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Roman roads in the Upper Galilee and Lower Golan regions: Relationships to natural migratory routes

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ROMAN ROADS IN THE UPPER GALILEE

AND LOWER GOLAN REGIONS:

RELATIONSHIPS TO NATURAL MIGRATORY ROUTES

A Thesis

Presented to the

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and the

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University of Nebraska

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THESIS ACCEPTANCE

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ABSTRACT

The geoarchaeological problem herein was to identify the Roman roads in the Upper Galilee and Lower Golan regions of Israel. The primary objective was to identify an anthropogenic relationship of land use as a function of the physical geography of the region. The secondary objective was to identify the most favorable routes of passage to the ancient city of Bethsaida.

This thesis pursued a multi-disciplinary approach to meeting the objectives. Field investigation was conducted to acquire data on the elevation, slope, aspect, lithology, and hydrology of the terrain regarding cost factor values of travel by foot. An archaeological investigation was conducted in conjunction with the field investigation to acquire data regarding the spatial distribution of Roman road remnants and artifacts on the landscape. Finally, a Geographic Information Systems (GIS) investigation was conducted to implement spatial analysis by devising a Site Suitability Analysis Process which ranked and weighted the physical geography data layers of slope, aspect, hydrology, lithology, and probable estuarine coastline. The process included generating a map of Surface Friction from the ranked and weighted values, and generating a model of Areas of Favorable Passage. This analysis facilitated identification of areas favorable for passage over varied terrain by taking into consideration the cost factor values of travel over a friction surface.

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As is true with the majority of life's rewarding experiences, this thesis was not a singular accomplishment, but rather a collective accomplishment, comprised of the "bits and pieces" of many who shared their knowledge.

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INTRODUCTION

PROBLEM STATEMENT

While researching the possibility of Roman roads in the Upper Galilee and Lower Golan regions of Israel, specifically those roads that may have led to the site of ancient Bethsaida, it was noted that the ancient international routes, e.g., the great Trunk Road and the Via Maris, traveled through the study area within close proximity of possible Roman road sites. Further research revealed that the Romans methodically built their roads to conform to the natural terrain of the region, and utilized existing roads whenever possible. Since the ancient routes actually were natural migratory routes, with historical documentation from the 20th century BCE attesting to their antiquity, the question became whether the Romans used the natural migratory routes as a foundation for their road network in the Upper Galilee and Lower Golan regions, or constructed new roads.

The problem was to locate Roman roads in the Upper Galilee and Lower Golan regions. Therefore, from a geoarchaeological perspective, the primary objective was to seek an anthropogenic relationship of land use, specifically natural migratory routes, as a function of the physical geography of the terrain. The secondary objective was to determine the most favorable routes to Bethsaida. In order to acquire the data necessary to meet these objectives, a multi-disciplinary investigation was conducted:

1)   Field investigation to gather data on the physical geography of the study area;

2)   Archaeological investigation to gather data on the spatial distribution of archaeological artifacts, e.g., road fragments and potsherds, within the study area;

3)   GIS investigation to implement spatial analysis by designing a Site Suitability Analysis Process and theoretical models.

The latter investigation took into consideration the human cost factors which dictate travel through variable terrain to create paths of least resistance over areas of favorable passage. The objectives required reconstruction of the paleoenvironment by generating a theoretical model from physical geography and archaeological data acquired through the investigations.

OBJECTIVES

The resistance to movement, spatial friction, affects human choices and is a function of time and cost (expenditure of calories). Recent studies have shown that humans and primates use a least-distance strategy to travel between locations, seeking the paths of least resistance. Determining routes of efficiency regarding time and energy costs of traveling over the landscape can facilitate identifying human land use patterns on a landscape (Hartley and Wolley-Vawser, 1994).

The physical geography data acquired through the field investigation included the elevation, slope, aspect, hydrology, and surface lithology of the study area. Additionally, radiocarbon data indicative of a probable, ancient

estuarine coastline of the Sea of Galilee was incorporated into the physical geography data layers (Shroder and Inbar, 1995). In recent studies regarding the application of GIS in archaeology, Hartley and Wolley-Vawser (1994) and Tobler (1993) incorporated data from topography (slope and aspect) and hydrology to successfully create routes of efficiency models for relationship with archaeological and historical data. The use of topographic maps at a 1:50,000 scale as data sources was found to be sufficient (Vawser, personal communication, 1996) (Merchant, 1985).

The archaeological data gleaned from the investigation was used to analyze the spatial distribution of ancient settlements and surface material remains. The archaeological data facilitated differentiation between attested and inferred roads when overlain upon the Areas of Favorable Passage model.

The GIS investigation involved devising a Site Suitability Analysis Process which assigned ranked and weighted attribute values to the physical geography data layers for the creation of a surface friction map. The data layers and resultant map layers were used to conduct the final spatial analyses by generating Areas of Favorable Passage models.

Chapter II

STUDY AREA

SITE SETTING AND REGIONAL PHYSIOGRAPHY

The study area was the Upper Galilee and Lower Golan regions of Israel (Figure 1). Specifically, the study area was bounded by the cities of Hazor to the west, Bethsaida to the east (~ 35° 30' N to 35° 40' N), and Kefar Nahum to the south, Gadot to the north (~32° 53' E to 33° 2' E), within the Northern Jordan Rift Valley (Figure 2). The ancient city of Bethsaida was located at the northeast corner of the Sea of Galilee on the Beteiha Plain, east of the Jordan River. The Jordan River flows southward from the Hula Basin into the Sea of Galilee.

THE LEVANT

The Levant is a land bridge, which connects the continents of Asia and Africa, and is divided longitudinally, north to south, into four zones: The Coastal Plain; the Western Highlands; The Jordan Rift Valley; and the Eastern Plateau. The physiography of Israel is largely influenced by these structural lines which reinforce the characteristics of the Levant as a Land Bridge. The physical features of the Levant are products of fracturing due to plate tectonics as the Asian and African plates grind past each other along a transform fault. The stress of the fracturing produced blocks and rifts which formed in a predominantly north-south or northeast-southwest pattern. These structural patterns influenced the geomorphology of the land (Baly, 1993).

Figure 1: Map of the Study Area
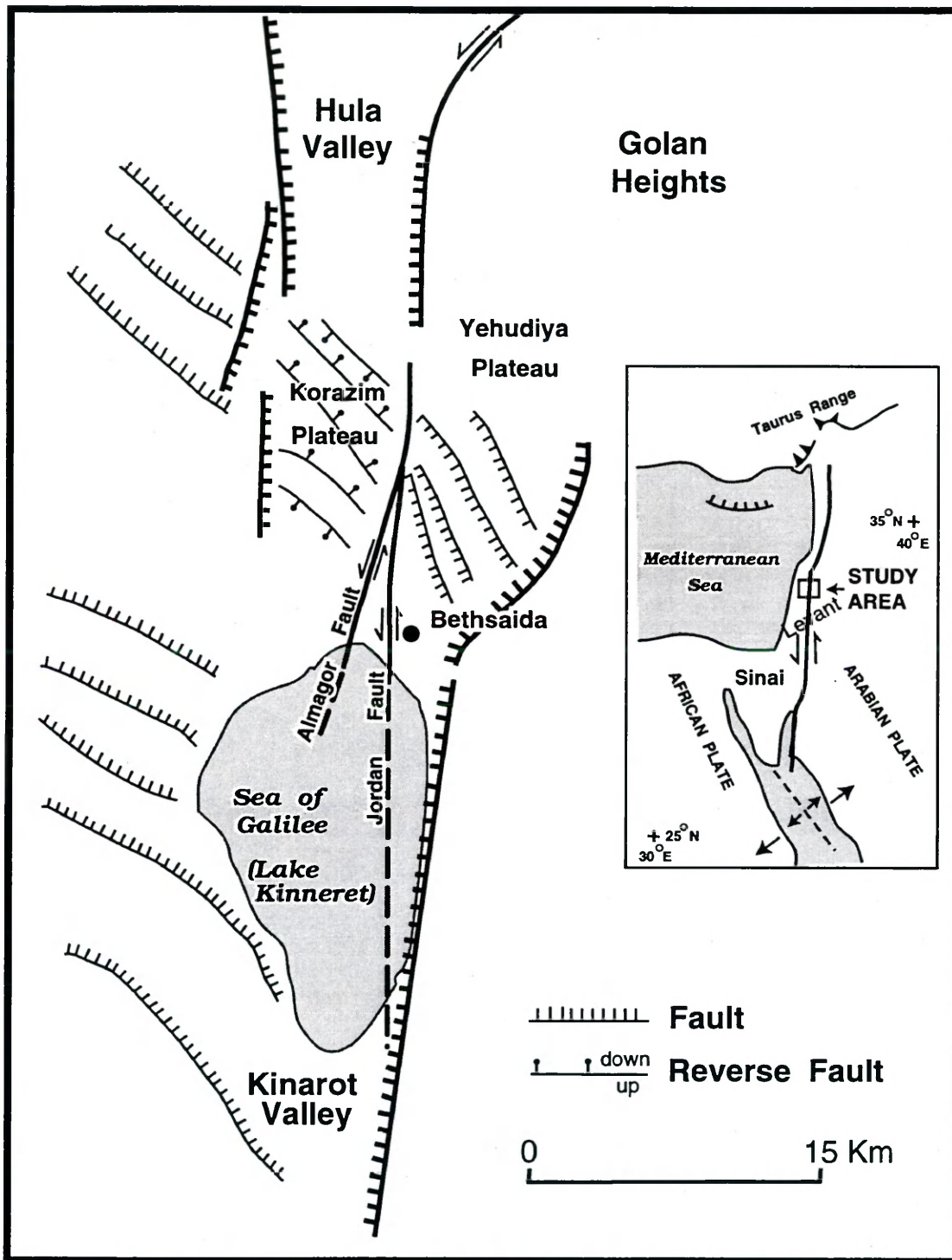
Source: Shroder and Inbar (1994)
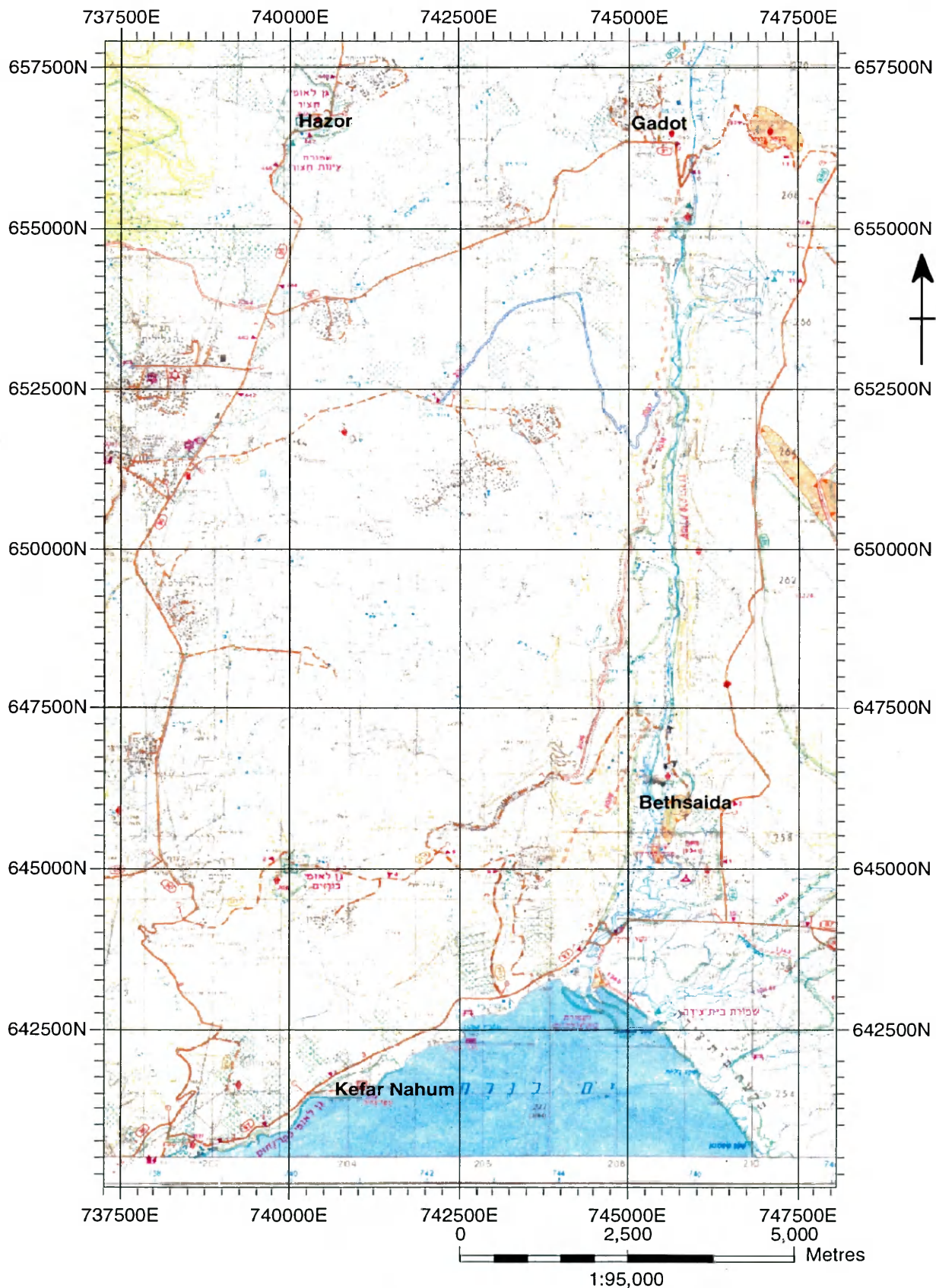
Figure 2: Upper Galilee and Lower Golan Regions of Israel

GEOLOGY

The geologic foundation of Israel consists of various limestones which were formed as marine sedimentary deposits during late geological periods; the last phases of the Mesozoic era are the Cenomanian, Turonian and Senonian, with the Eocene near the beginning of the Tertiary. The karstic limestone is very porous and allows water to be absorbed quickly and deeply into the earth until the water reaches a perched layer of non-porous rock which forces it to travel laterally until freed through a surface spring. These springs exist throughout the rift valleys. The Cenomanian, Turonian and Eocene are quarried as excellent building stones, one of Israel's natural resources; they also weather into terra rosa, the fertile red-brown soil of the Mediterranean. The Senonian rock has a different composition than the other lithic materials and erodes into a light gray, infertile substance not suitable for agriculture. It also is very porous, develops a smooth surface, and dries quickly, even during the wet winter season, which makes it very suitable for traffic. Senonian chalk was strategically distributed throughout Israel, such as along the base of hills and the Megiddo Pass from the Sharon to the Jezreel Valley (Aharoni, 1979).

SOILS

Four main types of soils are found regionally. Terra Rosa soils formed of limestones and dolomites dominate the Upper Galilee and Lower Golan regions. Dark Rendzina soils formed from Eocene carbonates predominate in the Lower Galilean, southern Golan and northern/western slopes of the Irbid Plateau regions. Light Rendzina soils formed of marls from Lower Cretaceous

and Senonian, and are found scattered in the Lower and Upper Galilee and Lower Golan regions and on top of Irbid Plateau regions. Grumosols and Brown Mediterranean soils formed from the basalts and occur widely in the eastern Lower Galilean and Golan Heights regions. Due to the drier climate of the present, pedogenesis of Terra Rosa is curtailed. Furthermore, the A horizon is largely absent due to erosion as a result of anthropogenic land use (Shroder and Inbar, 1994).

CLIMATE

The climate of the Levant varies from the near subtropical Mediterranean of the central and northern Israeli regions to the subtropical desert to the south. The region is subjected to brief, wet winters with long, dry summers. Cyclones dominate the winter season, producing heavy rainfalls and flash flooding in the Upper Galilee and Lower Golan regions of the Beteiha Plain. Barometric lows arrive in Israel via two routes and influence the amount of winter precipitation. The first route comes by way of northern Italy through the Adriatic Sea, Greece and the Aegean Sea to produce the greatest amount of precipitation for the winter season of the Levant. The second route comes by way of southern Italy, over the central Mediterranean to produce a reduced amount of precipitation. Precipitation usually begins in November, reaching maximum values by mid December, and continues through January, until the first half of February. Approximately three-fourths of the annual precipitation falls during this time frame. The Upper Galilee and Lower Golan regions receives on the average 1100 mm annually (Horowitz, 1979).

Temperatures are a function of elevation and distance from the Mediterranean, but usually averages approximately 20° C. Diurnal differences are more pronounced in the hills of the Upper Galilee and Lower Golan regions. Prevailing winds are western and northwestern, with the exception of approaching cyclones which produces eastern winds (Horowitz, 1979).

HULA BASIN

The Hula Basin was formed by a defined fault line which ran east out of Tyre to drop from a height of 500 m to 100 m. The fault scarp is marked by strong springs at Dan and Caesarea Philippi. A dam of basalt blocks the southern end of Hula Basin to form Lake Hula. The Sea of Galilee formed behind another basalt dam. The Lebanon/Anti-Lebanon Range north of the Hula Basin has a northeast-southwest alignment which abuts against the north-south line of the Jordan Rift Zone. This mountainous region was formed as a result of faulting and folding. The northeast-southwest alignment of the mountain ranges, plus the lithic composition of basalt outcrops, funneled travel along the eastern edge of the Anti-Lebanon range, through Damascus, east of Lake Hula to cross the Jordan south of the Lake but north of the basalt dam (Baly, 1971). Other streams, freshwater lakes and marshes have existed over time in the Hula Basin, leaving their sediments (fluvial, lacustrine and paludal, respectively) stratified within regional basalts, ranging from 1.7 mya to 0.9 mya. These deposits were later deformed by rifting due to tectonic activity (Shroder and Inbar, 1994).

JORDAN RIFT VALLEY ZONE

The Jordan Rift Valley Zone runs the entire length of Israel, from the Hermon Range in the north to the Bay of Elat in the south. It is divided into four sectors separated by thresholds lower than the surrounding mountains but higher than the average valley floor. The Northern Jordan Valley is the smallest sector and consists of the Korazim Plateau of elevated basaltic block north of the Sea of Galilee in the Upper Galilee and Lower Golan regions. The orientation of the Korazim block is a function of two fault systems, one which runs north-south and the other north-northwest and south-southeast. The Northern Jordan Valley is bisected by the Jordan River (Horowitz, 1979).

GALILEAN REGION

The Galilean region is divided centrally by a large fault scarp which cuts across Galilee north of Acco to divide the northern from the southern section (Fig. 1). The Upper Galilee and Lower Golan regions is higher in elevation, hilly, and was heavily forested during Biblical times, and was sparsely populated. The Lower Galilee is a series of broken, down-faulted basins of marshy lowlands as a result of poor drainage, but excellent for growing wheat after the winter floods. Due to successful agriculture, this area had a greater population density (Baly, 1971).

The major source of water for the upper Jordan originates from three main tributaries; Nahal Hermon, Nahal Dan, and Nahal Iyyon, which flow into the Hula Valley. Although some springs and small streams add to the Jordan, the greatest water source to the lower Jordan is from the Transjordan Plateau;

the Yarmouk and the Yaboq. The Jordan River attains final base level at the Dead Sea. The Sea of Galilee and Lake Hula were the two intermediate lakes of the Jordan drainage system. Lake Hula was drained during modern times and the marshes were eliminated (Horowitz, 1979).

The Jordan is confined by a narrow basalt gorge which is probably oriented along a rift fault splay. Slope failures, common among the basalt rocks of the Jordan canyon, frequently produced landslides. Additionally, local earthquakes triggered tsunamis which resulted in catastrophic flooding and devastation of the slopes of the Beteiha Plain (Shroder and Inbar, 1994).

Chapter III

LITERATURE REVIEW

OVERVIEW

Although the structure of the natural migratory routes of the Levant

changed through time to accommodate changes in modes of transportation as a

result of the increased innovativeness of humans, the spatial distribution of the

natural migratory routes remained constant due to the unique geologic and

geographic characteristics. Primary and secondary natural migratory routes

were ancient tracks which wound along the Mediterranean coast, with inland

routes leading away from the coast northeastward to Mesopotamia by way of

Megiddo and Damascus (Aharoni, 1993). In earliest writings dating to 1950

BCE, the natural migratory routes were approximately five meters wide, with

passage marked by stone cairns. Wells were conveniently located at the end of

each day's journey to accommodate pedestrian and mule traffic. After 1500

BCE, the natural migratory routes were cleared for the safe passage of military

chariots, as well as for traders' large, solid-wheeled carts pulled by

domesticated wild asses. Following the introduction of domesticated camels

from Mongolia, approximately 700 BCE, natural migratory routes served camel

caravans enroute with its trade (Baly, 1974).

The characteristics of natural migratory routes remained constant through

time until the arrival of the Romans. During the first century BCE upon arrival in

Egypt, the natural migratory routes did not satisfy the Roman criteria of road

construction. However, the Romans made few changes to the existing Egyptian roads, and continued the Egyptian custom of using stone cairns rather than milestones to mark the repair of a road. The use of milestones had become customary throughout the Roman Empire since 123 BCE. Trajan (98-117 CE) expanded and improved upon the Egyptian road network for strategic, rather than economic purposes (Von Hagen, 1967).

GEOLOGIC AND GEOGRAPHIC CONSTRAINTS TO NATURAL MIGRATORY ROUTES

Introduction

The Eocene limestone of the Shephelah, located midway between the Philistine coast and the Dead Sea, was not very steep, nor covered with heavy forest. However, it supported the growth of maquis, a thick thorn-covered bush which influenced travelers to go around the Eocene limestone in favor of the valleys of Cenomanian chalk. The chalk was easily eroded and formed passageways and groves free of boulders, standing moisture, and vegetative cover. Cenomanian chalk was the foundation of all ancient roads of the Levant, and allowed ease of passage through the interior, favoring warriors on horseback and chariots, as well as traders leading wheeled carts drawn by domesticated mules (Baly, 1963).

The Rift Valley Zone north of the Upper Galilee consisted of the Hula Basin. South of Lake Hula, the Rift Valley Zone of the Upper Jordan is a basalt gorge with steep sides rising up to 308 m above sea level through which the Jordan River races toward the Sea of Galilee. Due to the difficult terrain, the

natural migratory route clung to the foot of the highlands until descent to the shores of Lake Hula was possible (Baly, 1963).

Levant as a Land Bridge

The history and fate of ancient Israel lay in its geographical position as that portion of land which bridged the gap between Egypt and Mesopotamia. This land bridge, the Levant, provided the foundation for the establishment of natural migratory routes and passage of merchants and armies throughout time. Natural migratory routes served as lines of communication between the two ancient empires, and were important trade and military routes upon which the balance of power rested. Control of the natural migratory routes meant control of the power and wealth of trade, and control of the Levant. (Baly, 1963).

Levant as Part of the Fertile Crescent

The Fertile Crescent is a sickle shaped, expanse of cultivable land, arcing from the Nile delta in Egypt, northward along the Mediterranean coast, then eastward across the sources of the Tigris and Euphrates Rivers in Mesopotamia on to the Persian Gulf (Figure 3). It lies between mountain chains to the north extending from the Mediterranean Sea to the Arabian Sea, and the Arabian Desert to the south. The Fertile Crescent was the birthplace of agriculture, and the Cradle of Civilization. The source of the Euphrates is approximately 40 miles east of the Mediterranean Sea, originating within the Anotolian mountain range. This juncture southward, for about 400 miles along

the Mediterranean Coast to the Nile Delta, defined the Levant Coast within the

Fertile Crescent (Baly, 1963).
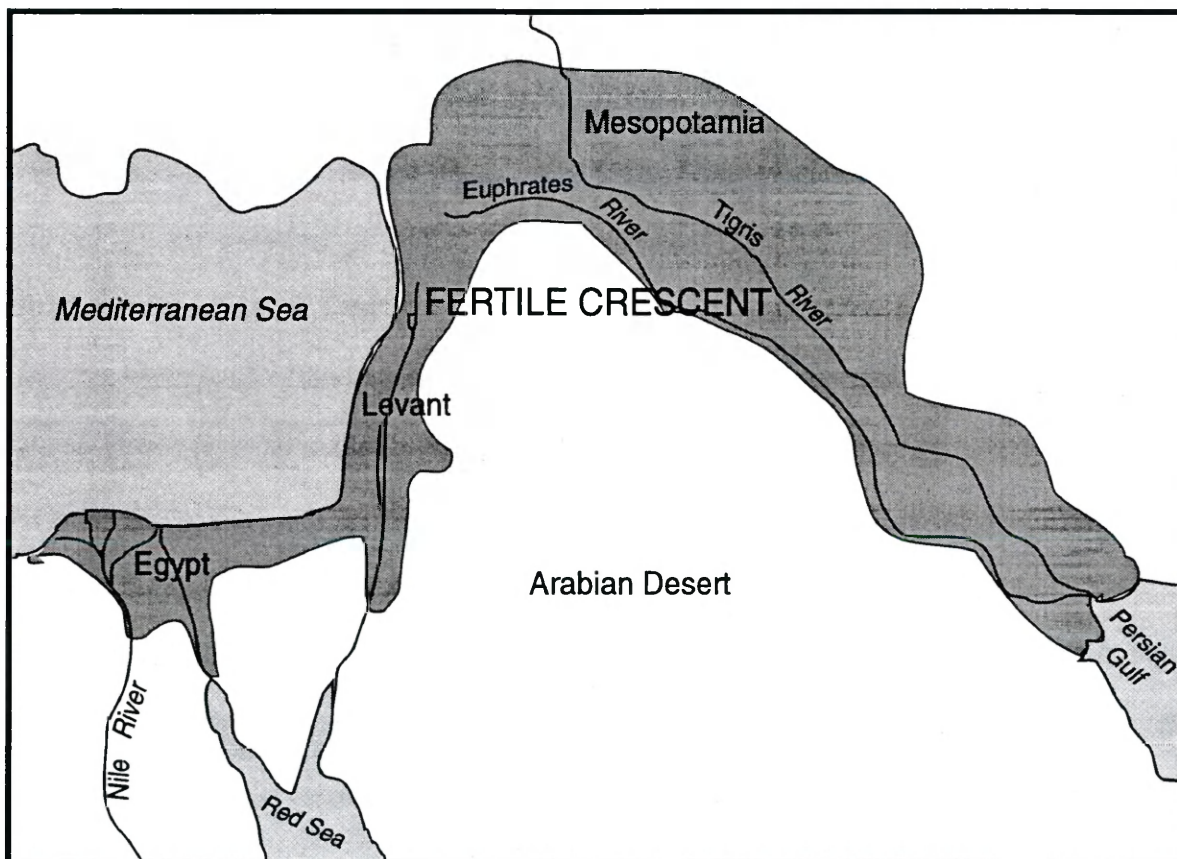
Figure 3: The Fertile Crescent

ESTABLISHMENT OF NATURAL MIGRATORY ROUTES

During the end of the Tertiary Period, the Miocene and Pliocene epochs,

and especially the Pleistocene Epoch of the Quaternary Period, great tectonic

activity was shaping the Levant, especially in the Rift Valley Zone. Mountains

formed, and volcanoes produced basalt outcrops with deep rift zones cleft

between them. This region was already occupied by the predecessors of Homo

sapiens (Aharoni, 1979). The migration of hominids throughout the unique geologic constraints of the Levant initiated the establishment of ancient natural migratory routes.

The establishment of natural migration routes is influenced by the spatial friction of varied terrain. Human choice regarding travel by foot, is a function of time and cost (expenditure of calories). Determining paths of least resistance regarding human time and energy cost factors may facilitate identifying ancient human land use patterns on a landscape (Hartley and Wolley-Vawser, 1994).

Roads are the means by which humans connected settlements, and established links of commerce and communication within a region, expanding outward to connect cities, nations and continents. Roads, however, usually began as natural migratory routes established by animals in search of water or food. Humans followed the animals in search of the same, only to be followed by other humans throughout time. Eventually roads become established as a result of ease of trafficability between locations, and as a result of following the natural migratory routes which conformed to the terrain and environment. Favorable roads were identified by stone or wooden markers, and later improved upon by clearing the road of debris for ease of passage as modes of transportation improved from foot traffic to wheeled traffic. Sophistication was reached when roads were surveyed, laid deliberately to overcome environmental obstacles, constructed according to rigorous methodology, paved, identified by permanent markers, and mapped (Negev, 1990). Strategically located in the heart of the Middle East between Egypt and Mesopotamia, and between northern Arabia and the Mediterranean, most of the

natural migratory routes of ancient Israel became internationally important roads (Roll, 1983).

The placement of roads required the same parameters as the placement of settlements: available water resources and hospitable environment to facilitate movement of people and goods for the purpose of commerce and communication. In ancient times, even the most well traveled roads were subject to poor passage. During the 13th century BCE, an Egyptian official wrote about the difficulty of travel through the Megiddo Pass which was strewn with boulders, and filled with "reeds, thorns, brambles, and 'wolf's paw'," and exclaimed that the rider "seest the taste of pain!" (Baly, 1974).

Originally, primary and secondary natural migratory routes were ancient tracks which wound along the Mediterranean coast from Alexandria to Antioch, with inland routes leading away from the coast northeastward to Mesopotamia by way of Megiddo and Damascus (Figure 4) (Aharoni, 1993). The primary natural migratory route descended out of Damascus, crossed the Jordan to Hazor, and dominated the western portion of the Rift Valley Zone. It wound along the perimeter of the Galilean hills to the edge of the Sea of Galilee near Gennesaret, and on to Migdal through the Valley of the Robbers to the Lower Galilee plateau. Hazor and Migdal were important strategic points along this route. The ancient route then passed north of Mt. Tabor and southwest through the Jezreel Valley to Megiddo, another strategic point along the road and the pivot point of the primary natural migratory route (Baly, 1963).
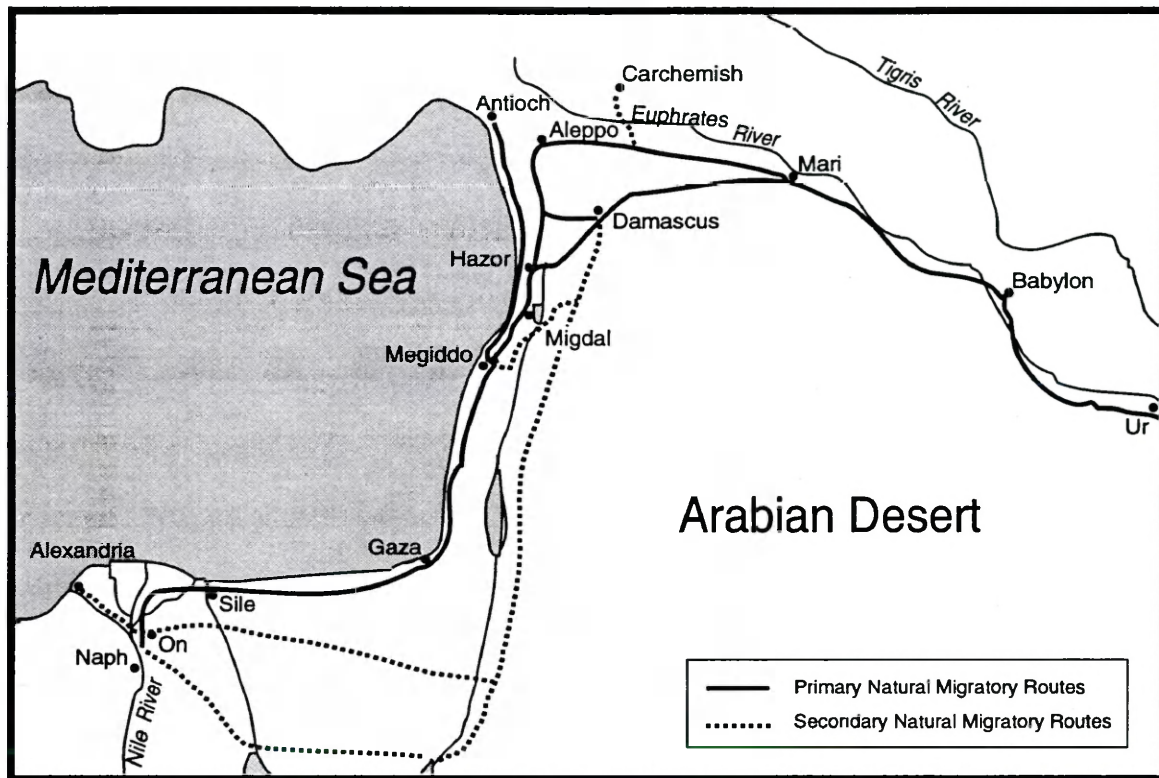
Figure 4: Primary and Secondary Natural Migratory Routes

At Megiddo, the ancient route divided into several branches (Figure 5).

The first branch was the descent from Damascus described above. The second

branch veered northwest to Carmel, along the coast north to Tyre, Sidon, and

Antioch. The third and most important branch traveled through one of the main

Cenomanian chalk valleys from Megiddo southwest to the coast by crossing

central Carmel (Highway 65 follows this ancient route from Afula to Hadera) and

southward along the coast. A fourth branch cut through a second Cenomanian

chalk valley located east of the Eocene limestone through the Plain of Sharon,

past the Samarian Hills southwest toward the coast to Ashdod, Ashkelon, Gaza,

and Egypt. The fifth branch out of Megiddo traveled southeast to Beth Shan,

over the Jordan River, and connected wiith the King's Highway (Baly, 1963).
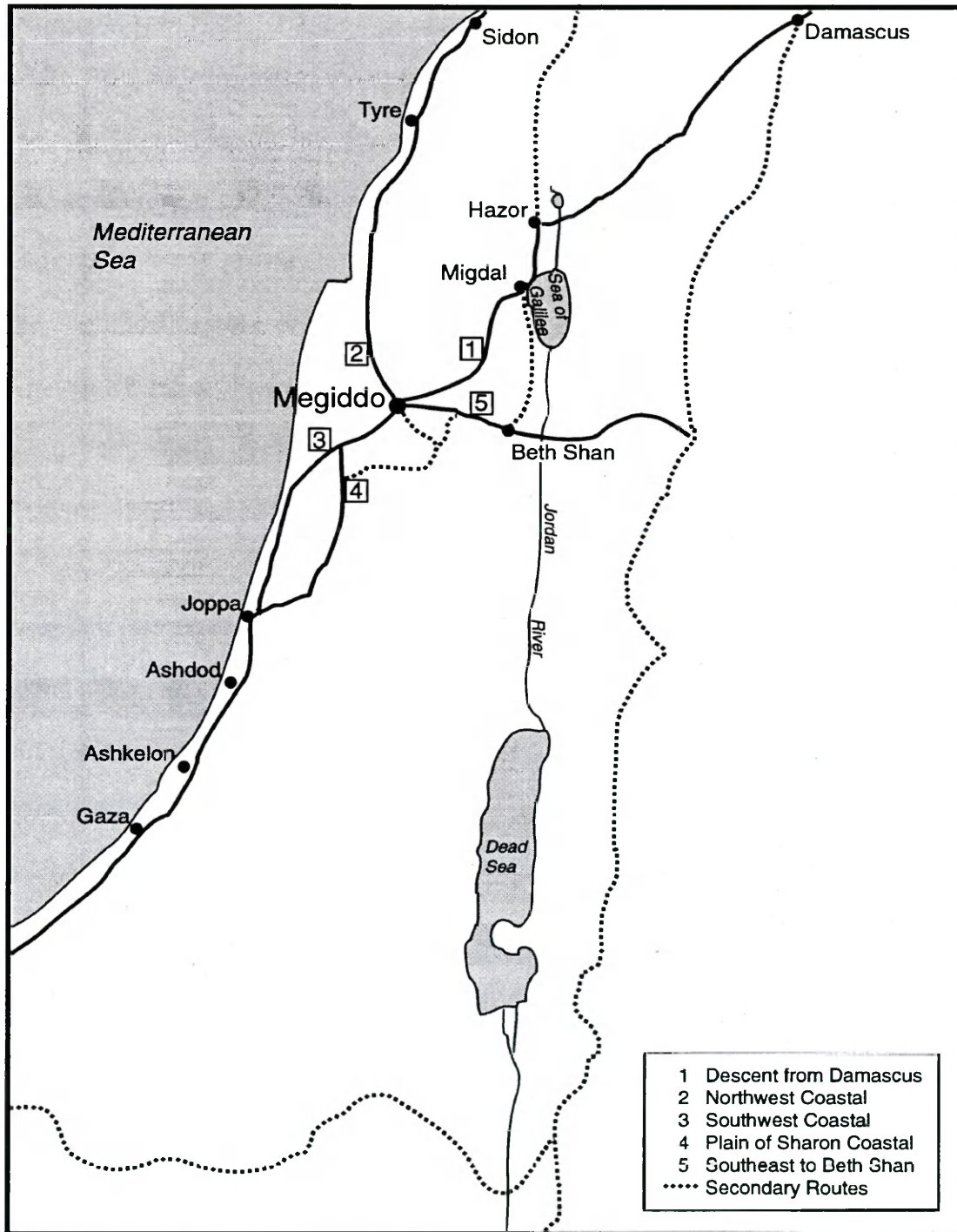
Figure 5: Ancient Routes out of Megiddo

The Jezreel Valley posed a unique problem concerning drainage of the valley during the winter rainstorms. The water divide directed the water southeast toward the Jordan River with the remainder west of the divide directed northwest through the narrow Kishon Pass toward Acco. During the winter rainy season, areas below the 250 foot contour remained flooded and waterlogged, and created seasonal traffic difficulty. The Megiddo Pass, or Palestinian bridge, laid astride a narrow passageway of volcanic rock oriented in a northeast-southwest direction north of Mt. Tabor to Megiddo. This pass remained dry and could be traveled yearlong, making it of central importance as the crossroads of the natural migratory route known as the great Trunk Road. There were three strategic locations of great importance to the control of the Via Maris; Hazor in the far north, Gaza in the south, and centrally located Megiddo located in the heart of ancient Israel (Baly, 1963).

Within the area of the Middle East, natural migratory routes were forced to follow the rocky highlands and not the valleys, due to the danger from flash flooding. The river valleys frequently have steep sides with few tributaries, thus none of the major rivers are natural causeways (Baly, 1971).

The placement of natural migratory routes were constrained by the shifting sand dunes along the Mediterranean coast, which caused the ancient trade route to develop further inland. Due to the combination of other geologic and geographic features of the coastal region and the Jezreel Valley, e.g., rich alluvial soil, ample surface and ground water sources, and location of the primary natural migratory route, these areas exhibited the greatest population density in the past as well as the present. Control of these areas, especially the

Jezreel Valley, meant control of the natural migratory route. Acquisition of the

Jezreel valley was always the main objective of Mesopotamia and Egypt

(Aharoni, 1979).

Throughout the Old Testament, as well as written Egyptian and

Mesopotamian accounts, mention of all routes referred to roads as rough tracks,

possibly leveled, and cleared of boulders. Paved roads and bridges did not

exist during this period of history. The terrain posed extreme hardship to

travelers when confronted by steep slopes, basalt outcrops, and marshes, as

well as thick vegetative cover and forests (Baly, 1963).

THE IMPORTANCE OF ROAD NETWORKS

Trade and communication between distant sites were facilitated by the

development of road networks, the earliest being little more than tracks for foot

traffic. The world's first roads developed in Persia at approximately 3500 BCE,

soon after the emergence of the wheel in Mesopotamia. This new innovation

inspired Persian kings to create an empire out of conquered lands by laying

down road networks. It is logical that the first road appeared in Persia. The

Persian Royal Road grew out of Susa, over the Tigris River, along the

Euphrates River, on to Sardis, and eventually extended to Ephesus (southwest

corner of Turkey on the Mediterranean Sea). The Susa-Sardis portion of the

road was 1,677 miles long and trade caravans took 90 days to travel from end

to end (Von Hagen, 1967).

The Egyptians developed a road network within their empire which

consisted of five ancient, primary routes. The first went to Libya westward along

the Mediterranean coast; the second followed east-northeast along the Mediterranean coast to Palestine, Tyre and, Antioch; the third over the Sinai peninsula to Aqaba; the fourth traveled parallel along the Nile to Nubia; and the fifth climbed the mountain range between the Nile and the Red Sea, from Coptos to the natural port of Berenice on the Red Sea (Von Hagen, 1967).

These original, ancient Persian and Egyptian roads were systematically repaired, enlarged, and in some places paved with stone slabs by the Romans, so that the ancient roads could be joined to the primary roads which led to Rome. Trajan (98-117 CE) incorporated the five primary Egyptian roads into the Roman road system, linking them to the Nabatean kingdom and constructing a dual system of roads connecting the caravan cities of Petra and Damascus to Syria. The Roman road network in Israel served as backup for the important trade routes northward through Transjordan from Elath through Petra, on to Damascus enroute to Mesopotamia (Von Hagen, 1967).

THE MANY NAMES OF THE LEVANT'S ROAD NETWORK

The Trunk Road

This was the road of the "Invader from the North," the same ancient migratory route referred to in Figure 5 as the Descent from Damascus, and also known as the Via Maris. The great north-south oriented Trunk Road originated out of Assyria to Egypt by way of Carchemish on the Euphrates River, Calneh, and Aleppo, then east of Kadesh to skirt the basaltic outcrop of the Anti-Lebanon range and on to Damascus. The great Trunk Road descended southward out of Damascus, directly through the Northern Kingdom of ancient

Israel, past the foot of the Judaean hills, crossed westward over the Jordan River at a place known as the Bridge of Jacob's Daughters, passed through Hazor and Megiddo, and finally along the Mediterranean Coast to continue eventually into Egypt. Due to the geomorphic restrictions of basalt mountain ranges along the Mediterranean coast to the west, and the Arabian Desert to the east, the Trunk Road was naturally funneled out of Mesopotamia southward toward Damascus, the keystone to the Levant (Baly, 1963).

Egyptian Coastal Road

One of five principal Egyptian roads, the Egyptian Coastal Road crossed the seven streams of the Nile and traveled along the Mediterranean Coast to Palestine, Sidon, Tyre, and into Lebanon. Little more than a primitive track, it probably evolved as a result of overland journeys from Alexandria in Egypt along the Mediterranean coast into Antioch, along the Anatolian shore into Hellespont (Von Hagen, 1967).

Way of the Land of the Philistines

During the 13th century BCE, Egypt controlled the coastal road. However, during the reign of Rameses III (1279-1213 BCE), the Egyptians battled assaults by the "Sea People," displaced peoples of Greek origin. The Sea People destroyed several towns along the Levant coast, e.g., Sidon and Tyre, and seized a section of land between Joppa and Gaza. The Sea People bestowed their name on this strip of land, Pelast, or Philistia, out of which the term "Palestine" originated. Thus, the southern length of the coastal road

between Gaza and Joppa became the "Way of the Land of the Philistines"

during the 13th century BCE (Wright, 1957).

Way of the Sea

Mention of this ancient trade route by the name "way of the sea" occurred

only once in the Old Testament in Isaiah 9:1 where the author states: ". . . the

way of the sea, the land beyond the Jordan, Galilee of the nations." This

passage is in reference to Tiglath-Pileser III of Assyria in 732 BCE who

destroyed Hazor (Mazar, 1990) and conquered the Galilee, Gilead, and coastal

regions, established the Assyrian districts of Dor, Gilead and Megiddo, forced

the inhabitants into exile (Aharoni, 1979).

The above reference to the "way of the sea" referred to the eastern

branch of the Via Maris which led from Egypt, north toward the Plain of Sharon

to Megiddo, and continued northeastward through the Jezreel Valley, past Mt.

Tabor and the western shore of the Sea of Galilee to Hazor, and on to

Damascus and Mesopotamia. Although use of the "way of the sea" has been

applied to all branches of the Via Maris, it is doubtful that the term was used

during ancient times to all branches of the primary natural migratory route. The

southern portion is referred to specifically as the "way to the land of the

Philistines" in many sources beginning with Exodus 13:17 (Aharoni, 1979).

Via Maris

Latin versions of the Bible first mention the "way of the sea" as the Via

Maris in reference to Isaiah's passage. Although Roman sources have not

been found which make reference to the "way of the sea," scholars of the Middle Ages applied this term to the branch of the Via Maris which descended from Damascus through the interior of Israel to the sea. Modern scholars have continued to apply the term Via Maris to the great Trunk Road from Egypt to Damascus to Mesopotamia via Megiddo and Hazor (Aharoni, 1979).

TRADE ROUTES OF THE LEVANT

The Egyptian coastal road was an important trade route, linking Alexandria to Tyre and Antioch. Located within the Fertile Crescent, ancient Tyre was known for its wealth and opulence, and exotic trade goods. Tyre was especially famous for its cedars from Lebanon and purple dye harvested from the mollusk. The portion of the coastal road located within Tyre was paved prior to arrival of the Romans. The Egyptian coastal road continued from Tyre to the ancient seaport of Sidon, Berytus (Beirut), Byblos, Tripolis, and Antaradus, linking it to a lateral road which led to Palthera, and Antioch. From Antioch, the coastal road continued along the Anatolian coast and eventually into Ephesus where it joined the ancient Royal Persian road which originated out of Mesopotamia (Von Hagen, 1967).

Later in history, the Romans constructed military routes over the ancient trade routes. Roman inscriptions on milestones document that the military repaired and repaved the ancient Egyptian coastal road over a period of 300 years (Von Hagen, 1967).

MILITARY ROUTES OF THE LEVANT

Egyptian

The Papyrus Anastasi I, written by an Egyptian scribe by the name of Hori during the reign of Rameses III (1279-1213 BCE) gave the most inclusive account of the history and branches of the natural migratory routes. The main branch described by Hori begins in Sile of Egypt to continue along the coast is described as "the way of Horus" later to be referred to as the "way to the land of the Philistines." This section was heavily fortified with Egyptian forts, wells, and defense units. Thutmoses' III army completed the journey from Sile to Gaza of 150 miles in ten days (ten miles per day). After this point, the natural migratory route turned inland approximately three or four miles due to the rolling sand dunes along the coast and continued past Ashdod, Ashkelon and Joppa (Aharoni, 1979).

The annals of Thutmoses III (1479-1425 BCE) listed the route as it veered inland from Gaza to Yaham, a distance of 75 miles which was covered in 11 or 12 days (seven miles per day). The route proceeded to Aphek through the Sharon Plain along the eastern side of the hill country approximately eight miles from the coast. The natural migratory route headed northeast from the Plain of Sharon toward the Plain of Jezreel. It is believed that there was a second branch which went by way of the Plain of Acco through the Carmel range but this branch may have been used only during the Bronze Age. Many accounts by Thutmoses III and others mention the danger associated with that part of the Egyptian coastal road from the Sharon through Wadi 'Ara and

Megiddo to the Plain of Jezreel since the narrow passageways and ravines could be easily blocked

Mesopotamian

The natural migratory route out of Mesopotamia was known as the road of the "Invader from the North." Although historical documentation noted that invasion frequently came from the north into Israel, historical accounts do not document the Israelites' use of the natural migratory routes to either launch an attack or fight back along it, probably due to the steep ascent of the plateau (Baly, 1963).

Israelite

The Israelite's only hope for political security was in control of the natural migratory route at its locus, Megiddo. Control could be exerted over the Egyptians and Philistines, and the Mesopotamians out of Megiddo, since expansion of power was possible only along that route. The strength of any nation lay in its ability to conduct trade, and the control of trade was determined by control of the primary natural migratory route. Since Damascus was dependent upon the trade received via the great Trunk Road, whereas Egypt (reliable agriculture due to regulated Nile) and Phoenicia (sea economy) were not, Israel bought alliance with Egypt and Phoenicia and fought with Damascus for control of the Trunk Road. It is not a coincidence that ancient Israel attained the height of its greatest wealth, power, and glory during the reign of David and

Solomon. Israel controlled the great Trunk Road during the reign of David and Solomon, and, therefore, kept foreign power out of the Levant (Baly, 1963).

Roman

The major road network was constructed to ease movement of troops, therefore direction and construction of roads were dictated by strategic considerations. A good road network facilitated rapid communication within the empire, and promoted trade. Civilian use of the roads replaced military use during times of peace. Although major roads were built to withstand heavier traffic, cross country roads used by traders were just cleared tracks. The cross country roads may have linked settlements to each other, to eventually connect to the major road network; however, few material remains have been found, nor were these roads recorded in official Roman documents (Wacher, 1987).

Roman road building is unique throughout the ancient world in that they were constructed to endure through time, resting on a foundation of solid roadbed, properly laid and engineered. It is believed that the Romans adopted their road building procedures from either the Carthaginians who supposedly were first to pave roads with stone slabs, or the Etruscans who also were believed to pave their roads. However, since insufficient material remains have been found of either culture to confirm their respective road building methods, it is assumed that the road building techniques of cambered road constructed in a deeply laid road bed is unique to Roman technology (Von Hagen, 1967).

In 450 BCE, the Roman Patricians established the laws for the building and maintenance of roads within the ancient text known as the Twelve Tables.

The administration of the roads was defined, as well as the width, which was not to exceed 4.8 m, thus allowing two wheeled vehicles to pass each other (Von Hagen, 1967).

The Roman Empire constructed road networks for approximately 845 years, and built more than 53,000 miles of roads. The importance of constructing a solid road network to the Roman Empire was demonstrated through its public laws. The first edict issued by the Roman Patricians in 450 BCE established the road building laws; and the last edict of Emperor Theodosius in 395 CE, titled, "On the repairing of the highways and bridges," stated:

" ... the roads, have been honored with the titles of great names.... Therefore no sort of man of any dignity must desist from the construction and the reconstruction of our highways and bridges.... we also oblige the Divine Christian Church to participate in this work. It is our will that all men vie in their zeal in repairing the public ways..." (Von Hagen, 1967).

Beginning with the 20 roads which led out of Rome, the Roman road system eventually grew in space and time to 372 distinct roads with a spatial distribution of 53,000 miles and covering the entire empire over a period of 800 years. The Roman road system brought Pax Romana to the furthest reaches of the empire, as well as security, trade and prosperity to the outlying provinces. Therefore, the Roman roads eventually spread over the ancient roadways of Israel, incorporating Israel into the larger Roman Empire (Von Hagen, 1967).

CARTOGRAPHIC REPRESENTATIONS OF ROMAN ROADS

The need for maps was unique to Romans due to the extensive road network which they constructed throughout the empire. The construction of milestones on main roads simplified the development of road maps and itineraries. Milestones provided information regarding distances between cities, and a sense of scale was established in constructing the maps (Dilke, 1985).

Agrippa's Map

During the consecutive reign of Julius Caesar and Augustus, Agrippa (63 - 12 BCE) was entrusted with the task of compiling a map of the known world. In addition to mapping the road network throughout the empire, Augustus wanted a huge wall map for several reasons: to locate new colonies in order to award land to discharged veterans; to establish an image of Rome as the benevolent center of the Roman Empire; and, to further the propaganda of Imperialistic Rome. It was the custom of Rome to install huge wall maps on colonnade walls of official buildings. Agrippa mapped the majority of the known world, and included the new territories of Holland and France prior to his death in 12 BCE. Augustus completed construction of the world map after Agrippa's death. Agrippa's map was installed on a portico wall on the east side of the Via Lata (Via del Tritone). The colonnade was built by Agrippa's sister and the wall on which the world map was installed was named for Agrippa. Agrippa's map displayed the road network throughout the Roman Empire; most scholars assumed that later itineraries were based upon Agrippa's map (Dilke, 1985).

Antonine Itinerary

The Antonine Itinerary, produced in 217 CE, was a compilation of military routes used by Marcus Aurelius Antoninius, listing cities, routes and distances between cities. First printed in 1521, it has subsequently been published many times for use by scholars (Von Hagen, 1967).

Peutinger Table

The Peutinger Table, a road map possibly dated to 250 CE, is a Ptolemaic projection of the Roman world in severe spatial distortion, depicting the Roman Empire from Britain to India (Figure 6). Cities, inns, points of interest, the Roman road network, and distances between cities are recorded. The map, which measures a length of 22 ' 5" and height of 13.5," was first copied in medieval times, and has been published continuously since 1587. (Von Hagen, 1967). The Peutinger Table was based on known Roman roads throughout the Roman Empire, and depicted settlements and historical sites connected by the roads. Distances between points were recorded for the convenience of the traveler (Wacher, 1989).

The Peutinger Table is believed to be a civilian road map rather than a military map, since military camps are not shown. It is thought to have been associated with the cursus publicus, postal service and staging posts, instituted by Augustus (27 BCE- 14 CE), and used by those involved in public service. Since the Peutinger Table lists cities destroyed by the eruption of Vesuvius in 79 CE, it is possible that the Peutinger Table was copied from a first century CE source which was produced prior to the eruption of Vesuvius. The towns of
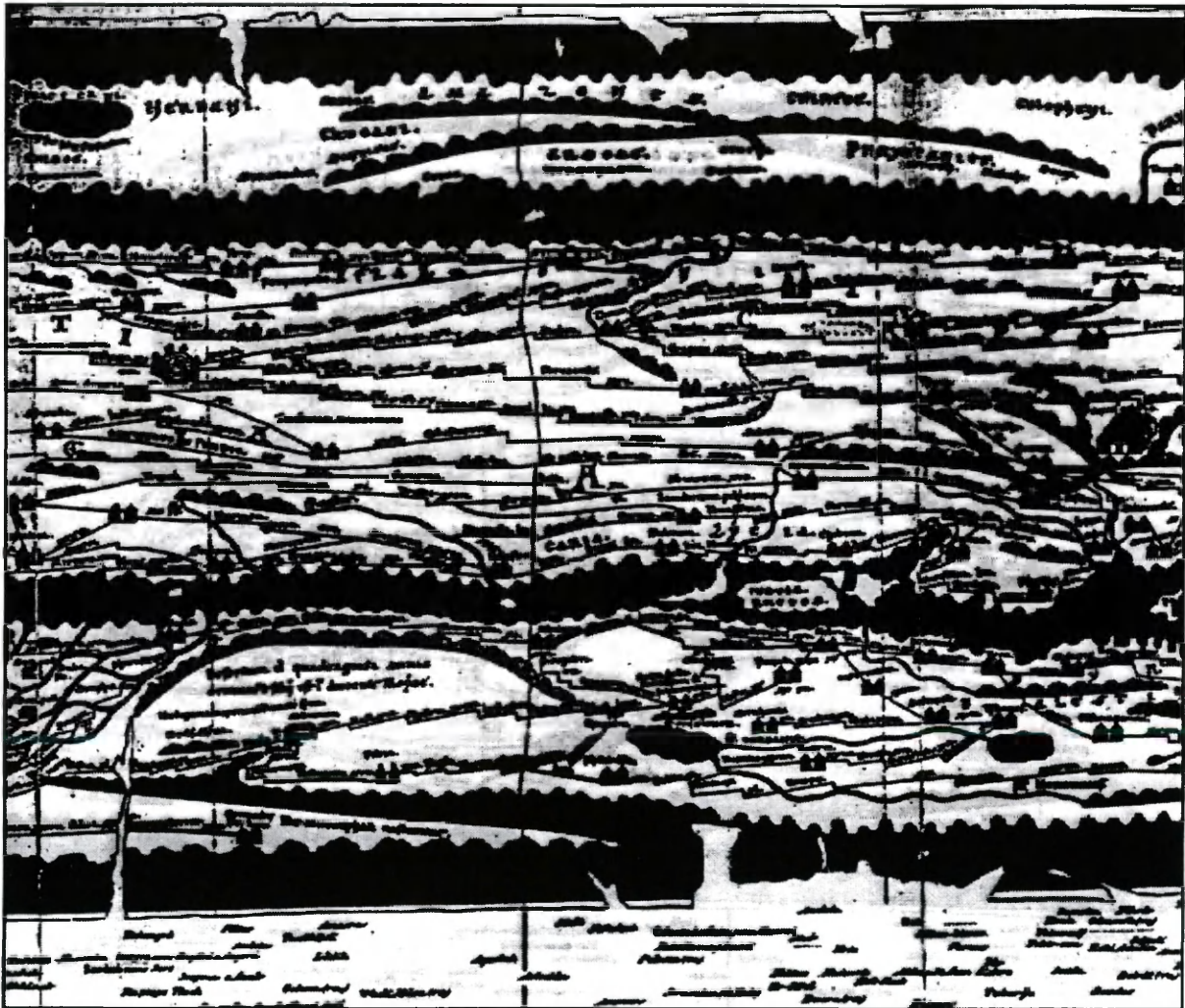
Figure 6: A Section of the Peutinger Table

Pompeii and Herculaneum on the Gulf of Naples were consumed by Vesuvius and lost to habitation and history. However, both cities were included on the Peutinger Table. Since both cities were lost to antiquity during the first century CE, it is questionable as to whether the memory of their locations would have survived over two centuries for inclusion in a third or fourth century CE production of the Peutinger Table (Dilke, 1985).

The Peutinger Table was purchased by Conrad Peutinger and shown

publicly early in the 16th century CE. It was believed to have been drawn by a

13th century CE monk from Colmar, France, and it was assumed that the 13th

century map was based on an earlier map drawn in the fourth century, even

though it is now known that the map contained even earlier information. Three

cities in Israel of the Roman period are shown on the map with their pre-

Severan names of Betogabri (Bet Guvrin), Luddis (Lydda), and Amavante

(Emmaus). During the Severan period (193-235 CE), the cities were renamed

Eleutheropolis, Diospolis, and Nicopolis, respectively. Aelia Capitolina is

shown with the former name of Jerusalem, and Israel is noted as (Syria)

Palaestina. These name changes occurred ~ 139 CE. Many scholars believe

the map reflects the Roman road network during the Antonine period (161-180

CE), drawn after 139 CE but prior to 193 CE. The roads on the Peutinger Table

correspond to known milestones dated from 162 CE (Roll, 1983).

Medeba Map

The Medeba Map was a mosaic cartographic representation of the Holy

Land, produced between 560-565 CE. The map was constructed on the floor of

a Byzantine church built in the ancient town of Medeba, Transjordan. A notation

on the map related that construction costs were paid by the people of Medeba.

Much of the map was destroyed with only a portion perserved depicting

Jerusalem. The map illustrated sites of the Holy Land, including Jewish and

Christian places of importance. It is presumed to be based on a Roman road

map since all sites depicted are connected by Roman roads (Avi-Yonah, 1970).

Tabula Imperii Romani

The Tabula Imperii Romani is an international project of contemporary times undertaken to map all known Roman roads and other cultural artifacts of the Roman empire throughout the former empire. This project, begun in 1928, has been interrupted by wars and political conflicts, continues with its objective by using all ancient and contemporary documents, while incorporating new archaeological discoveries (Von Hagen, 1967). The Tabula Imperii Romani Judaea-Palaestina was completed in 1994 and maps the attested and inferred roads of the Roman Empire throughout Israel (Roll, 1994).

THE ROMAN ROAD NETWORK IN ISRAEL

Roman Roads Built by the Military

In the new provinces, main roads were mostly built by the army and paid for by the state with the spoils of war. Construction of some of the roads were financed by wealthy citizens who were rewarded with statues in honor of their generosity; some roads were financed by customs duties and tolls. Outside the limits of Roman cities, many roads were just tracks which had been leveled and cleared of debris boulders. The ancient Egyptian coastal road which connected Tangiers to Alexandria to continue on through Israel and Lebanon and on into Antioch, needed little modification by the Romans since the dry soil and bedrock could easily sustain traffic. This road was later extended from Antioch throughout Asia Minor around the entire coast of the Mediterranean Sea during the reign of Trajan (98-117 CE) (Liversidge, 1976).

One of the greatest reasons for the construction and recording of roads by the military was to gather geographical information about the terrain for intelligence purposes. Decreed by Caesar and Augustus, the work was begun by Agrippa. The information gathered resulted in the compilation of itineraria for use by governors and army officers. Pliny the Elder wrote that generals were ordered to gather as much geographical information as possible, even while engaged in battle, and to forward such intelligence on to Rome (Dvornik, 1974).

Tiberius (14-37 CE) believed in disciplining soldiers by teaching them to become builders of roads. The soldiers built roads during all seasons, quarried and transported raw lithic materials to the site, then cut and placed the stone. The soldiers cleared and leveled the land, felled trees, built bridges, retaining walls, viaducts, causeways, and erected milestones (Von Hagen, 1966).

Trajan was the greatest builder of Roman roads and improved all existing roads throughout the Empire. Army legions utilized the roads to keep the Pax Romana; the soldiers taught the people of the provinces how to build and repair roads, bridges, guard stations, and signal towers. The empire's road network not only brought swift overland transport and communication, but also security, out of which growth, freedom, trade, and movement flourished, extending Pax Roman throughout the empire (Von Hagen, 1966).

Hadrian (117-138 CE) put the final boundary on the Roman Empire in 134 CE by building limes (fixed lines of defense) throughout the empire, thus completing 53,000 miles of roads. The goal of Rome was to conquer the known world, and extend Pax Romana through trade. Pax Romana was accomplished via roads (Von Hagen, 1966).

Environmental Criteria to Placement of Roman Roads

The Romans put great emphasis on the geology and physical geography of the land, and placed the roads accordingly (Table 1). The Romans advantageously used the terrain strategically when configuring placement of roads, utilized local lithics as much as possible, and made as few changes to the terrain as possible, modifying only to meet their needs regarding the proper criteria for road construction (Roll, 1983).

TABLE 1: ENVIRONMENTAL CRITERIA TO PLACEMENT OF ROMAN ROADS

Mountainous terrain
* along the ridge tops or at least high enough up a slope for reconnaissance and surveillance purposes,
* maintain constant elevation
* avoid deep valleys or narrow streambeds
    a)   minimize topographically disadvantageous position
    b)   minimize maintenance considerations due to:
         * flash floods
         * catastrophic floods
         * tectonic activity

Hilly regions of low relief, gradual gradient change
* close to the hill slopes
* followed contours
* minimize danger from flash/catastrophic floods

Level valleys and flatlands
* directional straightness or straight as possible
* minimize maintenance and repairs
* minimize travel time between locations

Forested regions
* minimize hostile ambush

Source: after Roll (1983)

Methodology for the Construction of Roman Roads

Land surveyors used an instrument called a "groma" to survey the land

with a great deal of accuracy. It is assumed that surveyors were used to

determine the placement of roads, however documentation is unclear regarding

the extent of surveying the roads (Wacher, 1987).

An "architectus" served as Roman engineer to each legion, overseeing

the construction of buildings, bridges, and roads. He was expected to be:

> ". . . a man of letters, a skillful draftsman, mathematician, familiar
>
> with history, philosophy, music (so as to know how to tune
>
> catapults by striking the tension skeins) . . . not entirely ignorant of
>
> medicine, familiar with stars, astronomy, calculations. . . ." (Von
>
> Hagen, 1967).

His staff consisted of an "agrimensor" (surveyor) and a "liberator" (leveler). An

"architecti" and "agrimensor" were assigned to each legion; Roman soldiers

were required to provide the actual road building labor. Each soldier was

issued, in addition to the tools necessary for war and subsistence, a shovel,

pick, saw, hatchet, and sickle. During times of peace, the soldiers were

required to construct roads, by decree of Emperor Augustus, to prevent

indolence among the troops (Von Hagen, 1967).

Geographical obstacles were overcome by the logic of engineering and

military strategy, which determined the course of the road. Romans preferred to

not make a cut into the earth's surface which would require construction of

retaining walls and drainage systems; a large cut into the earth could allow

moisture to gather (Von Hagen, 1967).

Even though Roman roads were legendary for their "straightness," this technique was used only in the absence of physical obstacles. The Romans knew that straight roads were dangerous since movement could be anticipated. Therefore, the Romans utilized "directional straightness" which provided the best route possible when confronted with varied terrain (Von Hagen, 1967).

Differential use of the roads dictated differential construction methods, but placement of the roads were made according to two criteria: 1) use of local soil and lithic materials; and 2) roads were built to conform to the terrain. If the terrain was flat, roads were built according to the most direct route from Point A to Point B. If the terrain was marshy or through lowlands, the roads were wider and built up with embankments or raised timber frameworks. Roads built through hilly or mountainous regions were placed topographically. The road construction was based upon the lay of the land, the intended use of the roads, and available soils and lithic materials (Wacher, 1987).

Roads construction consisted of clearing away vegetative cover, removal of soft topsoil, placement of layers of stones with smaller pebbles and gravel at the bottom to facilitate drainage, with the final top material dependent upon available lithics. The roads in Israel observed along Korazim were constructed of black basalt. Curb stones were placed to mark the edge of the roads, and ditches were dug to drain away moisture (Wacher, 1987). Construction of the road was accomplished according to precise methodology (Table 2). Along both sides of the newly constructed road, drainage ditches were cut to facilitate removal of moisture, and curbstones were placed to separate the road from the sidewalk. Although Roman roads are infamous for their straightness, the roads

are comprised of a series of straight lengths which coincide with the length from one sighting mark to the next. Gradual changes in direction were made per section to accommodate changes in the terrain (Liversidge, 1976).

Pavement was usually laid down only within a city, most of the roads interconnected throughout the empire lacked a pavement. If the road was laid within a city with use of polygon shaped stones as pavement, the construction of a deeply laid road bed was not always undertaken (Von Hagen, 1967).

TABLE 2: ROMAN ROAD CONSTRUCTION METHODOLOGY

- The road was planned by the linesman by using surveyor's poles;
- "Rigor" line was laid down;
- The surveyor straightened the line;
- Grids were determined by using a "groma" (a wooden cross-piece with plumb lines hanging from each of the four ends) to determine right-angles;
- The road was plowed and a "ruderato" (ditch) was dug until solid rock or gravel was unearthed;
- The road bed was filled with rubble and/or crushed stones to a depth of approximately 18 inches;
- Sand or coarse gravel was poured over the bedding material and tamped down physically with rammers to produce a water tight layer;
- A second layer of smaller stones was laid;
- A third layer of gravel was spread;
- Top layer of polygon shaped stones were placed as pavement

Source: after Von Hagen (1967)

Classification of Roman Roads

Characteristics of the terrain dictated the type of road constructed. If the

terrain was relatively solid, lacking moisture laden soils or marshy areas, then

the road was constructed with minimum foundation. Roman utilitarian

methodology dictated the construction of a road upon a firm foundation, in order

to minimize repair and maximize utilization. The classification of the roads was

also determined by the terrain (Table 3) (Von Hagen, 1967).

TABLE 3: ROMAN ROAD CLASSIFICATION

Viae Proper
* city roads
* paved
* 4.8 to 6.5 m wide
* two wheeled carts wide

Viae Vicinales or "Actus"
* community roads
* either paved, gravel or dirt
* 3.6 m wide
* one wheeled carts wide

Viae Rusticae or Itinera
* secondary roads
* gravel or dirt
* 2.4 m wide
* foot traffic

Viae Terrena
* rural dirt roads

Source: after Von Hagen (1967)

Most roads in North Africa and other dry regions were gravel roads, prepared road beds finished with gravel surfaces lacking pavement. Causeways were constructed over marshy areas, with some roads constructed upon raised beds of timber and packed earth, and others built upon wooden piers sunk into the earth and filled with packed rocks and stones until the road was raised approximately six feet above the flooded plain (Von Hagen, 1967).

The spread of the road network across the entire Roman empire facilitated the extension of citizenship and ease of travel abroad. Rutilius Namatianus wrote in 416 - 417 CE of Rome:

"What used to be the world, you have made into a city" (Dilke, 1975).

Bridges

Referred to by the Romans as the "little brother to the road," bridges were constructed of wood for temporary crossings, or by lashing pontoons together for quick crossings. Permanent bridges were constructed of wood early in the history of the empire, to be replaced by stone as the preferred building material later in the empire's history. These later bridges were constructed of large stones, with one arch for the crossing of a small river, and more arches for crossing larger rivers (Dilke, 1975).

In order to overcome natural obstacles of the terrain, the Romans constructed raised earthen and/or wooden embankments over marshy areas, or along the contour of a hill in order to improve the gradient. If an embankment was built to improve the gradient, a cut would be made into the side of the hill to provide a ledge upon which the road would be laid. Steep sections of roads

were usually paved, however, level stretches would have just a layer of gravel

spread over the surface. The use of gravel eliminated damage due to freeze-

thaw process (Dilke, 1975).

Milestones

Main roads were provided with cylindrical milestones, many of which

have survived. Distances are given on these in Roman miles:

5 Roman feet = 1 pace (passus = one double space) = 4.9 ft = 1.5 m

1,000 paces = 1 Roman mile (mille passus, or MP) = 49 ft = 1.5 km

(Dilke, 1975)

The Romans erected milestones along important roads at fixed intervals

of one Roman mile. Milestones discovered in Israel indicated that distances

were measured from major cities: Panais, Hippos, Scythopolis, Diocaesarea,

Ptolemais, Legio, Caesarea, Neapolis, Jaffa, Antipatris, Iamnia, Nicopolis,

Eleutheropolis, and Aelia Capitolina, which were main junctions of Israel's road

network. The starting point of each road was the center of the city (usually a

public monument); the junction of these roads were within these cities. To date,

more than 500 hundred milestones have been discovered in Israel (Roll, 1983).

Milestones were constructed of local limestone, approximately 150-250

cm (5-8 ft) high of square base, and cylindrical milestone. Inscriptions consisted

of two parts: the first inscription is official and written in Latin, with the name of

the current Roman ruler during which construction took place; the second

inscription is functional and written in Greek, listing the name and distance from

the major city where the road began and name and distance of the city to which the road leads. The use of Greek began during Hadrian's reign (Roll, 1983).

The importance of milestones were threefold:

1) visual markers for the traveler, recording distance and date of construction;

2) served as propaganda markers to remind the traveler of the might and extent of the Roman Empire;

3) served as important geographic markers to measure distance along the road, location within the general area, and a grid reference system over the region (Roll, 1983).

As a form of propaganda, milestones declared to all travelers that the road is part of the Roman Empire, and served as means of self-adulation by the road's benefactor. In some instances, the message of adoration was lengthy enough to cover the entire milestone (Von Hagen, 1967).

Milestones found in situ are important pieces of archaeological evidence since they indicate that a Roman road existed at that site, even though the road may no longer exist. Unfortunately, many milestones have been removed from their provenance and displaced without preserving the exact location of original placement. Removal of an artifact from its provenance destroys archaeological data and minimizes the chance of relocating the exact site of a Roman Road (Von Hagen, 1967).

The Political Establishment of Roman Roads in Israel

The New Testament and Josephus (1981) do not mention road construction or maintenance prior to the First Revolt, 66 CE. After the initial uprisings, Emperor Nero ordered Vespasian to stop the revolt. Agrippa II sent 60,000 men to Ptolemais, the Romans launched their attack and won control of Galilee and the Golan. In order to move large forces rapidly from one front to another, maintain efficient communication between the central command and field units, and ensure a steady flow of supplies, the Romans improved and maintained existing roadways, as well as built new ones (Roll, 1983).

Josephus wrote a description of the construction of the road to Jotapata, during an advance of the Roman army led by Vespasian:

"Vespasian sent a body of infantry and cavalry in advance to level the road leading to it, a stony mountain track, difficult for infantry and quite impracticable for mounted troops" (War 3, 7, 3, (141)).

Josephus also wrote that the troops included special units of:

"pioneers, to straighten sinuousities on the route, to level the rough places, and to cut down obstructing woods, in order to spare the army the fatigues of a toilsome march" (War 3, 6, 2 (118)).

A milestone dated to 69 CE discovered near Afula, the earliest milestone found in Israel, confirmed that road construction was performed by soldiers of the Tenth Legion on the Caesarea to Scythopolis/Beth Shean road, under Commander Marcus Ulpius Traianus (Trajan's father) (Roll, 1983).

The Romans constructed roads in Israel in response to political and military events. When the First Revolt ended, Judaea was established as a

praetorian province centered in Caesarea, with the Tenth Legion stationed at Jerusalem (86 CE). Although documentation of road construction during this period of time is scarce, it is believed that the Romans maintained the main roads between the important administrative centers along the coast and to the wilderness (Roll, 1983).

From 98-117 CE, expansion of the Roman Empire affected the local road network of Israel. In 106 CE, the Romans annexed the Nabateans, renamed this area Provincia Arabia, and built a new road from Bostra to Aila which bisected the new frontier. The Israel road network became the rear guard for the eastern frontier following the acquisition of Arabia (Roll, 1983).

During the time of Hadrian (117-138 CE), unrest in Galilee tested the effectiveness of the Tenth Legion at Jerusalem. The outcome of these events resulted in the addition of the Second Legion stationed near Megiddo (later Legio) and the construction of roads to facilitate access to the isolated, troubled Galilean region. A milestone (dated at 120 CE) attested that the road from Ptolemais to Diocaesarea (Sephoris) was built by the Second Legion; a second milestone (also dated at 120 CE) attested to the construction of the Diocaesarea (Sephoris) to Legio (Megiddo) road by the Sixth Legion. During 130 CE, additional construction was undertaken along the Jerusalem - Bet Guvrin - Legio - Diocaesarea, and Jerusalem - Hebron roads (Roll, 1983).

The Bar-Kokhba uprising of 132-135 CE resulted in a further expansion of the Roman road network for immediate military use. In order to easily reach areas of insurrection, the Romans improved the existing road network and built new roads to those remote areas which harbored rebels. Although milestones

have not been found which date to the beginning of this time frame, the roads built for immediate use by the military were later converted to highways complete with milestones to attest to their construction (Roll, 1983).

Following the Bar-Kokhba rebellion (139-162 CE), the Roman administration rebuilt Jerusalem (renamed Aelia Capitolina), declared the city "off limits" to Jews, and renamed Judaea "Syria-Palestina." The Romans also launched additional road building projects in order to facilitate increased security and increased movement of troops during periods of unrest. A large number of milestones have been found which date from this period of time, with the greatest number found along the major roadways of Palestinia and dated to 162 CE. This ties in with the ascension of Marcus Aurelius to Emperor (161 CE), and the custom of the new emperor ordering the repair of roads and highways throughout the Empire (Roll, 1983).

The Romanization of Israel

After Roman occupation of Israel, the Romans replaced the rough tracks of ancient roads with an expanded network of constructed roads. The Romans also drained marshes, built cities and extended cultivation to the edge of the desert. Emphasis of political power was removed from the mountainous areas to be placed in the plains and along the coast. The capital was moved from Jerusalem to Caesarea, and Acco, Joppa, Gaza and Ascalon became Roman seaports. The interior road network became important trade routes and a road was built from Acco to the Sea of Galilee at Tiberias during 132-135 CE for the export of fish and wheat to Rome (Baly, 1971).

During early Roman occupation the Upper Galilee became important to Rome for its exports. The people of Upper Galilee resented the Roman intrusions and the Galilean region became a hotbed of resentment and revolt. Nevertheless, the region around the Sea of Galilee became important as exporters of wheat and fish. Migdal became an important site where the fish were salted and prepared for export through Acco (Ptolemais) to Rome. The routes remained basically the same throughout the Galilean region with passage leaving Migdal through the Valley of the Robbers toward Mt. Tabor then southwestward to Megiddo and the new Roman capital of Caesarea on the coast (Baly, 1971).

The Romans were the only ancient power to systematically build paved roads. The roads and bridges were constructed for the official business of the military and administrative officials, but later roads were extended to connect important towns and settlements in Israel. In the mountainous parts of Israel most roads were carefully placed for strategic advantage, thus following the chief ridges where possible (Roll, 1983).

The phases of road building in Israel are listed in Table 4. Since roads were built for the expedient movement of troops, the road network was built in response to political uprisings. After the fall of Rome, no administrative government properly maintained the Roman road network in Israel, until the end of 19th century (Avi-Yonah, 1970).

TABLE 4: HISTORICAL ITINERARY OF ROMAN ROADS CONSTRUCTION

First Revolt 68 CE: Commander Vespasian
* Ptolemais to Gamla (inferred route, no milestones found to date)

Second Wave 69 CE: Commander Vespasian
* Caesarea-Hadera-Afula-Beth Shean
    * milestone outside Afula MS 69 CE
* Caesarea-Jerusalem
* Jaffa-Neapolis
* Coastal Road

Emperor Trajan (98-117 CE)
* Bostra-Aila
* 106 CE Nabatean region becomes Provincia Arabia

Emperor Hadrian (117-138 CE)
* Ptolemais-Sephoris-Tiberias MS 120 CE
* Diocaesarae-Legio MS 120 CE
* Jerusalem-Diocaesarae; Jerusalem-Hebron road

Emperor Pius (138-161 CE)
    Jerusalem rebuilt 139 CE
* Sixth and Tenth legions stationed at Jerusalem

Emperor Marcus Aurelius Antonine (138-161 CE)
    As a new emperor, rebuilt and repaired existing road network

Severan Period (193-235 CE)
    peaceful era: roads built for civil administration, not military
* Sixth legion sent to North Africa

End of Third century CE
    Four north-south arteries:
    - Antioch-Alexandria (way of the land of Philistines)
    - Caesarea-Antipatris-Eleutheropolis
    - Diocaesarea-Legio (Megiddo)-Neapolis-Jerusalem-Hebron
    - Jordan Rift Zones (assumed)
    Eight east-west arteries

Few roads built after Severan-Late Roman-Byzantine period
* pilgrim travel (road maintenance only)

Source: after Roll (1983)

RECENT ARCHAEOLOGICAL RESEARCH ON ROMAN ROADS

During a personal interview conducted with Dr. Israel Roll, Tel Aviv University, on July 24, 1995, the possibilities of Roman roads in the Bethsaida region were discussed (Figure 7). Roll stated that there were confirmed road fragments between Gov Josef and Almagor; however he questioned a possible continuation to the east (toward Bethsaida) since road fragments have been confirmed to the south (toward Kefar Nahum). Regarding an Acco-Ramat-Bostra road, Roll stated that if the Romans had wanted a road from Acco to Bostra in the 4th century CE, they would have built it. However, the Romans preferred to cross the Jordan River at Bet Yerah which is south of the Sea of Galilee (ten arches of a bridge are still visible) and not at Gesher Nahayrim. He stated that organized Romans were systematic, and planned construction of roads and bridges for official Roman use by the military and imperial administrators. He emphasized that public roads forded rivers; Roman roads used bridges (Roll, 1995).

Regarding a road north out of Bethsaida to Panais along the east side of the Jordan River, Roll noted three milestones: Benot Ya'aqov Bridge; 4 km to the north of the bridge; and, near Panais. He stated that there are no clear remains of pavement, the road may continue to Theodosisus, and the possible road at Benot Ya'aqov may be a public road and not an official road, due to absence of milestones. It is important to note the distinction between main versus secondary roads; milestones are placed on official roads. (Roll, 1995).
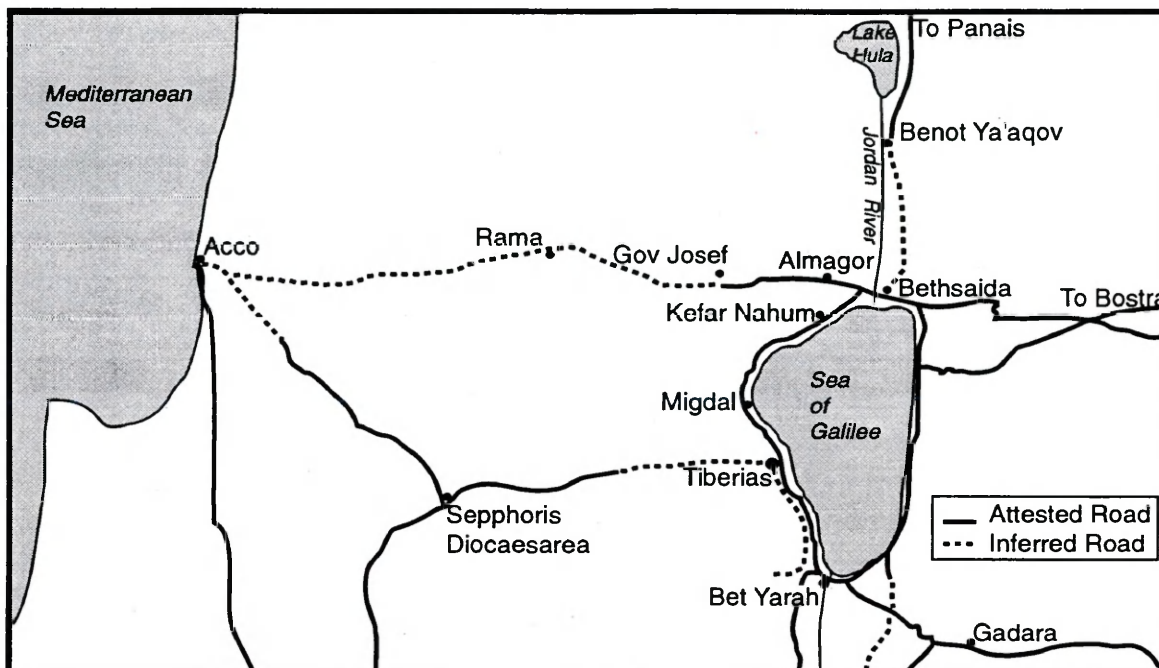
Figure 7: Probable Roman Roads According to Roll, 1993.

In an article titled, "Eastern Galilee, Survey of Roman Roads," Ilan (1992) discussed the survey of Roman road fragments and milestones found along the Gesher Benot Ya'aqov-Tiberias road (Figure 8). The road descended from the Golan to east of the Jordan River, close to a modern road, past a Roman-Byzantine ruin where a milestone was recorded. The road continued to the ruined bridge west of Khan Benot Ya'aqov at the Jordan River. West of the Jordan River the road continues (in fragments) in the orchards of Kibbutz Gadot, north of Nahal Rosh Pinna, with a milestone associated with a road in situ in an orange grove of the kibbutz. Another milestone was located next to the road above the Nahal Rosh Pinna southeast of the Kibbutz Mahanayim orchards. The road is visible again south of Khan Gov Yosef and eventually continues on to Migdal and Tiberias (Ilan, 1992).
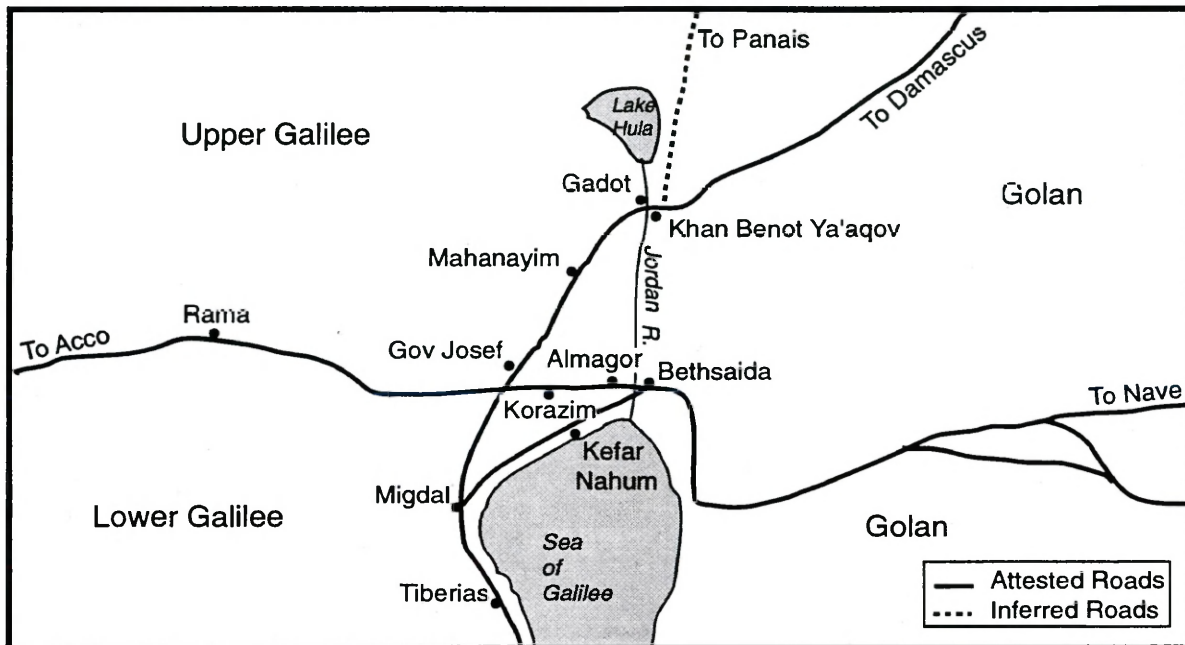
Figure 8: Probable Roman Roads According to Ilan, 1990.

A second road, the Acco-Ramat Korazim-Bethsaida Road, was surveyed by Ilan (1992). Aligned in an east-west direction at Gov Yosef near Zomet 'Ami'ad, to 500 m north of Kefar Korazim where it descended to cross Nehal Korazim. The ancient road was covered by a modern road leading to Almagor but was visible again outside the city limits. Road fragments were surveyed beyond Moshav Almagor, on to Beq'at Bethsaida, cross the Jordan pass Tell Bethsaida, and on to the Golan and Bashan (Ilan, 1992).

The Acco-Ramat Korazim-Bethsaida road does not have any known milestones along any of the road fragments. A surface survey and reconnaissance of this section in particular did not yield road fragments.

The accuracy of scholarly mention of the Via Maris was researched by B.J. Beitzel (1991) and presented in his article "The Via Maris in Literary and Cartographic Sources." Beitzel traced the historical documentations, literary and cartographic, to dispell the undocumented dogma which accompanied the placement of the Via Maris in Israel (Figure 9). His research revealed that many studies conducted by earlier scholars, e.g., Gottlieb Schumacher and Carl Ritter, on the whereabouts of the Via Maris were based on undocumented assertions (Beitzel, 1991). Schumacher's equation of placement of the Via Maris stated that it was a highway which stretched between Damascus, Kuneitra, Hazor, Megiddo and Gaza. However, Beitzel asserted that the Schumacher equation is without support from historical documentation within the Bible. This equation is also unasserted in later documents and within the Crusader literature and did not occur in writing prior to the thirteenth century. Study of the writings of Quaresmius (1969) revealed that the Via Maris was a roadway which connected Acco to Kefar Nahum, without mention of travel through Damascus, Kuneitra, Hazor and Megiddo. Quaresmius believed the Via Maris to be an east-west road which connected the seaport of Acco to Kefar Nahum located on the northwest corner of the Sea of Galilee. Beitzel also discussed Hartmann's studies (1910; 1918) which examined the geographic perspective of locating the Via Maris between Damascus and Canaan by linking the villages that served as resting places for Islamic or Crusader travelers. However unique Hartmann's studies were, they did not provide literary support for the Via Maris as the road between Damascus and Megiddo during the Middle Ages (Beitzel, 1991).
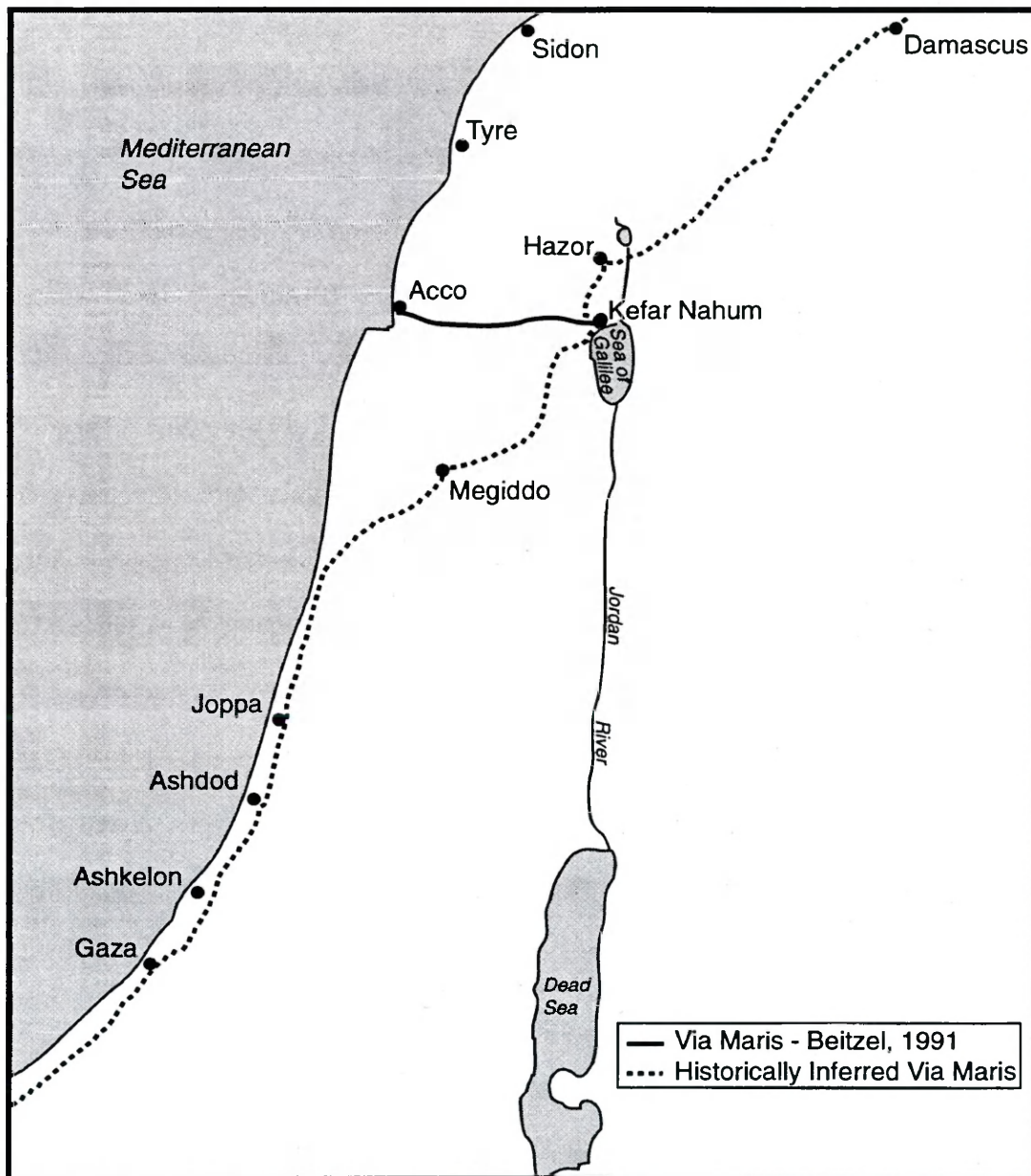
Figure 9: Probable Via Maris According to Beitzel, 1991.

Beitzel's cartographic search produced three dozen maps which depicted the Via Maris as a roadway between Acco and Kefar Nahum. Although a roadway was delineated between Damascus, Hazor, Megiddo, and Gaza, not once was that highway designated as the Via Maris. Beitzel stated

that not one map (from the period of 1474 to 1800) examined during his research designated the road between Damascus, Hazor, Megiddo, and Gaza as the Via Maris (Beitzel, 1991).

Beitzel's study concluded that since Kefar Nahum was the one city consistently mentioned throughout all historical documentations, that the Acco to Kefar Nahum connection (east-west roadway) would be the most reasonable. Based on Kefar Nahum's occupied existence, it would have been pivotal to the Via Maris tradition prior to the eighth century CE, or after the Crusades and early Ottoman era (13th - 16th centuries). Therefore, based upon the literary and cartographic assertions of the Via Maris, when studied in context of the occupation of Kefar Nahum, Beitzel hypothesizes that the term Via Maris was reintroduced after the Crusader period and assigned to the east-west roadway between Acco and Kefar Nahum for the purpose of pilgrimage to "Jesus' 'own city'." (Beitzel, 1991). Where the term Via Maris is used during the Common Era to describe an east-west road within the Syro-Palestine region between Acco and Kefar Nahum, the term is indicative of an east-west route of post-Crusader periods, and no earlier (Beitzel, 1991).

An article titled "Milestones in Judaea, from Vespasian to Constantine," Isaac (1978), discussed the construction of roads and placement of milestones. He stated that:

> "... at present there is no evidence of a Roman road network
>
> existing in Judaea before Hadrian (117-138). Up to that time the
>
> local standard may have been thought sufficient, while in wartime,

the legions brought with them units whose task it was to straighten,

to broaden and to level existing roads."

Isaac stated that milestones in Judaea were set up to serve the military; Jewish

sources do not refer to a Roman road network before the third century.

Milestones were erected by order of the central government, and the first

systematic construction of roads in Israel is dated by those earliest known

milestones in Israel. As noted previously in this literature review, the custom of

erecting milestones on Roman roads was established by the year 123 BCE.

However, Isaac stated that :

"there is no reason to suppose that roads were made or repaired

only when milestones were set up."

This statement has been interpreted to imply that milestones are not

conclusive evidence of proving existence of Roman roads. However, that

goes contrary to existing historical documentation, and contrary to

accepted standards of most scholars. Isaac concluded that if milestones

are an indication of road maintenance, then:

"Judaea may be suspect of having had a provincial government

with little initiative of its own" (Isaac, 1978).

Regarding placement of a Roman road in the vicinity of Bethsaida,

Isaac (1978) mapped out a known road from Ptolemais (aka Acco) to

west of Tiberias, an inferred road traveling east toward Tiberias, and a

possible road from Tiberias following the Galilean shoreline to Bethsaida

to continue north and east along the coast (Figure 10).
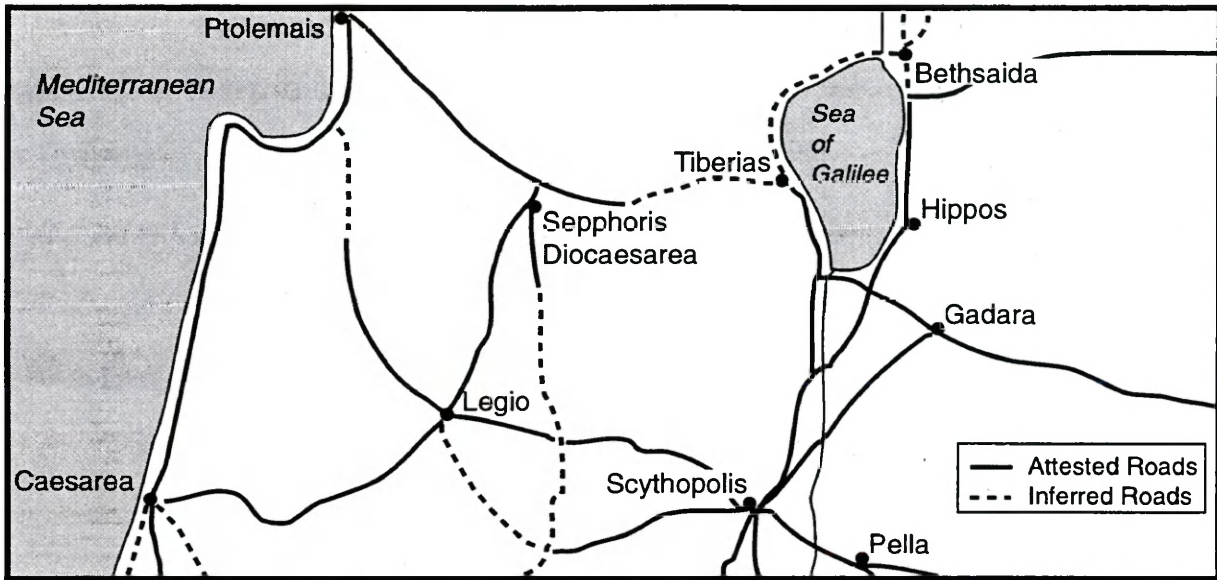
Figure 10: Probable Roman Roads According to Isaac, 1978.

Chapter IV

METHODS

As stated previously, the problem was to identify Roman roads in the Upper Galilee and Lower Golan regions of Israel. Therefore, the primary objective was to identify an anthropogenic relationship of land use, e.g., Roman roads in relationship to natural migratory routes, as a function of the regional physical geography. The secondary objective was to determine the most likely routes of access (areas of favorable passage) to the ancient port city of Bethsaida situated on the northeastern shore of the Sea of Galilee. In order to acquire the data necessary to meet these objectives, investigations were conducted within three fields of study:

1) Field investigation to acquire physical geography data;

2) Archaeological investigation to acquire data on the spatial distribution of archaeological artifacts on the landscape;

3) GIS investigation to compile and process the data, and to conduct spatial analysis

The above investigations took into consideration the human cost factors which dictate travel through variable terrain to create paths of least resistance over areas of favorable passage. The resistance to movement, spatial friction, affects human choices and is a function of time and cost (Hartley and Wolley-Vawser, 1994).

The physical geography data acquired through the field investigation included the elevation, slope, aspect, hydrology, and surface lithology of the

study area. Additionally, radiocarbon analysis of organic matter in muds indicative of an ancient, probable estuarine coastline of the Sea of Galilee was incorporated into the physical geography data layers. In recent studies regarding the application of GIS in archaeology, Hartley and Wolley-Vawser (1994) and Tobler (1993) incorporated data from topography (slope and aspect) and hydrology to successfully create routes of efficiency models for relationship with archaeological and historical data. The use of topographic maps at a 1:50,000 scale as data sources was found to be sufficient (Vawser, personal communication, 1996), (Merchant, 1985). A search of publications did not yield studies that incorporated surface lithology data into a slope-aspect-hydrology dataset to create routes of efficiency models for GIS analysis.

The archaeological data were used to analyze the spatial distribution of ancient settlements and surface material remains, e.g., known road fragments, milestones, and other archaeological artifacts (potsherds). The inclusion of the archaeological data facilitated differentiation between attested and inferred roads when overlain upon the models of Areas of Favorable Passage.

The Geographical Information Systems (GIS) investigation involved a search of available cartographic sources for maps of the study area appropriate for the research. These maps were used as data sources and used to identify and generate those specific data layers and operand maps necessary to meet the objectives. The GIS investigation also involved devising a site suitability analysis process which assigned ranked and weighted attribute values to the physical geography data layers of slope, aspect, hydrology, surface lithology, and probable estuarine coastline for the creation of a surface friction map. The

data layers and operand maps generated were used to conduct the final spatial analyses and generate Areas of Favorable Passage models.

FIELD INVESTIGATION

Field investigation of the study area was conductcd in the Upper Galilee and Lower Golan regions of Israel, July 10-21, 1995, in conjunction with the Bethsaida Excavations Project, sponsored by the University of Nebraska at Omaha, and directed by Dr. Rami Arav, Director of Excavations of the Bethsaida Excavations Project, UNO, and Dr. Richard A. Freund, Professor of Religion, UNO. This field research was part of the geology research directed by Dr. John F. Shroder, Jr., Professor of Geography and Geology, UNO. Since primary data was desirable over secondary data, the purpose of the field investigation was to gather data on the physical geography of the study area (elevation, slope, aspect, hydrology, surface lithology, and probable estuarine coastline) in order to gain firsthand familiarity and knowledge of the study area, and conduct reconnaissance and surface surveys of selected sites chosen as a result of the initial literature review. Field investigation included photography of the terrain.

Investigations were conducted on the following sectors (Figure 11) :

- The northern sector of the upper Jordan River and the Hula Valley;

- Thc midsector dominated by Jordan River Rift Valley, and regions wesl and east of the Jordan River Rift Valley, the Korazim and Golan Plateaus, respectively;

- The southern sector of the Beteiha Plain, including Bethsaida Spring.
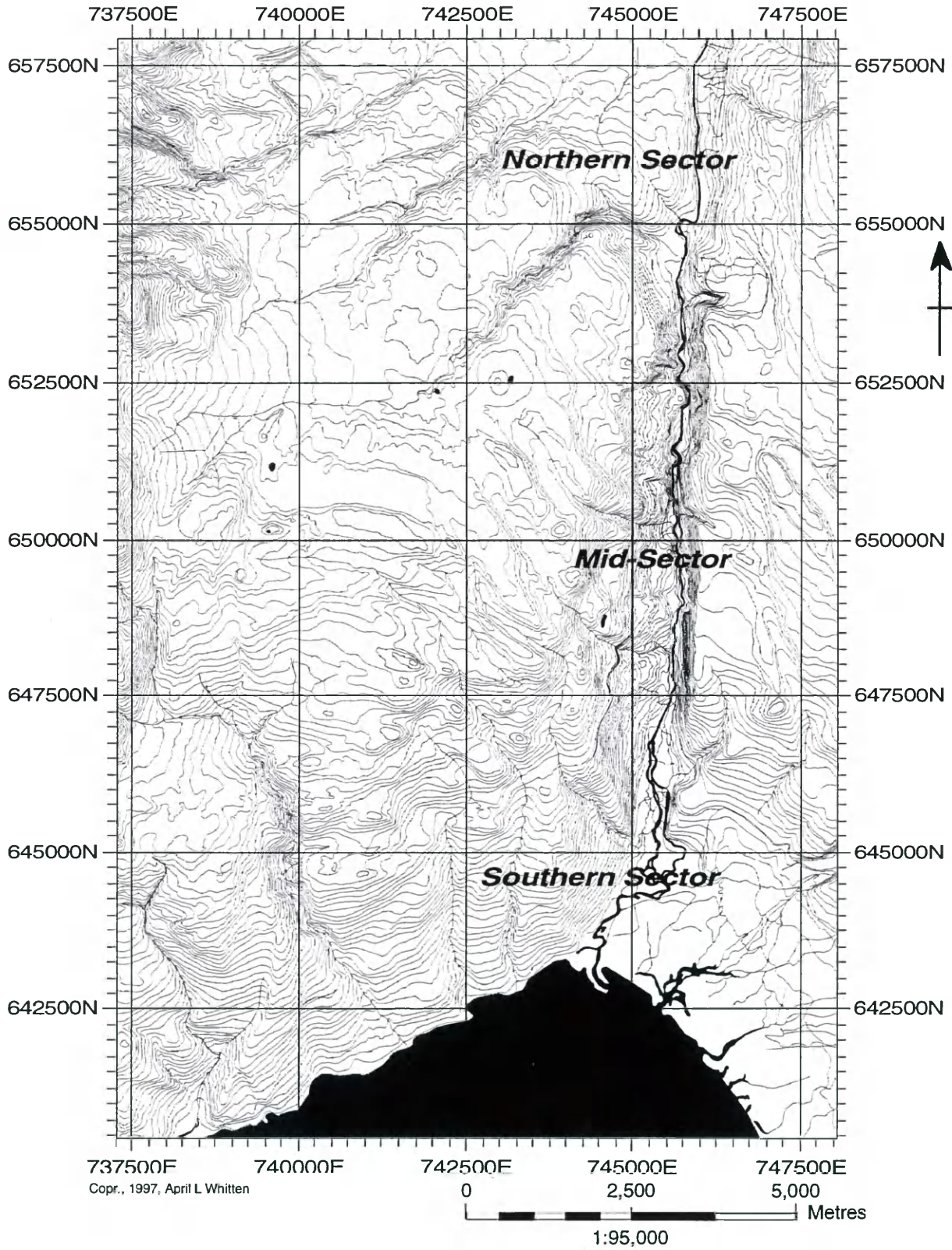
Figure 11: Sites of Field Investigations

Copr., 1997, April L Whitten

737500E 740000E 742500E 745000E 747500E

657500N 655000N 652500N 650000N 647500N 645000N 642500N

Northern Sector

Mid-Sector

Southern Sector

0 2,500 5,000 Metres

1:95,000

ARCHAEOLOGICAL INVESTIGATION

The archaeological investigation was conducted in conjunction with the field investigation for the purpose of reconnaissance and surface survey of selected archaeological sites chosen as a result of an initial literature review. Surveys included viewing fragments of Roman roads, milestones, and classification of other archaeological surface material remains. The following sites were investigated for their relationship with the terrain and proximity to each other (Figure 12):

- The Bethsaida Excavation Site

- The Watermill Site located west of Bethsaida, east of the Jordan River;

- The Josephus Encampment Road Site east of the Jordan River;

- The ancient city of Korazim;

- The ancient settlement of Amnun;

- Kefar Nahum (Capernaum);

- The ancient settlement of Almagor;

- The area between the Almagor and Amnun

Investigations were also conducted at numerous unnamed sites along the western ridge overlooking the Jordan River Rift Valley, and in the northern sector of the study area at Gadot and Benot Ya'aqov. Surveys of these sites provided additional opportunities to study the relationship of ancient sites to the physical geography of the northern sector.
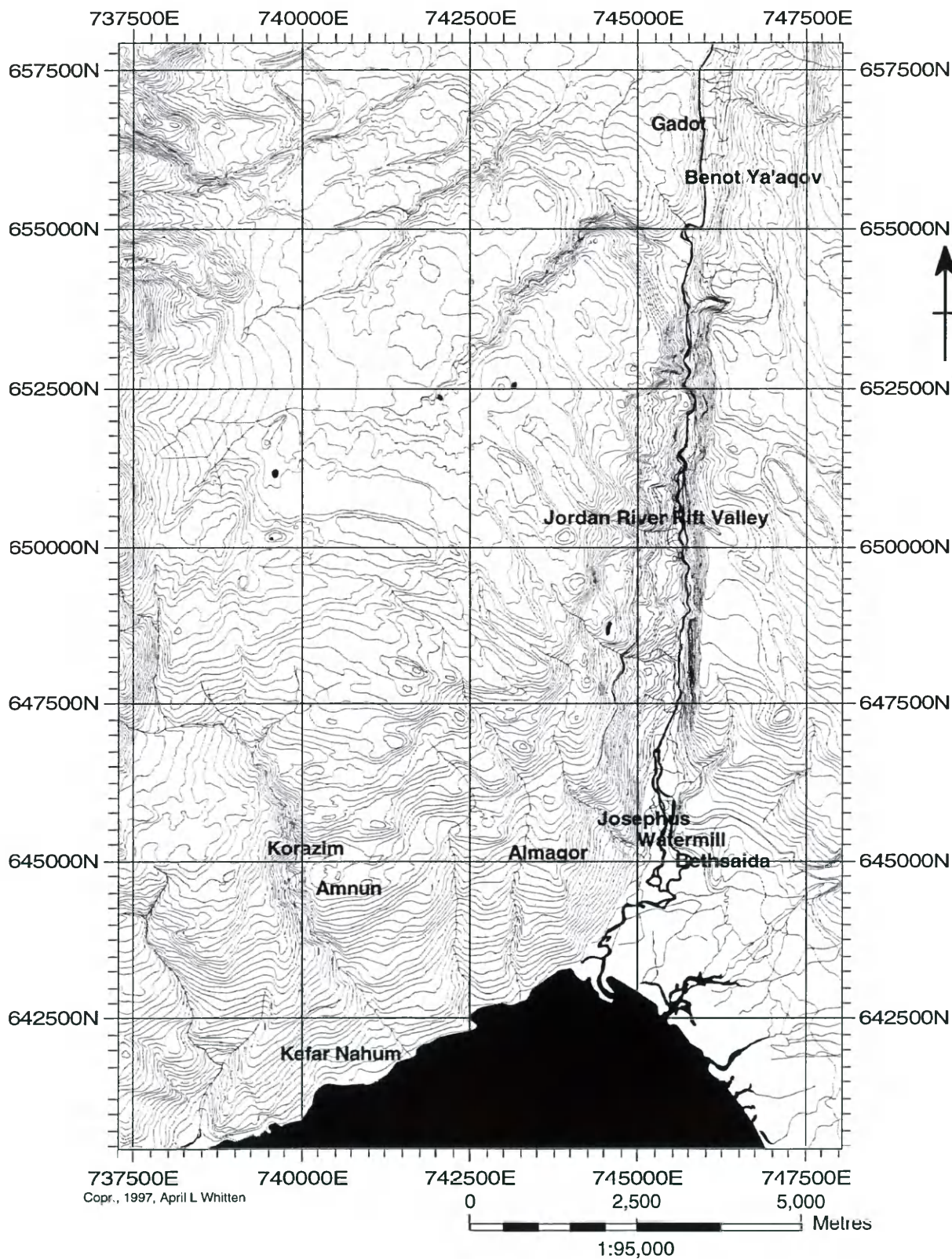
Figure 12: Sites of Archaeological Investigations

GEOGRAPHIC INFORMATION SYSTEMS INVESTIGATION

The GIS investigation was conducted to determine the most efficient method of spatial analysis. Identification of an anthropogenic relationship of land use as a function of the physical geography, and identification of the most likely routes of access to Bethsaida as characterized by the terrain required reconstruction of the paleoenvironment or characterization of the terrain by generating a theoretical model from the physical geography data and archaeological data acquired through the field and archaeological studies.

Map Selection

The initial GIS investigation involved a search of available cartographic sources for maps of the study area appropriate for the research. These maps were used as data sources and were used to identify and generate those specific data layers and operand maps necessary to meet the objectives. The search for appropriate maps of Israel and the study area was compounded by two factors: 1) due to security reasons, topographic maps were available only at scales of 1:50,000, 1:100,000, and 1:250,000; and, 2) Israel is a Hebrew speaking nation, thus maps written in English were scarce. In order to overcome these factors, and still meet the research objectives, the following maps were selected:

1)   Touring Map of Israel, 1:50,000, Hebrew, Israel, 1987;

2)   Quadrangle maps of the Teverya and Zefat regions, 1:100,000, Hebrew and English versions, Survey of Israel, 1994;

3)   Steimatzky Guide to Israel, Northern Sheet, 1:250,000, both

Hebrew and English versions, Survey of Israel, 1994.

The Touring Map of Israel at 1:50,000 scale was selected as the base map to

produce a scanned image for the GIS analysis of the study area. This map

provided topographic data and contour lines at 10 m intervals, and provided site

location of ancient sites and ancient roads. Written in Hebrew, the language

barrier of the map was overcome by using the Hebrew and English versions of

the Steimatzky maps to cross-reference the Hebrew version to the English

version of the Touring Map and Steimatzky map, and matching it to its mate on

the English version. At a scale of 1:250,000, the Steinmatzky maps omitted

many ancient sites and ancient roads. The use of the Quadrangle maps of

Teverya (directly north of the Sea of Galilee) and Zefat (north of the Sea of

Galilee to the Hula Basin) completed interpretation of the 1:50,000 Hebrew

map. The Quadrangles were excellent maps and provided site locations of

ancient cities and ancient roads; however, at a scale of 1:100,000, their use was

precluded as a base map.

Data Structure

A raster based data structure was selected for use because it is based on

a grid which facilitates overlay operations between map layers, efficiently

represents high spatial variability, and allows for the efficient manipulation and

enhancement of digital images. These features facilitate terrain analysis and

outweighs the advantages of using a vector based data structure. Therefore,

the raster based data structure was selected to model the paleoenvironment.

One disadvantage to the use of raster based data structures was that it is not as compact as a vector based data structure, and requires greater data storage capabilities. This disadvantage can be overcome through compression of data (Aronoff, 1995).

Software and Hardware

With the decision made to use raster based data structures, Map*Factory software was selected for desktop GIS analysis on a Macintosh PowerMac. Originally, it had been proposed to use MAP II and Surface III to conduct this research; however, Map*Factory was the latest version of MAP II and eliminated the problems associated with the earlier version of MAP II. The use of Map*Factory also eliminated the problem of degradation of data as a result of importing data between MAP II and Surface III. The choice to use software compatible with a Macintosh PowerMac was based on personal preference for Macintosh hardware, and convenience of operating from home, as well as at the university. The PowerMac used for the analysis was a Performa 6214CD, equipped with a PowerPC 603 RISC processor/75 MHz, 1.35 GB hard drive, and 40 MB RAM.

Data Layers

The GIS investigation was implemented to identify and generate those specific data layers and operand maps necessary to process the data, and devise a site suitability analysis process to create a surface friction map of ranked and weighted attribute values of slope, aspect, hydrology, surface

lithology, and probable estuarine coastline of the physical geography data layers. The processed data in the form of data layers and operand maps was used to conduct spatial analyses and generate Areas of Favorable Passage models through use of the spread and regroup functions.

Chapter V

RESULTS AND DISCUSSION

INTRODUCTION

This chapter presents the results of the investigations conducted to meet the objectives of this thesis. Associated photographs, maps, and tables are presented from the field and archaeological investigations. The results of the GIS investigation are also presented in this chapter and includes associated data layers, operands maps, and models generated as a result of the investigation. The methods and procedures used to meet the objectives are given in a step-by-step manner.

RESULTS OF FIELD INVESTIGATION

The field investigation of the study area revealed a rugged terrain carved out of basaltic outcrops and divided sharply by the Jordan River Rift Valley. Within the confines of the study area, the Jordan River Rift Valley was flanked on the west by the Korazim Plateau and on the east by the Golan Plateau; to the north the Jordan River Rift Valley is bounded by the Hula Basin, with the southern sector of the study area ending in the Beteiha Plain on the northeastern shore of the Sea of Galilee.

The study area was a 10 km by 15 km (150 km^2) region which rose steadily in elevation from 209 m below sea level along the northern shores of the Sea of Galilee to 590 m above sea level in the Naphtali Mountains

approximately 8 km northwest of the northern shoreline of the Sea of Galilee. This variance in topography resulted in a rise in elevation of 799 m over a distance of ~ 8000 m to produce an ~ slope of 9.99 degrees. A slope of ~ 10 degrees, combined with a rugged, rocky terrain littered thickly with basalt debris, and covered with razor-sharp, thorny vegetation, made travel by foot difficult and arduous. Even without the thorny vegetative cover, travel by foot over the basaltic hills of the Korazim Plateau to the north of the Sea of Galilee and west of the Jordan River Rift Valley required a great expenditure of calories in terms of human cost factors. Although the field investigation did not extensively cover the Golan Heights east of the Jordan River Rift Valley, similar conditions of great slope, rugged rocky terrain of basalt debris, and thorny vegetative cover prevailed. Thus, travel by foot was as difficult and arduous through the Golan on the eastern flank of the Jordan River Rift Valley, as was travel by foot on the western flank.

Northern Sector

The physical geography of the northern sector of the study area consisted of the Hula Valley. This region was a natural depression of streams, marshes, and freshwater lakes. The Hula Basin today stands 70 m above sea level, ~14 km north of the Sea of Galilee which at present has an elevation of 209 m below sea level. This equates to an average slope of ~2 degrees from the Hula Basin to the Sea of Galilee through the Jordan River Rift Valley.

One of the unique attributes of the Hula Basin was the presence of lacustrine and limnic chalk found in the Gadot and Ashmura Formations,

Figure 13. Looking north upstream the Jordan River towards Gadot.

respectively. The Gadot Formation overlies the Preglacial Pleistocene Cover

Basalt, begins in the southern section of the Hula Basin near the location of the

former Lake Hula, and extends southwest toward Rosh Pinna and southeast

toward Gadot and Benot Ya'aqov. The Ashmura Formation overlies the Hulata

Formation of peat in the vicinity of the midsection of the Hula Basin, formerly

ancient marshes. The Gadot and Ashmura chalk have the favorable properties

of erodibility, quick drying, and high porosity; further, it degrades into an infertile

soil (Horowitz, 1979). Therefore, these properties combine to result in dry,

smooth, vegetation-free, natural walkways highly amenable to traffic by foot through areas of favorable passage, and low cost factors regarding expenditure of calories.

Mid-Sector

The Jordan River Rift Valley runs through the heart of the study area in a north-south direction. As noted earlier, it is carved through the basalt rock of the Korazim and Golan Plateaus by the Jordan River. Descending rapidly from the Hula Basin to the Sea of Galilee, the waters race through the boulder strewn gorge between steep valley walls of basaltic outcrops. The Jordan River Rift Valley lies astride the Almagor and Jordan transform faults and is part of the Dead Sea-Jordan Rift system. Tectonically active, the Jordan River Rift Valley is subject to slope failures and landslides which result in catastrophic breakout floods (Shroder and Inbar, 1995).

Travel by foot within the gorge was difficult in most places due to the presence of boulder strewn floodplains alongside steep terrace walls of great slope, and impossible in many places due to the absence of any type of floodplain between the steep terrace walls. At those places, the traveler was faced with the choice of scaling a very steep, rocky wall, tunneling through thorny vegetative cover, or crossing the river. Through personal experience, crossing the river was a much less than desirable option, due to the high velocity of the water and the presence of insurmountable boulders midstream. Tunneling through thorny vegetative cover is possible only if the traveler was small and could squeeze past the thorns, or if the traveler was large and thick-

skinned. However, scaling a very steep, rocky wall could be accomplished if the traveler was creative, inventive, and can overcome the effects of gravity.

Figure 14. South, downstream Jordan River toward the Sea of Galilee.

Travel by foot along the eastern or western ridge of the Jordan River Rift Valley was difficult and fatiguing, and required great expenditure of calories. Travel was negatively impacted by the combined effects of rugged terrain of black, basalt rocks which radiated heat relentlessly, thorny vegetative cover, and variation in elevation during descent southward toward the Sea of Galilee.

Southern Sector

The physical geography of the southern sector of the study area was comprised of the Beteiha Plain. The tell of ancient Bethsaida was located within this region and consisted of a mound situated on the southern edge of the Yehudiya Plateau within the Golan Heights (Shroder and Inbar, 1995). Bethsaida was east of the Jordan River Rift Valley and rose to an elevation of 166 m below sea level above the Beteiha Plain (elevation 209 m below sea level). The Beteiha Plain is a floodplain comprised of the dark brown to black clays of the Tabgha Formation possibly derived from weathered basalt (Horowitz, 1979). Several rivers run through the Beteiha Plain on their way to the Sea of Galilee; the Jordan, Meshoshim, Zawitan, Yehudiye, Sefamnun, and Daliyot Rivers (Shroder and Inbar, 1995). Presently, the Beteiha Plain was an easy region to travel by foot since it is a gently sloping plain of < 0.5 degree slope; however, it is a lowland floodplain subjected to seasonal flooding as a result of winter rainstorms and close proximity of the rivers (Figure 15).

The Bethsaida Spring west of the city of Bethsaida was a deep sweetwater spring which flowed westward into a pool and deep channel of the Jordan River. A recent study of the clay rich sediment surrounding the Bethsaida Spring was conducted by Shroder and Inbar (1995). The deposition of organic rich, fine-grained clay sediments found in close proximity of the Bethsaida Spring was indicative of a quiet, shallow body of water, typical of lagoons, estuaries, and swamps. Their research included carbon 14 analysis of organic rich mud taken from a backhoe trench cut 1.5 m deep and 25 m south of the Bethsaida Spring. Analysis of the organic rich clay gave carbon 14 dates of

Figure 15. The Beteiha Plain, north of the Sea of Galilee.

2,035±170 years BCE, which equated to the deposition of clay sediments in an

organically rich, quiet, shallow body of water located near the edge of ancient

Bethsaida about 2,700 to 1,800 years ago (Shroder and Inbar, 1995). The data

from the research, therefore, indicated that ancient Bethsaida may have been

located on or near a probable estuarine coastline of the Sea of Galilee. Since

ancient Bethsaida was referred to historically in the Bible and other ancient

texts as a fishing village, location on or near a coastline was desirable for the

support of a fishing industry. With this information taken into consideration,

travel by foot south of ancient Bethsaida across the present-day Beteiha Plain

may not have been possible, or at the very least, negatively impacted by the

presence of a probable estuarine coastline of quiet, lagoonal waters. These

estuarine waters would have been subjected to the seasonal flooding of winter

rains during the wet season, and would have been swampy, marshy lowlands

due to the moisture retentive capabilities of clays during the dry seasons of

spring, summer and fall. Present-day Bethsaida is situated ~ 2 km north of the

Sea of Galilee.

RESULTS OF ARCHAEOLOGICAL INVESTIGATIONS

Results per site are presented in this section. Surveys of selected sites

included viewing Roman Road fragments, milestones, and classification of other

archaeological surface material remains. The surface material remains are

classified in the text of this manuscript (Table 13).

Bethsaida Excavation Site

The Bethsaida excavation site was visited daily and photographs taken

of its relationship to the terrain (Figure 16). The tell rose ~ 34 m above the

Beteiha Plain and commanded a good view of the Sea of Galilee 2 km south of

the mound. The Jordan River was easily visible less than 1 km west of the

mound. The Jordan River was less than 1 km west of the Bethsaida excavation

site. The ancient city was located on a mound at an elevation of 166 m below

sea level; the elevation levels of the Beteiha Plain and Sea of Galilee ranges

from 209 m below sea level at the present shoreline, to 200 m below sea level at the base of the Bethsaida tell.

Figure 16. The Bethsaida Excavation Site.

Watermill Site

The Watermill Site was located west of Bethsaida and east of the Jordan River, at an elevation of approximately 200 m below sea level (Figure 17). It was a lowland of slight relief and yielded some surface material remains dating to the Hellenistic-Early Roman periods with a few pieces dating from the Byzantine and Middle Ages. Fragments of Roman roads were not found at this

site. The Jordan River was crossed by foot fairly easily at the Watermill Site and an investigation was made of the "Josephus Encampment Road" west of the Jordan River across from Bethsaida.

Figure 17. Watermill Site located in the foreground on the Beteiha Plain west of Bethsaida.

Josephus Encampment Site

The Josephus Encampment Road site is the reputed location of the camp occupied by Josephus Flavius during the Jewish Revolt of 67 CE (Figure 18).

Although the encampment site itself was virtually archaeologically sterile since no surface material remains were found at the encampment site, surveys of a jeep trail running parallel and west of the Jordan River repeatedly yielded many surface material remains. Numerous Stone Age lithics were found clustered at the southern end of the jeep trail.

Figure 18. Josephus Encampment Road Site.

The northern end of the jeep trail largely yielded Early Hellenistic-Early Roman period material remains, with one artifact from the Iron Age and four from the Roman period. The northern section also contained many Dolmen enclosed within rectangular stone walls ~20 m x 30 m (Figure 19). The Dolmen in the Galilee and Golan regions date from the Early to Mid-Bronze periods. Although the Josephus Encampment Road was archaeologically rich with surface material remains dating from Stone Age lithics to Early Roman artifacts, the site's close proximity to the Jordan River necessitated consideration of possible fluvial deposition versus anthropogenic deposition of material remains.

Figure 19. Dolmen at the probable Josephus Encampment Site.

Ancient City of Korazim

Visits to Korazim yielded good viewing of Roman Road fragments and numerous surface finds of material remains. It was noted that the Romans built roads to conform to the natural contour of the hillsides with cuts made into the sides of the hills, and slight embankments built along the outer edges of the roads, thus maintaining a constant elevation (Figure 20). The roads viewed were not built to take the straighter route of ascending descending hills. The surface of the roads were slightly cambered and retained their matrix of closely fitted surface rocks. Surface material remains found at Korazim ranged from Early Hellenistic through the Roman period, with a few pieces from the Byzantine period and the Middle-Ages. Korazim is located ~ 5 m west of Bethsaida and ~ 4 m north of the Sea of Galilee. Situated an at elevation of ~ 80 m above sea level, just east of the river Nahal Korazim, the ancient city commands an impressive view of the Sea of Galilee and surrounding terrain.

Figure 20. Roman roads leading to Korazim.

Ancient Settlement of Amnun

The ancient settlement of Amnun lies directly southeast of Korazim. A Roman Road heading out of Amnun traveled south to Kefar Nahum and follows the natural contours of the terrain while maintaining a constant elevation or very gradual ascent/descent by going around hills versus the straighter course of over hills (Figure 21). The Amnun site yielded many surface material remains

from Early Hellenistic through the Roman period. Amnun is located

approximately 40 m above sea level, less than 1 km east of the river Nahal

Korazim, and also commands a spectacular view of the Sea of Galilee just 3 km

south of the ancient city.

Figure 21. Roman Road leading to Amnun eastward out of Korazim.

Kefar Nahum

A visit to Kefar Nahum (Capernaum) provided an opportunity to view artifacts in an outdoor museum style setting. A Roman milestone was on display, having been removed from its original provenance with a notation to its former location as being "100 m northeast of the Synagogue" (Figure 22). The exact location was not given and supposedly has been lost to history. Removal of an artifact from its provenience destroys its archaeological significance and, therefore, should not be used as data.

Figure 22. Milestone at Kefar Nahum.

Ancient Settlement of Almagor and Area between Almagor and Amnun

East of Amnun, the ancient settlement of Almagor is overlain by the modern city of Almagor. Surface material remains were not found in the vicinity of the ancient city. Roman Road fragments are reputed to exist on either side of the ancient city; however, attempts to locate road fragments were unsuccessful. Situated near the top of a steep slope which overlooks the Sea of Galilee and the Beteiha Plain at approximately 20 m below sea level, the site lies approximately 3 km west of Bethsaida, approximately 3 km east of Korazim, and 2 km north of the Sea of Galilee.

An investigation of the area between Almagor and Amnun yielded some surface material remains (Figure 23). The majority of the artifacts were dated from the Iron Age with just one artifact each from the Early Roman and Roman periods, and Byzantine period. The area between Amnun and Almagor did not have a road or trail as well defined physically as the Roman road between Korazim and Amnun, or the Roman road heading southward out of Amnun toward Kefar Nahum. Actual fragments of Roman roads were not identified between Almagor and Amnun, nor was an attested road between Almagor and Amnun located (Ilan, 1992). The area between Amnun and Almagor was covered with thorny vegetation which made the investigation difficult, and time-consuming, yet yielded a good view of the Sea of Galilee from its vantage point of ~ 10 m below sea level.

Figure 23. Area between Amnun and Almagor.

Miscellaneous Sites

South of the Tuba II landslide site, situated on a bluff west of the Jordan

River, were the remains of an ancient settlement of several four walled

enclosures of basalt rock (Figure 24). Very few surface material remains were

found; all artifacts were Roman coarseware.

Figure 24. Ancient Settlement above the Jordan River overlooking the Rift Valley.

A survey of the Kibbutz Gadot provided another opportunity to view a milestone that had been found in an orchard located on the property of the kibbutz. However, the milestone had been removed from its original provenance, and placed in a flower garden as an ornament (Figure 25).

Figure 25. A Roman Milestone in a flower garden at Kibbutz Gadot.

Analysis

Analysis of the data acquired during the archaeological investigation was

conducted by producing a spreadsheet to document the surface material

remains according to time period and location (Table 5), and to aid in the

analysis of the spatial distribution of the data over time and space. The table

indicated that of the nine sites visited, the Korazim-Amnun-Josephus

Encampment Road-Watermill region contained a high concentration of artifacts

clustered in the early Hellenistic-Early Roman periods. The Korazim-Amnun-Josephus Encampment Road-Watermill sites yielded data (artifacts dated from the Early Hellenistic-Early Roman period of 333 BCE - 67 CE) at 3.3%, 10.3%, 8.7%, and 27.2%, respectively, for a total of 49.5% of all the surface material remains found during the archaeological investigations. Furthermore, of the nine sites visited, only Korazim and Amnun yielded data clustered in the Roman period, yielding 7.6% and 10.8% of the data, respectively, for a total of 18.4% . The above percentages of the data dating to the Early Hellenistic-Early Roman and Roman periods accounted for ~ 67.9% of the total data acquired from the Korazim-Amnun-Josephus Encampment Road-Watermill region. With the exception of 12% of the data clustered in the Stone Age period from the Josephus Encampment Road site, and 5.4% of the data clustered in the Iron Age period from the Amnun-Almagor Pass site, the remainder of the data are randomly dispersed through time and space within the Korazim-Amnun-Josephus Encampment Road-Watermill region. The total percentage of data clustered in the Early Hellenistic-Early Roman period and the total percentage of data clustered in the Roman period yield percentages of 50% and 22.8%, respectively, of the total of all surface material remains found at all locations.

Site	Paleolithic	Chalcolithic 4300-3300BCE	Early Bronze 3300-2300BCE	EML Bronze 2300-1200BCE	Iron Age 1200-586BCE
Korazim		1			
Almagor					
Amnun					
Watermill					
Kefar Nahum					
Josephus	22				1
Roman Fort					
Amnun-Almagor					10
Gadot					
TOTALS	22	1			11

Site	Babylon-Persian 586-333BCE	Hellen-E Roman 333-67BCE	Roman 67BCE-300CE	Byzantine 300-500CE	Middle-Ages 500-1500CE
Korazim		6	14	1	5
Almagor					
Amnun		19	20	4	
Watermill		16		1	3
Kefar Nahum					
Jcsephus		50	4		
Roman Fort			3		
Amnun-Almagor		1	1	1	1
Gadot					
TOTALS		92	42	7	9

Table 5: Summation of Surface Material Remains

Figure 26. Roman Road following the contours at Korazim and olive press

Therefore, if one were to consider the distribution of artifacts over time and space within the study area as indicative of Roman influence and, indicative of probable placement of Roman roads (Figure 17), it could be summized that the distribution of 50% of the artifacts prior to the Jewish revolt of 67 CE may be indicative of a greater Roman influence in the study area within the Korazim-Amnun-Josephus Encampment Road-Watermill region during the end of the Early Hellenistic-Early Roman period. Furthermore, it could be summized that the lower percentage of 22.8% of artifacts within this same

region after the Jewish Revolt (the beginning of the Roman period) may be indicative of a decreased Roman influence on the region, with the exception of Korazim and Amnun, both of which retained high percentages of distribution of artifacts during the consecutive Early Hellenistic-Early Roman and Roman periods. The continued Roman influence in the cities of Korazim and Amnun may explain the presence of Roman roads at Korazim, Amnun, and Kefar Nahum (attested location of milestone), whereas inversely, the decreased Roman influence may account for the absence of Roman roads at the other sites. This is significant because the Romans did not begin their road building program in Israel until after Israel had become subjugated to Roman rule following the Jewish Revolt of 67 CE (Roll, 1983).

RESULTS OF GIS INVESTIGAITON

A methodical approach to implementing spatial analysis through the application of GIS entailed viewing the study area as a microsystem comprised of the interrelated physical geography attributes of slope, aspect, hydrology, lithology, and probable estuarine coastline, nested within a time and space setting of ancient cities and paleoenvironment. Viewing the study area as a system comprised of interrelated elements permitted separation and isolation of variables, facilitated construction of data layers and operand maps (maps generated by combining data layers), and facilitated creation of a theoretical model. Therefore, the model was represented by:

PE   =   AC + DEM + PGD

where, PE represented the Paleoenvironment, AC represented the Ancient Cities, DEM represented the Digital Elevation Map, and PGD represented the Physical Geography Data layers of slope, aspect, hydrology, lithology, and probable estuarine coastline.

Remembering that the paleoenvironment is an anthropological setting, and that the resistance to movement, spatial friction, affects human choices as a function of time and cost (expenditure of calories), it is advantageous to use the physical geography data layers of slope, aspect, hydrology, lithology, and probable estuarine coastline, to generate a surface friction map. These attributes strongly contributed to the surface friction of the terrain, and greatly influenced the human cost factors that dictated travel by foot through variable terrain to create paths of least resistance over areas of favorable passage. The use of a site suitability analysis process ranked and weighted the attribute values of the physical geography data layers, and combined the data layers algebraically to create a surface friction map that favored lower, most desirable friction values, and amplified greater, least desirable friction values. Therefore, the surface friction map was represented by:

PGD   =   S + A + H + L + PEC

where, PGD represented the Physical Geography Data layers, S represented the Slope, A represented the Aspect, H represented the Hydrology, L represented the surface Lithology, and PEC represented the Probable Estuarine Coastline.

However, in order to produce a surface friction map of those data layers which influenced the human cost factors of travel over a friction surface, a

process was needed to assign meaningful values that favored the lower, most desirable friction cost values, and amplified the greater, least desirable friction cost values of the physical geography attributes.

DEVELOPMENT OF A SITE SUITABILITY ANALYSIS PROCESS

Weighting the Attribute Values

A search of the literature did not yield studies which cited suitability analysis processes that ranked and weighted physical geography attribute values, nor were there any articles regarding the use of lithology to create friction maps. As far as can be determined, research to create routes of efficiency, or Areas of Favorable Passage models, by incorporating surface lithology data into slope, aspect and hydrology datasets has not been conducted. However, literature reviews yielded few studies regarding creation of "friction maps" to generate routes of efficiency by using the slope of a surface. In a study conducted by Hartley and Wolley-Vawser (1994), a friction map was created by squaring the slope (F_S = slope^2). This method of squaring the slope favors the lower, most desirable slope, and unfavorably weights the greater, least desirable slope. Desiring an effective process, use of the squaring of values method was applied to all of the ranked values assigned to the physical geography attributes, with the exception of aspect. Since the slope, hydrology, lithology, and probable estuarine coastline attributes contributed fairly equally toward the accumulation of human cost factors traveling over a friction surface,

aspect contributed the least. Therefore, the ranked values of the aspect attributes were not weighted.

Ranking the Attribute Values

The physical geography attribute values were ranked on a scale of 1 through 10, with 1 = Most Favorable, and 10 = Least Favorable. Ranking the values through the use of an ordinal scale, and weighting the values by the squaring of values method, produced a powerful and effective process of assigning values to the attribute. By applying this process to the physical geography attributes, the lowest friction threshold for the Most Favorable values was determined and weighted accordingly (Table 6). The value of zero for the hydrology and PEC attributes indicated that the absence of water or wetlands on the terrain did not increase the cost factor of travel over a friction surface; however, the use of a value of 1 would increase the cost factor of the surface friction map.

TABLE 6: MOST FAVORABLE RANKED - WEIGHTED ATTRIBUTE VALUES

Slope	1^2	= Most Favorable	0 degree slope
Aspect	1	= Most Favorable	Horizontal (max sun/wind)
Lithology	1^2	= Most Favorable	Smooth, dry, veg free
Hydrology	0^2	= Most Favorable	Absence of body of water
PEC	0^2	= Most Favorable	Absence of PEC

Regarding the Least Favorable values and applying the same process of ranking the attribute values 1 through 10 and applying the squaring the value method to the ranked values, the greatest friction threshold for the Least Favorable values were determined, and weighted as follows (Table 7). Land surfaces were ranked 1 through 9 because travel by foot across land, even the most rugged terrain, was more favorable than travel by foot across bodies of water such as the Jordan River, or through a probable estuarine coastline. Thus, hydrology and PEC were ranked 10 since crossing bodies of water greatly impedes travel by foot.

TABLE 7: LEAST FAVORABLE RANKED - WEIGHTED ATTRIBUTE VALUES

Slope	9^2	= Least Favorable	9+ degrees slope
Aspect	9	= Least Favorable	North (min sun/wind)
Lithology	9^2	= Least Favorable	Wet, floodplains
Hydrology	10^2	= Least Favorable	Presence of body of water
PEC	10^2	= Least Favorable	Presence PEC

Ranked and Weighted Attribute Values of Slope

The use of the above site suitability analysis process facilitated ranking and weighting the attribute values of the physical geography data layers. Therefore, applying the process to all of the attribute layers, the following weighted attribute value sets were created (Table 8). Recalling that the resistance to movement, spatial friction, affects human choice and is a function

of time and cost regarding expenditure of calories (Hartley and Wolley-Vawser, 1994), it is assumed that travel by foot over horizontal ground or ground of least slope is most favorable in terms of expenditure of energy. The rationale to this scheme is self-evident.

TABLE 8: RANKED AND WEIGHTED ATTRIBUTE VALUES FOR SLOPE

0 degrees	$= 1^2$	$= 1$	< expenditure of energy
1-2 degrees	$= 2^2$	$= 4$	
3 degrees	$= 3^2$	$= 9$	
4 degrees	$= 4^2$	$= 16$	
5 degrees	$= 5^2$	$= 25$	
6 degrees	$= 6^2$	$= 36$	
7 degrees	$= 7^2$	$= 49$	
8 degrees	$= 8^2$	$= 64$	
9 degrees	$= 9^2$	$= 81$	> expenditure of energy

Ranked and Weighted Attribute Values of Aspect

Aspect identifies the orientation of the slope toward the sun. Since a dry slope was preferable over a wet or moist slope and offered greater stability (less slippage), slopes with the greatest sun and wind exposure were ranked Most Favorable. The study area was located in the northern hemisphere, thus greatest sun exposure would be on the south facing slopes resulting in drier slopes (Shroder, 1971). Additionally, the location of the study area east of the Mediterranean Sea resulted in prevailing westerly winds off the Mediterranean which increased the dryness of those slopes facing westward (Horowitz, 1979).

Therefore, aspect was ranked as follows, and is not squared due to its small contribution toward the accumulation of human cost factor over a friction surface (Table 9). This ranking scheme favored the dry, stable, sunny slope for areas of favorable passage. Additionally, the south facing, sunlit slopes provided the traveler with a greater amount of travel time by daylight, as well as warmer travel in areas of high altitudes.

TABLE 9: RANKED AND WEIGHTED ATTRIBUTE VALUES OF ASPECT:

Horizontal	=	1	maximum sun and wind
South	=	2	
Southwest	=	3	
Southeast	=	4	
West	=	5	
East	=	6	
Northwest	=	7	
Northeast	=	8	
North	=	9	minimum sun and wind

Ranked and Weighted Attribute Values of Lithology

Ranking the surface lithology required consideration of travel by foot over the friction surface of the earth. In this scheme, smooth dry land surfaces with minimum vegetative cover were favored over rugged, rocky terrain and forested mountainous terrain. Also, dry land is favored over wet, marshy lands or bodies of water. The attributes of surface lithology were ranked 1 through 10 and contained only four classes (Table 10):

TABLE 10: RANKED AND WEIGHTED ATTRIBUTF VALUES OF LITHOLOGY

Chalk	$= 1^2$	$= 1$	easily eroded, porous, infertile
Basalt	$= 7^2$	$= 49$	min slopc 7 degrees, rocky, rugged
Mountains	$= 8^2$	$= 64$	min slope 8 degrees, rugged, forested
Floodplains	$= 9^2$	$= 81$	clay minerals, floodplains, swamps

Soft chalk is porous and dries quickly. Additionally, it erodes easily and degrades into a poor, infertile soil which leaves the surface free of vegetation (Horowitz, 1979). The unique characteristics of soft chalk resulted in a Most Favorable friction surface ranked as $1^2 = 1$, due to low expenditure of calories.

Basalt is an igneous rock, fine-grained with angular surface features, which can easily cut and bruise the feet of traveler and beast. The basalt hills have a minimum slope of 7 degrees which increased travel by foot difficulties over the rock-strewn terrain. Additionally, weathered basalt produced black, fertile soil which was favorable to vegetative cover (Horowitz, 1979). Therefore, basalt was ranked as $7^2 = 49$ due to its minimum 7 degree slope, rocky rugged terrain, heat retention due the black color of the basalt, and thick vegetative cover since these factors combined to increase the expenditure of energy of travel by foot over this friction surface.

The Naphtali Mountains are a rugged, mountainous terrain with minimum slope of 8 degrees, rising sharply above the basalt hills of the Korazim Plateau. The soil of the Naphtali Mountains is weathered basalt, resulting in heavily forested terrain (Horowitz, 1979). Therefore, the mountains were ranked as

$8^2 = 64$ due to its minimum 8 degree slope, and very rocky, rugged, and heavily forested terrain. Travel through the forested mountains not only impeded travel by foot, but reduced visibility, combining to increase the expenditure of energy of travel by foot over this friction surface.

The floodplains consisted of clay minerals of the Tabgha Formation. These clays were probably derived from weathered basalt (Horowitz, 1979), and have great moisture retentive capabilities. Due to the low elevation of 200 to 209 m below sea level directly north of the Sea of Galilee, and the close proximity of the Jordan, Meshoshim, Zawitan, Yehudiye, Sefamnun, and Daliyot Rivers, the floodplains were subjected to seasonal flooding during the winter season and tended to be swampy and marshy the remainder of the year. Therefore, adhering to the ranking scheme of Dry = Most Favorable, and Wet = Least Favorable, the floodplains were ranked as $9^2 = 81$, since floodplains could be dry a minimum amount of time during the year, or flooded or marshy a maximum amount of time during the year, but may not be flooded or marshy 100% of the time.

Ranked and Weighted Attribute Values of Hydrology and PEC

The Hydrology and Probable Estuarine Coastline attributes were ranked and weighted as follows (Table 11). As noted previously, the value of zero for the hydrology and PEC attributes indicated the absence of water or estuarine coasts on the terrain and did not increase the cost factor of travel over a friction surface; the use of a value of 1 would needlessly increase the cost factor of the

surface friction map. Recalling that land surfaces are ranked 1 through 9 since

travel by foot across land is favorable over travel by foot on water, hydrology

and PEC are ranked 10, since crossing bodies of water greatly impedes travel

by foot. This, of course, does not preclude travel by boat; however, in that case,

roads are not relevant.

TABLE 11:   RANKED AND WEIGHTED ATTRIBUTE VALUES OF
            HYDROLOGY AND PEC

Hydrology:	0^2	$= 0$	Absence of water
	10^2	$= 100$	Presence of water body
PEC:	0^2	$= 0$	Absence of PEC
	10^2	$= 100$	Presence of PEC

Spatial Analysis Operations and Creating Areas of Favorable Passages Models

The final step of the GIS investigation involved determining the

operations needed to conduct the spatial analysis and create an Areas of

Favorable Passage model. The theoretical model of the paleoevironments was

represented by:

PE   = AC + DEM + PGD

The use of a site suitability analysis process to rank the attribute values on a

scale of 1 through 10 and weight the attribute values by using the squaring the

value method, yielded an effective means of converting physical geography

data layers into ranked and weighted data layers which can then be added

together algebraically to produce a surface friction map:

$$PGD_{RW} = S_{RW} + A + L_{RW} + H_{RW} + PEC_{RW}$$

The squaring of values method was applied to all of the ranked attribute values

with the exception of aspect, as discussed above.

Use of the data layers and operand maps to conduct spatial analysis by

creating an Areas of Favorable Passage model was accomplished by using the

spread operation and regroup function. Therefore, the theoretical model was

used as a template to generate a theoretical model of the paleoenvironment

through GIS spatial analysis. Substituting AFP (areas of favorable passage) for

PE, the spatial analysis to generate an Areas of Favorable Passage model by

using the spread operation was represented by:

AFP = Spread AC To 50,000 Over DEM In SFM

where, "Spread AC" represented spreading outward through Ancient Cities

(data layer) by seeking lowest values, "To 50,000" represented the maximum

friction value set to spread from ancient city to ancient city, "Over DEM"

represented travel over elevation data by taking vertical and horizontal values

into account, and "In SFM" represented the cost (expenditure of energy) of

traveling from cell to adjacent cell over a surface friction map.

The spread operation produced a model which connected the ancient

cities by areas of favorable passage. The use of the Regroup function was used

to group the incremental values generated by the spread operation and defined

those increments of lowest values which identify the areas of favorable passage.

After identifying the areas of favorable passage, the cover operation was used to overlay the Ancient Roads, Ancient Cities, Areas of Favorable Passage, and Hydrology data layers onto a shaded relief model to produce a map layer which met the primary and secondary objectives of this thesis.

CREATING AND EDITING DATA LAYERS AND OPERAND MAPS

In order to create and edit maps, certain tasks must be performed in preparation of processing the data. Those steps must betaken prior to tracing the scanned image and producing data layers.

Cell Resolution

Calculating the cell resolution defined the square parcel of land represented by one map cell. The cell resolution was determined initially so that future maps generated from the scanned base map will share the same resolution. The base map selected had a 1:50,000 scale and used a 1 km^2 grid of Israel and UTM coordinates. Selecting a grid line in the base map of 1000 meter in length (1 km), the distance was measured by drawing a line to match the length of a one meter section of a grid line, measured in units of number of cells, and calculated for a total of 234 cells per 1000 m. This measurement was tested several times over the surface of the map to ensure accuracy. To calculate cell resolution, 1000 m / 234 cells for a cell resolution of 4.2735 m. Rounding the figure to 4.27, this equates to each cell representing a 18.23 m^2

parcel of land. Other studies have successfully used cell resolution of up to 30 m^2 (Hartley and Wolley-Vawser, 1994).

Georeferencing the Maps

The next step involved georeferencing the base map and creating a map geometry. The scanned base map referenced dual coordinate systems of Universal Transverse Mercator (UTM) and Israel Grid. Desiring to produce a wider than regional application of the maps, the UTM coordinate system was selected. Map*Factory provided a Geometry Editor which allowed the user to register cells in predetermined formats of UTM or Latitude/Longitude. A map geometry was created by selecting three cells on the scanned map and assigning row and column coordinates in terms of real world UTM coordinates recorded on the scanned map. Providing UTM coordinates to a row and column location registers the cell and defines the map geometry. The process is completed by building the coordinate system geometrically by interpolation between the registered points and throughout the base map (Kirby, 1996). The process was tested to determine the accuracy of the map geometry by measuring distances in UTM coordinates.

The UTM coordinate system was registered to the scanned base map which was then used to generate all data layers and operand maps. Therefore, the grids on all data layers and maps generated for this study are registered to the UTM grid of the scanned base map.

After setting cell resolution, and registering and defining map geometry, the scanned base map resulted in a data layer of 4,185 rows and 2,549

columns, for a total of 10,667,565 cells. This scanned map was used as the base map, or template, for the construction of the remainder of the data layers and resulting operand maps.

Data Layers and Operand Maps

Scanned Base Map: The base map was used as the template to build the data layers needed for the GIS analysis (Figure 27). The theoretical model of the paleoenvironment represented as:

PE   = AC + DEM + PGD

and

PGD = S + A + L + H + PEC

provided a template for creating the data layers and operand maps needed for spatial analysis. Therefore, the initial step in creating the operand maps was to reconstruct the paleoenvironment by building the physical geography data layers.

Ancient Cities: This data layer was created by placing pixel points at the location sites the ancient cities selected for this analysis. This data layer was used in the Spread operation during the spatial analysis (Figure 28).

Topography: The scanned map was set to a ratio of 1:4 through the Zoom function to enlarge the image and facilitate tracing each contour line with a line or open polygon tool. The contour lines ranged from 209 m below sea level to 590 m above sea level, cell values ranging from -209 to 590. Tracing the contour lines was tedious and time intensive (~ 170 hours). The traced lines of assigned elevation values were grouped to separate the input
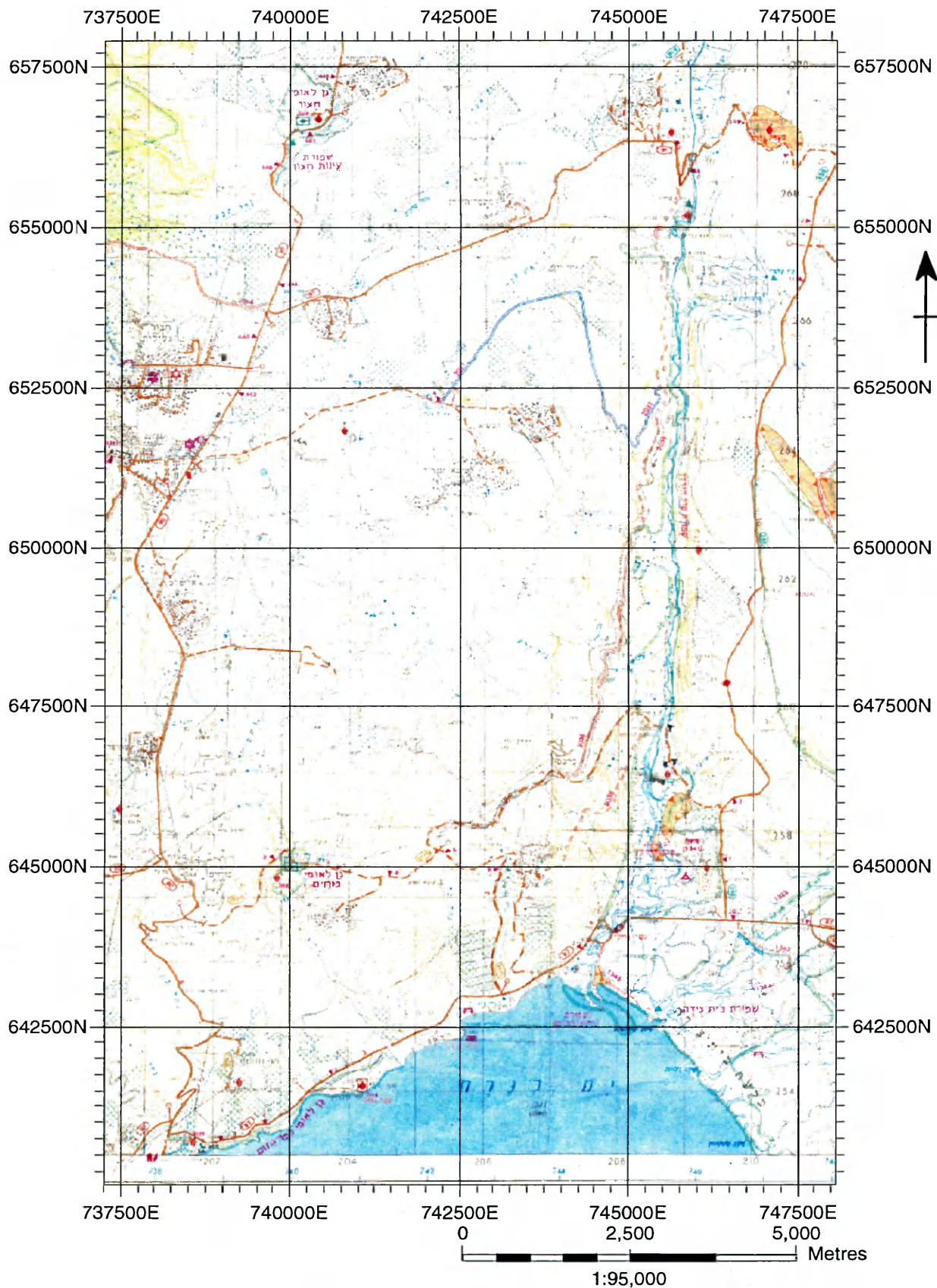
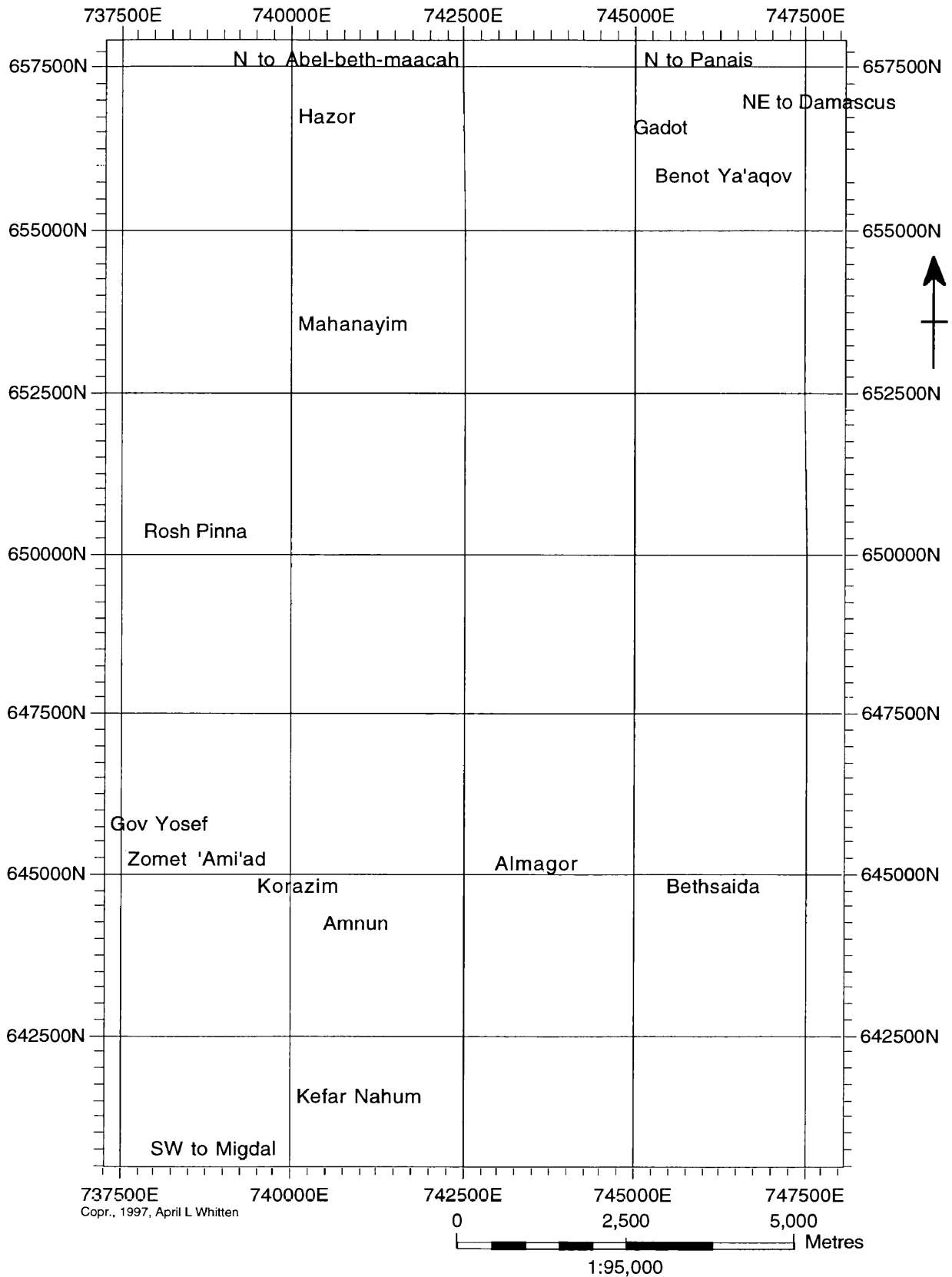**Figure 27: Scanned Base Map**

Figure 28: Ancient Cities

data from the background values of the scanned map. The background values of the scanned image were grouped and coded Void and removed from the final data layer (Figure 29).

Hydrology: The hydrology data layer was traced and generated as described above with the open polygon tool. Bodies of water were filled in after boundaries were defined with the "paint can" tool. The elevation of the hydrology ranged from 211 m below sea level to 500 m above sea level. Cell values were set to 0 for land and 100 for hydrology (Figure 30).

TopographyOnHydrology: The generation of a DEM required data layers of contour lines. In most cases, the hydrology is masked or set as VOID during the interpolation process. However, in this instance due to the elevation range from 209 m below sea level to 590 m above sea level, it was necessary to combine the topography and hydrology data layers. This was accomplished by using the Cover operation which overlays data layers to produce a composite data layer (Figure 31). The cover operation combined maps layers to preserve the cell value of the last nonvoid cell value stacked in the data layers. Void cells are treated as transparent, cells of value are treated as opaque, in much the same way as stacking transparencies on an overhead (Kirby, 1996). In this instance, the topography was placed on top of the hydrology because it was necessary to preserve the values of the contour lines. The hydrology cell values were then changed to match the corresponding topography cell values in which the hydrology cells lay. Combining the data layers of topography and hydrology ensured that bodies of water, e.g., lakes, did not straddle or fall within different elevation levels. Rivers naturally change elevations as they descend
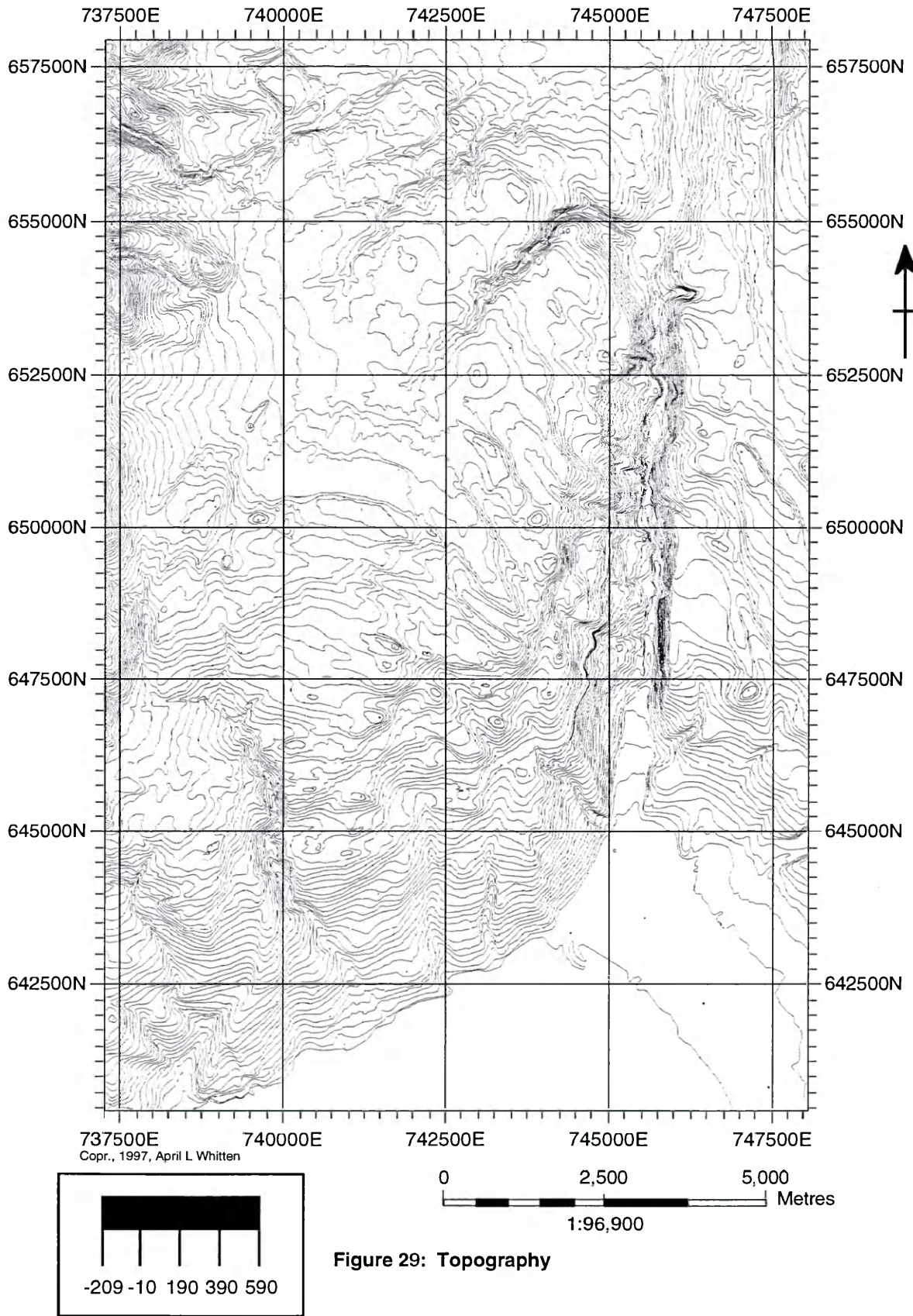
0   2,500   5,000

Metres

1:96,900

-209 -10 190 390 590

Figure 29: Topography

Copr., 1997, April L Whitten

	0	Land
	100	Hydro

0   2,500   5,000   Metres
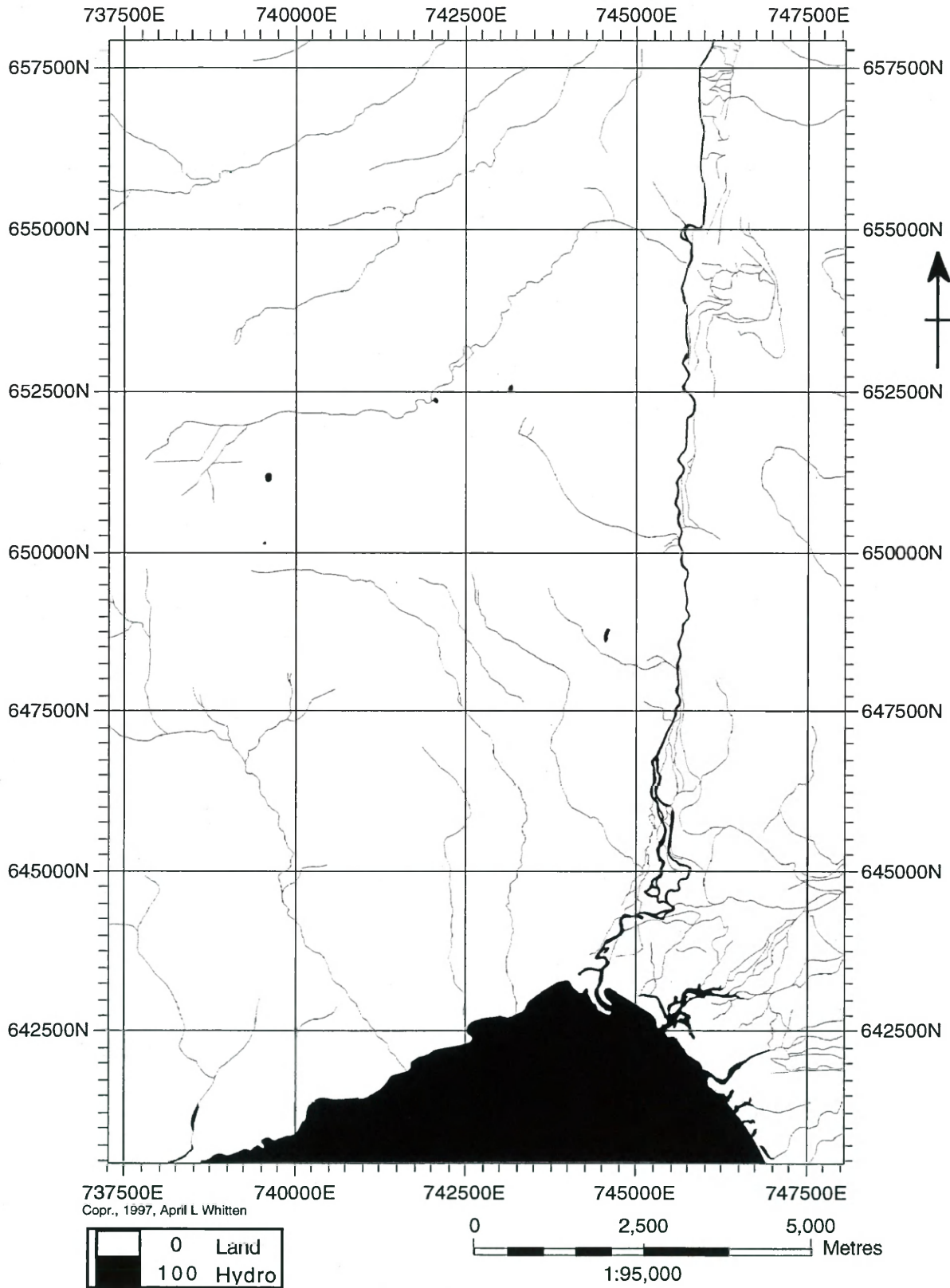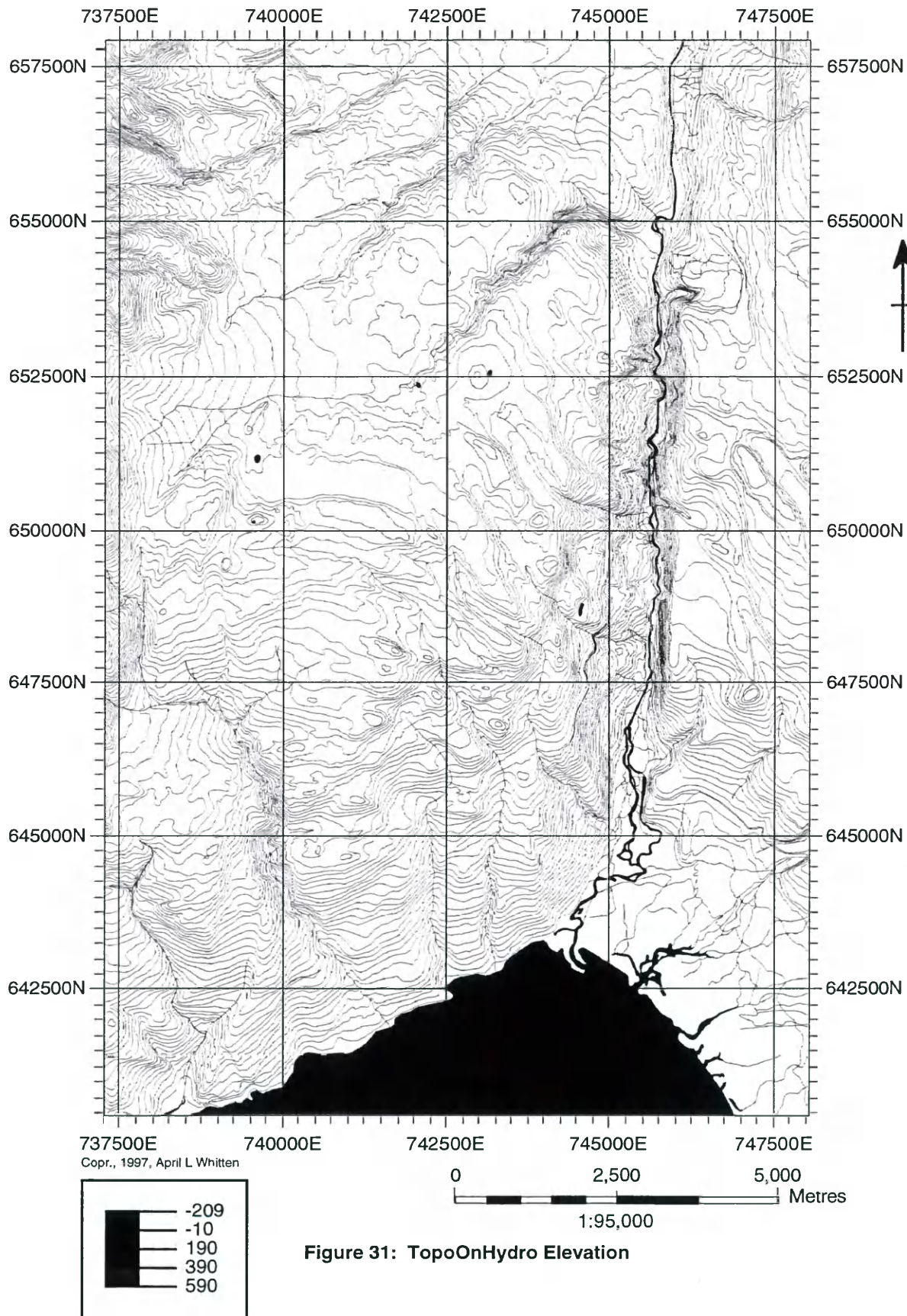
1:95,000

Figure 30: Hydrology

Figure 31: TopoOnHydro Elevation

through drainage systems, therefore, the elevation values between contour lines were changed to reflect the elevation values of the terrain.

DEM: Production of the Digital Elevation Model was accomplished in a two step process, by using the Interpolate and Scan operations. The Interpolate operation uses sparse data, e.g., contour lines, to create continuous data through a two pass approach (Figure 32). The use of the Step modifier allowed the user to chose the tightness or weave of the first pass, e.g., a designation of Step 1 means the initial pass interpolated values in each cell, whereas the designation of Step 2 or Step 3 interpolated values for every other or every third cell, respectively. The greater the Step increment, e.g., Step 10, the faster the interpolation process was completed with a smoother result. However, accuracy was sacrificed when such a "loose weave" of initial data was produced on the first pass. The second pass interpolated values for every cell, using the fabric of the first pass as a foundation. During both passes, the interpolation was conducted within a 3 cell x 3 cell window by using:

target cell value = $\Sigma_i \, e_i/d_i \, / \, \Sigma_i \, d_i^{-1}$

where, "e" is the elevation of an adjacent cell, "d" is the distance between the adjacent cell and the target cell, and "i" is number of cells. The interpolation averaged the summation of elevation values divided by distance values, and divided by either the summation of the inverse (distance) square values, or inverse (distance) values. The inverse square modifier weighted the value based on the inverse square of the distance ($1/d^2$ or d^{-2}); the square modifier weighted the value based on the inverse of the distance ($1/d$ or d^{-1}). The user
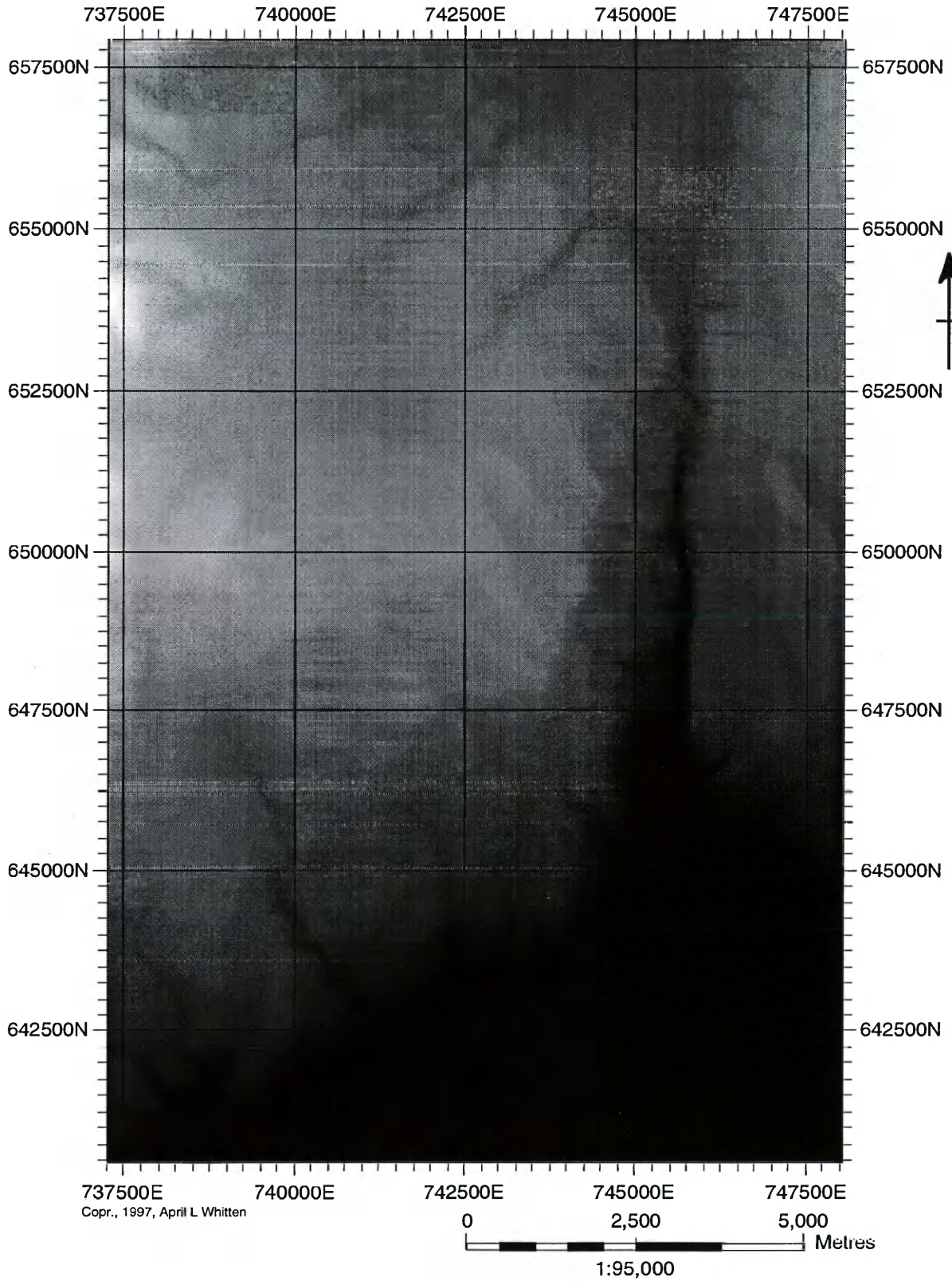
Figure 32: Interpolated TopoOnHydro

defined use of the inverse square or inverse modifier as denominator. The use of the inverse square was standard in other programs; therefore, that option was initially selected. However, the DEM produced weighted values along the contour lines which resulted in data layers of "zebra striped" artifacts. This effect persisted even after filtering the DEM several times through a scan or lowpass filter to smooth the data (Kirby, 1996). Unsatisfied with the results of the use of the inverse square modifier, the inverse of the distance modifier was used, which resulted in a stepped data layer consisting of 3,996 elevation values. The interpolation process was set at:

<TopoOnHydro = Interpolate To 0.20 m Step 2 w/o InverseSquare> where, "To 0.20 m" defined interpolate to a distance of 0.20 m, and "Step 2" defined first pass interpolation on every other cell. Processing time for interpolation with the inverse square modifier was approximately 38 hours; processing time for interpolation with the inverse modifier was about 12 hours.

Scan: The second step to completing production of a DEM involved use of a filter to smooth the data. The interpolation process resulted in a DEM data layer of stepped data at 0.20 m elevation increments. Since a neatly stepped landscape is anomalous in the real world, and desiring to model reality, the Scan operation was used to smooth the data by generating a data layer of summary statistics based on the values of cells found within a moving window. A 3 x 3 square window was selected to produce an average of summary statistics $(\sum_i X_i / n_i)$ in order smooth the data and remove the stepped data increments (Kirby, 1996). The scan operation was set at:

<TopoOnHydroDEM = Scan Average Within 3 Square>

which, resulted in a DEM of 39,243 elevation values. The DEM was now ready

to be used to generate the physical geography data layers; processing time

took ~ 55 minutes (Figure 33).

Slope: Map*Factory used the Grade operation to produce a data layer of

maximum or average gradient values of steepness. The resulting cell values of

the operand map represented the slope (rise over run) of the elevation. Within

a 3 x 3 window, the algorithm is performed on the six north and south cells to

produce the mean of X, and on the six east and west cells to produce the mean

of Y. Use of the maximum modifier resulted in a cell value based on eight

slopes. The gradient is calculated by:

$$<Grade = (\sqrt{X^2 + Y^2}) \times 100>$$

where, the square root of the mean of X^2 plus the mean of Y^2 are multiplied by

100 to produce a gradient percentage (Kirby, 1996). Slope is an important

attribute to consider when determining areas-of-favorable passage since the

steepness of the slope can deter passage over the landscape. Due to the

unique geologic constraints of the study area, the maximum modifier was

selected in order to emphasize the maximum variance of slope. The slope cell

values were determined according to the site suitability analysis process

described in the Methods chapter and are as indicated in the map legend

(Figure 34).

Aspect: Map*Factory used the Orient operation to produce a data layer

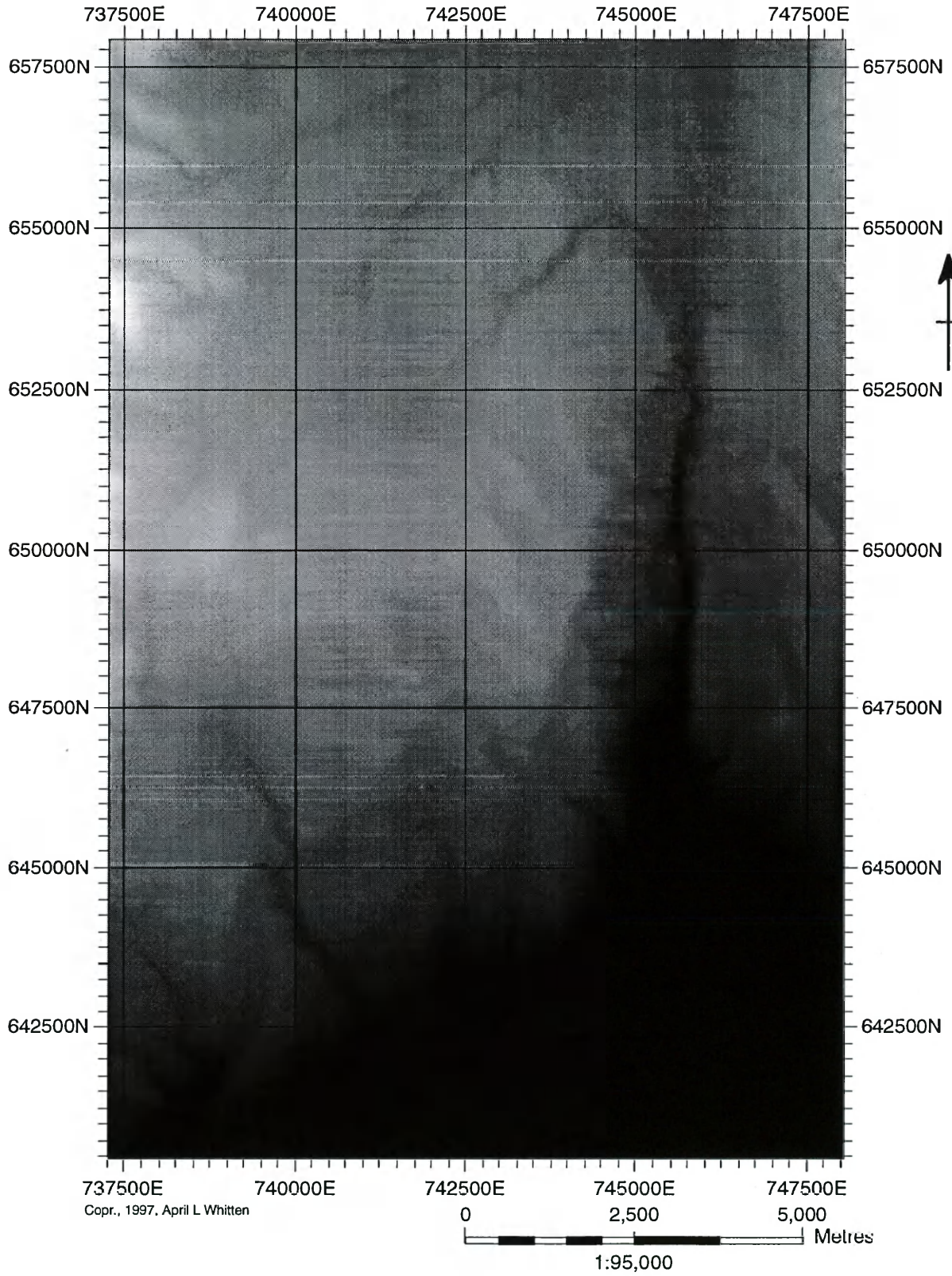of values representing the orientation of a slope defined by either cardinal
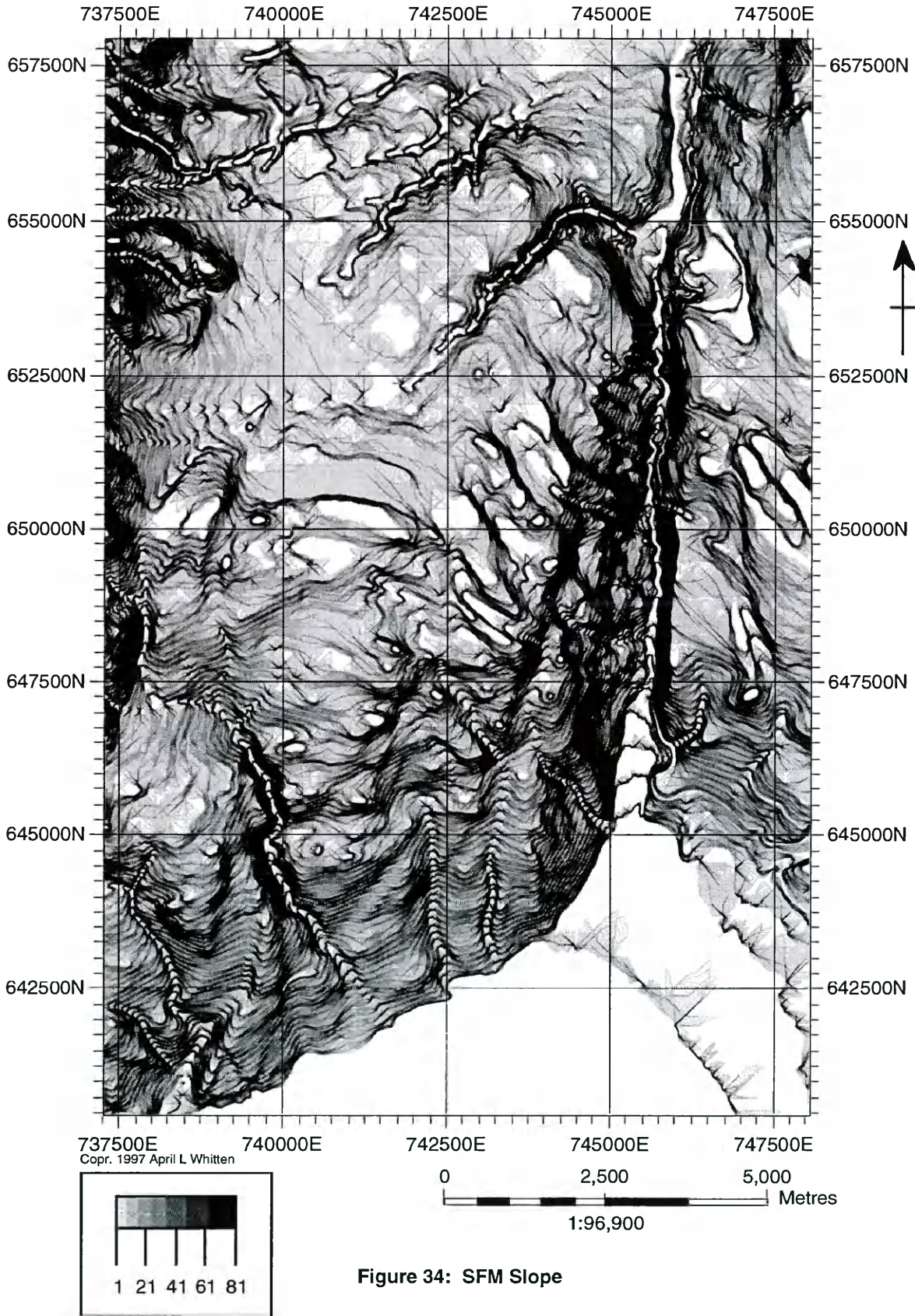
Figure 33: DEM TopoOnHydro
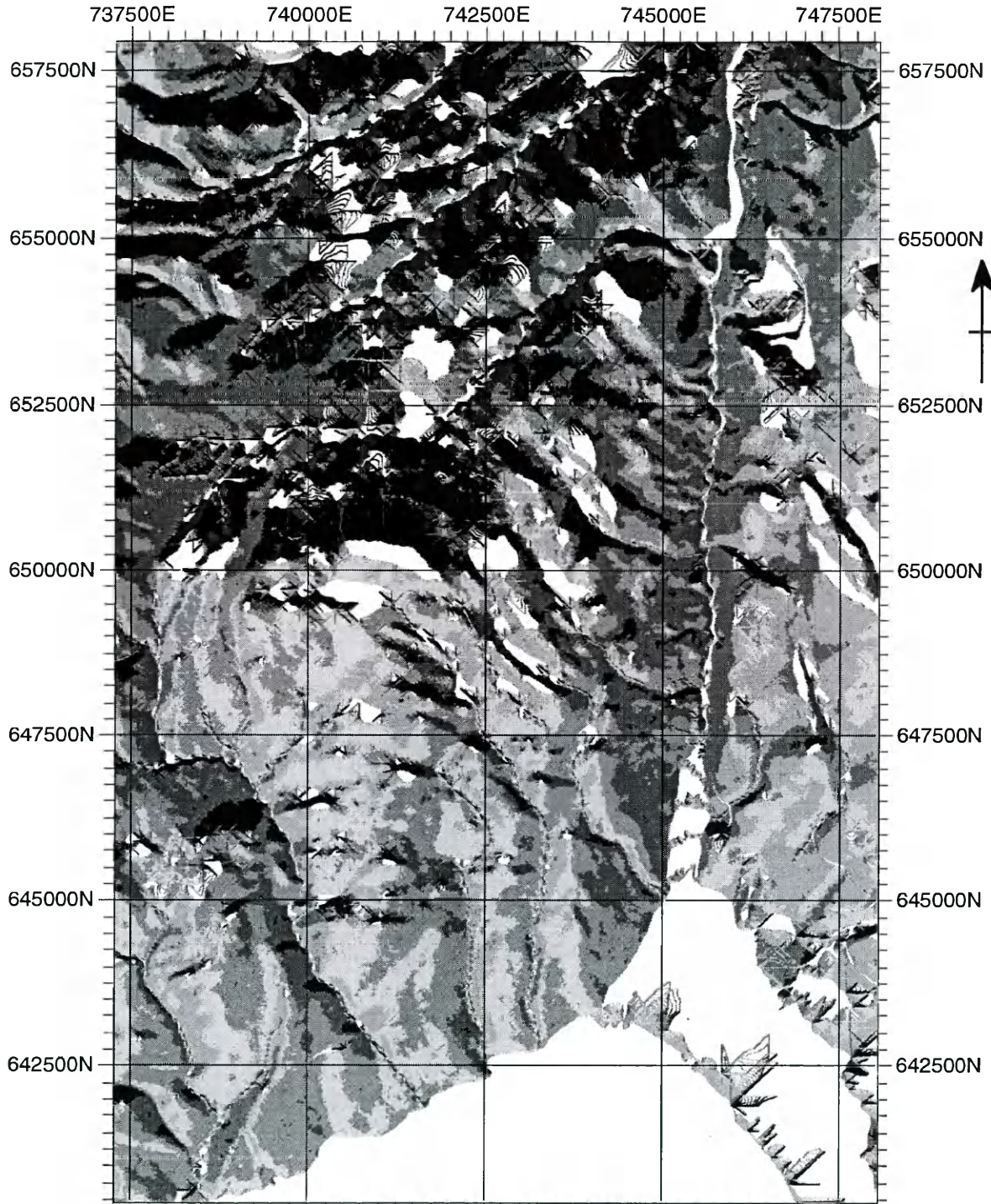
Figure 34: SFM Slope

1:96,900

compass points (1 through 8, beginning 1 = N, 2 = NE..., 8 = NW, with 9 = flat) or

360 degrees clockwise (1° - 360 °, 1° = N..., 90° = E..., 180° = S..., 270° = W...,;

361° = flat). The aspect is derived from the elevation data of the DEM (Kirby,

1996). The cardinal compass points modifier was selected for the purpose of

ease in classifying orientation of the slope and setting cell values to produce a

surface friction map. The cell values of aspect were set according to the site

suitability analysis process described previously and are as indicated in the

map legend (Figure 35).

Lithology: The surface roughness of the physical geography was

represented by the Lithology data layer. This operand map was created from

the scanned image of the base map by tracing the regions according to the

lithology described by Horowitz (1979) in his general geologic map of the Hula

Valley, Israel. The regions were defined by tracing with the open polygon tool,

assigned values according to a grayscale, and set cell values according to the

site suitability analysis process of ranking and weighting values as previously

described. (Figure 36).

Hydrology: This data layer was generated from the scanned base map.

The cell values are set to 0 for absence of water and 100 for presence of water

according to the ranking and weighting scheme described in the Methods

chapter (Figure 37).

Probable Estuarine Coastline (PEC): This data layer was generated by

using the scanned base map and tracing the region as defined by data from a

study conducted by Shroder and Inbar (1995) regarding the location of a

Figure 35: SFM Aspect

1	Level	
2	S	
3	SW	
4	SE	
5	W	
6	E	
7	NW	
8	NE	
9	N	

Copr., 1997, April L Whitten

0   2,500   5,000 Metres

1:96,900

Copr., 1997, April L Whitten

	0	Water
	1	Chalk
	4 9	Basalt
	6 4	Mtns
	8 1	Clavs

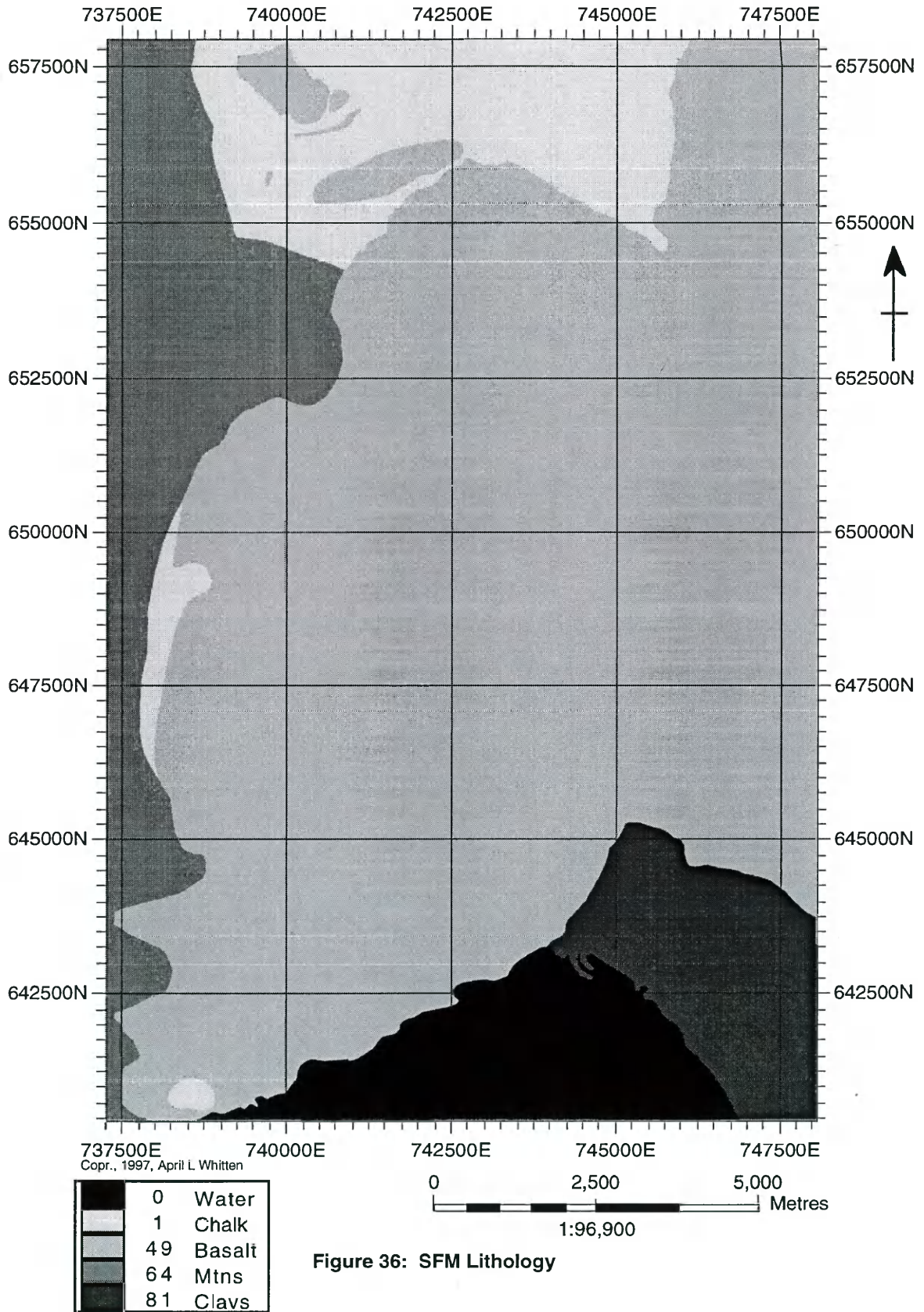0   2,500   5,000
Metres
1:96,900
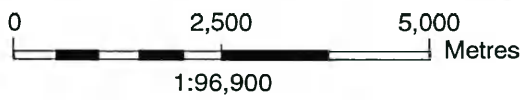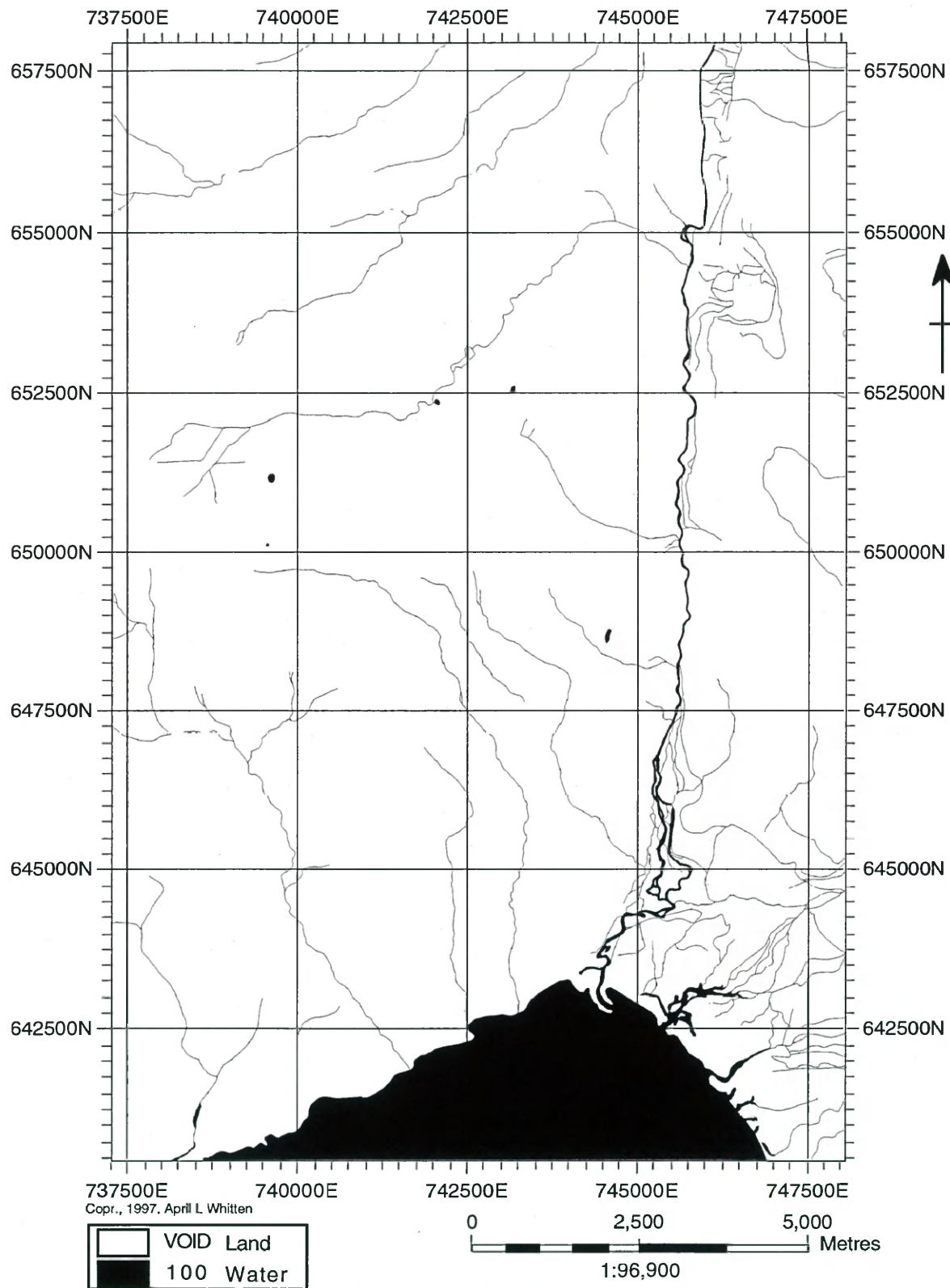
Figure 36: SFM Lithology

Figure 37: SFM Hydrology

probable estuarine coastline. As discussed previously, the PEC values were set to 0 for absence of PEC, and 100 to presence of PEC (Figure 38).

Surface Friction Map: This operand map was generated by combining the ranked and weighted physical data layers of Slope, Aspect, Lithology, Hydrology, and Probable Estuarine Coastline algebraically by addition:

$$\text{<PGD}_{RW} = S_{RW} + A + L_{RW} + H_{RW} + PEC_{RW} >$$

This operation resulted in a surface friction map of combined values from 2 to 371, with the lowest values representing Most Favorable friction values, and the highest values representing the Least Favorable friction values (Figure 39).

SPATIAL ANALYSIS

Areas of Favorable Passage Model

Spatial analysis of the study area was performed with the data layers and operand maps by using the Spread and Regroup operations. The theoretical model was used as a template to generate a theoretical model of the paleoenvironment through GIS spatial analysis. Therefore, substituting AFP (Areas of Favorable Passage) for PE (Paleoenvironment), spatial analysis was conducted by using the spread operation as represented by:

<AFP = Spread AC To 50,000 Over DEM In SFM>

where, "Spread AC" represented spreading outward through Ancient Cities by seeking lowest values, "To 50,000" represented maximum value set to spread, "Over DEM" represented travel over elevation data taking vertical and horizontal
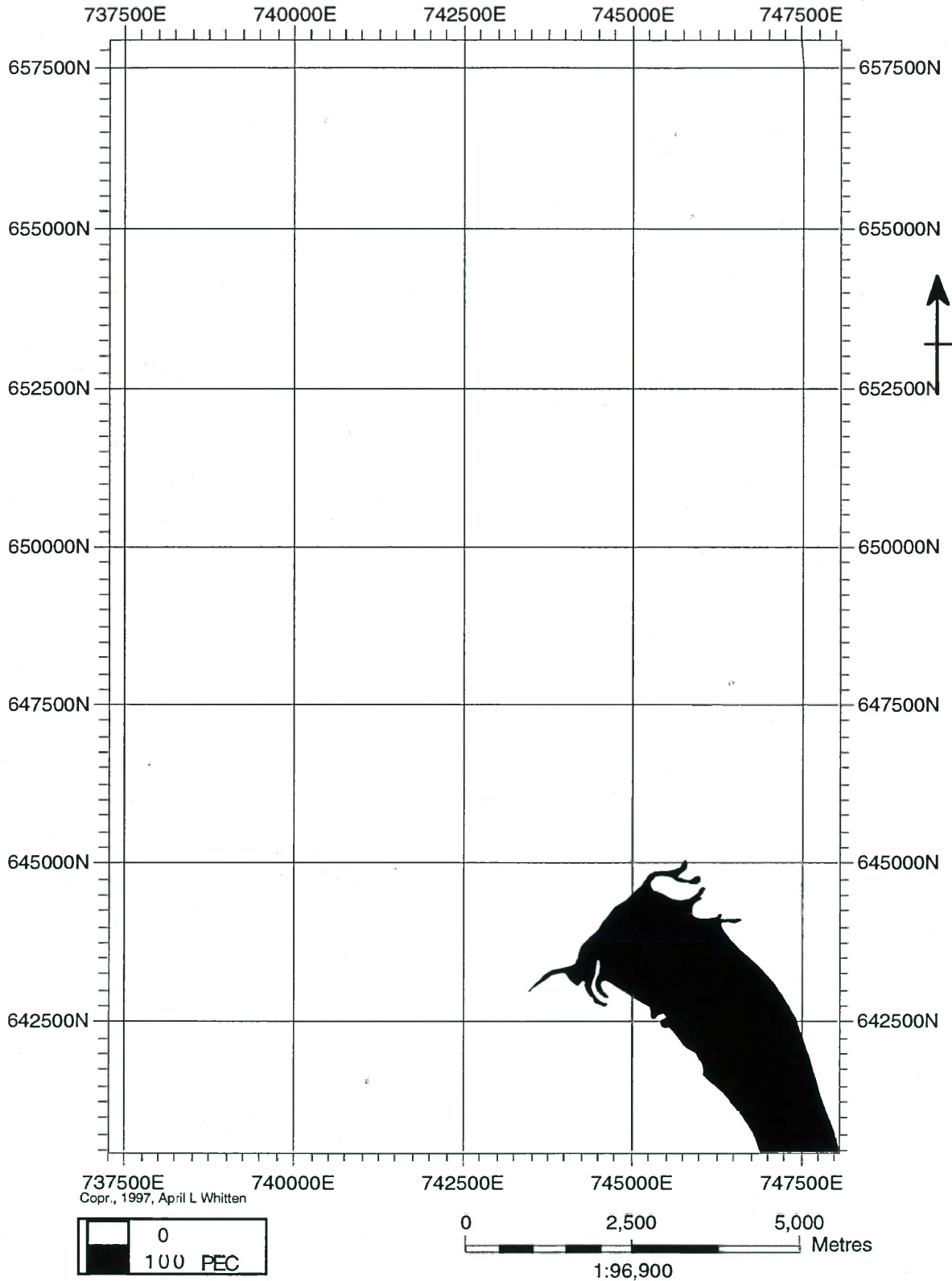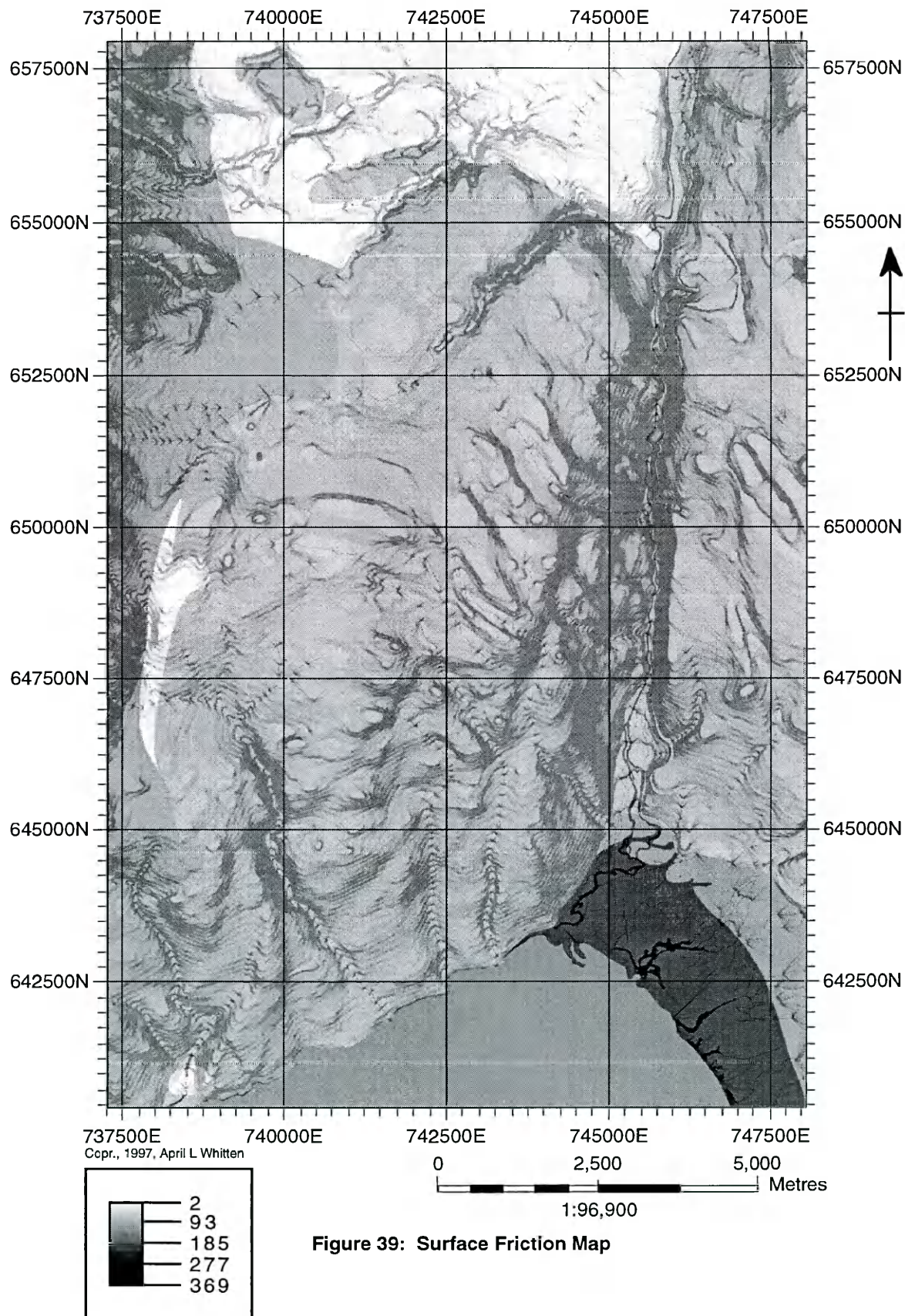
Figure 38: Probable Ancient Estuarine Coastline

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Figure 39: Surface Friction Map

1:96,900

0   2,500   5,000   Metres

2
93
185
277
369

values into account, and "In SFM" represented the cost (expenditure of energy) of traveling from cell to adjacent cell over a surface friction map.

The spread operation produced a model by creating a data layer of values by interpolating outward from a center cell to adjacent cells, seeking the lowest cumulative value, while moving in the direction of the lowest cumulative value. The interpolation reiterated from cell to cell, calculating the cumulative cost of travel over the horizontal and vertical distances of the DEM, spreading outward, and covering the distance from Ancient City to Ancient City, while "traveling" in the values of the Surface Friction Map. The spread operation calculated the shortest path of non-Euclidean distance by calculating cost from the target cell (Ancient City) through all adjacent cells. Diagonal distances were multiplied by an additional factor of $\sqrt{2}$ (1.41421) when vertical distances of elevation were included in the operation, in addition to horizontal distance (Kirby, 1996).

The spread operation took 134 hours of processing time for completion. The results produced an Areas of Favorable Passage model which defined those areas where travel would be least impeded by the factors of the physical geography of the terrain as represented by the values assigned in the Ancient City map, the DEM, and Surface Friction Map (Figure 40).

The Regroup operation was used on the Areas of Favorable Passage model to systematically group the values in equal increments in order to indicate the increasing cost factors (> expenditure of energy) associated with passage over the terrain. Recalling that the spread function was allowed to

Figure 40: Areas of Favorable Passage Model

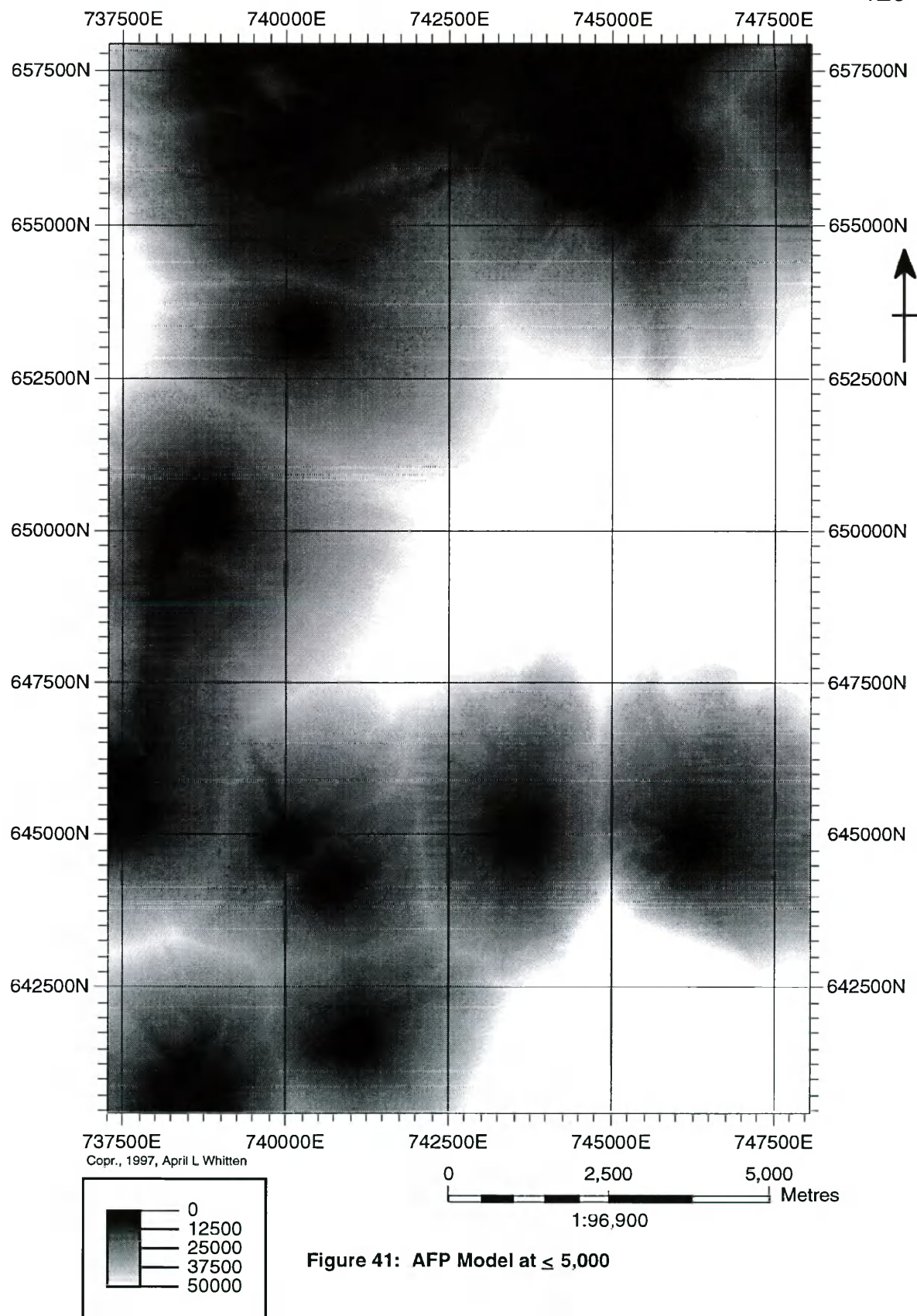Copr., 1997, April L Whitten

1:96,900
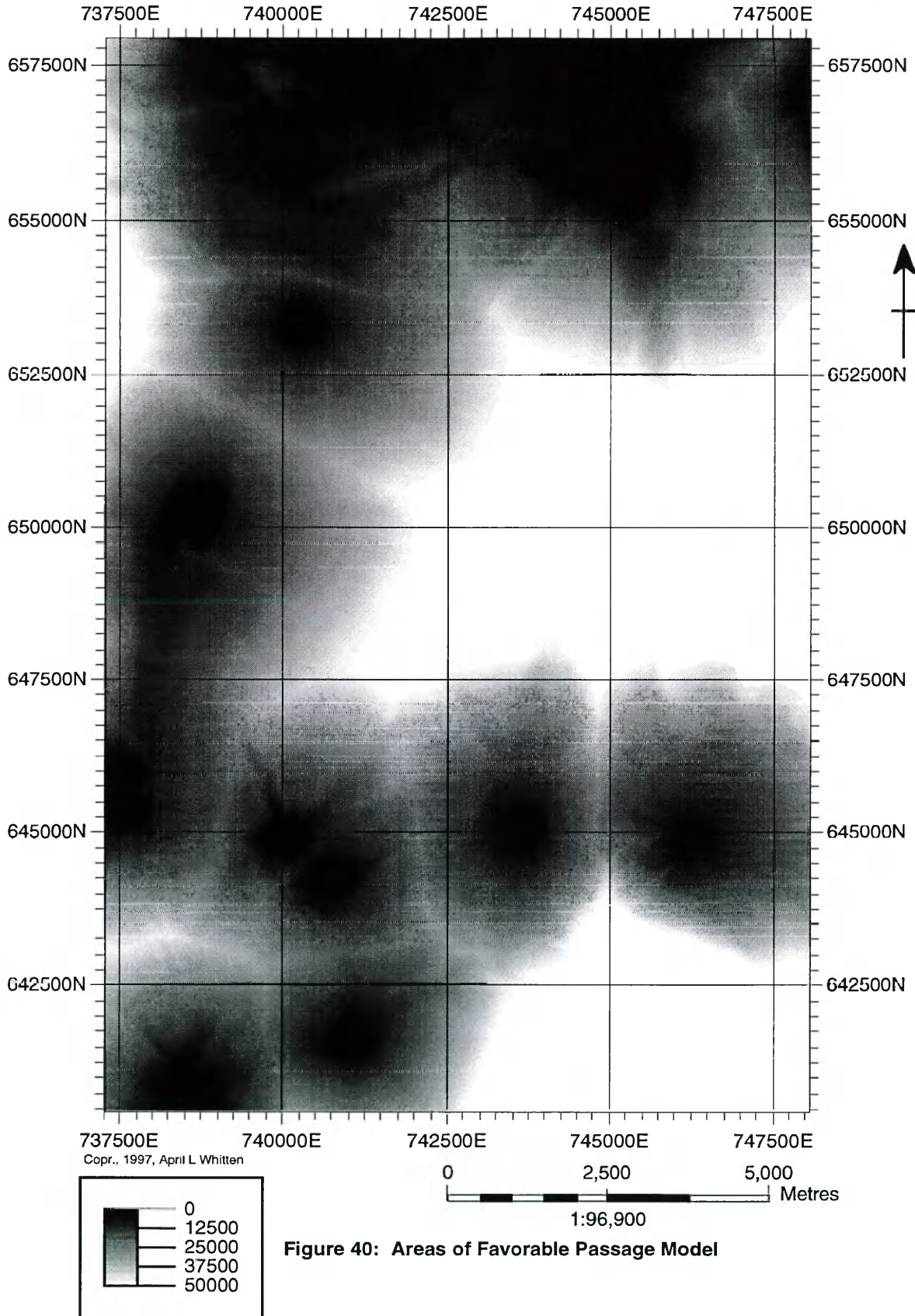
spread to a maximum (Least Favorable) cumulative cost of 50,000, the lowest

values were Most Favorable. Furthermore, ranking the cost values on a scale of

1 through 10, with 1 = Most Favorable, and 10 = Least Favorable (1 = 5,000, 2 =

10,000, 3 = 15,000..., 10 = 50,000), facilitatcd interpreting the cost factor values.

ANALYSIS OF THE AREAS OF FAVORABLE PASSAGE MODELS

The cities in the northern sector (Benot Ya'aqov, Gadot, and Hazor) and

routes leading toward those cities (NE to Damascus, N to Panais, and N to

Abel-beth-maacah) were joined by regrouping cost factor values of $\leq$ 5,000

(Figure 41), equating to 1 = Most Favorable. These cities were located on

terrain of $\sim$ 3° slope, with lithology comprised of chalk. Fording the Jordan

River can be accomplished in the northern sector due to the shallower slopes

and wider floodplain along the river north of Benot Ya'aqov. Mahanayim was

joined to the northern sector at cost factor values < 10,000 (Figure 42), which

was the equivalent of a 2, slightly less than Most Favorable. The western sector

(Rosh Pinna, Gov Yosef and Zomet 'Ami'ad), were joined at values between

10,000 to 15,000, for a ranking of 2 to 3. The cities of Korazim and Amnun

were joined at values of $\leq$ 15,000 (Figure 43); however, these cities are of the

Roman-Byzantine period and were not associated with the ancient great Trunk

Road. With the exception of Korazim and Amnun, those ancient cities joined at

the lowest cost factor values of 5,000 through 15,000 were located along the

great Trunk Road, its route constant due to the constraining geologic and

geographic characteristics of the region (Von Hagen, 1967). Therefore, I

Figure 41: AFP Model at ≤ 5,000

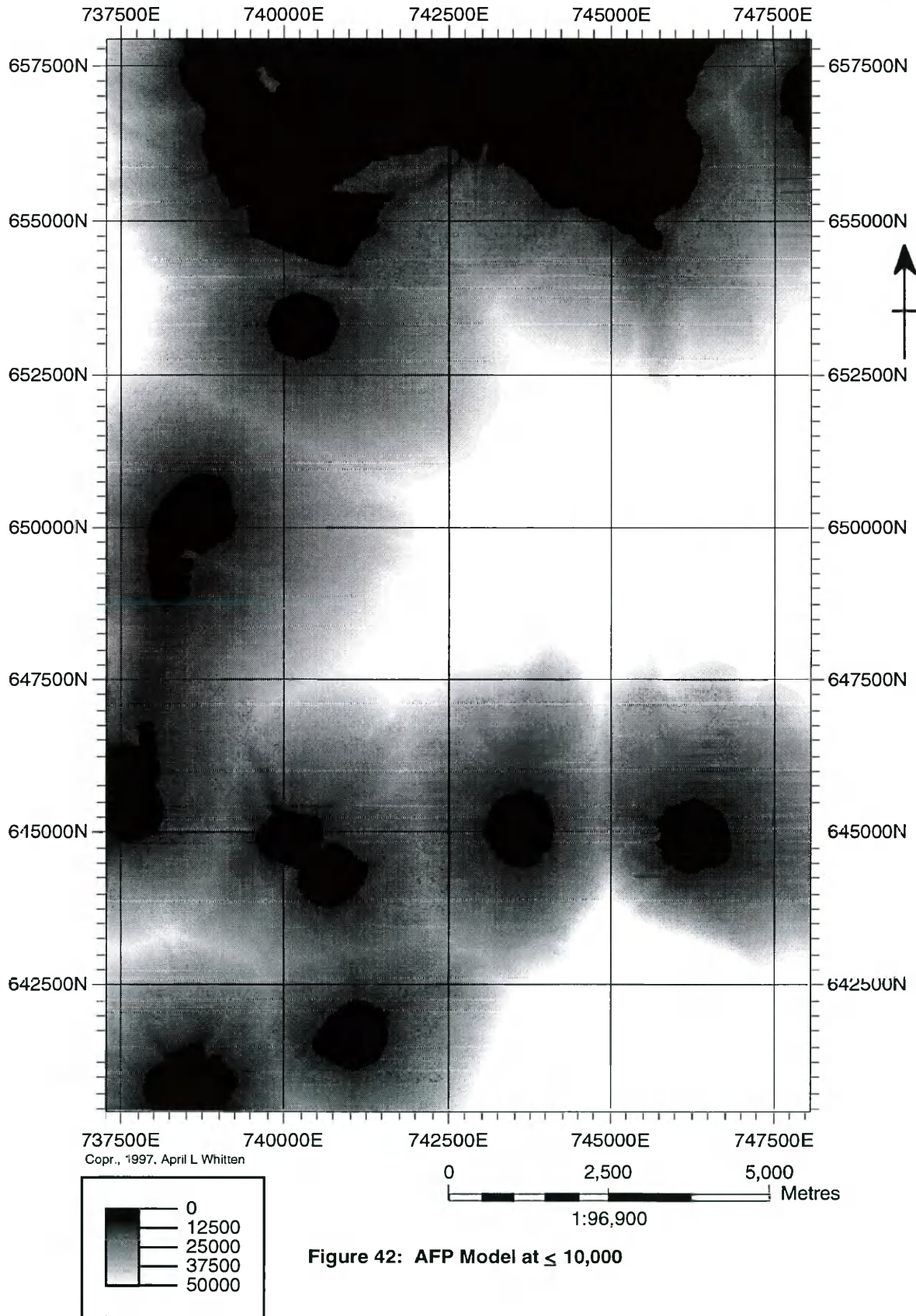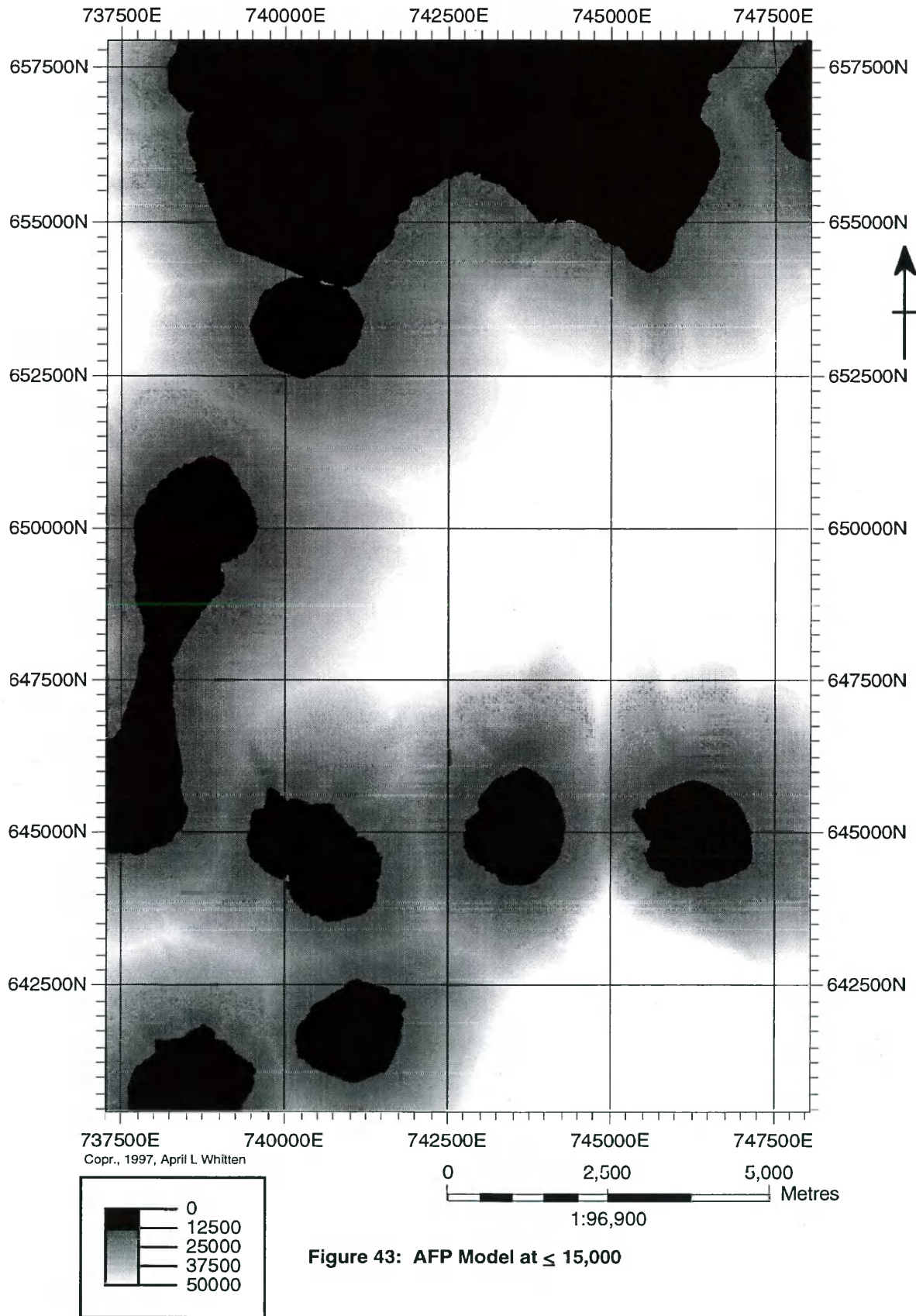Copr., 1997, April L Whitten

1:96,900

Copr., 1997, April L Whitten

Figure 42: AFP Model at ≤ 10,000

Legend:
0
12500
25000
37500
50000

0   2,500   5,000 Metres

1:96,900

Figure 43: AFP Model at ≤ 15,000

Copr., 1997, April L Whitten

1:96,900

interpret the low cost factor values of the northern sector as a function of

favorable slope of ~ 3°, combined with a favorable lithology of chalk, to create

areas of favorable passage

The cities of Korazim and Amnun joined with Kefar Nahum to the south,

and Gov Josef and Zomet 'Am'iad to the northwest, at cost factor values ≤

25,000 (Figure 44). I interpreted increased cost factors as a function of

increased expenditure of energy due to the rugged, rocky terrain of the basalt

hills and increased slope. Chalk is absent in those regions of greater cost

factor values. Applying the same scale discussed above, the value of 25,000

(Figure 45) is the equivalent of 5, and ranked as Favorable.

The city of Almagor joined with the Korazim and Amnun group at a cost

factor value of 26,500, for a ranking of ~ 5.3, slightly Less than Favorable. The

city of Almagor joined with Bethsaida at a cost factor of 27,300, for a ranking of ~

5.5, again slightly Less than Favorable. The city of Rosh Pinna finally joined

with Gov Yosef and Zomet 'Am'iad at a cost factor value of < 29,400, or ~ 5.9

(Figure 46). I interpreted these increased cost factors as a function of >

expenditure of energy due to the basalt hills, increased slope, and absence of

chalk, with the additional factor of greater distance. The distance between

Almagor and Amnun is greater than the distance between those cities joined at

lower cost values. Traveling over a greater distance required greater

expenditure of energy. However, the distance between Almagor and Bethsaida

was less than the distance between Almagor and Amnun. Therefore, regarding

the greater cost factor values separating the cities of Bethsaida and Almagor,
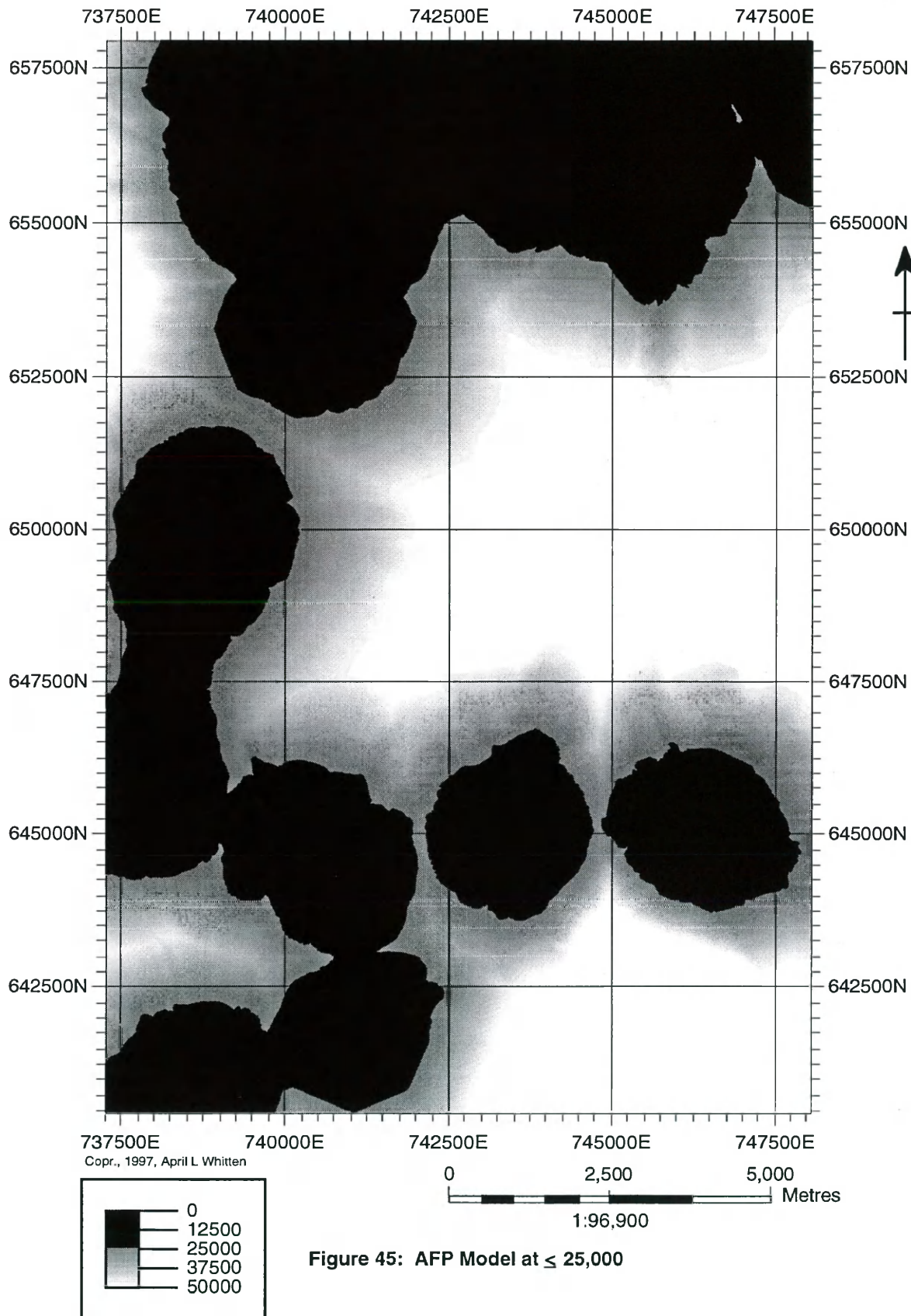
Copr., 1997. April L Whitten

Figure 44: AFP Model at ≤ 20,000

1:96,900

0   2,500   5,000 Metres
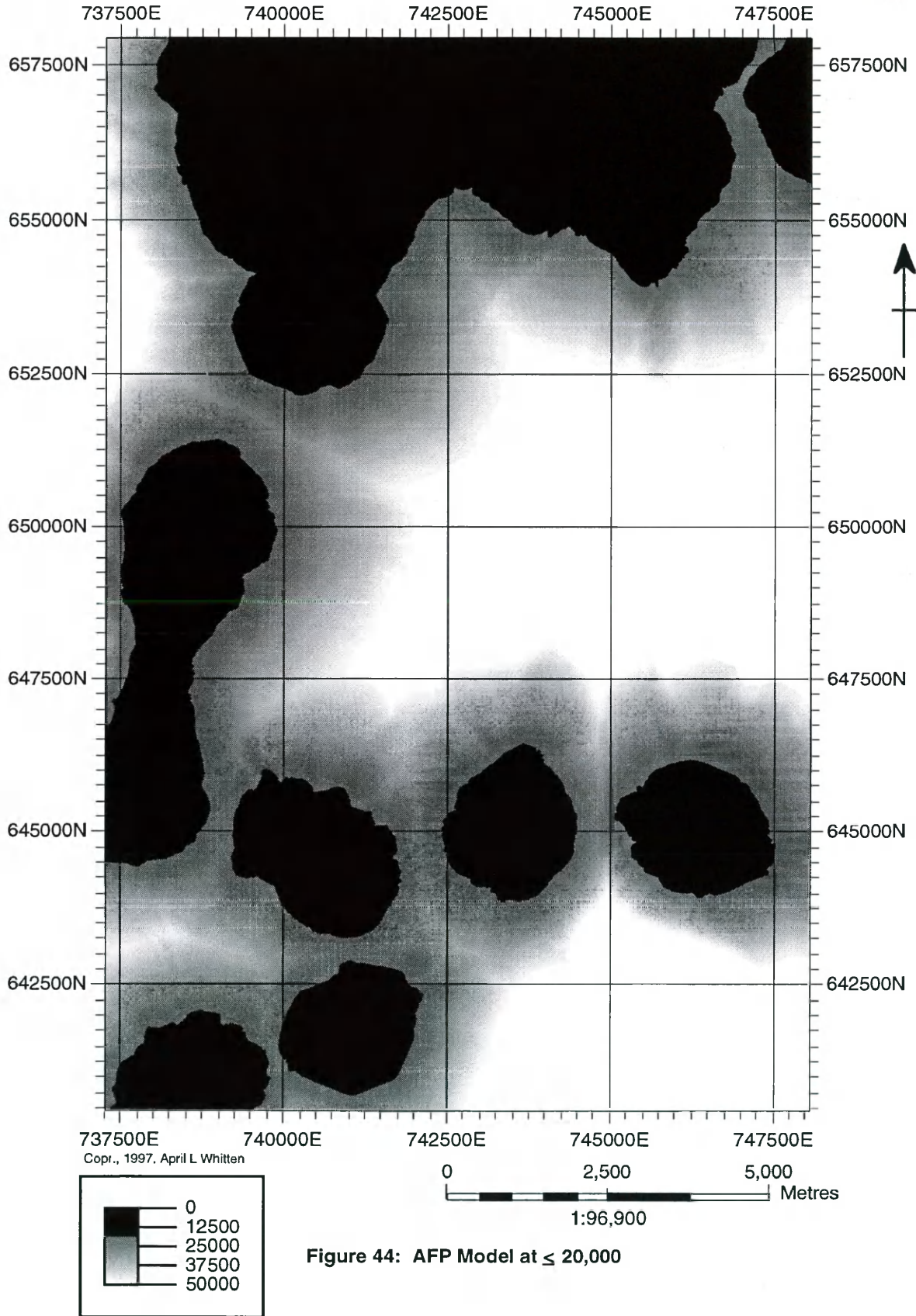
Figure 45: AFP Model at ≤ 25,000

	0
	12500
	25000
	37500
	50000

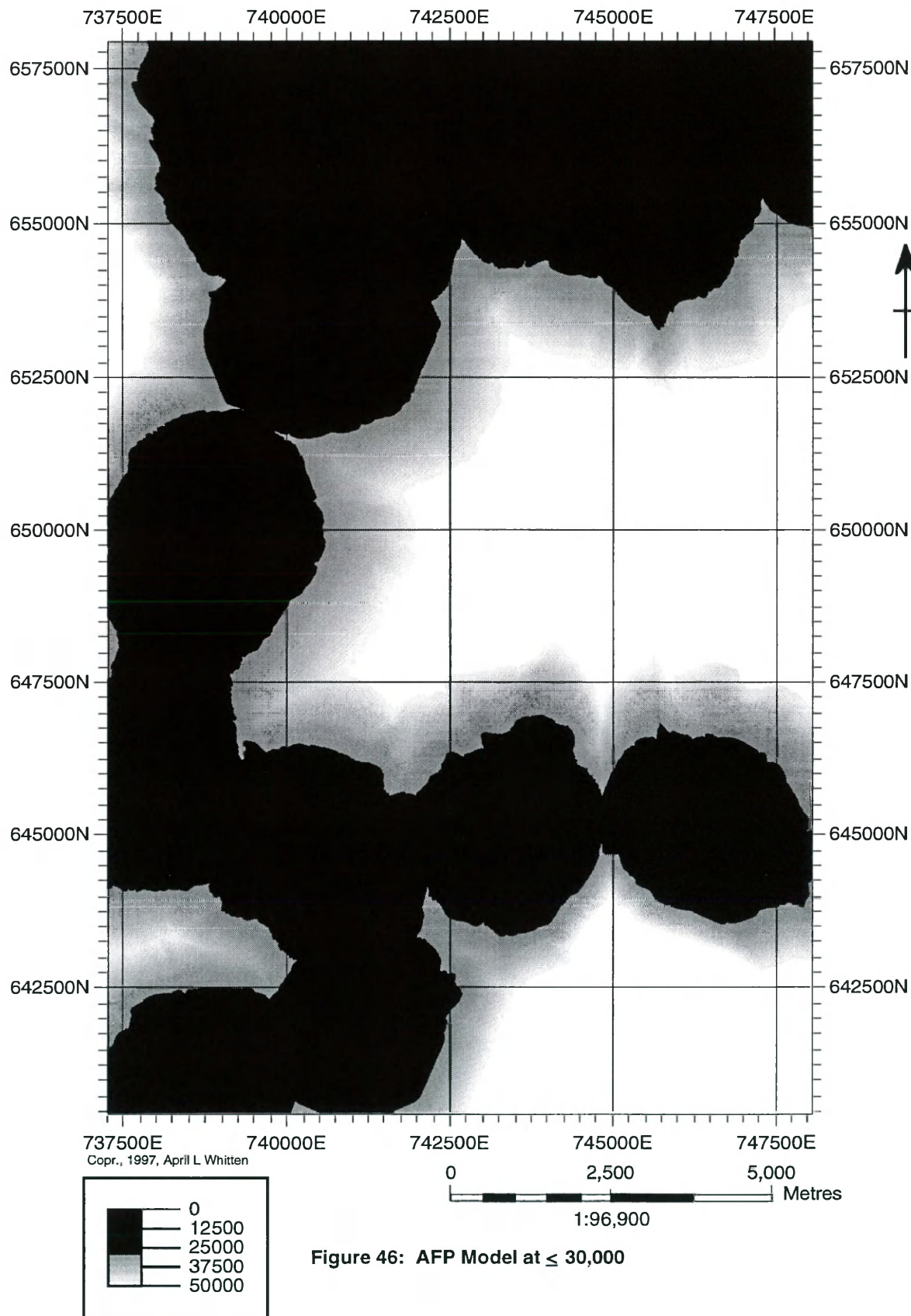**Figure 46: AFP Model at ≤ 30,000**

the additional factors of steepness of the Jordan Valley gorge, the hydrology of the Jordan River, and the PEC contributed to the increased cost factor values of expenditure of energy in spite of the shorter distance. Bethsaida and Almagor were the only two Ancient Cities that contended with separation by hills of steep slope, the Jordan River gorge, and probable estuarine coastline.

The results of the Areas of Favorable Passage model were compared to the Table of Artifacts (Table 13) presented in the Archaeological Results section. The table showed a relationship of artifacts to Roman Road fragment; the model indicated that the cities of Almagor and Bethsaida were hampered by more than just a greater distance from the Korazim and Amnun and westward block. The additional cost factors of greater slope and increased ruggedness of the physical geography of the region, may have negatively impacted the placement of primary Roman roads east of Korazim and Amnun. Further analysis and archaeological investigation is needed in this area.

Composite Cover: After analyzing the Areas of Favorable Passage model, the final process was to use the cover operation to overlay the Ancient Cities, Areas of Favorable Passage, and Hydrology data layers (Figure 47) onto a shaded relief model to produce a map layer which met the primary and secondary objectives of this thesis.

This final process created a paleoenvironment/cultural model which joined the ancient cities along the natural migratory routes noted historically and confirmed archaeologically. These routes generally conformed to the terrain, restricted by the geologic constraints of the region, and appeared to favor the chalky regions of the study area. Some of the most ancient
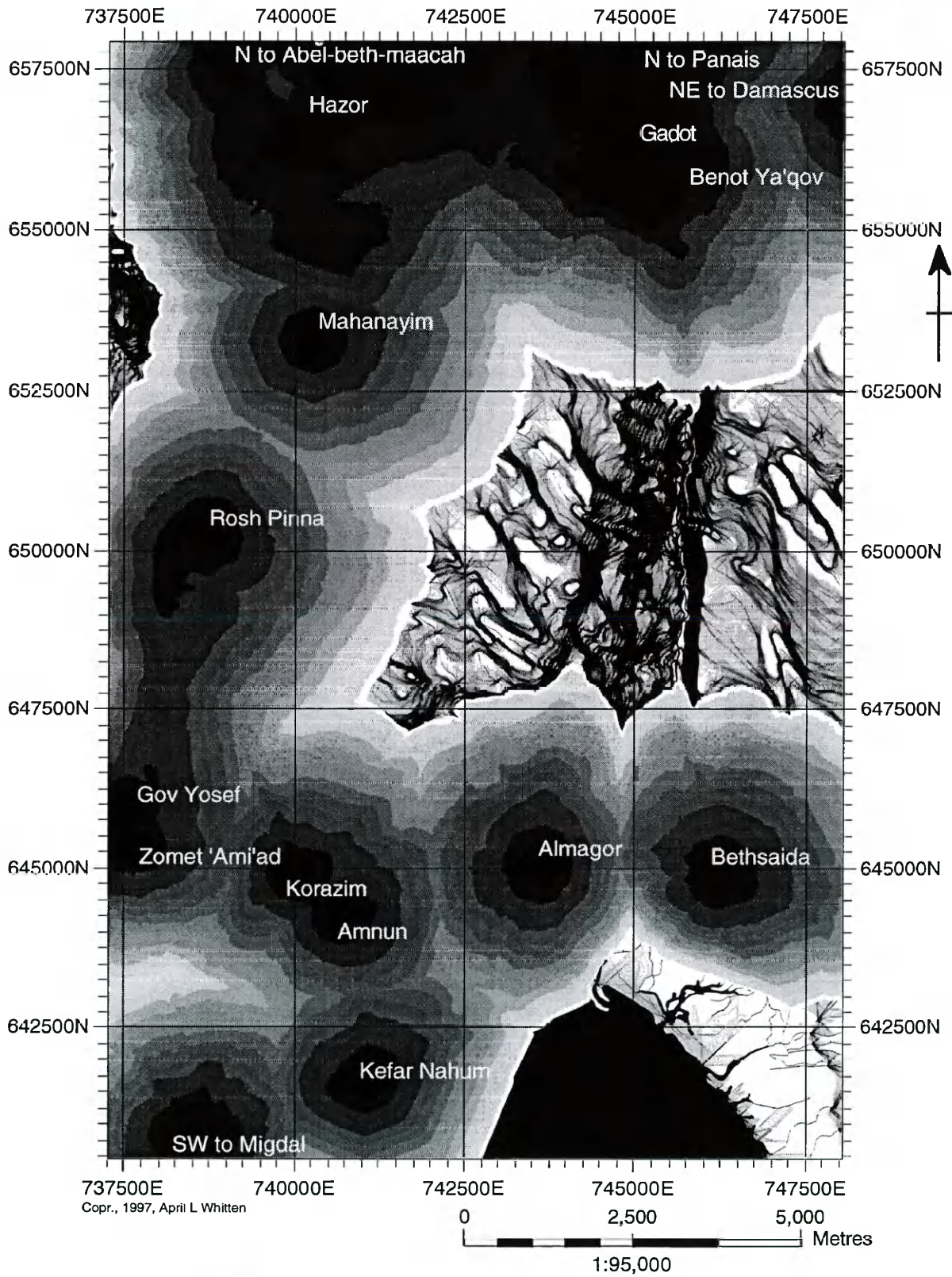
Figure 47: Composite Cover - AFP Over Shaded Relief

settlements referred to throughout the historical records, e.g., Hazor, occurred along the chalky regions, taking root between the basalt and the mountains, in much the same way one is "caught between a rock and a hard place." The Korazim Plateau west of the Jordan River gorge was left largely untouched as an area of favorable passage, as was the Golan Plateau east of the Jordan River and directly north of Bethsaida as represented by the exposed midsection of the composite cover. The Jordan River gorge at its steepest, as well as the Korazim and Golan Plateaus, were classified as not favorable for passage since their values exceeded the 50,000 value range set as maximum limit and were left untouched. The Naphtali Mountains west of Mahanayim were also left untouched and, therefore, classified as not favorable for passage. It was assumed that the Jordan River Rift Valley would be left as unfavorable due to its steep slope and rapid waters. Further, the Beteiha Plain south of Bethsaida is not shown to be favorable for passage.

It is interesting to note on the Areas of Favorable Passage model that favorable passage "bleeds" into the Sea of Galilee along the northwest shoreline and toward the mouth of the Jordan River. At first the results were considered anomalous as travel by water could not be easier than travel over land, no matter how steep the slope. However, travel in the waters along the shore, especially from Kefar Nahum to Bethsaida through the mouth of the Jordan River, would be a favorable way to reach Bethsaida. Historical documents such as the Bible make reference of travel to Bethsaida over water. The Areas of Favorable Passage model indicated the water along the shore as an area of favorable passage.

Chapter VII

SUMMARY AND CONCLUSIONS

This thesis has been an exercise to solve a problem by means of a multi-disciplinary approach. In order to meet the objectives, it was necessary to identify the variables and data required for the task. Setting the problem and objectives as follows:

Problem: Identify Roman roads in the Upper Galilee and Lower Golan regions of Israel;

Objective$_p$: Identify an anthropogenic relationship of land use, e.g., Roman roads in relationship to natural migratory routes, as a function of the physical geography;

Objective$_s$: Identify areas of favorable passage to Bethsaida.

The geoarchaeological problem was approached from the anthropological, physical geographical perspective of human and environment interaction by seeking an anthropogenic relationship of land use as a function of the regional physical geography (cultural ecology). Furthermore, the problem was approached from the systems perspective of interrelated, integrated subsystems working together within arbitrary boundaries, over time and space. These perspectives facilitated separating the problem into variables to facilitate study of the human-natural environment relationship, and to facilitate building a theoretical model:

Paleoenvironment = Culture + Environment.

Furthermore, due to the unique geologic constraints of the region, and the rich historical documentation of natural migratory routes, the GIS perspective was implemented to provide a means to gather and process the diverse data, and produce information which may add to our understanding of the human-environment relationship. Since a greater understanding of the structure increases our understanding of the process, GIS greatly enhanced the analysis of this geoarchaeological problem.

The most significant aspect of this research project was designing a Site Suitability Analysis Process to rank and weight the cost factor values in order to generate a Surface Friction Map and create an Areas of Favorable Passage model. Using the theoretical model of the paleoenvironment as a template, the problem to produce an effective process of ranking and weighting the values of the physical geography data layers was sufficiently solved. Designing the process was a challenging experience in absence of earlier studies which incorporated lithology into a slope-aspect friction map.

The spatial analysis of generating an Areas of Favorable Passage model gave a greater understanding of the role lithology played in developing the natural migratory routes of the study area. As noted previously, the ancient cities of the Upper Galilee region documented as being on the natural migratory route of the great Trunk Road, were located on chalk, a small link in the chain of knowledge about the human-environment interaction. This study was not meant to reflect an exercise in environmental determinism. It was meant to shed some light on the choices we, as humans, make regarding the use of our environment. An understanding of our human land use and the human-

environment interaction may facilitate identifying archaeological sites from the past, and may lead to greater decision making capabilities for our future needs.

Regarding the relationship of Roman roads to the natural migratory routes of the Upper Galilee and Lower Golan regions, road fragments with milestones were found within close proximity to the cities of Benot Ya'aqov, Gadot, Hazor, and Mahanayim. Milestones associated with road fragments were also found in close proximity to Gov Yosef, Kefar Nahum, and on the way to Migdal. All of these artifacts lay along the natural migratory route of the great Trunk Road. Since the Roman roads were associated with the natural migratory route, and remembering that the great Trunk Road had been established since the dawn of antiquity, it is probable that the Roman roads of the Upper Galilee and Lower Golan regions were laid in relationship to the natural migratory routes (Figure 48).

Finally, regarding the most favorable routes of passage to Bethsaida, it is obvious that roads to Bethsaida did exist since the ancient city was viable during an extensive historical period of time. Even little villages do not thrive without roads to bring trade and communication to their doors. However, due to the geologic constraints of being perched on the edge of basalt hills, with the Golan at its back, and the Sea of Galilee at its feet, surrounded by the Beteiha Plain and estuarine coast, these factors may have combined to eliminate placement of a primary Roman Road based on the construction criteria that the Romans employed in their road building scheme. It is probable that a secondary, unpaved road would have been laid between Almagor and
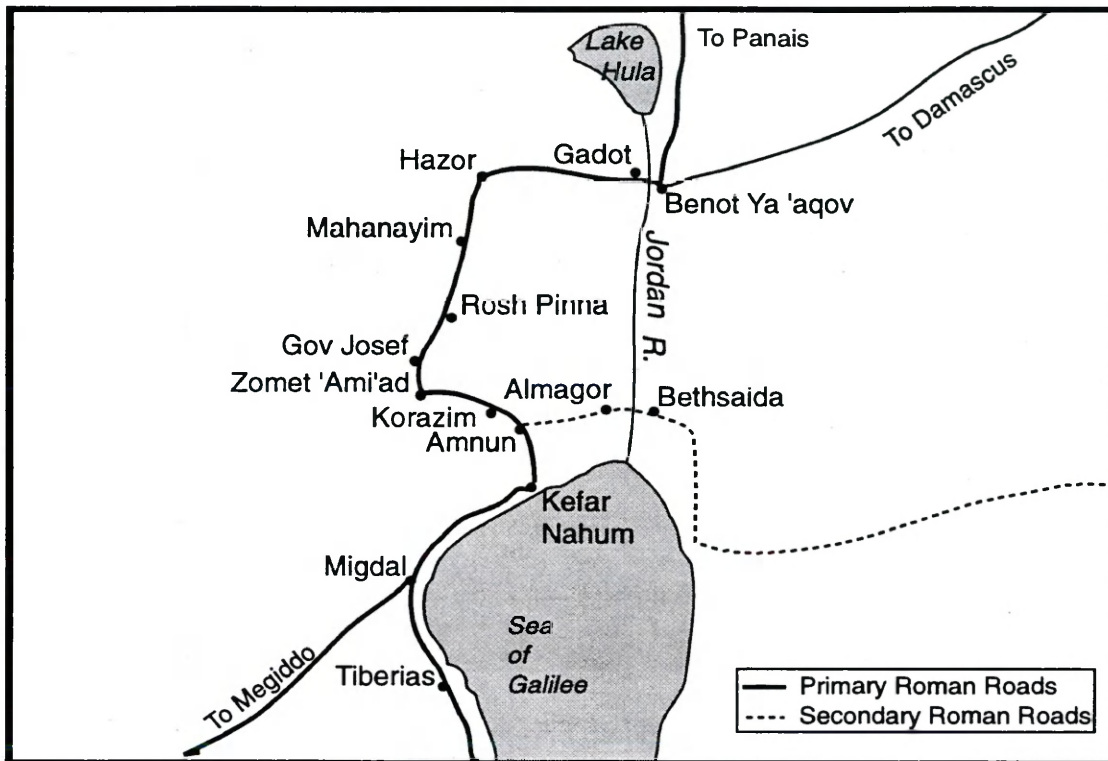
Figure 48: Probable Roman roads in relationship to natural migratory routes,
according to AFP Model.

Bethsaida, as indicated on the Areas of Favorable Passage model, for the

support of foot traffic, but probably not for the support of the military. Primary

roads were built by the military for military purposes, with associated milestones

left in situ as "calling cards." Also, it may be unlikely that roads were laid by the

Romans to descend the Golan Plateau to Bethsaida, due to the rugged terrain

and great slope. It is significant to note that the midsection of the model (Jordan

River Rift Zone) was left untouched and, thus, was classified as not favorable

for passage. But, this classification was just a way of looking at a

geoarchaeological problem to identify where were the most likely places the

Romans would have built their roads, and not as a means of proving or disproving the existence of Roman roads at Bethsaida.

One other interesting factor generated by the model is the favorable passage between Kefar Nahum and Bethsaida by water along the shore and into the mouth of the Jordan River. Since Bethsaida was a fishing village on the shore of the Sea of Galilee, travel over water could most likely have been the most favored means of traveling to and from Bethsaida.

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