

INTERNATIONAL DIFFUSION OF INNOVATIONS:  
A CASE STUDY OF THE DIFFUSION OF THE CONCEPT OF  
INTEGRATED RIVER BASIN DEVELOPMENT IN DEVELOPING COUNTRIES

by

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ABSTRACT

One of the dilemmas challenging developing countries is the selection of appropriate strategies to achieving economic and social development comparable to the levels in the developed countries of Europe and North America. In the last few decades, on the advice of experts, various sectoral and spatial strategies have been tested; none of which has been overwhelmingly successful.

One response to this apparent impasse in development has been natural resources development, especially water resource development. With respect to the latter, proponents point to the concept of integrated river basin development. It is argued that the concept holds the key to the social and economic development because the river basin is a system in dynamic equilibrium and is more easily influenced by man through manipulation of factors which dominate the local scene and which mask broad regional patterns of basin and stream behaviour.

However, besides this theoretical argument for the adoption of the concept, very little experience exists of the conditions under which the implementation of the idea could be successful in the developing countries. Existing

evidence is based solely on work done in the advanced countries. Perhaps as a result, the use of the idea was until the 1940's localized - restricted to North America and Europe. That is, it was not until the 1940's that it was adopted in some developing countries. Since then, the pace of the adoption has not been as rapid as could be expected. Such adoption behaviour raises questions such as where and when the concept was adopted and why the relatively late and slow rate of adoption in spite of the proclaimed advantages.

Diffusion research offers some explanation for the variations in the spread of phenomena. Among the explanations is that the diffusion process is influenced by the characteristics of the adoption unit and the innovation. Using this as the theoretical premise, the adoption of the concept of integrated river basin development in 24 African, Asian and Latin American countries between 1940 and 1971 is analyzed, with the aid of correlation, stepwise regression, and discriminant techniques.

The results show that fewer countries than expected have adopted the idea. It is also evident that not only were the adoption rates in the countries related to a number of political, social, economic and physical characteristics of the countries as well as one characteristic of the innovation, but also some of these variables

significantly influenced the adoption rates. The important variables were: year of entry into the United Nations; year of political independence; gross national product; size of the river basin in the country; and the relative advantage of the innovation.

The analyses further show that the importance of these factors varied from one region to another, suggesting the existence of different factors in the development processes of the developing countries. While political factors were important in Latin America, political and socio-economic factors were paramount in Asia. In Africa, physical variables such as the size of the river basins were the most important.

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typed the manuscript.

Even so, I am solely responsible for the content of  
this thesis.

Kingsley Opoku Okyere  
December 1978  
Victoria, British Columbia  
Canada

DEDICATION

To "Internationalism", the beleaguered  
and forgotten ally of mankind.

## CHAPTER I

### INTRODUCTION

#### 1.1 The Problem

One of the central problems in the economic and social development of developing countries is that they are usually the recipients of economic and social innovations suggested by "experts" who have little or no knowledge of the developing countries. The impact of pursuing development can be destructive particularly when the innovations are adopted without prior assessment of their compatibility with the conditions in the developing countries.

One of the innovations adopted by developing countries over the last three decades has been the concept of integrated river basin development. In 1970, a United Nations committee reiterated the need for the concept in developing countries when it observed that:

opportunities for further fruitful economic and social growth in the river basins of the world - both large and small - are great . . . in regions where economic [ and social ] development is already well advanced, a river basin may lose some of its cohesion as an economic entity . . . . The situation is often different in less developed areas where, because of the lack of economic development water projects may have more dominant influence.<sup>1</sup>

The concept has been defined in several ways. In 1953, Huffman<sup>2</sup> defined it as:

a comprehensive development program for a river valley [ which ] involves working with three resources of equal importance - water, land and people.

Two years later, the Bureau of Flood Control of the Economic Commission for Asia and the Far East (ECAFE)<sup>3</sup> defined the concept to include

multi-purpose use, unified development<sup>4</sup> of entire basins, social benefit and costs applied to a region, comprehensive development of all resources, and unified control.

In 1958, White<sup>5</sup> defined it as embracing three ideas - multi-purpose storage project, basin wide program, and comprehensive regional development. An international symposium in 1963 interpreted the concept as the "co-ordination of all purposes and all projects in a river basin or sub-basin."<sup>6</sup> Finally, in 1970 a panel of U.N. experts interpreted the idea as meaning "the orderly marshalling of water resources at river basins for multiple purposes to promote human welfare."<sup>7</sup> Three themes are common to these definitions - multiple-purpose, unified/basin-wide, and co-ordinated/comprehensive development.

Current literature suggests that each of the three component ideas of the concept has separate roots in western civilization and came to be associated with each other only in present day theory and practice.<sup>8</sup> The multiple-purpose

idea began in the 1800's in North America and Western Europe as a way of simultaneously responding to flood control and navigation problems.<sup>9</sup> In North America, endorsement of the idea was first made in the United States in 1879, with the establishment of the Mississippi River Basin Commission. In the same year, the concept was first referred to in Europe in a treaty between Switzerland and Baden.<sup>10</sup> Implementation of the idea was, however, delayed until early in the 20th century as the search for ways to make water serve more than one purpose continued. In the opinion of Teclaff, Ackerman<sup>11</sup> and White<sup>12</sup>, the discovery of the technique of hydro-electric power generation, reinforced concrete, the development of earth moving machinery and the public perception of the need to conserve resources were the factors that greatly influenced the implementation of the idea which began with the start of the Pathfinder dam<sup>13</sup> in the United States and others in Western Europe.

Nowhere in Latin America, Asia, or Africa was there a major multi-purpose storage project. This is not to say, of course, that there were no combinations of two or more purposes in water storage or that the concept of multiple use was not current in public thinking.<sup>14</sup> On the contrary, under British supervision irrigation barrages were constructed in India, and the canals were used for navigation

where suitable. In Eastern Asia, too, works on the lower stretches of streams combined navigation or flood control with irrigation.<sup>15</sup>

While the idea of multiple purpose was gathering force, there was a complimentary, but not corollary, formation of the idea of basin-wide development. The first major basin in the U.S. in which this idea was incorporated in a complete design was the Miami basin. The program later played a major role in the authorization of the Colorado and Tennessee basin projects.<sup>16</sup> In Western Europe, the desirability of treating basins as units was recognized in law in 1919 in France; and in Germany and Italy, the concept was accepted by engineers as necessary to effective planning at about the same time.<sup>17</sup>

The third aspect of the concept, comprehensive development, had neither a prototype nor a sterling demonstration until the Hoover Dam project and the Tennessee valley scheme. These developments thus make the Colorado basin project epitomized by the Hoover Dam project of 1928 the first development of an integrated river basin project. By the end of the 1930's the concept had become well established not only in the United States but also abroad.

Construction began on the Rhone projects in 1937. Between 1937 and 1955 a number of such projects were undertaken in the Soviet Union. The adoption of the concept was

not evident in the developing countries of Africa, Asia, and Latin America until after 1940 when it spread to Asia and Latin America.<sup>18</sup> The Gal Oya project in Sri Lanka was begun in 1949. Work also started on the Cauca program in Colombia in 1955, and the Damodar program in India was initiated in 1950 and completed in 1959. The concept was evident in Africa during the late 1950's and early 1960's during which time projects were completed in Rhodesia, Egypt, Ghana and Sierra Leone, to mention only a few. The latest developments in several developing countries outstrip those in other parts of the world in terms of:

- a. the size of the basin area tackled, and
- b. the huge power potential (measured in kilowatts) to be produced.<sup>19</sup>

The foregoing review clearly shows that:

- a. the concept has its modern origin in western economic development; and
- b. until the 1940's the utilization of the idea was localized - restricted to Europe and North America.

Assuming that the idea is as important in the economic and social development of the developing countries as the experts claim, such adoption pattern raises a number of questions; namely:

1. Where in the developing countries has the concept been adopted since 1940?
2. When was the concept applied to specific basins in the adopting countries?

3. What has been the rate of adoption of the innovation?
4. What kind of factors appear to be associated with the rate the innovation was adopted in the respective countries?
5. What theories explain the diffusion of the concept?

Diffusion studies permit one the opportunity to assess the compatibility of innovations within a given environment and identify the factors that underlie their acceptance. Such studies also seek to describe the factors that impede or enhance the spread process. In this thesis, therefore, the diffusion of the concept of integrated river basin development to the developing countries will be studied.

## 1.2 Objectives

The general objective of the study is to analyze the degree to which the adoption of an institutional innovation (for example the concept of integrated river basin development) is related to either the characteristics of the adopting unit or the innovation. Specifically, the research will seek to answer the above-noted questions.

In order to attain the above objectives, this research will identify:

1. social and economic characteristics of developing countries concerned with water resource development;
2. selected characteristics of integrated river basin development;

3. the time of adoption of the concept in developing countries;
4. the rate of adoption of the concept in the respective countries; and,
5. the relationship between the rate of adoption and the selected characteristics. For the latter objective, a model suitable for examining the relationships will be formulated.

### 1.3 Hypotheses

In pursuit of the foregoing objectives, it is hypothesized that:

$H_0$ : No significant statistical relationships exist between the rate of adoption of the river basin concept and the selected characteristics of either the countries or the innovation.

$H_1$ : Significant statistical relationships exist between the rate of adoption of the river basin concept and the characteristics of adopting countries/innovation.

The above hypotheses stem from a number of recurrent themes and conclusion of diffusion research as well as the author's own conjectures.

### 1.4 Scope

The research is focused on the adoption of the concept during 1940 to 1971 by the developing countries and examines the factors underlying the adoption rates. The choice of the period is based on the fact that the concept was not clearly evident in the developing world until the 1940's and also availability of statistics preclude the inclusion

of countries that adopted after 1971. For the purposes of the study, countries still under colonial administrations will be excluded.

#### 1.5 Importance of Study

The importance of this study lies primarily in its potential contribution to international development, especially in developing economies. Technological, social, economic, institutional and other changes that occur in the developing countries have traditionally been adoptions of exotic (European and North American) materials. The transfers, by and large, occur without due recognition of the fundamental differences between the developing countries and the originating countries - leading to frequent charges of "Eurocentricism"<sup>20</sup> and most importantly, dismal failures of expensive and important programs.

By focusing attention on the diffusion of the concept of integrated river basin development - an idea whose modern origin is rooted in Western economic development, the environment in which innovations flourish in the developing countries may be uncovered. Such a finding could be a basis for future transfers of innovations (material and non-material); and the importance of this in avoiding wastes and accelerating development in the poor countries cannot be overemphasized.

Further importance of the study can be found in the significance of the concept in practice. The idea of multiple-purpose water storage, while once considered of doubtful practical value, now is firmly established in present construction technology. The idea of unified basin planning has moved slowly from theory to practical application: first slowly in intrastate drainage, then quickly in more challenging interstate drainage, and across international boundaries to cover complete basins. The idea of comprehensive regional development has gained gradually in application.

Throughout these developments, however, there has been conspicuous lack of careful appraisal of the work accomplished; and more importantly, the relationship between the characteristics of the political units and the concept. A strategy capturing imaginative support, as this one does, deserves penetrating assessment, and such examination has been largely absent. For every 100 studies of what might or should be done with a river system, there are very few that deal with the above relationships and hardly any that deals with the results.<sup>21</sup> Even though this study may be too late for already executed programs, it will point to the utility of such analyses for future programs in river systems.

The role of geography in development has been in defining the linkages and impacts of programs not only on people and environments, but also other programs. By assessing the linkages between the characteristics of the countries and this development tool, the spirit and purpose of geography is being maintained.

Finally, diffusion research will be greatly enriched by the testing at a low resolution level (global scale) the concepts and generalizations arrived at from studies made at higher levels (individual and community scales).<sup>22</sup>

#### 1.6 Study Limitations

The limitations of the study are:

1. The description of the relationship between the rate of adoption and the characteristics of the developing countries or the concept will be valid to the extent that the generalization established by diffusion research is confirmed. The generalization upon which the research hypothesis is based suggests that the rate of adoption of an innovation is a function of the characteristics of the adopting unit and the innovation.

2. The data to be used in the analyses are accurate insofar as that obtained from the envisaged sources are valid.

3. The results can be applicable only to the developing countries of Africa, Asia, and Latin America.

### 1.7 Definition of Terms

This section of the chapter explains the terms that are used in the thesis.

Innovation - is defined as any technique, or practice perceived as new by the individual.<sup>23</sup> In this study, innovation has the same meaning except that the newness is perceived not by the individual but by some collective decision-making institution of government.<sup>24</sup>

Developing countries - describes the "UNCTAD Group of 77" which declared themselves as developing in the second ministerial meeting of November, 1971 at Lima, Peru.<sup>25</sup> They include all countries in Africa, except South Africa, all countries in Central and South America, all countries in the Indian and South East Asian subcontinents as well as the independent and unaffiliated islands of the Pacific, Indian and Atlantic oceans except Japan.

Characteristics of Innovation - refers to the relative advantage of the concept of integrated river basin development.

Characteristics of the countries - refers to the socio-economic, physical, political characteristics of the developing countries.

Adoption Unit - means the individual or group that is adopting the innovation.<sup>26</sup> The term, in this research, thus refers to the developing countries under study.

Adoption time/time of adoption  
Adoption date/date of adoption - are used interchangeably and denote the year in which a country first constructed river basin projects.

Integrated river basin development - is defined as embracing multi-purpose storage project, basin-wide programming, and comprehensive development, after G.F. White's 1958 definition.

Rate of adoption/Adoption rate - is defined as the relative speed with which an innovation is adopted by members of a "social" system.<sup>27</sup> It is measured, as Mansfield<sup>28</sup> and Rogers and Haven<sup>29</sup> did, by dividing the number of units adopting in a given year by the number yet to adopt that year.

#### 1.8 Organization of Thesis

The study proceeds from a review of water resource development, pointing out its economic importance and associated problems. Various institutional arrangements suggested to curb such associated problems as well as those related to general economic and social development are also discussed. Chapter 3 focuses on the theoretical framework of the study and reviews some of the literature on diffusion, particularly those in the fields of anthropology, sociology, economics and geography. International and developing world diffusion literature are also examined. Chapter 4 outlines some of the known characteristics of the developing

countries and the innovation and their relationships to water resource development. In Chapter 5, the methodology used in the study is discussed in detail and concludes with some of the problems encountered in the field. The field data is analyzed in Chapter 6 with the summary and conclusions resulting detailed in Chapter 7.

## CHAPTER 2

### WATER RESOURCE DEVELOPMENT

#### 2.1 Introduction

In recent years, increasing emphasis has been placed by geographers, economists, planners, sociologists, and other social scientists on the search for appropriate strategy for economic and social development in developing countries.<sup>1</sup> One of the strategies has been water resource development. Accordingly, this chapter outlines its salient features and makes several comments about them. Before then, it might be appropriate to examine some of the different views on water resource development as a development strategy.

#### 2.2 Water Resource Development As A Development Strategy

Water resource development is one of the many resource-oriented development strategies that have supplanted spatial and sectoral strategies in recent years.<sup>2</sup> Its importance in the rapidly changing context of economic and social development is recognized world-wide. Lewis et al<sup>3</sup> state that there seems to be a relationship between water and growth and some developed countries provide evidence of the significant effect of water

resource development on economic growth. Garrison and Paulson<sup>4</sup> in examining the effect of water availability on employment in water-oriented manufacturing activity, concluded that there existed

a significant relationship at the micro-location level between water oriented manufacturing activity and water availability.

Though this point of view is disputed by Howe<sup>5</sup> and Cox et al<sup>6</sup>, the differences in opinion should not be misleading as the disparity in the conclusions may be the result of several factors. Among them are:

1. The disparity in the existing levels of development in the study areas;
2. The inability of the data and growth indices to measure true output; and
3. Lack of consideration of the time lag between water investment and the resulting economic growth.<sup>7</sup>

In the developing countries, on the other hand, overwhelming evidence of positive relationship between water resource development and economic development seems to exist. Gopalakrishnan<sup>8</sup> reported that:

India's multidimensional water development programmes have contributed significantly to the promotion of the country's economic growth.

A United Nations panel of experts confirmed his point when it concluded that:

Investment in water resource development projects has less negative impact on the regional economy (in less developed countries) than is the case in developed countries. The higher level of income in a developed country compared to a developing country means that the relative changes in income level from the same amount of investment will be less. Also, the greater amount of existing investment in water resource means that the rate of return from further investment is likely to be less.<sup>9</sup>

In other words, in developing countries, water resource development may affect local, regional, and national economic output - and growth which may have tremendous impact on the social and political environments as well.

### 2.3 Economic Importance of Water Resource Development

The economic effects of water resource development in a developing country may be examined further by discussing five potential benefits from each investment.

These are:

- macro-economic effects,
- direct effects on development and output,
- economic effects on improved health,
- effects related to averted costs to the economy, and
- rural to urban drift and population relocation or stabilization.

#### 2.3.1 Macro-Economic Effects

The macro-economic effects of water resource development programs of relatively large size<sup>10</sup> may be viewed as being associated with economic growth, redistribution

of income and possible balance of payments problems.<sup>11</sup>

A country would experience an increase in the overall economic activity as a result of water development programs if the country is not already fully employing all of its resources - a rare phenomenon in developing countries.

At a minimum, the increase in a country's economic activity or output would be equal to that proportion of the increase in direct program expenditures made by those newly employed in the program and those directly or indirectly supplying services, equipment and material to the program.<sup>12</sup>

Redistribution of income would also take place if the water development program is at least in part financed from funds raised by taxing economic output or income. This could generally result in a redistribution of income within the country from urban to rural and from higher to lower income population. This follows from the fact that per capita economic output and income are almost always higher in urban areas than in rural areas.

In addition, disposable income would also be redistributed through time because, through taxation and user fees for water resource development, income is generally shifted from current consumption (assuming low rates of saving in rural areas of developing countries) to consumption in the future at what would hopefully be at a higher per capita level.<sup>13</sup>

The extent of the impact of water resource development on a country's balance of payments would clearly vary from country to country, depending on the natural and technical resources of each. The potential impact can be evaluated in advance. Given a country's needs and resources such impacts can be influenced by designing the program and all individual projects to take advantage of local labour (an abundant and low priced resource in most developing countries), materials, supplies, topography, and technology whenever possible.<sup>14</sup>

#### 2.3.2 Direct Effects on Development and Output

There may be direct short and long-term effects on the economic output of a developing country or region that result from water resource development. Direct short-run effects could be derived from encouraging fish farming in a reservoir constructed for hydro-electric power generation. Under such conditions, and depending on local costs of fishing, a country could gain an extra food source and increase its water system revenue through fishing operation requiring little additional capital investment.<sup>15</sup> In the long run, firms or industries that generally congregated in certain areas (like urban growth centres) may be attracted to other areas of the country and thus aid in the spatial diffusion of development.

### 2.3.3 Economic Effects of Improved Health

Water resource development, especially the provision of potable water could greatly improve the health of a population. For example, White<sup>16</sup> and his associates have provided perhaps the most extensive set of estimates of the proportions of different diseases in rural areas of East Africa which may be prevented by the introduction of water supplies (see Table 2.1).

One of the immediate effects of such improved water supply would be a reduction in mortality rates. The economic benefit of this could be in terms of the labour output which might result with an increase in average life expectancy. A reduction in mortality among children who are not economically productive would also result from improved water supply. Such an improvement would have little short run economic value unless significant amounts of mothers' time were freed to be used productively. The long run value, however, would be much greater. A reduction in morbidity among those in the labour force could increase labour productivity and thus earnings and output. The economy might benefit by (a) reduced worker absentee rates, (b) improved worker vigor<sup>17</sup>, and (c) less earning loss by members of families caring for others who are ill.<sup>18</sup> The spread of diseases could also be reduced. It has been demonstrated that potable water

Table 2.1  
Relation Between Water Supplies and Infectious Diseases

Disease	% Reduced By Water Improvement
Cholera	90
Typhoid	80
Leptospirosis	80
Bacillary dysentery	50
Amebic dysentery	50
Tularaemia	40
Paratyphoid	40
Infectious hepatitis	10
Enterviruses (some)	10
"Gastroenteritis"	50
Skin sepsis	50
Skin ulcer (chronic)	40
Trachoma	60
Eye inflammation	70
Scabies	80
Yaws	70
Leprosy	50
Tinea	50
Otitis externa	40
Louseborne typhus	40
Louseborne relapsing fever	40
Ascariasis	40
Urinary schistosomiasis	80
Rectal schistosomiasis	40
Guinea worm	100
Yellow fever	10
Onchocerciasis	20
Malaria	10
Gambian sleeping sickness	80

After: White, G.F., et al, (1972).

supply systems help retard the spread of epidemic diseases such as cholera and typhoid.<sup>19</sup>

#### 2.3.4 Averted Costs

In concept, a water resource development program could have the effect of reducing some of the costs which the local or national economy is currently experiencing, such as possible one-time reductions in present expenditures. For instance, rural water supply programs which lower water-related disease rates, provide an opportunity for a country to reduce some of the expenditures currently made for health and medical services.<sup>20</sup> In the same context, generation of hydro-electric power would curtail the expenditure on imported energy.

#### 2.3.5 Rural to Urban Drift and Population Location

In addition to health and economic benefits, another benefit would be obtained from stemming migration from rural to urban areas. Most developing countries have been experiencing migration of population from rural to urban areas. Although the causes of such population movements are many and diverse, a water resource development program, whether to supply water for domestic consumption or agricultural use, may help alleviate some of the "push" factors of migration.<sup>21</sup>

Planned relocation of population could also result where groups of people occupy disease infested regions.

Irrigation and/or hydro-electric projects which cause inundation of the diseased regions provide opportunities for relocation of the population.<sup>22</sup> The resettling of 80,000 people away from the tsetse infested Volta basin in Ghana is a classic example. In other countries, constantly shifting population (nomadic pastoralists) may be able to live sedentary lifestyles when water resource programs make it possible to provide perennial pasture.

In effect, water resource development is essentially spatial in concept, for while the initial program often relates to a specific drainage system which is usually clearly delimited in physical terms, the benefits may relate to wider areal units, which may be regional, national, or even international in character. Such benefits as well as the development process itself may be further related to other resource management programs within the specified areal unit (Figure 2.1).<sup>23</sup>

#### 2.4 Problems of Water Resource Development

In order to attain the benefits of water resource development developing countries must often deal with numerous problems such as:

- nature of the economies of the developing countries,
- technological standards,
- physical environment,
- level of water demand,

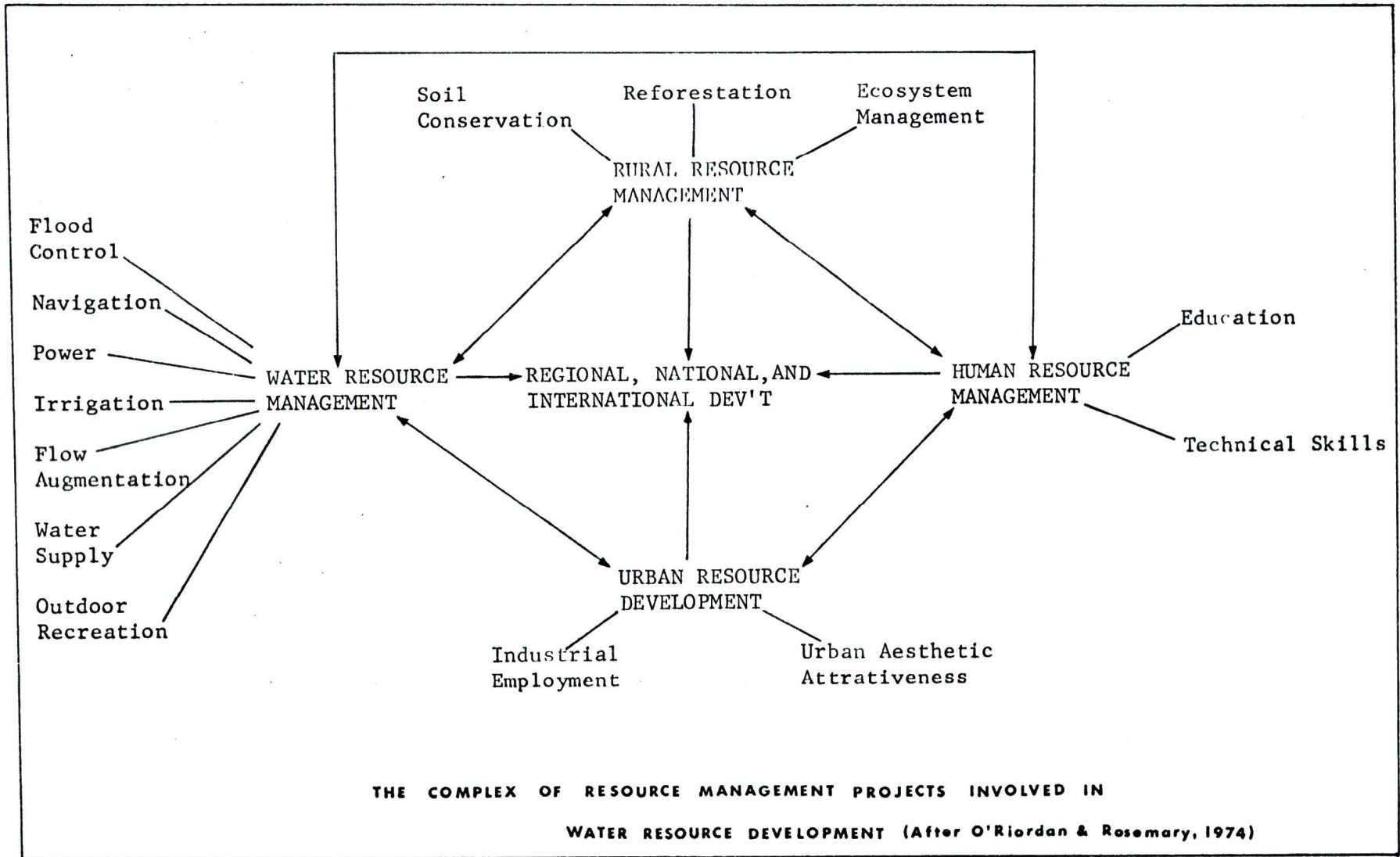


Figure 2-1

- manpower inadequacy,
- lack of data base, and
- undeveloped water institutions.

#### 2.4.1 Nature of the Economies

In developing countries investment in water resource development has a greater relative impact because of low income levels. This impact may be either positive or negative, depending on whether the investment is well planned or not. If the investment is inappropriate and incompatible with other areas of the economy, society and environment, the results may be disastrous. In many cases, the level of the economy is close to subsistence, and there often <sup>is</sup> ~~are~~ only a small margin to absorb the ill effects of badly planned investments. The larger the development, the more people may be affected and the greater is the possibility of a large scale disaster. This factor partly accounts for the caution in undertaking huge water projects and the current emphasis on "intermediate" or "village" technology.

#### 2.4.2 Technological Standards

The technological infrastructure to ensure and maintain basic forms of water resource development - is often primitive or non-existent. Consequently, water development and water use technologies have often been borrowed from developed countries with a generous water

supply. As many developing countries are in arid and semi-arid zones, these transfers of water development and water use technologies place an inordinate strain on both scarce water resources<sup>25</sup> and foreign exchange.

#### 2.4.3 Physical Environment

As observed above, developing countries are mostly located in hot climates, and therefore their water systems offer distinctive problems. The rivers carry widely varying quantities of water during the year. Torrential rains occur in a few months of the year and drain off quickly. The uneven flow and the very large maximum discharge of the rivers give rise to peculiar engineering problems. Special attention in design and construction of diversion and spillway works is, for example, usually needed. The fluctuations in the water cycles may also greatly affect the national income by as much as two and half per cent - twice the effect experienced in developed countries<sup>26</sup> - which inhibits the ability of the countries to finance water development programs without external assistance.

#### 2.4.4 Level of Demand

While consumption and water use per capita in developed countries ranges from 400 to 600 litres per day<sup>27</sup>, in some developing countries use may be limited to little more than the four litres needed to sustain life.<sup>28</sup> This level of

demand, while indicating a great potential for the future, creates an air of uncertainty around many water resource development programs.

#### 2.4.5 Manpower

Still another great handicap for developing countries undertaking water development programs is the lack of trained specialists. Quite often problems arise when consultations with foreign specialists are necessary. This can lead to (a) delays in programs, (b) a strain on the financial resources of the country, and (c) inappropriate solutions by the foreign specialist through lack of familiarity with the local environment.

This problem is the result of inadequate training programs for local personnel. Successful training programs require a careful preparation of lists of requirements, both immediate and long term, and selection of best available men. Places of training have to be found in the advanced countries before the selected men can begin their training. These are usually cumbersome and long exercises which lead to inevitable delays and at times irreversible events.

#### 2.4.6 Data Base

Lack of water resource data is another problem. This stems in part from the very short period of time for which statistics on water resources have been gathered.

In the absence of the relevant statistics, approximations are used which increases the likelihood of errors in planning projects. H.P. Michael<sup>29</sup> summed up the problem when he noted:

Of all technical water problems in developing countries the absence of long range hydrologic records represents the most disturbing handicap to swift development. It causes uncertainty and leads to uneconomic investment in all branches of hydraulic engineering work.

#### 2.4.7 Water Development Institutions

Modern water development in a developing country demands the firm establishment of three institutions in its water code.<sup>30</sup> First a strong water department or statutory body which in the field of water affairs carries out the integrated social and economic policy of government. The department may be responsible for establishing and maintaining an inventory of all water resources as well as of present and potential uses, administration of the water laws and control of uses; as well as taking initiatives regarding all development projects and discouraging damages and dangerous practices. In short such a department could be a motor for a progressive water policy.<sup>31</sup>

Second, an advisory council on water affairs, recruited from representative sections of the public. In developing countries (tropical and subtropical) major water-related decisions frequently impose heavy sacrifice and restrictions

on some members of the community. It is, therefore, imperative that the public be satisfied that at least the principal, legal, administrative, economic and social aspects have been discussed with independent experts and any vested interests before major new water allocations, particularly unpopular measures of some consequence or departures from the hitherto proclaimed policy are put into practice. This advisory body would create the necessary atmosphere of confidence, yet cannot claim to be a water parliament and hence does not interfere with political responsibility.<sup>32</sup>

Third, legal provisions adapted to the requirements of up-to-date and possibly future water development practice and giving to the government ultimate control over all water resources. This may mean the final departure from traditional doctrines of the former colonial powers, namely, the "riparian principle" for surface waters, the rule of "unlimited use" for ground water, both doctrines which in local variations have been adopted from the Common Law.

A few developing countries such as Turkey, Israel, Egypt, India, and Mexico have taken steps in one or two of these areas. However, in the majority, attempts in these directions are slow and hence a drag on efficient water resource development.

These and many other factors, taken together, operate as disincentives and create a "vicious cycle" of stagnation in water resource development in developing countries, which in turn impede general economic and social development of the countries (Figure 2.2).

## 2.5 Institutional Innovations

The adoption of institutional innovations has been suggested as an effective instrument of economic and social change. As one United Nations publication puts it:

The institutional and organizational arrangements for the water function, like those for other major public services, are an essential part of a developing nation's socio-economic and policy administrative infrastructure. No less than technological innovation, institutional and organizational adaptation is a necessary concomitant of, if not an indispensable prerequisite for, the process of modernization and development.<sup>33</sup>

Institutional innovations in water resource development may be classified as those related to the: (1) allocation of responsibilities, and (2) appropriate areal unit for water development and/or management.

### 2.5.1 Allocation of Responsibilities

A basic problem in water resource development is the allocation of responsibilities within and among different levels of administration - local, regional, national, and international. This lag has been traced in many cases to inadequacies in the: (1) prevailing body of water legislation, and (2) organizational structures of the

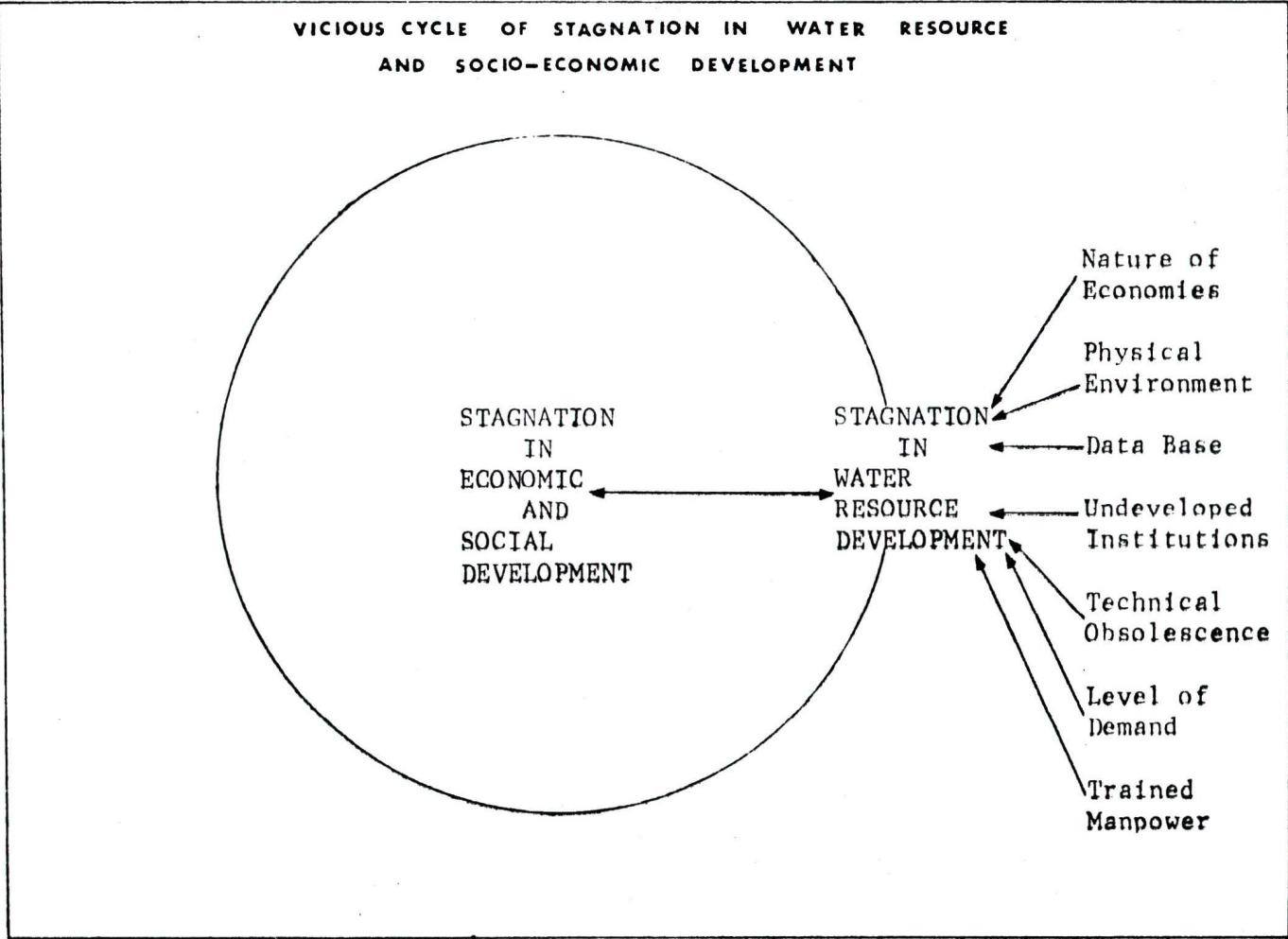


Figure 2.2

bureaucracies charged with the development and administration of the water resources. It is also recognized that water laws and organizational structures of various developing countries are deeply rooted in tradition, physical environment, economy, needs, and other factors. For instance, defined ownership by the central government can mean a superior ability to proceed with water development projects without the delay of buying up or otherwise obtaining the necessary water rights. However, such a system can fail to detect the need for transfers or the existence of physical and economic inefficiencies in use, and can fail to motivate technological changes in water management called for by changing conditions of demand and supply.

It is, therefore, impossible to suggest a universal body of laws and/or organizational structure. In fact, a survey of several developing and developed countries suggests four categories of basic laws of water ownership; central government ownership and control; central/provincial (or state) government ownership and control; co-operative social ownership and control with qualified private access to supplies; modified private ownership. Infinite number of organization structures are also discernible, a rough classification of which may be as follows: centralized; co-ordinated - decentralized; and decentralized.

However, it is recommended that if the following components are guaranteed in the formulation of the institutional arrangements, a logical and scientific basis would have been created for the development and evaluation of water resources development. With regard to the body of water legislation, the following components must be observed.

- a. Laws and case law pertaining to the ownership and use of water;
- b. Laws and case law pertaining to the authority for and administration of water planning and management;
- c. Laws and/or administrative rules pertaining to procedures to be used in water planning and management (such as the United States Water Resources Council's Principles and Standards of 1973); and
- d. International treaty obligations.

Regarding organizational structure, it is suggested that the:

- a. set of water agencies should be assigned a set of planning and/or management tasks with related authority. There should also be:
- b. sets of government and non-government decision makers which must approve or can influence the (rules of the game) laws, policy, and water - related budget - for example, legislative committees, executive agencies, inter-ministerial committees or task forces, appeal boards, and national or regional special interest groups; and
- c. agency structure - with sets of formally and informally defined relations consisting of:

- (i) interagency authority structure; who can tell whom to do what?
- (ii) administrative procedures, including channels of co-ordination and information flow among water agencies; and
- (iii) informational and education linkages to external parties, including decision makers; should be accounted for.

Over and above the foregoing, allowance for public held values and perceptions regarding:

- a. the roles of government and planning generally;
- b. water as a resource; the nature of water related problems and the "water is different" syndrome; and
- c. agencies - their proper roles, their effectiveness and the credibility of their informational and educational ties to external publics - should be upheld.<sup>34</sup>

#### 2.5.2 Appropriate Areal Management Units

The selection of appropriate areal units for development and management of water resources in the developing countries is another institutional area where innovations are considered essential. Various kinds of units have been tried before in several developed countries.<sup>35</sup> Their selection according to Barr<sup>36</sup>, have been based on at least four (4) types of factors, namely, the

- 1. physical and economic characteristics of the resources (water);
- 2. nature and the magnitude of the services to be provided;

3. comprehensiveness of the viewpoint adopted;  
and
4. possibilities for improving efficiency in  
the performance of water management functions.

For the developing countries, the river basin is the areal unit suggested for water resource development. However, as noted before, the adoption of the concept in developing countries was not only delayed until the 1940's but also since then the rate of adoption has not been as fast as anticipated. It is hoped that this thesis will lead to better understanding of the factors underlying the adoption pattern.

## 2.6 Overview

Since attainment of statehoods, virtually all developing countries have experimented with one or more forms of development strategy, none of which seems to work. In recent years, the trend has been towards resource oriented strategies. One of these set of strategies is water resource development. Though it has great potential for lifting the developing countries out of the doldrums of underdevelopment, its implementation is beset with a myriad of problems including institutional constraints. Consequently, institutional innovations have been suggested by both government and independent development experts.

One such institutional innovation is the concept of integrated river basin development. This concept has been

known for some time to be most beneficial to the developing countries but it was not until the 1940's that it was first adopted. Its adoption was even further delayed in Africa until the late 1950's and early 1960's. It is the purpose of this research, therefore, to study the diffusion of the concept in developing countries between 1940 and 1971, and to seek answers to among other questions, why the adoption of the concept in developing countries was delayed so long.

## CHAPTER 3

### THEORETICAL FRAMEWORK

#### 3.1 Introduction

Diffusion research seeks to offer explanations for the spread of innovations. This chapter will review two major aspects of diffusion research:

1. the research questions examined by various disciplines in the social science, and
2. the concepts and generalizations reported in diffusion literature.

#### 3.2 Diffusion Research in the Social Sciences

Within the social sciences, each discipline tends to focus upon certain elements involved in a diffusion process. In seeking to understand how cultures develop and change, anthropology has researched the spread of cultural traits among societies. This is exemplified by the research of Gordon Childe<sup>1</sup>, Kroeber<sup>2</sup>, and Ralph Lintin.<sup>3</sup>

Kroeber's definition of diffusion:

the process, usually but not necessarily gradual, by which elements or systems of culture are spread; by which an invention or a new institution adopted in one place is adopted in neighbouring areas and in some cases continues to be adopted in adjacent ones until it may spread over the whole earth

is a clear testimony to the above noted nature of anthropological diffusion studies. Evident in the anthropological literature is also the lack of interest in the spread of cultural traits within a single society. Homer Barnett's definition of diffusion demonstrates this absence of interest. He noted that diffusion is:

The growth in popularity of a new idea within the society of its origin then comes under the heading of "adoption", "acceptance", or some similar term, whereas the passage of an idea across ethnic boundaries is usually referred to as its "spreading", "borrowing", or "diffusion".<sup>4</sup>

The above definitions could be attributed to anthropologists who rejected the theory of unilinear evolution - the classical nineteenth century thesis which dealt with particular cultures, and placed them in stages of a universal sequence.<sup>5</sup> Thus, the twentieth century anthropologists regard cultural development as essentially divergent, except as diffusion tends to level differences.<sup>6</sup>

Sociologists, on the other hand, have tended to focus their research on the spread of phenomenon within societies. Although Tarde<sup>7</sup> made observations in the nineteenth century on the process of imitation within a society, it was not until the early twentieth century that concrete interest in diffusion research was developed in sociology. The early Americans in this field are classed by Rogers<sup>8</sup> as early sociologists and they include

Tarde, Bowers<sup>9</sup>, and Mcvov<sup>10</sup>, to mention only a few.

Bowers defined cultural diffusion as:

The concept found in sociological literature to symbolize the process by which inventions become adopted by society.

Implicit in this definition is the emphasis on cultural diffusion of inventions. This fact, Cohen<sup>11</sup> maintains, points to the impact of anthropology on sociologists. This assertion is borne out in the words of Bowers, who noted that:

Most research in this field has been done by anthropologists, their chief emphasis having been diffusion across societal boundaries . . . The nature of diffusion within a society is, however, still largely unknown.<sup>12</sup>

That is, as late as 1938, the nature of diffusion of phenomena within society was considered still largely unknown. It was not until the 1963 work by Katz, Levin, and Hamilton that what can be considered as a classical definition of diffusion from the sociological point of view was arrived at. Diffusion, they said, may be characterized as:

. . . the (1) acceptance, (2) over time, (3) of some specific item - an idea or practice, (4) by individuals, groups or other adopting units, linked (5) to specific channels of communication, (6) to a social structure, and (7) to a given system of values, or culture.<sup>13</sup>

This definition, it should be noted, points to general elements that are involved in any diffusion process:

adoption by specific acceptance units, the time element, and an item that spreads. The definition further emphasizes spread within a society and reference is made to the role of a communication network in a diffusion process. These are characteristic of much of the research done by sociologists. It should also be noted that the above definition, like that of the anthropologists, indicate lack of interest in the impact or the significance of economic and spatial factors on diffusion.

In contrast to sociologists, economists have demonstrated interest in one area of cultural invention; namely, technology. Their major concern is with the impact of technological inventions on economic development.<sup>14</sup> Many studies deal with the causes and conditions for the appearance of technical innovations. Hakanson<sup>15</sup> for instance observed that profitability, foreign competition and economic development were some of the major reasons for the differential rates of diffusion of special presses in the paper making industry in Western Europe. Many others discuss the influence of technological change on an economy, and many more are confined to analysis of technological spread within one industry. Except in a few cases, economic diffusion research has rarely had any spatial dimensions. In fact to the knowledge of the author, only one economist, Griliches<sup>16</sup>, has examined the spatial

spread of a technological innovation. This neglect does not mean that spatial theory is unimportant in diffusion research. On the contrary, it is an important key to understanding the variations in adoption of innovations.

The spatial dimension of diffusion research absent in other social science inquiries has been the subject of geographical research. This is manifested in the words of Torsten Hagerstrand, whose work has been most influential since the 1950's. He noted that:

The diffusion of innovations - the origin and dissemination of cultural novelties - is an area of study which concerns all sciences dealing with human activity, including, not least of all, cultural and economic geography . . . Analysis of the innovation diffusion in question is aimed at gaining an understanding of distributional changes between points in time.<sup>17</sup>

Explicit in the above statement is Hagerstrand's concern for spatial diffusion of innovations. However, it by no means suggests that geographical studies in diffusion began in the 1950's. On the contrary, one of the traditional concerns of geographers (at least since Ratzel) has been the interpretation of the spread or retrogression of the things that occupy space on the face of the earth. Ratzel<sup>18</sup> in the second *Anthropogeographie*, described the patterns of population and culture that had resulted from the process of diffusion from centres of origin. Ellen Semple<sup>19</sup> also discussed the various ways culture change could be

brought about - by conquest, infiltration, influence and many other ways.

Traditionally, geographers have sought explanations of diffusion through the deciphering of historical processes. By plotting patterns resulting from the diffusion process on maps, it has been possible to identify centres of origin and directions of spread. Biogeographers and cultural anthropologists have used the cartographic method to throw light on the subjects they were investigating. Carl Sauer's<sup>20</sup> thought-provoking hypothesis regarding agricultural origins and dispersals uses the cartographic method to illuminate prehistoric problems. Kniffen<sup>21</sup> used maps of house types to reveal directions of migration, as Kurath<sup>22</sup> did with word usage and pronunciation in the late 1940's. To these, Hagerstrand added the importance of "distance". Nevertheless, he also stressed that distance/space alone can never be the sole factor that explains diffusion or change in distribution. In his words,

The spatial or chronological approach to the diffusion of innovation is only one of many and cannot be isolated from others. Its importance ought to vary with the form of the observed population's distribution and with the communications media involved.<sup>23</sup>

This observation, coupled perhaps with the lack of any new qualitative general finding in his studies, made him base all the causal explanations of his studies on one

additional factor: interaction and communication between individuals. Although the effect of communication and interaction is not explicitly analyzed in his work, Hagerstrand made important contributions to diffusion literature when he explicitly incorporated distance in analyzing the spread of innovations, and pioneered the use of mathematical models to describe and predict the diffusion on innovations.

He developed two kinds of models: first the inductive model (empirical generalization) to describe the characteristics of innovation waves; and second a stochastic model in which he made use of a Monte Carlo simulation to predict the probability of innovation spread. Individuals, he postulated, are more likely to be informed about an innovation the closer they are to the source of the innovation. Distance, of course, is not a mere linear distance, but also a measure of contiguity and contact.

These contributions have provided influential basis for considerable progress in geographical research in diffusion. For instance, in 1965 Yuill<sup>24</sup> made use of the simulation models to show the possible patterns of spread around several kinds of barriers. Morill<sup>25</sup> and Bowden<sup>26</sup> also have employed the quantitative approach though without rigorously questioning the underlying assumptions.

It is important to note that these diffusion studies have been done at different resolution levels. Hagerstrand's was a high resolution level which permitted him to focus on specific individuals and made possible certain general concepts regarding individual human behaviour. Yuill, on the other hand, worked at a somewhat lower resolution level that focused on groups rather than individuals. It is also possible to study diffusion processes at a very low resolution level - a global scale, and to see whether the concepts, models and generalizations of the upper resolution levels do necessarily apply. This is something that is missing in the literature on geographical diffusion. Without question, diffusion research generally can be enriched by the examination of this resolution level.<sup>27</sup>

### 3.3 Major Findings of Diffusion Research

These different perspectives have resulted in two groups of generalizations about diffusion of innovations. First there are those that pertain to how innovations spread, which include the:

- neighbourhood effect;
- hierarchical effect; and
- logistic curve.

Second, there are those generalizations that explain the role of factors that affect the course of diffusion such as the roles of information, interaction, the innovation,

the adoption unit, and the communication process. In this chapter, findings related to the aforementioned generalizations will be discussed.

### 3.3.1 Neighbourhood Effect

The neighbourhood effect states that the closer a potential adoption is to a source of innovation, the greater the likelihood the unit will adopt before potential adopters, that are farther away. This finding confirms Hagerstrand's contention that space or distance does influence adoption of innovations. Bower's<sup>28</sup> work on the direction of intra-societal diffusion and Grilliches,<sup>29</sup> on hybrid corn are some of the studies that support this generalization.

In an examination of agricultural diffusion, Coleman and Marsh<sup>30</sup> concluded that the most influential parameter leading to adoption was the vicarious experience that individuals obtained from viewing the results of adoption by a neighbour. Crain<sup>31</sup> also found in his study of fluoridation in cities that cities were more likely to adopt fluoridation if a neighbour adopted it. However, Tornquist<sup>32</sup> in his study of adoption of televisions in Sweden did not find the concept relevant as did Cliff.<sup>33</sup> These results seem to suggest that the neighbourhood effect is operative in homogeneous population sets where interpersonal communications underlies the diffusion process. It will be interesting to see whether the characteristics of the

developing countries is an adequate basis of homogeneity to allow the neighbourhood effect to be operative.

### 3.3.2 The Hierarchical Effect

The hierarchical effect defines a criterion for the hierarchy (size, social status, etc.) and suggests that the higher the ranking of a potential adoption unit, the greater the chance of adoption before units in the hierarchy regardless of the relative spatial locations of the units.

Thus Hagerstrand noted:

In addition to the influence from the centre on the neighbourhood districts we find short circuits to the more important places at a greater distance.<sup>34</sup>

The validity of the hierarchical effect is also supported by Casetti, and Semple<sup>35</sup> on the basis of their study on the diffusion of tractors in the United States. In examining modernization in Sierra Leone, Riddell<sup>36</sup> found that the modernization process moved down the urban hierarchy along the transportation system.

On the other hand, Huang and Gould's<sup>37</sup> study of the spread of Rotary Clubs in Kansas and Nebraska did not overwhelmingly establish the presence of hierarchical pattern in the two areas. While the pattern was evident in Kansas, the opposite was true in Nebraska. Another partial confirmation of the hierarchical effect was given by Shepperd<sup>38</sup> in his study of the diffusion of shopping centres in Canada. His conclusion was that the concept was

more evident in the early stages of adoption than the later stages.

### 3.3.3 Logistic Curve

It is also the concensus of diffusion researchers that the accumulation of adopters through time results in a logistic curve. It is to be pointed out, however, that the logistic curve could be accounted for by factors other than time. For example, Griliches<sup>39</sup> in his hybrid corn study explained the observed logistic curve as a result of supply and demand factors. Mansfield<sup>40</sup>, in his study on the adoption of new irrigation techniques accounted for the observed logistic curve by the size of investment involved. Hudson<sup>41</sup> demonstrated that in a given central place system, the logistic curve can be derived by the joint operation of hierarchical and neighbourhood effects. The existence of such divergencence of opinion indicates that different processes might lead to the explanation of an observed diffusion.

### 3.3.4 Information, Communication and Interaction

There is agreement in the literature that information spread precedes or coincides with adoption.<sup>42</sup> On the other hand, only partial answers have been found as to whether it is the availability of information that determines the rate of adoption, or the character of communication. The exact roles of the various media have also to be

established, though there is a general concensus that both media and interpersonal contact do affect diffusion, especially when the adoption units are individuals.<sup>43</sup>

When the adoption unit is a public institution or a government body, very little is known about the role of information and communication media and of personal interaction in affecting the adoption of an innovation. The little research in this area by McVoy<sup>44</sup> and Crain<sup>45</sup> simply point out that the decision to adopt an innovation in a community is influenced by ones from neighbouring and/or higher status communities which have already adopted. Crain specifically questions the relevance of studying the role of inter-personal contact and of communication when the adoption unit is a city.

It seems apparent that the role of information, communication, and interaction as factors affecting diffusion remains to be explored deeper. Indications are that these factors vary in significance with the size of the adoption unit or with the kind of innovation under study.

### 3.3.5 The Innovation and Adoption Unit

It is further agreed that the characteristics of both the innovation and the adoption unit affect the course of diffusion. Regarding the innovation, the important characteristics include the relative advantage or profit-

ability, compatibility, divisibility, complexity, and observability or communicability.<sup>46</sup>

By relative advantage it is meant "The degree to which an innovation is superior to the ideas it supersedes."<sup>47</sup> The term is often expressed in economic profitability, though it may be measured in other ways. As Johnson and Wilkening pointed out, the nature of the innovation may determine what specific type of relative advantage (e.g. economic or social) is important to adopters.

In 1964, Schultz<sup>48</sup> argued against the prevailing view that socio-economic variables are important determinants of the rate of adoption of innovations among peasants in less developed countries. He argued instead that relative advantage is the only attribute of innovations affecting their rate of adoption. This study may go to show whether or not this assertion is valid for adoption at the government level.

Compatibility is "the degree to which an innovation is consistent with existing values and past experiences of the adopters."<sup>49</sup> The values and experiences of the adopters include cultural norms and previously adopted ideas. There are several investigations which show the compatibility of new ideas affecting the rate of adoption of the innovation. Graham<sup>50</sup> for example, found that class structure explained the differences in the adoption of

television. Yeracaris<sup>51</sup> also found that the acceptance of tuberculosis testing was a direct function of the degree to which the innovational characteristics are compatible with the health practices, attitudes and values of the respondents.

The degree to which an innovation may be tried on a limited basis is also a measure of its divisibility or trialability. While some ideas can be tried on the installment plan (trial over time), others cannot be divided for small scale trial. There is very little evidence in support of the impact of this attribute on innovation diffusion. One of the few is provided by Fliegel<sup>52</sup> and others who found a correlation between divisibility and the adoption behaviour of farmers.

Complexity is also related to the "degree to which an innovation is relatively difficult to understand and use."<sup>53</sup> Kivlin's<sup>54</sup> study on farm innovations concluded that the complexity of farm innovations was more highly related, in a negative direction to their rate of adoption than other characteristics of the innovations except relative advantage.

Observability, otherwise termed communicability or visibility, refers to the degree to which the results of an innovation are visible to others.<sup>55</sup> Among the studies that confirm the importance of this characteristic in adoption

decisions are those of Hruschka and Rheinwald.<sup>56</sup> They established that the more observable innovations which were demonstrated by German pilot farmers diffused more widely than less visible innovations.

Various researchers have also drawn attention to the dangers of ignoring the characteristics of the adopting unit.<sup>57</sup> How these characteristics influence the diffusion of an innovation vary as some research shows that they may affect the diffusion process either negatively or positively. Thus, it is difficult to generalize on the factors underlying the diffusion process and there is a need for further research into those factors. It is important to observe that the foregoing generalizations have been reached mainly on the basis of studies at the individual level.<sup>58</sup> It will not only be interesting to know whether it is easy to generalize at the international level but also whether the above generalizations are applicable at that level.

#### 3.4 International Diffusion of Innovation

The world is a system in which the states, countries, communities and individuals are parts where understanding the parts does not guarantee understanding of the whole. International studies are, therefore, logical continuation of local or national studies. As noted in Chapter 1, international diffusion studies are also important for international trade and development. In spite of these

facts, diffusion across national boundaries has been little researched.<sup>59</sup> Apart from archaeological studies of prehistory innovation diffusion, the only major examples known are that of Woodruff<sup>60</sup>, Maddala and Knight<sup>61</sup> and Pedersen.<sup>62</sup>

Woodruff's work is a descriptive account of the origin of production techniques in the rubber industry. Maddala and Knight examined in some detail the factors determining the rate of diffusion world-wide of a single new technique in the iron and steel industry, the top-blown oxygen converter (L-D process) and they refuted the allegation of development theorists that: (1) technical change originating in the industrialized countries tends to have labour-saving bias and hence unsuited for developing countries; and (2) size of market is not a basis for adoption of advanced technology in developing countries.

Pederson tried to apply diffusion concepts to his study on the spread of ten innovations in South America. He isolated three common factors which have influenced the diffusion pattern. They are Spanish colonial administrative hierarchy, the total national product, and a dichotomous factor which differentiates between the European and North American influence fields. However, in focusing his study on only Latin America, he was unable to make any generalization concerning other nations of the developing world

or the international diffusion of innovations.

### 3.5 Innovation Diffusion in the Developing Countries

Although much is known about the diffusion of innovations in developed countries<sup>63</sup>, relatively few studies have been completed on the spread of ideas in less developed nations.<sup>64</sup> The few diffusion studies conducted in these countries have been characterized by: (1) the use of small sample of respondents in single villages, (2) concepts, design and research methods borrowed directly from U.S. and European diffusion research; and (3) concentration on peasant agricultural activities.<sup>65</sup>

In a study on the agricultural development in Taiwan, Phillipines and Thailand, Ruttan<sup>66</sup> analyzed the factors that accelerated the diffusion of new crop varieties. He noted that an important factor in the diffusion process was the rapid irrigation development, especially in Taiwan between 1900 and the 1920's. In an update on Ruttan's work, Rogers generalized with regard to the Green Revolution in Asia that the: (1) rate of adoption of high-yielding varieties has been extremely rapid, (2) fast rate is traceable in part to the (a) great relative advantage of the miracle seeds over previous varieties, (b) compatibility of the innovations with the spread of fertilizers, irrigation and other supportive innovations, and (c) rapid availability of the seeds which were imported by the ship load, rather

than having to go through the slower process of seed multiplication. (3) The preconditions for rapid diffusion were novel and not likely to be repeated, nor was the rate of diffusion likely to continue to 100 per cent adoption.

Between 1964 and 1968 the U.S. Agency for International Development sponsored a project under the direction of Rogers to undertake a comparative study of agricultural technology in Brazil, India and Nigeria. The purpose of the project was to identify peasant village characteristics considered relevant to the success of change programs, as well as individual socio-economic, social, psychological and communication variables which distinguished the innovator and the opinion leader from the rank and file.<sup>67</sup>

The results led to eleven general conclusions. Among them were that the success of village programs agricultural change were positively related to the villages:

- a. socio economic development,
- b. institutional development,
- c. openness,
- d. communication/integration, and
- e. leaders' modernization.

### 3.6 Overview

Diffusion research in the social sciences provide some explanation for the spread of innovations. However, the various disciplines emphasize different elements of diffusion

research. While anthropologists are concerned with the spread of cultural traits, sociologists and economists focus attention on diffusion of cultural inventions and technology respectively. Geographers, on the other hand, after the pioneering work of Torsten Hägerstrand have emphasized the spatial aspects of diffusion. The culmination of research in these fields has been a set of generalizations that describe and explain the diffusion process.

Nonetheless, these generalizations have been mainly generated from studies on individuals rather than institutions. In spite of the importance of international studies in international trade and development, the field of international diffusion of innovations is little researched. Hence its relationship to existing concepts and generalizations is yet to be established. The existing concepts also emphasize distance, time and information as major factors affecting the spread of innovations.

Among the few diffusion studies that have been conducted on developing countries, there is overwhelming bias towards peasant studies. They have also been based on concepts and theories originating from research about the developed countries. Above all, the studies have all been based on small samples. Most important of all, despite the importance of the concept of integrated river basin development to national and international development, the diffusion of the idea is yet to be analyzed.

## CHAPTER 4

### CONCEPTUAL FRAMEWORK

#### 4.1 Introduction

In Chapter 1 it was noted that one objective of this study is to identify the characteristics of the developing countries and the innovation. This chapter, therefore, outlines the known characteristics of the countries and the innovation along with their implications for economic and social development. This will provide a rationale for the selection of relevant variables and an understanding of possible relationships between them.

#### 4.2 The Developing Countries

The developing countries of this study include the whole of Asia with the exception of Japan, the whole of Africa with the exception of South Africa, and the whole of the western hemisphere except for the United States and Canada (that is, Latin America and the Caribbean area). Thus the developing countries contain about two-thirds of the world's population approximately 2.5 billion people. Some of the countries are very large (for example, India, Brazil), while others are tiny ministates (for example, Gambia, Honduras). Some have extremely subsistence

societies - in fact little beyond subsistence agriculture (for example, the Comore Islands); others have sophisticated industrial and urban and social patterns (such as Egypt and Israel). Some are democratic and ultra-capitalist, while others are communist and centrally planned. Most are mixed economies in varying degrees.<sup>1</sup> Thus, it is impossible to classify the developing countries by one criterion.

As Myint<sup>2</sup> puts it:

The first thing to bear in mind about the developing countries is that beyond the broad common fact of poverty it is rarely safe to make generalizations about them without carefully specifying the type of developing country one is considering . . . Instead of a monolithic theory to cover all the countries it will be more fruitful to look for alternative theoretical models to suit different types of developing countries.

Various classification attempts have been based on manifestations of the known common characteristics of the countries which are mainly socio-economic.

#### 4.3 Socio-Economic Characteristics

Some of the most frequently referred to characteristics are:

- rapid growth of population and, consequently, of labour force,
- polarized distribution of development and wealth,
- resource exploitation stressing agriculture,
- lack of capital and technical, economic and managerial training as well as of effective social and political administration,

- adherence to ancient customs,
- low labour productivity,
- poor and limited industrial production,
- low per capita income and low standards of living<sup>3</sup>

These characteristics can greatly affect development efforts, especially water resource development, as will be discussed later.

#### 4.3.1 Rapid Population Growth

The rate of population growth in developing countries stands out as an important factor explaining the continued low level of development. Presently, the annual population growth rate averages 2.5 per cent. The U.N. has projected an even higher incremental rate of around 2.6 per cent for the 1980's.<sup>4</sup> The high birth rate means that the proportion of children and young people at any time in developing countries is much higher than in the developed countries. Typically, nearly half the population is under 15 years and almost two-thirds under 25. This means that those countries have to devote much of their resources to raising the next generation, while providing services of a given standard to an enlarged and rapidly urbanizing population.

The foregoing circumstances inevitably result in increased labour force which Nurkse<sup>5</sup> has noted to be "surplus" and Lewis<sup>6</sup> as "unlimited". Regardless of the designation,

there is considerable under-utilization of labour which distorts the investment patterns as development funds are directed to non-productive activities necessitated by the burgeoning population.

#### 4.3.2 Polarized Distribution of Development

Within most developing countries the spatial pattern of development has been exceedingly uneven. In West Africa, for example, the region extending some 200 miles inland has moved rapidly into the money economy whereas the vast interior regions have been relatively little touched by modern advance.<sup>7</sup> In Argentina, the Greater Buenos Aires conurbation and a few cities in the interior absorb most of the existing capital. In Brazil the same is true of the coastal zone and, particularly, the area between Rio de Janeiro and the south of Sao Paulo. In Peru, the wealth is concentrated in Lima and Callao and in the narrow agricultural belt. In Mexico, the bulk of public and private capital is taken up by Mexico City and no more than six of the 31 entities of the country.<sup>8</sup> Similar concentrations can be found in Asia.

But the concentration of wealth is possibly most evident at the social level. A survey of ten African countries has revealed excessive degrees of concentration of wealth. For instance, the wealthiest class comprising only five per cent of the population receives no less than

40 to 50 per cent of the gross domestic produce (G.D.P.).<sup>9</sup> Again, similar situations can be found in Asia, especially Indian, Pakistan, Sri Lanka, the Philippines; and Latin America.

The situation in the latter is typified by Brazil where the most important sectors of industry are held by branches and subsidiaries of the great international trusts and an oligarchy made up of the old landowners and the businessmen and industrialists strengthened by the 1930 revolution who, after inevitable frictions, have finally come to an understanding.<sup>10</sup> In Chile, it is estimated that most of the economic activity and social wealth is controlled by no more than three or four financial groups.<sup>11</sup>

The consequences of the uneven spatial and social development are tremendous. The former accentuates rural to urban migration, urban sprawl, and slum development - in short, uneven population distribution which only perpetuates the uneven development. Social inequalities also result in persistence of employment and underemployment. Under such conditions, the tax base of the economy is limited and resource investments suffer.

#### 4.3.3 Resource Exploitation

Most developing countries are monocultural economies; that is, dependent on the exploitation of one resource for both income and employment. In many, the majority of the

labour force derive their livelihood from food production.<sup>12</sup> It is not uncommon to find at least 70 per cent of the labour force dependent on agriculture. In South East Asia, it is close to 75 per cent, and in Africa between 80 and 90 per cent of the population found in the rural areas is engaged in agriculture.

Coupled with the export orientation of the economies, this specialization results in a far reaching impede of production and/or development efforts. The economies are subject to the fluctuations in the international prices of primary products<sup>13</sup> which create corresponding changes in national incomes. This, in turn, causes fluctuations in the implementation of programs.

#### 4.3.4 Lack of Capital and Trained Manpower

In the developing countries investment is basic to development. However, the capacity to draw off significant amounts of savings from the domestic economy is limited by the low level of individual income. The creation of capital requires that either individuals or enterprises in the country set aside some portion of their current incomes for investment.<sup>14</sup> The phenomenon of scarcity of capital and its relationship with savings has been observed by Nurkse<sup>15</sup>, in Latin America. He noted that:

On the supply side, there is the small capacity to save, resulting from the low level of real income. This low real income is a reflection

of low productivity, which in turn is due largely to the lack of capital. The lack of capital is a result of the small capacity to save, and so the circle is complete. On the demand side, the inducement to invest may be low because of the small buying power of the people which in the final analysis, is due to low productivity. The low level of productivity, however, is a result of the small amount of capital used in production, which in its turn may be caused at least partly by the small inducement to invest.

The effect of this inadequacy of capital is that the countries' ability to undertake important development programs is limited.

Scarcity of trained human resources is yet another trait of developing countries. Insufficient educational programs means that most governments lack the administrative ability to execute large and complex development schemes, and that governments and private firms must continue for years to import expensive foreign manpower. It also means that countries must devote substantial resources to education and the development of skills; causing reductions in investments in other resource development options such as water.

A. de Vajda<sup>16</sup> identified the magnitude of the challenge posed by this trait to water resource development when he wrote:

The greatest obstacle to the success of irrigation and drainage schemes in most developing countries is not technical. It is the lack of well trained permanently employed technical personnel . . . Very few of the developing countries possess a well-

organized and well-staffed administration able to carry out design, construction and which is even more important, to supervise operation of large . . . projects.

#### 4.3.5 Adherence to Ancient Customs

In the face of modernization, ancient customs are still preserved in many developing countries. Among the many prevailing customs, Lewis<sup>17</sup> for instance, observed that more women marry in developing countries than in Europe. In India, he contends, only one per cent (1%) of women were not married at the age of 45. It has also been observed in the same subregion that women marry at an earlier age. These marriage practices, reinforced by high fertility, go to boost the population growth rate which in turn act<sup>s</sup> as a brake on economic development.

With regard to agriculture in particular, the ancient land tenure arrangements, "communal" ownership, is maintained resulting in small unconsolidated land holdings. Where matrilineal inheritance patterns exist, fathers pass their properties (farms, businesses, etc.) to nephews not sons. These patterns of land holdings and inheritance tend to reduce incentives to improve land and, more importantly, lack of clear cut ownership claims exposes land titles to uncertainty and makes it difficult to establish systems of agriculture credit. These in turn go to affect production levels. In terms of water resource development, the effect of such traditions can be illustrated by the fact that an

excellent reservoir site may be bypassed because it would inundate historical or religious monuments of great value to the people.

#### 4.3.6 Low Productivity

Partly as a result of the lack of capital, as Nurkse noted, and partly as a result of the adherence to old traditions, labour productivity in developing countries is considered to be low. On African agriculture, Kimble noted in 1960 that:

The productivity is still so low that it takes anywhere from two to three people - men, women, and children, to raise enough food to supply their own needs and those of one additional non-food-growing adult.<sup>18</sup>

The low productivity is by no means confined to agriculture. On the contrary, the problem exists in industry and administration as well.

#### 4.3.7 Poor and Limited Industrial Production

The industrial sector of the developing countries is small in terms of (1) the variety of products, (2) the labour force employed, and (3) its rate of growth. The high share of agriculture in their gross domestic products<sup>19</sup> is a manifestation of the low level of industrial development. Though urged by the desire for self-sufficiency and expanding local markets production has in recent years increased considerably in some countries - 47 per cent in Mexico, 36 per cent in Brazil, 24 per cent in

Argentina, and 20 per cent in India<sup>20</sup> - the increases are nominal in relation to their potentials. This is because of limitations imposed by such obstacles as uncertain demand, income fluctuations, political uncertainties<sup>21</sup>, heavy reliance on imported inputs, and insufficient social infrastructure.

The implications of this lag in the industrial sector are many. Among them are the continued reliance on foreign goods at the expense of foreign exchange reserves. The countries also remain prone to international economic fluctuations such as inflation and depression. The cumulative effect of these is reduction in development efforts in all sectors of the economy. In water resource development particularly, this leads to reliance being placed on imported machinery which invariably are unsuited to the local environment.

#### 4.3.8 Dependence on External Economic Relationships

One other characteristic of the developing countries is their dependence on relationships with external economies, especially advanced countries. Nowhere is this dependence more apparent than in the importance of international trade to the developing countries; whether measured by the large proportion of exports in national product<sup>22</sup>, the considerable importance of imported capital goods in the annual increase of development capital<sup>23</sup> or by the

often substantial amount of imported agricultural staples in domestic consumption.<sup>24</sup>

This dependence, accentuated by instability in export prices<sup>25</sup> result in variable foreign earnings and secular deterioration in terms of trade - all of which worsen the countries' external financial positions and eventually development efforts.

#### 4.3.9 Low Per Capita Income and Standards of Living

The best known attribute of the developing countries is their low per capita incomes and standards of living. It should be realized, however, that the developing countries are not all poor in terms of per capita income, though the overwhelming majority of them are.<sup>26</sup> In most of Latin America, per capita income figures are less than U.S. \$270.<sup>27</sup> In Africa, it is considerably less and even worse in Asia. The low per capita incomes prevent the generation of a sizable investment surplus. New sectors of modern economic growth thus remain very small, especially in terms of employment; and often foreign controlled. The national economy at large remains deprived of new capital infusion. Consequently, standards of living remain virtually constant.

It is to be noted that this discussion begs a number of questions concerning the basis or causes of these characteristics. Many radical development experts and

scholars have attributed them to imperialism or colonialism.<sup>28</sup> Though such arguments fall beyond the scope of this study, it is reasonable to assume that political characteristics are important in water resource development.

#### 4.4 Political Characteristics

Political characteristics might include:

- a. International and/or interregional ties; and,
- b. decision-making and political stability in the country.

##### 4.4.1 International and/or Interregional Ties

International and interregional institutions are emerging as major sources of development initiatives.

This is basically because of the:

- a. perceived utility of multilateral co-operation which they represent; and
- b. the large amount of financial resources that such organizations can provide.

Institutions that have been involved in development programs in the developing countries include the United Nations and its regional agencies, the European Economic Community (E.E.C.), the Organization for Economic Co-operation and Development (O.E.C.D.).

Many developing countries are affiliated with such institutions through bilateral and multilateral agreements and have consequently gained tremendously from the financial and technical resources they can and do provide for various

development projects including water resources.

#### 4.4.2 Decision-Making and Political Stability

Development programs are affected by the degree to which the decision-making process is autocratic versus democratic. If the decision-making process is autocratic, such that a few interested parties can make a decision to go ahead with a water development project in spite of adverse opinion, then resource development may proceed quickly. Such conditions are common in developing countries where the concentration of wealth gives sections of the community room to sway certain decisions in their favour. This is typified by the Walawaganga irrigation project in Sri Lanka which was initiated in spite of contrary opinion expressed by a World Bank Mission.

Besides the unusual political culture, the political stability of many of the countries are always uncertain. Governmental changes are rampant and usually accompanied by violence, nationalizations, and outright confiscation of resources and investments. These events scare away private capital. Consequently, many of these countries have had to rely only on multilateral aid in developing their water and other resources - a fact which impedes the pace at which such programs can be accomplished.

#### 4.5 Characteristics of the Concept

The concept of integrated river basin development is characterized by three theoretical and interrelated ideas - multi-purpose, basin-wide programming, and comprehensive regional development. These characteristics are what go to make the concept an attractive development approach; and must, therefore, be present whenever the concept is applied or implied, be it in the developing or developed world. Precluding one of the components also precludes the execution of an integrated river basin program. Hence, these characteristics are indispensable parts of any water resource development planned in the framework of the concept.

Like any other innovation, the concept may also be characterized in other ways - compatible, profitable, communicable, complex, and divisible.

The concept is compatible with a number of practices that take place in the river basin and also enhances the profitability of some of these practices or activities. For example, irrigation agriculture in a river basin would not only be compatible with a basin project, but also its profitability in terms of yield would be enhanced. A case in point is irrigation agriculture in the Sudan (Nile Basin) which received a boost in profitability as a result of its compatibility with the development of the

Sudanese portion of the Nile basin.

The concept is not easily communicable in the sense that a potential adopter cannot readily envision the results such as the visible structures like dams, reservoirs, lake, giant power station, etc. It is also a relatively complex concept because of the need to join or coordinate two or more uses under one development scheme. Its implementation demands input from administrators, engineers, hydrologists, sedimentologists, meteorologists, geologists, and other specialists.

Furthermore, the concept is indivisible. However, the benefits are divisible in that once a concept has been implemented, some projects may be added and others discontinued. For instance, an irrigation program can be added or discontinued while the provision of power, recreation, fishing and others are still pursued. Thus the concept of integrated river basin development can be said to be compatible, profitable, complex, communicable, and divisible.

These characteristics are related to water resource development in the sense that any country seeking to derive optimum benefits from the application of the concept must also ensure that the above characteristics are favourable.

#### 4.6 Characteristics of Water

The characteristics of the concept cannot be devoid of comments on the characteristics of water. It is the nature of water that seems to give the concept of integrated water resource development the observed characteristics. Therefore, the characteristics of water as they relate to water resources development will be outlined.

Water is contained.<sup>29</sup> Surface water is contained in natural channels and much more is held in basins. Underground water is confined by aquifers. This containment almost always results in the need for sophisticated technology and considerable expense in water resource development programs in developing countries.

Water is also dynamic. It flows from one area to another in constant motion, through a network of channels, basins and aquifers. All of this is interconnected in a great hydrological cycle, the atmosphere replenishing the land with precipitation, the land discharging the water back into the ocean, the ocean replenishing the atmosphere. Such interrelationships very often result in long periods of data collection prior to developments; without which faulty projects are constructed.

The resource knows no artificial boundaries.<sup>30</sup> There is the Rio Grande, the Nile, the Mekong, to mention only a few, which pass through different nations. Obstruction or

modification in quantity and/or quality of water in a particular part of a river basin in a certain state affects the quantity and/or quality of water in another state. It is this characteristic that makes it essential to promote co-operation, and joint planning of river basins between and among nations in the form of integrated river basin development. International river basin commissions such as the Mekong, Mano, Niger, etc. have been established in recognition of this characteristic of water.

In spite of its dynamic nature and disrespect for artificial boundaries, water is relatively scarce. Some appreciation of the degree of scarcity may be gained from the following observations on the volume and distribution in the world.

Table 4.1

## Distribution and Volume of Water

<u>Location</u>	<u>Percentage</u>
Sea	95
Polar Regions	4
Lakes	}
Rivers	
Atmosphere	
Soil and Vegetation	
Ground	
	100

Source: Quigg, P.W. "Water as an Essential Resource", p. 1.

Table 4.1 clearly shows that the distribution of water in the hydrosphere is startlingly unbalanced. Only one per cent is liquid freshwater accessible at limited cost. Most interesting is the fact that of the one per cent that is liquid freshwater, 98.55 per cent is found in the ground, Table 4.2.

Table 4.2

## Distribution of Freshwater

<u>Location</u>	<u>Per Cent</u>
Biological	0.05
Rivers	0.10
Atmosphere	0.10
Soil	0.20
Lakes	1.00
Ground	98.55
	<hr/>
	100.00

Source: Quigg, P.W. "Water an Essential Resource", p. 1.

Of the volume of groundwater, only half is within a half a mile of the surface and therefore within reach of man.<sup>31</sup> This accessible groundwater occurs in areas where surface water is insufficient or negligible, as in the Sahara, and Southwestern sector of the U.S., and is therefore frequently over-exploited. The over-exploitation is complicated by the fact that renewability is very slow, if at all possible. Underground water is further subject to contamination with toxic substances - a phenomenon which increases the cost of using the resource.

Water is characterized as a universal resource and an essential ingredient of most economic activities. It has infinite variety of uses for domestic, agricultural, industrial, and recreational purposes. In terms of development, such competitive uses present allocation problems which, when not resolved, impede development in various ways.

Perhaps the most important characteristic of the resource is the interdependence of its uses within any given river basin or channel or aquifer.<sup>33</sup> The use of a water system for one purpose has effects on other uses which are often difficult to reconcile. It is partly to reconcile these uses that the concept of integrated river basin development is suggested. The concept, it is further contended, holds the key to most of the problems posed to not only water resource development but also general economic development by the characteristics of the resource.

#### 4.7 Other Factors

The close dependence of the success of water resource development programs on favourable circumstances other than the characteristics of the countries and the resource has not always been sufficiently considered.

One of these circumstances is that pertaining to the international money market. Integrated water resource development is capital intensive because many structural

components are associated with comprehensive integrated programs. The scarcity of capital in the developing countries and from the United Nations Agencies, means the developing countries have almost always had to borrow from the international money markets. The prevailing interest rates can be said to influence the planning and nature/magnitude of the programs undertaken. The degree and direction of the influence of the money market conditions on the adoption of the concept can only be ascertained by including the circumstances (manifested in the interest rates) in the forthcoming analysis.

#### 4.8 Overview

The foregoing pages have touched upon the known characteristics of the developing countries, the innovation, as well as other factors related to water resource development. In initiating an integrated river basin program, it can be expected that other things being equal, and also in the name of efficient utilization of financial, human and material resources, these factors or characteristics will play prominent roles; particularly with respect to the implementation time table. Whether or not these factors were considered in the case of the adoption of the concept in the developing countries is not known.

## CHAPTER 5

### METHODOLOGY

#### 5.1 Introduction

The discussions in the preceding chapters made it evident that several variables may be related to water resource development in developing countries. To discover the variables related to the adoption of the concept of integrated river basin development in the developing countries, certain methodological procedures must be followed. This chapter describes the research procedures that are employed in this research, and it comprises seven sections:

1. general hypothesis,
2. sample unit,
3. choice of dependent and independent variables,
4. specific hypotheses,
5. sources of data and collection procedures,
6. data analysis; and,
7. data and procedure limitations.

## 5.2 General Hypothesis

In the light of recurrent themes and conclusions of diffusion research provided in the foregoing chapters, the general premise of this study is that: - significant statistical relationships exist between the rate of adoption of the river basin concept on the one hand, and the characteristics of the adopting unit and the innovation on the other.

The term "rate of adoption" is measured by dividing the number of individuals adopting in a given year by the number yet to adopt that year. The characteristics of the adopting countries and the innovation refer to those noted earlier in Chapter 4 to be related to water resource development. The hierarchical effect will also be considered as well as the neighbourhood effect. The term hierarchy is used in a flexible manner - primarily to ascertain whether or not there exist relationships between the rates of adoption in the adopting units and size variables, in this situation population and river basin. The justification for using population size to test the hierarchical effect lies not only in the fact that it is often used in diffusion studies but also the innovation in question is population related by virtue of the fact that it is adopted to serve the interests of the population in the adopting unit concerned. Size of river basin is also

used as a further test of the influence of the variable in the adoption process. The neighbourhood effect is also used to test the relevance of distance variables.

### 5.3 Sample Unit

In the search for sample units, a population of sixty-five developing countries were selected for this study (Appendix 1). Their selection was based on two criteria, first they are members of the group of countries who have declared themselves as developing<sup>1</sup> and second, they possess river basins that have the potential to be developed for integrated purposes.<sup>2</sup> It was also anticipated that by studying a reasonably large group of countries, meaningful generalizations on the developing world and/or international diffusion could be made.

### 5.4 Choice of Dependent and Independent Variables

The degree to which the rate of adoption of the innovation (concept) is related to the characteristics of both the concept and the adopting units is one way to uncover the variables underlying the adoption of the innovation among the developing countries. Thus the rate of adoption was designated as the dependent variable ( $Y_1$ ).

Seventeen independent variables representing the characteristics of the adopting units and the innovation were chosen. The selected characteristics of the adopting units also represent the countries' physical or situational,

political, social, and economic traits. It must, however, be conceded that the categories into which the characteristics fall are not mutually exclusive; so that a given variable may in fact be in more than one category (Table 5.1). The variables as defined or calculated and with their justifications are as follows.

Period of colonial rule ( $X_1$ ), was calculated as the number of years for which the country was under colonial administration. It was chosen as a variable because Pedersen<sup>3</sup> showed that diffusion of innovations in 18 continental states in South America (two of which are included in this study) between 1808 and 1955 was partly influenced by colonial administrative hierarchy. It was also selected to take cognisance of the fact that under-development is in part a product of the developing countries' past and present relationship with colonial powers.<sup>4</sup>

Another political characteristic, political instability ( $X_2$ ), was chosen since the ability and/or willingness of governments to adopt innovations is related to the existing political structure and political culture.<sup>5</sup> In the absence of any standardized measure of political culture and/or structure for developing countries, and also in the light of the recurrent unconstitutional changes of governments - a fact which is accepted as hindrance to

Table 5.1

## Independent Variables and the Constructs They Represent

Variable	Codename	Construct				Source*
		Political	Social	Economic	Physical	
1. Period of Colonial Rule ( $X_1$ )	Colorule	+				ak
2. Political Instability ( $X_2$ )	Uncocha	+				ak
3. U.N. Admission Year ( $X_3$ )	Unentry	+				ak
4. Independence Year ( $X_4$ )	Indeyear	+				ak
5. Absolute Population ( $X_5$ )	Abspop		+			bj
6. Population Growth Rate ( $X_6$ )	Popgrowr		+			bj
7. Illiteracy Rate ( $X_{19}$ )	Litrat		+			bcj
8. Unemployment Rate ( $X_{17}$ )	Unemprat		+			bj
9. G.N.P. ( $X_7$ )	GNP			+		b
10. Income Per Capita ( $X_8$ )	Incopcap			+		b
11. Capital Scarcity ( $X_9$ )	Forexres			+		bd
12. Primacy of Agriculture ( $X_{10}$ )	Primagri			+		b
13. Export Orientation ( $X_{11}$ )	Exporien			+		b
14. Size of River Basin ( $X_{13}$ )	Basinsz				+	efi
15. Proportion of Basin Area in Country ( $X_{14}$ )	Propncou				+	efi
16. Distance to Washington ( $X_{15}$ )	Distwash				+	g
17. Distance to Nearest Adopter ( $X_{16}$ )	Captadop				+	g

\*See Appendix 6.

development, political instability was selected as a surrogate. It was defined as the number of unconstitutional government changes such as military coup d' etats that took place in the country up to the adoption time. In view of the United Nations endorsement of the concept, its role as a purveyor of development funds, and also the meaning of political independence to developing countries, two variables were introduced to represent these political dimensions. They were simply defined as year of entry into the U.N. ( $X_3$ ), and year of independence ( $X_4$ ).

The importance of these political variables in water resource development and particularly integrated river basin development is perhaps best expressed by Naylor.<sup>6</sup>

In his words,

Under the Pax Britannia, steady development took place under the Colonies and Protectorates, the extent and rate being limited by the need to spread a limited amount of available capital or by deliberate policy . . . With independence, the countries themselves are impatient of development. As there is now little security for capital investments, finance is sought from any source, such as the World Bank.

The second set of variables are traits related to the social environment. Earlier in Chapter 3 it was pointed out that population growth in developing countries stands out statistically as the main factor explaining the continued low level of economic development. It can easily be visualized that population factors will be among the

major considerations for decision makers faced with the need to adopt an institutional innovation for economic and social development.

Furthermore, Brown and Gustavus<sup>7</sup> showed that population is a significant factor in the diffusion of non-profit motivated diffusion with central propagator support. Consequently, the following population variables were selected for the analysis: population size ( $X_5$ ), measured as the absolute number of people in the country at the adoption time; population growth rate ( $X_6$ ), defined by the growth rate in the adoption year; illiteracy rate<sup>8</sup> ( $X_{19}$ ), also calculated as the percentage of total population who could not read and write; and unemployment rate ( $X_{17}$ ), the proportion of the unemployed labour force.

Gross national product ( $X_7$ ) was employed as an economic characteristic. It was defined as the total dollar value of all goods and services produced in the country during the adoption year. Other economic surrogates include income per capita ( $X_8$ ), measured as the average income per head of the population in the country; capital scarcity ( $X_9$ ), calculated as the amount of foreign exchange reserves at the adoption year; primacy of agriculture ( $X_{10}$ ) - the proportion of gross national product (G.N.P.) from agriculture; and export orientation ( $X_{11}$ ) - the proportion of G.N.P. derived from exports.

The selection of gross national product was particularly based on the fact that most contemporary writers have given attention to it in spite of its inadequacies as a reasonably reliable guide to broad differences in productive capacity and levels of economic welfare. The inclusion of agricultural and export characteristics and their relationships to GNP as variables was based on an important observation by Coutsinas and Paix.<sup>9</sup> They noted that one of the three<sup>10</sup> principal variables useful for the classification of "underdeveloped" space is the structure of exports. In their words:

As far as exports are concerned, we must take into account not only their quantitative importance, but more importantly the nature of the product (basic materials, semi-finished products, consumer goods, machinery and equipment), their diversity and their proportional relation to the whole . . . The analysis of the export . . . in any case, has significance only in relation to the value of these exports compared with the G.N.P. This is why the amount of external trade of each country, that is to say, the share of external trade, in the G.N.P. is a significant variable.

On the whole, the selection of these economic variables was based on Pedersen's<sup>11</sup> discovery in South America and Roger's<sup>12</sup> assertion that possession of adequate financial resources is a sine qua non for the adoption of innovations, especially for innovators. In other words, these variables were selected because it was conjectured that the availability of financial resources would determine

whether a country resorts to foreign borrowing to finance the innovation or not.

The fourth category of variables represent the characteristics of the innovation. The lone characteristic in this category was relative advantage ( $X_{12}$ ). It was operationally defined as the number of new opportunities (uses) provided by the implementation of the concept over and above previous uses in the basin.<sup>13</sup> Relative advantage is sometimes expressed in terms of benefits over costs. However, the use of this interpretation in this study was limited by the fact that basin programs are ongoing and therefore there is essentially no end to the cost and benefits incurred. Nasbeth and Ray<sup>14</sup> and Mansfield<sup>15</sup> among many others, have also established that relative advantage is a powerful adoption factor.

Two other variables considered to represent the physical characteristics of the countries were included: These were (1) the size of the river basin tackled or developed ( $X_{13}$ ), and (2) the proportion of the basin area in the country ( $X_{14}$ ). These two variables were included not only because they represent physical characteristics of the adopting units but more importantly, there has been a tendency in the study of development to neglect the significance of geographical size or scale.<sup>16</sup>

Two distance variables, considered primarily as instruments for testing the neighbourhood effect were distance to Washington D.C. ( $X_{15}$ ) and nearest adopter ( $X_{16}$ ). The selection of distance to Washington was based on the assumption that as the first concrete adoption of the concept was in the United States, the initial impact of demonstration effect would be in countries near the U.S. Likewise, the developing countries would be influenced by adoption in the neighbouring countries than adoption(s) in distant locations. These variables were measured by the straight line distances between the capitals of the countries concerned - a method which Nordbeck<sup>17</sup> has indicated is an adequate measure of distance.

To ascertain the effects of interest rates ( $X_{20}$ ) on the adoption rates, the prevailing interest rates at which the countries borrowed funds were also included in the analysis.

#### 5.5 Specific Hypotheses

In the light of the foregoing assumptions, the following specific hypotheses regarding the behaviour of each of the independent variables are formulated.

1. Those countries with slower adoption rates would be those with
  - (a) long periods of colonial rule and numerous unconstitutional changes of government;

- (b) large population and high population growth rates;
  - (c) high illiteracy and unemployment rates;
  - (d) great distance from Washington, D.C. and other adopters; and
  - (e) high interest rates.
2. Those countries with high adoption rates would be characterized by
- (f) early independence and admission into the United Nations;
  - (g) high gross national product and income per capita;
  - (h) high foreign exchange reserves, great dependence on agriculture and exports;
  - (i) large basin areas with large proportion of the basins under their political jurisdiction; and
  - (j) high relative advantage.

It is thus expected that period of colonial rule, political instability, G.N.P., income per capita, capital scarcity, primacy of agriculture, export orientation, relative advantage, size of basin tackled and proportion of the basin area in the country will be positively related to the rates of adoption. In other words, most of the economic and social variables are expected to be positive in their effects on the rates of adoption. On the other hand, the influence of political and physical variables are expected to be varied.

## 5.6 Sources of Data and Collection Procedures

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Data on the foregoing variables and other aspects of the study was obtained from three main sources.

1. Previous literature on integrated river basin development,
2. Reports of the United National Water Resources Branch, the World Bank, the International Development Association; the Economic and Social Council and the 1977 Water Conference in Argentina; and
3. Documents in foreign diplomatic missions in Canada and the United States.

Access to these reports and documents was initiated with the mailing of notices/letters (Appendix II) to the diplomatic missions of the sixty-five countries in Canada and the United States, as well as the U.N. agencies (Appendix III). The objective here was to inform those concerned of an intent to visit their offices and to give them some idea of the subject matter being pursued. This was done to identify countries which adopted the concept and to give them time to prepare for the visit if data was needed.

A thirty per cent response was achieved (Appendix IV) and trips were made to the offices of both those who did and did not reply to the letters. This, as already noted, provided access to documents and publications which could not have been procured through the mail. A research guide (Appendix V) was prepared as an aid in the data collection process.

## 5.7 Data Analysis

The first step in the data analysis was to identify the temporal trends in the diffusion of the innovation by preparing graphs of the cumulative level of adoption over time. Cartographic procedures were employed to identify the spatial trends.

The second step of analysis involved testing the relationship between the characteristics of the adopting units/innovation and the adoption rate. This type of analysis was designed to examine the simple relationship that existed between the dependent and the independent variables - a process deemed essential to test the hypotheses. The analysis was accomplished with the aid of Kendall rank correlation procedure. Kendall was selected over Spearman and Pearson because of the presence of tied ranks in the data, especially the dependent variable, and also because it is distribution free and useful with very small samples.<sup>18</sup>

The degree of independence or association among the independent variables was tested with Pearson correlation procedure. This analysis not only served as further verification of the relationship between the dependent and independent variables but also was deemed a necessary step prior to the regression analysis that followed.

The next stage in the analysis was the examination of variation in the dependent variable accounted for by the independent variables. At this stage stepwise multiple regression analysis was used with adoption rate as the dependent variable. Stepwise regression procedure was chosen for its ability to allow the examination at every stage in the regression, the variable incorporated into the model in previous steps - a process which helps to identify potential explanatory variables. The procedure is demonstrated as a viable analytical technique for such studies by Brown and Hanham.<sup>19</sup>

In the course of these analytical investigations, the adopting units were also divided into adopter categories, based on the date of adoption of the concept. This procedure is common practice in diffusion studies involving social and economic groups.<sup>20</sup> However, this study implemented this approach by applying it to countries as adoption units. Though the distribution of adopters was normal and would have allowed division of the sample into the ideal categories, such a division in this case would not have yielded meaningful results as the groups would have been too small. Therefore, only three groups were classified. Malecki, Specter and Brown<sup>21</sup> have shown the effectiveness of a three category scheme of adopter classification.

Group one consisted of all adopters between 1940 and 1949 (innovators), group two between 1950 and 1959 (early adopters) and group three between 1960 and 1967 (early majority). The groups comprised 16.4 per cent, 34.6 per cent and 50 per cent of the entire adopters respectively. It is to be noted that the division allowed a decade by decade look at the adopters. Such a look was significant in view of the importance of decade planning in countries and among international agencies. Furthermore, the adopters were subdivided into three groups, African group, American group, and Asian group, based on the continents in which the adoption units are situated.

The underlying reason for these kinds of divisions was to discover whether any kind of generalization that applied to all adopters was also relevant to chosen subsets of the entire population. It was also hoped that with such a division, the importance of flexible application of theoretical concepts and generalizations would become evident.<sup>22</sup> More importantly, it was designed to attempt to establish the different weight of the determinants of the diffusion process at various stages, and also evaluate and compare (them) to the long run determinants for the entire population of adopters.

### 5.8 Data and Procedure Limitations

The above noted process was fraught with a myriad of problems.

1. The exchange of notes with the embassies and agencies was frustrating. Replies were long in coming. Many, as shown by the response rate, did not even acknowledge the receipt of the notice/letter. This greatly delayed the trips to their offices.

2. As an Argentinian embassy official observed, the diplomatic missions serve mainly cultural interests. Therefore, many officials had little or no knowledge on the subject under investigation, a fact which led to time consuming discussions.

3. Even though most of the data sought was available, the large majority of them were classified documents which could only be released with permission from the home government (see Appendix IV). This partly accounted for the long delays in replies received and perhaps even those still not accounted for.

## CHAPTER 6

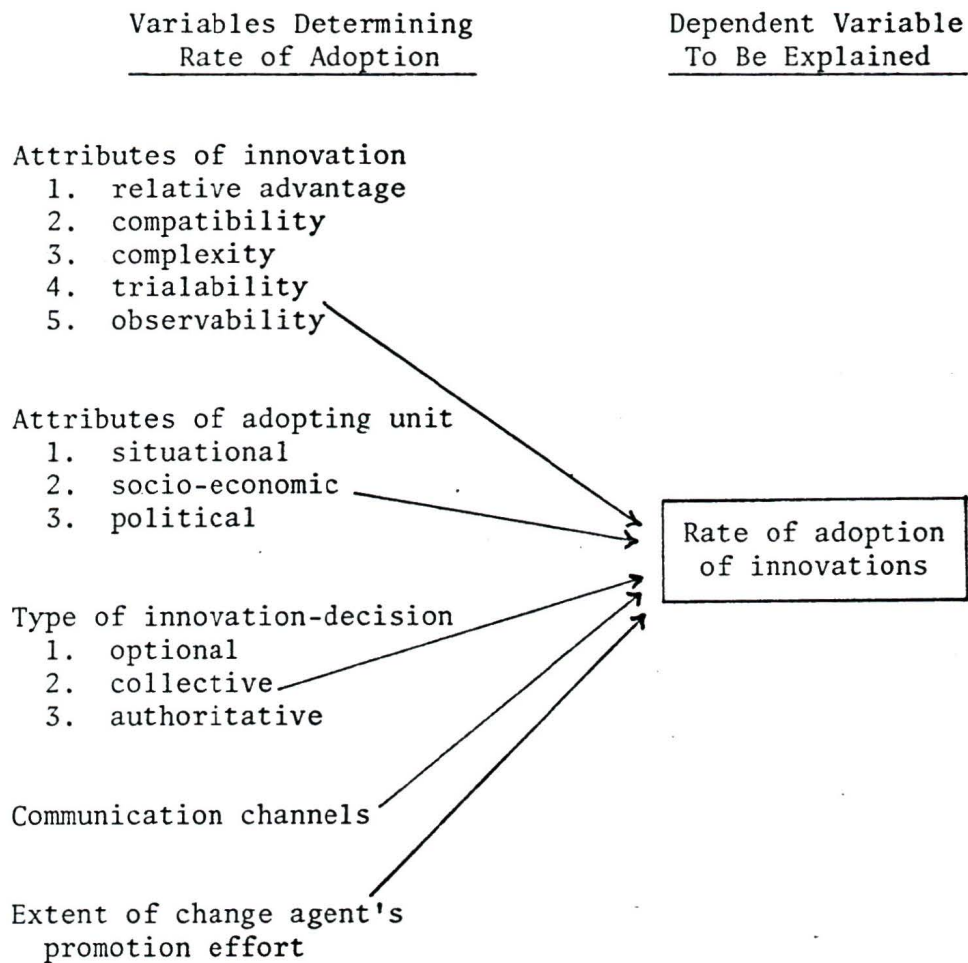
### RELATIONSHIP BETWEEN ADOPTION RATE AND SELECTED CHARACTERISTICS

#### 6.1 Introduction

The theoretical and conceptual frameworks presented in Chapters 3 and 4 respectively suggest that the rate of adoption of an innovation by an adoption unit may be affected by a variety of factors. As Figure 6.1 indicates, these factors may pertain to any one of the following: innovation, adoption unit, type of innovation decision, communication channels, and extent of the change agent's promotion effort. It is the purpose of this chapter to test the validity of the foregoing framework with regard to the adoption of the concept of integrated river basin development in developing countries. In other words, this chapter will test the relationship between the attributes of the innovation and the adoption units on the one hand, and the rates of adoption on the other. The chapter is divided into two parts. Part One will examine the simple relationships between the dependent and independent variables and Part Two will focus on the relative roles of the independent variables on the dependent variable.

Figure 6.1

A Paradigm of Variables Determining  
the Rate of Adoption of Innovations



Source: Rogers and Shoemaker, 1971.

To put the analysis into perspective, the conditions under which the adoptions occurred, that is, the various characteristics of the countries at the adoption dates will be analyzed. Thereafter, the spatial and temporal spread of the innovation will be discussed along with the rates of adoption. The examination of the relationships between the dependent and independent variables will be carried out with the designated adopter categories - Entire Adopters, Africa, Asia, Latin America, Innovators, Early Adopters, and Early Majority - as the basis. This is designed to ascertain the regional differences in the adoption pattern.

## 6.2 Situational Conditions

The average size of the river basin tackled was 617,500 square kilometers. This is, however, deceptive as basins as small as 153 square kilometers and as large as 3.03 million square kilometers were developed (Table 6.1). It is to be noted that in most cases portions of the basins, that is, sub-basins, were developed. As Table 6.2 shows, 45.8 per cent of the adopting units developed sub-basins. In 54.2 per cent of the cases studied, entire basins were tackled. Evidently, the primary reason for the failure to develop entire basins was the lack of complete jurisdiction over the basins. Other factors may also have been significant.

Table 6.1  
Size of River Basins Developed

Area of Basin (in sq. km.)	Percentage of Adopting Countries In Category	Number of Adopting Units in Category
0 - 999	12.5	3
1,000 - 10,999	16.6	4
11,000 - 100,000	25.0	6
110,000 - 1 million	33.3	8
1 million	12.5	3

Table 6.2  
Proportions of Basin Areas in Adopting Countries

Proportion of Basin Area (Percentage)	Percentage of Adopting Units in Category	Number of Adopting Units in Category
0 - 9	4.2	1
10 - 39	25.0	6
40 - 99	16.6	4
100	54.2	13

The direct financial costs of implementing the projects were as varied as the number of basins developed. In 41.6 per cent of the countries costs were either still being incurred on the projects or there were no accurate estimates of the costs available. However, in the remaining 58.4 per cent of the sample where cost estimates have been prepared, direct costs ranged from between U.S. \$1 million to U.S. \$6.5 billion. In 8.3 per cent of the cases costs were less than U.S. \$30 million. In another 8.3 per cent, costs were in excess of U.S. \$100 million but less than U.S. \$200 million. Sixteen point six per cent of the countries had costs running between U.S. \$200 million and U.S. \$1 billion, and in 25 per cent of the sample expenditures of over U.S. \$1 billion had to be incurred.

Many of these countries received considerable financial assistance from foreign governments and organizations. The volume of the assistance ranged from few thousands to billions of dollars. The largest purveyors of finance were the United Nations lending agencies, notably the International Development Association and the International Bank for Reconstruction and Development. Other adopters borrowed from the open international money markets. Beside the financial assistance, there were many forms of non-material and/or technical assistance

from the above sources. It is to be noted that all funds received by the adopters carried rates of interest, which ranged from three per cent to about six per cent.

### 6.3 Socio-Economic Conditions

The socio-economic conditions under which the adoptions took place also varied considerably. The populations of the countries, for instance, ranged from two million to 358 million. The mean population was 34.2 million. Table 6.3 shows that 41.7 per cent of the countries had populations under 10 million. Twenty point eight per cent had between 10 and 19 million people, while 33.3 per cent had between 20 and 99 million. One country, India, had the largest population at the time of adoption, 358 million.

Unlike the absolute populations, the annual rates of population increase in the countries did not vary very much. They ranged from one per cent to four per cent. The growth rate of two members of the sample was about one per cent. It was about two per cent in ten countries, around three per cent in another group of ten countries, and approximately four per cent in the remaining two adopting units.

The unemployment situation in the adopting countries also differed. Two of the countries had rates of less than one per cent. Half of the adopters registered between

Table 6.3  
Population of Adopting Units

Number of People In Adopting Unit (millions)	Percentage of Adopting Units in Category	Number of Adopting Countries in Category
0 - 9	41.7	10
10 - 19	20.8	5
20 - 99	33.3	8
100+	4.2	1

Table 6.4  
Illiteracy Rates in Adopting Countries

Percentage Illiteracy	Percentage of Adopting Units in Category	Number of Adopting Units in Category
0 - 49	20.8	5
50 - 80	16.6	4
81 - 100	62.5	15

one per cent and ten per cent unemployment while ten others also recorded rates of between 15 per cent and 20 per cent. The average figure was 4.5 per cent.

Illiteracy rates were consistently high (Table 6.4). Only five countries had rates below 50 per cent. Five others had rates of between 51 and 70 per cent. The majority of the adopting units, 15, had populations which were between 81 and 93 per cent illiterate. The average illiteracy rate was 69.5 per cent.

As observed in Chapter 4, one of the distinguishing characteristics of developing countries is their high level of poverty. This was perhaps best brought out in the gross national product figures of the countries under study. The majority, 83.3 per cent, had G.N.P. figures of less than U.S. \$1 billion. In fact, figures for 12.5 per cent of the sample were below U.S. \$50 million. Twenty point eight per cent had between U.S. \$50 million and U.S. \$100 million. Fifty per cent recorded values of between U.S. \$100 million and U.S. \$1 billion. Only 16.7 per cent broke the billion dollar barrier (Table 6.5).

A further testimony of the poverty of the countries under study was provided by the income per capita figures. Forty-five point eight per cent of the countries had per capita incomes of less than U.S. \$100. Another 37.5 per cent had between U.S. \$100 and U.S. \$200, while the

Table 6.5

## Gross National Product of Adopting Countries

G.N.P. (in millions of U.S. Dollars)	Percentage of Adopters in Category	Number of Adopters in Category
49	12.5	3
50 - 99	20.8	5
100 - 999	50.0	12
1,000 +	16.6	4

Table 6.6

## Income Per Capita Of Adopting Countries

Per Capita Income (in U.S. Dollars)	Percentage of Adopters in Income Group	Number of Adopters In Income Group
0 - 100	45.8	11
100 - 200	37.5	9
201 - 1,000	12.5	3
1,000 +	4.2	1

figures for 12.5 per cent ranged from U.S. \$200 to U.S. \$400. Incomes in excess of U.S. \$1,000 were enjoyed by people in only 4.2 per cent of the sample. The average per capita income was U.S. \$207 (Table 6.6).

Perhaps as a result of the adverse terms of trade experienced by the developing countries (pointed out earlier), their international financial positions in terms of foreign exchange reserves were not very healthy. The average reserve was U.S. \$158 million. This is however unrepresentative as 20.8 per cent of the countries had just over U.S. \$2 million in currency and gold reserve at their respective adoption dates. Twenty-nine point one per cent also had less than U.S. \$100 million. Twenty-five per cent had between U.S. \$200 million and U.S. \$400 million. Only 4.2 per cent had over U.S. \$500 million to their credit abroad.

It was also observed in Chapter 4 that two of the familiar characteristics of the developing countries are their dependence on external economic relationships and their exploitation of single resource, (principally agriculture) for employment and income. These observations were also borne out by the figures on the contribution of agriculture and exports to gross national product. The majority of the countries, 58.3 per cent, derived over half of their G.N.P.s from agriculture and exports of domestic produce.

#### 6.4 Political Conditions

One common trait of developing countries is the fact that the majority have been under colonial rule at some period in their histories. Regarding the countries under study, the average length of colonial domination was 133.5 years. Sixteen point six per cent had been under colonial yokes for periods of less than 50 years. Twenty-nine point one per cent had been ruled by foreign powers for between 50 and 99 years; 20.8 per cent others for over 100 years but less than 200 years; and another 20.8 per cent for between 245 and 423 years. Only one adopter, Thailand, had never been colonized.

By the time of the adoptions, however, all but one of the countries were politically independent. The only exception was in Rhodesia where the adoption occurred under colonial administration. Many have been politically independent for long periods of time. The earliest to gain independence was in 1821 and the latest in 1965. Twelve point five per cent were granted independence from their colonial lords before the beginning of the twentieth century. Sixteen point six per cent were granted similar status before 1925 and 29.1 per cent before 1950. Between 1955 and 1965 another 29.1 per cent also achieved independent status.

In spite of the autonomous status enjoyed by the countries, not all were members of the United Nations at their times of adoption. It is important to note that to this day, 16.6 per cent of the sample are still excluded from the world organization. It may also be noted that 37.5 per cent of the sample that gained independence before 1945 were all admitted into the U.N. in the same year the organization was formed. On the whole, half of the adopters joined the world group before 1950. Twenty point eight per cent also joined between 1950 and 1960 with the rest, 12.6 per cent joining in the 1960's.

The developing countries have presumably been known for their unstable post-independence political conditions. Yet, analysis of the period between independence and adoption of the concept suggests that the majority have been fairly stable. In 54.1 per cent of the countries there were no unconstitutional changes in government during the period. However, in 25 per cent others there had been at least one change. In another 16.6 per cent there had been two disruptions and at least three changes in the remaining 4.2 per cent.

Some of these unconstitutional changes in government had been brought about by military and others by civilian uprisings. Further analysis showed that 70.8 per cent

of the adopters had prior to their adoption times had no military governments. On the other hand, 16.6 per cent had at least one military government, while 8.5 per cent had also had two such governments. There had been three military regimes in 4.2 per cent of the sample. It was also evident that at the adoption years, 12.5 per cent of the countries were ruled by military regimes while the large majority, 87.5 per cent had civilian administrations.

It was under these conditions that the concept of integrated river basin development was adopted in the developing countries under study. What remains to be seen is the relationships between these conditions and the rates of adoption. Before examining such relationships, it might be appropriate to look at the spatial and temporal pattern of adoptions.

#### 6.5 Temporal and Spatial Spread of the Concept

A study of the 65 countries selected earlier showed that 24 had adopted the concept by the terminal date of 1971. As Table 6.7 shows, there were no adoptions until 1947 and none after 1967. The mean adoption year was 1958, with a standard deviation of 6.6 years. As Table 6.8 shows, between 1947 and 1951, there were six adoptions. Between 1952 and 1957 four other countries implemented

Table 6.7  
Distribution of Adoption Times and Adopter Categories

Year	No. of Adopters		Category
1947	2	Mexico Taiwan	
1949	2	Brazil Sri Lanka	Innovators (16.6%)
1950	2	India Iraq	
1955	1	Colombia	Early
1956	1	Iran	Adopters
1957	1	Philippines	(33.4%)
1958	2	Rhodesia Afghanistan	
1959	1	Egypt	
1960	1	Pakistan	
1961	1	Ghana	
1962	2	Sierra Leone Sudan	Early Majority
1963	1	Nepal	(50%)
1964	4	Kampuchea Laos Thailand Vietnam (S)	
1965	1	Nigeria	
1966	1	Cameron	
1967	1	S. Korea	
Total	24		100 %

Table 6.8  
Distribution of Dates of Adoption

Date (Period)	Percentage of Countries Adopting During Period	Number of Countries Adopting in Period
1947 - 51	25.0	6
1952 - 57	16.6	4
1958 - 63	29.1	7
1964 - 71	29.1	7

the idea. Seven followed in the period 1958 and 1963, with the remaining seven countries adopting between 1964 and 1967.

For the purposes of this analysis, the four countries that adopted prior to 1950 were designated as innovators (the group included both innovators and early adopter categories of the ideal type). Eight countries which also adopted from 1950 to 1959 were classified as early adopters; and the final twelve countries (1960 - 1967) also named early majority. This classification, it may be noted, takes into consideration the fact that many countries may be adopting the concept in the 1970's and beyond. When that is done, it will be easy to fit them into this framework of analysis.

The growth in numbers of adopters has often been described in the form of cumulative frequency curve. As noted earlier in Chapter 3, several studies have shown that the accumulation of adoptions can be described by a logistic function with a characteristic "S" shaped curve. Figure 6.2 describes the cumulative growth of the adopters of the concept under study. It is clear from the figure that the beginning of the adoption was slow and not until after 1955 did a consistent spread begin. It is to be noted that the early period, pre-1950, included the immediate post World War II years, a period when investment funds were scarce. On the other hand, the boom in the adoption in the 1950's coincides with the height of the post war reconstruction period during which the colonies (developing countries) experienced tremendous expansion in infrastructure construction. The continued growth in adoption in the 1960's also perhaps reflects the accelerated development programs that many developing countries embarked upon in that period.

The speed with which the innovation spread to the countries may be better explained by looking at the rate of adoption during the period (Table 6.9). As can be seen from the table, the rates for the individual years fluctuated considerably and, therefore, it is difficult to discern any pattern. However, if the averages for

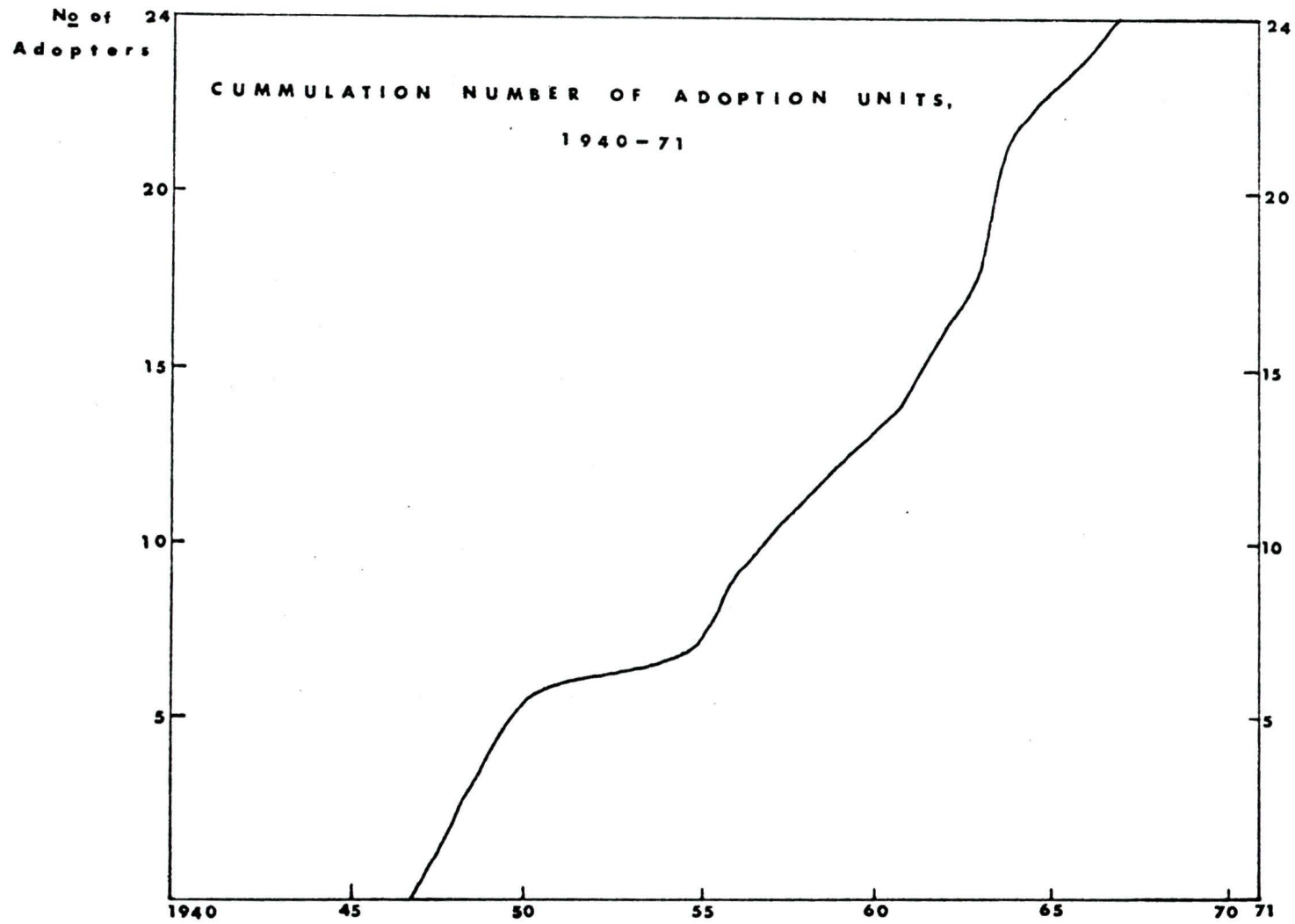


Figure 6-2

Table 6.9  
Rate of Adoption of the Concept

Year	Yearly Rate	Period	Periodic Rate
1947	0.09	Innovators	0.05
1949	0.10		
1950	0.11		
1955	0.05		
1956	0.13	Early	
1957	0.07	Adopters	0.07
1958	0.08		
1959	0.08		
1960	0.09		
1961	0.10		
1962	0.25	Early	
1963	0.14	Majority	0.48
1964	1.33		
1965	0.50		
1966	1.00		
1967	0		

the periods are examined, a significant pattern emerges. It is evident that between 1947 and 1959 the pattern of adoption was relatively uniform. But during the 1960's there was a tremendous increase in the rate of adoption. This ties in with the observation in diffusion literature

that adoptions increase slowly at first, then rapidly and finally taper off. Whether the adoption will taper off in the future is not clear from this study.

Figure 6.3 also shows the geographical or spatial spread of the concept. The earliest countries to adopt were located in Asia and Central America: Taiwan, Sri Lanka, Brazil, and Mexico. Countries that adopted between 1950 and 1959 generally were contiguous to the innovators; only in Rhodesia was there adoption without an apparent spread from a nearby innovator. In the post 1960 adoption period, the contagion pattern dominated the Asian countries but not apparent among the African Group of countries. Nevertheless, the overall patterns seem to suggest initial establishment in some regions, followed by outward spread to neighbouring countries.

The spatial diffusion pattern seems to be more discernable when the continents are isolated. In the Americas, Mexico's innovativeness was followed by Brazil and Colombia (Table 6.10 and Figure 6.4). In Asia, Taiwan's Akongtien program set the pace for the Gal Oya Scheme in Sri Lanka. The Damodar in India and the Tigris and Euphrates program in Iraq followed immediately. Programs in Iran, the Philippines, Afghanistan, Pakistan, Nepal, Thailand, Vietnam, Laos, Kampuchea, and South Korea also followed in that order (Figure 6.5). In Africa,

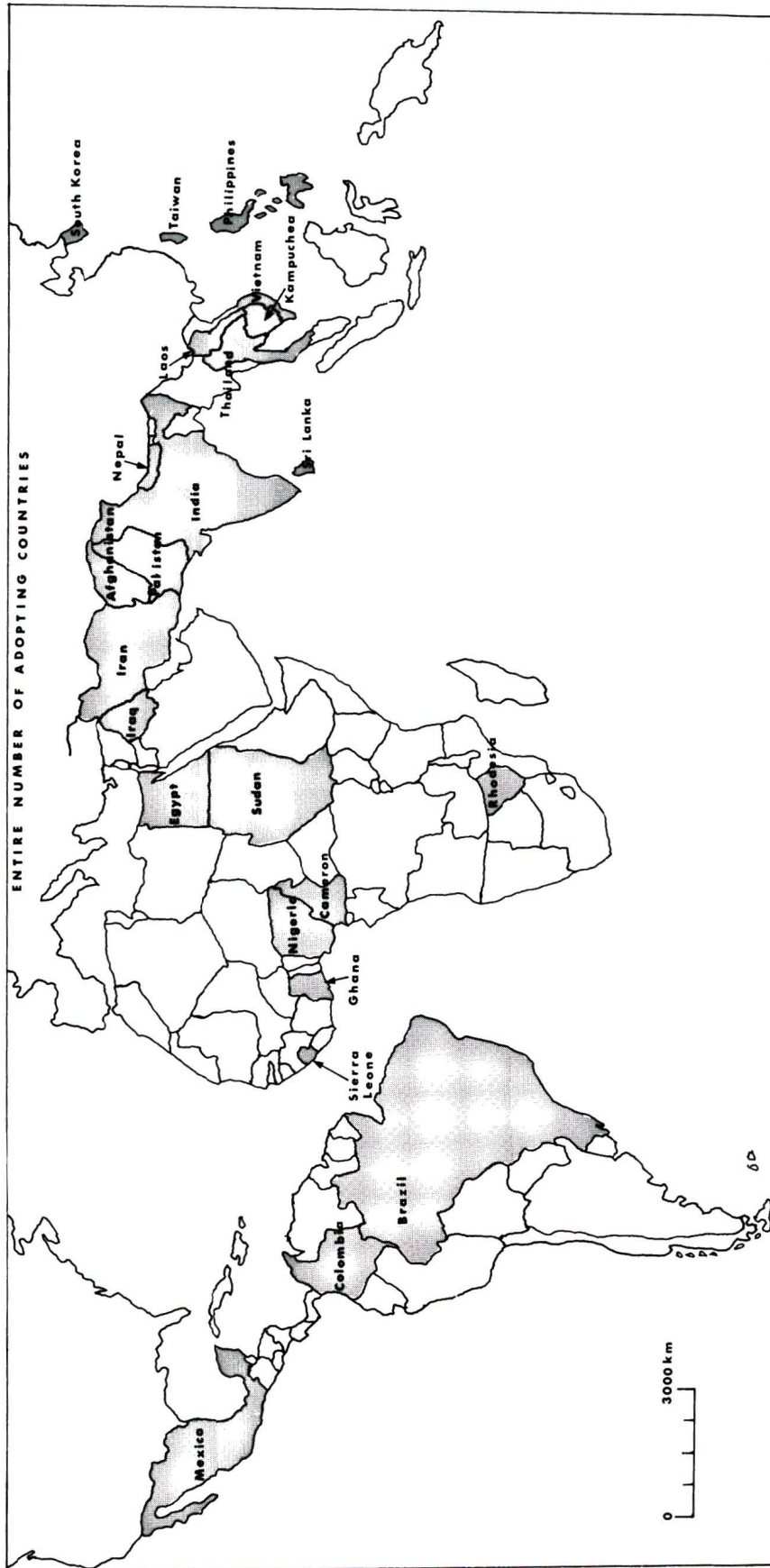


Figure 6.3



Figure 6-4

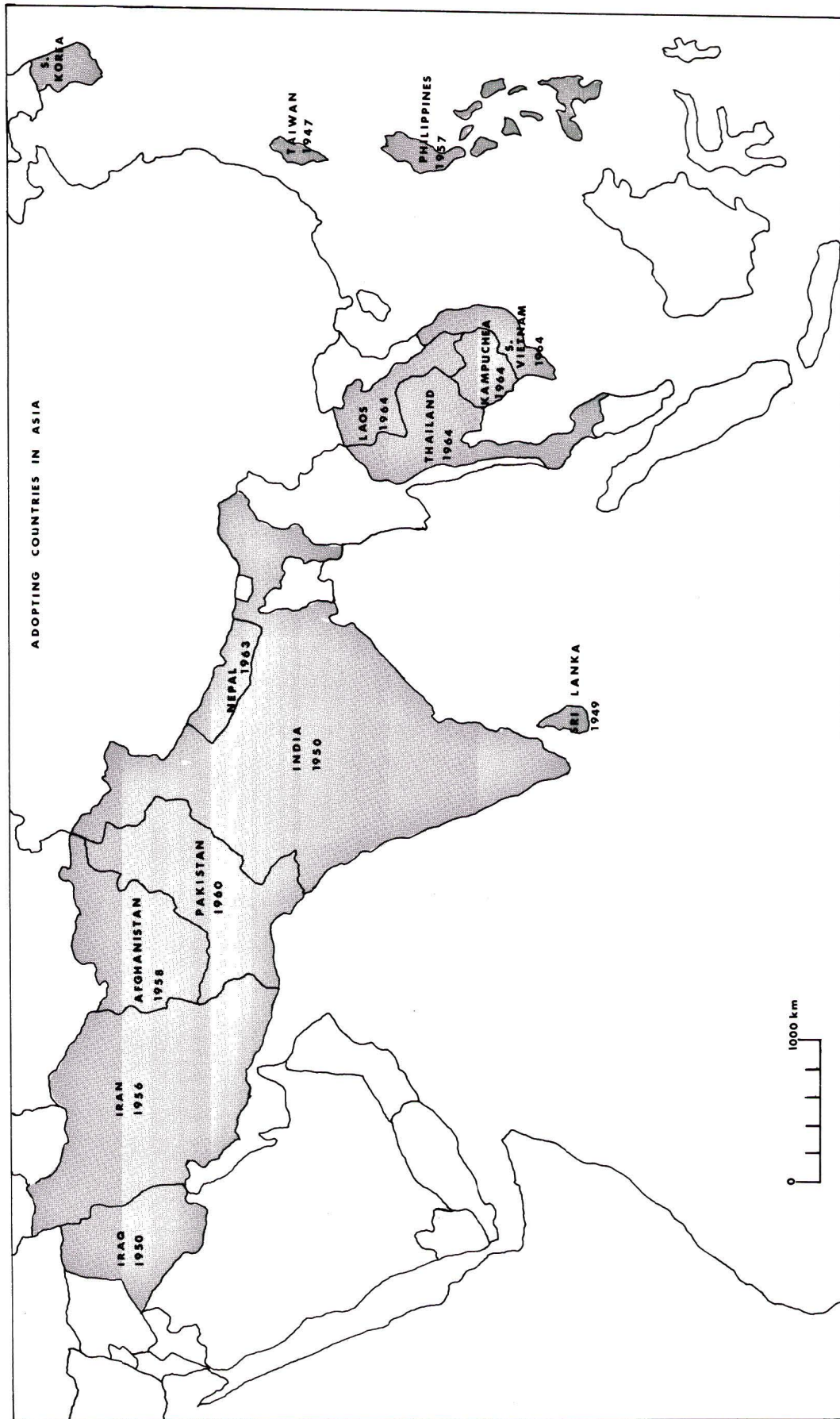


Figure 6-5

Table 6.10  
Order of Adoptions By Sub Region

Sub Region	1947	1949	1950	1955	1956	1957	1958	1959	1960	1961	1962	1963	1964	1965	1966	1967
Latin America	Mexico	Brazil		Columbia												
Asia	Taiwan	Sri Lanka	India Iraq		Iran	Philip- pines	Afghan- istan		Pakis- tan			Nepal	Laos Viet- nam Kampuc- hea Thai- land			South Korea
Africa							Rhod- esia	Egypt		Ghana	Sierra Leone Sudan			Nigeria	Cameron	
Total	2	2	2	1	1	1	2	1	1	1	2	1	4	1	1	1

on the other hand, the order was Rhodesia, Egypt, Ghana, Sierra Leone, Sudan, Nigeria, and the Cameron (Figure 6.6). The foregoing pattern of adoption, at least confirms Teclaff's observation that among the developing countries, the concept first spread to Asia and the Americas, and later into Africa.

It is also important to recognize that since 1971, many integrated programs have been either planned or even embarked upon. In the Senegal, Chad and Mano basins of West Africa, reconnaissance projects have been completed. Work got under way in 1978, on the Tana river scheme in Kenya<sup>1</sup> - which is expected to cost £100 million. In the Kagera river basin of Burundi, a five year program was launched in 1971 by the United Nations Development Program to survey, and collect basic data towards the preparation of comprehensive and integrated development plans for the basin. Guyana, in its most ambitious development effort to date, is planning to develop the Upper Mazaruni river basin at an estimated cost of U.S. \$400 million which is expected to be completed in the early 1980's.<sup>2</sup>

The spatial and temporal patterns of the adoptions described above lead inevitably to the question - is the adoption pattern related to any factors? More precisely, are the rates of adoption related to the characteristics of the countries or the innovation? The following sections

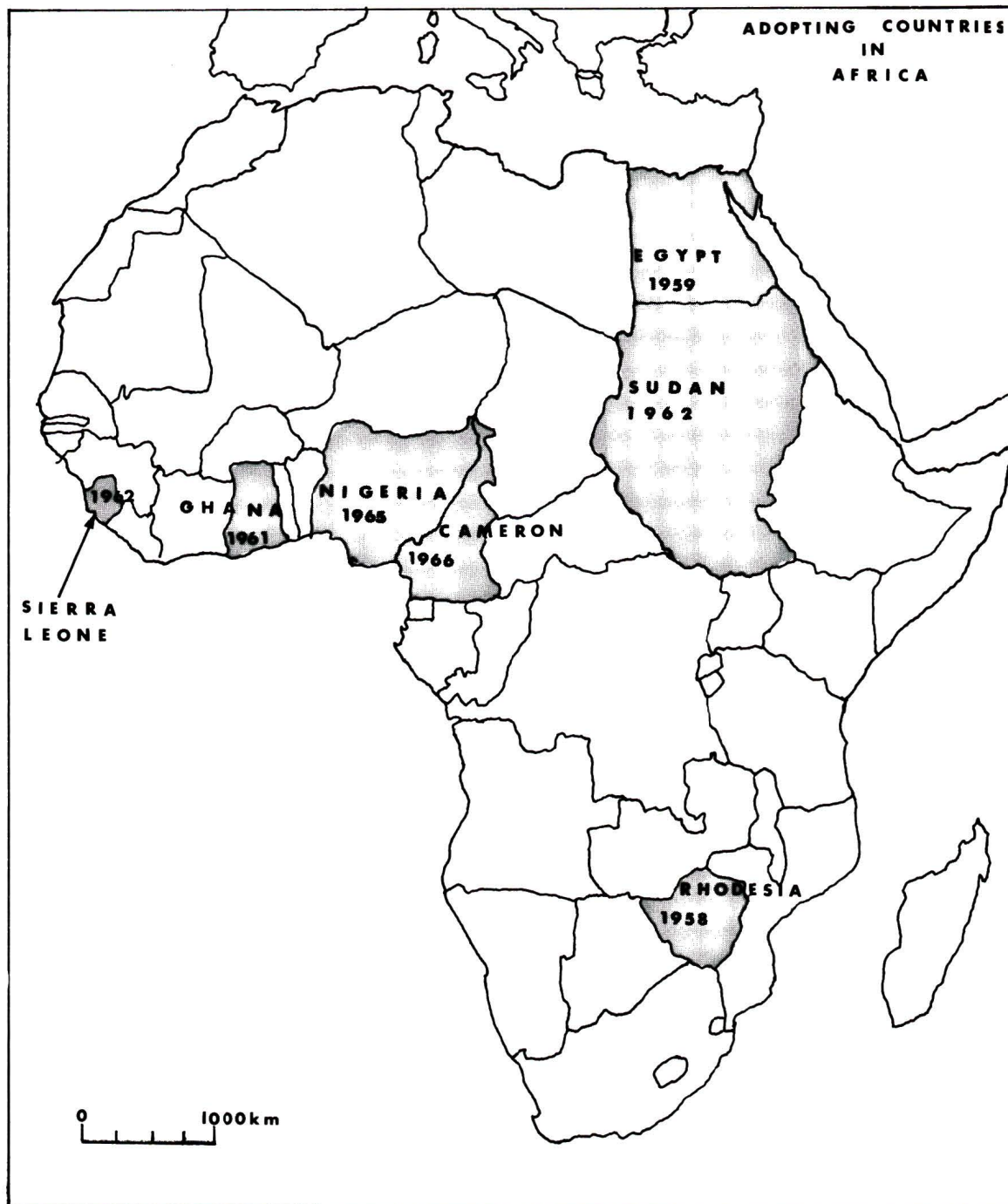


Figure 6-6

will attempt to address this question.

#### 6.6 Rate of Adoption and Characteristics of Adopters: Analysis of Simple Relationship

The statistical procedure chosen to test the relationship between the adoption rate and the characteristics of the concept/countries is Kendall's Tau correlation. It should be noted that the basis of the analysis is the assumption made earlier that no significant statistical relationships exist between the rate of adoption and the selected characteristics. In other words, all things being equal, in the course of the analysis, no significant correlation co-efficients are expected. All co-efficients are tested at  $\alpha = 0.05$ .

##### 6.6.1 All Adopters

Among the 24 countries, the significant relationships between the dependent and independent variables are shown in Table 6.11. There is an inverse relationship (-0.462) between rate of adoption and the proportion of the basin area in the country ( $X_{14}$ ). This relationship is not as hypothesized and suggests that countries with high proportions of the areas of potential basins had slower rates of adoption. The year of entry into the United Nations ( $X_3$ ) also correlates highly and positively (0.591) with the adoption rate. Such a relationship confirms what was hypothesized earlier and also suggests that countries that were admitted into the United Nations early were quick

Table 6.11

Pairwise Correlation of Dependent Variable With Independent Variables:  
All Adopters

Independent Variable	Dependent Variable: Rate of Adoption ( $Y_1$ )	N	Significance Level
Propncou ( $X_{14}$ )	-0.462	24	.002
Unentry ( $X_3$ )	0.591	20	.001
Indeyear ( $X_4$ )	0.466	21	.002

adopters while late entrants adopted it with some caution. A significant relationship also exists between the dependent variable and independence year ( $X_4$ ) of the adopting countries. The relationship is direct and as predicted (0.466). It indicates that countries that were early in achieving independence were also quick in adopting the concept. Implied in this relationship is the suggestion that despite the recognized importance of the concept as a development strategy, colonial authorities did not quicken the pace of implementing the concept in their colonies. Thus, it was not until after independence that the self-governing states accelerated the adoption process.

The correlation coefficients in Table 6.11 show that there is no relationship between population size and rate of adoption. In other words, if the adopting countries are arranged in hierarchical order based on their populations, the resulting pattern will not be related to the speed with which they adopted the concept. However, the table shows that if the proportions of basin areas in the countries are arranged in a similar hierarchy, the pattern will be related to the pattern of adoption to the extent that the high ranking countries will be those with slower rates of adoption. This implies that though the rates of adoption of the concept were related to the sizes of the basins in the respective countries, the adopting units with larger basin areas did not necessarily adopt the innovation quicker than their counterparts with smaller basins. On the contrary, units with smaller basin areas were quicker in adopting the concept. In other words, contrary to expectation, the adoption of the concept did not follow a hierarchical pattern based on either the size of population or river basin.

There is no concrete evidence of neighbourhood effect from Table 6.11 in spite of the apparent indication of such phenomenon from spatial arrangement of the adopters as shown in Figure 6.3. This situation seems to suggest that neither the relative proximity of the countries to the

United States nor neighbouring early adopters was significantly related to the rates of adoption of the innovation. As the neighbourhood effect is related to visibility or communicability, it could be said that demonstration effect was not an important factor in the adoption of the concept in the developing countries.

#### 6.6.2 Latin America

Among countries in this subregion, only two characteristics are related to the rate of adoption (Table 6.12). These are population growth rate and independence. The relationship between the former and the dependent variable is perfect and inverse. It corroborates what was predicted and suggests that countries with high population growth rates were slower adopters of the concept than those with low population growth rates. This relationship must be viewed in context of the fact that the region has one of the highest population growth rates in the world. Hence, it could be conjectured that the slow implementation of the concept was because they could not afford to implement the innovation; as they had to divert resources from such investments to meet the immediate socio-economic needs of the growing population.

The second variable, independence year correlates perfectly and directly with the dependent variable. The direction of the relationship is also as predicted and

Table 6.12

Pairwise Correlation of Dependent Variable With Independent Variables:  
Latin America

Independent Variables	Dependent Variable	N	Significance Level
Popgrowr ( $X_8$ )	-1.000	3	.05
Indeyear ( $X_4$ )	1.000	3	.05

Table 6.13

Pairwise Correlation of Dependent Variable With Independent Variables:  
Africa

Independent Variables	Dependent Variable	N	Level of Significance
Propncou ( $X_{14}$ )	-0.790	7	.009
GNP ( $X_7$ )	0.585	7	.034
Forexres ( $X_9$ )	0.585	7	.034

Table 6.14

Pairwise Correlation of Dependent Variable With Independent Variables:  
Asia

Independent Variables	Dependent Variable	N	Level of Significance
Unemprat ( $X_{17}$ )	0.340	14	.049
Unentry ( $X_3$ )	0.398	14	.029

conforms with the relationship observed among the entire sample, namely, countries that gained early independence quickly adopted the concept. Again, it is evident that the hierarchical principle is not validated among these countries. That is, the adoption among this regional grouping did not follow a hierarchical principle based on either the size of the population or the river basin in the country. There is no evidence of neighbourhood effect either.

#### 6.73. Africa

Three independent variables show significant relationships with the dependent variable (Table 6.13). The size of the basin area in the country correlates highly and inversely (-0.790) with the rate of adoption. Such a relationship means that the higher the proportions of the basin area in these countries the slower their adoption rates. It is to be noted that the significance and direction of the relationship is consistent with earlier observations.

The relationship between adoption rate and two other variables - G.N.P. and foreign exchange reserves ( $X_9$ ) are in both cases direct (0.585). The implication here is that countries with high G.N.P. and large foreign exchange reserves had high adoption rates while those with low values were slow in adopting. These relationships are as expected and seem to suggest that the rich

countries in the group were quick in implementing the concept. This behaviour apparently stemmed from attempts to improve their economic positions further. It also conforms with the generalization in diffusion literature that the possession of adequate financial resources is a *sine qua non* for adoption of an innovation.

The relationship between the proportion of basin area in the country and the adoption rate indicates that the hierarchical principle was not in effect here. As in the case of the entire adopters and Latin American countries, the neighbourhood principle was also unrelated to the adoption process.

#### 6.6.4 Asia

With respect to the Asian countries, a significant though low association (0.340) is found to exist between unemployment rate and the adoption rate (Table 6.14). The understanding here is that countries with high unemployment rates were quick in adopting the concept. In part, it suggests that the Asian countries were burdened by high unemployment and therefore, implemented the idea early perhaps to cope with the situation. The difference between the direction of the above relationship and that observed among the Latin American countries should be recognized. While in Asia direction of the relationship is direct, in Latin America it is inverse. This is a

pointer to the differential importance of the variable in the two regions.

A relationship similar to that among the entire sample regarding the association between year of entry into the U.N. and the dependent variable also exists among the Asian countries. Here the association can be described as moderate (0.398) and also suggests that countries that were early in entering the U.N. quickly adopted the concept. Like in the case of the entire sample, this relationship suggests that the United Nations was a positive factor in the adoption process in Asia.

#### 6.6.5 Innovators

Some of the prerequisites of innovations are the control of substantial financial resources to absorb the loss of an unprofitable innovation and the ability to understand and apply complex technical knowledge. In the light of this generalization, variables such as G.N.P., foreign exchange reserves, and illiteracy rate can be expected to be highly related to the adoption rate. The significant correlation coefficient for the sub-group is as shown in the table below (Table 6.15). It can be observed that among this sub-group, only one independent variable, population growth rate, is significantly related to the rate of adoption. The relationship is inverse and perfect; implying that members of this group who had high population

Table 6.15

Correlation of Dependent Variable With Independent Variables: Innovators

Independent Variable	Dependent Variable	N	Significance Level
Popgrowr	-1.000	4	0.028

growth rates also had slow rates of adoption than their slow growing counterparts. This ties in with the observation made earlier with regard to the countries in Latin America. In fact, a look at Table 6.7 indicates that two of the countries in this group are in Latin America. This gives credibility to the level of association contained in Table 6.15. Thus, it can be said that these innovators could not hurry to adopt the concept because of the burden posed by high unemployment and/or underemployment.

#### 6.6.6 Early Adopters

Within this adopter category, the relationship between the dependent and the independent variables is valid on two occasions (Table 6.16) - with relative advantage of the innovation ( $X_{12}$ ) and unemployment rate ( $X_{17}$ ). It should be recognized that this is the first time in the analysis that the relative advantage of the concept has correlated significantly with the rate of adoption. The inverse and moderately high relationship can be interpreted as meaning that the relative advantage

Table 6.16

Correlation Between Dependent Variable and Independent Variables:  
Early Adopters

Independent Variable	Dependent Variable	N	Significance Level
Uses (X <sub>12</sub> )	-0.6527	8	0.023
Unemprat (X <sub>17</sub> )	0.6416	8	0.016

was a significant factor in determining the adoption rate among this group. This interpretation supports an important generalization derived from diffusion research - the relative advantage of a new idea, as perceived by members of a social system affects its rate of adoption. On this occasion, however, the direction of the relationship suggests that the variable affected the pace of the adoption in a negative way. In other words, with respect to the early adopters, the relative advantage of the innovation was not a positive factor in the adoption process.

The relationship between the dependent variable and unemployment rate (X<sub>17</sub>) is direct (0.6416). The association between the two variables is not as hypothesized. The indication, however, is that the rapid pace of adoption among this group was related to high unemployment rates. It can be pointed out that in this group, while relative advantage of the innovation made a

negative contribution to the rate of adoption of the concept, the contribution of unemployment was positive.

#### 6.6.7 Early Majority

In this category, the dependent variable correlates significantly with a physical characteristic of the countries - proportion of basin area in country ( $X_{14}$ ). The relationship is similar to that encountered among both the entire sample and the African subgroup - inverse. Such a relationship suggests that given higher proportion of basin areas, these countries adopted the concept much slowly (see Table 6.17). This is inconsistent with the hypothesis that countries that have higher basin areas would adopt quite quickly. Indeed, it is contrary to the hierarchical principle. However, it is consistent with observations made among the entire adopters and the African group of countries.

Table 6.17

Correlation of Dependent Variable With Independent Variables: Early Majority

Independent Variable	Dependent Variable	N	Level of Significance
Propncou ( $X_{14}$ )	-0.4523	12	0.29

At this juncture it should be noted that eight variables, proportion of basin area in country ( $X_{14}$ ), year of entry into the U.N. ( $X_3$ ), year of independence ( $X_4$ ), population growth

rate ( $X_6$ ), G.N.P. ( $X_7$ ), foreign exchange reserves ( $X_9$ ), unemployment rate ( $X_{17}$ ), and relative advantage of the innovation ( $X_{12}$ ) have correlated significantly with the dependent variable. The relationships displayed with regard to the entire group are not maintained in the various subgroups examined. This suggests regional differences in importance of the variables.

Entirely obscured are any incidence of either the hierarchical or neighbourhood effect, even though variables were introduced to test them. Even so, the foregoing relationships lead us to tentatively accept the general hypothesis that the adoption rates of the concept in the developing countries were significantly related to the characteristics of the countries and the innovation.

Yet, it is hard to say whether the relationships shown are simple relationships between the dependent and independent variables. In other words, the existence of interdependent relationships cannot be ascertained from such simple analysis of correlation. The establishment of the absence of multicollinearity will not only give credibility to the foregoing findings, but is also considered essential for any further statistical analysis such as regression. Therefore, to test the existence of inter-correlations among the independent variables, Pearson correlation analysis will be performed. The Pearson

procedure is chosen because it is needless to observe rank order among the variables.

#### 6.7 Test for Inter-Correlations - All Adopters

Table 6.18 shows the correlations among the independent variables regarding the whole sample. Direct relationships exist between the relative advantage of the concept and the population growth rate as well as foreign exchange reserves. This suggests that countries which had high relative advantages also possessed high population growth rates and larger foreign exchange reserves. A correlation coefficient of  $-0.472$  is observed between the proportion of basin area in the countries and foreign exchange reserves; which implies that adopters with large basin areas within their political boundaries also had very little reserves abroad and vice versa.

An inverse relationship of  $-0.534$  between population growth rate and time of entry into the U.N. also suggests that rapidly growing countries were early entrants into the United Nations than their slow growing counterparts. With regard to gross national product, a high and direct relationship is recorded with foreign exchange reserves ( $0.722$ ). This suggests that the richer countries not only had higher G.N.P. figures but also had larger  
 ✕ monetary reserves abroad, perhaps a ← truism.

Table 6.18

Matrix of Correlations Among Independent Variables - All Adopters

	Uses	Propncou	Popgrowr	G.N.P.	Forexres	Indeyear
Popgrowr	0.479 (24) (009)					
Forexres	0.430 (24) (.026)	-0.472 (24) (.015)		0.722 (24) (001)		
Unentry			-0.534 (20) (.008)	-0.381 (20) (.048)	-0.792 (20) (.053)	0.568 (20) (.007)

Another significant though low association is found between G.N.P. and time of entry into the U.N. (-0.381). Though a relatively low correlation, it suggests that the richer developing countries were admitted into the U.N. before the poorer ones. Finally, a direct link between year of independence and year of entry into the U.N. is encountered (0.568). The relationship goes only to show perhaps the obvious fact that countries that attained independence early also gained early admission into the U.N. organization. It should be observed that one variable, unemployment rate, bears no significant relationship with any of the other variables, suggesting its independence. It may be asked as to whether the same kinds of relationships

are observable among the adopter categories or subgroups.

#### 6.7.1 Latin America

Among the countries in the Americas, no significant associations can be found between any two independent variables. It can be stated, therefore, that the variables are independent and thus those variables that correlated significantly with the dependent variable were not influenced by any inter-correlations.

#### 6.7.2 Asia

Regarding the Asian adopters, significant relationships are found to exist among many variables, and are shown in Table 6.19. The relationships exhibited by the variables here are essentially the same as that in the entire sample. Countries that had high relative advantage were the very ones with high population growth and large foreign exchange reserves, even though they turned out to have smaller basin areas under their political jurisdiction.

Adopters with high population growth rates were also admitted into the U.N. earlier than the slow growing. This corresponds with the observed relationship between these two variables regarding the entire sample. High G.N.P. adopters also had large foreign exchange reserves and high unemployment rates. At the same time, those with large foreign exchange reserves also experienced high unemployment rates (0.634). Adopters who gained independence early also gained

early entry into the United Nations.

Table 6.19

Matrix of Correlation Among Independent Variables: Asia

	Uses	Popgrowr	G.N.P.	Forexres	Indeyear	Unentry	Unemprat
Propncou	-0.52 (14) (052)						
Popgrowr	0.672 (14) (004)						
Forexres	0.565 (14) (014)		0.677 (14) (011)				
Unentry		0.713 (12) (005)			0.762 (12) (002)		
Unemprat			0.562 (14) (036)	0.634 (14) (024)			

### 6.7.3 Africa

Table 6.20 shows the relationships among the variables on the basis of data drawn from the African group of countries in the sample. The relationships between G.N.P. on the one hand and unemployment rate (0.904) and foreign exchange reserves (0.687) on the other are both high and

Table 6.20

## Matrix of Correlation Among Independent Variables: Africa

	<u>G.N.P. Unemprat</u>
Unemprat	0.904 (7) (030)
Forexres	0.687 (7) (044)
Uses	-0.990 (7) (005)

---

direct. Such relationships suggest that within the category, adopters with high G.N.P.s also had high unemployment rates and foreign exchange reserves while those with low G.N.P.s had low unemployment rates and small reserves. The relationship between G.N.P. and foreign exchange reserves is consistent with that observed among the entire sample, and the Asian countries. It is also evident from the table above that the countries with high unemployment rates had little relative advantage adopting the concept. These two forces might have played significant roles indirectly in the fact that the first adoption in Africa was in 1958.

#### 6.7.4 Innovators

Within this subgroup, only one significant relationship exists among the independent variables (Table 6.21). A high and direct relationship exists between G.N.P. and foreign exchange reserves, suggesting that at their adoption times, the countries with high G.N.P.s also had high foreign exchange reserves. In view of the importance of financial resources in the implementation of the concept, it may not be too far fetched to say that it was probably because of the association between these two variables that made it possible for the countries in this group to adopt the concept earlier than any other country in the sample. This suggestion may be borne out by the regression analysis that will follow this discussion.

Table 6.21

Matrix of Correlation Among Independent Variables: Innovators

	<u>G.N.P.</u>
Forexres	0.9727
	(4)
	(0.014)

---

#### 6.7.5 Early Adopters

With respect to the early adopters, the associations among the independent variables are as shown in Table 6.22.

Table 6.22

Matrix of Correlation Among Independent Variables: Early Adopters

	Uses	Propncov	G.N.P.	Forexres
Forexres			0.692 (8) (0.028)	
Indeyear		0.698 (8) (0.027)		0.818 (8) (0.012)
Unentry	-0.777 (7) (0.020)			

Four out of the eight variables show significant associations. Like previous analyses, significant correlation exists between G.N.P. and foreign exchange reserves. Also closely associated are year of entry into the U.N. and year of independence. This association is similar to that observed among the entire sample and the Asian group of countries.

#### 6.7.6 Early Majority

Within this subgroup, new associations among independent variables previously unnoticed are discernable (Table 6.23). One of such associations is the positive relationship between population growth rate and relative advantage. Thus among this group, the countries that had high

Table 6.23

Correlation Among Independent Variables: Early Majority

	Popgrowr	Propnecov	G.N.P.	Indeyear
Forexres	0.535 (11) (0.045)	-0.601 (11) (0.025)		
G.N.P.			0.733 (11) (0.005)	
Uses	0.486 (12) 0.055	-0.598 (12) (0.020)		0.931 (9) (0.001)

population growth rates also had high relative advantages for implementing the concept. Relative advantage also correlates positively and highly with year of independence, suggesting that though the countries in this group had high relative advantages for implementing the concept, they were late in achieving independence. There is also positive association between population growth rate and foreign exchange reserves. The positive direction of the relationship suggests that the countries with high population growth rates also had high foreign exchange reserves. G.N.P. again correlates directly with foreign exchange reserves, also suggesting that adopting units

with high G.N.P.s had high currency reserves.

Inverse relationships are observed between the proportion of the basin areas in the respective countries on the one hand, and the relative advantage of the concept and foreign exchange reserves, on the other. These indicate that among this group of countries, those with high proportion of basin areas in their territorial limits lacked in relative advantage and foreign exchange reserves while their counterparts with small basin areas had high relative advantages and more foreign exchange or financial resources. It is conceivable that the former situation was the case among countries in this group, hence their inability to adopt the concept early.

#### 6.8 Interaction Term

From the foregoing discussion, it can be seen that significant inter-correlations exist among the independent variables that cannot be ignored if the variables are to be employed in any further rigorous analytical procedure such as regression. To ignore the presence of the relationship will lead to the multiple regression equation yielding inaccurate 'Y' estimates. In other words, the fit of the regression equation will not be as good as it could be if interaction between the independent variables were taken into account.

There are a number of ways to deal with this problem.

Three of the most popular methods are:

1. Creation of a new variable which is a composite scale of the set of highly inter-correlated variables and use the new scale variable in the regression equation in place of its components; or
2. Using only one of the variables in the highly correlated set to represent the common underlying dimension; or
3. Including a multiplicative<sup>2</sup> term in the regression equation.

However, there are a number of problems in employing any but the third alternative above. By employing the technique of principal component analysis, it is possible to create a new variable which is a composite scale of the set of highly related variables as suggested by the first alternative. However, by so doing the ability of the researcher to ascertain the variation in the dependent variable attributable to the individual independent variables is sacrificed. Besides, in this situation, the inter-correlations among the independent variables are not so high to make this method appealing.

The second alternative takes into account only the common underlying dimension among the variables to the neglect of the uniqueness of the individual variables. Such an approach could likely result in throwing away or ignoring significant variation in the dependent variable attributed

to the uniqueness of the independent variables.

The most widely used approach is the third alternative. It involves the creation of what is called interaction term from various combinations of the independent variables.<sup>3</sup> This term becomes a new independent variable in itself and is included in the regression run. The extent of the increase in the coefficient of determination ( $R^2$ ) is a measure of how much the variation in the dependent variable is due to the interaction or inter-correlation among the independent variables. The new variable created in this situation is termed "Interact" ( $X_{18}$ ).

#### 6.9 Determinants of the Variation in Adoption Rate

The analyses of the simple correlations show that the assumption that significant statistical relationships do not exist between the dependent and independent variables is not valid. Eight characteristics show significant associations with the dependent variable. The analyses further show that the relationships between the independent and dependent variable vary from region to region and from one adopter category to another. In short, the preceding section analyzed the nature of the relationships between the rate of adoption and the selected characteristics. The extent to which variation in the dependent variable is explained by variations of the independent variables has not been determined. This section

of the chapter will examine this relationship.

The selected methodology is stepwise multiple regression analysis, a procedure already noted to have been demonstrated by Brown and Hanham to be appropriate. It may be reiterated that by using the stepwise multiple regression technique, it is possible to disentangle the separate influences of the independent variables and to obtain reasonable estimate of their relative effect. It is also important to note that the contribution of an independent variable to the explanation of the variation in the dependent variable will be considered as insufficient whenever it fails to meet "F" and "t" tests for a sample with the same number of observations.

As in the preceding analyses, the basic assumption in this discussion is the hypothesis that there is no significant statistical relationship between the rate of adoption of the concept on the one hand, and the characteristics of the countries/innovation on the other. Furthermore, as in the previous discussions, the effects of the independent variables on the dependent will be carried out with regard to the entire sample, the continents (regions) and the designated adopter categories.



Table 6.24

## Summary Statistics of Regression Analysis: All Adopters

Variable	Multiple r	$R^2$	$R^2$ increase	Standard Error	F- value	t- value	D.F.
$X_{14}$	.51	.261	.261	.00234	7.80*	2.79*	1,22

\* Significant at  $\alpha = 0.05$

Table 6.25

## Perceived Attributes of Innovations and Their Rate of Adoption

Author(s) of Investigations	Type of Respondents	No. of Innovations Studied	No. of Attributes of Innovations Measured	Percentage of Variance in Rate of Adoption Explained	Attributes of Innovations Found to Be Significantly Related to Rate of Adoption
1. Kivlin (1960); Fliegel and Kivlin (1962a); Fliegel and Kivlin (1962b)	229 Pennsylvania farmers	43	11	51	1. Relative advantage 2. Compatibility 3. Complexity
2. Tucker (1961)	88 Ohio farmers	13	6	-	None
3. Mansfield (1961)	Coal, steel, brewing and railroad firms	12	2	50	1. Relative advantage (profitability) 2. Observability (rate of interaction about the innovation among the adopters)
4. Fliegel and Kivlin (1966a)	229 Pennsylvania farmers	33	15	51	1. Trialability 2. Relative advantage (initial cost)
5. Petrini (1966a)	1,845 Swedish farmers	14	2	71	1. Relative advantage 2. Complexity
6. Singh (1966a)	130 Canadian farmers	22	10	87	1. Relative advantage (rate of cost recovery, financial return, & low initial cost) 2. Complexity 3. Trialability 4. Observability
7. Kivlin and Fliegel (1967a); Kivlin and Fliegel (1967b)	80 small-scale Pennsylvania farmers (and 229 large-scale farmers)	33	15	51	1. Relative advantage (savings of discomfort)
8. Fliegel and others (1966)	387 Indian peasants	50	12	58	1. Relative advantage (social approval, continuing cost, & time-saving) 2. Observability (clarity of results)
	80 small-scale Pennsylvania farmers	33	12	62	1. Relative advantage (savings of discomfort, payoff & time-saving)
	229 large-scale Pennsylvania farmers	33	12	49	1. Trialability 2. Relative advantage (initial cost)

The level of explanation contributed by the variable can be examined in terms of the direction of the relationship, which is negative. This relationship ties in with that established during the correlation analysis and also conflicts with the earlier suggestion that countries with high proportions of basin areas will be quicker in adopting the innovation than those with small areas. A likely explanation for the relationship could be that the monetary cost of adopting the concept favoured countries with small basin areas within their boundaries, hence their ability to adopt early. As countries with small basin areas were those that shared river basins with other countries, it is conceivable that they were able to reduce such monetary costs through sharing agreements.

The above analysis demonstrates that among the entire sample, one characteristic can only explain the variations in the rate of adoption of the concept. Adding variables not discussed in the foregoing analysis may improve the level of explanation.

#### 6.10.2 Other Adopter Categories

In contrast to the entire sample, the sizes of the other adopter categories are such that no meaningful results can be obtained from further analysis. In fact, a basic rule of thumb in stepwise multiple regression analysis is that there must be at least twice as many

observations as there are variables. This rule cannot be satisfied in this analysis because of the number of observations in the categories. To partly account for this problem or inadequacy, discriminant analysis will be used in the discussion of the categories instead of regression analysis.

#### 6.11 Stepwise Discriminant Analysis

Discriminant analysis attempts to statistically distinguish between two or more groups of cases defined by a particular research situation. To distinguish between the groups the researcher selects a collection of discriminating variables that measure characteristics on which the groups differ. The mathematical objective of discriminant analysis is to weight and linearly combine the discriminating variables in some fashion so that the groups are forced to be as statistically distinct as possible.<sup>4</sup> The analysis attempts to do this by forming one or more linear combinations of discriminating variables, called "discriminant functions". These functions are of the form

$$D_i = d_{i_1}Z_1 + d_{i_2}Z_2 + \dots + d_{i_n}Z_n$$

where  $D_i$  = score on discriminant function  $i$ ,

the  $d$ 's = weighting coefficients, and

the  $Z$ 's = standardized values of the  $n$  discriminating variables used in the analysis.

The maximum number of functions that can be derived is either one less than the number of groups or equal to the number of discriminating variables, if there are more groups than variables. The analysis can be executed by either a direct or stepwise method. The stepwise procedure is chosen in this situation as it results in an optimal set of variables being selected. In other words, the stepwise procedure is a more efficient way of approximately locating the best set of discriminating variables than the direct method.

The groups to be separated here are the adopter categories classified - early majority, early adopters, and innovators. The analysis will also be applied to the regional groups - Africa, Asia, and Latin America. The discriminating variables are the eight characteristics of the concept and the adopting units earlier noted to be related to the rate of adoption of the concept. A variable will be deemed significant and entered into the discriminating function if its 'F' value, taking into account of other variables in the function, indicated a 0.05 statistical level of significance.

In short, the purpose of the analysis is to determine whether the classification between categories only arbitrarily separate a continuum of types of adopters or whether they represent distinct breaks. Since the categories have been

determined on the basis of the rate of adoption of the concept (dependent variable), the extent to which the classification is confirmed will indicate the degree to which the discriminating variables (independent variables) explain the variations in the rate of adoption.

It is hypothesized that if the dependent variable is not dependent on the discriminating variables, then the discriminant analysis would predict a significantly (statistically) different classification.

#### 6.11.1 Analysis of Results

Table 6.26 reveals that among the innovators, early adopters, and early majority, three of the eight variables - proportion of basin area in the country ( $X_{14}$ ), relative advantage of the innovation ( $X_{12}$ ), and year of independence ( $X_4$ ) - comprise the discriminating function. The table further shows that of the three variables, proportion of basin area in the country makes the highest contribution to the power of the function which is represented by the canonical correlation and Wilks' Lambda coefficient of Table 6.28. It is also evident from Table 6.27 that the three variables are able to correctly classify 54.17 per cent of the cases.

However, Table 6.28 indicates that the discriminating function is statistically insignificant at the required 95 per cent level of confidence. It can, therefore,

Table 6.26

## Standardized Discriminant Function Coefficients - Adopter Categories

Variable	Function
$X_{12}$	0.691
$X_{14}$	0.932
$X_4$	0.095

Table 6.27

## Predicted Results - Adopter Categories

Actual Group	Predicted Group		
	Innovators	Early Adopters	Early Majority
Innovators	100 %	0.0 %	0.0 %
Early Adopters	37.5 %	0.0 %	62.5 %
Early Majority	16.7 %	8.3 %	75.0 %

Percent of "grouped" cases correctly predicted: 54.17%

be said that the dependent variable is not dependent on any of the discriminating variables. In other words, among the innovators, early adopters and early majority, none of the variables considered can adequately explain the variations in the rate of adoption of the concept.

Table 6.28

## Summary Statistics of Discriminant Analysis - Adopter Categories

Function	Eigenvalue	Relative Percentage	Canonical Correlation	Function Derived	Wilks' Lambda	Chi-Square	D.F.	Significance
1	0.533	82.97	0.590	0	0.587	10.68	6	0.100

Table 6.28 shows that on the average, 54.17 per cent of the cases were correctly classified. In other words, 54.17 per cent of the categories were rightly classified. This includes all the innovators, none of the early adopters, and 75 per cent of the early majority. It may thus be concluded that the three variables - proportion of basin area in country, relative advantage of the concept, and year of independence may explain almost the entire variation in the rate of adoption among the innovators, 75 per cent of the variation among the early majority, but none of the variation in the early adopter category.

Tables 6.29 through 6.31, also show the results of the analysis regarding the regional groupings. Gross national product ( $X_7$ ), proportion of basin area in country ( $X_{14}$ ), and the relative advantage of the concept ( $X_{12}$ ) are shown to possess significant discriminating power (Table 6.30) and consequently constitute the components of the discriminating function. Of the three variables contributing to the function, gross national product is by far the most important. The overall ability of the variables to separate the groups is again fairly high and demonstrated by the canonical correlation (0.594) and the Wilks' Lambda coefficient (0.503) (see Table 6.29).

Table 6.29

Summary Statistics of Discriminant Analysis - Regions

Function	Eigenvalue	Relative Percentage	Canonical Correlation	Function Derived	Wilks' Lambda	Chi-Square	D.F.	Significance
1	0.545	65.61	0.594	0	0.503	13.72	6	0.03

Table 6.30

## Standardized Discriminant Function Coefficients - Regions

Variable	Function I
$X_{12}$	0.218
$X_7$	1.029
$X_{14}$	0.337

Table 6.31

## Predicted Results - Regions

Actual Group	Predicted Group		
	Latin America	Africa	Asia
Latin America	66.7 %	33.3 %	0.0 %
Africa	0.0 %	42.9 %	57.1 %
Asia	7.1 %	0.9 %	92.9 %

Percent of "grouped" cases correctly predicted: 75.01 %.

From Table 6.31, it can be seen that 75 per cent of the cases in the three categories were correctly classified. It is to be noted that this average is more than that obtained in the previous analysis. More importantly, it should be observed that 66.7 per cent of the Latin American cases, 42.9 per cent of the African observations

Table 6.32

## Related and Determining Variables of the Adoption Rates

	Year of Independence	Yr. of U.N.	Population Growth Rate	Unemployment Rate	G.N.P.	Foreign Exchange Reserves	Size of Basin	Relative Advantage	Total Expl.
All Adopters	*	*					**		26.1
Latin America	*		*						66.7
Africa					**	*	**	**	42.9
Asia		*		*	**		**	**	92.9
Innovators			*						0
Early Adop.				*					0
Early Maj.							*		0

\* = Related to adoption rates.

\*\* = Partly predicted adoption rates.

and 92.9 per cent of the Asian countries were also correctly classified. In other words, given the three characteristics of the countries and the innovation, namely, gross national product, proportion of basin area in the country and the relative advantage of the innovation, 66.7 per cent of the Latin American countries, 42.9 per cent of the African countries and 92.9 per cent of the Asian countries would have adopted at the rates they did.

#### 6.12 Overview

The relationship between the selected characteristics and the adoption rates as discussed above have not shown intergroup consistency. In the analysis of the simple relationships, the results show that when all the adoption units are considered as a group, only three independent variables were significantly related to the adoption rates (Table 6.32). These are size of basin in country, date of entry into the United Nations, and date of independence. The latter variable, together with population growth rate were related to the adoption rates in Latin America. In Africa, the significant variables were proportion of basin area in country, gross national product, and foreign exchange reserves. Among the Asian countries, unemployment rate and date of entry into the United Nations were significant.

When the theoretical adopter categories are considered population growth rate was significant among the innovators; relative advantage and unemployment rate among the early majority; and size of basin in country among the early majority. On the whole, eight variables were related in various ways to the rates of adoption of the groups.

In determining which of the foregoing variables were most influential with regard to the rates of adoption, some consistency was observable among the categories. Table 6.24 shows that regarding the entire sample, only one variable did significantly predict the adoption rates. This was the proportion of basin area in country. In the Latin America, Asian and African countries, relative advantage of the innovation and gross national product were the most significant predictors of the rates of adoption. Regarding the innovators, early adopters and the early majority, none of the variables considered could account for any amount of the variations in the rate of adoption.

The levels of explanation of the adoption rates achieved, especially for the entire sample was low but respectable for a study at this low resolution level. The explanatory levels achieved for the other categories were also comparable to studies done elsewhere with individuals as adoption units. It is significant to note that the

pattern of adoption did not appear to have followed the hierarchical pattern based on the size of river basins in the countries. The neighbourhood effect was also not evident. Equally worth noting is the apparent unrelatedness of such seemingly important variables as interest rates. The suggestion is that the loans received for the implementation of the innovation were "soft", and mainly from international organizations whose lending objectives are simply to provide such loans and not necessarily to make profit.

## CHAPTER 7

### SUMMARY AND CONCLUSIONS

#### 7.1 Introduction

In the introductory chapter, it was stressed that developing countries in their quest for standards of living comparable to those of the developed countries have experimented with numerous development approaches; none of which seemed to have been a panacea. Under such circumstances, and following the success of some water resource development programs in various parts of the world, various specialists have argued for and succeeded in convincing some developing countries to turn to water resource development, especially the concept of integrated river basin development, as a means of achieving their envisaged levels of economic and social development. It was also noted that the adoption behaviour of the adopting developing countries did not support the stated importance of the concept in the development aspirations of the countries. This is because not only have few countries adopted the concept but also they were late in doing so - a fact which led to a number of questions. Among them were:

1. Which countries adopted the concept between 1940 and 1971?
2. What factors explain the pattern of adoption?

In the light of these and other questions, this thesis was set out to study the diffusion of the concept of integrated river basin development in developing countries between 1940 and 1971. The study was based on the premise that no significant statistical relationships exist between the rate of adoption of the concept on the one hand, and the characteristics of the countries and the innovation on the other. There were five basic objectives, namely to identify:

1. Social and economic characteristics of developing countries concerned with water resource development;
2. selected characteristics of the concept of integrated river basin development;
3. the time of adoption of the innovation;
4. the rate of adoption of the concept in developing countries; and
5. the relationship between the rate of adoption and the characteristics of the countries/innovation.

The obvious question to ask at this point is: did the thesis succeed in its intentions?

## 7.2 Characteristics of Countries and Concept Concerned With Water Resource Development

In discussions in Chapter 4, it was noted that a myriad of characteristics of the developing countries were related to water resource development, either directly or indirectly. Some of the characteristics considered included population growth rate, unemployment rate, income levels, productivity levels, to mention only a few. It was also established that other characteristics were important. These fell under political, and physical or spatial characteristics.

In the course of analysis, four socio-economic characteristics of the countries were found to be associated with the rate of adoption of the concept of integrated river basin development. These were population growth rate, gross national product, foreign exchange reserves, and unemployment. Political and geographical characteristics were also related. The respective factors were year of entry into the United Nations, year of independence, and size of basin in the countries. One characteristic of the concept was also associated with the adoption - relative advantage. The nature of the associations between these characteristics and the rate of adoption of its concept were quite significant to warrant further attention and analysis (see Tables 6.11 to 6.17).

### 7.3 Time of Adoption of the Concept

The times of adoption of the concept in the developing countries ranged from 1947 to 1967. Thus, it took 20 years for the 24 countries to adopt the concept, an average of 1.2 adoptions per year. Adoption of the concept started simultaneously in Latin America and Asia, in Mexico and Taiwan, to be precise; during the second half of the 1940's. Further adoptions took place in continental Asia and South America before the end of the decade. Between 1950 and 1960, the concept received its greatest acceptance in the developing countries as about half of the adoptions occurred during the decade. Again, Asian countries were most of the adopting units. More countries adopted in the 1960's, especially in Africa. At the end of the period under review, 24 of the potential 65 plus countries had embraced the concept. The rates at which the innovation was adopted were also inconsistent. There were no clear-cut patterns. However, when the adopter categories were examined, the rates increased towards the terminal date, 1967.

#### 7.4 Relationship Between Rate of Adoption and the Characteristics

Although certain variables or characteristics were shown to be associated with the adoption of the concept, understanding such simple associations was secondary to ascertaining the influence of the characteristics on the rates of adoption.

##### 7.4.1 Socio-Economic Characteristics

It is significant to note that among the entire sample none of the observed socio-economic characteristics significantly influenced the rate of adoption in the countries. Thus, looking at the developing countries as a whole, the rate of adoption of the concept cannot be accounted for by their socio-economic characteristics. The same situation was evident among the adopter categories, notably the innovators, early adopters and early majority. Among the Asian, African and Latin American countries, however, gross national product (an economic variable) was a significant and positive predictor of the rate of adoption of the innovation.

##### 7.4.2 Political Characteristics

Decisions to adopt a large new innovation such as new basin development plans are invariably made by governments. It is no wonder that the political characteristics of developing countries stood out as one of the most potent explanatory factors that determined the rates

of adoption of the concept.

Regarding the entire sample, none of the political variables seemed to have significantly influenced the rates of adoption. The same was the case with respect to the adopter classes and the regional groupings.

#### 7.4.3 Physical/Situational Characteristics

In any development programs with spatial implications, it can be expected that the physical characteristics of the unit or country concerned will be one of the deciding factors. It appears that with respect to the adoption of the concept of integrated river basin development, the physical characteristics of the basin, namely, its size in the adopting unit, was generally the most consistent influencing factor or predictor of the adoption rates. Among both the entire sample and the regional groupings, the variable exercised significant influence on the observed rates of adoption. With reference to the theoretical categories, however, no significant effect on the adoption pattern was discernable.

#### 7.4.4 Characteristics of the Innovation

In many discussions about the diffusion of new technology, ideas, and norms, the profitability or relative advantage of the new process in relation to the old stands out as an explanatory variable. In this study, there was no exception to this rule. The relative

advantage of the concept while not explaining the rate of adoption among all the adopters, was significant in accounting for the variations in the rate of adoption among the regional groups.

Table 7.1 and Figure 7.1 provide visual summaries of the relationships between the adoption rates and the selected characteristics of the countries and the concept. Table 7.1 outlines the pattern of simple relationships that existed between the dependent and independent variables of the various adopter categories. Figure 7.1, on the other hand, compares the existing paradigm of variables determining the rate of adoption of innovations to those observations made in this study. From the Table 7.1 it can be seen that:

1. Socio-economic characteristics were important in all the regions. In Africa and Asia such factors were positively related to the adoption rates, while in Latin America their associations were mainly negative. The same characteristics were also important among the innovators and early adopters, among whom their effects were negative and positive respectively.

2. Political characteristics were important among all adopters especially the Asian and Latin American countries. The influence of such characteristics was consistently positive.

Table 7.1

## Simple Relationships Between Adoption Rates and Selected Characteristics

Adopter Category	Variables			
	Socio-Economic	Political	Physical/ Situational	Relative Advantage of the Innovation
All Adopters	0	+	-	0
Africa	+	0	-	0
Asia	+	+	0	0
Latin America	-	+	0	0
Innovators	-	0	0	0
Early Adopters	+	0	0	-
Early Majority	0	0	-	0

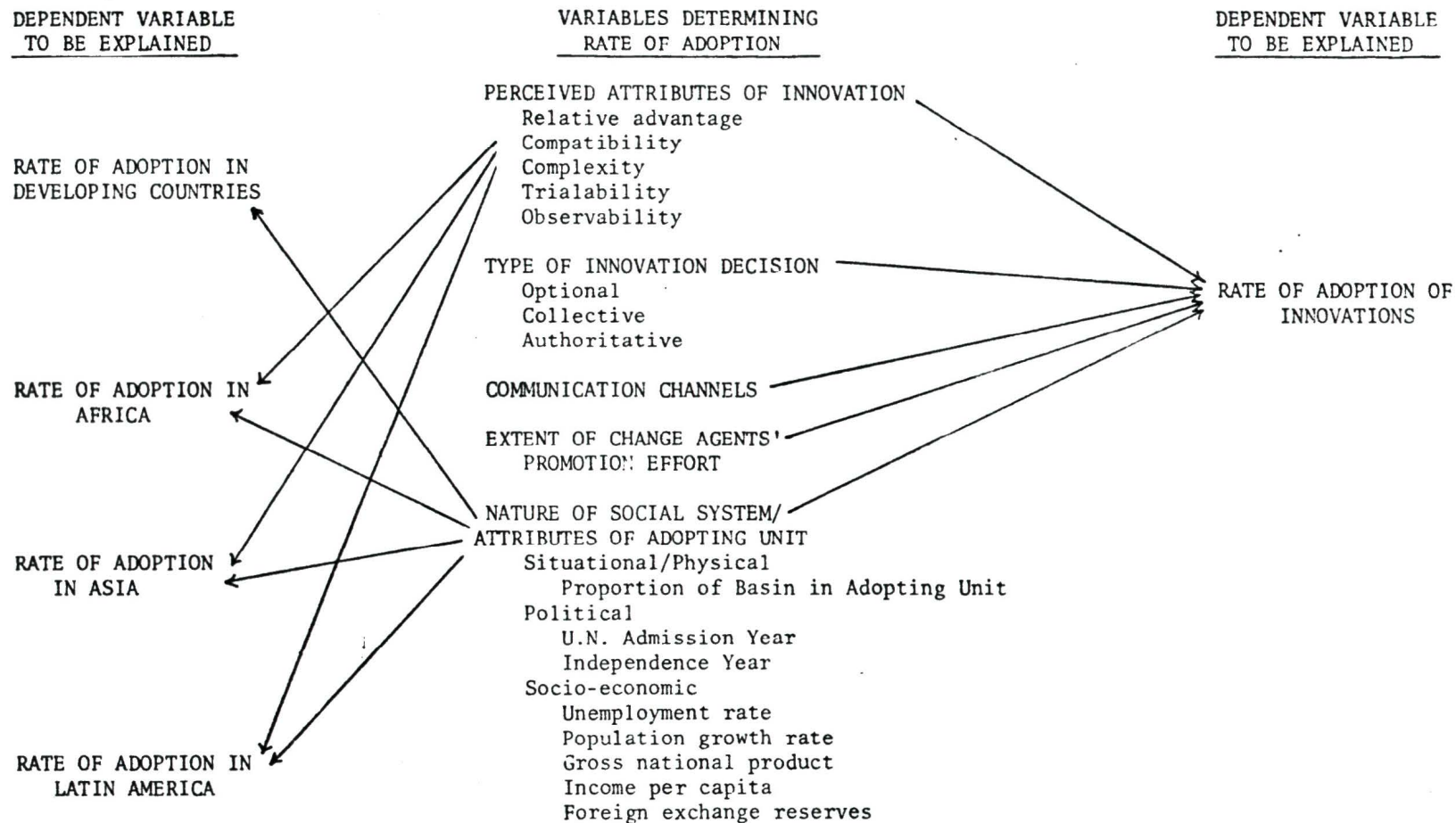
0 = No significant relationship

+ = Significant and positive relationship

- = Significant but negative relationship

Figure 7.1

Prior Research and This Study: A Comparison of Paradigm of Variables Determining The Rate of Adoption of Innovations



3. Physical or spatial characteristics of the river basins were also important elements in the adoption of the concept. This was generally so among all the adopters, and more so among the African countries.

4. The relative advantage of the concept was also a significant consideration among the early adopters, most of whom were Asian countries.

Figure 7.1 also shows that while the existing theoretical paradigm may be relevant to the current study, much of it is not clearly supported by this report.

#### 7.5 General Conclusions

In the light of the foregoing, several general conclusions can be drawn from the study.

1. The adoption of institutional innovations in developing countries is indeed related to the characteristics of the countries. The allegation that institutions are adopted without regard to the peculiar characteristics of the developing countries is not supported by this study.

2. The adoption of the concept of integrated river basin development as a tool of economic and social development is far from complete in the developing countries of Africa, Asia, and Latin America. It is likely to continue, especially in Africa and Latin America where the potential is greatest.

3. Mere possession of a developable river basin is not a sufficient factor or condition for the adoption of the concept in the developing world. Instead, political factors are by far the most important considerations in the diffusion of the idea.

4. The United Nations organization is an important force in the diffusion of institutional innovations in the developing countries. Neglect of this factor in any attempt to enforce or promote the diffusion of this or any other institutional innovation may lead to failure.

5. Equally important are the countries' characteristics, particularly soci-economic and physical or spatial. They reinforce the influence of the political variables.

6. There are some underlying differences among the developing countries of Africa, Asia and Latin America. Therefore, any diffusion attempt should search for and take cognisance of the differences. In other words, the term "developing countries" is too broad for the self-professed developing countries. Each is developing in some respects and perhaps developed in others. In fact, this conclusion underscores the ambivalence of certain socio-economic characteristics of the developing countries. While certain characteristics encourage development in some areas, the same factors impede

progress in other regions.

#### 7.6 Specific Conclusions

As this study was undertaken within the framework of existing literature on diffusion, it is appropriate to reconcile the foregoing findings and conclusions with those of the existing literature. Several conclusions emerge from the present study that are valid for the investigation of innovations diffusion in general and international diffusion as well as diffusion within the developing world.

Earlier in Chapter 2, it was observed that several generalizations have resulted from studies in the various social sciences. Among those mentioned were the logistic curve, the hierarchical and neighbourhood effects. The cumulative growth of adopters presented in Figure 6.2 shows that the concept of logistic curve is not confirmed by this study - the primary reason being that the adoption process is far from complete.

It has also been shown that adoption of the concept in the developing countries followed neither the hierarchical nor the neighbourhood principle though attempts were made to test the validity of the concepts. Apparently at the international level, the flow of information essential for diffusion is warped and shaped more by diplomatic relationships and ties, and political con-

siderations than either proximity to an existing adopter(s) or the known hierarchical systems.

It was also earlier mentioned that the characteristics of the adopting unit and the innovation affect the diffusion of an innovation. In fact, this was the premise of this study. The results of the analyses presented above show that indeed the characteristics of the adopting units and the innovation affect the adoption even at the international level.

With respect to the area of international diffusion of innovations, it can be said that some of the diffusion generalizations made from studies of small communities and individuals, that is at high resolution levels, are valid. Furthermore, the field of international studies on diffusion is not as impenetrable as the dearth of research seems to suggest.

Regarding the developing countries, as said before, diffusion studies have been conducted at either the village or community level. This study has shown to a significant extent that a precondition to understanding the diffusion of innovations among the developing countries is to account for the variations of their characteristics, and the relative advantage of the innovation.

## 7.7 Recommendations

The findings reported above are suggestive of future policy-making and research. Therefore, by way of recommendations, it is strongly suggested that:

1. Research on the usefulness of the concept in the developing countries should be accelerated. The suggestion of experts for the adoption of the concept in the developing countries is not based on any impeccable empirical studies. The apparent slow rate of adoption seems to suggest that the countries are not confident in the potentialities of the concept as a development framework. Further research will hopefully remove any such doubts.

2. The involvement of the United Nations and its specialized agencies should not only be continued but even strengthened as it seems to be the most potent factor affecting the adoption rates. In this respect, the role of the United Nations should be focussed on:

- i. admission into the world body of countries that stand to gain from the adoption of the concept; and
- ii. encouraging discussions and agreements among countries that share river basins to plan and execute joint basin programs in order to increase the advantages of the

adjoining countries.

3. The independence of dependent countries should be accelerated as part of the international effort to boost development in the developing countries.

4. Concerted efforts should be made to improve the socio-economic factors such as reducing the high population growth and unemployment rates - which have been shown to impede adoption.

5. It will be important to determine if the present findings will hold true in the case of other innovations.

6. Some of the present findings may merit testing with the decision makers in the countries studied here.

FOOTNOTESCHAPTER 1

<sup>1</sup>United Nations, *Report of a Panel of Experts, Integrated River Basin Development* (New York: 1970), p. 1.

<sup>2</sup>R.E. Huffman, *Man Irrigation Development and Public Water Policy* (1953) Cited in Footnote No. 44.

<sup>3</sup>U.N., *Multi-Purpose River Basin Development, Part 1* (U.N. Publication Sales No. 1955, II, F. 1)

<sup>4</sup>Unified development refers to the treatment of the entire river basin as a hydrologic unit in a manner which ignores border. See Footnote No.

<sup>5</sup>G.F. White, "A Perspective of River Basin Development," *Law and Contemporary Problems*, 1958, pp. 157-184.

<sup>6</sup>J.D. Chapman, *The International River Basin* (Vancouver: U.B.C. Publication Centre, 1963).

<sup>7</sup>U.N. (1970), op. cit.

<sup>8</sup>L.A. Teclaff, *The River Basin in History and Law* (The Hague, Martinus, Nijhoff, 1967), p. 114.

<sup>9</sup>*Ibid.*

<sup>10</sup>*Ibid.*

<sup>11</sup>*Ibid.*, (cited).

<sup>12</sup>G.F. White (1958), op. cit.

<sup>13</sup>The project combined hydroelectric power with irrigation and was started in 1909 by the Bureau of Reclamation. Note that in 1888 the Wisconsin Valley

improvement company undertook power and flood control programs on the Wisconsin river but being a private effort, it falls outside the scope of this study.

<sup>14</sup>G.F. White (1958), op. cit. p. 163.

<sup>15</sup>*Ibid.*

<sup>16</sup>*Ibid.*

<sup>17</sup>*Ibid.*

<sup>18</sup>L.A. Teclaff, op. cit., pp. 115-118.

<sup>19</sup>*Ibid.*, p. 119.

<sup>20</sup>T.G. Cannon, "Geography and Underdevelopment," *Area*, Vol. 7, No. 3, (1975), pp. 212-216.

<sup>21</sup>G.F. White, op. cit.

<sup>22</sup>P. James, *All Possible Worlds* (Indianapolis: New York, The Odyssey Press, 1972), pp. 520-522.

<sup>23</sup>Formulated from definitions by Rogers, E.M., (1962), p. 13 and Pedersen, P.O., (1970), p. 237.

<sup>24</sup>Alternative and generally more inclusive definitions have been offered in the past. See for example, Thompson, V.A. "Bureaucracy and Innovation," *Administrative Science Quarterly*, 10 (June, 1965), p. 2; Wilson, J.Q., "Innovation in Organization: Notes Toward A Theory," in Thompson, J.D., ed. *Approaches to Organizational Design* (Pittsburgh: University of Pittsburgh Press, 1966), p. 106; Barnett, H.G., *Innovation: The Basis of Cultural Changes* (New York: McGraw-Hill Book Co., 1953), p. 7, Mohr, L.B. "Determinants of Innovation in Organizations," *American Political Sciences Review*, Vol. 63, No. 1 (1969), p. 112.

<sup>25</sup>World Health Organization (WHO), "Community Water Supply and Sewage Disposal in Developing Countries (end of 1970)," in *World Health Statistics Report*, Vol. 26 (1976), p. 721.

<sup>26</sup>E.M. Rogers (1962), p. 122.

<sup>27</sup>*Ibid.* p. 134.

<sup>28</sup>E. Mansfield, "Technical Change and the Rate of Imitation," *Econometrica*, 29: 741-766.

<sup>29</sup>E. Havens and E.M. Rogers, "Adoption of Hybrid Corn: Profitability and the Interaction Effect," *Rural Sociology*, 26 (1961): 409-414.

CHAPTER 2

<sup>1</sup>Among the many strategies suggested are Hirshmann's spearhead action in unbalanced growth. [See Hirshmann, A.O., *Strategy of Economic Development* (New Haven: Yale University Press, 1958)]. There is also the Balanced Growth and Big Push strategy of Rosenstein-Rodan and Nurske. [See Rosenstein-Rodan, P.N., "Notes on the Theory of the 'Big Push'", in Howard S. Ellis (ed.) *Economic Development for Latin America*, (London: St. Martin's Press, 1961), pp. 57-66. Also see Nurske, R., *Patterns of Trade and Development*, (Stockholm, 1959)] In recent years stress has been put on the need to recognize the institutional, social, cultural and psychological factors of development. [See for example Hoselitz, B.F., *Sociological Factors in Economic Development*, (Glencoe: The Free Press, 1960)] Still others have urban development strategies. [See for example Friedmann, J.R.P., *Regional Development Policy in Venezuela*, (Cambridge, Mass.: The M.I.T. Press, 1966)].

<sup>2</sup>The other major resource-oriented development strategy is mineral resource development.

<sup>3</sup>W.C. Lewis, et al. *Regional Economic Development - The Role of Water* (Economics Department, Utah State University Foundation, 1971).

<sup>4</sup>C.B. Garrison and A.S. Paulson, *The Effect of Water Resources in Industrial Growth in the Tennessee Valley Region* (Centre for Business and Economic Research, University of Tennessee, Knoxville). See also "Effect of Water Availability of Manufacturing Employment in Tennessee Valley Region," *Water Resource Research*, Vol. 8, pp. 301-316.

<sup>5</sup>C.W. Howe, "Water Resources and Regional Economic Growth in the United States, 1950-1960," *Southern Economic Journal*, Vol. 34, pp. 477-489.

<sup>6</sup>P.T. Cox, C.W. Grover, and B. Siskin, "Effect of Water Resource Development on Economic Growth," *Water Resource Research*, Vol. 7, pp. 32-38.

<sup>7</sup>R.H. McCuen, "Water Resource Investment and Economic Development: Balanced versus Unbalanced Investment Strategies," *Water Resource Bulletin*, Vol. 10, pp. 522-530.

<sup>8</sup>C. Gopalakrishnan, "Economic Growth Through Water Resource Development: India," *Water Resource Bulletin*, Vol. 8, pp. 459-472.

<sup>9</sup>United Nations, *The Demand for Water: Procedures and Methodologies for Projecting Water Demands in the Context of Regional and National Planning*, (Natural Resource/Water Series, No. 3, 1976).

<sup>10</sup>Local water projects which are not part of a large national or regional program would not affect the national economy significantly.

<sup>11</sup>R.J. Saunders, et al. *Village Water Supply* (Baltimore: The John Hopkins University Press, 1976), p. 57.

<sup>12</sup>*Ibid.*

<sup>13</sup>*Ibid.*, p. 59.

<sup>14</sup>*Ibid.*, p. 61.

<sup>15</sup>*Ibid.*, p. 62.

<sup>16</sup>G.F. White, et al. *Drawers of Water: Domestic Water Use in East Africa* (Chicago: University of Chicago Press, 1972).

<sup>17</sup>See page 5 of Chapter 2.

<sup>18</sup>Saunders, op. cit., p. 69.

<sup>19</sup>*Ibid.*, p. 71.

<sup>20</sup>*Ibid.*, pp. 76-77.

<sup>21</sup>*Ibid.*, p. 78.

<sup>22</sup>This is typified by tsetse infected basin of the Volta river that mainly stretches from Ghana to Upper Colta.

<sup>23</sup>See page 8 of Chapter 2.

<sup>24</sup>U.N. (1976), p. 179.

<sup>25</sup>*Ibid.*, p. 178.

<sup>26</sup>G.F. White, "Prospering With Uncertainty," in E. Vlachos, ed., *Transfer of Water Resource Knowledge* (Fort Collins; Colorado: Water Resource Publication, 1972).

<sup>27</sup>U.N. (1976), op. cit., p. 179.

<sup>28</sup>The U.N. Children's Fund (UNICEF) calculates that the human body needs a water intake of as much as 6 litres a day and considers an additional 38 litres an absolute minimum for body hygiene and other household uses. See Somanader, K.J. "Piped Dream: Providing Water for Rural Communities in Sri Lanka," *UNICEF News*, Issue 83/1975/1.

<sup>29</sup>H.P. Michael, ed., *Water Development in Less Developed Countries*, (Berlin: Dunker and Humbolt, 1965), p. 31.

<sup>30</sup>*Ibid.*, pp. 179-183.

<sup>31</sup>*Ibid.*

<sup>32</sup>*Ibid.*

<sup>33</sup>United Nations, *National Systems of Water Administration* (New York, 1974), p. 37.

<sup>34</sup>See C.W. Howe, *The Design and Evaluation of Institutional Arrangements for Water Planning and Management* (Report prepared for the U.N. Water Conference, Mar del Plata, Argentina, March, 1977).

<sup>35</sup>These units are Individual Federal Agencies, Individual Agencies together with assistance from an Advisory Committee, Interagency Committees, Interagency River Basin Commissions, State Water Resource Projects, State Federal Commissions. For detailed discussion of the areal units see *Organization and Methodology for River Basin Planning*, (Water Resource Centre Atlanta, Georgia: Georgia Institute of Technology 1964), pp. 73-74.

<sup>36</sup>L.R. Barr, *Areal Re-Organization of Water Management in England and Wales* (M.A. Thesis, Department of Geography, University of Victoria, 1973).

CHAPTER 3

<sup>1</sup>G.V. Childe, "A Prehistoric Interpretation of Diffusion," in L. Wagner and Marvin W. Mikesell, *Reading in Cultural Geography*, (Chicago: The University of Chicago Press, 1962).

<sup>2</sup>A.L. Kroeber, "Diffusionism," in *Encyclopedia of the Social Sciences*, (ed.,) E.R.A. Saligman, (New York: Macmillan 1930-1934), Vol. V, p. 139.

<sup>3</sup>R. Linton, *The Study of Man*, (New York: Appleton-Century Company, 1936).

<sup>4</sup>Barnett, op. cit., p. 291.

<sup>5</sup>See J.H. Steward, *Theory of Cultural Change*, (Urbana: University of Illinois Press, 1963), pp. 14-15.

<sup>6</sup>*Ibid.*, pp. 27-28.

<sup>7</sup>G. Tarde, *The Laws of Imitation* (Gloucester, Mass.: Reprinted by Peter Smith, 1962), a Collection of Tarde's articles on communication and other subjects in sociology appears in Clark, T.N., (ed), *On Communication and Social Influence*, (Chicago: The University of Chicago Press, 1969).

<sup>8</sup>E.M. Rogers, *Diffusion of Innovations*, (New York, The Free Press, 1962).

<sup>9</sup>R.V. Bowers, "The Direction of Intra-societal Diffusion," *American Sociological Review*, Vol. 2 (1937), p. 826.

<sup>10</sup>E.C. McVoy, "Patterns of Diffusion in the United States," *American Sociological Review*, Vol. V (1940), pp. 219-227.

<sup>11</sup>Y.S. Cohen, *Diffusion of an Innovation in an Urban System*, (University of Chicago, Department of Geography research paper No. 140, 1972), p. 8.

- <sup>12</sup>Bowers, op. cit.
- <sup>13</sup>E. Katz, M.C. Levin, and H. Hamilton, "Traditions of Research on the Diffusion of Innovation," *American Sociological Review* No. XXVIII, (1963), p. 240.
- <sup>14</sup>See J. Schumpeter, *The Theory of Economic Development*, Cambridge, Mass.: Harvard University Press, 1949) also David P.A., *Technical Choice Innovation and Economic Growth*, (Cambridge University Press, 1975), and Stiglitz, J.E. et al., *Readings in Modern Theory of Economic Growth*, (Cambridge, Mass.: The MIT Press, 1969).
- <sup>15</sup>S. Hakanson, "Special Presses in Paper-Making," in *The Diffusion of New Industrial Processes: An International Study*, L. Nasbeth and G.F. Ray, (eds.), Cambridge University Press, 1974, pp. 58-104. The volume contains other studies along the same line.
- <sup>16</sup>See Z. Griliches, "Hybrid Corn: An Exploration in the Economies of Technological Change," *Econometrica*, XXV, (1957), 501-522. Also Mansfield, op. cit.
- <sup>17</sup>T. Hagerstrand, *Innovation Diffusion as a Spatial Process*, translated with a post script by Allen Pred (Chicago: University of Chicago Press, 1967), pp. 1 and 6.
- <sup>18</sup>Cited in P. James, (1972), p. 520.
- <sup>19</sup>E. Semple, *Influence of Geographic Environment*, (1911).
- <sup>20</sup>See C.O. Sauer, *Agricultural Origins and Dispersals*, (New York: American Geographical Society, 1952).
- <sup>21</sup>See F.B. Kniffen, "Folk Housing: Key to Diffusion," *Annals of the Association of American Geographers*, Vol. 55 (1965).
- <sup>22</sup>H. Kurath, *A Word Geography of the Eastern United States*, (Ann-Arbor: University of Michigan Press, 1949).

<sup>23</sup>*Ibid.*, pp. 6-7.

<sup>24</sup>R. Yuill, "A Simulation Study of Barrier Effects in Spatial Diffusion Problems," Technical Report No. 1, Contract Nonr. 1228 (33) Task No. 389-140. (Evanston: Northwestern University, Department of Geography, 1965).

<sup>25</sup>R.L. Morrill, "Waves as Spatial Diffusion," *Journal of Regional Science*, Vol. VIII, (1968), pp. 1-18. See also "The Shape of Diffusion In Space and Time," *Economic Geography*, Vol. XLVI (1970), pp. 259-268.

<sup>26</sup>L.W. Bowden, *Diffusion of the Decision to Irrigate*, Research Paper No. 91 (Chicago: The University of Chicago, Department of Geography, 1965).

<sup>27</sup>James, *op. cit.*

<sup>28</sup>Bowers, *op. cit.*, p. 829.

<sup>29</sup>Griliches, *op. cit.*

<sup>30</sup>A.L. Coleman, and C.P. Marsh, "Differential Communication Among Farmers in a Kentucky County," *Rural Sociology*, Vol. 20, 1955, pp. 93-101.

<sup>31</sup>R.L. Crain, "Fluoridation - The Diffusion of an Innovation Among Cities," *Social Forces*, Vol. 44 (1966), pp. 467-475.

<sup>32</sup>G. Tornquist, *Growth of TV Ownership in Sweden, 1956-65: An Empirical Theatrical Study*. (Stockholm: Almqvist and Wicksell, 1967).

<sup>33</sup>A.D. Cliff, "The Neighbourhood Effect in the Diffusion of Innovations," *Transactions and Papers of the Institute of British Geographers*, Vol. 44 (1968), pp. 75-84.

<sup>34</sup>T. Hagerstrand, *The Propagation of Innovation Wages*, Lund Studies in Geography No. 3-4 (Lund, Gleerup, 1952), p. 8.

<sup>35</sup>E. Casetti, and K. Semple, "Concerning the Testing of Spatial Diffusion Hypotheses," *Geographical Analysis*, Vol. I (1969), pp. 254-259.

<sup>36</sup>J.B. Riddell, *The Spatial Dynamics of Modernization in Sierra Leone*. (Evanston: Northwestern University Press, 1970).

<sup>37</sup>Jui-Cheng Huang, and P. Gould, "Diffusion in an Urban Hierarchy: The Case of Rotary Clubs," *Economic Geography*, Vol. 54, No. 4, (October 1974), pp. 333-340.

<sup>38</sup>E.S. Sheppard, *On The Diffusion of Shopping Centre Construction in Canada*. Studies in the Diffusion of Innovation, Discussion Paper Number 36, Department of Geography, The Ohio State University.

<sup>39</sup>Griliches, op. cit.

<sup>40</sup>Mansfield, op. cit.

<sup>41</sup>J.C. Hudson, "Diffusion in a Central Place System," *Geographical Analysis*, Vol. I (1969), pp. 45-48.

<sup>42</sup>Research studies support the influence of both personal and impersonal sources of information. Those pertaining to personal sources include Rogers, E.M. and Beal, G.M., "The Importance of Personal Influence in the Adoption of Technical Changes," *Social Forces*, Vol. 36 (1958), pp. 329-335. An example of those supporting impersonal sources of information is Wilkening, E.A. "Roles of Communication Agents in Technical Change in Agriculture," *Social Forces*, Vol. 34, (1956), pp. 361-367.

<sup>43</sup>See E. Katz, "Interpersonal Influence," *International Encyclopedia of the Social Sciences*, 1968, iv, p. 179.

<sup>44</sup>McVoy, op. cit.

<sup>45</sup>Crain, op. cit.

<sup>46</sup>See Rogers (1962), op. cit. pp. 120-147.

<sup>47</sup>*Ibid.*

<sup>48</sup>T.W. Schultz, *Transforming Traditional Agriculture* (New Haven: Yale University Press, 1964), p. 164.

<sup>49</sup>Rogers, (1962), op. cit.

<sup>50</sup>S.Graham, "Class and Conservatism in the Adoption of Innovations," *Human Relation*, Vol. 9 (1956), pp. 91-100.

<sup>51</sup>C.A. Yeracaris, "Social Factors Associated With the Acceptance of Medical Innovations," Paper presented at the American Sociological Association, St. Louis, (1961). Cited in Rogers, op. cit., p. 127.

<sup>52</sup>F.C. Fliegel, et al. "A Cross-National Comparison of Farmers' Perceptions of Innovations as Related to Adoption Behaviour," *Rural Society*, Vol. 33 (1968), pp. 437-449.

<sup>53</sup>Rogers, op. cit.

<sup>54</sup>J.E. Kivlin, Characteristics of Farm Practices Associated with Rate of Adoption, Ph.D. Thesis, University Park: Pennsylvania State University (1960), Cited in Rogers, op. cit. p. 130.

<sup>55</sup>Rogers, op. cit.

<sup>56</sup>E. Hruschka, and H. Rheinwald, "The Effectiveness of German Pilot Farms," *Sociologia Ruralis*, Vol. 5 (1965), pp. 101-111.

<sup>57</sup>F.C. Fliegel, and J.E. Kilvin, "Attributes of Innovation as Factors in Diffusion," *American Journal of Sociology*, Vol. LXXII, (1966), pp. 235-236.

<sup>58</sup>See either, E.M. Rogers, op. cit. or E.M. Rogers, and F.F. Shoemaker, *Communication of Innovations*, (New York: The Free Press, 1971).

<sup>59</sup>This is the concessions of numbers of researchers including Brown, L.A., Herr, P.J., and Agnew, J.A., *The Diffusion of Community Innovations: A Conceptualization and Empirical Analysis* (Studies in the Diffusion of Innovation, Discussion paper No. 31, Department of Geography, Ohio State University), p. 1. See also Brown, L.A. and Hanham, R.Q., *The Provision of Innovations Within the Context of Geographical Diffusion Theory*, (Discussion paper Number 29. Department of Geography, Ohio State University).

<sup>60</sup>W. Woodruff, "An Enquiry into The Origins of Invention and Intercontinental Diffusion of Techniques of Production in the Rubber Industry," *The Economic Record* (December, 1962), pp. 479-497.

<sup>61</sup>G.S. Maddala, and P.T. Knight, "International Diffusion of Technical Change - A Case of the Oxygen Steel Making Proces," *The Economic Journal*, Vol. 7 (September 1967), pp. 531-558.

<sup>62</sup>P.O. Pedersen, "Innovation Diffusion Within and Between National Urban Systems," *Geographical Analysis*, Vol. 2, No. 3 (July, 1970), pp. 237-252.

<sup>63</sup>About 1,000 publications are available. See Council for Planning Librarians Exchange Bibliography, No. 1420 - 22 (December 1977).

<sup>64</sup>Rogers, op. cit. p. 87.

<sup>65</sup>W.A. Herzog, Jr. "Diffusion of Innovations to Peasants in Brazil, Nigeria," in *Inducing Technological Change for Economic Growth and Development*, Solo, R.A. and E.M. Rogers (eds.), (East Lansing: Michigan State University Press, 1972), p. 102.

<sup>66</sup>V. Ruttan, "Planning Technological Advance in Agriculture: The Case of Rice Production in Taiwan, Thailand and Phillipines," in Solo and Rogers, *Ibid.*, pp. 52-77.

<sup>67</sup>Herzog, op. cit., p. 107.

CHAPTER 4

<sup>1</sup>A.W. Singer and J.A. Ansari, *Rich and Poor Countries*. (London: George Allen and Unwin Ltd., 1977), pp. 45-46.

<sup>2</sup>H. Myint, *The Economics of the Developing Countries* (London: Hutchinson, 1967), p. 14.

<sup>3</sup>See L.G. Scheidl, "Some Problems of Developing Countries," *Tijdschrift voor Economische en Sociale Geografie* (December, 1964), pp. 250-251.

<sup>4</sup>Singer, op cit., p. 49.

<sup>5</sup>R. Nurkse, *Problems of Capital Formation in Underdeveloped Countries* (London: Oxford University Press, 1955).

<sup>6</sup>This view was expressed by Lewis in his famous Manchester School Paper.

<sup>7</sup>J.S. Uppal and L.R. Salkever, *Africa: Problems in Economic Development* (New York: The Free Press, 1972), p. 11.

<sup>8</sup>A.M. Alonso, "Reflections on Latin American Underdevelopment," *The Developing Economies*, Vol. VI, (March, 1968), No. 1, p. 67.

<sup>9</sup>A. Angelopoulos, *The Third World and the Rich Countries* (New York: Praeger Publishers, 1972), p. 30.

<sup>10</sup>Alonso, op. cit.

<sup>11</sup>*Ibid.*

<sup>12</sup>The exception includes the oil producing developing countries.

<sup>13</sup>This is the result of low income elasticity of demand for primary products.

<sup>14</sup>L. Stein, *Economic Realities in Poor Countries* (Sydney: Angus and Robertson, 1972).

<sup>15</sup>Nurkse, op. cit., p. 5.

<sup>16</sup>A. de Vajda, "Factors Influencing Planning and Operation of Irrigation and Drainage Projects in Developing Countries, in Michael, H.P. op. cit. p. 94.

<sup>17</sup>W.A. Lewis, *The Theory of Economic Growth*, (London: Geoge Allen and Unwin Ltd., 1961), p. 305.

<sup>18</sup>G. Kimble, *Tropical Africa* (New York: The Twentieth Century Fund, 1960), p. 572.

<sup>19</sup>Forty per cent to fifty per cent, on the average.

<sup>20</sup>I. Little, T. Scitovsky, and M. Scott, *Industry and Trade in Some Developing Countries*, (London: Oxford Unigersity Press, 1970), p. 32.

<sup>21</sup>This is particularly applicable to foreign entrepreneurs.

<sup>22</sup>S. Kuznets, "Quantitative Aspects of the Economic Growth of Nations: IX Level and Structure of Foreign Trade - Comparison for Recent years," *Economic Development and Cultural Change*, Vol. XIII, No. 1, Part II (October, 1964), pp. 9-10.

<sup>23</sup>See for example the foreign exchange components of various categories of total investment for India's third plan: In Meier, G.M. *Leading Issues in Development Economics*, (New York: Oxford University Press, 1964), p.143.

<sup>24</sup>The shipment of grain by the U.S. and Canada to developing countries is a dramatic example of this type of external economic relationship.

<sup>25</sup>This is because of lack of commodity stabilization agreements. The international wheat agreement is one of the best known examples of commodity agreements.

<sup>26</sup>Current estimates of national income per capita are deficient in several respects as measures of inter-country differences in levels of economic welfare. Hence the use of increase in per capita income as a sole identification of development must be avoided. This was emphasized by a study conducted by some Indian economists - See Divatia, V.V. and V.V. Bhatt, "On Measuring the Pace of Development", *Banca Nazionale del Lavoro Quarterly Review*, (June, 1969).

<sup>27</sup>Alonso, op. cit., p. 61.

<sup>28</sup>See for example S. Clarke, *Problems of Growth in the Third World*, (London: Sheed and Ward, 1974); N. Ashcraft, *Colonialism and Underdevelopment*, (New York: Teachers College Press, 1973).

<sup>29</sup>J.W. MacNeil, *Environmental Management*, (Information Canada, 1973, p. 153.

<sup>30</sup>United Nations, Centre for Economic and Social Information OPl/CESI NOTE WATER/8, 24 August, 1976.

<sup>31</sup>P.Q. Quigg, *Water: The Essential Resource* (New York: National Audobon Society, 1976), pp. 1-2.

<sup>32</sup>MacNeil, op. cit.

<sup>33</sup>*Ibid.*

CHAPTER 5

<sup>1</sup>The declaration was made at the Second Ministerial Conference of Developing Countries in Lima Peru, November 7, 1971.

<sup>2</sup>United Nations, Map No. 1026, Rev. 1, October 1969. Provided in U.N. 1970. op. cit.

<sup>3</sup>Pedersen, op. cit.

<sup>4</sup>See Cannon, op. cit. Also see Blaut, J.M., "The Theory of Development," *Antipode*, Vol. 5, No. 1 (1953) pp. 22-26; and Folke, S., "First Thoughts on the Geography of Imperialism," *Antipode*, Vol. 5, No. 3 (1973), pp. 16-20.

<sup>5</sup>See Herr, Agnew, and Brown, op. cit.

<sup>6</sup>A.H. Naylor, "Hydro-electric and Integrated River Basin Development in Less Developed Countries," in Michael, op. cit. p. 164.

<sup>7</sup>L.A. Brown and G.D. Gustavus, *The Diffusion of a Population-Related Innovation: The Planned Parenthood Affiliate* (Studies in the Diffusion of Innovation, Discussion Paper Number 37, Department of Geography, The Ohio State University).

<sup>8</sup>The definition of illiteracy used here is synonymous with that given by UNEECO which is "the ability both to read and write." This definition thus includes under illiterate all semi-literates - persons who can read but not write. See UNESCO, *Literacy 1969-1971*, (Paris, 1972).

<sup>9</sup>G.Coutsinas, and C. Paix, "External Trade and Spatial Organization: A Typology," *Antipode*, Vol. 9, No. 1 (February 1977), pp. 97-109.

<sup>10</sup>The other two are structure of exports, and the rate of external trade which is defined as *total imports + total exports*. (G.N.P.)

<sup>11</sup>P.Q. Pedersen, op. cit.

<sup>12</sup>E.M. Rogers, op. cit., p. 169.

<sup>13</sup>It should be noted that the degree of relative advantage is often expressed in economic profitability, but the relative advantage dimension may be measured in other ways too, hence the operational definition adopted.

<sup>14</sup>Nasbeth and Ray, op. cit.

<sup>15</sup>Mansfield, (1961), op. cit.

<sup>16</sup>See W.G. Demas, *The Economics of Development in Small Countries with Special Reference to the Caribbean* (Montreal, McGill University Press, 1966); see also E.A.G. Robinson, (ed.) *The Economic Consequence of the Size of Nations* (London: Macmillan, 1960).

<sup>17</sup>Nordbeck, S., "Computing Distances in Road Net," *Regional Science Association Paper*, Vol. 12 (1964), pp. 207-220.

<sup>18</sup>R. Hammond, and P.S. McCullagh, *Quantitative Techniques in Geography: An Introduction* (Oxford: Clarendon Press, 1974), p. 201.

<sup>19</sup>L.A. Brown and R.Q. Hanham, "Diffusion Through an Urban System: The Testing of Related Hypotheses," *Tijdschrift voor Economic en Sociale Geografie*, (November/December, 1972), pp. 388-392.

<sup>20</sup>See for example, A. Menzal, "Innovation, Integration and Marginality," *American Sociological Review*, Vol. XXV (1960), pp. 704-713, and Rogers, (1962), op. cit. Chapter 5.

<sup>21</sup>E.J. Malecki, Spector, A.N., and Brown, L.A. *Adopter Categories in a Spatial Context: Artificial Insemination in Southern Sweden*. (Studies in Diffusion of Innovation, Discussion Paper No. 5, Department of Geography, The Ohio State University).

<sup>22</sup>After Cohen, op. cit., p. 43.

CHAPTER 6

<sup>1</sup>See *Times of London*, Wednesday (July 12, 1978), p. 7.

<sup>2</sup>See U.N., *Development Forum*, Vol. 4, No. 9, (November - December 1976), Supplement, p. 3.

<sup>3</sup>As the name implies, a multiplicative term is a product of two or more other terms. It is a new predictor variable created by multiplying scores on one predictor by corresponding scores on one or more others.

<sup>4</sup>The procedure used in computing the term in this study is as follows: Suppose there are three variables -  $X_1, X_2, X_3$

$$\text{Interact} = X_1 - X_2 + X_1 - X_3 + X_2 - X_3 + X_1 - X_3 - X_2$$

Where - multiplication

See Nie, N.H. et al., *Statistical Package for the Social Sciences*, (Toronto, McGraw-Hill, 1975), pp. 372-373.

<sup>5</sup>See Nie, et. al., *Ibid.*, pp. 434-467.

## APPENDIX I

<u>Country</u>	<u>River Basin</u>	<u>Size (Sq. Mi.)</u>	<u>Amount Within Country</u>
Batswana	Limpopo	100,000-1 ML	Part
Cameron	Chad	Same	"
Burundi	Congo	Same	"
Chad	Chad	Same	"
Dahomey	Oume	100,000	"
Ethiopia	Jaba-Shibelk	100,000-1 ML	"
Gabon	Ogoque	Same	"
Ghana	Volta	Same	"
Guinea	Niger/Senegab	Same	"
Ivory Coast	Sassandra-Komoe	100,000	"
Kenya	Lakerudulk/Nile		"
Lesotho	Orange	100,000-1 ML	"
Liberia	St. John/Cestos	100,000	"
Malagasy	Betsioboka	100,000	"
Malawi	Congo	1 ML	"
Mali	Niger	1 ML	"
Morocco	Guir/Daoura/Dra	100,000	"
Niger	Niger	1 ML	"
Nigeria	Niger	Same	"
Senegal	Senegal	100,000-1 ML	"
Sierra Leone	Kaba	100,000	"
Somalia	Juba-Shibeli	100,000-1 ML	"
Sudan	Nile	1 ML	"
Swaziland	Umbeluzi	100,000	"
Tanzania	Congo	1 ML	"
Togo	Mono	100,000	"
Tunisia	Merjerdo	Same	"
Uganda	Nile	1 ML	"
Egypt	Same	Same	"
Upper Volta	Volta	100,000-1 ML	"
Equit-Guin	Chiloango	100,000	"
Angola	Cunene	100,000-1 ML	"
C. Brazzavile	Congo	1 ML	"
Zaire	Same	Same	"
Gambia	Gambia	100,000-1 ML	"
Zambia	Congo	1 ML	"
C. Africa	Chad	Same	"
Burma	Irrawady	100,000-1 ML	"
Srilanka	Galoya	100,000	"
India	Ganges	1 ML	"
Iran	Kura-Araks	100,000-1 ML	"
Iraq	Tigris	Same	"
Jordan	Jordan	100,000	"

<u>Country</u>	<u>River Basin</u>	<u>Size (Sq. Mi.)</u>	<u>Amount Within Country</u>
Laos	Mekong	100,000-1 ML	"
Indonesia	Tami/Fly	100,000	"
Malaysia	Golok	Same	"
Thailand	Mekong	1 ML	"
Syria	Tigris	100,000-1 ML	"
South Yemen	Tiban	100,000	"
North Yemen	Tiban	100,000	"
Pakistan	Brahamaputr	100,000-1 ML	"
Bolivia	Amazon	1 ML	"
Brazil	Amazon/Pathos-Mirim	Same	"
Chile	Valdiva/Puelo/Yelcho	100,000	"
Columbia	Cauca/Mira/Amazon	1 ML	"
Ecuador	Mira/Matajaf/Zarumilla	100,000	"
Argentina	Laplata	1 ML	"
El Salvador	Leuyca	100,000	"
Guatemala	Grijalva/Usuma/Cinta	Same	"
Guyana	Essequibo/Massare	100,000-1 ML	"
Haiti	Massare	100,000	"
Honduras	Negro/Goascoran/Leuyca	Same	"
Mexico	Grijalva-Usuma/Hondo/RG	100,000-1 ML	"
Nicaragua	San Juan/Negro	100,000	"
Panama	Sixaola	Same	"
Paraguay	Amazon	1 ML	"
Peru	Amazon/Lake TiticacaChira	1 ML	"
Uruguay	La Plata	Same	"
Venezuela	Orinoco	Same	"
Mauritania	Atui	Same	"

Source: United Nations Map No. REV. 1 October 1969. Quoted in *Integrated River Basin Development*: Report of a panel of experts. New York, 1970.



# UNIVERSITY OF VICTORIA

P.O. BOX 1700, VICTORIA, BRITISH COLUMBIA, CANADA V8W 2Y2  
TELEPHONE (604) 477-6911, TELEX 049-7222

*Department of Geography*

April 6, 1978

Dear Sir/ Madam:

I am currently engaged in graduate research concerning the adoption of the concept of integrated river basin development in developing countries. Some of the data needed (see attached) for the research I believe is available in your office (or library), and I am planning a visit in May. Therefore I shall be very grateful if you would fill in the stub below and return it in the enclosed envelope so that I can better plan my visit.

Yours sincerely,

Encls.

Kingsley Okyere

-----  
Your visit would be most convenient on . . . . .

When you come, please see Mr./Mrs./Miss . . . . .

Room: . . . . . Tel.: . . . . .

Below is a sample of the type of information that I will be seeking during my visit.

- (1) Rivers in your country that have been developed for integrated (co-ordinated) purposes.
- (2) Date (year) when construction started.
- (3) Cost of project(s)
- (4) Sources of finance
- (5) Estimated benefits of project(s).

Many of these, I believe, could be easily obtained from feasibility reports and annual budget proposals.



UNIVERSITY OF VICTORIA

P.O. BOX 1700, VICTORIA, BRITISH COLUMBIA, CANADA V8W 2Y2  
TELEPHONE (604) 477-6911, TELEX 049-7222

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Room: . . . . . Tel.: . . . . .

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- (4) Sources of finance.
- (5) Estimated benefits of project(s)

Many of these, I believe, could be obtained from feasibility reports on the projects.

EMBAJADA DE GUATEMALA  
CANADA

No./CAN/173/78/U.C.

Ottawa, April 14, 1978

Mr. Kingsley Okyere  
University of Victoria  
P.O. box 1700, Victoria, B.C.  
Canada, V8W 2Y2

Dear Mr. Okyere:


In reply to your letter of recent date, I am very pleased to furnish you with the addresses, where they can provide you with all the necessary information:

"DIRECCION GENERAL DE ESTADISTICA"  
7a. avenida 12-39 Zona 1  
Teléfono: 80798  
Guatemala, Guatemala, C.A.

"INSTITUTO GEOGRAFICO NACIONAL"  
Avenida Las Américas 5-76 Zona 13  
Teléfono: 63280-81-82.  
Guatemala, Guatemala, C.A.

Hoping the above information will be of help to you, I remain,

Very Truly Yours,

  
Third Secretary  
(Consular Affairs)

/Mes

# INSIVUMEH

INSTITUTO NACIONAL DE SISMOLOGIA, VULCANOLOGIA,  
METEOROLOGIA E HIDROLOGIA  
MINISTERIO DE COMUNICACIONES Y OBRAS PUBLICAS  
7a. AVENIDA 14-57, ZONA 13  
GUATEMALA, A. C.

197

TELEFONO: 63944

CABLE: INSIVUMEH

OFICIO No. 082-78

REF. DSH/SAS

Guatemala, 2 de junio de 1978

Señor  
Kingsley Okyere  
University of Victoria  
P.O. Box 1700, Victoria  
British Columbia, Canada V8W 2Y2

Estimado Señor Okyere:

Nos es grato enviarle para su uso dos ejemplares de publicaciones que pueden ser de utilidad para sus estudios.

Atentamente,



[Redacted Signature]  
Ing. Arturo David Acajabón  
Encargado de la Sección  
Agua Superficial

ADA/ocr



## OFFICE OF THE HIGH COMMISSIONER FOR GUYANA

CABLE ADDRESS: GUYHICOM, OTTAWA.  
TEL: 235-7249

SUITE 309,  
151 SLATER STREET,  
OTTAWA, CANADA

Ref: No. 10/2/1

May 5, 1978

Mr. Kingsley Okeyere,  
University of Victoria,  
P.O. Box 1700,  
Victoria, B.C.  
V8W 2Y2.


Dear Mr. Okeyere,

With reference to your letter of April 6, 1978 I regret to inform you that this office is out of the information you need for your research. A copy of your letter was therefore passed on to the appropriate authorities in Georgetown for their prompt attention.

We are still waiting on a response from Georgetown, and as soon as we hear from them, will transmit the information on to you; or, if you are planning to come to Ottawa, kindly call my secretary, Mrs. Joyce Headley at the above number and she will convey the information you require.

With every good wish.

Yours sincerely,

  
(R. J. Headley)  
for High Commissioner



## EMBASSY OF THE HASHEMITE KINGDOM OF JORDAN

100 BRONSON AVENUE, SUITE 701, OTTAWA K1H 6G8

TELEPHONE 238-8090

KS/4/1/277

April 20, 1978

Mr. Kingsley Okyere  
University of Victoria  
P.O. Box 1700  
Victoria, B.C.  
V8W 2Y2

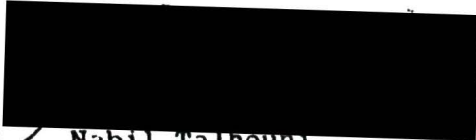
Dear Mr. Okyere:

With reference to your letter, dated April 6, 1978,  
I regret to inform you that the information you desire is  
not available at this Embassy. Please write to the following  
address:

National Planning Council  
Zahran Street  
Third Circle Jabel  
Amman - JORDAN

With best regards,

Yours truly,

  
Nabil Talhouni  
Counsellor

HIGH COMMISSION OF MALAYSIA



SURUHANJAYA TINGGI MALAYSIA

60 BOTELER STREET  
OTTAWA K1N 8Y7  
CANADA

May 4, 1978.

Mr. Kingsley Okyere,  
Department of Geography,  
University of Victoria,  
P.O.Box 1700, Victoria,  
British Columbia, Canada.  
V8W 2Y2

Dear Sir,

With reference to your letter dated April 6, 1978, we have only few relevant materials at the office to offer you. You may have them mailed or at whatever your conveniences .

However you are welcomed to meet us (names as attached) and make the usage of our library.

May I suggest that you also write to the address below for more references : -

Department of Geography  
University of Malaya  
Pantai Valley  
Kuala Lumpur  
Malaysia

Thank you.

Yours sincerely,

A black rectangular box redacting the signature of the sender.

(Khalidah Kayat)  
Second Secretary  
Acting Information Attache

TELEPHONE: PL 5-8470 (3 LINES)  
TELEGRAMS: MALAWIAN, NEW YORK

IN REPLY PLEASE QUOTE NO. INF 8/5



PERMANENT MISSION OF THE REPUBLIC  
OF MALAWI TO THE UNITED NATIONS  
777 THIRD AVENUE  
NEW YORK, N. Y. 10017

May 1, 1978

Mr. Kingsley Okyere  
Department of Geography  
University of Victoria  
P. O. Box 1700, Victoria,  
British Columbia, Canada V8W 2Y2

Dear Mr. Okyere,

Please refer to your communication of April 6, 1978 in which you requested for permission to visit this Mission in May this year for the purpose of conducting a research in the concept of integrated river basin development in the developing countries.

I am sorry to advise that our programme of work is so tight that it is not possible to grant you permission to visit this Mission for the purpose you have mentioned. If you wish, however, to secure the information you want urgently, you may check with the World Bank Library in Washington, D.C. since some of our river valley projects have been financed with assistance from the World Bank.

Yours sincerely,



D. Y. J. KALILANGWE  
Minister  
for Ambassador and Permanent  
Representative

DYJK/nc

## EMBASSY OF PAKISTAN

170 METCALLE STREET

OTTAWA, CANADA

K2P 1P3

CABLES "PAREP"

TELEPHONE 238-7881



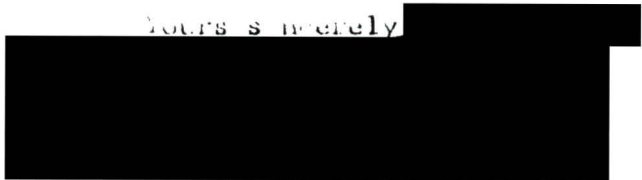
Ms. /3/78

18 April 1978

Dear Mr. Myere,

With reference to your letter of April 6, we have to inform you that the information that you require is not available with us. However, we are writing to the relevant authorities in Pakistan and shall let you have the information as soon as we receive it.

Yours sincerely

  
Dr. Farouk A. Kana  
Charge d'Affaires

Mr. Finlay Myere  
Department of Geography  
University of Victoria  
P.O. Box 1700  
Victoria, B.C.

Senegal Embassy



Ambassade du Sénégal

57, avenue Marlborough  
K1N 8E8

~~XXXXXXXXXXXX~~

OTTAWA, le 14 avril 78  
19...

N/Réf. : ATK/NMB/036/109/ASC.

Cher Monsieur,

J'accuse réception de votre lettre en date du 6 avril 1978 dans laquelle vous me faites part de votre désir d'obtenir des renseignements sur le développement intégré des bassins fluviaux.

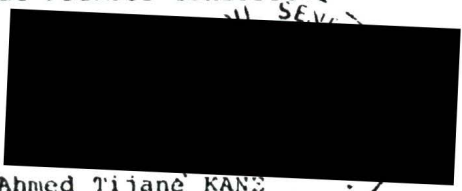
Pour le Sénégal, je dois dès à présent vous dire qu'aucun bassin n'a en fait été développé pour le moment, mais que ce pays est fortement engagé avec ses voisins (le Mali et la Mauritanie) dans le processus de développement du bassin du fleuve Sénégal. Il en est de même pour le bassin du fleuve Gambie. Maintenant vous devez vous dire qu'il s'agit là de projets.

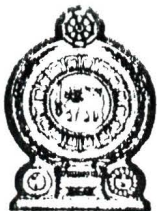
S'agissant de votre passage à OTTAWA, je ne peux pas vous fixer de rendez-vous dès maintenant, mais je pourrai le faire si vous m'appelez au téléphone environ une semaine avant la date que vous aurez retenue pour votre déplacement.

Croyez, cher Monsieur, à l'assurance de ma haute considération.

Le Premier Conseiller

Monsieur Kingsley Okyere  
University of Victoria  
P.O. Box 1700,  
VICTORIA, British Columbia,  
Canada V8W 2Y2

  
Ahmed Tijané KANE



*High Commission for Sri Lanka*

*85 Range Road, Suites 102-104*

*Ottawa, Ont. K1S 1S6*

*Canada*

*Tel. 237-8705 8449*

May 2, 1978


No. INF/3/2

Mr. Kingsley Okyere,  
University of Victoria,  
British Columbia  
P.O. Box 1700,  
Victoria B.C.

Dear Sir,

Thank you for your letter dated April 6th and I regret the delay in replying. You could visit this Mission at any time you happen to be in Ottawa and make use of whatever material we have. I would appreciate it if you could give us an indication of when you might be here in May. The Mission will be closed on the 22nd of May, which is a Sri Lanka holiday.

Yours truly,

  
F.M.D. Fernando  
Acting High Commissioner.

EMBASSY OF THE SYRIAN ARAB REPUBLIC  
2215 WYOMING AVENUE, N. W.  
WASHINGTON, D. C. 20008

May 9, 1978

Kingsley Okyere  
Department of Geography  
University of Victoria  
P.O.Box 1700  
Victoria, B.C.  
Canada V8W 2Y2

Dear Mr. Okyere:


Thank you for your letter and for your plan to visit us  
in the Embassy.

In response to your inquiry, I regret that those data  
you mentioned are unavailable in this Embassy. However,  
I suggest you write to the following address:

Ministry of Euphrates Dam  
and Water Supplies  
Damascus  
Syria

With best wishes.

Sincerely yours,

  
Toufic Abouchaer  
Information Officer

TELEPHONE : 233-2744  
TELEX : 053-4469  
TELEGRAPHIC ADDRESS : UGACOM OTTAWA



THE REPUBLIC OF UGANDA

UGANDA HIGH COMMISSION

270 LAURIER AVENUE, WEST  
SUITE 601, OTTAWA K1P 5V5

OUR REF. INF/01


14th April, 1978

Mr. Kingsley Okyere  
University of Victoria  
P.O. Box 1700, Victoria  
B.C. , V8W 2Y2

Dear Sir,

We regret to inform you that we do not have the information you are looking for. Our rivers have not been tempered with in any way. I would kindly advise you not to make the trip.

Yours truly,

  
for: Hector Dracho  
HIGH COMMISSIONER

EMBAJADA DE VENEZUELA  
CANADA

Ottawa, May 3rd, 1978


Mister Kingsley Okyere  
University of Victoria  
Department of Geography  
P.O.Box 1.700  
Victoria, British Columbia  
V8W 2Y2

Dear Mister Okyere:

Regarding your letter dated April 6, 1978, I am pleased to inform you that the following Department of our Ministry of External Affairs can provide you with the data for your research on "Integrated River Basin Development", in developing countries.

MINISTERIO DE RELACIONES EXTERIORES  
Dirección General Sectorial de Fronteras  
Caracas 101  
Venezuela

Yours Truly,

  
Francisco Alvarez  
First Secretary

FA/SF/sag.-



## INTERNATIONAL INNOVATION DIFFUSION

RESEARCH GUIDE**I: SITUATIONAL CHARACTERISTICS**

1. River basins in country	Area (sq. kms.)	% in country
a.....	.....	.....
b.....	.....	.....
c.....	.....	.....
d.....	.....	.....
2. Basins developed for integrated purposes		
	Basin	Purposes
	Year	
a.....	.....	.....
b.....	.....	.....
c.....	.....	.....
d.....	.....	.....

**II. SOCIO-ECONOMIC CHARACTERISTICS**

1. Country's characteristics in adoption year	
a. population	.....
b. population growth rate	.....
c. Unemployment rate	.....
d. Illiteracy rate	.....
e. Gross National Product	.....
f. Income per capita	.....
g. Contribution of Exports to G.N.P.	.....
h. Contribution of Agriculture to G.N.P.	.....
i. Foreign exchange reserves.....	.....

III. POLITICAL CHARACTERISTICS

- a. Length of colonial rule .....
- b. Governmental changes between 1928 and adoption year .....
- c. Number of military gov'ts during the period .....
- d. Type of government in power at the start of development .....
- e. Year of entry into the United Nations .....

IV. PROJECT DEVELOPMENT

- 1. Monetary cost of projects .....
- 2. Sources of finance
  - a..... Amount.....
  - b.....
  - c.....
  - d.....
- 3. Interest on Loans
  - a.....
  - b.....
  - c.....
  - d.....
- 4. Estimated monetary benefits of projects .....
- 5. Prior use(s) of basin .....

V. OTHERS

- 1. Distance between capital and Washington, D.C. ....
- 2. Distance between capital and nearest adopting unit .....

APPENDIX VIMAJOR SOURCES OF STATISTICAL DATA

- a - Embassies
- b - United Nations, *Statistical Yearbook*, New York: U.N. Publications, 1948-1968.
- c - Unesco, *Literacy, 1969-71*, Paris, 1972.
- d - International Monetary Fund, *Balance of Payments Yearbook*, Washington, 1960 - 1967.
- e - United Nations, *Flood Control Series*, Nos. 8-32.
- f - United Nations. Proceedings of the Ninth and Tenth Sessions of the Regional Conference on Water Resource Development in Asia and the Far East.
- g - Compiled from Bartholomew, *The World*, Edinburgh, Bartholomew and Sons, Ltd., 1976.
- h - International Association and International Bank for Reconstruction and Development, *Statement of Loans*, Washington, September 1977.
- i - United Nations Economic and Social Council. Committee on Natural Resources, *Register of International River Basins*, Geneva, May 1977.
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VITA

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Place of Birth: TWENEDURASE-KWAHU GHANA

Date of Birth: OCTOBER 18, 1951

Educational Institutions Attended, with Dates of Entering  
and Leaving:

UNIVERSITY OF GHANA (LEGON) 1972 to 1975

UNIVERSITY OF VICTORIA, B.C. 1976 to 1979

Degrees, Diplomas, Etc., Awarded, with Dates and Names of  
Institutions:

B.A. (Honors) 1975 University of Ghana

Honors and Awards:

University of Victoria Fellowship 1976/77

University of Victoria Scholarship 1977/78

Publications:

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TITLE OR THESIS/DISSERTATION

INTERNATIONAL DIFFUSION OF INNOVATIONS: A CASE STUDY OF THE

DIFFUSION OF THE CONCEPT OF INTEGRATED RIVER BASIN

DEVELOPMENT IN DEVELOPING COUNTRIES

Author:



KINGSLEY OPOKU OKYERE

December 1978

Date