M. Ali Akman QUANTITATIVE APPROACHES TO HITTITE HISTORICAL GEOGRAPHY Bilkent University 2023

Quantitative Approaches to Hittite Historical Geography: A Network Analysis of Hittite Toponyms

A Master's Thesis

by

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To my sisters

QUANTITATIVE APPROACHES TO HITTITE HISTORICAL GEOGRAPHY: A NETWORK ANALYSIS OF HITTITE TOPONYMS

The Graduate School of Economics and Social Sciences
of
İhsan Doğramacı Bilkent University

by

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In Partial Fulfillment of the Requirements for the Degree of
MASTER OF ARTS IN ARCHAEOLOGY

THE DEPARTMENT OF
ARCHAEOLOGY
İHSAN DOĞRAMACI BİLKENT UNIVERSITY
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I certify that I have read this thesis and have found that is fully adequate, in scope and in quality, as a thesis for the degree of Master of Arts in Archaeology.

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ABSTRACT

QUANTITATIVE APPROACHES TO HITTITE HISTORICAL GEOGRAPHY: A NETWORK ANALYSIS OF HITTITE TOPONYMS

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August 2023

There are many references to place names in the Hittite texts, and the understanding of their locations is crucial to the study of Hittite history and society. In the past, the examination of these place names, which occur more than 20,000 times, was limited to methods that were qualitative in nature. Nonetheless, due to the Hittite Toponyms project led by Adam Kryszeń, there is now an exciting opportunity to conduct a comprehensive quantitative study of Hittite toponyms. This research presents an original statistical methodology based on network analysis to gain a deeper understanding of the relative positions of toponyms in Hittite texts. Toponyms are represented as nodes in a network, and the strength of their connections is determined by the frequency of their occurrence in the same text fragment. This thesis demonstrates the proposed methodology's ability to explain geography through examples at different scales, including a modern case study and a case study on Durmitta's location. The results highlight that when combined with qualitative methods, the suggested statistical approach can offer new insights into Hittite historical geography, improving our comprehension of this ancient civilization.

Keywords: Hittite historical geography, network analysis, co-occurrence network, quantitative text analysis, toponymy.

ÖZET

HİTİT TARİHİ COĞRAFYASINA KANTİTATİF YAKLAŞIMLAR: HİTİT TOPONİMLERİ ÜZERİNE BİR AĞ ANALİZİ

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Ağustos 2023

Hitit metinlerinde çok sayıda yer adına atıfta bulunulmaktadır ve bu yer adlarının konumlarının anlaşılması Hitit tarihi ve toplumunun incelenmesi açısından büyük önem taşımaktadır. Geçmişte, 20.000'den fazla kez geçen bu yer adlarının incelenmesi niteliksel yöntemlerle sınırlıydı. Ancak Adam Kryszeń liderliğindeki Hitit Toponimleri projesi sayesinde, Hitit toponimleri üzerine kapsamlı bir niceliksel çalışma yapmak için heyecan verici bir fırsat doğmuştur. Bu araştırma, Hititçe metinlerdeki yer adlarının göreceli konumlarını daha iyi anlamak için ağ analizine dayalı özgün bir istatistiksel metodoloji sunmaktadır. Toponimler bir ağdaki nodlar olarak temsil edilir ve bağlantılarının gücü aynı metin parçasında görülme sıklıklarına göre belirlenir. Önerilen metodolojinin, modern bir vaka çalışması ve Durmitta'nın konumu üzerine bir vaka çalışması da dahil olmak üzere farklı ölçeklerdeki uygulaması, metodun coğrafi ilişkileri açıklama yeteneğini göstermektedir. Sonuçlar, önerilen istatistiksel yaklaşımın nitel yöntemlerle birleştirildiğinde Hitit tarihi coğrafyasına dair yeni anlayışlar sunabileceğini ve bu kadim uygarlığa dair anlayışımızı geliştirebileceğini vurgulamaktadır.

Anahtar Kelimeler: Hitit tarihi coğrafyası, ağ analizi, eş-oluşum ağı, nicel metin analizi, toponimi.

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Chapter I: Introduction

Since the initial publication of the Hittite tablets from Boğazkale, the study of Hittite historical geography has become a crucial subfield within Hittitology. Over the past century, extensive research has significantly enhanced our comprehension of the geographical organization of the Hittite Empire (E. Forrer 1924; Goetze 1940; Garstang and Gurney 1959; Weeden and Ullmann 2017). Despite these advancements, uncertainties still exist concerning the major political and cultural centers of the empire. As a result, Hittite historical geography remains an active area of investigation for Hittologists and Hittite archaeologists. While research in this field traditionally adopts a qualitative approach, primarily centered on critical analysis of textual sources, quantitative methods, such as statistical analysis, have rarely been utilized in Hittite studies. This thesis proposes a novel statistical approach to Hittite historical geography, utilizing network analysis based on the Hittite Toponyms database (Kryszeń 2023)[1] . The primary objective is to illustrate networks at various levels and to showcase the potential of statistical methodologies through a case study of Durmitta. By applying statistical techniques, this research aims to offer valuable insights into the spatial dynamics of the Hittite Empire.

[1] see 1.2

1.1 Birth and Evolution of Hittite Historical Geography

Almost completely erased from the collective memory of humanity, the only fragments of knowledge about the Hittites remained in the Old Testament (Seters 1972, 5). Little was known about the Hittites, and the first questions about them were quite simple. Who were these Hittites and where did they live? Therefore, it is possible to say that the beginning of Hittite historical geography studies began with the first studies of Hittitology. Some of the ruins that attracted the attention of Western travelers to Anatolia were seen as evidence of the existence of a civilization that predated the Greek civilization (Mellink 1966, 132). However, the true extent of this civilization was not revealed until the discovery of the archives at Boğazköy (Hawkins 1986, 365). The place names on these tablets, especially the similarity of some of the names to Homeric place names, made the subject very attractive to Western scholars (E. Forrer 1924, 58). Thus, Hittite studies were popularized by their position in relation to the Old Testament and Homer, the two main sources of inspiration for archaeological and ancient history studies of the period, and assumed the role of a bridge between two geographies and two different time periods.

Hittite history, and Hittite historical geography, gained autonomy as a field of research later on when it began to formulate and answer its own questions. First systematic study on Hittite historical geography can be seen as Goetze's "*Kizzuwatna and the problem of Hittite geography*" (1940). In his book Goetze proposed a location for Kizzuwatna which is accepted today, but more importantly he criticizes the comparative method, matching toponyms from different periods, and argues for

using textual analysis to deduce the geographical locations. Since then the proposed contextual method has become the norm in studies of historical geography (Kryszeń 2014, 422).

Since the 1940s, our understanding of Hittite historical geography has significantly improved. Most scholars generally agree that the conducted studies have successfully identified major regions mentioned in Hittite texts, although the specific boundaries of these regions are still subject to debate. However site identifications are mostly due to tablet finds in archaeological sites. Identifications such as Maşat Höyük/Tapikka (Alp 1977), Kuşaklı/Šarišša (Müller-Karpe 2002) , Oymaağaç/Nerik (Czichon 2009), and Kayalıpınar/Šamuḫa (Müller-Karpe, Müller-Karpe, and Rieken 2017), have allowed researchers to pinpoint certain locations and elaborate on the relative positions of other toponyms. However, locations of some of the important cities mentioned repeatedly in the texts are still under discussion, such as Arinna, Ankuwa, Durmitta and Zippalanda (Forlanini 2008; 2009; Corti 2017).

Historical geography outside of Hittitology refers to a multidisciplinary field that studies the historical implications of geography. However, Hittite historical geography became synonymous with endeavor to understand relative or absolute location of toponyms mentioned in the Hittite texts. To achieve this aim scholarship had relied on two main methods, contextual method, critically analyzing texts to understand relations of toponyms and comparative method, identifying toponyms from different periods. The discussions of methodology have revolved around the necessary balance of these two qualitative approaches, yet these discussions remained limited in the last 40 years with only a single article dedicated to this

problem (Kryszeń 2014). Because the type and amount of evidence varies widely, as does the motivation for locating each toponym, studies often lack a systematic methodology.

Only recently has the need for systematic methods become apparent, and only a few researchers have proposed and applied them. One of these researchers, Barjamovic, used a quantitative method in his research based on co-occurrence analysis of toponyms for Old Assyrian textual evidence (Barjamovic 2017). No attempt has ever been made to apply a similar idea to Hittite texts. Scholars have expressed the opinion that such an attempt would be ineffective because the nature of the Hittite texts is quite different from that of the Old Assyrian texts (Kryszeń 2014, 424; Weeden and Ullmann 2017, 6). This thesis demonstrates that it is possible to understand geographical relationships through a corpus of non-economic and non-geographical texts through a more sophisticated analysis of co-occurrence data using network analysis. Until recently, however, such a quantitative study of Hittite toponyms was not possible because there was no digital database of Hittite toponyms with their attestations. Thanks to the efforts of Adam Kryszeń, such a database has been created, called Hittite Toponyms (HiTop).

1.2 Hittite Toponyms Database (HiTop)

The Hittite Toponyms (HiTop) project was initiated by J. Klinger and funded by the TOPOI research program of the Freie Universität Berlin. The project involved the digitization of data from the Hittology Archive Mainz under the direction of J. Klinger and G.G.W. Müller, with Dr. Adam Kryszeń supervising the process

(Kryszeń 2023). After the digitization was completed, Dr. Kryszeń performed an independent review and expansion of the database, resulting in the HiTop database, which he generously shared with me, making this study possible. The database is now publicly available at hethiter.net/: HiTop.

The database consists of over 2700 distinct toponyms and includes their occurrences in Hittite texts, totaling around 20,000 instances (Kryszeń 2023). For each record, the database provides information such as the toponym, its transliteration, its publication or inventory number, and its position in the text. Some instances also include additional details such as grammatical notes and contextual information about its usage. The information allows for the distinction between different uses of toponyms, providing valuable insights for the analysis.

1.3 Aims of the Thesis

The primary goal of this thesis is to provide a set of analytical tools within a consistent methodological framework based on HiTop, a public database of 2700 Hittite toponyms. These analytical tools can be used to understand different types of relationships between toponyms, which include their geographic relationships as well as their administrative, religious, and political relationships. The achievement of this goal depends on three objectives: (1) Understanding existing methodological tools and frameworks, their strengths and weaknesses, in Hittite historical geography. (2) Understanding tools of network analysis and possible statistical approaches that can be applied to the available data. (3) Constructing a consistent methodological

framework that includes both quantitative and qualitative methods that can answer questions of historical geography.

In addition to its immediate goals, this thesis serves as a broader example of computational quantitative research in the field of Hittitology. Hittitology itself is currently undergoing a process of digitization of texts, driven by the goal of improving resource accessibility for researchers engaged in qualitative analysis. However, the digitization of texts also opens up new and exciting possibilities for quantitative research that have not yet been explored. Since this study is one of the first systematic attempts to conduct quantitative analysis on Hittite texts, its most fundamental task and overarching goal is to demonstrate the potential of quantitative analysis and to provide a tangible example for the field of Hittitology. It is hoped that this research will stimulate and motivate other researchers in the field to undertake quantitative analysis.

1.3 Structure of the Thesis

This thesis is organized into five main chapters. The second chapter that follows the introduction chapter of this thesis focuses on an examination of the methodological challenges of Hittite historical geography. By examining the goals and methods of the field, this chapter highlights the existing issues that are frequently addressed. Since the primary goal of this thesis is to introduce a new quantitative method for Hittite historical geography, it is essential to analyze and address these prevailing methodological problems. Remarkably, the field's state has been gradually changing since the 2010s, as scholars have increasingly engaged in open discussions about the

lack of systematic methodologies. Building on these ongoing discussions, this chapter contributes to the discourse by conducting a comparative analysis of three recent studies that employ systematic methodologies. The aim is to gain a comprehensive understanding of the core principles of systematic methodology in the field of Hittite historical geography.

The third chapter presents the methodology of the study. Since network analysis has never been used in a Hittitology study, it begins with explaining fundamental concepts of network analysis. Second section explains how a co-occurrence network of toponyms can be used to gain insight into historical geography. And finally the proposed methodology and fundamental concepts of network analysis are demonstrated using a co-occurrence network of 81 provinces in Turkey mentioned in 30,000 online news articles. With this example it was demonstrated that non-geographical texts can be statistically analyzed to gain geographical information.

Chapter four of this thesis undertakes the construction and analysis of a co-occurrence network encompassing Hittite toponyms on the largest scale using the HiTop database. This extensive study represents a pioneering effort to present the complex relationships among toponyms as depicted in Hittite texts, adopting a comprehensive and holistic approach that has not been previously explored. The final network includes 1705 toponyms and more than 17000 edges between them. A force-directed layout of the network illustrates a relative geography of Hittite Empire that draws close parallel to current understanding of Hittite political geography.

In the fifth chapter, the focus shifts to a discussion of Durmitta's location, using both statistical and text-critical methods. This investigation takes into account the data generated by the network constructed in the previous chapter. The arguments for Durmitta's location, initially derived from text-critical analysis of Hittite texts, are thoroughly examined and statistically tested within the network framework. This integrated approach constitutes a synthesis of existing and proposed quantitative methods and offers a comprehensive analysis of one of the most controversial toponyms in Hittite historical geography.

Chapter II: Aims and Methods of Hittite Historical Geography

For more than a century, scholarship on Hittite historical geography has aimed to understand the geographical organization of the Hittite world (E. Forrer 1924; Albright 1925; Goetze 1940; Garstang and Gurney 1959; Güterbock 1961; Forlanini 2009; Kryszeń 2016; Gander 2022). From Goetze's influential publication in 1940 until the early 2010s, the field of Hittite historical geography predominantly consisted of fragmented efforts and individual studies focused on enhancing comprehension of limited geographical areas or identifying isolated toponyms. However, a shift towards a more comprehensive and systematic approach to Old Assyrian and Hittite geography can be observed with the works of Barjamovic (2011), Kryszeń (2016), and Gander(2010; 2012). These scholars demonstrate an increasing interest in examining the subject as a whole, employing more consistent methodologies. On the other hand articles published in the field often do not see the need to discuss aims and methods. It is understandable to a certain extent that discussing aims and methods in every article may appear impractical; yet, there is also a lack of meta-discussions on this subject, except Adam Kryszeń's "Methodology and the Problem of Hittite Geography" (2014).

As a concrete example of this claim, *Hittite Landscape and Geography*, which was edited in 2017 and includes both archaeological and philological research on Hittite historical geography, can be examined (Weeden and Ullmann 2017). In the Introduction by Weeden and Ullmann, the word *method* occurs a total of sixteen times. These sixteen occurrences mostly refer to problems of methodology (2017, 1). Four of them are used to describe Barjamovic's methodology, three of them are used to refer to the methodological problems pointed out by Kryszeń. However, only three

of the eleven articles in the philological section of the book mention the word *method* or *approach* (Gander 2017, 262; Corti 2017, 219; Barjamovic 2017, 312). Only a single article devotes a special section to this topic (2017, 262). Among the authors contributing to these articles, a single article provides a sentence with word *aim* that explains the objective of its research. (2017, 236). These numbers show that even though the need for a discussion on methods and aims is apparent and known by the researchers, this need is not being fulfilled.

Considering that the main purpose of this research is to make a methodological contribution to this field, it is necessary to discuss the research history with focus on aims and methods of research in order to diagnose theoretical and methodological problems of the field. Nevertheless, this chapter doesn't include a survey of the history of research, which can be found in Adam Kryszeń's *A Historical Geography of the Hittite Heartland* (2016, 8-19). The aims and methods of Hittite historical geography are examined and discussed in the first and second sections of the chapter. The third section comparatively examines the works of Barjamovic, Kryszeń, and Gander in order to present the essentials of a systematic methodology in the field. The final section compares and discusses three objectives of historical geography: identification, localization and relative geography.

2.1 Aims of Hittite Historical Geography

Garstang, in the preface of the famous book "*The Geography of the Hittite Empire*", clearly explains the purpose of the study. He points out that the Hittite archives contain many records of military campaigns and achievements. And he continues,

"*These fascinating records, even when lucidly translated from the Hittite idiom, remain for the most part unintelligible"* (Garstang and Gurney 1959, 7). He states that there is a great need for a map that can tentatively indicate the relative positions of the states and kingdoms in Hittite Anatolia, and explains his aim as fulfilling this need This is the same goal that Goetze set 19 years prior, namely, that Hittite historical geography should be studied to understand narratives of the past (Goetze 1940, 22:1). To a certain extent, Goetze, Garstang and Gurney have achieved their goals. The locations they have established for major Anatolian kingdoms are accepted by most Hittitologists.

Subsequently, historical geography started to evolve with its own set of questions and answers, sometimes neglecting the essential 'so what' aspect. Studies in historical geography have often remained detached from historical inquiry. Recently, however, there has been a noticeable shift as researchers have begun to actively pursue historical questions and recognize the essential role of historical geography in unraveling them. For example, the historical geography of the Old Assyrian period is evaluated in the larger context of the trade networks of the Middle Bronze Age (Barjamovic 2018); History of Western Anatolia studied in synthesis to its historical geography (Gander 2022).

Although identifying and understanding the relative locations of toponyms is essential to answering certain historical questions, it is important to recognize that the process of locating toponyms alone does not always enhance our understanding of history. Furthermore, even in cases where there are significant historical

implications associated with the location of toponyms, the scholarly literature often fails to highlight these connections, as discussed in the introduction to this chapter.

2.2 Methods for Interpreting Textual Evidence

The methods for inferring the approximate or relative position of toponyms in Hittite texts can be divided into two groups. These are the comparative and the contextual methods. Researchers usually use a combination of both methods in their investigations. In this section, I will review these two methods, present the various ways in which they are used in the existing literature, and discuss their respective methodological advantages and disadvantages.

2.2.1 Comparative Method

The method known as the comparative or philological method involves associating toponyms mentioned in earlier texts with toponyms found in later sources. This approach has been utilized in Near Eastern studies to establish connections between ancient place names and modern locations (Barjamovic 2011, 66). Early Hittitologists also employed this method to identify ancient Anatolian toponyms (E. Forrer 1924). Remarkably, many names in Mesopotamia have remained recognizable in their original forms for thousands of years, and the same applies to certain Anatolian toponyms. The preservation of ancient toponyms offers a valuable opportunity for studying historical geography. Unlike the contextual method, the comparative method enables the identification or localization of these place names.

Since the very beginning of Hittite historical geography studies, the comparative method has been criticized even by the researchers who employ the method. Forrer acknowledges that the problem of homonymy may cause confusion (E. Forrer 1926, 20). Goetze in his influential work, *"Kizzuwatna and the Problem of Hittite Geography",* argued in favor of contextual method over comparative method. Garstang, in the review of Goetze's book, acknowledges the method's limitations and notes that any similarities identified through this approach are often "*illusory and misleading*" (Garstang 1942, 233).

An example that illustrates the strengths and weaknesses of the method in question is the identification of the city of Kummaha. It has been associated with classical Commagene / Iron Age Kummuh based on Assyrian and Urartian sources. This argumentation appears plausible, as all the phonetic changes can be explained by linguists (Weeden and Hawkins 2017, 289). However, Hawkins and Weeden present a conflicting text, the Deeds of Šuppiluliuma, which suggests that Muršili's grandfather waged war against the king of Ḫayaša, who invaded Šamuḫa near Kummaha. Consequently, the authors argue that the identification of Kummaḫa as Kemah, classical Camacha, is more likely than Commagene (2017, 290). This example highlights the "illusory and misleading" nature of the method while also acknowledging its practicality when combined with a text-critical approach.

There are several things to consider when employing comparative methods:

1. Linguistic plausibility: The phonetic difference between compared toponyms should be explained by historical linguistics.

2. Homonymy: A toponym may have been used to refer to two or more different places that are unrelated.
3. Coincidental similarity: Similarity between two toponyms can be coincidental and such possibility is stronger for shorter names.
4. Toponymic relocation: Toponyms may also refer to different places in different time periods. This is often the case for ethnic toponyms. Cities often move for various reasons. For a modern example of city of Most see (David 2018)

Despite its methodological problems when its results are compared with a contextual method, the comparative method can be very useful. Max Gander argues that comparative method should not be ruled out, since the most important identifications in western Anatolia, such as Parḫa – Πέργη and Kastaraya – Κέστρος or the identification of the cities of Lycia, owe much to this method and these identifications improved our understanding of geography of this region (2022, 89). As in any scientific research, the comparative method should be employed systematically. Isolating an ancient toponym and looking for similar names in different periods will almost always yield some results since there are thousands of different toponyms used in Anatolia by people from different linguistic backgrounds.

It is crucial for researchers employing the comparative method to provide a clear explanation of their methodological process. This includes specifying the sources that are examined, outlining how phonetic similarity is assessed, and presenting possible other identifications that exhibit similarities to the toponym under investigation. By addressing these questions, researchers can enhance the reliability

of their results and make them more accessible for other scholars to use and build upon.

2.2.2 Contextual Method

Contextual methods involve studying how place names are related to each other and physical landscape through textual analysis. These methods can be further divided into two groups: text-critical approaches and statistical approaches. This section will introduce them and discuss their strengths and weaknesses.

2.2.2.1 Text-Critical Approach

The primary method used in Hittite historical geography is the text-critical approach. Researchers employing this approach typically isolate a particular toponym and analyze the texts that refer to it. Through this analysis, they aim to gain insight into the relationships between the selected toponym and other toponyms. Consequently they suggest localizations relative to known anchor points, or identifications based on philological evidence.

Researchers may come to different conclusions when analyzing the same texts because text-critical approaches rely on textual interpretation. These differences in interpretation can arise from a variety of factors, including variances in (1) transliteration, (2) translation, or (3) assessment of the significance of geographic information. There is also the problem of homonymy and the disagreement between

different researchers on whether an ancient toponym refers to more than one place[2]. Therefore, in order to effectively apply the contextual method and develop sound arguments, researchers must have the necessary expertise to evaluate paleographic and philological evidence, as well as a comprehensive understanding of the corpus in order to assess geographic significance across different textual genres.

2.2.2.2 Statistical Approaches

Statistical analysis of texts is the quantification of a textual corpus in some way and the detection of patterns and trends in the resulting data (Roberts 2000, 259). Quantitative approaches provide a different perspective or interpretation of texts beyond their semantic meaning. While traditional methods of textual analysis focus primarily on understanding the explicit meaning conveyed by words and sentences, quantitative approaches introduce an additional dimension of analysis. Rather than examining semantic content alone, quantitative approaches allow researchers to explore patterns, trends, and relationships within texts based on numerical data. This broader view allows for insights that may not be apparent through traditional qualitative analysis alone.

Unfortunately, none of the statistical methods potentially applicable to Hittite historical geography have yet been applied. There are two main reasons for this, firstly, the fact that a dataset to which statistical methods can be applied has only recently been constructed, and secondly, the mistaken impression that statistical methods will only be meaningful on economic texts. Researchers argued that the

[2] see discussion on Nenassa and Walma in 5.4.3

diverse nature of Hittite documents is not suitable for a quantitative analysis (Kryszeń 2014, 424; Weeden and Ullmann 2017, 6). The reason for this misunderstanding is that there are only two studies in Anatolian historical geography that have used statistical methods and they were applied to Old Assyrian texts, which are mostly economic documents.

The first of these two studies was conducted by Waldo Tobler and Sam Wineburg which aimed to localize toponyms in Kültepe tablets using a statistical gravity model (1971). This paper, published in Nature under the title "A Cappadocian Speculation", is based on the assumption that places that are often mentioned together in texts are closer to each other than places that are not. In fact, this assumption is Tobler's "first law of geography", which he defines as "everything is related to everything else, but near things are more related than far things" (1970, 234). And in fact, this study is designed as an example of how this "law" can be applied. Looking at the co-occurrence of toponyms, the authors attempted to calculate the coordinates of names with unknown locations. The results show the location of Hattus to the northeast of Kanes and Zalpa to the southeast (1971, 41). The study also attempted to predict the coordinates of 33 settlements that are not parallel to the current understanding of the geography of the period.

Although the study states in its title that this is speculation, it is worth discussing why this study did not reach the right conclusions. First of all, as mentioned under different headings in this chapter, it is not possible to make a localization based on texts alone. Economic texts may point to more rational connections between geographical places, but this does not mean that they point directly to geographical

connections. As Barjamovic has often argued, there are many reasons for trade between two cities other than geographical proximity (Barjamovic 2011, 67). The two cities, whose names are often mentioned, could be the final destinations of trade. They could be the source of a valuable resource or demand. There might be political, social, cultural reasons for two cities to conduct trade. The study also ignores physical geography and calculates a distance in birds' eye view. Such simplification will significantly distort results.

The second study is conducted by a team of economists and Barjamovic titled "Trade, Merchants, and The Lost Cities of The Bronze Age" (2019). They use a larger database compared to Tobler and Wineburg, and employ a complex economical model. Study puts forward possible locations for the lost cities and also gives a rate of confidence for each. The results of the study are surprisingly similar with either Forlanini's or Barjamovic's suggestions for some cases such as: Durhumit, Kuburnat, and Ninašša (2019, 1478). Some of the suggestions are far from existing suggestions and some of them are too imprecise to make a conclusion. Researchers then make a proof of concept by trying to find a location of a known city (2019, 1484). Overall, compared to Tobler and Wineburg's work, the study is more successful in locating lost cities of the Middle Bronze Age. However, it also clearly shows that such studies always need to be compared to results of text-critical approaches and their results should not be used to make an identification solely.

Perhaps the most interesting part of the study is the part where researchers test Ramsay's hypothesis that large cities in Anatolia are placed at "road-knots" where several natural roads intersect (2019, 1491). Through a complex topographical

model, the study showed that the number of intersections in the 20 km environment of a city is closely correlated with the size of the city. This study shows the importance of topographical studies for the studies of historical geography of Anatolia.

These two studies demonstrate three important facts about statistical methods in historical geography. First, they are not alternatives to text-critical approaches. The results of these studies are only meaningful when they are compared to results of text-critical approaches. However, they have the potential to support or refute an argument in favor of another. Second, “calculating” locations of toponyms is not a realistic aim. Constructing a relative geography would be more useful and possible aim for a statistical approach. Third, any localization without consideration of the topography can’t provide reliable results.

2.3 Systematic Methodology in Hittite Historical Geography

A systematic methodology is crucial for conducting studies in a standardized, structured, and replicable manner, which is strongly needed for the study of Hittite historical geography. It is characterized by five key features: (1) A well-defined goal, providing a clear focus for the research. (2) A set of procedures, carefully designed to guide the researcher in achieving the goal. (3) A system for collecting data, which includes the selection of appropriate data sources, methods of data collection, and strategies for minimizing bias. This systematic approach to data collection is crucial for the validity and reliability of the study's results. (4) A method or methods for drawing conclusions from the data is employed, employing statistical analysis,

qualitative analysis, or other analytical techniques, depending on the nature of the study. Lastly, a systematic methodology includes (5) a way to present the results of the study effectively. This can be achieved through organizing the findings in a meaningful manner, utilizing appropriate data visualization techniques, and providing clear explanations of the results.

In a field troubled by methodological issues, scarcity and the variety of data which makes it challenging to analyze as a whole, it is vital to employ a systematic approach. In the case of Hittite historical geography, sources are inherently biased. However, this circumstance emphasizes the critical need to conduct a systematic study to prevent further biases from affecting researchers' conclusions.

This section will compare and contrast the methodologies of three recent monographs which employed a systematic study as defined above. These are in chronological order, *"Historical Geography of Anatolia in the Old Assyrian Colony Period"*, *"A Historical Geography of Hittite Heartland"* and *"Geschichte und Geographie Westkleinasiens in der Hethiterzeit"* (Table 1). The purpose is to show how systematic studies on historical geography can be conducted and how different decisions on methodology translate into differences in results.

Study of different regions, periods and sources evoke different research questions and offer different possibilities of research. These differences compel researchers to create their own systematic approaches that would fit their own research questions and data. The three studies examined in this section focus on different regions and/or periods through different sets of sources and questions with occasional coincides.

Max Gander, who works on history of Western Anatolia in LBA, discusses problems of historical geography and history together. This approach allows the researcher to evaluate the implications of historical geography for history. Barjamovic uses topographical analysis and incorporates it in his arguments, simply because his data consists of occurrences of trade centers in economic texts which are often argued to present rational and pragmatic geographical relations. Adam Kryszeń, on the other hand, offers a systematic methodology using text-critical contextual methods only. This is a natural result of the size of his work. Hundreds of toponyms and text requires a detailed and clear analysis. The distinction in the approaches stems from differences in research questions which is shaped by the available evidence. Therefore, a "one-size-fits-all" method and approach cannot be suggested for the study of historical geography.

However similarities of the approaches point to a core structure for text-critical contextual methods. The researchers agreed upon these four main steps: (1) defining and classifying the corpus, (2) constructing clusters, (3) analyzing individual occurrences of toponyms, and (4) constructing a relative geography. While classifying the corpus, Barjamovic divides the texts into two categories: itinerary or not, since itineraries contain more meaningful geographical information. Kryszeń, with a similar motivation, defines five further groups according to their geographical significance. Gander classifies texts based on their genre. The three studies make a first level more general group of toponyms, Barjamovic and Kryszeń further create clusters around major centers. This is necessary as for a systematic study it is crucial to examine available evidence as a whole, and related toponyms together. In order to carry out this comprehensive study, it is essential to cluster toponyms that are more

closely related to each other. While examining the individual toponyms and their occurrences, Barjamovic starts with presenting the number of co-occurrences of the examined toponym with other toponyms. Although he is calling this “presentation” a statistical approach, use of tables and bar-charts are considerably weak to achieve what he intends. Kryszeń has a more strict routine for examining occurrences. This consistency makes his results both more understandable and reliable. The other common feature of the three studies, is that they aim to construct a relative geography and present their results with a diagram showing the relative locations of toponyms to each other. Identifications are not argued or suggested with few exceptions that are widely accepted. Barjamovic, since he also works with physical geography, offers more precise localizations. Kryszeń and Gander offer localizations based on already identified sites and regions. The issue of identifications and localizations will be discussed later in this chapter.Even though, inherently different, these studies share this four-step structure which seems essential for conducting consistent study using contextual methods.

Overall, the comparison reveals two facts. First, the sources and research questions are decisive for the structure of the methodology. It is therefore not possible to conduct a systematic and therefore reliable study without defining the purpose of the research. As obvious as it may sound, this fact is often ignored in the name of identifying or localizing place names that seem "important". Second, the core structure of text-critical approaches stays the same. And in this thesis I’ll demonstrate that these four steps: Defining and classifying a corpus, clustering toponyms, examining individual toponyms, and presenting the results using a graph can all be improved by employing analytical tools of network analysis.

2.4 Conclusion

The study of the historical geography of the Hittites in isolation from their history has presented several challenges. The concentration on locating toponyms on a map has resulted in studies that are both lacking in systematicity and replicability, thus compromising their reliability. There are two key questions that need to be addressed in order to overcome the methodological problems of Hittite historical geography. First, what are the goals of Hittite historical geography within the larger contexts of history and the social sciences? Second, what objectives need to be met to achieve such broad goals: Identification, localization, or construction of a relative geography? Although the answers to these questions may vary depending on the research question, their relevance does not. Therefore, these questions need to be addressed by researchers in the field.

Identifications made in the past have contributed greatly to our understanding of historical geography. However, the most reliable identifications of settlements have come from new discoveries of textual evidence by archaeologists. There are also several identifications accepted by the majority of scholarship that have been supported by the comparative method, but the method has proven to be misleading in many cases. Therefore, the construction of relative geography should be the primary goal of Hittite historical geography. Because it is an achievable goal and also because it has the necessary explanatory power for many historical questions we have. Kryszeń also argues that identification or localization is not possible without further evidence than textual evidence and thus the aim should be reconstruction of relative geography (Kryszeń 2016, 389). Considering the physical geography of Anatolia with textual analysis may help researchers to localize some of the toponyms.

Barjamovic argues that the location of ancient settlements should be dictated by the harsh topography of Anatolia and thus be predictable for major centers, while he still advocates for the reconstruction of relative geography as a main methodological framework (Barjamovic 2011, 68).

Chapter III: Methodology

This thesis presents a statistical approach to analyze the relationships among toponyms in Hittite texts using network analysis tools. In this chapter, the methodology is explained, starting with an introduction to the fundamental concepts of network analysis, as there is a scarcity of prior research in Hittitology utilizing this approach. The subsequent sections cover the construction of a co-occurrence network, analysis methods employed, and the validation of the proposed method through a case study conducted on a modern dataset.

3.1 Fundamentals of Network Analysis

The idea behind network theory is that complex systems can not be understood by examining parts of it in isolation (Siegenfeld and Bar-Yam 2020, 8). Based on this concept, network theory studies the ways the parts of a system interact while concentrating on the system as a whole. Network analysis has been applied to various social sciences to analyze complex social structures (Borgatti et al. 2009, 892). As discussed in Chapter III, the dataset employed in this thesis is a reflection of a complex system of polities, cities, villages, rivers and mountains that are interacting with each other through political, religious, economical and cultural activities. Therefore, examining it through network analysis can provide insights that have been overlooked before. The present study is an attempt to employ network analysis in a novel way by making the first attempt to use co-occurrence networks in a historical geography study. Consequently, it is necessary to explain some of the terminology that the aimed audience may be unfamiliar with.

3.1.1 Network

A *graph* or a *network* is a mathematical structure consisting of *nodes* and *edges*. Nodes represent the components of the system, and edges represent the interactions between them (Newman 2010, 1). For example, in a social network, nodes can represent individuals, and edges can represent their friendships. Edges can have *weights* which indicate the strength or importance of the interaction between the nodes they connect (Newman 2010, 112). Weight is often visualized as the thickness of the edges. The aim of constructing networks is to express the data mathematically. Thus graphs can be analyzed in various ways, including visual analysis, centrality analysis, community analysis and node classification analysis.

3.1.1.1 Co-occurrence Network

A co-occurrence network is a type of network that captures relationships between selected entities based on their co-occurrence patterns in a given text corpus. It represents nodes as entities and edges as co-occurrence relations. Co-occurrence networks are widely used in linguistics and various social sciences to analyze association patterns and discover meaningful relationships between entities (Segev 2021, 5). Co-occurrence network is also used in various researches in Assyriology to understand the relationships of people of ancient Near East (Wagner et al. 2013; Cline and Cline 2015; Maiocchi 2016).

3.1.2 Centrality

Every system has parts that vary in importance. This variation is often reflected in the results and consequences of the system's functioning. For example, in a trade network, certain cities may have significantly more influence than others due to their location, resulting in their growth (Walther 2014, 179). Similarly, in an army, the

importance of a general is not the same as that of a private, as the loss of the former can have more far-reaching consequences. It is crucial to recognize such variations in importance when analyzing and evaluating the functioning of a system. Centrality measures in network analysis allow researchers to measure the importance of a node within the network (Hage and Harary 1995, 57). To be able to measure the importance of a node, one should be able to define the quality of the node that makes it important. The different definitions of importance result in different measures of centrality.

An important node has more connections than others. *Degree centrality* thus measures the importance of a node by simply as the total number of edges (Zhang and Luo 2017, 301). Betweenness centrality also considers the importance of the edges that a node has. In simple terms, betweenness centrality quantifies how often a node acts as a bridge or intermediary in the flow of information or interactions between other nodes in a network (Freeman 1977, 35). Similarly closeness centrality defines being important as being in the center of the network. It calculates a node's distance to each other node lower the distance, a node becomes more important (Zhang and Luo 2017, 301). While all of these measures have their own uses, none of them would suggest a king as an important figure in the social network of a royal court. In such a network, an army commander or a cook would have more connections, be more mediating, and probably be closer to others than a king. A king's importance comes from the quality of his connections. He would know important people who would have more important connections. *Eigenvector centrality* assumes that the importance of a node depends on the importance of its connections. This measure takes into account both the quantity and quality of

connections, emphasizing the significance of being connected to influential nodes in the network. For more detailed explanations of different centrality measures see Newman (2010, 168).

3.1.3 Community Detection

Another common feature of systems is that they form groups or clusters. A village is composed of families that have a higher interconnectivity. In a ceramic assemblage bowls show stronger similarity among themselves and plates do the same. Consequently, network analysis includes detecting these groups or communities as they are referred to in network studies. There are several algorithms that aim to identify communities in a network that are more densely connected to each other than to the rest of the network (Lancichinetti and Fortunato 2009, 1).

Evaluating the communities that are detected is easier than detecting them, just like anything else. Modularity-based algorithms are designed to take advantage of this fact. It is possible to measure the quality of communities in a network using the metric called *modularity*. It is calculated by comparing the number of edges within the communities to the number of edges between the communities (Newman 2010, 373). High modularity indicates strong and distinct communities, whereas low modularity indicates a more homogenous and interconnected network. Community detection algorithms that are used in this study start with assigning each node to its own community. The algorithm evaluates the modularity gain or loss that would occur if a node is moved from its current community to a neighboring community. Eventually it would be moved to the neighboring community that yields the highest increase in modularity. This process is executed for each node iteratively until there is no significant increase in modularity (Blondel et al. 2008).

3.1.4 Visual Analysis and Force-directed Graph Visualization

Visual network analysis is the use of visual representations to gain insight and understand the structure and patterns of networks. There are several different algorithms to calculate positions of nodes based on their relations. In this study a force-directed graph visualization algorithm called Force-Atlas 2 is used (Jacomy et al. 2014). In a force-directed layout nodes that have stronger edges are attracted to each other, while nodes with weaker edges repel each other. The algorithms are based on the concept of simulating a physical system where nodes act as particles and edges act as springs or forces. Since it was assumed that frequently co-occurring toponyms are geographically closer to each other than toponyms that do not, a force-directed algorithm is the best choice for visualizing the network.

3.3 Methodology

The methodology put forward comprises three primary steps. The initial step involves constructing a co-occurrence network. The second step is providing a preliminary analysis that will be referenced for more detailed examination. Subsequently, the final step entails compiling and contrasting the arguments about the geographic location of a toponym to the results of statistical analysis merging existing methods with the proposed one. Chapter IV describes the process of the first and second step, while Chapter VI demonstrates the practical implementation of the third step.

3.3.1 Construction of a Co-occurrence Network

3.3.1.1 Text Selection

The first task to be completed is to decide on the corpus which will be used to construct the network. The selection depends on the research question. Entities relate to each other in different contexts. This thesis focuses on geographical relations, however the same methodology can be used to understand different kinds of relations between Hittite toponyms, such as religious influence areas of cult centers. Therefore, text selection is unique to the research question.

Not all texts provide the same information about the geographic location of places. Also, the geographic value of a text varies for different toponyms. One text may be crucial for understanding the location of one toponym, while the same texts may be misleading for locating another. Different researchers select texts to analyze according to their own criteria. Such selections are typically made by analyzing each text and its context individually. But one of the strengths to analyze the whole corpus is that it shows the common pattern that all occurrences show, rather than relying on one text alone. However, it is also true that some texts contain toponyms that are not geographically related in any way. Thus, it is possible to improve the ability of the final network to show geographic relationships by text selection. Consequently, a selection of texts can be made either categorically or quantitatively. Both categorical and quantitative selection of texts can be useful, depending on the research questions and the nature of the corpus. For an example of categorical selection, see 3.4.1 and 4.1.1; for an example of quantitative selection, see 4.1.2.

3.3.1.2 Toponym Selection

After selecting the corpus, the next step is to decide on a list of nodes or entities in which the research question of the study aims to understand the relations between them. For this study, the goal is to understand the geographical relations of toponyms, so only toponyms were included in the network and not other entities. This in itself is a kind of entity selection that is categorical. However, a further selection among the toponyms may contribute to increase the ability of the network to provide insight into historical geography.

There are two points to consider when selecting toponyms. The first is whether the toponym has a meaningful range of relationships within the network. The only thing that can be said about a toponym that is mentioned only once is that it has a relationship with other toponyms with which it is mentioned. Such analysis would be misleading because of the limited data set. The opposite is also true, a toponym that is related to every other toponym in the network will not contribute to the network's power to explain geographical relations. The second issue is whether a toponym actually refers to a geographical location or not. Toponyms are not always used to refer to a geographical location, but sometimes to refer to another entity that is somehow related to that location such as a deity, a polity, an institution. For examples of toponym selection see 3.4.1 and 4.2.

3.3.1.3 Defining Co-occurrence

In a co-occurrence network, an edge indicates that two nodes connected by it co-occur. However, different variations of co-occurrence can be used. The definition must be based on the nature of the corpus. In a corpus of letters, it is more logical to assume a relationship between two entities if they co-occur on the same text, while in

a corpus of historical documents that narrate events over a long period of time, in-text proximity should be considered. For the network of Turkish provinces, units of co-occurrence are defined as individual texts, as the corpus is composed of short texts, while for the Hittite toponym network a co-occurrence is defined in the scale of fragments.

3.3.2 Initial Analysis

3.3.2.4 Force-directed Visualization

Visualization is the tool that best reflects the power of the network to explain geographical relationships. The Force-directed visualization algorithm used in this study, Force Atlas 2, simulates a physical environment in which toponyms that are related to each other exert a gravitational force on each other, while toponyms that are not related to each other or are relatively weakly related repel each other. When the system stabilizes after enough iterations, the result is a manifestation of the geographical information that the network possesses. The two examples in this study demonstrate the success of this method in illustrating a relative geography, see 3.4.2.1, 4.4 and 4.5.

However, like any analytical tool, it has its flaws and biases. Therefore, the relative positions suggested by this method can only be meaningful when compared to both the text-critical method and other statistical methods. As discussed earlier it is not possible to filter out geographical relations only within a textual corpus. The constructed network also shows cultural and political proximity.

Another bias is the centrality bias. It does not mean that every toponym with a high centrality is located in the center of the explored area. However, nodes with a central position in the network may appear closer to the center of the visualized graph. Likewise, a toponym located in the geographical center of the researched area but with low centrality within the network will be pushed to the margins.

3.3.2.5 Centrality Analysis

The calculation of centrality measures for the constructed network is one of the essential analyses of the network. While it does not directly contribute to the understanding of the geographic relationship, it is useful to understand the role of the toponym within the system. In this study, degree, betweenness, and eigenvector centrality are often used and compared to detect possible biases regarding the position of the toponym in the force-directed graph.

3.3.3 Integrating Text-critical and Statistical Approaches

Throughout the thesis, a consistent emphasis has been placed on the need for diverse and complementary methods in Hittite historical geography due to the limitations of available sources. Furthermore, it is suggested that the integration of these methods should follow a hierarchical approach. As discussed earlier, without text-critical evidence, reliance on the philological method alone can be misleading. However, when text-critical evidence points to potential identifications within a given environment, the comparative method can be used to enhance our understanding.

The same principle applies to the integration of the statistical method with text-critical and philological methods. The structured approach, in which the arguments generated by text-critical analysis are compared with the results of the statistical approach, would yield the best results. When the statistical analysis aligns with the text-critical argument, it not only strengthens the overall argument but also validates the quantitative method as an independent and valuable approach. On the other hand, if inconsistencies arise between the two analyses, it prompts a deeper examination of the differences and highlights the importance of considering both qualitative and quantitative perspectives in the study of Hittite historical geography. This examination may uncover overlooked relationships between toponyms or reveal potential biases in the results of the statistical analysis. Through this comprehensive contextual analysis, a relative geography can be constructed. The comparative method can then be used to gain further insights. This integrative framework is an ideal approach, provided that there is sufficient textual evidence for the region or toponym under study. However, the research question and the toponym in question may dictate a different structure to be followed.

3.4 A Modern Example of a Co-occurrence Network of Toponyms

This section introduces the fundamental concepts of network analysis through an example study, with the aim of improving the readers' understanding of the methodology and demonstrating the capabilities of the approach. In order to achieve this, a database of 30,000 news articles that are available on the Internet was used[3]. A co-occurrence network of Turkish provinces was constructed then analyzed. The

[3] The news articles were collected from www.cnnturk.com, which were published between November 2020 and December 2022. Access to the database is at github.com/makman12/TurkishProvincesInNews.

results that will be demonstrated in this section show that inherently non-geographical texts can yield geographically meaningful results when analyzed in numbers. Needless to say the example study can only be a proof for the potential of the approach. Hittite textual records can not be compared to a corpus of modern news articles and analysis of eighty one toponyms can not be compared to analysis of the hundreds. The purpose was to experiment with a smaller co-occurrence network of toponyms with known locations. In that regard, example study was successful to show possible problems and solutions.

3.4.1 Construction of the Network

For each one of the 81 provinces of Turkey a node was created. Two provinces were linked if they co-occur in the same article. The weight of the edges was determined by the number of times two toponyms were mentioned together divided by two rounded down. The purpose was to eliminate weak connections and consider relations that at least two times occurred. The initial configuration of the network resulted in a "hairball network", a term used to describe networks that are overly complex and convoluted. Hairball networks typically have a high concentration of connections between nodes, making comprehension and navigation difficult.

The analysis of the initial network revealed two reasons for its densely connected structure. First, it was identified that some articles mentioned a large number of provinces unrelated to each other. At a closer look, it appeared that these are mostly forecast news. This “genre” of texts was then removed from the analysis. Second, it was understood that excessive connectivity in the network, particularly due to the presence of metropolises: İstanbul, Ankara, and İzmir. These cities were virtually connected to every other province in the network and didn’t provide any meaningful

insights apart from the fact that they have high centrality. Consequently these provinces were removed from the network.

The insights gained in this step is applicable to the Hittite toponym network. Some of the genres may distort the results and some toponyms may not be relevant to the study because they are too central such as Ḫatti or Ḫattuša.

3.4.2 Analysis of the Network

The proposed analysis consists of three main components: visual analysis, community detection, and centrality analysis. These analyses were conducted and their results were evaluated in terms of their alignment with expectations. It is hoped that visual analysis will provide a sense of relative geography. The purpose of applying community detection algorithms is to identify groups of neighboring places, thereby contributing a relative understanding of the geography of the regions. The expectation of conducting centrality analysis is to determine the relative importance of a given location. The surprising accuracy of the results indicates that when the data is large enough, analysis of non-geographical texts can yield geographical insights.

3.4.2.1 Visual Analysis and Community Detection

The network was analyzed using the community detection algorithm developed by Blondel et al. (2008). The analysis revealed a total of 12 communities, which are illustrated in Figure 1 using different colors. Visualizing the network based on the geographical coordinates of the cities in Figure 2 shows that the detected communities are composed of neighboring cities and geographically meaningful

except in some cases. On the other hand some communities also show demographic similarities. Southern eastern provinces that have high Kurdish populations are in the same community. Western parts of the country are composed of smaller, more intra-connected communities.

3.4.2.2 Centrality Analysis

The results show that the eigenvector centrality of cities correlated with their population. The correlation can be demonstrated statistically with the Pearson correlation coefficient (PCC) which is a measure of the linear relationship between two variables (VanPool and Leonard 2010, 224). The PCC of 0.7622 indicates a strong positive relationship between eigenvector centrality in the constructed network and the population of Turkish cities according to Turkish Statistical Institute's data ("TÜİK - Veri Portalı" 2023). This means that as the centrality of a city increases, its population is likely to increase as well. The p-value of $5.237\ e^{-16}$ indicates that this relationship is statistically significant, and is unlikely to have occurred by coincidence. This suggests that eigenvector centrality is a strong predictor of population in the network of Turkish cities.

Figure 3 illustrates that Aydın and Ordu are clear outliers, with higher centrality (or lower population) than expected. This is likely due to the phenomenon of homonymy, where Aydın is a common surname meaning "intellectual" in Turkish, and Ordu means "army" in Turkish. The cities of Hakkari and Diyarbakır are notable outliers in the data probably due to ongoing political instability in the southeastern region of Turkey which makes them appear on news more frequently than their population would otherwise suggest.

3.4.3 Results

The example study demonstrated the potential of a co-occurrence network of toponyms. It was found that frequently recurrent toponyms, such as Hatti, Hattusa, and Arinna, may lead to excessive connectivity in the network of Hittite toponyms. Excluding these toponyms from the network could enhance comprehensibility and ease of analysis. Furthermore, it was observed that certain types of texts that include a large number of toponyms can complicate the network, making it more complex and challenging to analyze.

Chapter IV: A Network Analysis Approach to the Relative Geography of Hittite Anatolia

In this section, a co-occurrence network of Hittite toponyms is constructed and analyzed with the aim of presenting a general relative geography similar to the given modern example in 3.4. The primary objective is to determine the positions of each toponym in a Cartesian coordinate system through network analysis.

In the network, each toponym included in the study is represented as a node, and each pair shares an edge that weights the number of times two toponyms occur on the same fragment. Thus, in the final representation, two frequently occurring toponyms are assumed to be geographically close to each other. The definition of co-occurrence chosen for this study is not the only one possible. A co-occurrence can be defined as occurring in the same line, in the same texts, or in the same CTH number. However, previous experiments have shown that defining co-occurrences based on fragments provides the most geographically meaningful networks.

In order to construct the largest possible scale of relative geography, it is necessary to filter the initial data. As discussed in 3.3.1.1 text selection is a fundamental step in the analysis as toponym selection is. After these selections, the network is visualized using a force-directed algorithm. The x,y coordinates of nodes in the graph are used to construct a relative geography. The results are compared on two different levels. First, its ability to show the cardinal positions of toponyms relative to the Hittite

capital is tested. Second, its ability to construct regional relative geography diagrams with toponyms in the heartland is tested and compared with the results of Kryszeń (2016, 392).

4.1 Defining Co-occurrences

The nodes in the co-occurrence network of Hittite toponyms are defined as toponyms. However, defining co-occurrence is not so straightforward. Co-occurrence can be described as the presence of two or more toponyms sharing the same CTH number, same text, same fragment, or the same line. A combination of these can also be used. Defining co-occurrence based on texts is ideal, but not possible because HiTop only refers to attestations on fragments, and joins of fragments are not available as a database. As a result, co-occurrence was defined based on fragments.

4.2 Text Selection

The need for text selection based on research questions is discussed in detail in 3.3.1.1. The current network is constructed to reflect geographic relationships as much as possible, so text selection aims to filter out a part of the corpus that doesn't contribute to this goal. Analyzing each of the 5,231 fragments individually to determine their geographic value is not an option due to the immense scale of work involved, which falls outside the scope of this research. However, adopting such an approach would introduce an inherent bias from the outset, compromising the overall reliability of the study's findings. Consequently selection can be either categorical or quantitative.

4.2.2 Categorical Selection

Although fragments can be categorized according to their various qualities such as shape, findspot, chronology, the only categorization that seems to potentially improve the final results is genre. Determining the genre of Hittite texts is a challenge in itself, and the process generates its own methodological problems, since one can only categorize texts according to one's own understanding of texts and one's own modern concepts of genre. The closest attempt at genre identification is the categorization of texts in CTH (Košak et al. 2022).

For this study, I experimented with all possible combinations of CTH categories, expecting that one combination would produce a network that was comparatively more capable of revealing geographical relationships. Selecting texts based on CTH categories did not yield tangible improvements than networks that included all texts. In fact, this result was to some extent expected, since removing large "genres" such as historical texts or festival texts and cults drastically reduces the number of fragments. For a method whose reliability depends heavily on the size of the data it processes, such a loss of data inevitably leads to worse results. On the other hand, removing a smaller group of texts doesn’t affect the overall capability of the network to provide geographical insights. Categorical selection may work if texts are categorized according to their geographical value. However, this would be a biased interpretation, since there is no consensus on which texts are more geographically valuable or not.

4.2.2 Quantitative Selection

Quantitative selection of texts is filtering out outliers (z-score > 3) among the fragments according to some feature of a fragment. One of these features could be

the number of unique names a fragment contains. The mean number of unique names attested on the fragments is 5.8 and standard deviation is 8.82. So removing outliers means to remove any fragment that has more than 33 unique place names (Figure 4). While this filtration does improve the results, the filtration is solely based on numbers of connections that a fragment creates rather than quality of the relations.

Alternatively a network of fragments can be constructed with a similar approach to the main network. However this time nodes are defined fragments and two fragments are connected when they have a common toponym (Figure 5). Centrality analysis of the resulting network shows that fragments that include a large number of toponyms that are geographically unrelated have relatively high eigenvector centrality. 27 fragments[4] have a z-score above 3 and are outliers. These 27 fragments include 8 out of 14[5] fragments that have more than 33 unique names. The remaining 13 fragments are outliers based on eigenvector centrality, despite having fewer than 33 names. For example, KUB 24.4 (CTH 376: Hymns and prayers to the sun goddess of Arinna) contains only 14 different names, but these names are very frequent[6]. Another example is KUB 19.9 (CTH 83 Report of Ḫattušili III. about the campaigns of Šuppiluliuma I.) Although it contains only 15 names, the relationships of these names cannot be considered geographical[7].

Fragments that are outliers according to the number of names they contain are excluded from the analysis, preventing them from creating their own centers of

[4] Bo 86/299,KBo 1.1,KBo 1.4,KBo 10.12,KBo 22.39,KBo 3.1,KBo 3.46,KBo 3.6,KBo 4.10,KBo 4.13,KBo 4.4,KBo 5.3,KBo 5.6,KBo 5.8,KBo 6.28,KUB 1.1,KUB 14.13,KUB 14.17,KUB 15.34,KUB 19.20,KUB 19.50,KUB 19.9,KUB 21.1,KUB 24.4,KUB 36.90,KUB 6.45,KUB 6.46.
[5] Excluded fragments are: KUB 26.43, HT 2, KUB 26.50, KBo 3.4, KBo 70.109, VBoT 68
[6] Arawanna, Arinna, Arzawa, Ḫalap, Ḫatti, Ḫurri, Kalašma, Karduniaš, Kaška, Kizzuwatna, Lukka, Mitanni, Pitaššša, Zippalanda.
[7] Amurru, Ḫalap, Ḫiššašḫapa, Ḫurri, Irrita, Išḫupitta, Kargamiš, Kaška, Kinza, Mala, Mizri, Pitaššša, Šutu, Wištawanda, Zuliya.

gravity within the network. For example, a place name that is associated with 60 different names gains relative importance in the network because it has 59 different links. Excluding these tablets from the analysis solves this problem. On the other hand, the names mentioned in tablets that are outliers according to eigenvector centrality mostly refer to gods or polities. Identifying these fragments and excluding them from the analysis increases the power of the network to show the geographical relationships of place names. As a result, a total of 33 fragments were removed from the further process of analysis.

4.3 Toponym Selection

Given that the purpose of this network is to understand the geographical relationships between places, toponyms that often do not refer to a geographical location should also be excluded from the analysis. As with the texts, this filtration can be done categorically or quantitatively. For this selection it seems that the best fit is to use a combination of both methods. For discussion on toponym selection see 3.3.1.2.

Removing the following three categories of names from the analysis will increase the network's ability to provide geographic information: (1) Outlier hubs, (2) Sacred Cities, (3) Foreign toponyms. The quantitative measures would help to identify toponyms that limit the network's aimed ability that fit one of these three categories. 36 toponyms that have 3 or higher z-score of Eigenvector centrality in the unfiltered initial network. 18 of them can be assigned one the three categories these are: Ḫatti, Ḫattuša, Arinna, Nerik, Zippalanda, Ḫalap, Šamuḫa, Ḫurma, Mizri, Alašiya,

Ḫanigalbat, Amurru, Aššur, Niniwa, Karduniaš, Agade, Ḫurri, Mitanni. Consequently these toponyms are removed before further analysis.

4.4 Construction of the Final Network

After selection of texts and toponyms that will be incorporated into the final analysis, a co-occurrence network of Hittite toponyms has been constructed. In 1303 fragments 1705 toponyms have occurred. Toponym pairs that occurred on the same fragment were connected. There are a total of 17737 edges in the constructed network. Average path length in the network is 3.08 which means that, on average, it takes 3.08 steps to reach one toponym from another within the network. 19 communities were detected with a modularity score of 0.584 which indicates that detected communities are statistically significant and distinct within the network of Hittite toponyms. After the filtration of the most central nodes from the network, the following toponyms have emerged as the top five in terms of eigenvector centrality: Arzawa, Kaška, Ankuwa, Kargamiš, and Ḫupišna (Figure 6).

4.5 Visualization

The software Gephi has several options for visualizing the network. In this study Force Atlas 2 layout has been used. In parallel to the Tobler’s First Law of Geography, it is expected that two toponyms that frequently co-occur are more close to each other than two toponyms that rarely co-occur. Tobler's First Law of Geography, often summarized as "everything is related to everything else, but near things are more related than distant things," suggests that geographic proximity plays a crucial role in the relationships and interactions between locations (W. R. Tobler

1970, 234). Therefore a force-directed layout has been preferred. X and Y coordinates for each node were calculated using Force Atlas 2 and normalized between 0-1 to be used in further analysis (Jacomy et al. 2014). The only adjustment made to the layout was the orientation of the network. Since the network does not exhibit any inherent directional properties, the positions of the nodes were rotated to ensure that Kizzuwatna would be positioned in the south and Arzawa in the west. This rotation was purely for convenience and did not affect the underlying structure or relationships within the network. By aligning Kizzuwatna with the south and Arzawa with the west, it provides a consistent frame of reference for interpreting the positions of other toponyms in relation to these key nodes. In the graph, X positions of the nodes are shown, colors indicate communities and node size indicates eigenvector centrality.

4.6 North, East, South and West of Hatti

In order to test the network's capability to provide geographical relations between toponyms, four lists of toponyms have been collected for each cardinal direction. The results show that while northern and western places are clearly clustered, eastern and southern places are more sparsely located. However, the positions determined by Force Atlas 2 for major centers seem to be parallel with current understanding of Hittite historical geography apart from two important center: Tarḫuntašša and Kargamiš. In Figure 7, these clusters are shown with ellipses that are centered in mean X and Y coordinates. The diameters of the ellipses show the standard deviation.

4.7 Relative Geography: Heartland

To assess the accuracy of the network, two regions were selected for analysis and the results compared to current understanding. A relative geography diagram was created for a predefined subset of toponyms.In the heartland region, the major centers identified by Adam Kryszeń were used as reference points. Kryszeń's work includes a diagram illustrating the relative geography of these centers, allowing for a comparison between the network's results and his findings. By comparing the network's determined locations of toponyms with Kryszeń's established centers and relative geography diagram, it becomes possible to evaluate the level of accuracy and agreement between the network analysis and the existing knowledge presented by Kryszeń.

Figure 8 was created by preserving the relative positions of the toponyms within the main network. To construct this diagram, two edges were drawn from each toponym connecting it to the closest neighboring toponyms. By preserving the relative positions of toponyms from the main network, Figure 8 provides a simplified representation that emphasizes the immediate connections and proximity between toponyms.

Figure 9, originally created by Adam Kryszeń, uses text-critical contextual methods outlined in Chapter II (392) of his work. This diagram provides an overview of the geographical relationships between the major centers in the Hittite heartland. A comparison of diagram X with the network diagram reveals a general parallelism between the two. The spatial arrangements and connections depicted in both

diagrams are closely aligned, indicating a consistency in their depiction of geographic relationships within the Hittite heartland.

It is important to note that in the diagram constructed using network analysis, the central position of a toponym not only indicates its geographic location, but also reflects its overall importance within the network. Therefore, the general direction or orientation of the toponyms is a more reliable indicator of their relative positions. For example, in the network analysis diagram, Durmitta appears much closer to the center than in Adam Kryszeń's interpretation. However, both diagrams agree on the northwest direction of Durmitta. This suggests that while the exact placement may differ, the general understanding of Durmitta's location relative to the center (Hattusa) is consistent between the two approaches. Similarly, Šapinuwa is positioned more centrally. Despite this difference, both diagrams agree on the northeastern location of Šapinuwa. This suggests that although the exact placement varies, the overall understanding of Šapinuwa's position relative to other toponyms is accurate. By considering the general direction and orientation of toponyms, we can gain meaningful insights into their relative positions and relationships within the network.

The apparent differences of two diagrams are mostly because of the misleading nature of the diagrams. For example, Kryszeń only suggest a eastern location for Kartapaḫa but diagram seems to suggest a southern location which is not the case (285). Nevertheless there are at least two contradicting suggestions between two re-construction: Ankuwa and Tawiniya both are difficult to locate based on contextual evidence.

4.8 Conclusion

This section presented a rough relative geography of the Hittite Empire using a statistical approach strictly based on network analysis to clarify the potential strengths and weaknesses of the proposed method. Such an isolating approach is normally not preferable as it only presents a single aspect of available evidence and its results will greatly improve when it is used in combination with other methods. . The present study here shows that network analysis can be used in three out of four fundamental steps of a systematic methodology: (1) text selection, (2) toponym clustering, (3) presenting a relative geography. The following chapter will take Durmitta as a case study to demonstrate how a network analysis approach can be integrated with other statistical approaches and more importantly with text-critical approaches which is one of the fundamental steps of a systematic methodology as discussed in section 2.5.

The accuracy of any statistical study in any field is determined by the amount of data analyzed. This fact is also evident in this case. The level of accuracy shown in the heartland of the Hittite Empire cannot be replicated for a peripheral region. When the same method used to construct the relative geography of the heartland is applied to the west (Figure 10), the results do not agree with the current understanding. It should be remembered that the current understanding did not emerge from contextual text-critical analysis, as it provides only limited insights. The main source of reconstruction for the region has always depended on the comparative philological method (Gander 2022, 17). As already emphasized in this thesis, the methods of

Hittite historical geography differ considerably for different regions, since the available data are not evenly distributed. Therefore, a solution based on network analysis cannot be offered that will help locating every single toponym.

Chapter V: Locating DurmittaThrough Integrated Analysis

5.1 Background

Durmitta, referred to as Durḫumit in Old Assyrian sources , occupied a prominent position as a center of economic, religious, and political significance throughout the Middle and Late Bronze Ages. In the Old Assyrian period (also called the *karum* period), Durmitta held a pivotal role in the copper trade, and there are indications that the region may have contained a salt source as well (Barjamovic 2011, 242; Erkut 1990, 3). The city also had a significant religious tradition, which included the cult of Telipinu (Corti 2017, 232). Beyond its economic and religious prominence, Durmitta played a substantial political and military role in the conflicts between the Kaška people and the Hittite state (Kryszeń 2016, 347).

The location of Durmitta, an influential center of economic, religious, and political importance, has fundamental historical implications. A proper understanding of the location and extent of Durmitta can lead to a better understanding of the geographic extent and structure of the Old Assyrian trade network in Anatolia. By identifying Durmitta's location, scholars can gain insight into the trade routes, connections, and economic activities that occurred within this ancient network. Secondly, a good grasp of the location of Durmitta is essential to our understanding of the relationship between the Hittite Empire and the Kaška people, and can shed light not only on their interactions and the extent of their geographical spread, but also on the political dynamics, cultural exchanges, and potential conflicts in the region during this period. Finally, since the Durmitta was a site of frequent conflict and military activity , its

location and extent are important factors for the study of the territorial structure of the Hittite Empire.

Durḫumit occurs more than 220 Old Assyrian texts (Barjamovic 2011, 242). However, the texts available do not provide information about the location of Durmitta (de Martino 2017, 253). In Hittite texts, it appears a total of 80 times in 56 different texts. This frequency ranks it as the 33rd most frequently mentioned toponym, making it an ideal candidate for statistical analysis. Even though the city is one of the best attested toponyms in the Hittite corpus, and the occurrences are evenly spread across major literary genres (Figure 11), there are no festival itineraries that mention Durmitta (Kryszeń 2016, 348). The fact that Durmitta is mentioned both as a town and a region further complicates its localization (Figure 12).

5.2 Existing Localizations and Identifications

Due to its significant historical implications and the conflicting nature of textual evidence regarding its location, Durmitta has emerged as one of the most controversial toponyms in Hittite historical geography. The scholarly consensus regarding the location of Durmitta has shifted, favoring a western placement within the Hittite heartland rather than the previously proposed northeastern position. This change in location is primarily due to a reassessment of the geographical boundaries of the Kaškaean territory[8]. Earlier assumptions that placed the Kaška to the east

[8] Discussed in Kryszen 2016, 345

influenced earlier tendencies to place Durmitta in the same region. Barjamovic's localization of Durmitta around Amasya stands as an exception to this consensus (2011, 242–67). Determining the location of Durmitta and its associated land along the north-south axis presents a more challenging picture, as researchers have made divergent suggestions ranging from Tosya in the north to Tuz Gölü (Salt Lake) in the south.

Some of the suggestions for localization and identification that are still relevant are (Map 1):

1. Around Çankırı (Forlanini 1977)
2. Karakeçili (Forlanini 2009)
3. Tosya / İskilip (Matthews Glatz 2009)
4. Merzifon (Barjamovic,2011)
5. Between Çankırı and İskilip (Kryszeń, 2016)
6. Town Kızılırmak (Corti, 2017)
7. North of Tuz Gölü, South of Kızılırmak (de Martino, 2017)

5.3 Key Texts and Scholarly Debates on the Location of Durmitta

Although there are fifty-six different texts that refer to Durmitta, only a limited subset provide insight into its possible location. Given the scope of this research, this section will primarily examine the key texts that scholars have consistently referred to in support of their respective localizations and identifications of Durmitta.

5.3.1 CTH 61: Annals of Muršili II

In the Ten-Year Annals of Mursili II, KBo 3.4, Mursili describes rebellions of the Kaskeans who became hostile against him. “The Kaškaeans of the land of Durmitta turned hostile against me, and the Kaškeans came to battle against me and they began to attack the land of Durmitta. I, My Sun, went and attacked Ḫalila and Duddušga which were two main Kaškaean districts” (Kryszeń 2016, 348). This fragment has contributed to the view that Durmitta placed in the borderland and was frequently targeted by the Kaškaens in various attacks. (Kryszeń, 349; Barjamovic, 245).

In the Comprehensive Annals, KBo 14.20+ i 9-12, there is a passage that offers a directional indication regarding the location of Durmitta in relation to the Hittite capital.

KBo 14.20+ i 9-12[9]:
9. [... from (the town of) …] and (the town of) Ḫakpiš towards the country of Tuḫmutaru.
10. [and the country of …; from (the town of) …] towards the country of Ḫuršamma and the country of Tuḫmiyara;
11. [from (the town of) … towards the country of …]mu; from (the town of) Durmitta towards the country of Durmitta’s
12. [(town of) …] and the towards the Dahara valley of the country Tapapanuwa.

One interpretation identifies the land of Tapapanuwa and the river Dahara as landmarks situated in the direction leading towards the town of Durmitta from

[9] Translation of Houwink ten Cate (1966, 178)

Ḫattuša (Kryszeń 2016, 351). There is also a different interpretation of the same text that suggests the enemy went to Tapapanuwa and the river Dahara from Durmitta (Forlanini 2009, 57; de Martino 2017, 253).

5.3.2 CTH 529.7: KUB 48.105 + KBo 12.53

The text describes the procedure that the great king took to restart the production of cult supplies in different towns spread over four districts: Wašḫaniya, Durmitta, Kaššiya, and Tapikka (Cammarosano 2018, 271). It has been suggested that both the districts (Wašḫaniya, Durmitta, Kaššiya, and Tapikka) and the towns named under district of Durmitta are ordered geographically (Forlanini 2009, 49–56). For 'district' of Durmitta (KUR ^{URU}Dur-mi-it-ta) seventeen towns are, of which nine names were preserved, in the following order: Liššina, Nenašša, Uwalma, Tinizidašša, Pitaniyašša, Malitaškuriya, Kalašmitta, Tamettaya, Durmitta.

Based on this text t researchers proposed a southern location for Durmitta (Klengel and Archi 1980), because Nenašša and Walma, which appear on this text under the district of Durmitta, , are known to be situated south of the Hittite heartland according to Old Assyrian and Old Kingdom sources (Barjamovic 2011, 327–37). The fact that these places are listed under the district of Durmitta has led Forlanini to suggest placing Durmitta in the southern region (Forlanini 2009, 51). However, as the remaining textual evidence points to a northern position for Durmitta, it has also been suggested that Nenašša and Walma could be homonyms and refer to different settlements in the north (Barjamovic 2011, 256).

5.3.3 CTH 81: Apology of Ḫattušili III

The Apology describes yet another Kaška attack located in Durmitta. The enemy of Durmitta attacked Tuḫuppiya and had reached Ippašana and Šuwatara (Kryszeń 2016, 351). The later two toponyms are only mentioned in this excerpt. Perhaps a variation of Ippašana, Uppašana is mentioned in CTH 106 and was likely located in the Tarḫuntašša frontier (Forlanini 2009, 56), which would support a southern location

However, Durmitta is also mentioned in another part of the Apology, where Ḫattušili III lists ravaged (*dannatta*-) regions that his brother gave him to rule when he made him king of Ḫakmiš (Otten and others 1981, 14). These are Išḫupitta, Marišta, Ḫiššašḫapa, Katapa, Ḫanḫana, Taraḫna, Ḫattena, Durmitta, Pala, Tummanna, Kaššiya, Šappa, and the Ḫulana river land. These locations support a northern location.

5.3.4 CTH 381: Prayer of Muwattalli II to the assembly of gods

Since its initial transliteration, the text in question has attracted considerable attention in the field of Hittite historical geography. In fact, the inclusion of 140 deities from 83 different locations has led to the assumption that the arrangement of these locations has some geographical significance (Singer 1996, 172). However, the exact motivation behind the ordering of these locations has yet to be fully understood and remains an ongoing challenge for researchers in the field.

In the list Durmitta is placed after Liḫzina and before Nenašša[10] (Singer 1996, 14). Scholars have put forth the proposition that the ordering of the mentioned places

[10]II 10-14

supports the notion of a close geographical proximity between Nenašša and Durmitta (de Martino 2017, 254). Consequently, this line of reasoning suggests that Durmitta should be positioned in the southwestern region of the Hittite heartland.

5.4. Analysis

5.4.1 Centrality of Durmitta in the Network

The centrality measures of Durmitta within the network of Hittite toponyms consistently indicate its central position. In terms of eigenvector centrality, Durmitta ranks 11th among a total of 1,705 toponyms within the network even though it is the 33rd among the most mentioned toponyms (Figure 13). While the frequent occurrence of Durmitta in texts could be attributed to the conflict in the region, its higher eigenvector centrality relative to its degree and betweenness centrality suggests that its centrality is primarily driven by its connections to other important toponyms in the network. This implies that Durmitta's significance goes beyond its frequent mentions, indicating its crucial position within the broader network rather than being confined to an obscure corner of the empire.

5.4.1 Durmitta’s Position and Neighbors in the Network

Durmitta's position within the network of Hittite toponyms, as presented in the preceding chapter, offers valuable insights into its relative location within the empire. Durmitta is situated in the northwest region of the network (Figure 14). The neighboring toponyms of Durmitta, those that frequently co-occur with it, are primarily concentrated in the northern part of the network. The positions in the network supports Adam Kryszeń’s interpretation of attack of the Kaška discussed

under section 3.1 in this chapter. Both Tapapanuwa and Daḫara are located northwest of Durmitta relative to the center of the network. (Figure 15).

However, the placement of Durmitta in the network may be subject to two potential biases. Firstly, the close relationship of Durmitta with the Kaškaeans could lead to an overemphasis on its northern position. Although it is recognized that the Kaška are associated with events in the northern regions, the extent of their influence in the south and west, as well as the nature of the term "Kaška" itself, remain the subject of ongoing scholarly debate[11]. In this context, it becomes crucial to consider the location of Durmitta without succumbing to circular reasoning driven by the northern bias. Another possible bias arises from Durmitta's role as a highly central node within the network, evident from its eigenvector centrality score of 0.588, ranking it 11th among all toponyms. This centrality may create an illusion of Durmitta being closer to the network's center than its actual position suggests. Taking these biases into account is essential to avoid drawing inaccurate conclusions and to maintain an objective analysis of Durmitta's location within the Hittite toponymic network.

5.4.1.1 North-South Axis

Due to the nature of the data analyzed, proximity reflects not only geographical proximity but also cultural and political proximity. In the network of modern Turkey's provinces presented in Chapter III, it was argued that provinces with close ties to each other are not only shaped by their geographical proximity but also by a variety of cultural similarities. This might also be the case for Durmitta. In the whole

[11] According to Gerçek, the term "Kaška" used in Hittite sources was merely a social designation used to refer to political opponents, without any real ethnic or linguistic connection (2012, 343). See also discussion of Kaška frontier by Zimansky (2007, 157–73).

network Durmitta seems well connected to the northern provinces. Figure 16, shows Ḫakmiš and Durmitta share a great portion of their neighbors. While a southern town Tuwanuwa, shares much less with Durmitta (Figure 17).

5.4.1.2 West-East Axis

Durmitta's position in the network along the West-East axis provides valuable information about its location. In line with most text-critical arguments, network analysis supports the notion that Durmitta is situated in the western region. Figure 18 and 19 illustrate the relationships between Durmitta, Pala, and Tapikka. It is evident that Durmitta shares a larger sphere of influence with Pala compared to Tapikka. Although the first bias mentioned earlier does not apply to Durmitta's western location, the centrality bias remains relevant to its position along the West-East axis. It is possible that Durmitta appears closer to the center in the network than its actual physical location.

5.4.2 Geographical Understanding of Toponym Sequences

It is possible to perform statistical tests to determine whether the place names in a given text exhibit a geographical ordering based on given locations in the network. By comparing the average distances between consecutive place names in the text with the average distances observed in randomly ordered sequences, it is possible to assess whether the original ordering shows a significantly shorter distance.

For KUB 48.105 + KBo 12.53, the original order has z-score of -2.3 which indicates that while the order is geographical to a certain extent %2 of random orders have smaller mean distance (Figure 20). Positions in the network loosely align with the

idea that four ‘districts’ are in a direction from south to north. Durmitta seems to be an exception to that might be because of the centrality bias (Figure 21).

Average mean distance of CTH 381 has a z-score of -4.28 which shows that original order has substantially lower mean distance when compared to random orders (Figure 22). Therefore the text does provide further support for already discussed relation between Liḫzina - Durmitta - Nenašša.

5.4.3 Homonymy of Nenašša and Walma

In the network of Hittite toponyms, Nenašša seems to refer to a single city as neighbors of Nenašša are well connected (Figure 23). The relation between Durmitta and Nenašša is also secure as they co-occur in four different texts[12]. Figure 24, shows vectors that are drawn from the center of the network to each gravitational center of fragments that mention Nenašša. There are only four fragments that suggest a northern location for Nenašša as KUB 48.105 one of them which shows a strong pull to NW. The other fragment that shows a notable northern pull is KUB 26.2 which is a list of LÚ.AGRIG administrators that also mentions Durmitta.

Walma is known to be a homonym and refers to two different cities, one in the south that is mentioned in the Old Assyrian and Old Kingdom texts and one in the West. The homonymity is apparent in its fragments' vectorial representation (Figure 25). Figure 26 shows how different fragments of two Walma are separated. However there seems to be no evidence to suggest a third Walma in the north of Hittite heartland as proposed by Kryszeń (2016, 381).

[12] CTH 8, CTH 231, CTH 381, CTH 529

5.5. Discussion

The results obtained from the texts analyzed to determine Durmitta's position through text-critical and statistical methods are as follows:

1. The Kaškaeans of the land of Durmitta have attacked Durmitta and its surroundings several times.
2. From the perspective of Ḫattuša, the land of Tapapanuwa and the river Dahara are in the direction of the city of Durmitta.
3. Nenašša and Uwalma are in the district of Durmitta.
4. There is no conclusive evidence that Nenašša and Uwalma are other cities than the known southern cities from the Old Kingdom period.
5. Force-directed visualization of the network of Hittite toponyms locates Durmitta northwest relative to the gravitational center of the network.
6. High centrality of Durmitta within the network contradicts with its location on the edge of the empire.
7. Durmitta it's not well connected to toponyms that are thought to be in the east while it is well connected to the west.

All text-critical and statistical analyses point to a western localization, contrary to Barjamovic's proposal to locate Durmitta east of Ḫattuša. Also Durmitta has well established connections to the southern cities such Nenašša, Uwalma and U/ippašana which can’t be explained if Durmitta is in the far north.

If all the statements are accurate, it would support the notion that the Land of Durmitta covers a sizable strip that stretches across the central Kızılırmak valley, as suggested by Corti in 2017 (232). Within the land, it is conceivable that the city of

Durmitta is positioned towards the northern portion. The region's unexpected extent and the decentralized placement of the town of Durmitta within it could be attributed to a expansion of the territory during the reigns of Muwatalli II and Ḫattušili III. It is plausible that the relocation of the capital might have facilitated a reorganization of administrative divisions, including land of Durmitta. A combination of statistical analysis and text-critical examination leads to the probable location of Durmitta being to the east of Ankara and to the west of the Hittite capital.

Based on the available data, the most convincing argument for the location of Durmitta is that it was not as far north as previously thought. The presence of extensive evidence indicating the city's and the region's connections with well-known cities to the south must not be overlooked. Based on the statistical and text-critical approach, Durmitta can be located east of Ankara and west of the Hittite capital. This localization contradicts the current understanding of the relations between Kaškaeans and the Hittite Empire, as it would mean that the Kaska also lived close to the capital and not just in the frontier. Therefore revisiting some previously accepted historical concepts is required.

Based on the presented data, the most compelling proposition regarding the location of Durmitta is that it probably existed at a more southward position than previously thought. It's important not to ignore the substantial body of evidence that underscores the city's connections to well-known southern cities and the broader region. This repositioning challenges the prevailing understanding of the dynamics between the Kaškaeans and the Hittite Empire. This scenario implies that the Kaska civilization

resided closer to the capital instead of just on the periphery. Therefore, it is essential to reevaluate previously accepted historical concepts.

Chapter VI: Conclusion and Future Research

The Hittite texts contain an extensive collection of more than two thousand toponyms, providing insights into the complex socio-political system embedded in Anatolian geography. Consequently, understanding this socio-political system requires a comprehensive understanding of the geographic organization within the Hittite empire. Thus, the importance and appeal of Hittite historical geography has persisted among Hittitologists for several decades. Despite its continuing importance, however, the field continues to struggle with unresolved methodological challenges, resulting in an increasing number of discussions of these issues over the past decade. This research participated in these debates and advocated for the use of quantitative methods in the field.

This thesis presented a quantitative methodology based on network analysis that effectively depicts relative geography across multiple scales. The results presented in Section 4.5 demonstrate its effectiveness in defining regions within the empire. The results presented in Section 4.6 are also consistent with those of a qualitative study conducted on a specific region, highlighting its comparable success. The compatibility of the method with existing methods for determining the location of a toponym is demonstrated in section 5.4, emphasizing its potential for integration with existing methods. Analysis on modern Turkish news and HiTop databases cumulatively showed that statistical analysis of non-geographical texts is capable of providing geographical insights. These findings are consistent with Tobler's prediction and refute the notion that Hittite texts, due to their diverse nature, are not suitable for quantitative analyses.

6.1 Future Research of Co-occurrence Network of Toponyms

The use of the co-occurrence network of toponyms constructed in this thesis offers a wide range of potential applications. This thesis has presented several illustrative examples of these applications. First, it can help resolve debates about the geographic ordering of toponyms within specific texts by providing statistical insights (see 5.4.2). In another application, the network can be used to explore the associations between toponymic endings and specific regions. Furthermore, the applicability of the network extends beyond the realm of historical geography. For example, it can facilitate comparisons of the spheres of influence of different cult centers and enable investigations into the dominant deities in different regions. Overall, the co-occurrence network of toponyms has significant value in addressing a wide variety of research questions.

6.2 Quantitative Methods in Hittitology

Hittitology's ongoing digitization efforts, exemplified by projects such as HiTop, hold great promise for the field. These efforts have the potential to greatly enhance quantitative research in several areas within Hittitology. Linguistic studies, for example, can benefit from quantitative analysis of words and grammatical particles whose precise meanings remain elusive. Studies of the administrative structure of the Hittite empire can be enriched by integrating quantitative methods alongside

qualitative approaches.Such studies are already being conducted in Assyriology and their number is increasing every year. (Wagner et al. 2013; Cline and Cline 2015; Pagé-Perron 2018; Larsson 2021; Khan et al. 2022). As these digitization projects continue to expand, the range of potential applications for quantitative research in Hittitology will broaden considerably.

Hittitology is making significant progress in digitization with various continuing projects (Rieken and Schwemer 2022; Burgin et al. 2022, vel sim). However, there is a lack of quantitative studies that can fully reveal the true potential of these projects. The current digitization efforts do not provide an adequate structure to utilize this potential effectively. The texts that have been digitized are not available in formats that researchers can readily use, which complicates their study by computational methods. In contrast, Assyriology benefits from initiatives such as CDLI, which facilitate research by sharing data in multiple formats (CDLI contributors 2023). Ongoing digitization projects in Hittite Studies should strive to achieve a similar level of visibility and accessibility.

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Figures

Figure 1. Co-occurrence network of Turkish provinces in a force-directed layout.

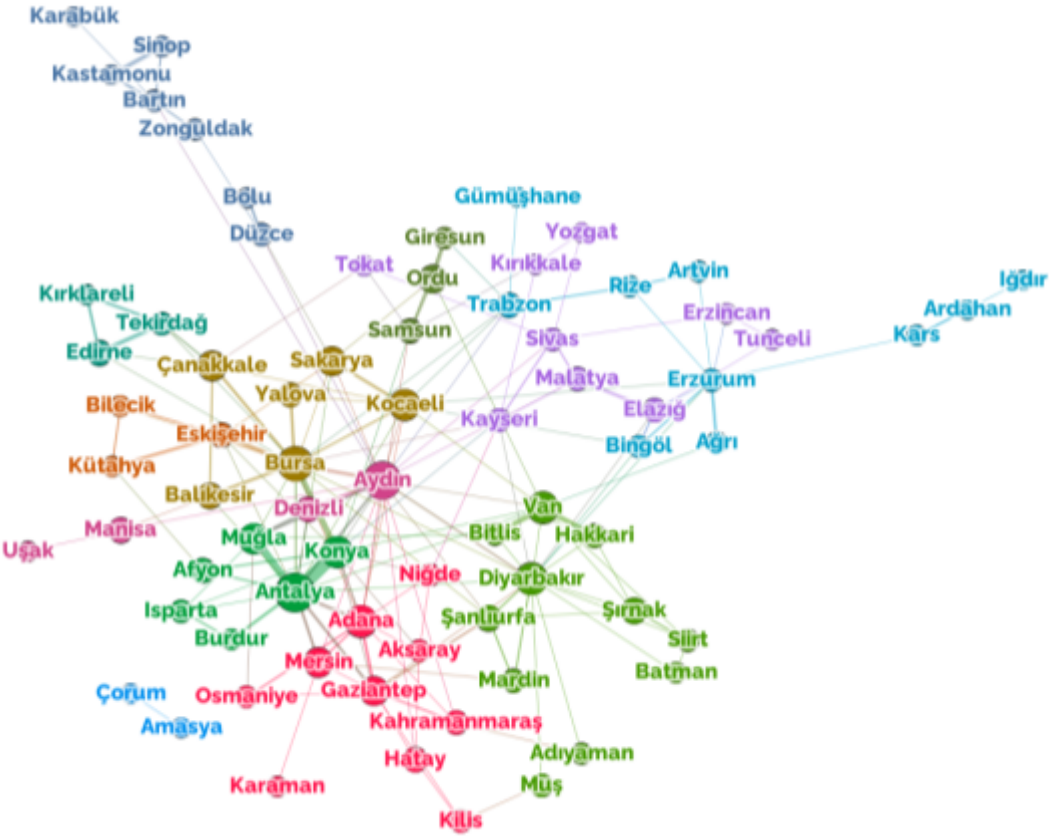


Figure 2. Co-occurrence network of Turkish Provinces anchored to original locations.

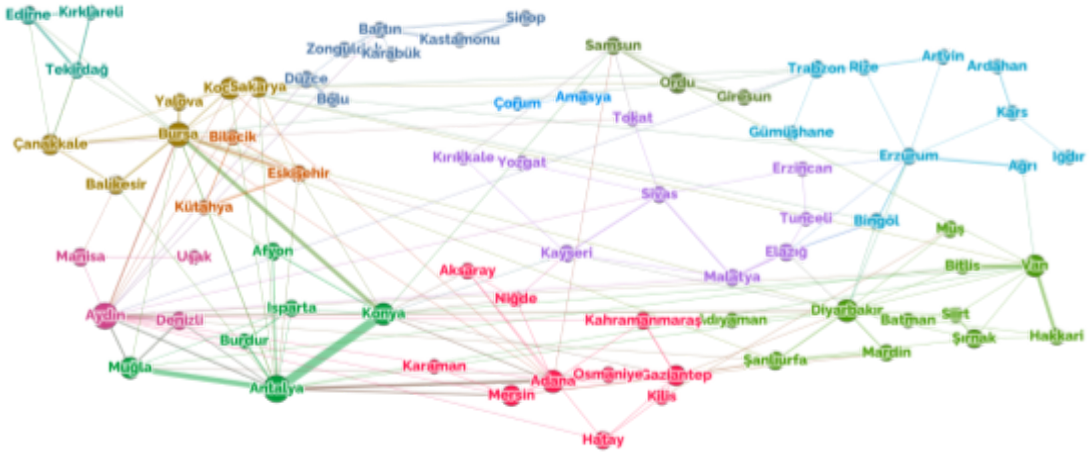


Figure 3. Correlation Between Centrality and Population of Turkish Provinces

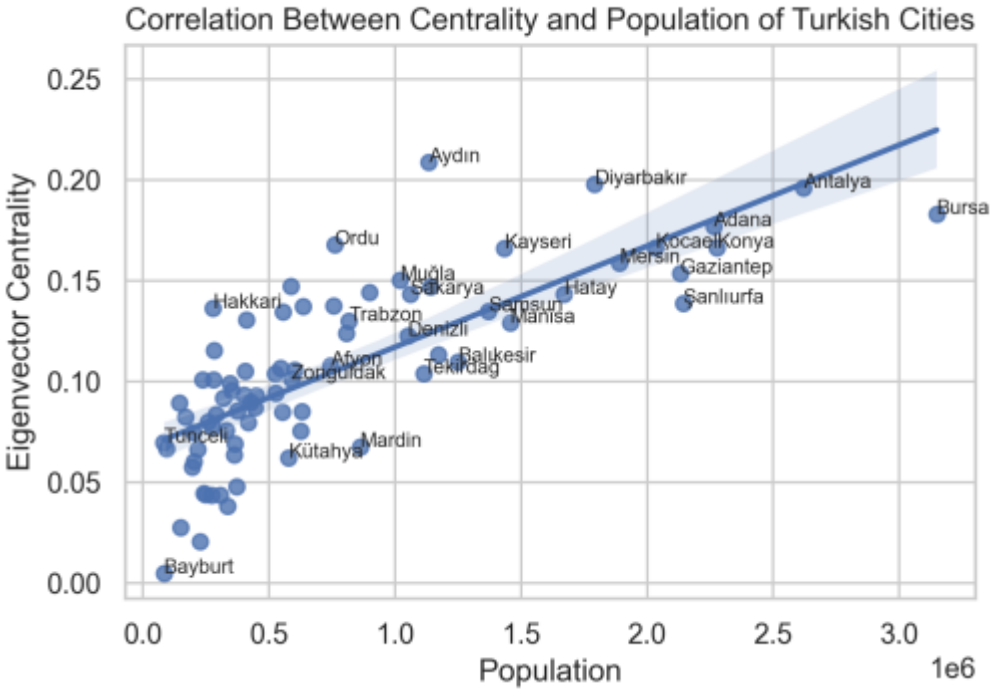


Figure 4. Distribution of toponyms across fragments, with outliers highlighted in red

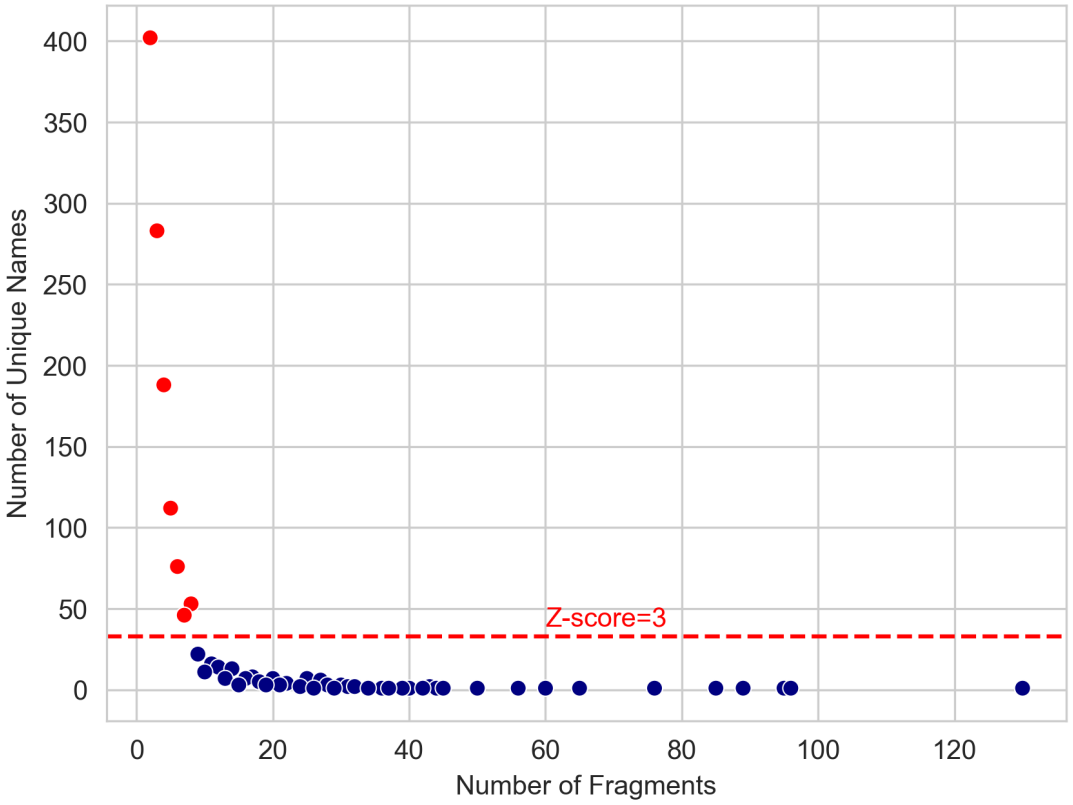


Figure 5. Co-occurrence network of fragments in a force-directed layout

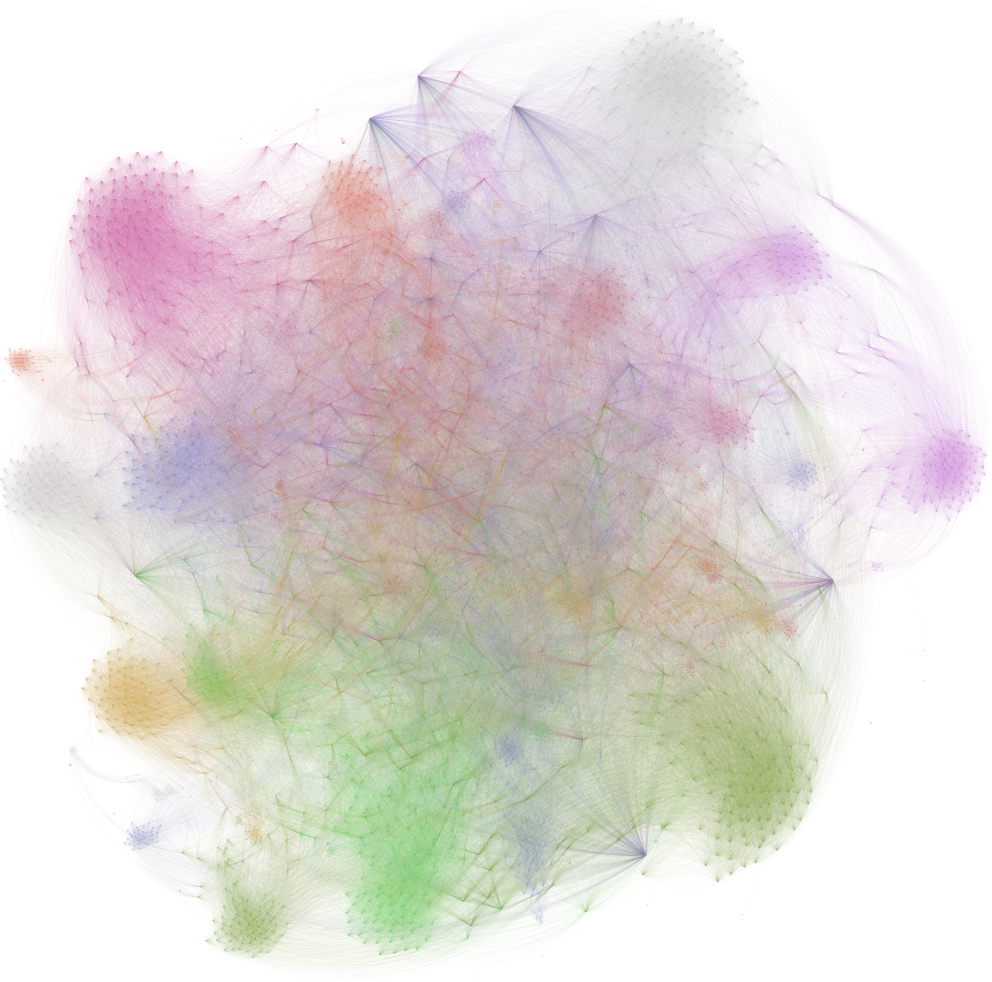


Figure 6. Co-occurrence network of Hittite toponyms in a force directed layout. Colors indicate detected communities. Node sizes indicate eigenvector centrality.

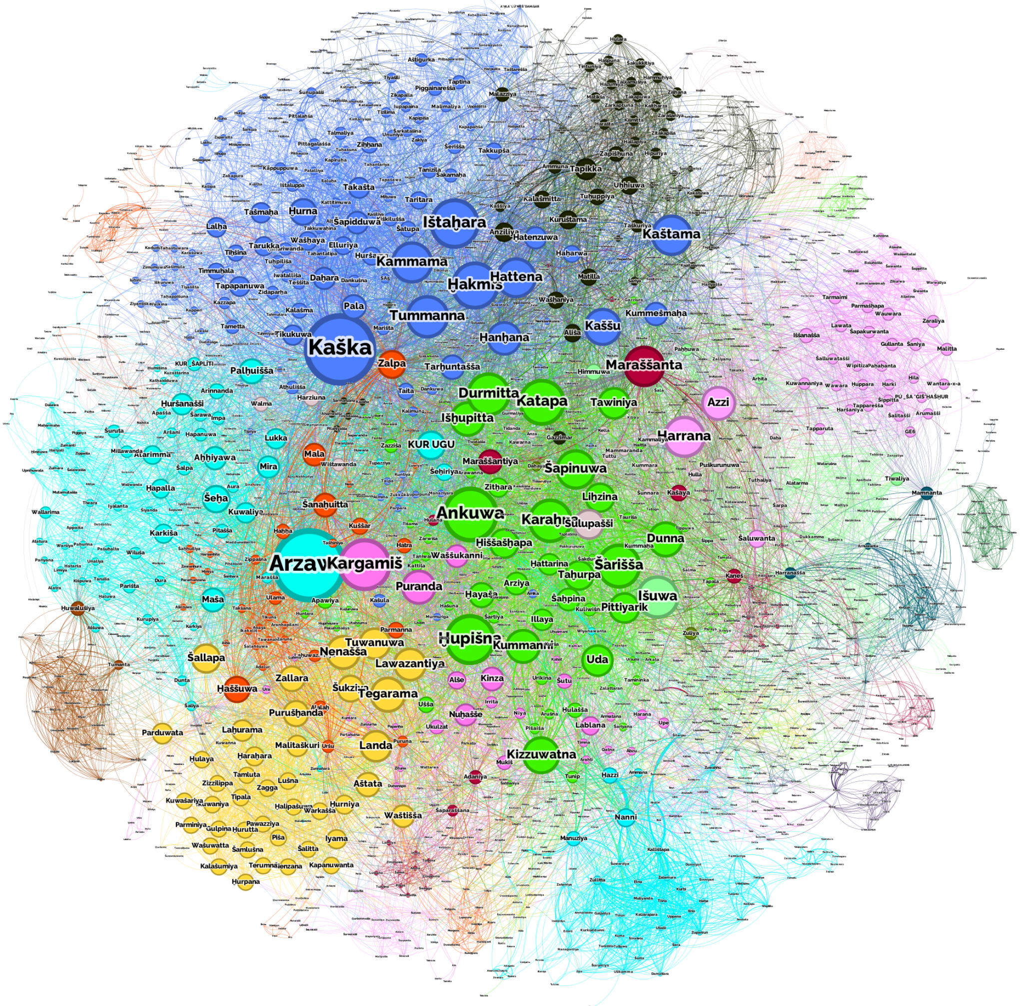


Figure 7. Selected toponyms highlighted in the cartesian coordinate system with calculated locations through network analysis.

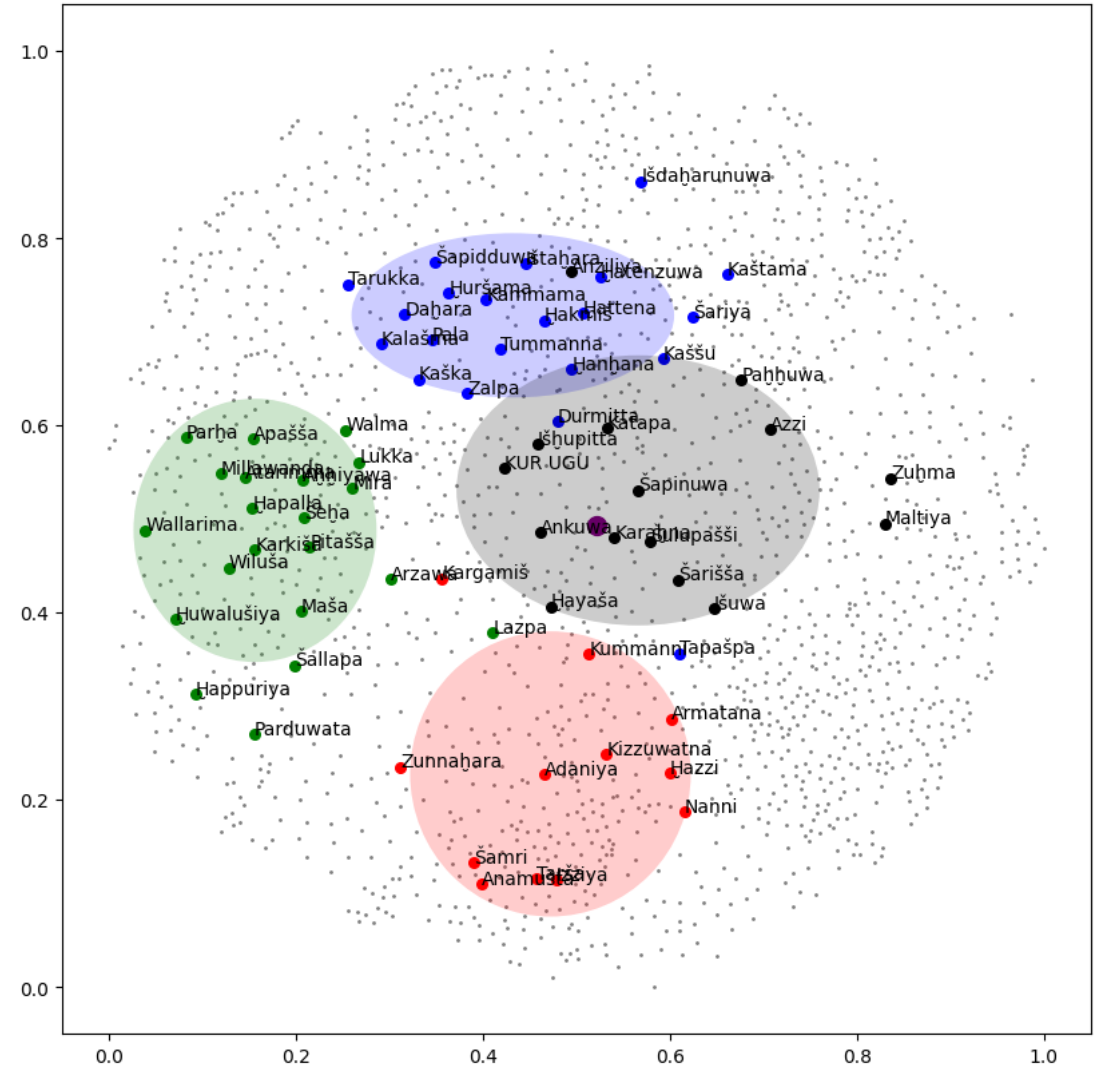


Figure 8. Selected toponyms in Hittite heartland with calculated locations through network analysis.

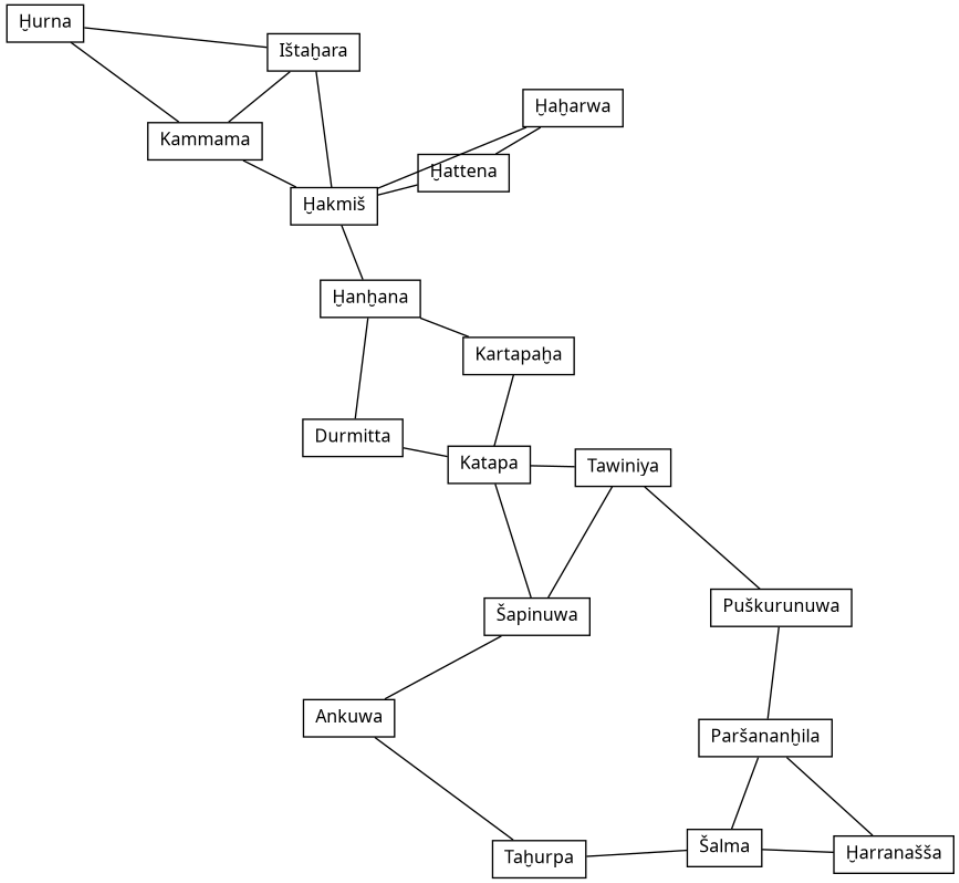


Figure 9. Adam Kryszens's relative geography of Hittite heartland. The diagram in page 392 is reconstructed (Kryszen, 2016).

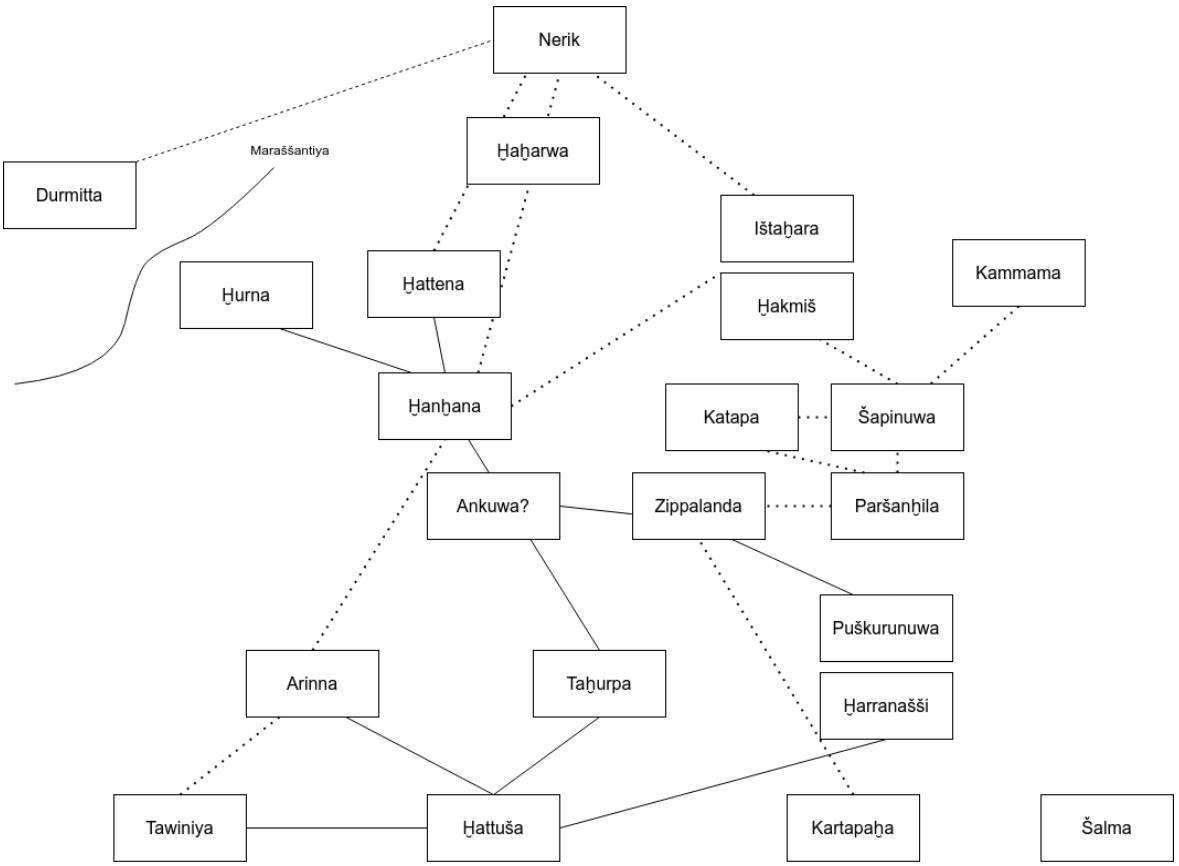


Figure 10. Selected toponyms in Western Anatolia with calculated locations through network analysis.

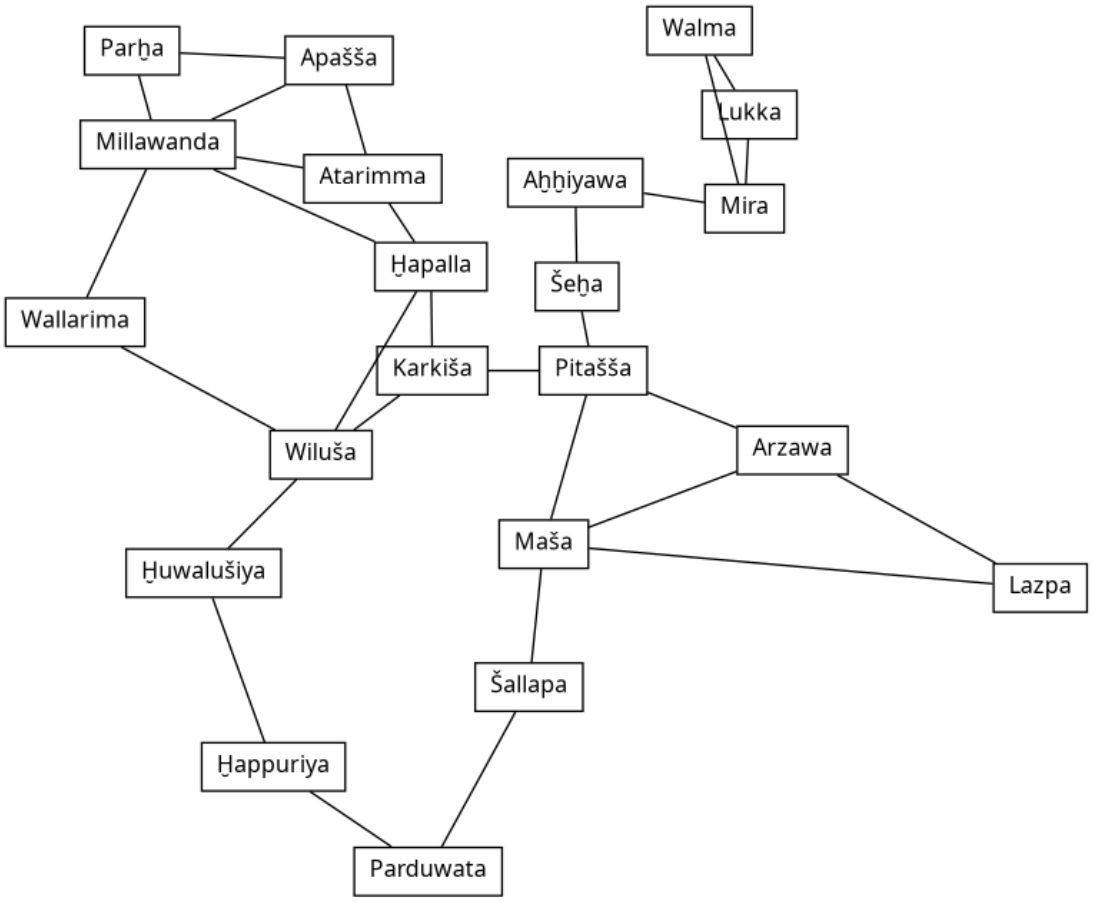


Figure 11. Occurrences distribution of Durmitta by genre.

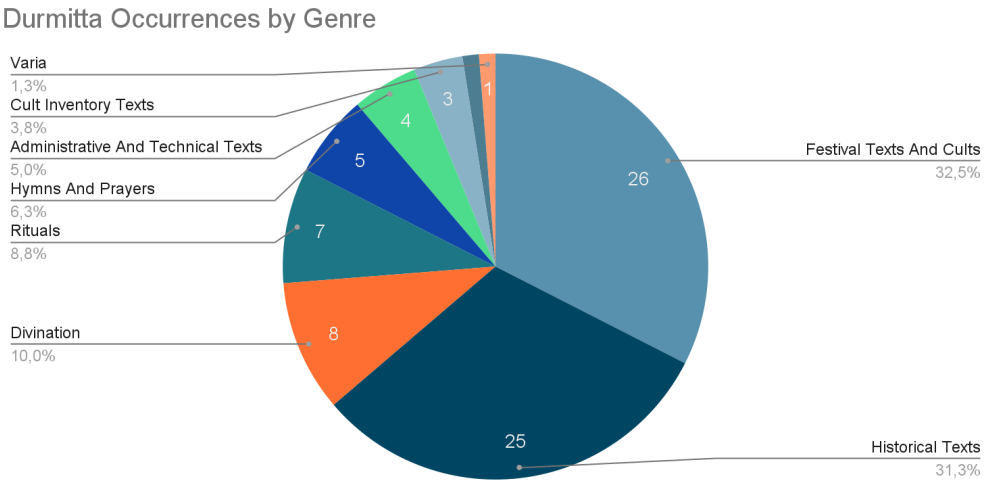


Figure 12. Geographical Identifier distribution of Durmitta

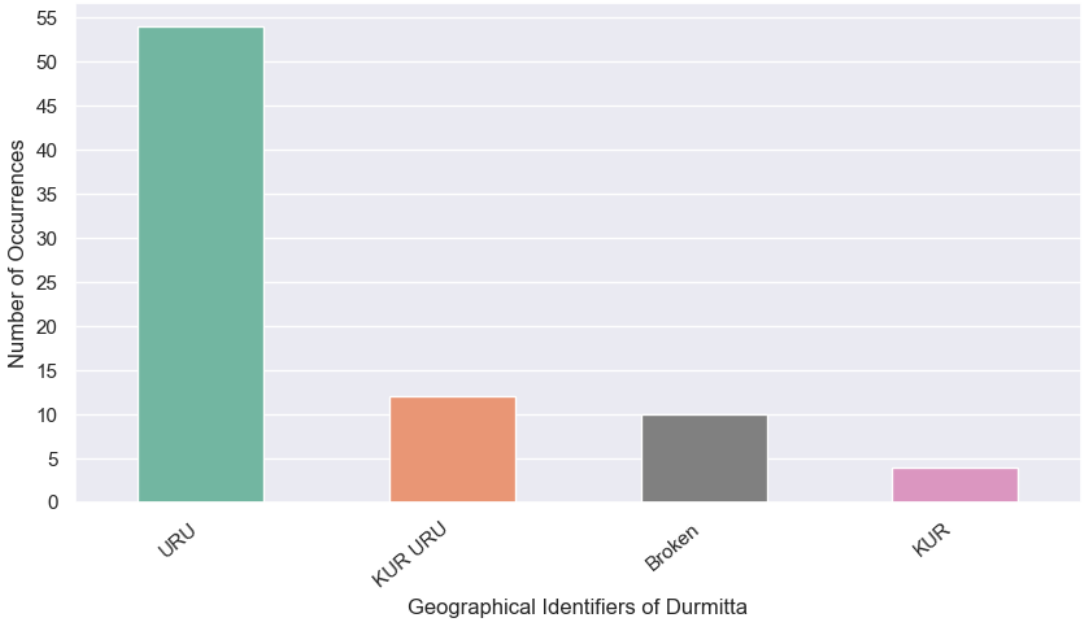


Figure 13. Comparison of normalized centrality measures of most central twenty toponyms in co-occurrence network of Hittite toponyms.

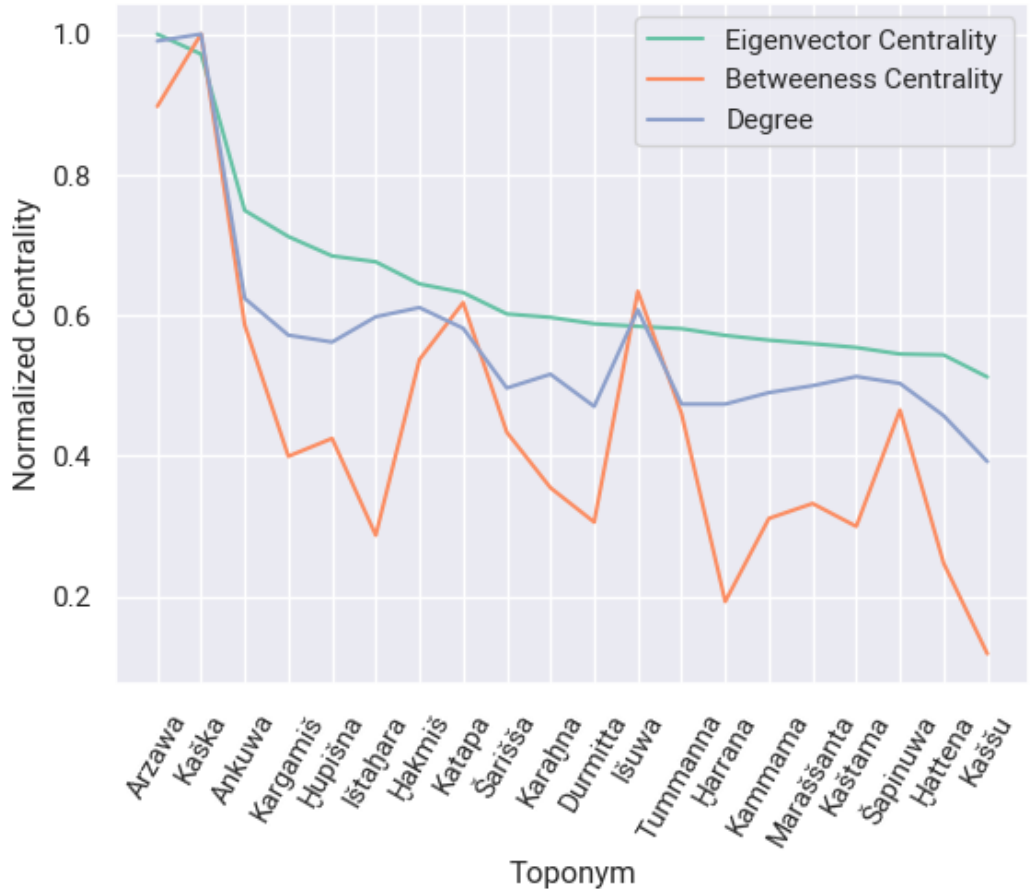


Figure 14. Highlighted Durmitta and its neighbors in the co-occurrence network of Hittite toponyms.

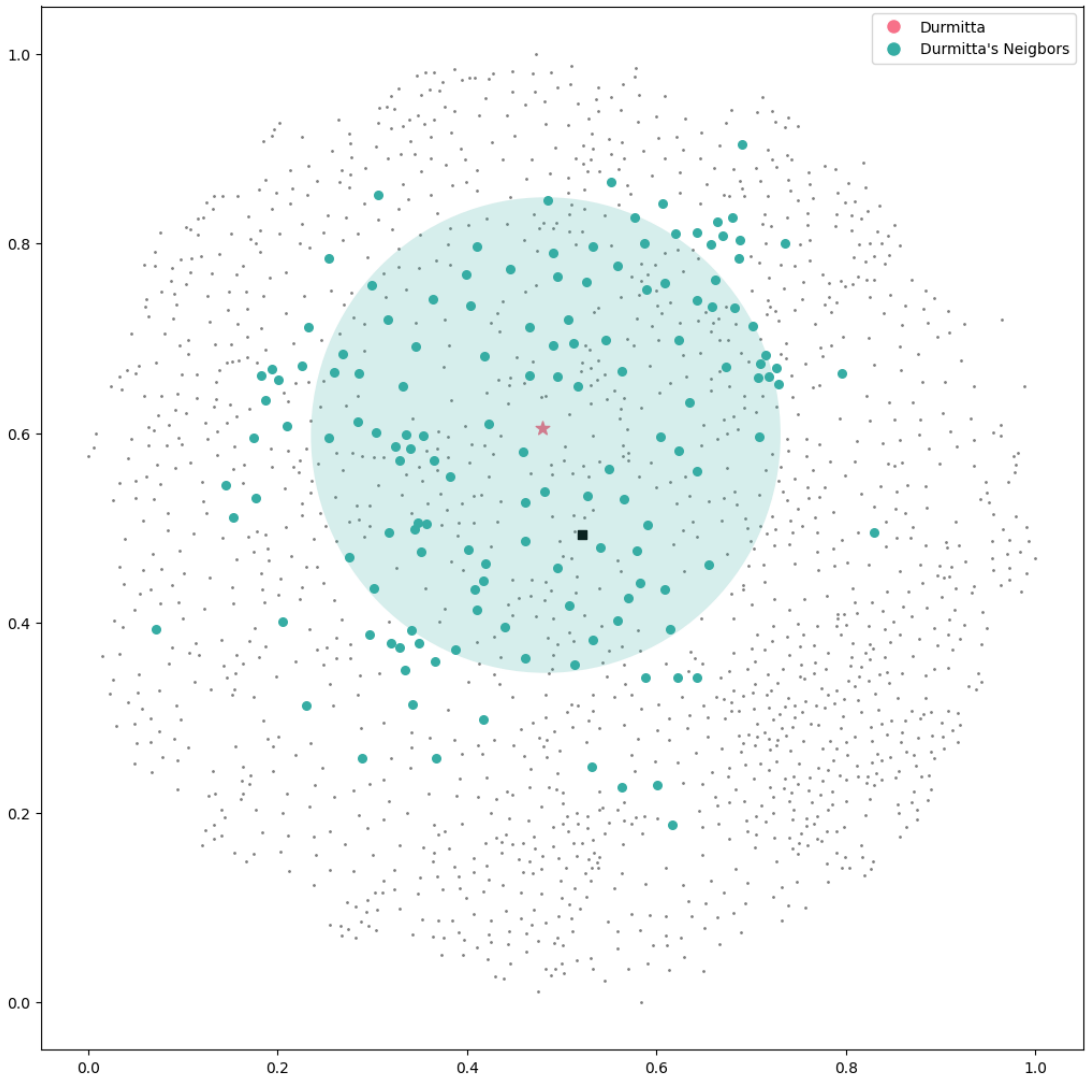


Figure 15. Locationš of Durmitta, Daḫara and Tapapanuwa

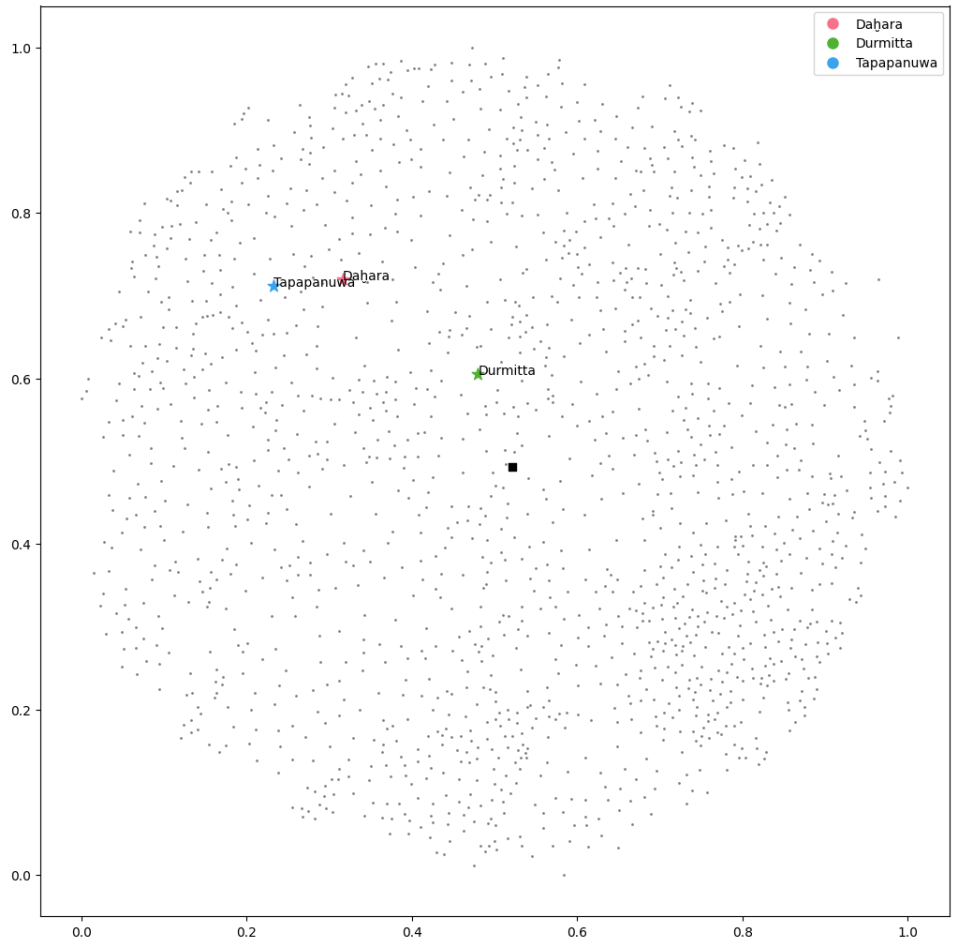


Figure 16. Intersection of neighbors of Durmitta and Ḫakmiš

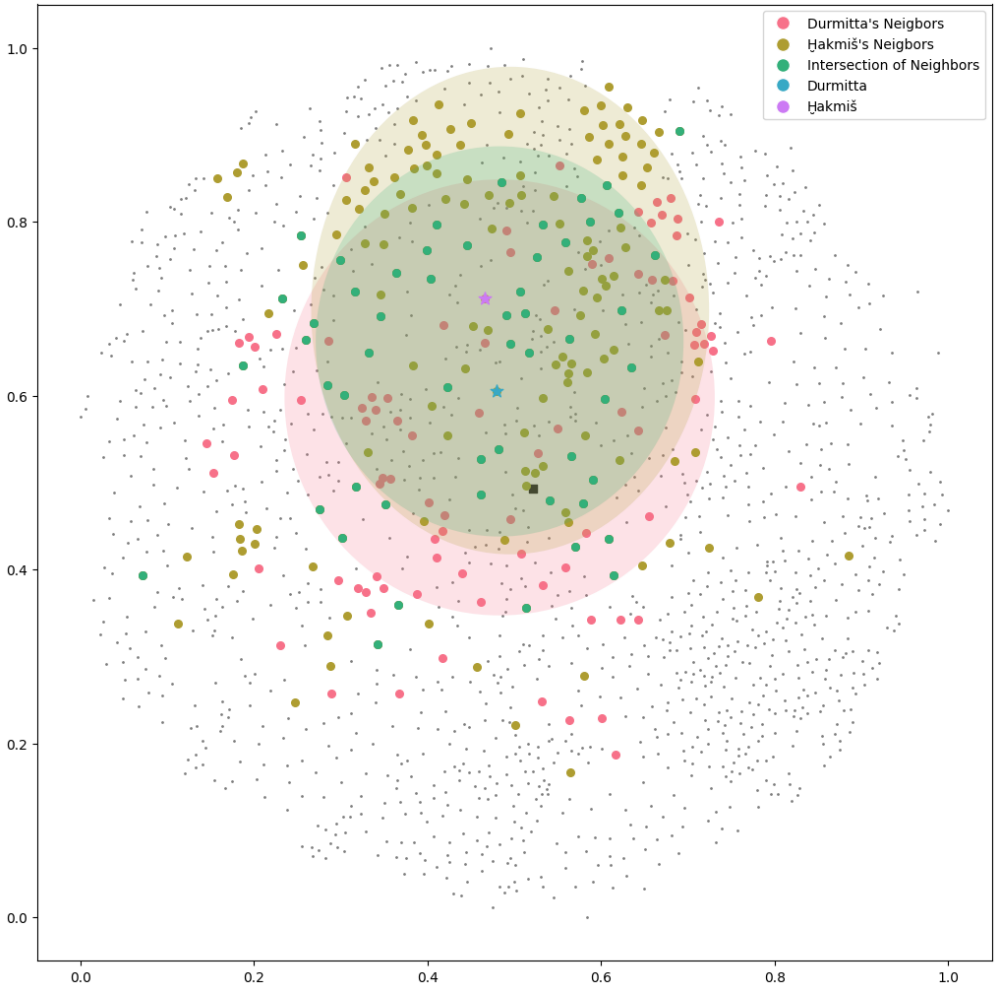


Figure 17. Intersection of neighbors of Durmitta and Tuwanuwa

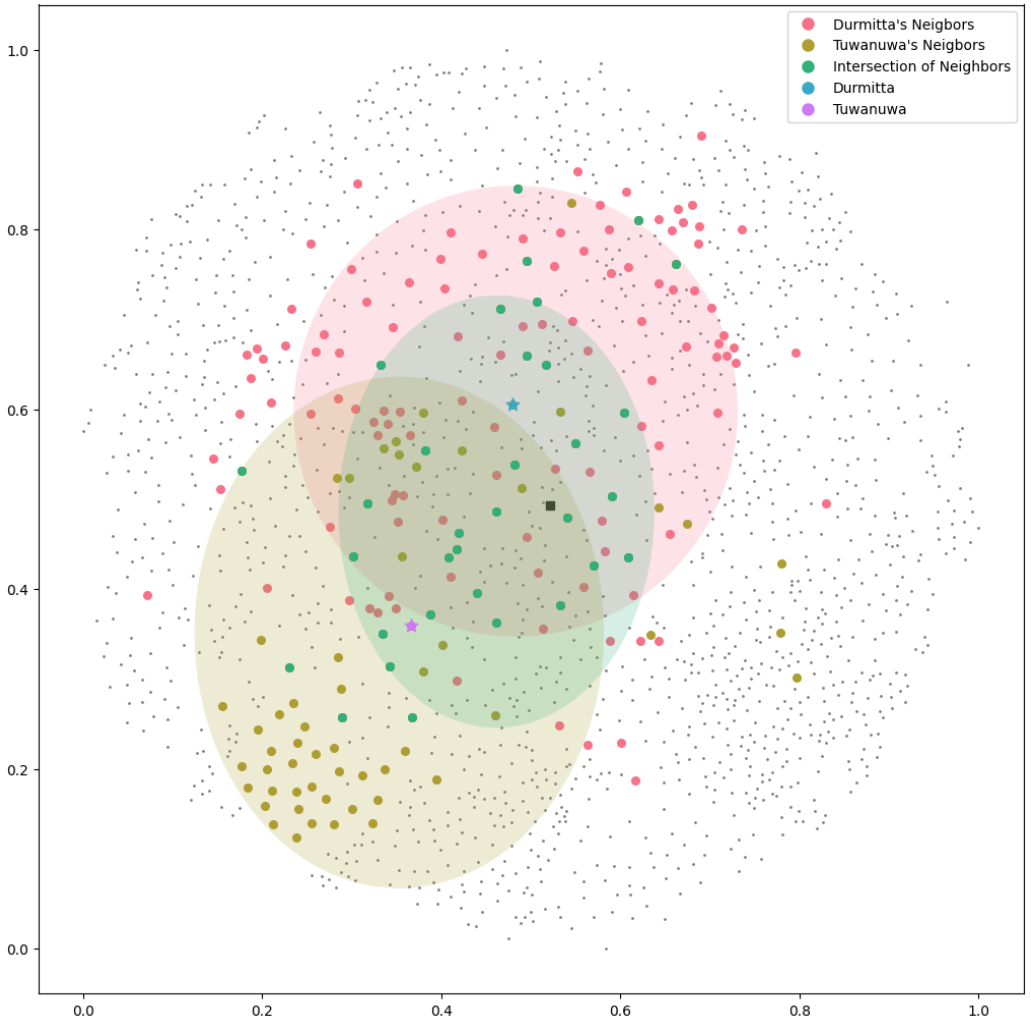


Figure 18. Intersection of neighbors of Durmitta and Pala

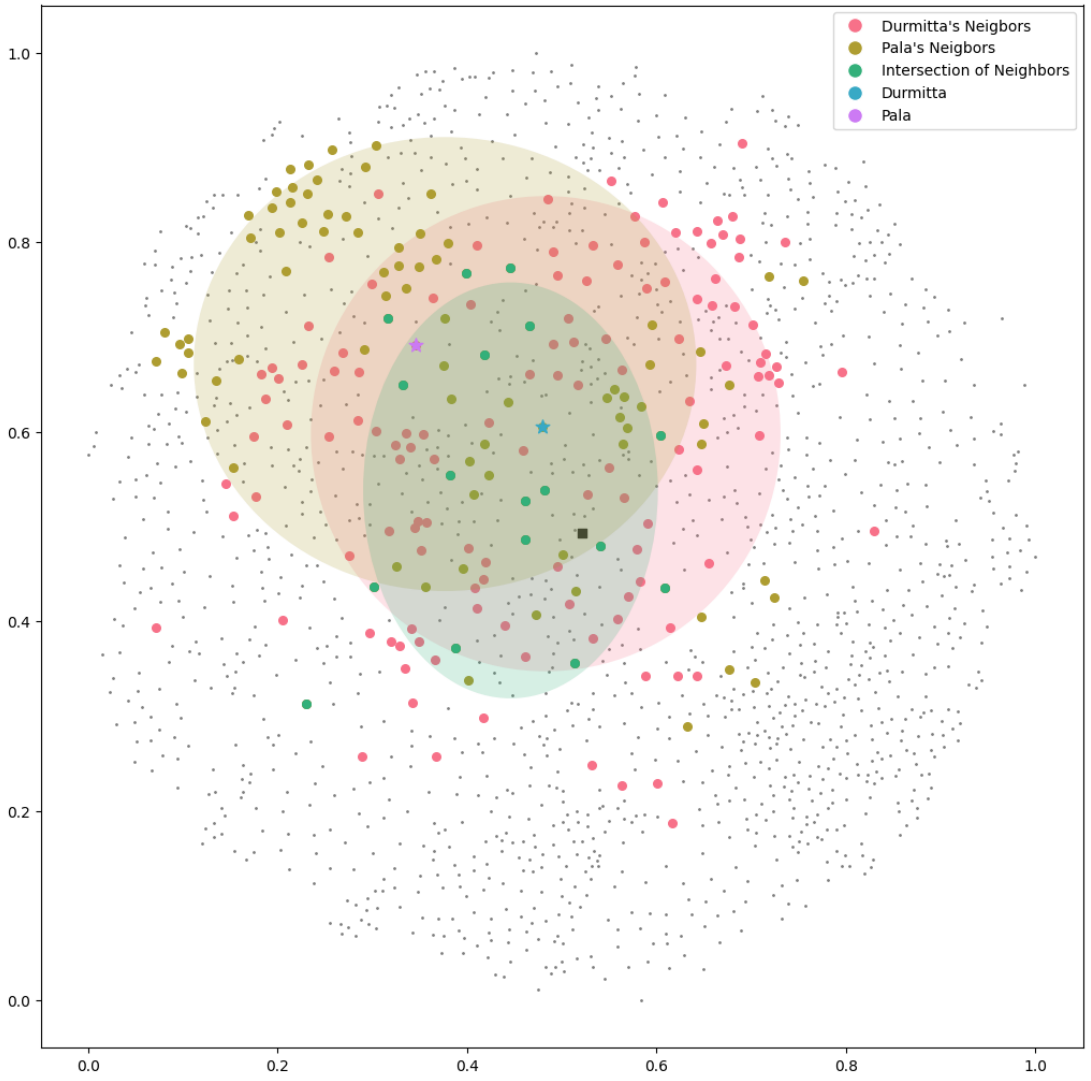


Figure 19. Intersection of neighbors of Durmitta and Tapikka

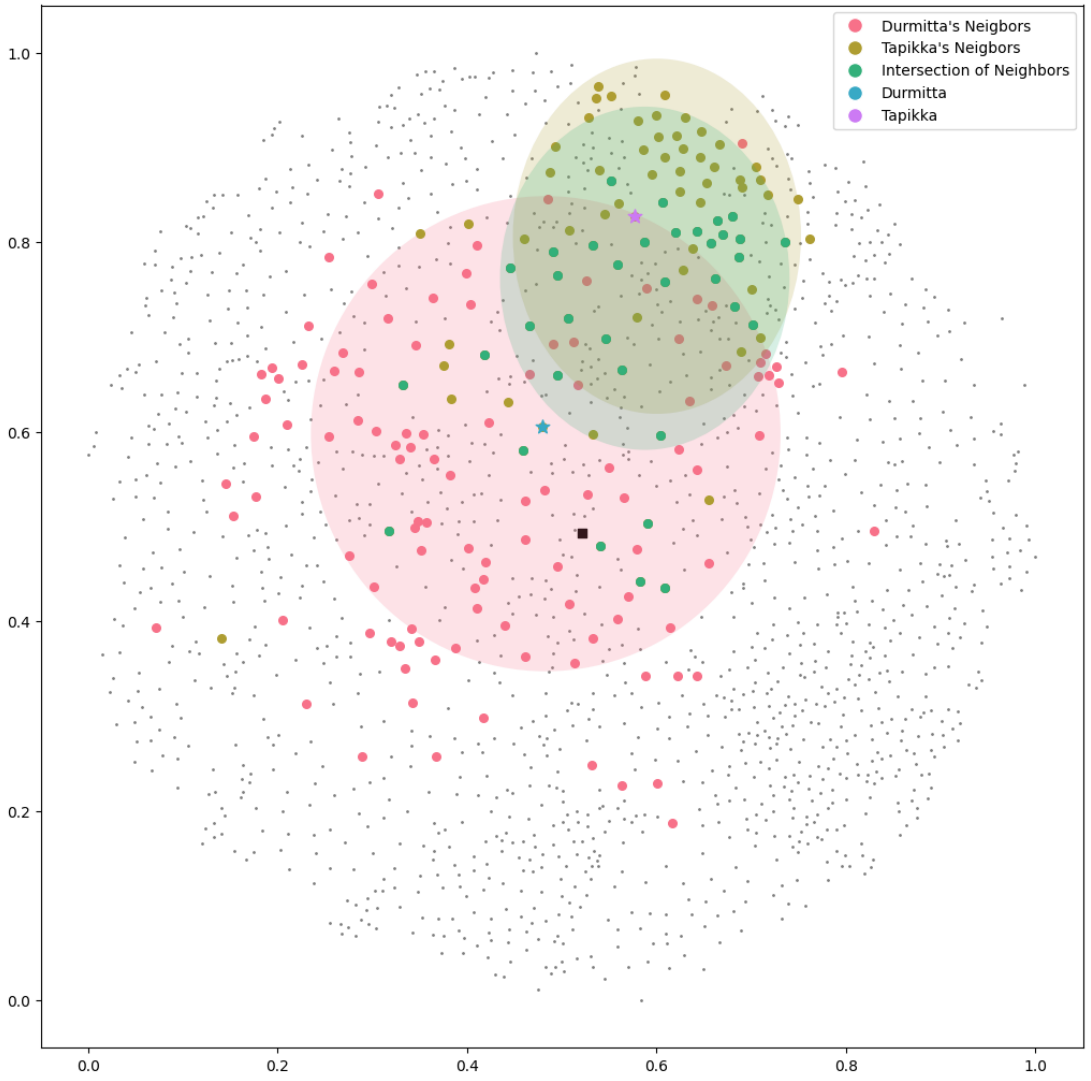


Figure 20. Mean distance of KUB 48.105 + KBo 12.53 compared to a random sample.

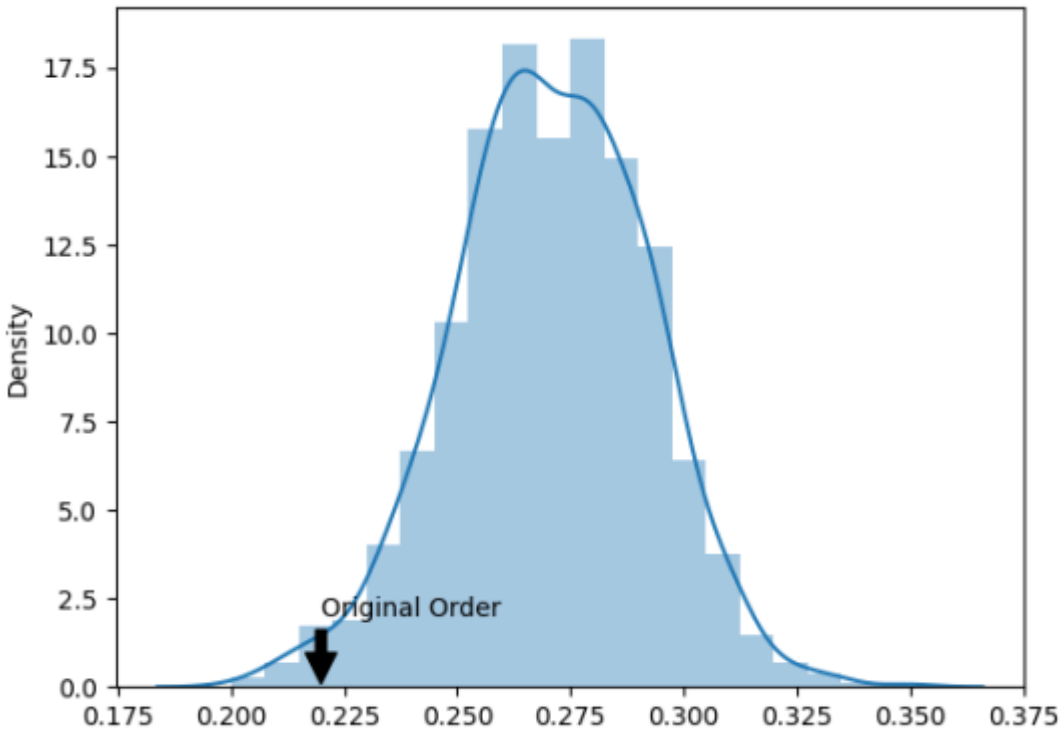


Figure 21. Locationš of Durmitta, Kaššiya, Wašẖaniya and Tapikka

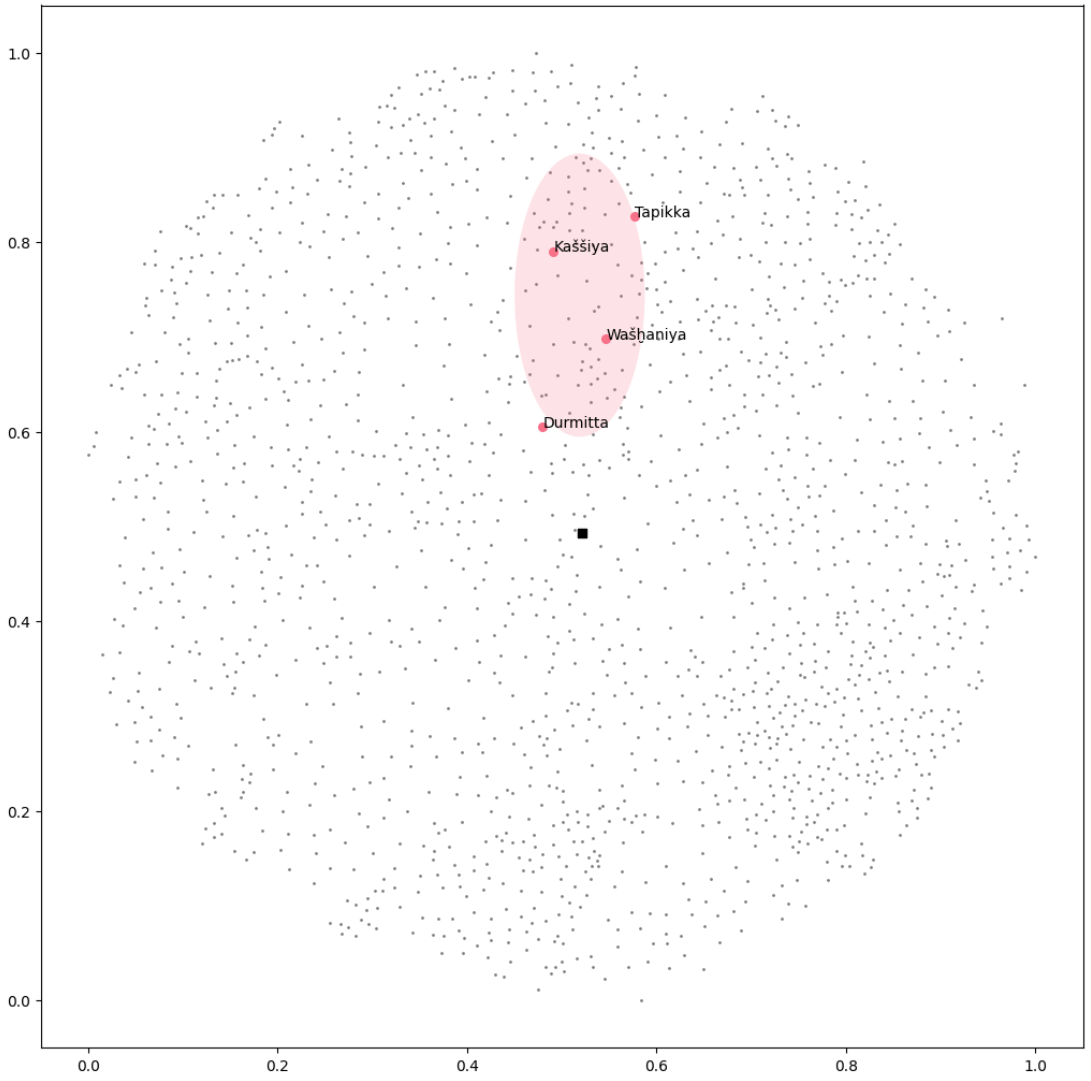


Figure 22. Mean distance of CTH 381 compared to a random sample.

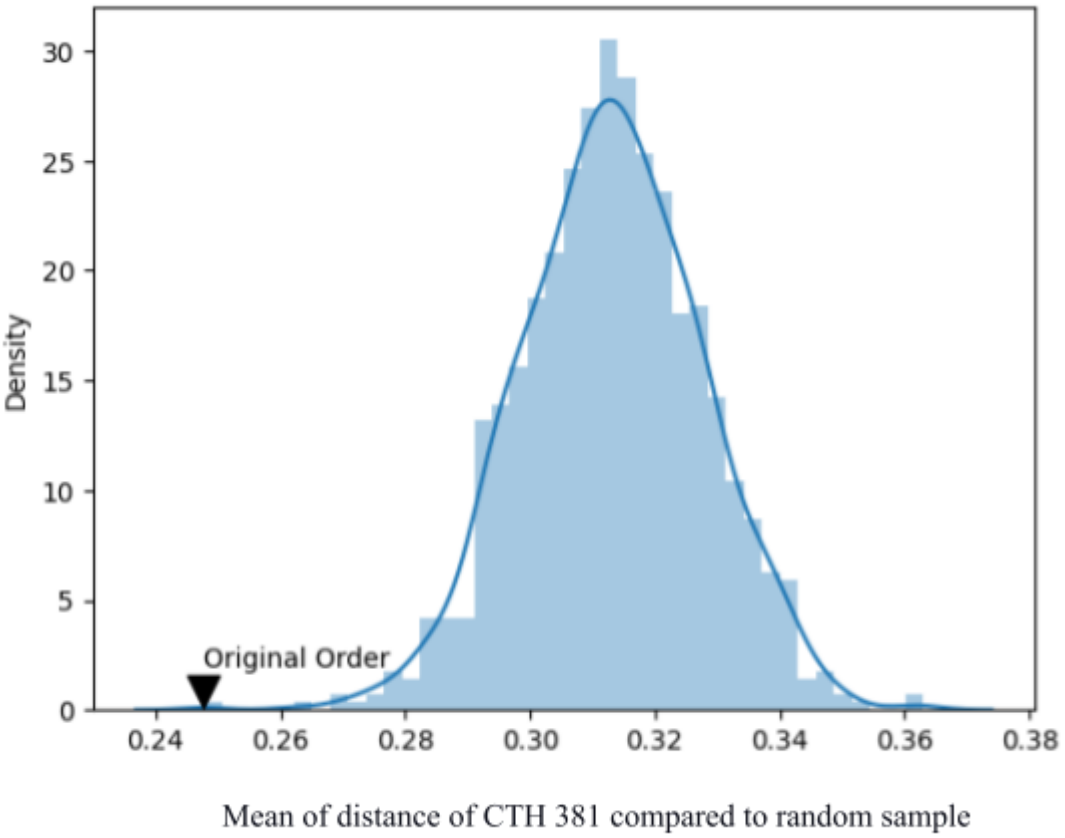


Figure 23. Intersection of neighbors of Durmitta and Nenašša

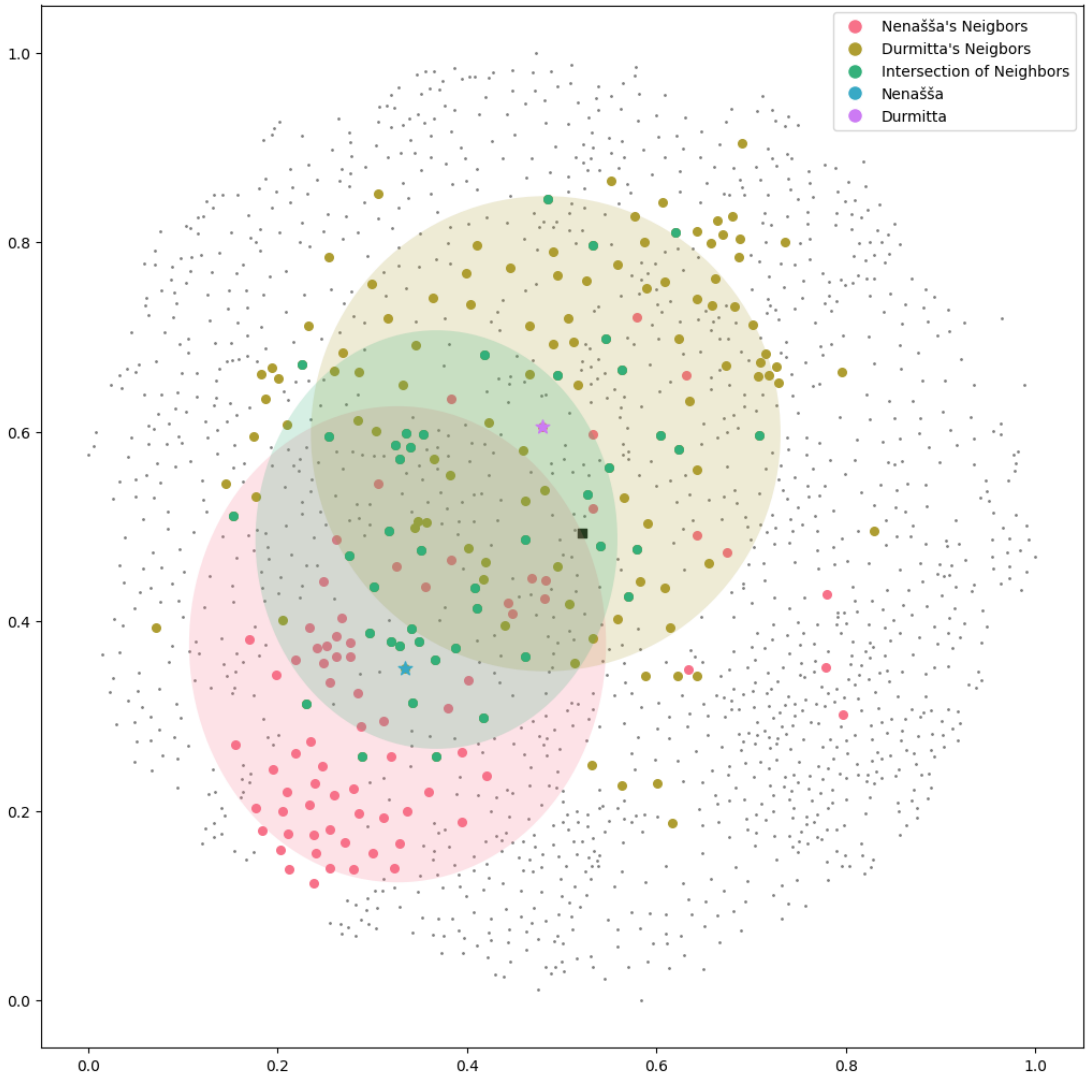


Figure 24. Vectorial representation of fragments mentioning Nenašša. Vectors originating from the gravitational center of the network to each fragment's individual gravitational center.

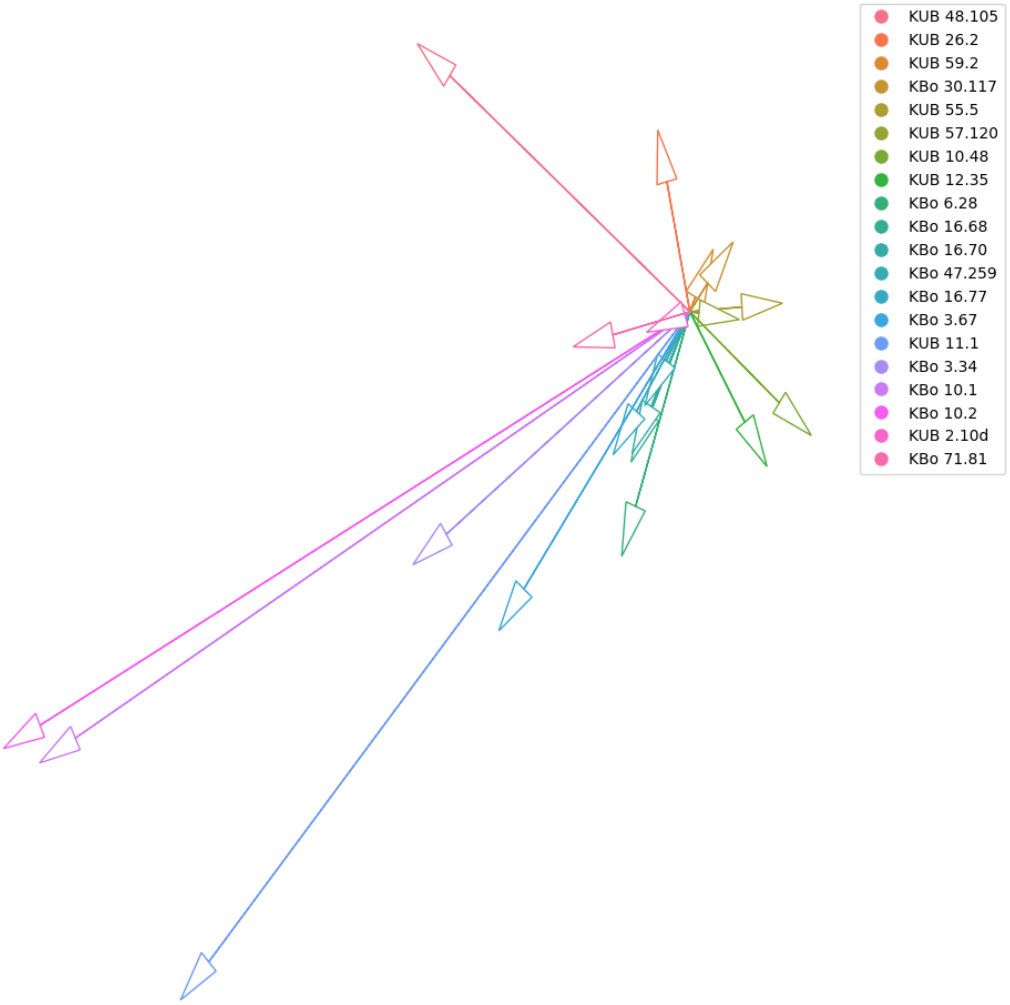


Figure 25. Vectorial representation of fragments mentioning Walma.

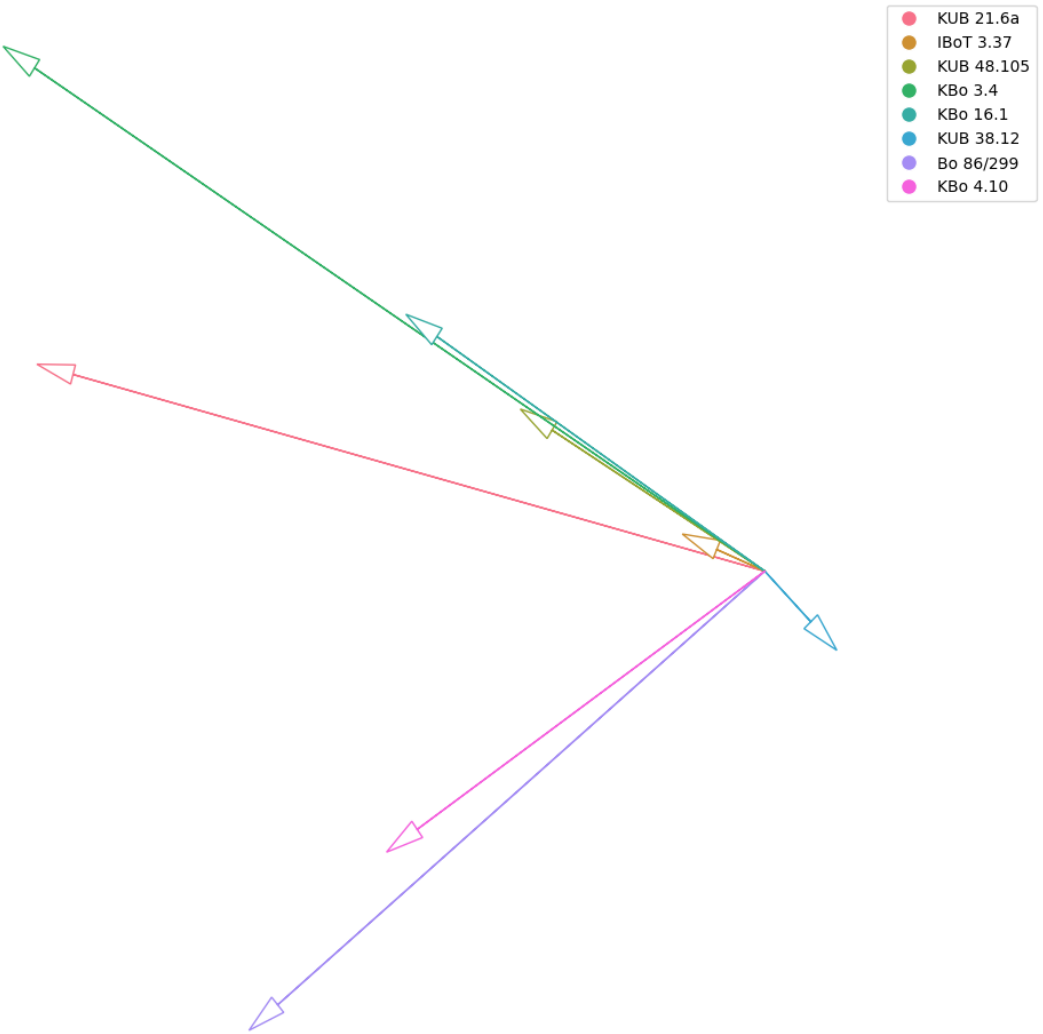
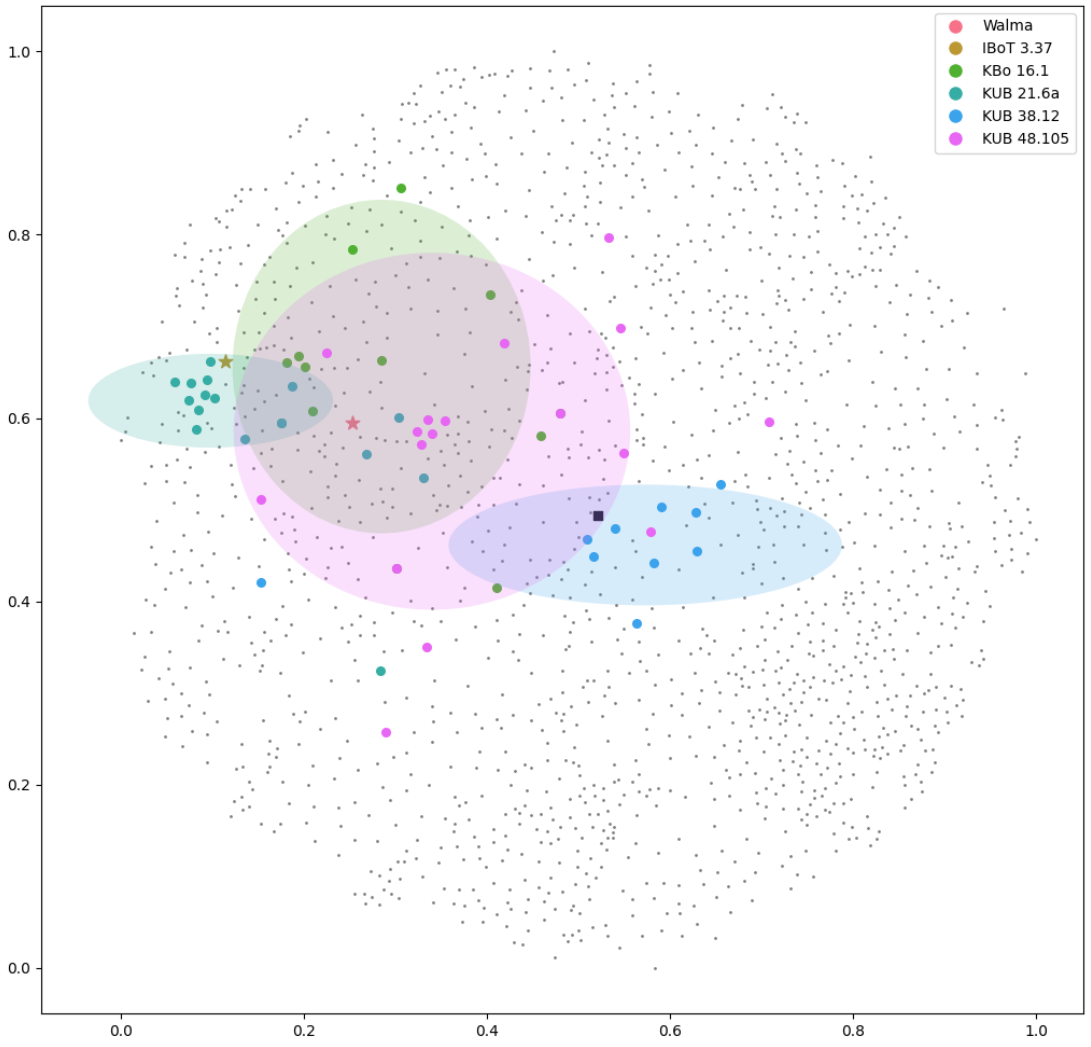


Figure 26. Locations of toponyms that co-occurred with Walma by fragment.



Tables

Table 1. Comparison of the three methodologies

	Historical Geography of Anatolia in the Old Assyrian Colony Period	A Historical Geography of Hittite Heartland	Geschichte und Geographie Westkleinasiens in der Hethiterzeit
Defining corpus/region	Old Assyrian Sources	Great Bend of the Kızılırmak River	Western Anatolia
Focus	Topography	Relative Geography	History
Method of Contextual Analysis			
Grouping texts	Itinerary or not	Based on geographical information	Varied
Clustering	Major Centers	Major Centers	Geographical Regions
Co-occurrence data	Tables & Bar charts	No	No
Textual analysis of instances	Yes	Yes	Yes
Use of Other Methods			
Topographical Approach	Yes	No	No
Comparative Method	Discusses	No	Discusses
Results of Analysis			
Construction of a relative geography with visuals.	Yes	Yes	Yes
Identification	No	No	No
Localization	Yes	Yes	Yes

Maps

Map 1. Suggested localizations for Durmitta.