5-2016

Trade and Transport in Late Roman Syria

Christopher Wade Fletcher
University of Arkansas, Fayetteville

Trade and Transport in Late Roman Syria

A thesis submitted in partial fulfillment
of the requirements for the degree of
Master of Arts in Anthropology

Christopher Fletcher
University of Arkansas Fayetteville
Bachelor of Arts in Anthropology Spring 2013
Bachelor of Arts in History Fall 2013

May 2016
University of Arkansas

This thesis is approved for recommendation to the Graduate Council

____
Dr. Jesse Casana
Thesis Director

____
Dr. Kenneth L. Kvamme
Committee Member

____
Dr. Wesley D. Stoner
Committee Member

Abstract

Despite the relative notoriety and miraculous level of preservation of the Dead Cities of Syria, fundamental questions of economic and subsistence viability remain unanswered. In the 1950s Georges Tchalenko theorized that these sites relied on intensive olive monoculture to mass export olive oil to urban centers. Later excavations discovered widespread cultivation of grains, fruit, and beans which directly contradicted Tchalenko's assertion of sole reliance on oleoculture. However, innumerable olive presses in and around the Dead Cities still speak to a strong tradition of olive production. This thesis tests the logistical viability of olive oil transportation from the Dead Cities to the distant urban centers of Antioch and Apamea. Utilization of Raster GIS and remote sensing data allows for the reconstruction of the physical and social landscapes of Late Roman Syria. Least Cost Analysis techniques produce a quantitative and testable model with which to simulate and evaluate the viability of long distance olive oil trade. This model not only provides a clearer understanding of the nature of long distance trade relationships in Syria, but also provides a model for investigating ancient economic systems elsewhere in the world. Furthermore, this project allows for the generation of new information regarding sites that are currently inaccessible to researchers.

Acknowledgements

I would like to express my sincere gratitude to my committee for their support and invaluable feedback on this project. Special thanks are due to my advisor Dr. Jesse Casana for assistance selecting and refining this research topic. I also owe a heartfelt thanks to all of my graduate colleagues in the University of Arkansas department of Anthropology. Without their feedback and support this project would have been much the lesser. Finally I owe special thanks to Karen Pownall, my steadfast editor. Without her aid this project would have been impossible.

Dedication

This Thesis is dedicated to my whole family. Without your unwavering support, I could have never made it so far.

Table of Contents

Chapter One: Introduction

The exact nature and scale of ancient economies are, and have long been, fiercely debated in history, anthropology, and more recently, archaeology. There is no shortage of texts by economists or historians discussing ancient economics, but these sources rarely integrate archaeological data into their analyses (e.g. Weber 1905, 1927; Marx 1964; Frank 1933-40; Polanyi 1957a 1957b; 1963; Finley 1977). For decades, any debate regarding ancient economies was dominated by conflicting tendencies which either viewed past economic behavior as similar, albeit more simplistic version of our own, or a radically different creature altogether (Smith 2004). For the bulk of the later twentieth century, ancient economies in general, and the ancient Greek and Roman economies in particular, have served as a battle ground for these fundamentally different models of past economic behavior. This dichotomy of views was chiefly expressed in history and archaeology as the primitivist vs modernist debate.

For decades influential primitivist scholars expressed the tendency to view ancient economies as fundamentally different economic systems by highlighting "the small-scale, agrarian orientation, and stagnant nature of ancient economic activities" (Smith 2004: 75). Moses Finley's persuasive primitivist writings dominated the bulk discussion of ancient economics for decades (Finley 1999). However, as historical and archaeological research progressed, higher levels of economic activity than previously suspected became increasingly clear. On the back of this new data, and in opposition to primitivist thought, modernists felt that the differences between ancient economies are our own economic systems were a matter of scale, not of type (Smith 2004).

The "same versus other" conundrum was expressed slightly differently in economic anthropology. In economic anthropology this propensity to polarize past economies took the form of the formalist and substantivist schools of thought. Similar to the modernists, formalists argued that ancient economies and non-capitalist economies differ only slightly from capitalist economies. Whereas substantivists posit that ancient and non-capitalist economies are radically different from modern capitalist economies. The economic anthropologist Karl Polanyi was amongst the most outspoken substantivists. Polanyi's work provided a number of fascinating insights into economic inquiry. However Polanyi's firm rejection of any possible capitalistic factors in non-capitalistic economies has limited exploration of these fruitful topics. Polanyi felt that reciprocity and redistribution were the key factors that drove past economic behavior. While these ideas are not without merit, reciprocity and redistribution cannot fully explain the variety of economic production and specialization evident in the archaeological record (Decker 2001, 2009). When confronted with new data regarding the scale and specialization of past economies, Polanyi's model could not satisfactorily reconcile these new data. The rigidness of Polanyi's models can be exposed by his rejection of the concept of "prices" (Polanyi 1957). Polanyi held that equivalencies, set by royal decree, permanently fixed the value of tradable goods.

The age old debates between modernists/primitivists and formalists/substantivists, though perhaps not as widely debated now, still cast a major shadow on modern economic scholarship. The eloquent and persuasive rejection of capitalistic elements of the ancient economy from imposing scholars like Finley and Polanyi still forms a baseline for much of the discussion of ancient economics. Lost in the length and breadth of these debates was the role that archaeological data could play. The above debates were largely driven by historical data and economic theoreticians. While these sources provide much fodder for interesting discussion, archaeology is ideally poised to help further elucidate ancient economic systems. Despite its utility, only relatively recently have archaeologists begun to apply the wealth of relevant data gleaned from survey and excavation (Greene 1986; Harris 1993; Smith 2004).

A single case study, such as Late Roman Syria, is unlikely to resolve the decades old debate of modernists versus primitivists, but it can provide invaluable insight into the operation of an ancient economy.[1] In his conclusions, Greene cites transportation as "...the key to defining the physical limits to trade" (Greene 1986: 169) Discussion of transport in Roman trade is far from novel, however earlier scholars tended to treat speed of movement (e.g. walking, marching, or cart speed) as the main factor in travel (Casson 1974). While speed of travel is an important factor, other physical factors such as access to roads, topography, and the presence of hydrological features all play an important role in the relative ease of trade.

Ancient economies defy easy description and direct examination. However, archaeological evidence and specific case studies can provide fascinating glimpses into the experiences of long past economies. This thesis will examine a specific element of economic activity in the highlands of northwestern Syria. Through a detailed examination of the nature and extent of Late Roman olive oil trade in the limestone massif region of Syria, the degree and

[1] Here and throughout this project the "Late Roman" will be used in lieu of "Byzantine" or "Late Antique."

landscape of the greater Late Roman economy can begin to be addressed.[2] This thesis utilizes remote sensing and Geographical Information Systems (GIS) to reconstruct the physical and cultural landscape of Late Roman Syria. From these data, a testable Least Cost Path (LCP) model is then created. Utilizing technical GIS model building allows for the creation of testable and repeatable datasets that can be examined both quantitatively and qualitatively (White and Surface-Evans 2012; White and Barber 2012). Such a model tests the logistical viability of the regional olive oil trade. Relative viability is tested against contemporaneous lowland settlements. These settlements, located in the neighboring lowland valleys, allow for the direct comparison of accumulated cost of travel and trade. These contemporary lowland sites are, geographically speaking, much closer to the urban centers. Given this proximity, it can be assumed that travel to and from these sites would be less costly. The cost of travel to and from these lowland sites forms a baseline against which travel cost from the Dead Cities can be tested. If the olive oil trade is found to be viable then larger conclusions of interregional trade and economic structures can be examined. If the olive oil trade of northwestern Syria is not logistically viable then its role in interregional trade can be viewed as exaggerated and inaccurate.

This thesis is divided into seven chapters. The first chapter is this introduction of the methods, goals, and scope of this thesis. The second chapter provides a much more thorough background of the archaeological research and landscape of the limestone massif in Syria. The

[2] Limestone massif is a collective physiographic term applied to five limestone hill ranges in northwestern Syria. I will refer to this geological formation as the “limestone massif” or more simply the “massif.”

second chapter will trace the history of archaeological discovery and thought in northwest Syria and highlight some of the critical ambiguities that still remain in modern scholarship.

Chapter three will describe the remote sensing methods used to locate and study the Dead Cities. Determining the location of the Dead Cities proved to be anything but straightforward. As such, a number of distinct methods were utilized to compile a dataset containing a significant number of these sites. Chapter three will also discuss the issues and accuracies of remote sensing in the limestone massif region.

Chapter four discusses the digital reconstruction of the Late Roman physical and cultural landscape of the limestone massif region. Multiple aspects of the landscape were studied with the intent of translating them into the final model. These aspects include topography, hydrology, wetland marshes, settlement patterns and road networks. This process hinged on determining which features of the landscape were present during the Late Roman period. As such, the modern landscape was viewed as a palimpsest that, though reused, still contained indelible traces of the Late Roman landscape (Casana 2003). Chapter four also discusses the textual and digital sources drawn upon to interpret and integrate the Late Roman landscape.

Chapter five discusses the reconstruction of the Least Cost Path model itself. First the base layer data (discussed in chapter four) must be properly formatted and weighted. Once created, the LCP model allows for the drawing of some initial observations. These initial findings are briefly discussed. A simple test of the model's construction is performed at the end of chapter five to validate that the model has interpreted the data correctly.

Chapter six provides a framework for the scale and value of the oil surpluses potentially produced in the limestone massif region. This chapter quantified the hypothetical oil surplus based on an agricultural model proposed by Decker (Decker 2009). Chapter six then discusses some of the archaeological evidence that supports oil export from the Dead Cities.

The findings of this thesis are discussed in full in chapter seven. The initial observations from the previous chapters are addressed in light of the findings of the full model. The exertion required to move trade goods from the sites themselves to the nearby urban centers is quantified and discussed. The results of this chapter illustrate how the Dead Cities fit into the fabric of the wider eastern Mediterranean trade. In addition, the findings of this thesis can shed new light on the age old questions of economic life in the Dead Cities, and their eventual abandonment. Ultimately, these findings allow the opportunity to reevaluate the long standing debates regarding the nature of the Late Roman economy.

Chapter Two: Background

The complex landscape of Northwestern Syria is fascinating in its own right. Steep rugged Jebels (an Arabic term for mountain or hill) rise high above the perfectly flat Amuq and Ghab agricultural plains. The Jebels Wastani, Il A'la, Barisha, Sim'an, and Zawiye collectively form the limestone massif. The limestone massif stands roughly between 400 and 800 meters above sea level. Though this is not high compared with the Amanus Mountains to the north, from the perspective of the flat plains, the Jebels dominate the horizon. To see the rough windswept expanses of the Jebels today, one would be hard pressed to imagine that such a landscape, at one time, supported a flourishing Late Roman countryside.

The limestone massif region receives comparatively sparse rainfall, between 300-600 mm per year (Casana 2014). The soil on the massif is thin, poor, and rocky. Even in the modern era, the Jebel highlands have remained an underpopulated hinterland. Only quite recently has population and development begun to increase here. The topography of the Jebels is broken and cut with steep and narrow wadis. This broken physical landscape renders travel difficult and time consuming. Despite all of these factors, dotting the massif every one or two kilometers are some of the most intact examples of Late Roman architecture, village life, and religious structures in the world today. Collectively, these marvelously preserved structures are known to Western scholarship as "The Dead Cities."[3] In reality, the Dead "Cities" are actually agglomerations of hundreds of villages, monasteries, pilgrimage sites, and farmsteads. The misleading term "*Le Ville Mort*" was coined by the early French antiquarian Charles-Melchior-de

[3] Despites its limitations, the term "Dead Cities" or "Dead Cities Sites" will be used to collectively describe these sites.

Vogue (de Vogue 1865-77). These sites all date from the Roman or Late Roman Periods 100 B.C. to A.D. 600, and there is little evidence for settlement previous to these periods (Foss 1996). Due in part to their astonishing level of preservation, the Dead Cities have come to lead the discussion of the Roman/Late Roman countryside (e.g. Decker 2009; Wickham 2005). Prior to the current political upheaval in Syria, the Dead Cities were a tourist mainstay. Daily trips left from Aleppo and allowed tourist to step backward in time (Beattie and Pepper 2001). In 2011 these stunning sites were collectively proclaimed a UNESCO World Heritage Site. Despite being known to Western scholarship for a century and a half, and having a certain fame in archaeological and tourist circles, fundamental questions concerning the subsistence, settlement patterns, and eventual abandonment of the Dead Cities are still not satisfactorily answered.

By comparison, the wide flat valleys of the Amuq and the Ghab basins nestled between the Jebels are fertile, arable, and comparatively well-watered. The Orontes River, now heavily canalized, flows south to north in the Ghab valley and skirts the edge of the Amuq. The Karasu and Afrin rivers, also partially canalized, flow across the Amuq plain, and eventually join the Orontes on its march to the sea. Both the Amuq and the Ghab were densely settled during the Bronze Age (Casana 2007: 2012). Hundreds of mounded “Tell” sites dot both valleys, some rising as high as 30 meters above the valley floor (Casana 2014). Unsurprisingly these valleys have played host to a number of major archaeological surveys and excavations (Braidwood 1937, 1960; Courtois 1973; Marfoe 1979). In spite of this archaeological attention, comparatively little archaeological attention has been devoted to the Roman or Late Roman periods in these valleys. This sampling error effectively demarcated two spheres of study. The fertile lowlands are associated with Bronze Age and Iron Age settlements, while the rugged highlands were thought to have been settled exclusively during the Roman and Late Roman periods. More recent scholarship has begun to uncover evidence which suggests this trend is at least somewhat inaccurate (Casana and Wilkinson 2006; Graff 2006). Despite these recent efforts, interactions between the highlands and lowlands are not yet well understood.

What Makes a Dead City?

The phrase “Dead Cities” is something of an umbrella term. This term does not really refer to one type of building or settlement. In reality, the Dead Cities are a collection of widely dissimilar structures. Large ornate churches, villages, monasteries, olive presses, one massive early cathedral, and isolated farmhouses, all are considered to fall within the Dead Cities’ category. The main unifying themes do not fit a single typology but are instead high levels of preservation, building materials, and geography. Despite the variation in usage, the Dead Cities are practically all built from skillfully cut limestone blocks, made ubiquitous by the surrounding geological formation. For reasons still not fully understood, sometime after their social and economic peak in the sixth century, the Dead Cities were abandoned. More surprisingly, very little settlement returned to this area prior to the twentieth century. As a result, few structures in the Dead Cities were robbed for building materials in later construction, leading to the remarkably high level of preservation evident today. This abandonment and subsequent paucity of resettlement was confined to the Jebel region. As a result the Dead Cities are only found atop these rugged Jebels. The well preserved villages, churches, and farms are an amazing anomaly. Nowhere else in the surrounding region do such structures exist. This has led to the Dead Cities often being thought of as a single homogenous function of Late Roman rural settlement. Such a position masks the internal variations that make the Dead Cities such a compelling topic.

During the late nineteenth and early twentieth centuries, the Dead Cities were visited by a number of foreign explorers. Despite this attention, none of the early explorers studied the full extent of the region. Figure 1 shows the extent of investigation by these early scholars.

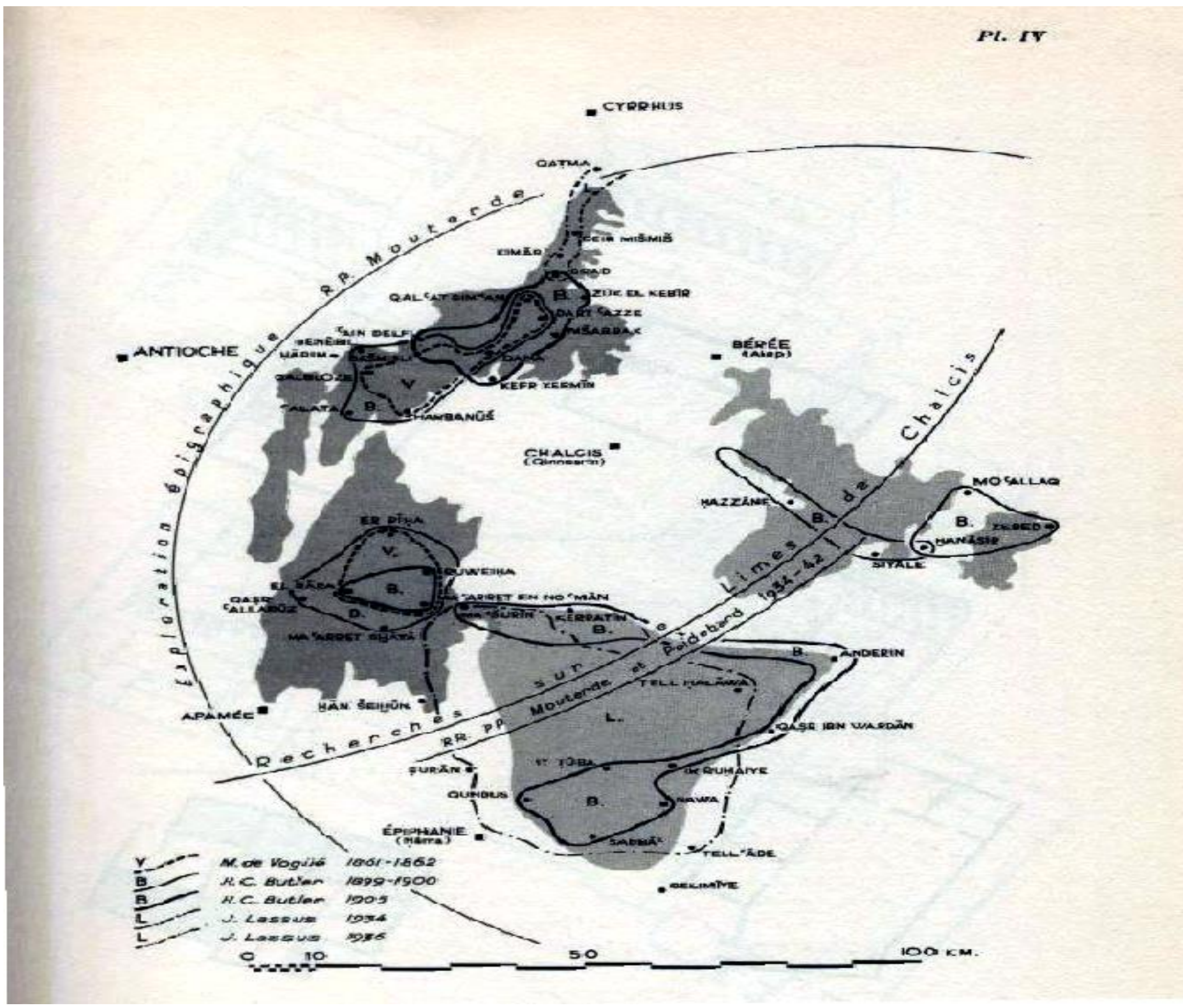


Figure 1: Routes of the Early Investigations of the Dead Cities (Tchalenko 1953 Pl IV)

In the mid-19th century, the French Count and antiquarian Charles-Jean-Melchior de Vogue brought the Dead Cities to the attention of the Western scholarship. In the period between abandonment and de Vogue's visit, little appears to have affected these sites. Doors, roofs, and windows, all likely made of wood, had rotted away, but otherwise these villages still appeared nearly habitable (Butcher 2003). de Vogue, later to be the French ambassador in Constantinople, was captivated by the stately ruins dotting the landscape. Perhaps influenced by his own circumstances, de Vogue saw the Dead Cities as large estates of a rural aristocracy (de Vogue 1867). De Vogue was fascinated with the architectural remains of the Dead Cities. His research produced a series of detailed drawings and lithographs which were the first glimpse many Westerners had of these remarkable sites. De Vogue did not confine his analysis solely to architecture: he was the first scholar to speculate on the mysterious abandonment that befell these villages. To de Vogue, the answer was the Arab expansion. He theorized that the Arab invasion in A.D. 636 drove the inhabitants away, never to return. De Vogue's contributions and ideas concerning the Dead Cities would continue to shape discussion of these settlements for decades.

It was the turn of the century before Princeton architect Howard Crosby Butler made the next major investigation of the limestone massif. Unsurprisingly given his profession, Butler was amazed by the scale and preservation of the Dead Cities. As with de Vogue before him, Butler was utterly fascinated by the churches and monasteries, especially the great cathedral of Saint Simeon:

> "The great cruciform church, with its hypaethral octagon in the middle, is unique in the history of architecture, and is not only the most beautiful and important existing monument of architecture between the buildings of the Roman period of the second century and the great

> church of Sta. Sophia of Justinian's time, but also from the point of view of architecture as an art by itself, regardless of engineering feats, marble incrustations and mosaic decorations, is the most monumental Christian buildings earlier than the masterpieces of the eleventh and twelfth centuries in Northern Europe" (Butler 1903 97-98)

Butler's work, like de Vogue's, was mostly descriptive in nature (Butler 1903). However Butler's work was more widespread and detailed. Despite a fixation on architecture, Butler too was mystified by the abandonment on such a large scale. Unlike de Vogue, Butler highlighted environmental degradation as the prime driver for desertion. He theorized that the limestone massif had previously been well forested and supportive of vegetation. Over time, Butler believed, deforestation, coupled with frequent Sassanian invasions, rendered the landscape unable to support its large population. Between the two World Wars, the Dead Cities would receive a number of visitors, including the famed priest turned pilot Father Antoine Poidebard (Mouterde and Poidebard 1945). However, it would be after the Second World War before an archaeologist undertook a comprehensive study of the Dead Cities.

Any research concerning the Dead Cities is inherently built on the back of Georges Tchalenko's pioneering work. In the mid-1950s Tchalenko, working under the auspices of the French Archaeological Institute, published the three volumes of *Les Village antiques de la Syrie du nord.* These volumes are the gold standard concerning the Dead Cities. Unlike his predecessors, Tchalenko performed much more systematic surveys of these sites. To date, his publications are the only comprehensive list of the Dead Cities sites that has been compiled. Despite their age, Tchalenko's maps and illustrations are still salient; he is the first archaeologist (for this region) to use a uniform coordinate grid system. The resulting maps much more closely corresponded to both the physical and social landscape. In fact, many papers discussing the Dead Cities either used updated versions of Tchalenko's maps, or simply reproduced them (a fair number of his maps appear in this thesis, including Figure 1) Again differing from his predecessors, Tchalenko applied much more focus on interpreting the sites (Tchalenko 1953).

To Tchalenko, the ruins of the Dead Cities held an amazing variety of structures. Foss outlines some of Tchalenko's reading of the structures: "….in his view, a great variety of remains: peasant villages, villas, groups of aristocratic residences, villages developed from single estates, villages of small farmers, small market towns, outlying industrial and commercial centers, and imperial estates." (Foss 1996, 49) Tchalenko's perception of this variation of building type and purpose gives a new texture to the Late Roman social landscape.

Scholarly discussion of Tchalenko's work, for better or worse, typically revolves around his ideas regarding agriculture, subsistence, and olive oil. He saw a society based completely on the production and trade of olive oil. For Tchalenko's claims to be properly discussed, I must first briefly discuss the widespread use and value of olive oil in the Late Roman Period.

Olive Oil in the Late Roman Period

The impact of olive oil on the Classical and Roman Mediterranean cannot be overstated. Decker sums up the importance of oil below.

> "The vines and olives were not staples in the same way that grain was; one could survive without them. Wine and olive oil were, nonetheless, indispensable cornerstones of the diet and, what we might term, cultural staples---crops without which Mediterranean life was inconceivable (Decker 2009: 149).

In fact, the average Roman would likely have consumed an amount of oil unimaginable today. Mattingly suggests that "20 litres per capita may be a useful rule of thumb value for average annual consumption in the Greco-Roman Mediterranean heartland." (Mattingly 1988: 22) Oil was not only consumed, but was also utilized in a variety of manners such as medicines, lamp oil, and personal hygiene. Not only was the consumption of olive oil ubiquitous, but the values of surplus oil could literally shape empires. Mattingly insinuates that the shift in political power to emperors hailing from Tripolitania is a least partially driven by the enormous profitability of olive oil production (Mattingly 1988).

The idea that the clearly prosperous Dead Cities' fortunes were based on the oil trade is not unreasonable in itself. In Tripolitania, Mattingly establishes his case of surplus production and trade by noting that the number of olive presses greatly outstrips what would have been necessary to sustain the local population (Mattingly 1988, 1988b). This is also the case in the limestone massif. Olive trees are also one of the few crops that could thrive in thin dry soil of the massif. Evidence for olive trees and presses are abundant. Later projects, based around the large site of Dehes, found 245 presses in forty-five villages (Tate 1992; Wickham 2005). This disparity is a clear sign the olive pressing was not solely intended for local use. It is clear the olive held an extremely important position in the economics of the region. However Tchalenko sees the oil trade as the sole driver of livelihood, construction, and prosperity. He imagined busy harvest and pressing seasons, followed by the mass exportation of surplus oil to the nearby urban centers, and on to other regions (Tchalenko 1953; Foss 1996). Tchalenko, through the vector of interregional trade, saw the Dead Cities as part of a greater Eastern Mediterranean economic system. This idea will be more thoroughly discussed and evaluated in chapter six.

Even the mysterious abandonment of the Dead Cities could be explained by the olive oil trade. Tchalenko believed that the Sassanian sack and occupation of Antioch in the mid-sixth century deprived the Dead Cities of their connection to Roman markets. The oil trade was permanently disrupted, and soon after the Dead Cities began to be abandoned (Tchalenko 1953). Tchalenko's economically driven interpretation is admittedly compelling, but would be firmly critiqued by his successors (Tate 1992).

Tchalenko's work, as all before him, was based on survey and analysis of the standing ruins. In the 1970's the French Institute of Archaeology in Damascus tasked Georges Tate and his colleague Jean-Pierre Sodini with conducting the first, and to date only, major excavation in the Dead Cities. Tate and Sodini chose a larger town, Dehes, which Tchalenko had described as a prosperous market town. Between 1976 and 1978 Tate and Sodini excavated at Dehes and surveyed the surrounding sites. This project made a series of observations that called Tchalenko's reading of the region into serious doubt. First, Tate reinterpreted the structures themselves and found that 95% of the ruins were actually domestic in nature. The remaining 5% were primarily either churches or structures housing oil presses (Tate 1992). Tate and Sodini found no villas or meeting houses at Dehes (Foss 1996). In fact, practically all of the structures on the limestone massif were variations of a single domestic structure design. These domestic structures were designed to shelter animals on the first floor, with room for the families on the upper level (Tate 1992). Gone were the notions of the de Vogue's aristocratic estates, or Tchalenko's agoras. These domestic structures, while well decorated, were utilitarian in nature (Tate 1992; Wickham 2005). Furthermore, Tate and Sodini discovered evidence for the growing of grapes, fruit, wheat, beans and other vegetables, complimented by animal husbandry (Foss 1996). Additionally they found that the Dead Cities were not abandoned in one episode. Many sites supported inhabitants for centuries after the disasters of the sixth century. Some of these sites were occupied as late as the ninth century, far later than Tchalenko and his predecessors had assumed. In light of these discoveries, Tchalenko's ideas of intensive olive monoculture collapsed. Despite this new evidence, it would be a mistake to completely dismiss Tchalenko's theories. More recent scholarship has begun to reevaluate many of his ideas.

Despite the complete dismissal of Tchalenko's monoculture model, some issues between Tchalenko, Tate, and Sodini are not satisfactorily addressed. The presence of livestock and other crops firmly contradicts olive monoculture, but then why are there so many olive presses? Tate and Sodini feel that oil was used as a cash crop to supplement the Dead Cities' other crops (Tate 1992). Wickham concedes that the Dead Cities would not have relied solely on oil production, but it was nevertheless their main export good and the primary source of their prosperity. Wickham also points out the Late Roman amphorae 1 (LRA1), primarily used for the transport of oil and wine, was the most widely distributed amphorae of the period (Wickham 2005: 445). This further implies a strong oil export culture. Tate's interpretation of the household economy, one built on subsistence, is likely accurate. However Wickham feels that Tchalenko's reading of the "macroeconomy" of the region is more plausible (Wickham 2005: 446). Elements of Tchalenko's theories and Tate and Sodini's observations do not necessarily contradict each other. While Tchalenko's monoculture model of oil production has been dismissed, it would be a mistake to relegate oil to a mere supplemental cash crop as Tate and Sodini do.

In addition, Tate and Sodini cited the widespread disasters of the sixth century, (invasions, plague, earthquakes) coupled with overpopulation, as the catalyst for the long slow decline of the Dead Cities. The limestone massif could well have been overpopulated based on Tate's work. Tate and Sodini calculated that as many as 300,000 people might have occupied the massif, on an estimate of density of domestic rooms (Tate 1992). Tate imagined, after the *coup de grace* of the Islamic invasion, something of a Malthusian crisis overtook the region, leading to the slow abandonment of the Dead Cities. However, more recent scholarship has found this theory less convincing (Wickham 2005). Tate's own work suggests that some Dead Cities sites were occupied until the ninth century. From the disasters of the sixth century to the final abandonment of the ninth century, generation after generation still inhabited these sites. Foss reports that the Dead Cities experienced continuous expansion from the third to the late fourth centuries (Foss 1996). By A.D. 550 stagnation had taken hold. No new buildings appear to have been built after this point. Damaged buildings, with the exceptions of some churches, were only crudely repaired (Tate 1992). Tate's notions of overpopulation could explain this relatively sudden end to prosperity, but is harder pressed to explain the centuries of continued occupation. Wickham feels that it is more likely that Tchalenko's view of the Dead Cities as suddenly finding themselves isolated from previous markets better describes the situation. The evident prosperity of the Dead Cities was built on the oil trade. A sudden disruption of this trade could end the period of nearly continuous expansion. However, as Tate and Sodini discovered, the Dead Cities were largely agriculturally self-sufficient. The inhabitants, deprived of their oil trade, could nevertheless survive on their own agriculture. This would explain the sudden halt in building and development. With no oil trade the inhabitants would be without the capital necessary for expansion. While not perfect, Wickham's combination of Tate's and Tchalenko's theories of economics provides a more logical representation of the situation in the Dead Cities.

More recent discussions of the Dead Cities have focused more on the interconnected nature of their economic system with that of the wider Mediterranean world. Earlier literature tended to view the Dead Cities as isolated, lost in the marginal Jebel region. Recent scholarship has shifted the focus from describing the ruins themselves to integrating the Dead Cities into the wider Late Roman world. Casana (2014) frames the relatively short lived phenomenon of settlement on the limestone massif as part of a wider expansion into formerly marginal regions, fueled by agricultural intensification and specialization seen across much of the Levant. As such, the Dead Cities must be viewed within the context of contemporaneous lowland settlement. Casana goes on to suggest that the well-made stone houses, practically unique to the Dead Cities, are likely only made from limestone because of its abundance on the massif. The lowlands would likely have constructed similar dwellings, but of the less durable mudbrick and wood. Casana believes that stone would actually have been less expensive than hauling mudbrick and wood up the Jebels, "…even the most modest of houses and outbuildings among the Dead Cities are constructed of limestone..." (Casana 2014: 213-214) As such, the remarkable state of the Dead Cities can likely be read as a sampling error of preservation.

Discussion

Despite the relatively early date of discovery, surprisingly few questions about the Dead Cities have been sufficiently answered. This is due in large part to the dearth of excavation in the massif region. Tate and Sodini's two seasons in the 1970's are the only excavations to be carried out in the Dead Cities themselves. Despite some issues, Tate and Sodini's findings fundamentally reshaped our view of these sites. Even so, they only excavated a handful of structures, and surveyed approximately forty more villages. This represents only a tiny fraction of the sites still present in the landscape. Furthermore, Dehes is quite a large site, and does not appear to represent the bulk of the Dead Cities. Much of our understanding of the Dead Cities is based on antiquated research and limited excavation. This discrepancy is felt even more keenly when compared to the extensive research undertaken in the nearby lowland valleys. The exact social and economic nature of the Dead Cities is still much debated today. This thesis will shed new light on the logistical viability of the olive oil trade. This, in turn, provides new insight into the age old questions of subsistence and abandonment.

<u>Chapter Three: Locational Analysis of the Dead Cities</u>

Despite being known to Western scholarship for well over a century, locating, and even numbering, the Dead Cities is deceptively difficult. Much has been written interpreting the complex architectural, economic, and social themes of the Dead Cities, but really only Tchalenko devoted substantial time and energy to accurately mapping these sites in their entirety (Tchalenko 1953). Tchalenko, in his seminal three volume *Villages Antique de la Syrie du Nord,* devotes the bulk of his second volume to scientifically mapping the Dead Cities. However, no highly accurate modern maps of the Dead Cities exist. To further muddy the water, modern sources do not even agree on the number of Dead Cities. Many sources simply list some variation of the fairly large range of 400-700 individual sites (Butcher 2003; Foss 1996). Frustratingly, even Tchalenko never states a specific number, but does map 1066 individual sites. UNESCO was able to neatly sidestep this complicated issue. When inducting the "Ancient Villages of Northern Syria" into their list of World Heritage Sites in 2011, UNESCO opted for the pragmatic approach of simply drawing discrete polygons around the greatest extent of the five Jebels. This move ensured that all of the Dead Cities were covered as official world heritage sites without having to go to the trouble of identifying or mapping each individual site. These amorphous polygons cover hundreds of individual sites, but provide no specific site data. In essence the organization sworn to protect and conserve these sites would be very hard pressed to provide accurate spatial data for any but the most well-known sites. These critiques are raised not to deride UNESCO or to discount Tchalenko's contribution, but to illustrate the difficultly of producing even a simple dataset or map of the Dead Cities.

In truth, the difficulties of accurately mapping the Dead Cities extend far beyond a dearth of modern mapping effort. The world in general, but the Middle East especially, has undergone massive industrial, agricultural, and population expansion since the end of World War II. Once an underpopulated marginal region, expansion in each of these sectors has slowly pulled the limestone massif into modernity. Stones walls demarcating ancient field boundaries, virtually indestructible before the invention of industrial machinery, are now bulldozed to make room for modern agricultural efforts. Spurred on by massive population growth, modern villages and urban areas have expanded their borders, swallowing up some of the Dead Cities as they grow. Furthermore, the ongoing Syrian Civil War is greatly affecting the Dead Cities. Looting, intentional destruction, and a desperate need for building materials are only a few of the most pressing threats to the Dead Cities (Casana and Panahipour 2014). Destruction and damage of these sites is only a footnote on the unmitigated human catastrophe that the current conflict has caused, but one that might have acute repercussions on a post-conflict Syria. In essence, the long term effects of increased urbanization and mechanization are slowly pressing the Dead Cities on all sides, while the sharp pressures of the Syrian Civil War are erasing whole sites as this thesis is being written.

In addition to these long term obstacles of site location, the Dead Cities themselves actually present something of a conundrum for site location. In general, remote sensing has been a brilliant tool for archaeology because it allows researchers to see their sites from a much broader lens. As such, many sites or related features that appear innocuous from ground level are much more apparent when viewed from high above. The Dead Cities actually represent the opposite problem. Due to the magnificent level of preservation of architecture, the Dead Cities are easily recognizable from ground level. However, due, in part, to their relatively small surface area, these sites are easily missed in even the highest resolution satellite imagery. Even the largest and most well preserved of the Dead Cities typically cover less than ten hectares. For example, Serjilla, one of the most widely known sites, is only approximately eight hectares in area. More surprisingly, the religious complex of Qal'at Sim'an, with its monumental cruciform church, famous in both the ancient and modern world, reaches only a modest 5.5 hectares. There are exceptions to this rule. Deir Siman, a pilgrim refuge center and religious community, could measure up to twenty hectares (depending on how one chooses to draw the perimeter). However, the vast majority of Dead City sites are much more likely to be closer to Serjilla in size. Furthermore, unlike many earlier period sites, the Dead Cities were not occupied over a long enough period to cultivate the massive landform change so easily detectable in aerial and satellite imagery. Over time, human actions, such as building, rebuilding, refuse disposal, and general landscape modification, result in sites not only growing outward but also upward. Colossal sites such as Tell Brak, Aleppo, and Tell Mardikh (Ebla) are easily noticeable in satellite imagery not only because of their area, but also their topographic profile. This is especially true of CORONA imagery. Due to the black and white nature of the imagery, topographic features such as mounds, pits, or holloways, cast a shadow that serves to highlight the site itself. More crucially, these same human processes alter the soil chemistry. Human driven soil alteration also tends to modify the soil color. In the black and white CORONA imagery, these soils are clearly evident (Menze and Ur 2012). The limestone massif has relatively little top soil. As such, the process of soil alteration is less visible in and around the Dead Cities. Due to their small area, relatively short period of occupation, and position on the limestone hills, the Dead Cities are all but invisible in many satellite images. Figures 2 and 3 show a comparison of Tell Brak (Figure 2) and Sergilla (Figure 3) displayed at the same 1: 50,000 scale.

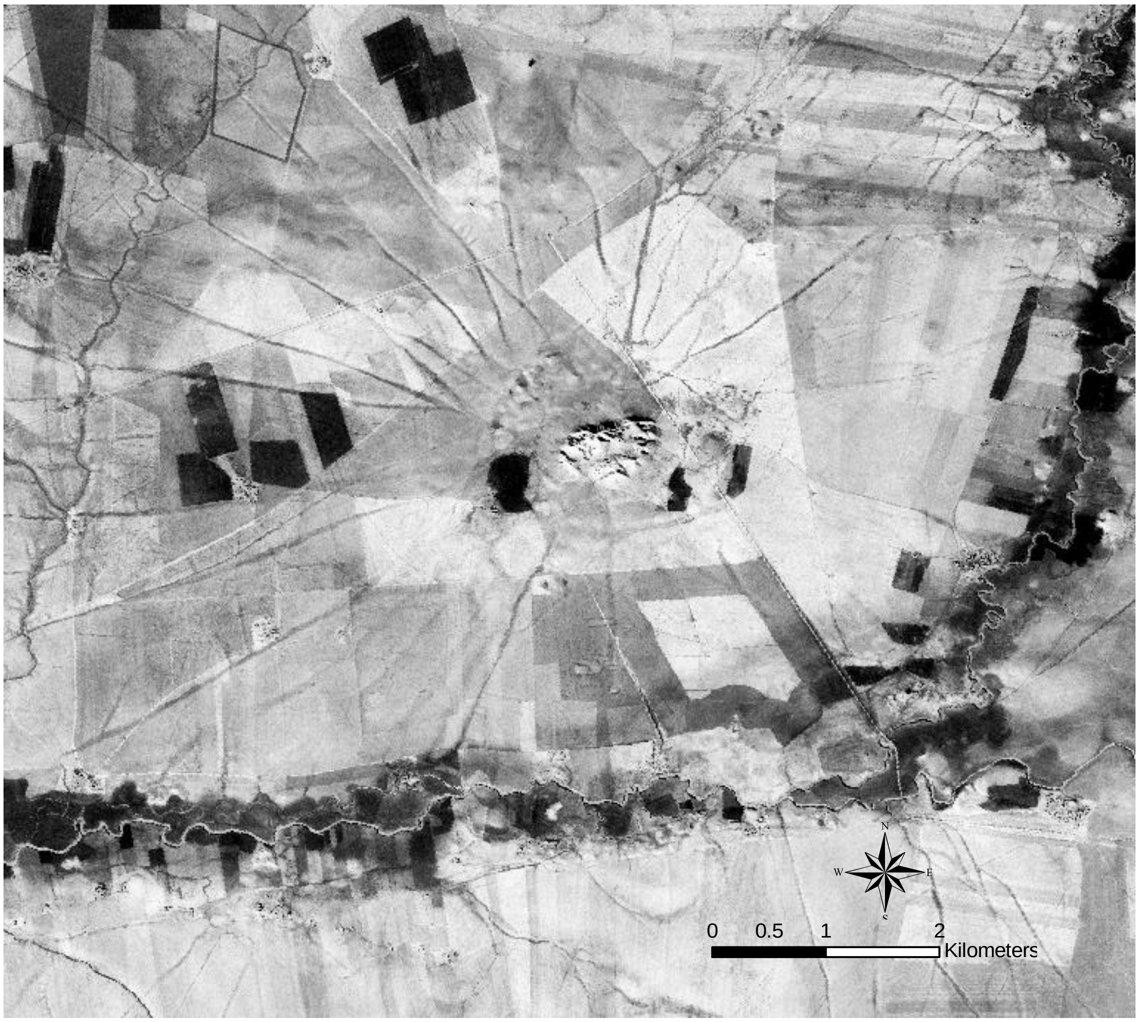


Figure 2: Tell Brak in CORONA Imagery viewed at 1:50,000 scale

In short, through a confluence of disparate factors, the Dead Cities are far from an ideal candidate for an intensive remote sensing survey. However, due to the ongoing Syrian Civil War, traditional ground based survey methods are completely out of the question for the

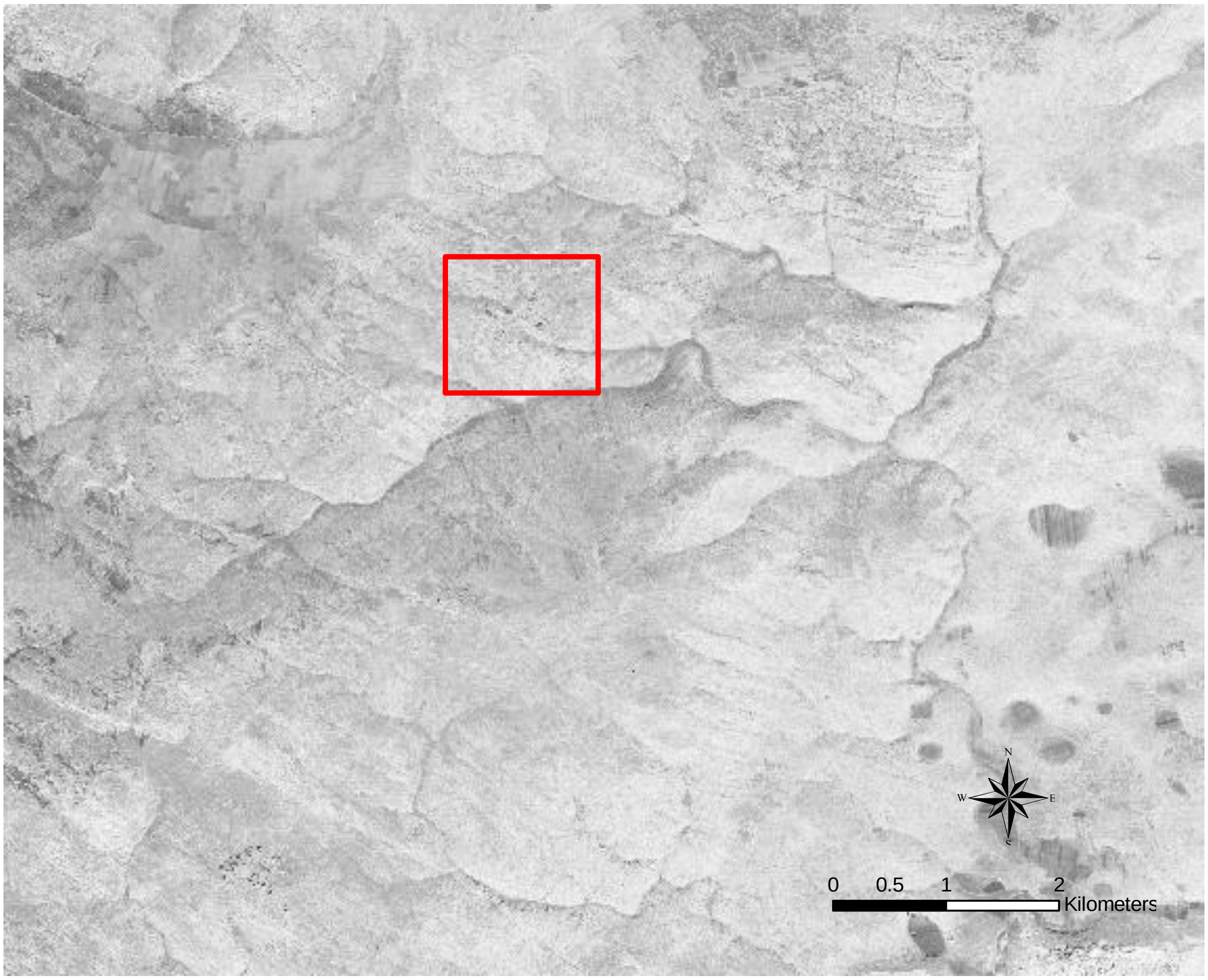


Figure 3: Sergilla in CORONA viewed in 1:50,000 scale

foreseeable future. In absence of the ability to survey these sites directly, remote sensing presents the best opportunity to accurately map the Dead Cities. With the aforementioned issues still at play, exhaustively mapping all of the Dead Cities is likely impossible, or at least prohibitively expensive in terms of available research time. Despite these challenges, determining the exact positions of the Dead City sites is critical to the success of this research project. To attempt to overcome these stated challenges, three different remote sensing methods were utilized. The remainder of this chapter will evaluate each methodology individually. Each method provided a sharp increase in site discovery. However each method also incurred an additional unique suite of problems and errors.

Remote Sensing Methods

Remote Sensing Imagery

The benefits of declassified CORONA spy satellite images for archaeological survey purposes are well attested (Beck *et al.* 2007; Casana *et al.* 2012; Ur 2013). Despite the project originating in the 1960s, CORONA images boast a remarkable average resolution of 2.5 meters per pixel (Casana *et al.* 2012). In fact, CORONA images are an extremely valuable tool for this particular survey precisely because of their age. The bulk of the CORONA scenes used for this project were recorded during the late 1960s or early 1970s. These images capture a period in time before the disruptive effects of modernity were in full force in the limestone massif. Many of these effects present in modern imagery, such as urban expansion and agricultural intensification, are practically nonexistent during the period these images were captured. Due to patchy collection and general unavailability of traditional aerial photography (non-satellite imagery), CORONA images are the oldest images available of the Syrian highlands. By predating the modern concerns of urban expansion, agricultural expansion, canal building, and landscape modification, CORONA scenes show an underpopulated hinterland. Stripping away relatively modern additions serves to highlight the Late Roman Period, which was the only period of intensive settlement of this marginal massif region (Casana 2014). Although far from a perfect analog, CORONA scenes offer us the best approximation of this complex landscape as it would have been experienced during the Late Roman Period. Even with these benefits, CORONA alone would be insufficient for the purposes of this project. CORONA helps to highlight clusters of structures on a largely unoccupied landscape, but lacks the resolution to distinguish between Dead City sites and more recent settlement. To make this determination, imagery with much higher spatial resolution is necessary.

Digital Globe imagery is among the highest quality imagery available today. Its imagery boasts sub-meter pixel resolution and typically offers numerous recent scenes of most regions. In addition, these images are recorded in realistic color. As it happened, this colorization ended up being much more useful than expected. Digital Globe is an excellent dataset, but shows a much more cluttered and developed landscape. Using both CORONA and Digital Globe imagery in concert allowed the strengths of each image suite to offset the weaknesses of the other. CORONA images, guided by the georeferenced maps, allowed potential sites to be identified. These possible sites were then verified using the Digital Globe imagery.

Method One: Georeferencing Existing Maps to Guide Site Prospection

Despite Tchalenko's hard work, more than sixty years have passed since his initial survey. The maps Tchalenko produced provide an excellent starting point for remote sensing-based survey. Although he includes a variety of maps throughout his three volumes, these maps are the only examples that contain all known Dead Cities sites (all three of these maps are visible in Appendix 1). These three maps are foundational to the study both of this region and the Dead Cities themselves. Despite Tchalenko's admirable work, paper maps, no matter how meticulously created, will practically always contain spatial errors. Attempting to accurately translate a three dimensional landscape to a two dimensional paper map is always a difficult. The rugged topography of the limestone massif appears to be especially resistant to precise representation. With this in mind, Tchalenko's maps are astoundingly accurate, but some level of distortional errors must be expected.

Further compounding these expected distortions, is a dearth of acceptable ground control points (GCPs). For these maps to be any use in remote sensing, they must first be carefully georeferenced. GCPs act as tie in points between points on the paper maps and real world positions. Due to Tchalenko's focus on the Dead Cities themselves, there are very few usable GCPs present in the maps. As a result, each maps received 5-7 unique GCPs. This paltry number is far from ideal. Indeed even some of GCPs selected were general at best. Tchalenko includes only a few modern cities for reference. As such, large cities like Aleppo, Idlib and Jisr-es-Sugur had to act as very general spatial reference points. The resulting georeferenced maps are still surprisingly accurate, all issues considered. Despite this better-than-expected accuracy, these maps are far from perfect. Ideally GCPs should be spread fairly evenly throughout the map that is being georeferenced. The dearth of decent tie-in points insures that the GCPs are often clustered and collinear. Due to the sub-optimal number and distribution of GCPs the spatial accuracy varies considerably, even within each individual map. This shifting accuracy insures that points on Tchalenko's original maps do not necessarily always match up with their correct real world points. In addition, the GIS method referred to as "rubber sheeting" adds considerably to the spatial inaccuracies of these georeferenced maps. Essentially, the process of georeferencing stretches the existing maps (Tchalenko's paper maps) to fit a series of points (GCPs) on a known digital surface. In forcing the existing maps to stretch across the GCPs, the scale can become extremely distorted. Rubber sheeting of these maps stretches the points, intended to represent the small area of a Dead City site, into a large polygon that covers several hundred meters. While this process does narrow down the potential area of site location to within a few hundred meters, (fairly good by some standards) this is often still too broad to easily identify sites. Couple this broad area with the spatial errors already mentioned, the small area of the typical Dead City site, and the dense clustering of sites across the Jebels, and individual site location remains challenging. Yet despite these challenges, georeferencing Tchalenko's maps does greatly decrease the potential area of site location for each site. Moreover, these maps provide a valuable point of departure for site location.

The initial success of this method of site location appears to have been driven by several factors. Firstly, this method appears to have been especially adept at locating the larger and more well preserved Dead Cities. Not only are these sites easier to locate due to their size, but their comparative "intactness" (greater proportion of standing structures) makes them doubly easy to spot on the CORONA images. This relative intactness also served to make verification of each site with the Digital Globe imagery straightforward. Furthermore, the vast majority of sites located using this method are still isolated on the landscape. That is to say that these sites are not currently being encroached upon by modern urban development. These sites exist today much as they did a millennia and a half ago. As Foss notes "…many of them look as if they had been abandoned yesterday" (Foss 1996: 58). These villages stand in sharp contrast to the rugged and largely empty landscape surrounding them. Sites discovered using digitized maps also tended to be preserved in clusters. In the CORONA imagery, multiple sites would often be visible simultaneously. Figure 4 shows a particularly dense clustering of sites along the Jebel Zawiye. Each new site discovered would often lead to the discovery of three or four other sites. So, for a time, this method performed exceedingly well. However, the number of large, well-preserved, isolated sites is relatively small. Past this initial flurry of site discovery, fewer and fewer obvious sites materialized.

In short, this first attempt at site location by digitizing Tchalenko's maps was met with considerable success. However due to the issues discussed above, this method primarily located previously known or spatially larger sites. As such, this method quickly met a point of diminishing returns. While the sites located using this method were a good start, these

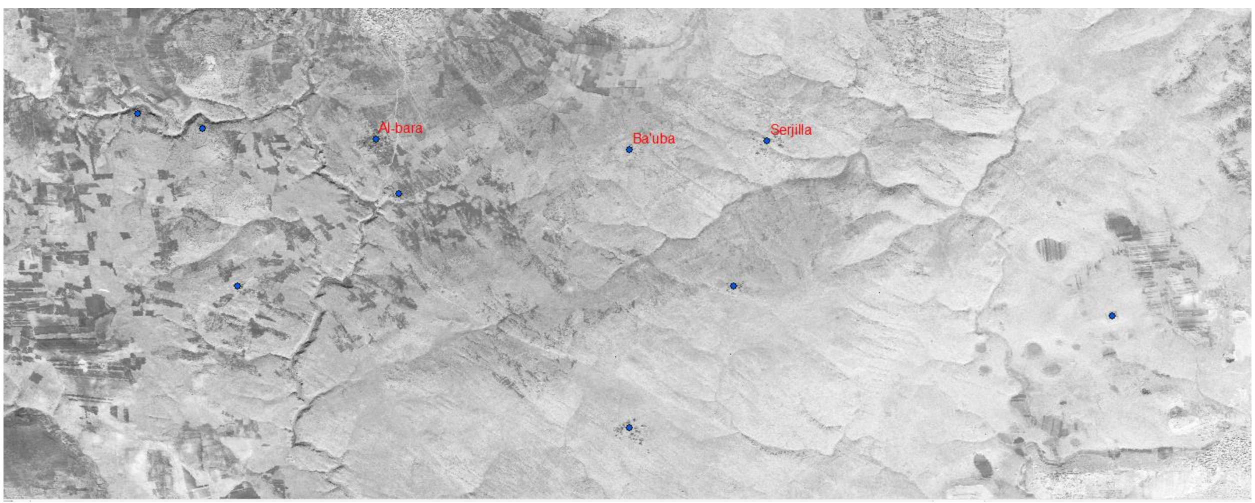


Figure 4: A Cluster of Dead Cities Clustered Across the limestone massif Landscape

approximately fifty sites are not a robust enough sample size on which to build a Least Cost Path Analysis model. Furthermore, due to the high settlement density, the sites discovered tended to be clustered together. This clustering effect would likely skew Least Cost Path models, and not be properly representative of the trade and transport potential of the limestone massif as a whole.

Method Two: Crowdsourcing Site Location with Google Earth

Although visiting the Dead Cities is currently out of the question, this has only been true since 2011. The Dead Cities played a vital role in the tourist economy of pre-war Syria (Burns 2009). As such, even many of the most remote and obscure of the Dead Cities were subject to the tourists' gaze. Wherever in the world tourists go, pictures are taken. This method of site location uses a rudimentary form of crowdsourcing to harness thousands of tourist's photographs to help pinpoint the location of Dead Cities.

Given the abundance of geospatial data currently available to researchers, it is easy to forget that even as recently as a decade ago, satellite imagery was not widely available to the public at large. In 2005 Google made two very important contributions to publicly accessible satellite imagery. First in February, Google Maps went live. Then in June, Google Earth was launched (http://www.google.com/about/company/history/). Given the availability of more robust GIS platforms, few professional archaeologists have embraced Google platforms for research purposes. In fact, the vast majority of "archaeological" data available on Google Earth appears to be geared toward amateur enthusiasts (Hirst 2015). Regretfully, Google Earth may actually present a clear and present threat to archaeological sites (Tarlach 2015). Despite these issues, Google Earth remains a deceptively powerful platform.

For the purposes of this project, the available satellite imagery is less important than the "photos" layer. This layer allows users to upload photos directly onto the Google Earth platform. The bulk of these photos were originally taken by tourists all across the globe. Google Earth then allows users to upload their photos using a site called Panoramio (https://support.google.com/earth/answer/148126?hl=en). As users upload their photos, they are able to select general area where the photograph originally taken. The end result is an open source ground level view of virtually every area of the globe.

Since this process is entirely voluntary, photo coverage is far from uniform across a landscape. Unsurprisingly given their fame with tourists, hundreds of photo of the Dead Cities appear on Google Earth. The methodology from here is fairly simple. While slowly scrolling across the limestone massif landscape, clusters of photo become visible. In general, a cluster of photographs implies something significant at the ground level. Given the general emptiness of the limestone massif these clusters, more often than not, gather around Dead Cities. Figure 5 shows one such cluster around a Dead City site. Although these clusters help to draw attention to particular areas, they are not always reliable. Figure 6 shows a dense cluster of photos incorrectly placed in a nearby agricultural valley. When a cluster of photos appears to represent a site, Digital Globe imagery must be used to verify that it is, in fact, a Dead City. This method is particularly effective in areas of urban expansion. Even with the high resolution of the imagery, structures can be difficult to make out. This is exacerbated when archaeological structures are surrounded by modern buildings. Ground level photographs from Google Earth help to guide the surveyor much closer to the archaeological structures themselves. This makes distinguishing sites and modern cities immensely easier.

Figure 5: Cluster of Google Earth Photographs Clustered around a Dead City

Figure 6: A Dense Cluster of Google Earth Photographs Incorrectly Placed in an Agricultural Field

Despite these faults, using Google Earth photos to guide site location met with significant success. Another forty-five to fifty-five sites were confidently mapped using this method. While not crowdsourcing in the truest sense, this method made the efforts of thousands of visitors and tourists available to aid in serious analysis. In using these public photographs, hundreds of hours of painstaking aerial survey were condensed to only a few days.

In a similar manner to the previous method, using Google Earth photos to guide survey had tremendous initial success, which was followed by rapidly diminishing returns. There are many possible reasons for this fall off in site location: although tourists and enthusiasts have likely photographed nearly every inch of the limestone massif, the voluntary nature of uploading images tends to skew site location to larger more tourist friendly (i.e. more intact) sites. In addition, reliance on Digital Globe imagery to verify suspected site location serves to filter out very small sites or isolated structures and features. Occasionally the Google Earth photographs would point to a single small feature, such as a standing column or lonely burial marker. While these photos may have been placed properly, the resolution of the Digital Globe imagery is not sufficient to confidently map a site. Even some individual structures, likely from the period of interest, had to be discarded due to lingering doubts over identification. As such, possible sites were not mapped or given an identification number unless they were without a doubt a Dead City site. While this limited the number of sites mapped, it did ensure that each site’s precise location could be trusted while performing the Least Cost Analysis.

Overall, this method approximately doubled the number of sites accurately mapped. Despite some significant flaws and partial reliance on non-professionals, this method did greatly increase both the number and distribution of recorded sites. While this method was very helpful in the limestone massif, due to the peculiar nature of the Late Roman settlement history and preservation, this method is unlikely to maintain its utility in wider archaeological contexts.

Method Three: Brute Force Method

This method was the most straightforward and least artful used. Although the previous two methods had accurately recorded around a hundred Dead City sites, the maximum possible number of sites was desired for future analysis. To this end, a systematic and exhaustive methodology was employed. This methodology, termed “Brute Force” by Casana (2014) relies on trained analysts methodically combing each image for evidence of archaeological sites.

Simply put, the brute force method entailed slowly scrolling across the limestone massif manually searching for sites. This method did not rely on georeferenced maps, publically uploaded photos, or previous research at all. This method was extremely labor intensive and tedious. However it did yield approximately a dozen additional sites.

While a dozen new sites may be paltry compared to the results of the previous two methods, but there are mitigating circumstances. It is important to remember that the previous two methods were especially efficient at locating large and well preserved sites. As such, these new dozen sites were typically much more ephemeral, and would likely only have been found using this method. However, this method was also far and away the most time consuming. The investment of time per site located roughly quadrupled while using this method. In addition, this method is exceptionally tedious, but paradoxically requires the researcher’s constant attention. These factors combine to make this method slow, boring, and physically, as well as mentally, exhausting. Furthermore, despite adding more sites, the rate of sites discovery was so low as to make continued effort futile.

Conclusions from Site Locational Analysis

Clive Foss' article, *The Dead Cities of the Syrian Hill Country,* contained a figure of considerable relevance to a discussion of locating the Dead Cities (Foss 1996: 50). Although the site location aspect of this project was undertaken without prior knowledge of Foss' findings, the two datasets match up remarkably well. Figure 7 shows Foss' map overlaid with my dataset of Dead Cities. 89 sites (76%) fell with his area of "Numerous well preserved villages." 21 sites (17%) fell within the "Partially destroyed villages" parameter. While only 5 (4%) were termed "Isolated Ruins" by Foss (Foss 1996). Finally 2 sites (1%) fell completely out of Foss' classifications. The combination of Foss' map with this new spatial data provides interesting insights into the modern state of the Dead Cities. The sites located generally fall into two different loose clusters. One cluster in the north along the Jebels Wastani, Il A'la, Barisa, and Sim'an, with another cluster of sites is scattered along the Jebel Zawiye. Originally I viewed these loose clusters as symptomatic of imperfect site location. While this is undoubtedly at least partially true, in light of Foss' map, it appears that this clustering is also an artifact of site preservation.

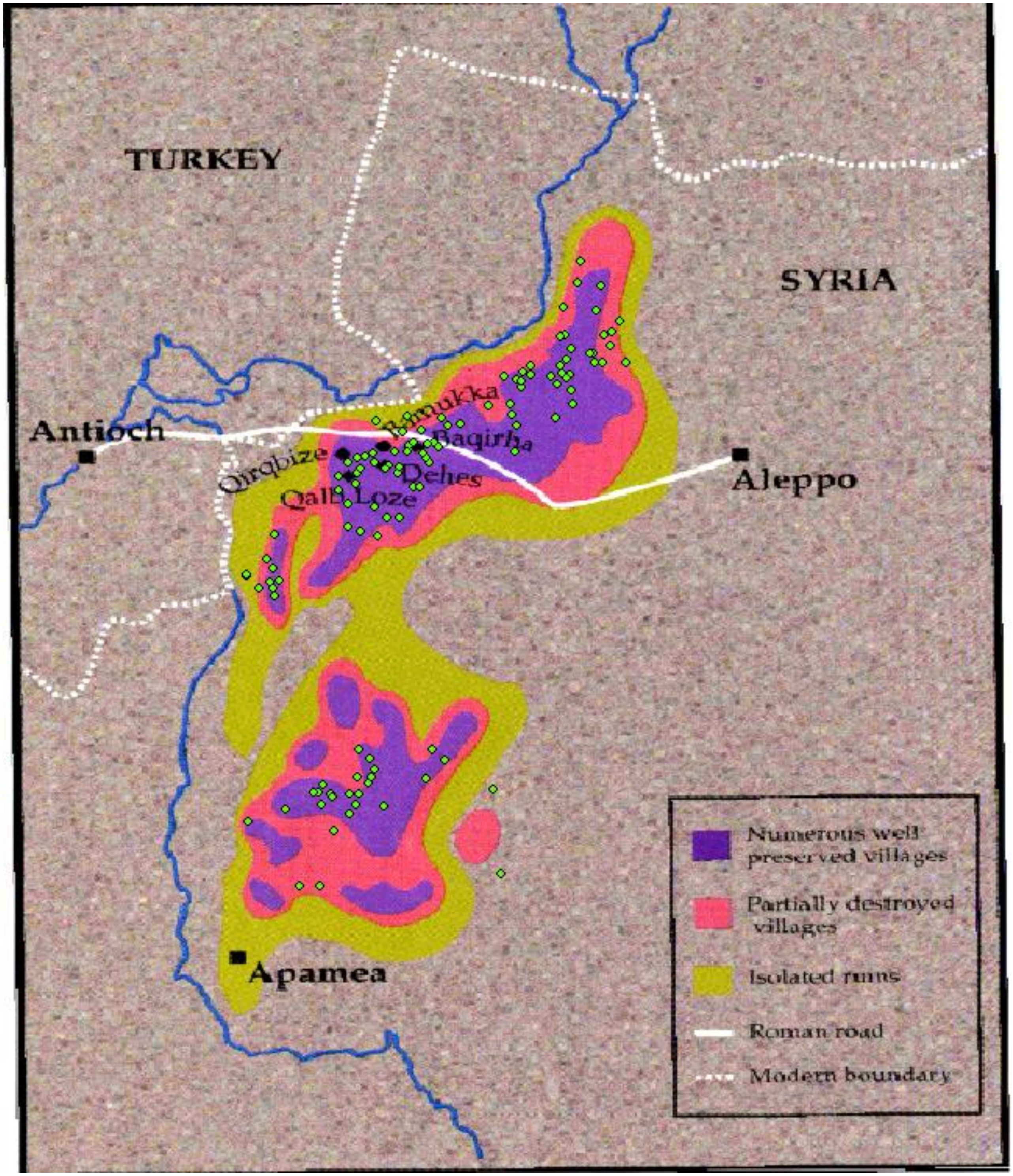


Figure 7: Foss' Map of Site Preservation Displayed with the authors Dead Cities Dataset

As discussed above, the relationship between site location and preservation is fundamental to this survey: well preserved sites are easier to locate. The relationship to elevation is equally intuitive. Simply put, as elevation increases so does the likelihood that sites will be well preserved. At first glance, this appears to be simply of a function of the highland nature of the limestone massif region. These sites were also protected from encroaching modernity. However, it is important to note that although the majority of Dead Cities sites appear on the elevated Jebels, those on the highest portions of these Jebels have the highest chance of being located (at least using the methods discussed above).

These particular methods were used, in part to match the eccentricities of the Dead Cities, but were also intended to complement each other. These methods had major overlap, especially on their reliance on CORONA and Digital Globe imagery. Notwithstanding these similarities, each method produced a distinct dataset of sites. Though no individual method would have been sufficient, utilizing three different methods of sites location allowed for the creation of a unique dataset. The shapefile produced as the culmination of these efforts is the first (to the author's knowledge) attempt to create a digital database containing a large number of the Dead Cities. Vexingly enough, this thesis project is the first research to attempt to study of the Dead Cities in their entirety since Tchalenko's work in the 1950s (Tchalenko 1953-8). With that in mind, this project was not able to replicate Tchalenko's results. Tchalenko's maps contained 1066 distinct sites (Tchalenko 1953). At present this project has mapped 117 Dead City sites. Since there is no scholarly consensus on how many Dead Cities remain in existence today, this shapefile represents somewhere between 16% to 29% of the total sites (based on the most often cited range of 400-700 sites) While these represent only a fraction of Tchalenko's sites, 16-29% of sites are a fairly representative sample size. In addition to their numerical salience, the sites recovered here are well distributed throughout the limestone massif region. This distribution, across such a rugged and broken landscape, will contribute to the production of a usable Least Cost Path model. Furthermore, sites located in the future can be incorporated into the parameters of the LCP models with ease. In short, as new sites are located, they can simply be added into the existing model to further refine analysis.

Chapter Four: Reconstruction of the Late Roman Landscape

Attempting to reconstruct an ancient landscape is never a simple task. Landscapes, like cultures, are inherently dynamic. Natural processes, as well as the actions of inhabitants can radically change a landscape over time. Such was the case in Late Roman Syria. When the Roman Empire first consolidated its influence over the territory of modern day Syria, it found a land well suited to their efforts. The Levant, unlike Rome's imperial possessions in the West, already possessed a strong culture of urbanization (Pollard 2000). The territory most germane to this project already contained a number of impressive urban areas. Antioch, Apamea, Beoria, Chalcis, and Cyrrhus were already urban centers by the beginning of the Roman period, but would reach new heights of population, economic power and political growth. Though population estimates tend to be tenuous in Antiquity, Michael Decker reports that both Antioch and Apamea had populations well in excess of 100,000 people by the fifth century (Decker 2009: 19-20). Each of these cities, under the Romans, would dominate considerable surrounding territory. Perhaps due to this millennia old tradition of urbanization in the East, the Romans appear to have shifted the focus of their engineering attention not on the cities, but on the surrounding landscape itself. In other words, in the West, Rome founded great cities while in the East, Rome shaped the landscape to their needs and desires.

When discussing ancient landscapes, it is important to distinguish between two different types of data: cultural and environmental (White and Surface-Evans 2012). Cultural data can include settlement location, settlement type, road networks, subsistence patterns, and land use. While environmental data refers to naturally occurring features such as topography, slope, land cover and natural hydrology (White and Surface-Evans 2012). To attempt to reconstruct the Late Roman landscape, both sets of data must be examined and incorporated. Each dataset provides unique challenges and uncertainties. This chapter will detail why each element of the landscape was incorporated, and how each element was illustrated. Furthermore this chapter will offer some thoughts on the accuracy of this landscape reconstruction, and attempt to justify decisions made regarding the incorporation of data into the subsequent model.

The effect of Roman landscape modification cannot be overstated. During the Roman and Late Roman Periods rivers were canalized, bridges were built, swamps and lakes were drained, roads were built, and settlements spread to previously undesirable sectors of the landscape (Weulersse 1940; Decker 2009; Casana 2014). While these modifications were profound, they are often difficult to detect in the modern environment. Landscape alteration has continued unabated for the subsequent millennia and half (with the exception of the Dead Cities sites, which were left relatively undisturbed until recent centuries). This continuity of human-landscape interaction makes reconstructing a single period exceptionally difficult. In addition, the twentieth century brought a technological acceleration that surpassed even the Roman's ability to shape the landscape. As such, it is helpful to view the landscape as a palimpsest (Casana 2003). The landscape must be painstakingly pried apart to reveal only the alterations of the Late Roman period. Despite these difficulties, remote sensing, satellite imagery, and GIS analysis allow researchers see past the accumulated landscape changes of subsequent centuries.

Intensive landscape alteration leave traces on the modern landscape. The traces are often quite subtle, but evident nonetheless. High resolution satellite imagery is very helpful in this regard. Relatively subtle soil color and texture changes are detectable using Digital Globe imagery. These minute changes are often evidence of hydrological activity past or present. Other hydrological features leave only a slight depression on the modern landscape. These "scars" are practically invisible in modern imagery, but are often highlighted nicely in the CORONA imagery. As discussed in chapter three, the CORONA images also offer the advantage of preceding many of the more dramatic landscape alterations of the twentieth century. This imagery, paired with the indispensable maps of Tchalenko (1953) and Weulersse (1940) help to direct reconstruction of the Late Roman landscape. These maps offer approximate areas for roads, river channels, lakes, marshes, and canals which can then be compared with the modern landscape. Such a fusion of traditional publication and modern imagery allows for reasonable illustration of past landscapes. Doubtlessly this reconstruction is imperfect, but will allow for the construction of a testable, quantitative approximation.

Roman Roads

It is tempting to view the countryside of Late Roman Syria in much the same way it is romanticized today. Modern visitors to this region tend to fixate on the desolate beauty of the windswept Jebels (Beattie 2001). While this sequestered view of the limestone massif is certainly charming, during the Late Roman period this countryside was quite densely populated. Hundreds of settlements dotted both the highlands and fertile valleys (Tchalenko 1953; Tate 1992; Casana and Wilkinson 2005). The lynchpins of trade and communication for this diffuse settlement pattern were the roads and paths that connected small rural villages to the urban centers of Antioch and Apamea, and beyond to the sea. It is safe to say that the Romans built excellent roads. Only small fragments of these road beds remain today. These fragmentary remains are far from sufficient to reestablish the routes of the Late Roman roads on their own. However a careful consideration of the surrounding topography, aided by detailed maps and a study of modern highway development, provides a solid foundation on which a reasonable estimation of Roman roads can be established.

For this area of consideration, there were a number of principle roads. Arguably the most important road ran east to west from Antioch (modern Antakya) across the Amuq plain, over the Jebel Barisha, to the Eastern city of Beoria (modern Aleppo). Another principle road ran south to north from Apamea skirting the eastern Ghab plain, crossing the Orontes River at Jisr Ash-Shughur and then again at Darkush, before finally intersecting the Antioch-Aleppo road on the eastern bank of the Orontes near Tell Tayinat. Another significant road also ran north from Apamea, but veers east between the Jebel Wastani and Jebel Zawiye and eventually connects to the modern city of Ad Dana. This road then continues northward along past Deir Sim'an and along the western edge of the Jebel Sim'an (Tchalenko 1953: Pl. XXXVII). Detailed maps, such as Tchalenko's, provide an excellent departure point for tracing the Roman roads. Tchalenko appears to have preferred graceful gently arcing roads. Figure 8 illustrates Tchalenko's interpretation of the Roman road positions during this period. While this is visually appealing, it fails to take into account the broken and rough terrain, especially between Jisr Ash-Shughur and Darkush. As such, once georeferenced, Tchalenko's maps served as a general guide to the tracing of roads, but not the final authority.

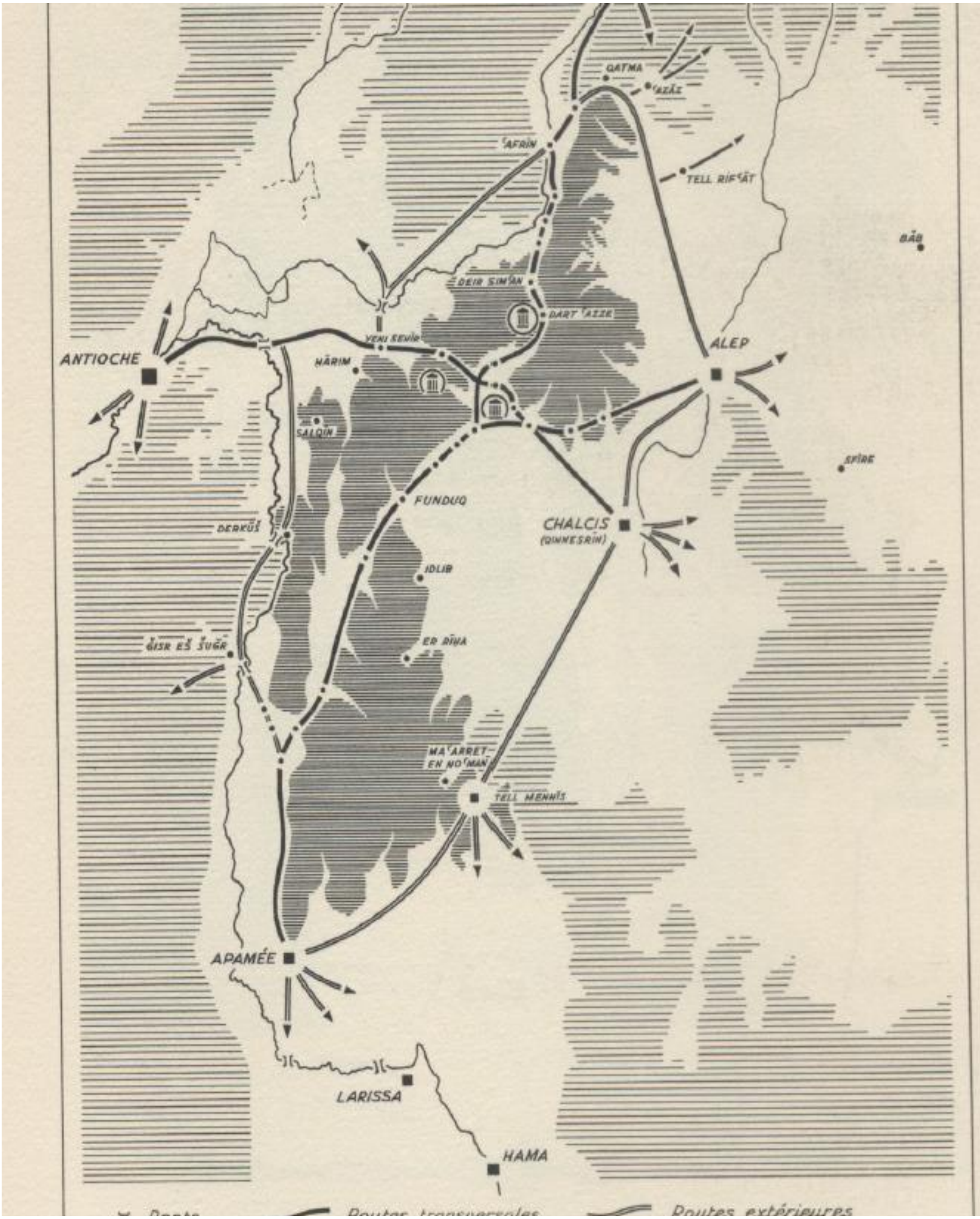


Figure 8: Routes exterieures et routes transversales antique du Massif Calcaire (Tchalenko 1953 Pl. XXXVII)

In the intervening decades more modern roads have begun to crisscross the highland region, but during the peak CORONA mission years (1960s and 1970s) surprisingly few roads braved the steep broken terrain of the Jebels. The roads that did exist were fairly narrow and tended to carefully switchback up and down the undulating terrain. It stands to reason that, given the dramatic topography, only a few possible pathways exist through the Jebels (before modern road construction equipment). These small roads, easily visible in the CORONA images, therefore can stand as an analogue for areas where Roman roads are known to have existed, but traces cannot be found. It stands to reason that, given the scarcity of options on the Jebels themselves, some of the 1960s era roads are quite possibly built on the remains of the Roman roads. Unfortunately, this is impossible to investigate further at the moment. Regardless, these roads act as an approximation of the route Roman roads would have travel.

While the Jebels conveniently funneled the roads into a small number of likely routes, the Amuq and Ghab plains offer practically infinite possible routes. However, both Tchalenko (1953) and Weulersse (1940) suggest that the roads likely hugged the edge of the Jebels, where the valley floor was less marshy. Due in part to 1500 years of continuous agriculture, only very faint traces of the roads remain across the valley floors. As such, Tchalenko’s maps were used extensively to illustrate these sections of the road. While it would be preferable to connect the faint traces on the landscape to reconstruct the valley, the traces are simply too ethereal to utilize with any certainty.

Overall the combination of CORONA imagery, careful reading of the topography, and interpretation of surviving traces of the roads themselves provided an educated guess as to the road locations. This is not to imply that these renderings are the discernibly *the* locations of the road, only that these illustrations of the road are accurate enough to not distort the subsequent Least Cost Analysis models. As a point of reference, it is helpful to illustrate the speculative position of these roads compared to their positions in Tchalenko's maps. It is well worth noting that Tchalenko's maps also reference a labyrinth of smaller *routes interieures* or "inland routes." These wind their way up through the Jebels and would doubtlessly aid in understanding how goods and people moved across this landscape. However, other than these maps, there is no evidence at all as to where these smaller pathways would have been. As such, these smaller pathways had to be omitted from the "roads" dataset. However these suggested pathways are traced and added to later iterations of the model to test their efficacy. The East to West Road matches up nearly perfectly with my shapefile, while the North-South road differs in a few places. As discussed above, these differences occur most often on broken highland terrain. The graceful arcs of Tchalenko's routes cannot possibly be representative of how a physical road would run across such treacherous landscapes. Furthermore, while such differences appear considerable in Figure 9, in reality, these differences amount to between 200 meters and approximately three kilometers. While this margin of disagreement is not optimal, such distances are relatively paltry considering the size of the landscape discussed.

This shapefile likely does not reflect the "true" position of the Roman Period roads. There simply isn't enough information to plot the roads with absolute certainty. However this roads shapefile represents a best guess as to where the roads would possibly have run. Even if the exact position is incorrect, these roads serve as a good approximation of the physical Roman roads. When incorporated into the Least Cost Analysis model they will act as a funneling force, bringing people and goods from the plains and highlands and moving them rapidly toward the urban centers.

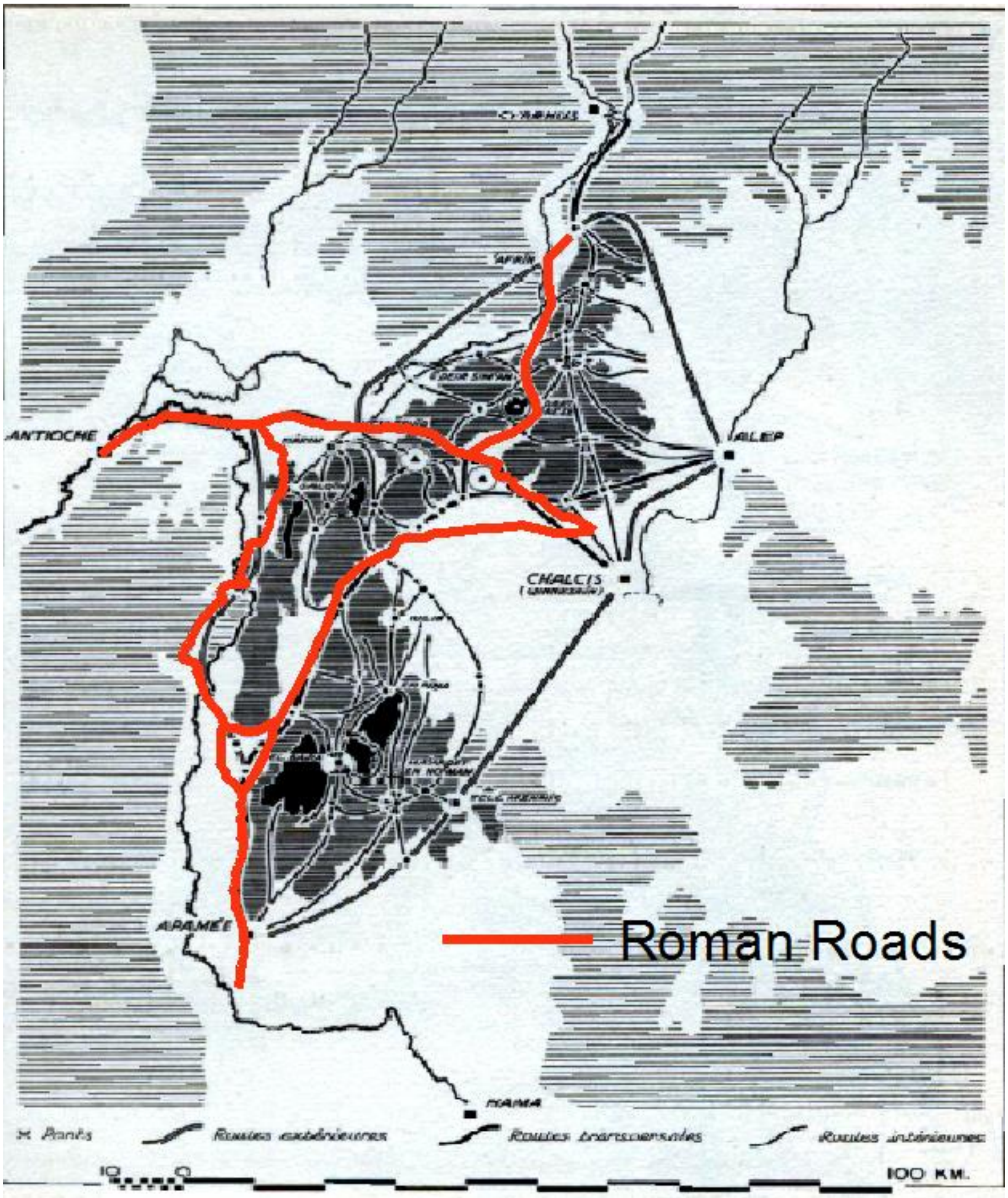


Figure 9: Roman Road Dataset Display with Tchalenko's Map of Routeways

Hydrology

Given the relative aridity of Northwest Syria, typically 300-600 mm per year, it is unsurprising how critical hydrological features are to questions of movement and trade across the limestone massif landscape (Tchalenko 1953: Pl XXIX; Casana 2014: 195). Despite its relatively low precipitation, during the Roman and Late Roman Periods a remarkable number of hydrological features appear to have been present. These features include three major rivers, the Orontes in the Ghab valley, the Afrin and the Karasu in the Amuq, as well as one large fresh water lake in the Amuq referred as The Lake of Antioch, or Lake Amik alternatively, a large number of Roman Period irrigation canals and possibly a large area of marshlands in each valley.

Given the technology available to modern researchers, it is tempting to simply use the "Hydrology" toolkit, standard in most GIS platforms, to create a flow model based on topographic data. Although such a method would be far easier, it would inextricably distort the interpretation of this landscape, and drastically alter the subsequent model. Such a hydrological model would only be reflective of the modern landscape and, given the broken nature of the Jebel landscape, greatly overestimate the role of flowing water in regional trade and transport. Since the Late Roman period, this region has undergone continuous change. Large areas of the Amuq and Ghab plains, once wet marshland, were drained, turned into agricultural land, and then slowly re-flooded after the Romans left, only to be permanently drained during the 1960s (Wieser 2012; Casana 2008). Such dynamic and continuous landscape changes require a level of attention and interpretation that current GIS is unable to provide. Like the Roman roads discussed above, the paleohydrology of northwestern Syria must be carefully teased out of the modern landscape.

The Orontes River, in its modern form, is highly canalized in the Ghab valley. However this was not always the case. The floor of the Ghab plain is littered with extinct river channels and ancient canal features. For this reason, determining where the Orontes flowed during the Late Roman Period is quite difficult. The use of CORONA imagery is again paramount to redrawing the Orontes' Late Roman course. Figure 10 shows the complexity of determining the course of a single river across an open floodplain. In Ghab valley, there are numerous possible

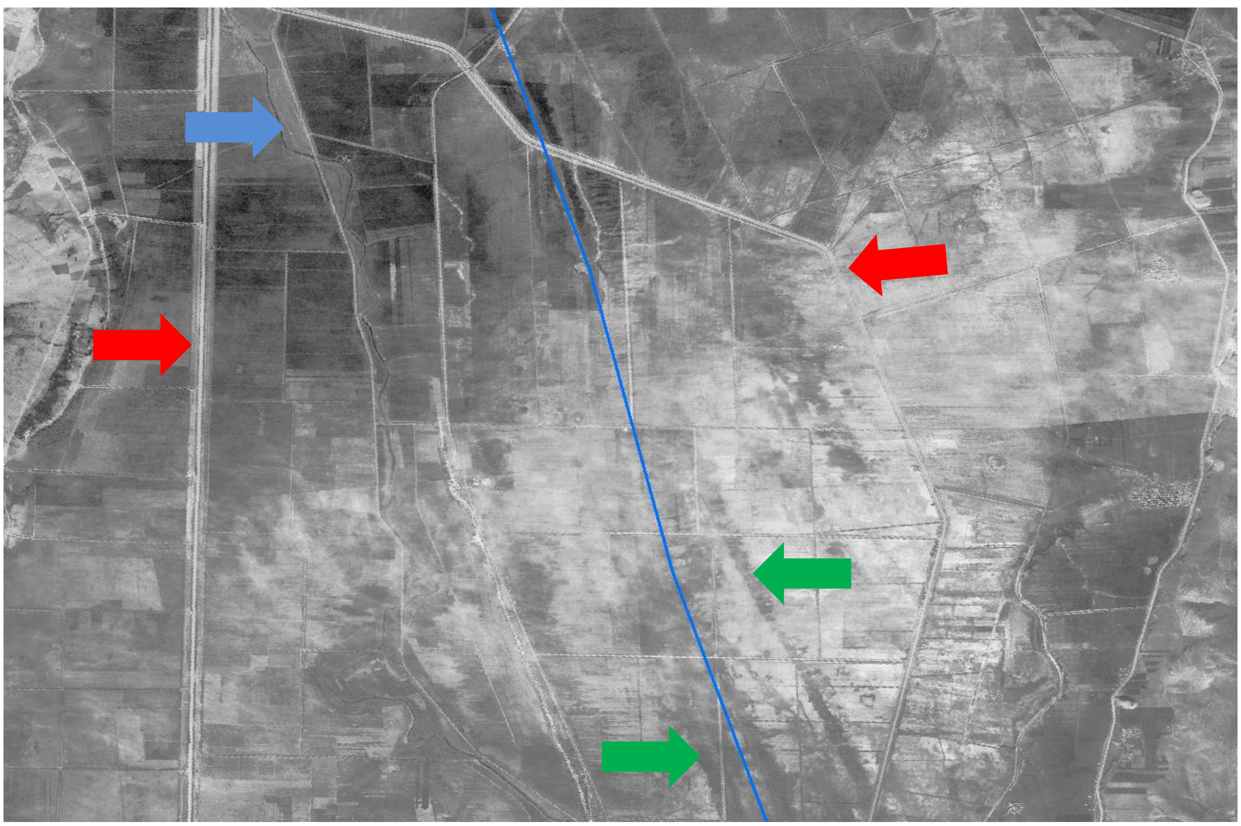


Figure 10: CORONA Image showing the Complex Hydrology of the Orontes River in the Ghab Valley. Modern irrigation features in Red. 1960s Orontes course shown with Blue arrow. Ancient canals in Green. My estimation of the Roman Period river course illustrated with a Blue line.

routes for the Orontes to flow. However, as the Orontes flows out of the northern extent of the Ghab, the river plunges into a deeply incised canyon with cliffs on each side of the river. As such, I can determine the course with relative certainty. The Orontes does not spill out of this canyon until it reaches the southern portion of the Amuq plain. As the Orontes skirts the southern portion of the Amuq plain, numerous extinct bends in the river are noticeable, but a general river route is fairly easy to ascertain. Finally, the Orontes flows back south through ancient Antioch and onward to the sea. In addition to the main course of the Orontes, a number of the more obvious ancient canal features, indicated in Figure 10, were also added to the “Hydrology” shapefile.

The Afrin and Karasu rivers are somewhat more straightforward to map. The Afrin runs from North-East to South-West along the northern most extremities of the Jebel Sim’an, then out into the Amuq plain where, in the Late Roman Period, it would have flowed into the Lake of Antioch. The bulk of the Afrin River appears to have more or less maintained its course since the fifth century. Although as Figure 11 shows, significant meander scars are visible along the Afrin. These typically run parallel to each other, and rarely diverge more than a kilometer at the most distant point. There is some uncertainty as to how the Afrin would have intersected the

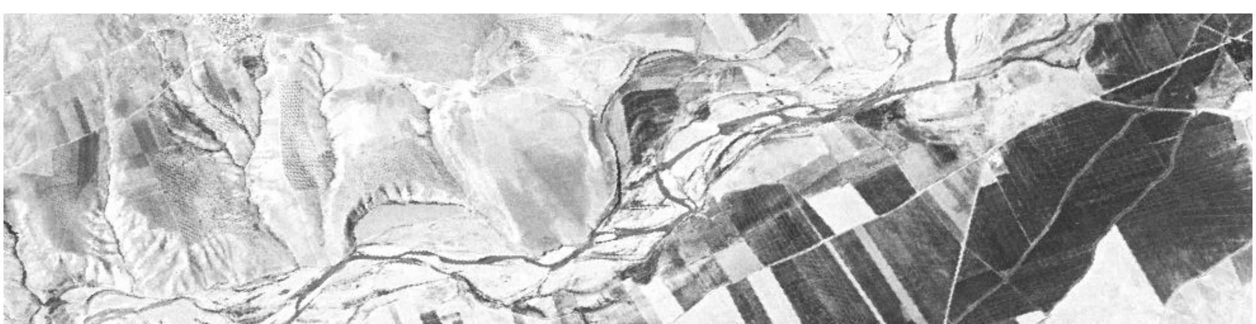


Figure 11: Meander Scars along the Afrin River, in a CORONA Image

Lake of Antioch. The modern course is canalized as soon as it reaches the open Amuq plain, but Wuelersse (1940) suggests that the Afrin would have flowed directly into an extension of the Lake of Antioch north of the modern canal. Furthermore, in the CORONA imagery there is a channel of the Afrin that runs north of the modern canal and intersects the Lake further to the north. In light of this evidence, this was the final route chosen for the Afrin River.

The Karasu River runs north to South along the western edge of the Amuq plain. The northern portions of the Karasu are straightforward to map, but as the Karasu reaches the openness of the Amuq Plain proper, it becomes nearly invisible. Predictably the modern course of the Karasu is highly canalized. CORONA images suggest a number of possible river channels. Even Wuelersse's usually detailed maps are somewhat lacking on the Karasu. Due to this dearth of reliable information, an approximate river course was chosen between the end of the obvious river course and the point at which the Karasu intersects the Lake of Antioch. Although all of the suspected river courses are approximate, the southern portion is tenuous even by comparison.

The importance of the Lake of Antioch is difficult to overstate. Libanius' *Oration in Praise of Antioch* is filled with admiration for the lakes and rivers surrounding Antioch.

> "Is it then surprising that we, who inhabit such a country and enjoy such a trading place who have as an ally the lake, and have the highway of the river as a helper, is it surprising that we adorn the city as though for a festal assembly"? (Downey 1959: 680)

Clearly Libanius is fond of The Lake of Antioch. He goes as far as to cite it as an "ally" and gives it considerable credit for the prosperity of Antioch (*In Praise of Antioch 260-266).* Libanius speaks of the Lake as an economic and agricultural asset, not a hindrance. Although writing more than a century before the peak of settlement along the limestone massif, it is reasonable to assume that this positive attitude about the Lake likely continued into the fifth and sixth centuries. However this attitude did not survive into the present. The draining of the Lake in the mid-twentieth century caused severe ecological repercussions (Casana 2008). Despite its permanent draining in the 1960s, evidence for the past extent of the Lake of Antioch is ample. In the winter of 1970, the Lake still held a considerable amount of water. Even in modern imagery, the footprint of the Lake is clearly evident by the stark difference in soil color. Figure 12 shows a comparison of the Lake of Antioch while it still held water, and how it appears in modern imagery. Although these images show the Lake after efforts to drain it were already underway, they provide a general outline of the extent of the Lake. Since the Lake was fed by both the Afrin and Karasu Rivers, the actual volume of the Lake likely changed significantly with the seasons. As such, renderings

Figure 12: The Lake of Antioch in CORONA mission 1112-2203Aft December 2nd 1970 (left) and in modern Google Earth Imagery (right)

of the Lake of Antioch from these images very likely underestimate its original size.

The Marshes in the Amuq and Ghab basins are perhaps the most challenging feature of the landscape to reconstruct. It is well known that in the early 20th century these marshes stretched over large portions of both valleys (Eger 2011; Wieser 2012). However the formation of these marshes and their salience in the Late Roman countryside is a matter of no small debate. Both Eger's (2011) and Weulersse's (1940) estimate reflect twentieth century marsh extents. Evidence for the extent of these marshes in the Late Roman Period is difficult to parse out. Libanius, in his glowing account of the Antioch countryside, does not mention the words "marsh" or "swamp" once during his entire oration (Downey 1959). Since Libanius fawningly describes practically every other aspect of the Antioch region, this absence is striking. However, given the obvious bias Libanius has for the region, it is possible that he simply omits a less pleasant feature of the landscape.

Modern archaeologists and geoarchaeologists are not in agreement over the areas these marshes formed, nor even how they formed. Eger suggests that these marshes were, at least in part, the result of much heavier precipitation between November and March (Eger 2000: 63). However, both Eger (2000) and Casana (2008) feel that such widespread inundation (at least as was observed in the twentieth century) of the Amuq and Ghab valleys probably did not take shape until after the Late Roman Period. In fact, Casana (2008) sees the late period expansion of settlement into the surrounding highlands as a primary driver for the erosion that would clog up the valleys and eventually re-inundate the lowland valley floors. Some evidence, in the form of Roman canals visible in CORONA images, suggests that although the marshes predate Roman influence, these marshes would have been drained or at least much smaller by the fourth and fifth centuries (Casana 2008; Eger 2011; Wieser 2012). This is firmly corroborated by the Amuq Valley Regional Project's discovery of a number of Roman and Late Roman sites on areas known to have been covered by the marshes (Casana and Wilkinson 2008). The marshes appear to bookended Roman influence in the region. By the seventh century, as Roman influence waned, the massive canals were no longer being maintained. It is reasonable that this neglect, coupled with loose highland sediment, and periodic heavy rain, could overwhelm the Roman Period canals and slowly inundate the valleys once more.

Despite this evidence to the contrary, it is worthwhile to incorporate the marshes into the Least Cost Path model. Though it appears unlikely at this point, if present during the Late Roman period, these marshes would have presented a considerable obstacle to regional trade and movement. Since Weulersse and Eger map the marshes with slightly different extents, a simple Boolean intersection was performed to establish an area of accord between Weulersse and Eger.

Topography

Given the broken and rough nature of much of the limestone massif, the influence of topography on trade cannot be understated. To act as a stand-in for the physical topography, digital elevation models (DEM) can be used. ASTER satellite imagery produces a DEM with a spatial resolution of thirty meters.[4] While resolution is not excessively high, especially compared to LiDAR data, it is the highest resolution data freely available for northwestern Syria. In addition, this resolution is precise enough to detect topographic and even some major cultural features, it is coarse enough to omit modern features, such as highways and buildings, which would not have existed in the Late Roman Period. The rugged massif itself is somewhat resistant to natural change. However, despite its robustness, even the stone of the surrounding Jebels changes over time. These changes, such as quarries and bulldozing, are unavoidable but relatively minor. From the ASTER DEM a slope model can easily be created, which illustrates the changes in elevation from pixel to pixel. Once weighted properly, the "Slope" becomes an approximation for the differential difficulty of moving across this rugged landscape.

Settlements

The final component of the Late Roman landscape that must be considered is the presence and location of Late Roman settlements. As discussed at length previously (Chapter Three), the exact

[4] ASTER GDEM is a product of METI and NASA

locations of the Dead Cities were quite difficult to ascertain. While knowing the locations of the Dead Cities is essential to test the viability of trade across this region as a whole, comparative sites are needed.

Since the bulk of survey projects in and around the Ghab and Amuq valleys have primarily focused on mounded “Tell” sites, Late Roman settlement patterns have traditionally been underrepresented (Braidwood 1937; Courtois 1937; Marfoe 1979). Until fairly recently, only Tchalenko (1953) has devoted significant attention to Roman and Late Roman sites. Fortunately, two University of Chicago projects helped to correct this imbalance in the 1990s and mid-2000s.

The Amuq Valley Regional Project (AVRP) was one of the first archaeological projects to adopt the use of CORONA imagery (Casana 2003; Casana and Wilkinson 2005). The AVRP documented a large number of previously unknown late period sites. A shapefile containing all of the Roman and Late Roman site locations was generously given to me by Jesse Casana. This shapefile contains 228 sites covering the bulk of the Amuq Plain.

The Northern Ghab Regional Project helped to further elucidate the settlement history for the Ghab Plain. This survey discovered sites ranging from Pre-Pottery Neolithic all the way forward to the present (Graff 2006). Like the AVRP, the NGRS documented a considerable number of Late Roman sites. This shapefile contains an additional sixty-six Late Roman sites in the Ghab valley. These sites were also given to me by Jesse Casana.

Together, with the site location data from my remote sensing survey, these two survey shapefiles help to reconstruct the settlement pattern of Late Roman Syria. Far from de Vogue’s notion of the Dead Cities existing in an isolated landscape, we can now easily see that the Late Roman countryside was densely occupied. Though these datasets are not exhaustive, they are a large enough sample size to allow us to better understand both settlement patterns, and potential avenues of trade.

Conclusions

All landscapes are dynamic and complex, and this landscape is no exception. This chapter has articulated one of many possible readings of the Late Roman landscape of northwestern Syria. Though each of the facets discussed above is based on a variety of corroborating data, there are undoubtedly inaccuracies and mistakes contained in these datasets. However, the true utility of digital approaches to archaeology is their ability to be updated as new data emerges. As new data is published, or reevaluated using new technologies, these datasets can easily be adapted to fit new paradigms and answer new research questions. As such, perfection is not sought with this interpretation of the ancient landscape. This data characterizes an approximation of a long past landscape, but one that has the capacity to be as dynamic as the landscapes themselves. Figure 13 shows the full extent of the physical and cultural landscape discussed in this chapter.

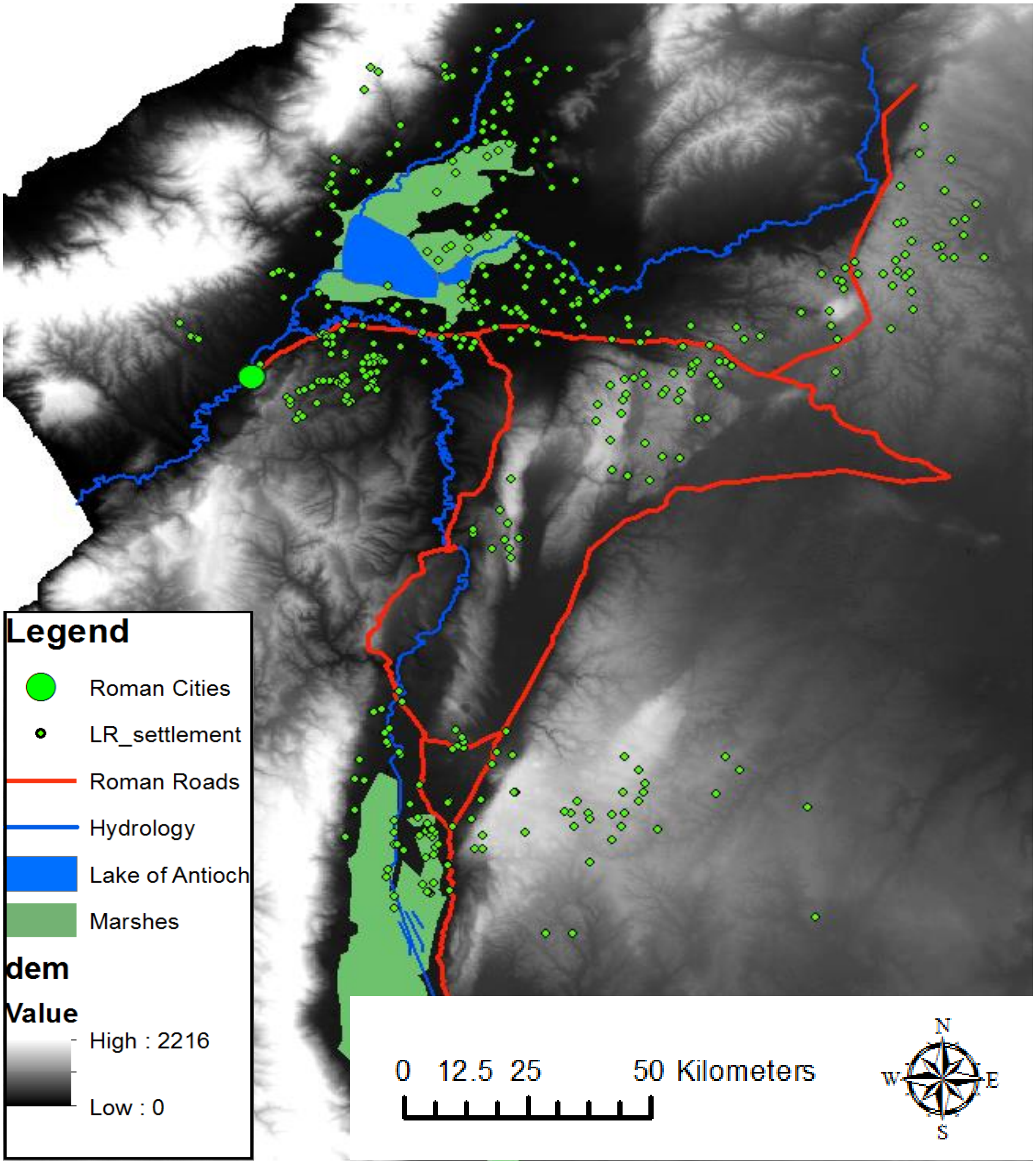


Figure 13: The Author's reconstruction of the Late Roman Landscape

Chapter Five: Least Cost Path Model Construction

GIS model building is one of the most powerful avenues of investigation available to archaeologists. These models offer the flexibility critical to properly examine cultural questions, but are still robust in producing testable scientific data. The GIS platform ArcMap is used throughout the model building process.

Chapter four detailed the types of data selected for representation in this model. This chapter will discuss the incorporation and classification of this data into this model. If weighted properly, this wide variety of physical and cultural data can be seamlessly shaped into a robust model. Although a wide variety of GIS modelling techniques are available to researchers, this specific type of modelling is referred to as Least Cost Path (LCP) analysis (White and Surface-Evans 2012). Working within the framework set by the author, the GIS program will utilize Raster data to compute the least costly pathway between points. On a perfectly flat isotropic plain, the shortest distance would, of course, be a straight line. However, as this model is constructed, differential values or “weights” will be given to each type of data. These data will be scaled to attempt to replicate the actual experience of moving across a physical landscape. For example, moving up a steep slope is noticeably more difficult than walking along a flat plain. As the slope increases, the weight given to the data will also increase. Each dataset is given a specific weight based broadly on trial and error. Once all of the data is combined into a single continuous raster surface, the resulting “pathways” function as a potential avenue of movement across the landscape. Each pathway is given a unique number and therefore can be compared against each other. From these resulting pathways we can begin to examine the differences in difficulty and duration of trade and travel from each village to the urban areas.

One more consideration before the model is constructed: since the aim of this model is to test the viability of olive oil trade from Dead Cities, this model will be constructed with the assumption of overland trade. This overland trade would likely have used carts or wagons transporting heavy amphorae, or caravans of donkeys and camels hauling skins fill with oil (Decker 2009). This assumption is somewhat flawed from the outset. Libanius specifically states that the Orontes was a major avenue of trade (Libanius XI: 260-265). In fact, Libanius paints a picture of the Lake and rivers as funneling trade goods right into the heart of Antioch, and later out to the Mediterranean Sea (Libanius XI: 263-264). This presents a substantial challenge to this model. Although the idea of the Orontes as an avenue of trade is fairly well attested, little is known about the scale of trade along these routes, cost relative to land transport, or even what types of cargos would be typically carried (Downey 1961; Libanius XI; Casana 2003). Unfortunately this matter is further complicated by the nature of LCP analysis. LCPs are excellent at treating a linear feature, such as a river, as either an impediment **or** an avenue. However with LCPs there is not straightforward way of treating the river as both an impeding and channeling force. This type of complexity is possible to model, but not without the creation of a transport network from scratch. Furthermore, the utility of the Orontes as an avenue of trade is accepted, but little else about river based trade is understood. For instance, there is virtually no evidence regarding the scale or duration of river trade. It is also unclear which individual actors would be involved in river trade. Was this an elite trade activity, or a means of transport open to all traders? Without firm answers to these questions, the presence of river based trade cannot be properly incorporated into the model. With these issues in mind, this analysis assumes only overland trade.

Considering the Construction of the Model

The process of constructing a LCP model is inherently subjective. The relative value given to each type of data heavily influences how the GIS produces the pathways. If the data is weighted inconsistently or illogically, then the resulting pathways will be of little value. Constructing the model is a negotiation of sorts. If the researcher, subconsciously or otherwise, produces the model with specific expectations in mind, then the resulting data is compromised. If the researcher does not scale the data properly across all facets, then one particular dataset can be overrepresented in the model, thus heavily coloring the interpretation of the data. This folly was noticeable in earlier iterations of this model. The Slope layer was not properly scaled down, and the resulting model was dominated almost exclusively by the Slope values, to the detriment of the other datasets.

With these serious considerations in mind, though still subjective, much thought has been dedicated to the weighted value of each dataset. Given the number of sites and complexity of this model, fairly small values are preferred to large ones. In general, data values are assigned on a 1-10 scale. This ensures that the resulting data are express in manageably small sums.

Rasterized Data

Raster GIS data are expressed through a series of rows and columns. These rows and columns create numerous square units referred to as cells. This model will be constructed primarily using raster GIS data. Each cell will be given values used to represent the accumulated exertion of crossing each cell. The bulk of the data used to reconstruct the Late Roman landscape was drawn in the form of vector GIS data. The data discussed in previous chapters was primarily vector data. Vector data are expressed using points, lines, polylines, and polygons. For this model to be functional, most of the vector data must be converted into a raster format. Only the settlement shapefiles are able to remain vector data without disruption of the process. This is because the point shapefiles act as the origin and destinations of the pathways and are therefore not given a weighted value. In the interest of standardizing pixel size, I opted to use the base resolution of the ASTER DEM to act as the uniform size. Although ASTER DEM data has a world average of 30 meters resolution, the coverage of Syria is approximately 25 meters. It is also important to note that all vector data layers were created with an attribute column called “value.” The value column is where relative cost weights will be applied later in the model building process. Value will also be the common attribute column that links all base data together in a single continuous raster layer. Once all of the base data is converted into raster format, then relative values can begin to be assigned to each layer.

Creation of Slope Layer

The creation of the Slope layer is straightforward. The tool *Slope* in ArcMap quickly creates a slope layer from any DEM available. Using this tool, the ASTER DEM can easily be converted into a Slope layer. The GIS does this by looking at the relative height of neighboring pixels and calculating the degree of slope or the percent rise between pixels. The percent rise option was used for this project. Since the slope layer is produced directly from the ASTER DEM there is no need to specify a pixel size.

Reclassification of Data

This step is the heart of the model. Reclassification allows the researcher to specify exactly what value should be given to each range of data. For example, slope data is often displayed as a continuous “stretched” layer with unusably high data values. The *Reclassify* tool breaks this stretched data into ranges that can be given more manageable data values, in this case 1-10. This method of reclassification also mitigates outlier values that were abnormally high or low, to produce a more representative approximation of the topography. The logic here is simple: as the slope increases, so does the difficulty of crossing the landscape.

It is important to note that while reclassifying data, two additional considerations must be made. Firstly, the extent of each layer must be identical. This will ensure that all data layers are the same size. Next it is crucial that while reclassifying, the “NoData” pixels be given a value of “0.” This will allow the GIS to composite all of the base layers together without distorting the underlying data values of each layer. This effectively creates a binary between pixels with data values and pixels without data values (NoData).

Unlike the Slope layer, the remainder of the base datasets do not need to be scaled down. However each dataset must be individually weighted. The hydrology layer is fairly straightforward. Though the Orontes River is larger than the Karasu or Afrin, I have chosen not to assign them differing values. As such, all three rivers, plus the canal features included earlier, will be given a very high value of 10. The reasoning behind assigning such a high value revolves around the difficultly of transporting carts or caravans across wide rivers. It is reasonable to assume that crossing a major river would be roughly equivalent to crossing the steepest terrain found in the slope layer. With this high value, rivers will be treated as significant barriers. The only exception to this high value would be the points at which the roads cross the river. During the Late Roman Period these points of the river would have been traversed by bridges. Most of these bridges crumbled long ago, but one is standing near the ancient Roman city of Cyrrhus, near to northern extent of this survey region.

A special “Bridges” shapefile could have been generated for this project, but the manner in which the Roman Road is incorporated into the model renders such an addition unnecessary. The Roman Road must be built into the model in a way that would make them an attractive route for the pathways. If a road is nearby it will be the easiest, least steep path, even if it not the most direct route. Given the rough and broken terrain of the limestone massif, these well-built Roman Roads, by comparison, would be paradise. Weighting the road values correctly is a difficult task. I want the roads to be an attractive option for travel, but not so attractive as to dominate the other data facets. As such, the roads layer was given a weighted value of “5.” This might seem an odd choice at first, but the roads layer will be subtracted from, instead of added to, the composite layer later on. In other words, all of the other data layers will be added into a single composite layer, and then the roads layer will be subtracted from it. Effectively this will render the area of the road a more cost effective option without creating a negative value. Since negative values are both illogical and disrupt processing, they must be carefully avoided. In essence, as the road crosses a river, the road will maintain its cost advantage over the surrounding pixels. As such, no special “bridges” shapefile was needed.

Assigning value to the Lake of Antioch presents the same problem as the rivers. The Lake was easily large enough to support both fishing and sailing, but it is impossible to discuss the Lake's role in regional trade at this point. As new data becomes available it might be possible to reassess the Lake as a possible avenue of water based transport, but unfortunately for now the Lake must be treated as an obstacle. Like the Hydrology layer, I opted to assign the Lake of Antioch the highest value of "10."

As discussed above, the marshes in both the Amuq and Ghab valleys present a challenge to interpreting the Late Roman landscape. If present during the Late Roman Period, these marshes would have been a substantial obstructing force to regional trade. These marshes would have varied anywhere between soft boggy soil all the way up to standing fresh water, possibly several feet deep. To cover this variability, a mid-range value of "5" was assigned to the marshes. Since there are deep doubts over the presence and extent of the marshes during the Late Roman Period, two iterations of the model will be created to address this issue. One model with the marshes included, and one model without them. This will allow for a comparison not only of the pathways themselves, but also the overall cost incurred.

Compositing the Base Layers into Friction and Cost Layers

Now that the base data layers are properly formatted, they can be combined into a "friction" layer. This layer will be an amalgamation of all of the base data layers. The friction layer will act as a composite stand-in for the accumulated difficulty of moving across each pixel. The process of combining these layers is fairly straightforward. The tool *Raster Calculator* in

ArcMap allows the researcher to create a simple string of arithmetic that instructs the program on how the researcher wishes the data to be compiled.

The data can be combined and recombined *ad nauseam.* The key to this step is to combine the data in a way that is both meaningful and robust. Since I wish to test the model first with the marshes present, and then without the marshes, I will need to make two separate friction files. The Figure 14 contains the sum of all of the base layers, minus the Roman Roads, plus the additional value of 6. This additional value is added for two specific reasons. First it

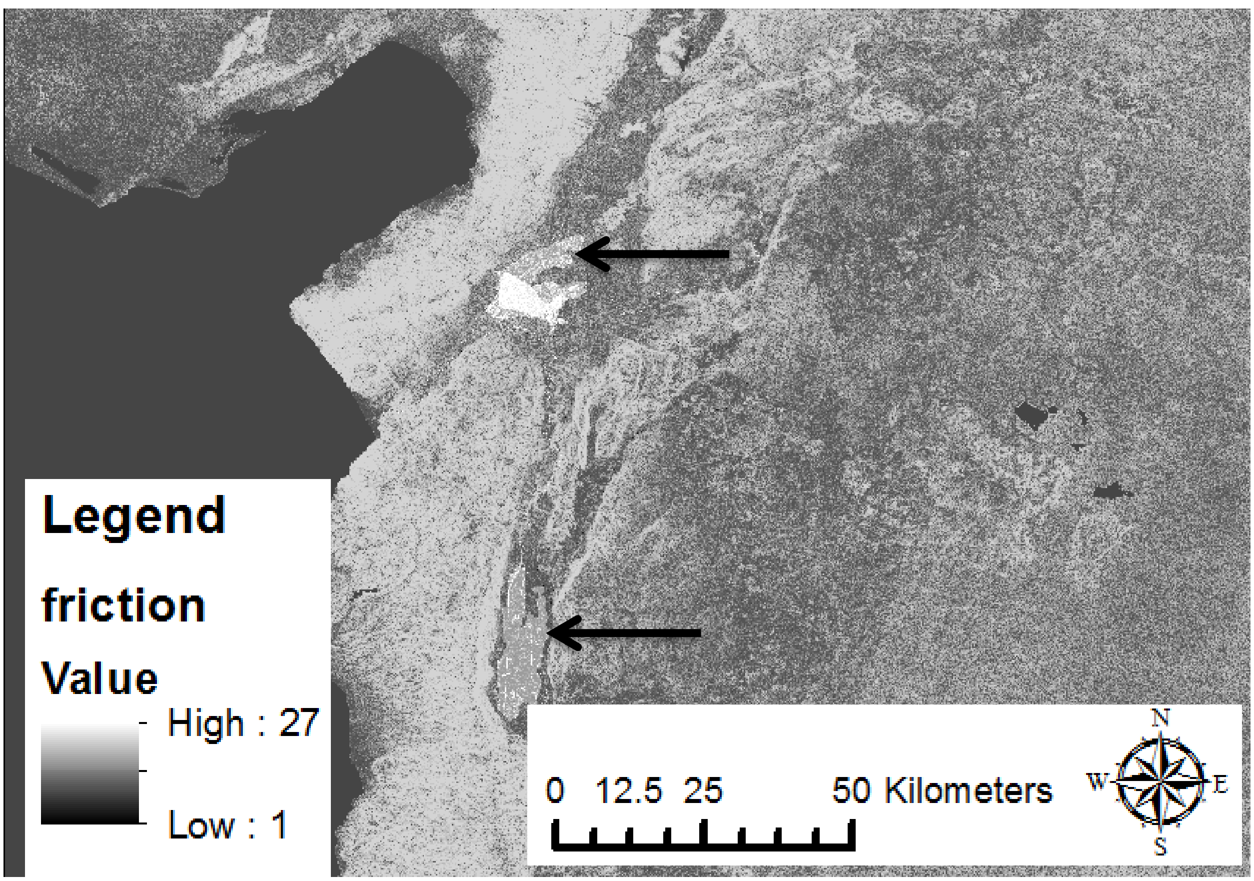


Figure 14: Friction Layer with Marshes Indicated

ensures that every pixel will have a data value. For example if there is a location on this model that is flat and not covered by a river or marsh, then the base value would be “0.” However, once the roads layer is subtracted, if it crossed over this pixel with a “0” value then it would produce a value of “-5.” The program cannot understand negative values so this must be avoided at all costs. In short, by adding “6” to each pixel I ensure that the lowest possible data value per pixel is 1. The arithmetic string used to create the first friction layer (with marshes, Figure 14) is as follows, with the resulting layer displayed below it.

"lake_antioch" + "hydrology" + "slope" + "marshes" + 6 - "roads"

This friction layer clearly illustrates both the Lake of Antioch and the marshes as having higher values than most of the surrounding landscape. The Figure 15 is created using a very similar arithmetic string. The only difference for this layer will be the exclusion of the marshes layer.

"slope" + "lake_antioch" + "hydrology" + 6 - "roads"

The resulting layer will appear very similar to the friction layer previously generated, but will lack any of the information associated with the marshes. Both of these friction layers can now act as an approximation of the environmental resistance incurred while traveling across a landscape.

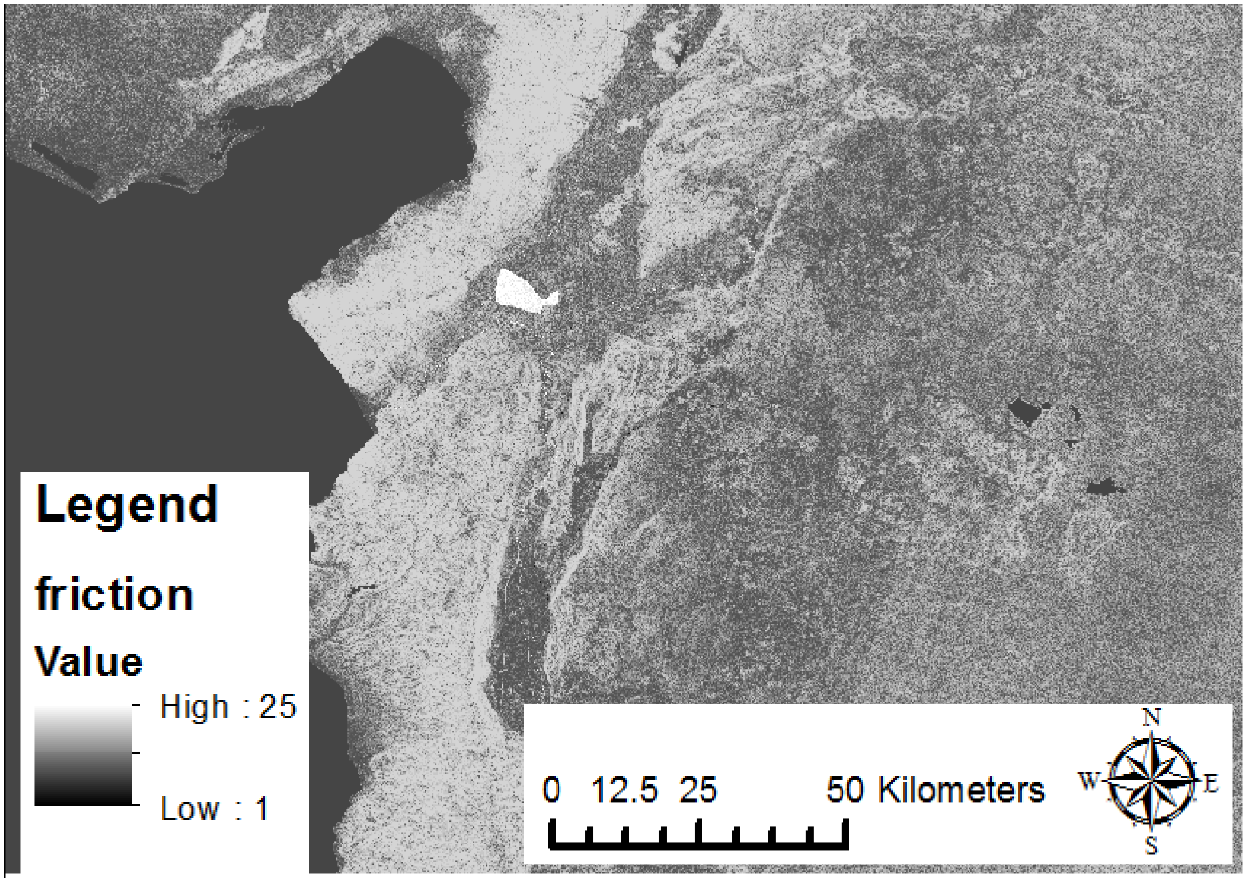


Figure 15: Friction Layer Without the Marshes Included

Now that the base data layers are all conveniently housed in one file, estimations of the cost of travel can now begin to be made. There are several tools available to perform this calculation, but the most effective is *Cost Distance.* This tool allows the researcher to choose a point or points of origin and calculate the accumulation of cost outward. Figure 16 uses the Roman cities of Antioch and Apamea as the points of origin for this process. *Cost Distance* not only creates a "cost" raster, but also creates a "backlink" raster that contains directional movement data critical to generating pathways. Since the "Cost" layer takes into account both physical and cultural data considerations, it can be read as a stand-in for area of influence, or even extent of political control. With this step complete we can begin to speculate on the potential areas of influence that each city might have commanded. Figure 16 suggests that the northern cluster of the Dead Cities appear to mostly fall into the Antioch catchment area, while the southern cluster of the Dead Cities appears to be much more closely related to Apamea.

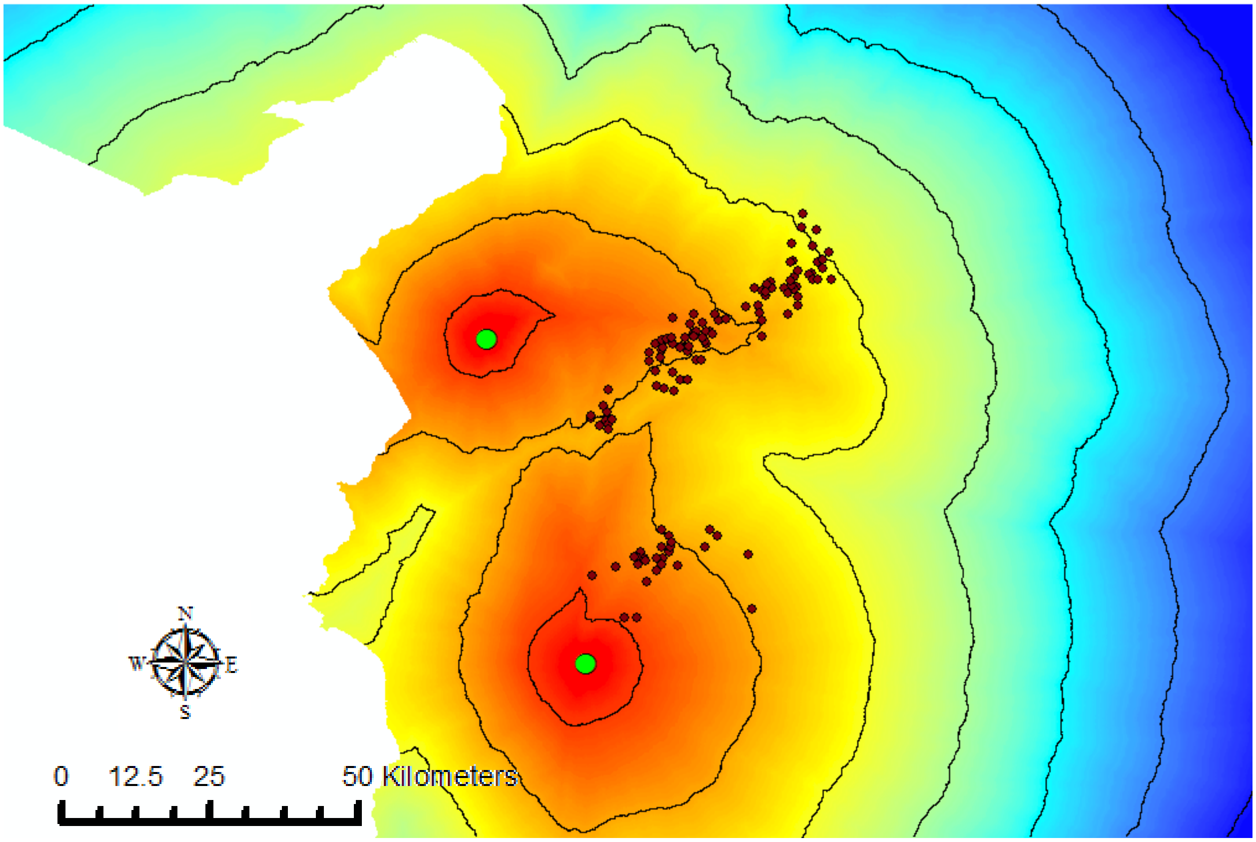


Figure 16: Cost Layer Originating from Antioch and Apamea

Interestingly, there are a number of Dead City sites situated across the southern portions of the Jebels Wastani Il A'la and Barisha that straddle the line between the two cities' spheres of influence. In rough terms of cost, these Dead Cities appear to be midway between either urban center. In addition, we can now better appreciate the confining nature of the topography of the limestone massif. Traversing either the Amuq or the Ghab valleys incurs little cost from the nearest city, but traveling even a few kilometers up into the Jebel regions rapidly experiences higher cost. As might be expected, the steep Jebels act as a funneling and confining force on travel from the cities. On an isotropic plane these cost would increase outward in large graceful circles. By contrast the Cost layer shows hemming effects of the topography, but also the extending power of the road systems. From each city, the low cost areas extend furthest along the roads. This demonstrates the ability of well-maintained roads to extend influence, even across rugged terrain.

Finally all of the data is in place to calculate the pathways themselves. These pathways will illustrate the least costly path between each Dead City and the most accessible urban area. The tool *Cost Path* will calculate the pathways. The process will take into account not only the “Cost” layer, but also the “Direction” layer created above. Using these two raster layers simultaneously allows the program to calculate the most efficient pathway from pixel to pixel. Figure 17 illustrates the results as a series of direct pathways cascading down from the Jebels onto the fertile plains, and finally into the regional urban centers.

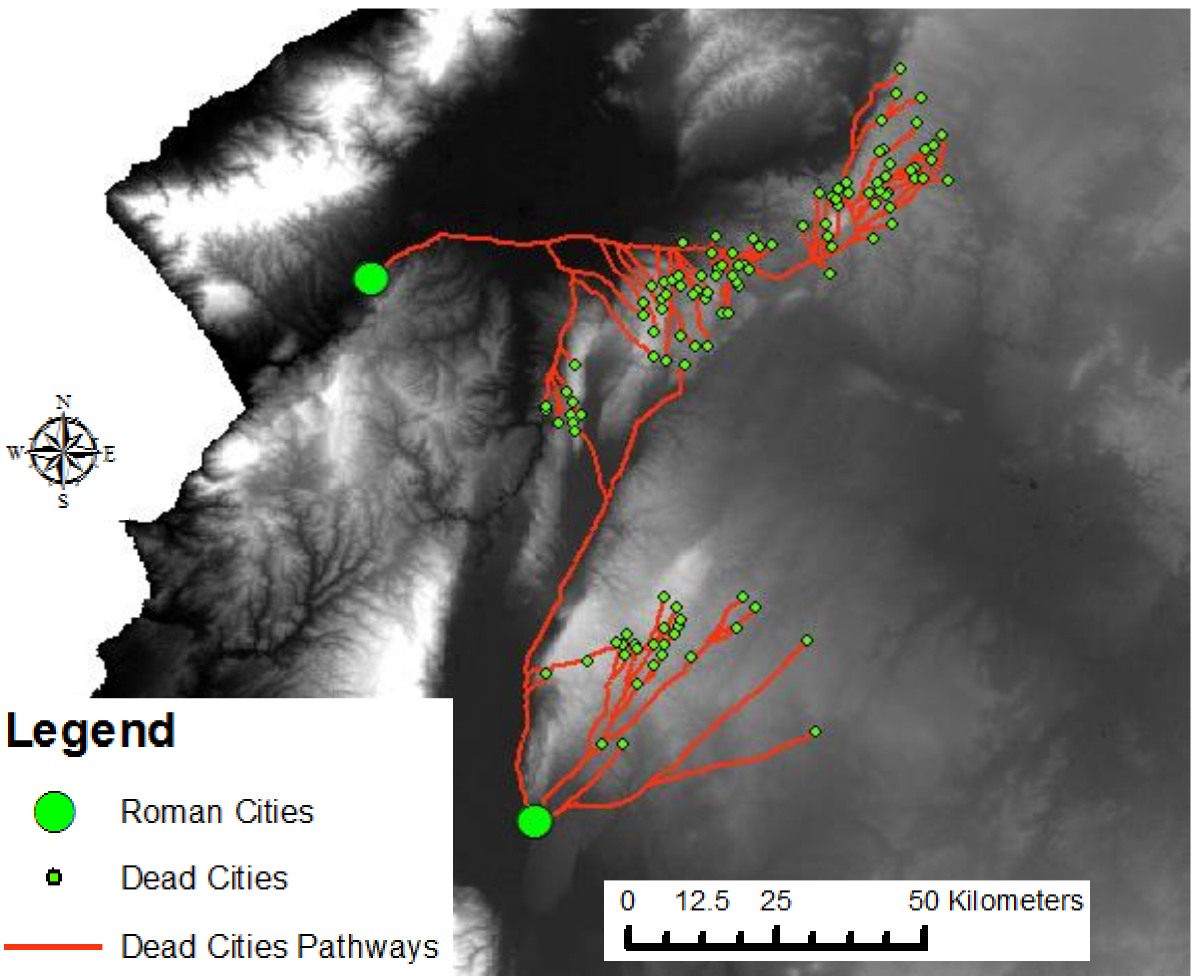


Figure 17: Least cost Pathways between the Dead Cities and Urban Centers

Although these pathways are only hypothetical, they are able to provide a good estimate as to how trade would have flowed across the landscape, particularly since transport of goods likely included wheeled carts or caravans of animals. Not only do these pathways provide paths of least cost, they also calculate cost in arbitrary units labelled as “PATHCOST.” These arbitrary units can easily be converted into more meaningful units such as travel duration or energetics (kilocalories required). Most critically for this project, the PATHCOST values can be directly compared across settlement datasets. In essence I can compare the exertion required to travel from the Dead Cities directly against that required traveling from the other Late Roman settlements. This head to head comparison can hint at the level of increased difficulty incurred while crossing the Jebels. In turn, these values will help evaluate the viability of trade across this landscape.

Conclusions

The pathways are drawn to the roadways, as areas of lower cost, but not overpoweringly so. The topography clearly has a funneling effect on the pathways, but overall does not appear to greatly restrict travel across the region. Practically all of the northern cluster of sites are drawn toward Antioch. This is hardly surprising. The flat Amuq plain and the presence of the road along its southern edge provide an excellent route for most of these sites. However, as Figure 18 shows, along the southern portion of the Jebels Wastani and Barisha two sites are drawn southward toward Apamea. This two sites hint at some fascinating findings. Firstly, these two sites are drawn into Apamea’s area of influence despite a much greater Euclidean distance. From the first of these sites, Antioch is 35 kilometers away while Apamea is 62 kilometers away, nearly double the distance. This implies that position and ruggedness of the Jebels can have a very powerful effect on how travelers might have chosen move across the landscape. This isn’t particularly surprising given the steepness and extent of the Jebels. However, these two sites hint that the margins between the costs of going to either city might be much finer than previously assumed. In fact, sites located just over a kilometer away from the sites in questions are drawn to Antioch. The difference of a mere kilometer can have radical effect on the resulting pathway. Such fine margins could well mean that despite this model's findings, sites located in this area of the Jebel Wastani and Jebel Il A'la are, in terms of cost accumulated, practically equidistant to either city. This hints at a less obvious relationship between the Dead Cities and the urban centers.

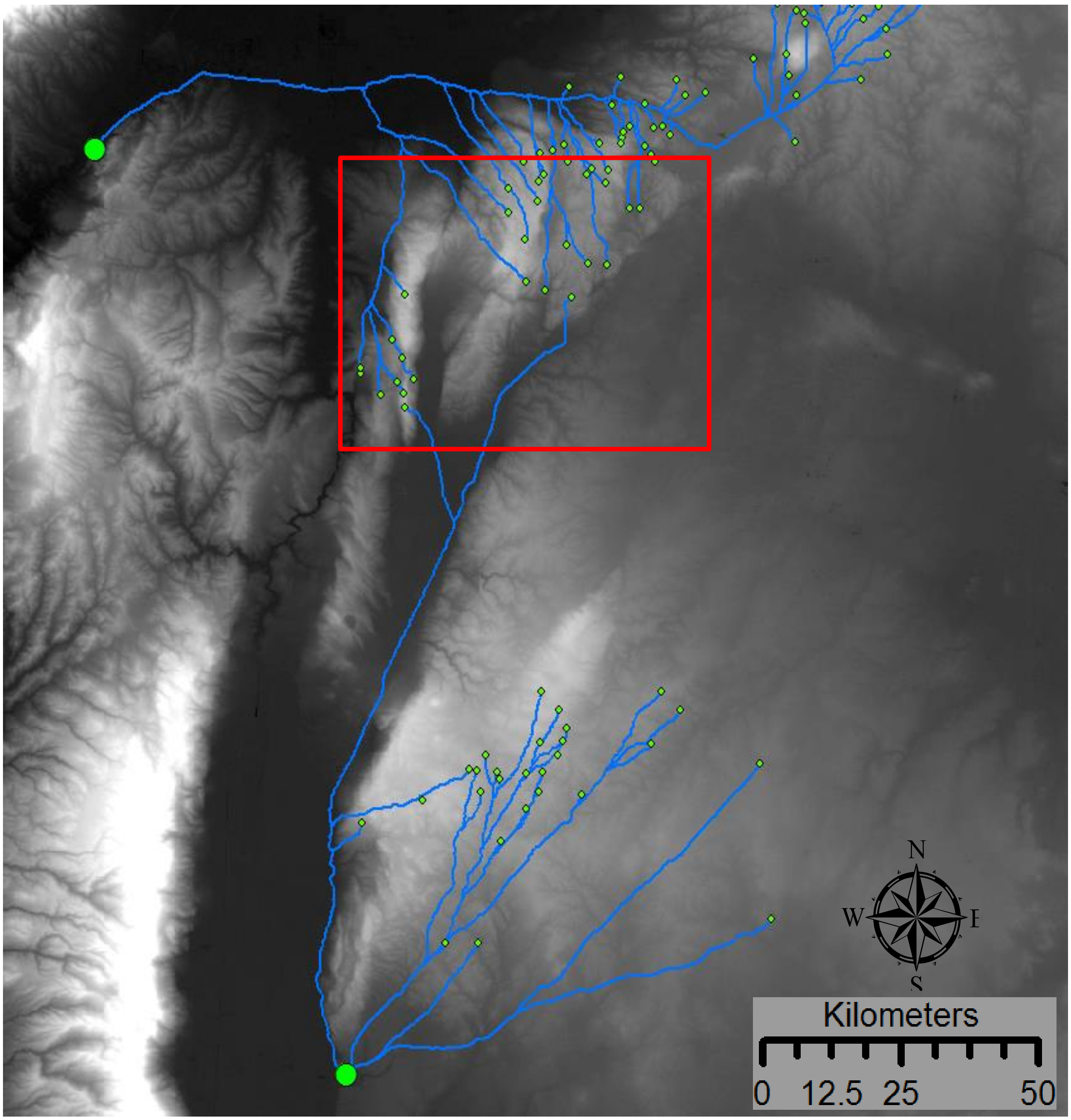


Figure 18: Pathways Displayed Over the DEM with the Area Discussed In Red

While these findings are encouraging, they must first be compared against other settlements of this period before more firm statements about the viability of trade can be made.

Other Observations from the Models

In addition, possible areas of influence can be approximated using this approach. As briefly discussed above, the *Cost* layer can be read as an area of possible influence. Given the goals of this thesis, it is instructive to examine and compare the *Cost* layers generated for the Roman Cities and the Dead Cities. The area of easy access around Antioch and Apamea is logical. The flat Amuq and Ghab valleys are easily accessible, while the steeper Jebels are more difficult to access. It is also notable how the roads carry influence further from each urban center. The area of easy access (displayed in red) can be traced with a polygon. This allows the suggested area of influence to be mapped quantitatively. Figure 19 provides a direct comparison between these two *Cost* layers. Although fairly large, the proportion of the region easily accessible to Antioch and Apamea is dwarfed by that accessible from the Dead Cities. Admittedly, the Dead Cities are numerically superior and spread across a wider area, but

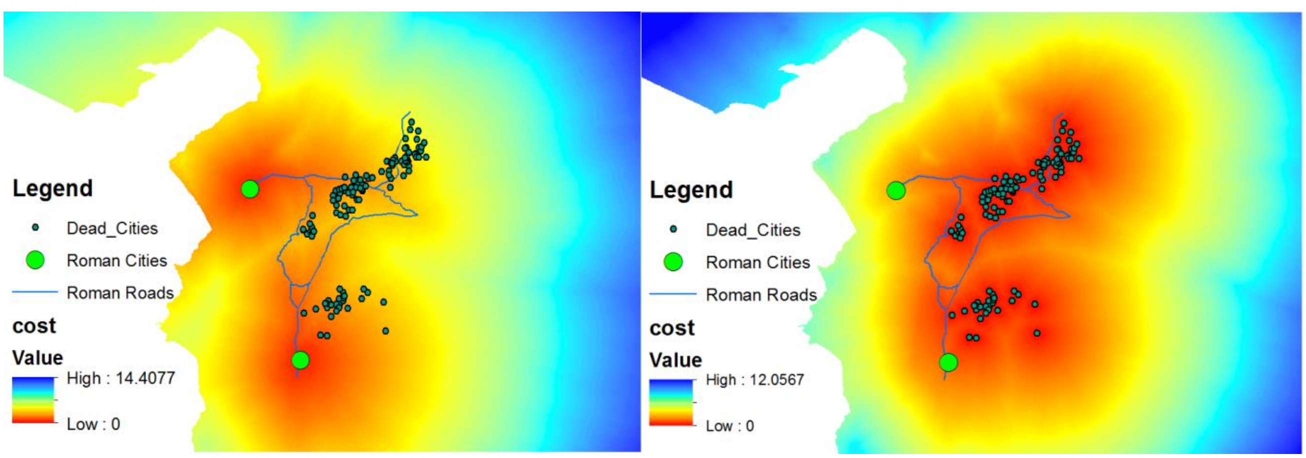


Figure 19: Comparison of the Roman Cities Cost Layer (Left) and the Dead Cities Cost Layer (Right)

nevertheless the area that is easily accessible is substantially greater. Based on these *Cost* layers, it is reasonable to infer that combined, Antioch and Apamea had easy access to approximately 30,250 square kilometers. This is a massive territorial catchment. In fact, it is approximately two and a half times higher than the 12,000 square kilometers that Decker estimates for the combined hinterland of Antioch and Apamea (Decker 2009: 172). More strikingly, the area of easy access of the Dead Cities is higher still. At 37,665 square kilometers, the Dead Cities can easily access a massive swath of the surrounding landscape. This is fairly logical. Traveling from the lowland urban centers to the Dead Cities would be made more difficult by the steep Jebels. However, travelling from the Dead Cities, the terrain would become more manageable as one moved down the Jebels and away from the Dead Cities. While it is not a perfect stand-in for political control, these layers demonstrate a landscape that is much more inter-accessible than one might have previously expected. Only 10 of the currently mapped Dead Cities (8%) fall outside of Antioch and Apamea's suspected area of influence. Both Antioch and Apamea and 99% of the Late Roman valley settlements fall into the Dead Cities area of access. In addition, this Dead Cities-centric area of access covers a wide swath of territory to the north and east of the limestone massif, suggesting not only easy access to Antioch, Apamea, and the coast, but also to the other principle cities of the region: Cyrrhus, Chalcis, and Beoria. As Figure 20 shows, despite administratively belonging to Antioch or Apamea, the Dead Cities occupy a zone that was bordered by the territory of practically every major urban center in western Syria. This implies that instead of the hinterland barrier that it has traditionally been viewed as, perhaps the limestone massif and its settlements can be viewed as more a territorial bridge between the hinterlands of five different urban centers.

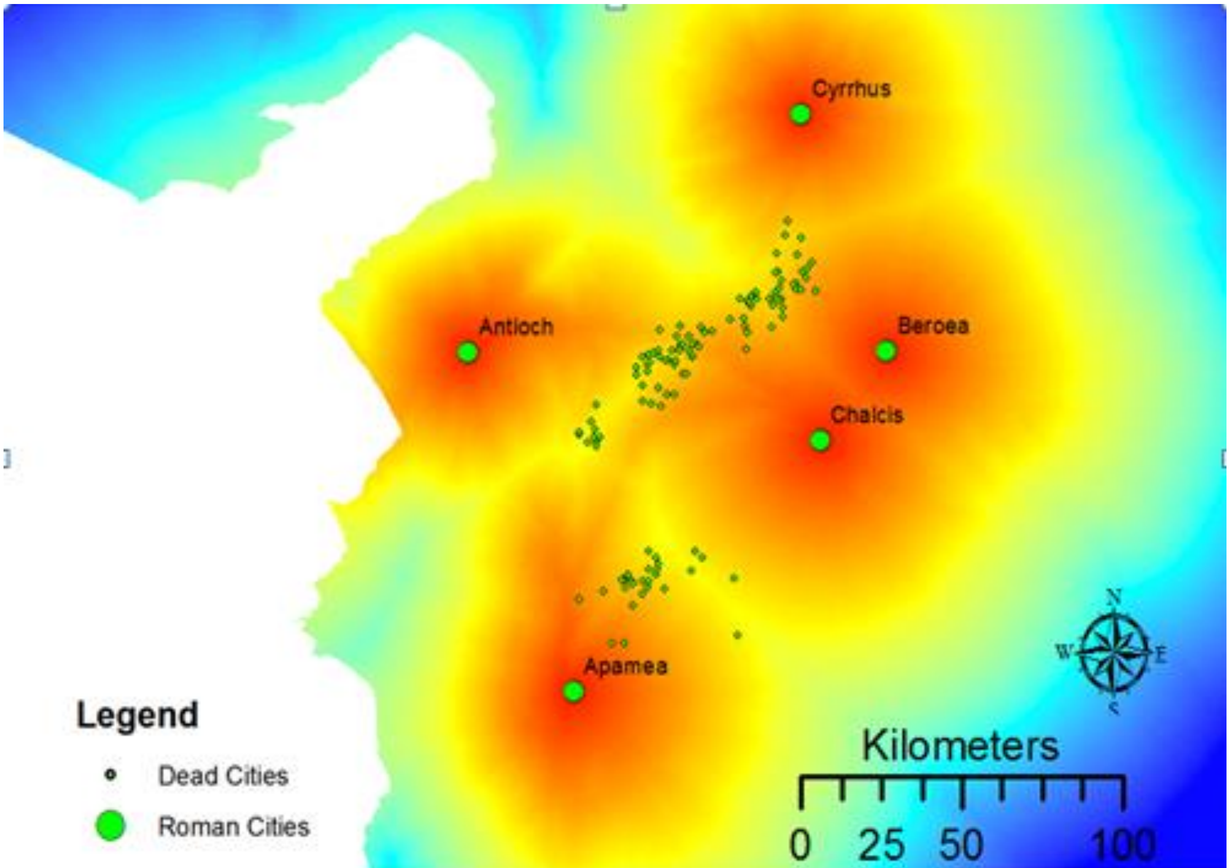


Figure 20: Cost Layer Generated from All Late Roman Urban Centers

Chapter Six: Olive Oil Case Study

Given the high value of olive oil, and the insatiable demand that Late Roman society would have needed, mass exportation of olive oil could easily have led to the construction of such obviously prosperous sites as the Dead Cities.

The Olive Oil Trade

The potential scale of trade between the Dead Cities and the wider eastern Mediterranean is difficult to quantify. Decker creates an agriculture potential model that can serve as useful approximation of output (Decker 2009: 169-173). It should be prefaced that I do not entirely agree with Decker's model. It appears likely that Decker overstates the number of presses in the hinterland of Apamea and Antioch and therefore distorts the oil output. Despite some misgivings, Decker's model can serve as a possible "best case scenario." For the sake of internal consistency I will use the figures that Decker cites. Though not intended to be specifically accurate, this model does give some sense of the massive scale of olive oil that could be produced. Decker places the potential number of presses in the combined hinterlands of Apamea and Antioch at between 9,000 and 10,000 (Decker 2009). Since this number includes possible presses in the Amuq and Ghab valley's this is almost certainly overstated. The figure of 3,850 presses across the limestone massif is more reasonable (based on 5.5 presses per village) (Decker 2009). Based on replication of the pressing technology, it is estimated that each press instillation could press between 4,000 and 8,000 liters of oil per pressing season. This is a representation of only the smaller scale presses. Some of the larger presses could have produced substantially more oil. Assuming that all of the 3,850 presses were active all at once, we arrive at between 15.4 million and 30.8 million liters of oil produced annually. This is quite possibly conservative given the number of presses and increased size of many of them. It is worth estimating here how much oil would have been necessary to support the region. Mattingly suggests that 20 liters of oil per year per capita is a fair rule of thumb, though some have placed this number up to 50 liters (Mattingly 1988). Tate estimated the population of the limestone massif at 300,000, while Decker estimates the population of Antioch and Apamea at 150,000 and 115,000 respectively (Tate 1992; Decker 2009: 20). To this we could add another 100,000 possible inhabitants of the valley settlements. This would put the overall population at 665,000. The estimated population of northwestern Syria would have required approximately 13.3 million liters of oil per year to subsist. This leaves us with a potential oil surplus somewhere between 2.1 million and 17.5 million liters per year. While none of these numbers were intended to be concrete, they do convey a sense of scale. Mattingly also cautions that olive trees tend to produce a bumper harvest one year then substantially less the next year (Mattingly 1988). As such, this massive surplus could not be guaranteed every year. However in years of good harvest, this massive surplus represented a huge agricultural windfall.

It appears that the limestone massif alone was possibly able to meet all of the oil needs of the region with plenty of surplus remaining. It is tempting to regard such a surplus as a stockpiling for periods of poor production, however oil can only be stored for about a year before it runs the risk of going rancid (Mattingly 1988). This clearly suggests that this surplus was produced with the intention of trade. Given that the needs of the regional populous are already met, it stands to reason that this surplus would be exported to other parts of the Late Roman world. This oil was likely shipped in the LR1 amphorae. This amphorae type was produced relatively locally, on the coasts of Cyprus and Celicia (southern coast of modern Turkey), but LR1 sherds are found all over the eastern Mediterranean (Karagiorgou 2004; Decker 2009). Wickham notes that these sherds are rarely found in the Dead Cities themselves (Wickham2005). Rather than contradicting export trading, this observation quite possibly reinforces it. Despite the roads, maneuvering a cart, loaded with heavy amphorae, up and down the Jebels would have been slow, difficult and inefficient. Decker's assertion that the oil was brought down the Jebels in skins carried by donkeys or camels is possibly closer to the mark (Decker 2009). The logistical concerns of oil shipment, and the massive scale of oil potentially produced, suggest that the oil likely changed hands several time from press to table.

Tchalenko notes several "meeting houses" in a number of sites near the edges of the limestone massif (Tchalenko 1953). Although this classification was critiqued by later researchers, Tchalenko could quite possibly be correct. The high level of internal variation of the Dead Cities sites definitely leaves room for individual site specialization. Perhaps some Dead Cities specialized on the mass transport of oil, while other focused on its production? Given the density and proximity of settlement this is hardly impossible, but given the paucity of archaeological excavation in the sites, such a possibility remains only conjecture.

As it now appears likely that overland transportation was not prohibitively expensive, and assuming Decker's production model is at least semi-accurate, the possible markets for this massive oil surplus extend in every direction. The major population centers of Chalcis, Beoria, and Cyrrhus are likely destinations. The presence of a large military force in Syria cannot be dismissed as a likely recipient of at least some oil (Pollard 2000). More distant eastern population centers along the Euphrates River likewise cannot be ruled out as recipients. Many of these suppositions are only theoretical at this point but, using this methodology, could be more thoroughly explored.

However, most of the current evidence (some textual, but mostly ceramic) points to the feeding of the oil into a wider eastern Mediterranean economy. Mattingly compares oil production and export of Spain, Tunisia, and Tripolitania (Mattingly 1988). Mattingly concedes that especially in the case of Spain, some oil was being shipped directly to Rome itself. The exact circumstance of such activity, either government subsidies or individual economic activity, is still up for debate. Nevertheless some form of seaborne trade was taking place during the Roman period. Therefore, it stands to reason that, in one form or another, transportation of bulk oil across the Mediterranean was probable during the Late Roman Period. A general picture of the destinations of these oil shipments can be gleaned from the recovery of LR1 amphorae. Karagiorgou estimates that in the early and mid-sixth century LR1 amphorae type made up as much as 10% of the ceramic deposit at Carthage, and more impressively, 15% of the ceramics assemblage from Constantinople (Karagiorgou 2004; Decker 2001). The total ceramic assemblage of Constantinople for this period likely numbers in the tens of millions. 15% of such a massive accumulation indicates a strong trade relationship. Such massive cities are obvious destinations for oil shipments. Constantinople alone had a population of at least 500,000 and therefore would need at least 10 million liters of olive oil per year.

Even Decker's optimistic estimations of Syrian olive oil productions come nowhere close to supplying all the oil needed for the Late Roman Mediterranean population. It is likely more accurate to view the limestone massif as only one of a number of major oil producing centers across the Mediterranean basin. Tripolitania, Cyprus, Tunisia, and Spain all sported robust oil exporting potential. However by the mid-fifth century, as the Dead Cities were hitting their peak, Spain and Tunisia were lost to the empire. As such, it is probable that the burden of oil production shifted eastward. In light of this increased burden, the volume of oil produced in the Dead Cities and its place in greater interregional trade can be better understood.

Chapter Seven: Conclusions

Until now, the Dead Cities have been treated as an isolated phenomenon. This thesis was designed not only to view the Dead Cities in the context of the Late Roman landscape, but also to view these sites as only one portion of a densely populated region. The exact nature of the olive oil trade in the Dead Cities has been much debated, but until now little quantifiable or testable data has been presented.

Settlement Density

Even before the final models were completed, a number of interesting insights became apparent. Most obviously, but woefully lacking in earlier literature, are the settlement patterns of northwestern Syria. Late Roman settlement has traditionally been viewed as densely populated, but confined to the limestone massif. However thanks to the work of the AVRP and the NGRS, the Dead Cities can be viewed within the context of contemporaneous settlement. Although none of these data sources are comprehensive, their combination gives us a partial glimpse into the settlement density of the Late Roman period. As noted in chapter three, only Dead Cities' sites that could be verified with satellite imagery were included in this analysis. As such, the limestone massif is less densely populated in Figure 21 than it would have been in during the Late Roman period. The same is also true of the southern Ghab valley and Jebel Nusayrism, neither of which has yet been fully surveyed.

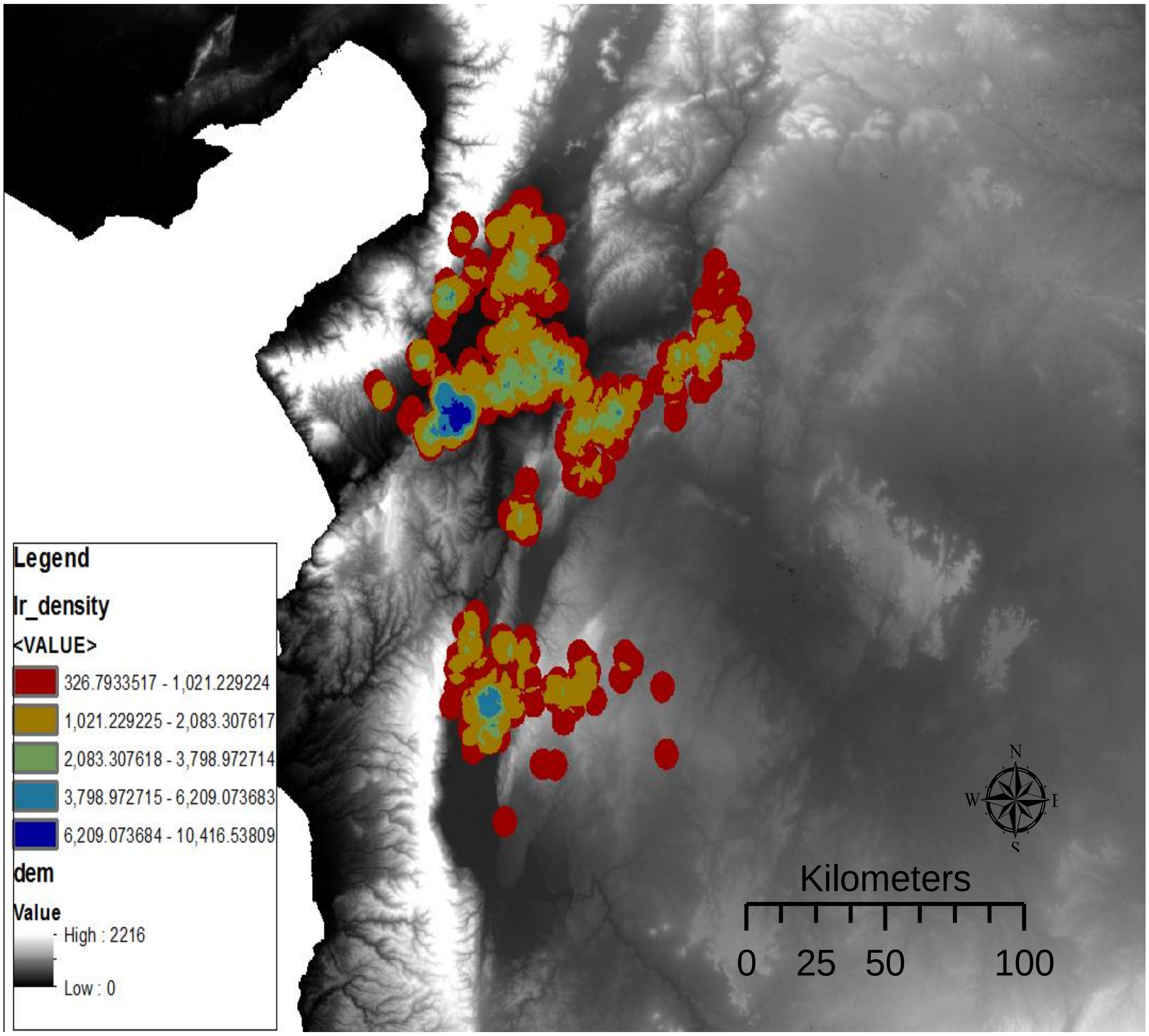


Figure 21: Settlement Density in Late Roman Syria

While Figure 21 only reflects a portion of the likely settlement for this era, it does help to visualize the Dead Cities as part of a densely populated region. Interestingly, the area of highest density is in the south-western portion of the Amuq valley and the central area of the Ghab valley, far from the heights of the Jebels. Despite their absence from literature discussing the Dead Cities, based on current information, the lowland settlements actually possess a higher settlement density.

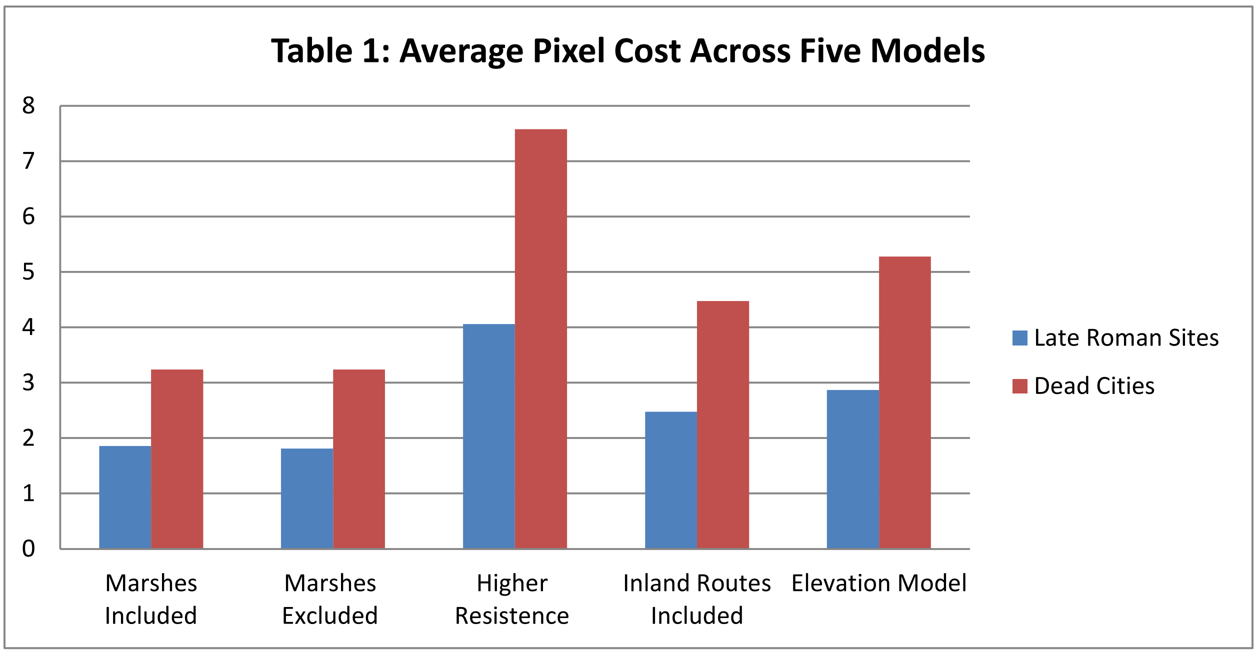
Discussion of the Models

The true power of GIS modelling is in its adaptive ability. Virtually any variable can be added or removed from the model. If one source of data has become overrepresented, it is a simple process to reevaluate its salience.

In an attempt to mitigate potential biases in any one model, five distinct models are constructed. Each model is designed to illuminate particular questions, but can nevertheless serve as interesting comparisons to each other. As briefly discussed in chapter four, the presence and extent of the marshes in the Ghab and Amuq valleys are difficult to determine. With this model-based approach, both scenarios can easily be examined. In addition to these two models, one model with substantially higher data values was constructed (Higher Resistance Model). In the two previously mentioned models, the rugged landscape of the limestone massif did not appear to greatly affect the course of the pathways. To insure that this was not an artifact of the values assigned to the slope data, I created this model with greatly increased slope values for comparison.

The fourth model was designed to determine the potential effect of the small "inland routes" evident in many of Tchalenko's maps (Tchalenko 1953). These routes leave virtually no traces and were therefore considered too subjective to be included in the earlier models. However their potential to alter the calculation of pathways was too powerful to completely dismiss. Finally, the elevation model doubled the initial values given to the slope layer, and removed the Roman roads from consideration.

For the ease of comparison, the most relevant data was compiled into Table 1. Though some of the calculated pathways changed somewhat from model to model, the resulting data shows a remarkable consistency. This is most evident in the relationship between the average Pathcost of the Dead Cities and the other Late Roman settlements. The Pathcost for each route is calculated by dividing the total accumulated sum by the number of cells in each line. As such, the average Pathcost can act as a stand-in for relative exertion required to travel along each path. As Table 1 demonstrates, the average Pathcost accrued when traveling from the Dead



Cities was markedly higher, approximately double, than that accumulated traveling from the valley settlements. This is not surprising. The valley settlements are located on the broad flat plains, while the Dead Cities straddle the rugged limestone massif. In addition, the Dead Cities are generally located further from either Antioch or Apamea. In fact, this distance and the ruggedness of the Jebels were thought to represent the most logical barrier to trade.

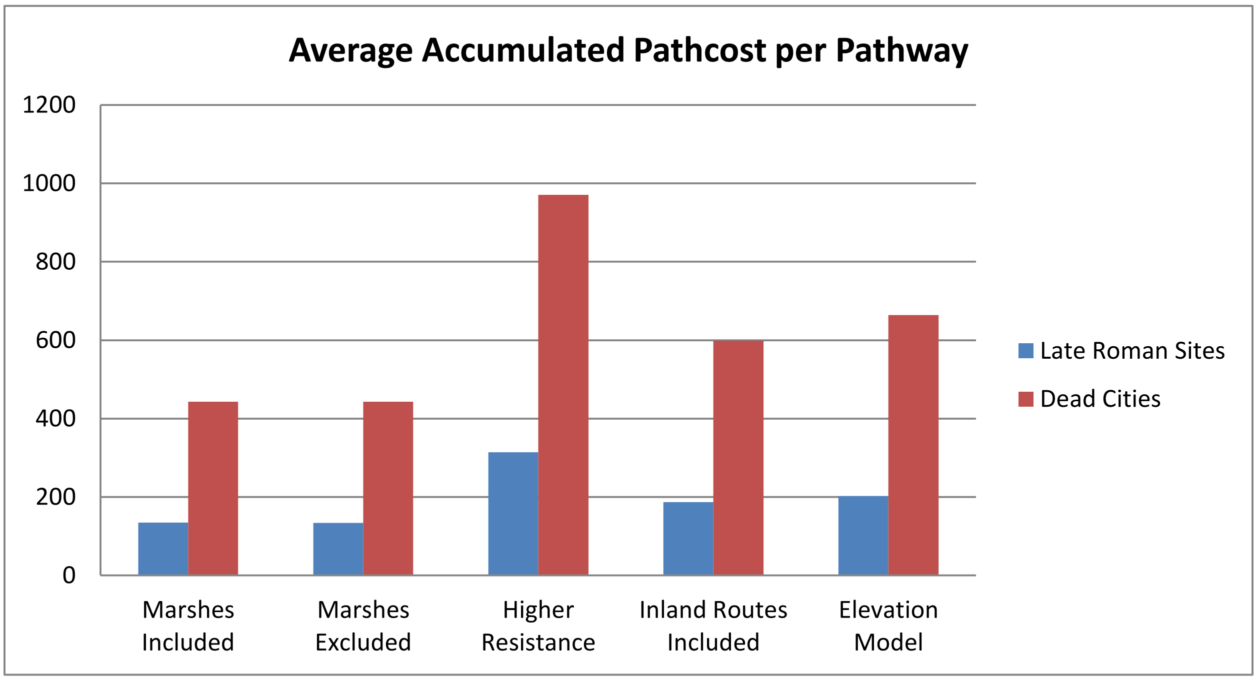
This logical assumption appears to be seriously overstated. Regardless of the parameters used, each model produced a similar relationship between the average Pathcosts of these sites. Simply put, each model determined that, on average, it requires approximately 1.75 times more exertion to reach the Dead Cities than it does to reach the valley settlements.

Admittedly, this exertion ratio does vary, but only slightly. This is especially striking considering that each of these models was built intentionally to advantage or disadvantage certain aspects of the landscape. As discussed above, the extensive marshes in the Ghab and Amuq valleys would greatly hamper travel to and from the settlements therein. As such, this model was built to accrue greater cost traveling across the open valley floors. This would clearly advantage the Dead Cities, since they reside on the dry heights of the Jebels, far above the marshes. Interestingly, though the valley settlement’s average did rise, the increase was minimal.

Next the “inland routes” model adds additional low cost pathways crisscrossing the Jebels themselves. These pathways function as miniature roads, allowing for lower cost travel across the rough terrain. This model also incorporates the marshes in the valleys. Essentially this model was the optimal combination of factors for travel through the Dead Cities. However, as with all previous models, the exertion ratio hovered around 1.75 times more difficult.

Lastly, the elevation model doubled the slope values and removed the Roman roads layer. This was designed to be a worst case scenario travel for the Dead Cities. With much higher slope values and no channeling roads, the Dead Cities would seem to be isolated on the periphery. Although this produced the highest exertion ratio at 1.83, it does not suggest an unmanageably higher cost to reach the Dead Cities.

Since ArcMap arranges the Pathcost data in a somewhat convoluted way, it is necessary to compare it in discreet ways. The above discussion was based on the average cost per pixel. However the data can also be arranged to show the average accumulated cost per pathway. Analyzing the data in this manner paints a somewhat different picture. Using this metric, the



average exertion from the Dead Cities is approximately triple that of their lowland counterparts. This is a substantially different number than Table 1 arrived at. Both tables show different aspects of the same data. Depending on how the data is interpreted, the Dead Cities are between two and three times more difficult to reach than their lowland counterparts.

While these statistics are interesting, what does this really mean for this project? In essence, no matter what parameters are incorporated, the exertion relationship between the valley settlements and the Dead Cities remain strikingly similar. If this ratio is not greatly affected by changes made to the models then what is the driver of such a relationship? It appears likely that the main source of this disparity of exertion lies not in topography or hydrology, but in geography. Speaking in general terms, the valley settlements are located much closer to the urban centers of Antioch and Apamea. The Dead Cities, on the limestone massif, are generally located further from these urban centers. Since all of the iterations of the models seem to imply that the landscape doesn't play as significant a role as previously assumed, it seemed likely that Euclidean distance could be the main driver of accumulated exertion. Table 3 illustrates the relationship between the Euclidean distance of the Dead Cities and valley settlements. Unsurprisingly, the relationship between the average Euclidean distances (Dead Cities average divided by Valley settlements) equals 1.83. This closely parallels

Table 3: Average Euclidean Distance

Settlement Type	Average Euclidean Distance (to the nearest urban center)	Exertion Ration
Late Roman Valley Settlements	26.16 km	1.83
Dead Cities	47.97	

the average pixel cost ratios discussed in Table 1. This implies that the main driver of increased cost accumulation is distance. While the environmental and social factors (e.g. roads, slope, and hydrology) do play a role in cost accumulation, it is relatively minor compared to the role played by distance. While distance does not account for all of the difference of exertion, based on the consistency of the above data, it seems to be the most salient aspect of overall accumulated cost.

Using Casson's suggested daily travel of 24-32 kilometers per day, on foot, these distances can begin to be put into better context (Casson 1994: 188). Tracing the calculated pathways between some of the farthest sites provides a rough estimate of travel time. Following the calculated route, the most remote valley settlement is 82.41 kilometers from Antioch. This is roughly between 2.5 and 3.5 days of travel time. The most remote Dead Cities is 139.08 kilometers away from Antioch. To reach this settlement, it would take between 4.3 and 5.7 days of travel. While these travel times are considerable, they are paltry compared to many distances covered during the Roman and Late Roman periods (Casson 1994). Casson states that during the Roman period, Imperial messengers would travel as many as 40 days to reach Antioch from Rome (Casson 1994: 188). While this example is drawn from the Roman administration, not the economy, it does demonstrate that destinations six days away should not be viewed as especially far.

Although more travel time is required from the most remote of the Dead Cities than many of the valley settlements, there are also a considerable number of the Dead Cities that are roughly equivalent in terms of travel time. The presence of the good quality road between Antioch and Chalcis seems to be a major factor. Overall, despite their distance to the cities, the Dead Cities are more well-integrated within the road system. Only 1% of Dead Cities' sites are located more than 24 kilometers (one day's travel time) from a road. 12% of the valley settlements fall outside of one day's travel to the nearest road. Admittedly these sites are in the extreme northern Amuq plain, but as such, travel from these settlements would have to traverse the Lake and possibly even the marshes. Furthermore the differential speed of road travel versus off-road travel is a factor that would likely strongly assert itself.

In summary, across all of the models constructed there is a demonstrably higher average cost of travel to and from the Dead Cities versus contemporary valley settlements. Though considerable, this additional required exertion is not prohibitively high. This is especially true when considering the high value and demand of olive oil.

In aid of the goals of this project, using these *Cost* layers as a guide, it is possible to calculate the region of viable interaction. As the areas of access for both the Dead Cities and the urban centers have already been calculated, it is a simple matter to perform a Boolean calculation. Using the "Boolean And" tool, the GIS will automatically create a polygon of the territory covered by both previous *Cost* layers. The resulting layer represents the areas that are easy to access from both the Dead Cities and the urban centers of Antioch and Apamea (Figure 22). Since the estimation of the prices of ancient commodities is notoriously difficult, I am

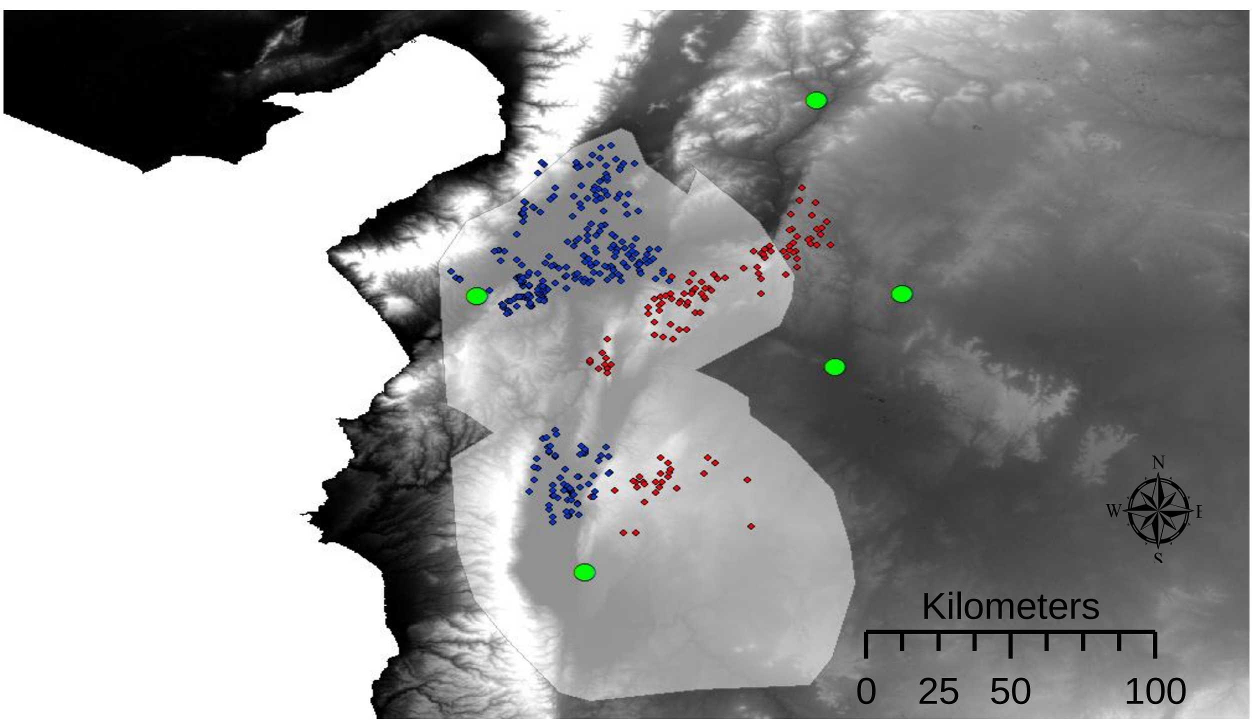


Figure 22: Area of Mutual Low Cost Access and Exchange

hesitant to evaluate a region of viability of olive oil production based on bulk value and shipping costs. In lieu of speculating on the value of commodities, this proposed sphere of interaction is the best estimate of an area of viable trade interaction. All areas covered by the white polygon are mutually low cost to access. Though potentially lasting for days or even a week at a time, travel cost within this polygon is relatively low. Given the large number of the Dead Cities that fall within this region, trade within this region appears not only viable, but potentially extensive.

Economic Implications

This thesis strongly suggests that overland transportation, long thought to be far too ponderous and inefficient, is in fact perfectly viable for this region. Furthermore, the Roman roads skirting the perimeters of the Jebels integrated the Dead Cities into a regional system of commerce and logistics practically invisible in the modern landscape. This case study has produced a number of interesting insights into the local economic activity of Late Roman Syria. However this information also has wider implications to the larger debate over the nature of the ancient economies.

At first glance the widespread commodities trade and implied driving forces of supply and demand appear to firmly support the “modernists” reading of ancient economies. However it would be a mistake to purely equate modern notions of economic activity directly to ancient history. Though many of the elements of the Late Roman economy appear capitalistic, there are also powerful overarching economic forces at play.

During the early Roman period, the central authority devised a redistributive system, the *Annona,* of subsidized grain and oil. This system was designed to keep high population areas, such as Rome herself, well supplied. Food shortages foster civic discontent, something all emperors fear. This system was so widespread that early historians viewed individual economic activity as only possible through utilizing the extra space in the ship's hold around these subsidized goods (Duncan-Jones 1974).

The Roman and Late Roman emperors themselves were not strangers to widespread economic policies and actions. In A.D. 362, Julian's setting of the grain prices in Antioch upset a number of wealthy grain merchants. Additionally in the reign of Anastasius, the emperor forbade the export of olive oil to non-imperial territory in the northern Black Sea. These examples demonstrate that the Emperors wielded the power to manipulate the economic conditions based on their own needs and desires. Furthermore, each emperor would feasibly have different economic ideas. Any emperor could expand or cancel the policies of their predecessors. Furthermore the extensive system of taxes-in-kind to support large frontier garrisons could have placed a massive burden on certain regions during the Late Roman period (Pollard 2000). Since the volume and even types of goods collected are not well understood, the potential effect on the economy is impossible to quantify. These potentially widespread effects on the ancient economy are homogenized in modernist viewpoints. Though many of these forces have modern capitalist equivalents, it appears that reading the Roman and Late Roman economy as a direct analogue to modern capitalism is not entirely appropriate.

Though these findings appear to support modernist view of the ancient economy, it does not completely dismiss elements of primitivist viewpoints. Tate and Sodini's excavations clearly demonstrated that local agriculture in the Dead Cities was, at least partially, geared toward subsistence. Such local-centric subsistence could be construed as evidence for little need of interregional interaction. However, as the next section will discuss in more detail, the current evidence suggests that both widespread exportation for capital and small-scale subsistence farming existed contemporaneously. This implies, at least in this case, neither of the major interpretations of ancient economics fully captures the experience of the inhabitants of the Dead Cities.

If anything, the findings of this thesis complicate the study of ancient economics. Perhaps it is more apt to speak of a plurality of ancient economies. If these findings hold true over the larger region, then it is more accurate to think of each settlement as engaged in multiple economic behaviors simultaneously. The Dead Cities concurrently participated in at least two wildly different economic models. Due to the coarse nature of the data on the Dead Cities, it is unclear at present whether *all* of the Dead Cities engaged in both behaviors. It is quite possible that individual sites, or even individual families, would have operated exclusively in one economic sphere or another. The exact economic makeup of the Dead Cities is impossible to determine with the current data. However, it does appear that the age-old debate between modernists and primitivists does not fully articulate with experience of these unique sites.

Abandonment

Like those that came before me, I cannot help but apply these new findings to the abandonment of the Dead Cities. Tate and Sodini's discovery of subsistence agriculture (fruits, cereals, livestock, etc.) in the Dead Cities seemed to powerfully refute Tchalenko's theories of olive based monoculture. However, Tate and Sodini's framing of olive production as a "cash crop" does not fully explain the ubiquity of the presses across the limestone massif.

In light of the suggestions of this thesis, the limestone massif is better understood as a dynamic and integral part of the northern Syrian political and economic landscape. The prosperity of the Dead Cities was built upon and hedged by the olive oil trade, both domestically and interregional. After the disastrous events of the sixth century, the Dead Cities found themselves isolated from the greater Roman world, first temporarily, but following the Arab conquest of Syria, permanently. Given the implication of increased viability of, and suspected reliance on, trade markets for the oil, a relatively sudden alienation from these markets would have been disastrous. While this would have represented as massive loss of income capital, the subsistence needs of the population were still being met through local agriculture (Tate 1992). The loss of the major source of capital explains how, though the Dead Cities were occupied until the ninth century, building and rebuilding seems to have ceased by about A.D. 550 (Foss 1996). Furthermore the disruption of the eastern Mediterranean trade can be seen in the dearth of shipwrecks after A.D. 650 (Kingsley 2004). This is further corroborated by the absence of any Umayyad pottery in the current shipwreck databases (Kingsley 2004: 35). If Kingsley's suggestion is correct, the limestone massif, now in Umayyad territory, would have been cut off from the sea, and thus its most lucrative markets. These suggestions appear to support Wickham's theory of the local subsistence economy, supported by an interregional "macroeconomy" based on oil (Wickham 2005). As it now appears, Tchalenko's ideas of regarding the abandonment of the Dead Cities may not have been as far from the mark as previously thought. It is possible that Tchalenko had the driving forces of abandonment mostly correct, but was incorrect in the rapidity of abandonment.

Conclusions

The findings of this thesis firmly suggest that trade and travel to and from the Dead Cities was not only viable, but also, given the position of the limestone massif practically assured. The density of population, both rural and urban, the extent of the roads, and the obvious prosperity of the Dead Cities themselves already strongly suggests the presence of intensive trade. This supposition is still more firmly supported by the findings of this thesis. All iterations of the models support the relative viability of fairly long distance trade in this region. Furthermore the extensive archaeological evidence for olive oil surplus in the Dead Cities speaks to an oil producing economy that was clearly geared toward more than mere subsistence. Mattingly (1988) suggests that olive oil cannot be stored for more than a year with serious risk of the oil going rancid, thus stockpiling of oil can safely be ruled out the in the Dead Cities. Finally and perhaps most critically, the recovery of LR1 amphorae regionally produced and typically filled with oil or wine, all across the Mediterranean basin and beyond. In light of this evidence, the reality that northwestern Syria was a major trade center, based at least partially on the mass exportation of olive oil, becomes irrefutable. The Dead Cities, previously viewed as isolated ruins, must now be understood as an critical component of the complicated political, social, and economy fabric of Late Roman Syria.

References

ALCOCK, S.E. 1997. *The Early Roman Empire in the East*. Oxford, England: Oxbow Books.

BANG, P.F. 2007. Trade and Empire In Search of Organizing Concepts for the Roman Economy *Past & Present*, 3–54.

BEATTIE, A. & T. PEPPER. 2001. *The rough guide to Syria*. 2nd ed. London: Rough Guides.

BRAIDWOOD, R.J. 1937. *Mounds in the plain of Antioch, an archeological survey*, Chicago, Ill.: University of Chicago Press.

BRAIDWOOD, R.J. & L.S. BRAIDWOOD. 1960. *Excavations in the Plain of Antioch*. Chicago: University of Chicago Press.

BRYCE, T. 2014. *Ancient Syria* . Oxford, England: Oxford University Press.

BURNS, R. 2009. *The monuments of Syria a guide*. Rev. London: I.B .Tauris.

BUTCHER, K. 2003. *Roman Syria and the Near East*. Los Angeles: J. Paul Getty Museum :

BUTLER, H.C. & F.A. NORRIS. 1930. *Syria: publications of the Princeton University archaeological expeditions to Syria in 1904-5 and 1909. Div. 1 Geography and itinerary*. Leyden: Brill.

BUTLER, H.C. & E.B. SMITH. 1929. *Early churches in Syria, fourth to seventh centuries*, Princeton: Pub. for the Department of Art and Archaeology of Princeton University.

CALLOT, O. 1984. *Huileries antiques de Syrie du Nord*. Paris: Libr. orientaliste P. Geuthner.

CAMERON, A. 1998. *The Cambridge ancient history*. Cambridge: Cambridge University Press.

CASANA, J. 2004. The Archaeological Landscape of Late Roman Antioch, in *Culture and Society in Later Roman Antioch*.

CASANA, J. 2007. Structural Transformations in Settlement Systems of the Northern Levant *AJA American Journal of Archaeology*, 195–221.

CASANA, J. 2008. Mediterranean valleys revisited: Linking soil erosion, land use and climate variability in the Northern Levant *Geomorphology*, 429–42.

CASANA, J., J. COTHREN. & T. KALAYCI. 2012. Swords into Ploughshares: Archaeological Applications of CORONA Satellite Imagery in the Near East *IA Internet Archaeology*.

CASANA, J. & T. WILKINSON. 2006. Settlement and Landscapes in the Amuq Region. Essay, in *The Amuq Valley Regional Projects* , 1: 25–66. Chicago, IL: University of Chicago.

CASANA, J. & M. PANAHIPOUR. 2014. Satellite-Based Monitoring of Looting and Damage to Archaeological Sites in Syria *Journal of Eastern Mediterranean Archaeology & Heritage Studies*, 128–51.

CASANA, J. 2014. The Late Roman Landscape of the Northern Levant: A view from Tell Qarqur and the lower Orontes River Valley *Oxford Journal of Archaeology* , 193–219.

CASSON, L. 1994. *Travel in the ancient world*. Johns Hopkins Paperbacks. Baltimore: Johns Hopkins University Press.

COURTOIS, J.-C. 1973. Prospection archéologique dans la moyenne vallée de l'Oronte (El-Ghab et Er Roudj. Syrie du Nord-Ouest) *Syria syria*, 53–99.

CZAJLIK, Z. 2013. *Aerial archaeology and remote sensing from The Baltic to The Adriatic: selected papers of The Annual conference of The aerial archaeology research group, 13th-15th September 2012, Budapest, Hungary*. Budapest: Institute of archaeological sciences, Faculty of humanities, Eötvös Loránd University.

DE JONG, M., F. THEUWS. & C. VAN RHIJN. (ed.) 2001. *Topographies of Power in the Early Middle Ages*.

DE VOGUE, le C.M.de. 1865-77. *Syrie centrale*. Paris: Baudry.

DECKER, M. 2001. Food for an Empire: Wine and Oil Production in North Syria, in *Economy and exchange in the East Mediterranean during Late Antiquity: proceedings of a conference at Somerville College, Oxford*.

DECKER, M. 2001. *Economy and exchange in the East Mediterranean during Late Antiquity: proceedings of a conference at Somerville College, Oxford, 29th May, 1999*. Oxford: Oxbow.

DECKER, M. 2009. *Tilling the hateful earth: agricultural production and trade in the late antique East*. Oxford: Oxford University Press.

DENTZER, J.-M. & W. ORTHMANN. (ed.) 1989. *Archeologie et Histoire de la Syrie II: La Syrie de l'epoque achemenie a l'avenement de l'Islam*.

DOWNEY, G. 1961. *A history of Antioch in Syria: from Seleucus to the Arab conquest*. Princeton, N.J.: Princeton University Press.

DUNCAN-JONES, R. & K.R. BRADLEY. The Economy of the Roman Empire *The American Journal of Philology*, 224–24.

EGER, A. 2008. The Spaces Between the Teeth: Environment, Settlement, and Interaction on the Islamic-Byzantine Frontier, (Dissertation, University of Chicago) 1–612.

EGER, A.A. 2011. The Swamps of Home: Marsh Formation and Settlement in the Early Medieval Near East* *Journal of Near Eastern Studies* 70: 55–79.

FINLEY, M.I. 1973. *The ancient economy,* Berkeley: University of California Press.

FOSS, C. 1996. Dead Cities of the Syrian Hill Country *Archaeological Institute of America* 49: 48–53.

FOSS, C. 1997. Syria in Transition, A. D. 550-750: An Archaeological Approach *Dumbarton Oaks Papers*, 189–89.

FRANK, T. & A.C. JOHNSON. 1933. *An economic survey of ancient Rome,* Baltimore: The Johns Hopkins Press.

FRANKEL, R. 1999. *Wine and oil production in antiquity in Israel and other Mediterranean countries*. Sheffield: Sheffield Academic Press.

Google Earth Add photos 2015 - *Earth Help*. Accessed. https://support.google.com/earth/answer/148126?hl=en.

GRAFF, S.R. 2006. *Economy and society: an archaeological reconstruction of the political and informal economy of northwestern Syria in the third millennium BC*.

GREENE, K. 1986. *The archaeology of the Roman economy*. Berkeley: University of California Press.

HARRIS, W.V. 1993. *The inscribed economy: production and distribution in the Roman empire in the light of instrumentum domesticum : the proceedings of a conference held at the American Academy in Rome on 10-11 January, 1992*. Ann Arbor, MI: University of Michigan.

HAYWOOD, R.M. & F.M. HEICHELHEIM. 1938. *An economic survey of Ancient Rome,* Baltimore: The J. Hopkins Press.

Hirst K. Kris Biography - About's Guide to Archaeology 2015 *About.com Education*. Accessed. http://archaeology.about.com/bio/k-kris-hirst-3021.htm.

HULL, D. 2008. A Spatial and Morphological Analysis of Monastic Sites in the Northern Limestone massif, Syria *Levant* 40: 89–113.

JAKOBY, E. 2013. Considering Kranzhugeln: An Exploration into the Structural Variation and Environmental/Spatial Distribution of the Thrid Millennium "Kranzhugel" Sites, (Master's Thesis, University of Arkansas) 1–123.

JONG, L.D. 2007. Narratives of Roman Syria: A Historiography of Syria as a Province of Rome *SSRN Electronic Journal SSRN Journal*.

KARAGIORGOU, O. 2009. Mapping trade by the Amphora, in *Mapping trade by shipwrecks , in Byzantine trade, 4th-12th centuries: the archaeology of local, regional and international exchange : papers of the thirty-eighth Spring Symposium of Byzantine Studies, St John's College*.

KARAKHANIAN, A., V. TRIFONOV., T. IVANOVA., A. AVAGYAN., M. RUKIEH., H. MININI., A. DODONOV. & D. BACHMANOV. 2008. Seismic deformation in the St. Simeon Monasteries (Qal'at Sim'an), Northwestern Syria *Tectonophysics*, 122–47.

KAROLL, A. 2011. The Early Bronze Age IV to Middle Bronze Age I Transition in the Orontes Valley, Syria: A View From Tell Qarqur. (Master's Thesis, University of Arkansas)

KINGSLEY, S. 2009. Mapping trade by shipwrecks, in *Byzantine trade, 4th-12th centuries: the archaeology of local, regional and international exchange : papers of the thirty-eighth Spring Symposium of Byzantine Studies, St John's College*.

LIBANIUS. 1959. *Libanius' oration in praise of Antioch (oration XI)*. Philadelphia, Pa.: American Philosophical Society.

MANGO, M.M. 2000. The Commercial Map of Constantinople *Dumbarton Oaks Papers* 54: 189–89.

MANGO, M.M. 2009. *Byzantine trade, 4th-12th centuries: the archaeology of local, regional and international exchange : papers of the thirty-eighth Spring Symposium of Byzantine Studies, St John's College, University of Oxford, March 2004*. Farnham, Surrey, England: Ashgate Pub.

MANGO, M. 2009. Byzantine trade: Local, regional, interregional and International , in *Byzantine trade, 4th-12th centuries: the archaeology of local, regional and international exchange : papers of the thirty-eighth Spring Symposium of Byzantine Studies, St John's College*.

MARX, K. & F. ENGELS. 1967. *Capital; a critique of political economy.* New York: International Publishers.

MATTINGLY, D.J. & J. SALMON. 2001. *Economies beyond agriculture in the classical world*. London: Routledge.

MATTINGLY, D. 1987. Libyans and the 'limes' : culture and society in Roman Tripolitania *antaf Antiquités africaines*, 71–94.

MATTINGLY, D.J. 1988. Megalithic Madness And Measurement. Or How Many Olives Could An Olive Press Press? *Oxford Journal of Archaeology Oxford J Archeol*, 177–95.

MATTINGLY, D.J. 1988. Oil for export? A comparison of Libyan, Spanish and Tunisian olive oil production in the Roman empire *Journal of Roman Archaeology J. Roman archaeol.*, 33–56.

MATTINGLY, D.J. 1988. Olea Mediterranea *Journal of Roman Archaeology*, 153–61.

MLEKUŽ, D. 2014. Exploring the topography of movement *Computational Approaches to the Study of Movement in Archaeology Theory, Practice and Interpretation of Factors and Effects of Long Term Landscape Formation and Transformation*.

MOOG, S. 2015. Stand Strong, Stand Proud: Alternative and Pariah Femininities In San Diego's Punk Rock Community (Master's Thesis, University of Arkansas).

MOUTERDE, R. & J. LAUFFRAY. 1945. *Le Limes de Chalcis. Organisation de la steppe en Haute Syrie romaine. Documents aériens et épigraphiques. Plans et relevés de J. Lauffray et S. Mazloum. (Texte.-Atlas.)*.

POIDEBARD, A. 1934. *La trace de Rome dans le désert de Syrie; le limes de Trajan à la conquête arabe; recherches aériennes (1925-1932)*. Paris: P. Geuthner.

POLANYI, K. 1957. *The great transformation*. Boston: Beacon Press.

POLANYI, K. 1957. *Trade and market in the early empires: economies in history and theory*. Glencoe, IL: Free Press.

POLANYI, K. & H.W. PEARSON. 1977. *The livelihood of man*. New York: Academic Press.

POLLARD, N. 2000. *Soldiers, cities, and civilians in Roman Syria*. Ann Arbor: University of Michigan Press.

SAHLINS, M. 1972. *Stone age economics*. Chicago: Aldine-Atherton.

SANDWELL, I. & Huskinson, J. 2004. *Culture and society in later Roman Antioch: papers from a colloquium, London, 15th December 2001*. Oxford: Oxbow Books ;

SARRIS, P. 2011. *Empires of faith: the fall of Rome to the rise of Islam, 500-700*. Oxford [England: Oxford University Press.

SMITH, M.E. 2004. The Archaeology of Ancient State Economies *Annu. Rev. Anthropol. Annual Review of Anthropology*, 73–102.

SODINI, J. & G. TATE. 1981. *Déhès (Syrie du nord)*. Paris: Librairie orientaliste P. Geuthner.

TARLACH, G. How Google Earth Has Revolutionized Archaeology *Discory Magazine*.

TATE, G. 1992. *Les Campagnes de la Syrie du Nord du IIe au VIIe siècle: un exemple d'expansion démographique et économique à la fin de l'Antiquité.* Paris: Librarie orientaliste Paul Geuthner.

TATE, G. 1997. The Syrian Countryside during the Roman Era, in *The Early Roman Empire in the East*. Oxford, England: Oxbow Books.

TCHALENKO, G. 1953. *Villages antiques de la Syrie du Nord; le massif du Bélus à l'époque romaine.* Paris: P. Geuthner.

TCHALENKO, G. 1979. *Eglises de village de la Syrie du nord*. Paris: Librairie orientaliste P. Geuthner.

TEMIN, P. 2001. A Market Economy in the Early Roman Empire *The Journal of Roman Studies* 91: 169–81.

UR, J.A. 2012. CORONA Satellite Imagery and Ancient Near Eastern Landscapes *SpringerBriefs in Archaeology Mapping Archaeological Landscapes from Space,* 21–31.

VERHAGEN, P., S. POLLA. & I. FROMMER. 2014. Finding Byzantine junctions with Steiner trees *Computational Approaches to the Study of Movement in Archaeology Theory, Practice and Interpretation of Factors and Effects of Long Term Landscape Formation and Transformation*.

WARD-PERKINS, B. 1998. The Cities, in *The Cambridge ancient history*. Cambridge.

WEBER, M. & T. PARSONS. 1947. *The theory of social and economic organization*.

WEBER, M. 1958. *The Protestant ethic and the spirit of capitalism*. [Student's. New York: Scribner.

WEST, L.C. 1924. Commercial Syria under the Roman Empire *Transactions and Proceedings of the American Philological Association* , 159–59.

WEULERSSE, J. 1940. *L'Oronte. Étude de fleuve. Par Jacques Weulersse*.

WHITE, D.A. & S.B. BARBER. Geospatial modeling of pedestrian transportation networks: a case study from precolumbian Oaxaca, Mexico *Journal of Archaeological Science*, 2684–96.

WHITE, D.A. & S. SURFACE-EVANS. 2012. *Least cost analysis of social landscapes archaeological case studies*. Salt Lake City: University of Utah Press.

WICKHAM, C. 2005. *Framing the early Middle Ages Europe and the Mediterranean 400-800*. Oxford: Oxford University Press.

WIESER, A. 2012. Geoarchaeology of the Orontes River Floodplain Surrounding Tell Qarqur, Syria. (Master’s Thesis, University of Arkansas)

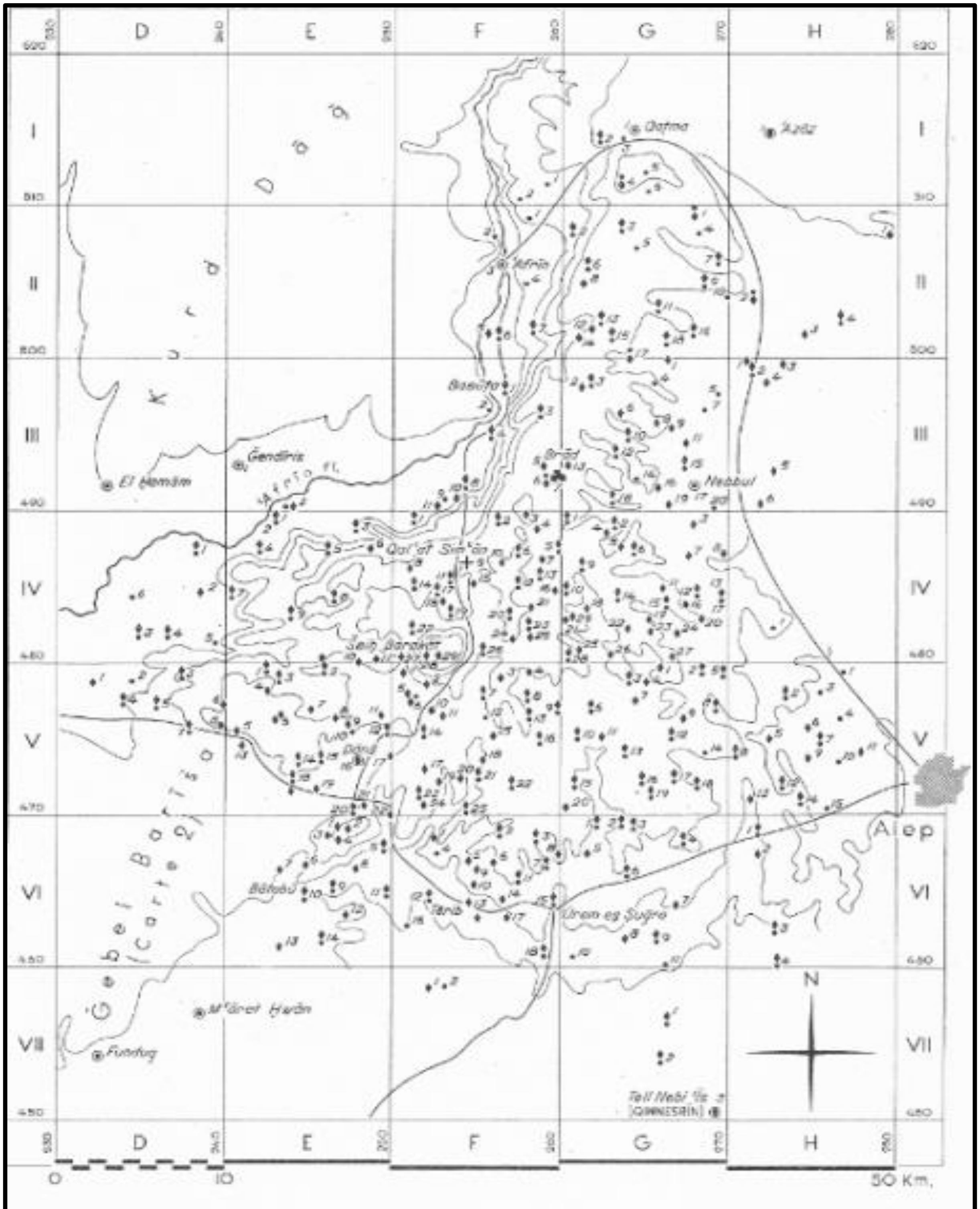
WILL, E. 1997. Antioche sur l'Oronte, métropole de l'Asie *Syria syria*, 99–113.

WILKINSON, T. 1999. Holocene Valley fills of Southern Turkey and Northwestern Syria: Recent geoarchaeological contributions *Quaternary Science Reviews*, 555–71.

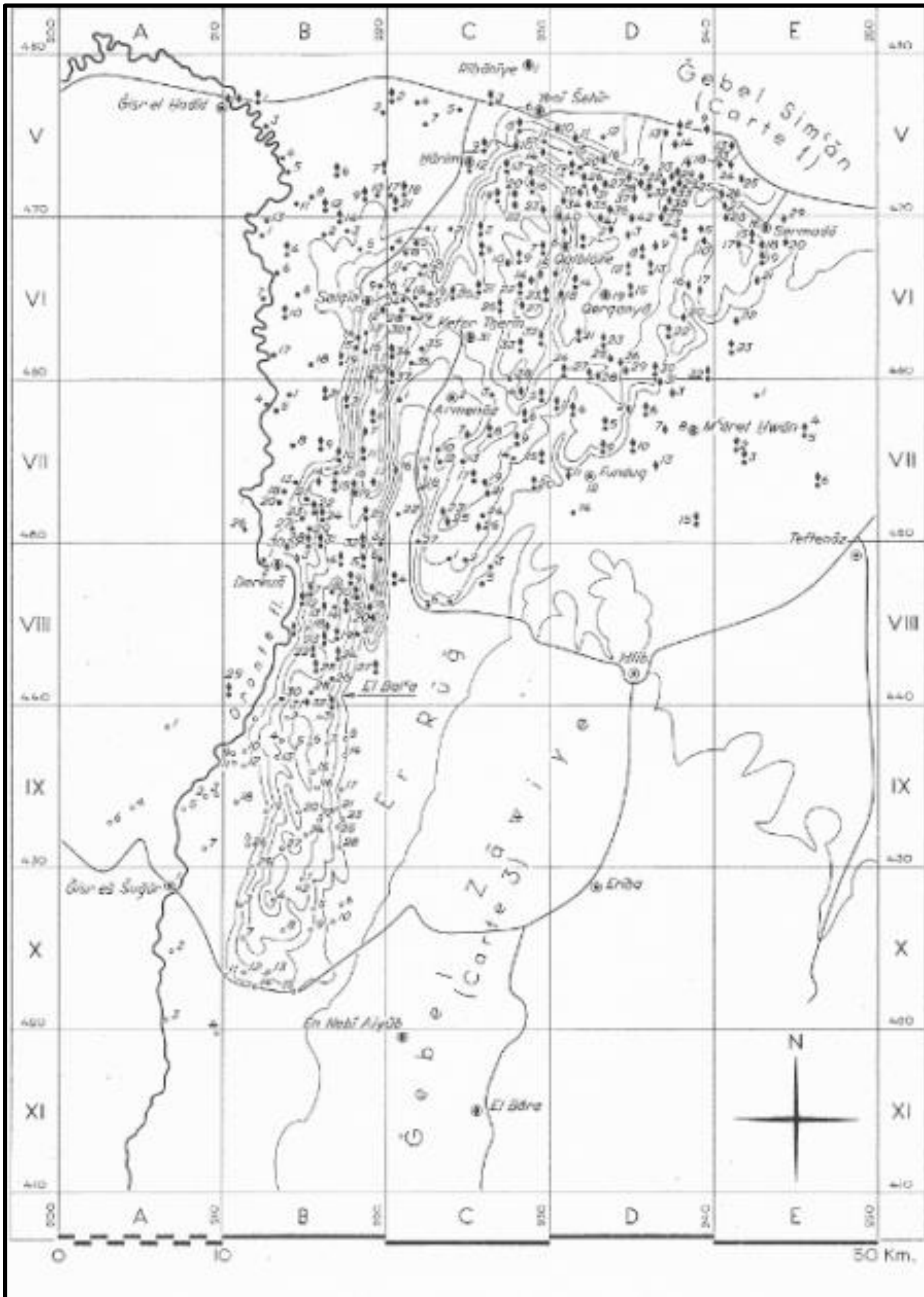
YENER, K.A., C. EDENS., T.P. HARRISON., J. VERSTRAETE. & T.J. WILKINSON. The Amuq Valley Regional Project, 1995-1998 *American Journal of Archaeology*, 163–63.

YENER, K.A. 2005. *The Amuq Valley regional projects*. Chicago, IL: Oriental Institute of the University of Chicago.

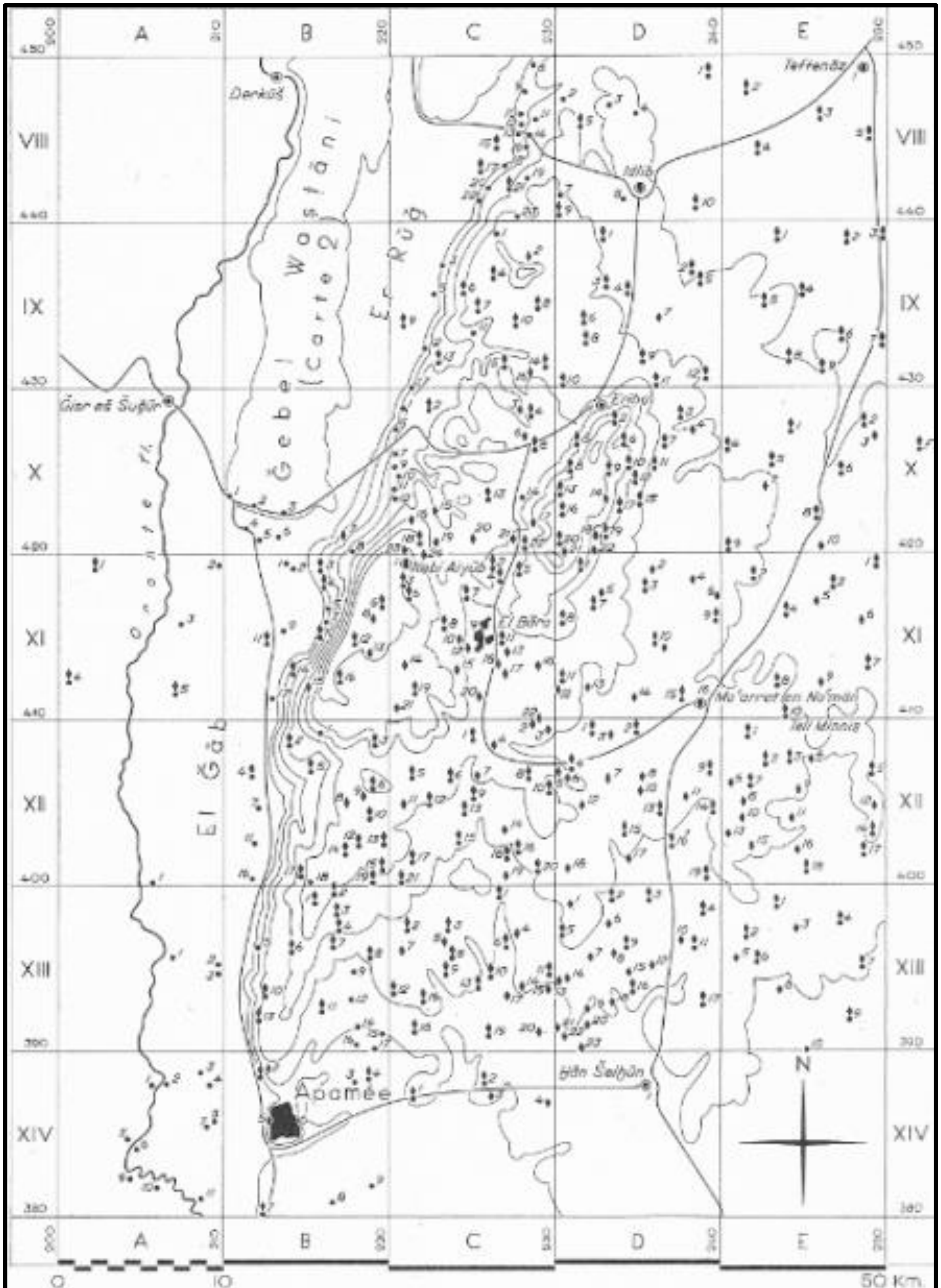
Appendix 1: Tchalenko's Maps of the Dead Cities



1. — Le Ğebel Sim'ân.



2. — Le Ğebel Bariša, le Ğebel il A'la, le Ğebel Dueili.



3. — Le Ğebel Zāwiye.