LARGE-SCALE TOPOGRAPHIC MAPPING FOR SUSTAINABLE DEVELOPMENT

(A CASE STUDY OF DUTSE, JIGAWA STATE)

BY

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Certification

I hereby certify that this work has been supervised, read and approved as meeting part of the requirements for the award of PGD in FUT Minna, Niger State.

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DECLARATION

I declare that this project titled "Large Scale Topographic Mapping For Sustainable Development -A Case Study of Dutse, Jigawa State" is an authentic work done by and has not been presented elsewhere for the award of any degree.

Dedication

To my family for their love.

Acknowledgement

I am most grateful to Dr. G. N. Nsofor of Federal University of Technology Minna, Geography Department for his many helpful suggestions and for critically reading the thesis. I am grateful to all staff of Geography Department, Federal University of Technology Minna, for their kind support, it is well appreciated. Surv. S. P. Olaleye, Surv. C. F. Njoku, Surv. Alh. F. Y. Jinadu, Mr. J. Tabara, Mr. R. O. Adebisi for the invaluable suggestions, and for supply of materials used for this work. Finally I must thank all friends and well wishers who contributed to the successful completion and encouragement, constructive, textual criticism throughout the preparations of this thesis.

ABSTRACT

Right from colonial days through our years of independence, Nigeria has not been able to produce map to cover the entire country except for 1:500,000 and 1:1 million series. Maps re tools required by environmental managers and planners for regulating human developmental activities. Mappings alone during colonial time were motivated by resource exploration and exploitation, and also for territorial control. The earliest maps were done mainly along coastal areas, where Europeans settled and possible areas of high resource potential. Subsequent attempts at producing topographic map coverage of the whole country had failed. Out of 1:25,000 series started in 1972, only 3.83% was completed. At the rate Nigerian population is growing, such information are needed for developmental planning. This project is an attempt to produce large scale topographic map of Duste, Jigawa State. The state is one of those created in 1996 with Dutse town as capital. Coupled with nation's map situation, and complete absence of maps in this new state, the effort has resulted in the theme of this project. The map produced is that of part of Duste township at scale 1:2000 using aerial survey method. This will make available to the Government of Jigawa tool for resource planning and allocation.

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List of Acronyms

SP - Photo scale

MS - Map scale

SM - Model scale

F - Focal length

H - Flying height

pp_1 - Principal point on photo one

pp_1^1 - conjugate principal point on photo two

pp_2 - Principal point on adjacent photograph

pp^1_2 - conjugate principal point on photo one

b - Photo base

bx - instrument base

bx^1 - approximate/computed base

bx, by and bz - instrument base components

Z max - Z range maximum

Z min - Z range minimum

K - Kappa rotation about Axis

O - Phi rotation about Y axis

W - Omega rotation about X axis

O - common phi rotation

P^1P^{11} - Photo points

L^1L^{11} - Mechanical projections centres

m^1m^{11} - Measuring marks

P - Mechanical model point

Z^1 - Instrument projection distance

P^1, P^2, P^3 and P^4 - standard points in model space

CP^1, CP^2, CP^3 and CP^4 - control points on map sheet

CP^1_1, CP^1_2, CP^1_3 and CP^1_4 - control points in model space

CHAPTER 1

1.0 INTRODUCTION

1.1 BACKGROUND TO STUDY

Nature has endowed Nigeria with variety of natural resources, ranging from agricultural land, forest potential to mineral resources. These have not been adequate mapped and quantified to established the feasibility of their exploitation of the socio - economic well - being of the generality of Nigerian people.

Over the years, Nigeria has been able to produce a few number of topographic and thematic maps for administrative use, and for natural resource development, but not enough parts of the country has been mapped at relevant scales. This is making land allocation for development planning difficult and inefficient.

With exception of some state capitals, most parts of the country have not been supplied with needed controls at appropriate intervals, not to take of mapping them. The early survey and mapping in Nigeria were motivated by colonial powers for resource exploration and exploitation, also for territorial control. Therefore, the earliest mapping activities were mainly done along the coast, areas with high relief, places where Europeans settled and place that were identified to possess high resource potential.

About the close of 19th century, map in Nigeria were provided by the explorers that invaded our part of Africa, the River Niger maps were prepared even before the advent of British rule in Nigeria. The beginning of surveying and mapping activities on the present Nigeria dated back to 1879, when the first survey department was established in Lagos and its colony (Ujunaw, 1988).

There was an attempt by 1910 to carry out topographic mapping of southern Nigeria, which was done at production scale of 1:125,000. There were no adequate framework of survey triangulation establish for subsequent work. By 1945, further triangulation work was done to enable more accurate and rapid topographic mapping. The introduction of aerial survey in 1948 enhances the situation of topographic mapping in Nigeria. This created opportunity for Nigeria to produce maps required for development of various projects which were of interest to colonial administration.

By 1950, only 10% of the whole country had been photographed and maps plotted at scale of 1:50,000. These maps were not contoured, except where they are needed for project specifically requiring relief representation. There were other scale of topographic maps produced before the independence in 1960. For example, the following maps were produced, the Kaduna west map at scale 1:62,000 in 1950, Shendam and Zamfara at 1:100,000 and Anambra river area at 1:25,000 both in 1958 (Ezra, 1998).

During the first national development plan period between 1962 - 1968, the topographic map coverage of the whole country at 1:50,000 was to be provided. The programme was to ensure that the second edition of maps were produced in most parts of the north and for many parts of the south. These maps were to be the first set of 1:50,000 contoured maps in Nigeria, unlike the earlier edition. Earlier there have been attempts to cover the country at scale 1:1 million, 1:500,000, 1:250,000 and 1:25,000 map series. The only successful coverage so far was the production of 1:1 million and 1:500,000.

Eight - three percent of the 1:50,000 series were completed, some areas have not had a single contoured topographic map for development planning. The 1:25,000 series ere started in 1972 for ears of dense population, but only 3.83% completed. the Nigeria map situation is bed, and for there to be better understanding of human activities within the environment, maps are needed to guide resource planners and environmental managers.

1.2 Statement of Problem

Nigeria has undergone several structural and political subdivisions, form three regions in 1953 to four in 1963, twelve states in 1967, nineteen states in 1976, twenty - one in 1987, thirty with Federal Capital Territory in 1991, to thirty - six in 1996. All these subdivisions are without any significant effort aimed at producing comprehensive administrative maps of the country to reflect these frequent changes.

1.3 Justification of project.

In view of difficulty faced in planning as a result of non - availability of appropriate maps; and in some cases local government headquarters made state capital. Hence, the need for maps in such place like Jigawa state became very critical. This project aimed to attempt to produce large scale topographic coverage of Jigawa State using aerial photography and photogrammetric methods at scale 1:2,000

1.4 Objectives of this Project

Though it is the duty of Federal Survey to produce map at varying scales for national development; but the land use decree of 1978 vests the control of land within state in the Governor of each state of the Federation. It is in this regard that state governments should embark on production of large - scale topographic maps to:-

(i) Identify the extend of each state land, number of towns and villages within its jurisdiction for administrative reasons.

(ii) Ensure effective land allocation system within each state

(iii) Record applications and grants of certificate of occupancy

(iv) Enhance revenue collection from ground rent

(v) Take inventory of resource potentials within each state.

(vi) And provide basic for planning and management of basic infrastructure for well being of the people.

Production of this large scale topographic coverage of Jigawa State will enable the Governor carry out these responsibilities.

1.5 Project

1.5.1 Location

Jigawa State with headquarters at Dutse is one of the six states created in 1996, and having twenty - one local governments. It is located in the northern most part of the country extending between latitudes 10^0 55′ 00" to 13 00′00" and longitudes 08^0 08′00" to 10^0 40, 00".

The state is bounded in the north by Niger Republic, in the east by Yobe State, Bauchi in the south, while Kano and Katsina States bounding the west and north - west respectively. It has a land mass of 22, 410 square kilometres and population of 2,829,929 people of mainly Hausa, Fulani and Galambi ethnic groups.

1.52 General Climate.

The climate of any place has both direct and indirect influence upon its vegetation, which inturn affect the soil. jigawa State lies in the Sudan Savanna vegetation zone of Nigeria. It is dry with annual rainfall less than 1000mm and light seasonal rainfall. These deficiencies develop soil richs in time, but very productive not with standing the low humus content so long as water can be supplied. The soil can support agricultural produce like groundnuts, millet guinea - corn and cassava.

Plants covers are mainly grasses which are kept short by great herd of cattle grazing in the state compared to other in Nigeria. Few tress such as data palm, silk cotton and baobao are available and scattered all over the place.

1.53 Geology

From the stand point of geology, Jigawa State is endowed with mineral resources such as kaolin, potash, amethyst, gold and copper. The state includes part of northern Nigeria affected seriously by wind erosion and desertification. There exist majors environmental problem to be tackled in this zone.

1.6 Arrangement of Thesis.

To this and, this thesis centres on large - scale topographic map of Jigawa State required for sustainable development. It is divided in four chapter. Following the introductory part is the chapter on review on methods and literature on map production. Chapter three deals with concept of photogrammetry map compilation; and finally, chapter four discusses Dutse sheet 14 as sample sheet part of Jigawa State, with conclusion highlighting the trend of mapping operation in the 21st century.

CHAPTER 2

2.0 Literature Review

2.1 The science of photogrammetry.

The relative concept of location on the earth surface originated from the fundamental attributes of distances and direction. The systematic format by which this is done was recognised more than 2,000 years ago, and the standard still remain today (Trewartha 1977).

For almost two hundred years, man has been involved in the art and sciences of determining location on land, sea, in the air, and later in outer space. Virtually all man's of his habitat on land, agricultural practices and all forms of infrastructures are space dependent. Man's travels from one place to another, as well as extra - terrestrial launches of satellite requires determination of location.

The earliest means of locating positions occupied by man and objects was done by field survey method, wherein instrument used for observation and measurement will be in - situ, and the product mainly plans and charts depicting relative and absolute position on the earth's surface. Mineral and oil exploration and exploitation were carried out using the field surveying.

As time went on, the practice of surveying advanced as a result of introduction of sophisticated theodolite, total station instruments and electronic distance measuring equipment, but there was still a limitation with this methods. Problems of exposure to different hazards on field while working, since surveyors must be directly in contact or within the vicinity of observation, they are exposed to possible attack in disputed areas, which may possessives danger to lives of survey team. Surveyors are exposed to harsh weather on field, such as rainfall, hot and cold weather depending on section.

Due to increase in population, survey in urban area has been very difficulty, movement of great number of people and vehicles make the use of ground survey approach unstable in urban area. While in the military, there is reed for fast means of carrying out surveying; and in situation of war, soldiers are interested in determining enemy location with dispatch. Hence the need for other methods of collecting information about the general environment that will take care of problems encountered in the field of land surveying; though the method is still very relevant for cadastral and engineering survey operations.

The science of photogrammetry started over a century ago as a result of read for test means of doing surveying. It involves the making of maps, plans and charts using aerial photographs. The photographs used are acquired from airborne crafts carrying metric camera flying over area of interest in a pre - determined pattern to obtain the photographs which are that are eventually used in the production of maps, mosaic and photomaps.

The science of photogrammetry evolved into want we today know as remote sensing. Basically, these two are using the same principle of acquiring data about the environment from a distance, using instrument sensitive to electromagnetic radiant energy. Data used in photogrammetry are from metric cameras which are either mounted in the surface at a close range, using terrestrial cameras, and those mounted in aircraft flying over project area at an altitude within the earth's atmosphere.

In the case of remote sensing, data are acquired using sensors sensitive to wider scope of electromagnetic spectrum, and the platforms for carrying. these sensors are usually launder into orbit at great distances in space, through there are special purpose sensors launched at lower altitude within the atmosphere.

Therefore, land surveying, photogrammetry and remote sensing, each has its relevance in providing information needed for better understanding the environment.

2.2 Reviews of Map Production

The use of maps spans over the centres primitive people of Eskimos produced maps of large areas of northern Canada without surveying instruments. These maps were remarkably well suited to their need, though they compare favourably with charts, made by surveyor using modern methods.

The first printed map is credited to the chinese in the 12th century, who produced maps clearly superiors to those of any contemporary civilization. Earlier, the famous Greek Cartographer ptolemy worked to compile maps of 8,000 places in Alexandra, scholars were able to make reconstructions of his maps.

Most maps produced in Europe in the Middle Ages were highly schematic like the itinerary maps used by the pilgrims. In the early 14th century Martin Behaim produced small globe of the earth, while by late 15th century, the production of maps greatly in created. Central to this effort was Gerhardus Mercator (1512 - 1594), who created many location on the world map, devised projections and produced a great atlas, published after his death.

The first modern atlas to appear was that of Abraham Ortelius (1570). One of the most significant contributions to the matric mapping was the English astronomer Edmund Harley, his first important terrestrial map was published in 1686.

In France, the arrival of Giovanni Domenico Cassini in 1669 was the beginning of topographic survey of that country. France led in the production of topographic mapping, and developed methods used as standard and widely adopted worldwide. The topographic mapping of France was completed in 1793 through astronomical determination.

American early maps included maps of Cape Hatteras produced in 1585 by John White; Captain John Smith's map of Chesapeake Bay (1612); Augustine Hermann's map of Lord Calvert's Maryland (1670), and John Foster's woodcut of New England (1677) was the first map drawn, engraved printed and printed in the then American colonies (ibid).

Topographic mapping by aerial photography make it possible to map areas otherwise difficult to reach. This method has reduced costs and increased the quality and accuracy of mapping. In addition, more accurate triangulation networks control; satellite information have improved topographic mapping.

2.3. Principles of Sustainable Development.

It is well established opinion that the later half of the twenty - first century has been a period of unprecedented political, social and economic change. The historian Eric Hobsbawm refers to it as a period of economic, social and cultural transformation, the greatest most rapid and fundamental in record history.

The ultimate role of economic development it mainly the improvement of standard of living or well - being among people. This involves the turning of resource, human or material into goods and services through appropriate economic programmes.

Economic development brings about considerable prosperity, but resultant consequence such as industrialisation, depletion resources, congestion and poorly planned urbanisation have brought disadvantages. Repaid population expansion in developing countries, Nigeria inclusive, is manifesting severe pressure as all available resources such as land, water, forest and air.

Resources are those things capable of creating new health; they are natural potentials which need to be enhanced for generating revenue for the people. Man will like to tap all natural resources that he needs; by so doing he destroys his environment.

Land is central to all natural resources and its characteristics are issues of human conflicts. The quality and quantity of topography, availability of surface and underground waters, nature of local climate and vegetation are issues determining the spread of man and his activities on earth surface.

As awareness of environmental problems grew in the 19th century, the 1987 world Commission of Environment and Development brought the concept of sustainable Development into the international agenda, though sustainability began to appear on national and international political agenda during the 1970s.

In 1972, sustainable development was the central theme of the United National Conference on Environment and Development (UNCED). Various national government were called upon to take actions at national level, and in particular to adopt strategies for sustainable development.

2.4 Sustainability - Nigerian approach.

In line with global objectives, Nigeria's national agenda for the twenty - first century is aimed at integrating the environment into development planning and decision making to ensure transition to sustainable development. The major challenges revolve round air pollution, water quality protection, land degradation prevention conservation practices, sanitation and biodiversity protection.

The National Policy on Environment in 1989 demonstrated the commitment to sustainable development. The policy is against human activities that are environmentally unfriendly, and mandates the right to ethical, balanced and responsible uses of land and renewable resources (Hassan, 1988).

In encouraging national, practicable, coherent and comprehensive approach to economic and social development, it is advised that everyone involved, affected and playing a role in the impairment of environment should aim at 'sane' development, devoid of negative consequences, such that environmental problems like overcrowding, poor ventilation, noise, insanitary conditions, contamination of public water supply etc. will be greatly reduced, if not totally removed.

2.5 Resource Management - Key to Sustainablity.

According to Popoola (1997), the built environment consist of spaces for every day activities of man, such as residential, educational, commercial, industrial and recreational built;t up spaces. A healthy or same development is closely linked with arrangement of buildings and structures to meet community needs without jeopardising their existence in whatever way either mans or in time to come.

The utilities brought into the environment are in line with what the people desire, the environment is improved by the extension of modern water distribution network, electricity and street lighting, surface drainage, sewage collection and disposal, refuse collection network, gas distribution network, telephone network and road and streets.

Public facilities like schools, hospital and civil halls, libraries, ire protection are provided; and economic infrastructures such as markets, shops, repair workshops and services industries, major shopping and commercial areas and industries may be injected into the city set up.

All the activities enumerated above are required to be located in geographical spaces by planners, maps are used as aid to provide knowledge about the spaces needed to make informed decisions concerning the environment. The desire to generate sound environmental behaviour to ensure standard and sustainable management is possible through increased used of maps, which are either generated from Geographic Information System (G. I. S), Remote Sensing Techniques or Through photogrammetric map compilation.

CHAPTER 3

3.0 Methodology for Photogrammetric Compilation

3.1 Introduction

Photogrammetric map compilation is based on transformation of two adjacent aerial photographs taken from two camera stations into maps. This involves conversion of two dimensional space photographs into three dimensional map space, the solution for this conversion or transformation is done mechanically on the instrument wild A8 Autograph. The principle is generally referred to as stereoscopic restitution, involving inner and outer orientations, and the plotting of map details.

3.2 Set of Data used.

A total number of six aerial photographs were used for the pencil compilation, three in each strip. figure 1 below shows these three in the first strip, made up of photograph nos 060, 061 and 062; while figure 2 are the photographs of second strip numbering 103, 104, and 105.

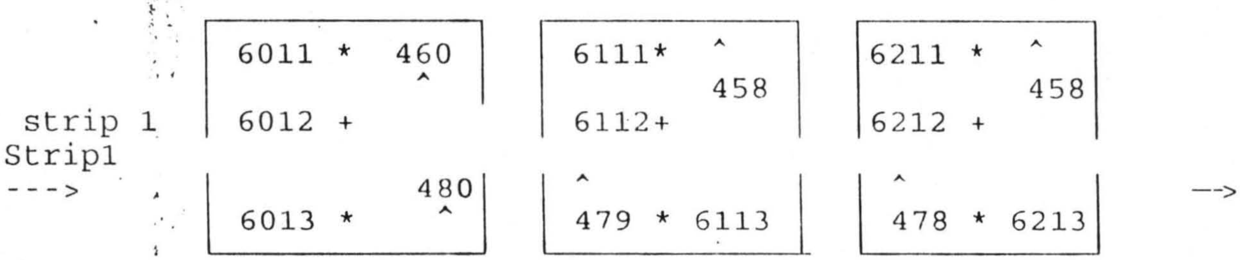

Fig - 1 shows first set of three photographs in strip one.

Figure 2 is sketch showing the relative position of controls appearing on each of the photographs on the second strip.

```
              | 1051   *   481  |   | 1041  *     ^   |   | ^      *1031 |
              |             ^   |   |            480  |   | 478          |
  strip 2     | 1052   +        |   | 1042  +          |   |        +1032 |
Strip2
--->          |              ^  |   |             ^    |   |  ^           |      -->
              | 1053   *    508 |   | 1043  *     507  |   | 506    *1033 |
```

Fig 12 shows second set of three photographs in strip two.

From the three photographs in each strip two models were formed. In strip one, we have models 1 and 2 as shows in figure -3 and

strip 1 ---->

* 6011	^460	*	^	*
		6111	459	6211
+ 6012		+		+
		6112		6212
6013	^	*	^	6213
*	480	6113	478	*

strip 1 ----->

model 1 model 2

Fig - 3 sketch showing model formed from photographs in strip one.

in strip two, we have models 3 and 4 in figure - 4 below.

strip 2 ---->

*	^	*	^	*	1031
1051	481	1041	478		
+		+	^	+	
1052		1042	480	1032	
*	^	*	^	*	
1053	508	1043	507	1033	

strip 2 ----->

model 4 model 3

Fig 4 sketch showing models formed from photographs in strip two.

Note that figures 3 and 4 show a total of four models covered the project area.

3.21 Determination of Extent of Project Area.

The following information were supplied as part of specification given in the acquisition of aerial photographs.

Format size: 230mm * 230mm

Camera Type : Wide Angle (151.84mm)

Forward overlap:60% of 230mm

Lateral overlap:20% of e30mm

Photography scale:1/6000

where sp - F/H

Sp :- photography scale

F - focal length of camera

and H - flying height of air craft

Below is shown two overlapping photographs to illustrate the positions of principal points and conjugate principal points.

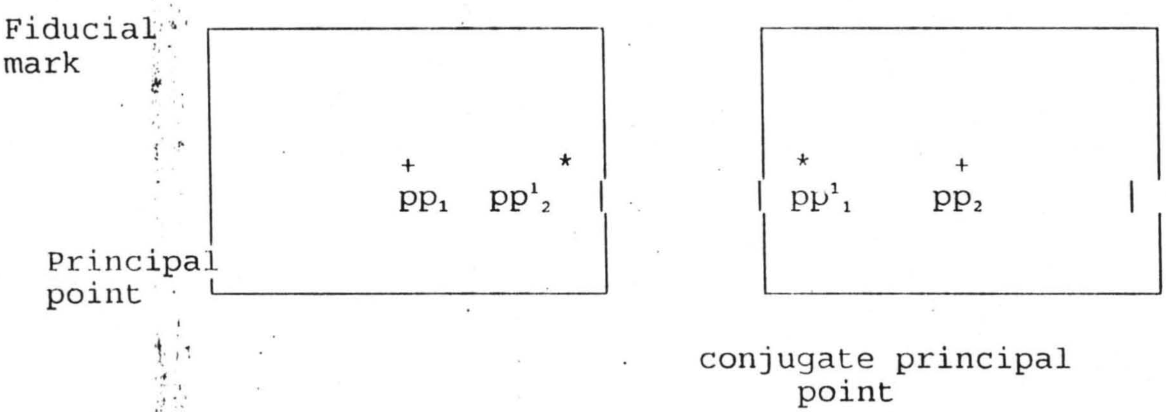

Fig 5 shows relative points of fiducial and principal point on adjacent photographs

When these two photographs are combined together to form an are of neat models, we have:

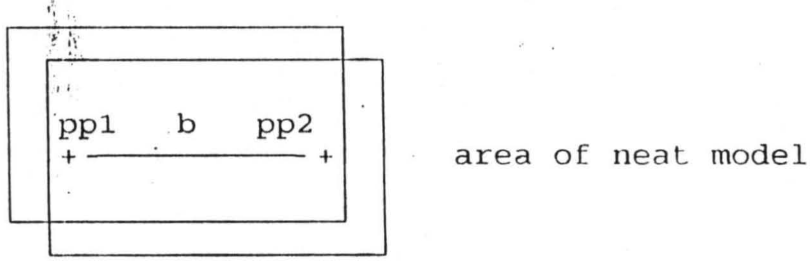

Fig 6 shows sketch of area covered by one model. The distance between any adjacent principal points pp_1pp_2 is the photographic base, b. The diagram below in figure 6 demonstrates how the area covered by the project is to be computed from overlapping photographs.

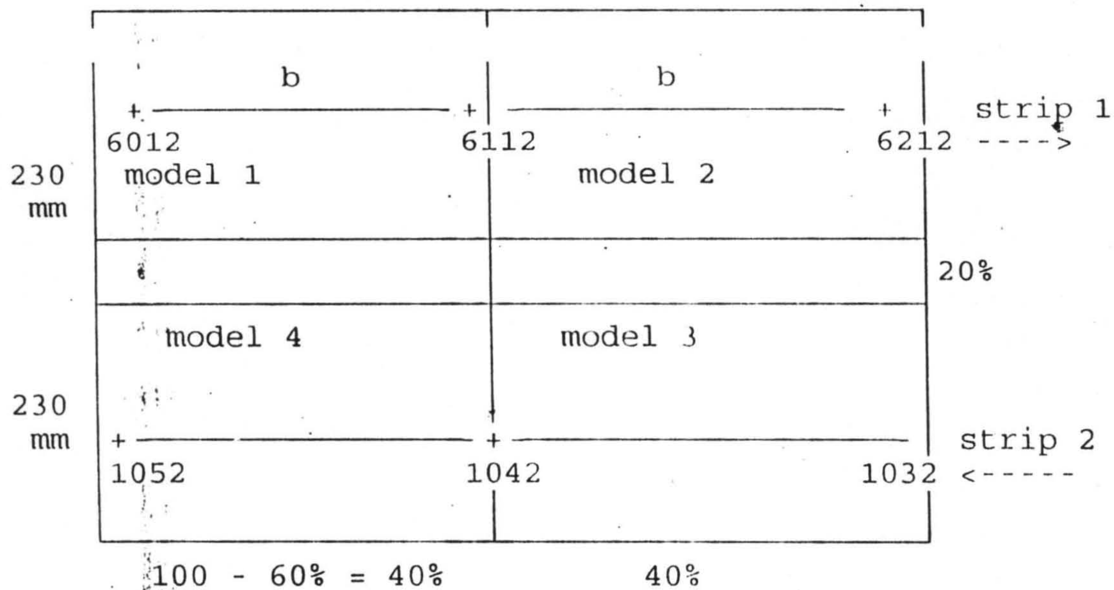

Fig 7 sketch of area covered by project.

The distance b is computed by:

100 - 60% = 40%
40/100 * 230mm = 92mm

ie b = 92mm

The length of project areas 2b = 184mm. The lateral overlap area of 20% common to strip one and two is computed as

20/100 *230mm = 46mm

The width of project area is computed as 230mm + 230mm - 46mm = 414mm

The length and width computed are distances on paper; on the ground, the photographic scale 1:6000 is used for conversion

Length - (184mm * 6000)/1000 = 1,084m or 1.084km

Width - (414mm * 6000)/1000 = 2,484m or 2.484km.

Therefore, the project area is deduced as

1.084km *2.484km = 2.693km^2

3.22 Determination of Model Scale

Model scale refers to the precision of plotting instrument; it is used to establish relationship between stereoplotter and the map table. usually on a stereoplotter, the view formed by the intersection of conjugate rays is known as stereoscopic model.

It should be noted that he accuracy of any measurement obtained from model formed, depend on instrument capability and orientation processes (which will be discussed later) is determined by the largest possible models scale chosen for compilation.

The largest ratio between photograph and model scale is calculated as follows;

From known photo scale and focal length given earlier, we have: Z_{max}/f = 350mm/151.84mm = 2.3

The largest possible ratio is:

SM = sp - 2.3.

sin.= 6000 - 2.3 = 2571.4

From the model table or chart the nearest value to that computed is 3000, therefore model scale chosen is 1:3000.

3.23 Determination of Gear Ratio

In order to establish the ratio at which details will transmitted from instrument model to map table or coordinatograph; the gear ratio is calculated as:

gear ratio = sm/ms

where sm - model scale and

ms - map scale, hence

g.r. = 1/3000/1/2000 = 2000/3000 = 1/1.5.

The adequate gear ratio used for transmission is 1:1.5.

3.24 Preparation of Map Sheet.

Map sheet was grided based on the number of squares computed from the highest and lowest coordinate values of controls used in compilation in both nothings and easting. The process is as follows:

plotting/map scale - 1:2000

1mm --> 2m

1cm --> 20m

10cm --> 200m

The grid interval at map scale 1:2000 is 200m. Based on the coordinate of controls used, the highest coordinate in northing is 1296664.574 and lowest is 1294281.257; while in the easting, the highest is 539194.378 and lowest 537387.802.

In determining number of squares in both northings and easting, we have:

129664.574		539194.378
1294281.257	and	537387.802
<u>2383.314</u>		<u>1806.576</u>

Number of squares in the northings are

2383.314/200 = 11.916 ~ 12 squares

and in the easting, it is

1806.576/200 = 9.033 ~ 10 squares

Therefore 12 * 200m = 2400m for northings and

10* 200m = 2000m for easting; from 537387.802, the closest round figure is 537300 and for 1294281.257 the closest is 1294200. For the highest values in northings --> 1294200

+ 2400

<u>1296600</u>

and highest value easting --> 537300

+ 2000

<u>539300</u>

The sketch of grided sheet is as follows;

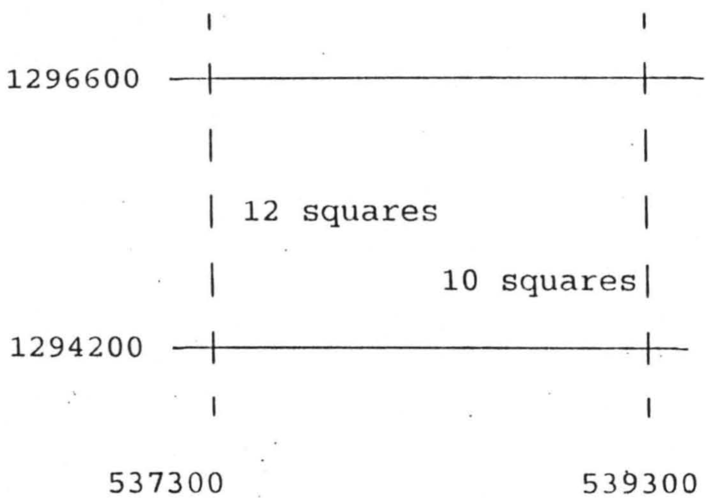

Fig - 8 shows a sketch of map sheet.

3.25 Autograph Wild A8.

wild A8 is a mechanical projection type of instrument with high performance lenses. Its main features are:

(i) Lazy tangs - as tracking units for photographs;

(ii) Intersection of space rods in a single model point

(iii) Common rotation phi (Q) for the projection system; but there is not 'by' and 'bz' as base component, only bx as instrument bas

3.251 Input for Wild A8.

In order to successfully use a wild A8 instrument, the following information should be known:

Format size; 230mm * 230mm and smaller photographs, normal and wide angle near vertical photographs, dispositions and negatives on glass plates or film base, paper prints and focal length range 98mm - 215mm.

3.252 Output from Wild A8.

The following operations are possible on wild A8. Large scale line maps, independent model Triangulation (IMT), numerical restitution for cadastral and engineering applications.

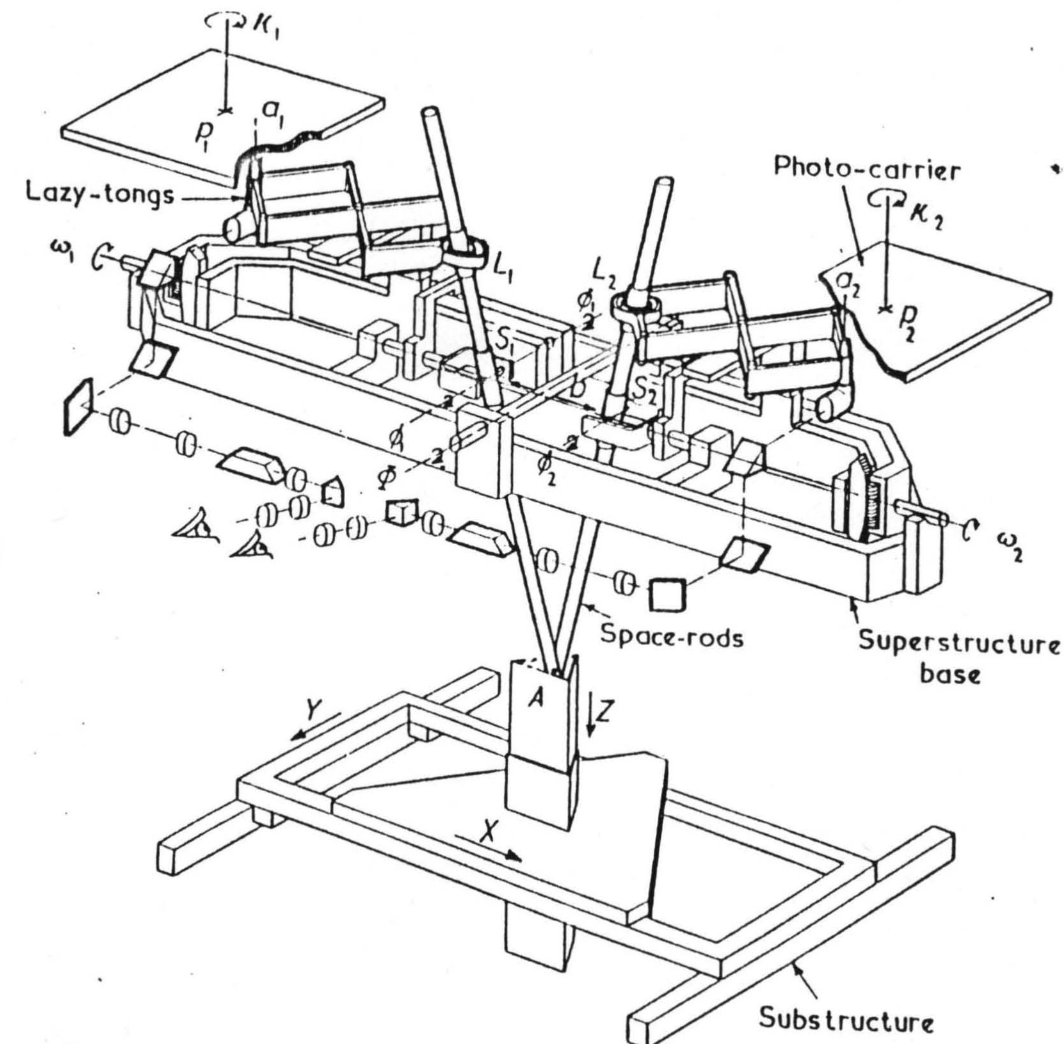

*Fig*9. A8 autograph space-rod diagram. (*Wild, Heerbrugg Ltd of Switzerland*).

From the diagram in figure - 9, we have

p_1p_{11} - as photo points

L_1L_{11} - Mechanical photo points

o_1O_1 - Mechanical projection centres

m_1m_{11} - Measuring mark

p - Mechanical model point

f - Principal distance, the length of perpendicular from O_1O_{11} to the mechanical photo planes described by lazy tangs.

bx - distance o1o11, the instrument base

z - instrument projection distance

3.253 Determination of instrument BX.

An approximate base should be introduced with model scale before orientation processes start, so that subsequent scale connection is kept minimum.

To compute approximate bx, the following formulate is used:

bx - photo scale/model scale * photo base

Sp = 6000

sm = 3000

Therefore bx = 6000/3000 * 92mm = 184mm

The approximate bx of 184mm will be set on the instrument.

3.3 Photogrammetric Principles

The principle of photometric is based in stereoscopic restitution involving the combined processes of inner and outer orientations, and the plotting of maps details.

3.31 Inner orientation

This process has to do with cantering of diapositive on the instrument left and right photo - carriers. To set up a model, two overlapping photographs were used; each of which was mounted on the camera and cantered with the aid of light table. The fiducial marks on each photograph were set to coincide with similar marks engraved on photo camera.

After both carriers with set diapositives are returned to the instrument, and camera focal distance introduced onto the instrument projectors by setting the dials on them. The process of inner orientation, the re -establishment of same relationship that existed between aerial camera lens and photographic plane on stereo plotter is complete. This stage is a fundamental one upon which accuracy of outer orientation greatly depend.

3.32 Outer orientation

The outer orientation of Wild A8 instrument consists of relative and absolute orientation of instrument projects.

3.321. Empirical Independent Relative Orientation

The points used for relative orientation performed empirically are standard at six points in the stereoscopic model spaces as shows in figure 10 below.

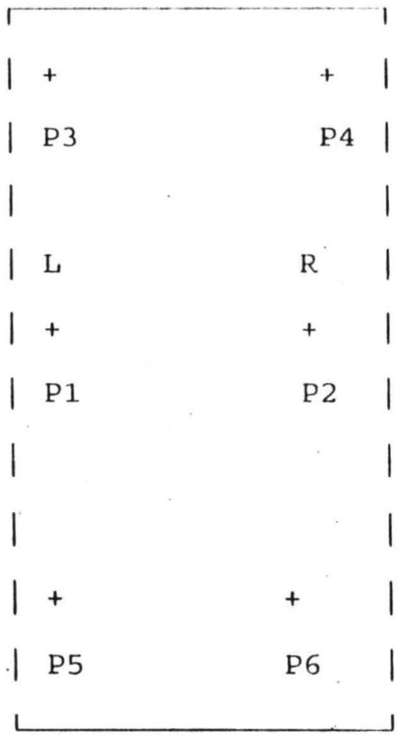

Fig - 10 shows position of standard points in any model.

The diagram in figure to shows on overlap area projected from two mounted diapositives, where

Lp1 - project of principal point at the left hand diapositive

RP2 - Projection of principal point at the right hand diapositive.

P - 3,4,5 and 6 - are points at the corners of neat model, located as orientation points.

The relative orientation of any model, carried out empirically on wild A8 is done using the elements of both left and right projects - K^1, K^{11}, Q^1, Q^{11} and w^1 or w^{11}.

where k - kappa element

Q - Phi and

W - omega element

These elements were used to eliminate Y - parallax at particular points based on following criteria:-

- for any given point, y - parallax is removed with element which causes maximum y - displacement at the point
- in removing y - parallax at other points, element (s) used must not create parallax at any point cleared before.

The steps of empirical independent relative orientation are started as follow:

Step 1 - estimate parallax at p - 1 and remove with k"

2 - estimate parallel at p - 2 and remove with k^1

3 - estimate parallax at p - 3 and remove with Q^{11}

4 - at this stage p - 1,2,3 should be free from y - parallax.

5 - estimate parallax at p -4 and remove with Q^1

6 - estimate parallax at p-5 and remove with w^1 or w^{11}, because they both have the same effect. In connecting for omega, an ensure quick convergence in the removal of y - parallax throughout model standard points.

7 - Repeat steps 1 - 6 until the whole points are free of y - parallax.

8 - p - 6 is used for checking. It must be free of parallax; if not, the whole steps must be repeated.

Relative orientation has to do with geometrical error connection, whereby shape f features in model space are corrected.

3.322 Absolute orientation of stereomodel

The reason for absolute orientation is to adjust the relative oriented model to conform in scale horizontally and in vertical position with datun of a map sheet. The relative positions of control points are shown in figure 11; these plotted positions on map sheet are compared to those of respective images appearing in he model space.

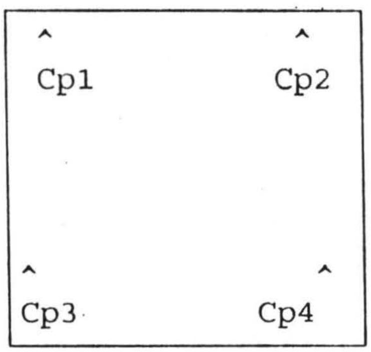

Fig - 11 indicating positions of plotted controls on map sheet

A minimum of three vertical and two horizontal control points are needed for each model. Though four controls whose x, y, z coordinates are known, are also adequate for this purpose. These points fall approximately at the corners of each stereoscopic model or chosen such that they fall at those places as shown in figure 11; coinciding approximately to the relative orientation positions 3,4,5 and 6 as shown.

Absolute orientation is of two stages:

(1) sealing and (11) levelling

(i) Scaling

For any model set up on the instrument, out of four control points appearing, any two diagonal points are required for this process. For instance, Cp1 and 2 were used for horizontal scale correction. These points must have been plotted at required map scale on the map sheet.

The situation is such that diagonal distance cp - 1 and 2 on the model was compared with corresponding distance on the map sheet this was done by increasing or decreasing the instrument base (bx) to vary the projection distance, so that the two distances compared fit. When this is achieved, the process of scaling is completed.

(ii) Levelling.

This stage is final step in absolute orientation out of four controls, three are required for levelling the fourth is only needed as check point.

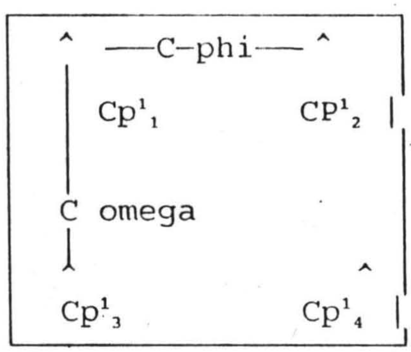

Fig 12 shows the two axes of absolute orientation in a model.

The diagram shown in figure 12 indicate the different axes of levelling, along common phi. (Q) with effect on x - axis and common omega (W) with effect on y - axis. The process involves 'forcing' datum heights of each of the three control points 1,2 and 3 on the model by tilting and tipping the plane in x and y directions using common elements phi and omega, until ground values are obtained for each of these three points.

Note that control point cp_4 is used only as check, if discrepancy does not exceed plus or minus (+/-) 0.5 of contour interval of plotting, the levelling process s accepted.

A check is repeated on model scale along diagonal because sometimes discrepancies may occur while performing levelling. The process of scaling is then quickly done, this time process will be faster, because of levelling that low been completed; the tow process of scaling and levelling are repeated until a finer result is obtained. The instrument is set ready for map complication.

3.33 Map Compilation or Plotting

The outline of any neat model defines the extent of are that is mapped whenever a model was set up, and oriented in space correctly. a composite of each model compiled covers the map sheet. Measurement of details were mode point by point and line by line in each model space, such that all measurements are transferred automatically by the interface system between instrument and the adjacent plotting table, on which map sheet is laid. The project area covers approximately 2.693 square kilometres if four models observed from two adjacent strips.

CHAPTER 4

4.0 Sample Sheet: Dutse Township Map.

4.2 Basic Features

The outline of this map is 75cm * 50cm, covering an area of 1.5 square kilometres. It enable the addition of such information as grid, scale and base data. Other features are the various conventional symbols known collectively as map data, that is map legend or key and lettering on the map body.

4.11 Grid Lines

The grid are network of lines used on the map. They are evenly spaced lines as 10cm interval on this map based on map scale. Each crossing of grid is at 90^0. It is referred to as cartesian grid. The Dutse Township map in the northings range between grid values 1295000 - 129600 and in the easting between 538000 - 539000. These coordinates are reference system used for locating positions on the map. They are similar, but do not have direct relation to latitude and longitude.

4.12 Scale of Dutse Township Map.

The most common ways to represent may scale are the fraction or ratio;. The verbal statement; and the graphic or linear representation. In this case, all the three types are used as shown on the map. At the tap, on the left side of the map is the representative fraction scale, while both statement and linear scales are placed by conversion at bottom. For examples, the representative fraction is shown as 1:20000, and statement scale as 1cm to 20m. This indicates that one unit on the map equal 2000 units on the earth; the same relationship is expressed in statement as one centimetre equal twenty metres.

4.13 Base Data and Symbols

Base data refer to background information being mapped. On this map, information mapped are streams, roads, trades, contours boundaries, area and vegetation cover.

The purpose of legend on the map is to form users of the meaning of various symbols used on the map; it thereby serve as a key explaining the map.

4.14 Lettering and Names on the Map

The lettering on this map was done using established conversional applied in cartographic lettering. The more important the feature, the larger the lettering and vice versa. For instance Rasheed Shekoni road covers a larger part of the road; and the same for Ahmadu Bello Way at the South - West end of the map. The spacing of letters and worlds is highly variable according to the area covered by the features named.

4.2 Prospect of this Map.

The Dutse Township map will be used by administrators and land managers to ensure that human development can be sustained in the following way:-

(i) Provide information for public policy making in the area of agriculture, fisheries, transportation, residential, education commercial, industrial and recreation.

(ii) Enable town planners understand the landscape of the area for effective dispensation of their work. The map shows drainage pattern, topography, area covered by vegetation, and other landuse.

(iii) Studies can be carried out from this map about information such as roads and streets network, residential set up etc.

(iv) From general view of the area, assessment of water resources development potential can be done. Data on quantity of water needed for domestic, industrial and agricultural users can be extracted.

(v) Revenue collection will be enhanced from ground rent, and will also stimulate effective land allocation scheme.

(vi) Finally, this map will serve as base for planning, management and development activities.

4.3 Conclusion: Trends in Map Production

There has been an increase in the use of computer worldwide, this has also stimulated change in the trend of mapping operations in recent time towards digital mapping system.

For example, photogrammetric map production and data collection are being replaced form analogue to analytical and/or digital systems. This is evident in the instrumentation change to Digital Terrain Model (DTM)- from Analogue plotters.

Mapping sciences such as photogrammetry, Remote sensing, photo/Image Interpretation, Global Positioning System (GPS) and Geographic Information System (GIS) are emerging as promising tools for land management.

Geographic Information System as management tool is used to collect data, store, analyse and present information to make decision easier for users of such information. It is time state and Federal mapping agencies all over the country engage GIS fully to manage production of maps in an effective to manner to facilitate:-

(i) Availability of appropriate maps needed for planning.

(ii) Digital mapping system will enable fast reproduction of map at any scale without difficulty.

(iii) The use of computer enable map information to be kept in data bank, while updating and retrieval for various planning activities will be done without problem.

(iv) Problem of map revision is removed as information are kept in data bank, while information are kept in data bank, while new data are added for updating any times

(v) Problem associated with cartographic presentation is completely overcome with the use of complex computer graphic designs.

(vi) Problem of preserving map sheets is remanded with use of computer data management system.

(vii) Mapping operations are now enhanced as a result of high speed at which data can be acquired and information retrieved to manage the entire environment.

Maps are therefore required as tool for bringing balance between development, environmental protection and likely consequences of environmental changes. In doing this, I have briefly highlighted the inescapable danger of non-availability of maps. No meaningful development planning and execution can be done for regulating human activities without use of maps.

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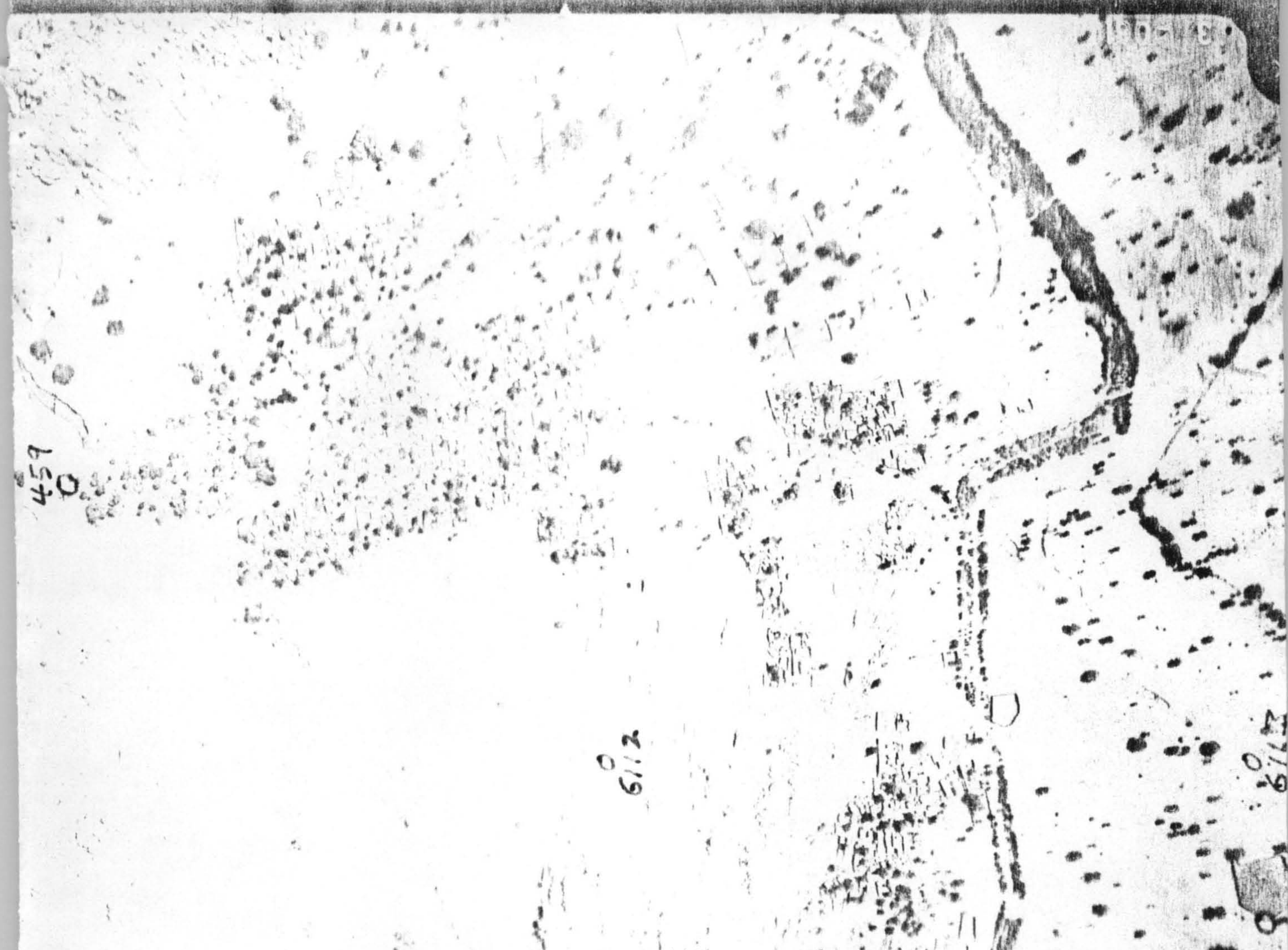
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