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SPATIAL DISTRIBUTION AND SETTLEMENT SYSTEMS: A CASE STUDY OF THE SOUTH WESTERN KENYA STONE STRUCTURES

A THESIS SUBMITTED TO THE DEPARTMENT OF HISTORY IN PARTIAL FULFILLMENT OF THE REQUIREMENTS FOR THE DEGREE OF MASTER OF ARTS IN ARCHAEOLOGY OF THE UNIVERSITY OF NAIROBI.

BY

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DECLARATION

This thesis is my original work and has not been presented for any degree in any University.

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Signature

This thesis has been submitted for examination with our approval as University Supervisors.

1. Prof. C.M. Nelson ______________________

Signature

2. Dr. H.W. Mutoro ______________________

Signature

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ABSTRACT

The stone structure Sites in South Western Kenya (SWK) Lake Victoria region mark points where early immigrants to the region settled. This work provides an interpretation of their location in space and distribution pattern here termed as settlement pattern. The work also establishes variables for site and individual structure location otherwise termed as settlement systems. This has been done by considering on the on set of the work that construction and location of *Ohingni* was a result of several interacting factors leading to a non random pattern of settlement. After a further consideration of settlement patterns, it was found out that clustering of both sites and structures could be a result of independent attraction of structures toward an unevenly distributed resource areas or attraction of structures toward each other and that structures were possibly located on areas safe from wild animals and free of water logging.

Nearest Neighbor Analysis (NNA) and Cluster Analysis (CA) as both descriptive and analytic methods reveal that these early settlements were clustered on particular resourceful areas. The R coefficients and CA results indicate that the settlements were highly clustered. This general pattern contains other sub-patterns related to particular variables within the cluster areas. This include Hilly Cluster patterns, River headland cluster patterns, Near the Lake cluster patterns and Dry spot cluster patterns. Associations between individual structure and cluster areas is also evident through the CA results although this will need further research and verification.

The distribution of the structures show that most settlements were located on hilly areas endorsed with abundant loose basalt rocks for structure construction. This was a prime determinant factor for location. The existence of other factors such as good drainage, water and land around hilly areas also explain hilly preference. These together with a number of social factors interact to generate a process of structure and site evolution forming a distinct settlement system model. This is basically a set of rules systematically developed to govern the location. expansion and spread of the structures in the region. At the end of the tradition. about early 20th Century, the rules had become outdated leading to different approaches in settlement strategies. In the overall, the work has completed the documentation of the stone structure sites from a reliable survey in the South Western Kenya region. It has also put forward. identified and evaluated several variables for the Ohingni distribution and lastly analyzed the settlement pattern by use of NNA and CA as would be done in any similar cases of agricultural adaptations.

ACKNOWLEDGMENTS

This work owes much to the comments and advice of my supervisor Professor C.M Nelson who spent many hours reading and streamlining this manuscript to its current shape. He also availed his computer expertise to aid in solving most of the analysis problems in this work. He does not, of course, share my responsibility for any errors which remain.

Many other individuals made this work and the field research it is based on a success. All my teachers at the University who prepared me as an archaeologist between 1988 and 1994. George and Janet both of survey of Kenya made it possible to obtain aerial photographs and a stereoscope which were important in revision mapping of the stone structures. George also prepared data for NNA and distribution maps from field sketches. Richard Ondiek of Thimlich Museum provided exceptional support, wise counsel, and skillful assistance through the field research in the bushy landscapes.

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CHAPTER ONE

INTRODUCTION

1.1 The *Ohingni* of South Western Kenya.

This work is an investigation of the spatial distribution of the stone structures locally known as *Ohingni* (*Ohinga* - singular) in South-Western-Kenya, Lake Victoria region. Distribution mapping, early patterns of human settlement as revealed by the structures and factors that led to such patterns, or "settlement systems" , are the major topics of analysis.

Important in this investigation, as in any other settlement pattern study, is the assumption that a pattern does exist if one can detect it (Earle 1976). This work focuses on aspects of early settlement strategies in order to explain the patterning of early settlements in the region.

The reason why this topic was chosen is twofold. First, it was desired that the study of the stone structures move towards an imaginative end away from the previous descriptive works, for example, Gillman (1944), Lofgren (1967), Onjala (1990) just to mention a few. Such descriptive works are spring-boards for further investigations. They aid in gaining a first understanding, a sense of problem and a preliminary classification which may become useful in solving problems of process, pattern, and interpretation. An investigation of the settlement pattern as revealed by the structures, and the determining factors of site location are especially useful in the study of the *ohingni* of South Western Kenya (SWK) .

The second reason why this topic was chosen was to evaluate ethnohistoric statements concerning the structures. This evaluation is aimed at finding reasons why the structures were located in the areas where they are found. It includes an examination of the relationship between the structures and their environmental, historical and socio-political determining factors.

1.2. The Aims of the Research.

This work examines the distribution of the stone structures. It is aimed at mapping the "total universe" of the surviving structures. This is important as most structures are being destroyed (Section 2.5).

Nearest Neighbor Analysis and Cluster Analysis (NNA and CA) are used to describe the pattern of spatial distribution of the structures. These were used to test whether the structures are clustered as observed. This was to eliminate bias which would arise by merely looking at and concluding that the structures are random, clustered or regular in distribution. The pattern discovered in this analysis is then used to search for and establish the factors of location for each structure .

A working hypothesis is proposed that construction and the location of *ohingni* is a result of several environmental, historical, and socio-political factors leading to a non random pattern of settlement. By several factors or critical resources pulling against each other in the location of the structures, patterns deviating from random and tending towards clustering were seen to be likely.

1.3. The Area of Research.

The fieldwork upon which this work is based was conducted in the months of October to December 1991, and January and April 1992. The area that was covered is approximately 1,300 km^2 and includes the lake region lowlands of Migori and Homa Bay Districts. Administrative divisions of Mbita, Ndhiwa (Homa Bay) and Nyatike (Migori) fall within this region (Figure 1.1).

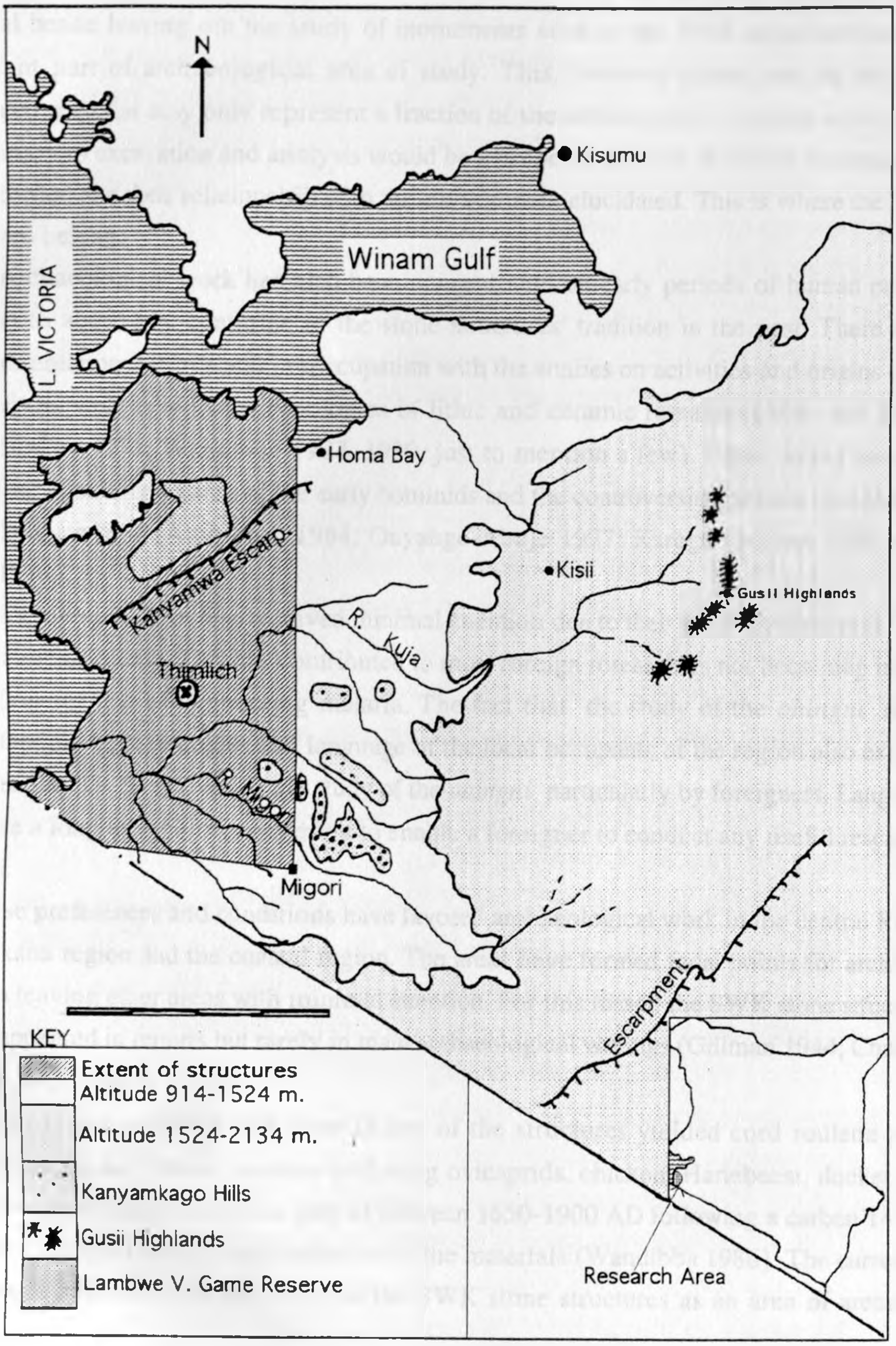

Figure 1. The area of study showing major geographical features.

This area has a landscape spotted with numerous stone structures which are remains of early settlers' activities in the region. These have received minimal archaeological consideration due to the following reasons.

1. Much of the archaeological work within the country has involved analysis of excavated material hence leaving out the study of monuments such as the SWK stone structures a lesser important part of archaeological area of study. This, however should not be the case since excavated material may only represent a fraction of the whole cycle of human activity. Essential preliminary to excavation and analysis would be a proper field work in which sites are discovered and recorded and their relationship with the environment elucidated. This is where the SWK stone structures belong.

2. Archaeological work has also been concentrated on early periods of human prehistory as opposed to about five centuries of the stone structures' tradition in the past. There has been a strong orientation towards and preoccupation with the studies on activities and origins of the early hominids as well as with the typologies of lithic and ceramic remains (Collet and Robertshaw 1980; Leakey 1931; Wandibba 1977, 1980, just to mention a few). Other works have revolved around the economic pattern of the early hominids and the controversial pastoral neolithic and parts of the historic time (Amborose 1984; Onyango-Abuje 1977; Karega-Munene 1986 and Sutton 1966, 1973).

3. The *ohingni* have also received minimal attention due to their harsh environment which falls within a malaria zone. This has contributed to most foreign researchers not becoming interested in the region for fear of contracting malaria. The fact that the study of the *ohingni* requires an understanding of genealogies and language of the local occupants of the region also explains why less attention has been given to the study of the *ohingni* particularly by foreigners. Language study may take a long time before mastering to enable a foreigner to conduct any useful research on the *ohingni.*

These preferences and conditions have favored archaeological work in the central Rift Valley, the Turkana region and the coastal region. The areas have formed focal points for archaeological research leaving other areas with minimal attention. For this reason the SWK stone structures have mostly appeared in reports but rarely in main archaeological writings (Gillman 1944; Chittick 1965; Lofgren 1967; Onjala 1990).

The only excavation so far done in any of the structures yielded cord roulette potsherds, grinding stones and faunal remains including ovicaprids, chicken, Hartebeest, ducker, hare and fish. These were assigned a loose date of between 1650-1900 AD following a carbon 14 dating on a charcoal sample found in association with the materials (Wandibba 1986). The current work is therefore a furtherance of the study of the SWK stone structures as an area of archaeological research.

1.4 Geographical Background.

Homa Bay and Migori Districts cover the lower Southern part of the Western Kenya region occupying an area of approximately 7,778 Km^2 South of the Winam Gulf of Lake Victoria . The regions climate has been characterized by Ojany and Ogendo (1973) as modified Equatorial with a marked rainfall variation and is lower than that of a real equatorial climate. This varies between 700-800 mm in the lake shore region and 1400-1500 mm in the higher eastern region. These amounts fall in two marked seasons of the long rainy season in the months of March to July (40% of total) and short rainy season from October to December (28% of total). The remaining 32% of the rain is distributed in the other months of the year.

The area is moderately high with a minimum altitude of 1163 m above sea level. The lake shore lowlands rise to heights of 1163-1219 m while the inland plateau rise to heights of 1220 to over 2272 m above sea level. The gently rolling land in the middle of the region is interrupted by Gwasi and Gembe hills to the north as well as Ruri, Homa mountain massifs and Kanyamkago hills to the east. These hills contribute to the land's general sloping towards Lake Victoria forming a closed basin. This, however, does not affect the temperatures which range from a minimum of 14-18° C to a maximum of 30-34° C. The breeze from the lake has a strong cooling effect which reduces the temperatures.

The hills which bound the two districts on the east and north have contributed to the distinct drainage pattern which together with other rivers of the Lake Victoria basin form centripetal drainage pattern. Kuja, the main river in this region, flows from Gusii highlands draining a basin of 5,180 km^2 together with its tributaries such as Ongoche, Migori, Osani, Sare and Riana (Ojany and Ogendo 1973). This network of rivers and streams provide fertile valleys within the region which provided a natural attraction to farmers, fishermen and in general, settlers who consequently exploited the resources. Settlements depended on the availability of water which was provided by the same streams and rivers.

Ecologically, Ojany and Ogendo (1973) have grouped the region under the Lake Victoria ecological zone. This is dominated by scattered tree grassland or low tree-high grass *(Combretum-hyparrhenia)*. Grass rises to heights between 1.5 and 2.5 m while trees (thorn bush or small trees) go up to between 3 and 4.6 m. with the highest reaching 9.1 m. (Edwards 1940; Edwards and Bodgan 1951; Ojany and Ogendo 1973).

This vegetation is capable of supporting a number of animals especially ungulates. These were many in the region in the past compared to the present when only a handful are still found in areas where the natural habitat remains more intact. Lambwe Valley is a case in point where such animals are still found. Some of these include Warthog *(phacochoerus aethiopicus)*, bushburk *(Tragelaphus scriptus)*, Defassa water buck *(Kobus defassa)*, Impala *(Aephyceros mampus)*, buffalo *(Syncerns caffer)*, Hippo *(Hippopotamus amphibius)*, Roan antelope *(Hipportragus aquinus)*, spotted Hyena *(Crocuta)*, Leopard *(Panthera paredus)*, Jackal *(Caniz mesomelas)*, Baboon *(Papio anabis)* and domestic animals (East African wildlife society 1977, survey of Kenya).

The role of such a diverse ecological and physical conditions in influencing the patterning of early settlements seems to have been of a considerable significance. The aquatic resources, basically fish, possibly attracted settlements towards the lake leading to near - the lake settlements. The interior rolling lands drained by several streams and dotted with low hills endorsed with loose basalt rocks and fertile surroundings were possible suitable settlement areas. Thus the lake, fertile valleys and plains or level ground, high forested hills and wildlife zones formed possible physical and ecological factors that affected the distribution and settlement of the early populations in the SWK Lake Victoria region.

CHAPTER TWO

OHINGNI: A RECORD OF SETTLEMENT STRUCTURE AND DISTRIBUTION

2.1 Sites, Artifacts and features

Fagan (1985:591) defines a site as " any place where objects, features, or ecofacts manufactured or modified by human beings are found. " This follows the traditional view of a site as any place where there are relatively dense traces of ancient occupation or activity as developed by Hole and Heizer (1973:86-87), Heizer and Graham (1967:14), Hester (1975) and Fagan (1978:82, 1981:93). Traditionally, the site formed a unit of archaeological investigation which with time attracted various analytical approaches. In the present work the concept has been adopted in the study of the ohingni which are concentrations of ruins of past settlements or built environments. They are traces of ancient occupation and other activities related to that life. The site approach to such concentrations allows for a first understanding of most valuable archaeological data derived from precise studies of associations between different concentrations without incorporating the complexities of modern approaches to the term site. This approach also makes the site both an observational and analytical unit.

Despite the widespread application of the traditional notion of the site both in the past and present, the analytical use to which the term has been put has come under increasing criticism within the last twenty years. Most archaeologists consider a site as a spatial localization of artifacts, a concentration in space of recognizable by-products of human modification of natural material, for example stone tools, lithic debris, or pottery sherds (Binford 1992). Through the works of Clarke (1972), Schiffer (1972, 1976, 1983), Foley (1981a), Dunnel and Dancey (1983), it has become clear that structuring of archaeological evidence only in terms of such desecrate spatiotemporal units is conceptually unsatisfactory. This may often be inapplicable and highly selective as a record of human behavior. Recommended to booster the traditional site concept is an approach based on the archaeological landscape (Zvelebil 1992). This enables the researcher to relate the distribution of archaeological materials to geomorphological forms and also to establish the variation in the stability and conditioned dynamics of landforms in more sophisticated ways than might be possible if we had less complete distributional information confined to high-artifact-density areas.

This notion of archaeological landscape has been incorporated in the study of the *ohingni*. Spatial relationships of the *ohingni* has been looked at inorder to infer the past use of the landscape in terms of structure construction and human preferences. Despite the discontinuous distribution of the sites, use of the landscape is still clearly evident in the areas of ohingni concentration. The work here, therefore, is to interpret the density and character of the more or less continuous distribution of the structures. More continuous distributions are found at the individual site level where structures are linked by corridors or small spaces between them. Less continuous distributions are found at the regional level where sites are separated by wide spaces at times in the tune of several kilometres.

But are the *ohingni* artifacts or features. Fagan (1981:574) defines an artifact as any object manufactured or modified by human beings and a feature as an artifact such as house or storage pit which can not be removed from a site. By these definitions the structures may be grouped in either of the two groups. However, considering the fact that they cannot be removed from the sites even though they qualify as artifacts because they are made by human beings, they are more of features than artifacts.

The *ohingni* have similar analytic characteristics to features that may be found in any archaeological setting. Though they may be considered as spatial localization of artifacts or as concentrations in space of recognizable by-products of human modification of natural materials, they remarkably differ from this unit of analysis. They cannot be taken out of their positions back to the laboratory for observation. Their description and analysis must be completed in the field. This qualifies them as features. They also exhibit a structured and, importantly, a complementary pattern among different things (in this case pieces of stone and various types of structures) that has reference to past organizational dynamics. This organization was by no means done by human agents. This further points toward the feature notion of the structures. In their archaeological context, the ohingni have been dealt with at two levels. First, at the site level, that is the location of the structures, and secondly at feature level, that is the characteristics and distribution of structures within sites. The term site, therefore, is used to mean the desecrate place where one or more structures are found.

2.2. The Identification and Distribution of *Ohingni.*

The purpose of this work is to map the location of *ohingni* in the entire region of study. For this reason an intensive and extensive search for these structures was launched in the entire region to recover all locations of the structures. This was necessary if the purpose of the work to establish the early settlement pattern in the region was to be realized. Only a complete recovery of all locations of structures could fulfill this purpose. This search was started by a systematic examination of aerial photographs. These were obtained from the survey of Kenya offices but could not be used in the field because there was no budget to purchase prints. So they were examined at the survey in stereo pairs through a mirror stereoscope and settlement data transferred to maps at a scale of 1:50,000 by means of revision mapping.

The stone structures in a three dimensional stereoscopic view appear as rings on the photographs. Initially , only a few photographs covering the central part of Macalder region were examined. They were mainly used as guidelines to localities and the types of topographic features to be visited in the field. Only a few photographs were examined closely to determine where the field survey should be focused.

The method that was preferred for field identification of structures was foot survey and observation. This was done from structure to structure until the whole area was covered. To quicken movement, bicycles were used. These were also used in transporting the field equipment, including the maps, writing materials, data sheets, a tent, measuring equipment, pangas and personal effects.

Foot survey was preferred for this stage for two reasons. First financing was limited, making it impossible to use a vehicle. Secondly, much of the study area is inaccessible to vehicles. Motorable tracks are few leaving large parts only reachable on footpaths.

During the survey, recourse was made to local expertise. Mr. R.O. Odero, the curator of Thimlich monument, was hired as a field assistant. He knew much of the region and led the way to most of the structures. Tips from the local residents also gave direction as to where the structures were to be found. These together with information from the aerial photographs (Table A.1) and the use of 1:50,000 topographical maps, led to the identification and mapping of structures, whether destroyed, poorly or well preserved.

By the end of survey and photograph examination, a total of 138 sites containing 521 structures was found. These were concentrated in the Kadem-Kanyamkago areas (Macalder sheet 129/4), Karungu area (Karungu sheet 129/3), Gwasi and Kaksingri Lake headlands (Gwasi sheet 129/1) and in Kanyamwa and kanyidoto areas(Homa Bay sheet 129/2). In these areas the structures are distributed in particular spots giving a first sight impression of a clustered distribution pattern.

One potential problem that confronted the survey work was that of site survival. Recently a number of *ohingni* have been brought down to provide stones for various construction. This could be a major problem in the application of spatial analysis to the study of the settlement patterns since maps resulting from the remaining structures give only a partial reconstruction of the original 'total universe' of structures in the region. Another problem of site survival is that structures made of earth are not as durable as those of stone. Simple stone structures have also been affected in the same way. Some have been reduced to mere traces of circumferences or have disappeared altogether. Uphill structures of stone have servived more than lowland small structures of both earth and stone, a situation which may give the picture that only hilly areas were settled.

These potential problems were addressed by using aerial photographs at the end of the foot survey to map sites destroyed since the photos had been taken or those which escaped identification in the field. Table A.1 therefore is a complete list of all aerial photographs used in this work. Through photographs, a total of 49 *ohingni* in 10 different sites completely destroyed were recovered (see Table 2.2). Access to the hilly Gwasi region proved much more difficult than expected in view of the steep river valley slopes, forested hill slopes and long distances which would have needed to be walked if sites were to be reached. As a result three of the sites marked in this region were not reached at all but marked on the basis of aerial photographs which luckily revealed them in a forested environment.

Apart from the recovery of sites, the photographs were used to revision map all the structures on a 1:50,000 topographical maps. Of the 521 *ohingni* identified in the region, 123 were not visible in the aerial photographs. These were located throughout the survey area. Out of the 123, three were built of earth while the remaining 120 built of stone. The reasons for their invisibility could be varied. The earth-built ohingni had very thin walls and were quite small in size. This possibly made them to miss out on the aerial photographs. The stone-built *ohingni* were also very small in size with some hidden under tree cover especially along the lake. Majority of these missing *ohingni* were found in areas where there were larger *ohingni* appearing on the photographs.

In evaluating the results of the field walking and aerial photograph examination, there are certain factors to be borne in mind. The most important of these is the problem of variable visibility of structures. Most were found covered in thickets making them difficult to see. This problem, was addressed using the aerial photographs in which thicket-covered structures were clearly visible. It is only on the forested Gwasi hills where the aerial photographs could not reveal many structures due to thick vegetation (Table A.1 V13A/1070-063-065). But not many sites were expected in this region of high hills whose slopes are too steep to be suitable for settlement or the construction of stone structures. Movement in such areas is also too difficult to warrant settlement. There is, therefore, confidence that on such steep and highly forested hills were no settlements and there are no missing data from such areas.

The location of all structures found during foot survey and aerial photo examination were revision mapped. These are basically walls of stone or earth of various sizes and in different stages of preservation expressed as points. Earth-built structures were too few to warrant a separate analytical treatment though they are marked with a different symbol on the maps.

2.3 Site Structure.

A total of 138 localities where structures were found were designated as sites. The number of structures per site varied for the entire region. Each site may be plotted on a scale of 1 to 18, the lowest and highest number of structures recorded for sites in the area of study. Table 2.1 shows that most sites have structures ranging between 1 and 4 with a majority of sites having 1 or 2 structures and only a few exceptions having over 5 structures. It further shows that 22.0% of the sites are single structure sites while the remaining 78.0% are multiple structure sites. This points towards a tendency of living together in large groups within a locality, a practice that would have created sites with multiple structures.

Structures on the various sites fall into two categories namely simple and complex ones. The simple structures consist of single enclosures which do not share walls other structures. Simple structures were also found in multiple structure sites as single enclosures forming isolated units. Simple structures are joined together by abutting walls or corridors to form complex structures. Architectural evidence (Onjala 1990) shows that complex structures come into being by connecting adjoining enclosures with gates and corridors (Figure 2.1). In most cases, structures within this category share walls. Larger mother enclosures have smaller structures extended from them. This may suggest population increase among the original inhabitants sparking off a series of extensions not far from the mother enclosures.

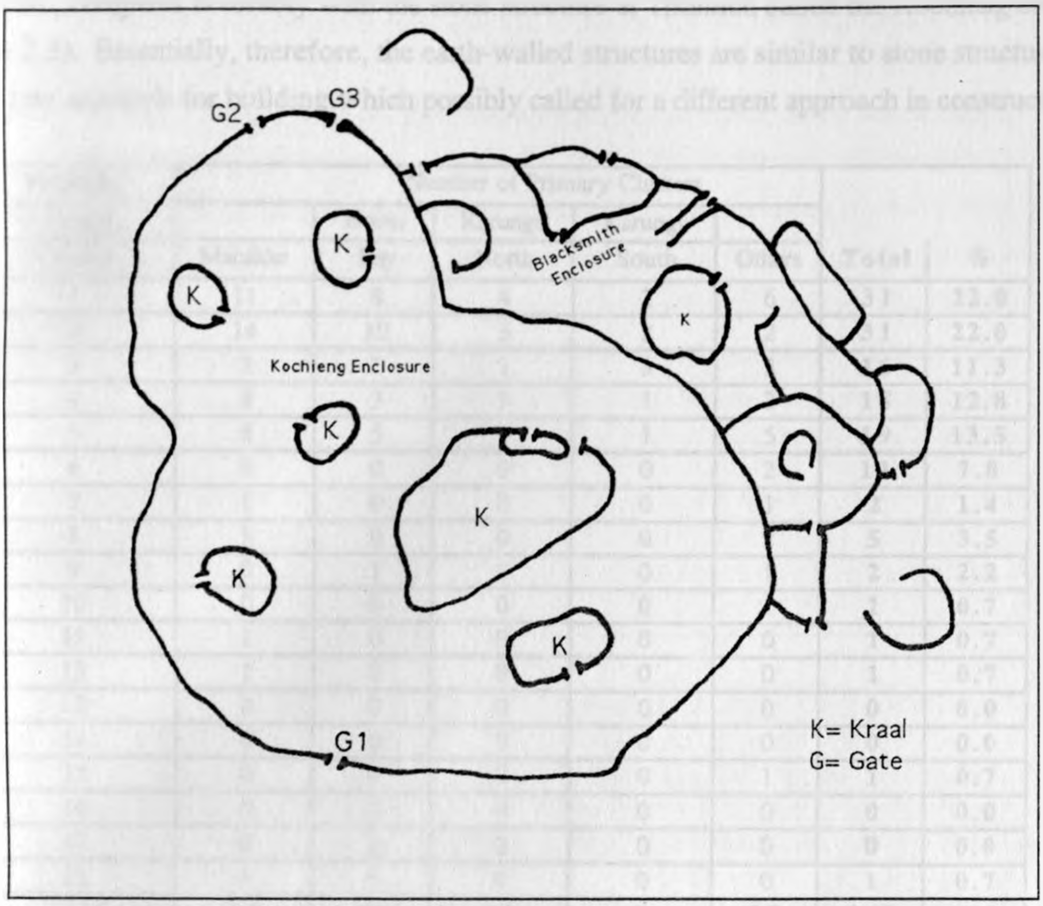

Figure 2.1. Sketch Map of Thimlich, a Complex Site.

During the survey, individual enclosures within complex structures were not used as analytical units. This is because the extensions and adjoining walls as well as corridors characteristic of such structures could not allow for accurate distance measurements for use in both nearest neighbor and cluster analyses used in this work. In the whole process of counting structures, therefore, a complex is treated as one irrespective of how many extensions it has. This therefore means that some of the single structure sites are complex structures as is the case at Koluoch site (M31). Both categories may also exist side by side on multiple structure sites as is the case at Thimlich (M19).

It was indicated earlier that some structures were built of mud. These structures are essentially the same as the stone structures and simply made from different raw material. Their wall plan and height are basically the same as those of the stone structures being circular with heights which do not exceed 4 metres. The gates are small just as in the stone structures and the laying of wall foundation also seems to have incorporated larger stones. They were identified in four places within the study area. The best example of these was at the village of Kimae (site KS4) on a plain South of Kuja River. This structure was built of clay and a few gravel inclusions at the base possibly due to absence of stones for construction. The remaining wall stood at 3.2 m high with a thickness of about 35 cm.

In terms of complexity, they are all simple structures. In all the four sites none had any adjoining walls or corridors. They are the same size as their stone counterparts. The largest of them all, Kimae, compares favorably with the stone structure at Thimlich called the Kochieng enclosure (Figure 2.3). Essentially, therefore, the earth-walled structures are similar to stone structures save for the raw materials for building which possibly called for a different approach in construction.

Structures in Primary Clusters	Number of Primary Clusters						
	Macalder	Homa Bay	Karungu North	Karungu South	Others	**Total**	%
1	11	8	4	2	6	**31**	**22.0**
2	14	10	3	2	2	**31**	**22.0**
3	7	2	1	3	3	**16**	**11.3**
4	8	3	3	1	3	**18**	**12.8**
5	8	5	0	1	5	**19**	**13.5**
6	9	0	0	0	2	**11**	**7.8**
7	1	0	0	0	1	**2**	**1.4**
8	3	0	0	0	2	**5**	**3.5**
9	0	1	0	0	1	**2**	**2.2**
10	0	0	0	0	1	**1**	**0.7**
11	1	0	0	0	0	**1**	**0.7**
12	1	0	0	0	0	**1**	**0.7**
13	0	0	0	0	0	**0**	**0.0**
14	0	0	0	0	0	**0**	**0.0**
15	0	0	0	0	1	**1**	**0.7**
16	0	0	0	0	0	**0**	**0.0**
17	0	0	0	0	0	**0**	**0.0**
18	1	0	0	0	0	**1**	**0.7**
Total sites	**64**	**29**	**11**	**9**	**27**	**140**	**100**
Total structures	258	80	25	24	134	**521**	
Structures per site	4.0	3.0	2.0	3.0	5.0		

Table 2.1. Number of structures per site within each subregion.

2.4. Structure Features and Contents of *Ohingni*

Both simple and complex *ohingni* have interior structures of various kinds. These include small enclosures, depressions and corridors.

The small enclosures within either simple or complex structures are grouped into three categories: cattle kraals, pens for smaller animals and garden fence structures. Cattle kraals or pens for smaller stock depended on the size of a particular structure. The larger an *ohinga* the greater the number of these small enclosures it would have. The kraals are larger and usually located at the centre of the structures, while the pens are smaller extensions to the outer walls of major structures or the walls of the kraals. Garden fence structures (?) are small enclosures close to the outer walls which were thought to have been *orundu* for growing vegetables. *Orundu* is a name the Luo give to small farms on which vegetable or other food crops are grown to supplement what is grown on larger farms. Normally these are found closer to residential houses or homesteads compared to larger main farms which are normally situated some distance from residential areas. Their products whether vegetable, onions, tomatoes or maize are usually constantly in use when ready. The Luo encouraged the use of *orundu* so as to allow the crops in the larger main farms to mature for harvest without interference.

Depressions found within *ohingni* have been identified as house depressions (Onjala 1990). This has been based on the observation of one such depression at the site of Thimlich (Kochieng enclosure) where associated features including a cooking place and a raised platform possibly used as a store. They are circular with an average diameter of 5 m. Inside the *ohingni*, they take a circular pattern aligned along the walls of the ohingni. In most of the *ohingni* they are not visible possibly due to interference through cultivation which has destroyed these features. Even though they have been called house depressions, they may turn out to be specially prepared areas for other functions, for example, places for threshing grain, firing pits or where grain was put to dry. Their function has not been accurately established. It is, therefore, not known what these depressions were and what they were used for.

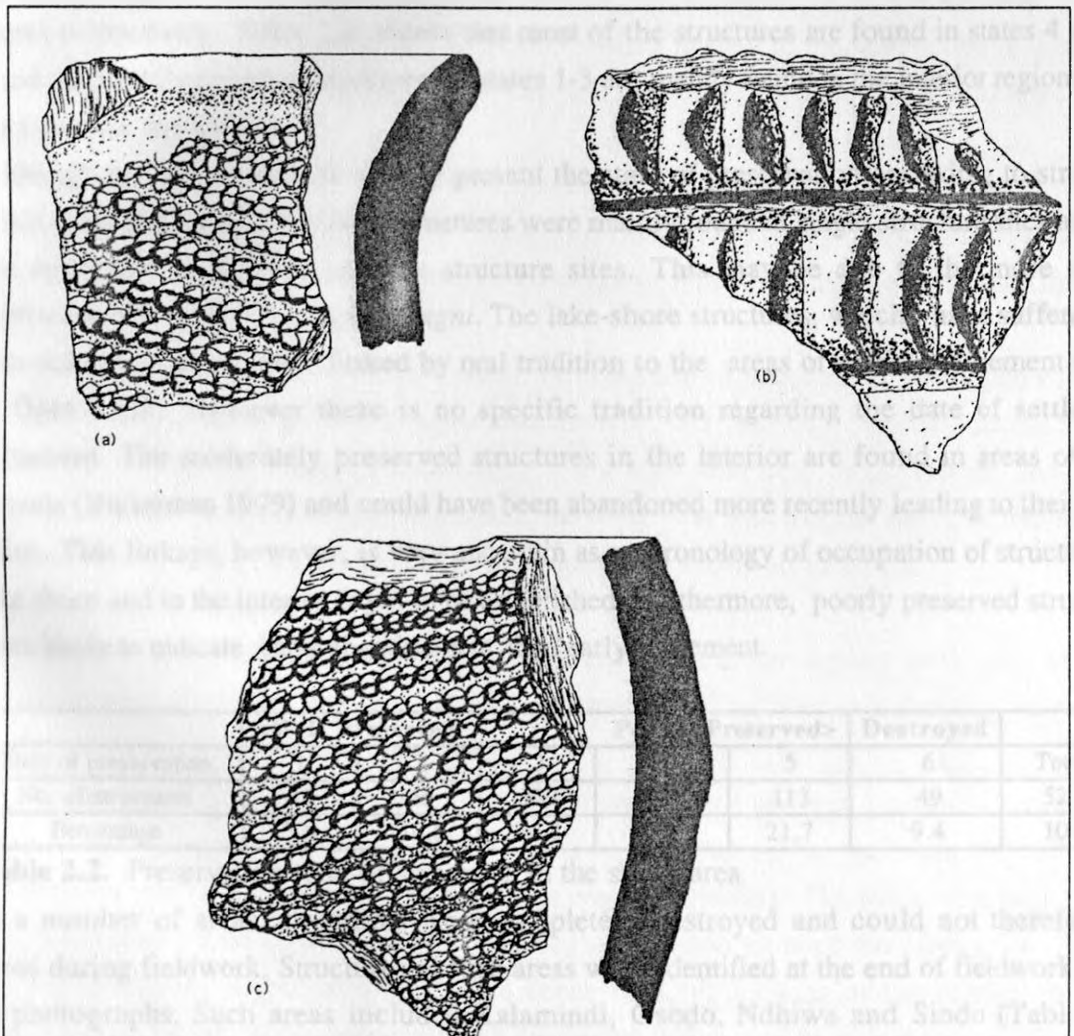

Figure 2.2. Typical cord rouletted potsherds common in the structures.

Corridors are paths joining structures mainly within the complex *ohingni*. They consist of low walls of stone which were possibly used to direct livestock and human movement.

Ohingni also enclose surfaces and middens littered with ceramic, lithic and faunal remains. At the complex *ohinga* of Thimlich, a set of neatly arranged stones was found suggesting an iron smelting area. Close to it were found other stones with smooth surfaces possibly where hammering of iron implements occurred. The potsherds found in most of the enclosures are cord rouletted (Figure 2.3). These are similar to Luo pottery made in the region today. These remains demonstrate that the structures were the primary components of settlements and therefore may be used to study the settlement pattern.

2.5 The Implications of Structure Condition

The structures vary a great deal in their physical condition in all the sites visited. Structures were found to be in different stages of deterioration. While some had almost destroyed walls, others still remained well preserved with high walls. Using general observation and simple wall height measurements, it was possible to group the structures according to their state of preservation on a scale developed earlier (Onjala 1990:64) where 1 and 5 represent well and poorly preserved structures respectively. Table 2.2 shows that most of the structures are found in states 4 and 5. Well and moderately preserved structures in states 1-3 are mainly found in the interior regions such as Kanyamkago and Kadem.

Although it is not possible to strictly present the state of preservation according to structure type, it is clear that poorly preserved structures were mainly found at single structure sites and the simple structures within the multiple structure sites. This may be due to the more sturdy concentration of multiple structure *ohingni*. The lake-shore structures, which have suffered the greatest deterioration, are also linked by oral tradition to the areas of earliest settlement (Ayot 1979, Ogot 1965). However there is no specific tradition regarding the date of settlement abandonment. The moderately preserved structures in the interior are found in areas of later settlements (Butterman 1979) and could have been abandoned more recently leading to their good condition. This linkage, however, is very uncertain as a chronology of occupation of structures at the lake shore and in the interior is yet to be established. Furthermore, poorly preserved structures are more likely to indicate early abandonment than early settlement.

	<Well Preserved			Poorly Preserved>		Destroyed	
State of preservation	1	2	3	4	5	6	Total
No. of structures	41	55	129	183	113	49	521
Percentage	7.9	10.6	24.8	35	21.7	9.4	100

Table 2.2. Preservation state of structures in the study area.

In a number of areas, structures were completely destroyed and could not therefore be observed during fieldwork. Structures in such areas were identified at the end of fieldwork using aerial photographs. Such areas included Kalamindi, Osodo, Ndhiwa and Sindo (Table A.1: V13A/1046-115 and 116; V13A/1046-017 and 018; V13A/1070 044 and 045). The deterioration and destruction of the structures in the region has been attributed to a number of factors. These include the following:

1) Time of abandonment: Recently abandoned structures are well preserved having high walls. Long abandoned structures on the other hand have deteriorated a great deal due to lack of maintenance in the past. Together with other factors, time of abandonment has played a part in structure condition throughout the area where the ohingni are found.

2) Deterioration due to exposure to the environment. Wind, lightning and earthtremors have been some of the agents of destruction of the structures in their exposed environments. Wind, especially, has been attributed to the destruction of walls not covered under some kind of vegetation. .

3) Deterioration due to imposed loads such as people and animals climbing the walls. These live loads make the stones to fall off the structures especially due to the fact that the stones forming the walls were arranged without any dressing or mortar to stick them together. Constant climbing on the walls therefore lead to stones falling off one by one therefore starting the process of structure destruction.

4) Deterioration due to re-use of the areas enclosed by the structures as farms and paddocks. This was observed to be quite common, a situation which has led to the destruction of gates and interior enclosures in most structures. Such re-use also encouraged destruction of structures due to imposed live loads.

5) Destruction due to re-use of the raw materials (stones) used on the walls. Stones from the structure walls have been picked and used for other construction. This has been more so near some urban centers and schools where such stones have found their way into the walls and floors of houses as well as roads and bridges.

It seems evident that all these factors affect the condition of structures in the region of study. This makes it difficult to assess and link site abandonment and condition. Further research may be necessary to address the issue of chronology. This may also help in explaining accurately differential structure conditions. For the moment, however, it is seen that the above factors worked together in shaping of the current conditions of structures as shown in Table 2.2.

2.6 Architectural History.

Architectural characteristics of the structures consist of circular zig-zag walls built of loose stones of various sizes and shapes. The blocks were used without any dressing or mortar. However, care was taken to ensure their stability .

The walls do not rise to a height above 4 m. and usually range between 1 m and 3.5 m. No dug foundation were observed at any of the sites. Instead, the base of the wall was built of larger blocks and was generally thickened to achieve the required stability. The walls were built in two phases joined with an infill. Because of the varied shapes and sizes of the blocks used, it was impossible to discern any courselines. Also, because of no dressing of the blocks, the wall surfaces are quite rough. Walls are dotted with buttresses which add to the general stability.

Each structure has at least one gate on its downslope side. These entrances were made to almost a uniform square of between 1.0 and 1.5 m which could only be used by one individual animal or person at a time. The two side walls of the gate were well constructed using carefully selected blocks which were laid horizontally on top of one another. About halfway the height of the gate (0.8 m) from the ground, holes were left in the side walls for lock poles. To form the ceiling of the gate a number of long slabs were arranged in a series, due care being taken to ensure that they were properly anchored. More blocks were then added on these blocks to raise the wall to the required height. Watch-towers were invariably built next to the gates. Wall thickness at the gates is normally double the general thickness of the rest of the structure wall. The number of gates, kraals and pens in a structure, depends on its size and complexity.

Abutting structures were formed by addition and not as part of the primary building of the *ohingni.* These additions were dictated by the needs of the inhabitants which sparked off expansions of structures to form complex ones.

The beginnings of this type of architecture in the region may be traced from the various groups of people who settled the region in the past two to three centuries. The peopling of the area started by about the 14th century with a series of immigrations from Uganda and Tanzania across the Lake into the lowland region and islands in the Homa Bay and Migori districts. By the time the Luo started to arrive in the region from Siaya through Mirunda Bay in the 17th century, a number of pre-Luo occupants were already settled on the Southwestern lowlands, Gwasi and the islands of Mfangano and Rusinga. These were later assimilated or forced to move elsewhere by the Luos.

What is not clear is whether the architectural skills responsible for the structures was carried from elsewhere into the region through these movements. Chittick (1965) and Gillman (1944) compare the structures with ones found on Ukerewe Island in Lake Victoria. This Island was possibly occupied briefly by the Abakunta group of people during their flight from Uganda following the killing of kabaka Junju. These same people went through Sese and Bagaya Islands and eventually settled on Rusinga and Mfangano islands as well as the southwestern lowland lake region (Ayot 1981). Cohen and Atieno- Odhiambo (1989) also report ancient monuments built of earth locally known as *Gunda - buche* in Siaya District. Similar mud structures are also known in Trans-Nzoia District, Western Province (Wandibba 1969). All these are areas from which people moved southwards to occupy the region in which *ohingni* are found.

On the basis of population movement into the region and the evidence of reported similar structures on Ukerewe Island and Siaya District, it is likely that the architectural knowledge was brought from elsewhere by the immigrants and was put to use in parts of the region due to favorable or determining factors. However, this requires further research as the issue of builders has always remained in debate. This is beyond the scope of the current work which is to asses the settlement system documented by the *ohingni.*

On the basis of oral literature the architectural history covers up to the first decade of the 20th century when abandonment of *ohingni* started *en masse* . After World War 1, no structures were being built. Instead, the inhabited ones were being abandoned as people opted for open settlements with homesteads being fenced using wood. The stone structure tradition therefore came to an end. Possible reasons for this include an end to the inter-clan conflicts over land as people acquired permanent titles under colonial law. There were no further major population movements. There was also breakdown of family and lineage ties early in the colonial era leading to shortage of united labor to build and maintain the structures. Finally, there was a drastic reduction of wild animals in the area as their natural habitat was destroyed during the colonial expansion of farming and settlement activities.

2.7. Archaeological Dating

Only the site of Thimlich has been test excavated and the work has yielded the only independent data for the occupation of an *ohinga.* The test trench was shallow and the stratigraphy has not been reported in detail. However, two charcoal samples of bone were dated using C14 dating method at Oxford Research laboratory for Archaeology and Art History. The two samples yielded dates of 110±80 and 200±80 BP. When calibrated, the two dates give a long range of about 1650 to 1900 AD (Wandibba 1986). This dating is however limited in providing an accurate date for the structures due to three reasons. First, the samples were drawn from only one site at which only one test trench was dug. Second the dated site seems to lie in a recently settled geographic region as opposed to other regions which have histories of very early occupation. Third, the samples used in the dating were taken from a trench several metres away from the enclosure wall and therefore have no direct relationship with the wall. For any accurate dating, material from beneath or closer to the wall has to be used.

A precise date for the construction of *ohingni* is not available at present. Excavation of architectural features for radiocarbon samples from numerous structures at several sites is required.

CHAPTER THREE

THE *OHINGNI* AS AN ETHNOHISTORIC PHENOMENON

3.1. The scope of material evidence

Material evidence for past human activities usually forms an important part of archaeological investigations. Such materials which may include excavated faunal, lithic and pottery remains or other cultural remains such as monumental buildings, ecofacts and features. These are usually the basis of interpreting the prehistoric past. In such interpretations, however, other sources may occasionally be used to fill in the gaps that may be left unfilled by the material evidence. In their introduction, Doran and Hodson (1975:1) recognised the use of sources other than material evidenced for archaeological analysis. They stated

> "Archaeology involves a great variety of different disciplines from prehistoric Archaeology, where material remains are the only direct source of information, to classical or industrial Archaeology, where the material remains simply fill out and give life to existing, though often scanty historic account. Then some of the most interesting and difficult branches of archaeology lie between these two extremes where historical (ethnohistoric) or direct ethnographic evidence competes with material evidence as the primary source of data".

The material data in this work are the settlements documented by the numerous stone structures in the area of study. These archaeological data are incomplete making it hard to understand the activities of the communities responsible for them. Therefore ethnohistoric data, especially oral tradition, has to be used together with the structures for a better understanding of the region's proto-history. Oral history regarding the structures forms part of this ethnohistoric interpretation.

3.2. Previous Interpretations

Ethnohistoric interpretation of oral traditions have not been focused primarily on explaining the *ohingni,* but rather on the broader question of settlement and other aspects of population movements. There is little or no linkage between the two even in areas where the structures would have given strength to the explanation of settlement and population movement. Nevertheless, a few interpretive references to the structures may be singled out from the compiled works based on oral traditions. These interpretations are directly related to population movement, settlement and the influence of the environment. To understand these isolated references, a brief account of early population movements is required.

The most recent phase of settling in the Southern Nyanza lake region started as early as the 15th century. Immigrants invaded the region from all directions and continued to enter as late as the 1940s. As Ogot (1967) and Ayot (1977) put it, much of this immigration occurred from the North, South and the West. Separate movements occurred at different periods of time although there is yet no well established chronology for each entry. Group identities for these immigrants is established on the basis of area of origin and direction of entry to the region. Oral tradition has it that early immigrants were basically of Bantu origin who spoke bantu dialects. This distinguished them from a later wave of immigrants who spoke a Nilotic dialect, Dholuo. This latter group consisted mainly of the Luo who entered the region from the north having lived in Siaya for some time. The date of entry for each group has been worked basically from the oral tradition's version of Age Generation (Ayot 1981). The same routes were possibly used by these groups of people at different periods of time (Figure 3.1).

From the North came two groups of people namely Bantu and Luo immigrants. The Bantu immigrants included the Waturi, Wagine, Wakiala, Wasamu, Walandu, Wagimbe, Wasohi, Wakisasi, Wakisaria, Wisokolwa, Kamageta, Kakan, and Kakseru who settled in the region between 1596 and 1688 (Ayot 1981). The Luo immigrations included the Karungu, Kanyamwa, Kadem, Kabuoch, Kaler, Kanyamkago, Kamgundho and Kanyidoto, who settled in the region from 1688 onwards. Both groups from the north passed through Mirunda Bay from the present Siaya District.

The immigration from the South was mainly by Bantu groups. These included Wategi, Kamagambo, Miuru, Kaksingiri and Kasgunga, who moved from Rieny in the Musoma area of Tanzania and settled in the region between 1655 and 1711. The Kaksingri and Kasgunga moved from Kisingiri on Sese Island and Bagaya Island respectively. They joined the Wategi at Rieny from where they moved to Kisegi in Gwasi. From here they expanded to the Usiri area where they assimilated the Kamwagenya people as they moved further north along the lake before expanding to the interior to occupy their present lands.

Immigrants from the West consisted of the people now occupying the Islands of Rusinga and Mfangano as well as other areas. Together with the other pre-Luo immigrants, these groups are commonly known as the Luo-Abasuba. They settled the place between 1596 and 1688. Escaping the wrath following the murder of Kabaka Junju in Uganda, these groups moved through Sese, Bagaya and Mageta Islands to their present homes (Ayot 1977).

From the East came another wave of immigration consisting mainly of a section of the Abakuria known as the Girango. This group, consisting of eight sub-communities, namely the Ba-Kamoti, Ba-Kini, Ba-Gire, Ba-Rieri, Ba-Gusero, Ba-Turi, Ba-Tegi and Ba-kamageta (Bakar 1958), occupied the Suna-Mohuru areas and eventually expanded to Kadem-Karungu areas where tradition still associate several structures with the Muksero, Wagire, Kamot, Waturi, Wategi and Kamageta. Figure 3.1 summarizes these movements and also shows major points of expansion and dispersal.

The majority of these groups still occupy the region. All the Luo clans as named above still occupy the region in areas bearing their names. At the turn of the century, the majority of people in these Luo clans except the Kabuoch and Kamgundho were still using *ohingni*.. These groups together with other clans such as the Kanyada had also assimilated the Bantu groups to an extent that the latter began to speak basuba which is a mixture of Bantu and Nilotic dialects. The Bantu groups became Luoized and are currently known as Luo-Abasuba. These, except for the Waturi, Kamageta, Kakseru, Wategi and the Girango group, who moved to Tanzania, still occupy the islands and the Kaksingri, Gwasi and Mohuru areas. They are associated with the *ohingni* along the lake and the areas they occupy.

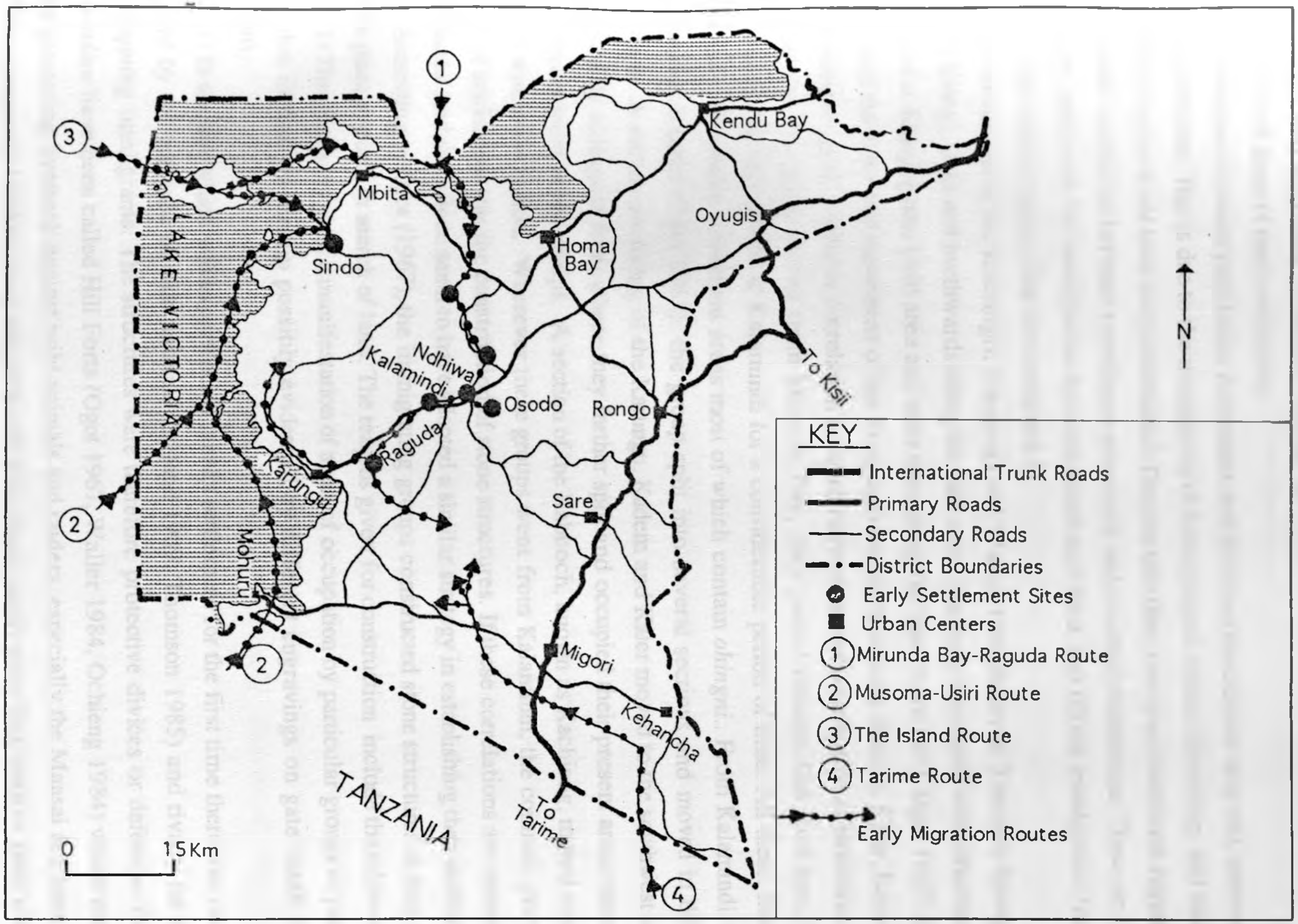

Figure 3.1. Migration routes used by early settlers in the region.

Ohingni have been interpreted as a consequence of the multiplicity of immigration into the region from the sixteenth century onward. The structures have been seen to reflect routes of immigration and migration, insecurity during the time of settlement and a clear and durable manifestation of areas of early settlement.

A correlation between population movement and structure distribution may not, however, be firmly established. This is due to the multiplicity of immigrations whose chronology and direction within the area have not been well established. Despite this flaw, two areas within the region give us a reliable correlation between population movement and structure distribution. These are (1) the lake shore areas with the immigration from the South and West, and (2) the immigration from the North to the interior region (See also section 6.1).

The movement of the Kaksingri, Kasgunga and Wategi from Rieny in Tanzania through the Lake to Kisegi, Usiri and northwards along the lake shore has been associated with structures that are found at Kisegi point, Usiri area and other sites along the lake (Ayot 1977, Ogot 1967). On the other hand the entry and movement of the Konyango family (Kabuoch, Kadem, Kaler, Kanyamwa and Karungu) gives a reliable correlation between movement and distribution of structures in the interior. As this group moved from Mirunda Bay, they passed through Got Ruri area, Ndisi, Ndhiwa, Osodo and settled at Kalamindi for a considerable period of time. All these, however, were only temporary settlement areas most of which contain *ohingni*.. From Kalamindi, which was called Ramba (Ogot 1967), the group split into several sections and moved in different directions. A section consisting of the Karungu, Kadem and Kaler moved to the southwest settling temporarily at Raguda from where they further split and occupied their present areas where they also encountered Bantu groups. A section of the Kabuoch, known as Kachieng, moved to several places within the region. Wherever these groups went from Kalamindi, the common practice in areas of settlement was the construction of stone structures. If these correlations are correct, both the Bantu and the Nilotic seem to have adopted a similar strategy in establishing their settlements.

According to Ogot (1967), the immigrating groups constructed stone structures as they moved from place to place in search of land. The reasons given for construction include the following:

1) The structures were a manifestation of areas of occupation by particular groups of people - a symbol of land ownership possibly evidenced by different engravings on gate lintels (Onjala 1990).

2) In an area which was experiencing human settlement for the first time there was insecurity posed by the presence of wild animals (Stigand 1909, Thomson 1985) and rivalry for land by competing immigrants. The structures were therefore protective divices or defensive forts and therefore have been called Hill Forts (Ogot 1967, Waller 1984, Ochieng 1984) which were used for protecting livestock against wild animals and raiders, especially the Maasai at a later period. They adequately blocked away any attackers who could hardly enter their narrow gates when they were defended.

3) The practice was faster than other forms of fencing such as wood or tree fencing. It was therefore easier for the moving populations to construct stone structures where they settled while

still scouting for better lands. The structures may therefore be used to establish points and direction of movement of particular people if the people responsible and the chronology of the structures can be established.

Security is a theme which runs through these interpretations and is, indeed, evidenced in the architectural techniques summarized earlier and described by Onjala (1990) in greater detail. But given the wide geographical distribution of *ohingni* in ecologically diverse setting, it seems likely that several socio-political and environmental factors played a role in their construction, design and distribution.

It is uncertain to what extent *ohingni*, as easily observable monuments, have contributed to their own oral history. On the one hand, their visibility helps to make them the objects of a continuing oral tradition. But on the other, it also makes them convenient symbols which can be incorporated easily into any oral tradition and used as a tangible proof of its varasity. This makes it hard to synthesize the data on the *ohingni* especially with all the groups claiming responsibility for them. This further creates a conflict between the archaeological and ethnohistoric data with the former indicating that the *ohingni* were made by one group while the latter indicates that they were made by different groups.

3.3 The Ohingni in the Oral History

The collection of oral history about the *ohingni* in this study was confined to finding out why the structures were located in particular environments and what functions they served within these environments. Four questions were of particular interest.

1. Why are most structures found in hilly areas, especially on gently sloping hills ?
2. What considerations or factors contributed to the selection of construction sites ?
3. The stone structures were used extensively until the first decade of the 20th century and then disappeared gradually. Why were the structures preferred to the kind of fences currently used ?
4. The architecture and popularity of the structures suggest a device to enhance the security of the occupants. Were the structures of any specific help in times of war or against wild animals ?

Using these questions as a means of focusing inferences, additional sociopolitical and historical data were obtained without raising such concerns directly. The use of interviews as a sociological fieldwork method often involves the use of questionnaires with Yes or No responses. These are usually filled in by the researcher as the interviewee responds to the questions. This procedure has many dangers and requires a thorough cross-checking of the results to eliminate errors. Where the interview method was used in this study questionnaires were not employed. Instead, I used open ended questions based on the four concerns or themes above. Questions were put to the informants in different ways on different occasions to determine the consistency of informants' responses.

Directed and undirected discussions on the various aspects of the structures ranging from their origin to their recent abandonment were also employed . This was done mostly in the evenings when taking a break from the day's survey. It was also done on occasions when our presence as strangers in an area attracted large gatherings. A question could be raised concerning a particular aspect of the structures and this in most cases sparked off a discussion between the people. The arguments in such discussions revealed some important points about the various aspects the structures. In most cases, arguments did not culminate in consensus. But the various views could be weighed to reach a conclusion. The answers given in interviews and the discussions were then compared against what was observed in the field.

Environmental features were observed directly, and used as an independent source of evidence on the setting of *ohingni*.. The main aim was to detect what factors led to the location of the structures. These two approaches were used to identify six potentially important factors:

1. Topography. This took into account the influence of topography on the location of a site. On what topographical features are the sites found? Are the sites located on hills, in valleys, by lake shores or on flat land ?

2. Water source. Distance to the nearest water source was considered. In cases where the present water sources have been created through modern technology, local people were interviewed concerning past water sources for the area. The distance to such sources was estimated and their significance to the builders of the structures assessed.

3. Raw materials for building. Construction of structures was done using loose stones of all sizes and shapes (Onjala 1990, Wandibba 1986). Where were these stones got? How far were they transported to the sites? were the structures built where these raw materials were easily and locally available? The source of stones for construction was examined by observation of the areas around the structures to establish whether the stones were locally available or were transported from elsewhere.

4. Accessibility. Apart from the general influence of topography on site location, are the sites easily accessible? Could they be reached easily from all directions or was there a particular way of reaching them? This issue of accessibility was considered in a wider perspective and did not rely on the confines of modern routes such as roads which were obviously absent when the sites were occupied.

5. Ecological environment. This involved examination of the ecological situation around the structures. Apart from observation of the modern ecological settings, secondary data especially on the past wildlife and vegetation of the area was gathered. Are the structures found in areas where wild animals roamed in the past ? Are they located in past forests? Information concerning the ecological situation was also obtained through interviews of the local elders on what factors were considered before a structure was built in an area.

6. Land use. The economic life of the builders of the *ohingni* has not been well established. Their pattern of environmental exploitation therefore is not well known. However, hunting and fishing seem to have been major subsistence activities of the early settlers in the region (Butterman 1979:104). With time, these early settlers, especially the Luo. obtained cattle and also grew millet which they used in their trade with the Maasai from whom they got ostrich feathers, buffalo hide

shields, meat and iron implements (Ogot 1965, Waller 1984:249). The excavated material from Thimlich (Wandibba 1965) also points toward the exploitation of the environment through hunting and grazing of domesticated animals. The presence of grinding stones and stone pestles in some of the sites (Onjala 1990: Appendix 1) further points toward the growing of cereals such as millet.

Interviews were conducted with knowledgeable men born between 1898 and 1962. The results both of interviews and directed as well as undirected discussions, and environmental observations, suggest that *ohingni* can be interpreted in three basic ways in the context of oral history.

1). The structures were built for purposes of security in a newly settled region where dangers abounded.

2). The structures were built due to social factors which made it possible for the culture to develop and thrive in this particular geographic region.

3). The structures were built on account of the favorable environmental conditions in the areas where they are located.

With regard to alternative 1, the oral tradition is vocal on the structures being primarily for security purposes. All the elders that were formerly interviewed agree that the structures were defensive or security devices. They protected property - both domestic animals and other non-living property from external intruders. They were therefore architecturally designed to prohibit easy entry by intruders or enemies. Wild animals, both big and small were kept away, and, only the ones which could climb or jump over the walls could enter the structures. Even so, such animals which included leopards and lions could not escape with their prey from inside the structures as lifting such above the 3.5 metre walls was not possible. A number of wild animals including Elephants, Buffaloes, Hyenas, Lions, Leopards and a host of antelopes are said to have roamed the place. This prompted the early settlers to adopt security devices which possibly led to the widespread construction of the stone structures.

The structures are also seen in the oral history to have been used to ward off human enemies. During times of wars or skirmishes, the structures offered better protection and remained as fortresses. Raiders, especially cattle raiders, could not succeed when animals were kept inside the structures. Stone structures had a number of security advantages not enjoyed by those of wood. First they were durable and once built are not easily destroyed and cannot be burned. Second, they offered a solid wall without any gaps which could be used by enemies to spy on the activities going on within the structures or to shoot arrows at the occupants. And lastly, they were an easier option especially in the absence of tools which could be used for cutting trees for fencing or time to develop tree fences. The rocks as seen earlier, were simply excavated or uprooted from the ground using logs. These advantages together with the need for security sparked off the construction of the structures leading to the present remains which form part of the local archaeological record.

With regard to alternative 2, the structures are seen as the product of movement of various groups of people into the region, social organization and clan antagonism. The elders, both Luo and non-Luo, agree that as they moved in search of land, they constructed stone structures where conditions were favorable. This was made possible by the fact that people usually moved in large groups and lived together in compact communities. Each group had a common origin and rendered allegiance to one or more recognised leaders. This enhanced clan unity and also kept traditional values intact. It increased the power of community action especially in times of skirmishes and in the construction of the *ohingni.* The unity of the people under a central command ensured a ready provision of labor necessary for the construction of the structures.

Other social factors leading to the construction and structuring of ohingni at various sites include: (1) clan antagonism which increased as more immigrants entered the region, sparking off a scramble for land and therefore insecurity as groups sought to dislodge others from already occupied land; (2) traditions such as a married man leaving his father's homestead to establish his homestead; (3) allowing relatives from far, foreigners and servants to establish their own settlements nearby for one reason or another.

With regard to alternative 3, the oral history is clear on the fact that careful consideration was taken in establishing a settlement in an area. A number of environmental conditions were weighed. First and foremost was the availability of building material which consisted of easily uprootable and loose rocks. The oral tradition is silent on the type of stones used in construction. Reference is only made to construction of structures where there was availability of such building material. Apart from reference to bigger stones forming the base of structure walls and long thin ones forming lintel or gate roofs (Onjala 1990) , there is no other specialized reference to stones used in *ohingni* construction. This lack of specialized vocabulary with respect to stone types such as stone which will not fire crack as opposed to one which will, stone which is suitable for one kind of wall construction and not another, foundation stones as opposed to wall stones, stones selected for construction of lintels and so forth is possibly due to the fact that no professionals were involved in such construction. Any group or anybody could do the construction. No strict methods were followed hence stones were used with minimal selection for particular wall parts. Construction took place wherever there was availability of stones of various sizes and shapes. This was an important consideration but went side by side with other requirements such as a good water source, room for future expansion and the accessibility of particular environments. These included the availability of grazing and arable lands and the absence of harmful wild animals and insect pests. Because of these considerations, most settlements were located on raised or hilly areas. Such areas, provided building materials easily. The hilly areas also provided a wider vision for checking any approaching enemies. It is also said that appropriate settlement sites were hills that large wild animals such as elephants, could not climb to reach residential areas. This is, however, highly doubtful since most settlements were located on gentle slopes of generally low hills. The hills and other raised grounds were also preferred as this left the valleys for cultivation and grazing. And since many of the valleys and flat lands are devoid of building materials, and, transportation of such material for long distances was not possible, such areas were considered unsuitable for settlements.

3.4 On the Credibility of the Oral History

The writing of the history of the lake region has depended on oral traditions of the people currently occupying it. In this, the issue of the stone structures has been inadequately handled. This is why I have presented in section 3.3, in some detail, the ethnohistoric interpretation of the structures. Due to limited time and funding for the research, however, it was not possible to gather completely comprehensive data to give more credibility to the oral tradition presented. Such data would include: a) rituals surrounding the location, construction, use and abandonment of structures, b) mechanism of labor organization and rituals establishing reciprocity and authority over sites, c) sayings and tales incorporating various aspects of the *ohingni*, d) any specialized words for the component structures in the entire region and e) specific words for stone work, buttresses, lintels and so forth. This data would also separate the mixed Bantu and Luo traditions in both linguistic and ritual terms hence helping in the problem of structure-people association. The collection of oral tradition presented here, therefore, was rather of a general nature, what the people in the area state repeatedly concerning the *ohingni*. If, or when, more detailed research is done, any major difficulties posed by the oral tradition, both about the *ohingni* and their makers, should be addressed. This would be useful in developing a contextually based history for the *ohingni* and a "down to earth" frame work for evaluating the speculative theories of ethnogenesis and tribal migration. Nevertheless, what the oral tradition presents now is not just some isolated statements, but a series of statements linked to each other and which can be systematized into a whole body of explanation. The statements involve significant problems containing a number of questions essential to most archaeological research topics on the *ohingni*. These include those which involve and interrelate all the structures that were constructed, especially their spatial distribution; all activities that were carried out during construction, occupation and abandonment; the relationship between the communities that created the structures; the environment and the structures themselves; their chronology and a host of other research particulars. It is obvious that if these questions can be thoroughly researched with informants giving sufficient exact information, it would be a great advantage to utilize the oral history in understanding the archaeology of the stone structures.

At present however, the oral history provides only cloudy information on the interpretation of the stone structures. This is due to a number of problems. First, the information given carries a lot of bias caused by the fact that all the occupants of the region want to associate themselves with the structures and will lie to make sure one is convinced that his/her grandfather is the one who constructed a particular structure. This claim for ownership even by groups that entered the region when the tradition was almost dying off, has greatly weakened oral history as a source of information in understanding the stone structures. Second, those who give the information are those born when the tradition was coming to an end. They did not witness the decision and choice of localities of construction or the systematic expansion and growth of the structures. They give second hand information got from the generations before them. This possibly contains elements of

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distortion leading to a wrong picture of the behavior and activity of the societies responsible for the structures. Three, the oral history is silent on the origin of the tradition. It does not explain pioneers of the tradition and with which wave of immigration it entered the region. It is also not possible to tell from the oral history the duration of occupation per structure or an authentic occupation sequence of the structures.

Despite all these limitations, oral history seems indispensable in the understanding of the stone structures at the current level of archaeological research. Currently, it is only the oral history that can give us a clue on people's movements, where they settled or constructed *ohingni* and on some of the social factors which affected the construction and structuring of the *ohingni.* It remains the primary source for first order hypotheses which might explain the historical origin and functions of *ohingni.* In contrast, archaeology may provide the only reliable way of confirming conclusively the historical aspects of much of the oral traditions which rely on *ohingni* as the physical evidence of their truth. Because of their durability, the archaeological data provide an excellent opportunity to study a specific pattern of settlement in the entire region alongside the propositions set in the oral traditions.

CHAPTER FOUR
RESOLVING THE ARCHAEOLOGICAL AND ETHNOHISTORIC VIEWS OF OHINGNI

4.1 Archaeological and Systemic Contexts

Ohingni are distributed across the landscape either singly or as parts of groups defining places which have been designated as sites. These (Table A. 2) are no longer part of the cultural system or systemic context which produced them. Instead they have passed into the archaeological context from which that past culture must be inferred.

Schiffer (1972, 1973) emphasizes the connection between the two states of cultural materials. Within the systemic context, behavioral activities create processes through which materials are transformed from systemic context to the archaeological context. This transformation constitutes the dominant factor shaping the proto-historic archaeological record, which consists of material in numerous archaeological contexts. The archaeological context, or record, can be observed directly in the present. From it, past systemic contexts are inferred.

The stone structures in their archaeological context can be observed directly in the present. They are supposed to reflect the past cultural activities that created them. However, they provide incomplete explanations of the factors and cultural processes that were responsible for their creation. Even if attention is to be completely focused on this record, it can still be seen that other processes of a cultural nature must be considered if it is to be explained. For example, in looking at site structure, one is forced to consider the various uses to which the different components structures were put so as to understand the reasons for their existence. "Uses" mean cultural activities of a community occupying a site at a specific time. It also touches on the historical context of sites. Recourse must be made to sources of information other than the archaeological record. This need is catered for in Chapter three which provides not only the ethnohistoric information necessary in understanding the structuring of *ohingni* as part of the archaeological record but also provides a background to the environmental context used in understanding the settlement system. As Doran and Hodson (1975:I) recognize, the use of other sources apart from material evidence is necessary in archaeological investigations. Ethnohistoric information has been used to provide evidence to support interpretation of the archaeological record. This is useful in presenting the proto-history of the region.

Figure 4.1 shows how the archaeological record has been used in this work and its articulation with the ethnohistoric record to aid in setting a prediction of settlement systems. The interpretation of the *ohingni* based on the two, however, seem to be in of conflict. Archaeologically, the *ohingni* are identical both in their construction and use. From this it can be argued that they belong to a single archaeological culture - one people - because they are all structurally identical and therefore define a single coherent settlement pattern. Only one population movement and only one group of people should therefore be associated with their building. In contrast, the ethnohistoric view asserts that the *ohingni* were built by different groups of people who entered the region at different times. All extant groups in the area claim that they built and used *ohingni* even though their cultural traditions are quite different. This would mean different construction traditions to reflect on the different cultural traditions. Yet the *ohingni* can not be classified, archaeologically, into different groups on this basis.

But, the archaeological and ethnohistoric evidence can be used to create a single picture of the cultural history of the *ohingni*. In most parts of the region, the oral tradition indicates association of *ohingni* with an early wave of Bantu immigrants who built and used the structures in the areas they settled. These groups were driven away or assimilated by later immigrants, the Luo, who also used the *ohingni*. This later group has since claimed responsibility for and ownership of *ohingni* in the region creating the interpretive conflict at hand. The following points may be advanced to resolve this conflict.

1) Reoccupation of *ohingni*. During the settlement period, the first group consisting of bantu groups constructed numerous *ohingni* in several parts of the region. As they expanded, they abandoned some while they built others. A later wave of immigrants consisting of the Luo groups then reoccupied the abandoned structures while at the same time took over the occupied ones from the Bantu groups whom they either drove away or assimilated. This group then claimed responsibility for and ownership of the *ohingni* which they, in fact, only inherited. Assimilation also affected the linguistic identity of the Bantu groups leading to similar reference to *ohingni* at the moment.

2) Copying the architecture. Although the later immigrants might have reoccupied pre-existing in the region, their claim for responsibility and use of the *ohingni* may be justified by the possibility that they copied the architecture and therefore made their own structures alongside the ones they inherited. If this is true then there would be little difference between the *ohingni* in the region as is, indeed, reflected archaeologically.

3) Importation of the skill. The immigrants moved from areas in which stone construction as well as mud construction is found (Onjala 1990, and Chapter Six of this work). There is therefore the possibility that all these groups moved into this region equipped with same skill which they applied as dictated by their needs and favorable environmental conditions. This possibly led to similar construction of *ohingni* although constructed by different people possessing different cultural traditions.

In view of the above discussion, the archaeological interpretation of *ohingni* may be taken as representing a single construction tradition as opposed to a single cultural tradition. This construction tradition was either brought from where the groups came from through each immigration or was inherited by some groups from others within the region. In this way the ethnohistoric interpretation of *ohingni* presents no conflict on the archaeological interpretation. Following, therefore, are some of the ways both archaeological and ethnohistoric views of *ohingni* have been used in this work.

1) Providing hints on localities of early settlement in the region. The archaeological record in the form of sites with their structures distributed across the landscape has clearly contributed to the knowledge of the early areas of occupation. These were directly observed during field sessions.

Ethnohistoric views on these early settlement areas on the other hand provide reasons why the areas were settled. This includes the cultural or social significance in establishing the structures. In this context therefore, the cultural or social processes directly related to the creation of the structures, is incorporated in the archaeological explanation. The needs of the people, for example, security against wild animals or human enemies amongst other needs created a condition leading to the construction of the structures which were further conditioned and/or modified due to other factors such as increase in population or desired design.

2) Understanding the creation of the sites. Processes responsible for forming evidence of the cultural past are diverse and at present poorly understood. While the *Ohingni* as part of the archaeological record contribute to the aspects such as raw materials used, structural layout and spatial distribution in space, the ethnohistoric views on the same provide processes responsible for this evidence of the cultural past. For example, ethnohistoric views explain the building process -how it was done and where it was done. The two therefore contribute to the understanding of the whole process of creating a structure. This include choice of locality, Choice of raw materials, laying the foundation and the whole building process. With the ethnohistoric views the socio-cultural context of the building process is uncovered.

3) Provision of checks on the research finding or results. The part of archaeological record dealt with in this work is a recent phenomenon dating to the past few centuries. It therefore competes with ethnohistoric evidence as a source of data. The two are therefore used in this work for counter-checking results obtained through each category. For example, the ethnohistoric view that the *Ohingni* were used as defensive forts is checked by assessing the architecture of the structures. Were they constructed to meet this particular need. Are they located in areas in which the occupants were less secure? Other checks include when ethnohistoric views become exaggerated for example, that the site of Kalamindi was occupied by the whole group of the JokOnyango consisting of Kadem, Karungu, Kanyamwa and Kaler people. Considering the size of the area occupied and the number of structures found in this area or observed on aerial photographs (Table A.1 VI3A/1046 - 115 & 116), this was not possible. The explanation may be that if at all this site of Kalamindi (HB 15) was occupied by this large group of people then either a) while the core people stayed here, other people must have occupied other nearby sites or b) they only stayed at the site for a short while before breaking and leaving to their various destinations as described in section 3.2, or c) the majority of the people occupied areas where non durable walls were constructed therefore leaving no trace of the wider settlement that might have occurred in the area.

4.2 Statistical Strategies used in the study of the *ohingni*

In this work, settlement pattern analysis is used in the traditional manner of settlement pattern studies in which archaeologists attempt to interpret the distribution of places where concentrations of ancient human artifacts are found within a landscape (Dewar *et al* 1992). This analysis is aimed at fulfilling two important objectives, namely, providing an interpretation of *ohingni* location in space and their distribution shapes or patterns, and, using variables for settlement locations, for the provision of possible models predicting a stable measure of attractiveness for any possible *Ohingni* site location. The two, that is, settlement patterns and settlement systems are dependent upon each other. A settlement pattern refers to the pattern of sites on the regional landscape. This may be empirically derived through sampling or total survey. Usually, it is studied by measuring their sizes and distances between them among other things. A settlement system, on the other hand, refers to a set of rules that generated the pattern in the first place. These are usually deduced through simulation or probabilistic models (Flannery 1976). The latter, which may be discussed with reference to such variables as distance from water or resource patches, slopes, exposure, elevation, aspect, drainage, and defensibility, is clearly necessary to understanding the former which is the distribution of sites or artifact across a landscape.

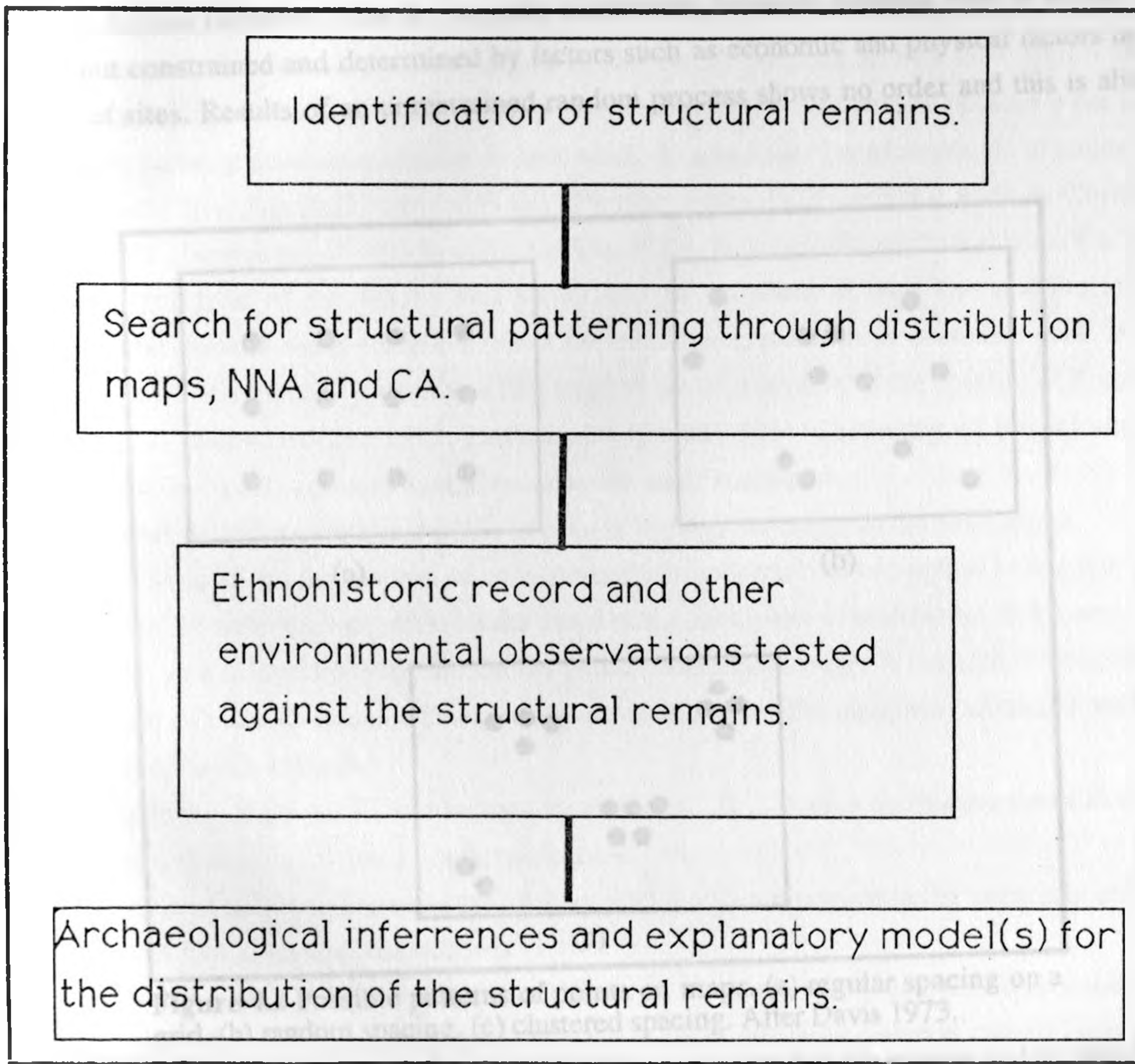

Figure 4.1 Articulation between the data from the structural remains and ethnohistoric record in the *ohingni* settlement pattern studies.

In searching for the way the *Ohingni* are located in space, use was made of distribution maps which showed the location of the structures. This was necessary in offering an objective description of the pattern of settlement of settlers of the region as revealed by the structures.

Although the human eye is very good at distinguishing between well aggregated, random and regular patterns, it is prone to see clusters where non may exist in weakly or unpatterned distributions (Orton 1980).

Three common types of distribution are shown in figure 4.2. Most maps reveal patterns like any of these or somewhere intermediate between these extremes. Usually the problem is to determine which pattern is revealed by a particular distribution map. This is exactly the problem which was tackled in this work. The major question was what pattern is revealed by the drawn distribution maps?

A random spacing as shown in Figure 4.2b means that all individuals have an equal chance of occurring at any given point on a surface plane (Earle 1976). Such random patterning is, however, not very common. Non-random spatial patternings are always expected in any distributions involving human behavior. This is because community behavior creating sites is always not random but constrained and determined by factors such as economic and physical factors in the location of sites. Results of an unrestrained random process shows no order and this is always very rare.

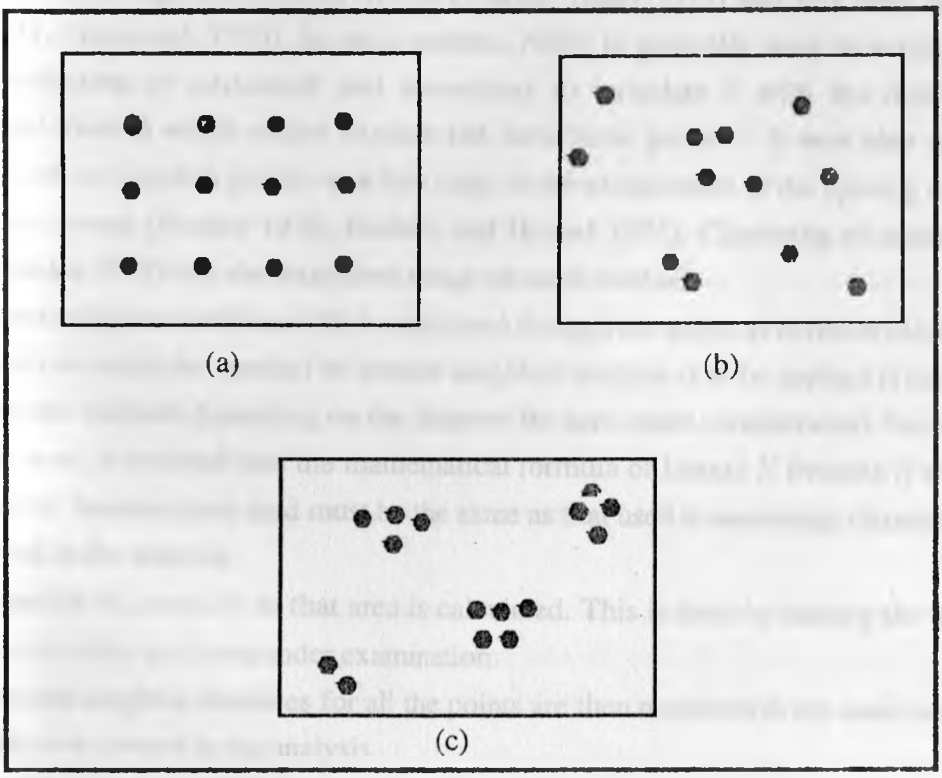

Figure 4.2 Possible patterns of points on maps. (a) regular spacing on a grid. (b) random spacing. (c) clustered spacing. After Davis 1973.

Clustered and regular patterning in distributions are a result of constraints put on populations involved in a distribution. Clustering may occur due to attraction of population toward strategic resources. It may also occur in a situation where new individuals originate from one or more parent populations already located in space. Regular patterning on the other hand usually occurs due to populations competing for resources so that the antagonism between them leads to allocation of resource territories in which no infringement occurs.

The method used here to describe structure distribution is known as nearest neighbor analysis. This is a technique borrowed from ecologists and human geographers. It uses a descriptive statistic called nearest neighbor coefficient which is used to determine the overall tendency of points in a distribution. It describes a scatter of points as being either random or non-random. If non-random, then it measures the degree and direction of non-randomness through figures which range from 0.00 to 1.00 showing a tendency towards a clustered pattern and 1.00 to 2.15 showing a tendency towards regular patterns. 1.00 represents a random distribution (Plog 1976).

This method was chosen for this work because it offers a high degree of objectivity for the description of distributions that can be mapped as points. Such points may include work areas, artifact locations, houses, communities, specialized service centers, towns and cities. It offered a manageable tool for describing distribution of the South-Western Kenya lake region stone structures once these were expressed as points on the maps It was also chosen because it has been successfully used in situations similar to this work. It was used, for example, to examine the distribution of Iron Age hill forts in Wales (Pierson-Jones 1973) and hill forts in Cornwall (Hodder 1971, Newcomb 1970). In such studies, NNA is generally used to establish a non-random distribution of settlement and sometimes to correlate it with the distribution of envirnomental factors which might explain the settlement pattern. It was also used in the identification of non-random pattern as a first stage in the examination of the spacing of Romano-British walled towns (Hodder 1972, Hodder and Hossal 1971). Clustering of mound sites in Alabama (Peebles 1973) was also examined using the same method.

The nearest neighbor coefficient (R) is calculated through six stages as outlined below.

1) The area in which the method of nearest neighbor analysis is to be applied is calculated by using appropriate methods depending on the shape of the area under consideration. For example, if a rectangular area is involved then the mathematical formula of Length X Breadth (l x b) may be used. The unit of measurement used must be the same as that used in measuring distances between points involved in the analysis.

2) The density of points (P) in that area is calculated. This is done by finding the ratio of the number of points to the total area under examination.

3) The nearest neighbor distances for all the points are then measured in the same unit used for calculating the area covered in the analysis.

4) The mean nearest neighbor distance is calculated by summing the distances and dividing by the number of points. This gives the observed mean nearest - neighbor distance, usually denoted as r_o or the observed distance.

5) The expected value (r_e) of the mean nearest distance if the points were randomly distributed is calculated using the formula

$$r_e = {}^{1/2}\!\!\sqrt{p} \ ,$$

where P is the point density in the area being examined.

6) The nearest neighbor coefficient is then calculated as the ratio of the mean distance observed (r_o) for the study area to the mean distance expected (r_e) for a randomly distributed population of a given density (Plog 1976). This is denoted as

$$R = r_o/r_e.$$

In calculating both r_o and r_e, the assumption is that the area under consideration is a plane (level) with populations being examined remaining independent.

7) The R Coefficients attained may then be subjected to further evaluation. This usually involves a test of significance for validation (Clarke and Evans 1954).

The figure derived from such calculations usually helps in identifying whether a distribution is random, clustered or regular. These patterns have R coefficients of 1.00, 0.00 and 2.15 respectively (Clarke and Evans 1954, Plog 1968a, Adams and Nissen 1972).

In its application, the method has both mathematical and archaeological requirements to be met. Mathematical requirements include the following.

1) A defined area in which the analysis is to be carried out. This may be set to meet the requirements of the research.

2) All populations being considered have to be expressed as points on a distribution map or sketch.

3) The points being considered should be independent and not dependent on distinct factors for their distribution.

4) There is always the assumption that the area under consideration is a plane with homogenous features and that the populations have equal chance of being located anywhere on this plane.

5) The populations being used in the analysis should be grouped into types and sizes.

These requirements translated into archaeological requirements in archaeological investigations are as follows:

1) The area being archaeologically examined must be distinctively set according to the requirements of the research.

2) Within the chosen area, all populations being examined whether they are work places, artifact locations, houses, communities, specialized service centers, towns or cities, have to be expressed as points and totally recovered to give a 'total universe' of sites.

3) Sites must be of the same period of occupation and should be grouped into types and sizes.

4) The results should be subjected to a test of significance for validation (Clarke and Evans 1954).

To meet these archaeological requirements, the following procedures and approximations were made.

First, concerning the area of analysis small areas were determined within each of the four areas of study. The boundaries were set on the basis of areas which had large numbers of structures.

These areas have been called Homa Bay, Karungu North, Karungu South and Mecalder Clusters (Figure 5.1 - 5.4).

Second, all structures which are part of the archaeological record in this work were mapped as points through revision mapping, field survey and aerial photo examination. The photographs used in this search for sites are given in Table A.1 with ones which led to the recovery of recently destroyed structures given in Table 2.3. Through this procedure, therefore, there is confidence that the recovery of structures in the entire region was complete.

Third, on the structure type, size and time period, it was difficult to set up a hierarchy of this nature. This was hampered by the fact that most of the structures were very overgrown and could not allow measurements to be taken. Only estimates for sizes could be made but this could not be relied upon to give accurate information to be used. Grouping the structures according to time period was also not possible due to lack of authentic dates for the structures. This problem was, however, solved by utilizing the ethnohistoric information that was collected. The lake-shore structures found in Karungu and Gwasi were considered older than the inland structures found in Homa Bay and Macalder areas. Both Karungu and Gwasi structures were generally considered contemporaneous. The Homa Bay and Macalder structures belong to different time period with the Mecalder structures being the latest in the region. This is based on the idea that much of the region under Macalder, for example Kanyamkago, was settled in the late 19th or early 20th century (Butterman 1979) and therefore forms an area of the most recent abandonment of structures. This information was used to classify the structures on a regional basis and their different nearest neighbor coefficients calculated. The coefficients were therefore calculated on this regional approach as opposed to dates for individual structures, a task that could not be managed within the limits of this work. All structures irrespective of size were treated equally. The rationale was that all structures are indicators of terminal prehistoric settlements in the South-Western Kenya lake region. They could therefore be used to investigate the pattern of that settlement within the vaguely defined time periods discussed in section 3.2. All the sites used in the analysis are generally considered contemporaneous. Since they fall within a period of about 300 years, archaeologically they may be considered contemporaneous. 300 years amounts to about two stnadard deveiations, or again to the standard error, which is typical for carbon dates on recent sites. Thus, in a normal archeological chronology, these sites would appear to be contemporarry. The structures are also assumed to represent a single construction sequence because of distribution and architectural similarity.

Apart from the NNA just described, Cluster Analysis (CA) was run to find out how the structures group and how many groups there were in each subregion. Cluster analysis is a spartial statistic which operates on the premise that membership for individual clusters is not known and that even the number of groups are unknown. Its main goal, therefore, is to identify the groups (clusters) and also assign each case to the group to which it belongs. It also allows for the determination of the characteristics the objects in question share as well as those in which they differ.

Hierarchical cluster analysis using agglomeration method was used. Agglomeration method is one of the linkage methods used in hierarchical clustering whereby clusters are formed by grouping cases into bigger and bigger clusters until all cases are members of a single cluster. In the first step, all points are considered separate clusters. In the second step, two of the cases are combined into a single cluster. And, in the subsequent steps, either a third case is added to the cluster already containing two cases or additional cases are merged into a new cluster. In all the steps, therefore, either individual cases are added to clusters or already existing clusters are combined. Once grouping is done, group membership in all steps remain permanent.

The agglomerative schedule that was used is complete linkage. This was based on a matrix of distance in the form of X and Y co-ordinates of each structure. The distances were given in metres representing actual distance North/South of the equator or East of Greenwich for each structure, previously expressed as points on a 1:50,000 topographical maps. Euclidian distances were used to measure the geographic spacing of the sites in the entire region. Excluded from the analysis are variables such as structure size, wall height and chronology. Only distance measures are used to determine which structures cluster together.

As a first step in the analysis, co-ordinates for each structure in the four subregions were taken. These were expressed as a two matrix distance measure (Table A.7 - A.10). These were then subjected to a hierarchical cluster analysis using complete linkage method. The results of this analysis is discussed in section 5.4.

Cluster Analysis for the *ohingni* was carried out for two reasons:

1. Nearest Neighbor Coefficients obtained (Fig 5.1) show the pattern of distribution as clustered thus only giving a descriptive terminology for the spatial distribution of the stone structures. Consequently, the analysis (NNA) does not offer any explanation or clue as to which and what types of clusters are present.

2. Even if NNA would provide such clues by, for example, a combined use of distribution maps (Figures 5.1-5.4), it lacks the methodology by which distance measures between structures and for each structure are used to identify clusters in a distribution. This is only provided in cluster analysis.

With regard to provision of possible models predicting a stable measure of attractiveness for any possible *ohingni* site location, an examination of the discovered nature and strength of any significant distribution patterning, trends, correlations or spatial structure within the stone structures and or/with other variables was used. Questions were put to the structural remains so as to extract interpretive information. An obvious preliminary question was "Why are the structures located where they are found?" Is it due to environmental or social reasons? It was expected that answers to such questions tested against the data would lead to an explanatory model for the *ohingni* settlement pattern.

Unfortunately, a vigorous statistical analysis was not possible for this testing. Some variables considered could not be quantitatively analyzed. These include especially the social ones which were derived from the current occupants of the area who are separated by many generations from the actual builders of the structures. Secondly, resources to subject the area to a thorough quantitative study were lacking. Detailed measurements in and around the structures and in the whole region of study obviously require a large sum of money and equipment which was not available for this work. Other problems such as the wider geographic distribution of the structures and the bushy state of most of them as well as the limited number of research assistants, further limited quantitative analysis in this stage.

For these reasons, the search for settlement systems utilized heavily qualitative assessment of the data. Archaeological observation has been used with correlates and stipulations derived from ethnohistoric information to arrive at inferences to predict distribution models. Variables have been played against each other and in turn against the stone structures and their locations. Through these procedures, rules which might have controlled the choice of site location and the resulting patterns have been proposed. The validity of such rules may in future be tested using statistical means or other quantitative methods once the limitations listed above are overcome.

4.3. Summary

The *ohingni* compared to other archaeological records, for example lithic, faunal and ceramic remains which may be adequately used to predict a community's past social behavior, seem to be less adequate especially when used alone. Their distribution was a consequence of social factors which are not readily revealed in their archaeological context. As a result, ethnohistoric views have been utilized to enhance understanding and to throw light in some of the activities that formed the systemic context of the structures. The pattern of distribution which appears as clustered on the maps has been subjected to two analyses namely, nearest neighbor analysis and agglomeration cluster analysis to find the real structural pattern. The results of these analyses as set in the next chapter contribute to the understanding of settlement systems which are important in predicting the rules which might have controlled the choice of site location and the eventual expansion and increase of structures on a site.

CHAPTER FIVE
PATTERNS OF STRUCTURE DISTRIBUTION

5.1. Introduction

This chapter deals with a simple sounding question. What is the pattern of distribution of *ohingni* and how did these settlements associate with each other? Most works on the *ohingni* have simply not provided us with reliable answer to this question. Even the on-site observers are not clear on what patterns of structure distribution exist in the region. Field observation during foot survey as well as aerial photograph examination tend to point to a particular pattern of distribution. Although this may be true, it remains questionable as no method has been used to establish such a pattern. Usually, the human eye is prone to seeing clusters where non may actually exist in weakly or unpatterned distribution (Orton 1980). The results of such observation may, therefore, not be relied upon to give us a description of the pattern of distribution exhibited by the *ohingni.*

Even more oblique is the relationship between the structures. Both observation and oral tradition relate structures in various ways using size, concentration and distance between structures amongst others. This is very attractive but is it a reliable means of establishing relationship between structures on the one hand and sites on the other ? A statistical method would possibly suffice to give more credibility to any claimed relationships.

In this chapter therefore, I use Nearest Neighbor and Cluster Analyses as statistical methods to determine the pattern of structure distribution and establish possible relationships between such distributions. These methods are theoretically discussed in section 4.2. In the four subregions used, the pattern of distribution is established in terms of individual structures and the relationships predicted in terms of both individual structures and sites in general. These terms are both defined in chapter two.

One pattern is evident in Table 5.1. Other related sub patterns are visible on the distribution and cluster maps. These will receive further comment later in the chapter. This will prepare us nicely for the discussion of complex settlement systems in chapter six.

5.2. Features of the Subregions

Four separate sub regions were studied by the use of nearest neighbor analysis method. The boundaries of these sub regions were determined to allow better management of the data (Getis 1964, Kariel 1970: 128). The sub regions identified in this manner are Macalder (M. sheet 129/4), Homa Bay (HB sheet 129/2), Karungu North (KN sheet 129/3) and Karungu South (KS sheet 129/3). They were thoroughly surveyed and all structures mapped. The forested hilly area of Gwasi hills on the northern boundary of Karungu area, however, gave very little positive result during both foot survey and aerial photograph examination. The aerial photographs (VI3A/1070 - 063 064 and 065) revealed nothing due to thick vegetation. Sites are unlikely to exist in this hilly-mountainous area due to its difficult terrain. This terrain was not included in the areas used to calculate the NN coefficients for lack of enough representative data and the lake boundary effect.

Karungu region was divided into two sub regions due to a large expanse of land between the two areas which contained structures. Such areas were left out as they would distort the nearest neighbor coefficient. Survey data from Gwasi (Fig. 1.1) were not included in the analysis. Most of the sites in this region are situated along the shore of Lake Victoria making nearest neighbor analysis difficult to apply. The boundaries of these subregions were determined on the basis of where sites were found. This was done to allow better management of the data (Getis 1964, Kariel 1970:128). No strict rules were set apart from the boundaries running closer to sites to enclose areas with concentration of sites. For Homa Bay subregion, the area covered by Lambwe Valley National Reserve was left out as dictated by this rule. Similarly the area covered by Lake Victoria in Karungu North subregion was left out in the NNA because no sites were expected in these areas. The northeastern parts of the two maps show spaces without sites. Similarly, the southwestern part of Macalder map and several parts of Karungu South map show spaces without sites. These areas were, however, included in the NNA calculation of area sizes. Their inclusion was mainly due to the following reasons: One, they were very close to the site areas and were thought to have contained sites which were either completely destroyed or missed out during the survey even though it is thought that all sites were recovered. Two, these areas have all the requirements for site construction and were therefore looked at as potential settlement sites. Their inclusion, therefore, was to cater for such distribution of sites had the potential been exploited. Three, if these areas were excluded from the analysis we would have a more sharper trend of clustering of the structures. Their inclusion has made the results a bit robust but significantly important statistically. They must have affected the R coefficients of the areas although this is minimal considering the pattern of structure distribution indicated on the maps and the results of the NNA.

For each sub region, the procedure for calculating the nearest neighbor coefficient (R) was followed as set in section 4.2. Both complex and simple structures were treated as points for purposes of measurements. The nearest neighbor distances were taken for all structures within the distribution boundaries as shown in Tables A.3. through A.6. As indicated earlier, measurements were taken from each dot or point representing a structure to its nearest neighbor.

The Macalder subregion has been the subject of intensive archaeological survey starting from the Thimlich prehistoric archaeological site area and spreading northwards into Kadem, Kanyidoto, and Kwabwai as well as Southwards into the Kanyamkago area (Onjala 1990, Robertshaw 1991, Wandibba 1986). The area around Thimlich including the western region of Mohuru has therefore received total coverage and all surviving structures mapped.

Various aspects of the natural environment of this sub region have been discussed in section 1.4. However, it will suffice to mention here that the sub region is criss-crossed by a number of small streams and rivers the biggest of which is River Kuja. It is also spotted with a number of hills, the highest of which is Nyakune, which stands at a height of 1402 m above sea level to the east of the Thimlich prehistoric site. The Kanyamkago hills dominate the eastern part of this region. These features were very important in the settling of the area which continued to as late as the early 20th century (Butterman 1979). Most of the sites found in this sub region are located on hilly areas leading to the names given to such sites being names for various hills.

As with the Macalder subregion, Homa Bay subregion has received intensive archaeological search for stone structures. A previous work (Onjala 1990) together with the fieldwork for the current work ensured a complete coverage of the region and all structures mapped.

The physical environment of the area in which nearest neighbor analysis was conducted is characterized by numerous small seasonal streams, swampy areas, isolated hilly areas and the Kanyamwa escarpment which runs in a NE - SW direction in the western part of the sub region. Part of the swampy and flat areas is covered by the Lambwe Valley National Reserve. The escarpment acts as a divide between the valley and the rest of the areas which had evidence of early settlement. No structures were found within the valley. Aerial photographs examined yielded no results due to vegetative cover (V13B/1070 - 012, 011, 010; V13A/1046 - 117, 118, 119). As was true with the Mecalder sub region, most structures here are located on slopes of low hills and therefore have assumed the names for those hills on which they are found.

The search for the stone structures in the Karungu region as indicated earlier, was complete except for the hilly region bordering Karungu and Gwasi. In this area, even aerial photographs (V13A/1070 - 063, 064 and 065) yielded nothing due to thick vegetation. Apart from this, large expanses of land separate the areas where the structures are found. This necessitated the division of the region into two sub regions, namely Karungu North and Karungu South. This was mainly for purposes of nearest neighbor analysis.

The physical environment in Karungu North sub region is characterized by Lake Victoria to the West, isolated hills rising above a flat lowland criss-crossed by small streams draining into Lake Victoria to the South East, and high hills including Nyatambe (1313 M) and Tigra (1565 M) to the north. Most of the structures found in this sub region appear on the south-eastern lowland hilly areas and the Lake-Shore hilly areas or peninsular lands.

Karungu South sub region is characterized by a few isolated hills to the north-east and mid-south. The hilly areas are separated by wide areas of low flat lands with a few streams. River Kuja which cuts across the sub region meanders in this sub region as it nears its destination Lake Victoria. Again structures are found mainly on hilly areas with the earth-built ones such as Kimae (KS4) and Kituka -Ojendo (KS2) found on raised flat areas. Comparatively, there are fewer structures in these two areas (KN and KS) than in the other two sub regions located in the interior.

5.3. The Degree of Clustering in Structure Distribution by NNA

Table 5.1 shows that the Nearest Neighbor Coefficient (R) for the four subregions are all less than one (1). This shows a tendency towards clustering of structures on a regional scale. Since the R values of 0.36, 0.30, 0.40 and 0.33 are very different from 1 and the number of points (n) as shown in Tables A.3 through A.6 is quite large, there is confidence that the pattern of distribution exhibited by the *ohingni* in the four subregions is really a clustered one. No test of confidence to establish this distribution is therefore really necessary.

Area Covered in the Study	Area in Km^2	Density of points (P)	r_o Value	r_e Value	NN Coefficient (R)
Macalder (M)	296.8	0.86	0.20	0.54	0.36
Homa Bay (HB)	167.8	0.47	0.22	0.74	0.30
Karungu North (KN)	61.7	0.37	0.33	0.82	0.40
Karungu South (KS)	116.0	0.20	0.37	1.12	0.33

Table 5.1. Nearest-Neighbor Coefficient (R) for the four areas of study computed through a six stage process as outlined in section 4.2.

Low values for densities (P) and the expected mean distances to nearest neighbor (r_e) are a result of inflated areas for the four subregions. Inclusion of spaces without sites in the areas where NNA was conducted, as discussed earlier, has led to larger areas in Km^2 lowering both density (P) and the expected mean distance to the nearest neighbor. This has eventually resulted in higher R coefficients. The expected mean distances to nearest neighbor is directly proportional to the densities. They are derived from the square roots of the density values. This implies that if all the spaces without sites in the four maps were excluded from the analysis, the Area values would reduce. This would in turn raise the density values leading to higher r_e values. And since the observed mean distances to nearest neighbor (r_o) remain the same, such higher r_e values would lead to smaller R coefficients therefore indicating more or a higher degree of clustering of structures in the four subregions.

Apart from these R coefficients which indicate that the *ohingni* exhibit a clustered pattern of distribution, a visual inspection of the distribution maps for the four subregions also confirm this. Cluster analysis run for the subregions also point to this conclusion. Three hypotheses result from these nearest neighbor coefficients. One, this clustering is a result of independent attraction of structures toward an unevenly distributed resource areas. Two, this clustering is a result of attraction of structures towards each other. In this case a mother structure will have several daughter structures a few meters around it creating a cluster of structures in an area. With an increase in population in such an area, the number of daughter structures is bound to increase creating more clustering. A third hypothesis that may be advanced is that early settlements were located on areas safe from wild animals and waterlogged places such as swamps. If this is true then it may help to explain the tendency of hill settlements and the lack of any traces of early settlements in the National Reserves area and its environs.

The first two hypotheses are more applicable in the four subregions. The third one, however, is more restricted to the Homa Bay subregion. Attraction of structures toward an unevenly distributed resource areas and attraction toward each other is applicable in the entire region. Since the sites are a result of population movement and settlement, it can be argued that new structures were formed by populations "budding off" from established community settlements, with their new settlements being located near their parent settlements. The result would be an initial pattern of site clustering. These hypotheses are further discussed in chapter six.

Table 5.1 indicates a nearest neighbor coefficient (R) of 0.30 for this sub region. This is a high tendency towards clustering. A visual inspection of the distribution map for this sub region and the cluster analysis results confirm this. Both the resource and budding hypotheses given in section 5.2.1 hold for this sub region and will be discussed in the next Chapter.

The nearest neighbor coefficient (R) for Karungu North and Karungu South are 0.40 and 0.33 respectively (Table 5.1). These show a strong tendency towards clustering which is further confirmed in the distribution map and cluster analysis results. The three hypotheses given in the previous sections hold for these two sub regions and will be discussed in the next Chapter.

5.4. Site Grouping and Association Through CA

Cluster Analysis proceeded as described in section 4.2. Tables A.11 through A.14 show the results of this analysis using agglomeration method which was run for the four subregions of Macalder, Homa Bay, Karungu North and Karungu South. In these agglomeration schedule tables, the number of structures being combined to form new clusters are shown in the column entitled "Cluster Combined." They also show the distance between structures being combined at each stage in the column entitled "Coefficients". These are Euclidean distance measures based on the matrix of distances for each structure. Small coefficients show that structures with fairly homogeneous distance measures are being merged. Large coefficients on the other hand indicate that structures with quite dissimilar distance measures, are being combined. In the column entitled "stage cluster 1st Appears" is indicated the stage at which a case is first involved in a cluster. The last column shows at which stage another case or cluster is combined with the ones appearing in that particular stage.

These results are carried in the dendrograms (Tables 5.2-5.5) and also in the maps (Figures 5.1-5.4). Clusters are drawn on the maps to about the fourth level of association. These results are further integrated in Table 5.6 where primary clusters are shown together with other subsequent clusters of the clustering hierarchy. A look at the cluster analysis results for Macalder subregion shown in Figure 5.1 and Tables 5.2 and 5.6 point towards clustering. These show 64 major cluster points (referred to as primary clusters) which are areas of early group settlements. Of the 64 primary clusters, only 10 are single-structure clusters. A crude average calculation of the number of structures per each primary cluster gives a mean of 4 structures per cluster. This indicates a tendency of group settlement within this area. These grouping of structures into 64 primary clusters through CA is significantly positive. During foot survey and the initial preparation of distribution maps for the Macalder subregion, 69 localities were designated as clusters. The CA results therefore, have confirmed 64 of these and merged the remaining 5 into the others. A further look at Figure 5.1 indicates that a clustering problem exists in the areas of M3, M2, M26, and M59. This was caused by the general closeness of structures in the M2-M3 area on the one hand and possibly feeding wrong figures into the computer for the M59 on the other hand. M59 ought to have been split into smaller clusters. These anomalies, however, have a minimal effect on the overall trend of clustering in the entire region.

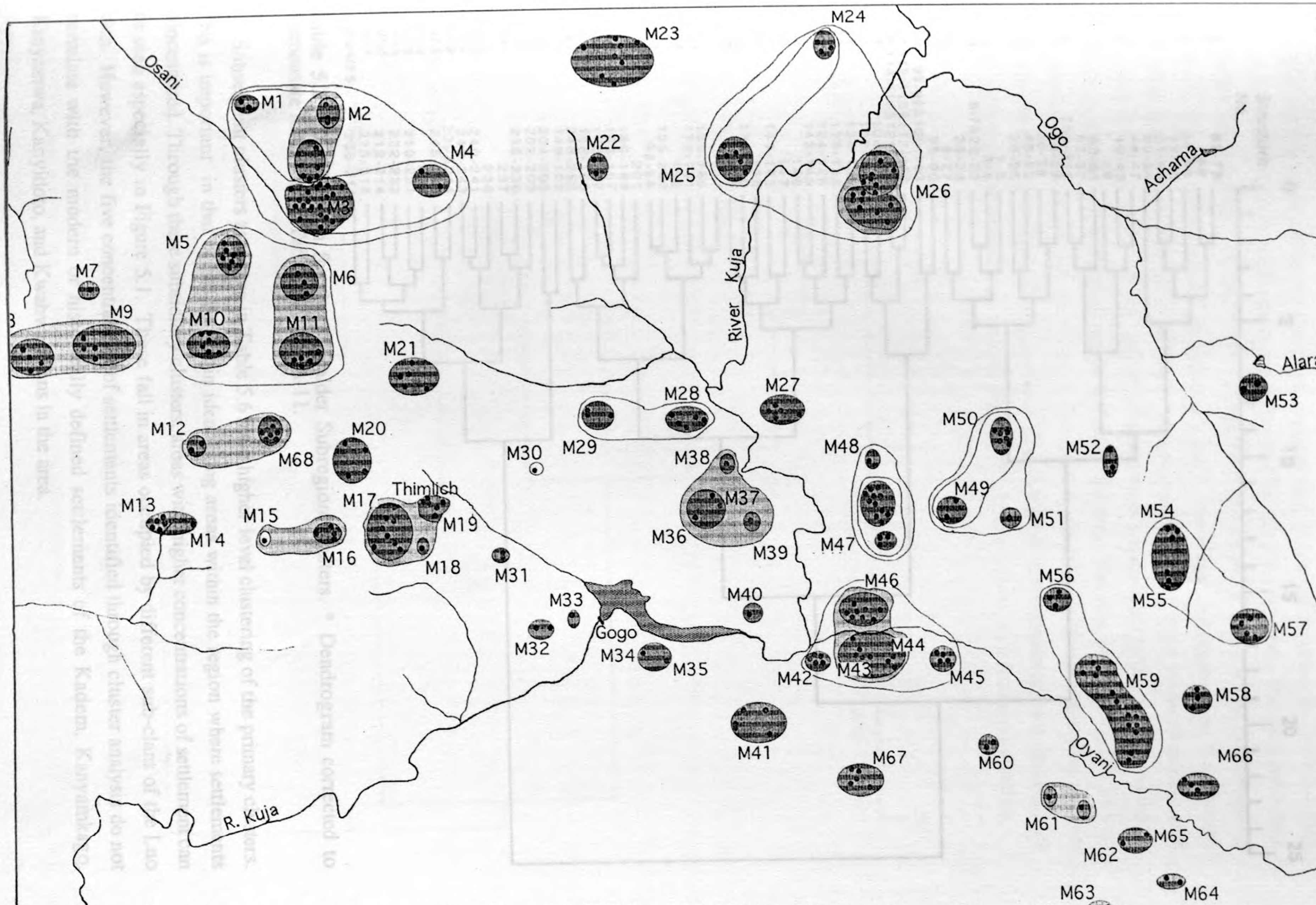

Figure 5.1 Distribution of Structures in Macalder subregion. Nearest Neighbuor and Cluster

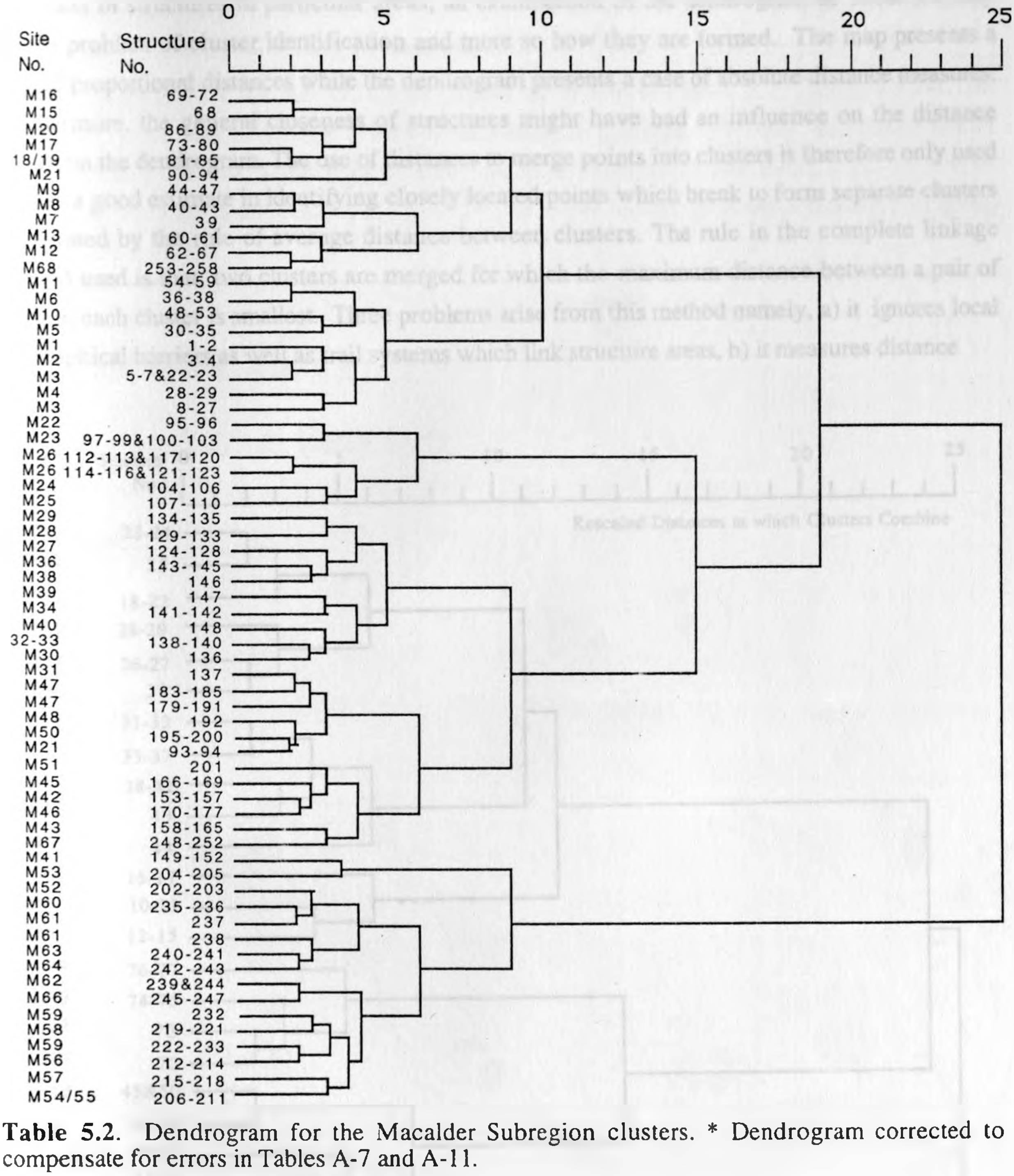

Table 5.2. Dendrogram for the Macalder Subregion clusters. * Dendrogram corrected to compensate for errors in Tables A-7 and A-11.

Subsequent clusters as shown in Table 5.6 form higher level clustering of the primary clusters. This is important in that it has helped in identifying areas within the region where settlements concentrated. Through these subsidiary clusters, areas with higher concentrations of settlement can be seen especially in Figure 5.1. These fall in areas occupied by different sub-clans of the Luo clan. However, the five concentrations of settlements identified through cluster analysis do not correlate with the modern or historically defined settlements of the Kadem, Kanyamkago, Kanyamwa, Kanyidoto, and Kwabwai clans in the area.

While a look at Figure 5.1 obviously confirms the existence of clusters due to the general closeness of structures in particular areas, an examination of the dendrogram in Table 5.2 may pose a problem of cluster identification and more so how they are formed. The map presents a case of proportional distances while the dendrogram presents a case of absolute distance measures. Furthermore, the general closeness of structures might have had an influence on the distance shown on the dendrogram. The use of distances to merge points into clusters is therefore only used here as a good estimate in identifying closely located points which break to form separate clusters as dictated by the rule of average distance between clusters. The rule in the complete linkage method used is that two clusters are merged for which the maximum distance between a pair of cases in each cluster is smallest. Three problems arise from this method namely, a) it ignores local geographical barriers as well as trail systems which link structure areas, b) it measures distance

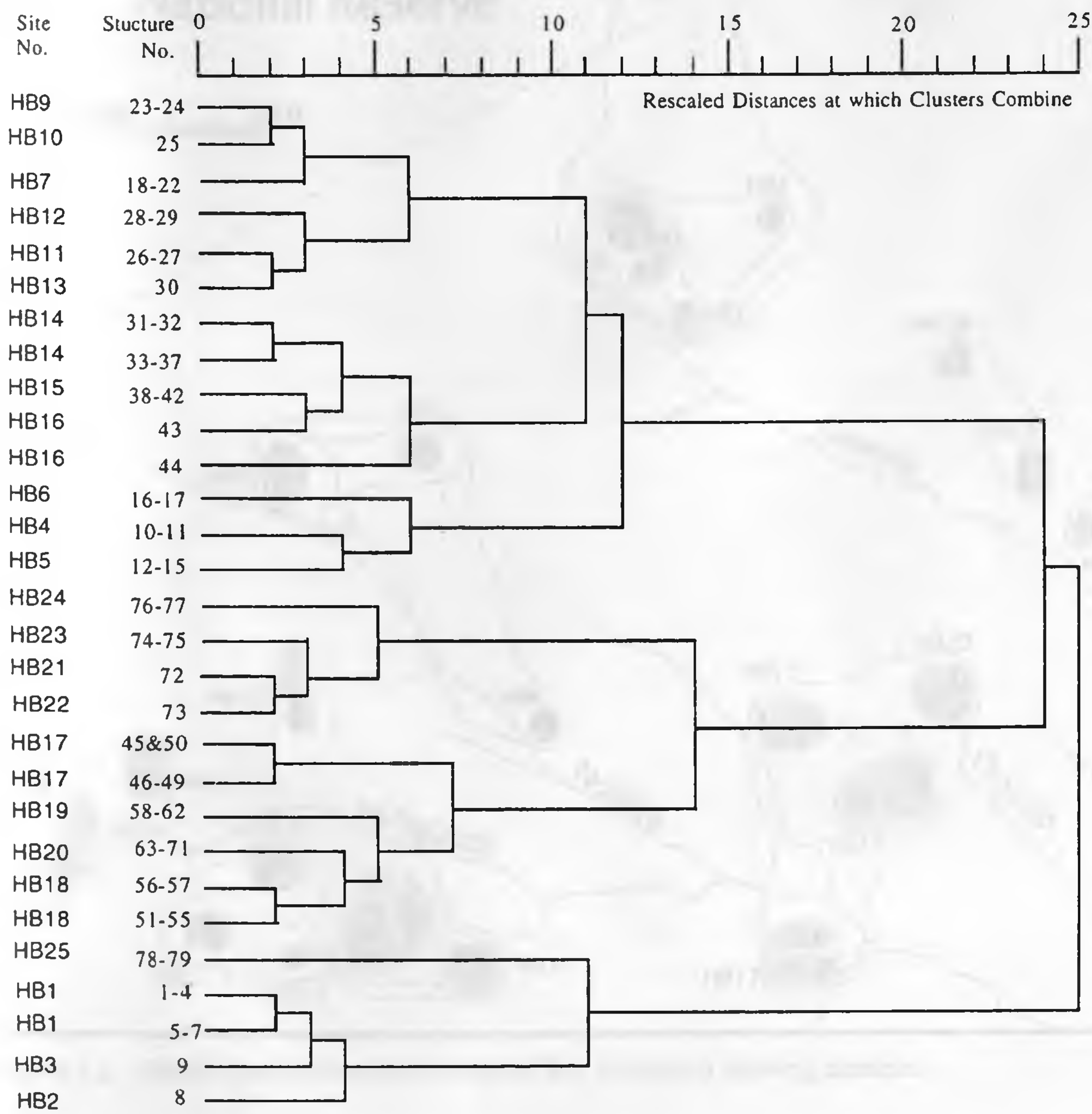

Table 5.3. Dendrogram for the Homa Bay Subregion clusters.

centre to centre in defined clusters rather than from edge to edge and c) in forming primary clusters, smallgroups of structures which havegaps of equal size tend to be agglomerated rather than seperated due to close spacing of structures.

The CA results for the Homa Bay subregion, presented in Figure 5.2, Tables 5.3 and 5.6, suggest that there was a clustered pattern of settlement in this region. Twenty nine major cluster points (primary clusters) form areas of early group settlements. Out of these, eight are single-structure clusters. A mean number of three structures per cluster indicates a tendency of group settlement in this area.

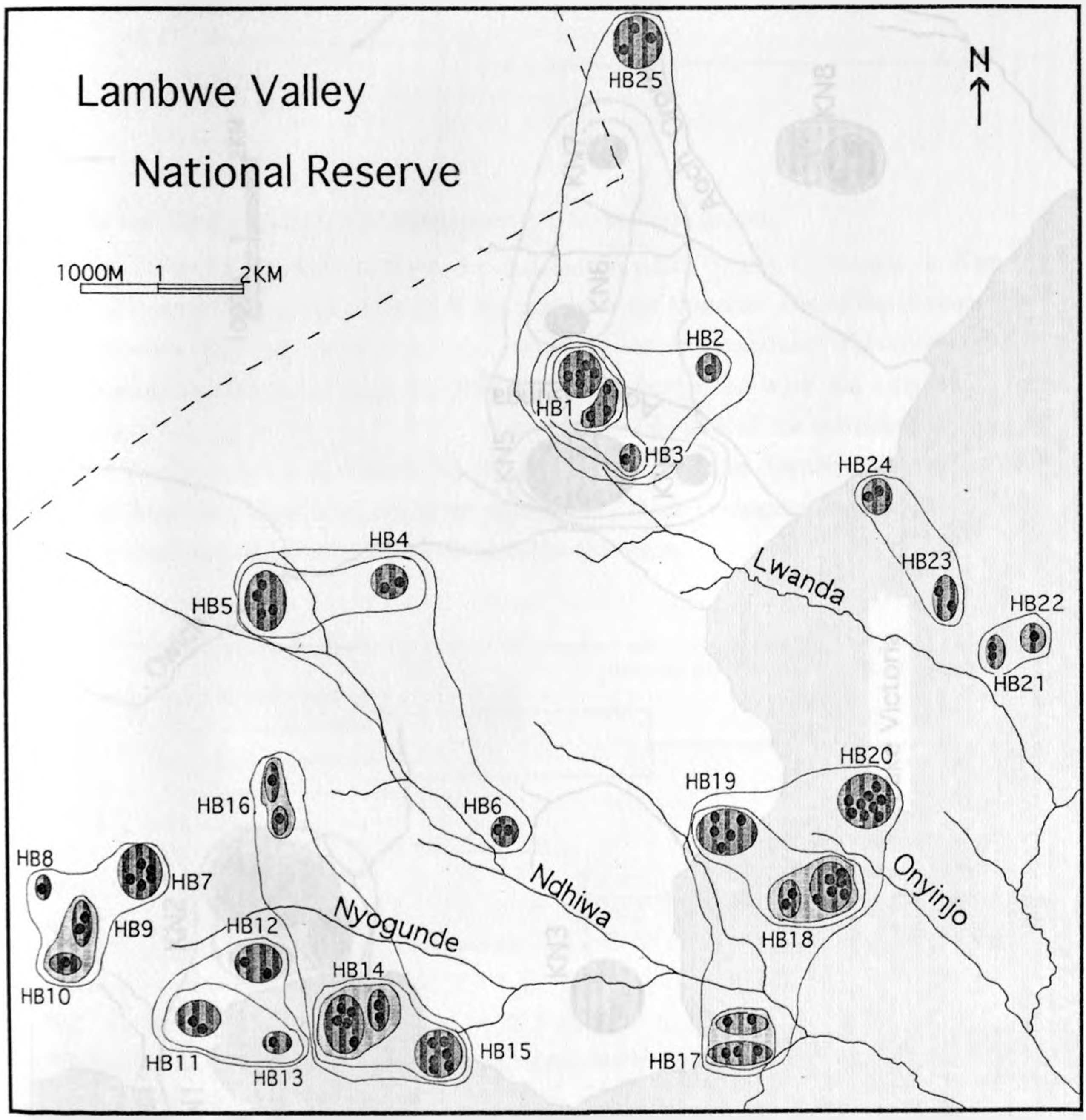

Figure 5.2. Distribution of structures in Homa Bay subregion showing clusters.

As hypothesized earlier, primary clusters seem to be associated basically hilly areas separated by large swampy stretches of land. Figure 5.2 and Table 5.6 reveal five concentrations of settlements wl resource areas. Due to a small number of structures in the region, cl visible in Figure 5.2. This is due to the general closeness of structu problems of distance as discussed for Macalder Sub region above is

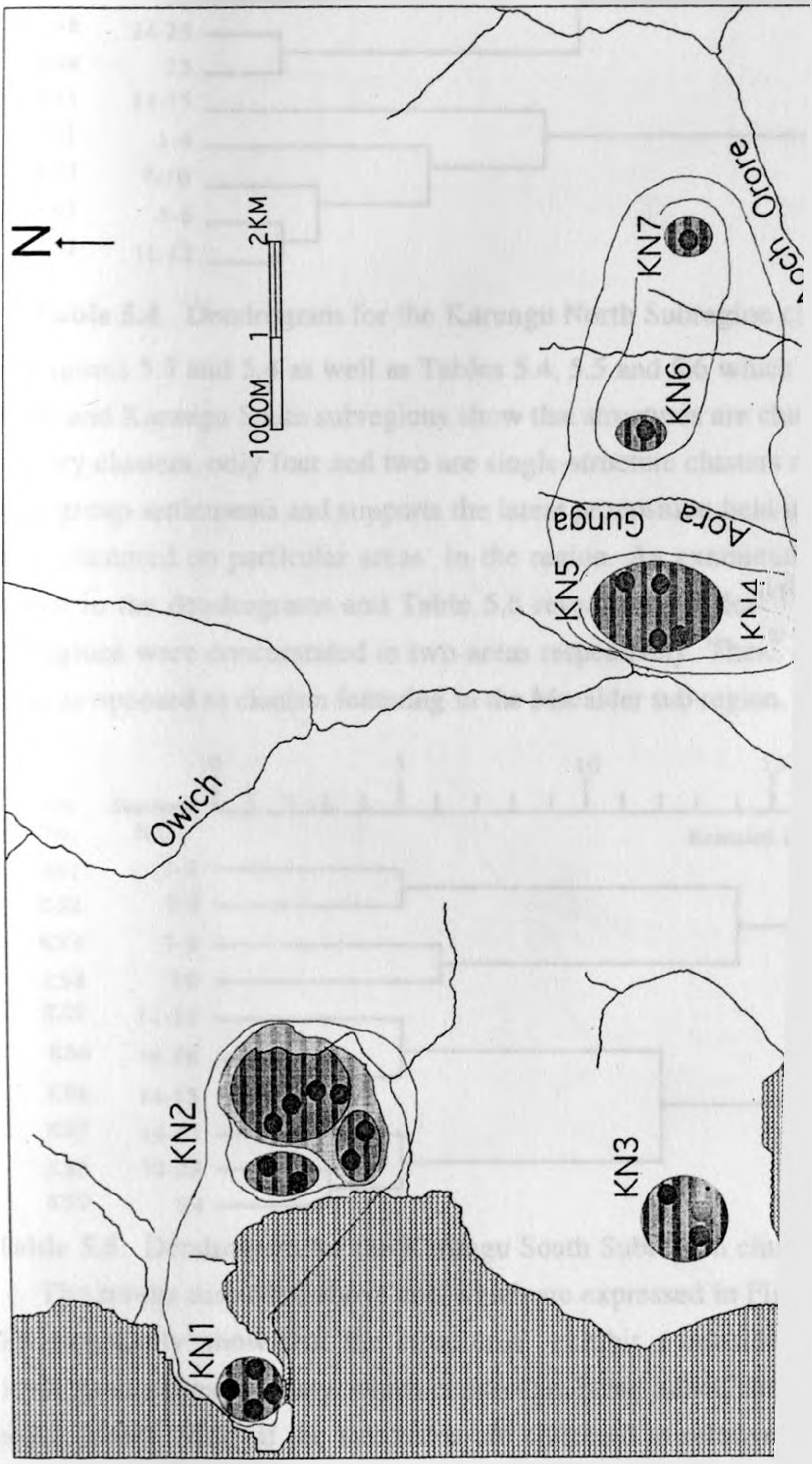

Figure 5.3. Distribution of structures in the Karungu North su

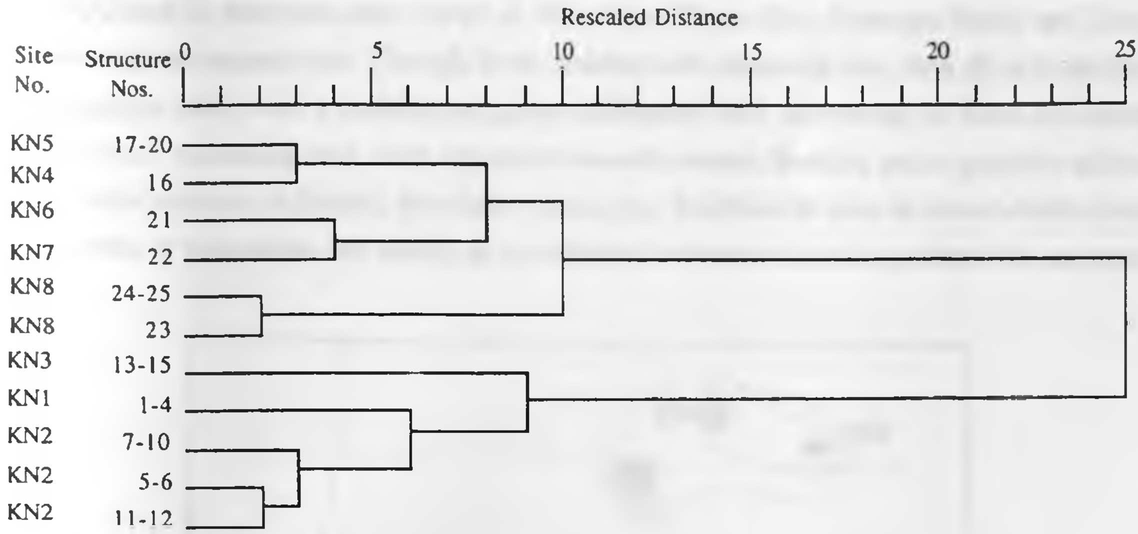

Table 5.4. Dendrogram for the Karungu North Subregion clusters.

Figures 5.3 and 5.4 as well as Tables 5.4, 5.5 and 5.6 which contain CA results for Karungu North and Karungu South subregions show that structures are clustered. Out of the eleven and ten primary clusters, only four and two are single-structure clusters respectively. This points towards early group settlements and supports the latent proposition held in this work that early settlements were clustered on particular areas in the region. An examination of the subsidiary clusters as shown in the dendrograms and Table 5.6 reveal that settlements in Karungu North and South subregions were concentrated in two areas respectively. These correspond basically to resource areas as opposed to clanism featuring in the Macalder sub region.

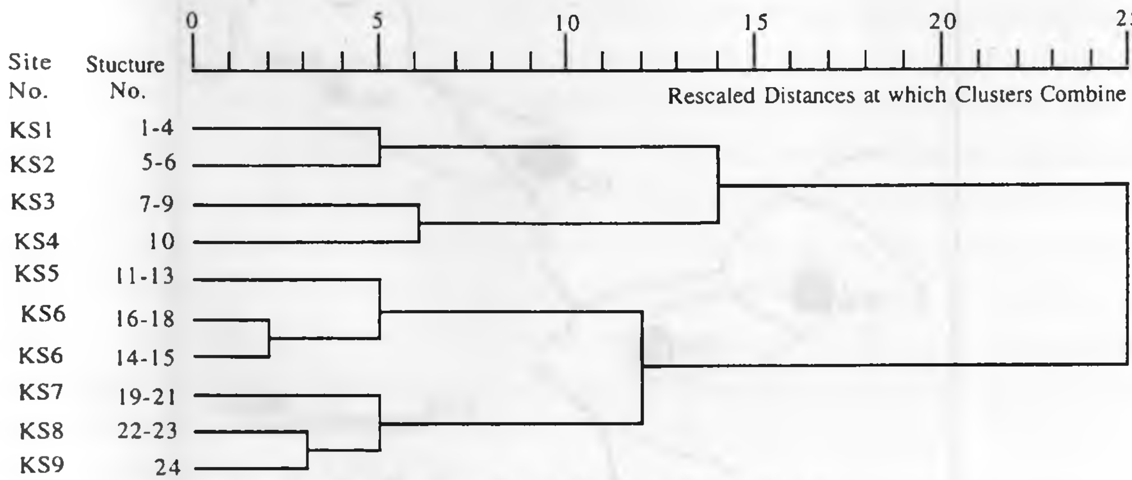

Table 5.5. Dendrogram for the Karungu South Subregion clusters.

The results discussed above and which are expressed in Figures 5.1 to 5.4 and Tables 5.2 to 5.6 summarily show that the structures exhibit a considerable degree of clustering. The dendrograms show not only which clusters are being joined but also the distance at which they are being joined. Most of the structures are clustered at relatively small distances as seen in the relatively small coefficients for the majority of the pairs in the agglomeration schedules in Tables

A.11 to A.14. Using the primary clusters, a crude mean shows that there are four, three, two and two (4, 3, 2 and 2) structures per cluster in Macalder, Homa Bay, Karungu North and Karungu South sub regions respectively. Though these numbers are relatively low, they do indicate that in the four regions there was a tendency of group settlement with an average of three structures per locality settled. Assuming that each structure housed several families and a possible additional group of other relatives or friends, the cluster areas may therefore be seen as areas which contained high densities of population and where environmental resources including stones for construction

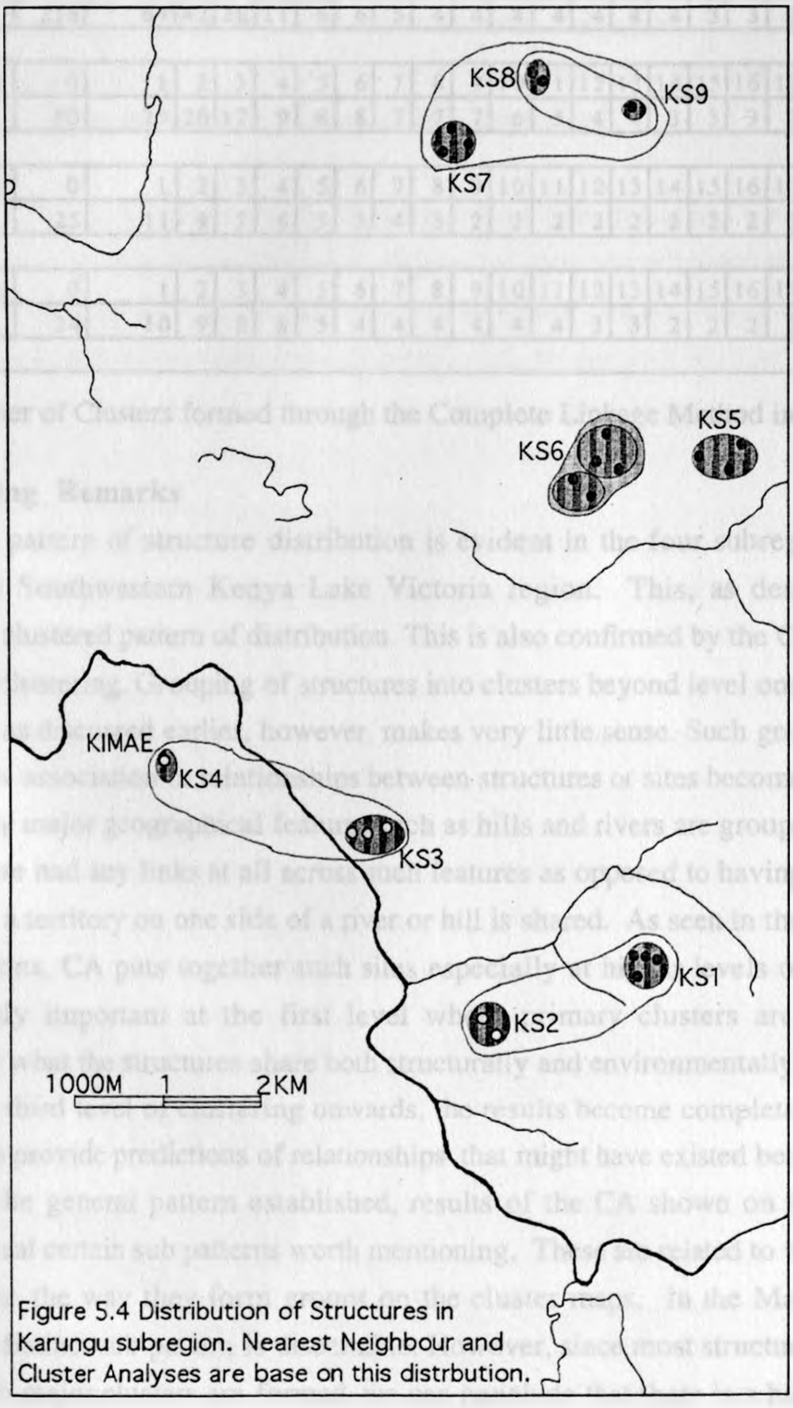

Figure 5.4 Distribution of Structures in Karungu subregion. Nearest Neighbour and Cluster Analyses are base on this distrbution.

were utilized to the maximum. These results may also be used to evaluate the results of the nearest neighbor analysis as set in Table 5.1. Both analyses tend to support the result that the structures are clustered at relatively small distances in the primary clusters.

	No. of Structures	Primary Cluster	Subsidiary Clusters																							
Macalder																										
Rescaled distance	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	2
No. of clusters	258	64	42	28	11	8	6	5	4	4	4	4	4	4	4	3	3	3	3	2	2	2	2	2	2	
Homa Bay																										
Rescaled distance	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	2
No. of clusters	80	29	20	17	9	8	8	7	7	7	6	5	4	4	3	3	3	3	3	3	3	3	3	3	2	
Karungu North																										
Rescaled distance	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	2
No. of clusters	25	11	9	7	6	5	5	4	3	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	
Karungu South																										
Rescaled distance	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	2
No. of clusters	24	10	9	8	8	5	4	4	4	4	4	4	3	3	2	2	2	2	2	2	2	2	2	2	2	

Table 5.6. Number of Clusters formed through the Complete Linkage Method in the four subregions.

5.5. Concluding Remarks

One general pattern of structure distribution is evident in the four subregions studied and therefore in the Southwestern Kenya Lake Victoria region. This, as described by the R coefficients, is a clustered pattern of distribution. This is also confirmed by the Cluster Analysis in the first level of clustering. Grouping of structures into clusters beyond level one which forms the primary clusters as discussed earlier, however, makes very little sense. Such groupings which are supposed to show association or relationships between structures or sites become unreliable when sites separated by major geographical features such as hills and rivers are grouped together. Such sites may not have had any links at all across such features as opposed to having links with those sites with which a territory on one side of a river or hill is shared. As seen in the cluster maps for the four subregions, CA puts together such sites especially at higher levels of clustering. CA, therefore, is only important at the first level where primary clusters are clearly defined corresponding to what the structures share both structurally and environmentally. Beyond this and especially at the third level of clustering onwards, the results become completely unreliable and cannot be used to provide predictions of relationships that might have existed between sites.

Apart from the general pattern established, results of the CA shown on the maps and the dendrograms reveal certain sub patterns worth mentioning. These are related to where the sites are found and also to the way they form groups on the cluster maps. In the Macalder subregion (Figure 5.1), no distinct sub pattern is discernible. However, since most structures are spread out on hills on which major clusters are formed, we can conclude that there is a hill- settlement sub pattern. The same is true for the Karungu South subregion. Hills as areas where building materials were found in these two areas could therefore be used to predict likely settlement areas for the pioneer settlers of the region. In Karungu North subregion, settlement occurred in two major areas as identified by the two cluster areas (Figure 5.3).Apart from the general hill location, sites seem to have identified with the lake in the western cluster and more with the headwaters of streams in the eastern cluster. These I call near-the-lake and headwater sub patterns of settlement respectively. It seems that water and building material was very crucial for the establishment of these settlements. The same trend seem to have existed in the Homa Bay subregion where headwater sub pattern is clearly visible in nearly all the cluster areas. However, another trend in this subregion is that much of the low and flat areas were not settled. Such areas were mainly swampy and were waterlogged for much of the year. This shows that settlements were set on dry areas hence dry spot sub patterns of settlement in this subregion.

The sub patterns mentioned above fall within the general pattern that has been discussed. These were a result of particular factors that dictated structure location on particular environments. While a mention of some of these factors has been done in this ending chapter, this is actually the subject of chapter six which also offers rules through which such settlements were set in the first place. To this we now turn.

EAST AFRICANA COLLECTION

CHAPTER SIX

SETTLEMENT SYSTEMS

6.1 Ethnohistoric Stipulations and Empirical Observations.

The theoretical literature pertaining to the emergence, location and expansion of the *ohingni* is substantial. The stone structure tradition in the region is surrounded by fantasy, myth and archaeological lunacy. Ever since the first report by Gillman (1944), scholars and the general public have speculated a lot about the structures. The discovery and gazetting of the well preserved Thimlich structure widened the scope of speculation, as the structures have since been compared with others such as those at Great Zimbabwe. This in tern invoked thoughts of a superior race from the north being responsible for the structures (Gillman 1944, Chittick 1965). Stories are also told by occupants of the region of early quasi giants who moved into the area constructing numerous stone dwellings due to their number and unity. These are said to have been driven away by new comers who consequently took over the structures. The remnant of such people- the Kachieng- are now confined to Bung Kachieng, a forest area in Homa Bay District.

On the aspect of settlement location, various views have been advanced ethnohistorically as discussed in section 3.2 and 3.3. These views suggest a multiplicity of factors responsible for the location of structures and the expansion of settlements. One factor cited is population movement. Structures are said to be constructed at particular points along the migration routes where people stayed for a period of time before moving on to new places. If true, such centers would be along major migration routes as revealed by oral tradition. In this region, however, multiple immigration of people occurred making it hard to discern any trends on the nature of people's movement and settlement. Nevertheless, two routes have been established which support a correlation between population movement and structure distribution. These are the Siaya - Mirunda route and the Musoma -Rieny - Usiri route. The former started at Ramogi and went through Imbo, Uyoma, Mirunda Bay, Ndhiwa,Osodo, Kalamindi and Raguda while the latter went through Musoma, Rieny, Mohuru, Ragwe (Ngeri), Usiri and Kaksingiri (Figure 3.1). Along these routes and especially at the points mentioned within our region of study, are found a considerable number of *ohingni* indicative of early settlements and possibly associated with early population movements. More structures could be attributed to the spreading out of people as settlement in the region increased and kin structures fissioned.

The lake seems to have played a major role in early population movements especially for groups that originating in Tanzania and Uganda. As a result, a number of structures are to be found along the lake shore areas, mainly l on raised peninsular lands (Table 6.1).

Another cited factor for structure location is security. It was indicated in section 3.3 that the structures were constructed for security purposes; that their location was determined by the sites chosen being strategic and safe from wild animals. They have been seen as protective devices and have therefore been called Hill Forts (Ogot 1967, Waller 1984, Ochieng 1984) used for protecting livestock against wild animals and raiders. Security as determining structure location is, however, only supported empirically by the architectural techniques exhibited in the structures. No other information, for example, amount of wild animals or wars and ethnic violence, could be amassed in support of the theory. It is a fact that they offered protection. Their small-sized gates and high-thickened walls did not allow easy entry by intruders. This security measure is evident in all the structures and points to the insecurity in the region while different groups of immigrants struggled for the possession of land. Once they settled they also protected their property using the solid walls. Security as a factor of location, however, is not firmly established as one of the prime factors of location as there are no confirmed battles fought in the region to show how they might have been used in such circumstances. Once constructed, however, the structures became good security devices.

On the environmental scene, a number of factors have been cited for the location of the structures. These include hilly areas endowed with raw materials which were used for construction, accessible areas which could also provide land for expansion, cultivation and grazing, and the availability of water for domestic use.

Ethnohistorically, hilly areas are said to be best for settlement and therefore attracted the construction of structures. A number of reasons are given for the choice of hilly areas. First, such areas could not be easily climbed by large wild animals which could cause havoc to residential areas. Second, the areas were well drained. Third, settlement on such areas left other areas for cultivation and grazing. It also minimized transportation of building material. Fourth, the areas provided a clear view of the surroundings and hence enhanced settlement security. Lastly, hilly areas provided abundant rock for structure construction. Three reasons, however, seem to have been more significant than others in explaining the choice of hilly areas. These are, availability of building material, good drainage and provision of clear view of the surrounding areas which was important in terms of security. According to these stipulations, hilly settlements were common as this minimized the cost of transporting building material in terms of time and energy expenditure. It also avoided the problem of water logging in settlement areas.

Geographical setting	1	2	3	4	5	Total
Number of Sites	11	7	0	27	93	138
%	8.0	5.1	0	19.6	67.3	100

Table 6.1. Distribution of sites according to geographical setting. 1= lake shore areas. 2 = near-river locations. 3 = valley sites. 4 = raised level ground. 5 = hilly areas.

Table 6.1 shows that hilly settlements were most common. Most structures were located on hilly areas where building materials were easily available. Lower parts of hills with gentle slopes and abundant rocks attracted more settlements. Such gentle hills also enhanced accessibility of settlements as stated in section 3.3. They were also preferred due to their being near the valley bottoms from which water could be obtained. water was very important in the choice of settlement areas. The distance to water sources therefore determined structure location. Such distances never exceeded three kilometers (Table 6.2). The lake, rivers, streams and springs were used as sources of water. When seasonal streams, springs and dams dried up, perennial rivers and Lake Victoria were used as sources of water. Though these sources of water seem numerous resulting to small distances between them and the settled areas, other factors such as lack of containers for storing water at home for use by the occupants make source of water one of the prime determining factors of site location.

Structure distribution also shows a strong relation to sources of raw material which was loose country rock. As stated previously, these were abundant in most hilly areas. Construction of structures in such areas was easier as rocks would be easily uprooted and used without any long distance transportation.

The relationship between structure distribution and raw material sources becomes more clear when areas without such rocks are observed. Only a few structures are found away from where rocks for building are found. These are earth-built structures with a few rock inclusions at the base.

Another trend exhibited by the structures in their distribution is a highly clustered pattern (Table 5.1). This trend suggests expansion from particular centers. Interviews conducted indicated that when an area was chosen considering the above factors, all people concerned lived together to enhance, security. As the number of people in a locality increased and the constructed structures became too small, adjoining structures were constructed. These shared walls with the original structures. Such extensions kept people together. With a further increase in population, separate structures were constructed some meters away from the original structures.

Distance in Km	< 1	1-2	2-3	> 3	Total
Number of Sites	83	41	9	5	138
%	60.2	29.7	6.5	3.6	100

Table 6.2. Distribution of sites in relation to distance from water sources.

Living together in large groups which created a clustered pattern of settlement in the region enhanced security as people scrambled or competed for land in the hitherto unsettled or sparsely settled areas. Large groups could fight off any attacks by enemies. Unity in such large groups also provided a cheap and ready labor force for the construction and maintenance of the structures as well as for other duties such as cultivation, grazing, fishing and hunting .

The distribution of structures seem to suggest that people mostly lived together in groups. Complex and large simple structures were, in most cases, surrounded by smaller simple structures built only a few meters away. This relationship may be used as a predictor of the social factors that influenced structure expansion and therefore the growth of settlement areas.

Population increase per structure or settlement area is explained by two factors, namely natural population increase and immigration. Newcomers, whether relatives or strangers who sought refuge, were always welcome. This led to more structures being constructed in an area and also into mixing up of people - a situation well evidenced in the region. All these social factors interacted with environmental and historical factors, especially population movement, to create clustered pattern as shown in section 5.2 and figures 5.1 to 5.4.

6.2. Discussion

Various theories and models have been used to explain settlement patterns and systems throughout the world. These may be categorized into deterministic models where settlements are never random and probabilistic models where settlements evolve and grow as simulated by near-random processes (Hagget 1965). In the former, settlements are determined by and spread gradually according to a set of definite rules built into the system. In the latter, however, settlements are a result of restricting rules on which growth depends.

Settlement location has also been seen in terms of outward connection and movement of resources (Clarke 1977). The assumption here is that settlement or sites in general would be selected so as to minimize unnecessary movements. Sites, therefore, represent minimum - least energy - cost locations. Their location depends on the distance to and from external resources, the weight of the materials to be moved and the effort or competitive cost of all movements (Foley 1977).

Elements of both deterministic and probabilistic models seem to have featured in the location of the South Western Kenya stone structures. A multiple cause interpretation has been advanced both theoretically and empirically for the location of the structures. It can be argued that resource availability, especially of loose basalt rocks for structure construction, water and good land for cultivation and grazing were three factors vital in the location of structures. These factors favored hilly areas endowed with abundant building material resulting into most settlements being located on hilly areas. Such areas were also well drained, a factor which was put into consideration so as to avoid waterborne diseases which could be contracted in swampy areas. These three factors were deterministic in the choice of settlement areas.

Each group of people as they entered the region taking various routes settled on areas which fulfilled these basic factors. Much of the land apart from the swampy and forested areas with a concentration of wild animals could be settled. There was also large pieces of land which could be used for settlement, grazing and cultivation in various parts of the region. The fertile valleys and other non-waterlogged areas could attract large settlements. All these advantages were, however, outdone by one factor - the availability of building material mostly found on hilly areas which also carried other advantages. This supports the hypotheses generated from the results of NNA that clustering of structures was a result of independent attractions of structures toward an unevenly distributed resources and that settlements were located on areas safe from wild animals and waterlogged places such as swamps. The construction of structures and establishment of settlements was therefore attracted towards areas with required building material, well drained land and water.

But while these three factors determined where settlements were located other factors came in to control the growth and expansion of structures in settled areas. The same factors also led to spreading out of structures. Three factors may be cited here. These are population budding, competition between the early settlers of the region and lastly co-operation.

Although the investigation of population size per structure was not possible for this work, structure sizes and numbers in an area were used as vague indicators of population size. Thus, large and concentrated number of structures were assumed to have contained large numbers of people. The suitability of locating or expanding structures on an area on the other hand was scored on the basis of the amount of loose rocks for construction on an area. A higher degree of resource availability and increased population in a settled area led to expansion of structures. These structures, whether simple or complex eventually reached their maximum limits for expansion either because of a very large population or little or no resources for further construction. Expansions and dependence on resource availability led to clustering of structures on hilly areas as previously stated. This was further caused by the desire of people to live together in large groups for security reasons.

Population growth as a social factor possibly led to an evolution of structures through a four way process. At the beginning of settlement in an area, here referred to as B1, the first structures were located on areas with loose country rock which was used for construction. This occurred on hilly or raised regions where this condition was met. This was to minimize transportation cost and energy expenditure. At the next stage, B2, when population living in a structure increased, adjoining structures (extensions) sharing walls with the original one were constructed. At a subsequent stage, B3, "daughter structures" were constructed a few meters away from the mother structures B1 and B2. Where the "daughter structures" were many and built very close to the mother structures, footpaths to link structures were constructed having low walls of stone. This created complex structures. In this way the original structures attracted smaller ones to create clusters in various localities. This support the hypothesis that clustering was a result of attraction of structures towards each other (Section 5.2).

At the next stage of structure evolution, B4, more daughter structures were constructed making use of the remaining building material. At this stage, it is believed, population increase and structure expansion reached maximum limits with building material having diminished. Newcomers to such an area therefore constructed structures on new and far distance localities meeting the basic requirements. At such new localities the whole process of structure evolution started a fresh. A section of the original occupants of an area could also move to a new area and start the process of structure evolution.

In some areas, however, resources could not allow the whole cycle of this process (B1-B4) to be complete. Some areas could only allow upto B1 leading to simple structures and single structure sites. Thus depending on either the amount of building material available, the population in an area or other factors, structures could be in any of the stages of B1, B2,.B3 and B4. This resulted into simple structures and/or single structure sites and simple structures and/or multiple structure sites (Section 2.3).

Increased population in the region either through fresh immigration or natural increase led to competition for land and other resources such as water points especially springs. The multiple immigration by various groups of people (Chapter-3) in the region also makes tenable the supposition that there was a competitive relationship between these groups for good land as well as other resources. Such competition led to founding of structures on various favorable localities as a means of acquiring a right to land ownership. Competition also led to dislodging of certain groups from their constructed structures to new localities where structures were newly constructed.

Co-operation between early settlers was also one other factor that was important in the distribution of the stone structures. Co-operate action enabled for the construction of structures whenever need arose. Needs could include population pressure requiring that a section of the population be moved elsewhere or ejection from an already settled area by newcomers resulting into a need for construction of new structures. Such needs resulted in construction of new structures on new localities. This exercise was made possible by cooperation or unity in the affected groups.

6.3. Summary and conclusion

The ethnohistoric stipulations, empirical observations and discovered trends of structure distribution discussed in this chapter illustrate the factors and rules that determined the location and spread of the South Western Kenya stone structures. Most of the variables discussed, however, could not be statistically analyzed due to the limited scope of this work. For this reason, the set of rules given here to have generated the clustered pattern of settlement in the region will remain subject to change in the face of adequate statistical means to test the validity of the rules. Until this is done and any appropriate changes made, the following rules (model) have been proposed to have led to the settlement pattern exhibited by the South Western Kenya stone structures.

1. The first structures in the region will locate on hilly areas with gentle slopes but endorsed with abundant loose country rocks easily uprootable.

2. Where loose rocks are not available but settlement has to take place due to one reason or another, earth-walled structures will be constructed on equally raised but somehow flat areas.

3. The suitable localities will be close to water sources with permanent water sources not exceeding a distance of 3 Km.

4. Location of structures on hilly areas will be in such away that a clear view of the surrounding is enhanced. It will also be in such away that accessibility - especially movement from the settlement to and from the surrounding areas is not strenuous.

5. Expansion of structures will be all around the original structures. This will, however, be determined by the room available for expansion as well as the availability of building material and the population making the settlement to expand.

6. Once structures are located in an area, the first stage of expansion will involve building small structures attached to the original ones. Then "daughter structures" will follow a few meters away from the mother structures and extensions. A second generation of "daughter structures" will then be constructed making use of the available room and building material in an area. Any subsequent expansion will then involve movement to a new locality where a similar process of expansion may continue or not depending on the social and environmental factors.

7. The pattern of expansion will continue until all suitable areas have structures. This will, however, depend on factors causing expansion. All basic requirements such as water, land for expansion, cultivation and/or grazing will always be available in such areas.

With regard to competition between the various immigrants in the region, rules 1 to 4 stated above will apply and then the following may further determine the spreading out.

1. Other factors being equal, structures will be constructed in the face of a fresh immigration in new areas by occupants of an area so as to pre-empt taking over land by the newcomers.

2. Newcomers will grab any unoccupied land or other resources establishing their ownership by constructing structures on suitable areas.

3. With intense competition, certain sections or groups of people will be forced out of their settlements by a stronger or more aggressive group to found new settlements in unsettled areas where requirements for structure construction is favorable.

4. Through time competition will die out once the competed for resources have all been permanently acquired. This will leave settlements established on nearly all suitable areas hence no further expansion or construction of new structures.

With further work on the South Western Kenya stone structures, it may be possible to test the validity of these "rules" by statistical means. In general the work has provided a formal framework within which trends in the settlement patterns exhibited by stone structures in the region might be used to establish the reasons for the choice of settlement localities and the expansion of settlements. A multiple cause course for the location and expansion of the structures in the region as has been advanced offers adequate explanation for the settlement systems yet remains pregnant with lots of food for thought to future researchers who might want to know, for example, the carrying capacity of the various sizes of structures in terms of human population, animal population and/or built huts. I would also strongly recommend a complete landscape archaeological investigation of the region so as to fully understand the impact of the environment on the location of the *ohingni* in the entire region.

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APPENDIX A

TABULAR DATA CITED IN THE TEXT

Aerial Photographs

Aerial photographs given in Table A.1 were useful in this work in two ways. First, examination prior to the field work was used to locate areas where structures were expected in the field. No attempt was made at this stage to check the details of individual sites. Such details were checked during the subsequent visit to particular areas. This also confirmed the presence of sites and structures in these areas. Secondly, examination after field work was used for ' revision mapping' but was also used to check for sites ethnohistorically mentioned and not physically counted during field walking.

Stereo pairs of aerial photographs were examined using a magnifying stereoscope. As stated in the text, structures appeared as circular rings on the hill slopes making it possible for their exact positions to be marked on the 1:50,000 topographical map series (revision mapping).The nature of these structures is different from the modern homestead fencing done trees or dry wood inside which modern houses were visible. For this reason, the problem of confusing modern inhabited homesteads with the structures was non-existent. The total set of sites dealt with in this work is therefore a combination of the following:

1) Site record kept at the National Museums of Kenya.

2) Sites found during field work and counter-checked with aerial photographs.

3) Sites found on aerial photographs whose existence were ethnohistorically supported.

All new records will be added in the National Museums' records with appropriate SASES numbers. Most of the structures were confirmed to be located on hilly areas as Table A.2 indicates. This is for reasons discussed in the text.

Flight Number	Photo Number	Area Name	Flight Number	Photo Number	Area Name
V13A/1046	010	Macalder	V13A/1069	165	Homa Bay
V13A/1046	011	Macalder	V13A/1070	08	Homa Bay
V13A/1046	012	Macalder	V13A/1070	09	Homa Bay
V13A/1046	013	Macalder	V13A/1070	010	Homa Bay
V13A/1046	014	Macalder	V13A/1070	011	Homa Bay
V13A/1046	015	Macalder	V13A/1070	012	Homa Bay
V13A/1046	016	Macalder	V13A/1070	013	Homa Bay
V13A/1046	017	Macalder	V13A/1070	014	Macalder
V13A/1046	018	Homa Bay	V13A/1070	015	Macalder
V13A/1046	019	Homa Bay	V13A/1070	016	Macalder
V13A/1046	020	Homa Bay	V13A/1070	017	Macalder
V13A/1046	021	Homa Bay	V13A/1070	018	Macalder
V13A/1046	022	Homa Bay	V13A/1070	019	Macalder
V13A/1046	109	Macalder	V13A/1070	020	Macalder
V13A/1046	110	Macalder	V13A/1070	034	Karungu
V13A/1046	*111	Macalder	V13A/1070	035	Karungu
V13A/1046	*112	Macalder	V13A/1070	036	Karungu
V13A/1046	113	Macalder	V13A/1070	037	Karungu
V13A/1046	114	Macalder	V13A/1070	038	Karungu
V13A/1046	*115	Macalder	V13A/1070	039	Karungu
V13A/1046	*116	Homa Bay	V13A/1070	040	Gwasi
V13A/1046	117	Homa Bay	V13A/1070	041	Gwasi
V13A/1046	118	Homa Bay	V13A/1070	042	Gwasi
V13A/1046	119	Homa Bay	V13A/1070	043	Gwasi
V13A/1046	120	Homa Bay	V13A/1070	*044	Gwasi
V13A/1046	121	Homa Bay	V13A/1070	*045	Gwasi
V13A/1069	153	Macalder	V13A/1070	062	Gwasi
V13A/1069	154	Macalder	V13A/1070	•063	Gwasi
V13A/1069	155	Macalder	V13A/1070	•064	Gwasi
V13A/1069	156	Macalder	V13A/1070	065	Gwasi
V13A/1069	157	Macalder	V13A/1070	066	Gwasi
V13A/1069	158	Macalder	V13A/1070	067	Gwasi
V13A/1069	159	Macalder	V13A/1070	068	Karungu
V13A/1069	160	Homa Bay	V13A/1070	069	Karungu
V13A/1069	*161	Homa Bay	V13A/1070	101	Gwasi
V13A/1069	*162	Homa Bay	V13A/1070	102	Gwasi
V13A/1069	163	Homa Bay	V13A/1070	103	Gwasi
V13A/1069	164	Homa Bay	V13A/1070	104	Gwasi

Table A.1: List of Aerial Photographs Used in Revision Mapping

Site Name	No. of Structures	Water Source	Distance to WS	Approx. Altitude	Map No.	Site No.	Setting
Osani Mkt.	2	Osani Stm.	0.4	1295	129/4	M1	Hilly Area
Paw Osani	2	Osani Stm.	1.1	1295	129/4	M2	Level Ground
Ongere	3	Osani Stm.	0.2	1295	129/4	M3	Hilly Area
Nyoniang	2	Osani Stm.	1.8	1311	129/4	M4	Hilly Area
God Jowi	6	Yap Seka	0.8	1295	129/4	M5	Hilly Area
Nyaruanda	3	Yap Seka	1.8	1280	129/4	M6	Hilly Area
Kiwiro	1	Ndiwa Spr.	2.5	1325	129/4	M7	Hilly Area
Ndiru West	4	Ndiwa Spr.	1.4	1219	129/4	M8	Hilly Area
Ndiru	4	Ndiwa Spr.	1.2	1325	129/4	M9	Hilly Area
Amuk Laki	6	Ndiwa Spr.	2	1280	129/4	M10	Hilly Area
Odingo	6	Dam	1	1280	129/4	M11	Hilly Area
Nyora	2	Ndiwa Spr.	1.5	1280	129/4	M12	Hilly Area
Ndiwa Church	5	Ndiwa Spr.	2	1219	129/4	M13	Hilly Area
Kopolo	1	Ndiwa Spr.	2.3	1234	129/4	M14	Hilly Area
Wangaya	1	Ndiwa Spr.	2.5	1250	129/4	M15	Level Ground
Nyawita	4	R. Kuja	3	1250	129/4	M16	Hilly Area
Maroo	8	R. Kuja	3	1250	129/4	M17	Level Ground
Kochiel	1	R. Kuja	3	1250	129/4	M18	Level Ground
Thimlich	6	R. Kuja	3	1295	129/4	M19	Hilly Area
Kokoth	4	R. Kuja	3.4	1280	129/4	M20	Hilly Area
Adino Ita	5	Dam	0.5	1295	129/4	M21	Hilly Area
Andato	2	Olasi Stm.	0.4	1280	129/4	M22	Hilly Area
Maranyona	8	Olasi Stm.	1	1280	129/4	M23	Hilly Area
Ponge	3	R. Kuja	0.5	1265	129/4	M24	Hilly Area
Kamasi	5	R. Kuja	1	1265	129/4	M25	River Bank
Minyere	13	R. Kuja	0.4	1280	129/4	M26	Hilly Area
Nyaroya	5	R. Kuja	0.5	1265	129/4	M27	River Bank
Nyagidha	5	R. Kuja	0.3	1311	129/4	M28	Hilly Area
Nyoniang	2	R. Kuja	1.5	1325	129/4	M29	Hilly Area
Nyakune	1	R. Kuja	2.2	1341	129/4	M30	Hilly Area
Koluoch	1	R. Kuja	1.8	1250	129/4	M31	Hilly Area
Ndawa	2	R. Kuja	0.6	1234	129/4	M32	River Bank
Gogo	1	R. Kuja	0.4	1234	129/4	M33	River Bank
Kingri	1	R. Kuja	0.4	1265	129/4	M34	Hilly Area
Nyamanja	1	R. Kuja	0.6	1295	129/4	M35	Hilly Area
Kanyodera S.	1	R. Kuja	1.6	1341	129/4	M36	Hilly Area
Kanyodera Sc.	2	R. Kuja	0.6	1341	129/4	M37	Hilly Area
Kanyodera Hill	1	R. Kuja	0.3	1325	129/4	M38	Hilly Area
Kanyodera W.	1	R. Kuja	0.8	1325	129/4	M39	Hilly Area
Kanyodera C.	1	R. Kuja	0.2	1280	129/4	M40	Hilly Area
Got Ogengo	4	R. Oyani	1	1311	129/4	M41	Hilly Area
Ondati	4	R. Oyani	0.2	1250	129/4	M42	Hilly Area
Miruya South	5	R. Oyani	0.8	1265	129/4	M43	Hilly Area
Miruya West	3	R. Oyani	0.2	1265	129/4	M44	Hilly Area
Mangongo	4	R. Oyani	0.2	1265	129/4	M45	Hilly Area
Miruya C.	8	R. Oyani	1	1265	129/4	M46	Hilly Area
Othoro Hill	14	R. Kuja	1	1280	129/4	M47	Hilly Area
Othoro Disp.	1	R. Kuja	1	1311	129/4	M48	Level Ground
Othoro Pln	2	R. Kuja	2	1280	129/4	M49	Level Ground

Table A.2 Information from the Structures used in Analysis of Settlement Systems.

Table A.2 Cont..

Maraga	6	Stream	0.8	1311	129/4	M50	Hilly Area
Ombo K. Sch.	1	R. Oyani	2	1295	129/4	M51	Level Ground
Lwanda	2	Stream	0.8	1341	129/4	M52	Hilly Area
Alara	2	Alara Str.	0.4	1325	129/4	M53	Hilly Area
Nyamanja N.	3	Stream	0.4	1372	129/4	M54	Hilly Area
Nyamanja C.	3	Stream	0.4	1372	129/4	M55	Hilly Area
Ombo	3	R. Oyani	1.2	1295	129/4	M56	Level Ground
Amoso	4	Stream	1	1417	129/4	M57	Level Ground
Amoso Hill	3	R. Oyani	1.3	1387	129/4	M58	Hilly Area
God Kochieng	14	R. Oyani	1	1311	129/4	M59	Hilly Area
Nyamanja	2	R. Oyani	1	1325	129/4	M60	Hilly Area
Miringa	2	R. Oyani	1	1311	129/4	M61	Hilly Area
Konduru North	1	R. Oyani	1	1372	129/4	M62	Hilly Area
Konduru C.	2	Nyamchi	0.8	1372	129/4	M63	Hilly Area
Konduru S.	2	Nyamchi	0.3	1341	129/4	M64	Hilly Area
Konduru S.E.	1	Oyani	0.5	1311	129/4	M65	Hilly Area
Konduru E.	3	Oyani	0.4	1325	129/4	M66	Hilly Area
Midida	5	Oyani	1.3	1372	129/4	M67	Hilly Area
Ndisi Logik	7	Lwanda Str.	1	1402	129/2	HB1	Level Ground
Paw Ndisi	1	Stream	0.8	1402	129/2	HB2	Level Ground
Ndisi Sch.	1	Nyanang St.	0.8	1402	129/2	HB3	Level Ground
Kombe	2	Nyanang St.	0.8	1492	129/2	HB4	Hilly Area
Kwamo	4	Nyogunde	0.8	1463	129/2	HB5	Hilly Area
Osure Sch.	2	Nyakwamba	0.6	1433	129/2	HB6	Hilly Area
Nyamogo	4	Nyakwamba	1	1448	129/2	HB7	Hilly Area
Nyarandi 1	1	Nyakwamba	0.8	1492	129/2	HB8	Hilly Area
Nyarandi 2	2	Nyakwamba	0.8	1448	129/2	HB9	Hilly Area
Nyarandi 3	1	Nyogunde	0.7	1417	129/2	HB10	Hilly Area
Kobama C. C.	2	Stream	2	1417	129/2	HB11	Hilly Area
Uruti	2	Nyogunde	1	1402	129/2	HB12	Hilly Area
Kobama Vet	1	Nyogunde	0.6	1372	129/2	HB13	Level Ground
Rabuor	7	Nyanang	1	1402	129/2	HB14	Hilly Area
Kalamindi	7	Ndhiwa	0.1	1372	129/2	HB15	Hilly Area
God Bondo	2	Ndhiwa	0.4	1372	129/2	HB16	Hilly Area
Osodo	6	Stream	0.5	1311	129/2	HB17	River Bank
Ndhiwa	7	Onyinjo	1.2	1311	129/2	HB18	Hilly Area
Siganana	5	Onyinjo	0.6	1341	129/2	HB19	Hilly Area
Loyom	6	Onyinjo	0.5	1341	129/2	HB20	Hilly Area
Mirogi Girls	1	Lwanda	0.4	1341	129/2	HB21	Level Ground
Mirogi Boys	1	Lwanda	1.2	1341	129/2	HB22	Level Ground
Kwoyo School	2	Lwanda	0.8	1356	129/2	HB23	Level Ground
Pap	2	Lwanda	1.8	1387	129/2	HB24	Level Ground
Kamato	3	Ogege	1.2	1280	129/2	HB25	Hilly Area
Rarage	4	Bala	1.8	1356	129/2	HB26	Hilly Area
Nyagidha	5	Stream	0.4	1325	129/2	HB27	Hilly Area
Ongako	3	Bala	1.2	1341	129/2	HB28	Hilly Area
Kibugu	6	Kibugu	1	1311	129/2	HB29	Hilly Area
Wayaga	5	Riana	0.8	1295	129/2	HB30	Level Ground

Table A.2 Cont.

Waganjo	1	Bala	0.2	1295	129/2	HB31	Hilly Area
Kouma	1	Bala	0.2	1295	129/2	HB32	Hilly Area
Obera School	1	Bala	1.8	1341	129/2	HB33	Level Ground
Rastra	4	L. Victoria	0.1	1158	129/3	KN1	Lake Shore
Nyatambe	8	L. Victoria	0.2	1203	129/3	KN2	Hilly Area
Okuodo	3	L. Victoria	0.5	1203	129/3	KN3	Hilly Area
Gunga School	1	Aora Gunga	0.2	1158	129/3	KN4	Hilly Area
Gunga	4	Aora Gunga	0.8	1213	129/3	KN5	Hilly Area
Gung	1	Aora Gunga	0.8	1265	129/3	KN6	Hilly Area
Tigra	1	Aoch Orore	0.8	1249	129/3	KN7	Hilly Area
Rabuor	3	Aoch Orore	1	1219	129/3	KN8	Hilly Area
Manyonge	4	Stream	1.3	1173	129/3	KS1	Level Ground
Kituka-Ojendo	2	Kuja	0.5	1173	129/3	KS2	Level Ground
Wath Onger	3	Kuja	1	1143	129/3	KS3	River bank
Kimae	1	Kuja	0.2	1143	129/3	KS4	Level Ground
Agenga	3	Uava	0.6	1158	129/3	KS5	Level Ground
Agenga School	5	Uava	0.5	1143	129/3	KS6	Level Ground
Lwala	3	Dam	0.6	1143	129/3	KS7	Level Ground
Kolal	2	Mifuare	1	1189	129/3	KS8	Hilly Area
Mifware	1	Mifware	0.5	1158	129/3	KS9	Hilly Area
Kuja Bank	1	Kuja	0.05	1158	129/3	KS10	River Bank
Thirakinga	2	L. Victoria	0.05	1143	129/3	KS11	Hilly Area
Kiabuya 1	1	L. Victoria	0.8	1219	129/1	GS1	Lake Shore
Kiabuya 2	5	L. Victoria	0.1	1143	129/1	GS2	Lake Shore
Rianungu	3	Miramba	0.6	1219	129/1	GS3	Hilly Area
Nyandiwa	1	L. Victoria	0.1	1143	129/1	GS4	Lake Shore
Kitawa	6	L. Victoria	0.6	1189	129/1	GS5	Lake Shore
Kitawa Sch.	4	L. Victoria	0.2	1143	129/1	GS6	Lake Shore
Rwancha	3	L. Victoria	0.3	1219	129/1	GS7	Hilly Area
Usiri Area	10	L. Victoria	0.6	1143	129/1	GS8	Hilly Area
Kisegi Point	8	L. Victoria	0.6	1143	129/1	GS9	Lake Shore
Kisegi Sch.	8	L. Victoria	0.2	1143	129/1	GS10	Lake Shore
Thirakungu	1	R. Nyenga	1.2	1387	129/1	GS11	Hilly Area
Nyasoti	2	Muchache	0.5	1417	129/1	GS12	Hilly Area
Siringiti	4	Stream	0.3	1478	129/1	GS13	Hilly Area
God Tonga	5	R. Nyenga	0.8	1448	129/1	GS14	Hilly Area
Ungoye	5	L. Victoria	0.1	1443	129/1	GS15	Lake Shore
Ragwe South	7	L. Victoria	0.1	1143	129/1	GS16	Lake Shore
Rowo	9	L. Victoria	0.1	1173	129/1	GS17	Level Ground
Manywanda	15	L. Victoria	0.2	1143	129/1	GS18	Lake Shore
Makende	2	Stream	0.2	1295	129/1	GS19	Hilly Area

Table A.2 Information from the Structures used in Analysis of Settlement Systems.

Nearest Neighbor Coefficients

Tables A.3-A.6 contain stages 2-6 of calculating nearest neighbor coefficients as outlined in chapter four. Distance measurements was done after all the required structures were marked as points on their respective maps. Due to scale problem, the maps were photographed and put in slides form. A slide projector was then used to magnify the maps on a screen (wall) from which distances between the points were taken. A scale of 20.8:8km. was used for taking measurements on the projected maps. The results were then used for calculating the nearest neighbor coefficients (R).

MACALDER			Distance					Distance					Distance	
Pnt	Str	N.N.	Cm.	Mtrs	Pnt	Str	N.N.	Cm	Mtrs	Pnt	Str	N.N.	Cm.	Mtrs
1	1.1	1.2	0.5	192	43	9.2	9.1	0.4	154	85	20.3	20.4	0.6	231
2	1.2	1.1	0.5	192	44	9.3	9.2	0.7	269	86	20.4	20.3	0.6	231
3	2.1	2.2	0.7	269	45	10.1	10.2	0.3	115	87	21.1	21.5	0.5	192
4	2.2	2.1	0.7	269	46	10.2	10.1	0.3	115	88	21.2	21.3	0.7	269
5	3.1	3.2	0.9	346	47	10.3	10.4	0.5	192	89	21.3	21.4	0.4	154
6	3.2	3.3	0.4	154	48	10.4	10.5	0.3	115	90	21.4	21.5	0.3	115
7	3.3	3.21	0.3	115	49	10.5	10.4	0.3	115	91	21.5	21.4	0.3	115
8	3.4	3.23	0.3	115	50	10.6	10.1	0.3	115	92	22.1	22.2	0.5	192
9	3.5	3.6	0.5	192	51	11.1	11.6	0.6	231	93	22.2	22.1	0.5	192
10	3.6	3.4	0.4	154	52	11.2	11.3	0.5	192	94	23.1	23.3	0.3	115
11	3.7	3.6	0.3	115	53	11.3	11.6	0.3	115	95	23.2	23.3	0.6	231
12	3.8	3.12	0.3	115	54	11.4	11.6	0.3	115	96	23.3	23.1	0.3	115
13	3.9	3.11	0.3	115	55	11.5	11.6	0.3	115	97	23.4	23.5	0.4	154
14	3.1	3.11	0.5	192	56	11.6	11.3	0.3	115	98	23.5	23.4	0.4	154
15	3.11	3.9	0.3	115	57	12.1	12.2	0.4	154	99	23.6	23.7	0.6	231
16	3.12	3.8	0.3	115	58	12.2	12.1	0.4	154	100	23.7	23.6	0.6	231
17	3.13	3.14	0.3	115	59	13.1	13.2	0.3	115	101	23.8	23.7	1.3	500
18	3.14	3.13	0.3	115	60	13.2	13.3	0.3	115	102	24.1	24.3	0.5	192
19	3.15	3.16	0.2	77	61	13.3	13.2	0.3	115	103	24.2	24.3	0.4	154
20	3.16	3.15	0.2	77	62	13.4	13.5	0.2	77	104	24.3	24.2	0.4	154
21	3.17	3.16	0.2	77	63	13.5	13.4	0.2	77	105	25.1	25.5	0.4	154
22	3.18	3.15	0.2	77	64	14	13.2	1.5	577	106	25.2	25.3	0.4	154
23	3.19	3.18	0.5	192	65	15	16.4	2.0	769	107	25.3	25.2	0.4	154
24	3.2	3.17	0.3	115	66	16.1	16.3	0.3	115	108	25.4	25.3	0.5	192
25	3.21	3.22	0.3	115	67	16.2	16.3	0.3	115	109	25.5	25.1	0.4	154
26	3.22	3.21	0.3	115	68	16.3	16.2	0.3	115	110	26.1	26.2	0.8	308
27	3.23	3.4	0.3	115	69	16.4	16.3	0.6	231	111	26.2	26.1	0.8	308
28	4.1	4.2	0.9	346	70	17.1	17.2	0.6	231	112	26.3	26.7	0.7	269
29	4.2	4.1	0.9	346	71	17.2	17.3	0.3	115	113	26.4	26.5	0.6	231
30	5.1	5.2	0.4	154	72	17.3	17.2	0.3	115	114	26.5	26.4	0.6	231
31	5.2	5.1	0.4	154	73	17.4	17.5	0.3	115	115	26.6	26.1	0.4	154
32	5.3	5.4	0.3	115	74	17.5	17.4	0.3	115	116	26.7	26.8	0.4	154
33	5.4	5.3	0.3	115	75	17.6	17.5	0.3	115	117	26.8	26.7	0.4	154
34	5.5	5.4	0.3	115	76	17.7	17.6	0.4	154	118	26.9	26.1	0.3	115
35	5.6	5.5	0.4	154	77	17.8	17.4	0.7	269	119	26.1	26.9	0.3	115
36	6.1	6.2	0.5	192	78	18	17.7	0.8	308	120	26.1	26.6	0.4	154
37	6.2	6.3	0.4	154	79	19.1	19.3	0.5	192	121	26.1	26.3	1.4	538
38	6.3	6.2	0.4	154	80	19.2	19.3	0.3	115	122	27.1	27.5	0.3	115
39	7	9.1	1.9	731	81	19.3	19.2	0.3	115	123	27.2	27.4	0.3	115
40	8.1	8.2	0.6	231	82	19.4	19.3	0.4	154	124	27.3	27.2	0.8	308
41	8.2	8.1	0.6	231	83	20.1	20.2	0.8	308	125	27.4	27.2	0.3	115
42	9.1	9.2	0.4	154	84	20.2	20.1	0.8	308	126	27.5	27.1	0.3	115

Macalder			Distance					Distance					Distance	
Pnt	Str	N.N.	Cm.	Mtrs	Pnt	Str	N.N.	Cm	Mtrs	Pnt	Str	N.N.	Cm.	Mtrs
127	28.1	28.2	0.5	192	186	47.1.	47.1.	0.2	77	245	66.3	66.2	0.4	154
128	28.2	28.1	0.5	192	187	47.1.	47.1.	0.2	77	246	67.1	67.5	0.2	77
129	28.3	28.4	0.4	154	188	47.1.	47.1	0.2	77	247	67.2	67.1	0.7	269
130	28.4	28.3	0.4	154	189	47.1.	47.1.	0.2	77	248	67.3	67.4	0.2	77
131	28.5	28.4	0.5	192	190	48	47.1	1.1	423	249	67.4	67.3	0.2	77
132	29.1	29.2	1.0	385	191	49.1	49.2	0.8	308	250	67.5	67.1	0.2	77
133	29.2	29.1	1.0	385	192	49.2	49.1	0.8	308	251	68.1	68.6	0.3	115
134	30	29.1	3.1	119	193	50.1	50.2	0.3	115	252	68.2	68.6	0.3	115
135	31	19.4	2.9	111	194	50.2	50.1	0.3	115	253	68.3	68.6	0.2	77
136	32.1	32.2	0.4	154	195	50.3	50.4	0.2	77	254	68.4	68.6	0.3	115
137	32.2	32.1	0.4	154	196	50.4	50.3	0.2	77	255	68.5	68.6	0.3	115
138	33	32.2	1.8	692	197	50.5	50.4	0.3	115	256	68.6	68.5	0.3	115
139	34	35	1.9	731	198	50.6	50.4	0.3	115			Mean	0.5	196.
140	35	34	1.9	731	199	51	49.1	1.9	731					
141	36	37.2	1.4	538	200	52.1	52.2	0.8	308		ro =	0.20		
142	37.1	37.2	0.6	231	201	52.2	52.1	0.8	308		p =	0.86		
143	37.2	37.1	0.6	231	202	53.1	53.2	0.6	231		re =	0.54		
144	38	37.1	1.4	538	203	53.2	53.1	0.6	231		ro/re	0.36		
145	39	37.2	1.3	500	204	54.1	54.2	0.3	115					
146	40	42.1	2.8	107	205	54.2	54.1	0.3	115					
147	41.1	41.4	0.8	308	206	54.3	54.2	0.3	115					
148	41.2	41.1	0.9	346	207	55.1	55.2	0.5	192					
149	41.3	41.4	0.9	346	208	55.2	55.3	0.3	115					
150	41.4	41.1	0.8	308	209	55.3	55.2	0.3	115					
151	42.1	42.2	0.3	115	210	56.1	56.2	0.3	115					
152	42.2	42.3	0.2	77	211	56.2	56.1	0.3	115					
153	42.3	42.2	0.2	77	212	56.3	56.2	0.4	154					
154	42.4	42.5	0.3	115	213	57.1	57.4	0.4	154					
155	42.5	42.4	0.3	115	214	57.2	57.3	0.4	154					
156	43.1	43.2	0.4	154	215	57.3	57.2	0.4	154					
157	43.2	43.3	0.3	115	216	57.4	57.1	0.4	154					
158	43.3	43.2	0.3	115	217	58.1	58.2	0.4	154					
159	43.4	43.5	0.3	115	218	58.2	58.1	0.4	154					
160	43.5	43.4	0.3	115	219	58.3	58.2	0.5	192					
161	44.1	44.2	0.3	115	220	59.1	59.2	0.4	154					
162	44.2	44.3	0.2	77	221	59.2	59.1	0.4	154					
163	44.3	44.2	0.2	77	222	59.3	59.4	0.4	154					
164	45.1	45.2	0.3	115	223	59.4	59.2	0.3	115					
165	45.2	45.3	0.3	115	224	59.5	59.6	0.5	192					
166	45.3	45.2	0.3	115	225	59.6	59.5	0.5	192					
167	45.4	45.1	0.4	154	226	59.7	59.8	0.3	115					
168	46.1	46.2	0.5	192	227	59.8	59.7	0.3	115					
169	46.2	46.3	0.4	154	228	59.9	59.8	0.4	154					
170	46.3	46.4	0.3	115	229	59.1.	59.8	0.3	115					
171	46.4	46.3	0.3	115	230	59.1.	59.1.	0.4	154					
172	46.5	46.6	0.2	77	231	59.1.	59.1.	0.3	115					
173	46.6	46.7	0.2	77	232	59.1.	59.1.	0.3	115					
174	46.7	46.6	0.2	77	233	60.1	60.2	0.3	115					
175	46.8	46.7	0.3	115	234	60.2	60.1	0.3	115					
176	47.1	47.13	0.2	77	235	61.1	61.2	0.6	231					
177	47.2	47.14	0.3	115	236	61.2	61.1	0.6	231					
178	47.3	47.1	0.3	115	237	62	65	1.7	654					
179	47.4	47.3	0.4	154	238	63.1	63.2	0.6	231					
180	47.5	47.9	0.3	115	239	63.2	63.1	0.6	231					
181	47.6	47.7	0.4	154	240	64.1	64.2	0.4	154					
182	47.7	47.8	0.3	115	241	64.2	64.1	0.4	154					
183	47.8	47.7	0.3	115	242	65	62	1.7	654					
184	47.9	47.5	0.4	154	243	66.1	66.2	0.5	192					
185	47.1.	47.11	0.2	77	244	66.2	66.3	0.4	154					

Table A.3 Data used in the calculation of NNC in Macalder Subregion.

HOMA BAY			Distance		HOMA BAY			Distance	
Pnt.	Str.	N.N.	Cm.	Metres	Pnt	Str.	N.N.	Cm.	Metres
1	1.1	1.2	0.4	154	44	16.2	16.1	0.5	192
2	1.2	1.1	0.4	154	45	17.1	17.2	0.9	346
3	1.3	1.4	0.3	115	46	17.2	17.1	0.9	346
4	1.4	1.3	0.3	115	47	17.3	17.4	0.3	115
5	1.5	1.4	0.6	231	48	17.4	17.3	0.3	115
6	1.6	1.5	0.7	269	49	17.5	17.4	0.3	115
7	1.7	1.6	0.8	308	50	17.6	17.5	0.3	115
8	2	1.5	3.9	1500	51	18.1	18.2	0.2	77
9	3	1.7	1.7	654	52	18.2	18.1	0.2	77
10	4.1	4.2	0.6	231	53	18.3	18.2	0.2	77
11	4.2	4.1	0.6	231	54	18.4	18.1	0.2	77
12	5.1	5.2	0.4	154	55	18.5	18.4	0.6	231
13	5.2	5.1	0.4	154	56	18.6	18.7	0.3	115
14	5.3	5.4	0.3	115	57	18.7	18.6	0.3	115
15	5.4	5.3	0.3	115	58	19.1	19.2	0.6	231
16	6.1	6.2	0.9	346	59	19.2	19.3	0.5	192
17	6.2	6.1	0.9	346	60	19.3	19.2	0.5	192
18	7.1	7.2	0.4	154	61	19.4	19.5	0.5	192
19	7.2	7.1	0.4	154	62	19.5	19.4	0.5	192
20	7.3	7.4	0.4	154	63	20.1	20.2	0.3	115
21	7.4	7.3	0.4	154	64	20.2	20.1	0.3	115
22	8	9.1	1.7	654	65	20.3	20.4	0.3	115
23	9.1	9.2	0.2	77	66	20.4	20.3	0.3	115
24	9.2	9.1	0.2	77	67	20.5	20.4	0.3	115
25	10	9.2	1.3	500	68	20.6	20.7	0.2	77
26	11.1	11.2	0.4	154	69	20.7	20.6	0.2	77
27	11.2	11.1	0.4	154	70	20.8	20.9	0.2	77
28	12.1	12.2	0.9	346	71	20.9	20.8	0.2	77
29	12.2	12.1	0.9	346	72	21	22	1.5	577
30	13	14.7	2.3	885	73	22	21	1.5	577
31	14.1	14.2	0.3	115	74	23.1	23.2	0.6	231
32	14.2	14.1	0.3	115	75	23.2	23.1	0.6	231
33	14.3	14.4	0.8	308	76	24.1	24.2	0.4	154
34	14.4	14.7	0.2	77	77	24.2	24.1	0.4	154
35	14.5	14.4	0.3	115	78	25.1	25.2	0.6	231
36	14.6	14.5	0.4	154	79	25.2	25.1	0.6	231
37	14.7	14.4	0.2	77	80	25.3	25.1	0.8	308
38	15.1	15.2	0.5	192					
39	15.2	15.1	0.5	192			**Mean:**	0.6	220.7
40	15.3	15.4	0.3	115					
41	15.4	15.3	0.3	115		$r_o =$	0.22	$r_e =$	0.73
42	15.5	15.3	0.5	192		$p =$	0.47	r_o / r_e	0.30
43	16.1	16.2	0.5	192					

Table A.4 Data used in the calculation of NNC in Homa Bay subregion.

Karungu north			Distance	
Obs	Point	N.N.	Cm.	Metres
1	1.1	1.4	0.4	154
2	1.2	1.1	0.6	231
3	1.3	1.2	0.6	231
4	1.4	1.1	0.4	154
5	2.1	2.2	0.8	308
6	2.2	2.3	0.7	269
7	2.3	2.4	0.4	154
8	2.4	2.3	0.4	154
9	2.5	2.4	0.7	269
10	2.6	2.5	0.6	231
11	2.7	2.6	0.8	308
12	2.8	2.1	1.0	385
13	3.1	3.2	0.7	269
14	3.2	3.3	0.5	192
15	3.3	3.2	0.5	192
16	4	5.3	2.1	808
17	5.1	5.2	0.2	77
18	5.2	5.1	0.2	77
19	5.3	5.4	0.4	154
20	5.4	5.3	0.4	154
21	6	5.1	2.8	1077
22	7	6	3.6	1385
23	8.1	8.3	1.0	385
24	8.2	8.3	0.7	269
25	8.3	8.2	0.7	269
		Mean	0.8	326.2
	ro =	0.33	re =	0.82
	p =	0.37	ro/re =	0.40

Table A.5 Data used used in the calculation of NNC in Karungu North subregion.

Structure (Point) Coordinates.

All the structures, as stated in the text, were plotted as points through 'revision mapping' on 1:50,000 topographical map series. Coordinates for these points was taken using the grids on the same maps. These were expressed as a two matrix distance measurement for the points (Table A.7-A.10) and were consequently used in the cluster analysis for the determination of the clusters formed. The coordinates were taken as the actual distance measurements for the points north or south of the equator and east of Greenwich.

Distance

Karungu south			Distance	
Obs	Point	N.N.	Cm.	Metres
1	1.1	1.2	0.4	154
2	1.2	1.3	0.3	115
3	1.3	1.2	0.3	115
4	1.4	1.1	0.8	308
5	2.1	2.2	0.7	269
6	2.2	2.1	0.7	269
7	3.1	3.2	0.3	115
8	3.2	3.1	0.3	115
9	3.3	3.2	0.7	269
10	4	3.1	6.1	2346
11	5.1	5.2	0.9	346
12	5.2	5.1	0.9	346
13	5.3	5.2	1.0	385
14	6.1	6.3	1.0	385
15	6.2	6.3	0.8	308
16	6.3	6.2	0.8	308
17	6.4	6.5	0.7	269
18	6.5	6.4	0.7	269
19	7.1	7.3	0.7	269
20	7.2	7.1	0.6	231
21	7.3	7.1	0.7	269
22	8.1	8.2	0.4	154
23	8.2	8.1	0.4	154
24	9	8.2	2.7	1038
		Mean	1.0	367.0
	r_o =	0.37	r_e =	1.12
	p =	0.20	r_o / r_e =	0.33

Table A.6 Data used in the calculation of NNC in Karungu South subregion.

Point	Structure	East	North	Point	Structure	East	North
1	M1-1	644880	9907800	67	M14-1	644200	9901400
2	M1-2	645000	9907700	68	M15-1	645050	9901200
3	M2-1	646100	9907700	69	M16-1	646025	9901400
4	M2-2	646150	9907450	70	M16-2	646175	9901300
5	M1-1	645950	9907075	71	M16-3	646050	9901375
6	M3-2	645950	9906775	72	M16-4	645800	9901300
7	M3-3	645975	9906650	73	M17-1	647000	9901700
8	M3-4	646100	9906525	74	M17-2	646950	9901500
9	M3-5	646300	9906500	75	M17-3	646950	9901175
10	M3-6	646150	9906400	76	M17-4	647075	9901050
11	M3-7	646075	9906325	77	M17-5	646875	9901250
12	M3-8	646000	9906200	78	M17-6	646875	9901475
13	M3-9	646000	9906050	79	M17-7	646650	9901100
14	M3-10	646075	9906025	80	M17-8	646800	9901350
15	M3-11	646175	9906000	81	M18-1	647375	9901075
16	M3-12	645975	9905850	82	M19-1	647450	9901750
17	M3-13	645725	9906025	83	M19-2	647700	9901725
18	M3-14	645650	9906250	84	M19-3	647600	9901625
19	M3-15	645825	9906100	85	M19-4	647550	9901525
20	M3-16	645900	9906200	86	M20-1	646275	9902650
21	M3-17	646000	9906525	87	M20-2	646550	9902525
22	M3-18	645850	9906650	88	M20-3	646550	9902225
23	M3-19	645750	9906675	89	M20-4	646300	9902150
24	M3-20	645575	9906475	90	M21-1	647325	9903825
25	M3-21	645700	9906300	91	M21-2	647525	9903425
26	M3-22	645750	9906250	92	M21-3	647200	9903475
27	M3-23	645800	9906300	93	M21-4	647150	9903625
28	M4-1	647525	9906675	94	M21-5	647250	9903650
29	M4-2	647800	9906450	95	M22-1	650050	9906800
30	M5-1	644575	9905700	96	M22-2	650050	9906575
31	M5-2	644600	9905600	97	M23-1	650400	9908525
32	M3-3	644725	9905525	98	M23-2	650700	9908500
33	M5-4	644600	9905425	99	M23-3	650450	9908450
34	M5-5	644650	9905300	100	M23-4	650400	9908275
35	M5-6	644550	9905425	101	M23-5	650500	9908200
36	M6-1	645650	9905200	102	M23-6	650375	9907850
37	M6-2	645750	9905050	103	M23-7	650200	9908000
38	M6-3	645800	9904900	104	M24-1	653375	9908425
39	M7-1	646250*	9905000	105	M24-2	653550	9908350
40	M8-2	641600	9904200	106	M24-3	653450	9908275
41	M8-3	641675	9904075	107	M25-1	652000	9906900
42	M8-4	641856	9904000	108	M25-2	652175	9906800
43	M8-5	641700	9903850	109	M25-3	652225	9906700
44	M9-1	642475	9904300	110	M25-4	652300	9906525
45	M9-2	642650	9904200	111	M25-5	652000	9906775
46	M9-3	642650	9904000	112	M26-1	654300	9906650
47	M9-4	642475	9904150	113	M26-2	654525	9906525
48	M10-1	644325	9904350	114	M26-3	654450	9906150
49	M10-2	644325	9904225	115	M26-4	654400	9905750
50	M10-3	644475	9904050	116	M26-5	654250	9905900
51	M10-4	644300	9904100	117	M26-6	654175	9906500
52	M10-5	644225	9904150	118	M26-7	654225	9906525
53	M10-6	644225	9904350	119	M26-8	654175	9906400
54	M11-1	645600	9904200	120	M26-9	654050	9906475
55	M11-2	645900	9904000	121	M26-10	654025	9906125
56	M11-3	645750	9903875	122	M26-11	653875	9906150
57	M11-4	645650	9903825	123	M26-12	653850	9906050
58	M11-5	645550	9903925	124	M27-1	652650	9903100
59	M11-6	645650	9903925	125	M27-2	652750	9903000
60	M12-1	644150	9902700	126	M27-3	653025	9902925
61	M12-2	644000	9902625	127	M27-4	652650	9902925
62	M13-1	643575	9901625	128	M27-5	652575	9903000
63	M13-2	643600	9901525	129	M28-1	651475	9902900
64	M13-3	643525	9901400	130	M28-2	651600	9902875
65	M13-4	643400	9901450	131	M28-3	651325	9902775
66	M13-5	643475	9901575	132	M28-4	651225	9902825

* This easting should be 642650.

Point	Structure	East	North	Point	Structure	East	North
133	M28-5	651150	9902975	196	M50-2	655950	9902600
134	M29-1	649875	9903025	197	M50-3	656050	9902600
135	M29-2	650225	9902975	198	M50-4	656025	9902525
136	M30-1	649050	9902175	199	M50-5	655925	9902475
137	M31-1	648600	9900925	200	M50-6	656025	9902400
138	M32-1	649025	9899850	201	M51-1	656050	9901325
139	M32-2	649150	9899825	202	M52-1	657600	9902350
140	M33-1	649675	9900025	203	M52-2	657650	9902050
141	M34-1	650400	9899700	204	M53-1	659825	9903275
142	M35-1	650975	9899300	205	M53-2	659625	9903175
143	M36-1	651325	9901250	206	M54-1	658475	9901125
144	M37-1	651700	9901750	207	M54-2	658600	9901100
145	M37-2	651800	9901600	208	M54-3	658525	9901005
146	M38-1	651900	9902225	209	M55-1	658450	9900525
147	M39-1	652250	9901375	210	M55-2	658500	9900400
148	M40-1	652200	9900000	211	M55-3	658450	9900400
149	M41-1	652400	9898550	212	M56-1	656775	9900200
150	M41-2	652450	9898200	213	M56-2	656850	9900150
151	M41-3	651950	9898175	214	M56-3	656700	9900000
152	M41-	652175	9898575	215	M57-1	659675	9899800
153	M42-1	653350	9899325	216	M57-2	659700	9899525
154	M42-2	653150	9899375	217	M57-3	659600	9899600
155	M42-3	653250	9899325	218	M57-4	659550	9899750
156	M42-4	653275	9899225	219	M58-1	658800	9898750
157	M42-5	653150	9899225	220	M58-2	658800	9898625
158	M43-1	653725	9899575	221	M58-3	658725	9898475
159	M43-2	653825	9899450	222	M59-1	657225	9899175
160	M43-3	653975	9899300	223	M59-2	657325	9899100
161	M43-4	653875	9899300	224	M59-3	657250	9898975
162	M43-5	653775	9899350	225	M59-4	657500	9898700
163	M44-1	654300	9899300	226	M59-5	657600	9898600
164	M44-2	654275	9899225	227	M59-6	657875	9898375
165	M44-3	654300	9899150	228	M59-7	657875	9898250
166	M45-1	654950	9899325	229	M59-8	657850	9898125
167	M45-2	655175	9899325	230	M59-9	657775	9898250
168	M45-3	655125	9899250	231	M59-10	657750	9898400
169	M45-4	655025	9899225	232	M59-11	659900	9897750
170	M46-1	653750	9900100	233	M59-12	657775	9897800
171	M46-2	653925	9900000	234	M59-13	657750	9897725
172	M46-3	654125	9900000	235	M60-1	655775	9898025
173	M46-4	654025	9899850	236	M60-2	655675	9897950
174	M46-5	653850	9899900	237	M61-1	656575	9897950
175	M46-6	653750	9899925	238	M61-2	656750	9897075
176	M46-7	653650	9899900	239	M62-1	657400	9896350
177	M46-8	653800	9899975	240	M63-1	657175	9895525
178	M47-1	654100	9901800	241	M63-2	657400	9895550
179	M47-2	654150	9901675	242	M64-1	658300	9895950
180	M47-3	654175	9901500	243	M64-2	658475	9895950
181	M47-4	654300	9901400	244	M65-1	658025	9896675
182	M47-5	654175	9901300	245	M66-1	658600	9897400
183	M47-6	654175	9901075	246	M66	658700	9897350
184	M47-7	654350	9901000	247	M66-3	658750	9897225
185	M47-8	654150	9900975	248	M67-1	653750	9897600
186	M47-9	654125	9901375	249	M67-2	653725	9897500
187	M47-10	654075	9901525	250	M67-3	653925	9897375
188	M47-11	654000	9901575	251	M67-4	653625	9897425
189	M47-12	653950	9901700	252	M67-5	653675	9897650
190	M47-13	654025	9901750	253	M68-1	645200	9902900
191	M47-14	654050	9901675	254	M68-2	645275	9902825
192	M48-1	654000	9902200	255	M68-3	645250	9902725
193	M49-1	655275	9901600	256	M68-4	645125	9902700
194	M49-2	655150	9901350	257	M68-5	645075	9902825
195	M50-1	655850	9902625	258	M68-6	645175	9902800

Table A-7 Data Used In Cluster Analysis In Macalder Subregion.

POINT	STRUCTURE	EAST	NORTH	POINT	STRUCTURE	EAST	NORTH
1	HB1-1	648550	9926175	41	HB15-4	646900	9917750
2	HB1-2	648675	9926150	42	HB15-5	646850	9918000
3	HB1-3	648800	9926275	43	HB16-1	647675	9918625
4	HB1-4	648875	9926150	44	HB16-2	647775	9920625
5	HB1-5	649050	9926050	45	HB17-1	650900	9918300
6	HB1-6	649075	9925775	46	HB17-2	650925	9917875
7	HB1-7	648800	9925650	47	HB17-3	650800	9917875
8	HB2-1	650300	9926250	48	HB17-4	650700	9917800
9	HB3-1	649275	9925175	49	HB17-5	650550	9917850
10	HB4-1	646475	9923650	50	HB17-6	650575	9918250
11	HB4-2	646275	9923575	51	HB18-1	651850	9919975
12	HB5-1	644750	9923625	52	HB18-2	651950	9919950
13	HB5-2	644725	9923500	53	HB18-3	652000	9919875
14	HB5-3	644900	9923325	54	HB18-4	651850	9919900
15	HB5-4	644750	9923275	55	HB18-5	651675	9919800
16	HB6-1	644850	9921200	56	HB18-6	651375	9919800
17	HB6-1	644850	9921200	57	HB18-7	651325	9919750
18	HB7-1	643300	9920175	58	HB19-1	650400	9920775
19	HB7-2	643375	9920050	59	HB19-2	650750	9920725
20	HB7-3	643275	9919925	60	HB19-3	650600	9920525
21	HB7-4	643175	9920000	61	HB19-4	650475	9920375
22	HB8-1	643025	9919850	62	HB19-5	650400	9920600
23	HB9-1	642550	9919500	63	HB20-1	652375	9921025
24	HB9-1	642550	9919500	64	HB20-2	652425	9920950
25	HB10-1	642325	9918975	65	HB20-3	652350	9920875
26	HB11-1	643925	9918250	66	HB20-4	652375	9920800
27	HB11-2	644000	9918200	67	HB20-5	652250	9920800
28	HB12-1	644550	9919000	68	HB20-6	652100	9920825
29	HB12-2	644850	9918850	69	HB20-7	652075	9920925
30	HB13-1	644900	9918025	70	HB20-8	652225	9920900
31	HB14-1	646225	9918450	71	HB20-9	652275	9920975
32	HB14-2	646225	9918350	72	HB21-1	653875	9922775
33	HB14-3	645900	9918000	73	HB22-1	654375	9923000
34	HB14-4	645825	9918250	74	HB23-1	653225	9923550
35	HB14-5	645875	9918350	75	HB23-2	653350	9923400
36	HB14-6	645750	9918425	76	HB24-1	652300	9924675
37	HB14-7	645700	9918250	77	HB24-2	652400	9924725
38	HB15-1	647025	9918025	78	HB25-1	649400	9930450
39	HB15-2	647025	9917850	79	HB25-2	649625	9930350
40	HB15-3	647095	9917750	80	HB25-3	649275	9930175

Table A.8 Data used in the cluster Analysis in Homa Bay subregion.

POINT	STRUCTURE	EAST	NORTH
1	KN1-1	619125	9914300
2	KN1-2	619300	9914175
3	KN1-3	619125	9914050
4	KN1-4	619000	9914200
5	KN2-1	620700	9915200
6	KN2-2	620950	9915050
7	KN2-3	621000	9914800
8	KN2-4	621075	9914650
9	KN2-5	621150	9914400
10	KN2-6	620925	9914375
11	KN2-7	620725	9914500
12	KN2-8	620575	9914875
13	KN3-1	620475	9912325
14	KN3-2	620375	9912100
15	KN3-3	620150	9912150
16	KN4-4	624500	9911500
17	KN5-1	624600	9912350
18	KN5-2	624525	9912300
19	KN5-3	624225	9912225
20	KN5-4	624225	9912375
21	KN6-1	625625	9912500
22	KN7-1	626950	9912150
23	KN8-1	626950	9910575
24	KN8-2	627000	9910125
25	KN8-3	626775	9910250

Table A.9 Structure coordinates used in the Cluster Analysis in Karungu North Subregion.

POINT	STRUCTURE	EAST	NORTH
1	KS1-1	637525	9893975
2	KS1-2	637550	9893950
3	KS1-3	637775	9893925
4	KS1-4	637575	9893750
5	KS2-1	635900	9893350
6	KS2-2	636050	9893200
7	KS3-1	634575	9895350
8	KS3-2	634725	9895300
9	KS3-3	634950	9895350
10	KS4-1	632600	9896150
11	KS5-1	638750	9899275
12	KS5-2	638600	9899025
13	KS5-3	638300	9899175
14	KS6-1	637300	9899425
15	KS6-2	637425	9899050
16	KS6-3	637125	9898800
17	KS6-4	636975	9898975
18	KS6-5	637175	9899075
19	KS7-1	635750	9802650
20	KS7-2	635950	9902500
21	KS7-3	635650	9902425
22	KS8-1	636575	9903225
23	KS8-2	636675	9903125
24	KS9-1	637625	9902825

Table A.10 Data used in the cluster analysis in Karungu South subregion.

The Agglomeration Schedule.

Tables A.11-A.14 show the agglomeration schedule containing the number of cases or clusters being combined at each stage. As discussed in the text, the method used is complete linkage. In this method, two clusters are joined for which the maximum distance between a pair of cases in each cluster is smallest. While these figures may not hold much meaning in this stage of cluster analysis, they may be useful for future analyses on the structures.

Stge	Clusters Combined		Coefficient	Stage Cluster 1st Appears		Next Stge	Stge	Clusters Combined		Coefficient	Stage Cluster 1st Appears		Next Stge
	Clstr 1	Clstr 2		Clstr 1	Clstr 2			Clstr 1	Clstr 2		Clstr 1	Clstr 2	
1	69	71	35.355339	0	0	90	66	206	207	130.000000	0	48	187
2	210	211	50.000000	0	0	69	67	256	257	134.629120	0	28	109
3	33	35	50.000000	0	0	84	68	215	218	134.629120	0	0	134
4	117	118	55.901699	0	0	71	69	209	210	134.629120	0	2	187
5	175	177	70.710678	0	0	33	70	178	179	134.629120	0	0	103
6	26	27	70.710678	0	0	82	71	117	119	134.629120	4	0	92
7	18	25	70.710678	0	0	82	72	62	66	134.629120	36	0	126
8	233	234	79.056938	0	0	198	73	64	65	134.629120	0	0	126
9	197	198	79.056938	0	0	102	74	225	226	141.421356	0	0	181
10	190	191	79.056938	0	0	31	75	124	125	141.421356	0	0	87
11	164	165	79.056938	0	0	78	76	228	229	145.773804	21	0	141
12	74	78	79.056938	0	0	108	77	40	41	145.773804	0	0	154
13	13	14	79.056938	0	0	94	78	163	164	150.000000	0	11	186
14	248	252	90.138779	0	0	121	79	44	47	150.000000	0	0	150
15	212	213	90.138779	0	0	110	80	1	2	156.204987	0	0	217
16	187	188	90.138779	0	0	135	81	37	38	158.113876	0	0	149
17	182	186	90.138779	0	0	99	82	18	26	158.113876	7	6	140
18	167	168	90.138779	0	0	116	83	180	181	160.078110	0	0	99
19	97	99	90.138779	0	0	144	84	33	34	160.078110	3	0	164
20	51	52	90.138779	0	0	64	85	60	61	167.705093	0	0	208
21	228	230	100.000000	0	0	76	86	242	243	175.000000	0	0	204
22	160	161	100.000000	0	0	106	87	124	127	175.000000	75	39	169
23	153	155	100.000000	0	0	115	88	172	173	180.277557	0	0	174
24	58	59	100.000000	0	0	105	89	144	145	180.277557	0	0	178
25	48	53	100.000000	0	0	132	90	69	70	180.277557	1	0	159
26	8	21	100.000000	0	0	111	91	253	254	182.002747	0	29	109
27	12	20	100.000000	0	0	148	92	117	120	182.002747	71	0	172
28	257	258	103.077644	0	0	67	93	92	93	182.002747	0	35	157
29	254	255	103.077644	0	0	91	94	13	15	182.002747	13	0	127
30	195	196	103.077644	0	0	139	95	171	174	190.394333	0	33	142
31	189	190	103.077644	0	10	103	96	121	122	190.394333	0	34	180
32	183	185	103.077644	0	0	104	97	104	105	190.394333	0	58	227
33	174	175	103.077644	0	5	95	98	154	156	195.256241	0	56	115
34	122	123	103.077644	0	0	96	99	180	182	200.000000	83	17	175
35	93	94	103.077644	0	0	93	100	45	46	200.000000	0	0	150
36	62	63	103.077644	0	0	72	101	222	224	201.556442	51	0	209
37	30	31	103.077644	0	0	124	102	197	199	201.556442	9	54	139
38	22	23	103.077644	0	0	120	103	178	189	201.556442	70	31	135
39	127	128	106.066017	0	0	87	104	183	184	201.556442	32	0	193
40	75	77	106.066017	0	0	137	105	56	58	206.155289	47	24	153
41	10	11	106.066017	0	0	111	106	159	160	212.132034	43	22	156
42	245	246	111.803398	0	0	122	107	115	116	212.132034	0	0	162
43	159	162	111.803398	0	0	106	108	74	80	212.132034	12	0	163
44	131	132	111.803398	0	0	133	109	253	256	213.600098	91	67	208
45	108	109	111.803398	0	0	143	110	212	214	213.600098	15	0	209
46	84	85	111.803398	0	0	125	111	8	10	213.600098	26	41	145
47	56	57	111.803398	0	0	105	112	42	43	216.416260	0	0	154
48	207	208	121.037186	0	0	66	113	204	205	223.606796	0	0	232
49	249	251	125.000000	0	0	121	114	170	176	223.606796	0	0	142
50	235	236	125.000000	0	0	213	115	153	154	223.606796	23	98	206
51	222	223	125.000000	0	0	101	116	166	167	225.000000	55	18	223
52	219	220	125.000000	0	0	138	117	95	96	225.000000	0	0	224
53	216	217	125.000000	0	0	134	118	240	241	226.384628	0	0	214
54	199	200	125.000000	0	0	102	119	149	152	226.384628	0	0	171
55	166	169	125.000000	0	0	116	120	6	22	226.384628	65	38	167
56	156	157	125.000000	0	0	98	121	248	249	230.488617	14	49	155
57	107	111	125.000000	0	0	143	122	245	247	230.488617	42	0	211
58	105	106	125.000000	0	0	97	123	102	103	230.488617	0	0	189
59	100	101	125.000000	0	0	158	124	30	32	230.488617	37	0	164
60	17	19	125.000000	0	0	148	125	82	84	246.221451	0	46	128
61	227	231	127.475487	0	0	141	126	62	64	247.487381	72	73	192
62	138	139	127.475487	0	0	182	127	13	16	250.000000	94	0	168
63	129	130	127.475487	0	0	170	128	82	83	251.246887	125	0	190
64	49	51	127.475487	0	20	132	129	3	4	254.950974	0	0	200
65	6	7	127.475487	0	0	120	130	112	113	257.390747	0	0	172

131	88	89	261.007660	0	0	176
132	48	49	261.007660	25	64	161
133	131	133	265.753632	44	0	170
134	215	216	276.134033	68	53	222
135	178	187	276.134033	103	16	175
136	193	194	279.508484	0	0	195
137	75	76	282.842712	40	0	165
138	219	221	285.043854	52	0	215
139	195	197	285.043854	30	102	216
140	18	24	285.043854	82	0	188
141	227	228	292.617493	61	76	181
142	170	171	292.617493	114	95	174
143	107	108	301.039856	57	45	173
144	97	98	301.039856	19	0	158
145	8	9	301.039856	111	0	188
146	86	87	302.076141	0	0	176
147	202	203	304.138123	0	0	232
148	12	17	325.960114	27	60	168
149	36	37	335.410187	0	81	179
150	44	45	347.311096	79	100	199
151	134	135	353.553406	0	0	219
152	28	29	355.316772	0	0	228
153	55	56	357.945526	0	105	160
154	40	42	364.005493	77	112	199
155	248	250	371.651733	121	0	225
156	158	159	371.651733	0	106	186
157	90	92	371.651733	0	93	166
158	97	100	375.000000	144	59	189
159	69	72	375.000000	90	0	202
160	54	55	378.318634	0	153	212
161	48	50	390.512482	132	0	218
162	114	115	403.112885	0	107	180
163	73	74	403.112885	0	108	183
164	30	33	406.970520	124	84	218
165	75	79	427.931061	137	0	183
166	90	91	447.213593	157	0	242
167	5	6	447.213593	0	120	200
168	12	13	450.693909	148	127	191
169	124	126	456.207184	87	0	231
170	129	131	460.977234	63	133	219
171	149	150	465.026886	119	0	177
172	112	117	477.624329	130	92	196
173	107	110	480.234314	143	0	227
174	170	172	485.412201	142	88	201
175	178	180	505.593719	135	99	193
176	86	88	506.211426	146	131	221
177	149	151	585.768738	171	0	225
178	143	144	625.000000	0	89	203
179	36	39*	632.455505	149	0	212
180	114	121	660.018921	162	96	196
181	225	227	673.145630	74	141	198
182	138	140	673.145630	62	0	230
183	73	75	694.622192	163	165	205
184	141	142	700.446289	0	0	220
185	239	244	704.450134	0	0	204
186	158	163	715.017456	156	78	201
187	206	209	725.430908	66	69	222
188	8	18	725.430908	145	140	191
189	97	102	726.722107	158	123	224
190	81	82	726.722107	0	128	205
191	8	12	765.261414	188	168	228
192	62	67	801.560974	126	0	229
193	178	183	838.152710	175	104	207
194	237	238	892.328430	0	0	213
195	193	201	900.347168	136	0	216

195	193	201	900.347168	136	0	216
196	112	114	905.538513	172	180	236
197	146	147	919.238831	0	0	203
198	225	233	1006.541077	181	8	215
199	40	44	1068.877930	154	150	244
200	3	5	1083.109009	129	167	217
201	158	170	1097.724976	186	174	206
202	68	69	1129.435669	0	159	235
203	143	146	1131.923096	178	197	231
204	239	242	1147.006958	185	86	214
205	73	81	1221.934937	183	190	221
206	153	158	1245.491821	115	201	223
207	178	192	1250.000000	193	0	233
208	60	253	1290.590942	85	109	229
209	212	222	1313.868286	110	101	237
210	136	137	1328.533081	0	0	230
211	232	245	1346.291260	0	122	234
212	36	54	1375.000000	179	160	226
213	235	237	1386.091675	50	194	241
214	239	240	1430.034912	204	118	241
215	219	225	1467.353027	138	198	234
216	193	195	1540.292236	195	139	233
217	1	3	1587.931030	80	200	239
218	30	48	1653.027466	164	161	226
219	129	134	1731.509399	170	151	238
220	141	148	1824.828735	184	0	243
221	73	86	1921.099976	205	176	235
222	206	215	2015.099243	187	134	237
223	153	166	2027.467651	206	116	240
224	95	97	2031.778809	117	189	247
225	149	248	2130.874268	177	155	240
226	30	36	2196.161377	218	212	246
227	104	107	2212.041016	97	173	236
228	8	28	2225.140381	191	152	239
229	60	62	2325.134521	208	192	244
230	136	138	2352.126709	210	182	243
231	124	143	2386.550781	169	203	238
232	202	204	2496.247070	147	113	254
233	178	193	2500.125000	207	216	250
234	219	232	2581.181885	215	211	245
235	68	73	2701.504150	202	221	242
236	104	112	2864.655273	227	196	247
237	206	212	3037.371338	222	209	245
238	124	129	3151.586914	231	219	248
239	1	8	3216.970703	217	228	246
240	149	153	3423.905029	225	223	250
241	235	239	3440.930176	213	214	249
242	68	90	3473.650879	235	166	251
243	136	141	3827.939941	230	220	248
244	40	60	3936.765869	199	229	251
245	206	219	3970.909912	237	234	249
246	1	30	4250.955566	239	226	252
247	95	104	4868.328613	224	236	255
248	124	136	5045.356934	238	243	253
249	206	235	5754.237793	245	241	254
250	149	178	6032.464355	240	233	253
251	40	68	6582.979980	244	242	252
252	1	40	7172.910645	246	251	256
253	124	149	7635.975586	248	250	255
254	202	206	8190.543457	232	249	257
255	95	124	11693.935547	247	253	256
256	1	95	14733.232422	252	255	257
257	1	202	19403.414063			

Table A.11. Agglomoration Schedule from the Cluster Analysis Results in the Macalder subregion.*Structure 39 incorrectly agglomerated due to error in measurements (see Table A 7)

Stge	Clusters Combined		Coefficient	Stge Cltr 1st Appears		Next	Stge	Clusters Combined		Coefficient	Stge Cltr 1st Appears		Next
Stge	Cltr 1	Cltr 2	Coefficient	Cltr 1	Cltr 2	Stge	Stge	Cltr 1	Cltr 2	Coefficient	Cltr 1	Cltr 2	Stge
1	23	24	.000000	0	0	55	41	28	29	335.410187	0	0	59
2	16	17	.000000	0	0	71	42	12	14	350.000000	18	22	66
3	56	57	70.710678	0	0	57	43	38	39	350.035706	24	27	60
4	51	54	75.000000	0	0	25	44	63	68	350.891724	36	11	64
5	65	66	79.056938	0	0	15	45	58	59	371.651733	23	0	49
6	70	71	90.138779	0	0	30	46	46	49	375.832397	33	0	54
7	63	64	90.138779	0	0	36	47	78	80	391.311890	34	0	74
8	52	53	90.138779	0	0	25	48	18	22	425.734650	35	0	63
9	26	27	90.138779	0	0	58	49	58	60	445.112335	45	29	68
10	31	32	100.000000	0	0	53	50	33	34	450.693909	0	31	53
11	68	69	103.077644	0	0	44	51	5	7	471.699066	37	0	56
12	76	77	111.803398	0	0	69	52	72	73	548.292786	0	0	62
13	34	35	111.803398	0	0	31	53	31	33	561.805115	10	50	67
14	39	40	122.065559	0	0	27	54	45	46	570.087708	39	46	73
15	65	67	125.000000	5	0	30	55	23	25	571.182983	1	0	63
16	47	48	125.000000	0	0	33	56	1	5	660.018921	38	51	61
17	20	21	125.000000	0	0	35	57	51	56	686.476501	40	3	64
18	12	13	127.475487	0	0	42	58	26	30	1000.624817	9	0	59
19	1	2	127.475487	0	0	38	59	26	28	1102.553833	58	41	70
20	18	19	145.773804	0	0	35	60	38	43	1168.866943	43	0	67
21	3	4	145.773804	0	0	38	61	1	9	1235.161987	56	0	65
22	14	15	158.113876	0	0	42	62	72	74	1274.754883	52	28	69
23	58	62	175.000000	0	0	45	63	18	23	1546.164551	48	55	70
24	38	42	176.776703	0	0	43	64	51	63	1651.703613	57	44	68
25	51	52	180.277557	4	8	40	65	1	8	1751.606445	61	0	74
26	36	37	182.002747	0	0	31	66	10	12	1765.290405	32	42	71
27	39	41	195.000000	14	0	43	67	31	38	2010.286011	53	60	72
28	74	75	195.256241	0	0	62	68	51	58	2055.024414	64	49	73
29	60	61	195.256241	0	0	49	69	72	76	2666.692627	62	12	77
30	65	70	201.556442	15	6	36	70	18	26	2774.549561	63	59	75
31	34	36	201.556442	13	26	50	71	10	16	2939.919189	66	2	76
32	10	11	213.600098	0	0	66	72	31	44	3225.872070	67	0	75
33	46	47	237.170822	0	16	46	73	45	51	3662.137451	54	68	77
34	78	79	246.221451	0	0	47	74	1	78	5276.480957	65	47	79
35	18	20	251.246887	20	17	48	75	18	31	5694.295410	70	72	76
36	63	65	257.390747	7	30	44	76	10	18	6325.713379	71	75	78
37	5	6	276.134033	0	0	51	77	45	72	7130.611816	73	69	78
38	1	3	325.960114	19	21	56	78	10	45	12704.453125	76	77	79
39	45	50	328.823669	0	0	54	79	1	10	13515.939453	74	78	0
40	51	55	333.541595	25	0	57							

Table A.12 Agglomeration schedule from the Cluster Analysis results in Homa Bay Subregion.

Stage	Clusters Combined		Coefficient	Stage Cluster 1st Appears		Next Stage
	Cluster 1	Cluster 2		Cluster 1	Cluster 2	
1	17	18	90.138779	0	0	12
2	19	20	150.000000	0	0	12
3	1	4	160.078110	0	0	10
4	7	8	167.705093	0	0	14
5	2	3	215.058136	0	0	10
6	9	10	226.384628	0	0	14
7	14	15	230.488617	0	0	11
8	24	25	257.390747	0	0	15
9	5	6	291.547607	0	0	16
10	1	2	301.039856	3	5	20
11	13	14	369.120575	0	7	22
12	17	19	395.284698	1	2	17
13	11	12	403.887360	0	0	16
14	7	9	431.566925	4	6	18
15	23	24	452.769257	0	8	23
16	5	11	700.446289	9	13	18
17	16	17	917.196838	0	12	21
18	5	7	917.877991	16	14	20
19	21	22	1370.447021	0	0	21
20	1	5	2159.282227	10	18	22
21	16	21	2734.273193	17	19	23
22	1	13	3116.989746	20	11	24
23	16	23	3572.551514	21	15	24
24	1	16	8978.063477	22	23	0

Table A.13 Agglomeration schedule from the Cluster Analysis results from Karungu North Subregion.

Stage	Clusters Combined		Coefficient	Stage Cluster 1st Appears		Next Stage
	Cluster 1	Cluster 2		Cluster 1	Cluster 2	
1	2	3	127.475487	0	0	8
2	22	23	141.421356	0	0	16
3	7	8	158.113876	0	0	12
4	5	6	212.132034	0	0	18
5	17	18	223.606796	0	0	9
6	1	4	230.488617	0	0	8
7	19	21	246.221451	0	0	11
8	1	2	265.753632	6	1	18
9	16	17	279.508484	0	5	15
10	11	12	291.547607	0	0	14
11	19	20	309.232910	7	0	19
12	7	9	375.000000	3	0	20
13	14	15	395.284698	0	0	15
14	11	13	460.977234	10	0	17
15	14	16	649.037720	13	9	17
16	22	24	1123.610229	2	0	19
17	11	14	1800.173584	14	15	21
18	1	5	1961.185913	8	4	22
19	19	22	2015.099243	11	16	21
20	7	10	2482.438232	12	0	22
21	11	19	4662.684082	17	19	23
22	1	7	5633.049805	18	20	23
23	1	11	10038.737305	22	21	0

Table A.14 Agglomeration schedule from the Cluster Analysis results from Karungu South Subregion.