ISSN 0031-7551

PHILIPPINE GEOGRAPHICAL JOURNAL

VOLUME 33 NUMBER 4 OCTOBER-DECEMBER, 1989

CONTENTS

Published Quarterly by
the Philippine Geographical Society and
the Philippine National Science Society (formerly NRCP),
Department of Science and Technology
Manila, Philippines

THE PHILIPPINE GEOGRAPHICAL JOURNAL

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The *Philippine Geographical Journal* is published quarterly by the Philippine Geographical Society and receives financial support from the Philippine National Science Society (formerly 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 — ₱40.00 Back issues range from US$10.00 to US$20.00 per volume for foreign orders and from ₱10.00 to ₱40.00 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 every Wednesday afternoon at this address: Bureau of Soils and Water Management, Rm. 503, Fifth Floor, Sunvesco Bldg., Taft Ave. cor. T.M. Kalaw St., Manila, Philippines.

Statements and opinions in the Journal are the authors' responsibility and do not necessarily reflect the views of the Society and the editors.

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

ISSN 0031-7551

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Philippine Geographical Journal, Vol. 33, No. 4
(October-December, 1989)

EDITORIAL

THE URBAN SYSTEM IN REGIONAL AND NATIONAL DEVELOPMENT

Cities play two kinds of roles for the spatial development of a country: first, as nodes of interaction between regional activities for individual regions and as centers of services for their tributary areas, and second, as components of a national urban system through which most interactions between regions take place. The urban system is hierarchical in form, ranging from the city or central place with the most diversified services many of which are specialized to one with few and less specialized services.

As nodes of interaction between regional activities, cities perform *intraregional or central place urban functions* consisting of activities which have limited or restricted markets or tributary areas due to the short range of their services or products. Within each area, practically all demand is satisfied by a single specific city or central place and beyond it other centers provide similar functions.

On the basis of such central place functions, the growth of the city depends on its transport access to the potential tributary area, on the degree of specialization and complementarity of activities in the tributary area, and on the demand for and the productivity of the activities of the tributary area which determine the ability to pay for central place functions.

The development of the region, therefore, depends on how city growth also promotes the development of the tributary area. The development of the tributary area may come about through the production and supply of commodities to the city or through the spillover of industries in the city to the tributary area due to more reasonable pricing of land or labor.

Another role of the city is the performance of *extraregional urban functions* for the country as a whole as well as its interactions with other regions and cities. These interactions include, among others, the flows of commodities, information, migration, technological and social innovations, capital, and decision-making power. These flows take place within regions and also between regions. However, for these flows to fully materialize, extensive and adequate communication and transport networks are needed. The presence of such infrastructures eventually results in the development of an urban system through which interactions subsequently take place.

Such a development enables cities to act as collecting and transshipment centers for the products of tributary areas intended for national or foreign markets. At the same time, cities function as distribution centers for products like implements and equipment coming from other regions needed for economic activities in tributary areas. In addition, the city may also become a producer and consumer of goods and services demanded in the national or foreign markets.

On the basis of intraregional functions, the development of the city and its tributary area will be fairly modest. However, if the extraregional functions of the city are dominant, its growth and that of its tributary area will be greatly accelerated. If both intraregional and extraregional functions are performed by a city and they are interrelated so that self-sustained development occurs and spreads to the tributary area, the city assumes the role of a growth pole or center. The economic structure of the city and its tributary area in comparison to that of other regions is important as it determines the type and direction of central place-hinterland interaction.

In the Philippines, several categories of cities or central places can be recognized. These are the national, regional, major, secondary and minor centers. The national center is Manila which has been politically expanded into the National Capital Region (NCR) that includes three other cities and 13 towns. Some of these in their own right can be classified as major, secondary and minor centers. Cebu, Davao, Iloilo and Zamboanga are clearly regional centers although Zamboanga's function as such is more limited compared with the others. Major centers include most of the provincial capitals and chartered cities. The larger towns with populations of 20,000-50,000 may be categorized as secondary centers and all others as minor centers.

The urban system of the Philippines is characterized by many small towns and a dominant national center with very few centers in-between. The minor centers at best function as simple retail and distribution nodes with hardly any impact in the development of the surrounding rural settlements. Some minor centers though have the potential of developing into major centers if urban functions can be diversified and access to their tributary areas improved so as to enhance the complementarity of central place-hinterland interactions. At the same time, several provincial capitals and chartered cities which are now functioning as major centers can become regional centers. The prospects of these central places to develop into regional centers are relatively favored because of the presence of a multitude of activities which, however, are not fully devleoped. In fact, some of the provincial capitals have been selected as growth centers in their respective regions in previous regional development plans and programs.

There are only four cities at present which clearly function as regional centers. Of these, Cebu has the most diversified activities that include both interregional and extraregional functions. Cebu has a rather extensive tributary area that includes central and eastern Visayas and northern Mindanao. Davao, Iloilo and Zamboanga in comparison have much less to offer in terms of services and commodities though they play significant roles in their respective regions. Davao, Iloilo and Zamboanga have limited extraregional functions although interregional functions are somewhat more developed. Even then regional interactions are limited due to island or peninsular location as well as topographic constraints and incomplete accessibility.

Iloilo's development as a regional center is due to the north-south alignments of the islands of Cebu and Negros which create an obstacle to east-west movement by water. Thus, the Visayas instead of being served only by Cebu, which is centrally located in the region, has to be served by Iloilo in the western portion. Iloilo though is facing competition from Bacolod which is just 36 kilometers across the Guimaras Strait.

Davao in southeastern Mindanao is somewhat isolated not only in terms of location at the head of Davao Gulf but also in terms of incomplete transport connections with surrounding areas. Zamboanga's peninsular location and the lack of a transport network except along the eastern side of the peninsula are barriers to regional interactions. Its connections with the islands to the south are almost entirely by water and these are by no means extensive. There is clearly a dearth of regional centers in the Philippines with both interregional and extraregional functions.

The National Capital Region, with Manila as the core, serves not only the entire country but also other cities and regions of the world. The NCR exceeds all other cities and regions in the availability of services and goods and, although it is not at the geographic center of the country, many specialized functions are performed for other cities and regions. The NCR has strong land connections to most cities and regions in Luzon as well as air connections to the more important cities and towns in the country. Its water transport links are about even with that of Cebu. The main commodity activity of the NCR is the distribution of imports since a large volume of raw material exports are generally shipped directly to foreign destinations from several parts including Cebu, Iloilo, Bacolod and Davao. The continuing flow of people from all over the country though is choking the NCR because available services cannot cope with this influx. Hence, other centers must be developed to divert the unrelenting migration.

Many cities and towns in the Philippines developed as a result of Spanish colonization and not from the generative processes of the indi-

genous societies. The present patterns of urban development indicate a changing urban system but the colonial urban patterns are still evident. The urban system of the Philippines must undergo a more dynamic change to enhance its role in regional and national development. This may be accomplished by a determined administration with an orientation towards countryside development and the provision of more diversified services and goods in selected cities or central places. Such services must include not only distribution but also manufacturing activities.

Telesforo W. Luna, Jr.

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POSTAL SERVICES OFFICE
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Name	*Address*
Editor: MELITON B. JUANICO	P.O. BOX 2116, MANILA
Business Manager: MELITON B. JUANICO	P.O. BOX 2116, MANILA
Owner: PHIL. GEOGRAPHICAL SOCIETY	P.O. BOX 2116, MANILA
Publisher: PHIL. GEOGRAPHICAL SOCIETY	P.O. BOX 2116, MANILA
Printer: BOOKMAN PRINTING HOUSE	373 QUEZON AVE., Q.C.
Office of Publication: RM. 503, SUNVESCO BLDG., TAFT AVE. COR. T.M. KALAW ST., MANILA	

In case of publication other than daily, total number of copies printed and circulated of the last issue dated JANUARY-MARCH, 1989:

1. Sent to paid subscribers	515
2. Sent to others than paid subscribers	485
Total	1,000

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Philippine Geographical Journal, Vol. 33, No. 4
(October-December, 1989)

ARTICLES

BEYOND SUBURBANIZATION: SOME CONJECTURES ABOUT THE FUTURE MORPHOLOGY OF THE MATURE METROPOLIS

Ernesto M. Serote*

ABSTRACT. Time was when students of urban growth were getting alarmed at the seemingly inexorable expansion of the metropolis. Now, it is being observed, in Western countries at least, that the metropolis has stopped growing. This is the phenomenon of mature metropolis which has prompted scholars to make predictions and extrapolations about what will happen once metropolitan areas reach maturity. This paper puts together these predictions that have appeared in the literature so far and argues that there is life for the metropolis — even after reaching maturity.

INTRODUCTION

This paper is an attempt to make educated guesses about the future shape that a metropolis, having reached the stage of maturity, is likely to take. Such an exercise cannot be lightly dismissed as idle speculation because at the moment just about every industrialized country in the West is concerned about its declining metropolitan areas. An indication of the growing concern for the problems of the great metropolises of the West was the holding — all in 1984 — of three major events: the "Metropolis 84" conference in Paris, the conference of the International New Towns Association in Rotterdam, and the Berlin Building Exhibition. Though held separately, all of these gatherings focused attention on the problems of metropolitan areas.

Concern for the mature metropolis is shared by public policy makers and private capitalists alike. Public policy makers are bothered by the phenomenon because the extraordinary scale and magnitude of the movement of population and economic activities have tremendous repercussions on the viability and ability of the state to cope with adjustment problems. Private capitalists are equally concerned because the built form of the environment represents a huge entrapment of capital investments which, failing to yield the desired level of returns, will seriously hamper the investors' drive for further accumulation.

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The paper proceeds by defining or characterizing the mature metropolis. Then it traces the factors or forces that have led to its decline. Finally, it surveys the alternative scenarios for the future of the metropolis and selects the one most likely to occur, citing support from existing literature.

The setting of the analysis is conspicuously Western, particularly on both sides of the Atlantic. The reason is simple, namely, that the urbanization-suburbanization-desurbanization-reurbanization cycle seems to be happening mainly in Western capitalist societies. The morphogenesis of Third World cities, on account of their peculiar historical and cultural specificities, follows a more complex pattern about which very little has yet been written. Inasmuch as this paper is mainly a survey of literature, no attempt is made to find out whether the observed patterns in the West are indeed happening elsewhere. The latter is the subject of a current investigation by this writer who hopes to make his findings available soon.

THE MATURE METROPOLIS

The phenomenon of maturity or decline of the metropolis had been going on for at least two decades but it was only during the 1970s that awareness of it became widespread and systematic attempts to analyze it began to be undertaken on both sides of the Atlantic. Brian Berry was among the first to analyze the American urban system and the "human consequences of urbanization." But it was Sternlieb and Hughes (1975) who first detected the "decline" of the metropolis through a systematic analysis of job migration. So far the most comprehensive study of the mature metropolis phenomenon was the holding of a three-day symposium at Washington University in June 1977. The papers read in that symposium were later edited and published by Charles Leven (1978) under the title "The Mature Metropolis." In Europe, Hall and Hay (1980) reechoed Berry's work and Van den Berg, *et al.* (1982) followed later.

From these studies the so-called decline of the metropolis can be seen as a shift or flight of population and economic activities not only from the central areas to the suburbs but also out of the metropolitan area into the non-metropolitan small towns otherwise known as exurbia. The problem lies not on the flight *per se* but on the consequences of such flight. For example, the loss of manufacturing jobs has driven thousands of low-wage unskilled metropolitan laborers to unemployment. Rentable space suddenly became unlettable and therefore property owners were forced to abandon their premises. Derelict land and buildings in turn meant loss of public revenues and, hence, collapse of public services which spawned a host of social problems like criminality, drug abuse, etc. How can we come to grips with this complex phenomenon in a more systematic way?

Spatial Concept

A convenient way to start is to be clear about the spatial concept of a metropolis. Let us adopt the system used by Hall and Hay in delineating the metropolitan area which they call "functional urban region" (FUR). Simply, conceive of a small circle inside a bigger circle. The small circle is the core or inner district. The area outside the small circle but inside the big circle is the hinterland or suburb. The entire area enclosed by the bigger circle is the metropolitan area. Outside the big circle is the exurban or non-metropolitan area.

The actual physical extent of this urban region varies from one country to the next but the concept is basically the same. Having conceptualized our metropolis, we will now be in a better position to understand what loss of population or decline in economic activities from the metropolis means.

Gain and Loss of Population

Gain or loss of population from the metropolis can be understood in both absolute and relative terms, depending on the direction and intensity of the net flow and the particular area under consideration.

TABLE 1. POPULATION BEHAVIOR IN THE METROPOLIS

Net flow of population	Core area (C)	Hinterland (H)	Total metropolitan region
1. Centralization			
1.1 During loss			
A ($-\Delta C < -\Delta H$)	−	−	−
B	+	−	−
1.2 Absolute	+	−	+
1.3 Relative ($\Delta C > \Delta H$)	+	+	+
2. Decentralization			
2.1 Relative ($\Delta H > \Delta C$)	+	+	+
2.2 Absolute	−	+	+
2.3 During loss			
A	−	+	−
B ($-\Delta C > -\Delta H$)	−	−	−

Legend: + (increase or gain)
− (decrease or loss)
Δ (change)
$>$ (greater than)
$<$ (less than)

Source: Cheshire and Hay in H.J. Ewers, *et al.*, 1986:150

The above table shows all the possible net flows of the metropolitan population. The two directions of flows are inward (centralization) and outward (decentralization). Thus, to say that people concentrate in absolute terms means that the core area gains and the suburb loses but

the entire region gains. Relatively, centralization can occur when there is overall gain but the core gains more than the hinterland does (the process of urbanization). Even when there is overall loss in the region if the loss of the core is lesser in degree than that of the hinterland or the core even realizes net gain, there is said to be centralization in relative terms. This is the process of *reurbanization* identified by Van den Berg, *et al.* (1982), a perceptible return to the core ostensibly as a result of urban renewal or inner city regeneration.

Similarly, absolute loss of population occurs when the core loses and the hinterland and the region realize a gain. In relative terms, population decentralization occurs when there is overall gain but that the hinterland gains more than the core, or when the hinterland gains whereas both the core and the region lose population. These latter two processes correspond to the process of *suburbanization.* Finally, relative loss occurs when all areas lose but the core loses to a greater degree than the hinterland. This process is identified by Van de Berg as *desurbanization* or the flight of the population to non-metropolitan exurbia.

Empirically, Hall and Hay found that in Western Europe generally, absolute decentralization has occurred from 1975 onwards. In the U.K. which is the most "mature," half of existing metropolitan areas are now in various stages of decentralization. On both sides of the Atlantic, there is now an observed trend of flight not only from the core to the suburbs but increasingly from the metropolis to exurbia. Berry (1981) has another term for this process: *counter-urbanization.* But why the outward drift?

There are many explanations offered such as increased car ownership, decentralization of jobs, etc., but the most basic reason for residential decentralization is the search for better, more healthful environment. No doubt the earlier period of centralization has led to congestion, pollution and the general breakdown in urban services and has rendered the inner areas unhealthful places for habitation. This is also the conclusion of Keeble who found that all available evidence "supports the environmental interpretation of urban emigration and population decline in Europe's major cities, with employment following or accompanying rather than preceding population shift" (in Ewers, *et al.* 1986:182).

Decline of Employment

The other dimension of the mature metropolis is the loss of economic activities from the core area. Again there are many explanations for this but Keeble codified them for us under three headings: production cost theory, the constrained location theory, and the marxist theories.

Under the production cost theory the dualistic pattern of production expounded by A.J. Scott and the product cycle theory of Thompson can

be categorized. Simply put, metropolitan manufacturing industry faces more operating costs than does the non-metropolitan industry and this affects the former's profitability, competitiveness, investment and employment change. If the industry becomes capital intensive it tends to move out of the core; only the firm that thrives on the built-in advantages of central location remains.

The constrained location theory is propounded by Fothergill and Gudgin (1982) who analyzed the urban-rural shift in British industry and found that due to technological change industry tends to increasingly become capital-intensive and land-intensive but that the metropolitan core cannot provide adequate and affordable space for expansion.

Marxists (Massey and Meegan, Savey, Aydalot) explain the decline in urban manufacturing as a consequence of restructuring, a strategy by capitalists to seek new profits through new forms of labor exploitation. The urban-rural shift in manufacturing location is seen by them as yet another strategy for capital accumulation. Along with concentration of investment expansion in large multi-plant corporations, the shift of production from metropolitan centers to areas characterized by exploitable unskilled and cheap labor, with little tradition of trades union organization or worker militancy, is but one of those capitalist strategies (Keeble in Ewers, *et al.* 1986:182-186). Elaborating on the restructuring thesis, Harvey (1987) and Martin (1987) are of the belief that the current crisis is only a spur for capital to adopt flexible strategies for further accumulation.

Be that as it may, let us now summarize the features of the mature metropolis. It is one in which the residential-employment function of the city has come to a stable or declining state due to substantial emigration of people and jobs to smaller non-metropolitan areas. The physical expression of this mature state is the preponderance of derelict land and buildings in the inner areas and the near obsolescence that the suburbs are likewise experiencing. Growth, it seems, is happening everywhere but in the metropolis.

So what is in store for the mature metropolis?

ALTERNATIVE FUTURES FOR THE MATURE METROPOLIS

At least three scenarios about the future structure of the mature metropolis can be constructed from existing literature: the city-less urban field, the hollow metropolis and the restructured revitalized city.

Urban Field Without a City

The concept of an urban field pertains to an entity that incorporates metropolitan areas and the intervening non-metropolitan areas. Similar to J. Gottman's "megalopolis," its physical form is described by Friedmann

and Miller (1965) as a "mosaic of different forms and micro-environments which co-exist within a common communications framework" (quoted in Hammett, 1973:78). It transcends the old concept of city and metropolis. As an ecological unit, it consists of the old established centers together with the intermetropolitan peripheries that envelop them.

A similar idea, that of a useless city, is also envisaged by Melvin Webber (1963). Based on the observation that increasing mobility of car-owning urban dwellers who live an urban way of life but whose settlements have been freed from spatial limitations, Webber predicted that "the city as traditionally conceived is no longer necessary (in a future) where people and activities, freed from the constraints of space, will diffuse across the land" (Hamnett, *ibid.*).

The "death of the city" idea therefore can be understood in different dimensions. First, the city "disappears" as a physical entity when continuous suburbanization keeps the city increasing in spatial scale, engulfing more and more of its hinterlands. Secondly, the city becomes irrelevant as a distinct socioeconomic system when urbanism shall have become a way of life of the whole society. Finally, the death of the city is assured when its traditional function is no longer needed because the values of society will have changed. Traditionally, the city is regarded as the center of power, the creator of wealth and the symbol of culture (Blowers, 1973:148). But if the move to return to the human scale as advocated by environmentalists gains widespread acceptance, then there will be no more need for the city as a dominant settlement form. Rather, the landscape will be a flat terrain dotted with small communities where the dominant mode of production is the village-type processing and where small-town values and perspectives prevail. When this occurs, then the demise of the city has occurred indeed.

What has been described above is highly unlikely to happen. In the first place, the observation that the metropolis continues to expand outwards does not pertain to the mature metropolis whose striking feature is that it has stopped growing or that it is even in decline. Secondly, the proposition that urbanism as a way of life will spread and permeate all societies in every corner of the world can be accepted as within the realm of the possible. But whether urbanism can maintain its dynamism without seeking nourishment and nurture, as it were, from the city is debatable. The role of the city as the center of diffusion of information and innovation is hard to replace. Still harder to replace are the physical artifacts that represent enormous social and economic capital already in place in the metropolis. Finally, the environmentalists' dream of recalling small-town values of community life and small-scale activities negates the very values that urbanism promotes. In fact, Scott (1980:39) seems to have found a growing evidence that small firms that had earlier located in small towns are beginning to return to the

core areas in such large cities as New York, New Orleans, London and Hongkong.

Hollow Metropolis

The term "hollow metropolis" was used by Wolf in characterizing the American mature metropolis. Peter Hall, for his part, describes in a more prosaic way the European metropolis as "simultaneously the scene of expansion and dynamism, destruction and decay" (in Ewers, *et al.*, 1986:140). If present trends continue, the same 'doughnut' structure will prevail. Extrapolated to the end of the century, Wolf predicts, the hollow metropolis "will be bigger, more diffused, and more hollow... (It) will have a growing inner area which is declining or stagnant in terms of population, where low-income groups, unpopular minority groups, and unemployables of various sorts will predominate" (quoted in Hamnett, 1973:77).

In the absence of meaningful intervention, the outer suburban ring will remain the more attractive location for new and expanding industries. Writing in 1977, Darin-Drabkin observed that industries are still attracted to locate in the metropolitan area. But since the availability of adequate storage space and of skilled manpower are increasingly important location considerations, firms tend to decentralize within the metropolitan region, particularly the suburbs (1977:16). The attraction of suburban locations is even stronger today among the emerging high-tech information-based industries. Being an intensive user of information and highly dependent on skilled manpower, this new industry requires, first of all, the presence of research facilities such as universities, laboratories, libraries and the like which often seek suburban locations. Secondly, a "cosmopolitan environment in democratic and open societies founded on humanistic values" (Knight, 1986:422) is a must to this emerging industry sector. This explains the observed concentration of high-tech industries in areas where a high level of government investment in R and D is located. In the case of Britain, the knowledge-based industry concentration in the Western Crescent (Hertfordshire, Hampshire, Berkshire, Buckinghamshire and Surrey) which is only within 40 miles of London is on account of the existence there of military research establishments (Hall, 1987:141-146). It may be added that proximity to cosmopolitan London is an added advantage.

The Restructured, Revitalized Metropolis

The emerging morphology of the mature metropolis is not one in which it is disintegrating because population and economic activities are dispersed evenly in small communities across the national territory. Neither is it going to remain a hollow metropolis with its outer ring continually growing while its core continues to rot. It appears that the

hollow part of the doughnut is now increasingly being filled up, this time with an entirely new mix of land uses and new levels of intensity. Indeed, to the degree that new investments are diverted to the inner cities decay of the core will be averted and the growth pressure on the greenfield urban fringe will be relieved.

This is the agenda of inner city regeneration. And the renewed attention being given by government on both sides of the Atlantic to the inner city problems permits a degree of optimism that the mature metropolis will not be allowed to die away but will be rejuvenated and will assume the functions that only a metropolis can perform. What are these functions?

According to Paul Cheshire and Denis Hay, analyzing the European urban system for the period 1971-1981, the functions of the metropolis are the following, among others:

> "The future role of cities is not as dense concentrations of manufacturing and associated employment... but something closer to that of the major cities before the industrial revolution: as administrative centers, as cultural centers in the broadest sense of cultural and as the providers of higher level services and of urban amenities. Economic activities that depend particularly on face-to-face contact will continue to enjoy a comparative advantage in the cores of major cities but increasingly other activities will be there only because in some sense the city is 'attractive'...
>
> "...To thrive, therefore, cities not only have to, but can, compete as attractive locations in which to live and advantageous places in which to locate economic activity. Thus, whilst in the past, the demand for the output of the city's manufacturing base may have been seen as the sources of its prosperity, its prosperity in the future will depend as much as, or more on, its urban services and its ability on the basis of these, to attract residents (with their income), activities, and even tourists" (in Ewers, *et al.*, 1986:167).

Cheshire and Hay just about said it all. But let us summarize the points they made. First of all, despite observed decentralization of economic activities from the metropolis the control and administrative function has not really left the center. D. Keeble corroborates: "Notwithstanding the extent of the urban-rural manufacturing and population shift (there is) continuing concentration of high-level decision-making quarternary functions (that is), headquarter offices, finance, banking and business services, government and public administration — in Europe's major metropolitan centers for reasons of information access and communications nodality..." (in Ewers, *et al.*, 1986:195). Secondly, the man-made locational advantages being sought after by new industries will come as a natural consequence of efforts to make the inner cities livable again. But even if less and less industries will be induced to locate in the core some local authorities will welcome this as an opportunity to reclaim new open space, an amenity that was such in short supply during the heyday of industrial development. Such reclaimed open space will

become the new "greenheart" for the rejuvenated metropolis to compensate for whatever portion of the greenbelt or urban fringe greenfield that failed to resist the pressure of development at the height of the suburbanization process. Indeed, studies by Vining and others (Cochrane and Vining, 1988) tend to indicate a strong tendency in recent years towards a return to the inner cities. This trend is increasingly taking place in North American, Western European and advanced developing countries.

CONCLUSION

The mature metropolis will not be allowed to die. As we said in the introduction, it is in the interest of both government and private capital to see the metropolis alive and well and, in the next Kondratieff cycle which is expected to start anytime soon, expect the restructuring of the metropolis as the dominant feature of regional policy. The elements of such a restructuring-oriented regional policy have been outlined by Martin (1987:23) as consisting of six parts, namely:

1. *Re-industrialization* — development of a new local economy based on high-technology industry and innovatory activities, involving new technology-based firms, research and development functions, science parks and technology transfer centers.

2. *Industiral de-maturation* — revitalization and modernization of existing mature industries and firms through financial restructuring, application of new production technologies, new product development and diversification of markets, so as to raise efficiency and competitiveness.

3. *Tertiarization* — development of new and expansion of existing marketable private sector services, both producer and consumer, and both local-based (non-tradeable) and exportable.

4. *Flexibilization and reskilling of labor force* — diversification and upgrading of skills and technical qualifications of resident labor force, through training, reskilling and education and workplace-experience programs, and development of new labor relations and flexible employment systems.

5. *Infrastructure renewal* — improvement and extension of physical infrastructure (roads, utilities), business infrastructure (marketing facilities, advisory services, telecommunications), and social infrastructure (eductional, cultural and leisure facilities).

6. *Financial reorganization* — creation of regionally and locally based financial markets, and venture capital and investment funds for new and expanding firms.

Morphologically then, when the mature metropolis will have been revitalized and restructured how does it look like? Charles Leven envisions the future metropolis as "likely to consist of a loose federation of smaller and fairly compact residential-employment centers, with the

across — but with very few people engaged in any long-distance commuting on a regular basis, and with much, or most of the land areas still used for non-metropolitan pursuits such as agriculture or mining" (1978:13).

This view, alas, is characteristically American. It is a mere re-affirmation of J. Gottmann's "megalopolis," which is understandable because of the seemingly limitless land area of the United States. In small countries like Britain and the Netherlands, there is more likely to be controlled or guided reurbanization. Core areas will be dominated by office tower blocks with plenty of open space between them, including green parks that had been reclaimed from derelict factory sites. High quality housing but not entirely of the "gentrified" type to accommodate the demands of the low- or medium-income workers will replace the rundown flats and terraced housing of a bygone era. Leisure and recreation facilities will be plentiful, catering to a new level of affluence and taste. Tourists will be attracted to the relics of the industrial age, carefully and imaginatively preserved. Suburban areas will maintain their low intensity land uses because reurbanization shall have relieved them of the pressure of development. The greenbelt and greenfields will have been happily preserved as the threat of renewed centralization is promptly decanted to the new and expanded towns which by that time will also be in need of revitalization.

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Philippine Geographical Journal, Vol. 33, No. 4
(October-December, 1989)

RECOMMENDED MEASURES FOR SOIL EROSION CONTROL IN URBAN LANDS

Romeo C. Bruce*

ABSTRACT. Good agricultural lands near the cities are being converted to urban uses without regard for slope and soil erodibility. Residential subdivisions are being developed on many hillsides and steep areas near the city mainly for dramatic settings and views. In many earth-moving activities for housing, topography is not considered, resulting in extreme excavations and fillings in construction areas. Damages due to erosion caused by conversion to urban uses such as housing, industrial estates, shopping centers, schools, highways and other facilities are in most cases ignored by engineers and developers. The problem of soil erosion sedimentation in urbanizing areas in the Philippines needs immediate solution. This paper provides planners, developers, architects, engineers and related practitioners with recommendations that will effectively reduce erosion and sedimentation while converting land for urban uses.

INTRODUCTION

Situational Analysis/Problems

Many hectares of agricultural and open space lands in the Philippines particularly near the cities are being converted to urban uses. These areas are used for housing, industrial estates, shopping centers, schools, highways and other facilities.

A study of 10 major cities outside Metro Manila indicated that built-up areas in the city expand by 1.5 to 5 percent every year since 1972. In Metro Manila, approximately 100 hectares of agricultural and open spaces are converted to residential subdivisions, industrial sites and other urban uses each year since 1970. A photo study of the Quezon City-Novaliches area indicated that about 30 subdivisions were being developed at the same time in 1980. Field checks made during the rainy season of that year showed the seriousness of soil erosion in these development areas. Numerous areas were developed for urban uses, resulting in considerable damages in construction sites, e.g., gullied slope on road banks, washed-out streets and debris-laden work areas. Damages occur not only on the surface of construction sites but also below them, resulting in clogged drainage ditches and pollution of streams and beaches, to name a few. During the conversion, land is disturbed and soil is exposed to erosion. The amount of erosion that occurs depends on the kind of soil, steepness of slope, time and method of construction and intensity of rainfall.

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The shortage of suitable building land around many cities in the Philippines is forcing developers to consider the use of steep sloping land and natural hillsides with all the consequent problems, of which landslide is the most serious. Too much sloping land has been developed for urban uses without regard for slope, soil erodibility or soil conservation practices which are necessary or even mandatory during certain types of development. For example, many residential subdivisions are being established on hillsides and steep slope areas for exceptionally dramatic setting and view. Streets and buildings are located without fitting them to existing topography. Extreme excavation and filling increase soil erosion both on-site and off-site the construction area.

In many cases, roads and highways appear to have been located more for convenience than for considerations of topography and stability of soil cover. It is quite evident that accelerated erosion and landslides have been induced as a result of road construction. Ocular examination will show a much higher concentration of landslides immediately above and below the roads. Where roads have been more stabilized, slides and deep gullies are frequently associated with poor or virtually non-existent road drainage. Better stabilization, both structurally and vegetatively and particularly better provision for drainage of rain water off the roads, will reduce road maintenance cost and provide a safer transportation system.

Damages due to erosion resulting from these conversions are in most cases ignored by engineers and developers. Only when the damage becomes so disastrous to life and property that people react and focus their attention on such construction projects. Many large landslides occur in nature even without man's intervention and a natural reaction of the uninformed is that all landslides are "acts of God" and something that cannot be avoided. But it has been shown that most landslides can be prevented and that many smaller landslides, particularly those on the road banks, would not have happened if proper precautions had been taken. Anyone who has seen the havoc brought about by landslides in urban areas and many mountain roads will appreciate the fact that studies on landslides and their prevention should be one of the most important concerns of urban development planners.

Definition of Terms

Urban Land — Land which is developed and largely built for human settlement and activities. It is a central district of municipalities and cities with a population density of at least 500 persons per square kilometer.

Soil — The unconsolidated mineral material on the surface of the earth that has been subjected to the influence of genetic and environmental factors such as parent material, climate, macro-

organisms and microorganisms, and topography — all acting over a period of time.

Erosion — The wearing away of the land surface by running water, wind or other geologic agents.

Soil Conservation — Protection of the soil against physical loss by erosion or against chemical deterioration, i.e., excessive loss of fertility by either natural or artificial means.

SCOPE AND OBJECTIVES

The recommendations can be applied to all areas developed for urban uses such as residential subdivisions, industrial sites and construction projects such as roads, highways and dams. The recommended measures to be adopted will depend on soil type, topography and other environmental factors.

This paper is aimed at providing planners, developers, architects, engineers, etc. with recommendations that will effectively reduce erosion and sedimentation in converting land for urban use.

EXISTING POLICIES/LEGISLATIONS RELATED TO SOIL CONSERVATION IN URBAN LANDS

1. *Presidential Decree 1121* — Creation of the National Environmental Protection Council

   Section 3, f. — One of the powers and functions of NEPC related to soil erosion control in urban areas is monitoring development projects initiated by government and private agencies and seeing to it that they are in line with government priorities on environmental protection.

2. *Presidential Decree 1151* — Philippine Environmental Policy

   Section 2. b. — One of the goals of Philippine Environmental Policy is to assure the people of a safe, decent, healthful, productive and aesthetic environment and encourage the widest exploitation of the environment without endangering human life or creating conditions adverse to the people.

3. *Presidential Decree 1152* — Philippine Environmental Code

   Section 22 of Title III entitled Land Management provides a rational, orderly and efficient utilization of land and its resources in order to derive maximum benefits and encourage the prudent use and conservation of land resources in order to prevent an imbalance between the nation's needs and such resources. Paragraph 16 of Article 3 states that all permits, licenses and clearance for the location/construction and/or operation of establishments shall

conform with the national land use scheme developed by the Ministry of Human Settlements.

4. *Presidential Decree 1160* — Vesting authority in Barangay Captains to enforce pollution and environmental laws and for other purposes. Section 1 states that the Barangay Captain, the Barangay Councilman and the Barangay Zone Chairman are deputized as police officers, with authority to effect arrest of violation in accordance with law, for purposes of enforcing and implementing national and local laws, ordinances and rules and regulations governing pollution control and other activities which create imbalance in the ecology or disturbance conditions.

5. *Presidential Decree 1198* — Requiring all individuals, partnerships or corporations engaged in the exploitation of natural resources or in the construction of infrastructure projects to restore or rehabilitate areas subject thereof or affected thereby to original condition.

6. *Letter of Instruction 549* — Ordering the National Environmental Protection Council to establish an administrative system for the evaluation of the environmental impact of projects being undertaken by government and the private sector and to create inter-agency task forces to study the major environmental threats in the Philippines such as soil erosion and the proliferation of toxic substances in the Philippine environment.

7. *Executive Order 648* — Empowers the Human Settlements Regulatory Commission to promulgate zoning and other land use control standards and guidelines which shall govern land use plans and zoning ordinances of local governments.

RECOMMENDATIONS

There are five principles involved in soil conservation in urbanizing areas:

1. Erosion and sedimentation commonly occur in construction projects involving major earth-moving activities.
2. Erosion and sediment control problems begin with the removal of protective vegetation and continue until adequate cover is restored.
3. If the erosion control program is considered early in the planning stage and made part of the development plan, problems in soil erosion, runoff and sedimentation as well as costs can be reduced.
4. Erosion and sediment control measures should be applied as part of the construction operation.
5. Problems in soil erosion, runoff and sedimentation can be reduced by:

(a) *Planning Techniques*

Wise planning can avoid or reduce many erosion problems in urbanizing areas. The development can be planned to fit the topography in order to keep the amount of earth-moving activities to a minimum. Bulldozing and grading should be done during the dry season in small increments and bare land should be protected after grading.

(b) *Vegetative Measures*

Temporary or permanent vegetation should be installed at the earliest opportunity. Good vegetative cover is the best protection against soil erosion. Vegetation dissipates the energy of rain. Furthermore, it tends to increase water percolation, thereby reducing runoff.

(c) *Structural Measures*

Permanent erosion control structures should be installed as early as possible in the construction schedule. Streets, if installed and paved early, can serve as diversions to reduce the length of slope and convey runoff from the construction site. If sediment basins are needed, they should be installed before any major land clearing or grading is done.

(d) *Timely Completion of the Project*

Timely completion of the project should be the main objective of any urban development project. This includes prompt installation of erosion and sediment control devices. In order to be effective, they should be installed before any damage occurs.

General Recommendations for Minimizing Erosion and Sedimentation in Areas Being Converted to Urban Uses

1. Consider the topography, natural drainage and soils for a given site. Avoid urban development in areas subject to flooding, landslide or other hazards to life or property.

   a. Urban development should be confined in areas not steeper than 20 percent slope. Special design and construction techniques are needed when developing slopes steeper than 20 percent.

   b. Avoid swampy/marshy areas. Development of swampy/marshy areas will create problems not only due to soil instability but also to changes in surface water flow and general surface hydrology of the area.

   c. Avoid filling natural drainageways. Natural drainageways draw away the surface water from the project area and covering them will retard the flow of water from the upland.

d. Avoid areas of shallow, slide-prone or extremely stony soil. Study soil maps available in the Bureau of Soils to avoid unfavorable areas for development. Make an on-site soil study to determine the suitability of the soil and design needs for specific structures.

2. Keep land grading to a minimum. There is no limit to the amount of earth moving that can be done with today's equipment. However, development plans should fit the topography so that only a minimum amount of earth moving will be required, hence, decreasing soil erosion.

Prepare a land grading plan which will include the following:

a. Proposed cuts and fills and their slide slopes
b. Location of drainageways and adjacent properties
c. Location and type of controls for drainage and water removal during and after construction
d. Source and type of filling materials
e. Placement of fill material and degree of compaction
f. Location of topsoil stockpile making sure it will not contribute to erosion and sedimentation

The following suggestions should be followed:

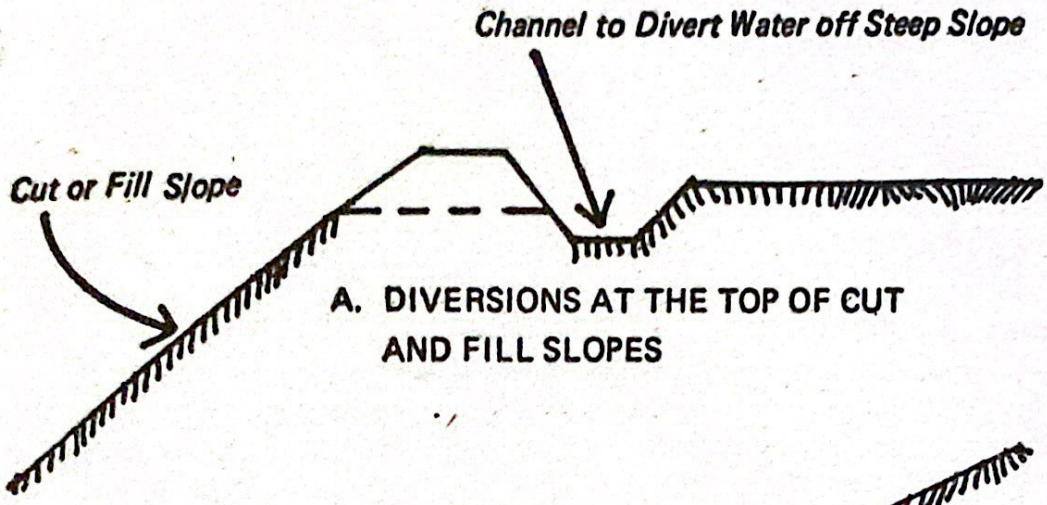
a. Divert water away from erosive areas with division canals. (See Figure 1.)
b. Expose small areas of land for as short a time as possible.
c. Temporary bridges or culverts should be used for crossing watercourses.
d. Construct basins to trap sediments before they enter the streams or cause damage to other properties. Construction should be done before any major land clearing or grading is done.
e. Dust should be kept within tolerable limits by sprinkling water.
f. Use mulch and/or temporary vegetation to protect bare areas during construction.
g. Where possible, save trees and other existing vegetation particularly along the perimeter of the construction area to act as buffer for noise and dust and for protection of neighboring properties.
h. Maintain drainageways in natural cover whenever possible.
i. Divert rain water to stream elevation or other non-erosive areas.

3. Establish and maintain soil conservation measures.

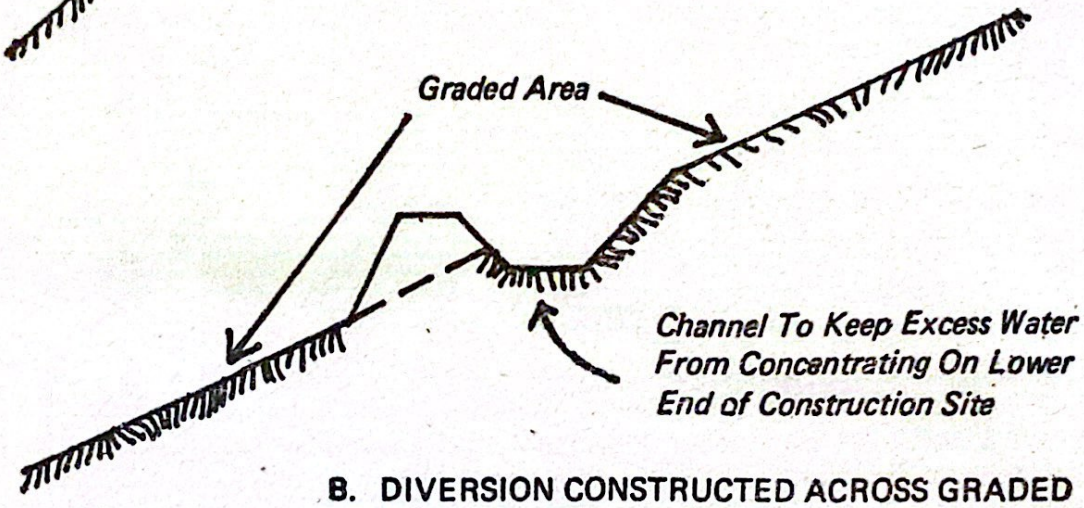
Permanent ground cover and landscape planting should be installed promptly after grading is completed in sections which will not interfere with the construction.

Recommendations for Soil Conservation in Subdivision Development

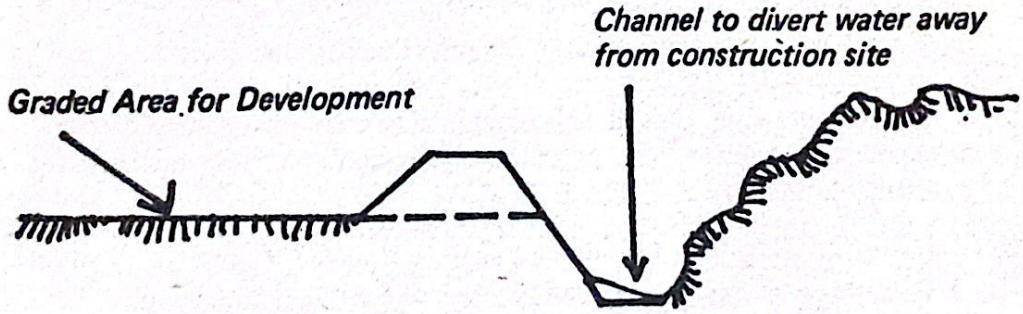
Whenever large open space lands near or within towns and cities are



A. DIVERSIONS AT THE TOP OF CUT AND FILL SLOPES



B. DIVERSION CONSTRUCTED ACROSS GRADED AREAS TO SHORTEN THE SLOPE AND REDUCE EROSION ON THE SLOPING AREAS



C. DIVERSION CONSTRUCTED ABOVE THE PROJECT SITE TO KEEP OUTSIDE RUN OFF WATER FROM ENTERING THE DEVELOPED AREA

FIGURE 1

ready to be sold to many interested buyers for residential purposes, private or public developers engage in the process of subdividing the land. They map out lines of streets and divide the land into blocks. The blocks are further divided into lots to facilitate distribution of land among individual property owners. They reserve some parts of the land as sites for parks, schools, offices, churches, hospitals and other public or semi-public buildings.

This is the process by which cities and towns are built and developed. Because initial decisions with respect to lot layout, street system design, sewerage systems, etc., have remarkably enduring effects on the environment, no local planning program can be considered adequate which does not include public control over this process. One aspect is the policy towards conservation of soils with the purpose of controlling or minimizing erosion and sedimentation.

To minimize soil erosion and sedimentation, developers should consider the following guidelines:

1. Plan the development to fit the topography.
   a. Recognize the hazards on developing slopes steeper than 20 percent.
   b. Plan streets and buildings to fit and utilize existing topography to avoid extreme excavations and fillings.
   c. Provide storm drainage to the street or to other areas where disposal does not include landslides, erosion or flooding.
   d. Vary lot sizes and shape according to topography and slope.
2. Schedule grading during the dry season.
   a. Avoid grading during the rainy season.
3. Practice small incremental development.
   a. Expose a small area of land at one time for as short a time as possible.
   b. Avoid removing topsoil and vegetation from large area.
   c. Apply temporary or permanent erosion control measures immediately after grading.
4. Maintain grading to a minimum.
   a. Excessive grading can be avoided by fitting topography in the development.
   b. Avoid deep cuts and fills. These can change the natural drainage pattern, create landslides and increase soil erosion.
5. Save topsoil.
   a. Strip and stockpile topsoil for future use to landscape the site.
   b. Cover the topsoil stockpile with temporary mulch-rice straw, twigs, etc.

6. Save trees and other existing vegetation.
   a. Where possible, save healthy trees, shrubs and other existing vegetation.
   b. Plant trees and shrubs on the perimeter of construction site.
   c. Protect existing vegetation from construction equipment.
   d. Avoid filling around trees.
7. Install street and storm drains early in the construction period.
   a. If installed early, streets can serve as diversions to control runoff water before land grading is started.
8. Provide for safe disposal or runoff water through:
   a. Grassed waterways
   b. Diversions
   c. Sediment basins
   d. Grade stabilization structures
9. Use vegetation to stabilize bare areas.
   a. Provide temporary protection for cuts, fills, stockpiles of soil and sloping land with mulch such as rice straw, twigs, leaves and other materials.
   b. Plant permanent vegetation promptly after final grading.

Recommendations for Soil Conservation in Road/Highway Construction

The building of roads is an important part of the building of cities. More than one-half of all the paved roads in the Philippines are located within urban areas. Roads are the greatest single cause of accelerated erosion and the greatest source of man-induced sediments in the country. It is not hard to believe this statement because a great number of landslides in the country take place on road cuts situated in the mountains of Cebu, Mt. Province, Ilocos Region and Nueva Ecija.

To avoid or minimize soil erosion, the following guidelines are recommended for road/highway construction:

1. Use drainage structures to divert or carry runoff water.
   a. Install diversions at the top of cut slopes where the land slopes toward the roads.
   b. Use diversion on all slope lengths greater than 50 meters, including slopes at interchanges.
   c. Plan diversions and drainageways to handle estimated peak flow for the design storm.
   d. Control seepage in cut slopes with sub-surface or vertical drains.
   e. Discharge flow from line channels, diversions and closed conduits into outlets capable of handling the flow at non-erosive velocities.

f. Use temporary bridges or culvert structures for crossing water courses.

g. Use coarse-grained materials for road base to drain water.

2. Use vegetation to stabilize bare areas.

   a. Species should be selected depending upon the existing local conditions. Among the species which can be used for roadside planting are grasses like pangola grass, bermuda grass, kikuyo grass, Napier grass, start grass and Guinea grass, shrubs like wild sunflower, lantana and dama de noche and fast-growing trees such as giant ipil-ipil and eucalyptus.

   b. Bring all cut-and-fill slopes to final grade as soon as possible and plant immediately.

   c. Use temporary plantings or mulch on stockpile of topsoil, on spoil, and in borrow areas.

3. In hillside subdivisions it is desirable to build streets of less than normal width to avoid excessive cut and fill and undue damage to trees and other natural features.

   a. Land to be cut or filled should be cleared of trees, stumps, roots, brushes, boulders and debris.

   b. Steepness of cut slope will depend on the soil and design. Cut slope of 30 percent is about the steepest for erosion control and stability.

   c. Cut slopes 10 meters or more in vertical height should be benched to keep water from flowing down the face of the slope.

   d. Fill material should be spread and compacted in a series of horizontal layers (usually 20 to 30 cm. thick) to attain the designed compaction. Filling should start at the lowest point.

EROSION CONTROL PLAN

The problems of soil erosion and sedimentation in urbanizing areas in the Philippines need immediate solution. They demand no less than cooperative effort between government and the land users, particularly subdivision developers. Government policies regarding the utilization and development of open space land for urban uses is of paramount importance.

To make the erosion control program for urban land effective, subdivision developers should be required to submit an *Erosion Control Plan* (ECLP) as a separate document or incorporated with other maps and plans for development. In any case, the plan shall be identified as Erosion Control Plan for the project. Like an architectural plan, ECP should be approved by the appropriate agency before any earth-moving operation starts.

An Erosion Control Plan should include the following:

1. Construction schedule showing the sequence and timing of operations. It should show areas to be opened up or exposed and dates proposed for beginning and completing clearings, grading, drainage facilities, as well as vegetative and structural measures for erosion control.
2. Topographic map at scale and contour interval appropriate for the area.
3. Slope map showing areas with slopes of:
   (a) 0 — 20 percent
   (b) 10 — 20 percent
   (c) 20 — 30 percent
   (d) 30 percent or more
4. Soil map showing different types of soil in the area.
5. Types and locations of temporary erosion control measure to be installed.
6. Types and location of permanent erosion control measures to be installed.

Policies which can be enacted include:

1. The Erosion Control Plan should be required when the development area exceeds a certain size (suggested limit is 1 hectare), or is near a lake or stream (suggested within 100 meters).
2. The Erosion Control Plan should be approved by the municipality or city having jurisdiction prior to construction activity. This should be the responsibility of the municipal or city engineer's office.
3. All subdivision developers must be required to complete the grading work and pertinent improvements within a reasonable length of time and in accordance with an approved plan or in a manner that will not create hazards.
4. Agencies that continuously undertake large earth-moving activities such as highway construction companies or land developers for residential subdivisions, industrial complexes, etc., should be given the option to develop a policy for erosion control that they would follow in all operations. An approved policy would exempt the company from obtaining earth-moving permits on a project basis. However, the sites would remain subject to inspection for compliance with standards.

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Philippine Geographical Journal, Vol. 33, No. 4
(October-December, 1989)

SCIENCE AND TECHNOLOGY POLICY

Emanuel V. Soriano*

ABSTRACT. Scientific and technological research and development have been demonstrated by developed countries as essential to their growth and progress. Today, the Philippines finds itself in the development phase where it lacks the expertise and financial resources of highly industrialized nations in increasing its store of technological and scientific knowledge and in refining its indigenous technological capabilities. Despite its resource inadequacies, the country can pursue a national policy towards the generation, application and proper utilization of S&T inputs. Six categories of policies are proposed, touching on: stimulating local technology; capitalizing on imported technology; encouraging private sector participation in R&D; developing a support system for industry and agriculture; supporting generative, mission-oriented and integrative R&D; and disseminating R&D based on the demand-pull strategy. For these policies to succeed, no less than the political will and a reorientation to a relevant S&T are called for.

In the past few years, many countries have become increasingly conscious of their economic vulnerability. Both experts and laymen of all political and economic persuasions have identified severe problems facing their countries: declining productivity, low product quality, massive unemployment, and unfavorable trade balances. The general consensus is that scientific and technological innovations constitute a key instrument for addressing these problems.

SCIENCE AND TECHNOLOGY PERSPECTIVES

In fact, scientific and technological research and development have been shown to be essential to a country's growth and progress, and directly correlated to an increase in people's productivity and quality of life.

The United States, United Kingdom, France, West Germany, Japan and the USSR have proven this beyond doubt. These six countries alone account for roughly 70 percent of the world's research and development (R&D) expenditures, and produce 65 percent of the world's gross national product (GNP), distributed over a mere 20 percent of the world's population.

The total world annual expenditures for research and development in the mid-'70s was about US$108 billion. Japan accounted for 10 percent of these expenditures, while the Philippines, which had 50 percent of Japan's population, spent less than 1 percent of Japan's R&D in 1982.

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The top six developed countries of the world (U.S., U.K., France, West Germany, Japan and the USSR) accounted for 70 percent of world R&D expenditures, while accounting for only 20 percent of the world's population and 65 percent of the world's GNP.

Figure 1 shows that the same six developed countries spent from 2 percent to 4.6 percent of GNP on research and development, with the USSR on top of the list. Japan, now at 2.3 percent, intends to raise its R&D spending to a long-term level of 3 percent. By contrast, the Philippines' entire science and technology budget, which includes not only R&D but also related infrastructure and manpower development as well as scientific and technological services, was about 0.47 percent of GNP in 1981.

Another area worth looking into is the relative participation of government and the private sector in the R&D effort. For the same top six developed countries, 50 percent of sources of R&D resources came from government while 50 percent was supplied by private sources. For Japan, 70 percent of R&D resources originated from the private sector while only 30 percent came from government. For the Philippines, more than 90 percent were government resources and a mere 10 percent were private ones.

In terms of proportion of R&D workers to population, there are about 3.97 million R&D workers all over the world, making a world ratio of 0.09 percent of total population. Japan has a high ratio of 0.49 percent to its total population. The Philippines, on the other hand, has only 5,000 R&D workers or less than 0.01 percent of its population. Based on the Japanese standard, the Philippines should have more than 40 times its current number of R&D workers.

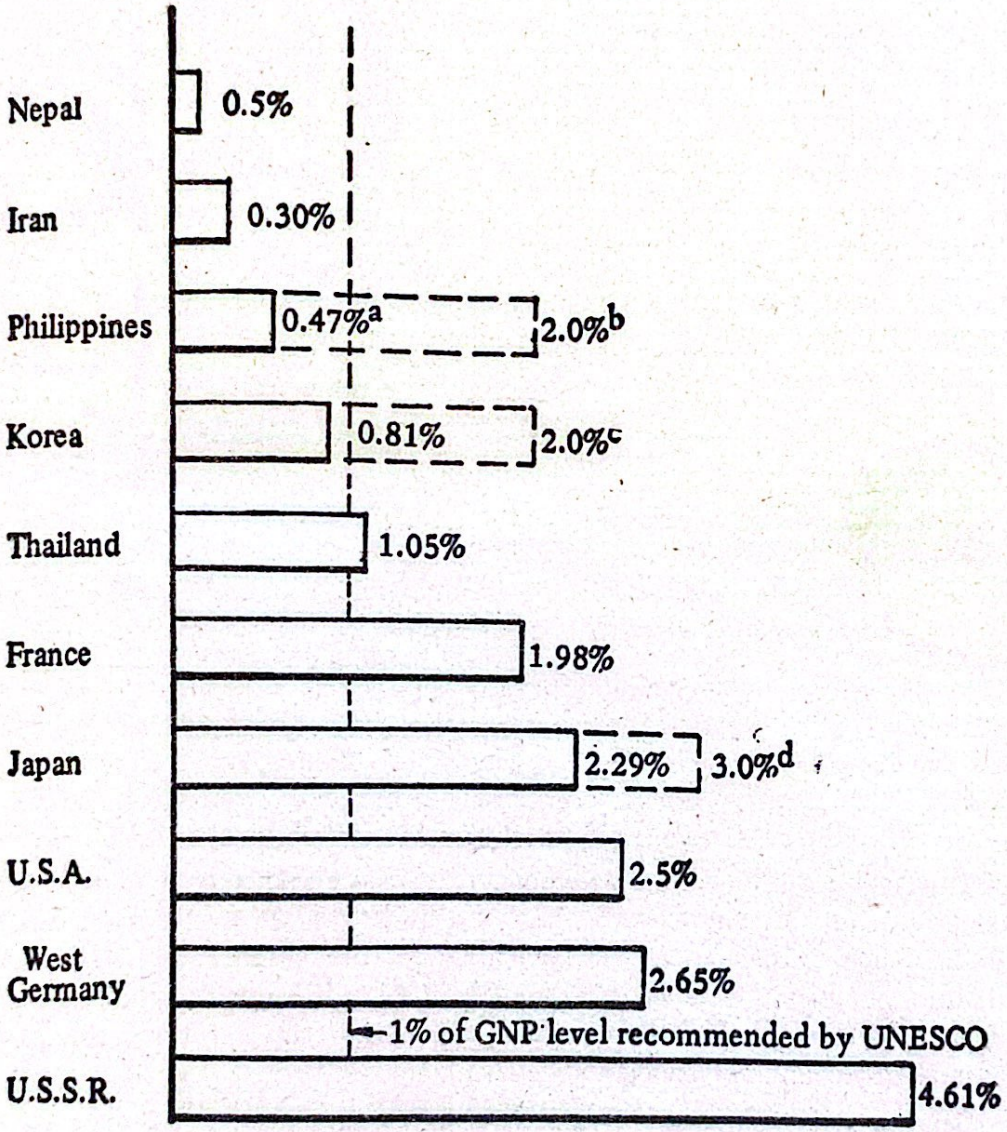
Obviously, the Philippines has a lot of catching up to do in allocating resources as well as in improving the quality of work in scientific and technological R&D. But is 0.47 percent of GNP, which is far below the 2 percent which has been prescribed for developing countries, adequate to meet the required pace of R&D in the country? Is this enough to spur the country to development?

At present, the Philippines finds itself in the developmental phase where it lacks the expertise of highly industrialized nations in the refinement of its indigenous technological capabilities. Assistance is being sought to encourage and bring about new, more concrete and innovative ideas and policies that, hopefully, will expedite the country's progress. This assistance has come in the form of technology transfer, most through importation from developed countries.

Such importation of technology has been justified by saying that it would be too expensive, too time-consuming, and impractical for the country to re-invent or duplicate what the developed countries have

already perfected and market-tested. However, I maintain that a line must be drawn between such thinking and nearly total dependence on foreign technology. This heavy dependence on foreign technology is responsible for the proverbial chicken-and-egg situation: we import technology because we do not have sufficient indigenous technology, and we do not have sufficient indigenous technology because we keep on importing foreign technology.

FIGURE 1. R&D EXPENDITURES AS PERCENTAGE OF GNP FOR YEARS BETWEEN 1975-1981



a. Includes total S&T expenditures, both for R&D and for related activities.
b. The current Philippine development plan, as recommended by the Department of Science and Technology (DOST), indicates a projected level of 2% of GNP for the '80s.
c. Enunciated in Korea's new 5-year socioeconomic plan,
d. Long-term level of expenditures recommended by the government's white paper on science and technology for the 1980's and beyond.

Thus, we observe the following conditions in the country today:

First, local industries do not actively pursue their own research and development programs because it is, or at least used to be, very easy and convenient to just import technology.

Second, development of R&D has been focused on the supply side without seriously considering how such R&D can be properly used by industries: R&D for R&D's sake, in other words. As a result, only a small percentage of R&D outputs has been useful enough to industries on a commercial scale.

Third, there is little, if any, significant tie-ups between industries and local R&D institutions for specific research work geared towards specific objectives.

Fourth, industries lack the necessary expertise and level of knowledge to make full use of R&D developed locally (lack of manpower and/or technical expertise).

Fifth, local industries do not fully trust locally developed R&D for commercialization purposes without government assistance.

Sixth, R&D in the basic sciences which serves as the foundation of technological innovation, until recently was not well-organized in the country.

The development of science and technology in the Philippines has been hindered by the inadequacy of resources, notably the deficient number of scientific and technical personnel and the deplorable physical state of many so-called scientific institutions.

In addition, scientific and technological R&D has been hampered by bureaucratic red tape inasmuch as all R&D institutions in the country are government organizations.

TOWARDS A NATIONAL POLICY

The goals of science and technology are the enhancement of national productivity and the improvement of the quality of life. Hence, science and technology must be an integral part of the country's overall plan and national policy. Science and technology must have priority in national development because they can provide the main vehicle for meeting the demands of social and economic development.

Science and technology is a matter of choice, and a wide range of options remains open. But we must recognize that such choices are available.

The government has taken a step towards the right direction by reorganizing and strengthening the former National Science Development Board into the Department of Science and Technology. However, this is merely the tip of the iceberg. The DOST recognizes that there is a

huge task ahead of us all and has initiated a set of policies to set the science and technology development wheel into motion.

These policies for the application of science and technology to national development are geared toward ensuring the generation, application and proper utilization of scientiiic and technological inputs to accelerate national economic and social development. They fall under six main categories:

Number One: *Policies for stimulating domestic technological innovation.* These will be stimulated further to develop self-reliance and, whenever possible, cost-effective alternatives to foreign technology.

Number Two: *Policies for importation, adaptation and assimilation of foreign technology.* These are intended to balance the beneficial and adverse effects of technology importation, as I have earlier discussed. The key lies in the coordination of importation with local R&D efforts as well as in the protection of local users of the imported technologies from unfair terms and conditions.

Number Three: *Policies for encouraging R&D in the private sector.* Earlier, it was pointed out that the Philippine government historically has accounted for 90 percent of R&D expenditures, with the private sector contributing only 10 percent. If R&D is to make any significant progress, the private-sector has to be involved more actively for at least three reasons: First, to augment the government's meager resources, and second, to lend efficiency to the R&D management process, which is oftentimes not workable in a purely government set-up. We must remember that the very nature of R&D calls for quick reaction times and purposive decision-making — you cannot, for example, make some microorganism under experimentation in the laboratory wait indefinitely for some government permits and clearances before proceeding to the next stage of the experiment. The third reason why the private sector should be involved is to inject the proper marketing orientation into R&D planning. Given the government's limited resources, only private enterprise operating in the open market can ensure the availability of R&D results (products and services) to the greater numbers of people.

Thus, the following policy initiatives to induce private sector participation have been proposed:

1. encouragement of in-house R&D
2. encouragement of contract-research arrangements
3. encouragement of consultancies for scientists
4. continued patents rights and funding assistance to investors
5. promotion of R&D entrepreneurship through a package of incentives and through provision of grants
6. strengthening of the science foundations

Number Four: *Policies aimed at developing the S&T service support system for industry and agriculture.* This means that the S&T support

system to private industry and agriculture will be expanded, with the government concentrating on required services which are not available to individual private firms. This also means that close linkages between research and extension systems in agriculture will be further developed to sustain the flow of technological innovations to end-users.

Number Five: *Policies with respect to research and development*

5.1 Research and development will address a comprehensive but focused range of concerns. Priority will be given to providing the basis for spawning scientific-based industries, at the same time giving impetus to basic research, natural sciences and mathematics.

5.2 Emphasis will be on mission-oriented research to address the country's need to enhance productivity and welfare services in a short span of time. This involves sustained support for agriculture and natural resource R&D, industry and energy R&D, and health sciences R&D.

5.3 Interface aspects with the social sciences and humanities will be given due attention.

Number Six: *Policies for disseminating and selling R&D*

6.1 A more aggressive stance for selling and disseminating R&D will be adopted. The demand-pull strategy of technological development will be employed to bring S&T results within the immediate reach of prospective end-users. As earlier explained, this is one area where the private sector is expected to make key contributions.

6.2 Efforts to move science and technology from research institutions to industry and to the countryside will be accelerated.

All these could spell the welcome change from the gloomy outlook that has been the prevailing forecast for years. But no less than the national will, the will of the political leadership, is necessary for success. The challenge has become even greater in view of the current economic crisis. The question is, will the national leadership deem future-oriented science and technology important enough to be allocated a reasonable amount of resources vis-a-vis other concerns of a here-and-now nature?

A second question might be asked: Will government priorities be properly oriented towards genuinely significant R&D or will it continue to actively promote technologies of the Bataan Nuclear Plant and the eleven MIP (Major Industrial Projects) types?

The answers to these two questions will largely determine the future of scientific and technological R&D in the country — for they will indicate whether or not what we now have is a set of "paper policies" which will largely remain neatly stacked in some forgotten library corner.

Philippine Geographical Journal, Vol. 33, No. 4
(October-December, 1989)

TRENDS IN THE PRODUCTION OF PULSES IN WESTERN UTTAR PRADESH

S. Najmul Islam Hashmi*

ABSTRACT. Pulses constitute an important source of dietary protein for the majority of the population in India. However, with the introduction of the Green Revolution, the production of pulses has lagged behind that of wheat and rice. The paper attempts to describe the changes in cultivated area, production and yield of pulses in Western Uttar Pradesh from 1967-68 to 1983-84. It has been found that for the period and study area considered, the hectarage and production of pulses such as gram, peas and tur — the more important varieties — decreased. This occurred despite the increases in the yield per hectare of gram and peas. On the other hand, lentil, moong and urad — the less important pulses — experienced increases in area and production. The government has recently introduced a program aimed at increasing pulse production and this includes a package of improved farming practices, use of new pulse varieties and production and marketing subsidies.

INTRODUCTION

Pulses are an important source of dietary protein for a vast majority of the population in India. In addition, they are also a rich source of energy, minerals and certain vitamins (Table 1). Besides their nutritional value, they also restore soil fertility through biological nitrogen from the atmosphere and conserve and improve the physical properties of the soil by virtue of their deep and well-spread root system. Pulses also provide nutritious green fodder to livestock. However, despite such a pivotal role, the per capita consumption is quite low. The per capita availability of pulses declined from 61 gm in 1951 to 51 gm in 1971 and 39 gm in 1985 against the FAO/WHO recommendation of minimum pulse requirement of 80 gm per capita. Singh (1980) estimated that to fill this gap in per capita availability and achieve a reasonable nutritional standard, the growth rate of production of pulses will have to be around 20 percent per annum for the next 5 years. The National Commission on Agriculture has estimated that by 2000 AD India would require about 35 million tons of pulses per annum while at present the country is producing only about 12 million tons (11.74 million tons in 1986-87).

Western Uttar Pradesh, comprising the district of Muzaffarnagar, Meerut, Bulandshahr, Ghaziabad, Aligarh, Mathura, Agra, Mainpuri Etah, Badaun, Shahjahanpur, Moradabad, Farrukhabad and Etawah, is an important agricultural region of Uttar Pradesh (Figure 1). With the introduction of the Green Revolution the food gain production has made

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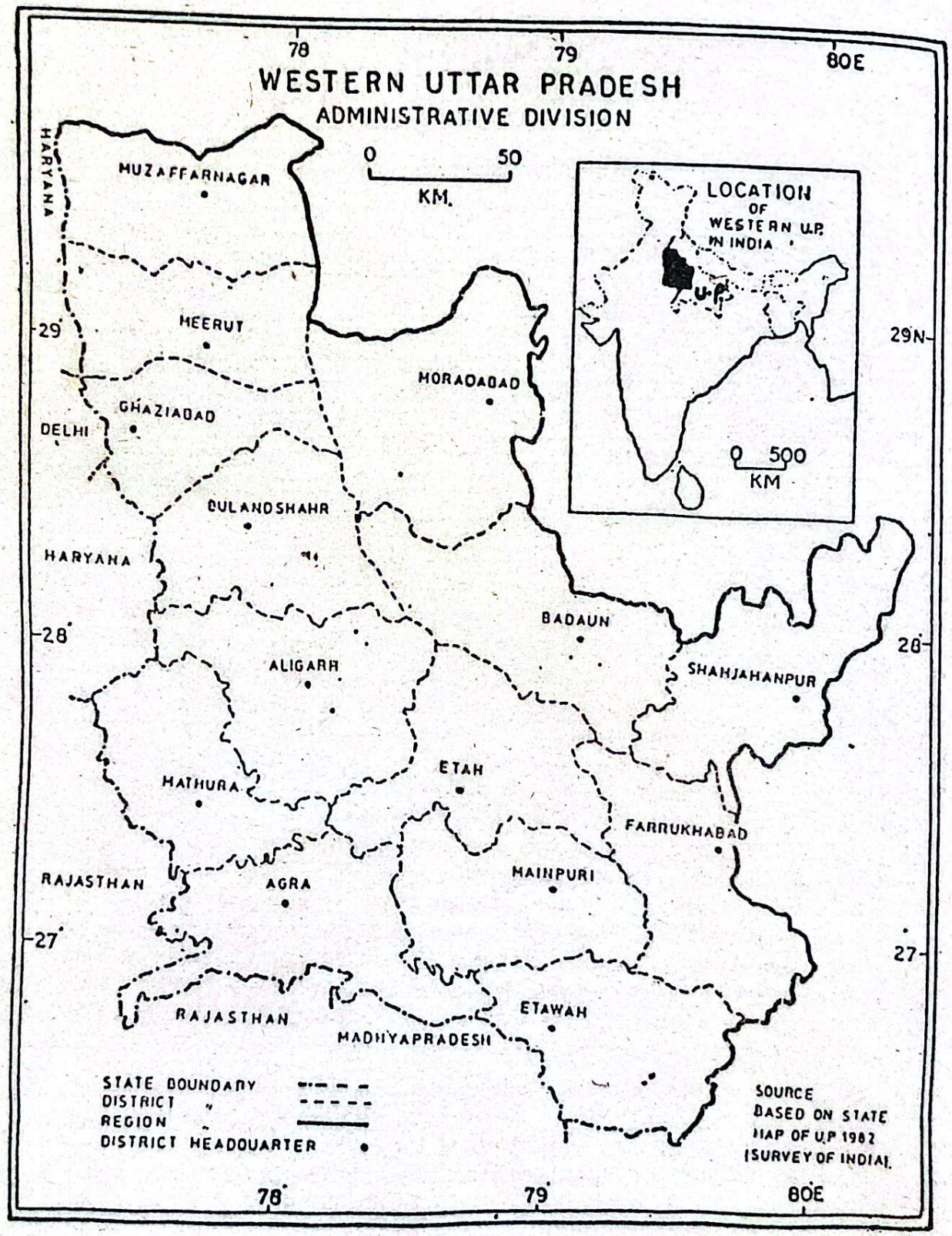

FIGURE 1

TABLE 1. NUTRITIONAL COMPOSITION OF PULSES (100 G OF DRY EDIBLE PARTS)

Crop	Energy (K call)	Protein (g)	Oil (g)	Total Carbo-hydrate(g)	Fiber (g)	Ash (g)	Ca (mg)	P (mg)	Fe (mg)
Pigeon pea	383	21.9	1.5	72.7	8.1	4.2	179	316	16.6
Urd bean	385	23.5	1.8	71.0	4.9	3.8	123	390	9.4
Mung bean	381	25.6	1.3	69.2	4.9	3.9	118	370	7.9
Cowpea	316	25.6	1.7	67.5	13.7	5.1	376	385	6.0
Moth bean	378	20.7	1.3	72.5	5.1	3.3	120	332	—
Chickpea	396	19.4	5.5	70.5	7.4	3.4	280	301	12.3
Lentil	393	26.9	0.8	67.8	4.3	3.2	71	331	7.7
Peas	391	25.6	2.3	65.5	9.1	4.1	91	331	6.6
French bean	318	22.1	1.7	69.9	15.9	6.2	318	425	12.4
Lathyrus	379	29.9	1.2	65.2	8.0	3.6	—	447	10.9

Source: S.S. Khanna and M.P. Gupta, "Raising Production of Pulses," *Yojana* 32(17)(1988):5.

a remarkable increase in Western Uttar Pradesh. Therefore, in the present paper an attempt has been made to examine the growth in area, production and yield of pulses, after the introduction of the Green Revolution, in the different districts of Western Uttar Pradesh during 1967-68 to 1983-84 and to suggest some measures to augment the pulse production. Simple growth rates of gram, pea, *tur*, lentil, *Urad*, *Moong* and total pulses were estimated from the time series (secondary data) collected from the Directorate of Economics and Statistics, Department of Agriculture, Krishi Bhawan, Lucknow. The simple growth rates of area, production and yield have been calculated for each pulse crop and total pulses to find out the trend of such crops in Western Uttar Pradesh and Uttar Pradesh as a whole.

A study of the achievements of the Green Revolution reveals that the phenomenal increase in the food output at the beginning of the program was mainly due to the technological improvement brought about in the cultivation of wheat and rice. But in this race of outputs, pulses have lagged so far behind. The Green Revolution which should actually be called "Wheat" and to some extent "Rice Revolution" left the pulse production comparatively untouched. The compound growth rates of production for wheat and rice during 1967-68 to 1983-84 were 7.93 percent and 6.22 percent per annum, respectively.

TRENDS IN PULSE PRODUCTION

The comparative data on area, production and yield of total pulses and their growth rates covering the period 1967-68 to 1983-84 are presented in Table 2. It can be observed from the table that the area under pulses in Western Uttar Pradesh decreased from 1,029,715 hectares in 1967-68 to 505,874 hectares in 1983-84. The production as well as

TABLE 2. GROWTH IN AREA, PRODUCTION AND YIELD OF PULSES IN DIFFERENT DISTRICTS OF WESTERN UTTAR PRADESH.

District	1967-68			1983-84			Growth in Percentage					
							Total Growth			Annual Growth		
	Area*	Production**	Yield***	Area	Production	Yield	Area	Prod.	Yield	Area	Prod.	Yield
Muzaffarnagar	37,583	34,957	9.30	12,861	6,546	5.09	-65.78	-81.27	-45.27	-3.87	-4.78	-2.66
Meerut	77,717	88,990	11.45	11,658	7,956	6.82	-85.00	-91.06	-40.44	-5.00	-5.36	-2.38
Bulandshahr	74,038	84,367	11.39	21,911	16,849	7.69	-70.40	-80.00	-32.48	-4.14	-4.71	-1.91
Ghaziabad	—	—	—	11,440	11,721	10.25	—	—	—	—	—	—
Aligarh	94,180	113,413	12.04	73,829	62,214	8.43	-21.61	-45.14	-29.98	-1.27	-2.65	-1.76
Mathura	94,386	137,491	14.57	32,619	23,886	7.32	-65.44	-82.63	-49.76	-3.85	-4.86	-2.93
Agra	123,473	146,246	11.38	58,191	63,628	10.93	-54.70	-56.49	- 3.95	-3.22	-3.32	-0.23
Mainpuri	72,154	89,916	12.46	28,300	27,779	9.82	-60.78	-69.10	-21.19	-3,57	-4.06	-1.25
Etah	76,996	112,028	14.55	55,857	51,116	9.16	-27.45	-54.37	-37.04	-1.61	-3.20	-2.18
Badaun	89,002	76,643	8.61	42,997	28,024	6.52	-51.69	-63.43	-24.27	-3.04	-3.73	-1.43
Shahjahanpur	76,032	49,676	6.53	45,900	26,747	5.83	-39.63	-46.16	-10.72	-2.33	-2.71	-0.63
Moradabad	79,886	68,464	8.57	15,783	9,170	5.81	-80.24	-86.61	-32.20	-4.72	-5.09	-1.89
Farrukhabad	52,768	44,321	8.40	33,232	35,745	10.74	-36.93	-19.35	27.86	-2.17	-1.14	1.64
Etawah	76,500	86,748	11.34	61,246	72,395	11.82	-19.94	-16.54	4.23	-1.17	-0.97	0.25
Total West U.P.	1,029,715	1,133,260	11.00	505,874	443,776	8.77	-50.87	-60.84	-20.27	-2.99	-3.58	-1.19
Total U.P.	4,091,628	3,286,039	8.03	2,832,219	2,498,826	8.82	-30.78	-23.96	9.84	-1.81	-1.41	0.58

* In hectares
** In metric tons
*** In quintals/hectare

the yield of pulses also decreased during this period. Similarly, district-wise analysis showed a negative growth rate in area and production in all the districts of Western Uttar Pradesh. The yield also showed a negative growth rate in all the districts except for the districts of Farrukhabad and Etawan. The total decrease in area, production and yield of pulses in Western Uttar Pradesh during this period was about 51 percent, 61 percent and 20 percent, respectively.

Gram

Gram is one of the most important crops among the pulses in Western Uttar Pradesh. It occupied about 51 percent of the total pulse area in 1967-68 and about 34 percent in 1983-84. But during the period 1967-68 to 1983-84, it did not make any progress. The area and production of gram decreased in Uttar Pradesh but the yield improved from 7.3 quintals per hectare in 1967-68 to 8.73 quintals per hectare in 1983-84. In Western Uttar Pradesh the yield of gram was almost the same during this period but area as well as production decreased by 3.95 percent per annum (Table 3).

Peas

Peas constitute the second most important pulse crop of Western Uttar Pradesh. It shared about 31 percent of the total area under pulses in 1967-68 which decreased to about 17 percent of the total area under pulses in 1983-84. Its area and production decreased by about 74 percent and 71 percent in Western Uttar Pradesh and by about 73 percent and 69 percent in Uttar Pradesh during 1967-68 to 1983-84. But its yield has made an increase of 11.42 percent in Western Uttar Pradesh and 15.55 percent in Uttar Pradesh during this period (Table 3).

Tur (Pigeon Pea)

Tur is the third important crop among the pulses of Western Uttar Pradesh. In 1967-68, it accounted for 13.71 percent of the total area under pulses in Western Uttar Pradesh and rose to 16.34 percent in 1983-84. In Uttar Pradesh, though it lost area by about 1.10 percent per annum, it recorded a positive growth rate of 1.02 percent per annum in production and 2.61 percent per annum in yield during 1967-68 to 1983-84. In the case of Uttar Pradesh, the area, production and yield decreased by -2.44 percent, -2.98 percent and -0.93 percent per annum, respectively (Table 3).

Lentil

Lentil is the fourth important *rabi* crop among pulses in Western Uttar Pradesh. In Uttar Pradesh its area, production and yield improved by 5.54 percent, 6.15 percent and 0.32 percent per annum, respectively, during 1967-68 to 1983-84. In Western Uttar Pradesh its area and

TABLE 3. GROWTH IN AREA, PRODUCTION AND YIELD OF DIFFERENT PULSES IN WESTERN UTTAR PRADESH AND UTTAR PRADESH

Pulse	1967-68			1983-84			Growth in Percentage					
							Total Growth			Annual Growth		
	Area*	Production**	Yield***	Area	Production	Yield	Area	Prod.	Yield	Area	Prod.	Yield
Gram												
West U P.	524,859	497.718	9.48	171,909	163 569	9.51	-67.25	-67.14	0.32	-3.95	-3.95	0.02
Total U.P.	2,262,818	1,650,868	7.30	1,358,260	1,186,072	8.73	-39.97	-28.15	19.59	-2.35	-1.66	1.15
Peas												
West U.P.	322,224	420,586	13.05	84,719	123 182	14.54	-73.71	-70.71	11.42	-4.33	-4.16	0.67
Total U.P.	848,434	862,014	10.16	229,024	268,911	11.74	-73.01	-68.80	15.55	-4.29	-4.05	0.91
Tur												
West U.P.	141,233	195 334	13.83	82,638	96 235	11.64	-41.45	-50.74	-15.83	-2.44	-2.93	-0.93
Total U.P.	636,774	609,085	9.57	517,533	715,187	13.82	-18.72	17.42	44.41	-1.10	1.02	2.61
Lentil												
West U.P.	22,267	12.942	5.81	33 577	15,032	4.48	50.79	16.15	-22 89	2.99	0.95	-1.35
Total U.P.	180,346	107,236	5.95	350,238	219,440	6.27	94.20	104.54	5.38	5.54	6.15	0.32
Moong												
West U P.	2,146	537	2.50	90,895	36,203	3.93	4,135.55	6,641.71	59.2	243.27	390.69	3.48
Total U.P.	12,961	3,448	2.66	151,128	53,707	3.55	1,066.02	1,457.62	33.46	62.71	85.74	1.97
Urad												
West U.P.	16,183	5,803	3.58	40.543	9,379	2.31	150.52	61.62	-35.47	8.85	3,62	-2.09
Total U.P.	141,698	50,007	3.53	223,215	55,127	2.47	57.53	10.24	-30.03	3.38	0.60	-1.77

* In hectares
** In metric tons
*** In quintals/hectare

production showed an annual increase of 2.99 percent and 0.95 percent while yield presented a negative growth of -1.35 percent per annum. In 1967-68, it shared only 2.16 percent of the total area under pulses in Western Uttar Pradesh but in 1983-84, it rose to 6.63 percent. Though area showed an annual increase of about 3 percent, due to negative growth in yield (-1.35 percent per annum) the production had less than one percent annual increase during this period (Table 3).

Moong (Green Gram)

Moong is the single important *Kharif* crop among the pulses in Uttar Pradesh as well as in Western Uttar Pradesh. In Uttar Pradesh, it has made an annual increase of 62.71 percent in area, 85.74 percent in production and 1.97 percent in yield while in Western Uttar Pradesh this increase was 243.27 percent in area, 390.69 percent in production and 3.48 percent in yield. The area under *moong* in Western Uttar Pradesh in 1967-68 was negligible (0.21 percent of the total area under pulses), but in 1983-84 it became about 18 percent of the total area under pulses (Table 3).

Urad (Black Gram)

Urad is the least important crop among the pulses of Western Uttar Pradesh. It has expanded its area from 16,183 hectares in 1967-68 to 40,543 hectares in 1983-84 with an annual increase of 8.85 percent. In 1967-68 it accounted for only 1.57 percent of the total area under pulses, but this rose to 8.01 percent in 1983-84. In Uttar Pradesh its area and production increased by 3.38 percent and 0.60 percent per annum but its yield decreased by -1.77 percent per annum. Its yield also showed a negative growth of -2.09 percent per annum in Western Uttar Pradesh and due to this decrease in yield, the production showed only a 3.62 percent annual increase as against an 8.85 percent annual increase in area (Table 3).

The above discussion proves that the *rabi* pulses (gram, peas, *tur* and lentil) have greatly lost their area during this period whereas *Kharif*[2] pulses (*Urad* and *moong*) have increased their area under cultivation. In 1967-68, the area under *rabi* pulses was more than 98 percent of the total area under pulses, which deceased to about 74 percent in 1983-84 while the area under *Kharif* pulses moved from less than 2 percent in 1967-68 to about 26 percent in 1983-84. However, the total area under pulses decreased by about 51 percent during this period, coming down from 1,029,715 hectares in 1967-68 to 505,874 hectares in 1983-84. The main cause for the decrease in area under *rabi* pulses is the introduction of the Green Revolution. The region is very suitable for wheat culti-

[1] Winter season
[2] Rainy season

vation and, therefore, due to high-yielding seed varieties, irrigational development, winter rain and other technological innovations, a large area of *rabi* pulses has been replaced by wheat crop. During this period, wheat registered an annual increase in area of about 8 percent. As far as the area under *Kharif* pulses is concerned, it is not generally affected by rice crop. Rice requires much water while the region receives only about 100 cms rainfall and hence the increase in area under irrigated rice is restricted. No doubt, rice made an annual increase of about 6 percent in area during this period but this area is snatched from *jowar* (great millet), *bajra* (pearl millet) and maize crops. A considerable area of *jowar*, *bajra* and maize crops is also replaced by *Kharif* pulses because pulses are more economical in comparison to these *Kharif* cereals.

As far as the yield and production of different pulses are concerned, it has been found that, generally, there were decreases in yield as well as production in all the crops except for *moong*. *Moong* is the only pulse crop which has increased its yield as well as production during this period. A notable point is that *moong*, generally, is not grown in *Kharif* season but it is grown in *Zaid*[3] as a third crop with the help of irrigation and plays an important role for the next crops in terms of increasing the nitrogen in the soil. It helps in the nitrogen fixation process in the soil, forming the nodulations in the roots that increase the nitrogen content of the soil. This increase of nitrogen in the soil helps in enhancing soil productivity.

CONCLUSION

Thus, the study reveals that the introduction of the Green Revolution has substantially boosted the production of wheat and rice and left pulse production untouched. In all the districts, not only areas under pulses have decreased but yields as well as productions also decreased. The main reason for this is that the yield of wheat or rice is much higher in comparison to pulses. The Green Revolution has raised the productivity of wheat and rice such that farmers prefer to grow these crops instead of pulses in fertile lands with all the yield-raising inputs and improved cultural practices. The farmers therefore continue to grow pulse crops on poor marginal lands of low soil fertility under rainfed conditions with generally no inputs like fertilizers, pesticides, etc. The uncertain and erratic rainfall creates a formidable barrier against timely planting and desired plant stand. Moreover, the pulses are more susceptible to pests and diseases and adverse weather conditions like snowfalls, haze, etc. as compared to cereals and other crops. Therefore, for the farmer it is less risky and more remunerative to grow a cereal than a pulse crop. Apart from the technological gaps for which more intensive research work is needed, there is an extremely slow flow of technology

[3] Summer season

from laboratories to the farmers' fields, not to mention the management gap at the farmers' end. The consequences of all these are low yields of pulses and lower returns from their cultivation in comparison to the cultivation of cereals and other crops.

The pulse prices, at present, are very remunerative to the farmers but it is the risk of crop failure due to pests and diseases that discourages the farmers to cultivate the pulses in large scale. Therefore, it is essential for agricultural scientists to bring about a technological breakthrough as in the case of wheat and rice by developing more high-yielding as well as pest- and disease-tolerant varieties of pulses. Keeping this view in mind, recently, a number of schemes and projects have been in operation to increase the production of pulses and with the help of these a large number of improved varieties of pulse crops have been evolved which are capable of enhancing and stabilizing the pulse production. Some of the improved varieties of pulses are given in the following table (Table 4).

TABLE 4. IMPROVED VARIETIES OF PULSES

Crop	Variety
Gram	GNG-146, Pusa 209, GG 588, BGM 408, BGM 413, Gaurav, JG 315, JG 74, Phule 5.
Arhar	Bahar, BDN1, BDN2, Maruthi, ICBL 87, Manak, DA 11, DA 6, MA 96.
Moong	Pant Moong 2, ML, 131, ML 267, M 2331, Pusa 101, PDM-11.
Urad	Pant U 19, Pant U 30, UG 218, LBG-11.
Pea	Rachna
Lentil	Pant L 639

Source: S.S. Khanna and M.P. Gupta, "Raising Production of Pulses," *Yojana* 32(17) (1988):8.

It has been found that an aggressive pulse variety development program has checked the declining trend in areas where irrigation has been introduced. It has been clearly demonstrated that effective weed control and fertilizer use are the most important production inputs. Timely application of plant protection measures could bring substantial increases in productivity. Therefore, the major task lies in motivating farmers to adopt the full package of practices for raising crop yields. For this, a centrally sponsored program has been introduced to assist the small and marginal farmers. This new program includes: the introduction of pulse crops in irrigated farming systems; bringing additional areas under short-duration *moong* and *urad* varieties in the summer season; cultivation of *arhar* under both irrigated and unirrigated conditions; use of improved pulse seeds; use of phosphatic fertilizers and

rhizobium culture (bacteria that help fix nitrogen in root nodules); plant protection measures; improved post-harvest technology; and price support. Under this scheme, assistance to small and marginal farmers is given by way of subsidies on certified seeds and fertilizers, plant protection measures, etc. This program appears to have evoked good responses in all the states and should be recommended.

Thus, there is need for more researches on pulse production to encourage demand for the crop. New varieties of pulses should be developed which are not only high-yielding but also stable and resistant to pests and diseases. It has been found during the field observation that short-duration varieties of *moong* are being grown during the summer months and they are giving good results. Therefore, efforts should also be made to introduce short-duration varieties of other pulses both under irrigated and unirrigated conditions. Finally, considering that pulses are mainly grown in dry and marginal lands where farmers are generally very poor, the government should come forward and provide the financial support to the farmers by way of subsidies on certified seeds, plant protection measures, fertilizers, equipment and operational activities. This will help greatly in increasing pulse production in Western Uttar Pradesh.

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Philippine Geographical Journal, Vol. 33, No. 4
(October-December, 1989)

RESEARCH REPORT

INTEGRATED STUDY OF ENVIRONMENTAL PROBLEMS OF METRO MANILA: AIR, WATER AND LAND POLLUTION

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ABSTRACT. Rapid industrialization and urbanization in Metro Manila, the Philippines' primate urban area, has resulted in menacing environmental problems which pose a threat to the health and comfort of residents and commuters. Air pollution in the metropolis comes from motor vehicles, power generating plants, factories and residences, with two-thirds being contributed by the first two sources. Water pollution in the metropolis' six major river systems and in Manila Bay comes from residences and industries, with more being contributed by the former. Land pollution is caused by the dumping on land of solid and liquid wastes by markets, residences and factories. The inefficiency of the present environmental management system may be traced to the failure to integrate efforts among the political units of the metropolis and among the various sectors in it. The deteriorating ecological condition in the metropolis can be stemmed by adopting solutions involving population relocation; industrial dispersal; resource reuse, recycling and reclamation; generation of land use decision maps; and integrative planning and implementation, among others.

INTRODUCTION

This study which was conducted with financial assistance from the National Research Council of the Philippines (now Philippine National Science Society), has the following objectives:

1. To present a reliable data base of the environmental situation in Metro Manila, especially on air, water and land pollution;

2. To identify the principal causes and sources of pollution and pollutants in Metro Manila; and

3. To propose solutions to minimize, with reasonable limits, the effects of pollution in the National Capital Region.

The data on air and water pollution in the study covered only the years from 1979 to 1983 which were furnished by the National Pollution Control Commission (NPCC). Whatever results and conclusions are presented should therefore be seen under this limitation, considering that the full report is coming out a few years later.

In view of the fact that the report contains 218 pages and the appendices of graphs and maps contain about 200 pages also, it is reason-

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able that only the summary, conclusion and recommendations are being given hereunder.

SUMMARY

Metro Manila is geographically defined by the four contiguous cities of Manila, Caloocan, Pasay and Quezon City and by the thirteen municipalities of Las Piñas, Makati, Malabon, Mandaluyong, Marikina, Muntinlupa, Navotas, Parañaque, Pasig, Pateros, San Juan, Taguig and Valenzuela. Its total land area of 636.10 square kilometers constitute about 0.5 percent of the total land area of the Philippines.

Metro Manila is the Philippines' dominant urban center which has continually assumed a pivotal role in practically all the country's affairs. It is the virtual nerve center of the country's administrative, economic, industrial, educational, political and social activities which usually shape up the events in the entire country. The heavy concentration of business establishments and industrial complexes in its limited area further enhances its domineering presence in the trade and industrial sector and its contribution to the growth of the national economy. Its link to the major cities of the world not only through the major airlines and shipping companies plying the route but also through the embassies and consulates makes it the country's gateway to international trade and tourism.

The full-blast industrialization and urbanization of Metro Manila have resulted in a number of menacing environmental problems which pose a growing threat to the health and life of Metro Manila residents. Extreme population pressure on limited space and resources seriously strain and degrade important life support systems. The accumulation of pollutive substances from different sources result in the alteration of the physical, chemical and biological properties of life support systems such as air, land and water system which affect the health and well-being of the inhabitants.

Air Pollution

The sources of air pollution in Metro Manila may be classified into four general categories. The first and major source is the internal combustion engine of motor vehicles, otherwise also known as mobile sources of air pollution. As of 1982, NPCC has estimated that there were operating in Metro Manila some 464,000 vehicles of all types, representing about 60 percent of the total vehicles registered in the country in that year. NPCC has also estimated that all the motor vehicles in the study area contributed the following air pollutants:

(a) 4,113 tons of carbon monoxide

(b) 13 tons of particulates or dusts

(c) 13 tons of sulfur dioxide

or a total of 4,139 tons of pollutants.

A second source of air pollution are the stationary generating plants located in Metro Manila and using bunker or diesel fuel oil. They contribute the following estimated daily pollutants:

(a) 3,952 tons of sulfur dioxide

(b) 103 tons of particulates

(c) 37 tons of carbon monoxide

totalling 4,112 tons of pollutants.

The third main source are the more than 1,150 industrial firms operating in Metro Manila, particularly metal fabrication, foundries, ceramics, textile mills, etc. and their total daily contribution is estimated by NPCC as follows:

(a) 2,961 tons of particulates

(b) 280 tons of sulfur dioxide

(c) 114 tons of carbon monoxide

or a total of 3,355 tons of pollutants.

Lastly, domestic residences in the metro area which do not make use of electric energy also contribute to pollution through their use of firewood and/or cooking gas either of which results in the release of incomplete combustion products. A rough estimate of the contribution from this source is shown below:

(a) 270 tons of particulates

(b) 120 tons of carbon monoxide

(c) 4 tons of sulfur dioxide

or a total of 394 tons of pollutants.

The above estimates of air pollutants in tons per day over Metro Manila show that motor vehicles contribute 34.9 percent, stationary plants 34.26 percent, industrial firms 27.96 percent, and domestic residences 3.28 percent. On overall basis, motor vehicles and stationary power plants contribute about two-thirds of the total air pollutants. Industries contribute about a fourth and domestic sources account for the remainder.

The principal effects of air pollution are health-related. Inhalation of particulates, carbon monoxide, sulfur dioxide and unburned hydrocarbons which are well-known health hazards predispose susceptible individuals to upper respiratory ailments. Gasoline engines produce great amounts of carbon monoxide while improperly maintained diesel engines release a great deal of smoky and ill-smelling emissions. Indus-

tries contribute a great deal of particulates, with domestic residences a distant second. Air pollution also results in damage to crops and property in the form of hastened corrosion in the case of the latter and stunted growth or untimely death in the case of the former. This condition is exacerbated by the presence of sulfur dioxide, which on contact with moisture in the air results in the formation of sulfuric acid.

To assess the quality of air in Metro Manila, NPCC has set up several monitoring stations equipped with continuous recording analyzers for three important parameters, namely: particulates, carbon monoxide and sulfur dioxide. The present study was fortunate to secure original data from five monitoring stations located in the following places: (a) Cubao (Elementary School), (b) Ermita (NPCC Office), (c) Malacañang, (d) Pasay (Elementary School), and (e) Quiapo (Plaza Miranda).

Monitoring data appear to show that, except at the Pasay station, there was an increasing trend of particulates from January, 1979 to December, 1983. Combining all the data, the particulate concentration was about 74 micrograms per cubic meter at the beginning and about 101 micrograms per cubic meter at the end of the 5-year period. In Pasay, however, the particulates measured about 100 micrograms per cubic meter at the start and dropped to only 62 micrograms per cubic meter at the end of the monitoring period.

For carbon monoxide, the compiled data showed that the concentration levels were decreasing, except for the Ermita station. The average of the four other stations was about 3.8 ppm in January, 1979 and decreased to about 1.6 ppm in December, 1983. For Ermita, the carbon monoxide level measured at 3.3 ppm at the start and increased to 9.0 ppm at the end of the period.

The concentration levels of sulfur dioxide showed a very slightly increasing trend, except in Ermita. Three stations averaged 0.026 ppm at the start of the period and about 0.030 ppm at the end. Records for the Quiapo station were so erratic and did not merit inclusion in the discussion.

The monitoring data given above indicate the overall picture of air pollution in Metro Manila and may be considered as the integrated result of all sources of pollution present. It must also be noted that all air pollutants, when not carried by the prevailing winds far away from the study area, are brought down by precipitation during the rainy days of the wet season and thus contribute directly to the water pollution problem.

Based on the five-year period (1979-83) data, the average hourly concentration of pollutants in Metro Manila were: 89 micrograms per cubic meter for particulates; 2.7 ppm for carbon monoxide; and 0.027 ppm

for sulfur dioxide which was fairly constant. These figures are below the standards of 250 micrograms per cubic meter for particulates, 30 ppm for carbon dioxide and 0.30 ppm for sulfur dioxide.

Water Pollution

Water pollution was determined from the analysis of monitoring data obtained from specific sampling points in particular rivers or waterways present in the area. There were a total of some 33 monitoring stations or sampling points which were located at the following rivers: (a) Malabon-Navotas River, (b) Tinajeros-Tullahan River, (c) Pasig River, (d) San Juan River, (e) Marikina River, and (f) Zapote-Parañaque River.

In general, all Metro Manila rivers and waterways are polluted in varying degrees. Industrial establishments operating on the banks of these waterways contribute to the total pollution load, but a significant, most probably greater, fraction is contributed by the greater population not served by the public sewerage system which covers less than about 15 percent of the metropolitan area.

Color and turbidity, as expected, increased significantly during the months of April to August, with the highest readings in June and August. Dissolved oxygen in the river, the single most important parameter, varied considerably but appeared to improve (i.e., to increase its level) greatly in the months of June to August in 1981 and 1982. This corresponds to the rainy months. In November of 1980, however, various rivers gave almost zero readings. Significantly constant was the pH value in all the waterways, which varied from 6.7 to 8.3. Water temperature closely followed that of ambient air values.

Biochemical oxygen demand (BOD) values varied considerably from a low of 2.8 ppm in July, 1982 to a high of 130 ppm in April, 1980. Total dissolved solids increased during the dry months of February to May since there was as yet no dilution from the rains. Chlorides and sulfates both decreased, the former from a value of 4,800 ppm in February, 1979 to 670 ppm in March of the same year; and the latter from 79 ppm in February, 1979 to 27 ppm in May, 1979. The presence of methylene blue active substances (MBAS), a parameter for measuring the levels of detergents, was recorded at a value of 2.9 ppm in February, 1979 but decreased to a value of 0.2 ppm in 1980-1981, then slowly increased to 0.8 at the end of 1983.

Heavy metals such as Fe, Mn and Ni were also found in significant concentrations which varied with the months. The highest value recorded for Fe was 17.5 ppm in April, 1983; for Mn, the highest value detected was 0.5 ppm in June, 1983; and for Ni it was 0.5 ppm in May, 1983.

Mercury was also detected with a high value of only 0.5 ppm in October, 1982, which is way below the standard (0.05 ppm) set by WHO for drinking water. Ag and Zn were also found but their values were all below the WHO standards.

The polluted river waters may be contaminated with some types of pathogenic bacteria and viruses coming from infected sewage discharges which sometimes lead to epidemic outbreaks of contagious diseases. The deplorable state of these rivers is briefly discussed below.

The Pasig River, the main navigable river in Metro Manila, exemplifies an "overused" river in an urban center. It is now seriously degraded, carrying an estimated population of 1,390,600 living in unsewered districts within the river basin. Although the installation of water pollution control devices by the water-pollutive firms have reduced industrial contribution to Pasig River pollution, there is still a considerable amount of effluent which is diverted to the river.

Marikina River, on the other hand, is partially polluted, with its upper reach receiving a Class A rating from NPCC, while its lower reach which is affected by industrial waste is classified as C. Industrial pollution is about 33 percent while load coming from domestic sources is estimated at 67 percent.

The Tinajeros River System is considered the most polluted river system in the country today. The latest NPCC estimate showed that 37 percent of its pollution load comes from industry and 63 percent from domestic sources. Despite the installation of wastewater treatment facilities by most of the industrial polluters there has been no noticeable improvement in the water quality due to the continuous discharge of domestic sewage which leads to siltation by organic and inorganic pollutants in the river bed.

The Zapote-Parañaque River is not as seriously polluted as the other major rivers in Metro Manila. Although its classification is also Class C, it has a higher DO content which averages 6.9 mg/1 and a lower BOD averaging 19.0 mg/1 — showing that it can support fish life.

The Manila Bay is likewise being seriously degraded due to the various types of solid and liquid wastes discharged into it. It receives huge amounts of waste materials, including grit and solid particles due to the run-down condition and overloaded capacity of present sewers and pumping stations in Metro Manila. A substantial volume of domestic, agricultural and industrial wastes are also being discharged into the Bay from the adjoining provinces of Bataan, Cavite, Bulacan and Pampanga. Garbage washings, oil and grease are also constantly being discharged by ships berthed at the piers of the North and South Harbors of Manila Bay.

Land Pollution

Easily discernible to the public is the problem caused by solid waste dumping on land or land pollution, particularly when collection of garbage and refuse is insufficient or inefficient and the materials begin to pile up on the sidewalks. Land pollution results from the introduction into the soil or land surface of solid waste materials such as organic wastes from the municipalities (markets), domestic and industrial solid wastes, environmentally persistent products (plastics), and inorganic wastes. Garbage and refuse dumps are not only unsightly but also attract and harbor insects, pests and disease-carrying vermin. Agricultural chemicals, such as fertilizers and pesticides, also cause land pollution and, together with surface runoff, ultimately contribute to water pollution.

Results of the 1981 "Metro Manila Solid Waste Management Study" which was partially financed by the World Bank, show that the estimated 1.2 million households contributed directly to the daily generation or production of almost 2,650 tons of solid wastes in the study area. The breakdown of the estimate is as follows:

Residential areas	1,300 tons
Markets	340 tons
Commercial firms	144 tons
Industrial firms	154 tons
Construction/Demolition	29 tons
Street Sweepings	486 tons
Institutions	136 tons
Others	60 tons
Total	2,649 tons

An analysis of refuse generation shows that the high-income families generated about three times as much as the low-income families as shown in the table below:

Sector	Population (mil)	Total Tons	Kilo/Capita
Low Income	4.196	704.9	0.168
Medium	1.531	304.4	0.202
High Income	0.566	270.1	0.477

The two major problems in solid waste management are the lack of sufficient number of trucks for collection and hauling as well as the absence of suitable dump sites within the metropolitan area. These two problems are the main worries of the management staff of the agency concerned with this service.

The inefficiency of the present system lies in the evident failure to integrate environmental efforts and thus secure a unified approach. There are quite a number of agencies assigned to deal with specified

aspects which are, of course, characteristically sectoral. Thus, there is a tendency to focus on the agencies' own respective areas of responsibilities and not to consider the intricate relationships of the various kinds of pollution. A unified approach is the holistic way of approaching environmental problems through comprehensive planning, assessment, control and decision-making. Projects and activities should be integrated considering functional linkages, resource utilization, access to basic services, and people participation in the planning and implementation processes. A number of strategies being recommended for adoption will now be considered.

Recommendations

1. Decongestion/decentralization of Metro Manila through an aggressive, feasible and implementable countryside development program. This will insure the gradual removal of squatters and the improvement of marginal communities in Metro Manila which all contribute to a significant level of environmental pollution.

2. Dispersal of industries outside of Metro Manila. This will complement the first recommendation and help remove the attraction the area offers to rural inhabitants who generally feel that all the opportunities are found only in Metro Manila with its principal industries.

3. Maximized utilization of resources through innovative processes of reuse, recycling and reclamation. These three terms are better understood by taking bottles as an example. If a glass of soft drink is used again in the original intent, the process is reuse; if the glasses or bottles are broken and grounded and manufactured again into similar bottles, the process is recycling; and if the ground pieces are made part of another product, say in the manufacture of tiles, then the process is reclamation.

4. Use of ecological mapping for generating land-use decision maps. This will help identify land areas which are to be developed into housing, refuse dumps or industrial estates and thus minimize and reduce expected pollution levels.

5. Integration of environmental consideration in project planning and implementation through the use of more recent methodologies, such as extended cost-benefit analysis, social costs analysis, and economic valuation of environmental degradation.

6. Translation of environmental research results into more usable technology or guidelines in the implementation of economic and other development projects.

7. Effective implementation of environmental policies and regulation through a workable and integrated management information system.

8. Participation of citizens' groups, including non-governmental organizations (NGOs), in project planning and implementation.

9. Intensified environmental information dissemination to arouse public awareness and commitment. Subjects in environmental studies should be incorporated in the elementary, secondary and tertiary levels of education.

10. Institutional reorganization of the major environmental agencies to effect the desired integrated management approach to the solution of Metro Manila's environmental pollution problems.

AUTHORS' NOTE

As this report was being written, several environmental agencies such as the NEPC, NPCC, ECP and certain offices under the Department of Natural Resources were being reorganized under a new Department of Environment and Natural Resources.

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