ISSN 0031-7551

PHILIPPINE GEOGRAPHICAL SOCIETY ☆1950☆

PHILIPPINE GEOGRAPHICAL JOURNAL

VOLUME 36 NUMBERS 1 & 2 JANUARY-JUNE, 1992

CONTENTS

Published Quarterly by
the Philippine Geographical Society and
the National Research Council of the Philippines
Department of Science and Technology
Manila, Philippines

THE PHILIPPINE GEOGRAPHICAL JOURNAL

The *Philippine Geographical Journal* is published quarterly by the Philippine Geographical Society and receives financial support from the National Research Council of the Philippines. It also receives occasional support, usually in kind, from the following Philippine agencies and institutions: Philippine Social Science Council; Bureau of Soils and Water Management, Department of Agriculture; Department of Geography, College of Social Sciences and Philosophy, University of the Philippines at Diliman; Department of Education, Culture and Sports; Bureau of Mines and Geo-Sciences, Department of Environment and Natural Resources; National Institute of Geological Sciences, College of Science, University of the Philippines at Diliman; and Philippine Atmospheric, Geophysical and Astronomical Services Administration, Department of Science and Technology.

The annual subscription rates are: foreign — US$20.00; domestic — ₱100.00. Back issues range from US$10.00 to US$20.00 per volume for foreign orders and from ₱20.00 to ₱100.00 per volume for domestic orders. All foreign remittances should be in United States dollars and made through either a US- or foreign-based American bank. Both foreign and local remittances should be payable to the *Philippine Geographical Journal.* The Journal is also available in microform at the University of Microfilms, Inc., 300 North Zeeb Road, Dept. P.R., Ann Arbor, MI 48106, U.S.A.

All communications relative to subscriptions, back issues, advertisements and Society business should be addressed to:

The Editor
Philippine Geographical Journal
P.O. Box 2116, Manila
Philippines

Business and editorial transactions may also be made at this address: Department of Geography, College of Social Sciences and Philosophy, University of the Philippines, Diliman, Quezon City, Philippines.

Re-entered as second class mail at the Manila Post Office on July 5, 1983.

ISSN 0031-7551

PHILIPPINE GEOGRAPHICAL JOURNAL

VOLUME 36 NUMBERS 1 & 2 JANUARY-JUNE, 1992

CONTENTS

PHILIPPINE GEOGRAPHICAL JOURNAL

SUBSCRIPTION AND GIFT ORDER

The Business Manager, Philippine Geographical Journal
P.O. Box 2116, Manila, Philippines

(to me ☐

Please send the Philippine Geographical Journal for ——— year(s) (as my gift ☐

MY NAME is (print) ____________________

Address ____________________

____

Send the gift issues to:

NAME ____________________

Address ____________________

Rates:

Foreign — US$20.00 per year for 4 issues; Local — ₱100.00 per year for 4 issues. For subscriptions of 2 or more years, the same yearly rates apply. Remittances are payable to the Philippine Geographical Journal. Foreign remittances should be in US dollars and made through either a US- or foreign-based American bank.

I enclose payment ☐ Please bill me for these orders ☐

PHILIPPINE GEOGRAPHICAL SOCIETY MEMBERSHIP

The President
Philippine Geographical Society
P.O. Box 2116, Manila, Philippines

I NOMINATE for Society membership the person named below ☐

(GIFT MEMBERSHIP) I nominate and enclose ₱/$ ————— for dues of the person named below ☐

ANNUAL MEMBERSHIP FEES: Foreign — US$ 25.00; Local — ₱100.00 — all renewable annually and payable to the Philippine Geographical Society.

LIFE MEMBERSHIP FEES: Foreign — US$200.00; Local — ₱1,000.00. Members are entitled to receive all Society publications.

I ENTER my name for Society membership and enclose ₱/$ —————.

NEW MEMBER'S NAME ____________________
(Please Print)

____
Street, Town/City

____
Province/State Country

MY NAME ____________________
(Please Print)

____
Street, Town/City

____
Province/State Country

Note: Xeroxed facsimiles of these forms may be used.

Philippine Geographical Journal, Vol. 36, Nos. 1 & 2
(January-June, 1992)

EDITORIAL

THE NEED FOR DISASTER MANAGEMENT AND ENVIRONMENT PLANNING

Natural hazards, both continuing and periodic in occurrence abound in the Philippines. These hazards are events that interact with human activities which may or may not kill people, destroy property or permanently damage the environment. There is, however, a general tendency to ignore their threat to human lives and property because some of these hazards such as earthquakes and volcanic eruptions, although potentially devastating, are infrequent or far in-between in the short human time scale. As a result the threat may be perceived simply as a"random act of nature".

In a study made by the Center for Research on the Epidemiology of Disasters with the support of the World Health Organization and the United Nations, the Philippines was pointed out as the No. 1 disaster country in the world. Covering the period from 1900-1991, the study cited 702 disasters as having occurred in the Philippines. These conditions could be explained by the fact that the Philippines is located in the typhoon belt and in the circle of volcanoes along the west central part of the Pacific basin. Furthermore, the country lies in a greatly fractured zone with faults or rifts found all over with the Philippine Trench to the east and the Manila Trench and several others to the west. Such a location means a rather high frequency of earthquakes.

Tropical Cyclones

Most high velocity winds in the Philippines are directly related to typhoons and other tropical cyclones. Others are caused by local conditions or by the intensification of prevailing winds due to a steep pressure gradient.

Tropical cyclones are of varying degrees of intensity. In their severest form they are the most destructive of all storms releasing tremendous amounts of energy. Whether the energy released is in the form of high velocity winds, in heavy rains, or in both, great destruction often occurs. The strongest of the tropical cyclones in the northwest central Pacific are called typhoons while in the west central Atlantic they are called hurricanes. In Australia and in areas around the Indian Ocean, these strong winds are referred to as willy-wallies or simply cyclones.

Most typhoons and other tropical cyclones that affect the Philippines develop east of the country in the Pacific Ocean. Others are formed in the South China Sea west of the country. These storms may occur at any time of the year but are most common from June to October with August as the peak month. Maximum surface temperature and evaporation attain their highest levels at this time.

The most severe typhoon can have a storm diameter of over 1,000 kilometers and last for a week or more with center spiralling winds of over 300 kilometers per hour and a pressure at the center of as low as 879 millibars. Torrential rains in the middle area of the typhoon can dump water in huge quantities within a short time causing destructive floods. Tidal waves and heavy seas along affected coasts are also commonly experienced during a typhoon. On the eastern coasts of the Philippines breakers with heights of 30 meters or more are common during a severe storm.

The Philippines is located in a region which have the greatest frequency of tropical cyclones. An average of 20 tropical cyclones annually enter or originate within the Philippine Area of Responsibility. However, less than half actually move close to or cross the country. Nevertheless, several of these storms that cross the Philippines usually cut a swath of destruction. More than 40 percent of the tropical cyclones which affect the country are restricted to northern Luzon and the Batanes Islands. Others cross the Visayas, southern Luzon especially the Bicol region, and Central Luzon. Southern Mindanao, Bohol, southern Negros and Palawan are rarely affected by tropical cyclones. The infrequent tropical cyclones formed in the South China Sea west of the Philippines generally move to the northeast crossing the northern tip of Luzon or the Batanes Islands.

A somewhat recent event that took place on November 5, 1991 focused attention on the devastating impact of typhoons in combination with the degraded condition of the environment. This was the destruction of a large section of Ormoc City at the head of Ormoc Bay in northwest central Leyte.[1] The triggering mechanism of this destructive event is typhoon "Uring" (international code name "Thelma"). The typhoon which moved in from the northeast induced the covergence of two air streams — the northeast and the southwest. Although the center winds did not approach a truly severe storm, the rains dumped by the typhoon were such as to cause the loss of several thousands of lives and damaged property worth millions of pesos. If there is any lesson learned from this event, it should be in the consideration of the destructive impacts of tropical cyclones and how certain measures must be taken to mitigate the impacts.

---

[1] See in this issue E. Eller and V. Asio. "The Flash Flood Tragedy of Ormoc City: A Brief Analysis From A Physio-geographic View."

Volcanic Eruptions

The perceived potential destruction of volcanic eruptions are defined not entirely by the characteristics of these events but also by their interaction with the human use systems of affected areas. The eruption of Didicas Volcano in 1952 in the eastern part of the Babuyanes island group north of Luzon was treated primarily as "one of these things" because the island was uninhabited and there was hardly any impact on areas relatively distant from the eruption. On the other hand, the more recent eruption of Mt. Pinatubo on June 16, 1991 was of national even international significance. The location of Mt. Pinatubo near large densely settled areas in Central Luzon made its eruption particularly devastating. The toll included nearly 900 persons dead, 42,000 homes destroyed and about 40,000 hectares of cropland covered by volcanic ash and billions of pesos in economic losses. Much of the destruction was caused by tons of ash dumped on the slopes of the volcano and surrounding highlands which later were loosened and transformed into lahar by heavy rains. This cement-like slurry moved down river channels, overflowed their banks and flooded low areas, covered and destroyed croplands, houses and buildings, bridges and communication lines. It was to be estimated later on that lahar flowing down the highlands will continue to threaten the surrounding areas for at least five years to as long as ten years after the eruption in 1991. Pyroclastic materials of hot gases, pumice and ash also flowed across the countryside.

Other effects of the Mt. Pinatubo eruption induced the sending up of an estimated 20 million tons of sulfur dioxide into the stratosphere creating a temporary polar cloud calculated to be as large as all the clouds at the North and South Poles combined. This sulfur dioxide laden cloud could intensify ozone depletion in the stratosphere. Ironically, the cloud from Mt. Pinatubo is expected to slightly lower global temperatures for the next four to five years by partly preventing infrared radiation and visible sunlight from reaching the earth's surface. This development, though, is estimated not enough to offset the ozone-depleting impact of the volcanic cloud.[2]

Another perceived effect of the volcanic eruptions is that the magma extruded contains the major elements required for plant growth — phosphorous, potassium, calcium, magnesium and sulfur. When the magma is in the form of lava that solidifies into rock, these elements are not available until after centuries or thousands of years of weathering. However, if the volcanic material is blasted out as ash, the elements can be available for plant growth after a few months especially in the humid tropics.

Mt. Mayon is another active volcano. Unlike Mt. Pinatubo which

[2] John Horgan, "Volcanic Disruption," *Scientific American* 226-3 (1992): 16-17.

was dormant for over 600 years prior to its eruption, Mt. Mayon has a history of 45 eruptions since the 1960s. The more recent eruptions occurred in 1984, 1978 and 1968 and records indicated that each eruption was preceded by a series of 50 or more earthquakes. However, such a pattern may not always be followed. The volcano may erupt virtually without warning or at most only a few volcanic tremors at short intervals may occur and not the usual 50. If this happens, it is likely that casualties will be high as many people continue to stay inside the permanent danger zone.

Mt. Mayon's most violent eruption occurred on February 1, 1814 in which more than 1,200 people died. Most of the victims sought shelter in the Cagsawa church believing its strong walls would save them. No one survived.

Mt. Pinatubo and Mt. Mayon are two of 21 active volcanoes in the Philippines. There are even more volcanoes which are considered to be dormant and like Mt. Pinatubo may likewise erupt again. The active volcanoes where significant settlements are found nearby and which may experience the worst impacts, must be monitored at regular intervals. At the same time people should not be allowed inside permanent danger zones which should be delineated around the volcanoes. People living on the slopes of Mt. Mayon have often said that from experience they know how the volcano acts and therefore they are acquainted with the signs of an impending eruption. But should one rely solely on experience as a safety measure in high-risks areas? If the volcano deviates from the "usual pattern" and erupts without warning, what happens then?

Earthquakes

The location of the Philippines along the "belt of fire" in the western Pacific basin places it not only in a well defined zone of volcanic activity but also in an earthquake-prone region. The Philippines makes up a part of the subduction zone where the north Pacific Plate collides with the continental shelf of the Asian Plate. A major fault, the Philippine Rift, runs through the eastern part of the Philippines. From the Davao Gulf, the fault runs through the Agusan Valley, Leyte, between the Masbate island group and the Bicol Peninsula, cuts across the isthmus in the northeastern part of Bondoc Peninsula to the open water between the Polilio island group and Quezon, then moves inland in a northwesterly direction through Dingalan to Gabaldon, Nueva Ecija, along the western base of the Sierra Madre and the southern slopes of the Central Cordillera, then out into the Gulf of Lingayen.

The strongest earthquake to hit northern Luzon in this century occurred at 4:26 PM on July 16, 1990. The epicenter was located near Rizal, Nueva Ecija along the main Philippine Rift. The earthquake registered a magnitude of 7.7 on the Richter scale. Three minutes later, another earthquake followed with its epicenter near Kayapa, Nueva Ecija north of Rizal along the Digdig fault which is associated with the main Philippine Rift. It was found out later that a 126 kilometer-long ground rupture developed along the Gabaldon-Kayapa segment of the Philippine Rift-Digdig Fault system. The displacements along the ground rupture ranged from 0.1 to 0.6 meter horizontally and from 0.1 to 0.2 meter vertically.[3]

The 1990 Luzon earthquake was severe and unusually long causing widespread destruction. In Baguio City, several multi-storey buildings collapsed including the Hyatt and Nevada hotels. The earthquake also triggered extensive landslides in nearby mountain ranges particularly along the steep sides of valleys, steep slopes with deep roadcuts and the outer curves of river bends. The widespread occurrence of landslides during the earthquake and those induced later by the heavy southwest monsoon rains isolated many places in central and northern Luzon for several weeks to several months.

Low-lying areas in central and northern Luzon which experienced a magnitude of 7.0 or higher suffered largely from liquefaction-related processes. The areas affected by liquefaction included beaches as in Agoo, La Union; alluvial fans as in Gerona, Tarlac; and, river deltas as in Dagupan City, Pangasinan. During the earthquake these types of deposits lost their resistance to deformation and underwent compaction with the attendant decrease in volume available for interstitial fluids causing an increase in pore pressure. Liquefaction then occurred as the pore water pressure matched the weight of the overburden. The liquefied deposits then gave way to over-lying man-made structures. Severe tilting and subsidence and extensive sand boil resulted particularly in places with heavy concrete structures. The effects of groundshaking were not very pronounced as shear waves were well developed through the liquefied layers.

Disaster Management and Environmental Planning?

Debates and discussions verge mostly on the causes of environmental problems and less on the prevention or minimization of such problems. Furthermore, problem-solving is undertaken only when the problem has become severe or when disaster has struck.

Most environmental problems arise from the improper use of land. Construction near known and active faults and on unstable ground causes damage to property and loss of lives as in Baguio City, Dagupan City and other nearby areas during the earthquake of 1990. Extensive destruction of the forest cover of highlands in particular watersheds or

---

[3] R.S. Punongbayan and R.C. Torres, "Correlation of River Channel Reclamation and Liquefaction Damage of the 16 July 1990 Luzon Earthquake in Dagupan City, Philippines," *Philippine Geographical Journal*, 35-3-4 (1991): 91-107.

catchment basins results in erosion, floods and deposition in adjacent lowland areas particularly during the typhoon season as in the case of Ormoc City. Settlements found near active volcanoes are subject to extensive damage to property when there is an eruption. Loss of lives are unavoidable when the eruption comes without sufficient warning as in the case of Mt. Mayon. Although there was time to evacuate people near Mt. Pinatubo the extent of the area affected and the resulting property losses were not anticipated. This was especially so in the widespread destruction caused by the lahar. Yet, despite current knowledge of the continuing danger posed by the lahar, disaster management of the affected areas appear to be sporadic and uncoordinated. Most of the work undertaken in preventing further losses due to rampaging lahar flows are done during the rainy season when risk levels are high. Plan formulation and execution in minimizing the effects of the lahar should also be done during the dry season at which time closer field examination and evaluation could be done to anticipate the direction of flow and possible further damage that may ensue in the following rainy season.

A sort of an environment impact assessment must be undertaken in those areas which are disaster-prone or high-risk due to known or active natural hazards. The assessment should discussed what would likely happen if specific proposed activities or projects are undertaken in such areas. The irreversible and irretrievable consequences must be pointed out particularly if certain projects are pushed through despite knowledge of high risks.

For these purposes, a land use plan should be evolved. Factors basic to environmental problems must be identified in the land use plan and derivative maps such as geologic, geographic, biological, hydrological and socio-economic could be also produced. In addition, special maps on seismic risk, flooding, erosion, soil, subsidence, and depth of bedrock are needed for all disaster-prone areas.

The purpose of the derivative and special maps is to put data or information into a form that can be used and understood by even a layman. It should be pointed out that land use decisions are usually political and people making such decisions are unfamiliar with the data that should be used in evaluating the best possible use of different land resources. In this connection, there is need for trained individuals who combine home knowledge on the use of data on natural hazards, basic environmental factors and the political disciplines to make optimal use of planning procedures and techniques thus enhancing disaster management and environmental planning.

TELESFORO W. LUNA, JR.

Philippine Geographical Journal, Vol. 36, Nos. 1 & 2
(January-June, 1992)

ARTICLES

THE ROLE OF GEOGRAPHY IN INVESTMENTS*

Melito S. Salazar, Jr.**

The Philippine Board of Investments (BOI) has been tasked to assist in the economic development of the country by promoting both domestic and foreign investments in preferred areas of economic activity. In line with this mission, BOI identifies in consultation with the public and private sectors, these priority areas and issues or lists them in the Investment Priorities Plan (IPP). BOI is further empowered to grant fiscal and non-fiscal incentives to these investments, which incentives range from income tax holidays to employment of foreign nationals.

For 1991, the priority areas identified were:

Agriculture includes the production of crops for feeds, sericulture, production or processing of agricultural inputs or by-products (*e.g., feeds, fertilizers, pesticides, and production of livestock and poultry breeders*), agricultural service (*e.g., irrigation, agricultural equipment pool,* and *post-harvest facilities*), and the nucleus estates and contract growing schemes of agricultural crops, aquaculture, livestock and poultry.

Likewise, the other priority areas listed have been categorized as Fishery, Forestry, and Mining activities which include the exploitation and development of mineral resources, mining and quarrying of metallic and non-metallic minerals, and processing of minerals.

Priority manufacturing activities are the rehabilitation and modernization of existing raw sugar factories and sugar refineries, production of pulp, textile and textile products, chemical products (which include basic industrial chemicals, petrochemical complex and fine chemicals), refined petroleum products, pharmaceuticals, cement, construction materials using non-traditional indigenous materials, metals and engineering products applying specific processes (such as design, and engineering, and/or machine building, forging, heat treating, metal casting, machining, etc.), motor vehicle parts and components, primary and secondary processing of ferrous metals, electronic products and their related components and parts, and shipbuilding, ship-repair or ship-breaking.

---

* Paper read during the 1992 General Assembly of the Philippine Geographical Society, March 31, 1992, Philippine Social Science Center, Quezon City.

** Governor, Board of Investments

Also listed are energy-related projects, i.e., power generating plants; public utilities (such as mass transport operations, telecommunications services including public calling stations, inter-island/overseas shipping and modernization of existing shipping lines, and electronic distribution in less developed areas); tourist accommodation facilities; research and development activities which are science and technology oriented; and infrastructure and industrial service facilities which include industrial estates (including science and technology parks, technology incubation centers and science and technology centers; and common service facilities and subcontracting activities for exporters.

We are now in the process of finalizing the 1992 IPP and among the important areas we have retained are those relating to infrastructure support — energy, telecommunications, and nucleus estate schemes. The reason why we have listed not only manufacturing activities is because we are aware of the sad state of infrastructure in the Philippines. It is also true that investors do not make their decisions purely on the basis of the fiscal and non-fiscal incentives that BOI can give them. Investors will put their money in if the general business environment is perceived by them as favorable.

What are the factors that investors look at? Political stability is obviously on top of the list. That is why we are confident that the coming elections which will herald a peaceful transfer of political authority will do much in building up investor confidence in the country. The road network, shipping lines, air transportation and other land transportation facilities are also important. Again, a provision in the BOI Omnibus Code encourages private business to construct such infrastructure as roads and bridges for their company's and the public's use and to be given incentives for this. Another government initiative to develop our country's infrastructure is Republic Act 6957 entitled "An Act Authorizing the Financing, Construction, Operation and Maintenance of Infrastructure Projects by the Private Sector, and for other Purposes." This law institutionalizes the government's adoption of the Build-Operate-Transfer (BOT) and the Build-Transfer (BT) schemes as proven and effective methods of encouraging the investments and participation of both foreign and local contractors in the country's infrastructure development program. With the BOT and BT schemes, and the incentives provided by BOI, we look to a future with more and better ships, planes, buses, road networks, ports, irrigation facilities, and even an expansion of the lightrail transit, among others.

Telecommunications and energy are, likewise, necessary infrastructure components. As such, BOI has liberalized the telecommunication listing to allow more firms that can register and avail of incentives. From the 1990 listing which only cover "less developed areas" as defined by BOI and National Economic Development Authority (NEDA), it has been expanded to "deficient areas/less developed areas in telecommunications" as agreed by BOI and Department of Transportation and Communication (DOTC). The projects registered in the countryside are big steps in our country's march to better communications for business and the public. Nucleus estate schemes (NES) in agriculture are continuously being promoted so that the farmers can be provided with the required technology, raw materials and other inputs by a nucleus estate (a processing facility, for example) which in turn will be the purchaser of the outputs of these farmers. In this manner, vital support in production and marketing is provided to the farmer, who most probably is a newly-emancipated tenant. BOT has also gone further in ensuring the provision of total infrastructure for the manufacturing facilities by providing incentives to the development of industrial estates.

An industrial estate is a generic term which refers to a large and suitable track of land subdivided and developed primarily for the use of a community of industries and provided with basic infrastructure and facilities such as roads, water supply, power, communication, sewage/drainage system, etc. This activity was first listed by the BOI in the 1989 IPP under a pioneer/non-pioneer status.

In approving an industrial estate, BOI ensures that the following requirements are met:

On the nationality requirement, foreign ownership is allowed but only to the extent of 40 percent — unless it locates in any of the 47 less-developed areas where a pioneer status will be given and, therefore, foreign ownership of over 40 percent is allowed. Moreover, PD 471 allows the lease of land to foreign-owned corporations for a period of 25 years, renewable for another 25 years.

On the size and capital requirement, the industrial estate should not be less than 50 has. with facilities to accommodate at least 5 locators. The applicant industrial estate firm should have sufficient paid-up capital at the time of BOI registration to undertake the project. As a minimum requirement, the industrial estate should have communication facilities, electric power, water, sewerage and drainage system, pollution control devices, and paved road within the estate. Moreover, the development of the whole industrial estate must be completed within a maximum period of five (5) years following a development phasing scheme required by the BOI.

Clearance from the Department of Agrarian Reform (land conversion clearance), Housing and Land Use Regulatory Board (zoning clearance), the respective local governments and municipalities, the Environmental Management Bureau, the National Water Resource Board, and, when applicable, the Laguna Lake Development Authority, must be submitted prior to registration.

As of this date, there are nine (9) approved industrial estates of which seven (7) are operational or about to be completed. These are Laguna Technopark, Inc., First Cavite Industrial Estate, Science Park of the Philippines, Gateway Property Holdings, Philstar Marketing, Luisita Realty, and Victoria Wave Ltd.

For the 1992 IPP, we are proposing the development of resort estates following the successful model of Cancun in Mexico.

You may ask what do all these have to do with geography? Although I can see from the interest you have shown that you are aware of the links between what we in BOI and our clients do and what you do. As geographers, you do not only make maps as the public will automatically think. Yours is the science of the earth's surface, form, physical features, natural and political divisions, climate, productions, population, etc. In all these discussions of infrastructure, you are important in providing us in BOI and our clients a picture of what the situation is and what it can be or may be. On a project level, regional level and national scope, the information your science provides will be of utmost importance to the plans and projects that we set.

Take the area of Pampanga, Tarlac and Zambales. The information you can share on the earth's surface, forms, physical features, climate, etc., as it is now and as how it can evolve will be extremely useful in deciding the form and process of development that the government, including the BOI, should promote if not encourage. Or given the climatic conditions of Visayas and Mindanao, what types of irrigation schemes, and where, should be supported by the incentives given by BOI?

I must confess that at this stage, our working relationship with you has not been established. This occasion is an opportunity to let us know where you believe you can help and it may lead to greater and productive interaction between us. Who knows it may even result in the creation of a permanent working committee composed of BOI and you.

Information-sharing is important. But information, too, is power. With your information, you may be in a position to bring about a dramatic change in the way we view our country. Right now, the regions and provinces we have are political subdivisions brought about more by a pandering to the political powers rather than by a commitment to a development orientation. When two powerful feudal warlords with their acquisitiveness fight for supremacy, the central power carves up the province into two, satisfying their ambitions. It really does not matter whether the resulting political subdivision has requirements for an integrated, resource-based development. You may want to look at one country in terms of your science and subdivide it according to the features most essential for development. And you may want to seize the opportunity of newly elected officials this June to present such a proposed subdivision to our new leaders. They may accept it or they may reject it. But if you have spread your gospel to the many, the few who lead may be motivated to follow your advice. We in BOI will certainly be behind you.

Let me leave you then with the thought that you can make your science an exciting base for involvement in our passionate desire to develop this country. BOI is doing its share through promotion of investments. We hope, may, we know, you will do your share.

Philippine Geographical Journal, Vol. 36, Nos. 1 & 2
(January-June, 1992)

SMALL-SCALE INDUSTRIES AND THE INFORMAL SECTOR IN A MEDIUM-SIZED URBAN CENTER IN THE PHILIPPINES: THE CASE OF SAN FERNANDO, LA UNION

Helmut Schneider*

ABSTRACT. The concept of an urban informal sector was formulated mainly on the basis of empirical surveys done in large metropoles of the so-called Third World. Whether the conclusions derived from this concept are valid — all or in parts — for smaller urban settlements located in considerable distance from the large metropoles, was the guiding principle of a survey of small scale industries undertaken in San Fernando, capital of Ilocos Region and the province of La Union in Northern Luzon, Philippines. The following questions will be discussed: 1. Is the sector of informal or small-scale production activities a homogeneous "economy of poverty" and may all those engaged in it be classified as "working poor?" 2. Who is able to enter this sector? 3. How may the customers of those small or informal enterprises be classified? The empirical evidence in San Fernando shows that there are significant deviations from the central thesis of the informal sector concept, which have to be taken into consideration for small-scale industries promotion strategy.

1. The "Discovery" of the Informal Sector

Twenty years ago, the dearth of development successes in Third World countries also led to changes in development theory which gave way to a new view of the role of small-scale industrial enterprises in the development process. In the context of modernization theory, which dominated the debate after 1945, small-scale industries were mainly seen as structures quickly to be overcome or at least to be modernized, as parts of a rapidly vanishing traditional sector (e.g., Staley/Morse, 1965). But with the switch to the new development paradigm of "redistribution with growth" (instead of "accelerated growth" alone, see Chenery, 1974), a new target group appeared: the "working poor," meaning those who — amidst the lack of survival alternatives — are forced to take up any occupation, no matter how little it pays.

This is also where the starting point for the informal-sector-concept is to be found. An informal sector was distinguished from a formal or organized one according to a definition of the International Labour Organization (ILO) in the sense that it is characterized by ease of entry for employment seekers, the use of local resources, the predominance of small-

---

* Helmut Schneider Ph.D., is currently Assistant at the Chair of Cultural Geography and Development Research at the Institute of Geography of Heinrich-Heine-University in Düsseldorf, Germany. Since 1982, he has undertaken several fieldtrips to the Philippines and to other Third World countries; his Ph.D. thesis on small-scale industries development in San Fernando, La Union was published in 1986. The present article is a revised version of a paper presented to the "European Conference on Philippine Studies" in Amsterdam, April 1991.

scale enterprises and of family labor, the use of labor-intensive technologies, the acquisition of qualifications outside the regular educational system, and the existence of competitive markets (ILO, 1972). New in the informal-sector-debate is the emergence of this long-neglected field which had been regarded as traditional and hampering development, whose gradual disappearance seemed certain, but is now seen as an outcome of the modernization process itself which would not disappear in the short run. Furthermore, the informal sector seemed to have a considerable potential for development, primarily concerning employment and income generation as well as commodity production and provision of services for lower-income groups. According to estimates compiled by the ILO, 20 to 70 percent of the employed population in Third World urban agglomerations are engaged in the informal sector, with a share of 20 to 30 percent of the total urban income (Sethuraman, 1981:8). But these figures depend heavily on the definitions being adopted. Presently, an action-oriented understanding of a "sector of relative poverty" has gained ground, but which cannot be marked off exactly (Elwert, *et al.*, 1983). The search for employment and income and the dominance of reproduction needs (of the individual and/or the family supersedes orientations on capital accumulation and profit maximization. Counted among the informal sector are the self-employed, petty commodity producers, craftsmen, and partly even petty capitalist enterprises, which already employ wage labor on a regular basis.

But there remains a gap between those definitions and the needs of practical research. For practical purposes, normally a pragmatic approach is adopted: the upper limit for informal enterprises mostly is measured in terms of numbers of employees. According to this, enterprises with less than 10-20 employees are counted among the informal sector (Sethuraman, 1981:189; Schmitz, 1982). Following this, almost all small-scale industries studied in San Fernando, La Union are part of the informal sector.

The strategic action of those belonging to the so-called "stratum of the unsecured" is directed towards a combination of different income sources (Elwert, *et al.*, 1983). A group of Bielefeld sociologists, arguing from the point of view of an "articulation approach," has criticized the informal-sector concept for still being dualistic. Households, enterprises and individuals can have functions beyond the limits of informal or formal sectors or may have to combine sources of income from different sectors, be it simultaneously or in the course of time.

The various approaches meeting in the critical discussion of the informal-sector concept (see e.g., Bromley, 1979; Sethuraman, 1981; Schamp, 1990; Turnham, 1990) have in common the assumption that commodities and services supplied by this sector are geared towards the demand of the low-income strata. Besides, it is assumed that the informal sector primarily is of interest to the so-called frustrated job seekers, e.g., less qualified migrants from rural areas who have no access to formal employment or are being pushed away from it. In this way it is said that a more or less homogeneous sector of poverty emerges.

What all those theories mentioned above have in common is that their empirical proof still is insufficient. In addition, previous research on small-scale industries and the informal sector has heavily concentrated on large urban areas. On the other hand, there is a need for related studies in small- and intermediate-sized towns and cities, which have to play a crucial role in all strategies of regional decentralization and of steering rural-urban migration away from the big agglomerations.

2. Profile of Respondents

In a study on Philippine small-scale industries development undertaken in San Fernando, La Union in 1983 (Schneider, 1986), it was found that the official Census of Establishments underestimates the number of small manufacturing enterprises. The NCSO Listing of Establishments in the year 1982 included only 95 manufacturing enterprises of all sizes (!) in San Fernando. But according to the author's own listing in 1983 there existed 338 small manufacturing enterprises (total workforce less than 100) in San Fernando. Through stratified random sampling, 94 enterprises were selected for the study.

The total labor force of the sample establishments was 703, ca. 75 percent were working on a regular basis (including the enterprise owners), 11 percent as seasonal laborers, and 14 percent of casuals.

Small manufacturing in San Fernando was shown to be dominated by men, whereas the share of females in the whole population of San Fernando was ca. 51 percent (1980). Among the enterprise owners, there were only 18 percent females; among the employed workforce women held a share of only 22 percent.

Thirty-two percent of the interviewed enterprise owners had 5 or more family members who depended on their income. It was found that the smaller the enterprise, the more family members depended on it. In 40 percent of all cases, the manufacturing establishment was the only source of family income; this number also increased with decreasing size of enterprises. The conclusion is that, on the average, more persons depend on the income of the smallest establishments compared with larger ones and at the same time those households have less chances to tap other sources of income.

Approximately thirteen percent of the interviewed owners had finished college, 57 percent had finished secondary school and 22 percent left school before finishing the secondary level. Concerning knowledge and skills needed for their present activity, 80 percent of the enterprise owners obtained these through "learning by doing," while 26 percent had some kind of vocational training. Most of the interviewed owners wished to have more practical and technical training. Of the sample enterprises' total workforce, about 67 percent were skilled laborers, 25 percent were semi-skilled and 8 percent unskilled.

The total investment was below ₱250,000 (1 Peso = US$ 20 ca. 1983) for 87 percent of all sample-enterprises, the majority (ca. 54 percent) had a total investment between ₱5,000 and ₱100. Sales per year were below ₱50,000 (1982) for 51 percent of the sample-enterprises; but 22 percent had sales per year between ₱100,000 and ₱500,000. The capital efficiency (value added per unit of capital) was 0.66 for the sample enterprises, compared with an average of 1.06 of large manufacturing enterprises in the Philippines (1978). The average daily income of enterprise owners was between ₱26-30 (1982), compared with ₱7.50-10 average daily wage for employed laborers in small manufacturing in San Fernando.

The main problem when taking up business was obtaining start capital (named as a problem by 54 percent of the interviewed owners) followed by marketing difficulties (named by 29 percent). Ninety percent of the enterprise owners were able to use own or family savings when setting up their business, 21 percent also used bank credits and only 9 percent had access to grants of government institutions (numbers do not add to 100 percent because of possible multiple answers). In those indus-making, tailoring) the owners are faced with the problem that workers who qualified themselves by training on the job, tended to leave in order to set up their own establishments. (For further details see Schneider, 1986).

3. Research Area and Selected Research Questions

For the reasons given above it was an aim of the study to find out whether the explanatory value of hypotheses based mainly on findings in big cities could be proved for a medium-sized regional center located in considerable distance from the next agglomeration (in this case Metro Manila). San Fernando, capital of La Union province and the Ilocos Region, situated at the northwestern coast of Luzon, and a municipality with almost 70,000 (1983) inhabitants, was chosen. The Ilocos Region is one of the traditional outmigration areas of the Philippines because of limited potential for agrarian production, a high degree of property fragmentation and a great population pressure originating from the Spanish colonial period.

So far, San Fernando has become to a very limited extent, the target of intra- and inter-regional migration, which continues to be directed preferably toward Manila, but also to pioneer areas in eastern Luzon or Mindanao. Migration to Manila, the outstanding economic center of the country, amounted to an average of 125,000 to 175,000 persons a year

(Bronger, 1983:114). Among the relative dynamic countries of the ASEAN group, the Philippines has to fight with the greatest economic and political problems for years. More than 750,000 people per annum enter the job market, and spatial disparities, augmented by the archipelagic character of the country, are distinct. This underlines the necessity to strengthen the function of small- and medium-sized towns and cities.

The three following questions show to what extent the above mentioned hypotheses can be verified or have to be modified by the sample surveyed:

1. Can all those engaged in informal enterprises be classified as belonging to a relatively homogeneous sector of poverty, i.e., the "working poor"?
2. Who has access to informal small-scale industries?
3. Who are the customers of informal enterprises?

4. Inner Differentiation of the Small-Scale Industries Sector

The small-scale industries sector in San Fernando differs markedly from a small group of manufacturing enterprises with 100 or more employees, indicating a highly polarized size structure:

— None of the enterprises surveyed employs more than 20 workers on a regular basis. If different forms of temporary employment are considered, an upper limit of 30 employees is not exceeded.

— All enterprises surveyed are one-owner, one-shop enterprises, while all larger manufacturing establishments in San Fernando are branches of big, partly transnational companies.

— The investment capital of more than 87 percent of the sample remains below the threshold for small-scale industries as it is defined by government agencies (₱250,000> <₱2 million). The majority even belongs to the lowest size category, the so-called "cottage industries" (De Vries, 1980; BSMI, 1982).

Despite this, it is by no means an indiscriminate unity as a closer look on the size structure will show. Following the theoretical discussion as well as the results of other empirical studies, it was to be expected that the self-employed, those working on a casual or seasonal basis and unpaid family laborers would hold big shares in contrast to regular wage labor. In the case studied, however, unpaid family workers only held a share of seven (7) percent while different forms of temporary employment accounted for 35 percent. On the contrary, regularly employed wage laborers already made up more than half (55 percent) of all employees. Among the business owners only 15 percent could be qualified as self-employed. These findings contrast with a study about the informal sector in Manila showing that more than half of the business owners surveyed were self-employed (see Jurado, *et al.*, 1981). As opposed to that, in the small-scale industries sector of San Fernando, a distinct hierarchisation already took place, in the course of which the development towards accumulation-oriented, petty capitalist production has progressed considerably.

It was to be expected that these differences would also be evident in the income structure. According to the author's estimation based on value-added figures of the sample enterprises, the average income of a business owner is 2.4 to 2.6 times as much as that of the employee. Views expressed in the relevant literature — that income differences between business owners and employees had no great weight and both groups lived almost "equally" in a state of relative poverty — could not be confirmed. At the time of the survey (1983), legal minimum wages for non-agricultural work outside Manila lay between ₱20 and ₱22. The average daily wages estimated for the small-scale industries sector in San Fernando were distinctly lying below this daily income of owners, even though only insignificantly. Considering the daily income necessary to meet the basic needs of a family of six (₱60 ca. 1983), the average daily wages achieved — partly even the income of business owners in the small-scale industries sector of San Fernando — are not sufficient, meaning that further sources of income have to be found.

These findings, however, do not allow one to speak of a homogeneous sector of poverty. Rather a differentiation and hierarchisation of income levels is typical. Compared with the daily wage in large scale industries (i.e., in the Philippine statistics enterprises with 10 and more employees), the incomes of business owners in the small-scale industries sector of San Fernando can be equal, partly even higher. This shows that working as "informal" entrepreneur can be an attractive alternative to "formal" wage labor and need not be a forced expedient as is implied by the hypothesis of the "frustrated job-seeker," who, lacking access to formal employment, has to do jobs with markedly lower income in the informal sector.

5. Access to the Small-Scale Industries Sector

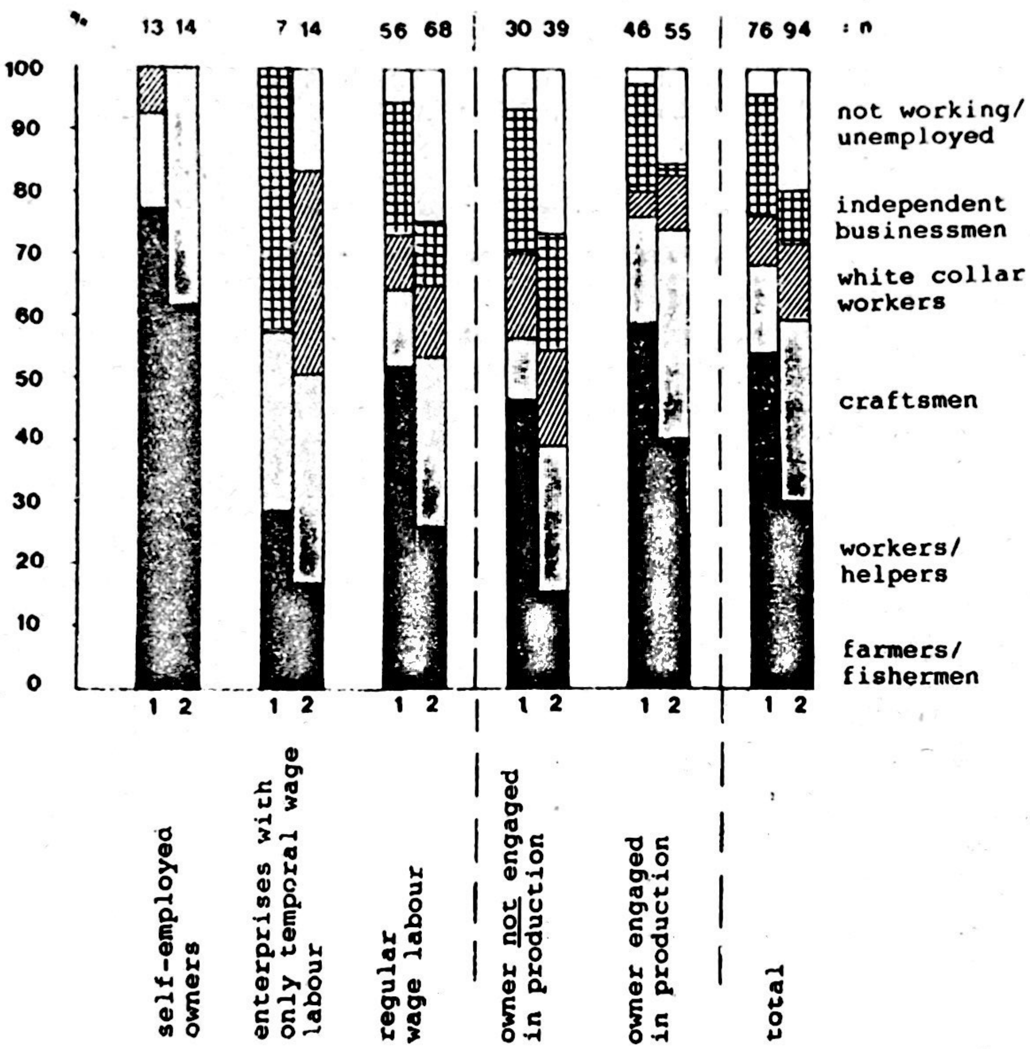
This brings us back to the second question: Who has access to the informal small-scale industries sector? A further reinforcing circumstance adds to the confusion about the validity of the hypothesis of the "frustrated job-seeker," which was formulated above with regard to the income relationships. Following this hypothesis, frustrated job-seekers entering the informal sector are predominantly poorly qualified, rural-urban migrants who have no considerable means available as start capital worth mentioning. Of those entrepreneurs who were interviewed in San Fernando, about one-half were in-migrants, a percentage share a little lower than that in Manila (60 percent) (following Jurado, *et al.*, 1981) — but nevertheless high above the average measured with the mobility of the total Philippine population. According to an estimate, approximately 30 percent of the Philippine population at the beginning of the 1970's did not live in their place of birth (i.e., Hanisch, 1983:411). For the majority of those questioned, the place of origin is the surrounding province. With regard to formal educational qualifications, the migrant entrepreneurs, compared with the population average of equal rank, were even better qualified. It is, however, striking, that 75 percent of the in-migrants employed paid laborers in their businesses. Self-employed — 15 percent of the total in question — are even less represented among the migrants. Taken together, this suggests the conclusion that among the migrant entrepreneurs, the majority were entrepreneurial, accumulation-oriented people who must also have had a certain amount of start capital at their disposal.

This supposition is also supported by the data that in the case of 80 percent of the enterprises concerned, there was a period of only two years between the in-migration of the owner and the establishment of the business; in a third of the related cases the year of in-migration and year of business start were even identical. One may assume that it is generally not possible to accumulate the start capital for larger units in the small-scale industries sector (employing already several paid employees) in such a short period of time.

It can be concluded from these results that the majority of migrant business owners strategically made commercial use of locational advantages of a central place like San Fernando. An already existing entrepreneurial rather than employment-oriented view must have determined their reasons for migration. So it is not the destitute, poorly-qualified, job-seeking rural-urban migrant who shapes the picture of small-scale production units in San Fernando.

But even the thesis of modernization theory — inspired by Weber and Schumpeter — emphasizing the role of the social outsider as a potential entrepreneur (e.g., Seifert, 1974), could not be confirmed. Indications of a particular role for ethnic or religious minorities among the questioned owners were not found. More importantly, however, is the assumption, formulated with regard to the supposition of the social outsider, that the owners of small-scale manufacturing enterprises "are drawn far more frequently from the trading sector than that of craftwork" (Michel/Ochel, 1977). But no proof could be found for this assumption either. Only about nine percent of the interviewed owners were self-employed before founding their business, though from those again only a few previously worked as traders. On the other hand, 60 percent had, before their "entrepreneurial" activities, performed craftwork or worked as (small) farmers, which as a rule are activities linked with low social status and earnings, showing an origin of lower social classes. Craftwork activities in a narrower sense, particularly those of tailoring and carpentry, again carry the largest weight in this group. The abilities and knowledge acquired in the course of depending employment can be incorporated by a relevant group in later, independent activities.

FIG. 1. OCCUPATIONAL AND SOCIAL ORIGIN OF ENTERPRISE-OWNERS ACCORDING TO TYPES OF ENTERPRISES (SAMPLE-ENTERPRISES)



1. activity of owner's father
2. owner-activity before taking up business

Source: Author's survey

The results underline the statements made earlier that taking up independent business activities in the small-scale manufacturing sector was, more specifically, seen by a large proportion of those interviewed as a process of social ascent; that is, from small farmers, laborers and craftsmen to independent small-scale business owners, whose incomes are, on average, comparable with those in "formal" employment. In any case, it is above that of independent employment in the "informal sector" or of small-scale farming. If one also regards as an indicator of social origin the job that was performed by the owner's father, more specifically the father's means of gainful employment, then an origin from lower social classes for 70 percent of those questioned can be assumed.

TABLE 1. SMALL-SCALE MANUFACTURING ACCORDING TO INDUSTRY GROUPS (NUMBER OF ESTABLISHMENTS IN %)

	San Fernando (1) (n= 338)	La Union (2) (n= 1226)	Ilocos (3) (n= 9197)	Philippines (3) (n= 76955)	Manila A (3) (n= 11406)	Manila B (4) (n= 400)
Manufacture of food	22.5	42.7	44.0	37.0	15.0	11
Manufacture of textile and wearing apparel	25.1	31.0	35.4	40.5	54.7	66
Manufacture of leather products	3.3	k.A.	0.17	1.8	4.6	k.A.
Processing of wood and cane	13.3	5.0	5.5	6.1	6.0	6
Printing industries	3.3	0.32	0.47	1.4	4.4	k.A.
Manufacture of building material and other non-metallic mineral products	10.6	7.2	4.5	2.8	1.2	k.A.
Metal industries	8.3	4.6	6.8	6.7	8.3	8
Manufacture of transport equipment	7.7	0.57	0.48	1.6	1.6	k.A.
Manufacture of electric and electronic equipment	2.4	k.A.	0.04	0.1	0.52	k.A.
Others	3.5	8.6	2.6	2.1	3.8	k.A.

Sources:

(1) Small manufacturing enterprises (own listing), establishments with an average total employment of less than 100

(2) Census of Establishments 1978 (unpublished data), establishments with an average total employment of less than 100

(3) Census of Establishments 1978 (Small Manufacturing), establishments with an average total employment of less than 10

(4) "Informal" small-scale enterprises (Jurado, et al. 1981, S. 121 ff.), establishments with an average total employment of less than 10

If one analyzes the data on the origins of the owners of the small-scale manufacturing enterprises of San Fernando, the following results arise:

— About half of those questioned are migrants, the majority coming from the surrounding area. The picture is not determined by the poorly qualified, destitute, employment-oriented and, in the first place, self-employed migrants. Much more dominant among the in-migrants — more so among all those questioned — is the already strongly entrepreneurial, commercially oriented type.

— Socially, the majority of those questioned came from lower social groups, and the work in the small-scale industries sector can be understood by them as a process of social ascent. Compared to former small-scale farmers, laborers and craftsmen, former merchants play only a marginal role among the interviewed owners.

6. Production for whom?

Finally, the third question: "Who are the customers of the goods produced by small-scale manufacturing establishments?" will be dealt with. In the academic literature the supposition is to a large extent incontestable — that "informal" manufacturing units produce as a priority cheap consumer goods for low-income groups (e.g., Sethuraman, 1981:33). Before this is examined on the basis of material gathered in San Fernando, a brief description of the industry groups in small-scale manufacturing and of the income structure of the population in San Fernando is given.

a) Branch Structure

Table 1 shows the branch structure of the small-scale industries sector in San Fernando in comparison with corresponding data at provincial and regional levels as well as for the capital region, Manila. Almost 90 percent of all business units account for industry groups where small-scale units enjoy comparative competition advantages. This is due to labor-intensive production, lower return-to-scale, the processing of spatially dispersed raw materials and the cost-intensive transportation of pre-products, as well as the necessity of direct-customer contracts. This applied to industry groups such as production of foodstuffs and clothing (including leatherwork) as well as construction materials and furniture. In San Fernando alone, half of the small-scale manufacturing units are in the foodstuffs and clothing sectors. This dominance of the production of consumer goods is certainly no special feature of the study area, but rather a characteristic of the (small) industrial structure in the Philippines as a whole.

In the case investigated, it shows, however, that these branches are of a clearly lower weighting (compared with the Philippine average), while a larger proportion is allotted to the remaining industry groups in manufacturing. The manufacturing structure of San Fernando proves itself, in comparison, to be more widely diversified. An explanation for this can be found in the combination of locational factors, which result, firstly, from the considerable distance to the next urban agglomeration (Manila), and secondly, from the central place functions of San Fernando. This determines a comparatively differential demand potential — compared with other small towns, but especially compared with rural areas — and at the same time, in comparison to metropolitan areas, a relatively confined market. Linked to that is an accumulation-maximum, which up to now counteracted the development of bigger autochthonous industrial production units. The lack of local large-scale business competitive pressure, as well as the existence of transportation-cost determined protection from suppliers from other areas gave small-scale manufacturing in San Fernando access to industry groups which in rural areas and — due to other reasons — also in Manila are not or at best in a very limited degree open for small-scale enterprises.

In the investigated example, such industry groups which benefit from and are connected with a modern building construction sector are affected by an intense local traffic resulting from the central place functions of San Fernando. In particular, those are construction material suppliers, for whom the local availability of "transportation-cost intensive" pre-products and at the same time low "weight per unit" prices for the final product represent a competitive advantage. The manufacture of construction components made of wood and metal as well as furniture production should also be mentioned here. Production of the latter will often be in accordance with the customers' wishes. This, and a bulky freight-intensive final product which can only be transported with the risk of damage under the available traffic conditions, acts as protection against competitors from outside.

Industry groups oriented towards local transportation are mainly engaged in construction and fitting of car bodies for small buses (jeepneys) as well as for motorbikes and motorbike side-cars (tricycles). While the traffic of the center of the settlement is made up mostly of tricycles, jeepneys serve as a means of interlocal transportation. In the car-body industry it is the expensive-to-transport final product and, especially in the case of San Fernando, the existence of a local, large-scale supplier of the pre-products like sheet metal and steel profiles which are costly to transport, which has the effect of acting as competitive advantage against suppliers from other areas.

b) Income Structure

To what extent the goods of the small-scale manufacturing sector are absorbed into the consumption of the low-income population groups depends naturally on the type of goods produced as well as on the available income of the local population. At the time of the study (1983), in the Philippines, the average monthly income of a household of six was ₱1,162, whereby, according to official data, 72 percent of all households were under this average sum. It can be assumed here that the level for the regional capital, San Fernando, is higher, although exact data was not available. As a yardstick, one may take the results of a survey in one barangay of San Fernando. According to that, the average level of monthly family incomes was ₱1,751, which 60 percent of the households did not attain. According to the personal valuations of those questioned and the "valid" definition of "absolute poverty" in 1983, ₱1,800 was regarded as sufficient to provide the livelihood of a 5-6 member family.

From these introductory remarks, it is already obvious that a large proportion of the Philippine population such as that of San Fernando cannot sufficiently satisfy their basic needs. The low-income level is reflected in the expenditure of an average family (data for the region, Ilocos, 1975): approximately 62 percent of the expenditure are allotted to food and drinks, but only 1.5 percent to furniture and 6.1 percent to clothing. Related to the assumed average income for San Fernando, it means that a six-member family, statistically, has ₱18 for clothing and ₱4.50 for furniture per month only.

c) **Production for whom?**

The initial question can be answered if one looks now at the types and the prices of the product produced by San Fernando's small-scale manufacturing enterprises. It can be assumed that the foodstuff and clothing industries account for a considerable volume of the demand by low-income groups. Bread, confectionary, rice and rice products, as well as diverse fish products are demanded by all social groups and are affordable for almost everyone. In the clothing industry, it must be differentiated between the standard mass-produced goods (T-shirts, trousers) and the custom-tailored ware. The latter is, as a rule, unaffordable for a household with below-average income (for example, ₱150 for an individually tailored pair of trousers).

Most products of the other branches are, in comparison, aimed at the needs and demands of higher-income groups. This applies, on the one hand to the aforementioned industry groups which are linked to the modern building activities. The minimum cost of building a modern, bungalow-style house was, at the time of investigation, about ₱100,000, which is far beyond anything that an average family can afford. But also beyond the reach of the majority of the population are the corresponding household articles produced by wood processing industries.

On the other hand, there are the goods of the transport-oriented sector (jeepney body work: ₱10-16,000, sidecars: ₱3,000) which are still more oriented towards the demand of higher-income groups. This is truc also for the altogether less-weighty electrical and printing industries.

The assumption that the goods of the informal small-scale industries sector are predominantly consumed by the lower-income groups could not be confirmed in the course of the undertaken study. In each case the hypothesis requires a qualification. Except from the less absolute figures dominating but below-average representation of the foodstuff and clothing industries (the latter not completely), most of the products of the other small-scale manufacturing units in San Fernando are demanded by a relatively narrow, but well-financed segment of the population made up of higher-paid civil servants, white-collar workers and entrepreneurs. Due to the lack of competitive alternatives that are found, for instance, in Manila, this group falls back on the products of the branches of small industry, which, due to the distance from Manila and of a central place location, enjoy comparative advantages.

It must be noted here that this does not apply to complex industrial production (e.g., electronics, optics, motors, etc.) for which the transport costs only account for a very small proportion of the cost of the final product. In these cases, small-scale manufacturing units do not have competition chances at all.

7. Summary and Conclusions

In summary, it has been shown that the central hypothesis about the functions of "informal" small-scale industries which, with few exceptions up to now, had been developed on the basis of studies in large metropoles, cannot be confirmed for regional centers lying in considerable distance from the next urban agglomerations as in the case of San Fernando, La Union.

More specifically, it must be qualified:

— The "informal" small-scale manufacturing sector is no homogeneous sector of poverty but it is rather characterized by the development of different types of businesses and income-levels, with the position of the independent business owner differing clearly from that of the dependent worker.

— The business owners, of whom the majority are migrants, are mostly commercially and profit-oriented. This means the search for employment and (adequate) income is outweighed by the "accumulation" desire. For the majority, the work in small-scale manufacturing enterprises is also a process of social ascent.

— The goods of these small-scale manufacturing units are only partly absorbed into the consumption of lower-income groups. The noticeable, above-average proportion of modern industry groups is explained by the demand of a small segment of higher-income groups.

Not only a greater differentiation of industry groups and of incomes, but also a stronger social mobility and hierarchisation seems to be made possible by the market niche constituted by distance from large metropoles and central place functions. This is revealed in the strong position of the larger, more developed enterprises among the small-scale industries units. That the access for destitute, job-seeking rural-urban migrants is more difficult and limited (in comparison to larger, urban centers) can be linked to this.

This might contribute to the fact that not only San Fernando, but also other small- and medium-sized towns in the Philippines could, up to now, function only to a limited extent as absorption basins for the rural-urban migration, thereby relieving the large cities. For verification of such suppositions, further investigation of the urbanization process in small- and medium-sized urban areas in different Third World countries is necessary.

LITERATURE

BSMI/Min. of Industry. *Programs and Services for Cottage, Small and Medium Industries.* Manila: 1982.

Bromley, R. *The Urban Informal Sector. Critical Perspective on Employment and Housing Policies.* Oxford: 1979.

Bronger, D. "Metropolization: Its Impact to Regional Development Planning in Developing Countries. The Philippine Case." *Philippine Geographical Journal* 27(3-4) 113-136.

Chenery, H.B. *Redistribution with Growth.* Oxford: 1974.

De Vries, B.A. A.O. *Philippines — Industrial Development Strategy and Policies.* Washington: 1980.

Elwert, G./Evers, H.D./Wilkens, W. "Die Suche nach Sicherheit: Kombinierte Produktionsformen in sogenannten Informellen Sektor." *Zeitschrift fur Soziologie* 12(1) 281-296.

Hanisch, R. "Philippine (Landeranalyse)." In Nohlen, D./Nuscheler, F. (Hrsq.) : *Handbuch der Dritten Welt, Bd. 7: Sudasien und Sudostasien.* Hamburg: 1983; 407-435.

ILO *Employment, Incomes and Equality: A Strategy for Increasing Productive Employment in Kenya.* Geneva: 1972.

Jurado, G.M. "The Manila Informal Sector." In Sethuraman, S.C. *The Urban Informal Sector in Developing Countries.* Geneva: 121-143.

Michel, H. and Ochel, W. *Landliche Industrialisierung in Entwicklungslandern.* Munchen: 1977.

Schamp, E.W. (HRSG.) "Der informelle Sektor." *Geographische Perspektiven eines umstrittenen Konzepts.* Aachen, Gottingen: 1990.

Schmitz, H. *Manufacturing in the Backyard: Case Studies on Accumulation and Employment in Small-Scale Brazilian Industry.* London: 1982..

Schneider, H. "Kleinindustrie in einem philippinischen Regionalzentrum. Das Bsp. der Mun. of San Fernando (Ilocosregion/Nord-Luzon)." Ein *Beitrag zur Rolle der Kleinindustrie im Entwicklungsprozeß.* Frankfurt: (Frankfurter Wirtschafts- und Sozial-geographische Schriften, Heft 50), 1986a.

Seifert, J. *Die Unternehmer in den Entwicklungslandern als aromen und Problem in der entwicklungswissenschaftlichen Forschung seit 1950.* Wiesbaden: 1974.

Sethuraman, S.V. (ed.) *The Urban Informal Sector in Developing Countries.* Geneva: 1981.

Staley, E. and Morse, R. *Modern Small-Scale Industry for Developing Countries.* New York: 1965.

Turnham, D., Salome, B. and Schwarz, A. *The Informal Sector Revisited.* Paris: OECD Publication, 1990.

Philippine Geographical Journal, Vol. 36, Nos. 1 & 2
(January-June, 1992)

GROUNDWATER RESOURCE POTENTIAL OF DHANIPUR BLOCK, ALIGARH DISTRICT, INDIA AND ITS ROLE IN AGRICULTURE

Azim U. Qureshi, M. Irfan Sabir and Akram Ali*

ABSTRACT. In order to give a boost to the foodgrain production programme, a high priority was given to water resource evaluation, development and management. With the advent of planning at the district level, the block level groundwater resource estimation has attained a great importance. Agriculture is a soil-plant-water system. In a soil-crop-water system, it is the water whose presence makes the land green or its absence convert the land into desert. Groundwater contributes over 50 percent of irrigation potential created in the country which very well testifies the role of groundwater in agriculture. The present paper deals with the evaluation of groundwater resource potential of Dhanipur Block, District Aligarh, India and its role in agriculture.

INTRODUCTION

Quantification of groundwater and surface water resources of any basin involves the application of the principle of conservation of mass, to account for quantitative changes occurring in the various components of the hydrologic cycle as applied to the basin. The quantitative changes may be expressed as a water balance equation in which the inflow-outflow and change in storage in a period of time are represented by individual components. The groundwater balance may be expressed in the form of an equation such as:

$$I - O = \pm \Delta S$$, where

I = Inflow
O = Outflow
ΔS = Change in storage

Groundwater is a replenishable resource. Refined quantitative answers are needed for drawing up plans for its utilization, management and conservation. The heavy demand of groundwater sometimes leads to excessive withdrawals and indiscriminate utilization which is often reflected in a serious imbalance of hydrogeological situations at a later date.

* Azim U. Qureshi (M.Sc., Ph.D. Alig.) is a Reader in Geography, Department of Geography, Aligarh Muslim University, Aligarh, India. His research interests in land use and agricultural geography. Currently he is working on the role of groundwater and its applications to agriculture. M. Irfan (M.Sc., M.Phil.Alig.) is a Research Scholar at Aligarh Muslim University, Aligarh, India. His research interests include role of groundwater in the development of agriculture. Akram Ali (Ph.D. Hydrogeology, Alig.) is a Research Assistant at the Remote Sensing Application Centre, A.M.U., Aligarh, India. His research interests include groundwater hydrology, hydrochemistry and environmental pollution.

It is, therefore, imperative to identify the various cycles of recharge and discharge of the groundwater regime and their effect on its variation with time.

In the state of Uttar Pradesh, there is large-scale water-logging in all the canal command areas while in the tubewell irrigated areas water levels show a declining trend due to overdevelopment of the shallow aquifers. Moreover, the advent of high-yielding varieties of wheat and paddy which needed assured and timely irrigation, has accelerated the pace of groundwater development through a large number of shallow farmer's tubewells in rural areas. Under the circumstances, the situation necessitates, as far as possible, the precise evaluation of groundwater resources of a basin or part of it.

PHYSIOGRAPHY, LAND USE AND DRAINAGE

Physiographically, the district of Aligarh has been divided into three distinct units, viz., the eastern upland, the western upland and the central depression. The study area that is the Dhanipur Block forms a part of the central depression and apart of the western margin of the eastern upland, covering an area of 293.94 sq.km. It lies between latitudes 27°46′ to 28°2′ North and longitudes 78°5′ to 78°18′ East (Fig. 1). The estimated area for cultivation is 222.44 sq.km. Cultivable fallow land is 16.59 sq.km., culturable waste land is 7.32 sq.km., barren and unculturable waste land is 17.36 sq.km., area under forest is 0.58 sq.km., pasture 1.03 sq.km., orchard and trees 0.91 sq.km. and land used for other works except cultivation is 27.71 sq.km. Total cropped area is 374.56 sq.km. The area sown more than once is 152.12 sq.km.

The area is drained by the Sengar River which flows in a northwest to southwest direction in conformity with the master slope of the Block. The river Kali drains it through the eastern margin of the Block. The Upper Ganga canal system passes through the upland part of the area.

GEOLOGY AND HYDROGEOLOGY

Geologically, the area consists of alternate beds of sand and clay of Quaternary age, which were deposited on the eroded surface of upper Vindhyan rocks.

Hydrogeologically, there occurs a three-tier aquifer system which lies in the depth ranging from 9 to 60, 99 to 100 and 179 to 200 meters below the ground level respectively. The aquifers' material consists of fine to medium sand which due north and forms a single-bodied aquifer system. The first aquifer which is about 50 meters thick is very much productive and at present serving various uses of water for domestic and agricultural purposes. A brief evaluation of groundwater resource potential of Dhanipur Block follows.

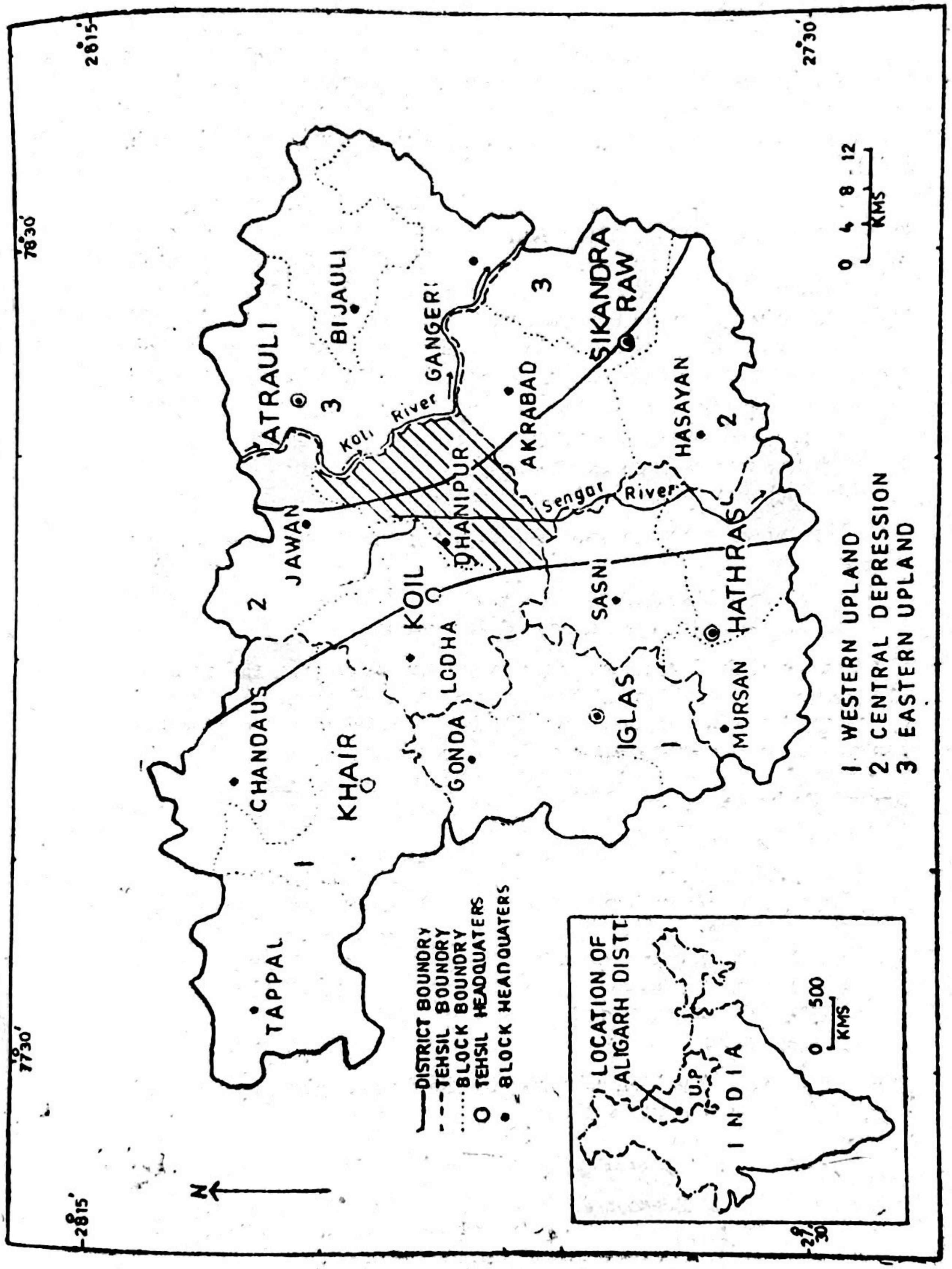


FIG 1. MAP SHOWING THE AREA OF STUDY AND ALSO THE PHYSIOGRAPHIC UNITS OF ALIGARH DISTRICT, INDIA

Groundwater Recharge

Evaluation of groundwater recharge parameter forms an important aspect of groundwater resource evaluation. It involves hydrometeorological and hydrological processes taking place on the surface and also involves sub-surface lithilogical characteristics (Baweja and Karanth, 1980).

Various estimations of groundwater recharge in the country have been made (Rao, *et al.*, 1965; and Pathak, 1982), while the earlier estimations were based on *ad hoc* norms not supported by field tests. A large amount of data generated in recent years as a result of the extensive multidisciplinary project studies undertaken by both the Central Groundwater Board as well as by the State Groundwater Department have made realistic appraisals rather easier. The major sources of groundwater recharge in the area are as follows:

(1) Recharge through rainfall.
(2) Recharge through canal seepage.
(3) Recharge through irrigation return flow.

There are various methods to estimate groundwater recharge, two of which are:

(1) Water table fluctuation method.
(2) Rainfall recharge method *ad hoc* norms.

In view of the prevailing irrigation pattern in the area, the quantum of seepage to the aquifers will be very significant. Hence, the estimation by seasonal fluctuation and specific yield have been adopted for the evaluation for the groundwater recharge in the present study.

Annual Recharge

Monsoon recharge

Geographical area	=	293.94 sq.km.
Water table fluctuation	=	1.2 m.
Specific yield	=	15%
I.M.D. normal yearly rainfall	=	697.2 mm.
I.M.D. normal monsoon rainfall	=	624.35 mm.
I.M.D. normal non-monsoon rainfall	=	43.8 mm.
Average rainfall of the observation year	=	788.15 mm.

Monsoon recharge has been calculated by the formula given by a groundwater estimation committee, thus:

Monsoon recharge = (Geog. area × Sp. yield × W.T. fluctuation) + Monsoon draft — (Monsoon canal seepage + Monsoon recharge from surface water irrigation + Monsoon groundwater recharge) ×

$$\times \frac{\text{Normal monsoon rainfall}}{\text{Average monsoon rainfall}}$$

+ Monsoon recharge from surface water irrigation

+ Monsoon recharge through canal seepage

$$= (293.94 \times 0.15 \times 1.2) + 10.25 - (7.24 + 23.60 + 8.67) \times \frac{624.35}{788.15} + 23.60 + 7.24$$

$$= 52.91 + 10.25 - 39.51 \times 0.79 + 23.60 + 7.24$$

$$= 52.91 + 10.25 - 31.21 + 23.60 + 7.24$$

$$= 90 - 31.21$$

$$= 62.79 \text{ M.C.M.}$$

Monsoon recharge from the entire area has been estimated to be 62.79 M.C.M.

Non-monsoon recharge

Non-monsoon recharge estimated for the area is given below.

Geographical area = 293.94 sq.km.

Non-monsoon rainfall = 46.7 mm.

Infiltration factor = 25%

$$\text{Non-monsoon recharge} = \frac{\text{Geog. area} \times \text{Infiltration factor} \times \text{Non-monsoon rainfall}}{10^3}$$

$$= \frac{293.94 \times 0.25 \times 46.7}{10^3}$$

$$= 3.43 \text{ M.C.M.}$$

Total non-monsoon recharge

$$= 3.43 + 24.85 + 9.46$$

$$= 37.74 \text{ M.C.M.}$$

Recharge through return seepage from applied irrigation

To evaluate the irrigation return flow to the groundwater, the irrigated area and volume of water applied for irrigation are taken into consideration for working out the total volume of water applied, of which 40% and 30% for monsoon and non-monsoon is assumed to return to groundwater body. Crop-wise, return seepage in the area has been calculated, which is given below.

TABLE 1. RECHARGE THROUGH IRRIGATION RETURN FLOW

Crop type	Area irrigated (sq.km.)	Average wetted depth (M)	Irrigation water applied (M.C.M.)	Seepage factor (%)	Seepage (M.C.M.)
Monsoon					
1. Kharif	147.56	0.4	59.02	40%	23.60
Non-monsoon					
2. Rabi	195.23	0.4	78.09	30%	23.42
3. Zaid	31.77	0.15	4.76	30%	1.43

Note: The total quantum of the irrigation return flow is computed to be 48.45 M.C.M.

Quantum of Recharge through Canal Seepage

The seepage losses from the canal have been estimated by using the formula given by Satish Chandra (1983). He opined that the following formula was applicable to the alluvial region of Uttar Pradesh.

$$W = 0.005\ C\ (B + D)^{0.67} \qquad \ldots\ldots\ldots\ldots (1)$$

where,

W = recharge from unlined bed of canal in cubic meter/sec/km.

B = width of canal in meter

D = depth of water in meter

C = a constant being 1.0 for intermittently running and 0.75 for constant running canal.

(a) Seepage from constant running Upper Ganga Canal
Total length of canal traversing through the study

Area = 18.65

C = 0.75

B = 5.64 m.

D = 3.5 m.

$$W = 0.005\ C\ (B + D)^{0.67}$$
$$= 0.005 \times 0.75\ (5.64 + 3.5)^{0.67}$$
$$= 0.005 \times 0.75 \times 4.40$$
$$= 0.0165\ m^3/sec/km.$$

Total seepage in the area through the total length of the canal

$$= 18.65 \times 0.0165$$
$$= 0.308\ m^3/sec/km.$$

(i) Monsoon recharge

Total running days during monsoon = 107

$= 0.308 \times 60 \times 60 \times 24 \times 107$
$= 2847398.4$ m³/sec/km.

$$= \frac{2847398.4}{1000000} = 2.847 \text{ M.C.M.}$$

(ii) Non-monsoon recharge

Total running days during non-monsoon = 144

$= 0.308 \times 60 \times 60 \times 24 \times 144$
$= 3832012$ m³/sec/km.

$$= \frac{3832912.8}{1000000} = 3.832 \text{ M.C.M.}$$

(b) Seepage from Harduaganj Distributary

Total length of canal = 17.78

$B = 3$ m.
$D = 1.2$ m.
$C = 1$
$W = 0.005\ C\ (B + D)^{0.67}$
$W = 0.005 \times 1\ (3 + 1.2)^{0.67}$
$= 0.005 \times 1.0 \times 2.61$
$= 0.01305$ m³/sec/km.

Total seepage through the entire length of Harduaganj Distributary

$= 17.78 \times 0.01305$
$= 0.232$ m³/sec/km.

(i) Monsoon recharge

Total running days during monsoon = 98

$= 0.232 \times 60 \times 60 \times 24 \times 98$
$= 1964390.4$ m³/sec/km.

$$= \frac{1964390.4}{1000000} = 2.385 \text{ M.C.M.}$$

(ii) Non-monsoon recharge

Total running days during non-monsoon = 119 km.

$= 0.232 \times 60 \times 60 \times 24 \times 119$
$= 2385221.2$ m³/sec/km.

$$= \frac{2385331.2}{1000000} = 1.964 \text{ M.C.M.}$$

(c) Seepage from Sumera Distributary
Total length of canal = 19.23 km.

B = 3 m.
D = 1.2 m.
C = 1
W = $0.005\ C\ (B + D)^{0.67}$
= $0.005 \times 1.0\ (3 + 1.2)^{0.67}$
= $0.005 \times 1.0 \times 2.61$
= 0.01305 m^3/sec/km.

Total seepage through the entire length of Sumera Distributary
= 19.23×0.01305
= 0.251 m^3/sec/km.

(i) Monsoon recharge
Total running days during monsoon = 85
= $0.251 \times 60 \times 60 \times 24 \times 85$
= 1843344 m^3/sec/km.

$$= \frac{1843344}{1000000} = 1.843 \text{ M.C.M.}$$

(ii) Non-monsoon recharge
Total running days during non-monsoon = 105
= $0.251 \times 60 \times 60 \times 24 \times 105$
= 2277072 m^3/sec/km.

$$= \frac{2277072}{1000000} = 2.277 \text{ M.C.M.}$$

(d) Seepage from Machhua Distributary
Total length of canal = 16.20 km.

B = 1.40 m.
D = 0.75 m.
C = 1
W = $0.005\ C\ (B + D)^{0.67}$
= $0.005\ 1.0\ (1.40 + 0.75)^{0.67}$
= $0.005 \times 1.0 \times 1.67$
= 0.00835 m^3/sec/km.

Total seepage through the entire length of Machhua Distributary
= 16.20×0.00835
= 0.135 m^3/sec/km.

(i) Monsoon recharge
Total running days during monsoon = 30
= 349920 m^3/sec/km.

$$= \frac{349920}{1000000} = 0.350 \text{ M.C.M.}$$

(ii) Non-monsoon recharge

Total running days during non-monsoon = 51

= $0.135 \times 60 \times 60 \times 24 \times 51$

= 594864 m^3/sec/km.

$$\frac{594864}{1000000} = 0.959 \text{ M.C.M.}$$

(e) Seepage from Komri Distributary

Total length of canal = 13.46 km.

B = 1.2 m.

D = 0.75 m.

C = 1

W = $0.005\ C\ (B + D)^{0.67}$

= $0.005 \times 1\ (1.2 + 0.75)^{0.67}$

= $0.005 \times 1.0 \times 1.56$

= 0.0078 m^3/sec/km.

Total seepage through the entire length of Komri Distributary

= 13.46×0.0078

= 0.105 m^3/sec/km.

(i) Monsoon recharge

Total running days during monsoon = 26

= $0.105 \times 60 \times 60 \times 24 \times 26$

= 235872 m^3/sec/km.

$$= \frac{235872}{1000000} = 0.236 \text{ M.C.M.}$$

(ii) Non-monsoon recharge

Total running days during non-monsoon = 41

= $0.105 \times 60 \times 60 \times 24 \times 41$

= 371952 m^3/sec/km.

$$= \frac{371952}{1000000} = 0.372 \text{ M.C.M.}$$

Total monsoon recharge through canals and distributaries

= a + b + c + d + s

= 2.847 + 1.964 + 1.843 + 0.350 + 0.236

= 7.24 M.C.M.

Total monsoon recharge through canals and distributaries

= a + b + c + d + s

= 3.832 + 2.385 + 2.277 + 0.595 + 0.372

= 9.46 M.C.M.

Gross groundwater recharge in the area

The gross groundwater recharge

= Monsoon recharge
+ Non-monsoon recharge
= 62.79 + 37.74
= 100.53 M.C.M.

Recoverable recharge

Eighty-five percent of the gross recharge as obtained above is taken to be recoverable recharge for irrigation.

Total groundwater resource for irrigation

= Gross recharge × 0.85
= 100.53 × 0.85
= 85.45 M.C.M.

Groundwater Draft

Groundwater is being tapped through open wells, hand-pumps, Persian wells, state tubewells, shallow farmer's tubewells, and pumping sets. The unit drafts for these groundwater structures, estimated below by the State Groundwater Department, Uttar Pradesh, (Hasan, *et al.*, 1982), have been utilized in the evaluation of the groundwater draft.

(a) Draft by state tubewells

Unit draft of state tubewells = 0.175 M.C.M.
Total number of state tubewells = 39

Total draft = Unit draft × No. of state tubewells
= 0.175 + 39
= 6.825 M.C.M.

(b) Draft by shallow farmer's tubewells

Total number of shallow tubewells = 0.0188 M.C.M.
Unit draft of shallow tubewells = 1178

Total draft = Unit draft × No. of shallow tubewells
= 0.0188 × 1178
= 22.146 M.C.M.

(c) Draft by pumping sets

Unit draft of pumping sets = 0.0109 M.C.M.
Total number of pumping sets = 1062

Total draft = Unit draft × No. of pumping sets
= 0.0109 × 1062
= 11.575 M.C.M.

(d) Draft by handpumps

Unit draft of handpumps = 0.000036 M.C.M.

Total number of handpumps = 7000

Total draft = Unit draft × No. of handpumps

= 0.000036 × 7000

= 0.252 M.C.M.

(e) Draft by dug wells

Unit draft of dug wells = 0.00036 M.C.M.

Total number of dug wells = 500

Total draft = Unit draft × No. of dug wells

= 0.00036 × 500

= 0.18 M.C.M.

(f) Draft by Persian wells

Unit draft Persian wells = 0.005 M.C.M.

Total number of Persian wells = 2

Total draft = Unit draft × No. of Persian wells

= 0.005 × 2

= 0.01 M.C.M.

Total draft from different groundwater structures

= a + b + c + d + e + f

= 6.825 + 22.146 + 11.575 + 0.252 + 0.18 + 0.01

= 40.988 M.C.M.

Monsoon draft = 10.25 M.C.M.

(25% of the total draft is taken as monsoon draft)

Net annual draft = 28.69 M.C.M.

(70% of the total draft is taken as net annual draft)

Water Balance

$I - O = \pm \Delta S$

$I = 85.45$ M.C.M.

$O = 28.69$ M.C.M.

$85.45 - 28.69 = \pm \Delta S$

$56.76 = \pm \Delta S$

The above evaluation of groundwater resource in the area shows that a 56.76 M.C.M. utilizable resource lies in the area.

TABLE 2. GROUNDWATER POTENTIAL AND STAGE OF DEVELOPMENT

Gross ground-water recharge in M.C.M.	Net ground-water recharge in M.C.M.	Gross ground-water draft in M.C.M.	Net ground-water draft in M.C.M.	Balance ground-water available in M.C.M.	Stage of ground-water develop-ment
100.53	85.45	40.99	28.69	56.76	33.57%

Stage of Groundwater Development

The stage of groundwater development in the study area as per the 'ARDC' 1979 (Agricultural Refinance and Development Corporation) norms is evaluated as:

$$\text{Stage of groundwater development} \quad \frac{\text{Net yearly draft}}{\text{Net recoverable recharge}} \times 100$$

$$\text{Stage of groundwater development in Dhanipur Block} = \frac{28.69}{85.45} \times 100$$

$$= 33.57\%$$

An area where the stage of groundwater development is less than 65% falls under the "white"; where the stage of groundwater development ranges between 65 to 85%, it falls under "grey"; and where the stage of groundwater development is more than 85%, it falls under the "dark" categories.

Accordingly, the stage of groundwater development in Dhanipur Block works out to be 33.57%, which naturally puts it under the "white" category.

CONCLUSION

The study shows that the groundwater development in Dhanipur Block is being done on a large-scale through the shallow farmer's tube-wells. The assured irrigation through groundwater has revolutionized the food production in the Block, which very well testifies to its role in transforming the rural landscape and the economy of the people in the area. High-yielding varieties of crops like paddy, wheat and also vegetables need assured irrigation in time. Surface water is also available but it is not assured irrigation due to the lack in management and local political exploitation. It creates waterlogging and soil salinization near the main canal while the water could not reach in the field through the distributaries away from the main canal, thus the farmers' need for their own shallow tubewells for assured irrigation. Since the data show that groundwater resource is available for irrigation, the government should manage more shallow tubewells for the farmers' irrigation needs in order to increase the foodgrain production in the area.

REFERENCES

Agricultural, Refinance and Development Corporation. "Report of the Groundwater Over-exploitation Committee" n.p.:1979:93.

Bajew, B.K. and Kranth, K.R. "Groundwater Recharge Estimation in India." Tech. Series H. Bull. 2. Central Groundwater Board, 1980.

Hasan, N., Johri, P.K. and Hasan, F. "Intensive Geohydrogeological Investigation, Block Jagat district Badaun, U.P." 1982.

Pathak, B.D. "Groundwater Resources and Development Potential in India." Central Groundwater Board, Government of India, 1982:112.

Rao, K.V., Raju, T.S. and Agashe. "Quantitative Studies on Groundwater Storage, Recharge, Draft and Safe Yield in Atrauli Area, Aligarh District, U.P." *Indian Geohydrology* 6(1) (1965):46-67.

Satish Chandra. "Hydrogeological Investigations in Groundwater Resources Evaluation." Proc. Seminar on Assessment, Development and Management of Groundwater Resources, Central Groundwater Board, New Delhi, 1983.

Philippine Geographical Journal, Vol. 36, Nos. 1 & 2
(January-June, 1992)

DIMENSIONS OF POLLUTION IN THE GANGA RIVER WATER BETWEEN NARORA AND KANNAUJ (U.P.), INDIA

M. Ishrat Saeed Khan*

ABSTRACT. Increasing population, rapid urbanization and expanding industrialization during the last few decades have threatened the environment with consequences of severe pollution. Environmental pollution includes pollution of water, and air, and definitely depends on the population growth. It has been proved that the rate of pollution is much faster than that of urbanization and industrialization Although science and technology have brought many benefits to mankind, nature will hit back if there is too much intrusion into its domain. Our natural resources are limited but human activities are unlimited. The general environmental and ecological changes that are now taking place due to the anthropogenic factors can be related to various forms of pollution. Therefore, keeping in mind the hazards of environmental pollution, a study of river water pollution has been undertakes. This study is mainly concentrated on runoff from rural settlements, cattle pens, agricultural holdings charged with residues of fertilizers and pesticides, and the pollution generated by cultural inhibitions. Thus, the coming together of the natural potential of river hydrology and of human needs and aspirations provides a unique focus and scope for geographical inquiry.

INTRODUCTION

The choice of the Ganga among the Indian rivers for the study of man-river interaction has obvious reasons. It is the most vital lifeline of the alluvial agricultural plains of north India and one of the most notable geographical dominants in the political history of the region. It has been an important element in the religious, social, cultural and linguistic wealth of the area. It has been revered since ancient times in the Hindu scriptures.

The Ganga basin is developing and has its own environmental problems. It is generally seen that development is accompanied by destruction. Many of the natural systems such as rivers have been affected due to increased human settlements and activities. Ganga is one such river which is facing grave dangers of pollution from increased human settlements and developmental activities all along its course. In other words, it can be emphasized that on account of the present trend of rapid urbanization, industrialization, modernization of agriculture, sewage and sullage, wastewater and cultural inhibitions, the quality of Ganga River water is undergoing rapid changes.

* M. Ishrat Saeed Khan (M.Sc., B.Ed. and M.Phil.Geog.) is a Senior Research Fellow at the Department of Geography, Aligarh Muslim University, Aligarh (India). He was also associated with the Ganga Basin Project, of which the present article is a partial output.

Hence, the use of Ganga River water for different purposes and the size of water pollution load in terms of organic and inorganic matters affecting the quality of water in the entire Ganga basin is getting more and more serious. It is, therefore, of great importance to bring out the possible relationship between human activities and the different types of pollution load discharged continuously in the river. It is noteworthy that no attempt has been made to study the problem of dimensions of Ganga River water pollution at such a micro level.

The Region

In the present study, the basic approach is rooted in the water pollution concept and is a compilation of information regarding the Ganga River water pollution under an ever-increasing population pressure, developmental activities along the Ganga River, and cultural inhibitions between Narora and Kannauj in Uttar Pradesh, India. This region, therefore, has been visualized as a micro region ecosystem in which the river Ganga is the principal ecological component. This region is part of Ganga Plain which is a gift of Ganga River and its tributaries to the nation and extends from 78°E to 80°E longitude and 27°N to 28°N latitude, covering an area of 26,398.44 sq.km. (Fig. 1). Physiographically, the entire region is almost an undulating vast alluvial plain. The drainage is well-developed and follows the general direction of the gentle slope of the land. The region experiences the tropical monsoon type of climate. The soils are generally fertile. The soils are *khadar* (new alluvium) and *bhangar* (older alluvium) and shows a considerable influence of the drainage in their distribution. There exist trees of subtropical dry type and are deciduous. The entire region is thickly populated. The population dynamics reveals a rapidly increasing population. The spatial distribution of population depicts the essential role of the Ganga River in the socioeconomic life of the people. The economic base is predominantly agricultural. The unprecedented growth witnessed in urban population has led to the rapid development of industrialization, along with the increase in the transportation lines and means of communication in the region.

Methodology

Since this is a micro-regional analysis, it is desirable to use the smallest unit, i.e., village for analysis. There are thousands of villages in the study region. However, collecting data from all the villages was not possible due to unavoidable circumstances. Therefore, a sampling frame has been developed to draw a representative sample of villages. Twelve villages were selected for intensive field survey (Fig. 2). These include three villages from Farrukhabad, two villages each from Budaun and Etah, with one village each from Aligarh, Bulandshahr, Hardoi,

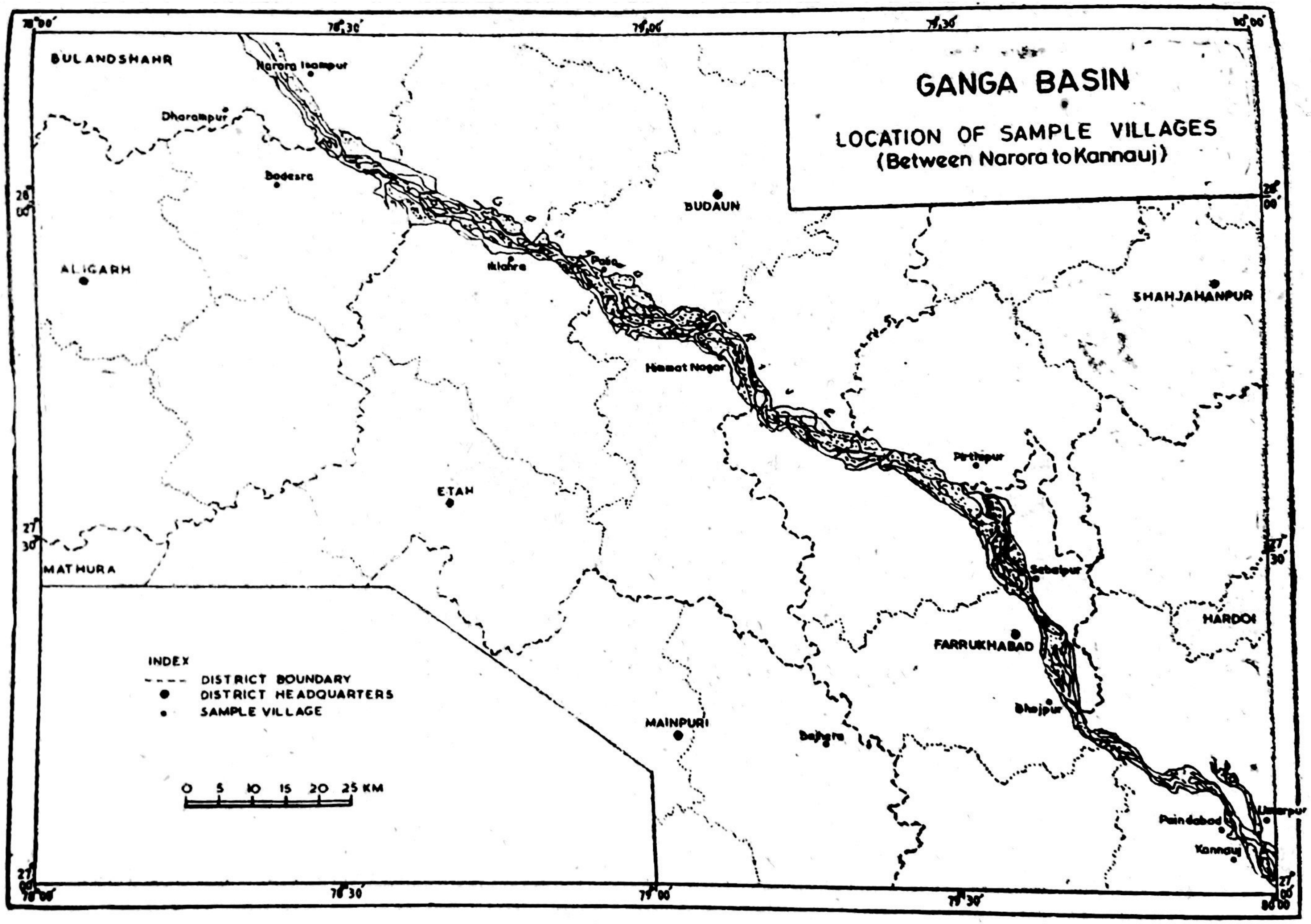


FIG. 1. GANGA BASIN (BETWEEN NARORA AND KANNAUJ)

Mainpuri and Shahjahanpur districts. These villages have been selected on the basis of population size, distance from the Ganga River and through the use of stratified random sampling on either side of the Ganga. In this selection, care has also been taken to select the villages located in the neighborhood of the approved sampling stations for the entire "Ganga Basin Project," i.e., Narora, Kachchla, Fatehgarh and Kannauj.

The information regarding the present paper was collected during the intensive field survey for a large research project under "Ganga Water Pollution and Coordination Cell" (1987-89) and is largely based on primary data collected for detailed investigations with a view to faithfully measure the interaction between man and his environment in the study region. In addition, the villages were carefully observed and noted. Community leaders, knowledgeable persons and a number of other villagers were also consulted with regard to the utilization of the natural resources.

Accordingly, the operational strategy of the study involves a man-environment format, visualizing the two components as being in a mutually interacting relationship ideally in a state of steady equilibrium. But the anthropogenic factors emanating from human interference in the natural ecological balance calls for an in-depth analysis of various aspects of the two components and how they act and interact with one another.

Population Pressure

The population is predominantly rural and agricultural. The rural settlements are distributed uniformly with inter-village distance varying from 2 to 4 km. (Fig. 3). Even in the flood-prone low-lying Ganga *Khadar* rural settlements lie at regular intervals. Many villages lie as near as 1 to 2 km. from the river. Most of the people live in medium to large villages having a few hundred to over 5,000 persons. Farrukhabad which lies inside the bend of the Ganga, is the only urban center with a population over 1,000,000. However, a number of urban settlements with populations varying from 5,000 to 50,000 lie on either side of the Ganga at regular intervals (Fig. 4).

Being part of the fertile Upper Ganga Plain, the region has a high population density which is the result of a combination of historical and natural factors. The high density could also be related to a favorable agricultural situation and related infrastructure, especially in *bhangar* tracts. Density is somewhat low in low lying *khadar* lands which are liable to frequent flood hazards. The *bhurs* and *usar* lands also exhibit low population densities. Thus, the overall population density in the study region varies from 400 to 800 persons per sq.km.

The total population of the sample villages is 26,715 persons (Table 1), comprising 14,016 males and 12,699 females. The sex ratio

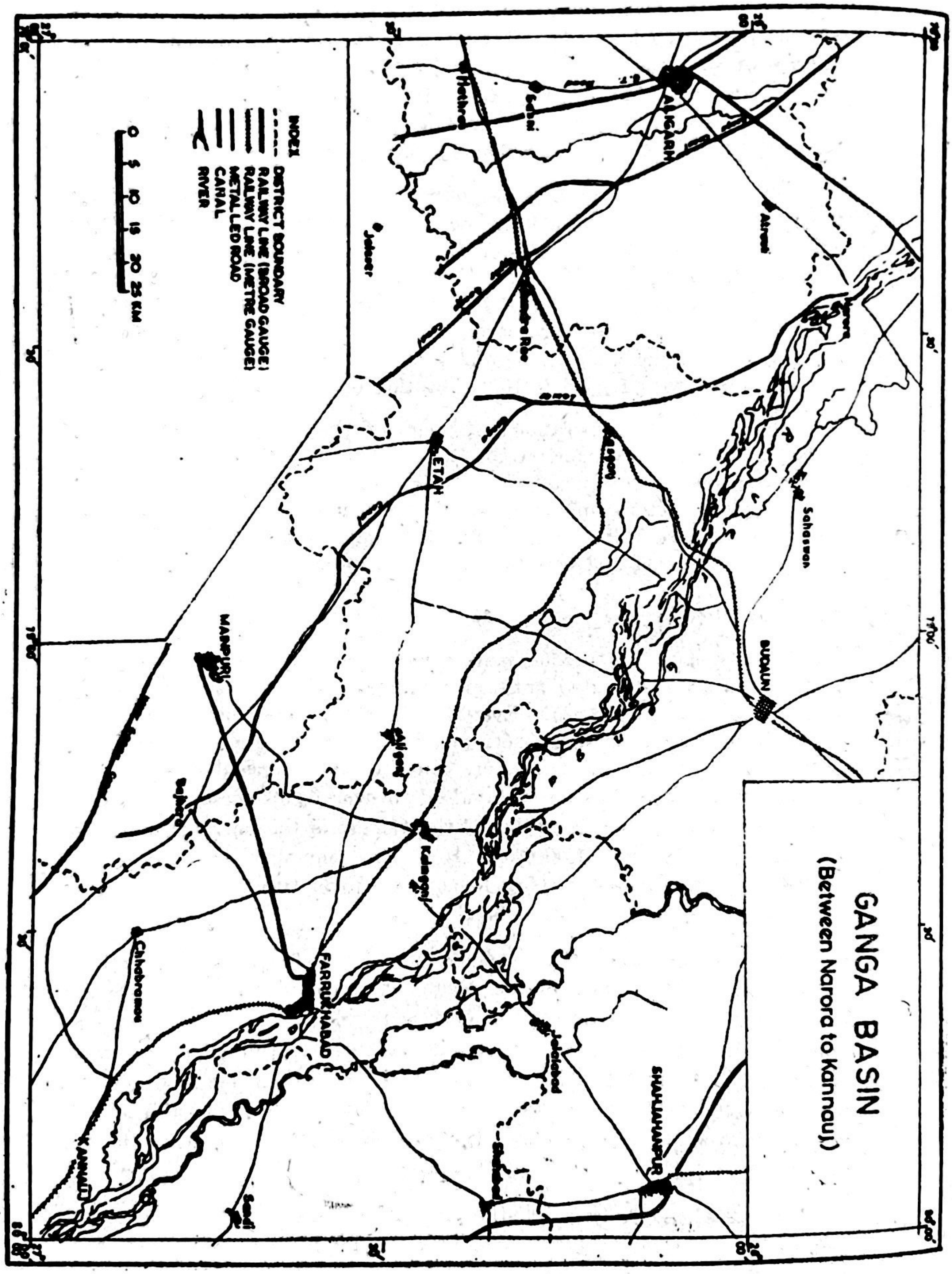


FIG. 2. GANGA BASIN (BETWEEN NARORA TO KANNAUJ)

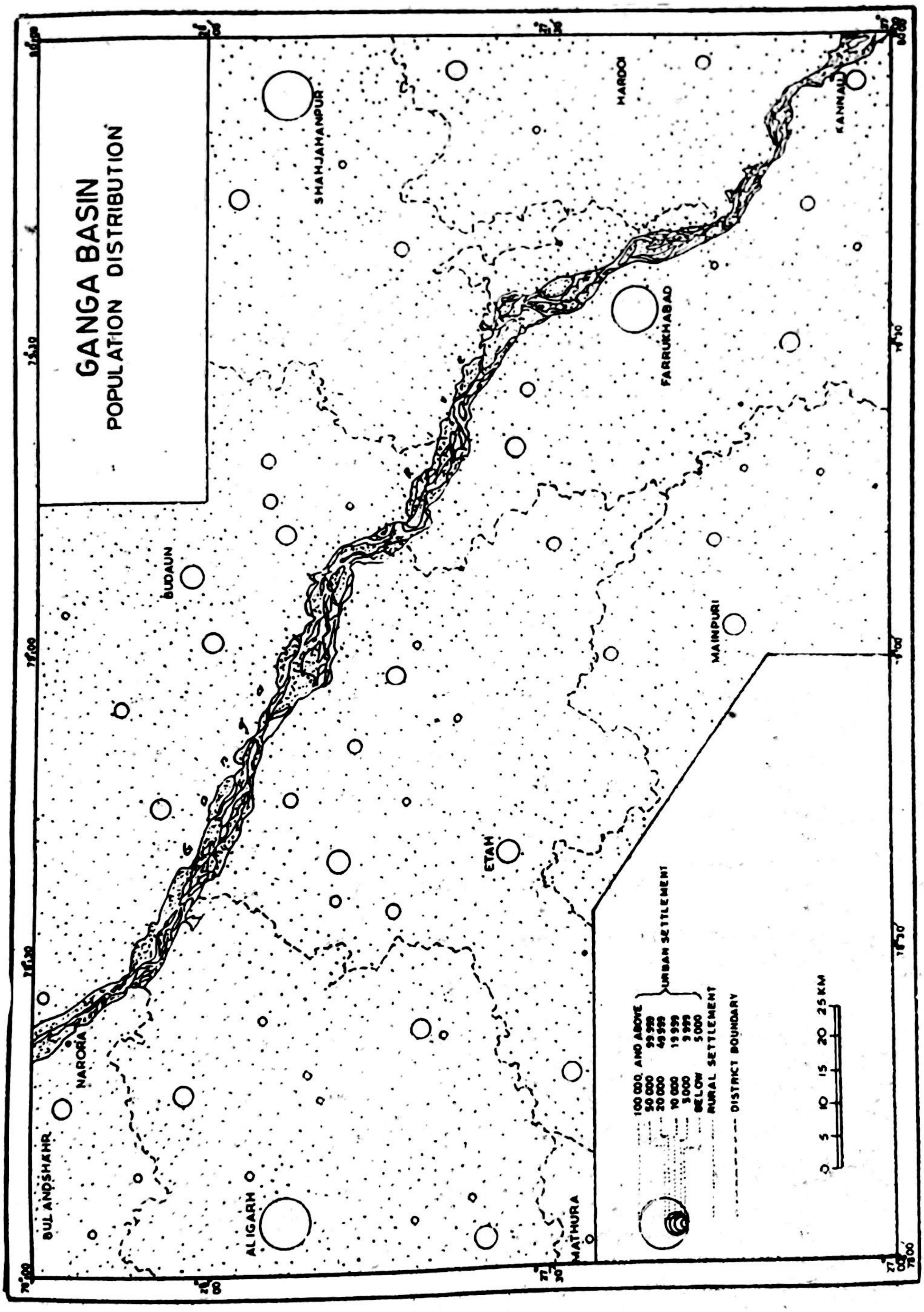


FIG. 3. GANGA BASIN POPULATION DISTRIBUTION

is 906, which is comparable to the micro-regional figure of 849 but falls below the national figure of 934. The population density in the sample villages is 494.4 persons per sq. km. This can be compared with the density of total population in the Ganga basin as a whole (297 persons/sq. km.) and the whole of India (196 persons/sq. km.). Thus, in the study region the population density is very high, even if compared to the thickly populated region of the whole Ganga basin. However, the population pressure in the villages nearest to the river is markedly less. In the two villages lying nearest to the river, Sebalpur and Palia, the population per hectare is 2.31 and 1.54, respectively, which are lower compared to 8.40 per hectare for the twelve sample villages.

The total number of households in the sample villages is 4,512, with each household, on an average, consisting of 5.92 persons. Thus, the degree of rural congestion is quite high as compared to the 5.86 national average.

TABLE 1. PRESSURE OF HUMAN AND ANIMAL POPULATION IN THE SAMPLE VILLAGES

Village/District	Total Area (Hect.)	Household (numbers)	Total Population (numbers)	Persons/ Hectare*	Cattle Population (numbers)	Cattle/ Hectare*
1. Isampur (Budaun)	152.23	403	2172	14.26	5215	34.25
2. Dharampur (Bulandshahr)	386.89	429	2702	6.98	2613	6.75
3. Badesara (Aligarh)	401.47	398	2497	6.22	2023	5.04
4. Iklahra (Etah)	266.76	228	2013	7.54	968	3.63
5. Palia (Budaun)	646.00	213	849	13.14	421	0.65
6. Himmatnagar (Etah)	477.70	198	1487	3.11	1226	2.56
7. Pirthipur (Sah ahanpur)	696.08	845	4869	6.99	6952	9.98
8. Sebalpur (Farrukhabad)	666.52	106	857	1.28	517	0.77
9. Bhojpur (Farrukhabad)	138.81	345	1846	13.30	2016	14.52
10. Bajehra (Mainpuri)	771.36	689	4228	5.48	4542	5.88
11. Umarpur (Hardoi)	541.08	482	2112	3.90	2209	4.08
12. Paindabad (Farrukhabad)	261.84	176	1083	4.13	1121	4.28

* Based on total area of the village.

The economic base is predominantly agricultural. This is borne out by the fact that 94.47 percent of the total population is engaged in agriculture. The agricultural density of population thus comes to 489.2 persons per sq.km.

As far as the cattle population in the sample villages is concerned, the total figure comes to 29,823 heads. It is observed (Table 1) that the highest figure of 34.25 cattles per hectare is attained by Isampur and is followed by Bhojpur and Pirthipur. In the rest of the villages, it ranges from 2.56 to 6.75 cattles to a hectare, except in Sebalpur and Palia which show densities of 0.77 and 0.65, respectively. These figures can be compared with the 5.52 cattles per hectare in twelve sample villages. The cattle population in Ganga basin as a whole is 152 heads to a square kilometer (1.52/hectare) on the average.

An assessment of the overall situation reveals that the highest concentration of cattles among the sample villages appears in the *khadar* villages (8.30/hectare), where livestock mostly depends on natural grazing. Because of frequent floods, cropping is limited and fodder supplies are inadequate in subsistence agriculture. A fairly high concentration of cattles is also reported from *bhangar* villages (5.89/hectare) where natural grazing is inadequate, depending on better supplies and provision of fodder together with water control and improved care.

Intensity of Agriculture

The overwhelming position of agriculture is the result of the land-use pattern in the sample villages. As much as 72.4 percent of the total area is devoted to agriculture. Only 19.8 percent of the total area is uncultivated while the percentage of culturable waste and grazing land is only 12.7. It is, therefore, clear that almost all of the culturable land in the sample villages has already been brought under cultivation. The remaining culturable land is largely devoted to village grazing. Thus, there is little scope of areal extension of agriculture in the sample villages.

The intensity of agriculture in the sample villages is quite high. This is in conformity with the general agricultural situation prevailing in the Upper Ganga Plains. The incidence of double cropping is quite high as is manifested in the ratio between gross sown to total cultivable area which is 181.92 percent (Table 2). The ratio between gross sown to net sown area is even higher (185.00 percent). However, in the villages lying closest to the river, because of less favorable ecological conditions, the pressure on agricultural land is less marked. In the three river-side villages of Sabalpur, Palia and Iklahra the ratio between the gross sown to total cultivable area is only 157.06 percent as compared to 165.90 for the twelve villages. Similarly, the ratio between gross sown to net cultivated area is only 159.16 as compared to 167.80 percent for the twelve villages.

TABLE 2. AGRICULTURAL LAND USE PATTERN IN THE SAMPLE VILLAGES (IN HECTARES)

Village Name	Total Cultivated Area	Net Sown Area	Gross Sown Area	Area Sown More Than Once	Average Number of Crops Grown
1. Isampur	117.43	115.48	213.64	98.16	1.85
2. Dharampur	343.59	340.40	731.86	391.46	2.15
3. Badesara	353.71	351.44	776.68	425.24	2.21
4. Iklahra	212.14	208.08	233.85	25.77	1.12
5. Palia	555.00	548.26	915.59	367.33	1.67
6. Himmatnagar	358.30	354.61	542.55	187.94	1.53
7. Pirthipur	518.01	510.51	704.50	193.99	1.38
8. Sebalpur	370.69	366.47	637.66	271.19	1.74
9. Bhojpur	86.60	85.21	116.04	30.83	1.34
10. Bajehra	570.41	504.10	1058.61	554.51	2.10
11. Umarpur	321.23	317.99	375.23	57.24	1.18
12. Paindabad	172.40	169.62	161.67	22.05	1.13

Pollutants from Fertilizers

In the period 1988-89, a total of 13,622.85 quintals of chemical fertilizers were used over a net area of 3,200.99 hectares, giving an average consumption of 425.5 kg. per hectare. (Table 3) Nitrogen is the most important fertilizer used, accounting for 64.33 percent of the total consumption. Phosphorus and potassium accounts for 22.74 and 12.92 percent, respectively, of the total consumption. It will be seen from the table that the average incidence of fertilizer used in the area is quite high although there are significant inter-village differences resulting from varying socioeconomic factors. It may be noted that the highest incidence of fertilizer input has been reported from sample villages where assured irrigation from the upper and lower Ganga canals is available. In most of the sample villages, both in *rabi* (crops sown in the beginning of winter) and *kharif* (crops sown upon the onset of the rains), the principal input is nitrogen, followed by phosphorus and potassium in that order. Use of fertilizers for the *zaid* (intermediate) crops is negligible and confined only to three sample villages (Badesara, Bajehra and Dharampur) — all having access to canal irrigation where *zaid* crops can be successfully grown.

It is estimated that in the sample villages about 2,044 quintals (about 15 percent) of chemical fertilizers of all kinds enter into the river water per annum (1988-89). The nitrogen content of these fertilizers would be 1,315 quintals, followed by phosphorus amounting to 465 quintals, and potassium 265 quintals. These nutrients added to the soils through fertilizers eventually find their way to the surface water systems and usually stimulate growth of algae in the surface water, often leading to

TABLE 3. CONSUMPTION OF CHEMICAL FERTILIZERS, PESTICIDES AND INSECTICIDES IN THE SAMPLE VILLAGES

Village Name	FERTILIZERS			PESTICIDES/INSECTICIDES		
	Total Consumption (Qts.)	Per Hectare Use (kg.)	Intensity of Use	Total Consumption (Qts.)	Per Hectare Use (kg.)	Intensity of Use
1. Isampur	67.29	31.5	54.05	42.87	0.36	50.04
2. Dharampur	1829.65	250.0	46.51	39.87	0.11	46.50
3. Badesara	2065.92	266.0	89.28	60.18	0.17	45.23
4. Iklahra	204.15	87.3	45.25	—*	—	—
5. Palia	1510.72	165.0	59.88	82.29	0.06	59.92
6. Himmatnagar	1161.06	214.0	65.36	23.90	0.07	65.12
7. Pirthipur	1803.53	256.0	72.46	30.03	0.06	72.43
8. Sebalpur	930.98	146.0	57.47	32.22	0.09	57.47
9. Bhojpur	148.53	128.0	74.63	37.39	0.43	74.61
10. Bajehra	3069.96	290.0	47.62	43.30	0.08	47.62
11. Umarpur	570.35	152.0	84.74	20.07	0.06	79.00
12. Paindabad	260.67	136.0	88.49	16.42	0.09	08.49

* The intensive survey of village Iklahra revealed that P & I are not used by the cultivators. Economic religious and backwardness factors are responsible.

eutrophication. Some nutrients like nitrites and ammonia, above certain critical levels of concentration, can be toxic to human use. Therefore, it is clear that the agricultural wastewater raises the nutrient level to a considerable degree in the Ganga river water; and that the nitrogen and phosphorus contents in the wastewater cross much beyond the critical values, in the process supporting an undesirable level of algal growth.

Contamination from Pesticides

As compared to the high consumption of chemical fertilizers and a high intensity of irrigation, the use of pesticides and insecticides is on the low side in the study region. The total consumption of different varieties of pesticides and insecticides was 378.54 kg. over an area of 822.27 hectares, giving an average consumption of only 0.46 kg. per hectare (Table 3). Lack of interest in the application of pesticides and insecticides is amply manifested in the fact that only 12.65 percent of the gross cultivated area and 22.5 percent of the gross irrigated area receive some amount of pesticides and insecticides. Indeed, in one sample village, Iklahra in Etah district, insecticides and pesticides are not used at all. Cultural inhibitions, rather than socioeconomic reasons, appear to be responsible for this state of affairs.

It is significant that the environmentally more damaging and persistent organochlorines are the dominant group of pesticides and insecticides used, accounting for over 97.2 percent of the total consumption. This may be because they are less expansive in most applications than the less persistent and more specific other alternatives and are safer for farmers to apply because of less short-term toxicity to humans. The use of organophosphates is negligible — only 0.79 percent of the total consumption. It will be noted that there exists obvious intra-village differences among the sample villages as far as the intensity of use of pesticides and insecticides is concerned.

Although the application of pesticides in thé sample villages has so far been on the low side, the pesticides are highly toxic and chemically more stable than the fertilizer residues. If the residues of pesticides, occurring in the agricultural wastewater effluents, find their way to the Ganga even in traces, they will adversely affect human health and may cause total annihilation of aquatic fauna. Thus, from a study of the records regarding consumption of pesticides, it is obvious how much of these pesticides and insecticides are reaching into the river and polluting the water. It is estimated that in the sample villages about 57 kg. (about 15 percent) of pesticides and insecticides of all kinds go into the river annually (1988-89). These include 55 kg. contents of organochlorine group followed by 0.45 kg. of organophosphorus group and 1.13 kg. of other groups. The evidences of harmful contamination of surface water and ground water in the lower Ganga basin are alarming. So, the consumption of very toxic pesticides and insecticides is an important future consideration regarding prevention of pollution load to the Ganga River.

Consumption of Water for Different Purposes

The area is characterized by a high intensity of irrigation. As much as 92.9 percent of the total cultivated area receives irrigation from are source or another (Table 4). Thus, the percentage of rainfed agriculture is very small (less than 7 percent). Some idea of the intensity of irrigation can be had from the fact that in the twelve sample villages the total irrigated area is 178.5 percent of the gross sown area. The average application of irrigation water is 188,608.4 liters per hectare. The use of water for irrigation purposes amounts to more than 80 percent and about 20 percent is consumed for domestic and livestock purposes. The average household use of water comes to over 35 liters per day per person, while about 66 liters per day per cattle consumption of water on an average is shown by the livestock. The industrial use of water is not reported from the sample villages.

Generation of Wastewater

The total quantity of fresh water used for various purposes in the sample villages comes to 6,558.12 million liters annually. It includes water used for domestic purposes amounting to 349.57 million liters while 717.35 million liters are being consumed by cattles annually. The largest share of water of 5,491.20 million liters (more than 80 percent) within the sample villages is claimed for use in irrigation alone.

TABLE 4. CONSUMPTION OF WATER AND GENERATION OF WASTEWATER IN THE SAMPLE VILLAGES

Village Name	Total Area Irrigated from All Sources (Hectare)	Intensity of Irrigation	Irrigation liters per hectare*	Household liters/day/person (Average)	Cattles liters/day/cattle (Average)
1. Isampur	117.43	98.34	173,813	33.81	65.44
2. Dharampur	322.15	99.00	230,218	35.94	63.87
3. Badesara	341.97	99.33	231,750	36.90	64.56
4. Iklahra	165.20	97.56	174,025	35.50	65.93
5. Palia	555.00	98.78	174,316	35.07	65.85
6. Himmatnagar	358.30	98.97	174,290	36.65	64.96
7. Pirthipur	470.26	98.40	174,287	34.86	67.34
8. Sebalpur	370.69	98.86	174,192	36.72	66.28
9. Bhojpur	81.94	98.30	174,417	34.78	64.77
10. Bajehra	362.61	99.08	232,968	37.27	68.32
11. Umarpur	321.33	98.96	174,544	36.33	67.20
12. Paindabad	172.40	98.39	174,481	36.40	66.19

* Figure based on the average of number of times different crops are irrigated in different cropping seasons in each sample village.

A major part of fresh water supply is used by the crops grown. But a substantial amount, nearly 20 percent of the total supply, goes off from the irrigated fields by subsurface seepage and overland flow as wastewater, gravitating towards the natural drainage systems. Thus, in the sample villages the wastewater flow generated from the irrigated fields is of the order of 1,098.24 million liters per annum. The wastewater discharge from irrigation contains an average rate of 0.322 grams of salts per liter of water. Thus, the total quantity of salts comes to 1,768.17 million grams annually. These salts are largely responsible for raising salinity and alkalinity in the Ganga water.

About 70 percent of available supply of fresh water to the rural settlements is drained off as wastewater. Therefore, the sample villages contributes a total amount of 244.75 million liters and 502.14 million liters wastewater from domestic and cattle sector, respectively, in a year. The sample villages do not have organized systems for discharge of wastewater. The wastewater is not totally absorbed in the homestead and fields within the village. Mostly the wastewater generated by human and cattle use drains in a small pond near the village, which finally find its way into the Ganga. The wastewater released from domestic and cattle use has a greater concentration of pollution and is a much greater source of pollution for the Ganga water, containing more than 700 milligrams of biochemical oxygen demand (BOD) per liter. In some villages like Isampur much of this load is actually contributed by the cane crushing units and by two units of large sugar mills (near village Palia) at Nagaria.

Organic Pollution Load

As far as the potential of organic pollution is concerned, the total organic pollution load (BOD) in the sample villages is of the order of 6,239 quintals a day, 271 quintals of which is contributed by the human sector; and the remaining 5,968 quintals comes from the cattle sector (Table 5). The dead animals thrown at the bank of the river and the dust — heaps flown during rains — affects the overall situation relating to the organic pollution load in the sample villages to some extent. The highest contribution of organic pollution load is released by Pirthipur, followed by Isampur. The lowest organic pollution load per day is generated by Palia, as compared to the rest of the sample villages.

TABLE 5. GENERATION OF ORGANIC POLLUTION LOAD IN THE SAMPLE VILLAGES

Village Name	Human Waste Quintals/Day	Cattle Waste Quintals/Day	Average Number of Dust-heaps Flown Annually	Average Number of Dead Cattles Thrown at the Bank/Vacant Land Annually
1. Isampur	22	1043	41	400
2. Dharampur	27	523	22	130
3. Badesara	25	405	20	100
4. Iklahra	20	194	35	75
5. Palia	9	85	21	35
6. Himmatnagar	15	245	39	100
7. Pirthipur	49	1391	68	550
8. Sebalpur	9	104	13	50
9. Bhojpur	19	403	30	160
10. Bajehra	43	908	26	225
11. Umarpur	22	442	71	175
12. Paindabad	11	225	33	100

The total organic waste generated in the sample villages on account of the large human and cattle population is of a sizable order. Therefore, the impact of organic load on the environment must be felt. The rate of BOD generation per sq.km. is 115.38 quintals every day. But, the load is actually too widely distributed over a large territory. Besides, in the sample villages the disposal of the organic wastes occurs more on land than directly in the water bodies. Thus, the wastes get dissipated over a much wider territory, reducing the hazards considerably. Animal dungs are systematically collected in the villages and are largely used up as fuel. But there are, no doubt, certain villages (Isampur and Bhojpur) where the density of population is high enough to call for the need of having organized treatment and disposal of the organic wastes.

The sources causing direct pollution of the river water are also very significant and of relevance in assessing the water pollution hazard

(Table 6). Most of the villagers, i.e., about 65 percent of them visit the river for bathing regularly in a year. The number of visitors swells tremendously on festive occasions. The extensive washing of clothes by the villagers (45 percent) in the Ganga water is witnessed by the bank-site villages. The washing and bathing activities add detergents and alkalies. More than 25 percent of the women from tha sample villages annually throw leaves, flowers, milk, flour, food stuffs, mustard oil, *ghee* (clarified butter), samigri (mixture used for perfume) and other materials into the Ganga water while performing religious customs and cultural traditions. Besides, the average number of dead bodies whose ash is disposed in the river comes to about 300 per annum. Persons who died from snake bite (and few dead bodies of infants) are also thrown into the Ganga, instead of being cremated at the river bank or on vacant land. The average number cf such dead bodies amounts to about 50 in a year in the sample villages.

TABLE 6. DIRECT GENERATION OF POLLUTION TO THE GANGA BY THE SAMPLE VILLAGES (PER ANNUM)

Frequency Bathing	Washing Frequency	Washing Material Bathing and	Frequency of Material Thrown Culturally	Average Number of Dead Bodies Whose Ash Disposed	Average Number of Dead Bodies Flown
65-85%	45-55%	Toilet Soaps and Detergents	25-35%	300	50

CONCLUSIONS

The present compilation of information will not be completed unless the natural sources of pollution in the Ganga water are not considered. These include decomposition of birds and wild animals, crop residues, leaves, flowers, grass, droppings of birds and vultures, and animal wastes in the river water. The huge amount of such pollution is the most important characteristic of the Ganga River water in the study region.

The above discussion reveals that the Ganga is facing the grave danger of water pollution due to the rapidly increasing human and animal population. The Ganga has been getting the pollution load in huge amounts in terms of fertilizers, insecticides, pesticides, domestic wastes, human and animal wastes, and also wastes resulting from cultural inhibitions. Some of these problems are of local origin, and they keep on occurring, sometimes reaching very acute proportions. These problems of water pollution and their dimensions are directly related to be increase in human and animal populations. The polluted water is causing serious health hazards in the form of certain water-borne and water-related diseases which are rampant and endemic in all the sample villages. Therefore, the study reveals the need for an integrated approach to the problem, simultaneously taking into account the social, cultural, economic and ecological dimensions.

Philippine Geographical Journal, **Vol. 36, Nos. 1 & 2**
(January-June, 1992)

THE FLASH FLOOD TRAGEDY OF ORMOC: A BRIEF ANALYSIS FROM A PHYSIO-GEOGRAPHICAL VIEW

E. Eller and V. Asio*

ABSTRACT. On November 5, 1991, Ormoc City in Leyte, Philippines was caught by a 2-3 meter high water and mudflow caused by typhoon Uring.[1] *The whole of* "Isla Verde" *was nearly destroyed and an estimated 8,000 people died, while several hundreds of bodies are still missing. Personal observation and survey have shown that the causes of that tragedy and the devastating extent of destruction are based on an interaction of different physical factors.*

Location

The total land area of the province of Leyte comprises around 6,200 km² and is located in the southeastern part of the Visayan islands, between 124°17′ and 125°18′ east longitude and between 9°55′ and 11°48′ north latitude. Ormoc, the second largest city of Leyte has approximately 120,000 inhabitants and is located in the northwestern part of the island. It is situated between the mouths of various rivers, which drain down to Ormoc Bay.

The Physio-geographical Parameters

The following discussion will describe, on one hand, the single parameters as topography, soil, climate and land use and, on the other, their combination and interaction.

1. **Topography and geomorphology.** In between and western smooth sedimentary highlands (200 meters above sea level) and the eastern volcanic highlands (100 meters above sea level), lies the alluvial plain of Ormoc. The Cordilleras, which stretch from Luzon over Samar and Leyte down to Mindanao, are composed of Pleistocene volcanoes and form the central watershed, from where the rivers flow eastward and westward into the sea. Most of the rivers (Anilao, Paniliaw, etc.) are perennial and flow from 800m down to sea level with a corresponding mean gradient of 10%. The current of the rivers is high and has proceed notch-shaped valleys, while lateral erosion is not dominant.

Coarse pebbles are found in the upper and middle reaches of the

* Elke Eller is a geographer from the Justus-Liebig-University of Giessen. She is presently conducting her Ph.D. research in Leyte and is based at the Visayas State College of Agriculture, Baybay, Leyte, Philippines.

Victor Asio is a soil scientist and faculty member of the Department of Agronomy and Soil Science at the Visayas State College of Agriculture, Baybay, Leyte, Philippines.

[1] Thelma (international name)

riverbeds, whereas fine material is accumulated in the lower reach of the meandering rivers.

Profiles 1 and 2 show the gradual ascent from the coastal valley in a northwestern direction. The mean inclination is around 1-5%. Immense alluvial accumulation which are rich in fine sediments characterize this area. Colluvium is found in the adjacent lower slope zone. Above the colluvium, the relief is turning steeper and the inclination reaches 10-20%. The change between the recent colluvium to the volcano clastics can be seen very clearly in the field. This area is covered by material, which is derived from higher massive volcanic rocks. Since the vegetation cover is very sparse the topsoils are already eroded and most of the riverbeds are very deeply engraved.

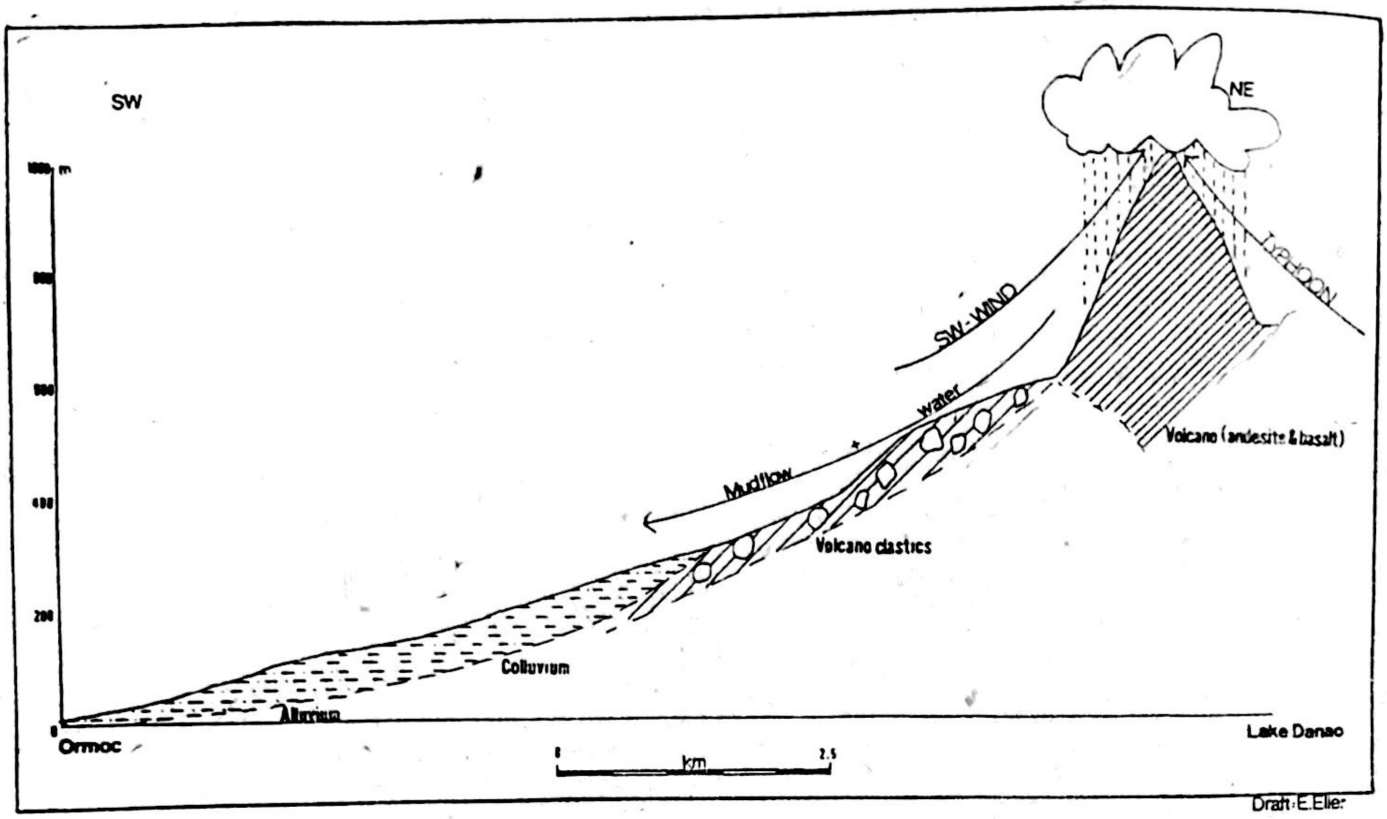
The adjacent higher region of the massive volcanic rocks is characterized by higher inclinations of approximately 50%. Here, erosion is the most important geomorphological process. Soils with a deep profile are missing since the erosion is much faster than the soil development. Deep canyons are found in this area.

2. **Soil.** The soils in the survey area are quite heterogeneous in relation to the parent material on which they have developed. The lowland near the coast is covered by young less-developed soils, which are mostly under cultivation. Throughout the year recent sediments from the catchment area are accumulated. The mean texture of the material varies from loamy sand (45-90% sand, 5-40% silt, 5-17% clay) to sandy loam (35-55% sand, 28-40% silt, 15-25% clay). The soils are generally deep with a medium to high permeability. The colluvium, which is rich in minerals, was derived from the higher portion of the central Cordilleras and accumulated on the foot of the slopes.

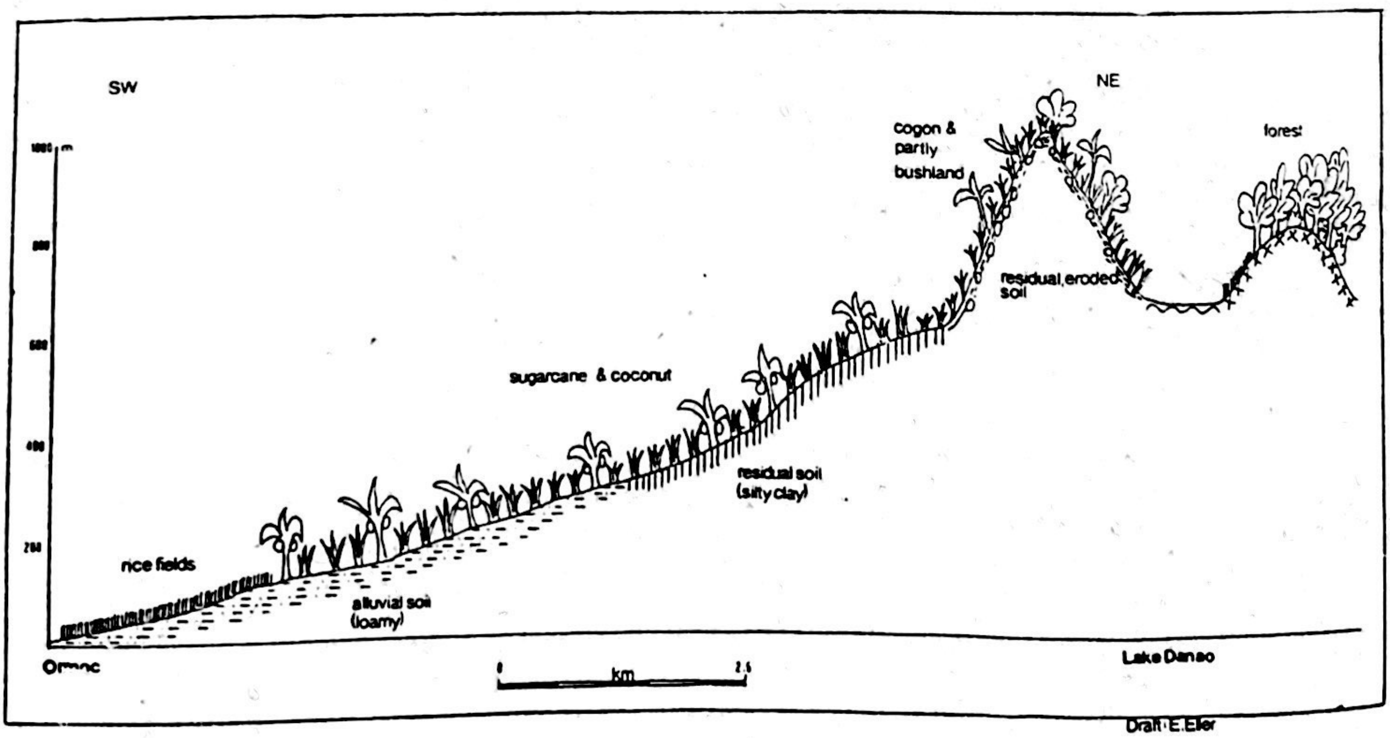
The third soil type is found on the quarternary volcano clastics. Its mean texture lies between clayic loam (5-35% sand, 30-50% silt, 35-45% clay) and silty clay (0-25% sand, 40-65% silt, 35-45% clay). The soils are in most cases eroded and the skeleton is very high due to less vegetation.

Finally, there are soils developed from the quaternary massive volcanoes. Since the inclination of this region is very steep and vegetation cover is missing, erosion is the dominant process and skeleton soils are abundant. The material is clay (0.25% sand, 30-55% silt, 45-65% clay), compact and characterized by low permeability. A high amount of water cannot infiltrate these soils, hence surface water is predominant.

3. **Climatic situation.** Because of its geographical position between 116°55′ and 126°36′ east longitude and between 4°23′ and 21°25′ north latitude, the Philippines is under the influence of various wind systems and can be divided into four climatic regions with different rainfall



Profile 1



Profile 2

patterns. Furthermore, there are many orographic barriers that are responsible for local variations.

While eastern Leyte stands under the influence of the northeastern trade winds (from October to April), western Leyte receives most of its rainfall from the southwest monsoon (Manalo, 1956). Ormoc has a mean precipitation of 2280 mm (Manalo, 1956); its highest amount of rainfall is recorded in July (Fig. 1). The typhoon season generally embraces the months of June to November and is responsible for at least one-third of the total rainfall.

4. **Land use.** In the area affected by typhoon Uring, only few marginal lands are still covered with secondary growth. Irrigated lowland ricefields are established mainly near the rivers.

Almost all remaining land suitable for agriculture is under industrialized sugarcane production. Up to 600 meters above sea level even unsuitable slopes are converted into sugarcane fields which expose the topsoils to the erosive power of rains.

Coconut trees are less abundant and often undercropped with sugarcane. The upper watershed area can be divided into four zones which in ascending sequence are:

1) Cogon wastelands: *Saccharum uligonosum* und *Imperata cylindrica* are the predominant grasses, characterizing a final stage of vegetational degradation aggravated through root and soil changes caused by overpopulation and unskilled cattle raising.

2) Kaingin forms: Slash and burn agriculture is with increasing intensity (unprevented) destroying the remaining uphill forests.

3) Secondary forest is almost absent as the pressure on land is very high and the *kaingineros* cannot afford to allow a sufficient regrowth of vegetation after some years of cultivation. This and forms of intensification (some flower-growing practices, etc.) enhance erosion.

4) Primary forest: The steeper mountain ridges are still covered with primary forest. Selective illegal logging, however, can be observed regularly. In addition, *kaingineros* are opening small farms in the forest areas. Although part of the area is considered to be a National Park, no authoritative measures for its protection are evident.

Most primary forest is still found in small areas in the eastern part of Lake danao. The west-exponated slopes are already deforested.

A multitemporal comparison between aerial photographs from 1973 and spot-imakes from 1988 shows the depletion of the forest, which must have been destroyed within 14 years only. In this context one should

Figure 1

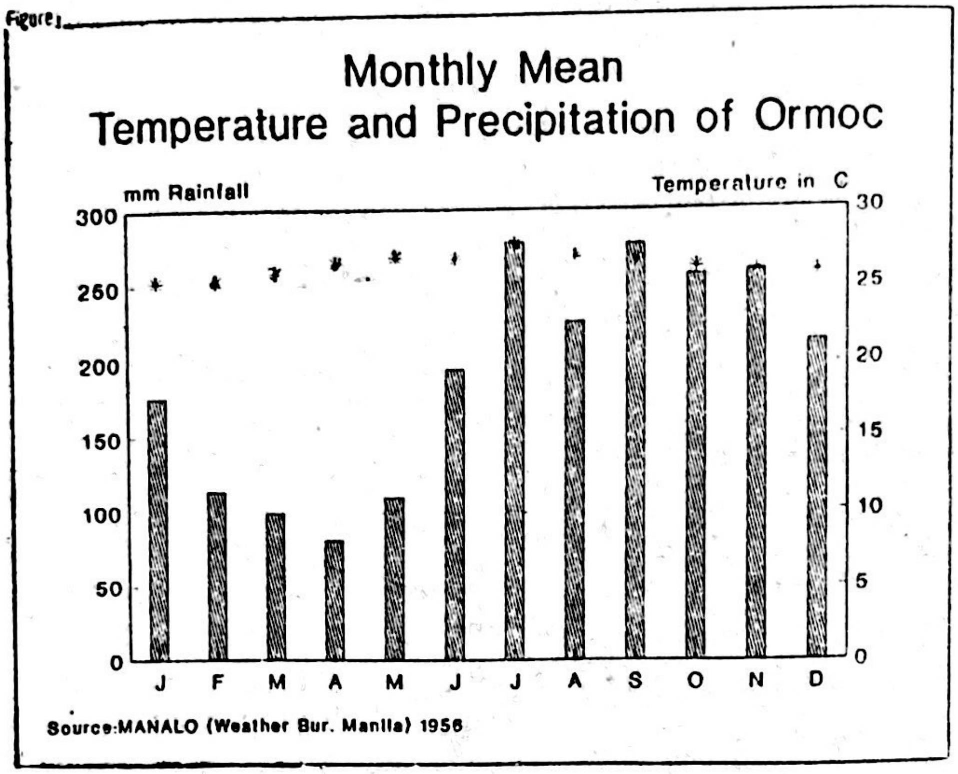
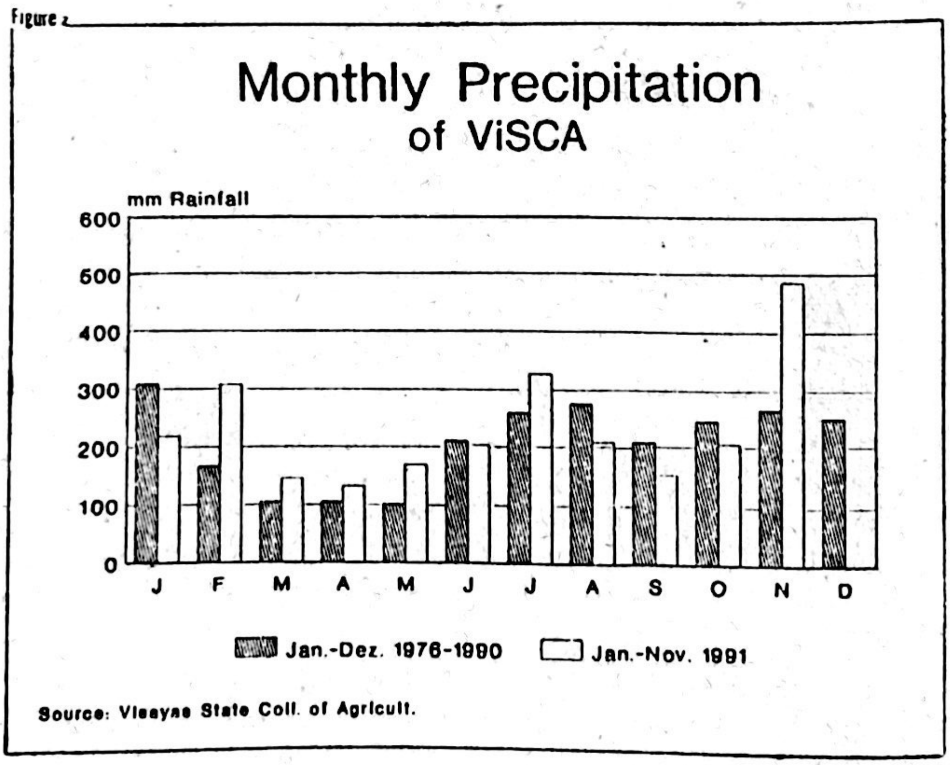


Figure 2



rofile 2

realize that logging and shifting cultivation (*kaingin*) are the two primary causes of forest depletion.

Constellation of the Parameters

The abovementioned characterization of the involved parameters indicates the following:

1. The actual land use shows that due to human influence the vegetation cover of the affected region has been changed during a maximum period of 14 years (1973-1988). Mainly the primary forest was destroyed and reduced to only 13.5% (Swedish Space Cooperation, 1988) of the total area of Leyte.

2. Since the slopes are deforested, the existing soils have become more and more degraded and eroded. The infiltration rate of the skeleton soils is reduced, hence most of the incoming water drains down to the valley. Higher rainfalls are causing extensive landslides which transport materials down to the lower portion of the mountains, where deeper soil profiles are found. Personal observations have shown that most of the landslides that were not present in the area before November 5, are located eastwards and southeastwards of Ormoc at an elevation of about 600 meters above sea level. No landslides were observed in areas covered with primary forest.

3. Due to the inclination of the Cordilleras and the low distance to the erosion base the current of the rivers is generally swift. As a matter of fact, the river channels are normally narrow and much water cannot be transported quick enough to avoid overflow.

4. Destruction in Ormoc was certainly triggered by the weather constellation, which brought about the high rainfalls. Since Ormoc City has presently no climate station, no precipitation data exist for the night of the 4th and the 5th of November. One can estimate, however, the high amount of rainfall by comparing the recorded data of the Visayas State College of Agriculture (VISCA) Fig. 2, which is located 30 km. south of Ormoc. Within a period of around 8 hours (3:00 A.M. tc 11:00 A.M.) 288 mm were recorded. One can safely assume that the rainfall in the mountains was distinctly higher.

According to the Department of Environment and Natural Resources (DENR) of Tacloban City, the high amount of rainfall was caused by the coincidence of two different wind systems. On the one side, a typhoon (Uring) came from northeast with a speed of approximately 70kph bringing moist air masses. On the other side, winds arrived from the southwest direction. These two wind systems were forced to ascend the Cordilleras and met each other in the abovementioned watershed area, unloading the high rainfall and causing the tremendous destruction.

The water, together with the eroded material, poured down to the valley at enormous speed. The narrow riverbeds were not able to transport the material so that masses of debris were accumulated in some places and bridges were clogged, damming the waters that finally burst, flash-flooding the areas below. The riverbed of the Anilao River, for instance, was widened spontaneously from 30 meters to 50 meters. As a result, the quarter "*Isla Verde*" in Ormoc City with 5,000 inhabitants, which was located along the embankment, was destroyed in a few minutes' time.

Within 30 km (from Ormoc in the north to VISCA in the south), 70% of the bridges collapsed. Since this area between Ormoc and VISCA is sparsely populated, fortunately less people died.

Such a catastrophe can recur any time (not only in the Philippines). Ecological considerations demand the immediate halt of illegal as well as legal deforestation and the institution of reforestation programs as well as land use changes towards an ecologically safe farming system.

Furthermore, new planning concepts in the restoration of the city are needed, as right now the survivors are resurrecting their quarters along the same flood-prone areas.

LITERATURE

Bronger, D. *Die Philippinen. Raumstrukturen, Entwicklungsprobleme, Regionale Entwicklungsplanung.* Mitteilungen des Instituts fur Auslandskunde. Hamburg, 1987.

Eller, E. (in preparation). "The Evaluation of the Environmental Potential of Leyte Using a Geographic Information System as well as Conventional Methods." Ph.D. research. University of Giessen.

Manalo, E. B. The Distribution of Rainfall in the Philippines. *Philippine Geographical Journal* 3(4) (1956):104-166.

Swedish Space Cooperation. *Mapping of the Natural Conditions of the Philippines.* Solna: 1988.

VISCA. *Climate Data (1976-1991).* Bohol: 1991.

ACKNOWLEDGMENT

Many thanks to the people in Ormoc, who gave the recent information. Furthermore, thanks to Dr. J. Margraf (VISCA-GTZ-Ecology Program, Baybay, Leyte) and to Dr. K. P. Traub (Philippine-German Cebu Upland Project, Cebu City) for further suggestions.

Information for Contributors

The *Philippine Geographical Journal* was instituted in 1953 to serve: as an outlet for scholarly articles ranging from geographical/spatial to socioeconomic topics particularly on the Philippines and other Third World countries; as a medium for the expression of professional opinions; and as a journal for reports on activities of the Philippine Geographical Society and other items of relevance to the geographic discipline. Its volumes usually contain academic articles and, occasionally, editorials, addresses, book reviews, reports, Society and geographical news, advertisements of interest to the geographic profession and certain special items. All manuscripts submitted for publication should conform to the following requirements:

Format and length. Manuscripts should be typewritten, double-spaced and use only one side of an 8½ x 11-inch bond paper. Computer printouts are accepted, provided they are legible. Because of rising mailing costs, rejected manuscripts will not be returned. Scholarly articles should range in length from 2,000 to 5,000 words while reviews, reports, news and special items should be less than 2,000 words. The editors reserve the right to stylistically edit articles and to reduce the length of reports, news and special items that they consider to be unnecessarily long or of little interest to readers.

Authors' affiliations and interests. Authors should supply, through a footnote on the first page of the article manuscript, information on their current employment (position/rank, institution/organization, address), educational attainment (degree, discipline, institution), and research interests and experience. If a manuscript has been presented as a paper in a conference, workshop or symposium, the particulars of the occasion should be footnoted, too.

Abstract. On the first page of the article manuscript between the author's name and the text, an abstract with a length ranging from 100 to 200 words should be included. It should summarize salient points and include key words.

References and footnotes. All works cited in the text in parenthesis (author, year, page) should be listed at the end of the article in alphabetical order, last name first, following the bibliographic format used in recent issues of the Journal. Comments and explanations on textual content should be placed as footnotes, indicated consecutively throughout the manuscript by numerical superscripts, and may include literature citations.

Illustrations and tables. Illustrations, which should be kept to a minimum, should be of professional quality and drawn in black ink on white paper or on thick tracing paper. They should not be more than two times nor smaller than the size of the manuscript paper. The style of the lettering should be either in Leroy or Century type. Figure numbers and captions should be indicated in pencil at the bottom of the paper way below the drawing or its borderline. As with other aspects of style, the format of the tables should follow that indicated in recent issues of the Journal.

Other guidelines and information. An article manuscript will be accepted on the understanding that it has not been submitted elsewhere and will not be until a decision has been rendered by the Journal. The Journal's decision will be made known within one month after receipt of the manuscript. Each author will receive five copies of the Journal. All materials submitted for publication should be addressed to:

The Editor
Philippine Geographical Journal
P.O. Box 2116, Manila
Philippines