INTEGRATING REMOTE SENSING AND GIS TECHNIQUE FOR THE ASSESSMENT OF CONFLICTS OVER ENVIRONMENTAL RESOURCES

A CASE STUDY OF KADUNA SOUTH L.G.A

BY

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BSC (ABU) PGD ENV.MGT. FUT. MINNA

M.TECH/SSSE/586/2000/2001

THESIS SUBMITTED TO THE DEPARTMENT OF GEOGRAPHY, SCHOOL OF SCIENCE AND SCIENCE EDUCATION, IN PARTIAL FULFILLMENT OF THE REQUIREMENT FOR THE AWARD OF MASTER OF TECHNOLOGY (M.TECH.) DEGREE IN REMOTE SENSING APPLICATION, FEDERAL UNIVERSITY OF TECHNOLOGY MINNA, NIGERIA

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DECLARATION

I, YAHYA Saleh Ibrahim, hereby declare that this thesis, with the title "Integrating Remote Sensing and GIS Technique for the Assessment of Conflicts over Environmental Resources": A Case Study of Kaduna South L.G.A. is my own hand work under the supervision of Dr. M. T. Usman.

DEDICATION

This theis is dedicated to my late father Mallam Ibrahim Musa, Mother Hajiya Adama Suleiman and my late elder Brother Saleh Dan'azumi Ibrahim who took me to Primary School, and later sponsored me up to University. And to all "NEPU" struggling members against oppression in Nigeria. May Allah reward all of you with Jannah Firdausiya Amin. "Nigeria Daya take amma kowa yasan gidan ubanshi" (Aminu Kano, 1979).

CERTIFICATION

This dissertation entitled " INTEGRATING REMOTE SENSING AND GIS TECHNIQUE FOR THE ASSESSMENT OF CONFLICTS OVER ENVIRONMENTAL RESOURCES"; A case study of Kaduna South Local Government Kaduna. Has been conducted by Yahya Saleh Ibrahim and it is not someone else work. It is done to meet the regulation governing the award of Master of technology of the Federal University of Technology Minna.

DR. M. T. USMAN SUPERVISOR	DATE
DR. M. T. USMAN HEAD OF DEPARTMENT	DATE
EXTERNAL EXAMINER	DATE
Professor J. A. Abalaka PROFESSOR J ABALAKA DEAN POST GRADUATE SCHOOL	20/11/03 DATE

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ABSTRACT

Conflict is an inevitable phenomena in life. While, there is constructive conflict, we also experienced the violent type of conflict, which disrupt and destroy environment, life and properties. Our quest here is to find out the type of conflict that is prevalent in our today's world. Therefore this study diagnosed resources conflict in Kaduna South Local Government Area in kaduna. Remote Sensing technique was employed to acquire boundary data, industrial resource data, land and population estimate data, in order to establish the contradictory relationship between them that led to tension and conflict in the area.

To obtained the above mentioned, data for Kaduna South, a multitemporal and multispectoral spot XS imageries for 1980 and 1990 with scale of 1:78000 and aerial photo for 1962, 1977 and 1991 with scale of 1:10,000 1:6000 and 1:10,000 well obtained. The classification for the spot XS image was divided into industrial sources of employment. Settlements in the study area, settlements based on tribe and settlements based on religion. The aerial photo only presented the land use per hectre, which we later compare with population of the area. The study shows a clear increase in population without an increase in hectre of land commensurate with the increase in population, thus making control of the land in the area become politically important leading to conflict and uncertainty as to who will control the area.

Most of the industries are located in this are therefore, interest of the government and the poor seeking for means of survival will be towards that area. Therefore, people will be seeking to control by all means which will lead to conflicts and uprising in the area and the State in general.

The time series analysis reveal that 58.76% was the population change 1963 – 1981. This is big enough to create problem, if the government did not plan against the increase. As the case may be in Nigeria this increase has not been taken care of, therefore a signal to the emergence of conflict due to resource distribution uncertainties by the government. While still within the period 1981 – 1991 exactly 10 years the percentage increase in population is 29%. A great pressure will be on the environmental resources, especially lands and other resources, if is not adequate for the population then conflict is eminent. The Total variation in population as explained by the time series analysis indicated that 83% of the population is explained by time. Therefore, the growth in population is not in consonant with provision of employment. From the statistical analysis we were able to establish an interdependent relationships between population density and land distribution per hectre of the study area, at 95% level of significance. We then concluded that population increase is independent of land distribution, which means an increase in population has said earlier spell doom for the study area.

Therefore, we can then concludes that Remote Sensing and GIS techniques/gives policy makers ready made instrument for potential conflict areas rather than being use as direct conflict resolution instrument, it help in gathering analyzing, simplifying and manipulating bulk or spatial data for immediate use or application in conflict resolution in the field or policy malting task, in various offices, Ministries, Institution or Government.

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CHAPTER ONE

INTRODUCTION

1.1 BACKGROUND INFORMATION

Violent internal conflicts in more and more countries are ruining the lives of millions of people and undermining the ability of their governments to provide security and a tolerable economic existence (Suleiman 1998). In this trend, Nigeria has and is experiencing its own share of conflict, which is usually triggered off or sparked up by the members of the society, with the intention, mostly to have access or control of environmental resources. Therefore, this study will question traditional analysis of conflict which rely primarily on ethnic, religious and cultural explanations since these do not take account of the increasingly – obvious link between the growing security of renewable resources and violent conflict in developing countries. Shortages of cropland, fresh water, woodfuel, pasture and marine resources cannot be ignored. Therefore, this research will argue that one cannot understand domestic conflicts simply in environmental terms. For environmental scarcity function in a society within a complex matrix of historically derived economic and political situations. In particular an unequal social distribution of resources exacerbates scarcity and fuels popular conflict in society.

Conflicts over environmental risks have existed in some form for hundreds of years. In the fifteenth century, for example, climatic changes led to public unrest and protests over food scarcities in the kingdom of castile (now spain) (Mickay 1981). An important factor in most colonial wars was control over natural resources (Glass Bergen 1995). In the late 19th century conflicts over nature conservation emerged (Percerval 1992). The

distinguishing feature of these historical and traditional conflicts is that they were resolved largely through public protests and uprising, war, air litigation. Modern environmental conflicts, characterized here as those resulting from industrial development, also rely to a large extent on such traditional approaches such as negotiation and mediation are being applied for resolving such conflicts which persists, such as those over the use and control of natural resources.

In this research we shall explore and discuss role of remotely sensed data and G.I.S. in strengthening alternative approaches to environmental conflict resolution, here using slightly technologically advanced technology as an alternative to the traditional method or as an addertive to its being elaborate enough to deal with the complex phenomena.

.2 STATEMENT OF PROBLEM

Among the outstanding features of a heterogeneous society is its multiplicity of complicated social problems. To be precise, there exists a contradiction as stated by Karl Mark, a German philosopher, "In our survival everything and everyone is in conflict with each other, therefore nothing stay what it is and nothing remained what it is, everything is in contradiction with everything". The Kaduna case could be due to heterogeneity of the society, leading to endless conflict in the bit of members of such a society to acquire, posses and control the limited resources available in such an environment to their advantage.

Kaduna being a cosmopolitan town, attracted different people, from different ethno-cultural background and religious affiliations. The above composition led to the emergence of differing interests leading to the struggle for the possession and control of the land, which in turn spark up

conflicts and uncertainties. It is therefore important for us to study this socio-environmental phenomenon using slightly different approach, with the intention of answering the following questions:-

1. Why are there conflicts in Kaduna?
2. What are the sources of the conflicts?
1. What is the means of collecting and collating the appropriate information?
2. How do we resolve the means of processing information for effective management of conflict?

.3 AIM AND OBJECTIVES

Conflict about resource, has become part of our today's development, therefore serious attention need to be devoted to its resolution. To do this information is needed about the resources, the genesis, the area, of conflict and the resources available in the area. To get the information about all the above, Remote Sensing and GIS is a ready-made instrument for use. Therefore our aims will include:

1. Demarcating the boundaries of potential conflict using remote sensing and GIS.
2. Locating the resources available in the area of conflict.
3. Attempt at providing solution, monitoring techniques and access to conflict areas with ease for future policy planning and development.

4 JUSTIFICATION AND SIGNIFICANCE OF STUDY

"Indeed the complexity and variety of causes, perception and manifestations of group violence baffle rational thought, complex social processes and phenomena, themselves dependent on multitude of objectives

and factors, impart uncertainty to the cause of violent conflict as well as to our attempts to understand and judge it as actual behaviour of actual people" (M. Suleiman 98 pg4).

Therefore, the project, try to exploit the recent advances in sciences and technology which continue to create hope and collect up to date data for conflict resolutions. These include the application of remote sensing in the area of boundary demarcation, conflict monitoring and predication and other sources of conflict in the environment.

Infact dynamic sources of social phenomena such as conflict is difficult to trace using survey, but it is made easier using remote sensing technique, with some degree of reliability and efficiency, it is as well cost effective.

Although remote sensing is not a panacea for resources development and management of problems, it can provide the data that are the basic tool for resources inventory, monitoring and management. It is therefore believed that, the study will be of great help to Kaduna State, in the area of mediation and reconciliation, before, during and after conflict.

.4.1 SIGNIFICANCE OF STUDY

This study will be of immense help to the government of Kaduna State and Kaduna – South Local Government Area, unparticular in the area of:-

1. Conflict resolution task
2. Mapping conflict areas
3. Demarcating conflict boundaries
4. Mapping Resources available in the area
5. Providing policy makers with ready-made tool for monitoring and management of conflicts in the area.

1.5 THE STUDY AREA

1.5.1 LOCATION

Part of Kaduna, which is South of River Kaduna, is the study area. Kaduna South has been selected for the study for the following reasons:-

(i) Availability of data

(ii) Areas as a source of conflict in Nigeria

(iii) Heterogeneity of the society

(iv) Familiarity of the area

(v) A former and present headquarter of northern states

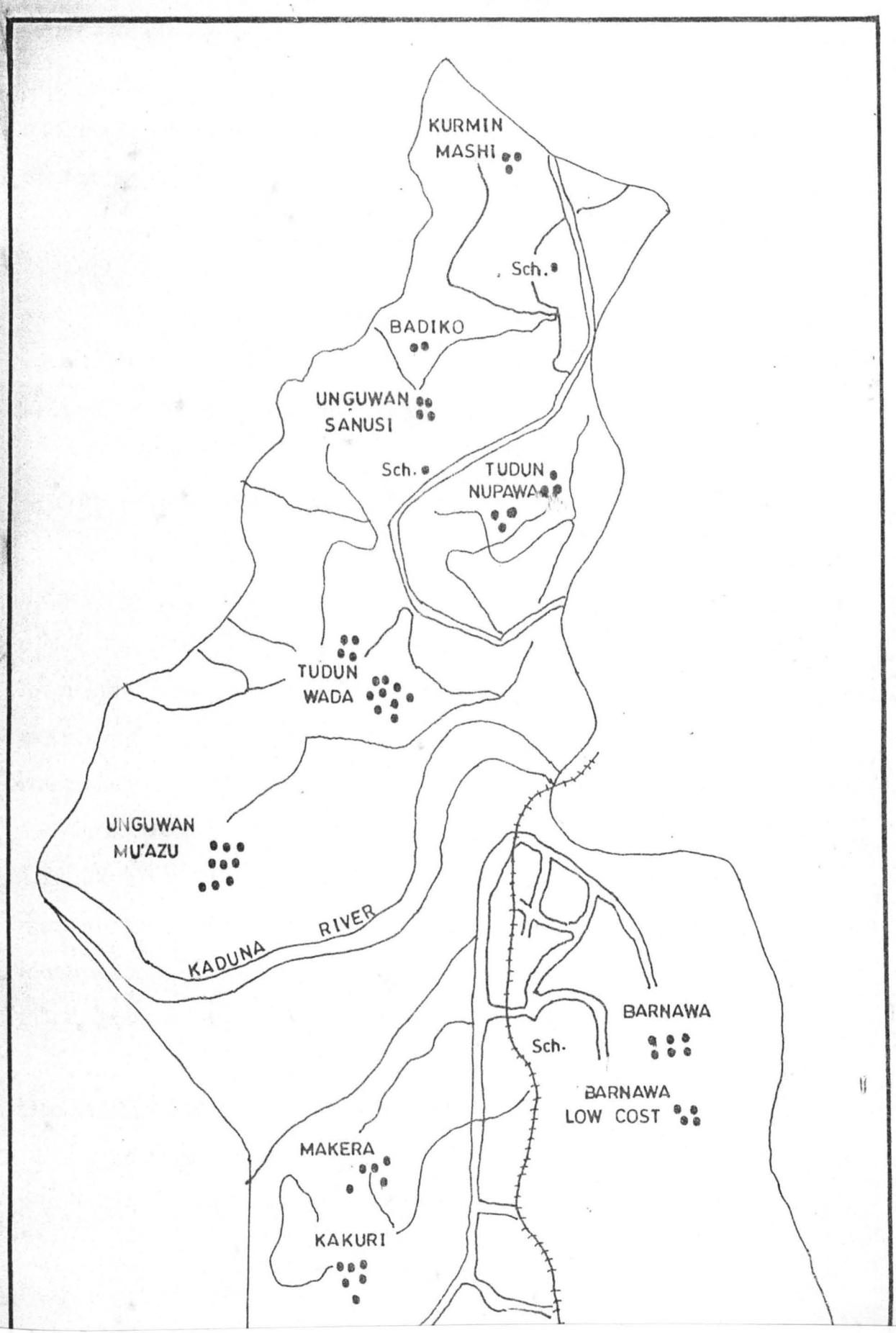
Kaduna South, a part of the Kaduna metropolitant town is located around latitude 10^0.29' 22"N and longitude 07^0 25' 26" E.

5.2 CLIMATE

Kaduna has a tropical climate. The rainfall pattern is generally governed by the movement of the inter-tropical convergence zone (ITCZ) which shows a steady decrease from south and north. The study area shares these characteristics and has distinct wet and dry seasons. The mean annual rainfall is about 1400mm and the length of the rainy season is 165 days. The rainy season starts between April and May and lasts to October (5-6 months) when the dry season sets in. The dry seasons starts around October/November and extends to March. The cold, dry and dusty month easterly harmattan wind prevails during the month of November to January, blowing from Sahara Desert.

The highest mean temperature is usually recorded between March and May and it is about 30^0c.

KADUNA SOUTH LOCAL GOVERNMENT AREA AS THE CASE STUDY AREA



literatures in chapter two. Chapter three discussed the research materials and methodology adopted. Chapter four consists of analysis and discussion of findings. Finally, chapter five presents summary, conclusions and recommendations.

CHAPTER TWO

2.0 LITERATURE REVIEW

Violent internal conflicts in more and more countries are ruining the lives of millions of people and undermining the ability of their government to provide security and a tolerable economic existence. The crisis cut across Africa, the Balkans, Central Asia, Europe and else where.

They questions traditional analyses of conflict, which rely primarily on ethnic, religious and cultural explanations since these do not take account of the increasingly obvious link between the growing scarcity of renewable resources and violent conflict in developing countries. Shortages of cropland, fresh water, wood fuel, pasture and marine resources cannot be ignored. Understanding domestic conflicts simply using environmental terms undermines reality. This is because environmental scarcity function in a society within a complex matrix of historically derived economic and political situation. In particular an unequal social distribution of resources exacerbates scarcity and fuels popular conflicts (Suliman 1998).

One of the main benefits that an inference capability to resolve conflicts. Conflict can occur with satellite images when one band of information classifies a pixel as one type object, say trees, and another band of information classified that same pixels as another type of object, say water.

Without the help of a skilled interpreter it is difficult to classify this pixel. Most spatial information systems and image processing packages do not provide the reasoning capabilities needed to make such decisions. However, expect systems technology provides many different conflict resolution strategies to help make these decisions. The remotely sensed

images used in studying conflict resolutions were produced by sot HRV satellite.

Humanly solve problems by combining facts with knowledge. Using their general understanding of the problem they use the facts to derive a conclusion. This process is referred to as reasoning. Expert systems model the reasoning process of humans using a technique called influencing (Durkin, 1994). An expert systems influence engine controls the application of knowledge fro the knowledgeable.

Forward chaining is when the reasoning happens from the facts to the conclusion. That is, the facts are entered into the system, which, in the context of this study, are the data in spot images. The system then works through the knowledgeable looking for rules matching data. The results of these matches lead to a classification of objects and phenomenon in the image.

A classification conflict will occur when more than one rule is matched on the facts asserted. Conflict often occur in classifying objects or phenomenon in a remotely sensed image due to arrears of an image that have more than one type of classification, or are involved in more than reasoning path by the influence engine.

From a users point of view a system act more intelligently. If the system fires rules based on context rather than order, as likely solutions are explored before unlikely ones. Conflict resolution is a way of providing a control strategy to influence the classification of pixel in our bit to analyse remotely sensed data.

There are many different conflict resolution strategies developed for forward chaining systems. The following are definitions of each –

First in first serve:- The rule applied will be the first rule that is matched.

Last in first serve. The rule applied will be the last rule that is matched.

Prioritization – The rule to apply will be selected based on priorities set on rules, with priority information usually provided by an expert or knowledge Engineer.

Specificity – The rule applied is usually the most specific rule, or the rule that matches the most facts. The strategy cannot be used to the rules are equal in specificity.

Recently – The rule applied is the rule that matches the most recently derived facts.

Fired Rules – Involves not applying rules that have already been used.

Line of Reasoning – Involves firing all rules with a separate line of reasoning.

This is a general discussion on conflict resolution on the acquisition of remotely sensed data, not on resource conflict. But suffice is to say that, it is our guiding principle for proper adoption in our study.

2.1 TYPES OF ENVIRONMENTAL CONFLICTS

Von Winterfeldt and Edwards(1994) proposed a typology of conflicts over environmental risks with a focus on technology as the source of controversy. They reviewed the controversies by the stakeholders involved, the values underlying the conflicts, and the pattern of conflict. This process yield a taxonomy with three broad grouping of technological controversies. Each grouping is further subdivided into two categories of impacts that generated the controversies – classified in that grouping.

The first grouping of technological controversies relates to food, drug, and consumer – products, such as cranbery poisoning, botulism, thalidomides, saccharin, plastic bags, and microwaves ovens. The controversies in this group arise because of two types of impacts.

1. Dramatic, unexpected health effects and
2. Uncertain, low dose health effects (Table 5.1) for example controversies over thalidomides and botulism emerged over unexpected health effects whereas controversies over saccharin and microwave ovens arose over, uncertain, low dose health effects.

The second grouping relates to industrial development such as offshore oil drilling, airport expansions, dams, car pollution, and fertilizer run-off. Von Winterfeldt and Edwards find two types of impacts associated with such development:

1. Local, large scale development impacts and
2. Diffuse, Widespread low dose pollution.

For example, controversies over airport expansion and claims arise because of local impacts associated with such development whereas the controversies over car pollution and fertilizer run-off – arise from widespread low dose pollution. The third grouping, technological mysteries and value threats, is related to controversies over technologies such as nuclear power, liquefied natural gas (LNG) siting, DNA – genetic – engineering, weather modification, and water fluoridation. Two types of impacts are – associated with this grouping:

1. Disaster-threats and catastrophic potential(examples are nuclear Power and LNG siting). And
2. Value threats and moral impositions (examples are weather modification and water fluoridation).

TABLE 5.1 A TAXONOMY OF TECHNOLOGICAL CONTROVERSIES

Technology category	Impact Sub-category	Example
A. Food/Drug/consumer products	A.1. Dramatic Unexpected health effects	Thalidomides;cranberry poisoning;Tampon-shock Botulism/Bonvirant;Plastics Bags.
	A.2. Uncertain, low-dose health effects	Cyclamates; Saccharin; X-Ray Shoe fittings; Microwave ovens; Food coloring
B. Industrial development	B.1. Local large scale development impacts	strip mining; off-shore oil drilling; Airport expansion Alaskan
	B.2. diffuse, widespread low-dose pollution.	Pipeline; Dams; Transportation noise; car pollution; DDT; Fertilizer run-off; SO_2 from power plant
C. Technological mysteries and value threats.	C. 1. Disaster threats and catastrophe potential.	LNG siting; DNA-genetic engineering; Nuclear power; Love canal; plutonium plant.
	C.2. Value threats and moral impositions	Weather modification; Air bags; Eater fluoridation; the "pill" Data banks.

SOURCE: Von Winterfeldt and Edwards (1984:63)

Bingham (1986) classifies environmental conflicts in the United States into two categories:

1. Site-specific and
2. Policy, site-specific, conflicts arise due to the proposed location or expansion of noxious and Industrial facilities or the application of a land use plan. Policy conflicts arise over proposed environmental policies and regulations:

1. Land use,
2. Natural resource management and use of public lands
3. Water resources
4. Energy
5. Air Quality, and
6. Toxics.

These principal issues, in turn, are sub-divided into more specific issues. For example, conflicts over land use include issues such as housing and neighborhood impacts, highway and mass transit, noise, solid waste and landfills, historic preservation, and sand and gravel operation. In her study, Bingham reviews 161 Case studies of conflict resolution in the United States, of which 115 were site-specific cases and 46 were policy cases. Table 5.2 shows the distribution of cases for conflicts over land use.

Jacobs and Rubino (1988) explored the use of typologies as a predictive tool for applying the techniques of mediation and negotiation for resolving environmental conflicts. In the case of natural resources, for example, they find a typology proposed by Ciriacy Wantrup (1968) to have such a predictive potential. This typology distinguishes between two types of natural resources;

1. Stock or nonrenewable resources and
2. Flow or renewable resources. The flow or renewable resources can be further distinguished into:

1. Flow not significantly affected by human action
2. Flow significantly affected by human action.

(a) Reversibility of decrease inflow not characterized by critical zone

(b) Reversibility of a decrease inflow characterized by a critical zone.

Jacobs and Rubino (1988) find that conflicts often arise over renewable natural resources for which the reversibility of a decrease inflow is characterized by a critical zone; They suggest further study of the typology to determine it's potential in applying negotiation for conflict resolution.

A second typology considered by Jacobs and Rubino (1988) views environmental conflict as form of political conflict;

1. The misunderstanding model,
2. The conflicting interests model, and
3. The basic principles model.

The misunderstandings model views conflicts as arising from a lack of understanding and communication among the participants. The conflicting interests model views conflicts as an inevitable outcome of pluralistic political process within which environmental issues are assessed and managed. The basic principals model views conflict as arising from differences in basic values and principals among the participants involved in the conflict. It participants agree that the conflict is best described by the misunderstandings models or conflicting interest model then the conflicts stands or relatively good chance for resolution.

Dixon (1991) proposes a typology, which considers environmental change as the primary driving force of acute National and International conflict, where acute conflict refers to a substantial probability of violence. He identifies seven types of environmental changes or problems, which may cause such conflicts

1. Greenhouse warming
2. Stratospheric ozone layer depletion
3. Acid deposition
4. Deforestation,

5. Degradation of agricultural land
6. Overuse and pollution of water supplies, and
7. Depletion of fish stocks.

The intervening factor between these environmental changes and acute conflicts are social efforts, of which four types are delineated by Homer-Dixon (1991);

1. Decreased agricultural production
2. Economic decline
3. Population displacement, and
4. Description of legitimized and authoritative Institutions and social relations. For example, deforestation can lead to reduce irrigation capacity because of erosion and silting. Reduced irrigation capacity can result in decrease agricultural production, which may lead to conflict over resource scarcity.

In his typology, Homer-Dixon (1991) identifies three types of acute conflicts:

1. Simple scarcity conflicts
2. Group identity conflicts and
3. Relative deprivation conflicts.

Simple scarcity conflicts are likely to arise over numerable resources such as water and fish, resources which are becoming scarce and which can be seized and controlled by users. Group-identity conflicts are likely to arise when different ethnic groups are brought together because of mass migrations of populations as a result of environmental change. Relative-deprivation conflicts are likely to arise when economic development and progress are affected by environmental degradation to the extent that citizens

become increasingly discontented by the gap between their economic status and the status day wish to achieve.

Troudalen (1993) also considered environmental change to be on driving force behind International environmental conflicts. He proposes a typology, the ABC- model, which distinguishes among three types of conflicts. The A-type conflicts are caused by unsustainable use of, control over, and access to natural resources. An example of the conflict between nations over access to resources such as oil as fish. The B-type conflicts are caused when negative environmental effects of resource use in one-country affects a second or more countries. These conflicts involve pollution of a shared resource such as seas or international rivers (For example, conflicts over pollution of the Mediterranean sea) or reduction and degradation of a resource for some countries through its use in other countries (For example, when a dam or irrigation projects reduces downstream discharge of an international river). The C-type – conflicts are caused when negative environmental effects of one resource use affect another resource system. Examples of such conflicts include those arising from the acid vain problem and potential conflicts associated with accelerated sea-level rise induced by climatic-change.

In this chapter we have reviewed a range of environmental conflicts. Some typologies such as those of Von Wilderfedt and Edwards and Bingham focus on environmental conflicts in the United States. Others, such as those of Homer-Dixon and Troudalen include regional and international environmental conflicts. The characterization of conflicts also differed among the typologies. For example, Bingham classifies the conflicts into two broad categories (site-specific and policy) and identifies the issues associated with the conflicts (land use water, resources, air quality etc).

Troudelan on the other hand, focuses on international environmental conflicts arising from resource control and use. We will use these typologies in discussing the role of Remote sensing and Geographic Information System (GIS) in environmental conflict resolution 2:3 alternative approaches to conflict resolution:-

Alternative approach to conflict resolution are the variety of approaches that allow the parties to meet face to face in an effort to reach a mutually acceptable resolution of the issues in a dispute or potentially controversial situation (Bingham 1986:5) Susskind and Kruikshank (1987:77) specify the following attributes of such approaches:

* An adhoc and informal process designed according to participant's preferences by dealing directly with each other
* Face to face interactions between representatives of the involved parties
* Collaborative problem solving for resolving the conflict
* Supplementary to conventional dispute resolution processes such as administrative decision-making or litigation
* Not involving fundamental value question or basic human rights.

De Klundert and Glasbergen (1995:73) identify the following characteristics of alternative approaches:

* Litigation is avoided, also for the future,
* The procedure is faster,
* More parties have access to the decision-making process,
* The costs are lower
* The result is not winner-takes all but 'win-win'
* Decisions and problems are not put off to the future and
* There is a basis for consensus in the future

Regarding the specific approaches, which have been proposed, there is a distinction made between negotiation and mediation. When the parties to the conflict interact directly to reach a mutually acceptable resolution process, the process is called mediation. Susskind and Kruikshauk (1987) have called these unassisted and assisted negotiation respectively. Carpenter and Kennedy (1985:295) make a distinction between three approaches: conflicts anticipation for potential conflicts, problem solving for conflicts that are acknowledge but not highly polarized, and mediation for highly polarized conflicts. In this study, we use the term negotiation to refer to direct interactions among parties in an environmental conflict and mediation for interactions that are facilitated by a third party or a mediator. Collaborative problem solving can occur either as part of negotiation or mediation, but we agree with carpenter and Kennedy that it is more likely to be used for conflicts that are not highly polarized.

The literature on alternatives approaches to conflicts resolution has identified a number of factors influencing the use of these approaches and contributing to their success and failure. For example Gusman and Harter (1986:298 – 299) identified the following factors as influencing the use of negotiation:

* Countervailing power: The outcome is genuinely in doubt because there is sufficient countervailing power among the parties so that each party is checked by another.
* Parties: Parties substantially affected by the outcome of the negotiations and necessary for it's successful implementation are willing to participate or at least to not oppose the negotiations.
* Issues: The issues are ripe and ready for decision.

Furthermore, a group of related issues has simultaneously surfaced, all affecting the same parties and all in need of resolution.

* Fundamental values: Parties are not called upon to negotiate any issue that they hold as a fundamental, basic value.
* Deadline: There is a realistic deadline.

Based upon a review of the literature, O'leary (1995:22-29) identified a number of factors influencing the success or failure of negotiation:

- Structure and process: Structuring the negotiations, as for example establishing ground rules to guide the negotiations, on the other and, is important for separating interests and not on positions.
- Parties: A practical limit on the number of parties involved in negotiations is around 15. Also, the parties must be representative of the constituents and deliver when the deal is struck.
- Motivation: Parties to a conflict must have the incentive to negotiate if the negotiations are to be successful. If any party believes that it can achieve it objectives by some other means other than negotiation (such as litigation), it is unlikely to participate in the negotiations.
- Timing: Negotiation and mediation can be used in either early or late stages of an environmental conflict. The issues for which the potential benefits of negotiation are likely to be the greatest are waste management, environmental protection, and emergency response. Multiple issues arising simultaneously can benefit the negotiation process since parties can prioritize issues and trade off positions.

Thus, some of the key variables influencing alternative approaches to environmental conflict resolution are that the relevant parties be included,

that they do not negotiate fundamental values, and multiple issues are available for trade offs.

2.2 APPLICATION OF GIS USING THE AFOREMENTIONED THEORIES

To further explore this issue, it is use full to consider the six levels of a conflict proposed by Von Winterfeldt and Edwards (1984);

1. Conflicts about data and statistics;
2. Conflicts about estimates and probabilities
3. Conflicts about assumptions and definition
4. Conflicts about risk-cost-benefit trade offs
5. Conflicts about distribution of risks, costs, and benefits and
6. Conflicts about basic social values

Von Winterfeldt and Edwards argue that while the lower levels of conflict (for example, about – data, statistics and estimates, and risk-trade offs) are technical in nature and can be resolved by gathering additional data, higher levels of conflict (about distribution of risks, costs and benefits and basic social values) cannot be resolved by additional research. They find that resolution of such conflicts must rely on political, institutional and economic mechanisms. These are also the conflicts for which GIS-based approach is not likely to be applicable. Thus if site-specific and policy conflicts are over issues of data and statistics or risk/benefit trade offs then GIS might proved beneficial to the alternative approach which are applied to resolve the conflicts. However, if the conflicts are over fundamental social values then it is unlikely GIS and for that matter alternative approaches to conflict

resolution such as negotiation and mediation, can be applied to such conflicts.

GIS can be applied to conflicts over industrial development and technological mysteries and value threats if the conflicts are about data and estimates or risks – benefit trade offs. For example, in the case of siting a nuclear power plant or a liquefied Natural Gas (LNG) terminal the conflict might be about the appropriateness of an emergency evaluation route. GIS can be applied to evaluate alternative emergency evaluation routes and the data used as part of the negotiation process.

While Homer Dixon (1991), and Troudalen (1993) focus on environmental changes as causes of societal conflicts in these classifications, GIS can be used as a predictive tool for conflict assessment by measuring and mapping the environmental changes that are causing the conflicts. An example of this is provided by the vulnerability analysis carried out in this analysis. Here GIS was used to identify and map social groups and locations in Africa that are vulnerable to food shortages. These social groups and locations in turn are likely to be associated with any conflicts that might emerge as a result of the potential food shortages.

Given the different environmental conflicts to which GIS can be applied, we now turn to the issue of potential uses of GIS in environmental conflict resolution. Specifically, we focus on uses of GIS in facilitating and strengthening conflict resolution. Alternative approaches such as negotiation and mediation, rely on consensual forms of decision-making and participatory tools and techniques for data analysis and fact-findings. As a technology capable of integrating large amounts of data from a variety of sources, a GIS can provide such tools and techniques. We provide some illustrations of these techniques here using hypothetical examples.

We now consider a case study and a conflict over the impacts on residential areas of a proposed highway in a community. Suppose that as part a joint problem – solving approach for resolving the conflict the parties to the conflict wish to identify the location of residential areas at various distances from the highways several techniques in GIS can quickly and easily yield the required data. Distances from the highway can be calculated and mapped using the technique of distance analysis. Residential areas can be retrieved from a land use map, using the reclassification techniques. The data on distance and residential areas can then be combined through the overlay technique to show the location of residential areas at various distances from the highway.

Another example is, if an Island nation would like to develop policies for managing coastal areas in anticipation of the impacts of accelerated sea level rise. Such policies are likely to generate conflict if they are introduced without an adequate information base and without incorporating the views and preferences of different stakeholders involved in coastal areas. A GIS can be used to develop needed information products as well as facilities a participatory approach for incorporating preferences of the stakeholders. GIS can be used to analysed a digital elevation model in conjunction with a scenario of sea-level rise to identify and map areas vulnerable to the impacts of accelerated sea-level rise. Such areas can be considered high-risk areas in coastal management policies and development in these areas restricted or banned. At the same time, the Island nation might allow development in other coastal areas that are at less risk from accelerated sea-level rise. In this case, the preferences of different stakeholders regarding areas for development are likely to differ and hence generate conflict. Developers will focus on characteristics such as accessibility of coastal areas to major

transportation routes and slope of the land. Environmentalists will focus on characteristics such as the presence of wetlands, existence of endangered species, and conservation of pristine coastal areas. Such problems are multi-criteria decision problems and tools and techniques are available in GIS to address such problems (Eastman Kyem, Toledano and Jin 1993; Eastman, Jin, Kyem and Toledano 1995) For example, a procedure called Multi-Criteria Evaluation (MCE) can used to weight and combine the preferences of developers, environmentalists, and governmental officials in order to determine compromise areas for coastal development. This procedure will further be illustrated in the next case study on solid-waste landfill siting which follows thus:-

GIS technology is used here as a tool in negotiation and collaboration problem solving for identifying suitable sites for a solid-waste landfill. In our case study; Key stakeholders such as the public, the developer, local officials and environmental agencies bring their interests and criteria on suitable sites for the landfill to the negotiation process. The GIS provides the necessary tools and techniques for evaluating and combining these interests and criteria. As our case is hypothetical in nature we begin by providing a context for it.

Our case study is located in the hypothetical community of null-town. Presently, the solid waste disposal needs of null-town are being met through an existing landfill. However, this landfill will soon reach its capacity and the community has to find an alternative for the disposal of its solid waste. The Town council for null-town has identified the following alternatives:

1. Expand the existing landfill
2. Find a private hauler to dispose the town's solid waste;
3. Build another landfill.

The first alternative (expand the existing landfill) is rejected, as there is no land available near the existing landfill for expansion. After surveying the private hauler serving the area in which the community is located, the council rejects the second alternative as being prohibitively costly for mill-town. If adopts the third alternative, build another landfill in the community, as the most feasible one for mill-town. The council also decides to pursue the concept of a commercial landfill rather than a landfill limited to waste from the turn. Such a commercial landfill, in the councils view, would generate much needed revenue for the town. However, recognizing that a large commercial landfill would not be acceptable to the residents of mill-town the council stipulates that the landfill can only accept wastes from communities within ten miles of mill-town.

Given this context, we describe the GIS based approach to negotiation and collaborative problem solving for site location. The approach is based on procedures and techniques developed for the use of GIS in addressing multi-criteria decision problems and involves four steps (for a detailed description of the approach see Eastman, Kyem, Toledano, and Jin 1993). In the first step the criteria of the different stakeholders regarding suitable sites for a waste facility are identified. In the third step these data layers are combined to create site suitability maps created in this step. The final step is the weighing and combination of the four suitability maps to arrive at a set of suitable sites. We describe and illustrate each step in further detail.

3 CONVERSION TO GIS DATA LAYERS

To convert to GIS data layers, we relied on a GIS database available for Milltown. This database consists of data layers on layers on land use; public water supply, wells, lakes and rivers, wetland, Major roads and the

100-year flood plain. Table 5.1 shows the data layers for Mill town. Other data, such as those on private water supply wells and areas of endangered and threatened species, are not included since these data do not exist for Mill town. For example, all residents of Mill town receive their water from the public water supply wells.

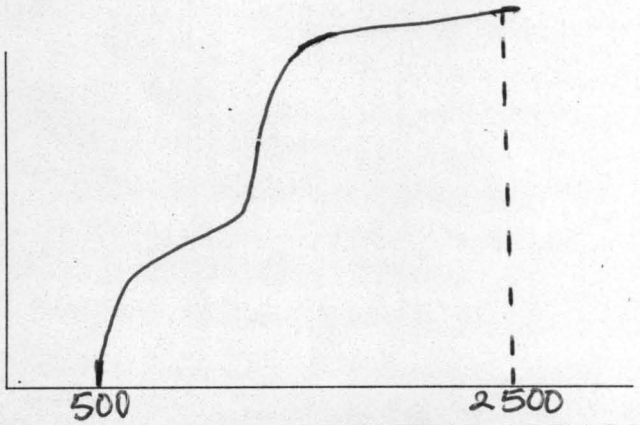
We used GIS techniques on the data layers shown in Table 5.1 to convert the criteria of each stakeholder into data to be used with the GIS in collaboration problem solving for site selection. We illustrate these techniques for two criteria. One of the DEP criteria is that landfills cannot be located within 250 feet of a lake or river. To convert this criterion into a GIS data layer, we used the data on lakes and rivers in mill town. Using a Euclidean distance technique in the GIS, we first created a data layer showing distances from lakes and rivers. We then employed at reclassification technique on the distance data layer to create the criterion data layer. In this criterion data layer, areas within 250 feet of a lake or river are unsuitable for siting the landfill and are assigned a value of 0: all other areas are suitable for the landfill and assigned a value of 1:

One of the citizens for the responsible siting (CRC) criterion is that the landfill should be located at a distance from residential areas in order to minimize aesthetic impacts and noise pollution. CRC specified s distsnce of 2,500 feet from residential areas as an optimal distance for siting the landfill. The, is CRC finds land areas beyond 2,500 feet suitable for landfill. At the same time, the DEP had already limited areas within 500 feet of residential areas as unsuitable for a landfill. Between these two distances of 500 feet and 2,500 feet (between the unsuitable and suitable boundaries), there is a region, which can be construed as fuzzy in nature (Zadeh 1965; leung 1983). It is fuzzy in the respect that as the distance to residential areas increases

from 500 to 2,500 feet the suitability of the landfill also increases; for example, a land area, which is 1,000 feet from residential, will be rejected by the citizen group for the landfill.

However, a land area, which is 2,000 feet from residential areas, might not be rejected by the citizen group as unsuitable for the landfill. From this logic and based on our experience with the use of fuzzy sets in GIS, we employed an S-shaped fuzzy membership function as shown to be applicable for most cases of criteria evaluation in suitability analysis in the case of distance to residential areas, the fuzzy membership starts from O as 500 feet, increases only gradually at first and then rapidly up to 2,5000, and then levels off at 2,500 feet when the membership becomes 1.

The use of fuzzy logic to convert the CRC criterion of distance from residential Areas into a GIS data layer. The land use Data layer for mill town is first re-classified to generate a data layer consisting of only residential areas.



ISTANCE FROM RESIDENTIAL AREAS FEET:

Euclidean distance technique is then employed on this data layer to create a data layer showing distances from residential areas. The fuzzy operation is then applied to this distance data layer. In the criterion data layer, the land areas shown in green are suitable for the landfill.

CHAPTER THREE

.0 RESEARCH METHODOLOGY

.1 MATERIALS

The materials to be used for this research are:-

1. Satellite Images of study area (Digital) Spot XS 1: 78,000
2. Aerial photos 1962, 1977, 1991, 1: 10,000 & 1:20,000
3. Two Compaq (prolinea $^4/_5$ desktop) personal computers
4. Hewlett Packard Desk Jet 640C colored Printer.
5. Measuring tape
6. Ranging poles
7. Preparation of Mosaic
8. Data Interpretation, using stereoscopes, a Mirror type Wild 514 with 3x magnification
9. Preparation of line Maps
10. Preparation

2 SOFT WARE

1. Satellite Images of study area (soft copies)
2. ERDAS version 8:3:1 – an Image processing and GIS soft ware
3. ARC/INFO VERSION 7:1:1 and 7:1:2. A Remote sensing editing Soft ware
4. ARC/VIEW Version 3:0:1

Other materials used for this study are topographic Map of Kaduna, Vegetation; land use map, population records, 1963, 1991 and estimate from 1980's Industries. Aerial photo and spot imageries of 1980 and 1990 were obtained. (soft Digital copies) from the Federal Department of Agricultural

and land resources (FDALR) and the aerial photo was adopted from Yusuf. The Images were to the scale of 1:78,000 for spot and aerial photo 1:10,000 and 1: 20,000 respectively.

3 IMAGE CLASSIFICATION

Supervise classification (which is the computer approach was used for this study), involves three stages the creation of training sites, the creation of signature files from the training sites and then application of a classification procedures to the image band using the signatures created from the training sites. Training sites are examples of informational classes such as forest, rangelands or Urban land much like categories on a Map. The categories are then characterized across the entire band to create a signature or spectral response pattern for each informational class. Finally, the signature of each informational class will be used to classify the full image by determining the most likely class for each informational class will be used to classify the full image by determining the most likely class for each individual pixel in the image.

4 DATA CAPTURE

It refers to the digitization process through which analogue map data is transformed into digital format for storage and analysis in the computer. In this task the mouse of the computer will be use to digitized the imageries on the screen with the aid of the ERDAS tools, thus enabling the delineation of informational features into polygon and hence the interpretation. ARCH/INFO will be used for editing and this is necessary because delineation do not terminate where they should be clean command will then be applied to correct all errors and adjustment and finally built command

was applied to recognized polygon and columns were subsequently applied to differentiate the different environmental resources features that sense as potential source of conflict.

.5 TRAINING SITES

The co-ordinates of study area will be inserted to clip out the scene of the study area from the satellite scene. ERDAS emerging software version 8:3:1 will be used to import imageries from CD and display on the screen (ERDAS is a remote sensing software that enables the imageries to be moved around on the computer..

.6 SIGNATURE FILES

After the creation of training site Vector file, the creation of the signature file commences. Signature file have statistical information about the reflectance values over different bands for these sites. To create signature file, ARC/INFO will be use.

As the ARC/INFO is naming it will ask for the name of the vector file and the name of each of the information feature of class to which identifiers will be assigned.

.7 CLASSIFICATION ROUTINES

In the process of visual and computer classification, where pattern of extremely small units will be encountered, generalization will be performed and the predominant category within each parcel will be label. And the mapping unit will be used on what could be satisfactorily interpreted and delineated on the spot image.

During the mosaic of the pictures and the visual interpretation we may encounter some process in identifying certain features to be interpreted, a systematic field checking will be undertaken in order to accurately asses and get familiar with some cultural and natural features of the area of study.

.8 IDENTIFYING POTENTIAL CONFLICT AREAS

The identified, interpreted and classified image will be scanned into the computer and then geo-referenced. Prior to the scanning however, the supervised classification technique will be used on the satellite image to cross-check the accuracy of the interpretation and classification.

Using the 'INITIAL' and 'POLYRAS' module in ERDAS, the vector images created was converted to raster images. By so doing the pixel values within each feature of information layer automatically took an identifier number. The overlay module will then be used to super-impose the 1980 on the 1990 data using the "RATIO" (FIRST IMAGE/SECOND IMAGE) routine. This then resulted into another Image (i.e. the composite land shrinkage, population, expansion, Industries and employment etc depicting area of conflict and area of no-conflict.

.9 SATELLITE IMAGERY SPOT X S 1:78,000

Plate 1 and 2 of the imagery is from spot x.s satellite of 1980's and 1990's showing the whole area of Kaduna and environs. It is from this imagery, that we develop our classification of the study area based on, settlements, settlement based on tribe, settlements based on religion, and industrial layout in Kaduna South Local Government.

10 AERIAL PHOTOGRAPHY 1:10,000 AND 1:20,000

An aerial photography of 1962, 1977 and 1991 photo mosaic were prepared and adopted from Yusuf (2001) Mosaic simply refer to an assembly of series of overlapping adjoining photographs into one continuous picture. It is used here as a map substitute in the study area. The mosaics for the three periods are measured as plates i, ii, and iii. And it is based on the mosaic we develop the relationship between population and land, in the study area.

11 REGRESSION ANALYSIS

This is used in testing the hypothesis about the relationships between two or more variables. Normally, the relationships between a dependent variable and one or more independents variables.

The method is also used to predict future values of the variables under study. And also, the coefficient of the economic relationship is used in decision-making

The model is to the case of two variables:

$Y_i = a + bx_i + e_i$

Where:-

Y_i = the value of the dependent variable for the i^{th} observation.

X_i = the value of the independent variable for the i^{th} observation

e_i = the value of a random error for the ith observation.

a= a parameter that represent the population regression

intercept or a is the mean of Y when the value of X is equals to zero.

b= the parameter that represents the slope of the population regression line, or b indicates the change in the mean value of the dependent variable Y for a unit increase in the independent variable X.

Using least squares estimates as discussed below,

The parameter estimates are thus:-

$$\hat{b} = \frac{\sum x_i y_i}{\sum x_i^2} \quad \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots \text{(1)}$$

where $\sum x_i = \sum (x_i - \bar{x})$

$\sum y_i = \sum (y_i - \bar{y})$ and

$\sum x_i y_i = \sum (x_i - \bar{x})(y_i - \bar{y})$ respectively

and

$$a = \bar{y} - \hat{b}\bar{x} \quad \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots \text{(2)}$$

TEST OF SIGNIFICANCE OF THE LEAST SQUARE ESTIMATES

a. Testifying with coefficient of determination (r^2)

Regression techniques and correlation methods are closely related, for R is the square root of the coefficient of determination. The differences lie primarily in interpretation. In correlation, r is on estimator for the population correlation coefficient ρ.

In regression, if x is not a random variable, there is no correlation and r^2 is simply a measure of closeness of fit. Thus, the sample correlation coefficient r is used to estimate the direction and the strength of the relationship between two variables. Therefore, the coefficient of determination r^2 is the proportion of the squared error that we think the regression can explain when we use the regression equation rather than the sample mean as a predictor. Thus

$$r = \frac{\sum x_i y_i}{\sqrt{\sum x_i^2}\sqrt{\sum y_i^2}} \quad \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots \text{(3)}$$

$$r^2 = \hat{b}\frac{\sum x_i y_i}{\sum y_i^2} \quad \text{or} \quad 1 - \frac{\sum (Y_i - \hat{Y})^2}{\sum (y_i \bar{y})^2} \quad \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots \text{(4)}$$

$r^2 = 0.95$ (say), gives a goodness of fit to the observed date because 95% of the variations of the Y-values earned their mean is explained by x. The remaining 5% is attribute to other factors.

THE STANDARD ERROR TEST

This justifies the statistical reliability of the linear regression estimates of $\hat{a}$ and $\hat{b}$. It attempts to know the goodness of the estimates:

The null Hypothesis is set thus:-

Ho : a = 0 or b = 0

Is tested against the alternative hypothesis

Hi: a $\neq$ 0 or b $\neq$ 0

at a specified level of significance (i.e 5%)

Ho is rejected if standard error S(â)<a/2 or $S(\hat{b}) < \hat{b}/2$ otherwise it is accepted.

Where:-

$$S(\hat{a}) = \sqrt{va(a)}$$

$$= \sqrt{\frac{\sigma_u^2}{\sum x_i^2}} \text{ since } \hat{\sigma}_u^2 = \frac{\sum e_i^2}{n-2}$$

$$= \sqrt{\frac{\sum e_i^2}{(n-2)\sum x_i^2}} \quad \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots (5)$$

$$S(\hat{b}) = \sqrt{\text{var}(b)} = \sqrt{\frac{\hat{\sigma}_u^2 \sum X_i^2}{n\sum x_i^2}}$$

where $\hat{\sigma}_u^2 = \frac{\sum e_i^2}{n-2}$ and

$\sum X_i^2$ is the sum of the actual observation

$$\therefore S(\hat{b}) = \sqrt{\frac{\sum e_i^2 \sum X_i^2}{(n-2)n\sum x_i^2}} \quad \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots (6)$$

CHAPTER FOUR

DATA ANALYSIS AND FINDINGS OF STUDY

1 DATA INTERPRETATION

This chapter presents an analysis of the data used in assessing the contribution of remote sensing and Geographic Information System (GIS) integration, assessing areas of potential resources conflicts. The data collected ranges from 1980 – 1990 for the satellite (SPOT XS) imagery 1962, 1977 and 1991, for the Aerial photographic and 1963, 1981 and 1991; population data from National Population Commission Kaduna. Although certain characteristics of the images and the objectives such as scale, resolution, tone texture, pattern, size, shape and shadow etc. were used as identification parameters, the pre-survey provided essential interpretation clues.

Numerous sources of conflict were identified and mapped aside the two mentioned above and their area of coverage were taken in meter square and converted into hectres and other related parameters of population and socially related phenomena.

SETTLEMENTS IN KADUNA SOUTH LOCAL GOVERNMENT

The following are the settlements in the Kaduna South, most of the settlements are either a reflection of cultural, Tribal and Religions symbols from their names etc.

TABLE (4.1)

a. Tudun Wada – predominately Hausa settlement

b. Anguwan Sanusi predominately Hausa settlement
c. Badiko – predominately Hausa/Retired soldiers
d. Auguwan Mua'zu – predominately Hausa settlement
e. Asikolaye – Hausa/Yoruba
f. Kabala West – Hausa/other tribes
g. Sabongarin T/Wada – predominately Hausa
h. Kurmin Mashi – Hausa and other tribes
i. Kakuri/Makera – Hausa and other tribes
j. Barnawa Hausa and other tribes
k. Station (Railway) Retired railway workers
l. Television – other tribes

From the above settlements names we can now sense the inherent conflict and contradictions in the above-dissected society. This is because people of differing interest and thinking were merged together, each struggling to control and maneuver each leading to disagreement and later conflict.

TABLE (4.2)

POPULATION OF THE SETTLEMENTS AS AT 1963, 1981, 1991

Settlements	1963	1981	1991
Kurmin Mashi	6376	9944	20026
Tudun Nupawa	9656	15060	39311
Badiko	997	1551	16265
Anguwan Sanusi	6576	10256	23971
Sabon Gari	12,695	22685	55588
Tudun Wada	35,494	55359	85828
Kabala West/Muazu	8011	12495	37713
Kakuri/Makera	20214	31527	32684
Barnawa	3164	4936	28344
Television	-	-	-

SETTLEMENT KADUNA SOUTH LGA

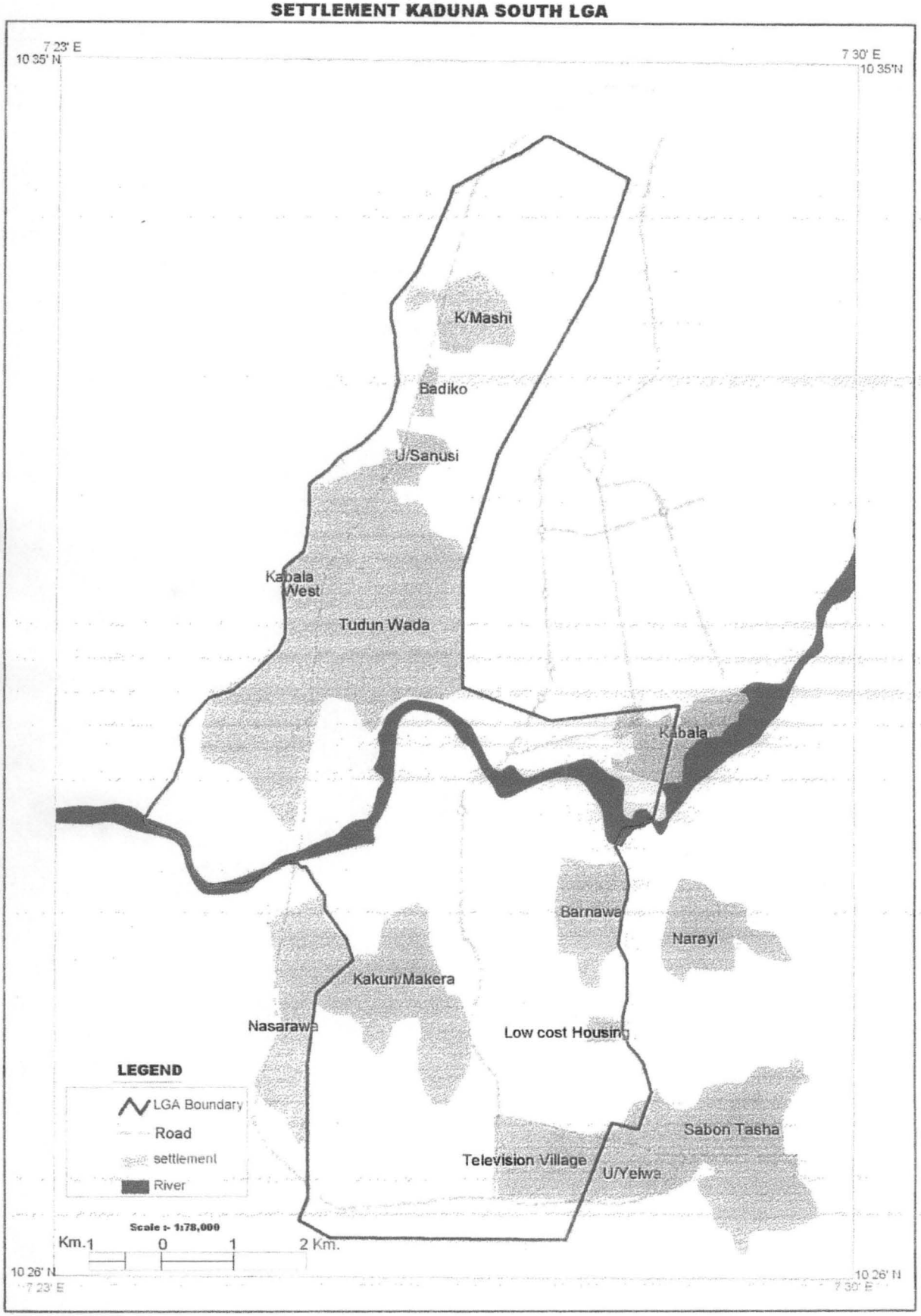


Figure 1

Source National Population Commission Kaduna.

Table 2 above shows the population of the local government in totality from the year 1963, 1981, and 1991. This allows one have the clear picture of how population is increasing in the area. This is because the area is an urban city center where immigration from neighbouring states and villages is in mass, this, due to the opportunity of employment and the presence of industries as a sources of skilled and unskilled labour, therefore increasing the tension on the society, land and other resources available leading to conflicts and contradictions.

.4 TABLE (4.3)

CHANGE IN POPULATION BETWEEN 1963 AND 1981

Settlements	A 1963	B 1981	B – A Change in Pop	100 (B-A)/A Rate in Pop. Increase
Kurmin Mashi	6376	9944	3568	55.96
Tudun Nupawa	9656	15060	5404	55.97
Badiko	997	1551	554	55.57
Auguwan Sanusi	6576	10256	3680	55.96
Sabon Gari	12695	22685	7990	55.96
Tudun Wada	35,494	55359	19865	55.95
Kabala West/Muazu	8011	12495	4484	55.97
Kakuri/Makera	20214	31527	11313	55.97
Barnawa	3164	4936	1772	56.01
Television	-	5696	-	-
Sub – Total	103183	163813	60630	58.76%

Source National Population Commission Kaduna.

The above shows the total population of the area and the changes that occur in population from 1963 – 1981 i.e 18 years in all. The difference in population as shown above is 60630, which is big enough to create problem if not properly taken care of. Therefore this increase in population did not tally with any increase in employment or rather is not in consonant or agreement, leading to struggles for the existing vacancies in both government ministries, parastatals and private companies: This triggered off tension leading to conflict. We should also remember that the supply of land for agricultural food production and for building of settlements is constant is

also not moving with increase in population. This also leads to conflicts and contradictions. While the 58.76% is the rate of population increase in a cumulative analysis from the figure this is alarming if proper planning is not made by the government.

We can also see that Television village did not appear in the 1963 census data this is because, we did not have data on it, or it is not in existence as at that period. The cumulative rate excluding television settlement.

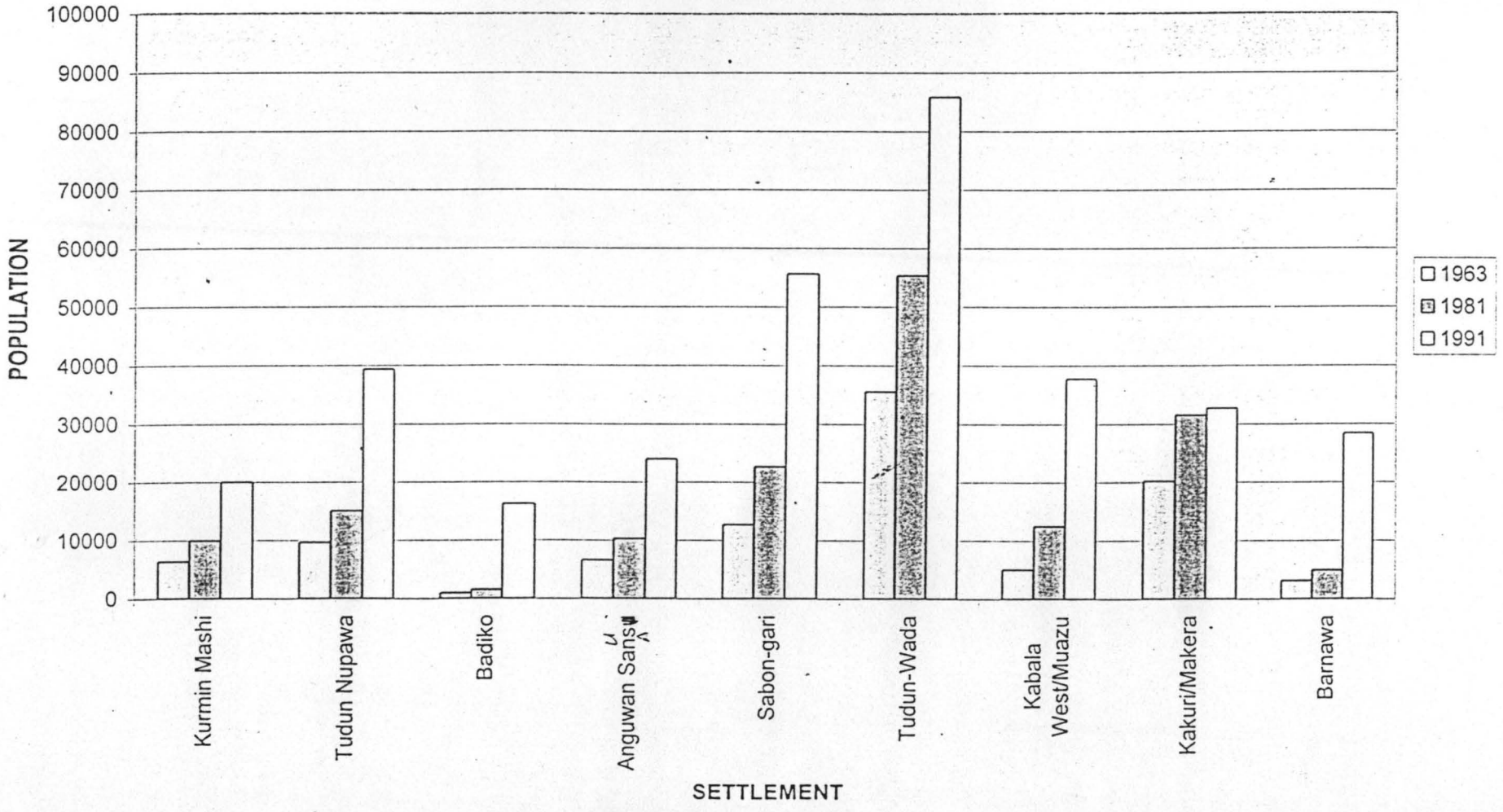
5 **TABLE (4.4)**

CHANGE IN POPULATION BETWEEN 1981 AND 1991

Settlements	C 1981	D 1991	Change in Pop C-D	Rate of Pop increase 100(C-D)/D
Kurmin Mashi	9944	19561	9617	49.16
Tudun Nupawa	1506	29,624	14,564	49.16
Badiko	1,555	3054	1,499	49.08
Angwan Sanusi	12495	24580	12,085	49.17
Sabon Gari	19,800	38,949	19,149	49.16
Tudun Wada	55,359	108,900	53,541	49.16
Kabala/West/Muazu	10,256	20,176	9920	49.17
Kakuri/Makera	23050	45,335	20,285	44.74
Barnawa	4936	6,710	4,774	49.17
Ungwan/Television	11827	28,344	16517	58.27
Station	3545	6973	3,428	49.16
Sub Total	167,827	335,206	167,379	49.93

Source – An Extract from National Population Commission Kaduna.

BAR CHART OF KADUNA SOUTH REPRESETING SETTLMENT AND POPULATION FROM 1963, 1981 AND 1991



Source - Field Survey

The above table also shows the population of the various settlements in Kaduna South Local Government with an amazing increase, without an equivalent increase in the other resources that help in supplementing life, therefore people are left to decide what to do to survive, this is deadly dangerous for a country. We can see from the above, within the period of 10 years the population increased by approximately 29%. This is serious since the government is not making plan toward this increase. The imminent thing to happen is conflict. Therefore most of the conflicts are directed towards maintaining the control of one resources or the other. Or is intended to threaten to get control of one resource or the other. This intent to control, leads to the emergence of disagreement later conflict.

4.6 TABLE [4.8]

POPULATION CHANGE BASE ON TIME SERIES ANALYSIS

Time X	Population Y	$(x-\bar{x})^2$	$(Y-\bar{Y})^2$	$(x-\bar{x})(y-\bar{y})$
1963 (0)	103183	235.11	$1.87 * 10^{10}$	$2.86 * 10^{11}$
1981 (18)	163813	7.11	$5.81 * 10^{9}$	203252.63
1991(28)	453104	160.44	$4.54 * 10^{10}$	3040380.11
(46) TOTAL	720100	402.66	6.991^{11}	2.860003244^{12}

$\hat{Y}^1$	$(Y-\hat{Y})^2 = e_i$ (error)	X^2
65133.82	1447740099	0
270495.28	$1.138 * 10^{10}$	324
384584.92	4694864324	784
	1.199426044^{11}	1108

Source Field Survey

using the formulae earlier explained:-

$\bar{Y} = 240033.33$

$\bar{X} = 15.33$

$\sum xy = 15635546$

therefore b $= 11408.97$ from equation (1)

$a = \bar{y} - b\bar{x}$

$= 240033.33 - 11408.97(15.33)$

$= 65133.8199$ from equation (2)

$\hat{y} = a + bx$ see table and

coefficient of determination r^2 is obtained from equation (4)

$$r^2 = 1 - \frac{1.199426044}{6.991}$$

$= 1 - 0.171567$

$= 0.828$ or 0.83

83%

Therefore, the above shows that 83% of the total variation in population is explained by time. Which indicate that the population is on the increase, 83% variation is an alarming variation in any case. Therefore, the government needs to planed for this increase or variation in population. Especially in the field housing or generally Social infrastructures, Food supply, Health and Employment. An increase in population without proportional increase in production of the above spell doom for any country.

4.7 STANDARD ERROR TEST

Ho: a = 0. Hi: a $\neq$ 0

Therefore, in this Ho: a = 0

Therefore, in this Hi: a $\neq$ 0

Using equation (5) we can then say that
S (â) = 17259.10

and a = 65133.8199

Therefore, a/L = 32566.91

Therefore,

S (â) < a/L. This is to say that S (â) is less than a/L. In this case we can then reject Ho and conclude that our estimation of is likely significant.

From equation (6)

S ($\hat{b}$) = 331682.97 and b = 11408.97

S ($\hat{b}$) $\neq$ $\hat{b}$/2 therefore, we can then concluded that â estimate is more significant than $\hat{b}$.

That is population increase or variation depends on time as estimated from our records obtained from aerial photography and national population commission Kaduna, of 1963,1981 and 1991 population commission records and 1962, 1977 and 1990 aerial photography. The result shows that population increase depends on time in Nigeria and Kaduna State in particular. The resultant effect of this if the Government did not plan, crisis /conflict is inevitable in the area of study, this is because increase in population without adequate or appropriate planning for the increase is a weapon use by crisis perpetrators to trigger up discord and disturbances. The government be it state or local government need to plan for an increase in population to avoid conflict and destruction in the society.

4.8 LAND AS A SOURCES OF CONFLICT

Contingency Table

This analysis tries to establish the fact that, there exist an association of interdependence between two mutually exclusive variables.

It is based on the hypothesis that,

1. There exist interdependence between population density and land distribution.
2. There does not exist interdependence between population density and land distribution.

This require that we divide the case study into two relevant section i.e South-South(SS) of the study area and South-North (SN) of the study area:

The South-North comprises of

(a) Tudun Nupawa

(b) Sabon – Gari

(c) Tudun – Wada

(d) Anguwan Sanusi

(e) Kurmin Mashi

(f) Badiko

(g) Kabala west / Muazu.

While the South-South comprises of

(a) Barnawa

(b) Makera / Kakuri

(c) Unguwan Television

We also assume the level of assurance to be 95% level of significance.

The distribution of land per hectre and population density of the areas under study.

TABLE (4.9)

Land distribution per hectre and population density 1981 & 1991

Population density between 1981-1991		Area of square land / hectre 1981 / 1991	Total
South-South	253402	253.070	138655.078
South-North	278702	616.677	279318.677
Total	417104	869.755	417973.755

Source: An Extract from Aerial Photo 1962, 1977, 1991.

To calculate the expected distribution of the population density and the distribution of land area we can then say (all expected value is on bracket).

Raw total x Column total

divide by the grand total

TABLE [4.10]

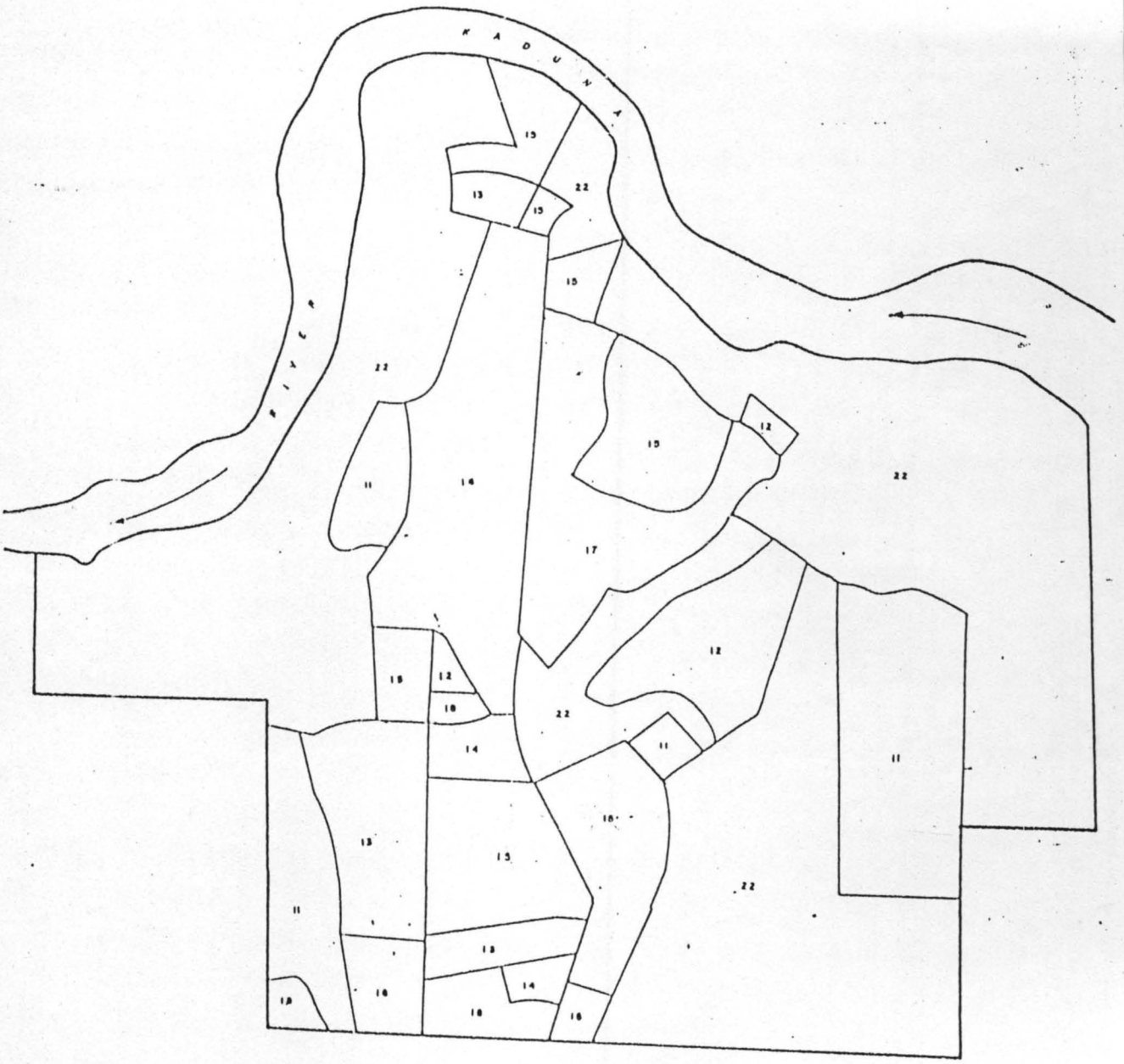
EXPECTED DISTRIBUTION OF POPULATION AND LAND PER HECTRE

Population Density		Area of land	Total
South-South	138402 (138867)	253.078 (288.53)	138655.078
South-North	278702 (278737)	616.677 (581.23)	279318.677
Total	417104	869.755	417973.755

Source: An Extract from Aerial Photo

$$X_i^2 = \frac{\sum (O_i - f_i)^2}{f_i}$$

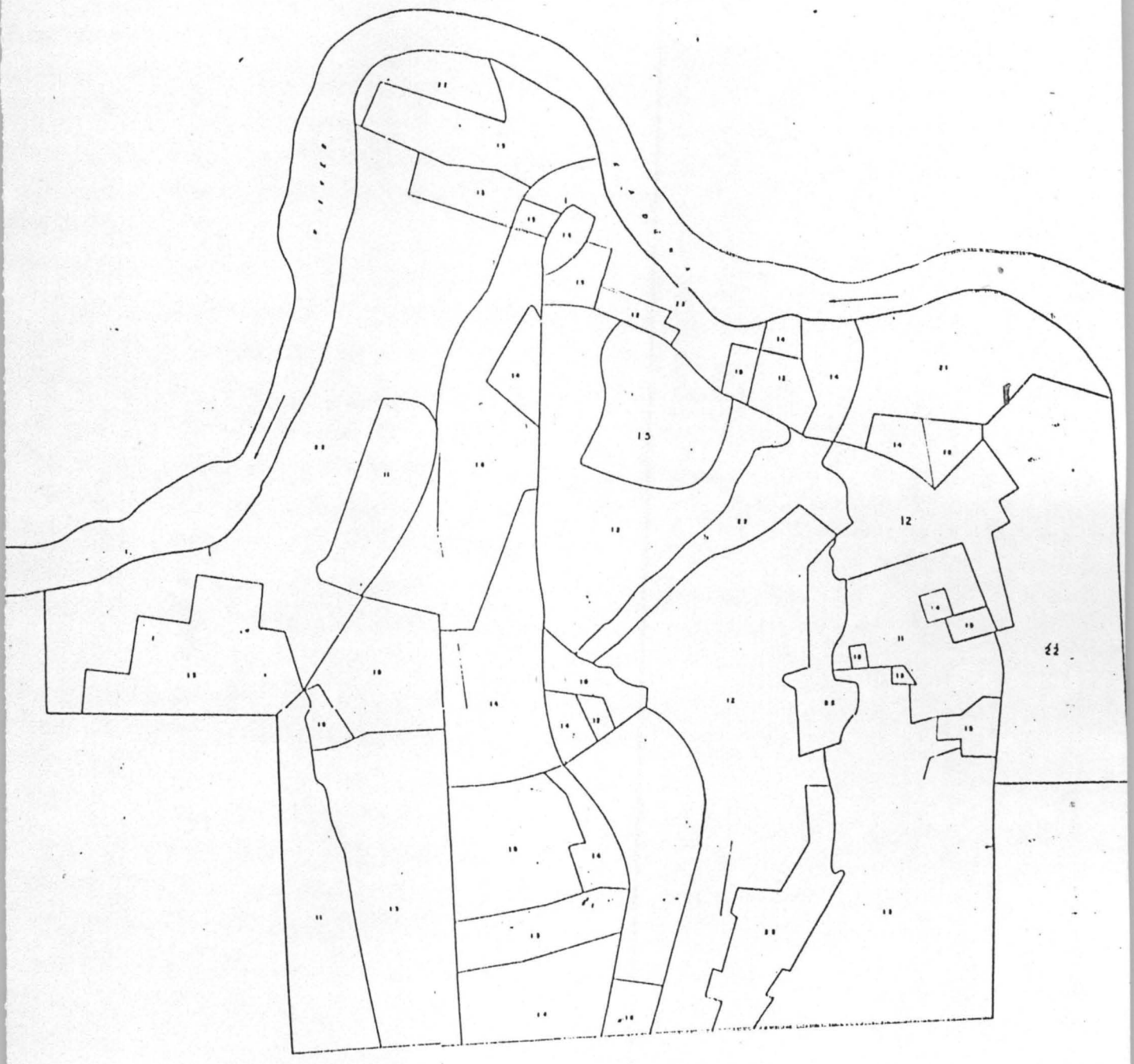
(1) Ho: that population growth is independent of land size.



11 RESIDENTIAL HIGH DENSITY
12 RESIDENTIAL LOW DENSITY
13 INDUSTRY
14 COMMERCE
15 INSTITUTION
16 TRANSPORTATION
17 OPEN SPACES
18 VACANT LAND
21 AGRICULTURAL PLANTATION
22 CULTIVATED LAND

Source aerial photo

FIG 2. LAND USE CLASSIFICATION OF THE SOUTHERN PART OF METROPOLITAN KADUNA DERIVED FROM 1:10,000 PHOTOGRAPHY TAKEN IN 1962



Source aerial photo

11 RESIDENTIAL HIGH DENSITY
12 RESIDENTIAL LOW DENSITY
13 INDUSTRY
14 COMMERCE
15 INSTITUTION
16 TRANSPORTATION
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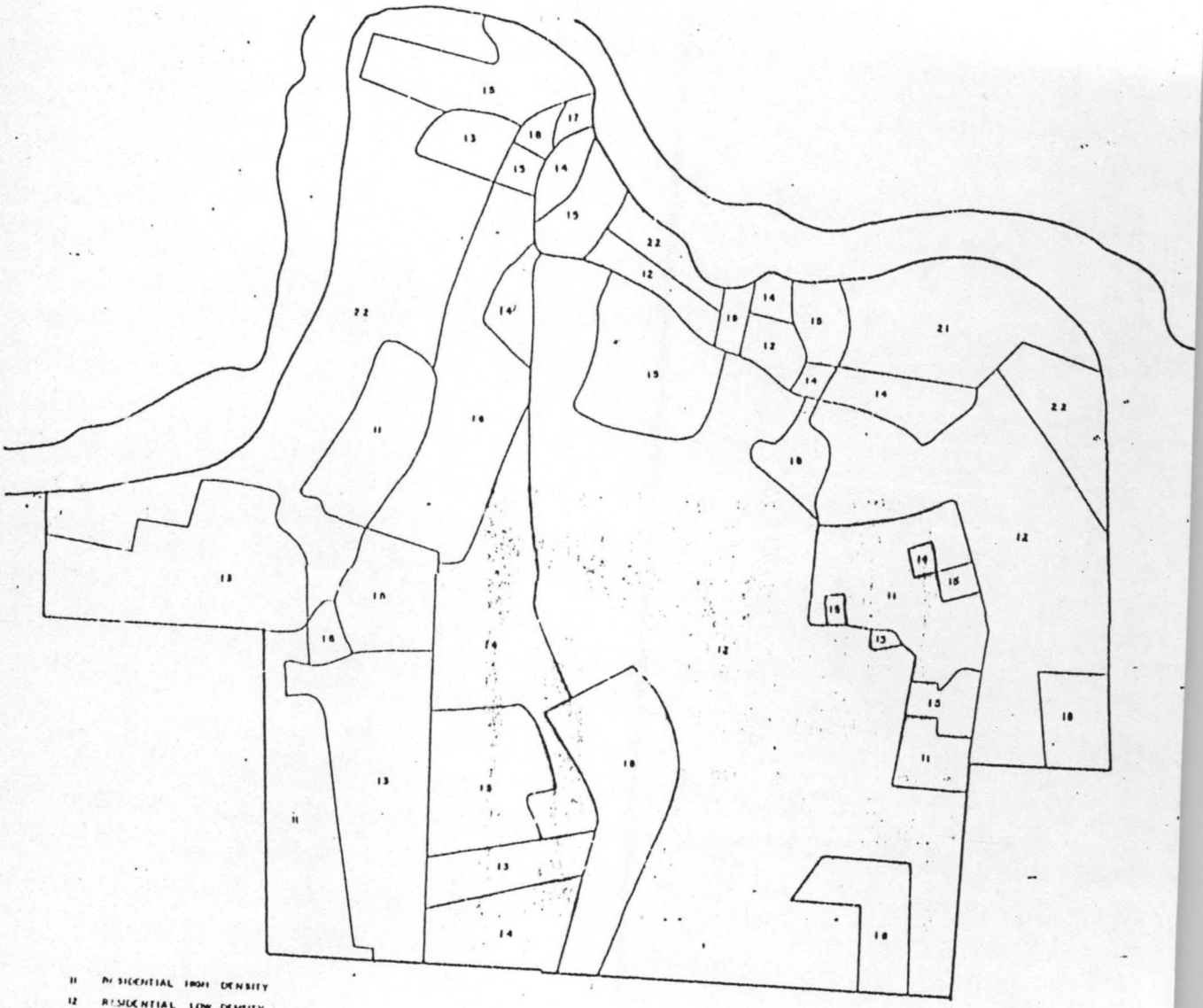
FIG 3. LAND USE CLASSIFICATION OF THE SOUTHERN PART OF METROPOLITAN KADUNA
DERIVED FROM 1: 6,000 PHOTOGRAPHY TAKEN IN 1977



Source aerial photo

FIG 4. LAND USE CLASSIFICATION OF THE SOUTHERN PART OF METROPOLITAN KADUNA DERIVED FROM 1:10,000 PHOTOGRAPHY TAKEN IN 1991

(2) Hi: that population growth depends land distribution.

The level of significance is at 5%.

$x_c^2 = 6.5311$

$X^2 0.05, 1 = 3.84146$

Since x^2 tabulated at 95% level confidence is below x^2 as calculated; then we have no reason to accept our null hypothesis; therefore, base on the fact on the ground we most conclude that population growth on land distribution.

Therefore, the ever-increasing population from 1963 down 1991 posed a great danger to peace. This is true because, the land compared to the population is not proportional, therefore stands as a source of conflict; for both the people in the South-North and the south-south part of the local government area.

4.9 DISTRIBUTION OF EMPLOYMENT BASED ON TWO CASE AREAS REFERENCED FROM SOME MAJOR INDUSTRIES

Kaduna South composed of two great district, bounded by Kaduna river that Kakuri and environs and Tudun Wada and environs. That simply referred in this study as South-South and South Northern part of the local government. Majority of the industrial resources if not all is located within the South-South part of the local government. These resources led to each of the two-side struggling to have firm control of the area so as to have the opportunity of employment, revenue generation and the members of the society to participate in petty trading for survival. Therefore in this section, we study the statistical implication of population and employment as one of the factor that can generate tension and later conflict. The spot x s imagery reveal the main settlement with two districts.

We establish the intertwining relationship and the opportunities open to people of the two district and the possibility of harmony or discord due to competition for the possession and control of the above available industrial resource (employment).

Below is the table of the estimated working members of South-South and South Northern part of the local government employed in the industries.

DISTRIBUTION OF EMPLOYMENT BASED ON TWO CASE AREAS REFERENCED FROM SOME MAJOR INDUSTRIES

TABLE 4.11

Industries	Estimated Industrial Population South-South	Estimated Industrial population South-North	Total Workforce
UNTL	5983	1490	7473
Fertilizer	381	134	515
IBBI	4112	-	4112
KTL	2897	2212	5109
Arewa Textile	2017	745	2762
NBL/7UP	1522	502	2024
Asbestos	387	123	510
Nortex	1781	937	2718
PAN	945	987	1932
RAW TOTAL	20025	7130	27155

Source: Referenced from payroll of respective industries

Below is the percentage of the estimated workforce for both South-South and South-Northern part of the local government (ie Kaduna South local government area).

From the percentages realized we can deduced that the percentage of workforce for South North is in the United Textile Limited with only 20% and the South recorded the highest percentage in the IBBI with 100%. This is because majority of the workers are from South-South. This is because, Muslim who dominated the South-Northern population do not work in an alcoholic company by virtue of the doctrine of their religion, therefore given non-Muslim resident in the South-South part to be employed in such an industry.

While the South-Northern part only recorded its highest workforce in PAN with 51% as against South 49%.

In the whole grand total of the percentage of 924%, the South-South part of the local government recorded 650% of the workforce as against 274% for the North-South part of the local government.

Therefore, the control of the resources of land and industries, rather than the employment (workforce) in the industry created tension and later conflict and unrest in the area. This is true because, one hardly heard each side complaining of the employment opportunity, but who owned and control the land and who control the revenue accruing from the industrial resource.

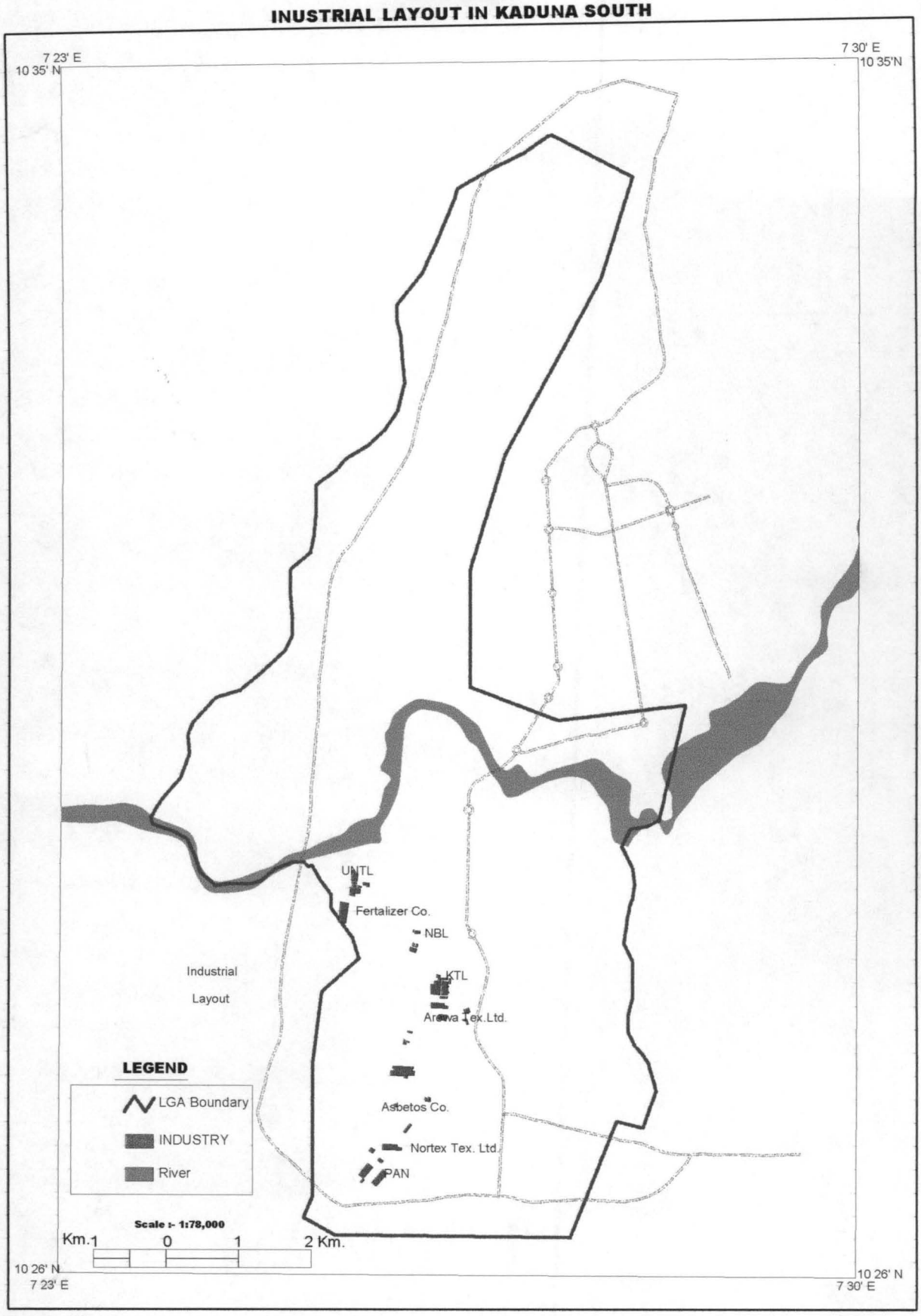

INUSTRIAL LAYOUT IN KADUNA SOUTH
7 23' E
10 35' N
7 30' E
10 35'N
UNTL
Fertalizer Co.
NBL
KTL
Arewa Tex.Ltd.
Asbetos Co.
Nortex Tex. Ltd.
PAN
Industrial
Layout
LEGEND
LGA Boundary
INDUSTRY
River
Scale :- 1:78,000
Km. 1 0 1 2 Km.
10 26' N
7 23' E
10 26' N
7 30' E

Figure 2A

PERCENTAGE DISTRIBUTION OF WORKFORCE, BASED ON TOTAL WORKFORCE CONSIDERED FROM THE SIDE (SOUTH-SOUTH AND SOUTH-NORTH)

TABLE 4.12

Industries	Estimate for South-South	Estimate for South-North
UNTL	80%	20%
Fertilizer	74%	26%
IBBI	100%	-
KTL	57%	43%
Arewa	73%	27%
NBC	75%	25%
Asbestors	76%	24%
Notex	66%	34%
PAN	49%	51%
Average	78.6	31.3

Source: Referenced from the payroll of respective industries

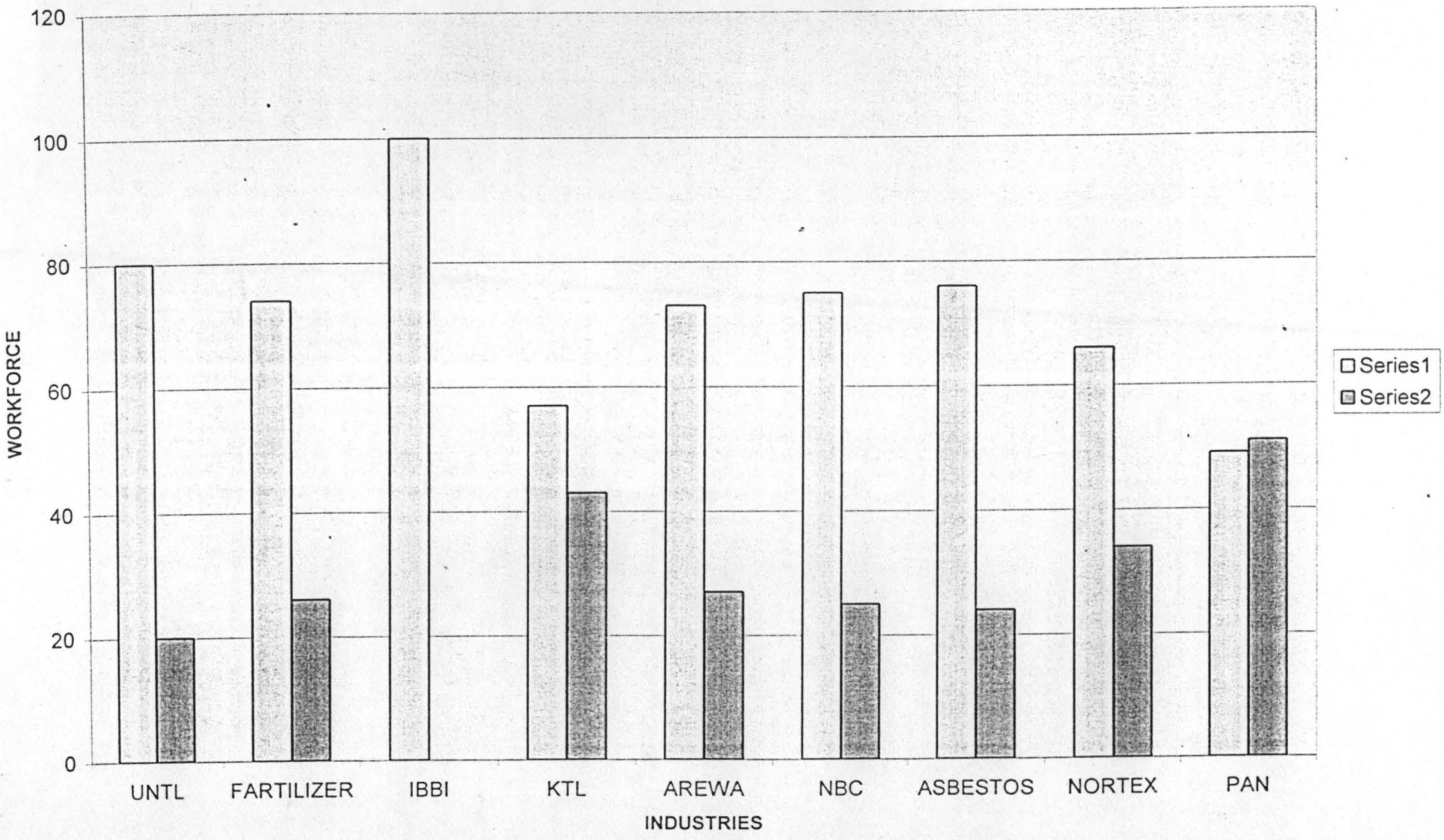
4.10 SETTLEMENTS BASED ON TRIBE

Because of the tension created in the local government, people are force to be conscious of where to stay, buy a plot or rent a house. Therefore, this tension on who control or owned the land led to the clear division that Hausa's are predominately residing in the South-Northern part of the local government and the non-Hausa's are now residing in the South-Southern part of the local government. This clearly depicted in our spot x s imagery of the 1980's and 1990's below.

4.11 SETTLEMENTS BASED ON RELIGION

This tension also led to most Christians to reside in the South-Southern part of the local government and the Muslims to reside in the

PERCENTAGE DISTRIBUTION OF WORKFORCE, BASED ON TOTAL WORKFORCE CONSIDERED FOR THE 2 SIDES S/S AND S/N



Source .. Field Survey

South-Northern part of the local government. This clear division, instead of brining peace and harmonious relationship; created a sustained tension for an outburst of crisis and chaotic situation in both the state and the local government in particular. This is because each is looking at its population strength and resource accumulation as a parameter to measure the disadvantages of its not controlling the South-Southern part of the state. This is clearly depicted in cut spot x s imagery of 1980's and 1990's.

Therefore, for clear monitoring and boundary demarcation of this area satellite imagery and a GIS achieve data is needed for an immediate usage in the area of routing the army/police to check the possibility of outburst of crisis. Remote sensing GIS can also help in indicating the places to locate and easily get to the danger spot's or areas during crisis. By this the crisis is either avoided or averted, therefore saving life and properties.

The combination of Remote sensing GIS, in harmony with other information can help in demarcating resource boundaries, easy routing to crisis area, spotting danger areas, reveal the terrain history and make it easing of construction of emergency troops buildings. These and many other functions can be performed by remote sensing and GIS in the area of conflict situations.

SETTLEMENT IN KADUNA SOUTH LGA BASED ON TRIBES

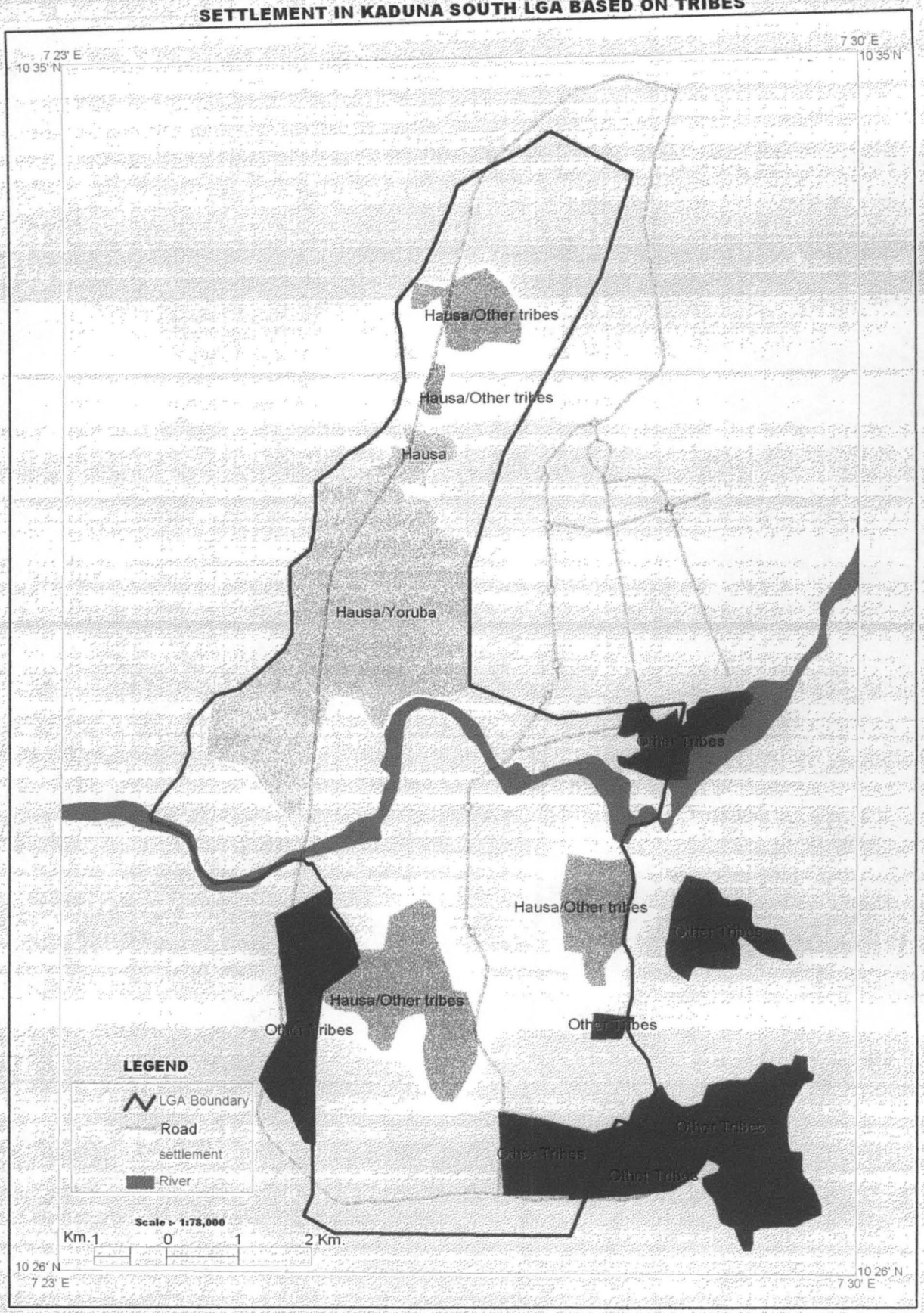
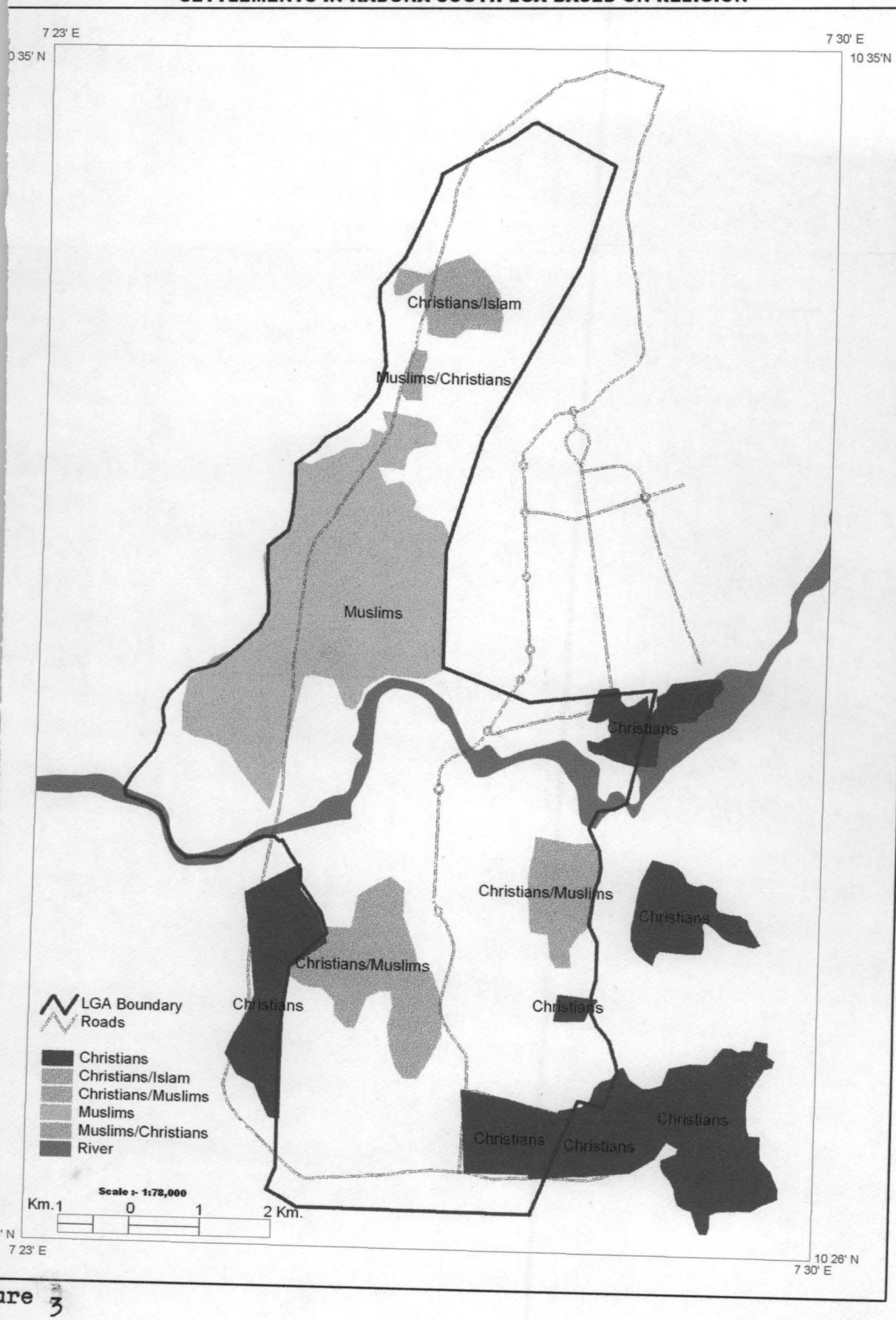


Figure 2

SETTLEMENTS IN KADUNA SOUTH LGA BASED ON RELIGION



ure 3

CHAPTER FIVE

5.0 SUMMARY, CONCLUSION AND RECOMMENDATION

5.1 SUMMARY

The thesis is concerned with identification of the sources of resource conflict in Kaduna town; with specific reference to the Southern part of Kaduna using an integrated Remote Sensing and Geographic Information System (GIS) technique, to establish the intertwining relationship between, population, land and employment on one hand and peace and discord on the other hand, in the study area. This is done using SPOT XS 80 meter resolution and aerial photography 1:10,000, 1:6000, 1:10,000 respectively for delineation of the boundaries and for the classification of resources available in the area.

Although remote sensing cannot on its own resolve resource conflict but, it provides those concerned, with ready-made instruments to use in conflict resolution. This is because remote sensing and GIS can provide a map classification representing different phenomena, which can serve as first hand tool in locating environmental resources and routing i.e how to get to them with ease. It can also provide information on the easiest route for the peacekeeping troops to follow to quell riots/conflicts. Infact, Remote Sensing can provide us with primary data that directly help us in taking decision and plan of action in conflict resolution.

With all these in our records, we need to develop a new approach to resource conflict, in a more scientific manner. To do this Remote Sensing and GIS can provide us with the impetus.

Our concern here was the second one that is conflict over natural resources, such as land, population, water etc.

From this study it can be seen that within the period 1963 – 1981, there was an increase in population of about 58.76%. This is alarming since the government did not plan socially, economically, technologically etc for the above mentioned increase. Therefore housing became a problem, schools were build without provision for employment etc. The ultimate therefore became survival by all means, which led to conflicts. The land in the study area shrank continuously from 1962 – 1991, which in essence shows a decrease in food production and the provision of housing. The end result will be that people get frustrated and conflict is inevitable. The figures for the period ie changes in cultivated farm land are 1962, 462612, 1977, 22890 and 1991, 105592. All are in hectres. This is adopted from (Yusuf 2001)

5.2 CONCLUSION

From the above summary, we can then concludes that:

a. Conflict is of different typologies

b. That most conflicts are resource related

c. That, an integration of Remote Sensing and Geographic Information System (GIS) can ease the work of resource conflict resolution in an area by providing us with first hand information.

d. That Remote Sensing and GIS are constricted in performing direct resource conflict resolution but can indirectly help.

3 RECOMMENDATION

It is very important to have reliable source of data for monitoring and management of Resource conflict for the purpose of planning and development.

An integration of Remote Sensing and Geographic Information System (GIS) can provide this source of data but with an integration of other sources and field measurements so as to correct the deficiencies of the imageries used.

For conflict resolution of any nature or kind a Remote Sensing data with higher resolution than SPOT X S and aerial photography is needed and therefore recommended. This is because it will provide a repetitive coverage for the conflicts. Ikonos and LAND-SAT 7 (and other sensors) that can provide higher resolution imageries for monitoring riots/crises, particularly in the areas that are difficult to delineate and penetrate are strongly recommended.

The imageries of conflict points should be obtained and those in charge of security administration, in the state and local government should purchase all the necessary GIS gadgets and associated information system components. This will facilitate easy location, monitoring and dispatch of anti riot police or army to the conflict area.

It is necessary to sincerely recommend specifically IKONOS, for its high resolution and its multi temporality and a computer that is very fast and reliable as a means of monitoring any environmentally related phenomena.

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SATELLITE IMAGERY (SPOT Xs 1990) SHOWING KADUNA SOUTH LGA

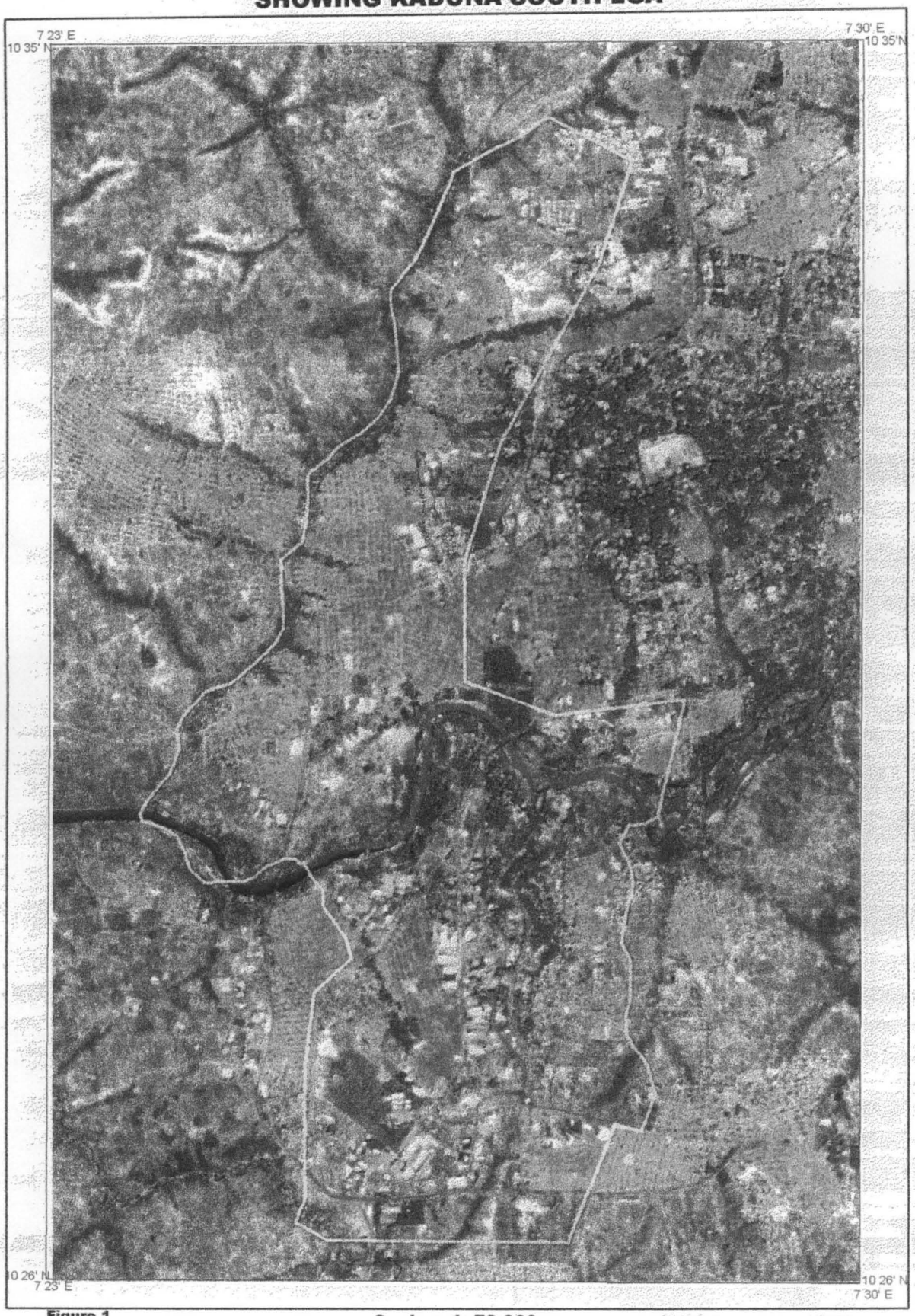

Figure 1

Scale :- 1: 78,000

APENDIX 2

SATELLITE IMAGERY (SPOT Xs 1990) SHOWING KADUNA SOUTH LGA

Figure 1

Scale :- 1: 78,000

APENDIX 3

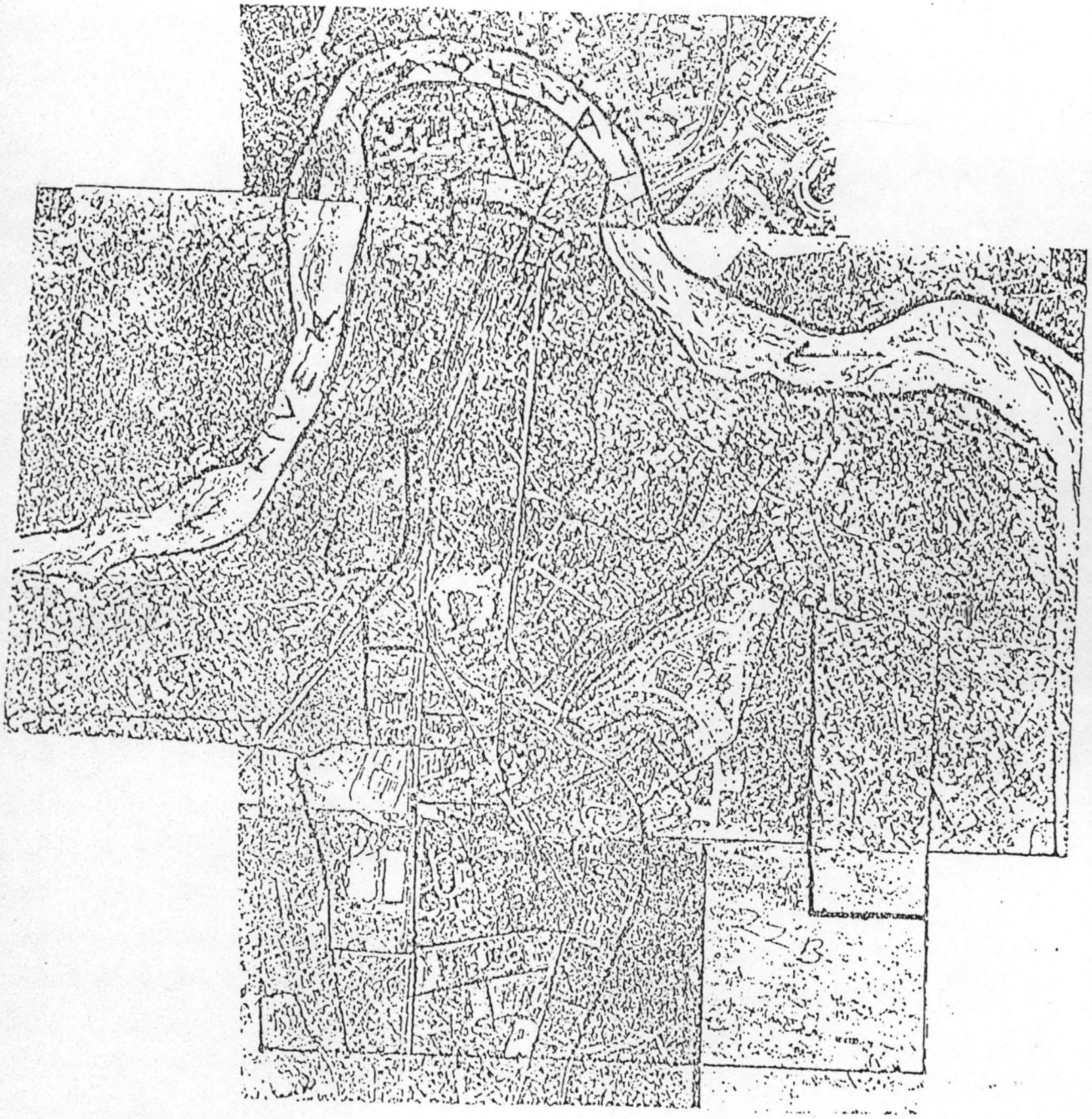

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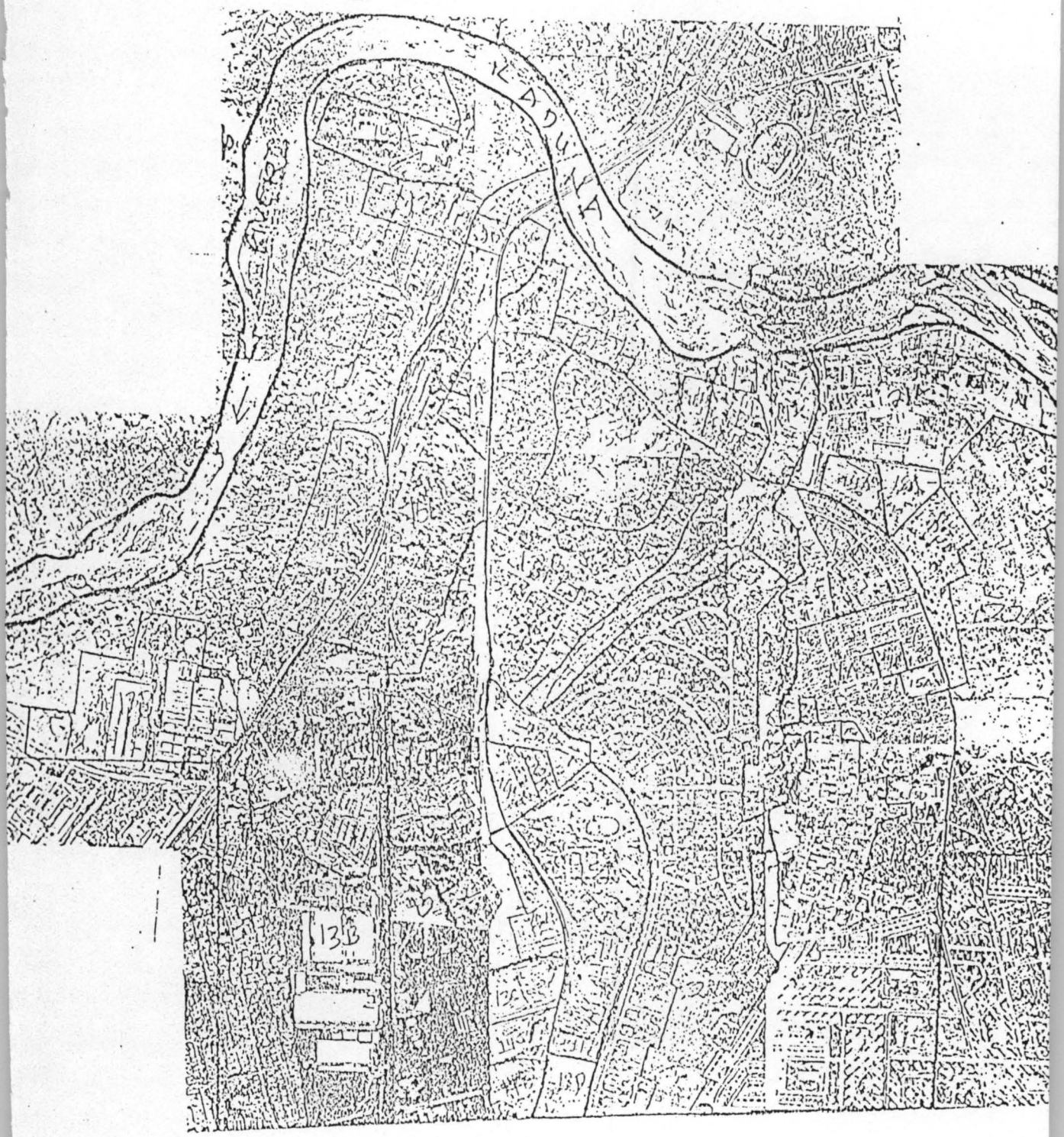
PLATE I: PHOTO MOSAIC OF THE SOUTHERN PART OF METROPOLITAN KADUNA (1962)

APENDIX 4



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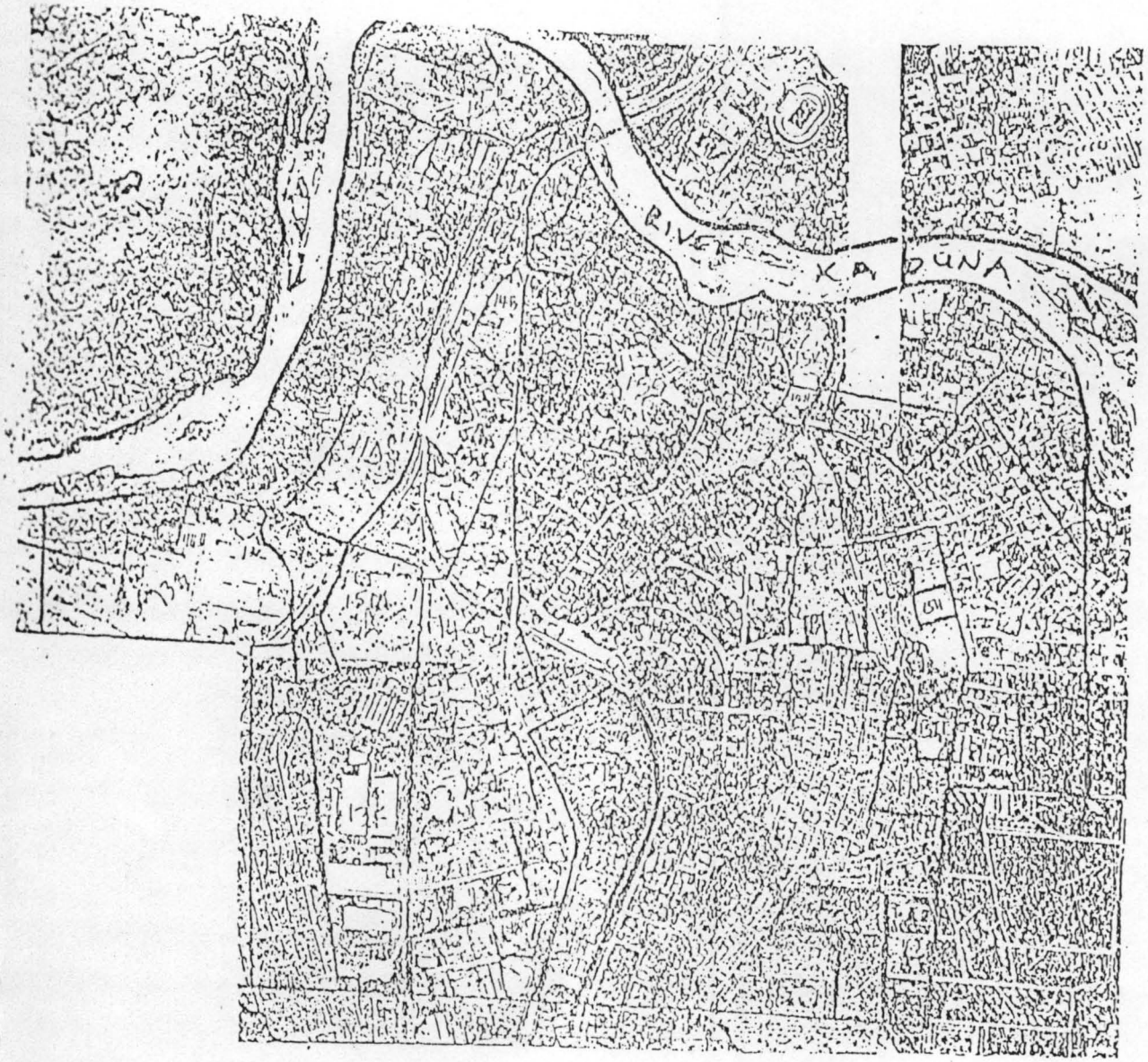
OF THE SOUTHERN PART OF METROPOLITAN KADUNA (1977)

APENDIX 5



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22 CULTIVATED LAND

PLATE III: PHOTO MOSAIC OF THE SOUTHERN PART OF METROPOLITAN KADUNA (1991)

ABOUR FORCE BY SEX AND MAJOR OCCUPATIONAL GROUPS 1963 CENSUS

MAJOR OCCUPATIONAL GROUPS	M	F	TOTAL
essional, Technical and Related Workers	8,151	791	8,942
inistrative Executive and Managerial Workers	1,021	39	1,060
ical Workers	6,798	417	7,215
es Workers	24,097	8,518	32,615
rmers, Fishermen, Hunters, and Related Workers	253,267	30,620	286,887
iners, Querrymen, and Related Workers	907	14	921
ransport and Communication Workers	6,994	1,459	8,453
raftsmen, Production process workers and Labourers ...	47,428	4,266	51,694
ervices, Sport, and Recreation Workers	35,223	6,936	42,159
Inspecified Workers	5,007	193	5,200
Total Employed	388,893	26,253	45,146
nemployed Persons	3,198	839	41,037
Total Labour-Force	392,091	27,092	419,183

Source:—1963 Census Report.

TABLE: 14

KADUNA STATE 1963 POPULATION CENSUS AND PROJECTION OF 6—7 YEAR-OLDS UP TO 1986 BY LOCAL GOVERNMENT AREA

Local Government Area	*Population Census* 1963	*Population Projection of 6—7 Year-Olds*					
		1963	1982	1983	1984	1985	1986
Serial No.							
1· KADUNA ...	149,910	4,497	16,265	17,403	18,621	19,925	21,320
2· ZARIA	370,290	11,108	17,759	18,202	18,657	19,124	19,603
3· KACHIA	296,570	8,897	14,223	14,579	14,943	15,317	15,700
4· IKARA	295,908	8,872	14,192	14,546	14,910	15,283	15,665
5· JEMA'A	220,300	6,609	10,565	10,830	11,100	11,378	11,662
6· SAMINAKA ...	190,525	5,716	9,137	9,366	9,600	9,840	10,086
7· BIRNIN-GWARI ...	29,798	894	1,429	1,465	1,501	1,539	1,577
KADUNA STATE TOTAL	1,555,301	46,593	83,570	86,391	89,332	92,406	95,613

Note: Percentage (6—7) year-olds of the total population is assumed at 3%.