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POLLUTION: THE DEBRIS OF TECHNOLOGY — PHILIPPINE SETTING*

by

BRIG. GEN. GUILLERMO A. PECACHE

It is always a pleasant occasion when experts from various fields of science come out from their 'shells' and discuss with their colleagues whatever they may have been doing inside their laboratories, classrooms or offices, or whatever may have been bubbling or boiling up in their minds. Scientists, it is said, are a proud people. They should be for the advancement of mankind from his primitive cave to his modern spacecraft would not have taken place without their contributions. Man has gradually discovered the mysterious forces and principles governing this awesome planet and universe, coming into grasp with an order behind an apparent chaos, a clarity after haziness, vision after blindness. Slowly has he mastered these laws and processes of which he previously had no control, thereby realizing up to a certain extent the potentialities of which man is considered as man.

Science is also responsible for ushering in the age of technology and industry. We are reminded of that historical event which broke out in England in the 18th century and from there spread to other parts of the world. I am talking, of course, of the Industrial Revolution. The rapid development of machine technology brought about vast social and economic changes. There was a terrific outburst of new inventions and innovations, thus maximizing efficiency in the production of goods and services. There was unprecedented growth and development.[1]

But despite its achievements, some historians have bitterly called this period as "the bleak age". As machines became more efficient, many businessmen desired to heap up profits and cut down investments. Thus, there was the exploitation of laborers. These workers included girls and boys below the age of eighteen who were forced to work, eat

* Lecture delivered by the NPCC Commissioner before the Philippine Association for the Advancement of Science recently at the Philippine International Convention Center.

[1] Encyclopedia Britanica (Vol. 5); Chicago: Encyclopedia Britannica, Inc. 1973; pp. 347-348.

and sleep in conditions which insulted their dignity. There was hunger, poverty, sickness and despair. It was also the start of the modern-day phenomenon called pollution — the debris of technology.[2]

CAUSES OF ENVIRONMENTAL POLLUTION

Environmental pollution, however, has been present on earth since its earliest beginnings and even before man's appearance on this planet. Some 5000 years ago, there must have been plenty of volcanic activities, major upheavals, heavy rains lasting for centuries, all of which polluted the entire planet. Modern science has found evidence of toxic gases, smoke and dust that dominated the ancient hydrosphere and atmosphere, causing the extinction of numerous species of flora and fauna.[3]

Even now, some forms of pollution result from natural phenomena. There are volcanic eruptions which trigger off landslides, dustfalls and mudflows into natural streams; tidal waves which result from movements of the oceanic floors; lightning-ignited forest fires which cause large-scale smoke and fly-ash; and windstorms and sandstorms which create hazards in the form of air-borne sand and particles. Over these forms of pollution, man exercises little or no control at all.

What we are interested in, however, is man-made pollution. This form of pollution is caused by several factors, foremost of which is rapid industrialization. Industrial growth and modern technology have provided us with many luxuries and great affluence but it has also contributed a lot of rubbish to the detriment of public health and the quality of our environment. These are in the form of industrial effluents and emissions like acids and alkalies, organic and inorganic chemicals, pesticides, heavy metals, smoke, dust, gases and suspended particles.

In the country today, we have identified the following pollutive industries as major sources of pollution: (1) Those principally causing water pollution like mining and ore processing firms, textile mills, food, milk and beverage plants, tanneries and ceramic plants. (2) Those principally causing air pollution like cement plants, power plants, wood processing and foundries, mirror and glass factories. (3) Those industries causing both air and water pollution such as sugar centrals, flour mills, soap and detergent manufacturing plants, chemical and fertilizer plants, oil refineries, and plants processing plastics, rubber and asbestos.

The contributions of industries to environmental pollution is aggravated by rapid population growth and urbanization. As we all know, the general public contribute a significant amount of pollution in the form of sewage, solid wastes and refuse. As population increases, so does the amount of wastes produced, thus making waste disposal a major

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[2] Hobsbawm, E.J.; The Age of Revolution (1789-1848); New York: New American Library, 1962; pp. 137-148.

[3] ————, "The Debris of Technology"; The Rotarian.

problem in congested urban areas. Uncollected garbage piles become breeding places for flies, mosquitoes and other disease-carrying insects while burning of dump causes obnoxious odor and excessive smoke. In addition, gaseous exhausts from motor vehicles constitute a large bulk of air pollutants, particularly in urban areas.

These factors which I have just mentioned — rapid industrialization, urbanization and population growth — are significant in the light of present realities existing in our country. As of the 1980 census, the country's total population was about 48 million, 12 percent of which reside in Metro Manila wherein the population is rapidly growing at a rate of 3.58 percent annually. Of the 6,340 industrial firms scattered throughout the country, around 37 percent are crammed within the Metro Manila Area.[4]

The implications of these figures are vividly manifested in the following facts and events:

1. In Malabon, Metro Manila and neighboring towns, the multi-million peso bangus industry suffers due to industrial pollution of the Tullahan-Tinajeros River. Eighty (80) percent of the 500 hectares of fish pond have been ruined, endangering the livelihood of around 20,000 Malabon fishermen and their families.[5]

2. Thirty-seven (37) rivers in the country today are severely polluted. For instance, the Tinajeros-Tullahan River System in the Metro Manila Area, the most polluted river system in the country at present, receives various types of wastes from some 39 industrial firms along its banks. The Pasig River System was once considered as "dead" but improvement has been noted in its water quality such that aquatic life is now thriving in it.

3. Metro Manila residents and commuters are breathing obnoxious gases such as oxides of nitrogen, carbon monoxide, aldehyde, hydrocarbons, etc., together with suspended particular matter which are emitted by some 464,095 motor vehicles (1982 BLT statistics) plying along the thoroughfares of the metropolis daily.

4. Only about 15 percent of the 5.0 million inhabitants of the metropolis are using proper sewerage systems. This means that more than 5 million are using only septic tanks to treat their domestic wastes. This condition has been worsened by dumping of garbage into esteros, creeks and rivers. It is estimated that 70-80 percent of the water pollution in the metropolis can be attributed to inadequately treated or untreated domestic sewage. The balance is traced to industrial sources.[6]

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[4] NPCC Research.
[5] The Mindanao Daily, 29 September 1983.
[6] NPCC Research.

5. Seven died and several persons were sick of the so-called red tide poisoning attributed to eating fish, clams, shells that are afflicted with the red algae. Sources suspected that pollution may be the possible cause of the red tide which affected an P11M livelihood project of oyster, clams and mussel farms in Western Samar and Leyte.[7]

6. The Ambuklao Dam in Benguet Province, when constructed in the early sixties, was expected to last for 100 years. But due to wanton logging and illegal kaingin which have caused soil erosion and continued accumulation of silt on the beds of the reservoirs of the dam, its expected life span was cut down to 25 years.[8]

7. A report from the Bureau of Mines and Geo-Sciences (BMGS) said that vast tracks of farmlands in at least 7 provinces in the country have been massively destroyed by mine tailings. In addition several irrigation dams, rivers and canals have been heavily silted by mine tailings. Heavily hit provinces include Cebu, Pangasinan, Marinduque, Palawan, Ilocos Sur, Negros Occidental and Benguet.[9]

8. Sixteen (16) vital watersheds near water sources and irrigation dams are fast losing their green cover, the result of illegal logging and inadequate conservation efforts. Two of these are near the Ambuklao hydroelectric dam, while the other is near Pantabangan Dam in Nueva Ecija.[10]

FAVORABLE FACTORS IN THE PHILIPPINE SITUATION

But even with these rather startling phenomena, the degree of pollution in the Philippines has yet to reach a critical stage. We could owe this to several factors in our favor. The geographical location of our country, for instance, is such that it is surrounded by oceans and seas, and with short river systems except in the Central Plains of Luzon and in Mindanao. Thus, river pollution is immediately carried into the seas where large-scale dilution occurs. Another factor is the tropical climate in our country which is characterized by monsoon seasons. This helps in the removal or diffusion of air pollutants. Local temperatures and humidities are high, thus preventing the occurrence of atmospheric inversions which tend to magnify the effects of air pollution.[11] Besides, the government has established environmental protection as a priority policy right at the outset of our industrialization program.

CRITICAL GLOBAL ENVIRONMENTAL SITUATION

In other countries, however, the extent of environmental pollution has reached serious levels. There is for instance, the mercury pollution

[7] Peoples Daily Forum, 29 September 1983.
[8] Bulletin Today, 24 August 1972, p. 1.
[9] Times Journal, 12 September 1983.
[10] Times Journal, 14 October 1983.
[11] Speech of Dr. Reynaldo M. Lesaca, former NPCC Commissioner, "Industrial Pollution and the Government's Role in its Prevention and Control."

of Minamata Bay in Japan which claimed 59 dead and 224 bedridden. Other examples are the "Killer smog" episodes, caused by a lethal mixture of sulfur dioxide and smoke particles, which occurred in Donora, Pennsylvania in 1948 and in London in 1952 and 1962; the disastrous oil spillage in Massachusetts some seven years ago when the tanker **Argo Merchant** spewed more than five million gallons of crude oil into fishing waters; and the lead poisoning of hundreds of inhabitants in a small village of Thailand.

MAN AND HIS ENVIRONMENT

All this provokes us to think how man, in his search for a better life, is destroying life itself. No sooner, he finds himself in a mess which he himself has made. His intelligence made him capable of creating miracle gadgets and amazing machines as well as controlling forces that challenge those of nature itself. Here probably lies his error. Nature has its own laws and systems. It has the ability to balance, cleanse and renew itself. But man has tampered with these intricate processes, thus threatening the very basis of life itself.

Today, we realize that science and technology must learn to coexist with nature. **If there is no future for science and nature together, then there is no future for humankind either.** We believe that science and nature are not antithetical in the same manner that development and environmental protection can go hand-in-hand and even reinforce each other. In fact, this is the philosophy behind our environmental protection program: the establishment of balance between progress and ecology.

GOVERNMENT MEASURES TO CONTROL POLLUTION

The first serious step towards environmental protection was taken by the government on June 18, 1964 when the President of the Philippines signed Republic Act No. 3931. This law created the National Water and Air Pollution Control Commission with the primary aim to maintain reasonable standards for the air and water quality of the country.

Twelve years later, confronted with the growing menace of environmental pollution, the government amended this law and issued Presidential Decree No. 984 on August 18, 1976. The decree was aimed to make the National Pollution Control Commission (NPCC) more effective in its function and more responsive to the demands of the time as occasioned by the intensive drive of the government toward full industrialization. This decree transformed the Commission from a multi-headed to a single-headed agency. Besides, the Commission was given quasi-judicial powers in order to effectively enforce the anti-pollution law.

FUNCTIONS OF THE COMMISSION

The functions of the Commission may be broadly divided into technological control and regulatory control of pollution.

Along the line of technological control, the Commission applies appropriate technologies and methods of pollution control. It conducts scientific experiments, investigations and researches to discover practical and economical methods of preventing and controlling air, water and land pollution. It also undertakes monitoring, surveillance, inspections and surveys of the location, magnitude, causes and effects of all forms of pollution.

In regulatory control, on the other hand, the Commission establishes environmental quality standards based on surveys, researches and studies. These standards are translated into implementing rules and regulations, which in turn provide the procedures and requirements for their compliance. Violators are penalized through temporary cessation of operations (as in the case of pollutive industries), apprehension and grounding (in the case of smoke-belching vehicles), or payment of fines.

Concomitant with these main functions, the Commission develops comprehensive multi-year and annual plans for pollution control consistent with the overall development plan of the government.

The Commission also establishes linkages with other government agencies as well as with the private sector in the matter of enforcement of anti-pollution laws and their implementing rules and regulations. It has sought, for instance, the help of the Bureau of Land Transportation and the Board of Transportation in the apprehension and grounding of smoke belchers; the Bureau of Plant Industry in regulating the use of pesticides and fertilizers for agriculture; the Ministry of Public Works and Highways in the dredging of clogged rivers and esteros; and the local government authorities in the relocation of squatters who are major contributors to the pollution problem in the Metro Manila Areas.

The Commission likewise collects and disseminates information relating to all kinds of pollution and their prevention, control and abatement. Recognizing the importance of the citizenry's awareness and involvement, the Commission periodically conducts comprehensive information and educational campaigns.

THE NATIONAL ENVIRONMENTAL PROTECTION COUNCIL

The National Pollution Control Commission is by no means the only agency in charge of safeguarding the quality of our environment. On April 18, 1977, the President signed Presidential Decree No. 1121 which

created the National Environmental Protection Council. The major functions of this council is to oversee, unify and integrate the planning, management and implementation of the total environmental protection program of the government.

ACHIEVEMENTS OF THE COMMISSION ON THE ASPECT OF POLLUTION CONTROL

The NPCC, together with other agencies attached to the Ministry of Human Settlements, has been relentless in its efforts to safeguard our environment, moving gradually from a bleak start to brighter prospects. The response of the citizenry to the call of environmental protection has significantly changed from that of apathy to that of active support and involvement. Before, industrial firms were wantonly degrading the quality of our environment through the discharge of their wastes and by-products without fear of prosecution. With the NPCC given more teeth, industries are now beginning to realize that there is an anti-pollution law with which they must strictly comply.

In 1983 the Commission ordered the temporary closure of one (1) industrial firm for violation of the anti-pollution law while imposing to 142 others penalty of fines ranging from ₱1,000 to ₱5,000 per day of operation. It has likewise ordered non-complying firms to set up pollution control facilities within definite periods of time.

Within a period of seven years (1977-1983), a total of 58,819 smoke belchers have been apprehended and grounded for emitting black smoke in violation of Letter of Instruction No. 551 and Presidential Decree No. 1181. Of this number, 12,981 vehicles have been allowed to resume operations after payment of fines amounting to ₱2,438,870 and compliance with the smoke emission standard set by the Commission. The rest remain grounded for failure to comply with the requirements.

The Commission has also launched a massive public information campaign via multi-media approach, thereby increasing pollution awareness in all levels of the social strata and gaining public support and participation towards pollution control.

In short, the NPCC can say that it has arrested the upward trend of pollution in the country and that it has raised the level of national awareness on the dangers of environmental pollution.

PROJECTIONS

Even with these modest accomplishments, however, pollution control is a continuing job. As industries grow, as cities develop and people mushroom, so does the menace of pollution become more apparent. Perhaps, we would grasp this better if we try to project the situation

of the country in the near future. We anticipate to reach full industrialization between 1987 and the year 2000. The share of agriculture to the Gross National Product (GNP) would decline while that of the manufacturing, transport, commerce and industries would tremendously increase.

Likewise, population rate is expected to reach the 70th million mark by the turn of the century. This is yet a medium forecast, i.e., granting that the growth rate is consistently kept low or even possibly reduced. But if such were not the case, it is probable that we will surpass the 100th million mark by the year 2000.

And what do these figures insinuate? For one thing, new types of pollutants are anticipated to arise. Noise pollution may soon become a major problem, particularly with the advent of supersonic commercial transport which is capable of splitting the sound barrier with a boom. Urbanization and high population growth will spawn numerous environmental sanitation problems such as sewage treatment and solid wastes management.

We also anticipate the shift from oil dependency to the tapping of other energy resources such as coal, geothermal, hydroelectric, solar and nuclear power. This may create new pollution problems such as lead and radioactive wastes.

With such a situation, we must have a more responsive pollution control program. We need new technological methods, more technical expertise and enough financial backing in order to cope up with the increasing demands of the time. And truly, there is no time for delay.

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INTEGRATING IMPACT ASSESSMENT PROCEDURE WITHIN THE REGIONAL PLANNING MACHINERY IN MALAYSIA

by

MORSHIDI SIRAT*

INTRODUCTION

Regional planners, especially those in the developing world, are presently looking for additional technique that could be utilized in assessing the massive regional development projects undertaken in these countries. Regional planners are in dire needs of a procedure that could link the study of environmental and social effects of these projects to the appraisal of economic gains and losses. This paper is an attempt to satisfy that need. The main aim is to formulate a procedure that could be 'practically' incorporated within the existing regional planning machinery in Malaysia. The present evaluation technique is too narrow in scope. As a result regional planners and public decision-makers are likely to ignore or (more likely) to overlook key problems and externalities of development projects. Cost Benefit Analysis as an evaluation technique has serious limitations and these limitations are inherent in its fallacious premise that all important human values can be adequately represented by money. Despite its weaknesses, Cost Benefit Analysis (CBA) is well-suited for addressing the strictly economic impacts of development projects. Environmental Impact Assessment (EIA) could be adopted as the technique for evaluating the intangible impacts of the projects. What is most needed in the context of developing world development is a 'total' Impact Assessment of development projects. The term 'total' Impact Assessment refers to the bringing together of the various impacts into an integrated whole so that a decision can be formed on whether the project should or should not be approved.

CONCEPTUAL BASIS OF THE IMPACT ASSESSMENT PROCEDURE

The evaluation of development projects should involve two main phases. First, there should be an analysis stage where the various impacts are categorized under a general classification of impacts such as environmental, social and techno-economic. These impacts are then

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defined and estimated. In so doing an understanding of the many consequences can be achieved. In view of the diverse impacts, there is bound to be problems in achieving coherence. To solve this problem, there is the second stage and this will involve the bringing together of all the evidence in stage one into an integrated whole. In this stage there should be a clear focus on the explicit trade-offs between measurable gains and more intangible environmental and social impacts. This clear focus could be achieved by linking the study of environmental and social effects to the appraisal of economic gains and losses: not by directly assigning monetary values, which cannot be done and is the major cause of the problem but by tying the evaluation to the criteria of cost benefit analysis and prescribing the necessity of a supported judgment.[1]

A major virtue of CBA is that an explicit conclusion is required that costs are outweighed by expected gains. In CBA, impacts are measured in non-technical terms and estimated principally by scientific methods. But CBA provides concepts and procedures for converting only some impacts of land development projects into their direct monetary equivalent. Hard economic impacts of these projects such a settlers incomes, revenues from the sale of oilpalm and rubber (two main crops planted in regional land development schemes in Malaysia), employment and economic opportunities, the costs for infrastructure, administrative and management, agricultural development and housing provision are amenable to quantification. These impacts could easily be assessed by means of CBA. But some environmental and social impacts such as landscape aesthetics, loss of wildlife, destruction of flora and fauna, community cohesion and personal development should not be described in monetary terms but left in their fundamental terms and should be considered not under economic assessment (that is CBA) but under EIA. There is a growing recognition that monetary measures of social impacts do not reflect equity and other human values that must be taken into consideration in decision-making.

A favorable recommendation for proceeding with land development projects implies that any negative environmental and social impacts outweigh any negative effects on economic welfare. Consequently, the rules of land development project formulation and justification could easily be made to require that recommendations for decision to proceed with a project include a declaration in the justification statements that the net economic benefits of the proposed projects outweigh any negative environmental and social impacts, or that the negative economic benefits are outweighed by anticipated environmental and social benefits (KNETSCH and FREEMAN, 1978, p. 243). The central point of this procedure is a comparison of values. A land development project might be shown

[1] This evaluation strategy was first suggested by KNETSCH and FREEMAN (1978, p. 244), but their framework was limited to the evaluation of environmental and economic impacts only. In land development projects the social consequences are numerous and it is vital to include these impacts in the evaluation process.

to provide a huge net gain over its life (assessed by means of CBA), but to incur (after an EIA exercise) such non-measured costs as destroying a valuable wildlife sanctuary, reducing the amenity of an agreeable landscape, proliferation of disease vector and community disruption. This procedure requires planners and analysts to assemble information and to make clear and explicit judgment about the values represented. Having to make a judgment that the environmental and social impacts are worth less or more than some amount is easier than having to put a specific value on them. Assessors' declaration should be supported by detail of evidence and assumptions and this should be arranged in such a way as to bear most directly upon a comparison of the net economic gain with any negative social and environmental effects. The key to comparison is the articulation of values and the assumptions concerning the time paths of expected benefits of preserving resources and alternative development proposal (KNETSCH and FREEMAN, 1978, p. 243). An indication of values associated with environmentally important resources and desirable social condition and the changes to them may be gained from various standards that may be adopted. But in Malaysia, there will be a problem because of a tendency to lay down standards which incorporate middle class values and beliefs. Assessing working class viewpoints on environmental quality may be difficult due to the low level of literacy.

THE REGIONAL PLANNING MACHINERY IN MALAYSIA

Land development, policy formulation, planning and evaluation occur at four levels (SOENARNO and OWEN, 1981, p. 54). These levels are (a) Parliament/Cabinet of Ministers/National Action Council level where 'politico-administrative policy' is formulated. The National Action Council (NAC) is more an evaluating and coordinating body than a policy formulation unit, (b) the Treasury, Public Service Department (PSD), The Economic Planning Unit (EPU), Implementation and Coordination Unit (ICU), Socio-Economic Research Unit (SERU) and other Inter-Agency Planning Group created by the EPU which is responsible for evaluating and appraising various programmes as already vetted by the EPU, (c) Ministry of Land and Regional Development and semi-government agencies level. This is where 'programmatic policies' or strategies are formulated, (d) Local or state level where 'implementation policies' are formulated.

Such is the institutional set-up for land development in Peninsular Malaysia. There is a plethora of agencies, ministries and departments involved in the planning and evaluation of land development policy and projects.

Regional planning studies in Malaysia usually involve four main stages. These stages are as shown in Table 1. It is the first stage which is relevant to the procedure conceptualized. It is the EPU especially the Regional Planning Section which mainly coordinates this regional plan-

ning exercises. Preliminary investigation has to be undertaken first before Terms of Reference is drawn up. This would involve the gathering and analysis of geographical, socio-economic and other relevant information. In most cases, the Terms of Reference consists of three parts (OMAR, 1977, p. 65). The first part gives the general outline of the purpose of the study, the study requirements and the nature of the proposals expected. The second part provides all the factual background information known to date on the region. The last part consists of the detailed Terms of Reference or Scope of Work which outlines the required tasks to be carried out by the consultants during the course of the study. The following section will explore a possible integration of the Impact Assessment procedure as conceptualized in the earlier part of this paper with the regional planning machinery discussed above.

INTEGRATING IMPACT ASSESSMENT WITHIN THE REGIONAL PLANNING MACHINERY IN MALAYSIA

Before the Impact Assessment procedure could be slotted in the regional planning process with ease, the latter has to be strengthened and improved first. A step towards this direction has been taken since the Third Malaysia Plan, 1976-80. Efforts have been made to develop new regional planning process at the regional and state levels with a view to enabling the states to plan their requirements more effectively.

On the national scale the Policy Formulation Committee (PFC) was established recently and it subsumed most of the activities formerly undertaken by the National Land Development Coordinating Committee (NLDCC) and the Committees on State and National Boundaries. The PFC serves as a planning/evaluative/regulative committee and is concerned with the determination of the national impacts of a particular policy proposal (SOENARNO and OWEN, 1978 p. 58). As such the PFC will undertake an evaluation of the national impacts of the various land development projects and regional development programmes to ensure the achievement of national goals. Impact Assessment procedure could easily be incorporated at the PFC level, that is, the Federal level. PFC should be concerned with the assessment of the impacts of the national land development policy rather on the impacts of specific projects. Regional authorities and the EPU should be left to determine the impacts of land development projects at the regional/state levels.

Such an Impact Assessment appears to offer a number of potential advantages over a system which is restricted to individual projects at the local level. If actions at the highest level, that is, at the Parliament and Ministerial level, are not subjected to such an assessment, lower levels of actions may not be specified. Impact Assessment confined to the lowest (project) level is inevitably inhibited in its examination of alternatives (LEE and WOOD, 1978 p. 103).

TABLE 1: VARIOUS STAGES IN A REGIONAL PLANNING STUDY

STAGES	MAIN TASKS INVOLVED	TIME TAKEN
(1) Drawing up Terms of Reference	— Gathering of information on region — Consultation with Federal and State Governments — Drawing up Terms of Reference — Invitation to consultants	Between 6 to 12 months
(2) Selection of consultants	— Evaluation of consultants' proposals — Negotiations with consultants	Between 3 to 6 months
(3) Monitoring progress of study	— Monitoring progress of study: Steering Committee — Dealing with policy issues: Steering Committee — Maintenance of close rapport with consultants — Liaison Officers, Coordinators and Counterpart Officers	Between 12 to 24 months
(4) Analysis of Draft Report	— Analysis of Draft Report — Provision of guidance to consultants — Maintenance of close rapport until completion of the study	(Usually about three-quarter stage of the study)
Completion of Study	Total	Between 21 to 40 months

Source: Adapted from OMAR (1977) *The need for an Integrated Approach to Regional Development Planning in West Malaysia*, Government Printer, Kuala Lumpur, p. 64.

Earlier, the importance of the first stage of the regional planning process was stressed. Preliminary investigations are usually undertaken at this stage. This would normally involve the gathering and general analysis of the available information in the region. This could be seen as synonymous to Initial Screening in the Impact Assessment procedure. At this stage, well before the regional planning studies are initiated, it is possible to determine whether a project should undergo a Preliminary Assessment. The nature of the project and its general location (as illustrated by the Preliminary Investigation exercise) are the only information required to make that decision. The Preliminary Investigation could be seen as an input to Impact Assessment. A link should be recognized between the Preliminary Investigation of the regional planning process and the Initial Screening and the subsequent Preliminary Assessment procedure. Preliminary Assessment is not intended to be time consuming procedure. But it should however be spread over the duration of the prefeasibility period of the regional planning study so that as the

land development project concept develops into an outline/draft plan, the environmental as well as the economic/technical and the social assessment of the project can be reviewed. The regional planner could be seen as playing a useful role at this stage by being responsible for coordinating this Preliminary Assessment — a study which is inevitably multidisciplinary in nature.

The process of data collection should not become a major preoccupation. More efforts should be directed towards the comparisons and accomodation of social, economic and environmental impacts. The collection of miscellaneous facts could become the dominant activity in Impact Assessment. While scientifically easy and a convenient means of showing concern such random fact gathering is subject to rapidly diminishing returns and is seldom useful to the purpose at hand, which has more to do with the comparison of values with or without the particular project (KNETSCH and FREEMAN, 1979 p. 242).

Before arriving at the final plan of land development, the regional planning study should first produce draft plans of land development programmes in the region. Preliminary Assessment should be directed towards these plans. The aims are (1) to examine and select from the options available, (2) to identify and incorporate into the plan appropriate abatement and mitigating measures (especially with respect to environmental impacts) and (3) to identify the significant residual impacts. The final plan of land development programmes should be subjected to a Detailed Assessment. The aims are (1) to describe the significant residual impacts (especially the environmental ones) predicted from the final land development project plan, (2) to specify mitigating and abatement measures in the final land development project plan and (3) to identify the costs and benefits of the project to the community. Detailed Assessment should continue over the duration of the project feasibility study. The evaluation of the economic/technical, social and environmental benefits and costs arising from the land development projects should be presented to the decision-maker in a coherent and integrated manner.

CONCLUSION

The main focus of regional development in Malaysia is through land development. The Government is determined to expand its development programmes for it believes that the significant 'achievements' in land development in the past for employment creation and income improvement provide a sound base for the expansion of the programmes. Major land development programmes involving a large and contiguous area have had and continue to have serious implications for the environmental systems and natural resources that the activity depends or impinge upon. That land development may adversely affect the natural and social environment and conversely, that the natural and social environment may pose

problems for development should no longer be in question. Attention should now be devoted on designing methods for mitigating the impacts and the conflicts. The use of Impact Assessment to detect existing and potential problems is a valuable step in this process. There cannot be a direct transplantation of western model of Impact Assessment without the essential conditions of available financial, technical and institutional resources. So, developing countries like Malaysia need to improvise and innovate assessment techniques.

Impact Assessment advocated in this paper provides a clearer focus on the explicit trade-offs being made between measurable economic gains and more intangible environmental and social impacts. It provides a procedure which could link the study of environmental and social effects to the appraisal of economic gains and losses. This procedure brings social and environmental aspects of land development on the same footing as economic aspect in the evaluation process.

It has been shown that the Impact Assessment procedure could easily be integrated within the regional planning machinery in Malaysia. An effective institutional structure already exists. What is needed is the Government's initiatives and commitments to implement such an assessment procedure. The value of the procedure depends on how they are conducted and how serious they are considered when completed. To be effective, Impact Assessment procedure must be built into the planning efforts as an ongoing process and not as a one time endeavor. In the TMP, the Government's policy was to ensure that, in the process of development, undesirable environmental (and social) consequences are minimized and early remedial action is taken to avoid prohibitive curative costs. The assessment procedure advocated in this paper may help the Government realized this aim.

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CHANGING PATTERN OF URBAN RANK-SIZE RELATIONSHIP IN A DEVELOPING ECONOMY: A CASE STUDY OF GUJARAT — INDIA

by

DR. U. P. SHAHI*

Geographers have turned to the concept of systems in their efforts to analyze the relationships in which they are interested. Despite controvercies in regard to its applicability, the notion of systems is attractive one in geography. The system is essentially a 'gestalt' concept in which the relationship between the elements make greater in sum than the mere addition of the constituents of which it is comprised.(1) One of the frequently cited justifications for treating sets of urban centers as systems has been the appearance of regularity in the distribution of the population sizes of the component urban units.(2) This aggregate approach concentrating on the characteristics of the whole set of places and the nature of the over-all growth process tending towards 'equifinality(3) may be seen as symptoms of the interrelatedness of individual units in an urban system. The distribution of urban centers of varying sizes at different distances in a region is said to have certain relationships which are supposed to be constant under ideal theoretical conditions. Very often a region or a large area contains many small towns, a lesser number of medium size towns and only a few large cities.(4)

The pattern of variation according to the size of urban centers in a region, described in terms of the 'rank-size rule' owes to Zipf's National Unity and Disunity.(5) It is a theoretical model to express the relationship of the empirical regularity in the size of the urban centers. According to Zipf, if urban centers of a country or region are arrayed in order of size and if Pr is the population of the rth ranked city and P_1 that of the largest (primate) city, their sizes can be described by the simple expression, i.e.

$$Pr = P_1 \cdot r^{-1},$$

In other words, the second largest will have about half the population of the largest city, the third city about a third of the population of the largest city and the nth ranked city will be one nth the size of the largest city. The rule is referred to as the 'rank-size rule' since rank

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multiplied by size will be a constant value equal to the size of the largest urban center. If the population of the largest city is known, the population of all other cities can be derived from the rank of their sizes. The rank-size rule is not a law of necessary behavior but a statistical regularity which appears where large number of urban centers are considered.(6)

THE OBJECTIVE

The main objective of the present paper is to examine the validity of the rank-size rule in respect of the urban centers of the study area on the one hand and to look into the changing pattern of urban rank-size relationship during the eight decades of the present century on the other. In order to make the study more analytical and explicit, an attempt has been made to answer the following questions:

i) how far does the size distribution of the urban centers of Gujarat follows the rank-size rule?

ii) how much does the size distribution of urban centers deviate from the theoretical norm?

iii) what is the position of each urban place in the theoretical curve?

iv) has the rank-size relationship been stable during the last 80 years (1901-1981) or has undergone significant changes?

v) if it has undergone significant changes, what has been the nature of change?

vi) how much is the primacy of the primate city?

THE STUDY AREA

Gujarat is one of the smaller States of India with an area of 195,984 Km^2 and a population of 33,960,905 persons in 1981. Lying on the Arabian Sea coast, it shares both the land and sea frontiers of the country. Though the State of Gujarat was formed on May 1, 1960 as a result of the bifurcation of the bilingual State of Bombay, nevertheless, it existed as a distinct cultural region even earlier and came to be formally known as Gujarat in the 10th century A.D.(7) and was a separate province during the late medieval period. Since it formed the southern most extention of the Indus Valley Empire, it can claim the double distinction of having witnessed one of the earliest urban developments and having experienced an uninterrupted longest history of urban growth since the Aryan colonization during the ancient period when the seeds of existing urban system germinated first in the form of capitals of Janapadas (the Hindu Republics) and religious centers. A number of clan strongholds of the early medieval period developed into towns.

Later on several inland fort-towns and sea ports were developed by the Hindu Rajas (kings) and other local chieftains. The area was finally annexed to Mughal Empire in 1572 A.D. as Subah (province) containing 10 Sarkars (districts), most of them under the suzerainty of various Rajput clans. The British could establish their complete control over Gujarat in 1818 and as a part of the Bombay Presidency, it consisted of 4 districts, 59 native states and about 303 estates. This highly disaggregated political structure proved quite favorable for the development of towns.(8) After Independence (1947) the princely states merged with the Indian Union and at present Gujarat consists of 19 districts divided into 185 talukas.(9)

The urban population of the study area has increased by more than five times during the eight decades of the present century. It is the third most urbanized State of the country with 31.08 per cent of population living in 220 urban centers (Fig. 1). It ranks only next to Maharashtra (35.03%) and Tamil Nadu (32.98%) in the level of urbanization. It is important to note that the level of urbanization in the study area during the present century has always been higher than the country as a whole.(10) The number of towns has increased from 163 in 1901 to 220 in 1981.

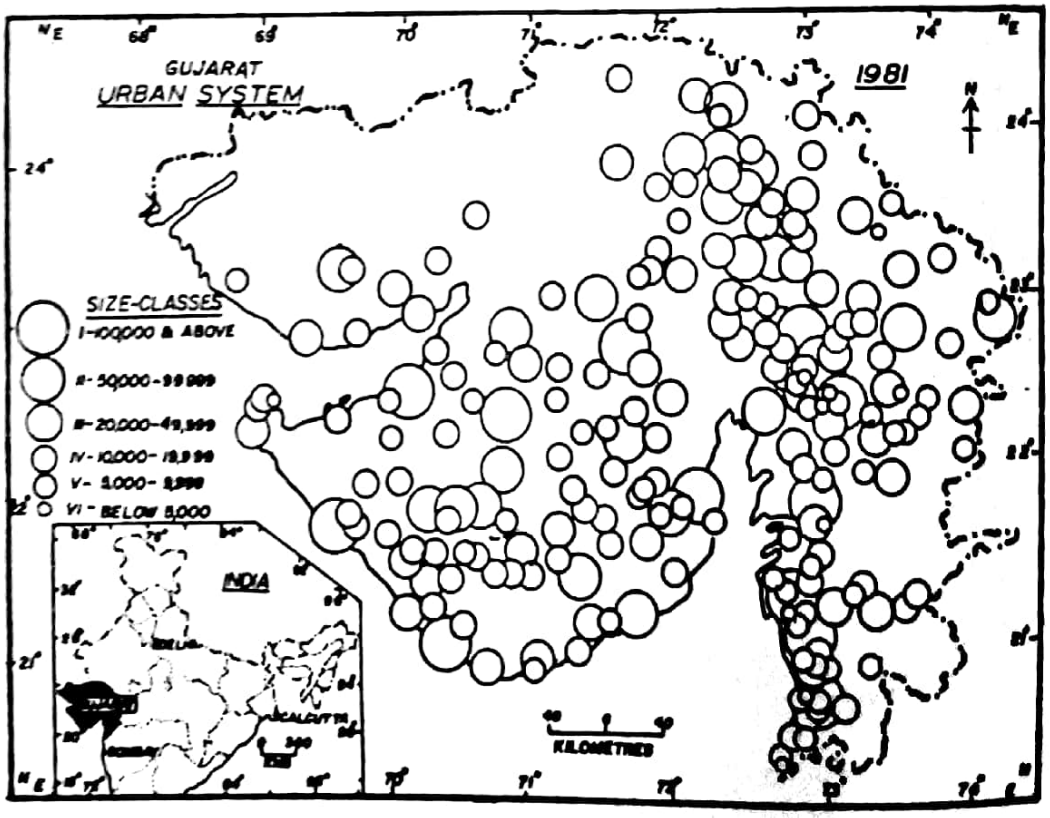

FIGURE 1

URBAN RANK-SIZE RELATIONSHIP IN GUJARAT

In order to examine the rank-size distribution of urban centers of the study area, 9 double logarithmic graphs, showing population size on the ordinate and rank on the abscissa, have been drawn for all the centers defined as urban at each census from 1901 to 1981 (Fig. 2). The graphs clearly indicate that the size distribution of urban centers does not conform to the rank-size rule. An analysis of the deviations from the theoretical rank-size relationship can be made with reference to the exponential lines — E-1 and E-2 — which represent the theoretical size distribution of urban centers calculated on the basis of observed and expected population size of the primate city respectively. The expected population of the primate city has been derived by dividing the total population of all the urban centers with the sum of the reciprocals of their ranks.

The deviations of the observed rank-size distributions from the exponential lines are significant in many ways:

(i) the pattern of rank-size relationship remains more or less similar from 1901 to 1931. The curves do not suggest any conformity with the rank-size rule. About 13 largest urban centers of the study area, including the primate city of Ahmadabad, are smaller than their expected size. Small urban centers are larger than their expected size but those having less than 3,000 population are smaller. Exponential lines E-1 and E-2 are gradually coming closer indicating thereby that the primate city is moving towards its expected population size. Rank-size distributions show irregular slopes in the graphs from 1901 to 1931 (Fig. 2).

(ii) The rank-size distribution in 1941, transitional in character, is significant on more than one count. The exponential line E-2, hitherto located to the right of line E-1, has not only come to the closest to it but has rather moved to the left of it. It shows that the primate city is now larger than its expected population size and the difference between its observed and expected population is the minimum. Towns above 40,000 and below 5,000 population are smaller than their expected size. Towns having a population between 20,000 and 40,000 tend to corroborate with the rank-size rule.

(iii) The graphs showing the rank-size distribution for 1951 and 1961 clearly indicate that the curve is gradually shifting from the right to the left of line E-1. Urban centers of above 30,000 and below 5,000 population are much smaller than their expected size. The primate city is becoming disproportion-

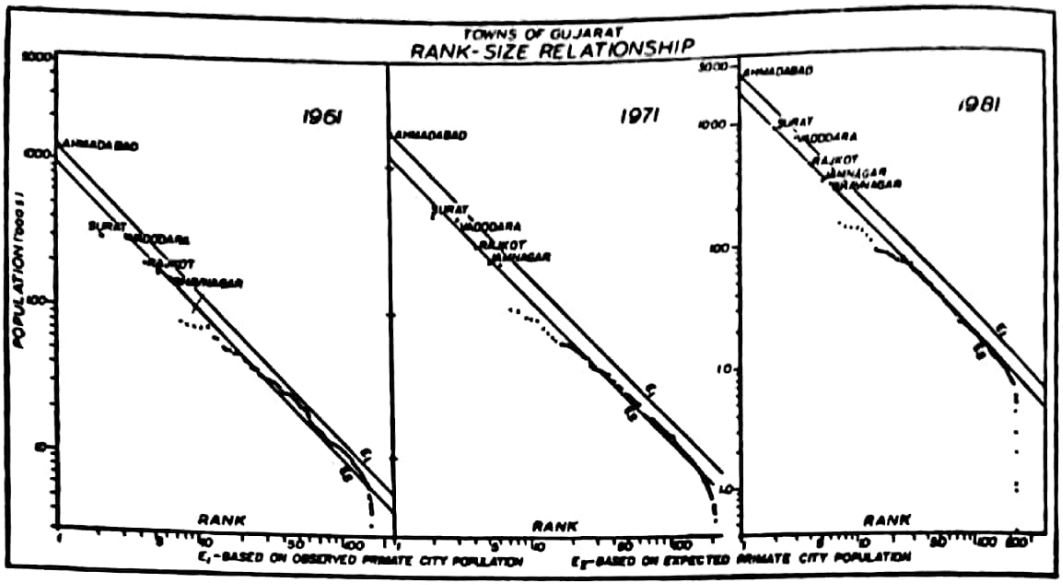

FIGURE 2C

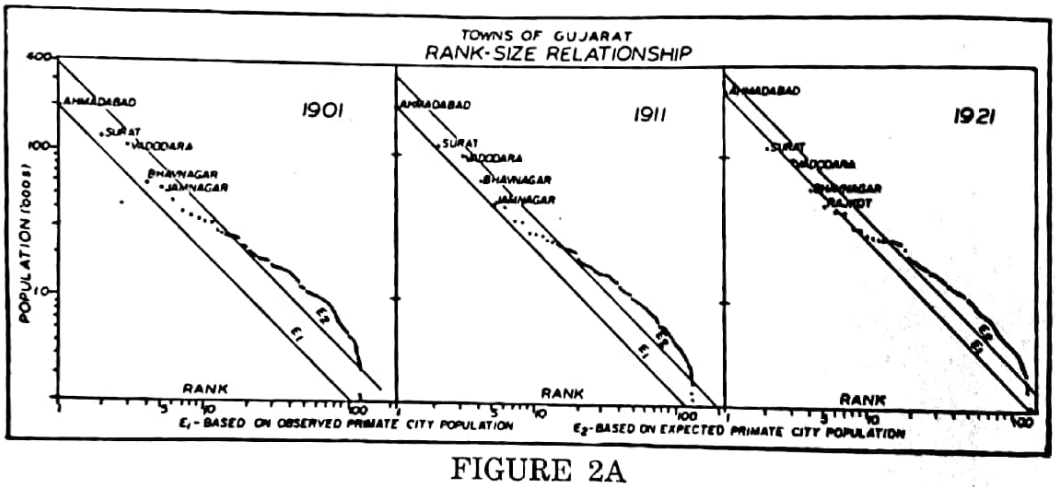

FIGURE 2A

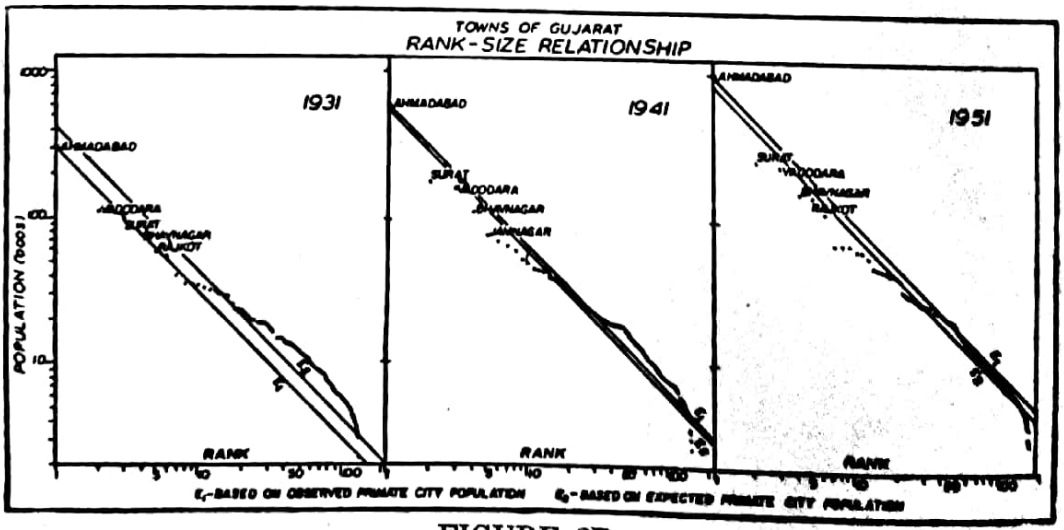

FIGURE 2B

ately large and the rank-size distribution does not correspond at all to the line E-1 based on its actual population. The observed population was 24.61 and 30.57 per cent larger than its expected population in 1951 and 1961, respectively (Table 2). It speaks of a very rapid growth of Ahmadabad, the primate city.

(iv) The pattern of rank-size relationship is more or less the same in 1971 and 1981. Again, the primate city is too big to conform to the rank-size rule. However, the middle portion of the curve shows a trend corroborating with the rank-size rule.

A COMPARATIVE ANALYSIS

A comparative analysis of all the graphs reveals the following facts:

(i) In 1901, the primate city was much smaller than its expected size and all other towns were bigger than their theoretical populations. Hence, the rank-size distribution curve lies above the line E-1. On the contrary, in 1981 as a result of a gradual change, the position is just the reverse. Now the primate city is much bigger than its expected size and all other urban centers are smaller than their theoretical population, hence, the curve lies below the line E-1, a quite significant change in eighty years of the present century.

(ii) The high primacy of Ahmadabad began to prevail over the region in 1931 when its population was about three times that of the second largest city (Vadodara) and it is prevailing since then.

(iii) The exponential line E-2 which was far above E-1 in 1901 has gradually shifted to a position far below it in 1981.

(iv) The shape of the rank-size distribution curve which was convex in its lower-half in 1901 is gradually tending to a strait line. It shows a tendency to move closer to the theoretical rank-size distribution, more so at the lower levels.

(v) The rank-size curves in all the graphs do not exhibit a definite pattern in their upper part and the right tails of the distributions gradually steepen.

Thus the rank-size distributions of the urban system from 1901 to 1981, with a flat top and several steps down the line, suggest that the study area has not been fully integrated into a functionally coordinated and interacting urban system, rather it represents a few urban subsystems each having, more or less, its own rank-size distribution.(11) An explanation of this phenomenon may involve consideration of the historical evolution of the urban centers of the study area; the geographical structure of settlements; development of transportation facilities; political

and administrative factors; the process of industrialization and the level of urban-industrial development.(12)

Gujarat has witnessed several politico-cultural successions each contributing in its own way to the development of the present urban system. Capitals of the Janapadas (the Hindu Republics) and religious centers of the ancient period, clan strongholds of the early medieval period, sea ports, inland forts, clan centers and other territorial headquarters of the late medieval period have influenced differently the origin and growth of urban centers in the study area.(13) An analysis of the spatial patterns of urban growth during the present century reveals that the high growth rate of towns of Gujarat before 1921 may be attributed to activities related to administration and navigation. During the period 1921-51, high growth was registered in urban centers which were all connected by railroad transport and had also developed small-scale and traditional industrial enterprises. Since 1951, high growth has occurred in towns located in industrial areas specially near the Ahmadabad-Vadodara industrial dynapolis.(14)

The study area has experienced a rapid growth of industrialization during the post-independence period. It is the third most industrialized State after West Bengal and Maharashtra. Industrial development of textiles, general and electrical engineering, vegetable oil, heavy chemicals, pharmaceuticals, cement, ceramics, fertilizers and petro-chemicals; establishment of hydro and thermal power projects; development of sea ports; a conscious policy of industrial dispersal have all influence differently the development of urban centers. Thus periodic changes in determinants of urban growth have caused the development of a sub-regional pattern of urban system in which distinct regions exhibit marked differentials in and diffused pattern of origin and growth of urban centers resulting in the present pattern of rank-size relationship.

PRIMACY OF AHMADABAD AND THE RANK-SIZE RULE

The deviations from the rank-size rule can be explained by various factors including the amount of foreign trade(15) and differential economic opportunities(16) which are responsible for the differential growth of urban centers. Consequently, some urban centers become disproportionately large while others become too small and the rank-size rule is thus invalidated. The same is true in case of Ahmadabad, the primate city of the study area, which is too large to conform with the rank-size rule.

The degree of primacy of the largest city can be measured by the ratio of its population to that of the second largest city or to those of some other ranks of cities combined together. A two-city index of primacy has been calculated with the help of the following formula:(17)

$$PI = \frac{P_1}{P_2}$$

Where, PI = index of primacy,
P_1 = population of the first city, and
P_2 = population of the second city.

Along with the primacy of the first city, the relative sizes of the smaller cities up to 4th rank have also been measure (Table 1).

TABLE 1. GUJARAT: PRIMACY OF THE LARGEST CITY AND SIZES OF THE FIRST FOUR CITIES AS FRACTION OF THE LARGEST (1901-1981).

Year	Primate city	Primacy index	Size of first 4 towns, if the largest is 1 (one)			
			1st	2nd	3rd	4th
1901	Ahmadabad	1.55	1	0.6418	0.5583	0.3036
1911	"	1.89	1	0.5299	0.4583	0.2800
1921	"	2.33	1	0.4286	0.3457	0.2168
1931	"	2.78	1	0.3597	0.3153	0.2409
1941	"	3.47	1	0.2880	0.2576	0.1728
1951	"	3.93	1	0.2544	0.2410	0.1572
1961	"	4.03	1	0.2479	0.2474	0.1610
1971	"	3.53	1	0.2831	0.2684	0.1726
1981	"	2.76	1	0.3628	0.2958	0.1766

Ahmadabad has been the primate city of Gujarat since the very beginning of the present century. Its primacy was the lowest in 1901 and the highest in 1961. A continuous increase in the index of primacy from 1901 to 1961 can be easily marked. However, the degree of primacy declines after 1961 and comes down to 2.76 in 1981 (Table 1). The reciprocality is the nearest to the rule in 1911.

Ahmadabad, located on both the sides of river Sabarmati, has been a seat of administration since its very inception in 1411 A.D, and has experienced many vicissitudes of urban growth. In addition to administration, trade and commerce, the city has also a very long industrial tradition. It is the 6th largest metropolitan center of the country. Though Gandhinagar is now the administrative capital of the State, Ahmadabad continues to function as the commercial and industrial capital of the State for all practical purposes. It is the largest inland factory city of India and has assumed the mantle of a leading city and expanding metropolis.

TABLE 2. GUJARAT: STOCHASTIC MODEL OF THE POPULATION OF PRIMATE CITY (1901-81).

Census Year	No. of towns	Sum of reciprocals of ranks	Sum of urban population	Actual population of primate city	Expected population of primate city	Difference between actual & expected population	Difference as % of expected population
1901	131	5.4562	1,880,655	185,889	344,684	— 158,795	— 46.06
1911	128	5.4331	1,788,612	216,777	329,207	— 112,430	— 34.15
1921	130	5.4485	1,925,670	274,007	353,429	— 79,422	— 22.47
1931	132	5.4637	2,199,670	313,789	402,033	— 88,244	— 21.94
1941	141	5.5294	3,136,760	595,210	566,505	28,705	5.06
1951	162	5.6673	3,999,996	877,329	704,055	173,274	24.61
1961	156	5.6297	5,206,730	1,206,001	923,610	282,391	30.57
1971	200	5.8772	7,496,500	1,741,522	1,272,478	469,044	36.86
1981	220	5.9724	10,556,431	2,515,195	1,767,536	747,659	42.30

A stochastic model of the actual and expected population of the primate city and its variation from the expected one provides interesting results (Table 2). The observed populations were 36.86 and 42.30 per cents larger than the expected populations of the primate city in 1971 and 1981, respectively, which indicates its accelerated growth. A continuous increase in this proportion since 1941 can be easily marked (Table 2). A net increase of 773,673 persons in the population of Ahmadabad, the primate city, during the decade 1971-81 only, is really alarming.

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GEOGRAPHY OF THE ZAMBIAN SETTLEMENTS

by

DR. PRITHVISH NAG*

Zambia, a land-locked country in south-central Africa, supports a population of 5,679,808 (1980) within an area of 753,000 Km^2 (i.e., 7.54 persons to the Km^2). This country came at the end of the 19th century under the European colonization and the so-called modernization under the connotation of the imperial powers was experienced late in this part of central Africa, which achieved independence in 1964. The line-of-rail with Copperbelt makes a unique feature of corridor development as north south axis in the middle of the country (see Figure 1). The present administration of 'One Party Participatory Democracy' has 9 provinces, 53 districts, 273 chiefs' territories and 32,472 villages. Only 22.4 per cent of the land is under permanent settlement while 40 per cent comes under the control of planning and extension services. Large areas are covered by water bodies, game parks and forest reserves while low-lying areas are infested by tsetse flies which discourage human settlements. Further, the distribution of human settlement is also effected by the different tribal and colonial settling processes, which have played an important role. In the following text, an effort has been made to assess the growth of Zambian settlements, their existing conditions and the processes of transformation and planning in order to (a) develop continuum of settlements; (b) check rural-urban migration, (c) discourage squatter settlements; (d) organize the country through settlements; and (e) highlight the possible trend for future settlements.

EVOLUTION OF ZAMBIAN SETTLEMENTS

The peopling and settling processes in this part of Africa is the outcome of the tribal and colonial organization during the different historical phases: The colonization processes can be traced in three phases which have fabricated the present settlement pattern. First phase (before 1850 A.D.) is dominated by the migration from the north (Zaire). During the second phase (1850-1900 A.D.) external threats by the Portuguese, Swahilis and slave-traders affected the Zambian settlements. In the last phase (after 1900 A.D.), the colonial settlement pattern emerged on the tribal space. The Europeans divided this territory into three types of

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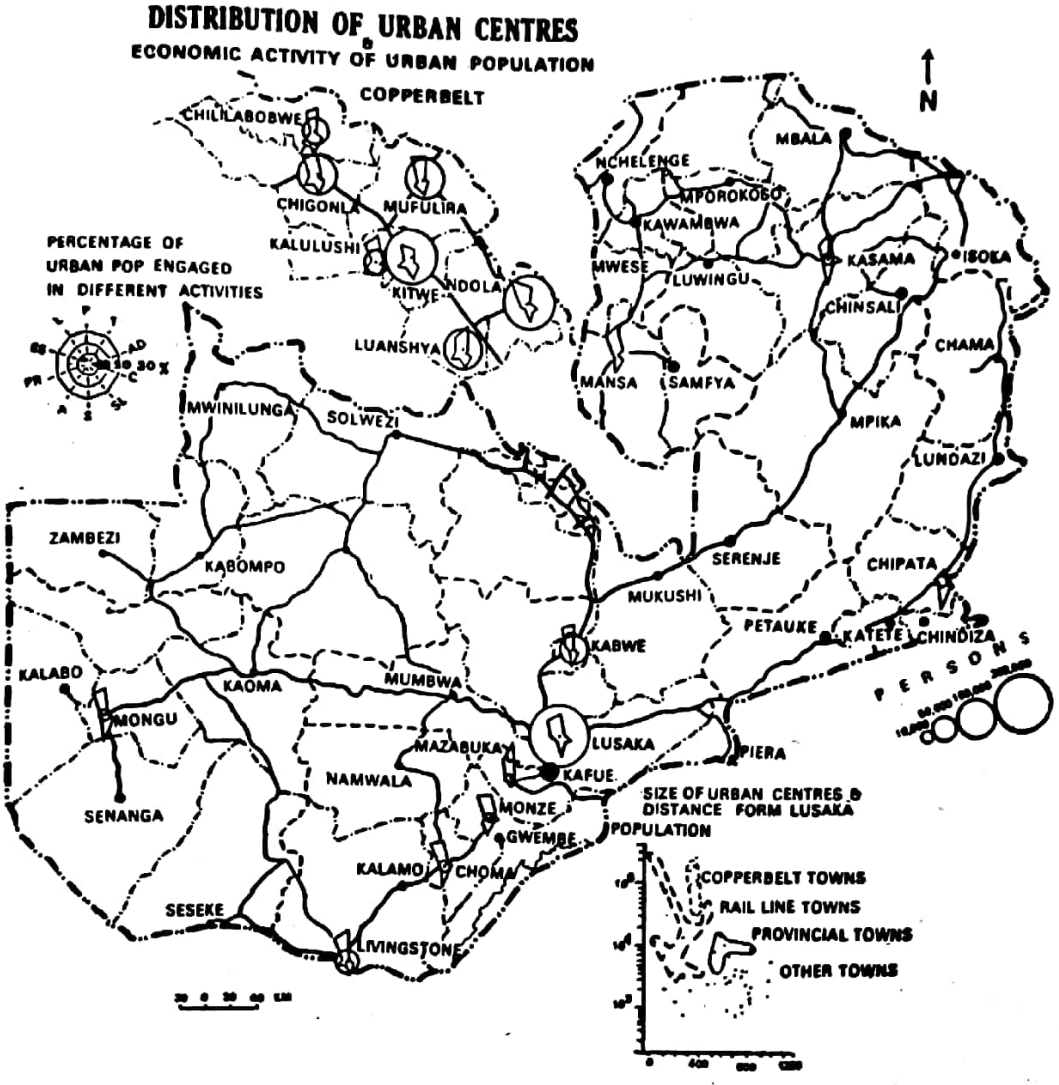

FIGURE 1

lands, viz. (a) Native Reserves; (b) Native Trust Land; and (c) Crown Land. These three types of land evolved different patterns of settlements which were divorced from each other. However, the tribal and colonial settlement organizations have some degree of synthesis through missions, administrative headquarters and transport points.(1)

To evaluate the role of the Indians, their settlement process should be studied in the light of the overall settlement process in the concerned area. There are evidences indicating the presence of Indians during the pre-colonial period. It was probably such evidences as the architecture of the ruins, names of territories such as **Mashonaland** (likely to have been derived from Shona, meaning gold in India), **Monikaland** (derived from **Monika,** meaning precious stone) and Sheba (misnomer of **Shiva**) whose **linga** is believed to be an important feature in the **Zimbabwe Ruins**

the presence and domination of the caste system instead of tribes and similar links, which raise possibilities of links of the areas lying on both sides of the **River Zambezi** with India.(2) However, the presence of Indian population during the Colonial period is owing to the historical accident of a common colonial era. The inter-continental Crown administration sought solutions for inter-related problems involving the land and peoples of Asia and Africa. In the case of relatively populous Asia, it was their people who were made to migrate and settle on lands in different parts of the colonial world, including Africa and particularly in Zambia. The role of Indians has changed after independence, when there was acute shortage of trained personnel for overall social and economic development of the country.(3)

RURAL SETTLEMENTS

The nature of chiefs' headquarters, neighborhood centers, villages, hamlets and homesteads were to be studied in relation to the organization of rural settlements.(4) Such organizations have close relationships with the economy, environmental resources and the heritage of land. On this framework developmental infrastructure is through agricultural camps, which is a non-social institution for the organization of rural settlements. But this infrastructure encouraged the growth of settlements along the line-of-rail, while the settlements away from it continued to decay up to five per cent a year. To study the distribution of the rural settlements, R_X-value was coined instead of R_N-value. It was found that the 'expected inter-settlement distance' — r_E is a factor of 'hypothetical spacing' — D ($r_E = 0.4653028$ D). Replacing r_E by D we get an alternative approach for the identification of randomness. R_X-value, as an index of the alternative approach, varies from 0 for clustered distribution to 1 for uniform distribution.(5) The other distributional indicies, viz. (a) observed inter-settlement distance, (b) density of settlements, and (c) spacing in agricultural area can be studied in relation to five ranges of R_X-values, varying from highly clustered to highly regular.

PLANNED RURAL SETTLEMENTS

The aim of the planned settlements in rural areas is to concentrate funds and energies of limited staff in specific model development schemes for which sites are chosen in relation to the broad national objectives. These schemes are located in the agricultural potential areas of Zambia, particularly in Central and Eastern Provinces. Since co-operatives support the government development policies, they are integrated with such planned development as well. During the colonial period, the main pre-occupation affecting rural development were administrative expediency and religious conversion, and most of the centers which developed are a direct product of these circumstances.(6) **Mungwi Settlement scheme**

proved to be a failure. During the post-independence period, the National Development Plans were oriented for planned rural change and development. **Miengewe Village Re-grouping Scheme** and **Kafubu Block** have some degree of success. In the Second National Development Plan (1972-1976), Intensive Development Zones (IDZ) were created and other planned rural settlements, such as **Chifwile** were moulded into IDZ concepts. **Kalichero** is a pattern of rural settlement planned on the same concept. The focus of this type of planning is oriented more towards the creation of Agricultural Growth Poles rather than the existing urban centers.(7)

URBAN SETTLEMENTS

The Urban Settlements in Zambia refers to the towns and cities which evolved with the advent of the colonial powers (Figure 1). These settlements have a long history of debacle and rejuvenation. **Chipata,** an early colonial town, has provision for the Indian population, while **Mongu** developed as a seat of indirect administration in **Barotseland Protectorate.** The urban planning during the pre-independence period was influenced by cost, density and racial pattern of houses and shopping centers. The study of **Kasama Town** (Figure 2) indicates about taking advantage of an escarpment in planning such a pattern. Urban planning during the post-independence period is effected by the housing problem, which has forced urban population to find out an alternative solution to this problem.

The urban settlements can be classified into four groups. **Mwinilunga,** a representative of **Boma Towns** (District Headquarters towns), indicates the slow growth in vast rural districts. **Mansa,** an example of provincial headquarters towns, reflects the fast peri-urban growth. **Livingstone,** a town on the line-of-rail, has suffered impulses of growth and decay. **Ndola City** in **Copperbelt** is the distributive and commercial center of Zambia and is a fast growing urban settlement. However, **Lusaka,** the capital city is a unique example of its kind. The unplanned development is at a faster rate than the planned growth. It is the most intricate exercise of urban planning in Zambia.(8)

SQUATTER SETTLEMENTS

The Squatter Settlements in Zambia refers to the densely mushroomed hutment settlements within the council boundaries where the houses are below the minimum recognized standards and without legal land rights. These settlements are associated with the urban centers in Zambia.(9) Their distribution is similar to the pattern of urban settlements. One of the most important factors for the growth of these settlements is owing to the colonial housing policies. After independence, the urban planning was motivated for up-grading these settlements, which as evinced from the case study of **Ndola City,** were developing

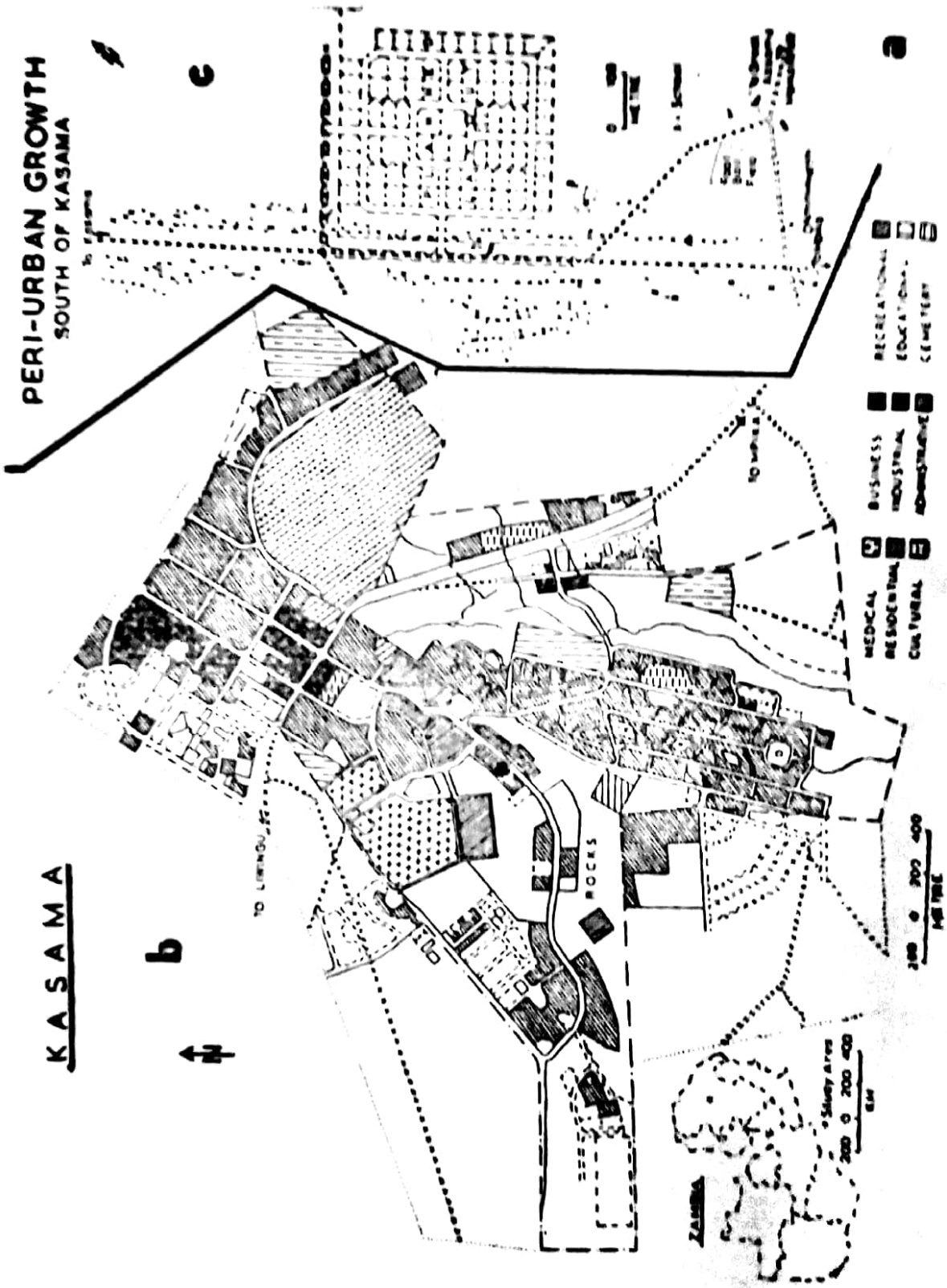
PERI-URBAN GROWTH
SOUTH OF KASAMA
KASAMA
a
b
c
ROCKS
BUSINESS
INDUSTRIAL
MEDICAL
RESIDENTIAL
CULTURAL
ZAMBIA

FIGURE 2 (a), (b), (c)

at a faster rate than the low cost housing areas. The physical structure shows the dominancy of in filling and out growing processes in cyclic fashion.(10) The average density is about 30 huts per hectare. In older settlements, the sex ratio and number of children are balanced owing to the migration from rural areas away from the line-of-rail. The residents are more engaged in blue collar jobs, however, there are some self-employed persons. These settlements are temporary and loosely organized and more linked with the city/town center. Squatter settlements, such as **Garneton** in the north and **Malota** in the south of the line-of-rail can be taken as sample studies. **Garneton** which was functionally linked with the nearby small holdings, became associated with the **Kitwe** city center with the passage of time. . .**Malota**, an old squatter settlement, has complications in the possession of plots which were once laid on grid-pattern.

PLANNING OF EXISTING SETTLEMENTS

The planning frame-work in Zambia has been highlighted in the Second National Development Plan. The Development Planning Division is the sole authority for Zambian planning which controls the Regional Planning Units, Provincial Planning Units and the Department of Town and Country Planning. However, a modified way for the organizing of Zambian settlements through Growth Poles can be suggested here. For such transformation it is imparative to study the environmental frame-work, administrative set up, population, circulatory behavior and nature of establishments. Though water-basins play a vital role, planning through them is only partially applicable in Zambia. The roads, railway and settlement have developed on the watersheds and high topography. The ill-drained and low-lying areas below 1,524 meters are infested by **tsetse flies** and human settlements are not found in such areas.(11)

It was realized that the Ward and Village Productivity Committee based planning will divert the rural settlements towards centers. To make this systems as an effective tool for planning it needs more spatial rigidity and more fixed with land. At present, it is a human organization rather than socio-territorial organization. The latter aspect is important for rural change in situation like Zambia. Population planning could be focussed on re-distribution.(12) Heavy migration of 15-44 age-group towards the line-of-rail has come in the planning and development of settlements elsewhere.(13) The circulation of population is mainly along this line. Functional planning based on nine types of establishments indicates that an agricultural, or a mining, or a manufacturing establishments can employ 46, 1203 and 84 persons, respectively. The distribution of urban centers has shown a tilt towards **Lusaka** while other service centers are widely distributed (see Table 1). On this framework the country can be planned through the growth poles, growth centers, growth points, service centers and service points.

TABLE 1. DISTRIBUTION OF POPULATION AND SETTLEMENTS IN ZAMBIA.

Province	No. of Districts	No. of Towns 1969	No. of Small Towns 1980	No. of Large Towns 1980	No. of Villages	Population in 1980	Percentage Distribution of Urban Pop. 1980
Central	5	4	7	1	4,015	513,835	7.5
Copperbelt	8	7	1	7	1,863	1,248,888	47.1
Eastern	6	6	8	—	5,563	656,381	2.4
Luapula	5	5	5	—	2,599	412,798	2.7
Lusaka	3	3	4	1	602	693,878	23.7
Northern	9	8	12	—	4,150	677,894	4.8
Northern-Western	6	5	8	—	4,820	301,677	1.6
Southern	9	8	20	1	2,947	686,469	7.6
Western	6	6	10	—	5,913	487,988	2.6
Total Zambia	57	52	75	10	32,472	5,679,808	100.0

FUNCTIONAL PLANNING OF RURAL AND URBAN SETTLEMENTS

The five stages for the transformation of the organization of the settlement have been identified. These stages are co-ordinated with the orders of the pole. The nature of poles, their organization and economy can be discussed, varying from a basic village to growth pole. While comparing this system with the Second National Development Plan framework of planning, it was found that with a few modifications both the approaches are complimentary to each other. But the development from below needs stability of rural settlements. Economic institutions as well as agricultural camps are to be incorporated with the hierarchy of poles. This arrangement of growth poles will develop a continuum of rural and urban settlements and the future labor force can be employed in these centers. Urban centers especially away from the line-of-rail will become more attractive in the proposed arrangement. The total set up will however discourage squatter settlements. The cost, density and racial bases of houses need to be changed in the future urban plans.(14)

PLANNING FOR FUTURE SETTLEMENTS

Three types of the areas can be carved out in relation to human settlements. They are: (a) areas not available for settlements; (b) areas available for settlement; and (c) existing settled areas. The areas available for settlement can be classified into (i) high accessibility areas; and (ii) poor accessibility areas. Contiguous fashion of diffusion with the former and hierarchical fashion with the latter is the likely pattern of future Zambian settlements, and the poles are to be established on such dynamics. After recognizing the problems, prospects, economic tendencies and planning methodologies, a railway line based model can be suggested for Zambia.

For a viable and dynamic settlement planning, based on the present administrative set up, the above-mentioned orders of settlements may be taken into account. It is possible to integrate the Second National Development Planning organization with the growth pole hierarchy. A village with Village Productivty Committee, service center with ward, growth point with district, and growth center or growth pole with province may be equated. There is no administrative order equivalent to service point to serve a neighborhood. To organize the settlements at lower order a ward may be divided either according to physical features, such as, water-basins, or by grouping service points. Further, such sub-ward areas can be organized by different forms of service points, such as: (a) agricultural camps, (b) agricultural growth centers (settlement schemes), (c) sub-bomas, (d) small scale industrial settlement, (e) recreational points, (f) transport points, and (g) rural service center. Only intensive co-ordination of settlements at grass-root will create a polarized space and hence poles will emerge on Zambian landscape. Diffusion of settlements must be co-ordinated with the diffusion of poles. Treatment as settlements at different orders will integrate the spectrum of poles which would ultimately reverse the gears of the line-of-rail based migration. This will check the growth of squatter settlements and deterioration of rural settlements.

It is however felt that there is a herculean task in front of the national planners to dilute the personality of the line-of-rail even in the distant future. The only way out is to develop similar economic line throughout the country which will lead to diffusion and interaction of poles, balanced regional development and economic potency to individual rural and urban settlements. This will not only organize the human habitations but also integrate the country in one functional settlement system which aims at 'One Zambia One Nation'.

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URBAN POPULATION DENSITIES: SOME CASES OF SPATIAL AND TEMPORAL VARIATIONS

by

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ABSTRACT

Population distributions with respect to time and space have been analyzed and negative exponential models are fitted to highlight the decline in urban densities away from the city centers. Results are more encouraging in the cases of Lucknow and Varanasi, where the total variances are 16.97 and 461.65. It is well expected of older cities, more dependent on natural growth patterns. Contrary to Lucknow and Varanasi, Kanpur, with higher variances (1277.16), is typical representative of an industrial city with several nuclei around it. The declining trend of the density gradients, with respect to time, is well explained by the line of best fits, which are becoming distant apart away from the city center and also by the reduction in variances, quite in accordance with the general notion.

The concept of negative exponential model of urban population densities appears to have its root in the 'distance-decay' concept of Von Thunen,(1) reshaped by Bleicher(2) as the first order negative exponential model and put in a more scientific fashion by Clark(3) as a 'simple mathematical equation of exponential decline with two generalizations: (i) excluding the CBD population density falls progressively to the outer suburbs and (ii) with the expansion and modernization of cities, the density falls in the center and rises on the outskirts. The second generalization may be made rather flexible by adding the term stagnation or retarded increase or actual decline, because, falling of density is expected only after the 'critical density' or saturation stage is reached, the stage, which itself has varied quantitative expressions, under different circumstances. On these generalizations he produced his initial hypothesis that, "The falling off of density, as one proceeds to the outer suburbs, follows a simple mathematical equation of exponential decline." Although the germ of these ideas is to be found in the works of Jefferson, a statistical geographer, referred by Berry, Simmons and Tennant,(4) credit for initiating and inspiring the modern researches goes to Clark.

The negative exponential model is expressed as —

$$dx = doe^{-bx}$$

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** This distance may also refer to the distances of approx. geometric centers of the wards or Mohallas, if the concentric rings are avoided.

Where dx = residential density, x** = the distances from the center considered (often the city center) to the middle of the concentric zones, drawn from the center.

e = natural log base

b = density gradient

o = estimated central density

Transformed this equation becomes —

$$\ln dx = \ln do - bx$$

ln = Natural or Naperian logarithm

In the model, there lies an empirical regularity seldom following any firm theoretical interpretation. Due to this reason, Harvey(5) calls it an unidentified model. In spite of this drawback, it possess excellent descriptive and predictive abilities. Several researchers have established through case studies of large number of cities, in different parts of the world, through time, that this equation produces very high coefficient of negative correlation between distance and density. Clark tested his hypothesis by producing values for central density (do) and the density gradient (b) in case of 20 cities, concluding 'that density falls off exponentially in all cities, at all times and that the density functions become flatter through time' (Mills).(6)

The model was extended and modified, later on, to cover more comprehensive aspects through the introductions of —

(a) certain regularities in the change in b and d_0 through time (e.g., Bussiere(7) and Cassetti,(8)

(b) observation of pivoting points (Patton),(9)

(c) use of critical densities (Newling,(10) Berry and Horton(11)),

(d) the models' use in giving total urban population estimates.

Population density is essentially scale specific and density values, therefore, depend to a considerable degree, on the system of areal units, for which densities are calculated. Keeping in view the continuum of density, as also commented by Bussiere, concentric rings may be a better choice over sectors/wards/mohallas, etc. Regarding scale, Harvey(12) rightly remarked, "that different processes become significant to our understanding of spatial patterns, at different scales," on which information is available and which influence the choice of ring size. Marsden(13) is further ahead in observing that as, "the aim being to maximize the observations, without excessive arbitrariness in large area, peripheral Census District Assignment," which provides justification for Cassetti(14) and Marsden(15) use of rings of increasing width, with increasing distance, from the city center', as also the pattern of increasing areas of statistical units in confirmation with the pattern of declining population densities. True, that measures like rings, "hide virtually all the

variations about the regression line and are too few in number to test for deviations of the observed pattern of decline from that expected to prevail,"(16) but the degree of such obscurity and unexplicitness increases in case of statistical units. Moreover, the former produces lower coefficient of correlation, as is evident from the results obtained for three cities, namely, Kanpur (-0.57)*,' Lucknow (-0.70) and Varanasi (-0.87), on the basis of census data 1961, by Brush,(17) who considered the centers of the wards, from the city center for distance factor and by the author, based on the center of the concentric rings, where the corresponding values of 'r' are -0.83, -0.987 and -0.956. The explanations to the varied results may be sought in the locational disabilities of population density. The existence of lower density wards near the city center like 14, 15 wards in Kanpur comprising the sparsely peopled railway yards, 19 in Lucknow incorporating partly planned Aishbagh industrial area and 5, 6, 8 in Varanasi covering the ghats of river Ganga are sure to lower down the values of r, resulting out of lower densities at shorter distances. It is, however, remarked that for a better comprehension of 'distance-decay' concept, the concentric rings be laid on the dot maps prepared with the help of actual distribution of built-up areas, is essential. It is this technique, which is applied here to arrive at such high values of the coefficient of correlation.

Coming to the scale, Brine's(18) observation on the Clarks' use of a framework of rings of one mile thickness, although, chosen on the basis of convenience, that it gives a pattern of gross population densities, confirms more closely to the negative exponential model. Further, a grid, coarser than this, produces an overgeneralized pattern, which is not particularly meaningful in any explanation of the decline. Nevertheless, larger rings can be useful, for example, in a comparative study of various cities as was done by Mills,(19) using only two rings (i.e., city and suburban). In addition to this, emphasis, here, is also laid on density patterns and areal expanses of the cities in selecting the inter-ring width. Quite in consonance with the above statement, for Meerut, Dehra Dun and JhansiM.Bs., which have lesser areal expanses, the inter-ring width of .25 km has been considered, while for larger cities (M.Cs.) like Kanpur, Lucknow and Varanasi, the inter-ring width has been doubled (.50 km).

Although, the emphasis, in this process, is laid on the formal representation of density distribution, as a function of distance, from the urban center. But paradoxically, the very definition of the center, the spatial coordinates of which are obviously key parameters — has not received proper attention (Bussiere,(20) Taited,(21) while other definitions of the correct centers, i.e., Geometric center, peak land-value and transport focus, based on the statistical formulation, were more suitable, which can avoid the desserted nuclei (like Raj Ghat of Varanasi, Laxman

* Computed on the basis of 116 statistical units.

Tila of Lucknow, etc.) and polynucleations. In the present case, the base year city center has been located in the middle of the densest ward, which generally coincides with peak land-value.

The appraisal of the process of urban sprawl and consequent evening out of the distributional gaps with respect to time, should result in the flattening of the 'distance-decay' curve or declining of the value of regression coefficient (b). A note of caution may be put with reference to the stage of development also because, with all its continuity and filling up of the voids, up to a certain stage, the inner zones still record proportionately higher gains than the outskirts, resulting in the increasing values of regression coefficient. The results obtained will be tested in the light of this postulate also.

RESULTS

The data have been processed on the above-mentioned framework. Computed densities of the rings and the corresponding distances from the center (mid-ring distances) were plotted on semi-log graph and the estimated lines of best fits were drawn. Following inferences can be deduced from the plots:

1. The density declines with distance in all the six sample cities (Figure 1), showing high negative relationship, which is also supported by the values of correlation coefficients, ranging from -.9987 (Lucknow to -.83 (Dehra Dun).

2. The model suits better in cases of Lucknow and Varanasi, with minor fluctuations, which is obvious from its almost overlapping computed (based on the regression line) and actual density plots (Figure 1) and is also evinced by the lower average variances; 16.97 in the case of Lucknow and 461.65 in case of Varanasi (Table 1).

3. The prominent fluctuations occur in the case of Kanpur, Dehra Dun and Jhansi owing to the development of various nuclei in the case

TABLE 1. PARAMETERS OF DENSITY DISTANCE CURVES

Cities	Years	d_0	b	r	r^2	Variances $(yi-yi)^2/N$
Kanpur	1951	5.8114	-.621	-.8301	.8263	2179.40
	1971	5.784	-.4944	-.864	.8409	1277.16
Lucknow	1961	6.1257	-.862	-.987	.9742	332.31
	1971	6.28937	-.864	-.9987	.9974	16.97
Varanasi	1961	6.215	-1.001	-.951	.9852	476.92
	1971	6.3556	-.887	-.956	.9813	461.65
Meerut	1971	6.228	-1.131	-.909	.9351	1135.28
Dehra Dun	1971	5.3069	-.989	-.873	.7621	846.13
Jhansi	1971	5.776	-1.319	-.866	.7709	960.44

of former and rugged topography in the cases of hill and plateau cities, Dehra Dun and Jhansi, respectively.

4. The density gradient falls off more steeply in areally small cities, as is expressed by the values of regression coefficient (b), -1.319, -1.131 and -.989, in the cases of Jhansi, Meerut and Dehra Dun, respectively, where population declines sharply beyond a certain distance. These are developed mostly around one nucleus. Most of the population and area are encompassed within 2 kms' circle from the center. Densities are insignificant beyond this limit. The case of Meerut M.B. is unique, since roughly above 2 lakh population of M.B. is distributed on only 13.81 km^2 area, that also, leaving two areally big wards which are very sparsely populated.

5. The results for 1971 are significant at 95% confidence limits, for Kanpur, Lucknow, and Dehra Dun.

7. The density gradient 'b' has shown a decline with time for Lucknow, i.e., through time there is a flattening or levelling off of actual density curve with distance from the center of the city.

8. The above conclusions can be further substantiated by the analysis of the coefficient of determination (r^2), which is the per cent of variation in the population density, accounted for by the estimates. For 1971, the figures for sample cities in order are: 99.20% (Lucknow), 98.0% (Varanasi), 94.10% (Meerut), 82.80% (Kanpur), 77.10% (Jhansi) and 76.20% (Dehra Dun). The F ratios in all the cities are in excess of one per cent level of probability, meaning thereby that the chances of obtaining the significant deviations are less than one in hundred cases and this indicates a highly significant relationship.

In other words, the results of analysis in all the above cities show the best fits of negative exponential model, in the order the cities are mentioned above. Thus, the spatial patterning of the population densities of these cities of U.P. give further empirical support to the first order negative exponential model itself.

A general survey of these analyses, pertaining to individual sample cities, may be given here in the sequel:

Kanpur U.A.: The density-distance semi-log plot for 1951 reveals three inflections, showing irregularities of the distributions. The first is marked at the mid-ring distance of 1.25 km, defined by the sharper gradient inward and gentler outward. After 1.75 km, it is followed by a gradual increase in density up to 2.25 km, which marks the crest of the maxima, after which again a sharp decline is observed up to the next stage, where a minima is reached (Figure 1). The first upward concavity corresponds with the large areas of sparsely inhabited portions of Cantt. and railway lands of wards 13, 14 and 16, and public and semi-public offices and industrial areas of wards 2 and 6, beyond which the city sprawl again appears and consequently the rise in density. The other

SPATIO-TEMPORAL VARIATION IN DENSITY GRADIENTS

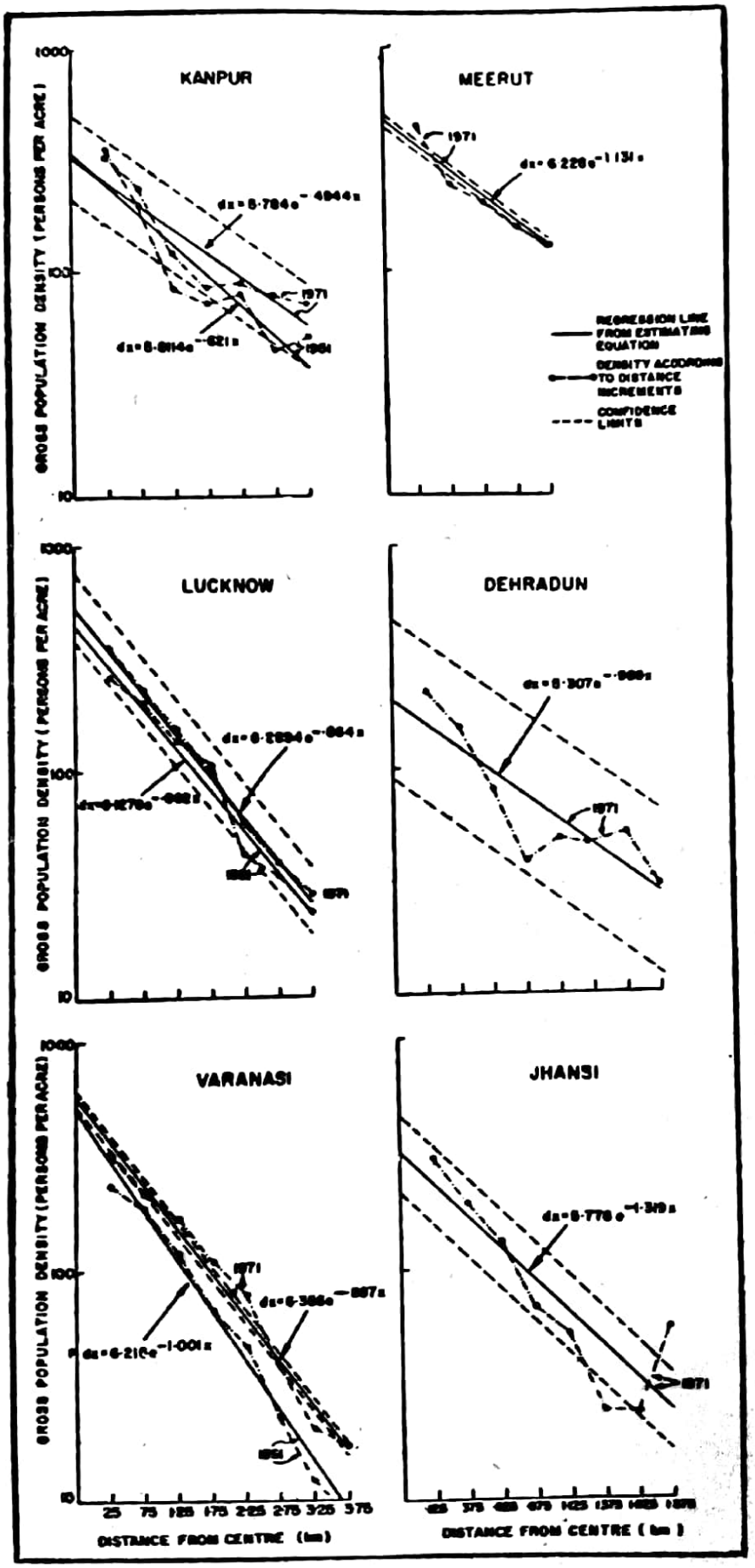

FIGURE 1

upward concavity may be attributed to the inclusion of uninhabited portions of Cantt., industrial areas of ward 15 and open spaces of wards 3 and 5.

Relative smoothening of the curve, resulting out of higher rate of increase, away from the center, is a general feature observed in 1971. The decline in the central zone 354 ppa in 1951 to 324 ppa in 1971) and the higher rate of increase beyond 2.25 kms distance are the two most remarkable features revealed by the graph (Figure 1). In the two decades' duration, most of the open spaces, lying in the wards 3,6,13,16 and Cantt., have been filled up which is obvious by the rising densities of these wards, from 35,20,47,53 and 11 ppa in 1951 to 48,24,52,69 and 17 ppa in 1971, causing the flattening of the first inflection. The densities of the areas covered by the second inflection, Cantt., wards 15,3 and 5 also rose from 11,33,35 and 40 ppa in 1951 to 17,46,48 and 49 ppa in 1971 resulting in the smoothening of the second inflection.

Similar interpretations can also be obtained by the lines of best fits for 1951 and 1971, which also show the increase of population on the outer fringe and a decline at the center, which is confirmed by the decline in the values of b from -.621 to -.4944, as well as, the total variances from 15,255.83 to 8,940.14 respectively. The coefficient of determination shows that in 1951, 82.63% of variation in population density was explained by the factor of distance, which, in 1971 increased to 84.09%.

Lucknow U.A.: More or less regular and sharp declining trend is observed in the densities in case of Lucknow, in 1961 (variations ranging from +17 at 1.75 kms' distance and -9.67 at 2.25 kms' distance, from the line of best fit), and in 1971, where the plot is much more smoothened (Figure 1), indicating, thereby, the absence of large and continuous zones of voids in between. It is also expressed by the higher value of coefficient of correlation between distance and density in 1971 over 1961 (from -.987 to -.9927), confirming the increasing interdependence with time. Unlike Kanpur, here the density has increased throughout the decade 1961-71. The maximum variation in the central zone (from 259 to 353 ppa) is, quite in contrast, to the hypothesis of depletion in the central zone, with time, after the stage of saturation, which holds good in the case of most of the ancient cities of the world. This shows that the saturation stage has not yet reached in Lucknow.

Varanasi M.C.: Both the actual density curves of Varanasi (Fig. 1) show more regular declines, as is evident from the maximum percentage variation of 25.55 at 1.75 kms' distance in 1961 and 25.63 at 2.25 kms' distance in 1971. Density in the central zone has increased from 249 to 332 ppa, depicting maximum numerical increase in the center.

The line of best fit for 1971 shows gradual flattening away from the city center, with reference to 1961, as is evident from the higher per cent variation in the densities of the peripheral rings (after 2.25 kms'

distance 65.68%, 62.20%, 63.30% and 85.31% variations are marked), although numerical variations are more significant in the center. This fact is also confirmed by the decrease in the value of 'b' from -1.001 to -.889. The coefficient of determination shows that 90.44% and 91.44% variations (Table 1) in population density in 1961 and 1971 respectively, are explained by the distance factor.

Meerut M.B.: The actual density plot of Meerut (Fig. 1) shows a beginning with a density of 444 ppa, more than the estimated population density of 364 at that point. Only at .375 km mid-ring distance, it falls sharply to 249 ppa, i.e., going even beyond the confidence limit (the estimated density at the point being 281 ppa). Then it is only at .75 km, that the actual density parallels the estimated one. Major portions of densely populated wards 7, 8 and 6 lie within .5 km distance from the center Zone, in the immediate vicinity with density lesser than the estimated, can be attributed to the sparsely populated areas of ward 4.

Like other cities, densities, here also, show very high inverse relationship with distances (correlation coefficient -.909). The regression coefficient b (-1.131) is next only to Jhansi, confirming sharper decline in density for reasons, mentioned earlier in the Results.

Dehra Dun M.B.: The analysis of the density-distance plot, with reference to the regression line, reveals appreciable fluctuations with respect to the estimated values, at almost all the points. To start with, the core itself presents a variation of +63 ppa, where the estimated figure is 157.53 ppa. The circle, enclosing the core, incorporates the maximum portion of ward 9, one of the densest wards of the city. Density declines onwards sharply to record values lesser than the estimated ones, beyond .50 kms' distance, reaching the maximum up to 39 ppa, at the mid-ring distance of .875, where the estimated density is 74 ppa. This unusual decline, within such a short distance, in comparison to other sample cities, can be attributed to the confinement of habitable space by the natural voids, occurring due to rugged terrain of Rispana Rao and Bindal. From this point onwards, the actual density starts rising indicating thereby, the new zone of settled portion up to nearly 1.75 km, which is represented by a density of 52 ppa, showing a positive variation of 16 ppa. This zone merges with the nuclei like FRI, Cantt., Premnagar, Raipur, etc.

The degree of irregularity in distribution, in comparison to other sample cities, can well be expressed by the lowest value of the correlation coefficient r (.83).

Jhansi M.B. and R.S.N.A.: Due to its situation on plateau and consequent effect of terrain, Jhansi also shows several fluctuations in its actual density curve (Fig. 1), which starts from a density of 304 ppa, at the city center where the estimated density is 232 ppa. As usual, it starts declining till it reaches 23.90 ppa, at the mid-ring distance of

1.375 kms. This value falls short of the estimated density by about 9 ppa and lies beyond the confidence limit. The sparsely settled wards of 4, 5, 7 and partly planned Civil Lines of 8, contributed to this low density, while a bit thickly settled portions of Cantt., RSNA and the parts of denser wards No. 1 and 9 raise the density further to 54 ppa lying beyond the confidence limit and being more than the estimated value (31 ppa).

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