla, Ladakh and Poonch. The productivity index value of these districts are 1.85, 1.02, 2.05 and 3.08, respectively. In these districts the area under pulse crops accounts for 10.28, 32.92, 18.51 and 24.69 percent, respectively.

TABLE 6. DISTRICTWISE PULSE CROPS PRODUCTIVITY INDEX, AREA, PERCENTAGE IN JAMMU AND KASHMIR

Name of districts	Productivity index value of pulse crops	Total area of pulse crops in hectares	Percentage of area under pulse crops in district
Anantnag	176.34	900	1.85
Srinagar	113.33	700	1.44
Baramulla	145.07	500	1.02
Ladakh	142.85	1,000	2.05
Udhampur	47.61	5,000	10.28
Jammu	26.66	16,000	32.92
Kathua	38.72	9,000	18.51
Doda	22.38	12,000	24.69
Poonch	169.20	1,500	3.08
Rajouri	119.04	2,000	4.11

(ii). *Medium productivity region*

The medium productivity regions occupy 2,000 hectares (4.11 percent) of the total area with the index value ranging between 115 and 130, covers the district of Rajouri. The productivity index value of district Rajouri is 119.04.

(iii). *Low productivity region*

The low productivity in pulse crops is characterized with the index value of 113.33 between 100 and 115 in the single district of Srinagar. The total area characterized with low productivity accounts to 700 hectares (1.44 percent) under pulse crops of the total area of the State.

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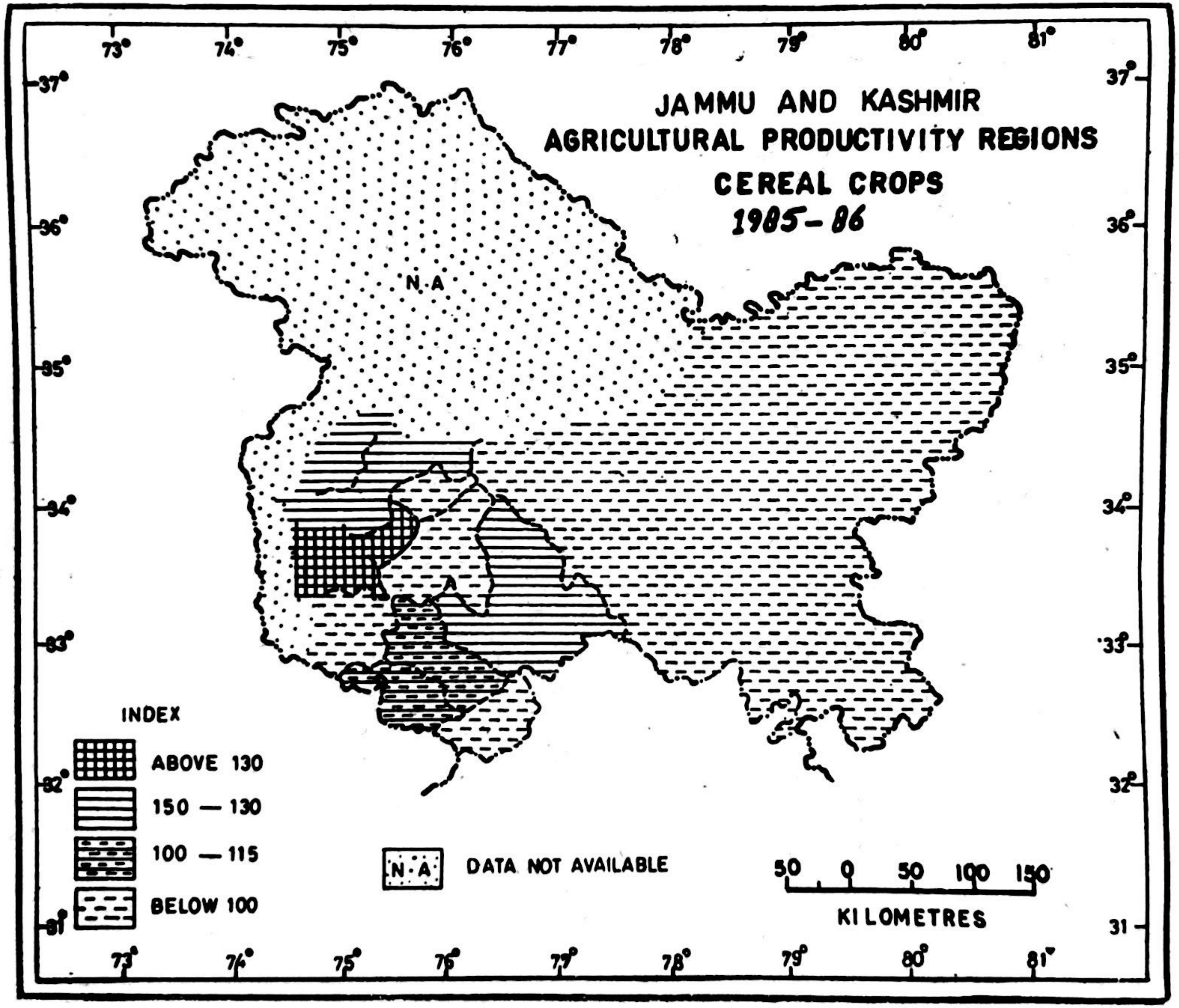

FIGURE 3. JAMMU AND KASHMIR AGRICULTURAL PRODUCTIVITY REGIONS CEREAL CROPS 1985-86

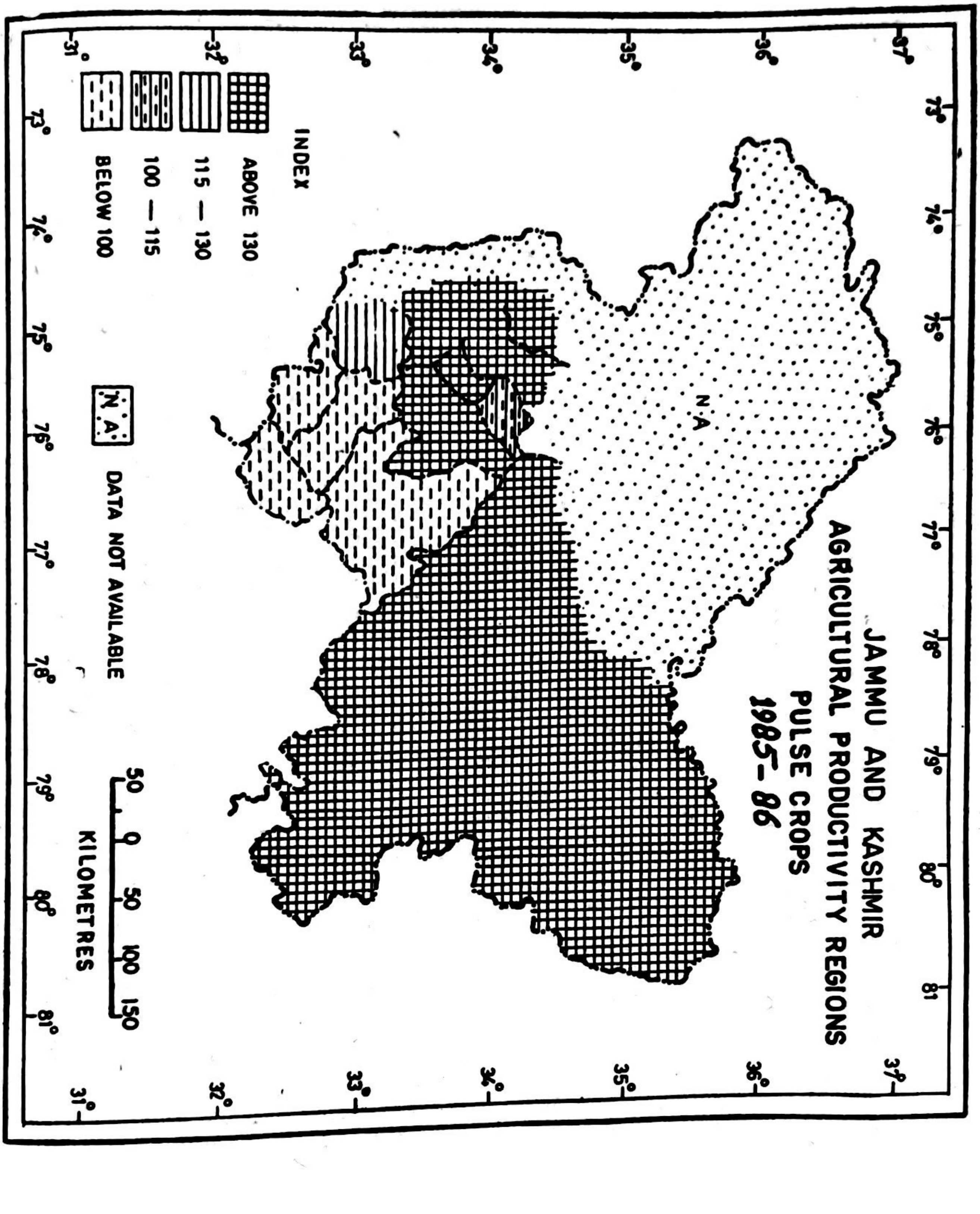

FIGURE 4. JAMMU AND KASHMIR AGRICULTURAL PRODUCTIVITY REGIONS PULSE CROPS 1985-86.

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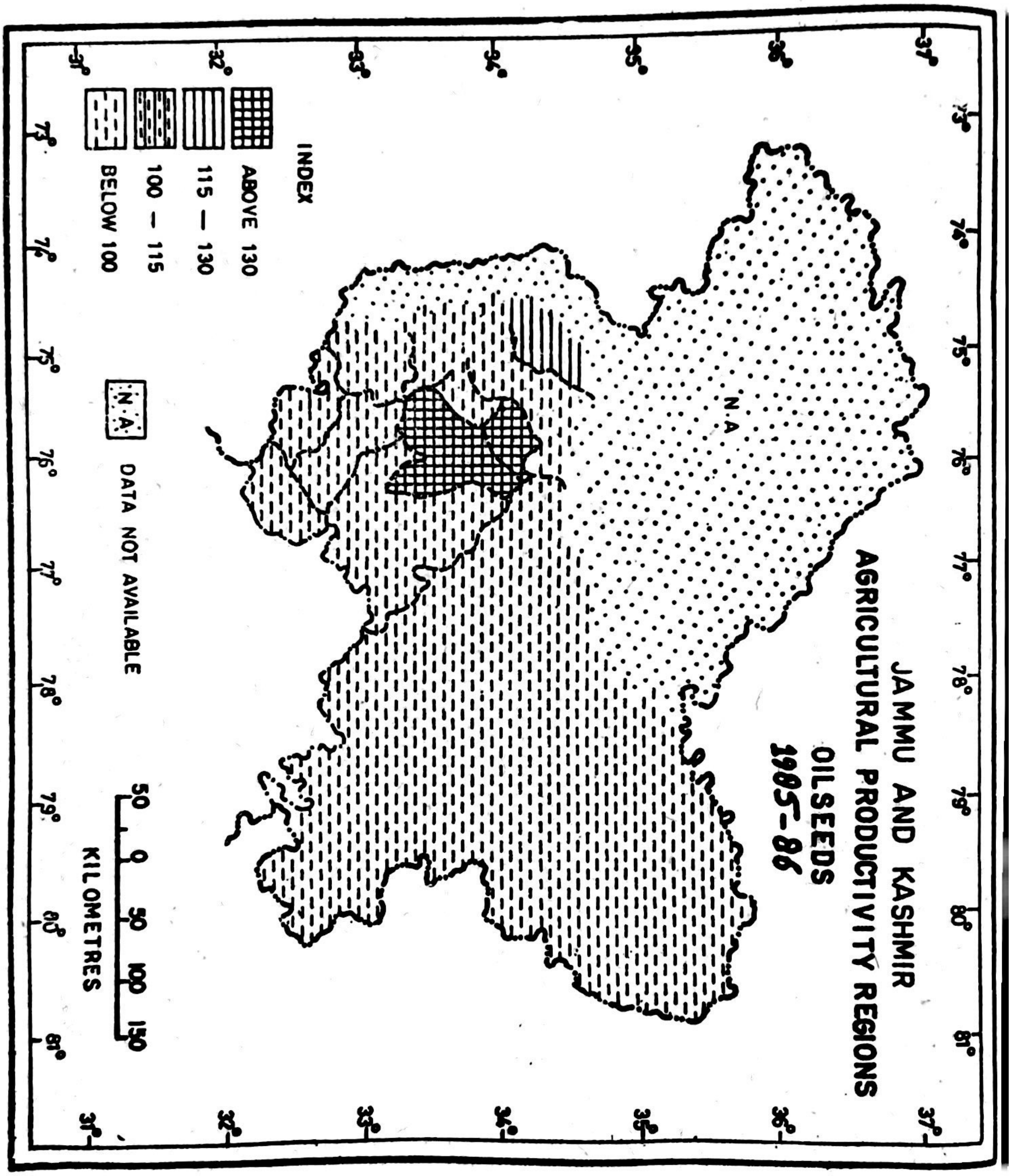

FIGURE 5. JAMMU AND KASHMIR AGRICULTURAL PRODUCTIVITY REGIONS OILSEEDS, 1985-86

(iv). *Very low productivity region*

The very low productivity of pulse crops with the indices below 100, occupy the largest area of 42,000 hectares (86.41 percent) of the total area of the State, extends over the districts of Udhampur, Jammu, Kathua and Doda. The index value of these districts computed for are 47.61, 26.86, 38.73 and 22.38, respectively.

(3). **Productivity regions, based on oilseeds**

In Jammu and Kashmir, mustard and til are important oilseeds, occupy third place after cereal crops and pulse crops. These two oilseeds cover an area of 37,146 hectares (4.35 percent) of the total cropped area of Jammu and Kashmir State. Mustard covers an area of 2.95 percent and sesamum with 1.40 percent of the total cropped area of the State.

TABLE 7. AREA UNDER DIFFERENT PRODUCTIVITY REGIONS — OILSEEDS, 1985-86

Productivity Rank	Range Index	Area under oilseeds in hectares	Percentage	Number of districts
High	Above 130	22,529	57.55	2
Medium	115 — 130	2,486	6.35	1
Low	100 — 115	Nil	Nil	Nil
Very low	Below 100	14,131	96.09	7

(i). *High productivity region*

The areas of oilseeds having high productivity with indices of more than 130, spreads over the districts of Anantnag and Srinagar, Table 8. The soils of these districts are alluvial in nature. New alluvium is being renewed and enriched every year by the silt spread over on either side of the streams. The necessary amount of irrigation is available from the Jhelum. The water is taken out through a number of drains from the main river to irrigate the fields. The area devoted in oilseeds is 2.51 percent of the total cropped area of the State. The percentage of total area of oilseeds in the districts are 44.50 in Anantnag and 13.04 percent in Srinagar 1985-86, Table 8.

(ii). *Medium productivity region*

Next to high, is the category of medium productivity of oilseeds in the district of Baramulla with the index value of 127.56. The area devoted to oilseeds in this district is 2,486 hectares (6.35 percent) of the total oilseeds area in the State.

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TABLE 8. DISTRICTWISE OILSEEDS PRODUCTIVITY INDEX, AREA, PERCENTAGE IN JAMMU AND KASHMIR

Name of districts	Productivity index value of oilseeds	Total area of oilseds in hectares	Percentage of area under oilseeds in district
Anantnag	171.98	17,423	44.50
Srinagar	193.78	5,106	13.04
Baramulla	127.56	2,486	6.35
Ladakh	85.37	43	0.10
Udhampur	50.50	2,055	5.24
Jammu	56.21	3,598	9.19
Kathua	38.19	5,494	14.03
Doda	69.12	861	2.19
Poonch	43.00	690	1.76
Rajouri	67.48	1,390	3.55

(iii). *Low and very low productivity regions*

Not a single district is characterized with low productivity. However, a very low productivity region is recognized with the indices below 100, spreading over the districts of Ladakh, Udhampur, Jammu, Kathua, Doda, Poonch and Rajouri occupied 14,131 hectares (36.09 percent) of the total oilseeds area of the State. The productivity value in these districts are 85.37, 56.21, 38.19, 69.12, 43.00 and 67.48, respectively.

(4). **Productivity regions, based on cash crops**

Potatoes and chillies do not occupy very signifiacnt position in Jammu and Kashmir State because of an insignificant area of 2,989 hectares (0.32 percent) of the total cropped area of the State. The total quantum of production of these crops is very low due to certain environmental restrictions. A sizeable number of districts show less than five percent of area devoted to these crops. Productivity indices computed for the districts, they can be out as having high, medium, low and very low productivity.

TABLE 9. AREA UNDER DIFFERENT PRODUCTIVITY REGIONS — CASH CROPS, 1985-86

Productivity Rank	Index Range	Area under cash crops in hectares	Percentage	Number of districts
High	Above 130	1,684	56.33	4
Medium	115 — 130	153	5.11	1
Low	100 — 115	Nil	Nil	Nil
Very low	Below 100	1,152	38.54	5

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(i). *High productivity region*

The region of high productivity with the index value of above 130, under cash crops occupy 1,684 hectares (56.33 per cent) of the total area of the State, spreading over four districts viz., Srinagar, Ladakh, Jammu and Kathua. The highest productivity is computed for the Kathua district being 252.29, Table 10.

TABLE 10. DISTRICTWISE CASH CROPS PRODUCTIVITY INDEX, AREA, PERCENTAGE IN JAMMU AND KASHMIR

Name of districts	Productivity index value of cash crops	Total area of cash crops in hectares	Percentage of area under cash in district
Anantnag	50.58	611	20.40
Srinagar	139.26	1,081	36.16
Baramulla	52.05	253	8.46
Ladakh	170.64	15	0.50
Udhampur	47.89	117	3.91
Jammu	159.35	331	11.07
Kathua	252.29	257	8.59
Doda	129.12	153	5.11
Poonch	80.45	67	2.24
Rajouri	44.75	104	3.47

(ii). *Medium productivity region*

Besides four districts having high productivity, single district of Doda is characterized by the medium productivity with an index value of 129, occupy 5.11 percent of the total cash crops area in the State.

(iii). *Low and very low productivity regions*

The area with very low productivity in cash crops occupy 1,152 hectares (38.54 percent) of the total cash crops area of the State, with the indices below 100, spreading over five districts viz., Anantnag, Baramulla, Udhampur, Poonch and Rajouri. The specific values of productivity in these districts are 50.58, 52.05, 47.89, 80.45 and 44.75, respectively.

Crop productivity regions — composite yield index

In order to understand the variations, which were recognized with individual values of crop yield index computed for cereal crops, pulse crops, oilseeds and cash crops, an attempt has been made by aggregating the individual values of productivity indices to get a composite value of productivity index to get composite value from the respective crops yield index. Table 12 shows the composite crop yield indices and Fig. 7 is based on Table 12. It is evident from the Fig. 7 that four district categories of productivity can be recognized as high, medium, low and very low.

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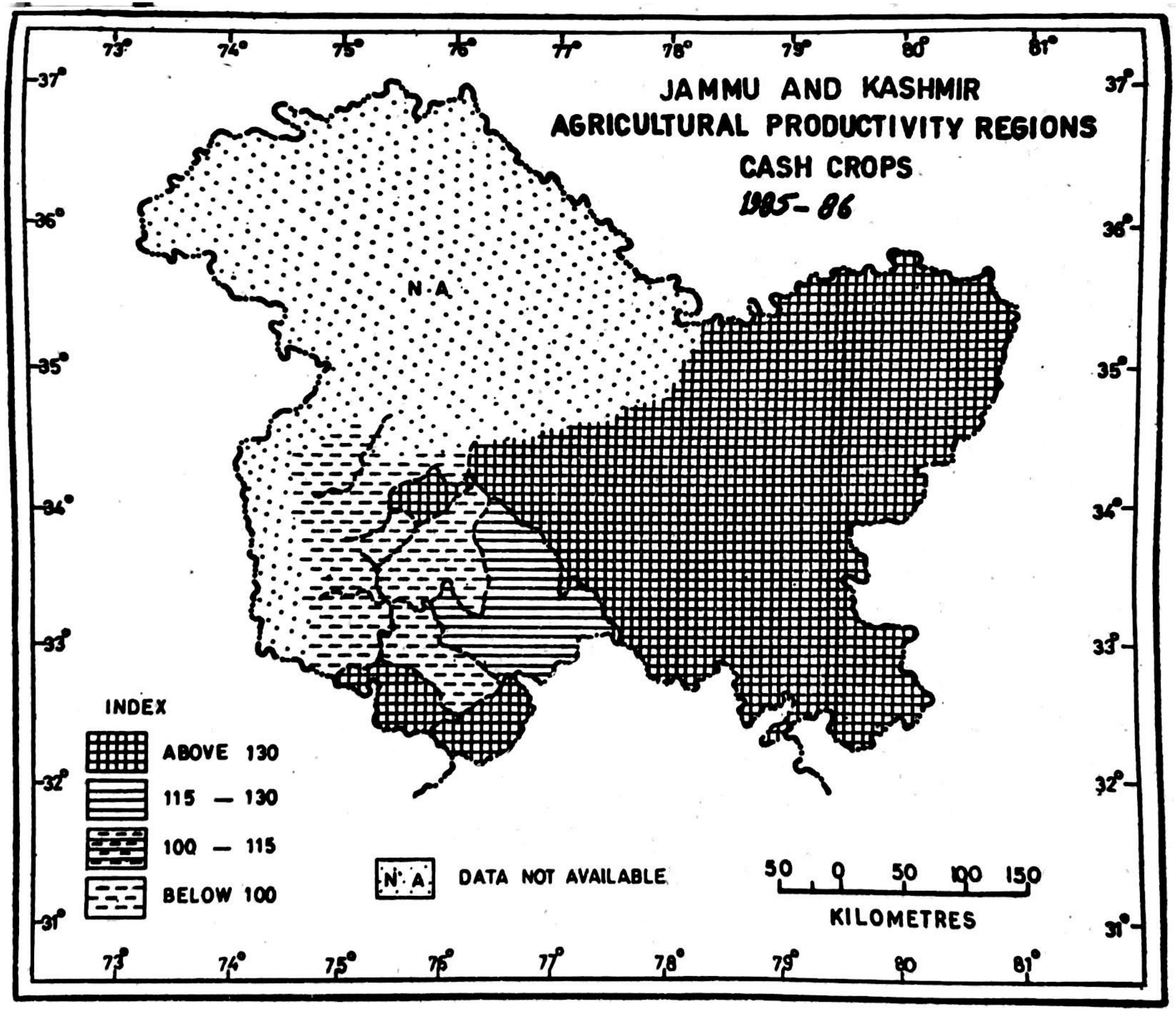

FIGURE 6. JAMMU AND KASHMIR AGRICULTURAL PRODUCTIVITY REGIONS CASH CROPS 1985-86

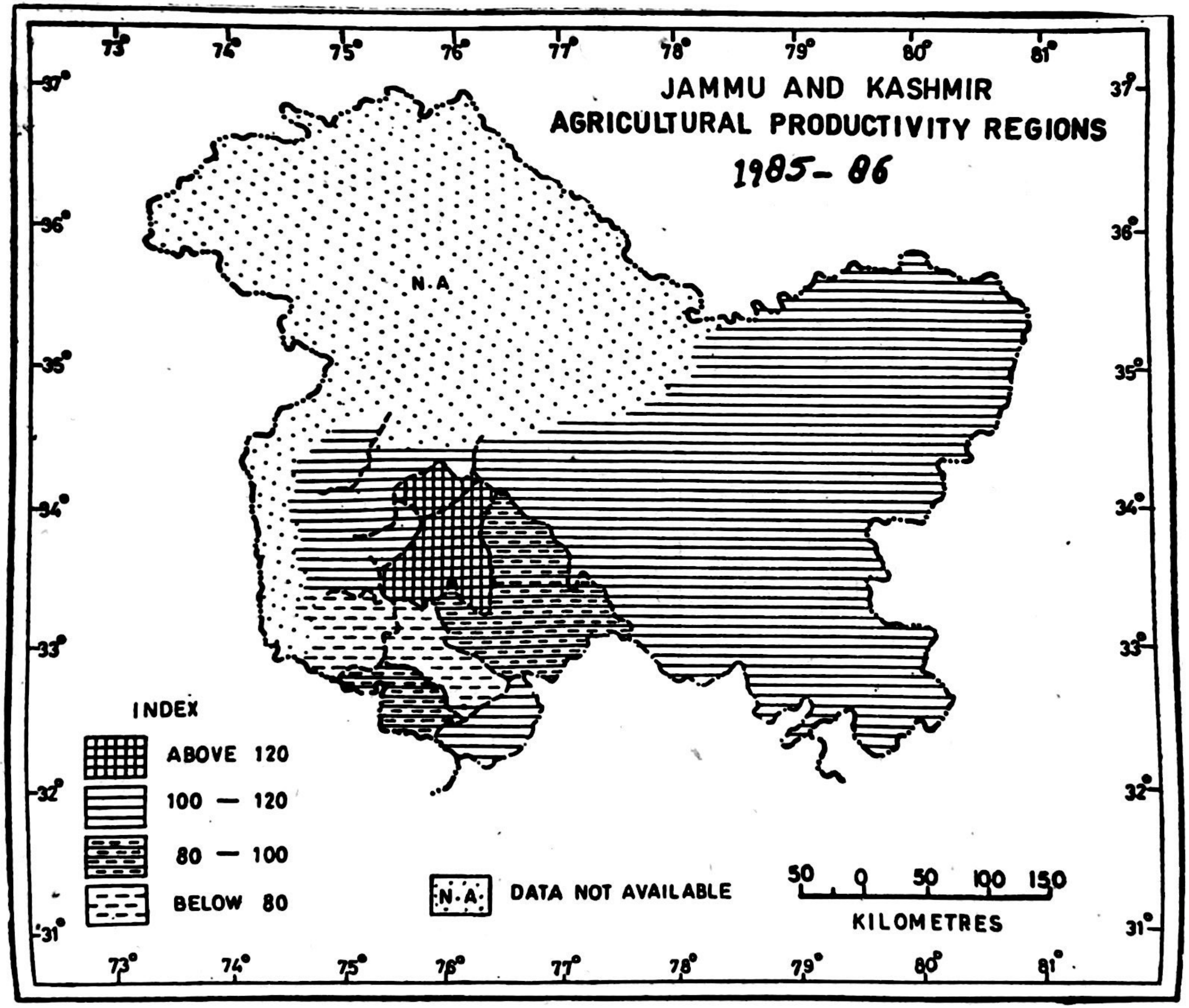

FIGURE 7 JAMMU AND KASHMIR AGRICULTURAL PRODUCTIVITY REGIONS 1985-86

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TABLE 11. AREA UNDER DIFFERENT PRODUCTIVITY REGIONS — COMPOSITE YIELD INDEX IN JAMMU AND KASHMIR

Productivity Rank	Yield Index	Area of productivity regions in hectares	Percentage	Number of districts
High	Above 120	194,186	25.18	2
Medium	100 — 120	235,307	30.57	4
Low	80 — 100	211,431	27.42	2
Very low	Below 80	129,650	16.81	2

(i). *High productivity region*

High productivity regions are recognized with an index value more than 120, are confined mainly to the districts of Anantnag and Srinagar. High productivity in Srinagar is characterized with the index value of 135.49. The share of this category in the total cropped area accounted for 25.18 percent.

TABLE 12. DISTRICTWISE COMPOSITE YIELD INDEX, AREA, PERCENTAGE IN JAMMU AND KASHMIR, 1985-86.

Name of districts	Composite yield index of productivity	Total cropped area of distdict in hectares
Anantnag	121.78	124,236
Srinagar	135.48	69,950
Baramulla	111.03	104,897
Ladakh	117.08	5,385
Udhampur	64.03	61,410
Jammu	88.91	148,599
Kathua	106.52	92,211
Doda	83.99	62,832
Poonch	111.91	33,210
Rajouri	79.99	68,240

(ii). *Medium productivity region*

The medium productivity region covers an area of 235,703 hectares (30.57 percent) of the total cropped area of State to include the districts of Baramulla, Ladakh, Poonch and Kathua with the indices ranging from 100 to 120.

(iii). *Low productivity region*

The low productivity region with the indices ranging between 80 and 100, extends over the districts of Jammu and Doda and occupying 211,431 hectares (27.42 percent) of the total cropped area of the State.

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(iv). *Very low productivity region*

The very low productivity region having index value below 80, spreads over the districts of Rajouri and Udhampur by occupying 129,650 hectares (16.81 percent) of the total cropped area of the State.

Thus, it is evident from Table 12 that only two districts of Anantnag and Srinagar have high productivity, four districts are characterized with medium productivity, Fig. 7, two districts of Jammu and Doda, have low productivity and the remaining two districts of Rajouri and Udhampur have very low productivity. Out of the total area of Jammu and Kashmir State only 194,186 hectares (25.18 percent) has high productivity, 235,703 hectares (30.57 percent) with medium productivity, while the percentage figure for low and very low area; 211,431 hectares (27.42 percent) and 129,650 hectares (16.81 percent), respectively. A largest chunk of area (about 43 percent) of the total area of the State is under low and very low agricultural productivity and these characteristics of productivity may be attributed to a number of natural, technological and socioeconomic factors operating in this region. The areas of low and very low productivity are confined mainly in the regions having the soils made up of disintegrated sand stones, coarse grained red soils (*kankar*). All these soils where the productivity is low and very low lack nutrients needed by the crops. Mostly the deficiency is nitrogen. The soils are of coarse texture, so they are less retentive of moisture. The pH value is very low. Lack of irrigation and management facilities predominate.

Besides, agriculture in Jammu and Kashmir suffers from unscientific methods of cultivation, small size of holdings, inadequate supply of manures and improved seeds and lack of assured irrigation facilities. Even cowdung though easily available is not used as manure but is used as fuel. Snowfall and strong winds also influence the nature of soils. With assured irrigation and necessary inputs in agriculture, e.g., capital, improved seeds, fertilizers and other technological changes in the methods of farming, there seems to be no reason why productivity cannot be raised to a satisfactory level. It has been claimed that land in Jammu and Kashmir, if coaxed well, can be made to support five times her population if agricultural efficiency is increased to Japanese level.

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