A SOCIO-ECONOMIC ANALYSIS OF UPSTREAM WATERSHED DEVELOPMENT IN OKLAHOMA

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Submitted to the faculty of the Graduate College
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in partial fulfillment of the requirements
for the degree of
DOCTOR OF PHILOSOPHY
May, 1967

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PREFACE

The research reported in this dissertation was conducted within the Economic Research Service, United States Department of Agriculture and Oklahoma Agricultural Experiment Station, cooperating in Hatch project 1041, "Economics of Agricultural Land and Water Use, Conservation and Development in Watersheds of Oklahoma." The dissertation is an analysis of the socio-economic environment of communities engaged in upstream watershed development processes.

I wish to acknowledge the help and guidance of my major adviser, Dr. Daniel D. Badger throughout this study. Thanks are also due to the other members of my committee: Dr. Neil R. Cook, Dr. Charles H. Little, and Dr. Carl E. Marshall.

Special appreciation is extended to Dr. James E. Martin and Dr. Dale D. Grosvenor for assistance in the statistical and computer programming analyses.

Sincere appreciation is extended to Mr. Morris L. Weinberger and Dr. Neil R. Cook, Economic Research Service, for their assistance and support during my entire graduate program.

Without the cooperation of the executive officers of the State Soil Conservation Board, the State Soil Conservation Service Office, and the interviewees, this study would not have been possible. Access to records and pertinent data were freely made available.

The author is indebted to the secretaries of the Watershed Economics Research Laboratory, Barbara Oberlander, Sonya Allison, and Carolyn Hackett, for their assistance in making computations and typing several drafts of the thesis.

Finally, special gratitude is due my wife and children who have endured my absence with patience.

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CHAPTER I

INTRODUCTION

The upstream watershed program in Oklahoma is an example of what local, state, and federal people and agencies can accomplish through cooperation. Thirty-eight percent of the land in Oklahoma -- 17 million acres -- are within the boundaries of upstream watersheds for which various community organizations have asked the Soil Conservation Service for planning assistance. Eighty million dollars have been spent on construction of upstream flood protection measures in Oklahoma by the Soil Conservation Service. As of May, 1966, thirty percent of the upstream flood prevention reservoirs in the United States under the Public Law 566 program[1] had been built in Oklahoma. In addition, 734 flood prevention reservoirs had been constructed in the 64 sub-watersheds of the Washita River basin [1].

The 115 PL 566 watersheds as well as the Washita watersheds are shown on the Watershed Protection and Flood Prevention Progress Map on page 2. The Washita projects are located within the thick, black lines drawn diagonally across the southwest portion of the state. The Washita basin is further advanced in development than the PL 566 projects due to its earlier inception and concentrated efforts by the

[1]Watershed Protection and Flood Prevention Act (Public Law 566 -- 83rd Congress, 68 Stat. 666), as amended.

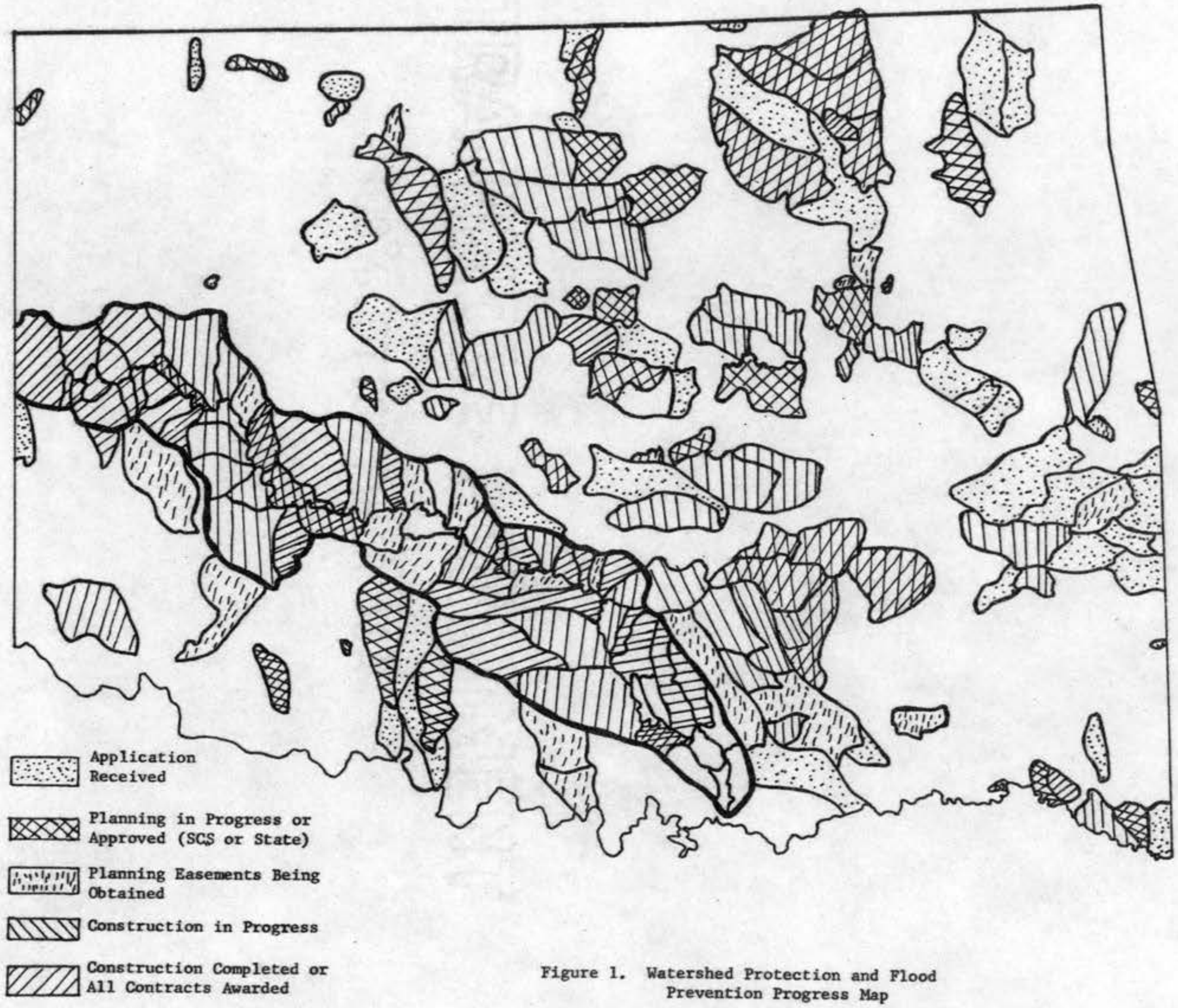

Figure 1. Watershed Protection and Flood Prevention Progress Map

local leaders in the program. The PL 566 watersheds are distributed rather widely throughout all areas of the state except the Panhandle.

The local people in each community must decide whether a proposed watershed project will be in their best interest. This decision must be made at an early date when reliable data and knowledge are not readily available. This often leads to confusion and hesitancy, and in many cases, retards the upstream watershed development program.

The local people in a proposed watershed project are in need of more adequate guidelines and information. These decision-makers face changing relationships among individuals, groups of individuals representing vested interests, and a myriad of institutions designed to facilitate the obtainment of diverse goals. Most landowners are involved in watershed projects because of developmental possibilities such as irrigation, land clearing and drainage, crop intensification, and recreation. But these possibilities are often conflicting.

The complexity of the decision is magnified because the primary service provided -- flood protection -- is not under the full control of any one individual or group. Instead, the decision to participate is dependent upon many factors such as: (1) water originating on land held by many landowners and in turn flooding the land of other landowners; (2) competing uses of flood detention reservoirs; (3) various types of facilitating organizations with overlapping authority representing diverse interests; (4) water rights and legal restrictions; and (5) other factors to be enumerated later in this study.

This research effort is a part of a larger effort to broaden the information base of participants in the upstream watershed program.

This additional information not only aids the individual decision-maker, but strengthens the whole program. Previous studies carried out at the Watershed Economics Research Laboratory[2] have already contributed to the available knowledge about the landowners' environment with emphasis upon changes brought about by the program. Jansma's [2] analysis of net secondary income due to the multiplier effect contributes knowledge about community receipts and expenditures from watershed development. Anderson's [3, 4] study provides information about the value of water for irrigation from structures developed under the upstream watershed program. Cook's [5] study of land use changes resulting from upstream watershed development provides a realistic appraisal of actual land use change after project establishment.

The present study purports to expand this body of knowledge. A study of institutional influences is necessary because they are known to have a substantial influence on the actual behavior of an economy.

The Problems

Because there is a wide divergence in the ability of communities to inaugurate and carry to completion development programs such as upstream watershed projects, it is desirable to discover the underlying reasons for this divergence. Since planning funds are generally always scarce and because planning is an expensive process, the available funds should be allocated to those communities which can adequately carry out

[2]The Watershed Economics Research Laboratory was established at Stillwater, Oklahoma by ERS, USDA in 1957. The laboratory is designed to carry on intensive analysis of watershed development for flood prevention, land stabilization, and agricultural and nonagricultural water management, including irrigation, other water supply, and recreation.

their responsibilities. Plans for a particular watershed soon become obsolete if the local people in the watershed do not quickly follow through on the plans to get construction underway.

State enabling legislation authorizes the special districts necessary for watershed sponsorship at the local level. A valid question is whether this legislation is adequate and facilitating, rather than inadequate and detrimental, for watershed development.

Can the local people make a decision regarding the acceptance or rejection of a proposed watershed project without adequate knowledge of possible benefits or costs? To make rational decisions, the decision-maker must know (1) his goals, (2) the alternative ways of reaching these goals, and (3) the probable consequence of choosing each alternative.

Problems such as (1) who should receive scarce planning funds, (2) whether current enabling legislation is adequate, and (3) can the local people make rational decisions with limited information and assistance, must be solved if the upstream watershed development program is to experience continued success. These problems stem from a lack of factual knowledge, which leads to inability to locate and assess alternative actions, and inability to determine data needs, statistical techniques, and analytical theories to adequately assess alternative actions. This study will attempt to determine the underlying causes of the above problems, and to develop some guidelines for more rational decision making in planning future watershed projects.

Objectives

The general objectives of this study are (1) to gain an understanding of the genesis of development using the Washita and PL 566 upstream watershed programs in Oklahoma as a vehicle for analysis, and (2) to discover the causes of disparity in rate of development between upstream watershed projects.

Research on the manner in which sponsoring organizations have carried out their responsibilities is almost non-existent. One purpose of this study is to delve into that area.

It is hypothesized that man's success in achieving development through group or community action is a function of his socio-economic environment. A specific objective of this study is to test this hypothesis by investigation of several community factors and socio-economic variables and their ability to predict development success.

It is also hypothesized that traditional decision-making theories leave much to be desired and must be substantially altered to be applicable to socio-economic decision-making problems. Thus, another specific objective is to assess the traditional decision-making assumptions of fixed and known alternatives and to examine suitable changes which will allow the people involved in watershed development projects to make more meaningful and hopefully, more accurate decisions.

It is hoped that the results of this study will add to the existing knowledge about the institutional arrangements which may affect man's rights and responsibilities as well as provide analytical methods whereby the landowner and other decision-makers in responsible positions can more adequately assess the uncertainties affecting the progress of the upstream watershed program.

Scope and Method

Only by learning more about the total environment -- including economic, sociological, psychological, and institutional -- can we reduce uncertainities. By adding to the knowledge of decision-makers, we hope to increase their managerial efficiency. The methodology will include some historical and analytically descriptive material in order to add to the fund of knowledge about the total environment. An analysis of the experience of 115 PL 566 and 65 Washita upstream watershed projects representing many different problem situations should provide additional information useful to the formulation of guidelines for future projects. Formulations of remedial measures require evaluation of factors of failures and successes of communities attempting development. The prediction of future events provides one of the most stringent tests of present theories. Analytical and statistical procedures will be utilized to predict and analyze the hypothesized relationships stated in the objectives.

The remainder of this dissertation is organized in the following manner. A review of the legislation and organizations responsible for watershed development is presented in Chapter II to gain a perspective of the requirements and responsibilities involved in upstream watershed development projects. The theory of decision-making and its applicability to group decisions associated with upstream watershed development is presented and discussed in Chapter III. This chapter also includes an introduction to two statistical techniques which can be utilized to analyze these problems. Chapters IV and V include a discussion of the use of these techniques and an interpretation of the findings. The sample survey used to check the validity of the analyses given in the previous two chapters is presented in Chapter VI. The last chapter includes the summary and conclusions.

CHAPTER II

INSTITUTIONS AFFECTING UPSTREAM WATERSHED DEVELOPMENT IN OKLAHOMA

Background

Soil and water conservation programs were begun in Oklahoma about 1920 with terracing used on the uplands and channel clearing used in the bottomlands to alleviate soil erosion and flooding damage. Out of the dusty 30's came an intensification of interest to alleviate the problems of soil losses by erosion and flooding. Neither upland control measures nor dams on streams and rivers could solve this situation alone.

The United States Army Corps of Engineers had been building large downstream dams to prevent flooding, but siltation was often a problem resulting in a need for increased reservoir capacities to hold the sedimentation. Out of this situation came the upstream watershed program which allowed small upstream dams to be built in conjunction with necessary soil conservation practices. This reduced flooding and siltation of downstream lands and reservoir facilities.

The Watershed Protection and Flood Prevention Act of 1954 (PL 566) enabled those who wished to manage and control their soil and water resources to do so with federal help. Of major importance to this program is the reliance on local interest, strength, and financial capability primarily through the organization and functioning of local organizations.

An evolution of institutional and organizational arrangements occurred simultaneously with the new program. Local improvement associations, river basin councils, state associations, and finally a national association came into being to back the program as the individual landowners visualized the problem and its solution. State legislation was passed which enabled interested groups of citizens and landowners to obtain the necessary powers and resources to carry through their plans. Opposing organizations were formed in order to correct, in their opinion, abuses resulting from misuse of certain powers by the newly formed organizations.[1]

This chapter analyzes the impact of various institutions on watershed development in Oklahoma. In light of the findings, a commentary on possible trends and evolvement of necessary institutions for proper water resource development in Oklahoma is presented.

Legislative Action Affecting Watershed Development

Water Law of 1905

The Eighth Legislative Assembly of the Territory of Oklahoma enacted the first water law, much of which is still in effect today. This law outlined the procedures for acquiring water rights, regulated

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[1]The Landowners' Protective Association of the State of Oklahoma was formed on April 30, 1963. This state association was created by the merging of several local organizations, the oldest being the Upstream Farmers' Association organized in 1958.

the use of water, and created the Office of Engineer to administer the water laws. The following principles of this Act have served as the foundation of subsequent legislation: (1) beneficial use is the basis, the measure and the limit of the right to use water; (2) water is a public property; and (3) Oklahoma's water resources should satisfy the greatest need and the most reasonable use.[2]

The Water Law of 1905 provided for "certain contingent reservations of water rights in case same are requested by U. S. Government, and for other purposes."[3] This recognition of federal rights to plan and develop streams within Oklahoma has persisted until recently. Only during the last few years has the State developed machinery to coordinate and influence proposed developments by federal agencies within the state.

Conservancy Act of 1924

The next significant piece of legislation was House Bill No. 47 of 1924 known as the "Conservancy Act of Oklahoma."[4] Little used until the passage of Public Law 566 thirty years later, Conservancy Districts have since become a major conveyance for putting watershed plans into action. This Act provides the needed authority to assess and tax property to assure financing of projects. Unlike other special districts, the Conservancy District is not a political corporation or subdivision

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[2] House Journal, Oklahoma Territory - 1905, p. 283.

[3] Council Journal, Oklahoma Territory - 1905, p. 133.

[4] 1923-24 Session Laws of Oklahoma, Chapter 139, p. 161.

of the state. But it does have governmental character with an elected board of directors who must be landowners within the district and live within the district. The District Court having jurisdiction over the majority of the affected area is vested with the power and authority to establish a Conservancy District[5] upon petition of 51 percent of the landowners, who must own at least 51 percent of the proposed area.

Conservancy Districts may be organized for any or all of the following purposes: to prevent floods, to regulate stream channels and stream flows, to reclaim and to develop land, and to provide irrigation, domestic, and industrial water supplies. Conservancy Districts may levy taxes, issue bonds, accept Federal financing, charge use fees, levy special assessments, and receive income from land sales. They have powers to make entry upon lands for survey and examination, to let contracts, to use dominant right of eminent domain, to pursue condemnation under the general law and to regulate to protect works.[6]

Soil Conservation Districts Law of 1937

In order to take advantage of funds and technical assistance provided by Public Law 46 passed by Congress in 1935, the state passed the Soil Conservation Districts Law of 1937 enabling the establishment of Soil and Water Conservation Districts throughout the state. These districts are true multiple-purpose districts with these functions: (1) to conserve soil and water resources; (2) to conserve other natural

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[5]Oklahoma Stat. Ann., tit. 82, sec. 541, p. 567.

[6]Ibid., p. 572.

resources and wildlife; (3) to protect property; and (4) to promote the health, safety and general welfare of the district. These districts are governmental subdivisions of the state, and as such, can sue and be sued, make regulations, and petition the court for compliance. They cannot assess and tax property; thus are different in these respects, from the Conservancy Districts.

Flood Control Act and Public Law 566

Actual upstream watershed planning and development have been underway on the Washita River since 1947. The Washita River Basin was one of eleven watersheds in the United States established by Public Law 534 (the Flood Control Act of 1944). Following the apparent success of these pilot projects, Congress passed the Watershed Protection and Flood Prevention Act in 1954 (PL 566). This law, as amended, provides for (1) flood prevention, (2) agricultural water management, including irrigation and drainage, and (3) non-agricultural water management, including recreation, fish and wildlife development, and municipal or industrial water supply. Watershed projects are limited in size to 250,000 acres or less, with individual structures having no more than 12,500 acre-feet of floodwater detention capacity or 25,000 acre-feet of capacity for all purposes.

Under the provisions of PL 566, the local sponsoring organization is responsible for developing interest and demonstrating financial and organizational capability to carry through to completion an upstream watershed project. Specifically, the sponsoring organization must acquire all land, easements, and rights-of-way needed for structures or other improvements at no cost to the Federal Government, to pay all legal fees and administrative costs involved in obtaining these rights, and to allocate these local costs among members or beneficiaries.

Development of the Operational Machinery for Water Resource Development

At first the Territorial Engineer (later the State Engineer) was responsible for planning, development and control of the State's water resources. The Soil Conservation District Law of 1937 created the Soil Conservation Committee, an administrative body which consisted of the President of the Oklahoma Agricultural and Mechanical College, the Director of the State Agricultural Extension Service, the Director of the State Agricultural Experiment Station, the State Supervisor of Vocational Agriculture, and one other member invited by the committee and appointed by the Secretary of Agriculture of the United States of America.[7] This Committee directed its efforts and the forces under its command to establish, as quickly as possible, Soil Conservation Districts throughout the entire state. The results of the committee's concerted effort are shown in Table I.

A State Association of Soil and Water Conservation Districts was organized in 1938. A disagreement on policies arose between the Association and the State Soil Conservation Committee over appropriation and distribution of funds for planning versus funds for actual construction. The Association was in favor of the latter. Each group presented their views to the legislature which accepted most of the

[7] Oklahoma Stat. Ann., tit. 2-804 (1941).

proposals of the Association and passed Senate Bill 78, March 12, 1945, amending Title 2, Oklahoma Statutes (1941) 804-807. This law established a State Soil Conservation Board consisting of five farmers living on the land and engaged in agriculture as their principal means of livelihood. The new board hired an Executive Director who was directed to get projects under construction as quickly as possible.

TABLE I

SOIL AND WATER CONSERVATION DISTRICTS ORGANIZED
IN THE 20-YEAR PERIOD, 1938-1958

Year	Districts Organized	Year	Districts Organized
1938	24	1948	1
1939	9	1949	1
1940	11	1950	1
1941	12	1951	1
1942	2	1952	1
1943	1	1953	1
1944	8	1954	1
1945	5	1955	1
1946	4	1956	1
1947	1	1957	1
		1958[a]	1
		Total	87

Source: State Soil Conservation Board Records (unpublished).

[a]Kingfisher County S & WCD was organized in 1958, completing the organization of the entire state into Soil and Water Conservation Districts.

In 1955 the Small Watersheds Flood Control Fund was created by the State Legislature at the insistence of the Association of Soil and Water Conservation Districts. Money in this revolving fund is made available to districts to acquire lands in hardship cases. The stipulation was made that 90 percent of the necessary easements, rights-of-way, or lands in fee simple must be acquired by the district to be eligible for the funds. The money is later paid back by the district from income derived from land sales or assessments on benefitted lands. All land sales by the districts must first be approved by the State Soil Conservation Board. Since the first appropriation was made in 1955, more than $875,000 has been appropriated for use in the revolving fund. Loans for $728,393.65 have been made while repayments have been $374,406.97 as of October 31, 1966. Thus, the net amount in the revolving fund as of October 31, 1966 was $521,013.32.

House Joint Resolution 520 of the 25th Oklahoma Legislature (1955) created the Water Study Committee, an interim committee composed of an Executive Citizens Committee and a Legislative Committee. The purpose of this Water Study Committee was to develop long range water policies and programs for Oklahoma. One of the major proposals of the Committee was that the legislature should establish a Water Resources Board. This proposal became law by Senate Bill 138 of the 26th legislature (1957), and the Board was given the overall responsibility for coordinating and developing the water resources of the state. One of the many functions of the Board is to consider applications for water rights and water use from special districts, municipalities, industries, and individuals.[8]

Frequently, conflicting or competitive demands for the limited water resources arise. Before 1955 there was no overall planning or

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[8]The 1963 Legislature established the Water Conservation Storage Commission. The members of the Water Resources Board are the officers of the Commission. The Commission is to determine if surplus waters exist in any project development and to reserve such water or storage capacity for future needs of the state or any political subdivision thereof.

coordination between state agencies. An informal committee operated with limited success until a 1963 Executive Order of the Governor created the State Agencies Coordinating Committee on Land and Water Resource Development. There are seven members of the committee with one member from each of the following state agencies: Water Resources Board, Wildlife Conservation Commission, State Highway Commission, State Soil Conservation Board, State Health Department, State Board of Agriculture, and the Planning and Resources Board.[9]

Inception of Watershed Projects

The Soil Conservation Service of the United States Department of Agriculture has the primary responsibility for carrying out the upstream watershed program once assistance is requested by the local people. A project is carried out jointly at the local, state, and federal levels.

The SCS Work Unit Conservationist of the sponsoring Soil and Water Conservation District represents the SCS to the local leadership and assists in keeping the various organizations and groups concerned informed. He also keeps the SCS Area Conservationist and State office staff informed of action taken by the sponsoring organization.

Upon requests for assitance, the Area Conservationist presents the program of the SCS to the local leaders and in turn presents the wishes of the local leaders to the SCS state office.

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[9]The Oklahoma Planning and Resources Board was merged into the Oklahoma Industrial Development and Park Department by the 1965 legislature.

The SCS state office makes assignments of an SCS watershed planning staff composed of engineers, hydrologists, geologists, economists, and other needed specialists to work with the local Work Unit Conservationist after the State Soil Conservation Board has determined priority of planning. The Area Conservationist submits a quarterly summary of recommendations for construction schedules, but the State Conservationist does the actual scheduling of construction.

The SCS state office sends applications for assistance to its Washington office. Also, the draft work plan is reviewed by the SCS Engineering Watershed Planning Unit and the SCS Washington office. The SCS Administrator allocates funds for approved watershed projects from money appropriated each year by Congress.

The SCS state office works closely with the State Soil Conservation Board in the upstream watershed program. The State Soil Conservation Board members are chosen from district supervisors [6]. In turn, the local Soil and Water Conservation Districts are administered by five landowners residing in the district. Three are elected by the landowners, and two are appointed by the State Soil Conservation Board.

The Cooperative Extension Service, the State Vocational Agriculture Education program, the State Agricultural Stabilization and Conservation Service, the USDA Forest Service, Farmers Home Administration, and the Fish and Wildlife Service are all assisting agencies which contribute to the development and promotion of Oklahoma's upstream watershed development program. Each of these agencies carry out extensive programs in water conservation and development.

Private Groups

Watershed Associations

Watershed associations are local, informal organizations which often bring the leadership and abilities of the people within a watershed into a common and unified group. Often called improvement associations, they have membership throughout the watershed. The members are typically those who own and operate land and property which will benefit by the project. Interested businessmen and civic leaders are often members. The association usually has a constitution with by-laws, officers, and board of directors.

Experience has shown that the key to a successful watershed project has usually been an active, well-organized watershed association. An active association works closely with the SCS technicians while the proposed project is being surveyed, evaluated, and then planned. Association members may assist in a survey of the watershed and its needs, raise funds to finance the organization of a conservancy district or to secure easements, conduct publicity and educational programs, sponsor tours to completed watersheds, print brochures on the watershed, and otherwise promote watershed protection and flood prevention on the watershed.

Flood Prevention Councils

In the early 1930's, an informal group of landowners and businessmen of the Washita valley organized with the purpose of discovering possible action which could be taken to arrest the frequent flooding of the Washita bottomlands. This informal group later organized the Washita Flood Prevention Council in 1938 to intensify efforts to solve their common problems.

Mr. Nolan Fuqua of Duncan, Oklahoma, was the first president of the Council and appointed a committee to investigate what had been accomplished in other states and what information was available from the federal government. A legislative committee was also appointed to investigate and develop water resources legislation to meet the needs of the state. The Washita Council was very influential in obtaining appropriations to develop the upstream watershed program in Oklahoma.

After Congress authorized the Washita River flood control program, one of the primary purposes of the Washita Council was to establish a set of criteria of need and capability to be followed in the planning of subwatersheds. One of the major priorities established by the Council was that the people of a proposed watershed must show a definite willingness to organize into strong associations and special districts, to seek assistance from SCS technicians, and demonstrate ability to secure necessary easements and rights-of-way. Many of the criteria established by the Washita Council are used by the State Soil Conservation Board today.

In addition to the Washita Council, the Cimarron River Flood Prevention Council, the Poteau River Watershed Council, and the Kaw Watershed Review Commission have been functioning within the Pulbic Law 566 program. The Council has no legal powers but provides guidance for the overall program of the river basin concerned. The Council members provide educational and informational assistance as well as leadership to local areas and districts within the river basin. Their recommendations for planning and installing watershed projects are highly valued by the state and federal agencies concerned.

State Association of Soil and Water Conservation Districts

The leaders of the Washita Council were also very influential in the formation of the State Association of Soil and Water Conservation Districts in 1938. This association has proven to be an influential and beneficial proponent of the upstream watershed program in Oklahoma. The Association has provided leadership, impetus, education, information, and assistance in the organization of new districts, in support of proposed watersheds, and in seeking improved legislation and appropriations from the state legislature.

Leadership provided by members of the State Association is a great force behind Oklahoma's conservation program. Perhaps the enthusiasm and willingness to give of one's self and time without remuneration came out of these men's experience during the dusty 30's. Perhaps it came from the witnessing of vast destruction of fields, roads, bridges, and utilities caused by the flooding of Oklahoma's streams and rivers. In any event, district supervisors and board members have contributed much time and effort to conservation in general and to development of the upstream watershed program in particular.

Other Influential Groups

The type and number of sponsors and assisting organizations involved with Public Law 566 projects for which application for assistance has been made is summarized in Table II.

TABLE II

SPONSORS AND ASSISTING ORGANIZATIONS OF THE 119 PL 566
PROJECT APPLICATIONS UP TO NOVEMBER 1, 1966*

Sponsors	
Soil and Water Conservation Districts	87
Conservancy Districts	68
Watershed Associations	63
Councils	3
Total	221
Assisting Organizations	
Chamber of Commerce	108
Cities	71
Banks and Businesses	52
County Commissioners	43
Lions Clubs	29
Farm Organizations	27
Sportsman Clubs	24
Rotary Clubs	18
Towns	18
Kiwanis	15
Newspapers and Radio	11
Federal Agencies	10
School Boards and Commissions	10
State Agencies	7
Businessmen's Associations	5
Garden Clubs	4
Other Miscellaneous Organizations	19
Total	471

Source: Compiled from the files of State and Federal Agencies by personnel of the Watershed Economics Research Laboratory, ERS, USDA, Stillwater, Oklahoma.

*Many of these sponsors and endorsers assist in the formation and development of more than one project. For instance, the 87 Soil and Water Conservation Districts appear 238 times on project applications.

A manifestation of the support of non-rural people is the endorsement by 169 civic and service clubs, 89 town and city governments, and banks, businesses and news media. More than twice as many assisting organizations as sponsors indicates the extent of community cooperation in project formulation and development. The broad support for the projects is demonstrated by the many diverse interest groups represented.

Current and Future Problems

Interagency Problems

Oklahoma's long status as a territory and the large proportion of Indian lands within the state have resulted in significant involvement by federal agencies in Oklahoma's water resource development.[10] The long established programs of these federal agencies affect the operations of the newer Upstream Watershed Program in both complementary and competitive ways.

The Bureau of Reclamation of the Department of Interior has constructed several multiple-purpose projects in Oklahoma. Prior to the organization of the Oklahoma Water Resources Board in 1957, the Bureau of Reclamation would appropriate all the unappropriated water rights to a stream and hold these rights indefinitely if it so desired.[11]

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[10] Oklahoma was an Indian territory from 1840 to 1889 at which time it became a territory of the U.S. Oklahoma became a state in 1907.

[11] See Session Laws of Oklahoma, 1905, Section 26, p. 287-288. Proper officers of the U. S. were required to file for unappropriated waters which could be held for a three-year period at which time plans must be filed or water shall become public property again. Once plans were filed, however, these water rights could be held indefinitely without actual construction.

Since the demand upon the scarce water resources has grown over time, the Oklahoma Water Resources Board now limits the Bureau of Reclamation to the holding of rights to unappropriated waters for no longer than a three-year planning period and an eight-year construction period.[12] Construction of Public Law 566 projects on streams with prior appropriated water necessitates that these projects are to be built for flood control purposes only, thus limiting upstream irrigation possibilities. If extended drouth should occur in these areas, foreseen difficulties could become controversies resulting in court cases to test the legality of the appropriations.

The United States Army Corps of Engineers has built multi-purpose projects in Oklahoma as a part of the control and development of the Arkansas and Mississippi Rivers. Due to recent policy changes of the Corps of Engineers which emphasize more upstream control and development, some Corps' projects have become smaller in size and could become competitive with Public Law 566 projects which have become larger over time.[13]

The Bureau of Indian Affairs of the Department of Interior has not developed a watershed program of its own. It does have a land conservation program, but Indian lands are not composed of tracts large enough to encompass an entire watershed. Some problems involving Indian lands in upstream watershed projects are: (1) the Indian lands are tax exempt which prohibits assessment of Indian lands; (2) Indians cannot sell

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[12] Oklahoma Stat. Ann. 1958, title 82, sec. 91, pp. 1881, 1882.

[13] An August 7, 1956 amendment to Public Law 566 increases the size restriction from 5,000 to 12,500 acre-feet for flood detention purposes and to 25,000 acre-feet for multiple purposes for any single structure.

their lands without the prior approval of the Bureau of Indian Affairs; and, (3) lack of management initiative and leadership inhibits upstream watershed development in an area with high Indian ownership. The Bureau of Indian Affairs does assist in the promotion of Public Law 566 projects in the project area, however.

Organization and Operational Problems

A major problem area in upstream watershed development concerns the extent of the powers of the sponsoring organization. The State Soil Conservation Board has recommended that Conservancy Districts be formed to insure adequate financial support and legal authority to meet project responsibilities. Care must be taken, however, that individual landowner rights are not abused.

How is the proper balance of power effected? Some of the leaders in the upstream watershed program throughout the state believe that abuses have been made through the misuse of available powers of a Conservancy District. Generally, this group of leaders would prefer that Watershed Associations, with donations and voluntary assessments of monies, be responsible for obtaining the necessary easements and rights-of way. The State Soil Conservation Board has acknowledged the capabilities of such an organization and presently accepts those associations showing financial responsibility of stated minimum standards as suitable sponsoring organizations (see Appendix A).

Another problem to overcome is misinformation and lack of information about construction sites, water rights, costs, benefits, and cost sharing. There exists a paradoxical situation, wherein no one can really tell what a proposed project will cost or how much of a beneficial effect it will have on the soil and water conservation problem in the community until plans are completed. A proposed watershed must have a financial responsible sponsoring organization to receive a high priority and subsequent planning assistance. Thus, members of the community need to know to what extent they are obligating themselves, so as to consider possible alternatives and make a rational decision.

It may take 6 or 7 years from the time interest is first developed until construction is started, due to the wait for establishment of priority and time required for planning. It is difficult to maintain the interest and enthusiasm of the local people over such a long period. Much dissatisfaction and misinformation may creep in due to rumors and uncertainties of actual project plans. Discrepancies between information provided by the preliminary survey and the final plan often lead to such rumors and dissatisfaction. But this is inevitable because project leaders change their plans as new information becomes available during project investigations.

When Conservancy Districts are sponsors, more careful attention must be given to acquiring easements and in assessing costs. As a result of a recent State Soil Conservation Board policy concerning multiple ownership, operating agreements must be obtained from each of the owners of a project site before obtaining easements. Better training of court-appointed assessors is planned. A move is now underway to require the court to appoint certified or trained assessors. The State Soil Conservation Board utilizes the revolving fund to enable districts to acquire easements in hardship cases so that undue pressures are not necessary for project survival. Opposition has proven beneficial in that powers are not abused as before and precautions are being taken to assure better relationships between the district and the landowners.

Some problems arise due to too much enthusiasm to get a program initiated. Backers and promoters may promise too much or paint too rosy a picture. Projected benefits are extolled without sufficient basis. Sufficient restraint by project leaders and sponsoring organizations must be stressed during this period by agencies assisting the local sponsors. More resources should be put into the preliminary and final survey and plans.

Other problems lie in the need for clarification of water rights where multiple ownership of project sites are involved. Also, as more and more of the better sites and projects are developed, the need for more technical assistance and improved methodology to evaluate the benefits and costs of proposed projects is evident. Whether the future trend is to voluntary improvement associations with few powers, or to reliance on governmental entities, there is a need for continued leadership at the local level.

Summary

The role of institutions is to provide suppliers of resources with incentives to invest by permitting them to claim benefits commensurate with costs. Changes in existing institutions are implicitly required to achieve optimum economic development.

The continuation of the high level of development of the upstream watershed program in Oklahoma depends upon making the necessary adjustments in facilitating institutions. Legislative action affecting watershed development provides adequate legislation to enable groups to form organizations with sufficient powers and capabilities to carry out the desired programs. These capabilities must not unnecessarily infringe upon the rights of the individual landowner, however. Organizations opposed to any infringement upon individual rights have been formed to offset any past intrusions.

An effective information and educational program by all agencies involved with watershed development must be continued and strengthened so that those concerned may make knowledgeable decisions. Coordination among agencies at every level is required to prevent duplication and wasted effort. Sufficient technical assistance in the development of plans and in carrying a watershed project through to completion is necessary to continued development. Most important, the continued responsible leadership and service, given willingly and unselfishly by the local citizens, is required.

The development of several types of private groups or lobbying organizations continues to assure success of the upstream watershed development program. The purpose of the remaining chapters is to develop information whereby interested citizens and planners can make more knowledgeable decisions.

CHAPTER III

DECISION-MAKING IN A SOCIO-ECONOMIC ENVIRONMENT

Introduction

Decision theory relates mainly to individual decision-making. In farm management the primary concern has been decision-making under risk and uncertainty and the resulting effect on farm organization [7]. The farm firm is usually treated as an individual, although some tenure studies have included owner-tenant combinations [8]. These studies look at the differences in optimum farm organization or profit maximum positions under alternative tenure arrangements. The micro-economic theory assumes a rational economic man with a single goal of profit maximization, providing a ready solution given certain other assumptions.

The classical decision theory is a theory of man choosing among fixed and known alternatives, to each of which is attached known consequences [9, p. 272]. An additional requirement not explicitly stated in the classical model, but nevertheless evident, is the ownership or control of the resources involved in the decision or problem situation. It is the latter requirement which raises questions about the applicability of such a model when resources and forces outside the firm are owned or controlled by diverse people holding differing objective functions. If the usual assumptions of classical decision theory do not hold, then what process of decision-making is applicable? Or, what changes in assumptions are required? Whether or not these assumptions are the relevant ones have not been questioned. But dissatisfaction with these assumptions has grown considerably during the past few decades by those interested in what goes on in real life [10, p. 51].

Real life decision-making involves fundamental social values. In an economic development problem such as the upstream watershed program, the unit of decision is a group of individual firms banded together to solve a common problem. If certain elements of the problem situation are not represented in the planning and decision-making process, solutions which are not compatible with the goals of those involved can be expected to develop. Therefore, the first requisite for group decision-making is that adequate representation of all elements of the problem must be assured.

Some Theories Applicable to the Problem

The relatively new cross-discipline of social psychology has contributed the idea "that social valuation as opposed to solely individual valuation is an existential reality; it is an empirically observable regularity in every society . . . it is . . . a value scale possessed pervasively by individuals but maintained and fostered and passed on to succeeding generations within or through a particular social system" [11, p. 397]. In our society it is reflected in and through the market place, the voting booth, and allegiance to certain ideologies.

Also in social psychology, within the realm of group theories, there are a continuum of views from the "Individualistic Thesis" on the one hand to the "Group Mind Thesis" on the other. Those holding to the individualistic thesis state that individuals are needy creatures who pursue their own needs using others only as a means to their own ends; a portrayal of economic man. In this view, there are no groups as such; group is merely a collective term referring to a multiplicity of individual processes. On the other hand, those holding to the group mind thesis state that there are laws of social systems that impose themselves upon individuals and mold them, often contrary to the wills of those who become their agent. The real entity is society and its processes; the individual is merely a cell of the social body who becomes its carrier and expression.

Somewhere in between these two extremes lies the view, held by this author, that there is both a distinctiveness and inseparability of group and individual; once a group is functioning, the primary unit is not just an individual but a socio-economic man. A particular individual can at the same time have tendencies and values that coincide with the group, that are peculiar only to him, or that oppose those of the group. Observed socio-economic facts are thus concurrently facts of the psychology of individuals and of environment and culture molded individuals who act and feel as members of groups.

A Recombination of Theories to Fit Socio-Economic Man

The above realization has implications about the appropriate decision-making theories applicable to socio-economic man. Socio-economic man is defined as an individual with full realization that certain resources necessary to the betterment of his welfare are owned or controlled by other individuals, and that through social and political contact and interaction these resources can be utilized to the benefit of all.

In the firm analysis approach, one simply calculates the optimum situation given an initial distribution of resources among firms. Then the actual situation is observed, any disparities noted, and changes are suggested for movement toward the optimum for individuals. But in the case of political and social studies, the analysis usually proceeds from a description of the current situation to a categorization of types representing various political and social similarities or singleness of purpose. This is primarily a classification process with inferences then drawn as to interaction processes which do or may occur. The good points of both approaches may be combined in an attempt to integrate the methods and obtain the relevant interrelationships involved.

Botanists have learned that vegetation in a particular area thrives because it has become adapted to the soil, climate, topography, and other conditions prevailing in the area. The particular species found is a function of its environment. To draw an analogy, the human resources of an area are a function of the environment of the community. Just as measurement of mineral elements of the soil, rainfall, and slope describe the vegetative environment, measurement of socio-economic variables such as Value of Minerals, Per Capita Income, and Median School Years Attended help describe the socio-economic environment of an area. Growth and development become a function of such an environment.

It is hypothesized that socio-economic data are reflections of man's reactions to his environment. If this is true, we can observe data of community variables in such a manner as to categorize or classify groups or communities according to their performance, with performance defined as ability to achieve social goals.

To utilize environmental variables to predict performance, a statistical technique capable of handling many variables is needed. This technique should be able to classify as well as predict since we are interested in observing differences between groups. Multiple discriminant analysis is a statistical technique which will accomplish these purposes.

Multiple Discriminant Analysis

Multiple discriminant analysis is used to examine and/or predict the group membership of individuals on the basis of a set of attributes of those individuals.[1]

Discriminant analysis represents a fairly new addition to the statistical techniques which are available to the economist.[2] To appreciate the importance of the discriminant function, we must place it in a setting among other prediction procedures. Four possible types of predictive techniques are presented in Table III.

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[1] Multiple Discriminant Analysis is concerned with the discrimination between three or more groups and is merely an extension of the more familiar discriminant analysis or two group classification.

[2] Fisher's development of the discriminant function in the 1930's [12] and its generalization by Lubin [13], Tiedeman [14], and others in the 1950's, has only recently been followed by practical application.

TABLE III

SOME TYPES OF PREDICTIVE TECHNIQUES

Dependent Variate	Independent Variate	Statistical Technique
1. Quantitative	Quantitative	Multiple Regression
2. Quantitative	Qualitative	Analysis of Variance
3. (a) Qualitative	Quantitative	Discriminant Analysis
(b) Qualitative	Quantitative	Factor Analysis
4. Qualitative	Qualitative	----

Source: Adapted from Ardie Lubin [13, p. 91].

The discriminant function, as well as factor analysis, should be considered of the same order of importance as multiple regression or analysis of variance. The main advantage of discriminant and factor analysis is the capability of assessing and predicting a qualitative dependent variate from a set of quantitative independent variates. As demonstrated later, this qualitative measure provides assistance in the assessment of socio-economic variables and their effect on community progress.

The discriminant function is an optimum discriminator and overcomes the problems usually associated with quantitatively specifying a dependent variable.[3] The group assignment procedure is derived from a model of a multivariate normal distribution of observations within groups. The concept of minimizing the percentage of misclassified

[3] Optimum in the sense that it affords the maximum possible discrimination. See Rao [15].

individuals is of the same importance and plays the same role as the least squares concept of minimizing the squared error terms of prediction.

Given the basic equation

(1) $$X_{ijk} = A_{jk} + Z_{ijk}$$

then the observation, X, of the k[th] stochastic variable in the i[th] group is equal to the overall level of the k[th] variable in the i[th] group (A_{jk}) plus some positive or negative error effect (Z_{ijk}). Thus $\hat{A}_{jk}$ is the best linear unbiased estimate of the observation that can be made knowing that the individual comes from the i[th] group. The least squares estimate of A_{jk} will be the mean of the n_i observations for each stochastic variable [13, p. 91]. The attribute of group membership has in effect been quantified by equation (1).

Given observations in the form

$$X_{ijk} \qquad \begin{array}{l} i = 1, \ldots, g, \text{ numbers of groups} \\ j = 1, \ldots, n_i, \text{ sample size of the } i^{th} \text{ group} \\ k = 1, \ldots, m, \text{ number of variables} \end{array}$$

then the means of variables considered within each group can be denoted by:

$$X_{i \cdot k}$$

The matrix S_i, which represents the sum of cross products of deviation from the means is described by:

$$S_i = (s^i_{kk'}) \quad k' = 1, \ldots, m$$

where

(2) $$s^i_{kk'} = \sum_{j=1}^{n_i} (X_{ijk} - X_{i \cdot k}) (X_{ijk'} - X_{i \cdot k'}).$$

The pooled dispersion matrix D, based on the matrices S_i is then necessary

(3) $$D = \frac{\sum_{i=1}^{g} S_i}{\left(\sum_{i=1}^{g} n_i\right) - g}$$

with the common mean

(4) $$X_{\cdot\cdot k} = \sum_{i=1}^{g} n_i X_{i\cdot k} \Big/ \sum_{i}^{g} n_i$$

and the inverted pooled disperson matrix $D^{-1}_{kk'}$ in order to calculate the Generalized Mahalanobis D^2 statistic, V:

(5) $$V = \sum_{k=1}^{m} \sum_{k'=1}^{m} (D^{-1}_{kk'}) \sum_{i=1}^{g} n_i (X_{i\cdot k} - X_{\cdot\cdot k}) (X_{i\cdot k'} - X_{\cdot\cdot k'})$$

which can be used as a chi-square with m(g-1) degrees of freedom to test the hypothesis that the mean values are the same in all groups [16]. The researcher is able to determine that the independent variables are capable of discriminating among groups when the null hypothesis of no difference is rejected. If not rejected, then the data indicate no significant group differences and alternative variables should be selected and the above processes repeated.

Upon failure to reject the hypothesis of no difference among means, the second phase is to calculate the $(i^*)^{th}$ discriminating function

(6) $$f^{m\times 1}_{i*} = \sum_{\ell=1}^{m} Z_\ell C_{i*\ell} + C_{i*0}$$

where

$i^* = 1, \ldots, g$, the number of functions

$\ell = 1, \ldots, m$, the number of variables

Z_ℓ = observation for each variable

$C_{i*\ell}$ = classification function coefficient

C_{i*0} = constant

and

$$C_{i*\ell} = \sum_{k=1}^{m} d_{\ell k} X_{i\cdot k}$$

$$C_{i*0} = -1/2 \sum_{k=1}^{m} \sum_{k'=1}^{m} d_{kk'} X_{i\cdot k} X_{i\cdot k'}$$

where

$(d_{k1}, d_{k2}, \ldots, d_{km})$ = k^{th} row of D^{-1}

D^{-1} = inverse of pooled dispersion matrix.

The $(i^*)^{th}$ discriminating function is then used to evaluate each data point such that for each observation,

$$P_i = \frac{e^{(f_{i*} - \max f_{i*})}}{\sum_{i*} e^{(f_{i*} - \max f_{i*})}} \tag{7}$$

results in probabilities of classification into each of the i groups. Final classification into a particular group is determined by the selection of the highest probability among each of the groups for every observation. If the experimental groups are widely separated, then the diagonal of largest probabilities of the frequency matrix will contain a large percentage of the frequencies compared to the off-diagonal elements (frequency of smaller probabilities). This gives a visual test of the ability to discriminate between groups.

Discriminant analysis can be used as a unified approach in solving a research problem involving multivariate comparison of several groups, which is likely to have as its three phases (a) the establishment of significant group differences, (b) the study and "explanation" of these differences, and (c) the utilization of multivariates from the samples studied in classifying a future individual known to belong to one of the groups represented [17, p. 414]. This technique is utilized in this study to evaluate several different environmental variables which may affect group performance, to establish significant group differences, and to classify future watersheds into several selected groups.

Of the socio-economic variables to be analyzed, it is possible that only a few of the many variables are explaining most of the community's performance while others are not contributing significantly. Perhaps it is possible to group variables into "clusters" or functional unities which will aid the researcher in evaluating socio-economic man in his environment. Such a possibility could lead to the development of patterns or regularities which would provide the basis for prediction of behavior of groups.

General Factor Analysis

The statistical technique which best handles the chore of explaining the possible interactions or grouping of variables providing similar explanations is factor analysis. Factor analysis begins with two assumptions: (1) that a certain chaotic area is not as chaotic as it appears, and (2) that it may be described by a small number of functional unities or factors. Factor analysis is an objective method for reducing a matrix of correlations between variables to fewer dimensions than the original matrix.

The method of factor analysis may provide insight concerning more general dimensions underlying the relationships and provide the opportunity for more parsimonious description of such relationships. It may be viewed primarily as a hypothesis generating technique rather than a hypothesis testing technique [18, p. 5].

Unlike most models, factor analysis does not require a division of variables into dependent or independent categories which often results in arbitrary decisions and may inject research bias into the results. Instead, from many variables the factor technique selects common factors which account for the inter-relationships between variables in the matrix. These common factors become the dependent variables of the system.

Observations of the variables are recorded in the form X_{ij} where $i = 1, \ldots, n$ cases and $j = 1, \ldots, p$ variables from which the means,

(8) $$X_{\cdot j} = \sum_{i=1}^{m} X_{ij}/n$$

the standard deviations,

(9) $$s_j = \frac{\sum_{i=1}^{n} (X_{ij} - X_{\cdot j})^2}{n-1}$$

and the correlation coefficients,

(10) $$r_{jj'} = \frac{\sum_{\alpha=1}^{n} (X_{\alpha j} - \overline{X}_j)(X_{\alpha j'} - \overline{X}_{j'})}{\sqrt{\sum_{\alpha=1}^{n} (X_{\alpha j} - \overline{X}_j)^2 \sum_{\alpha=1}^{n} (X_{\alpha j'} - \overline{X}_{j'})^2}} \qquad \begin{array}{l} j = 1, \ldots, p \\ j' = 1, \ldots, p \end{array}$$

are calculated in order to provide a correlation matrix indicating the degree of relationship between variables [19]. It is from this correlation matrix that the eigenvalues and eigenvectors are derived which, in turn, are utilized to obtain the coefficients (a_{jk}) of each factor, where:

(11) $$a_{jk} = \lambda_k V_{jk}$$

and

λ_k = k^{th} eigenvalue $j = 1, \ldots, p$ variables

V_{jk} = eigenvector $k = 1, \ldots, q$ factors

with the number of eigenvalues which are greater than unity determining the number of factors to be rotated.[4] Rotation is performed in order to maximize the difference between, and minimize the difference within, factors resulting in orthogonal factors explaining the maximum variance of the individual variables. The communalities (h_j^2)

(12) $$h_j^2 = \sum_k a_{jk}^2$$

are measures of the proportion of variance of the variable explained by the extracted factors and provide a valuable aid in the interpretation of contribution of the variables.

The mathematical solution to factor analysis ends with a table of factor loadings. The factors represented in the table of factor loadings are simply mathematical artifacts, designed to explain as much

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[4]The criterion of utilizing only those $\lambda > 1$ is but one of several choices (see Kaiser [20]) but is assessed to be the proper criterion according to Guttman in his classic paper of 1954 [21]. Guttman argues that the number of common factors in a domain must be at least as large as the number of latent roots greater than one of a correlation matrix with ones in the diagonal.

of the variance of all variables as possible with each successive factor [22, p. 7].

Since all variables are included in each extracted factor, it remains to determine the significant factor loadings so that each factor is reduced to its simplest form. This is accomplished by referral to statistical tables giving the minimum loading providing an acceptable level of significance.

In identifying the number of factors and their composition, i.e., the number of variables included in each factor and the relative size of the loading for each variable, we have, in effect, determined the dependent variables of the closed system of variables under analysis. Since the dependent variable is a complex factor consisting of several variables, the task remains to identify and name each factor. The identification is carried out by inspecting the variables with large loadings on a given factor and discovering what they have in common which is not shared by variables not having large loadings on that factor. Consequently, the naming of factors is highly subjective. Much like the establishment of a classification system, the name of either a classification or a factor is based upon its representativeness and ability to aid the researcher in conceptualization of the classification or factor space.

The factor analysis technique enables the establishment of patterns or regularities which form the basis for prediction of behavior of groups. Only through such a simplification can the complexity of interrelationships which evolves from a multiplicity of variables affecting development be better understood and eventually evaluated. This technique is utilized to evaluate progress of upstream watershed projects and is applied in Chapter V.

Summary

Adjustments in the assumption of full knowledge associated with classical decision theories is necessitated by the lack of ownership or control of resources involved in a social decision or problem situation. In reality, actual decision-making is carried out with less than full knowledge. Assuming there is both a distinctiveness and inseparability of individual and group in social decision situations, socio-economic man relies upon the resources of the community to solve problems common to the group as well as those resources solely owned and controlled by him.

It is hypothesized that man's reactions are a function of socio-economic characteristics of his community. It is proposed that socio-economic variables can be observed and analyzed according to community performance, with performance defined as ability to achieve social goals. It is further suggested that community or development projects can be classified according to rate of performance of development and patterns of regularities established.

Examination of two statistical techniques, discriminant analysis and factor analysis, suggests that they are highly complementary and provide a way to comprehensively and objectively analyze the environment of socio-economic man. These analyses include not only the delineation of important variables and factors contributing to performance or measures of ability to achieve group goals, but also the capability to predict the performance of future projects or group achievements similar to those already analyzed.

Upon the basis of these findings, the above statistical techniques will be applied to upstream watershed development projects to achieve the objectives of this study.

CHAPTER IV

USE OF DISCRIMINANT ANALYSIS TO PREDICT PERFORMANCE OF UPSTREAM WATERSHED PROJECTS

Introduction

Few analyses have been made of the performance of organizations responsible for the inception and carrying through to completion of resource development projects [23, 24, 25, 26, 27] . The time required to develop local interest in the project, to form the necessary institutional and organizational arrangements, and to obtain the needed lands, easements, and rights-of-way often becomes crucial in resource development success. If the above processes take too long, much dissatisfaction and misinformation may evolve, resulting in project abandonment in some instances.

Even fewer analyses have attempted to predict the performance of future resource development projects [28]. Should public monies continue to flow into development projects without some assurance of success within a reasonable time period? Current criteria and planning procedures rely primarily upon physical attributes and the associated benefit-cost ratio. In contrast, a new technique which utilizes socioeconomic data to predict performance measured by speed of development of upstream watershed projects is presented in this chapter. These results may be utilized as additional criteria in the allocation of scarce development funds.

The problem of measuring a qualitative attribute such as speed of development may be approached by the use of discriminant analysis. Speed of development may be defined alternatively as rate of progress. The purpose of this chapter is to illustrate how the technique is applied to an actual problem situation, the data requirements and limitations, the information derived, and how this information can be utilized by landowners and planners.

Data Requirements

The discriminant analysis technique requires the choosing of the dependent variable before analysis begins. Since the rate of progress of upstream watershed development is the major factor to be considered, some measure of time must be established. The time required for an upstream watershed development project to proceed through the various stages of development necessary to project completion is determined for each watershed which has made application for planning assistance.

The files of the State Soil Conservation Board contains the application for assistance and all dates of importance in the development process for each PL 566 watershed project in Oklahoma.[1] The date of application is considered as the base period. The number of days between the base period and each subsequent stage of development are recorded to determine the time lag involved. The subsequent stages are: (1) preliminary survey, (2) field examination, (3) sponsoring

[1]Access to the files of the State Soil Conservation Board of Oklahoma were obtained through the cooperation of the Executive Director, Marvin Emerson. The files are located in the State Capitol, Oklahoma City, Oklahoma.

organization formed, (4) work plan agreement signed, (5) supplemental agreements, (6) first easement obtained, (7) last easement obtained, (8) first contract let, (9) last contract let, and (10) project completion.

The time-lag is calculated for subsequent stages for every watershed. At each stage of development all time-lags are ordered and ranked by quartiles. The observations within quartiles are assigned the values 1, 2, 3, or 4, with 1 the fastest and 4 the slowest group. All stages are treated similarly, their ranks summed and then divided by the number of stages. In this manner a mean value for each watershed is obtained. The mean values are then ranked and divided into quartiles to obtain the group classification, i.e., every watershed is classified into either group 1, 2, 3, or 4, depending upon its performance in relation to the performance of all other watersheds.

The advantage of the above procedure is that out-of-sequence stages and/or missing stages do not adversely affect the classification since the performance of one watershed at each stage is compared against the performance of all other watersheds at that stage. Whenever difficulties do appear, it is reflected in the time-lag for that particular stage.

Since watershed development is a continuous process, and some watersheds started in recent years have not had adequate opportunity to complete their development, this analysis allows comparisons at each stage completed until the cut-off date of October 31, 1964, when data collection ended.

It was decided that four groups would adequately test the discriminatory power of the technique. If the model is a good predictor using four groupings, then three would certainly be acceptable. On the other hand, six groups would be a very minute classification while a simple dichotomy would be too gross a classification.

Twenty-two independent variables for the system under analysis are selected from more than 30 socio-economic variables which may affect the speed of project development.[2] The following variables are selected: (1) Farm Income, (2) Farm Wages and Salaries, (3) Median School Years Attended, (4) Number of Towns and Cities, (5) Percent Owner-Occupied Dwellings, (6) Value of Minerals, (7) Average Farm Size, (8) Percent Roads Paved, (9) Number of Households, (10) Watershed Area, (11) Other Income Exceeds Farm Income, (12) Percent Rural Non-Farm, (13) Percent Rural Farm, (14) Percent Residing in State of Birth, (15) Non-Worker to Worker Ratio, (16) Percent Working Outside County, (17) Employment, (18) Amount Returned Per Dollar Sales Tax Paid, (19) Percent Indian, (20) Auto, Truck, and Tractor Registrations, (21) Acres Irrigated, and (22) Per Capita Income.

The data for the above independent variables are gathered from secondary sources for all counties in Oklahoma with PL 566 projects.[3]

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[2]Eight of the 30 variables were eliminated due to high correlations which caused difficulty in subsequent matrix inversion routines. A test of accuracy included in the matrix inversion routine, when coupled with the simple correlations, helped identify these eight variables.

[3]The data were obtained from the following sources: <u>Inventory of Watershed Project Needs</u>, December 18, 1959, prepared by County Needs Committee; Nelson W. Peach, Richard W. Poole, and James D. Tarver, <u>County Building Block Data for Regional Analysis--Oklahoma</u>, Research Foundation, OSU, 1959; and <u>U. S. Census of Agriculture--1959. Oklahoma - Counties</u>, Vol. I, Part 36.

Counties are utilized as basic "building blocks", assuming projects encompassing more than one county would have characteristics similar to the county with the most area in the project, and projects smaller than a county have characteristics similar to the "building block" or county. Lack of time and funds dictates the use of readily available county data in preference to gathering many different kinds of quantitative data on all 115 PL 566 projects in the state.

The following criteria are met in the selection of the data: (1) the data must be readily available from secondary sources, (2) the data must be available for the same time period, and (3) the data must be available by county for all areas of the state. Additional advantages of the use of secondary county data are the possible extension of similar studies to other areas of the country, or, as is done later in this study, the application of other techniques to the same study area.

The Analysis of PL 566 Projects

The data representing the 22 selected variables for 115 PL 566 projects are utilized in a multiple discriminant analysis program for several groups [16]. An examination of the mean scores by group for these variables reveals no significant patterns or trends between groups (Table IV). Only one out of the 22 variables, variable 8, moves consistently in one direction. Thus, a precursory examination of the data does not indicate that the four groups are different from each other. However, the calculated Mahalanobis D^2 statistic of 89.82287 when tested as a chi-square with 66 degress of freedom allows

TABLE IV

MEAN SCORES OF 22 SELECTED SOCIO-ECONOMIC VARIABLES BY GROUP FOR 115 PL 566 PROJECTS

Variable Number	Description	Mean Scores for Group[a] 1	2	3	4
1	Farm Income	41.64785	36.98294	39.24703	34.81846
2	Farm Wages and Salaries	41.83214	39.96764	46.55185	41.63461
3	Median School Years	9.29643	9.43823	9.47407	9.21538
4	Number of Towns and Cities	9.07143	7.32353	8.59259	7.88462
5	% Owner-Occupied Dwellings	68.55714	67.68823	67.65926	69.59230
6	Value of Minerals	10.47691	9.68341	19.53445	3.84269
7	Average Farm Size	33.54643	35.40000	39.90370	30.51538
8	Percent Roads Paved	20.35000	21.45588	22.51381	30.57307
9	Number of Households	84.20571	113.99793	89.86740	166.07768
10	Watershed Area	99.41235	96.33435	124.02636	99.67122
11	Other Income Exceeds Farm Income	65.04642	54.97647	63.18518	80.18077
12	Percent Rural Non-Farm	42.30714	41.63723	37.07778	46.69615
13	Percent Rural Farm	20.69286	19.64412	18.43704	20.55769
14	Percent Residing in State of Birth	65.97500	65.10882	66.14074	64.73846
15	Non-Worker to Worker Ratio	2.06714	2.07588	1.92963	2.17192
16	Percent Working Outside County	14.37857	10.31176	13.96296	11.83077
17	Employment	74.04785	107.47146	80.14148	164.51153
18	Amount Returned/$ Sales Tax Paid	5.58857	5.39000	4.06370	6.02961
19	Percent Indian	3.14643	4.36765	3.28889	3.87308
20	Auto, Truck & Tractor Registration	41.50143	35.888058	39.73370	36.43038
21	Acres Irrigated	85.85357	177.93235	346.95926	87.19231
22	Per Capita Income	17.44357	18.48823	16.78481	17.18654

[a]Sample size for groups 1 through 4 are 28, 34, 27, 26, respectively.

rejection at the .05 significance level of the hypothesis that the mean values are the same in all the four groups for these 22 variables.[4]

The distinctive feature of D^2 is that it is a measure of distance rather than a criterion for testing the hypothesis of zero distance [29, pp. 301-33]. This provides the additional information that the four groups are not widely separated since D^2 calculated (89.82287) is greater than D^2 tabulated (85.61516) by a small margin. It must be remembered that distance, being a scalar quantity, does not exhaust the information in a comparison among three or more groups unless the latter happens to be collinear. The D^2 statistic allows transition from the multi-group concept of configuration to a two-group concept of distance, which is similar to canonical reduction.

The multiple discriminant analysis program is used to compute the matrix of classification function coefficients and constants (Table V). Comparisons between the classification function coefficients and the original mean values indicate that certain variables undergo considerable change in relative importance (Tables IV and V). For instance, variables 3 and 15 increase greatly while variables 1, 4, and 22 decrease. This suggests that Median School Years Attended (3) and Non-Worker to Worker Ratio (15) are more important in discriminanting between groups than the raw data would indicate. On the other hand, Farm Income (1), Number of Towns and Cities (4), and Per Capita Income (22) are less important as discriminators. The relative importance of

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[4]The formula for the D^2 statistic is given on page 36.

TABLE V

CLASSIFICATION FUNCTION COEFFICIENTS FOR 22 SELECTED SOCIO-ECONOMIC VARIABLES BY GROUP FOR PL 566 PROJECTS

Variable Number	Description	Function Coefficient for Group 1	2	3	4
1	Farm Income	-5.42199	-5.45949	-5.47971	-5.41164
2	Farm Wages and Salaries	2.74458	2.75250	2.76597	2.77228
3	Median School Years	135.23063	135.60979	135.87818	135.53874
4	Number of Towns and Cities	-0.86002	-1.01845	-0.97605	-1.25635
5	% Owner-Occupied Dwellings	13.55086	13.52180	13.63056	13.83270
6	Value of Minerals	-0.60693	-0.61326	-0.58566	-0.68876
7	Average Farm Size	1.29910	1.30348	1.32041	1.36544
8	Percent Roads Paved	-0.26734	-0.26173	-0.26341	-0.28789
9	Number of Households	2.96737	2.99772	2.98384	2.98589
10	Watershed Area	0.01043	0.00982	0.01119	0.01880
11	Other Income Exceeds Farm Income	-0.15318	-0.18013	-0.15098	-0.08306
12	Percent Rural Non-Farm	-0.69379	-0.65159	-0.69026	-0.66558
13	Percent Rural Farm	5.24073	5.23704	5.26726	5.27111
14	Percent Residing in State of Birth	7.72429	7.74026	7.82482	7.67196
15	Non-Worker to Worker Ratio	63.79415	65.75007	63.15572	63.75883
16	Percent Working Outside County	-0.66201	-0.72362	-0.69779	-0.70570
17	Employment	-2.78300	-2.80838	-2.79888	-2.79672
18	Amount Returned/$ Sales Tax Paid	7.23816	6.85242	7.07309	6.83506
19	Percent Indian	3.91031	4.09359	3.99014	4.05192
20	Auto., Truck, and Tractor Registration	2.20472	2.21254	2.20507	2.12116
21	Acres Irrigated	-0.01395	-0.01411	-0.01416	-0.01458
22	Per Capita Income	-8.41397	-8.50610	-8.54932	-8.44511
Constant		-1420.67831	-1422.26855	-1434.23712	-1440.93105

the function coefficient will affect the analysis of any new projects to be evaluated. The function coefficients serve as weights when combined with the new data in the discrimination functions.

The discriminating functions are used for two purposes: (1) to establish the probabilities of each original case falling within each of the four groups; and (2) to probabilistically classify future watershed projects into each of the four groups.

Each case within a group is assigned four probabilities by the program, one for each classification function. The largest of the four probabilities determines which group the individual case is classified within. The sum of all four probabilities is equal to unity.

The classification matrix of the original 115 projects provides a visual test of the discriminating functions (Table VI). A perfect discrimination -- agreement of group and function -- would result in all zeros in the nondiagonal elements. In this analysis, fewer misclassifications occur in the extreme groups, suggesting that the fastest and slowest groups are more easily determined. The slowest group has 20 out of 26 classifications in agreement.

An additional program is written to utilize the discriminating functions for prediction purposes.[5] Data on 57 delineated[6] watersheds are incorporated into the discriminating function in order to probabilistically classify each delineated watershed into the four groups.

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[5]The program is presented in Appendix B.

[6]These are watersheds which have been delineated by SCS personnel, but which have not yet made application to the State Conservation Board for assistance.

TABLE VI

CLASSIFICATION MATRIX FOR THE ORIGINAL 115 PL 566 PROJECTS

Group	Function 1	2	3	4	Total[a]
1	(17)	4	3	7	28
2	10	(10)	7	7	34
3	6	6	(13)	2	27
4	2	2	2	(20)	26
				Grand Total	115

[a]The probabilities for each of the 115 PL 566 projects are given in Appendix B, Tables I through IV.

If the i^{th} discriminating function is given by:

(1) $$f_{i*}^{m\times 1} = \sum_{\ell=1}^{m} Z_\ell C_{i*\ell} + C_{i*0}$$

then

(2) $$P_{ki} = \frac{e^{(f_{i*} - \max f_{i*})}}{\sum e^{(f_{i*} - \max f_{i*})}}$$

where:

Z_ℓ = the ℓ^{th} new observation; ℓ = 1, . . ., m, the number of independent variables

$C_{i*\ell}$ = discriminating coefficient for the ℓ^{th} independent variable and the i^{th} group

C_{i*0} = constant of the i^{th} group

P_{ki} = probability of the k^{th} case falling within the i^{th} group

The resulting classification of the 57 delineated watersheds are presented in Table VII. The classification of these watersheds give results which agree with a priori reasoning. With all watershed areas of the state having the same opportunity to make application for assistance, those more capable of achieving development have already acted. As a result, very few high probabilities are in the fast group while many watersheds have higher probabilities in the slower groups. In group I, only watershed No. 49 has a probability greater than 50 percent of falling within the fastest group. On the other hand, 17 of the 24 watersheds within group IV have probabilities of 50 percent or greater, with three having probabilities higher than 90 percent. This indicates that many problems have to be overcome to develop the slower watersheds and has implications about maintaining the present rate of development in Oklahoma. With the remaining watersheds having higher probabilities of slow development, the progress must be adapted to account for factors contributing to slow development.

The Analysis of Washita Projects

The Washita projects are more homogeneous and provided an opportunity to test the discriminant model under different conditions. Because of the homogeneity of the area, several more variables have to be eliminated due to high correlations and subsequent difficulties in matrix inversion routines. Sixteen variables are selected after performing correlation analysis and the means by group are given in Table VIII. The original rankings are derived from records of the secretary of the Washita Council rather than the State Conservation Board since

TABLE VII

CLASSIFICATION OF PL 566 WATERSHEDS IN OKLAHOMA WHICH HAVE NOT YET APPLIED FOR ASSISTANCE

Number	Watershed Name	County	Group I	Group II	Group III	Group IV
			(Probabilities)			
1	Gravier	Blaine	.05875	(.49873)	.35372	.08878
2	Upper Eagle Chief	Woods	.01381	.03197	.04927	(.90493)
3	Lower Eagle Chief	Woods	.05366	.14055	.16397	(.64180)
4	Indian Creek	Kingfisher	.22300	.08365	.21472	(.47861)
5	Cooper Creek	Kingfisher	(.34747)	.14290	.29836	.21126
6	Logan-Payne Lats.	Kingfisher	.25138	.09610	.23640	(.41609)
7	Council Creek	Pawnee	.37110	(.47563)	.12514	.02810
8	Cushing Lats.	Creek	.27079	.22214	(.48182)	.02524
9	Crooked Creek	Grant	.15963	(.41546)	.17091	.25398
10	Round Pond	Grant	.10666	.25616	.12622	(.51094)
11	Deer (Thompson) Creek	Grant	.17246	(.46141)	.17839	.18773
12	Chickasha Tribs.	Grant	.16498	(.43396)	.17430	.22675
13	Ralston Lats.	Osage	.14290	.05940	(.78935)	.00833
14	Ponca City Lats.	Noble	.14514	(.38537)	.37418	.09528
15	Keystone Lats.	Osage	.14426	.06052	(.78779)	.00742
16	Mule Creek	Alfalfa	.26212	(.36652)	.03338	.33796
17	Clay Creek	Alfalfa	.28474	(.40446)	.03389	.27690
18	Dog-Blue Creek	Rogers	.21246	.10855	.31204	(.36692)
19	West Lower Verdigris	Rogers	.17679	.08759	.26981	(.46579)
20	East Lower Verdigris	Rogers	.18883	.09452	.28451	(.43213)
21	Salina	Mayes	.09071	.30719	.26629	(.33579)
22	Cleveland and McClain Lats.	Cleveland	.20711	.22990	(.45818)	.10479
23	Aski and Konawa Lats.	Hughes	(.37154)	.20745	.25105	.16994
24	Upper Gaines Creek	Latimer	.03267	.21529	.02286	(.72917)
25	Canadian Co. Tribs.	Canadian	(.36496)	.24053	.11175	.28275

TABLE VII (Continued)

Number	Watershed Name	County	Group I	II	III	IV
			(Probabilities)			
26	Oklahoma Co. Trib.	Canadian	(.40532)	.27612	.11910	.19944
27	Okfuskee-Seminole Co. Tribs.	Okfuskee	.05015	(.69925)	.13728	.11329
28	Blaine County Trib.	Blaine	.05870	(.49790)	.35374	.08964
29	Tulsa Tribs.	Tulsa	.01583	.06553	.01106	(.90757)
30	Polecat	Creek	.27821	.21849	(.46336)	.03992
31	Lebas Creek and Tribs.	Jackson	.01675	.05820	(.92240)	.00263
32	Gypsum Creek	Jackson	.01785	.06567	(.91519)	.00127
33	Sweetwater Creek	Roger Mills	.00481	.01019	.14707	(.83791)
34	Middle North Fork	Washita	(.44303)	.38255	.08501	.08939
35	Timer Creek	Roger Mills	.01346	.03155	.36331	(.59165)
36	Stinking Cr. Lats.	Jackson	.01842	.06988	(.91092)	.00088
37	Upper Deep Red Run	Kiowa	.07876	(.43909)	.21538	.26675
38	Lower Deep Red Run	Tillman	.02524	.25796	(.62839)	.08839
39	Upper West Casch Creek	Kiowa	.08306	(.49343)	.22200	.20149
40	Lower West Casch Cr.	Cotton	.12329	.25255	.09070	(.53344)
41	Upper Mud Creek	Jefferson	.15370	.28314	.02790	(.53524)
42	Lower Mud Creek	Jefferson	.12443	.22306	.02336	(.62913)
43	Island Bayou	Bryan	(.46601)	.21503	.19774	.12119
44	Buck Creek	Pushmatah	.05477	.37526	.04929	(.52066)
45	Cedar Creek	Pushmatah	.09151	(.56549)	.06847	.27451
46	Lower Kiamichi	Pushmatah	.07937	(.47361)	.06204	.38496
47	Norwood	McCurtain	.11638	.24832	.04258	(.59270)
48	Greenleaf	Muskogee	.17468	.15280	.16182	(.51069)
49	Skin Bayou	Sequoyah	(.53413)	.05338	.11246	.30001
50	Haystack Cr. & Lats.	Greer	.14587	.23255	(.42653)	.19503

TABLE VII (Continued)

Number	Watershed Name	County	Group I	Group II	Group III	Group IV	
			(Probabilities)				—
51	Jefferson Co. Lats.	Jefferson	.20070	(.38664)	.03445	.37819	
52	Marshall Lats.	Carter	.02033	.11938	(.84544)	.01482	
53	Valiant Lats.	McCurtain	.08152	.16710	.03135	(.72001)	
54	Tom	McCurtain	.12051	.25828	.04385	(.57734)	
55	Glover Creek	Pushmataha	.07152	.41854	.05726	(.45266)	
56	Upper Mountain Fork	McCurtain	.03165	.05959	.01353	(.89522)	
57	Lower Mountain Fork	McCurtain	.01105	.01527	.00204	(.97162)	
	Totals[a]		7	15	11	24	57

Source: Inventory of Watershed Project Needs - Oklahoma, County Needs Committee, December 18, 1959.

[a]Totals of largest probabilities (those shown in parenthesis).

TABLE VIII

MEAN SCORES OF 16 SELECTED SOCIO-ECONOMIC VARIABLES BY GROUP FOR 65 WASHITA PROJECTS

Variable Name	Name	Mean Scores for Group[a]			
		1	2	3	4
1	Farm Income	56.73857	67.60555	58.21611	39.96066
2	Median School Years	9.48571	9.61667	9.18333	9.21333
3	Number of Towns and Cities	6.21429	7.55556	8.00000	6.20000
4	% Owner-Occupied Dwellings	66.56428	65.85000	66.67777	66.67333
5	Value of Minerals	114.37205	183.54475	259.00934	356.48324
6	Average Farm Size	502.85714	451.66666	455.83333	388.00000
7	Percent Roads Paved	19.04286	16.34444	16.91111	23.62000
8	Watershed Area	51.87935	87.58816	71.48733	96.68746
9	Percent Rural Non-Farm	36.09286	37.20555	48.10555	41.67333
10	% Residing in State of Birth	71.43571	67.89444	69.95555	69.93333
11	Non-Worker to Worker Ratio	1.64857	1.79000	1.95000	1.90933
12	% Working Outside County	9.32857	8.80556	8.21667	11.48000
13	Amount Returned/$ Sales Tax Paid	3.42571	3.49944	4.96611	4.53533
14	Percent Indian	3.74286	3.33333	4.81667	2.00667
15	Acres Irrigated	47.51143	59.92944	76.21167	13.63867
16	Per Capita Income	17.69071	15.52333	16.69722	18.46400

[a]Sample size for groups 1 through 4 are 14, 18, 18, and 15, respectively.

priorities and funding are based upon the Council's recommendations under the PL 534 program. Although the steps are fewer in number, the same time-lag analysis is utilized to establish rankings and subsequent groups as was done with the PL 566 analysis.

An examination of the mean scores by group for the 16 variables does not reveal any significant patterns or trends. Again, only one out of the 16 variables, variable 5, shows a trend throughout. However, the calculated Mahalanobis D^2 statistic of 84.95549 when tested as a chi-square with 48 degrees of freedom allows rejection at the .05 significance level of the hypothesis that the mean values are the same in all four groups.

The matrix of computed classification function coefficients and the constants are presented in Table IX. When comparisons are made between the original means and the classification function coefficients, several variables change in relative importance. Variables 11, 2, and 3 play a much greater part in the prediction equations while variables 14 (Percent Indian) and 12 (Percent Working Outside County) play a much smaller part. As in the case of the PL 566 analyis, Median School Years Attended and Non-Worker Ratio play a much more significant part than mere observation of the raw data would indicate.

The discriminating functions are developed to establish both the probabilities of the original projects (Appendix B, Tables V to VIII) and of future projects falling within each of the four groups. The classification matrix of the original cases indicate that in none of the groups are the mis-classifications greater than 50 percent, with the fewest mis-classifications appearing in group four (Table X). This

TABLE IX

CLASSIFICATION FUNCTION COEFFICIENTS FOR 16 SELECTED SOCIO-ECONOMIC VARIABLES BY GROUP FOR WASHITA PROJECTS

Variable Number	Description	Function Coefficient			
		1	2	3	4
1	Farm Income	-48.67951	-49.14603	-48.86044	-48.69344
2	Median School Years	1603.72774	1608.19656	1607.82213	1601.21843
3	Number of Towns and Cities	901.70931	909.60063	905.05664	899.84090
4	% Owner-Occupied Dwellings	222.46258	223.49301	223.22355	222.85044
5	Value of Minerals	-13.07138	-13.10895	-13.09001	-13.06720
6	Average Farm Size	0.40800	0.40276	0.41241	0.40634
7	Percent Roads Paved	157.15673	157.51759	157.15576	157.21793
8	Watershed Area	-0.27971	-0.26939	-0.27654	-0.27084
9	Percent Rural Non-Farm	-0.98085	-1.25417	-1.11493	-1.12455
10	% Residing in State of Birth	516.61144	517.65806	517.56939	515.90477
11	Non-Worker to Worker Ratio	8322.35620	8315.70898	8336.97205	8328.18933
12	Percent Working Outside County	-476.81714	-478.09785	-477.56219	-476.76453
13	Amount Returned/$ Sales Tax Paid	-38.39773	-35.65673	-37.39545	-37.76932
14	Percent Indian	-1378.83980	-1383.40810	-1382.13448	-1378.97823
15	Acres Irrigated	14.62427	14.66344	14.68147	14.68595
16	Per Capita Income	-200.83634	-202.14657	-201.10338	-200.83861
	Constant	-36270.51221	-36419.28027	-36442.52441	-36222.16162

again suggests that the slower projects are the easiest to recognize or discriminate. The classification matrix of the future cases indicate that none of the future projects fall in the fast group while four of the six fall within the slow group (Table XI). In fact, the one case falling within group two has less than a 50 percent chance of appearing there. On the other hand, none of the cases falling within groups three or four have less than a 50 percent chance while three have greater than a 90 percent chance.

TABLE X

CLASSIFICATION MATRIX FOR ORIGINAL WASHITA PROJECTS

Group	Function				Total
	1	2	3	4	
1	(9)	1	1	3	14
2	3	(9)	4	2	18
3	2	5	(9)	2	18
4	2	2	0	(11)	15
				Grand Total	65

Summary

The discriminant analysis technique provides a method of classification of watersheds into groups representing fast to slow accomplishment of watershed development, as well as a test of significance of these groupings. It also provides classification function coefficients to predict the behavior of subsequent watersheds for which data on the same variables are available. This prediction is based upon the performance of the original cases.

TABLE XI

CLASSIFICATION OF WASHITA PROJECTS WHICH HAVE NOT YET APPLIED FOR ASSISTANCE

Number	Watershed Name	County	Group I	II	III	IV	
			(Probabilities)				
1	Bradley	Grady	.05424	(.45322)	.44456	.04797	
2	East Laterals to Texhoma	Johnston	.06921	.00000	.00110	(.92967)	
3	Upper Wildhorse	Stephens	.00813	.00077	.00481	(.98626)	
4	Middle Wildhorse	Garvin	.07483	.23704	.18724	(.50087)	
5	West Laterals to Texhoma	Johnston	.00039	.00000	(.99951)	.00009	
6	Lower Wildhorse	Garvin	.04062	.28720	.13006	(.54211)	
	Totals[a]		0	1	1	4	6

[a]Totals of largest probabilities (those shown in parenthesis).

The measurement of a qualitative dependent variable, speed of development, is made possible through examination of time-lags between various stages of progress. Socio-economic variables which might affect rate of progress are selected as the independent variates of the system. The analyses may have been more accurate if socio-economic data could have been obtained on the individual watersheds rather than using County data, but the cost and time involved would be prohibitive. Secondary sources of County data are readily available and accomplish the goal of discriminating between groups with an acceptable level of significance.

In the above analyses, the sample is large enough to be quite representative of the areas under investigation, since 115 watersheds have made application for assistance under the PL 566 program. These watersheds represent 36 percent of the land in Oklahoma outside the Washita basin. Also, 65 subwatersheds in the Washita represent more than 90 percent of that basin. This allows credence to be placed on the predictive results.

In the analyses of the original cases, it is discovered that most of the watersheds which are predicted to progress quickly have already started development. The slower watersheds are yet to be developed. This suggests additional efforts may be required to maintain the present rate of development within the state. In both the PL 566 and Washita watersheds, two variables, Median School Years Attended and Non-Worker to Worker Ratio, prove to be more important in the discriminating equations than the raw data would indicate. The contributions of these and other variables will be further analyzed in the following chapter.

CHAPTER V

FACTOR ANALYSIS OF UPSTREAM WATERSHED DEVELOPMENT PROJECTS

Introduction

The multiplicity of variables affecting upstream watershed development projects creates a vast complexity of relationships that requires simplification if the essential factors of development are to be understood. Otherwise, the lack of precision of conceptualization and measurement reduces the researcher's effectiveness.

In the study of watershed development, numerous hypotheses may be suggested. The problem is to select the most relevant hypotheses. Must the researcher resort only to heuristic arguments based upon intuition and analogy in this selection? He does not if he chooses factor analysis for formulating his hypothesis and in selecting his dependent variables. Cattell [30, p. 362] states:

> Factor analysis is superior to most methods of exploration in comprehensively revealing such nexuses of interaction. It makes no assumptions about the direction of causal action, or about what is endogenous or exogenous to the system. If certain variables are in fact independent and outside the system, this will be shown by zero loadings in the factors that comprise the system. If nature does not know about the experimenter's favorite hypothesis which assigns pivotal importance to a set of supposed independent variables in a regression equation, the factor analysis will quickly show the fallacy of the supposed regression equation. If the experimenter has set up a criterion which he believes is influenced by such and such factors, the inclusion of the criterion in

> the factor analysis will quickly show whether in fact these factors need to be included in the regression equation for that criterion, and so on.

Heedful of the above sagacity, the factor technique is used to select common factors which account for the interrelationships between variables. The selected factors then become the dependent variables of the system. Inferences of causality and of relationships among the many variables are then made possible by the identification of these functional unities.

Data Requirements

Since the factor technique does not require the selection of a dependent variable, many independent variables are selected from more than 30 socio-economic variables which likely affect watershed development. To make later comparisons with the results of the discriminant analysis, the same 22 and 16 variables used in the discriminant program are selected to analyze development of the PL 566 projects and the Washita projects, respectively.

Analysis of the Factors for the PL 566 Projects

The general factor analysis program extracts six orthogonal factors based upon the criterion that all factors with eigenvalues greater than one be included as final factors. These six factors and the communalities, which are merely the summation of the squared row factor loadings, are presented in Table XII. The communalities are a measure of the proportion of variance of the variable explained by the extracted factors. A very substantial proportion of the variance is explained by the six

TABLE XII

ROTATED ORTHOGONAL FACTOR LOADINGS: PL 566 PROJECTS IN OKLAHOMA

Variables	Factors						h^{2*}
	A	B	C	D	E	F	
1. Farm income	(0.75285)	0.12318	-0.03912	0.15001	-0.02890	(-0.52274)	(0.88008)
2. Farm wages and salaries	(0.33516)	-0.25181	-0.13340	-0.09642	0.15910	(-0.80920)	(0.88295)
3. Median school years attended	(0.73536)	-0.36355	-0.14329	-0.23577	(-0.28525)	-0.18199	(0.86353)
4. Number of towns & cities	(0.42954)	-0.24096	-0.26133	0.22991	(0.60255)	-0.19349	(0.76422)
5. Percent owner-occupied dwellings	0.03683	0.00627	(0.33161)	(0.71593)	-0.15714	(0.27738)	(0.72555)
6. Value of minerals	0.09936	-0.07293	(-0.85913)	-0.01725)	0.14279	0.10806	(0.78565)
7. Average farm size	0.15127	0.21509	(-0.69884)	0.12787	(-0.30997)	-0.24269	(0.72885)
8. Percent roads paved	-0.09135	(-0.79209)	0.14756	-0.00648	0.24728	-0.07309	(0.72406)
9. Number of households	0.20363	(-0.92659)	0.02200	-0.10596	-0.02585	-0.04927	(0.91483)
10. Watershed area	0.05083	0.03020	(-0.60544)	-0.10135	-0.00121	-0.03651	(0.38166)
11. Other income exceeds farm income	-0.25770	-0.36001	0.14946	-0.00386	(0.80350)	0.09909	(0.87380)
12. Percent rural non-farm	(-0.64301)	(0.28494)	0.05096	(0.46064)	0.08953	-0.04792	(0.71976)
13. Percent rural farm	-0.05474	(0.56240)	0.22632	(0.50339)	(-0.38885)	-0.09346	(0.78384)
14. Percent residing in state of birth	-0.26041	0.21786	-0.20798	(0.61540)	-0.18244	(0.31961)	(0.67269)
15. Nonworker to worker ratio	(-0.84189)	0.13879	0.22101	0.17122	0.25846	0.06361	(0.87705)
16. Percent working outside county	-0.25260	0.11666	(-0.39801)	(0.49461)	(0.33462)	0.06196	(0.59628)
17. Number employed	0.21268	(-0.92119)	0.01899	-0.08807	-0.06407	-0.04492	(0.90807)
18. Amount returned per $ sales tax paid	(-0.86096)	0.13871	0.21918	0.14509	0.18303	0.07624	(0.86890)
19. Percent Indian	(-0.77495)	-0.01236	-0.06430	-0.00221	-0.04111	-0.10021	(0.61657)
20. Auto, truck and tractor registration	(0.85877)	0.01518	0.07757	0.07299	0.23161	(-0.29492)	(0.88968)
21. Acres irrigated	0.00042	0.03373	0.02214	(-0.32289)	-0.16142	(-0.78647)	(0.75047)
22. Per capita income	0.12430	-0.12808	0.01734	0.24976	(-0.84904)	0.00501	(0.81543)

$*h^2$ = communalities.

factors. The explained variance varies from a high of 0.91483 for variable 9 -- Number of Households, to a low of 0.38166 for variable 10 -- Watershed Area. The data on the number and percent of variables with the different percentages of variance explained are presented in Table XIII.

TABLE XIII

DISTRIBUTION OF COMMUNALITY COEFFICIENTS (h^2)
FOR PL 566 PROJECTS

Percent of Variance Explained	Number of Variables	Percent of Variables
90-99	2	9
80-89	8	36
70-79	8	36
60-69	2	9
50-59	1	5
49 and below	1	5
Total	22	100

Factor loadings are included in each of the six factors, A, B, C, D, E, and F for all 22 variables. However, only factor loadings of an acceptable level of significance are included in the final factors and are shown in parentheses (Table XII).[1] The final or basic factors are individually analyzed in the following sections, with the logic of interpretation as Cattell [30, p. 338] has stated:

[1]Significance was determined from Table 13 -- Percentage Points for the Distribution of Coefficients, Biometrika Tables for Statisticians, Vol. I, edited by E. S. Pearson and H. O. Hartley, Cambridge University Press, 1954, p. 138. [Significant loadings of .266 and above at $\alpha = .01$ and 91 degrees of freedom.]

> The definition of a factor as an empirical construct follows remarkably closely the procedures stated by Bacon and refined by Mill for arriving at the essential nature of anything. One observes where it is conspicuously present as a positive influence, where it is conspicuously present as a negative influence, and where it is generally absent . . .. These presences and absences suffice to give a reasonably clear picture -- an empirical construct -- of the dimension with which we are concerned.

Factor A - Level of Living

Level of Living emerges as the most important factor because it has the largest eigenvalue and has significant loadings on the nine variables below.

18	Amount returned per $ of sales tax paid	-.86096
20	Auto, truck and tractor registrations	.85877
15	Non-Worker to worker ratio	-.84189
19	Percent Indian	-.77495
1	Farm income	.75285
3	Median school years attended	.73536
12	Percent rural non-farm	-.64301
4	Number of towns and cities	.42954
2	Farm wages and salaries	.33516

These factor loadings are interpreted in the following manner. As variable 18, Amount Returned Per Dollar of Sales Tax Paid (a measure of welfare needs) increases by one unit, Level of Living decreases by .86096 of one unit. Similarly, as variable 20, Auto, Truck, and Tractor Registrations (a measure of affluence) increases by one unit, Level of Living increases by .85877 of one unit. Negative loadings on variables 18, 15, 19, and 12 when associated with positive loadings on variables 20, 1, 3, 4, and 2 present a logical and consistent functional unity indentified as Level of Living. Each factor loading may be analyzed to obtain the significance of the extracted factor. These relationships would be difficult to hypothesize beforehand from so many variables and interrelationships.

Factor B - Ruralism

This factor has significant loadings on 7 of the 22 variables, which are, in order of absolute magnitude:

9	Number of households	-.92659
17	Number employed	-.92119
8	Percent roads paved	-.79209
13	Percent rural farm	.56240
3	Median school years attended	-.36355
11	Other income exceeds farm income	-.36001
12	Percent rural non-farm	.28491

The very high negative loadings on variables 9, 17, and 8 along with smaller negative loadings on variables 3 and 13 indicate a strongly oriented rural economy of the extensive type. Positive loadings of the Percent Rural Farm and Percent Rural Non-Farm variables verifies the presence of a relationship identified as Ruralism.

Factor C - Sub-Marginal Resources

For this factor, significant loadings are obtained on only 5 of 22 variables, which are, in order of absolute magnitude:

6	Value of minerals	-.85913
7	Average farm size	-.69884
10	Watershed area	-.60544
16	Percent work outside county	-.39801
5	Percent owner-occupied dwellings	.33161

The high negative loadings on Value of Minerals, Farm Size, Watershed Area, and Percent Work Outside County indicate that as they all increase, Factor C declines. The single positive loading on Owner-Occupied Dwellings within this cluster indicates a most difficult situation of rural poverty due to absence of resources of any significant value, therefore, Factor C is identified as Sub-Marginal Resources.

Factor D - Immobility

This factor has significant loadings on 6 of the 22 variables. It is composed of 5 strong positive loadings pertaining wholly to living site and a single weak negative loading, Acres Irrigated.

These significant loadings are:

5	Percent owner-occupied dwellings	.71593
14	Percent residing in state of birth	.61540
13	Percent rural farm	.50339
16	Percent working outside county	.49461
12	Percent rural non-farm	.46064
21	Acres irrigated	-.32289

This cluster indicates close ties to the "home place" and preference to the home community; thus Factor D is identified as Immobility. The negative association of Acres Irrigated with Immobility suggests poor adaptability to new technologies. In other words, Acres Irrigated may be associated with observation and experience of farm operators who have lived or worked outside the local area and import new technologies resulting in a more intensive type farming.

Factor E - Exodus

This factor has significant loadings on 7 of the 22 variables, listed in order of absolute magnitude, as follows:

22	Per capita income	-.84904
11	Other income exceeds farm income	.80350
4	Number of towns and cities	.60255
13	Percent rural farm	-.38885
16	Percent working outside county	.33462
7	Average farm size	-.30997
3	Median school years attended	-.28525

High positive loadings on Off-Farm Income, Number of Towns and Cities and Percent Working Outside the County, when coupled with negative loadings on Income, Percent Rural Farm, Average Farm Size, and Median School Years Attended, suggests those leaving the farm may have more human and material resources compared to those remaining, thus identifying Factor E as Exodus.

Factor F - Water Depletion

This factor has significant loadings on 6 of the 22 variables, listed in order of absolute magnitude as follows:

2	Farm wages and salaries	-.80920
21	Acres irrigated	-.78647
1	Farm income	-.52274
14	Percent residing in state of birth	.31961
20	Auto, truck and tractor registration	-.29492
5	Percent owner-occupied dwellings	.27738

The three negative loadings on Farm Wages and Salaries, Farm Income, and Auto, Truck and Tractor Registrations are closely associated with the negative loading on Acres Irrigated, suggesting an inverse relationship with water supplies. When clustering with positive loadings on site variables adhering occupants to the land such as Owner-Occupied Dwelling and Percent Residing in State of Birth, this cluster of variables clearly indicates Water Depletion as the functional unity.

The above factors are as independent as possible, given the power of the statistical technique. Nevertheless, there is some overlapping due to the inherent nature of the phenomenon observed. A project development characterized by Immobility, for example, cannot escape being Sub-Marginal also. Thus, the overlapping that does exist is the result of intrinsic relationships.

Of the 22 variables listed in Table XII, eight appear as significant in two different factors, and four appear in three different factors. The four variables appearing as significant in three factors are Percent Rural Farm, Percent Working Outside County, Percent Rural Non-Farm, and Percent Owner-Occupied Dwellings. None of these would be considered a purely economic variable, such as farm income, for instance. This might indicate a need for more emphasis upon the study of social and psychological ingredients when investigating growth and development.

Regression Analysis of the PL 566 Projects

In extracting the above factors, we have selected a number of dependent variates which indicate the underlying structure of the socio-economic environment composed of 22 variables. The relationships among the original variables, which are measures of community characteristics permit the comprehension of the possible contribution of the measures when viewed as primary descriptive categories or factors.

The correlation matrix (Appendix D, Table VI) shows relations only among the variables, which may be independent of the descriptive categories. On the other hand, the factorial matrix describes the community variables in terms of a few descriptive categories. If, after observation of measured community characteristics in a wide variety of communities, there is a meaningful convergence into a few factors, the generality of the discovered factors should be recognized. This should substantiate their use as structural parameters.

But individual community variation cannot be attributed to only one factor. Twenty-two variates have been reduced to six factors. These six factors must be considered together in analyzing community differences.

To assess the value of the above simplification, multiple regression analyses of the original 22 variables, and of the six factors, is run on the dependent variable Rate of Watershed Development.[2]

When the 22 independent variables are regressed on the dependent variable, the R^2 is .896954. However, only one of the independent variables has a significant student-t value. On the other hand, when the six factors are regressed on the dependent variable, the R^2 becomes .873030 with three of the six factors having significant student-t values. By reducing R^2 by .023924, a gain from 4.5 percent to 50 percent of the significant student-t values of the independent variables is achieved.

The implication of the above analyses is that the factor technique enables a simplification of confounding effects, thus revealing the underlying relationships important to watershed development. The derived regression equation utilizing the six factors as independent variables can be expressed as:

$$Y = -0.00185X_1 - 0.00034X_2{}^* - 0.00058X_3 + 0.01069X_4{}^* + 0.00170X_5 - 0.00445X_6{}^*.$$ [3]

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[2]See Appendix D which outlines the regression procedure followed and presents the output in detail.

[3]The asterisk (*) indicates statistical significance at the .05 level.

Y ranges from zero to three representing fast to slow progress of watershed development. The coefficients can be interpreted in the following manner.

As Level of Living increases by one unit, Y decreased by .00185 of one unit, an increase in rate of development. Similarly, as Ruralism, Sub-Marginal Resources, and Water Depletion each increase by one unit, Y decreases .00034, .00058, and .00445, respectively. On the other hand, as Immobility and Exodus each increase by one unit, Y increases by .01069 and .00170 of one unit, a decrease in rate of development.

All of the above signs are in agreement with a priori reasoning except X_6 -- Water Depletion. The small values of the coefficients help explain the problems associated with a complex phenomenon such as development and leads one to suspect that several other factors outside the above closed system of 22 independent variables are involved. The above observation has additional implications about the usefulness of the factor analysis technique. Another possible use would be to reduce many variables, suspected of affecting development or other socio-economic processes, down to a number which is operational. For instance, the BMDO5M discriminant program utilized in the analysis is limited to 25 variables as a maximum. As many as 99 variables, which is the limitation of most correlation programs currently in use, could be reduced to 25 factors. This would allow analysis of many complex situations currently too complicated to resolve.

Analysis of the Factors for the Washita Projects

For the Washita basin the same 16 independent variables that were utilized in the discriminant program are selected so that later comparisons can be made. The factor analysis program selects five factors, again utilizing the criterion that the number of factors should equal the number of eigenvalues greater than unity. These five factors and the communalities are presented in Table XIV. The explained variance varies from a high of .95287 for variable 3 -- Number of Towns and Cities, to a low of .49664 for variable 8 -- Watershed Area. Those factor loadings considered significant at the .01 level with 47 degrees of freedom are enclosed in parentheses. Of the 16 variables listed in Table XV, variable 14 -- Percent Indian -- has significant loadings on four factors. Six variables -- 2, 4, 7, 11, 12, and 16 -- have significant loadings on two factors. The final factors including only the significant loadings are discussed more fully below.

Factor A - Commercial Agriculture

This factor has significant loadings on 6 of the 16 variables. In decreasing order of absolute magnitude they are:

15	Acres irrigated	.95824
3	Number towns and cities	.91221
1	Farm income	.82175
4	Percent owner-occupied dwellings	-.63025
14	Percent Indian	.61377
16	Per capita income	-.53346

The very high positive loadings of Acres Irrigated and Farm Income suggest an intensive-type agricultural community with large agricultural services indicated by the large proportion of towns and cities.

TABLE XIV

ROTATED ORTHOGONAL FACTOR LOADINGS FOR WASHITA
WATERSHED PROJECTS IN OKLAHOMA

Variables						
1. Farm income	(0.82175)	-0.34335	-0.14708	-0.32656	-0.05406	(0.92439)
2. Median school years attended	0.02268	(-0.55902)	-0.21257	(-0.69745	0.14690	(0.86622)
3. Number towns & cities	(0.91221)	0.18094	0.24706	-0.16332	-0.01696	(0.95287)
4. Percent owner-occupied dwellings	(-0.63025)	0.10150	-0.31013	(0.53512)	0.24683	(0.85097)
5. Value of Minerals	-0.15048	-0.09537	(0.85310)	0.20148	0.31813	(0.90132)
6. Average farm size	-0.26530	0.05630	(-0.72056)	0.26709	0.13555	(0.68248)
7. Percent roads paved	-0.10513	0.11625	(0.76213)	0.09839	(-0.39407)	(0.77038)
8. Watershed area	-0.01977	0.02126	0.06057	-0.05902	(0.69903)	(0.49664)
9. Percent rural non-farm	0.15737	(0.94819)	-0.03735	0.12089	0.06888	(0.94457)
10. Percent residing in state of birth	-0.16071	0.08999	0.01277	(0.93986)	-0.03955	(0.91900)
11. Non-worker to worker ratio	0.24899	(0.67797)	(0.60676)	0.04628	-0.03654	(0.89329)
12. Percent working outside the county	-0.08151	0.16067	(0.47248)	-0.06088	(-0.71923)	(0.77670)
13. Amount returned per $ sales tax paid	-0.17580	(0.88533)	-0.04462	0.25954	-0.08300	(0.89096)
14. Percent Indian	(0.61377)	(0.38780)	(-0.38703)	(0.47080)	0.17291	(0.92845)
15. Acres irrigated	(0.95824)	0.06155	-0.09482	0.02866	0.07664	(0.93770)
16. Per capita income	(-0.53346)	(0.56784)	-0.08770	-0.16175	-0.31267	(0.73864)

$*h^2$ = communalities.

TABLE XV

DISTRIBUTION OF COMMUNALITY COEFFICIENTS (h^2) FOR WASHITA WATERSHED PROJECTS

Percent of Variance Explained	Number of Variables	Percent of Variables
90-99	7	44
80-89	4	25
70-79	3	19
60-69	1	6
59 and below	1	6
Total	16	100

The high Percent Indian associated with negative loading for Per Capita Income suggests poor distribution of income between White and Indian. The negative loading for Owner-Occupied Dwellings may be accounted for by migrant laborers required by an intensive-type agriculture.

Factor B - Welfare

Factor B has the following six variables with significant loadings:

9	Percent rural non-farm	.94819
13	Amount returned per $ sales tax paid	.88533
11	Nonworker to worker ratio	.67797
16	Per capita income	.56784
2	Median school years attended	-.55902
14	Percent Indian	.38780

The high loadings of all positive variables except Median School Years Attended suggests a factor identified as Welfare. The only loading which might be inconsistent is for Per Capita Income. However, incomes so low that increased welfare raises average income is possible.

Factor C - Extractive

This factor is also composed of six variables with significant loadings:

5	Value of minerals	.85310
7	Percent roads paved	.76213
6	Average farm size	-.72056
11	Non-worker to worker ratio	.60676
12	Percent working outside county	.47248
14	Percent Indian	-.38703

The high loadings for Value of Minerals, Percent Roads Paved, and Non-Worker to Worker Ratio associated with a negative loading for Average Farm Size indicates extraction of resources at the expense of usable farm land. Indian lands not being transferable show up as a negative influence on the expansion of extractive industries.

Factor D - Immobility

Significant loadings on only four variables are as follows:

10	Percent residing in state of birth	.93986
2	Median school years attended	-.69745
4	Percent owner-occupied dwellings	.53512
14	Percent Indian	.47080

Positive loadings pertaining to site and nationality when coupled with negative loadings with educational attainment suggest a highly immobile populace.

Factor E - Extensiveness

12	Percent working outside the county	-.71923
8	Watershed area	.69903
7	Percent roads paved	-.39407

Negative loadings on two variables associated with transportation needs when connected with a positive loading on Watershed Area suggest a ranch-type economy with extensive landholdings and low labor requirements.

Regression Analysis of the Washita Projects

As in the case of the PL 566 analysis, a number of independent variates which indicate the underlying structure of the socio-economic environment composed of 16 variables are identified. These are reduced to five factors which together explain a large proportion of the variance of the original 16 variables (Table XV). In examining the exposed structure of the Washita sub-watersheds, a difference in the type of factors from that of the PL 566 areas is noted. To examine these and any other differences, a multiple regression analysis is computed for the original 16 variables and the dependent variable Rate of Progress.[4] This analysis is then repeated utilizing the five factors as the independent variables.

When the 16 independent variables are regressed on the dependent variable, the R^2 is .804763 but none of the independent variables are significant at the .05 level utilizing a student-t test. On the other hand, when the five factors are regressed on the same dependent variable, the R^2 becomes .691507 with two of the five factors having significant student-t values. By giving up .113256 of the R^2, a gain from zero to 40 percent of the significant coefficients is achieved. This implies that much of the confounding effects are removed by weighting with the factor loadings which are significantly different from zero. The underlying structure is then apparent for analysis.

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[4]See Appendix D which outlines the regression analysis and presents the output in detail.

Summary

Factor analysis is an objective method for selecting dependent variables which can be considered as the basic structure or functional unities of a complex system of interrelated variables. The selected factors, in turn, can be utilized as independent variables for a multiple regression analysis of Rate of Watershed Development.

The researcher cannot always choose both independent and dependent variables of a complex environment before analyses in order to investigate a complicated phenomena such as development. Cause and interaction are often circular, requiring caution in choosing dependent variates of a socio-economic system.

In the analysis above, factor analysis extracted the following factors from the correlation matrices of selected variables. These factors account for a large proportion of the variance in the dimensions of the selected variables.

PL 566	Washita
Level of Living	Commercial Agriculture
Ruralism	Welfare
Sub-Marginal Resources	Extractive
Immobility	Immobility
Exodus	Extensiveness
Water Depletion	

Each of the above factors are "clusters" of significant interrelated variables forming an empirical construct.

Proof of the ability of the mathematical derived "constructs" to simplify a complex interactional system is given when the factors are utilized in a multiple regression program to analyze differences in watershed projects with different rates of development. The factors are found to produce a high proportion of significant coefficients whereas the original variables cannot.

An interesting finding which could bear additional investigation is that the number of variables associated with the percent of variance explained forms a nearly normal distribution in the case of the PL 566 projects which are widely distributed throughout the state (Table XIII). However, in the case of the Washita projects, a skewed distribution of number of variables associated with percentage of variance explained occurs (Table XV). This would be expected since variables explaining a higher percent of variance should logically be associated with a more homogeneous area.

The selection of the original variables is still a subjective process. Although important dimensions may be left out, repeating the analysis with two different populations does provide a strong test of the basic relationships discovered. To test the technique and its complementarity with the discriminant analysis technique, a check survey is carried out and is discussed in Chapter VI.

CHAPTER VI

THE SAMPLE SURVEY

Introduction

The statistical analyses presented in Chapter IV and V are based primarily upon data derived from secondary sources. The original classifications of watersheds are developed from the State Soil Conservation Board's records. The classifications of the discriminant model are then derived from secondary county data as are the projected classification of proposed watersheds. Also, the factor analysis technique groups the highly interrelated variables from the same secondary data.

The results of a survey of 20 selected PL 566 watersheds are presented in this chapter. The purpose of the survey is to check the results obtained by the two statistical techniques.

The Sample

From each of the four group classifications, five watersheds with the greatest probability of being within that particular group are selected as the sample watersheds. The watersheds classified as being most like the group should be the best representative of that group. Such a stratification as this should be superior to a complete random sample. Watersheds selected at random could have nearly equal probabilities of being in two or more groups, thus being a hindrance when the object is to emphasize differences.

The counties within which the sample watersheds are located are indicated in Figure 2. No geographic bias from the above selection technique is apparent as indicated by a comparison with total PL 566 watershed project distribution (compare Figures 1 and 2).

The Sample Interviewees

A field survey of people actually engaged in project development at the local level is carried out on the sample watersheds. The local Work Unit Conservationist (hereafter referred to as WUC) and an active member of the Soil and Water Conservation District, Conservancy District, or Watershed Association are contacted. The board member is chosen on the recommendation of the WUC as the person being the most active and/or influential in the project development. The board member is contacted in addition to the WUC in order to obtain the opinion of a non-paid participant in the program and as a further check on the statistical analyses.

The Check List for Field Study (Appendix E) includes 12 questions pertaining to rate of progress and factors which either contribute to speed or hinder the progress of watershed development.

Analysis of the Results

The first two questions pertain to the classification of the sample watershed into one of the four groups. The sample watersheds have now been classified by four methods: (1) by means of the State Soil Conservation Board's records, (2) by the 22 selected socio-economic variables from secondary county data, (3) by the WUC's, and (4) by the board

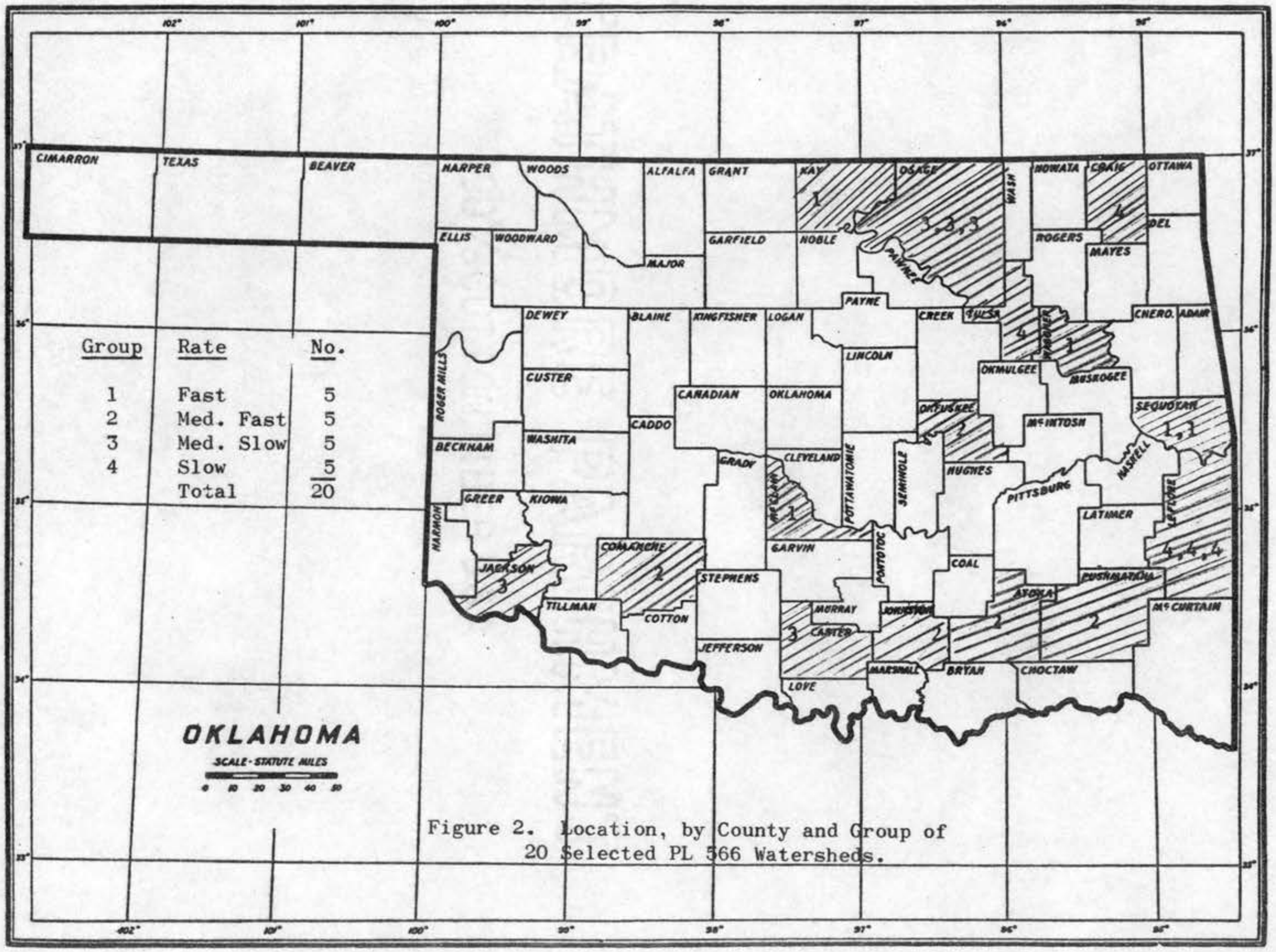

Figure 2. Location, by County and Group of
20 Selected PL 566 Watersheds.

members (Table XVI). When these four classifications are statistically analyzed by a χ^2 test, no significant difference is indicated between the classifications by the various methods. Also, Spearman's rank correlation test indicates that $r_s = .714$, which shows a close association in the answers obtained from the discriminant analysis and from all interviewees. The above tests, degrees of freedom, and level of significance are presented in Appendix F, Tables I and II.

Question three asks for the most significant contribution and/or deterrent to development progress. The most quoted contribution is cooperation among landowners and interested citizens of the community. Red tape and waiting on decisions by higher levels than the local organization are the most frequently mentioned deterrents (Table XVII). Opposition to conservancy districts and factions between areas are other frequently mentioned difficulties.

To determine whether laymen (as opposed to a researcher) can conceptualize the community factors and their effect upon rate of progress of project development, question four is posed. Each interviewee is asked to indicate whether a given factor has a positive, negative, or no effect upon rate of watershed development. The first test, whether a difference between factors and their effects can be determined by the total sample interviewees, shows that there is a difference at the .05 significance level (Appendix F, Table III). A high Level of Living is thought to benefit rate of progress as does Ruralism. Sub-marginal Resources and Immobility are indicated to have beneficial, retarding, or no effect almost equally by the respondents. Exodus and Water Depletion are considered to have beneficial or no effect upon rate of progress of watershed development.

TABLE XVI

CLASSIFICATION OF SELECTED SAMPLE WATERSHEDS INTO FOUR GROUPS BY DEPENDENT VARIABLES, INDEPENDENT VARIABLES, WORK UNIT CONSERVATIONISTS, AND BOARD MEMBERS

Group	Sample Watershed Number	Classed By: Dependent Variables[a]	Independent Variables[b]	WUC	Board Member
	95	1	1	1	1
	68	1	1	1	4
I	40	1	1	4	3
	101	1	1	4	4
	47	1	1	1	2
	88	2	2	2	3
	57	2	2	3	2
II	50	2	2	2	2
	33	2	2	2	2
	6	2	2	3	4
	59	3	3	2	2
	48	3	3	3	3
III	65	3	3	3	3
	67	3	3	3	3
	84	3	3	3	3
	17	4	4	4	4
	21	4	4	4	4
IV	16	4	4	4	4
	29	4	4	4	4
	82	4	4	4	4

[a]The dependent variable Rate of Watershed Development is determined from the State Soil Conservation Board's records of performance.

[b]The independent variables consist of 22 selected socio-economic variables available from secondary county data.

TABLE XVII

THE MOST SIGNIFICANT CONTRIBUTIONS AND DETERRENTS TO WATERSHED DEVELOPMENT PROGRESS AS RELATED BY INTERVIEWEES

Number of Times Related	Contributions	Number of Times Related	Deterrents
4	cooperation	10	red tape and wait on higher levels
2	recognized need	6	opposition to Conservancy District
2	Indian Service assistance	4	faction between areas
2	able to form Conservancy District	3	getting realistic economic information
2	prior experience with Conservancy District	3	lack of local leadership
2	contribution of easements	2	municipal water
1	recreation and value of water	2	competition of Corps projects
1	drainage	2	unprogressiveness
1	voluntary support	2	lack of support (people and funds)
1	single purpose project	1	local cost
1	people sold on project	1	easement obtainment
1	received high priority	1	poor education about responsibilities
1	irrigation	1	size restriction
1	Chamber of Commerce	1	Chamber of Commerce
1	data collected by oil company	1	prior experience with Drainage District
1	high class of people	1	one obstinate person
1	small area and few people	1	Landowners' Protective Association
1	municipal interest	1	too few benefits
1	help of state revolving fund		
1	good informational program		
1	drouth followed by floods		
29	Totals	43	

Source: Results of the field survey of 1966.

The second test, whether there is a difference between WUC and board member's selections, shows that there is no difference at the .05 significance level (Appendix F, Table IV).

The third test divides the four watershed groups into only two groups to see if the community factors as determined by the WUC's and board members have different effects on watershed development in the slow versus fast groups.[1] The test indicates that no significant difference in ranking exists at the .05 significance level (Appendix F, Table V).

The fourth test relating to question four indicates no difference between those who agree with the classification of the discriminant analysis about the effect of the community factors on rate of progress and those who disagree with the discriminant technique (Appendix F, Table VI).

Question five is aimed at the determination of any significant differences in type of sponsoring organization in the help they provide. No significant difference between Soil and Water Conservation Districts, Conservancy Districts, or Watershed Associations, City and County Commissioners is found (Appendix F, Table VII).

To determine if any difference in help afforded by type of endorsing organization exists, Question six was posed. There appears to be a significant difference (Appendix F, Table VIII). Civic clubs, farm organizations, cities, the Bureau of Indian Affairs, and county commissioners

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[1]The groups are combined in order to meet the assumptions underlying chi-square. The χ^2 may be used if fewer than 20 percent of the cells have an expected frequency of less than 5 and no cell less than 1 [31].

are more help in the upper one-half or faster watersheds while the Soil and Water Conservation Districts and Watershed Associations are associated with the lower one-half or slower watersheds. This is surprising since it is the usual process to form Watershed Associations and assistance from Soil and Water Conservation Districts is considered almost automatic. But the interviewees, who are actually involved in watershed development, choose the outside organizations as the most helpful.

The problems to overcome are grouped and then tested to see if there is any difference between the fast and slow sample watersheds. There is no significant difference in type of problem indicated (Appendix F, Table IX).

To determine whether a difference in sources of information to the local leadership exists between fast and slow groups, a χ^2 test of the answers to Question eight indicates that a significant difference does exist. The upper one-half receive more information from the SCS and State Soil Conservation Board while the lower one-half rely more upon information from other sources (Appendix F, Table X).

Distribution of information to watershed members, multiple purposes of the projects, project changes after first analysis, and different approaches (hindsight) -- all are not determined to be significantly different between the upper one-half and lower one-half. The results of respondents' answers to Questions eight through 12 are presented in Appendix F, Tables XI and XII.

Summary

The technique of selecting samples from those watersheds having the highest probability of being within a particular group is demonstrated to be a sample design with some merit. Application of discriminant analysis to studies utilizing secondary data provides an efficient and economical model of ranking selections by means of actual probabilities provided by the discriminant technique.

The sample survey indicates that the classification by means of secondary data is not significantly different from classification by original performance ranking, classification by the WUC's, or classification by board members. This survey thus provides a test of the validity of the statistical technique. The above checks are performed at both the state, county, and local levels further substantiating the "building block" or county data as a basis for analysis.

The results of the sample survey also indicate that the interviewees are able to detect differences between community factors and to assess their possible affect on the rate of project development. When the four groups are divided into the upper one-half and lower one-half, no difference between effect of community factors is evidenced, however.

Differences in help provided by endorsing organizations become apparent between the sample watersheds within the fast and slow groups. Organizations other than Soil and Water Conservation Districts and Watershed Associations provide more adequate help to the fast group. Similarly, the State SCS and State Soil Conservation Board provide more information to the fast group.

The results of the sample survey indicate that the people involved in the actual development of a watershed project have ideas which are of merit in evaluating watershed development progress. These people emphasize the need for more informational work, care in the formation of Conservancy Districts, the need of good local leadership, and an early start if project development is to be achieved within a reasonable time period.

CHAPTER VII

SUMMARY AND CONCLUSIONS

Introduction

The local people in each community, faced with a problem affecting their resources, and realizing that resources common to the group must be organized in a manner allowing receipt of benefits commensurate with costs, have had neither adequate theory nor factors upon which to act. These decision-makers are in need of more adequate guidelines and information. This research attempts to partially fill that gap.

Observance of one type of community development -- upstream watershed projects -- reveals that a wide divergence exists in the ability of communities to inaugurate and carry to completion the upstream watershed projects. The cause of this disparity in rate of development is investigated with the assistance of two statistical techniques heretofore not utilized in the resource economics area. Together with a precursory examination of enabling legislation and facilitating institutions, the findings of the statistical and institutional analyses provides an additional fund of knowledge which the individual landowner, the planner, and the agency director can utilize to improve their decision-making.

It is hypothesized that man's success in achieving development through group or community action is some function of his socio-economic environment. It is also hypothesized that traditional decision-making theories leave much to be desired since these theories are not adequate for problem solving when the resources are not solely owned or controlled by the individual decision-maker. It is further hypothesized that through statistical analyses of selected socio-economic variables, differences between rates of progress can be identified and further utilized to indicate the relative importance of the original variables. In addition, the identification of the underlying structure of factors contributing to performance or ability to achieve group goals can help explain the genesis of the development processes.

When the findings are viewed and analyzed in total, then, and only then, can the needed adjustments in traditional decision theories be noted. The multiple goals necessary to achieve community development give some indication of the decision-maker's reaction to his socio-economic environment. His success or failure reflects his ability to adapt and integrate personal and social objectives.

Summary

Economic development in Oklahoma through the use of upstream watershed projects has been facilitated by adequate enabling legislation and lobbying activities of backers of the program. It is possible to form organizations with sufficient powers and capabilities to carry out the desired programs under present laws. Conservancy Districts having the authority to assess and tax property have misused these powers in some instances and opposing organizations such as the Landowners' Protective Association were formed to effectively halt such abuses. As a result, more care is taken in the obtainment of easements and land. Also, operating agreements are obtained where multiple ownership of project sites are involved.

The State Association of Soil and Water Conservation Districts has proven to be an effective lobbying group procurring necessary funds from the legislature for the Soil Conservation Board and establishing a large revolving fund for purchase of needed lands by projects with insufficient funds of their own. The public educational program by this association also helps assure development success.

Because of the many state and federal agencies involved in the development of the state's water resources, coordination among agencies at every level is necessary to prevent duplication and wasted effort. As more and more projects are installed, the need for better planning and technical assistance is required. Competition for scarce water resources results in more reliance upon water laws and judicature. In turn, the individual landowner, as well as the planners and program directors, needs more and better information upon which to base his decisions.

Needed adjustments in the assumption of full knowledge associated with classical decision theories are noted since upstream watershed development concerns a community of individuals working together to solve a common problem. Since the resources of the entire community are involved, socio-economic variables are utilized as measures of community environment.

To assess community performance -- ability of a community to achieve development -- two statistical analyses are performed on the selected socio-economic variables. Discriminant analysis provides a method of discriminating between watershed groups representing fast to slow accomplishment of watershed development on the basis of socio-economic variables. The four groups into which all watersheds are classified are found to be significantly different. Upon the basis of the original sample, future watersheds which are delineated but which have not yet applied for planning assitance are classified into the four groups. Because of the large size of the original sample, the predictions are good. They agree with a priori reasoning that most of the remaining watersheds within the state would fall in the slower groups.

Factor analysis is an objective method for selecting dependent variables which may be considered as the basic structure of the complex socio-economic system of interrelated variables. These dependent variables or factors are analyzed and used to demonstrate the interaction which occurs within a complex socio-economic system. This simplification leads to the hypothesis that the underlying structure should provide a basis for understanding and predicting rate of progress of development. In consequence, the basic factors are regressed on the dependent variable Rate of Watershed Development. It is demonstrated that the factors are less efficient predictors than the original variables but the structural coefficients are more significant.

Observance of the relative importance of the selected socio-economic variables when utilized in discriminant and factor analysis indicates that several variables are more important than the raw data would indicate. For instance, Median School Years Attended and Non-Worker to Worker Ratio are more important in the discriminating functions than in the raw form in relation to the other variables. On the other hand, in the factor analysis Percent Rural Farm, Percent Working Outside County, Percent Rural Non-Farm, and Percent Owner-Occupied Dwellings appear frequently in the factors associated with the PL 566 projects while Percent Indian occurs the most frequently with the Washita projects.

The analyses of two programs -- the PL 566 and Washita -- enable an evaluation of the statistical models under different conditions. The discriminant program discriminates successfully between groups in each case and the predictions are in agreement with a priori reasoning. The factor analysis indicates the structural differences between a homogeneous area such as the Washita and the more heterogeneous area associated with the PL 566 projects scattered throughout the state. This is illustrated by the frequency of variables falling within different ranges of Percent Variance explained while the PL 566 projects, a more heterogeneous area, has a normal frequency distribution.[1]

The survey sample of 20 PL 566 watersheds provides additional substantiation of the two statistical techniques applied in the analysis. The technique of sampling utilizing probabilities proves quite useful when trying to determine differences between groups of watersheds having different rates of project development. The sample survey also substantiates the use of secondary county data as a substitute for primary data from each watershed which would be prohibitive in cost if no other alternative had existed.

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[1]Comparison of Tables XIII and XV demonstrates the difference in the two distributions.

The interviewees can detect differences between the affect of community factors on project development and are in agreement with the results obtained by the regression analysis. Differences are detected in the help provided by the various agencies to the fast versus the slow groups. The interviewees also agree with the findings of the institutional analysis that more informational work is needed, care must be exercised in the use of powers of the Conservancy Districts, the need of good, strong local leadership, and a follow through by all interested citizens with adequate technical and planning assistance provided.

Conclusions

Agencies interested in community development projects could utilize the techniques outlined in this study to provide more adequate guidelines and information to local people. The derived information of the suggested statistical techniques could also be utilized by agencies in establishing priorities for planning assistance and construction funds.

Differences do exist between rates of project development and these differences are useful in providing information for decision-making. But traditional decision theories assuming perfect knowledge must be relaxed in order to include socio-economic man who realizes the community may control resources necessary to achievement of his own or the group's goals.

A difference in structure and the relative importance of its components can be analyzed, thus providing insights into the real development processes. The success or failure of development is determined to be a function of the socio-economic environment. The closed systems of 22 and 16 socio-economic variables are analyzed with some degree of success.

The most important implication of this study is that development is a very complex phenomenon and any approach which utilizes only a very few variables or methods of analysis will not divulge much information or add to knowledge about the development processes. This is an attempt to develop and test some hypotheses which barely scratch the surface. Hopefully, the results will encourage other inquisitive researchers to delve deeper. Two statistical techniques not previously utilized in the resource economics area are utilized and are found to perform adequately.

The genesis of development, it is believed, lies within the socio-economic environment but is not adequately tested in this research attempt.

Need for Further Research

It is suggested that socio-economic man brings into his decision processes the certainties and uncertainties associated with other resource owners' control over resources necessary to the solving of a common problem. Methods, in the form of statistical techniques, were presented which could enable socio-economic man to assess the capability of his community to achieve development in comparison to other communities. How socio-economic man incorporates this new information into his decision processes and formulates his trading position is yet to be determined. The question of how to allocate costs commensurate with benefits is still unanswered.

Studies which attack the associated problems of trade-off formulation, benefit and cost analysis, and assessment could possibly unlock the mysteries associated with growth and development.

The ability of some communities to achieve these very tasks in an acceptable manner may be the grease which makes the wheels of development turn and which results in subsequent achievement of growth.

The study reported herein demonstrates that a closed socio-economic system identified by several socio-economic variables can indicate differences and structural relationships when the proper statistical techniques are applied. Similar analyses are needed of other types of development programs. Also, studies of other areas are needed to assess the generality of the conclusions of this study.

The differences (between the derived structural parameters) detected by both the interviewees and the factor technique need further examination, especially the effect between areas and between types of variables included in the closed model. The effect of time and change is not really tested in this study since all the secondary data is based on the 1950 census.

Only time will prove or disprove the predictions of the discriminant program. The present and future watersheds should be evaluated again sometime in the future to assess these predictions. Further testing of the relationship between a lowering of the R^2 associated with a gain in the number of significant coefficients (student-t values) is needed. More statistical research also is needed to develop techniques capable of utilizing qualitative variates to predict other qualitative variates. This would enable researchers to assess values and goals, trade-offs, and benefits and costs in a manner heretofore impossible. This could lead to breakthroughs in the area of subjective decision making, analysis of schedule shifters such as tastes and preferences, and benefit-cost analyses.

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APPENDIXES

APPENDIX A

THE CRITERIA FOR EVALUATING AND DETERMINING THE PRIORITY OF PLANNING WATERSHED APPLICATIONS UNDER PUBLIC LAW 566 IN OKLAHOMA

Physical feasibility of developing a sound program. (Total possible points - 10)

I. A. Need for structural measures indicated by following:

FACTOR	DESCRIPTION
5	Has been in high degree of use. High floodwater and sediment damage caused significant land use changes to lower-value agricultural uses.
4	High damages - floodwater sediment. Some land use changes to lower-value crops.
3	Moderate to high floodwater and sediment damage. No appreciable amount of land use change.
2	Low to moderate floodwater and sediment damage.
1	Low crop and pasture damage. Low non-agricultural damage.

B. Sites or channel improvement for adequate protection.

5	Sites available for excellent protection with less than average obstacles or cropland inundation; control 65 percent or more.
4	Sites available for excellent protection with less than average obstacles or cropland inundation; control 55-65 percent.
3	Sites available for adequate protection with average obstables and cropland inundated; control 50-55 percent.
2	Sites available for adequate protection. Average obstacles and cropland inundated; control 45-50 percent.
1	Sites available for control 40-45 percent.

II. Economic feasibility: (Total possible points - 10)

10	High benefits to justify excellent control and sites of

above average cost, e.g., drainage of one square mile. At least 75 percent reduction in damages could be justified.

6 Above 1:1 benefit-cost ratio and will justify adequate protection if larger more economical sites are obtained. Reduction in floodwater and sediment damage should be about 60 percent.

2 Low or doubtful benefit-cost ratio -- and protection will be justified if large economical sites are planned.

III. Land Treatment. (Total possible points - 10)

A. Basic plans.

5 More than 75 percent under agreement.

4 60 - 75 percent.

3 45 - 60 percent.

2 20 - 45 percent.

1 Less than 30 percent.

B. Adequacy of sediment control features of applied land program in light of natural land conditions within the watershed.

5 Excellent - Low sediment yields

4 Very Good - Below average sediment yields

3 Good - Average sediment yields

2 Fair - Above average sediment yields

1 Poor - High sediment yields

IV. Local sponsors' interest, willingness and resources. (Total possible points - 20)
Consideration will be given the following factors in determining the total points for this item:

A. Financing.

a. Authority to finance through a legal entity.

b. Demonstrated finance.

The sponsors of a watershed application will be considered to have demonstrated financial ability by pledging, prior to the time a priority is awarded, to have on deposit before surveying begins, funds in an account for carrying out their responsibilities equal to or exceeding the following:

(1) $10.00 per acre of the first 1,000 acres of expected protected bottom land or the entire acreage where less than 1,000 acres.

(2) $2.00 per acre for each additional acre of bottom land expected to be protected for the next 4,000 acres.

(3) $1.00 per acre for each acre of bottom land expected to be protected in excess of 5,000 acres.

(4) In watersheds where the sponsors will be required to cost share for drainage or other non-flood prevention measures, the estimated full amount of sponsors share of construction costs must be on deposit or a conservancy district organized.

B. Education and Organization.

a. Watershed association formed.

b. Meetings held and type.

c. Local publicity (newspaper, radio and television).

d. Tours of watersheds in place.

C. Multiple Purpose.

a. Municipal.

b. Industrial.

c. Recreation - added public recreation facilities.

d. Additional irrigation storage.

D. Attitude of Local People.

a. Understanding of program by leaders.

b. Expressed willingness of local people to exhaust all available resources for completion and maintenance of project.

c. Extent of opposition to project.

E. Other Available Pertinent Information.

APPENDIX B, TABLE I

EVALUATION OF CLASSIFICATION FUNCTIONS FOR EACH PL 566 WATERSHED FOR GROUP I

Case no.	Watershed No.	Function Number 1	2	3	4	Largest Probability	Function Number for Largest Probability
1	107	0.11632	0.12171	0.23132	0.53066	0.53066	4
2	103	0.35825	0.33256	0.09023	0.21896	0.35825	1
3	102	0.14452	0.06063	0.78757	0.00728	0.78757	3
4	101	0.59385	0.24033	0.13451	0.03131	0.59385	1
5	97	0.35698	0.04714	0.38143	0.21445	0.38143	3
6	95	0.70555	0.10377	0.08342	0.10727	0.70555	1
7	92	0.13510	0.07789	0.58148	0.20553	0.58148	3
8	87	0.47019	0.35713	0.12059	0.05209	0.47019	1
9	83	0.41371	0.05776	0.41240	0.11613	0.41371	1
10	78	0.43346	0.35542	0.17507	0.03606	0.43346	1
11	74	0.44211	0.38450	0.08512	0.08826	0.44211	1
12	68	0.69920	0.07751	0.12914	0.09415	0.69920	1
13	60	0.23329	0.21385	0.20296	0.34991	0.34991	4
14	52	0.27631	0.42853	0.16823	0.12693	0.42853	2
15	47	0.53242	0.05312	0.11213	0.30233	0.53242	1
16	43	0.51674	0.28979	0.15121	0.04226	0.51674	1
17	41	0.52257	0.30227	0.41714	0.02802	0.52257	1
18	40	0.64296	0.11930	0.23436	0.00338	0.64296	1
19	39	0.11641	0.24830	0.04253	0.59276	0.59276	1
20	38	0.48557	0.27483	0.03961	0.19999	0.48557	1
21	32	0.44746	0.10075	1.40439	0.04740	0.44746	1
22	26	0.43104	0.34861	0.17709	0.04326	0.43104	1
23	25	0.36773	0.51825	0.08019	0.03382	0.51825	2
24	23	0.15519	0.04018	0.05711	0.74751	0.74751	4
25	5	0.47400	0.11452	0.89232	0.01916	0.47400	1
26	4	0.15582	0.44935	0.36207	0.03276	0.44935	2
27	2	0.07521	0.45286	0.39612	0.07581	0.45286	2
28	1	0.43619	0.28511	0.17627	0.10243	0.43619	1

APPENDIX B, TABLE II

EVALUATION OF CLASSIFICATION FUNCTIONS FOR EACH
PL 566 WATERSHED FOR GROUP II

Case No.	Watershed No.	Function Number 1	2	3	4	Largest Probability	Function Number for Largest Probability
1	114	0.25577	0.64144	0.08657	0.01622	0.64144	2
2	115	0.48624	0.27536	0.03964	0.19876	0.48624	1
3	112	0.43267	0.28116	0.17612	0.11006	0.43267	1
4	110	0.50525	0.29107	0.04031	0.16337	0.50525	1
5	108	0.27346	0.23023	0.40609	0.09021	0.40609	3
6	105	0.12350	0.25334	0.09p34	0.53182	0.53182	4
7	96	0.11576	0.24676	0.04234	0.59516	0.59516	4
8	91	0.46831	0.35309	0.12122	0.05738	0.46831	1
9	90	0.02148	0.16657	0.19396	0.61798	0.61798	4
10	89	0.02732	0.30745	0.62987	0.03536	0.62987	3
11	88	0.03118	0.92492	0.02809	0.01581	0.92492	2
12	80	0.23203	0.28375	0.45366	0.03056	0.45366	3
13	70	0.46919	0.35493	0.12094	0.05493	0.46919	1
14	66	0.00594	0.02253	0.00452	0.96701	0.96701	4
15	64	0.37444	0.15480	0.30256	0.16820	0.37444	1
16	61	0.13046	0.49337	0.15810	0.21807	0.49337	2
17	57	0.05164	0.75309	0.13337	0.06190	0.75309	2
18	53	0.42914	0.34654	0.17507	0.04925	0.42914	1
19	51	0.28262	0.24864	0.45892	0.00981	0.45892	3
20	50	0.10019	0.72005	0.04606	0.13370	0.72005	2
21	45	0.23381	0.60543	0.13671	0.02404	0.60543	2
22	44	0.46749	0.11067	0.39688	0.02497	0.46749	1
23	37	0.51801	0.29208	0.15056	0.03935	0.51801	1
24	36	0.18312	0.16094	0.16789	0.48805	0.48805	4
25	35	0.07768	0.58208	0.04623	0.29402	0.58208	2
26	34	0.20686	0.51456	0.16365	0.11493	0.51456	2

APPENDIX B, TABLE II (Continued)

Case No.	Watershed No.	Function Number 1	2	3	4	Largest Probability	Function Number for Largest Probability
27	33	0.22765	0.64744	0.11842	0.00650	0.64744	2
28	28	0.11539	0.24586	0.04222	0.59643	0.59643	4
29	24	0.13298	0.33647	0.36370	0.16686	0.36370	3
30	12	0.03039	0.07301	0.89106	0.00554	0.89106	3
31	7	0.27381	0.22734	0.47789	0.02096	0.47789	3
32	6	0.21748	0.61455	0.14679	0.02118	0.61455	2
33	3	0.09333	0.25696	0.31416	0.33555	0.33555	4
34	113	0.45108	0.30410	0.17538	0.06943	0.45108	1

APPENDIX B, TABLE III

EVALUATION OF CLASSIFICATION FUNCTIONS FOR EACH PL 566 WATERSHED FOR GROUP III

Case No.	Watershed No.	Function Number 1	2	3	4	Largest Probability	Function Number for Largest Probability
1	111	0.48409	0.12133	0.38273	0.01185	0.48409	1
2	104	0.09600	0.19072	0.07388	0.63940	0.63940	4
3	99	0.07930	0.51962	0.37590	0.02518	0.51962	2
4	94	0.24057	0.19050	0.38560	0.18334	0.38560	3
5	84	0.14320	0.05954	0.78911	0.00815	0.78911	3
6	76	0.49022	0.12610	0.37526	0.00842	0.49022	1
7	75	0.59491	0.24201	0.13388	0.02921	0.59491	1
8	73	0.08730	0.50585	0.22838	0.17847	0.50585	2
9	71	0.69920	0.07751	0.21914	0.09415	0.69920	1
10	69	0.22598	0.32443	0.15149	0.29811	0.32443	2
11	67	0.14265	0.05909	0.78972	0.00855	0.78972	3
12	65	0.14263	0.05908	0.78973	0.00856	0.78973	3
13	62	0.14574	0.58647	0.16346	0.10432	0.58647	2
14	59	0.02513	0.03605	0.83707	0.00175	0.93707	3
15	55	0.37965	0.05115	0.39567	0.17354	0.39567	3
16	54	0.17819	0.11643	0.65626	0.04912	0.65626	3
17	49	0.18577	0.30114	0.48696	0.02614	0.48696	3
18	48	0.02144	0.13185	0.83862	0.00808	0.83862	3
19	46	0.47085	0.21851	0.19826	0.11238	0.47085	1
20	42	0.15055	0.41232	0.37307	0.06405	0.42323	2
21	31	0.24689	0.36369	0.16028	0.22914	0.36369	2
22	30	0.08921	0.24337	0.30376	0.36365	0.36365	4
23	22	0.34553	0.04521	0.37352	0.23574	0.37352	3
24	13	0.27250	0.22888	0.40582	0.09280	0.40582	3
25	11	0.38548	0.16530	0.31486	0.13486	0.38548	1
26	10	0.08967	0.26875	0.35248	0.28911	0.35248	3
27	8	0.15275	0.09183	0.62409	0.13133	0.62409	3

APPENDIX B, TABLE IV

EVALUATION OF CLASSIFICATION FUNCTIONS FOR EACH PL 566 WATERSHED FOR GROUP IV

Case No.	Watershed No.	Function Number 1	2	3	4	Largest Probability	Function Number for Largest Probability
1	109	0.17997	0.44449	0.11448	0.26106	0.44449	2
2	106	0.12356	0.25347	0.09137	0.53161	0.53161	4
3	100	0.13220	0.28682	0.04728	0.53369	0.53369	4
4	98	0.12045	0.25805	0.04377	0.57773	0.57773	4
5	93	0.59238	0.23814	0.31529	0.03419	0.59238	1
6	86	0.16501	0.35543	0.11483	0.36473	0.36473	4
7	85	0.19763	0.09956	0.29473	0.40808	0.40803	4
8	82	0.04893	0.10278	0.05185	0.79643	0.79643	4
9	81	0.05018	0.10565	0.05302	0.79115	0.79115	4
10	79	0.03596	0.15805	0.02277	0.78322	0.78322	4
11	77	0.23075	0.21104	0.20131	0.35690	0.35690	4
12	72	0.10094	0.12006	0.14633	0.63267	0.63267	4
13	63	0.28179	0.11011	0.25844	0.34967	0.34967	4
14	58	0.07579	0.56415	0.04549	0.31458	0.56415	2
15	56	0.40094	0.25020	0.17164	0.17722	0.40094	1
16	29	0.03128	0.13573	0.02013	0.81286	0.81286	4
17	27	0.06694	0.10870	0.14942	0.67494	0.67494	4
18	21	0.09074	0.02238	0.03549	0.85140	0.85140	4
19	20	0.14165	0.03635	0.05270	0.76929	0.76929	4
20	19	0.12635	0.03208	0.04764	0.79393	0.79393	4
21	18	0.12960	0.01444	0.02470	0.90029	0.78870	4
22	17	0.06057	0.01444	0.02470	0.90029	0.90029	4
23	16	0.09411	0.02328	0.03666	0.84595	0.84595	4
24	15	0.04789	0.32914	0.03175	0.59122	0.59122	4
25	14	0.10848	0.21947	0.34402	0.32803	0.34402	3
26	9	0.20384	0.31179	0.38576	0.09861	0.38576	3

APPENDIX B, TABLE V

EVALUATION OF CLASSIFICATION FUNCTIONS FOR EACH
WASHITA WATERSHED FOR GROUP I

Case No.	Watershed No.	Function Number				Largest Probability	Function Number for Largest Probability
		1	2	3	4		
1	64	0.82172	0.03347	0.08581	0.05900	0.82172	1
2	10	0.78003	0.17413	0.02950	0.01633	0.78003	1
3	55	0.77410	0.17952	0.02962	0.01676	0.77410	1
4	43	0.68895	0.08378	0.10057	0.12670	0.68895	1
5	40	0.77972	0.17440	0.02952	0.01636	0.77972	1
6	39	0.30202	0.02653	0.02770	0.64375	0.64375	4
7	36	0.78333	0.04670	0.09188	0.07808	0.78333	1
8	34	0.12755	0.18532	0.25010	0.43702	0.43702	4
9	29	0.81343	0.03618	0.08730	0.06309	0.81343	1
10	23	0.07267	0.18366	0.72287	0.02080	0.73387	3
11	20	0.77085	0.05127	0.09356	0.08432	0.77085	1
12	8	0.16869	0.48742	0.19732	0.14656	0.48742	2
13	4	0.76443	0.18834	0.02980	0.01742	0.76443	1
14	3	0.28764	0.00203	0.00601	0.70431	0.70431	4

APPENDIX B, TABLE VI

EVALUATION OF CLASSIFICATION FUNCTIONS FOR EACH
WASHITA WATERSHED FOR GROUP II

Case No.	Watershed No.	Function Number 1	2	3	4	Largest Probability	Function Number for Largest Probability
1	65	0.03598	0.55440	0.35586	0.05375	0.55440	2
2	60	0.10105	0.44740	0.04439	0.40716	0.44740	2
3	57	0.04181	0.33423	0.59177	0.03218	0.59177	3
4	56	0.08049	0.15891	0.74198	0.01862	0.74198	3
5	54	0.77898	0.17509	0.02952	0.01641	0.77898	1
6	49	0.03388	0.36581	0.02952	0.01403	0.58628	3
7	47	0.04012	0.52920	0.58628	0.05248	0.52920	2
8	37	0.20306	0.44114	0.37820	0.13807	0.44114	2
9	33	0.00380	0.44581	0.21774	0.00789	0.54250	3
10	28	0.03365	0.53811	0.54250	0.04330	0.53811	2
11	27	0.12964	0.18344	0.38494	0.43471	0.43471	4
12	21	0.03270	0.54484	0.25211	0.04358	0.54484	2
13	14	0.17126	0.48385	0.37888	0.14592	0.48385	2
14	5	0.00642	0.97933	0.19896	0.00217	0.97933	2
15	2	0.12583	0.18679	0.01208	0.43920	0.43920	4
16	1	0.00580	0.97853	0.24818	0.43920	0.43920	2
17	22	0.76944	0.18374	0.02973	0.01708	0.76944	1
18	51	0.50664	0.43103	0.02888	0.03345	0.50664	1

APPENDIX B, TABLE VII

EVALUATION OF CLASSIFICATION FUNCTIONS FOR EACH
WASHITA WATERSHED FOR GROUP III

Case No.	Watershed No.	Function Number 1	2	3	4	Largest Probability	Function Number for Largest Probability
1	63	0.14837	0.16903	0.27011	0.41248	0.41248	4
2	62	0.15126	0.16686	0.27270	0.40917	0.40917	4
3	59	0.20188	0.44288	0.21690	0.13834	0.44288	2
4	58	0.07584	0.17301	0.73126	0.01988	0.73126	3
5	26	0.02795	0.11612	0.78429	0.07164	0.78429	3
6	30	0.77075	0.05131	0.09355	0.08439	0.77075	1
7	52	0.03558	0.55689	0.35364	0.05389	0.55689	2
8	50	0.03435	0.56501	0.34640	0.05425	0.56501	2
9	45	0.01355	0.60510	0.36238	0.01897	0.60510	2
10	44	0.02310	0.14880	0.74177	0.08633	0.74177	3
11	42	0.02785	0.11650	0.78378	0.07188	0.78378	3
12	38	0.01542	0.69411	0.24223	0.04824	0.69411	2
13	31	0.00443	0.01238	0.97761	0.00559	0.97761	3
14	25	0.09650	0.11876	0.76986	0.01489	0.76986	3
15	19	0.80287	0.03980	0.08907	0.06826	0.80287	1
16	17	0.07128	0.18863	0.71887	0.02122	0.71887	3
17	16	0.03600	0.37606	0.55308	0.03486	0.55308	3
18	6	0.07834	0.02643	0.59579	0.29944	0.59579	3

APPENDIX B, TABLE VIII

EVALUATION OF CLASSIFICATION FUNCTIONS FOR EACH WASHITA WATERSHED FOR GROUP IV

Case No.	Watershed No.	Function Number 1	2	3	4	Largest Probability	Function Number of Largest Probability
1	61	0.00154	0.00104	0.00165	0.99577	0.99577	4
2	53	0.81958	0.03418	0.08617	0.06007	0.81958	1
3	48	0.04268	0.28368	0.13348	0.54017	0.54017	4
4	46	0.00196	0.00179	0.00194	0.99431	0.99431	4
5	41	0.13235	0.18151	0.25473	0.43141	0.43141	4
6	35	0.08563	0.01346	0.44023	0.46068	0.46068	4
7	32	0.06996	0.24335	0.17926	0.50743	0.50743	4
8	24	0.23529	0.03097	0.02440	0.70934	0.70934	4
9	18	0.22420	0.03178	0.02380	0.72021	0.72021	4
10	15	0.00395	0.00159	0.00305	0.99141	0.99141	4
11	13	0.17357	0.48087	0.20026	0.14530	0.48087	2
12	12	0.01893	0.07497	0.30623	0.59987	0.59987	4
13	11	0.31075	0.02602	0.02808	0.63514	0.63514	4
14	9	0.82796	0.03141	0.08462	0.05601	0.82796	1
15	7	0.03304	0.57349	0.33879	0.05469	0.57349	2

APPENDIX C

A Fortran program is written to predict the probabilities that delineated watersheds (but no application for assistance has been made) will fall into each of four groups, representing fast to slow rates of development. The input consists of the classification function coefficients and constants derived by the multiple discriminant analysis program, and data representing 22 socio-economic variables from the counties within which the watersheds are located.

The Fortran program merely carries out the calculations specified by the discriminating functions described in Chapter IV. The Fortran listing is as follows:

```
   FORTRAN LISTING    PL 566    1410-FO-970        Page 001
      DIMENSION C(22,4),CON(4),X(22),P(4),SUMF(4),F(22,4),E(4),FN(4)
00010 FORMAT(2X, F4.2,F4.1,F3.1,F2.0,F3.1,F8.6,2F3.1,F6.2,F6.3,F4.1,
      3F3.1,F3.2,F3.1,F6.2,F4.2,F3.1,F4.2/2X,F5.1,F5.2)
00015 FORMAT(8F10.5)
00016 FORMAT(4F11.5)
00050 FORMAT(35X,13HPROBABILITIES)
00060 FORMAT(1HL,5X,4(F11.5,8X))
      M=0
      N=57
      READ(1,15)C
      READ(1,16)CON
00055 READ(1,10)X
      M=M+1
      D036I=1,22
      F(I,J)=C(I,J)*X(I)
      SUMF(J)=SUMF(J)+F(I,J)
00036 CONTINUE
      FN(J)=SUMF(J)+CON(J)
00037 CONTINUE
      SE=0.0
      D040J=1,4
      E(J)=EXP(FN(J)-AMAX1(FN(1),FN(2),FN(3),FN(4)))
00040 SE=SE+E(J)
      D070J=1,4
      P(J)=E(J)/SE
00070 CONTINUE
      WRITE(3,50)
      WRITE(3,60)(P(J),J=1,4)
      IF(M.LT.N)GOTO55
      IF(M.EQ.N)GOTO65
00065 CALLEXIT
      END
```

The following adjustements are made for the Washita analysis:

```
      DIMENSION C(16,4),X(16),F(16,4)
00010 FORMAT(2X,F4.2,F3.1,F1.0,F3.1,F8.5,F3.0,F3.0,F3.1,F6.3,
      2F3.1,F3.2,F3.1,F4.2,F2.1,2F4.2)
      N=6
```

APPENDIX D

A Step-Wise Multiple Regression with variable transformations from Share General Program Library, ERMPR3, for the IBM 7090 is utilized. The program uses the raw input data for phase one and transformed data for phase two. The raw input data consists of the same data utilized in the discriminant program. The transformed data consists of the factor loadings multiplied by the associated variables which make up the cluster.

Because all values of the dependent variable vary between one and four, the dependent variables are transformed to a range of zero to three in order to include only the relevant range and eliminate bias. The regression line is then forced through zero.

The variable, coefficient, standard error of coefficients, T value, Beta Coefficient, and R^2 are presented in Tables D-I to D-IV. The Fortran program for transforming the raw data to factors is presented as the Fortran Source List. The means, standard deviations, correlation matrix, eigenvalues, and cumulative proportion of total variance explained are presented in Tables D-V to D-VIII.

APPENDIX D, TABLE I

SELECTED OUTPUT OF STEP-WISE MULTIPLE REGRESSION OF 22 SELECTED SOCIO-ECONOMIC VARIABLES FOR PL 566 PROJECTS

Regression Phase 1
Variables Entering 22
F Level 10.1923
Standard Error of Y = 0.5906
Constant 0.00000

Variable	Coefficient	Std. Error of Coef.	T Value	Beta Coeff.
X- 1	-0.00056	0.01017	-0.05536	-0.01492
X- 2	0.00259	0.00607	0.42747	0.07506
X- 3	-0.01079	0.10678	-0.10108	-0.06184
X- 4	-0.03645	0.03288	-1.10861	-0.19396
X- 5	0.03849	0.01797	(2.14170)	1.59997
X- 6	-0.00736	0.00578	-1.27247	-0.08714
X- 7	0.00505	0.00636	0.79359	0.11826
X- 8	-0.00269	0.00480	-0.55987	-0.04992
X- 9	0.00129	0.00788	0.16419	0.16953
X-10	0.00139	0.00081	1.71141	0.10966
X-11	0.00890	0.00474	1.87778	0.39429
X-12	0.00600	0.00686	0.87377	0.16655
X-13	0.00563	0.01214	0.46386	0.07558
X-14	-0.01193	0.01406	-0.84811	-0.47626
X-15	-0.23264	0.41936	-0.55475	-0.29718
X-16	-0.00646	0.00988	-0.65339	-0.05762
X-17	-0.00094	0.00688	-0.13696	-0.13204
X-18	-0.06254	0.04410	-1.14834	-0.25075
X-19	0.02918	0.02913	1.00173	0.08391
X-20	-0.00922	0.01403	-0.65724	-0.22964
X-21	-0.00001	0.00015	-0.07324	-0.00411
X-22	-0.00152	0.01884	-0.08087	-0.01701

R^2 = .896954

APPENDIX D, TABLE II

SELECTED OUTPUT OF STEP-WISE MULTIPLE REGRESSION OF SIX SELECTED FACTORS FOR PL 566 PROJECTS

Regression Phase 2
Variables Entering 6
F Level 20959.7888
Standard Error of Y = 0.6051
Constant 0.00000

Variable	Coefficient	Std. Error of Coef.	T Value	Beta Coeff.
X-1	-0.00185	0.00148	-1.25266	-0.07545
X-2	-0.00034	0.00017	(-2.03732)	-0.08994
X-3	-0.00058	0.00096	-0.60712	-0.03516
X-4	0.01069	0.00090	(11.91046)	1.37744
X-5	0.00170	0.00172	0.99202	0.04500
X-6	-0.00445	0.00038	(-11.56716)	-1.40313

DIAGONAL ELEMENTS

Var. No.	Value
1	3.086211
2	1.657632
3	2.852611
4	11.376569
5	1.750234
6	12.516031
7	0.127970

R^2 = .873030

APPENDIX D, TABLE III

SELECTED OUTPUT OF STEP-WISE MULTIPLE REGRESSION OF 16
SELECTED SOCIO-ECONOMIC VARIABLES FOR PL 566 PROJECTS

Regression Phase 1
Variables Entering 16
F Level 243790.4297
Standard Error of Y = 0.8511
Constant 0.00000

Variable	Coefficient	Std. Error of Coeff.	T Value	Beta Coeff.
X- 1	0.02666	0.05695	0.46810	1.00197
X- 2	-0.21143	0.51433	-0.41108	-1.20108
X- 3	-0.70109	0.73135	-0.95863	-3.17845
X- 4	0.07155	0.08258	0.86636	2.87573
X- 5	0.00259	0.00284	0.91261	0.56724
X- 6	0.00063	0.00149	0.42257	0.19022
X- 7	-0.03687	0.06945	-0.53091	-0.46010
X- 8	0.00134	0.00155	0.86274	0.08869
X- 9	-0.00233	0.03937	-0.05925	-0.06184
X-10	-0.10862	0.06701	-1.62091	-4.58777
X-11	3.40662	4.04230	0.84274	3.81452
X-12	0.07706	0.12181	0.63262	0.51209
X-13	-0.11813	0.29754	-0.39700	-0.35661
X-14	0.08963	0.25170	0.35611	0.26204
X-15	0.01075	0.00880	1.22196	0.64141
X-16	0.12538	0.14543	0.86219	1.31588

R^2 = .804763

APPENDIX D, TABLE IV

SELECTED OUTPUT OF STEP-WISE MULTIPLE REGRESSION OF FIVE SELECTED FACTORS FOR WASHITA PROJECTS

Regression Phase 2
Variables Entering 5
F Level 7.3280
Standard Error of Y = 0.9649
Constant 0.00000

Variable	Coefficient	Std. Error of Coef.	T Value	Beta Coeff.
X-1	-0.01505	0.00544	(-2.76509)	-0.27003
X-2	0.03474	0.00700	(4.96547)	1.17914
X-3	-0.00017	0.00014	-1.22503	-0.21505
X-4	0.00162	0.00559	0.29002	0.03529
X-5	-0.00052	0.00065	-0.80089	-0.10647

DIAGONAL ELEMENTS

Var. No.	Value
1	1.823929
2	10.784895
3	5.893878
4	2.831893
5	3.380050
6	0.308493

R^2 = .691507

APPENDIX D

FORTRAN SOURCE LIST
TO TRANSFORM RAW DATA TO FACTORS

```
Cox  Source Statement        PL 566

 0   $IBFTC DKNAME NODECK
 1   DIMENSION D (115,22),Q(9),R(7),S(5),T(6),U(7),V(6)
 2   10 FORMAT(3X,F4.2,F4.1,F3.1,F2.0,F3.1,6X,F8.6,2F3.1,F6.2,
     F6.3,3X,1F4.1,3F3.1,F3.2,F3.1,F6.2/3X,F4.2,F3.1,F4.2,
     F5.1,F4.2)
 3   20 FORMAT(9F8.5/7F8.5/5F8.5/6F8.5/6F8.5)
 4   80 FORMAT(6F11.5)
 5   65 FORMAT(3X,5HLEVEL,15X,4HSUB-/4X,2HOF,16X,8HMARGINAL
     28X,5XWATER/13X,6HLIVING,3X,9HRURALISM,3X,9HRESOURCES,2X,
     10HIMMOBILITY,3X,26HEXODUS,4X,9HDEPLETION)
 6   READ(5,10)((D(I,J),J=1,22), I=1,115)
17   READ(5,20)Q,R,S,T,U,V
20   WRITE(6,65)
21   QM=0
22   RM=0
23   SM=0
24   TM=0
25   UM=0
26   VM=0
27   DO 76,I=1,115
30   QM=D(I,18)*Q(1)+D(I,20)*Q(=)+D(1,15)*Q(3)+D(1,19)*Q(4)+D(1,1)*Q(5)
     1+D(1,3)*Q(6)+D(1,12)*Q(7)+D(1,4)*Q(8)+D(1,2)*Q(9)
31   RM=D(L,9)*R(1)+D(1,17)*R(2)+D(1,8)*R(3)+D(1,13)*R(4)+D(1,12)*R(5)
     1+D(1,11)*%(6)*D(1,12)*R(7)
32   SM=D(1,6)*S(1)+D(1,7)*S(2)+D(1,10)*S(3)+D(1,16)*S(4)+D(1,5)*S(5)
33   TM=D(1,5)*T(1)+D(1,14)*T(2)+D(1,13)*T(3)+D(1,16)*T(4)+D(1,12)*T(5)
     1+D(1,21)*T(6)
34   UM=D(L,22)*U(1)+D(1,11)*U(2)+D(1,4)*U(3)+D(1,13)*U(4)+D(1,16)*U(5)
     1+D(1,7)*U(6)+D(1,3)*U(7)
35   VM=D(1,2)*V(1)+D(1,21)*V(2)+D(1,1)*V(3)+D(1,14)*V(4)+D(1,20)*V(5)
     1+D(L,5)*V(6)
36   75 WRITE(6,80)QM,RM,SM,TM,UM,VM
40   WRITE(7,80)QM,RM,SM,TM,UM,VM
41   END
```

APPENDIX D, TABLE V

MEANS AND STANDARD DEVIATIONS OF SELECTED SOCIO-ECONOMIC VARIABLES

PL 566		Washita	
Means	Standard Deviation	Means	Standard Deviations
38.16094	21.19296	56.28522	26.70563
42.34434	21.89828	9.37538	0.71895
9.36174	1.12036	7.07692	2.51438
8.17391	3.15745	66.42307	3.74556
68.32346	3.43075	229.45288	282.27973
10.86895	16.24344	449.15384	220.80480
34.90173	16.38918	18.76154	8.70228
23.49651	19.63033	77.53817	78.28620
112.85327	184.91199	41.01538	15.72136
104.33979	78.35394	69.69845	5.46776
65.05390	33.07323	1.83138	0.28678
41.87390	18.42140	9.37231	5.80225
19.82260	9.79965	4.12877	2.83642
65.47824	5.58789	3.52615	3.33941
2.06113	0.41510	51.08123	85.17359
12.50261	7.72784	16.99384	3.62656
105.81293	205.87037		
5.27156	3.98432		
3.70522	2.95676		
38.27808	14.67865		
174.68260	609.09804		
17.53965	5.48210		

APPENDIX D, TABLE VI

CORRELATION MATRIX OF 22 SELECTED SOCIO-ECONOMIC VARIABLES FOR PL 566 PROJECTS

Row	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22
1	1.00000	0.63308	0.62111	0.39349	-0.04011	0.50976	0.33663	-0.15321	0.05961	0.06817	-0.33422	-0.33837	0.12562	-0.21136	-0.57842	-0.21742	0.06741	-0.62254	-0.43119	0.85056	0.25755	0.11822
2		1.00000	0.44106	0.41879	-0.34058	0.09926	0.18318	0.24627	0.33349	0.12500	0.00290	-0.34317	-0.25832	-0.39676	-0.38289	-0.08865	0.32571	-0.40630	-0.18851	0.50992	0.59203	-0.11049
3			1.00000	0.25805	-0.20636	0.18532	0.23507	0.11434	0.50490	0.11508	-0.29542	-0.62668	-0.32036	-0.43730	-0.76742	-0.38848	0.51555	-0.73608	-0.52249	0.59129	0.23116	0.37111
4				1.00000	-0.07189	0.28627	0.10007	0.18866	0.28190	0.16931	0.35758	-0.13469	-0.35736	-0.19170	-0.27583	0.17826	0.25884	-0.28335	-0.27700	0.52370	-0.05287	-0.29937
5					1.00000	-0.22764	-0.14642	-0.03119	-0.11497	-0.22167	-0.07633	0.23554	0.37872	0.40493	0.14620	0.13802	-0.09636	0.11708	-0.02364	-0.03882	-0.31894	0.26888
6						1.00000	0.54187	-0.02486	0.13889	0.33276	0.04286	-0.10101	-0.30955	0.10701	-0.22751	0.28275	0.03519	-0.26141	-0.02769	0.01869	-0.08411	-0.12221
7							1.00000	-0.33858	-0.13899	0.23792	-0.49886	0.05668	0.19091	0.08134	-0.31969	0.11849	-0.12113	-0.27529	-0.07189	0.05189	0.09752	0.17910
8								1.00000	0.61395	-0.09899	0.54864	-0.17886	-0.44810	-0.22249	-0.00100	-0.04451	0.59753	-0.03345	0.06289	0.00745	0.01592	-0.11741
9									1.00000	-0.00658	0.23817	-0.40597	-0.51110	-0.35164	-0.30304	-0.25176	0.99816	-0.28089	-0.17834	0.16803	0.01314	0.07847
10										1.00000	-0.10221	-0.12285	-0.10300	0.10735	-0.15918	0.10577	-0.00337	-0.16513	-0.00944	0.06639	0.07877	-0.01396
11											1.00000	0.17283	-0.43445	-0.14100	0.41139	0.20428	0.20201	0.31794	0.12627	-0.03933	-0.16370	-0.61708
12												1.00000	0.43121	0.35472	0.69531	0.30230	-0.40832	0.72953	0.37280	-0.51516	-0.18326	-0.06103
13													1.00000	0.40660	0.12970	0.09059	-0.48225	0.15241	-0.02168	-0.03436	-0.01880	0.32811
14														1.00000	0.26840	0.38589	-0.33059	0.25757	0.23269	-0.26907	-0.35841	0.22521
15															1.00000	0.27489	-0.31551	0.91488	0.62354	-0.61728	-0.18362	-0.28153
16																1.00000	-0.25126	0.22182	0.12212	-0.18116	-0.16703	-0.16032
17																	1.00000	-0.29160	-0.18907	0.16755	0.01112	0.11002
18																		1.00000	0.58660	-0.68134	-0.18858	-0.23975
19																			1.00000	-0.54030	-0.01305	-0.05889
20																				1.00000	0.15293	-0.06285
21																					1.00000	0.06986
22																						1.00000

APPENDIX D, TABLE VII

CORRELATION MATRIX OF 16 SELECTED SOCIO-ECONOMIC VARIABLES FOR WASHITA PROJECTS

Row	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
1	1.00000	0.44345	0.72040	-0.62752	-0.31335	-0.25241	-0.25489	-0.00249	-0.21114	-0.46265	-0.16055	-0.08736	-0.50436	0.22499	0.75851	-0.55597
2		1.00000	-0.04475	-0.34384	-0.22640	-0.07451	-0.29781	0.11622	-0.59974	-0.67237	-0.53446	-0.25962	-0.64607	-0.34986	0.00372	-0.23403
3			1.00000	-0.67826	0.03871	-0.38756	0.13103	-0.00363	0.29093	-0.31481	0.49585	0.10318	-0.09555	0.44023	0.86009	-0.35347
4				1.00000	0.02185	0.55468	-0.21728	0.11654	0.11806	0.56445	-0.25895	-0.25225	0.32127	0.03452	-0.53562	0.25063
5					1.00000	-0.47939	0.51622	0.06569	-0.05370	0.16235	0.42089	0.03601	-0.08448	-0.33039	-0.20417	-0.17709
6						1.00000	-0.40608	0.12821	0.06120	0.19426	-0.40409	-0.33070	0.12021	0.28642	-0.17528	0.09218
7							1.00000	-0.04062	0.04804	0.17186	0.45608	0.72229	0.06270	-0.26856	-0.12204	0.28832
8								1.00000	-0.02550	0.01285	-0.05988	-0.19010	-0.09671	0.11427	0.08640	-0.09587
9									1.00000	0.15719	0.63072	0.00942	0.83169	0.51905	0.22750	0.42330
10										1.00000	0.02388	0.01540	0.37124	0.40342	-0.10009	0.06786
11											1.00000	0.42097	0.58713	0.19173	0.16101	0.07410
12												1.00000	0.19316	-0.32141	-0.18272	0.26959
13													1.00000	0.35051	-0.16620	0.46777
14														1.00000	0.69806	-0.15275
15															1.00000	-0.38495
16																1.00000

APPENDIX D, TABLE VIII

EIGENVALUES AND CUMULATIVE PROPORTION OF TOTAL VARIANCE FOR SELECTED SOCIO-ECONOMIC VARIABLES*

PL 566		Washita	
Eigenvalues	Cumulative Proportion	Eigenvalues	Cumulative Proportion
6.38177	0.29008	4.28958	0.26810
3.59937	0.45369	3.61605	0.49410
2.28691	0.55764	2.96064	0.67914
1.81695	0.64023	1.55297	0.77620
1.74204	0.71941	1.05534	0.84216
1.19690	0.77382	0.93236	0.90043
0.86073	0.81294	0.54855	0.93472
0.73492	0.84635	0.42735	0.96143
0.62684	0.87484	0.27859	0.97884
0.47033	0.89622	0.18089	0.99015
0.45231	0.91678	0.09880	0.99632
0.40032	0.93497	0.03156	0.99829
0.35046	0.95090	0.01470	0.99921
0.29539	0.96433	0.00997	0.99984
0.25114	0.97574	0.00176	0.99995
0.15576	0.98282	0.00086	1.00000
0.13860	0.98912		
0.10215	0.99377		
0.06539	0.99674		
0.04516	0.99879		
0.02591	0.99997		
0.00063	1.00000		

*Sometimes referred to as latent roots and percent trace, respecitvely.

APPENDIX E

CHECK LIST FOR FIELD STUDY

Socio-Economic Analysis of Upstream Watershed Development in Oklahoma

Name and No. of Project ______________________________

1. In relation to other watershed development projects in Oklahoma what (is / was) the rate of progress of development for this project?

2. For purposes of this study, all projects are being classified into the following four groups -- 1) fast, 2) medium fast, 3) medium slow, and 4) slow. In which of these 4 classifications would you place this watershed?

3. What has been the most significant (deterrent / contribution) to the progress of development in this project?

4. Would you please indicate the effect that the following community factors would have on the rate of watershed development?

Factor	Positive	Negative	No effect
a. Level of Living			
b. Ruralism			
c. Sub-Marginal Resources			
d. Immobility			
e. Exodus			
f. Water Depletion			
g. Other ________________			

(1) Which of the above is the most important?

5. What sponsoring organization helped the most?

a. How?

6. What endorsing organization helped the most?

a. How?

7. What were the most important problems to overcome? List in order of declining importance.

8. What were the main sources of information to the leadership of the sponsoring organization?

9. What were the main means of information distribution to the members of the watershed?

10. (Are/Were) multiple purposes involved in this project?

a. What were they?

b. In what way did they affect project development?

11. Were any significant parts of the project changed after first analysis?

a. At what stage did such changes evolve?

b. What were the principal reasons?

c. What were the effects of these changes on rate of project development?

12. What would you do differently if you were able to go back in time to affect the rate of progress?

APPENDIX F

Chi-square tests to determine whether the observed sample differences signify differences among populations or whether they are merely the chance variations that are to be expected among random samples from the same population are performed on the several answers obtained from the interviewees described in Chapter VI.

The null hypothesis is that the K samples have come from the same population or from identical populations. This hypothesis, that the K samples do not differ among themselves, may be tested by applying formula (1):

$$\chi^2 = \sum_{i=1}^{r} \sum_{j=1}^{k} \frac{(O_{ij} - E_{ij})^2}{E_{ij}} \qquad (1)$$

where

O_{ij} = observed number of cases categorized in the i^{th} row of the j^{th} column,

E_{ij} = number of cases expected under H_o to be categorized in i^{th} row of j^{th} column,

d.f = (K-1) (r-1) [32, p. 175].

APPENDIX F, TABLE I

CHI-SQUARE TEST FOR DIFFERENCES IN CLASSIFICATION

Watershed Group	Classed by: Discriminant Analysis		Classed by: WUC		Classed by: Board Members		Total
1	5		11		14		30
		8.93		10.19		10.90	
2	10		12		13		35
		10.42		11.88		12.71	
3	15		14		14		43
		12.80		14.59		15.61	
4	20		20		20		60
		17.86		20.36		21.79	
Total	50		57		61		168

$\chi^2 = 3.675 < 12.59$ at $\alpha = .05$ and 6 d.f.

∴ no significant difference between classifications.

APPENDIX F, TABLE II

RANKS BY DISCRIMINANT ANALYSIS AND INTERVIEWS
(SPEARMAN'S RANK CORRELATION)

Watershed Number	Rank: Discriminant Analysis	Rank: Interviews	d_i	d_i^2
95	1	1	0	0
68	2	6	-4	16
40	3	13	-10	100
101	4	15	-11	121
47	5	2	3	9
88	6	7	-1	1
57	7	8	-1	1
50	8	3	5	25
33	9	4	5	25
6	10	14	-4	16
59	11	5	6	36
48	12	9	2	4
65	13	10	3	9
67	14	11	3	9
84	15	12	3	9
17	16	16	0	0
21	17	17	0	0
16	18	18	0	0
29	19	19	0	0
82	20	20	0	0

$$r_s = 1 - \frac{6 \sum_{i=1}^{N} d_i^2}{N^3 - N} \qquad N = 20$$

$= .714 > .377$ at $\alpha = .05$ $\therefore$ conclude that the two rankings are associated.

APPENDIX F, TABLE III

CHI-SQUARE TEST FOR DIFFERENCES IN COMMUNITY FACTORS

Factor	A High Level of Factor						Total
	Benefits Progress		Retards Progress		No Effect		
a. Level of Living	32	18.67	1	9.49	7	11.82	40
b. Ruralism	21	18.67	13	9.49	6	11.82	40
c. Sub-marginal Resources	11	18.67	15	9.49	14	11.82	40
d. Immobility	14	18.67	14	9.49	12	11.82	40
e. Exodus	16	18.67	8	9.49	16	11.82	40
f. Water Depletion	18	18.67	1	9.49	21	11.82	40
g. Other	8	7.93	9	4.03	0	5.03	17
Total	120		61		76		257

$\chi^2 = 61.594 > 21.03$ at $\alpha = .05$ and 12 d.f.

$\therefore$ there is a significant difference between the factors as viewed by the interviewees.

APPENDIX F, TABLE IV

CHI-SQUARE TEST FOR DIFFERENCES IN DETERMINATION OF THE COMMUNITY FACTORS' EFFECTS ON WATERSHED PROGRESS

Interviewee	Effect of Community Factors						Total
	Positive		Negative		None		
WUC's	57	61.16	37	31.09	37	38.24	131
Boardmembers	63	58.83	24	29.91	39	37.26	126
Total	120		61		76		257

$\chi^2 = 4.377 < 5.99$ at $\alpha = .05$ and 2 d.f.

∴ there is no significant difference between the WUC's and Boardmembers' selection.

APPENDIX F, TABLE V

CHI-SQUARE TEST FOR DIFFERENCES IN DETERMINATION OF THE EFFECT THAT THE COMMUNITY FACTORS HAD ON WATERSHED PROGRESS

Interviewees from:	Effect of Community Factors						Total
	Positive		Negative		None		
Upper 1/2	60	60.2	29	29.6	38	37.0	127
Lower 1/2	62	61.7	31	30.3	37	37.9	130
Total	122		60		75		257

$\chi^2 = .0096 < 5.99$ at $\alpha = .05$ and 2 d.f.

∴ accept Hypothesis H_o: no difference in ranking.

APPENDIX F, TABLE VI

CHI-SQUARE TEST FOR DIFFERENCES IN DETERMINATION OF THE EFFECT THAT THE COMMUNITY FACTORS HAD ON WATERSHED PROGRESS

Type of Agreement	Effect of Community Factors						Total
	Positive		Negative		None		
Agree with Discriminant Technique	88	84.9	36	39.7	55	54.3	179
Disagree with Discriminant Technique	34	37.0	21	17.2	23	23.6	78
Total	122		57		78		257

$\chi^2 = 1.563 < 5.99$ at $\alpha = .05$ and 2 d.f.

∴ accept null Hypothesis H_0: no difference in ranking.

APPENDIX F, TABLE VII

CHI-SQUARE TEST FOR DIFFERENCES IN HELP PROVIDED BY SPONSORING ORGANIZATIONS AS DETERMINED BY INTERVIEWEES

Interviewees from:	Type of Sponsor						Total
	S&WCD		Conservancy Districts		Watershed Assoc., City and County Commissioners		
Upper 1/2	17	14.04	5	5.72	4	6.24	26
Lower 1/2	10	12.96	6	5.28	8	5.76	24
Total	27		11		12		50

$\chi^2 = 3.151 < 5.99$ at $\alpha = .05$ ∴ no difference.

APPENDIX F, TABLE VIII

CHI-SQUARE TEST FOR DIFFERENCES IN HELP PROVIDED BY ENDORSING ORGANIZATIONS AS DETERMINED BY INTERVIEWEES

Interviewees from:	Type of Endorsor			Total
	S & WCD & Watershed Association	Civic Clubs and Farm Organization	City, County, Com. and Indian Affairs	
Upper 1/2	4 / 8.32	16 / 14.72	12 / 8.96	32
Lower 1/2	9 / 4.68	7 / 8.28	2 / 5.04	18
Total	13	23	14	50

$\chi^2 = 9.402 > 5.99$ at $\alpha = .05$ $\therefore$ are different.

APPENDIX F, TABLE IX

CHI-SQUARE TEST FOR DIFFERENCES IN TYPES OF PROBLEMS TO OVERCOME AS DETERMINED BY INTERVIEWEES

Interviewees from:	Type of Problem				Total
	Easements	Educational Programs and Communication	Apathy and Lack of Cooperation, Leaders & Funds	Requirement of Conservancy District and Others	
Upper 1/2	8	8	6	7	29
	5.54	5.97	7.67	9.80	
Lower 1/2	5	6	12	16	39
	7.45	8.02	10.32	13.19	
Total	13	14	18	23	68

$\chi^2 = 5.129 < 7.82$ at $\alpha = .05$ ∴ no difference.

APPENDIX F, TABLE X

CHI-SQUARE TEST FOR DIFFERENCES IN SOURCES OF INFORMATION TO THE LEADERSHIP OF SPONSORING ORGANIZATIONS AS DETERMINED BY INTERVIEWEES

Interviewees from:	Sources of Information				Total
	S & WCD	SCS	State Board	Other	
Upper 1/2	8 7.78	14 12.64	10 4.86	4 6.81	36
Lower 1/2	8 8.21	12 13.35	8 9.24	10 7.18	38
Total	16	26	18	14	74

$\chi^2 = 8.161 > 7.82$ at $\alpha = .05$ ∴ are different.

APPENDIX F, TABLE XI

CHI-SQUARE TEST FOR DIFFERENCES IN INFORMATION DISTRIBUTION
TO WATERSHED MEMBERS BY INTERVIEWEES

Interviewees from:	Information Source					Total
	Meetings	Personal Contact	Newpapers	Letters	Others	
Upper 1/2	14	9	10	5	5	43
	14.94	6.34	9.05	5.43	7.24	
Lower 1/2	19	5	10	7	11	52
	18.06	7.66	10.95	6.57	8.76	
Total	33	14	20	12	16	95

$\chi^2 = 3.689 < 9.49$ at $\alpha = .05$ ∴ no difference.

APPENDIX F, TABLE XII

CHI-SQUARE TEST FOR DIFFERENCES IN DIFFERENT APPROACHES RECOMMENDED BY INTERVIEWEES

Interviewees from:	More Groundwork		Better Procedures		Total
Upper 1/2	13	10.60	6	8.40	19
Lower 1/2	11	13.40	13	10.60	24
Total	24		19		43

$\chi^2 = 2.20 < 3.84$ at $\alpha = .05$ $\therefore$ no difference.

VITA

P. Thomas Cox

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Doctor of Philosophy

Thesis: A SOCIO-ECONOMIC ANALYSIS OF UPSTREAM WATERSHED DEVELOPMENT IN OKLAHOMA

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