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Mapping an ancient historian in a digital age: the Herodotus Encoded Space-Text-Image Archive (HESTIA)*

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ABSTRACT: HESTIA (the Herodotus Encoded Space-Text-Imaging Archive) employs the latest digital technology to develop an innovative methodology to the study of spatial data in Herodotus' *Histories*. Using a digital text of Herodotus, freely available from the Perseus on-line library, to capture all the place-names mentioned in the narrative, we construct a database to house that information and represent it in a series of mapping applications, such as GIS, GoogleEarth and GoogleMap Timeline. As a collaboration of academics from the disciplines of Classics, Geography**,** and Archaeological Computing, HESTIA has the twin aim of investigating the ways geography is represented in the *Histories* and of bringing Herodotus' world into people's homes.

Digital technology is fast revolutionising the ways in which we are communicating with each other and perceiving the environment around us. With internet access and web-mapping tools installed as standard features on the latest mobile phone technology, the whole world now can appear at our fingertips. In university circles too there can be little doubt of the role ICT has in the development of future academic practice, both in the sciences and arts, whether as a pedagogical tool or as a means of research: certainly, with major humanities funding bodies putting the digital world at the centre of grant applications, the

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next decade promises a revolution in approaches to the study of antiquity.[1] Yet, what this revolution will look like, or even how revolutionary the digitalisation of Classics will be, is still very much open to question. It is not only an issue of whether more traditional areas of study will be affected or able to take advantage of the latest technology, though many already are as a matter of course.[2] Even those studies that embrace the new ICT face an uncertain future in this brave new world. With software developing so quickly, what is to prevent work done in one format being rendered practically obsolete by future trends or simply left unrecorded in the virtual world of the digital age?[3] What infrastructure is there to support digital projects in the same discipline, let alone those in different disciplines or across institutions and nations, and, in its absence, how can projects speak to each other in the face of the growing multiplicity of media? [4] What single platform can be established for programmers and users alike, and how is a common standard to be found, managed and maintained?[5] And what impact will these new forms of media, these new ways of gathering, representing and

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[1] 'Digital Humanities' is one of only four 'emerging themes' in the AHRC's 'Future Directions' consultation (http://www.ahrc.ac.uk/About/Policy/Documents/FD%20emerging%20themes.pdf). See also the JISC (*Joint Information Systems Committee*) homepage (http://www.jisc.ac.uk/) and their video 'How digital technologies are creating a new paradigm in research' (http://www.jisc.ac.uk/whatwedo/campaigns/res3/video). An initial assessment of the role of digital media in the Humanities is attempted in the article by E.G. Toms and H.L. O'Brien, 'Understanding the information and communication technology needs of the e-humanist', *Journal of Documentation* 64 (2008), 102-30.

[2] Such as the widespread deployment in philologically oriented research of the *Thesaurus Linguae Graecae* (TLG: http://stephanus.tlg.uci.edu/), or the use of the on-line database *L'Année philologique* (http://www.annee-philologique.com/aph/), the most comprehensive index to scholarly work in Classical Studies.

[3] The classic example of a venture whose format was soon outstripped by technological advances was the BBC Domesday project (http://en.wikipedia.org/wiki/BBC_Domesday_Project). To a certain extent the rise of institutional on-line research archives, such as the University of Oxford's Research Archive (ORA: http://ora.ouls.ox.ac.uk/) or the Open University's Research On-line (ORO: http://oro.open.ac.uk/), has come about in an effort to address the problem of preservation. But these initiatives, while being of crucial importance particularly for maintenance of software formats used in traditional scholarship, do not address problems of compatibility between, and issues of sustainability of, current digital projects themselves.

[4] Just knowing what digital resources are available to the scholarly community will be a major task in itself. It is true that the AHRC hosts a handy website of humanities projects (http://www.arts-humanities.net/), which can be searched according to discipline, method or resource: but these are limited to AHRC-umbrella projects that are currently on-going.

[5] Various inter-organisational humanities-based projects are forming to meet the challenge of the rapidly changing digital world, from the large-scale cross-institutional projects such as Bamboo (which tackles the question 'How can we advance arts and humanities research through the development of shared technology services?' at http://projectbamboo.org/), Digital Research Infrastructure for the Arts and Humanities (DARIAH: http://www.dariah.eu/) and the Coalition of Humanities and Arts Infrastructures and Networks (CHAIN: http://digitalhumanities.org/centernet/?page_id=12), to smaller scale bottom-up groups, such as Digital Classicist (http://www.digitalclassicist.org/) or Antiquist (http://www.antiquist.org/blog/).

interpreting data, have on approaches to Classics or the Humanities more generally?[6]

While the general issues outlined above must in the end be addressed by strategy units at the institutional level and fall beyond the scope of an academic paper, they are a major concern for a particular case study with which we are currently engaged. HESTIA—the **Herodotus Encoded Space-Text-Imaging Archive** funded by the *Arts and Humanities Research Council* of the United Kingdom—investigates the ways in which space is represented and conceived in the work of the ancient Greek historian, Herodotus, using the latest information computer technology.[7] In his *Histories*, in the process of conducting his enquiry into war between Greece and Persia, Herodotus has cause to mention a whole range of different places: a digital mark-up of the text has allowed us to feed these locations into a database and reconstruct the world of the sixth-fifth centuries BCE (of Herodotus) using modern mapping systems. In this paper we outline our methodological approach to the examination of spatial ideas in Herodotus, in the belief that there are lessons to be learned, not only for the scholar of the *Histories* or of ancient historiography more generally, but also for anyone interested in developing ICT in large text-based corpora, particularly with regard to thinking about the way places are represented and conceived.[8]

Herodotus' opening salvo in his investigation—why was it that the Greeks and barbarians came into conflict with each other?—launches a narrative that is fundamentally interested in issues of space—primarily the growing reach of Persia and the places that come under her dominion or try to resist her power. The

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[6] The growing awareness of the potential impact of digitalisation on mainstream Classics can be evidenced by it being the subject of two special lectures delivered during 2009: Donna Kurtz (University of Oxford) gave the closing lecture of the Fédération internationale des Associations d'études classiques (FIEC, Berlin on 29 August 2009), on 'The future of the past: CLAROS' (the Classical Art Online Research Services); and one of the inaugural lectures in King's College London's series *The Arts, the Academy and the World* was on the theme of 'Decoding Pasts, Building Futures' (http://kcl.ac.uk/schools/humanities/week/arts/pastfuture.html). We at HESTIA are also trying to build 'new worlds out of old texts' ('Introduction' by T.J. Barnes and J.S. Duncan, in Barnes and Duncan (ed.), *Writing worlds: Discourse, text and metaphor in the representation of landscape* (London 1992), 3).

[7] See our website http://www.open.ac.uk/Arts/hestia/index.html for more information about our research goals. The use of ICT mapping resources in the Humanities was the major theme of the e-Science institute workshop, entitled 'Mapping Information with and without Geography: Approaches to Data Visualisation and Structure in the Arts, Humanities and Social Sciences', held in Edinburgh in September 2009 (more information at http://www.nesc.ac.uk/esi/events/1005/).

[8] While there has been recent interest in space within archaeology and history, as evidenced by a specialist panel at the 2007 Classical Association Conference dedicated to exploring the interactions of monuments, spaces and rituals in Delphi and Athens, there has been little recent work on submitting ancient Greek literary texts to spatial examination. In fact, a recent article by Tom Harrison on Herodotus ('The place of geography in Herodotus' *Histories*,' in C. Adams and J. Roy (ed.), *Travel, Geography and Culture in Ancient Greece, Egypt and the Near East* (Oxford 2007), 44-65) assigns the '*search of* geography and its place in the *Histories*' (44) the highest priority, yet fails to consider the potential for historical agents to offer differing views of space, the impact on conceptions of space when represented as discourse, or its performance within Herodotus' text.

world that Herodotus subsequently depicts is commonly represented in a form like that of Figure 1.[9] As will be immediately evident from such an image, the gap between representation and its objective—the actual topography of the area as we know it—is considerable: as a result, one primary objective of HESTIA is to deploy the latest satellite imaging freely available from NASA to re-present Herodotus' world in a more accurate fashion in a form most readily accessible to modern-day users (see Figures 4a-c). Yet, for all of its drawbacks, this non-realistic map does raise several important issues relating to the conception of space in the *Histories*, most notably the division of the world into three separate units, Europe, Asia and Libya, the importance of water bodies, in particular rivers, for organising that space,[10] and with it the social, political, and cultural construction of representations of space.[11] Indeed, 'mental maps' of this sort are growing in popularity in contemporary studies precisely in recognition of their value in bringing to light the ways in which space may be held to mean different things by different groups, which is a concern too for HESTIA, as we explain below.[12]

And yet..., still there is something not quite right with the image in Figure 1: this picture captures only a snap-shot of places mentioned in Herodotus, which otherwise presents a blank canvas regarding their flow through time—a point Herodotus himself is alert to. Immediately after his tongue-in-cheek account of the Persian rationalisation of (Greek) mythology, which has the effect of absolving them of blame for the recent conflict with the Greeks, Herodotus explains his own narrative focus (on Croesus and the generations after him) in terms of 'going through in detail towns of men both small and great alike: for of the places that were once great, most have now become small, while those that were great in my time were small before' (ὁμοίως σμικρὰ καὶ μεγάλα ἄστεα ἀνθρώπων ἐπεξιών· τὰ γὰρ τὸ πάλαι μεγάλα ἦν, τὰ πολλὰ σμικρὰ αὐτῶν γέγονε· τὰ δὲ ἐπ' ἐμεῦ ἦν μεγάλα, πρότερον ἦν σμικρά, 1.5). Another of HESTIA's aims,

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[9] This map has been chosen because, being published under a Wikimedia Commons license, it can be reproduced without any infringement of copyright—as is the case for all maps included here. But this map is typical of other reproductions of Herodotus' world: see O.A.W. Dilke, *Greek and Roman Maps* (London 1985), 58.

[10] For the importance of natural boundaries to Herodotus' conception of history and, in particular, rivers as demarcation boundaries and markers of transgression, see esp. H. Immerwahr, *Form and Thought in Herodotus* (Cleveland 1966), in the index under *river motif*; cf. D. Braund, 'River frontiers in the environmental psychology of the Roman world', in D.L. Kennedy, ed., *The Roman Army in the East* (*JRA* Supp 17, 1996), 43-7. This was also the subject of Katherine Clarke's presentation at the inaugural HESTIA workshop in Oxford on 13 January 2009 in a paper entitled 'On rivers: being transgressed and assisting the "good"'.

[11] See e.g. N.J.W. Thrower, *Maps and Civilization: Cartography in Culture and Society* (Chicago 1996); J.B. Harley, 'Deconstructing the map', *Cartographica: The International Journal for Geographic Information and Geovisualization* 26 (1989), 1-20; P. Jackson, *Maps of Meaning: An Introduction to Cultural Geography* (London 1994); K.T. Jones, 'Scale as epistemology', *Political Geography* 17 (1998), 25-8.

[12] So-called 'cartograms' are especially eye-catching in the way that they can represent territories in relation to a particular subject. So, for example, the larger a country's GDP, the more inflated it looks, and vice versa. See, e.g.: http://www.bbc.co.uk/blogs/thereporters/markeaston/2008/10/map_of_the_week_the_wealth_of.html

then, is to be more sensitive to the narrative context in which a particular location is mentioned; in other words, we tie Herodotus' naming of a place to its position in the text. This allows us to draw a series of maps that depict a world in flux, as well as to capture a sense of space as something lived, not abstractly conceived (Figure 5).

But even this approach has yet quite to represent space in a way that sufficiently captures its varied manifestations in Herodotus' narrative: for a further problem with the static scene portrayed by Figure 1 is the absence of any relational indicators—it is, to put it simply, a world without lines of interaction, where regions are separate from each other, and whose boundaries are rigidly policed by bodies of water. To a certain extent, as we have mentioned, this kind of ideologically marked division of the world into discrete units does map onto contemporary Greek thinking regarding self-definition against others, which is present too in Herodotus' aim.[13] But, as recent scholars have begun to show, the world of the Mediterranean from antiquity onwards may be better thought of as a 'contact zone', in which the key theme is connectivity rather than polarity, and where the seas and rivers act as facilitators of movement through and exchange between different places across the region.[14] Now, it is certainly debatable whether Herodotus represents, or is even interested in representing, a network culture that accurately maps onto his historical circumstances—the situation on the ground, as it were—thus making it problematic to use his narrative as evidence for the existence of specific real-life networks.[15] But, at the same time, at every step of the way through the narrative points of contact are made between different places in a variety of ways, either by Herodotus himself or by his historical agents. By seeking to lift these connections out of the text, we hope to counter the conventional emphasis on topography, which appears all too evident from our contemporary viewpoint of the world afforded by satellite imaging, and refocus attention instead on the *topological* relationships between places—the links that depend on human agency and the associative clusters that certain places form over the course of the narrative (Figures 8-10). It may also represent an

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[13] E.g. E. Hall, *Inventing the Barbarian* (Oxford 1989); P.A. Cartledge, *The Greeks and Others* (Bristol 2004 [1993]). But the picture of the 'self and other' in Herodotus' narrative is rather more complicated than that, and often shifts according to context so that the Persians may appear irrational and barbaric when facing the Greeks, but a good deal more orderly and civilised when fighting the Scythians: so F. Hartog, *In the Mirror of Herodotus* (Berkeley 1988 [1980]). For a vigorous challenge to a simple 'east vs. west' dichotomy in Herodotus, where it is not a total surprise 'to find Self in Other and Other in Self', see C.B.R. Pelling, 'East is east and west is west—or are they?', *Histos* 1997 (http://www.dur.ac.uk/Classics/histos/1997/pelling.html).

[14] The Mediterranean as a 'contact zone': J. Horden and N. Purcell, *The Corrupting Sea* (Oxford 2000); as a sea of 'connectivity': C. Constantakopolou, *The Dance of the Islands* (Oxford 2005). On networks in antiquity, see esp. I. Malkin, *The Returns of Odysseus* (Berkeley 1998); I. Malkin, C. Constantakopoulou and K. Panagopoulou (ed.), *Greeks and Roman Networks in the Mediterranean* (New York 2009).

[15] A point made with characteristic incisiveness and vim by Nicholas Purcell at the project's preliminary workshop (13 January 2009).

alternative route towards constructing a series of 'mental maps' of the world as conceived of by those who lived it.[16]

Before we go on to outline and discuss in more detail our application and use of digital resources to address some of these ideas, let us first take a brief example from the text to demonstrate their importance, particularly because close reading of this nature is used to bring to light spatial concepts that underpin our employment of ICT. In the fifth book of his *Histories*, Herodotus describes a meeting between Cleomenes, king of Sparta, and Aristagoras, tyrant of Miletus, who has come to Lacedaemon to solicit support for a revolt of Ionian Greeks from Persian control. Coming as it does at a critical juncture in the narrative, as Herodotus makes the transition from mapping out Persian power to narrating the subsequent conflict with the Greek world,[17] this episode brings to light a number of important issues for thinking about space in Herodotus. Having been admitted to converse with Cleomenes, and armed with 'a bronze tablet on which the map of all the earth was engraved, and all the sea and all the rivers' (ἔχων χάλκεον πίνακα ἐν τῷ γῆς ἁπάσης περίοδος ἐνετέτμητο καὶ θάλασσά τε πᾶσα καὶ ποταμοὶ πάντες, 5.49.1), Aristagoras first appeals to the Spartan's sense of Hellenic comradeship, before going on to articulate the material benefits of an Asian invasion, using his map as a visual support (5.49.5-7):

> 'The lands in which they dwell lie next to each other, as I shall show: next to the Ionians here are the Lydians, who inhabit a good land and have a great store of silver.' (This he said pointing to the map of the earth which he had brought engraved on the tablet.) 'Next to the Lydians,' said Aristagoras, 'are the Phrygians here to the east, men that of all known to me are the richest in flocks and in the fruits of the earth. [6] Close by them are the Cappadocians, whom we call Syrians, and their neighbours are the Cilicians, whose land reaches to the sea here, in which here the island of Cyprus lies... [7] Adjoining these is the Cissian land here, in which, on the river Choaspes here lies that Susa, where the great king lives and where the storehouses of his wealth are located...'
>
> "κατοίκηνται δὲ ἀλλήλων ἐχόμενοι ὡς ἐγὼ φράσω, Ἰώνων μὲν τῶνδε οἵδε Λυδοί, οἰκέοντές τε χώρην ἀγαθὴν καὶ πολυαργυρώτατοι ἐόντες." δεικνὺς δὲ ἔλεγε ταῦτα ἐς τῆς γῆς τὴν περίοδον, τὴν ἐφέρετο ἐν τῷ πίνακι ἐντετμημένην. "Λυδῶν δέ" ἔφη λέγων ὁ Ἀρισταγόρης "οἵδε ἔχονται Φρύγες οἱ πρὸς τὴν ἠῶ, πολυπροβατώτατοί τε ἐόντες πάντων τῶν ἐγὼ οἶδα καὶ πολυκαρπότατοι. [6] Φρυγῶν δὲ ἔχονται Καππαδόκαι, τοὺς ἡμεῖς Συρίους καλέομεν. τούτοισι δὲ

[16] According to contemporary geographers, the two-dimensional 'Cartesian'-style map, which has dominated Western horizons since the Enlightenment (A.J. Gurevich, *Categories of Medieval Culture* (London 1985)), has in effect replaced the 'discontinuous patchy space of practical paths by the homogeneous, continuous space of geometry' (D. Harvey, *Consciousness and the Urban Experience* (Baltimore 1985), 253) and restricted understanding by 'flattening out' multiplicity and multi-directionality (e.g. J. Fabian, *Time and the Other* (New York 1983)). The new media for visualising the world, then, have the potential to revolutionise not only approaches to space in Herodotus but also our own ways of conceptualising space, just as the new prose medium in which Herodotus was working must have influenced the spatial thinking of his contemporaries. See further §4 below.

[17] This is one of the primary reasons behind the book by E. Irwin and E. Greenwood (ed.), *Reading Herodotus. A Study of the Logoi in Book 5 of Herodotus' Histories* (Cambridge 2007).

> πρόσουροι Κίλικες, κατήκοντες ἐπὶ θάλασσαν τήνδε, ἐν τῇ ἥδε Κύπρος νῆσος κέεται... [7] ἔχεται δὲ τούτων γῆ ἥδε Κισσίη, ἐν τῇ δὴ παρὰ ποταμὸν τόνδε Χοάσπην κείμενα ἐστὶ τὰ Σοῦσα ταῦτα, ἔνθα βασιλεύς τε μέγας δίαιταν ποιέεται, καὶ τῶν χρημάτων οἱ θησαυροὶ ἐνθαῦτα εἰσί... ”

Being Spartan, Cleomenes needs time to process so many words: thus he invites Aristagoras to return three days later to reconvene the meeting. When that moment arrives, Cleomenes asks simply how many days' journey it was from the Ionian Sea to the king (5.50.1). At this point Herodotus observes a critical error on the part of the man from Miletus: he tells the truth (!). It was, Aristagoras concedes, a three months' journey inland (5.50.2). The consequences of such a reckless action immediately come to light, for, in response to the answer of 'thirty days', Cleomenes bade his Milesian guest depart Sparta before sunset (5.50.3).

The key issues that we take from this story for our analysis are as follows. First, Herodotus presents a world not only built on *networks* but also *interconnected* and *decentred*: there is little sense of a Greek-barbarian polarity at play here, other than in the rhetoric that Aristagoras employs. This networked world is evident not only from the string of places which Aristagoras mentions, as he hops from one place to another in his attempt to demonstrate to Cleomenes the ease by which conquest would be accomplished;[18] it is evidenced also from the very fact that a tyrant of Miletus goes to Sparta in order to seek an alliance in the first place.[19] Second, just as the story lays emphasis on the role of *human agency* in the production of networks, so the importance of *focalisation*—how a particular individual or group *sees*—comes to prominence in the conceptualisation of space.[20] This idea raises the crucial prospect that different peoples within the narrative conceive of space in alternative ways, a point that Herodotus wonderfully brings out in Cleomenes' (delayed) response to Aristagoras' proposal: the arguments for foreign adventure of the worldly Aristagoras (tyrant of a city at the hub of trade routes on the margins of the Persian empire) fall on the deaf ears of the king of a land-bound people (whose very territory, the Peloponnesos, signifies an 'island'), who finds a 'thirty day' journey *from the Ionian Sea* beyond his ken.

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[18] As Chris Pelling suggestively puts it, 'If Aristagoras were a website, he would be full of links' (C.B.R. Pelling, 'Aristagoras (5.49-55, 97)', in Irwin and Greenwood (n.17), 179-201, quotation on p.179). Pelling here is talking about Aristagoras' dense textual connections, whose personal history crops up at different points in the narrative of book 5. But the metaphor works rather nicely too for pointing to Aristagoras' worldliness, which is part of that same picture.

[19] In fact, just prior to this episode Herodotus has already recounted Aristagoras' journey to Sardis, where he makes a similar plea for an alliance, only on that occasion it was the invasion of Greece that he was pedalling to a Persian satrap—which further complicates a Greek-barbarian polarity. By juxtaposing the two episodes, Herodotus brings out the picture of an interconnected world. According to Paola Ceccarelli (in an unpublished paper, 'The Islands of the Aegean: Europe or Asia? Conceptualising the Aegean Space'), Aristagoras' method of stringing together of places in both of his road maps to war exploits pre-existing network ties—or at least network thinking. She also posits that Herodotus is drawing on models of the world, possibly produced in Miletus by figures such as Anaximander or Hecateus, wherein Sardis and Sparta act as the two poles around which the (Mediterranean) world revolves.

[20] E.g. I. de Jong, *Narrators and Focalizers in Herodotus* (Amsterdam 1987).

That answer too reveals a third important idea, that of space not as an abstract notion but as a phenomenon which is *experienced*. This is important because the 'bronze tablet' that Aristagoras brings with him, which marks an attempt to replicate the topography of the world in an abstract form, is then exploited by Aristagoras precisely on the basis of that abstraction: he uses the fact of the map's small size in order to collapse the distance between places, so that, by repeatedly pointing to them, he creates the impression that conquest was going to be *that* easy.[21] In this context it is important to note too that the features on the map solely depict seas and rivers—waterways that enable movement—thereby lending it a rhetorical force in an argument about conquest. In Aristagoras' hands, then, the map becomes a tool of persuasion.[22] Yet, *this kind of* abstract representation ultimately fails when confronted by the 'reality' (τὸ ἐόν, 5.50.2) of Cleomenes' question, 'just how far is it from the Ionian Sea to the King (i.e. Susa)?', which leads to Aristagoras' immediate expulsion from the king's company.[23] Significantly, Herodotus follows up this story with his own account of the places that Aristagoras covers, ostensibly in order to bear out the accuracy of Aristagoras' (foolishly) true answer of thirty days, but more importantly in a manner which conceptualises space as being 'hodological': that is to say, as a route, a journey, rather than as some kind of visual abstraction of topography etched on a map.[24] This in turn raises the issue of *medium*, as Herodotus glosses Aristagoras' visual display of space with his own discursive representation of that space over the course of two whole chapters (5.52-4).[25] Indeed, we find this example a timely

[21] Herodotus makes this process explicit with the aside, 'he said this showing the map of the world which he had brought engraved on the tablet' (δεικνὺς δὲ ἔλεγε ταῦτα ἐς τῆς γῆς τὴν περίοδον, τὴν ἐφέρετο ἐν τῷ πίνακι ἐντετμημένην, 5.49). For his part, Aristagoras uses deictics throughout, as, for example: 'next to the Ionians here are the Lydians' (Ἰώνων μὲν τῶνδε οἵδε Λυδοί); 'next are the Phrygians here' (οἵδε ἔχονται Φρύγες); 'here the island of Cyprus lies' (ἥδε Κύπρος νῆσος κέεται); and so on.

[22] On the rhetorical value of Aristagoras' map, see A.C. Purves, *Telling Space: Topography, Time ad Narrative from Homer to Xenophon* (University of Pennsylvania, Ph.D., 2002), 106-17.

[23] As Purves (n.22), 111 perceptively points out, 'Herodotus never offers us the direct, simultaneous, and all-encompassing view' of the map (or, indeed, of history). Instead, 'Cleomenes' question causes the map's deceptively "easy" illusion of scale to collapse' (112), while Aristagoras' reply 'swiftly undoes the illusion of the 1:1 scale which [his] combination of image and narrative had suggested' (112-3).

[24] 'Unlike the mapped version, [Herodotus'] territory is marked by regular borders (πυλαί (gates), ποταμοί (rivers) and οὖρα (boundaries) predominate), and highly specific, neutral distances from place to place... [M]easurement through time acts as the key with which to unlock the dazzling, instantaneous effect of... Aristagoras' marvellous [display]': Purves (n.22), 116-7. Purves goes on to describe Herodotus' narrative of that space as 'hodological', following the traveller's experience and limited in view, in contrast to the 'objective', all-seeing cartographical representation of Aristagoras (117-21). Cf. P. Janni, *La Mappa e il Periplo. Cartografia antica e spazio odologico* (Marcerata 1984); A.C. Bertrand, 'Stumbling through Gaul: maps, intelligence, and Caesar's *Bellum Gallicum*', *Ancient History Bulletin* 11 (1997), 107-22. For Romm, Herodotus is a key figure in the shift towards informant-led documentation of space: see J.S. Romm, *The Edges of the Earth in Ancient Thought: Geography, Exploration, and Fiction* (Princeton 1994), 34-44.

[25] As recent scholars have pointed out, until well into the fifth century BC there were very few written texts and little prose literature to speak of: R. Thomas, *Literacy and Orality in Ancient Greece* (Cambridge 1992); Herodotus' *Histories* stand at the cutting edge of research and the development of a new medium, prose literature: E. Bakker, 'The making of history: Herodotus'

warning for our own enterprise, as we try to represent Herodotus' world using modern GIS[26] mapping tools.[27]

This example has been used to draw attention to a number of key themes for thinking about space in Herodotus *Histories* that we hope to address—namely, the types of networks present and their interpretation, the influence of human agency and focalisation, the idea of space as something experienced and lived in, and the role of the medium in the representation of space—and to emphasise that close textual reading underpins our use of ICT throughout. The rest of the paper will set out in more detail that methodology and the resources that we have employed, paying particular attention to the decisions that we have made and the problems that we have encountered, in the hope that our project can contribute not only to offering a more complex picture of space in Herodotus but also to establishing a model for future digital projects in the Humanities which deal with large text-based corpora.

Our methodology takes the form of four stages (Figure 2): 1. the digital markup of Herodotus' text; 2. the compilation of a spatial database; 3. the production of basic GIS maps, as well as GoogleEarth and Timeline maps, using the database; and, finally, 4. the production and analysis of automated network maps.

1. Digital markup of Herodotus' text

Our first task, to obtain a digital copy of Herodotus' text, was accomplished with the minimum of fuss due to the text being available at the on-line classical library, Perseus.[28] Moreover, because Perseus releases texts under the Creative Commons Attribution Non-Commercial Share Alike license, we were free to use and adapt that text—in this case the 1920 Loeb translation of A.D. Godley—in whatever way we wanted.[29]

Historiēs Apodexis,' in E. Bakker, I. de Jong and H. van Wees (ed.), *Brill's Companion to Herodotus* (Leiden 2002), 3-32; S.D. Goldhill, *The Invention of Prose* (Oxford 2002).

[26] Geographical Information Systems refers to the use of digital media in the representation and analysis of geographic data. See http://en.wikipedia.org/wiki/GIS.

[27] One of the more intangible questions that this project raises is the extent to which writing down space changes its conceptualisation, or, to put that another way, how the form of medium influences the ways in which the data are received—a concern too from the perspective of contemporary forms of mapping: see n.11 above. Herodotus is particularly important testimony for the different ways in which space may be conceived of and represented because of his narrative strategy of combining 'stories' (logoi): his keenness to record the views of historical agents produces a series of micro-narratives that potentially destabilise any one over-arching conception of space. Indeed, by representing space partly through the eyes of his historical agents as he travels around the Mediterranean, Herodotus offers important new stimuli for our own explorations into space as structured by human experience (Y.-F. Tuan, 'Literature and geography: implications for geographical research,' in D. Ley and M.S. Samuels (ed.), *Humanistic Geography* (London 1978), 194-206) or by flow (D. Rodowick, *Gilles Deleuze's Time Machine* (Durham NC 1997)).

[28] At http://www.perseus.tufts.edu.

[29] For more information, go to http://en.wikipedia.org/wiki/Creative_commons_license.

We further benefited from the fact that the placenames or *toponyms*—the data which we were interested in extracting from Herodotus—had already been 'tagged' in the English mark-up of the text. That is to say, the XML[30] of the English translation of Herodotus, which basically describes the underlying structure of the text that we see on our computer screens, had been written (or 'marked up') in such a way as to identify and isolate all the geographical concepts that Herodotus mentions (Figure 3). This had been done using a standard grammar known as TEI, which sets a common schema for the tagging of data in large text-based corpora.[31] Using a TEI-marked-up text in turn allowed us to manipulate and represent the data in different ways.

While the capture of the digital text from Perseus gave our project a welcome initial boost, a number of issues resulting from that inheritance were raised, which have had to be overcome before the data could be properly stored in a database and utilised. These may be broadly classified into two groups, procedural conversion and data cleaning. In both cases below we briefly outline the problem and our response to it.

i) Procedural conversion

- The documents (Herodotus' *Histories* in both English and Greek) obtained from Perseus came marked-up in TEI version P4, which represents the version prior to the current (as of 2009) internationally recognised standard (P5). Therefore, both documents had to be converted from TEI P4 to TEI P5, a process which was facilitated by using an automated conversion tool developed by Sebastian Rahtz of OUCS.[32] This has been largely successful with the exception of the 'reg' attribute, which was no longer supported on this platform. While this has no effect on processing the documents, it still requires rectifying before the documents can be resubmitted to Perseus for reuse in their own text (as per the Creative Commons license).
- The Greek text was transformed from Betacode to Unicode using Hugh Cayless's Transcoder tool to simplify reading and enhance compatibility.[33]
- The decision was made early on in the project to use the *English version* of Herodotus' *Histories* for investigating spatial data, primarily on the basis of practical concerns. Using the Greek text would have severely limited the potential dissemination impact of the project; but, more importantly, it would also have meant going through the text and tagging the toponyms 'by hand', when they were already widely available to us from Perseus using the English

[30] XML = extensible mark-up language: http://en.wikipedia.org/wiki/XML.
[31] According to its website, http://www.tei-c.org/index.xml, 'the Text Encoding Initiative (TEI) is a consortium which collectively develops and maintains a standard for the representation of texts in digital form. Its chief deliverable is a set of Guidelines which specify encoding methods for machine-readable texts, chiefly in the humanities, social sciences and linguistics.'
[32] OUCS = Oxford University Computing Services. The process describing this conversion, along with a link to the relevant stylesheet, is laid out at http://www.tei-c.org/Guidelines/P5/migrate.xml.
[33] For the reference, see: http://epidoc.sourceforge.net/resources.shtml.

version.[34] Bearing in mind the scholarly value of using the Greek text, however, we devised a process by which each section of the text in both documents was assigned a unique identifier in order to draw an association between the two versions. This has meant that, while we are using the English text to extract spatial data, at every point in the process the Greek text is available for scrutiny alongside it.

- The English version of the Loeb text of Herodotus used by Perseus came with footnotes, which were also marked up. All footnotes were stripped out in order to prevent contamination by modern toponyms within them. These 'reference free' documents form the basis for the analysis.

ii) Data cleaning

- Many of the toponyms inherited from Perseus came already tagged with certain kinds of data, such as geographical co-ordinates, place type and modern-day location, deriving from not only the Perseus Gazetteer but also the Getty Thesaurus of Geographic Names (TGN). The information was of a variable nature and lacked consistency. We describe our standardisation of categories in §2 below, since it involves the database structure; but essentially the data cleaning that we undertook involved checking the data for inconsistencies and correcting them in the database.
- In particular it involved:[35]
  - removing duplicate entities for locations;
  - correcting references to false locations (in particular those with homonyms);
  - correcting coordinates;
  - correcting categorisation;
  - correcting parent territories.

2. Compilation of a spatial database

In this section we describe the type, structure and categorisation of our spatial database. The database that we have developed houses all the spatial data, which we extracted from the digital text of Herodotus' *Histories* (the English version), and can be queried in order to produce a series of automated results, which can in turn be visualised in the form of maps. The kind of database that is used and the ways in which the data in it are organised are crucial elements in determining the kinds of results that can be achieved.

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[34] Using the English text also has its own problems, of course. We discuss some of these below.

[35] This work took place in roughly two stages. Stage one involved going through the data when housed in the database in order to search for and correct inconsistencies or fill in notable gaps. In stage two we visualised the data in GIS and compared the results to the Barrington Atlas, and then corrected anomalies using GoogleEarth. We also conducted a book-by-book visual inspection of the network to check whether references had been assigned to the wrong location. It was found that this frequently occurred in the case of homonyms or when localities had changed their name.

i) Database type

The PostgreSQL[36] database is an industrial-strength open source database which was selected because its PostGIS[37] extension provides excellent functionality for spatial data and is widely supported by other applications. By storing information about *references*, *locations* and the *text* in the database it is possible to link it both to a Desktop GIS system and to Webmapping server simultaneously.

The sophisticated functionality of the database means that it can provide a powerful tool for analysis. It is worth remarking however that in this case the Principal Investigator and the two Co-Investigators had to spend time getting accustomed to the interface (and associated technologies such as the SQL query language) in order to make best use of it.

ii) Database structure

The table structure is extremely simple:

- A **section** table contains information about the section of Herodotus' text in which the locations occur;
- A **location** table identifies each unique location;
- A **ref** table ties these together by providing a unique id for all references to spatial locations within the text.

The advantage of using this structure is that updates to section or location will automatically filter through to their references. A virtual table (called a 'view') combining all these together can thereby be created which can be read by the webmapping server and GIS application. The Geometry points read by the GIS and mapping server, however, are updated by a script when latitude and longitude entries are edited.

iii) Data categorisation

In order to filter and query locations and references effectively so that different location types can be handled separately, it is first necessary to categorise them. This had been done to some extent by the Perseus project, but not in a consistent or normalised manner. Most importantly Perseus used only a single level of categorisation: in contrast we introduced two levels of categorisation for each location recorded in the fields 'geotype' and 'subtype'.

This broad categorisation separates places which are: 1) identifiable communities, encompassing both Greek poleis and other kinds of habitations, both Greek and non-Greek (= 'settlements'); 2) larger areas which may contain a

[36] PostgreSQL is a powerful, open source object-relational database system which has standard compliance: see http://www.postgresql.org/about/.

[37] According to the website http://postgis.refractions.net/, 'PostGIS adds support for geographic objects to the PostgreSQL object-relational database. In effect, PostGIS "spatially enables" the PostgreSQL server, allowing it to be used as a backend spatial database for geographic information systems (GIS)'.

variety of communities (= 'territories'); 3) natural features of the environment (= 'physical features').

iv) Problems, limitations

- It has not always been easy or self-evident which placename should be allocated into which category: for example, should the Pontus be considered a natural feature (for being a sea) or a territory (for describing an area which encompasses several different communities)?
- The hardest cases of all to decide were islands which may be all three. In this case we adopted a policy that if an island had no defined habitation it would be allocated to the 'physical features' category (e.g. Psyttalea, near Athens); one or two communities on an island would categorise it as a 'settlement' (e.g. Lesbos, Naxos); several communities would make it a 'territory' (as, for example, in the case of Crete, Cyprus and Samos).

Each of these 'geotypes' has a number of 'subtypes' in order to allow for more fine-grained querying and visualisation:

- 'settlements' mainly refer to inhabited places, but can also include cult sites (Delphi) or activity (e.g. mines);
- 'territories' may describe continents, countries, regions (e.g. Peloponnesus), districts (e.g. of the Nile), or Attic demes;
- 'physical features' encompass seas, rivers, promontories, straits, lakes, mountains, and springs.

3. Production of GIS maps using the database

With the database now populated with accurate data, and organised in a way that exposes that data to questions of different kinds and quality, the next task was to subject the database to a series of queries, and represent the results of those queries in the form of maps. Once again the choice of application was critical for determining issues of data preservation and analysis. Furthermore, different queries of ranging complexity were tried out in order to test the value of subjecting spatial data in Herodotus to this kind of analysis and way of visualising the data in these kinds of form.

QGIS Geographical Information System

QGIS is an Open Source GIS that provides an ideal utility for spatially querying the data.[38] Although its digitising functionality is limited, it connects easily to PostGIS and can read a wide variety of other spatial formats as well. NASA provides a free Web Mapping Service (WMS) called the Blue Pearl

[38] Quantum GIS (QGIS) is a user friendly Open Source Geographic Information System (GIS), which can provide a continously growing number of capabilities provided by core functions and plugins. With it one can visualise, manage, edit, analyse data, and compose printable maps: see http://www.qgis.org/.

Mosaic.[39] Since QGIS provides functionality for importing WMS services, this application has been chosen as a solution for providing a raster backdrop of the Earth's surface.[40] In addition, it even provides global coverage for each month, which has proven extremely effective for showing snow cover at different times, thereby giving a strong and immediate indicator of some of the natural boundaries to human habitation and movement.

Information from PostGIS can be projected on top of this 'backdrop'. When location points are selected, a drop down window lists all references to that location, including the Greek and English texts of the relevant sections. A Query Builder can also be used to highlight (and, if necessary, filter) subsets of points based on specified criteria.

SQL queries

SQL (Structured Query Language) is a standardised language for querying and managing databases.[41] (Generally speaking, user interfaces to databases will convert user commands into SQL 'under the hood' in order to execute them.) In addition, the PgAdmin application provides a useful interface with which to write, save and reload queries.[42] SQL querying was used to perform a variety of different functions, which included:

- producing a gazetteer of sites;
- producing the total number of references to a specific location. In order to make the data more robust, this can be done by reducing multiple references within a section or chapter to just one;
- producing a 'narrative timeline' table that lists the number of references to a location in 10-book 'chunks';
- generating a network based on co-reference of locations within a chapter;
- generating a network that weights the links by the number of times two locations are referred to in the same chapter.

Examples of maps in GIS

The most basic maps that are generated simply represent a 'flat' image of the spatial data: that is to say, they mark all the places that Herodotus mentions over the course of his work with a single point, thereby providing a snapshot of the huge scope of his enquiry. In this way one is able to gain an overview of the places mentioned in Herodotus, and divided according to the three categories that we outlined above, settlement, territory and physical feature (Figure 4a). When

[39] Available at http://wms.jpl.nasa.gov/wms.cgi.

[40] It works very well at high-to-medium scale, but starts to be become problematic at the lowest scales of interest. Alternatives will be investigated for final product deliverables and the project website.

[41] http://en.wikipedia.org/wiki/SQL.

[42] According to its website, http://www.pgadmin.org/, pgAdmin is the most popular and feature rich Open Source administration and development platform for PostgreSQL, the most advanced Open Source database in the world.

one hones in on a particular area, it becomes feasible for individual places to be labelled, so that points can be identified by their toponym, whether they are settlements, territories or physical features (which, in turn, can be differentiated according to colour coding: Figure 4b). Lastly, since each place is given a unique identifier in the database, which ties it to a particular location in the narrative, it is also possible to isolate places according to narrative section and thereby visualise Herodotus' world by book (Figure 4c).

The spatial data, however, can be represented in different forms, generated by two particular kinds of query-builder. First, a query can be built that 'counts' the number of times places are mentioned. These queries can be used to visualise places in GIS according to their frequency, whereby the 'symbology' function can be used to differentiate between and classify the results. Hence Figure 5 demonstrates the category of 'settlement', each of which is scaled according to the number of 'hits' each receives over the course of the *Histories*. The most popular settlements in the narrative, as depicted by the large purple circles in Figure 5, are the following: Athens, Sparta, Delphi, Miletus, Sardis and the islands of Samos and Salamis. This kind of information is interesting because, at a glance, one can see the most important places in Herodotus' world. At least three of these places come as little surprise, since they play an important role in the political, military and cultural affairs of sixth-fifth centuries BCE: those being Athens, Sparta and Sardis. Delphi arguably is equally important as a cultural and political centre in the Hellenic world: but there is certainly little doubt of the key role it plays in Herodotus' narrative.[43] The same is obviously true of Salamis island, it being the place of the decisive defeat of the Persian fleet by the Greek coalition. The value of this map, then, lies in the attention that it draws to Miletus and Samos: Miletus is the centre of the Ionian revolt and, thus, in Herodotus' words, 'the beginning of all evils for Greeks and barbarians alike' (ἀρχὴ κακῶν Ἕλλησί τε καὶ βαρβάροισι, 5.97.3);[44] Samos, on the other hand, appears to be important because of the text's post-history and the growth of the Athenian empire, which had resulted in—known to both Herodotus and his audience—the brutal subjugation of Samos.[45]

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[43] On the importance of the Delphic oracle in Herodotus, particularly as a source of information, see: H.W. Parke and D.E.W. Wormell, *The Delphic Oracle* (Oxford 1956); R. Crahay, *La literature oraculaire chez Hérodote* (Paris 1956); H. Flower, 'Herodotus and Delphic traditions about Croesus', in M.A. Flower and M. Toher (ed.), *Georgica: Greek Studies in Honour of George Cawkwell* (*BICS* Supp. 58, 1991), 57-77; L. Maurizio, 'Delphic oracles as oral performance: authenticity and historical evidence', *ClassAnt* 16 (1997), 308-34; E.T.E. Barker, 'Paging the oracle: interpretation, identity and performance in Herodotus' History', *Greece & Rome* 53 (2006), 1-28; J. Kindt, 'Delphic oracle stories and the beginning of historiography: Herodotus' *Croesus logos*', *Classical Philology* 101 (2006), 34-51.

[44] Herodotus is referring to the ships that the Athenians send to Miletus in support of the revolt. On the significance of this phrase, which comes from Homer (*Il.* 5.62-3), see three contributions to Irwin and Greenwood (n17): R.V. Munson, 'The trouble with the Ionians: Herodotus and the beginning of the Ionian revolt (5.28-38.1)', 146-67 (esp.149-59); C.B.R. Pelling, 'Aristagoras (5.49-55, 97)', 179-201 (182, 186); and J. Henderson, '"The fourth Dorian invasion" and "the Ionian revolt"', 289-310 (305).

[45] See E. Irwin, 'Herodotus and Samos: personal or political?', *Classical World* 102 (2009), 395-416; cf. P. Stadter, 'Herodotus and the Athenian Arche', *Annali della Scuola Normale Superiore di*

GeoServer/GoogleEarth/NASA data

In order to start experimenting with public dissemination it was decide to expose the PostGIS data as KML: a markup format that can be read by a variety of mapping applications including GoogleEarth.[46] This was achieved by installing GeoServer, an Open Source server that serves spatial data in a variety of web-friendly formats simultaneously,[47] including KML, SVG,[48] WMS, WFS[49] and PDF. GeoServer has currently been configured to show all the references to spatial locations using a specially constructed view in the database. This only exposes data that is likely to be of interest to the general public (i.e. internal identifiers other than the location ID have been removed) and column names have been altered to be more self-explanatory. Significantly, it should be automatically readable on any machine that has GoogleEarth installed. Furthermore, since the link is a network link, rather than a static KML file, any changes to the database result in automatic and more-or-less instantaneous updating of the data in the viewing application without any need on the user's part to do anything.

With this 'Herodotus geodata', users will be able to construct 'mashups' of visual and textual data. ('Mashups' are web applications that bring together different digital files, often of different forms, in this case visual and textual data.[50]) So, for example, since all places are linked to entries in the database, when one clicks on a particular location in GoogleEarth, it will be possible to bring up a dialog box containing Herodotus' text (in both English and Greek) for that particular location for every occasion when it is mentioned in the narrative (Figure 6). It is this part of the project that potentially has the greatest impact, with its capacity to reach beyond the borders of a strict academic environment to bring the world of Herodotus into peoples' homes. Furthermore, as the Ancient Rome Google project has shown[51], it is also possible to take a virtual tour in GoogleEarth of various sites from ground level. In the case of Herodotus' *Histories* this might involve linking different places that are mentioned with each other in the same stretch of narrative in chronological order, so that one could

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Pisa 22 (1992), 781-809; J. Moles, 'Herodotus warns the Athenians', *Papers of the Leeds International Latin Seminar* 9 (1996), 259-84.

[46] **Keyhole Markup Language** (**KML**) is an XML-based language schema for expressing geographic annotation and visualisation on existing or future Web-based, two-dimensional maps and three-dimensional Earth browsers: http://en.wikipedia.org/wiki/Keyhole_Markup_Language. It was developed for use with GoogleEarth.

[47] **GeoServer** is an open source software server that allows users to share and edit geospatial data. Designed for interoperability, it publishes data from any major spatial data source using open standards: http://geoserver.org/display/GEOS/Welcome.

[48] **Scalable Vector Graphics** (SVG) is a language for describing two-dimensional graphics and graphical applications in XML: http://www.w3.org/Graphics/SVG/.

[49] The Open Geospatial Consortium **Web Feature Service** Interface Standard (**WFS**) provides an interface allowing requests for geographical features across the web using platform-independent calls. For more, see: http://en.wikipedia.org/wiki/Web_Feature_Service.

[50] Or, as the account in Wikipedia puts it, 'a **mashup** is a web page or application that combines data or functionality from two or more external sources to create a new service'. For this quotation and more information, go to: http://en.wikipedia.org/wiki/Mashup_(web_application_hybrid).

[51] See http://earth.google.com/rome/.

follow the 'journey', say, of historical agents within the text. One particularly fruitful line of enquiry for a school audience to pursue, one imagines, would be to follow Xerxes' passage into Greece from the 'down-on-the-earth' perspective of one of his myriad troops.

'Narrative Timeline'

Whilst it is possible to visualise narrative change using graphs, and static differences using the GIS, it is still very hard to visualise spatial changes throughout the narrative; QGIS does not have useful functionality in this regard beyond the ability to turn layers on and off which becomes impractical beyond book level. GoogleEarth does have timeline functionality, providing a temporal 'slider' which can be used to make entities appear and disappear; but the KML provided by GeoServer does not provide temporal coordinates and even if it did, we are more interested in change through 'narrative time' (i.e. book, and chapter) than real time.

Instead, we discovered that the most likely candidate to provide this kind of functionality was a project called TimeMap.js: an Open Source JavaScript project that draws on several technologies in order to allow data plotted on GoogleMaps to appear and disappear as a timeline is moved.[52] We commissioned its developer Nick Rabinowitz to convert this model so that it could deal with 'narrative time', since the data that we had captured from Herodotus relates to a narrative (of nine books) rather than a strict sequence of dates. The result is illustrated in Figure 7. There are three primary reading panes: in the centre is the GoogleMap on which the places are plotted (using the familiar GoogleMap icons); the 'timeline' bar underneath, which shows the location of the places relative to the book section; and, finally, to the right a window for the text itself, which can be read in either Greek or English. In addition, we have retained the same schema by which the places are categorised according to whether they are a settlement, territory or physical place. Searches can be made either by book/section (using the 'jump to' facility or else the 'search' box) or by simply moving the 'timeline' bar with the browser. When one clicks on a particular place in the 'timeline', a dialog box pops up on the GoogleMap showing its location, as well as it being highlighted in the text reading pane.

In this way the Google Timeline Map is envisaged as a tool to complement one's reading of the narrative by showing in an easy-to-use format the location of places that are mentioned in a particular stretch of narrative. But, in order to integrate the visual and textual data more fully, one additional feature has been included. When places are first mentioned, they appear flush to the right-hand side of the 'timeline' bar and fully coloured in on the map. As one moves through the narrative, however, they move to the left of the 'timeline' bar accordingly and become ever fainter on the map, until, in both cases, they drop out altogether. In doing this, we have tried to reproduce more accurately the reading experience: that is to say, when a place is first mentioned, it makes an initial bold impression

[52] See http://code.google.com/p/timemap/ and http://www.nickrabinowitz.com/timemap.

in the mind; some chapters later, this place might no longer hold the attention so greatly, but its memory lingers on (captured in the Timeline Map by the faded icons), until it disappears altogether. By re-visualising the data in this format, we hope not only to assist in the reading experience of Herodotus but also to raise new research questions that would not have been apparent before the advent of such technology.

In this section, we have demonstrated just some of the uses to which the spatial data that we have captured in the database can be represented using different kinds of maps. The first kinds of maps are rather basic, simply showing the places that Herodotus mentions plotted in GIS using the latest satellite imagery. Even with this kind of map, however, the user can perform different queries in order to visualise the data in a more sophisticated form, say, either by book or by total count. The second kind of map that we demonstrated was GoogleEarth. Through the link provided on our website, users with this application can access all the spatial data that we have gathered in Herodotus: in other words, by clicking on the link, their version of GoogleEarth will open with our data loaded into it. This functionality provides the user with unprecedented capability for locating the precise whereabouts of the places that Herodotus mentions as well as finding out the information that the historian records about them. Lastly, we have shown the uses to which a 'timeline' map can be put: where the GoogleEarth application allows the reader to roam free over the world of Herodotus but somewhat detached from his narrative, the Timeline Map refocuses attention on the narrative itself and encourages the user to read text and image alongside each other. But even this map is not able to move the viewer away from a topographical simulation of the world. In order to extract and analyse the topological connections embedded in the text, an alternative strategy is needed: the production of network maps.

4. Production of network maps using the database

Thus far in this paper we have outlined the computer-based technology with which we have extracted spatial data from Herodotus' *Histories* to form a database of places and exemplified just some of the ways in which this database can be queried and used to represent a series of maps that shed light on the multifarious conceptions of space present in Herodotus' text. As Herodotus himself is alert to, however, the medium in which space is represented can fundamentally alter the way that it is conceived: the bronze engraving of the world, which Aristagoras brings with him in his conference with Cleomenes, collapses all sense of distance and is used by Aristagoras to create the impression that an easy conquest awaits[53]—an impression that Herodotus is quick to counter as he supplies the data, and effort, missing from that account with his own narration of the journey from the Ionian Sea to Susa. We acknowledge that our own use of new media to re-imagine space in Herodotus must inevitably also distort the picture, particularly since, with the advances to mapmaking brought

[53] On 'easy' being a catchphrase of Aristagoras, see Pelling (n.18), esp. 179-80.

about by the latest satellite imaging, it now appears possible to present the world as it really is. But, however accurate the maps, say, in GoogleEarth appear, the medium one uses can never be truly objective: the form chosen to represent space inevitably affects its understanding and is in itself framed by certain epistemological assumptions.[54]

In this last section, then, we outline how we try to better use the data capture of places in Herodotus by extracting and analysing the connections made in the narrative *between* places: that is to say, we aim to bring to light the ways in which the *Histories* articulate an understanding of space different from the topographically-based two-dimensional map that has dominated western cartography for centuries, by approaching geographical relationships through the lens of '*topological*' connections between places—those links that the human agent draws. In other words, we are interested in capturing and evaluating the mental image (or, better, images) of the world contained within Herodotus' narrative, not any supposed objective representation. Given that this paper is meant as an introduction to the ICT that we are using, we limit our investigation to the network maps that can be generated automatically from the database. But we will end with a note of caution relating to just how far an automated process can take us and gesture towards an alternative 'bottom-up' analysis of the text that will be needed, if one is to gain a more accurate picture of the network culture in the *Histories*.

Automated network maps

In §3 above we demonstrated how, with a database of spatial information captured from the *Histories*, we can re-visualise Herodotus' world in a variety of ways using the latest information computer technology and satellite imaging. While breaking new ground in terms of its application to the study of ancient texts, it was emphasised that this part of the project is largely concerned with *impact*; that is to say, it is engaged primarily with a view to bringing Herodotus to a whole new generation of readers.[55] The extent to which any of those maps offer a radically new way of thinking about spatial matters in Herodotus is perhaps more debatable, since other resources, such as the TLG or Perseus, or even conventional concordances, are already capable of identifying the most important settlements in Herodotus' narrative. On the other hand, the maps generated in §3 are of value for revealing the intensity of Herodotus' gaze, for denoting the landscape of familiarity, or even for prompting new kinds of research questions.

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[54] See n.11. Also J.W. Crampton and J. Krygier, 'An introduction to critical cartography', *ACME: An International E-Journal for Critical Geographies* 4 (2006), 11-33.

[55] Disquieting as many readers will find that term, given the controversy over its anticipated use, 'impact' is one of the key measures by which (it is proposed) Arts and Humanities research is to be assessed in the future *Research Excellence Framework* (REF)—at least according to the consultation document distributed by the *Higher Education Funding Council for England*: http://www.hefce.ac.uk/research/ref/impact/. Perhaps the aims and outcomes of this project, however, whose inception antedates that controversy by some time, may confirm that Humanities researchers as a matter of course accept the value of broadening accessibility, even if they also feel deep reservations about adopting this as a *criterion* for research assessment.

Moreover, much less easy to anticipate, and therefore of much greater scholarly value, is the existence, shape and magnitude of the connections that Herodotus draws between those places.

An early step in our analysis of the spatial data has been to explore rapidly-generated network maps based on simple co-presence of terms within sections of the text. Such networks have no semantic content as such; they simply reflect the fact that Herodotus is mentioning places 'in the same breath'. The purpose of producing such representations is to explore how strongly the narrative is bound to geographical territories and how clearly those territories are demarcated. It is also there to flag up potential 'weak ties' between them. An SQL query was written that generates a network map of lines, which extends between each pair of locations appearing in a single sentence (in the English translation) of Herodotus. The toponyms used, reference id, book number and full English and Greek texts are also recorded. The lines can be easily visualised in the GIS in conjunction with the town sites.

Figure 8 captures one such simple network, that for the subdivision of 'countries' with the broader 'territory' category across the entire *Histories*.[56] It shows, for example, a series of links connecting Greece to other territories within the Mediterranean world, primarily Italy, Thrace, Scythia, Persia and Egypt. Interestingly, however, from this broad brushstroke image of Herodotus' world, the territory that has the strongest connections in this basic network culture is not Greece, but Egypt: each one of the links that Egypt has to other territories scores in the highest rating. While this may not have been anticipated, it does make sense on reflection, since for a better part of one book Herodotus uses Egypt as the touchstone against which other cultures, including Persia and his own, Greece, are compared, offering in particular the long view which helps to place the Greco-Persian conflict in a new perspective. It is as a tool of comparison, then, that Egypt appears to be the centre of Herodotus' network picture of the Mediterranean.

Figure 9 complements this picture. It shows the co-reference network density of physical features scaled above the rank of one (to give a simpler, and more meaningful, picture). Two relationships stand out. The first is the connection between the river Ister (the modern-day Danube) in Scythia and the Nile. The strength of this relationship relates to the point made above regarding Herodotus' use of Egypt as a means of comparison: what is being shown is again not a 'real-

[56] 'Countries' can obviously be a rather misleading term to describe places as diverse as Persia, Egypt, Thrace, Greece, etc, particularly when the whole concept of, say, 'Greece' is hardly self-evident in the *Histories*. On the other hand, we have not used descriptors that Herodotus himself does not use. Moreover, the category of 'territory' could be misleading in such a query because like would not be being compared to like: the 'continents' of Europe, Asia and Libya are of a rather different order, and are used in a different way, from the 'countries' mentioned above. On the idea of 'Greece' in Herodotus, see: J.J. Price, *Thucydides and Internal War* (Cambridge 2001), 372-4; E.T.E. Barker, *Entering the Agon: Dissent and Authority in Homer, Historiography and Tragedy* (Oxford 2009), 195-8. On Hellenism more generally: E. Hall (n.13); Cartledge (n.13); J.M. Hall, *Hellenicity: Between Ethnicity and Culture* (Chicago 2002), 172-205.

life' network but in this case the use of physical features to frame comments made by the author relating two places to one another (Scythia and Egypt), both of which are on the margins of the known world, though in rather different ways.[57] The other strong connection marked in this map is between the Pontus and the Hellespont. This axis is important because it relates to the growing reach of the Persian Empire, as Darius casts his eyes westwards from the Pontus towards the Hellespont, the bridging point between east and west, in a move that anticipates his son's literal bridging of the Hellespont in his invasion of Greece. The map also demonstrates the extent to which physical features envelop anthropogenic constructs like territories, which acts as anchors for the geography of linkages between social formations constructed by Herodotus.

A whole range of other basic network maps can be quickly and easily generated that vary in nature according to the location type one chooses to focus on (settlement, territory or natural feature), the general scene in a particular book, the connections enjoyed by any one specific location, those locations that enjoy the most number of connections (the central 'hubs' in a network), or those networks that have the most frequent associations. We have supplied one last map (Figure 10) which illustrates one of these features, the personalised network of a single specific location, Susa, the capital of Persia. In this case it is readily seen the extent to which Herodotus' narrative focuses on Persian interference in Greek affairs: here we really do get a sense of the 'long arm' of Persian law and military might from this picture, particularly centring on Sardis (the site of its important satrapy in the wake of the defeat of Croesus) and Miletus (the centre of the Ionian revolt). From the perspective of Herodotus' narrative, Persia's network casts a shadow over the events and peoples of the eastern Mediterranean.

Thus the database can be used not only to gain a general sense of a broad network culture represented in Herodotus but also to generate a series of different types of network representations depending on the queries that one asks of the data. It should be noted, however, that none of these maps are sufficient in and of themselves. That is to say, the maps that are depicted do not show the results of an enquiry: rather, they are there to prompt new questions and provoke further investigation. In this way, the automated maps, both of the simple GIS kind and the more complex networks, should be regarded as *complementing* rather than replacing close textual analysis. In the last section of this paper we outline some of the problems and limitations to these computer generated maps, as well as suggesting a way forward that can help exploit them most fully.

Problems with the automated network maps

The first problem lies with the spatial data that we inherited from the Perseus digital copy of Herodotus' text, which, while providing the project with an initial boost, has several flaws. The most obvious deficiency is the fact that an English translation of a Greek original is being used, a translation, moreover, that is somewhat dated (which is why it can be used without infringing copyright). Being

[57] See Hartog (n.13).

at best an approximation of Herodotus' actual text, the translation lacks a standard of accuracy in terms of both grammar and syntax that would be necessary if the production of automated maps were the sole aim of the project. Indeed, in an effort to counter a degree of arbitrariness that can creep into the data from the use of a translation, we have chosen to extract networks on the basis of ten section 'chunks': to try to attempt a more refined process that takes the material one sentence at a time would give a misleading picture of the accuracy that is possible, when at the level of sentence structure the two texts—Greek and English—habitually depart.

A greater problem, however, relates to the basic raw data that we have captured from the digital text, in the form of the 'placename' category. Frequently a place may be named in the English translation—and, hence, captured in our database—which *is absent from* the Greek. At one level this is again a problem of the degree of imprecision in our data, which could potentially detract from its value. But there is more to it than that. The frequent absence of toponyms in the Greek text also brings to light a fundamental difference between English and Greek semantics in the way that a place may be thought of: what is a named geographical concept in the English translation (and hence captured in our database) frequently represents what in the Greek is the *people* who occupy that place, which, strictly speaking, ought not to feature in our data capture as it stands.[58] Significantly, this tendency to talk about peoples instead of places is not limited to Herodotus but is shared by many Greek authors, suggesting a certain cultural privileging of people over place.[59] So, for example, two peoples go to war, not two cities.[60] From an ancient Greek perspective, then, peoples are what matter, not the places in which they dwell. The best example of this type of thinking comes from Herodotus himself, when he describes the Athenian threat, as articulated by Themistocles, to up sticks and set up a new Athens somewhere else—in Italy![61] On the one hand, the type of category thinking that our analysis demands has helped to draw attention to this important aspect of Greek conceptions of space. On the flip side of the equation, the category of people often has a significant spatial dimension that is desirable to capture. Ironically, the

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[58] The replacement of a location with a pronoun is another factor influencing whether spatial information is missing from our database (if a pronoun is used in the English) and/or whether it accurately reflects the Greek (if a pronoun is used in the Greek, but a placename is used in the English).

[59] In the Catalogue of Ships in Homer (*Il.* 2.484-785), for example, it is notable the degree to which peoples are said to occupy or possess their locations: the groups are being stressed, not the places in which they dwell. See B. Heiden, 'Common people and leaders in *Iliad* Book 2: the Invocation of the Muses and the Catalogue of Ships', *Transactions of the American Philological Association* 138 (2008), 127-54.

[60] As the first line of Thucydides makes clear: 'Thucydides the Athenian wrote the war between the Peloponnesians and Athenians' (Θουκυδίδης Ἀθηναῖος ξυνέγραψε τὸν πόλεμον τῶν Πελοποννησίων καὶ Ἀθηναίων, 1.1.1).

[61] Herodotus 8.62.2, echoed by Nicias in Thucydides, 'for men are the polis' (ἄνδρες γὰρ πόλις, 7.77.7). For a collection of ancient sources which diverge on the relative importance of people over place, see S. Hornblower, *A Commentary on Thucydides: Volume III Books 5.25-8.109* (Oxford 2008), 720-1.

inexactness of the English Loeb comes to our rescue in several cases, because it frequently 'translates' the spatial idea contained with 'peoples' into a 'placename', though, it has to be said, there remain many instances when the English translation too names the people rather than the place, and there are obvious dangers in naming a place when it does not occur in the Greek. To a certain extent this problem may be resolved by extending the data capture to include the category 'ethnic' as well, which we may well endeavour to do at a future stage.[62] Even then we will be left with the problem of assigning a particular spatial location to an amorphous group of people, an issue that will become particularly evident when dealing with the nomadic culture of Scythia.[63]

A second, more general problem with the type of network maps generated above relates to the automated process itself, which largely relies on 'counting' the number of hits a particular connection between two or more places has, on the basis of the rough measure of ten section 'chunks', and has little to say other than whether a connection exists or not, or how strong it is. It is a desideratum in the future that the automated process nuances this quantitative approach, either by tailoring the chunks more closely to Herodotus' narrative,[64] or by using natural language processing to explore the possibilities of constructing a typology that identifies something of the nature of the networks being extracted.[65] In lieu of either of those approaches, which are beyond the scope and resources of the present project, however, we will be conducting a text-based qualitative analysis of networks in Herodotus to run alongside the automated process that we have thus far been describing.

What next?

The experience of using digital approaches and developing an automated process for the querying and visualisation of spatial data in Herodotus has taught us of the need to adopt plural approaches that make use of, but are not restricted by, the ICT. In particular, since it is simply not feasible to consider every single example of a network in the *Histories*, we aim to employ the following sampling methods:

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[62] The 'ethnic' category is a recognised class in TEI P5 and could be marked up. In addition, in the close textual analysis that we aim to employ alongside the automated generation of network maps, we propose using the concept of 'proxies'; that is, we will take peoples, either as groups or individuals, as representatives of the particular place whence they come. In doing this, we again appeal to Herodotus' own practice of using, say, 'Darius' to stand for the whole of Persia, as in 'for as yet none of these Cycladic islands was subject to Darius' (τῶν γὰρ νήσων τουτέων τῶν Κυκλάδων οὐδεμία κω ἦν ὑπὸ Δαρείῳ, 5.30). Even though it may be difficult to pin down certain groups, such as the Thracian tribe Paeonians, to a particular place, an important spatial dimension resides in their description.

[63] See Hartog (n.13).

[64] Such as his 'logoi': this kind of analysis has recently been attempted in the dedicated volume to Book 5 of Herodotus, edited by Irwin and Greenwood (n.17).

[65] Such as that being developed by Marco Büchler of eAQUA (Extraktion von strukturiertem Wissen aus Antiken Quellen für die Altertumswissenschaft): http://www.eaqua.net/index.php.

- Use the automated network maps to generate a 'quick and dirty' map that is made up of the simple raw count of occurrences when two or more places are mentioned with each other in the same sentence. This kind of network map, which is already at our disposal, can be used to capture an overall sense of the broad network culture as well as to flag areas of interest, which can then be investigated in more detail.
- At least two kinds of approach can be used to examine the network maps further. The first approach can explore the strength of the connections between places, as we have done in this paper, where the thicker (or darker) the line connecting two or more places is, the stronger is the link between them (see Figures 8-10). A second approach can examine the places themselves for the degree to which they are part of a network (their 'degree centrality').
- Take a sample area or a sample location and investigate it for all the different kinds of networks that can be found within it and assess how it interacts with the rest of the world.
- Take one particular section of narrative and investigate it for the different ways in which it represents networks.

No matter what sampling criteria that we employ, however, one conclusion is plain: ICT can greatly enhance our understanding of spatial concepts in Herodotus *provided that* it is accompanied by a close textual analysis. Ultimately, it is this need to marry 'quantitative' and 'qualitative' approaches that we regard as the most interesting implication of the initial steps that we have taken. We look forward to carrying our work further in a series of individual Herodotean case-studies; but it may be that this first airing of the underlying principles of HESTIA may already prompt other scholars to think of possible applications to other authors and other fields.

Figure 1: Herodotus' world view

(http://en.wikipedia.org/wiki/File:Herodotus_world_map-en.svg)

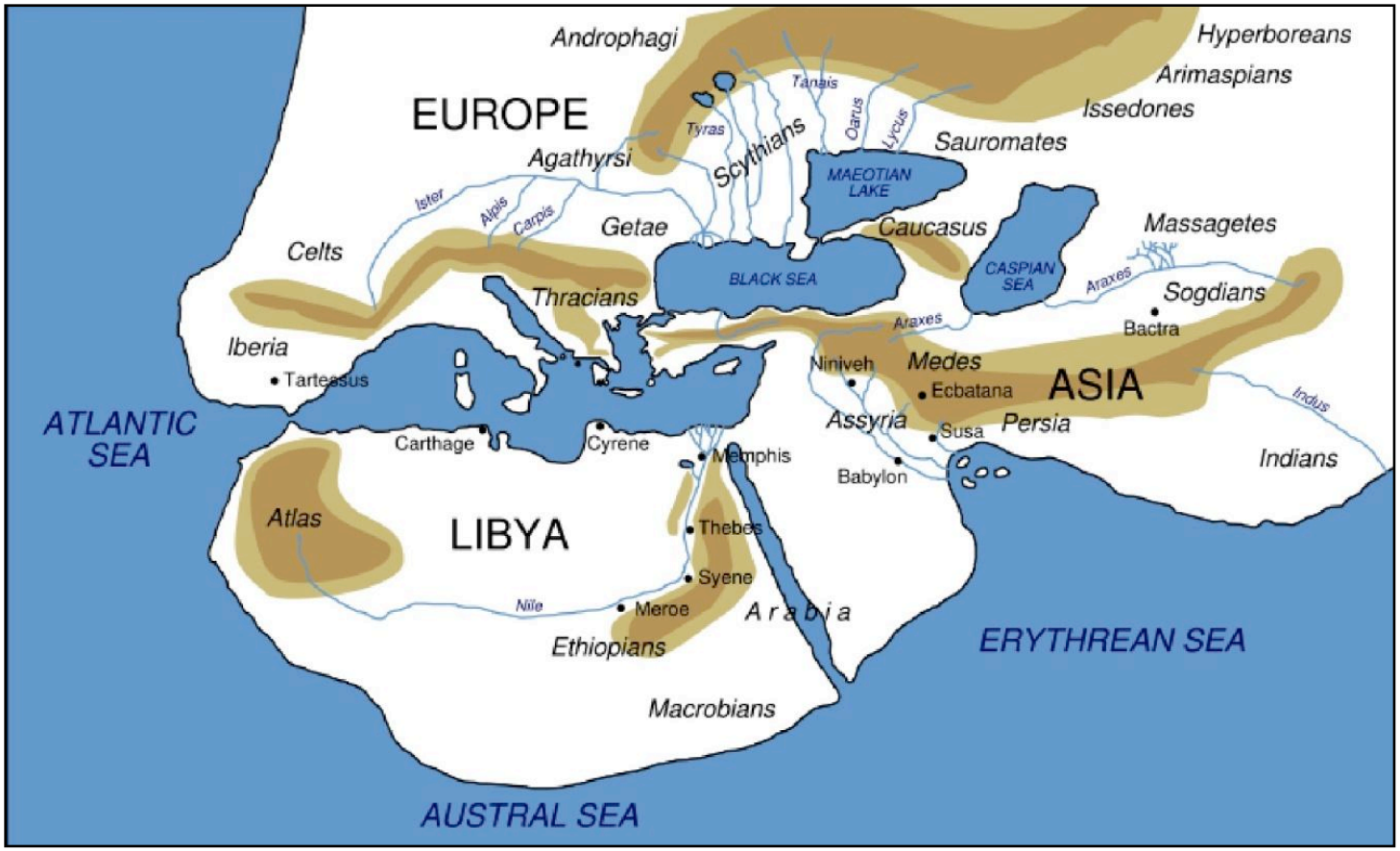

Figure 2: Architecture of HESTIA

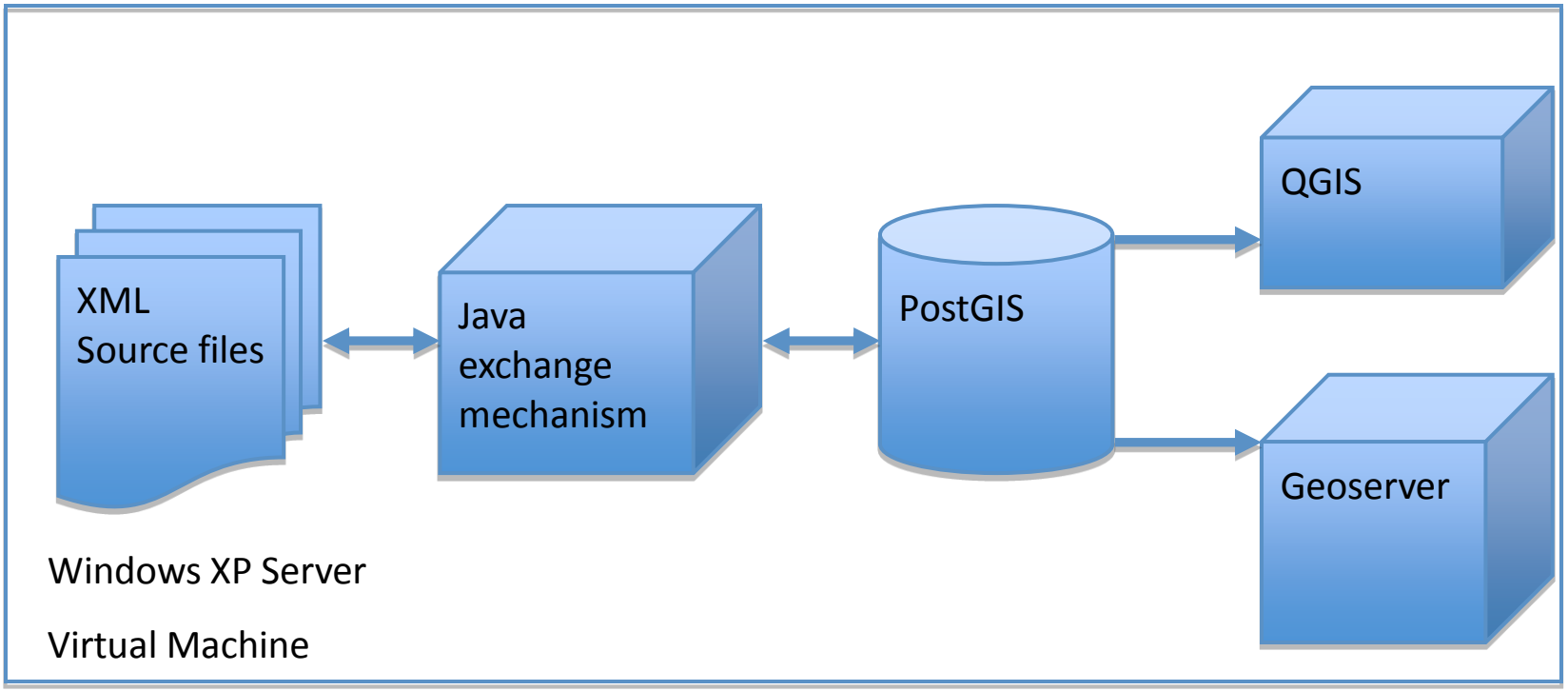

Figure 3: Herodotus encoded in TEI P4 XML

Figure 4a: all toponyms in the *Histories*

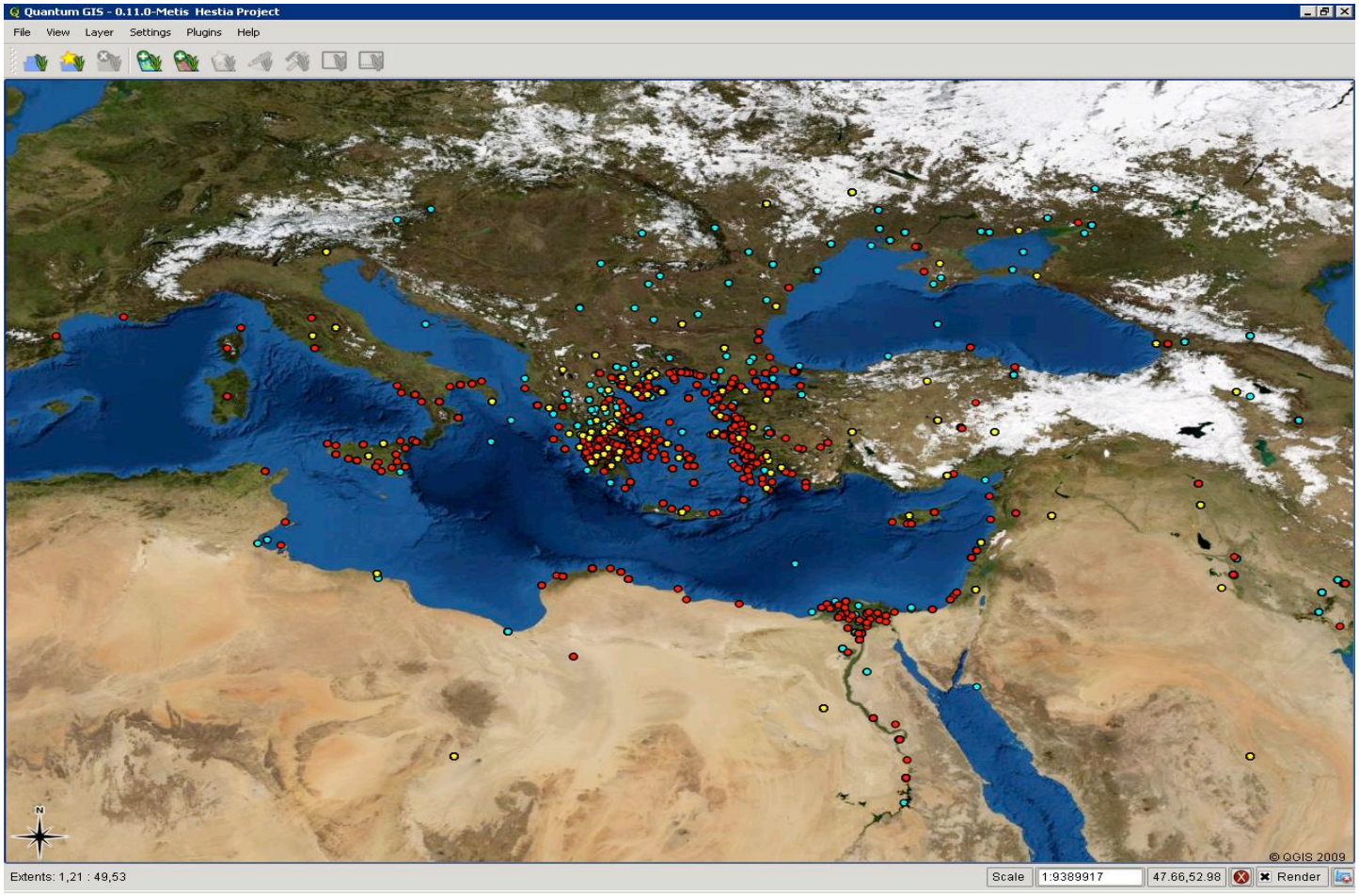

Figure 4b: all toponyms (Pontus region)

Figure 4c: all settlements in book 1 (Aegean region)

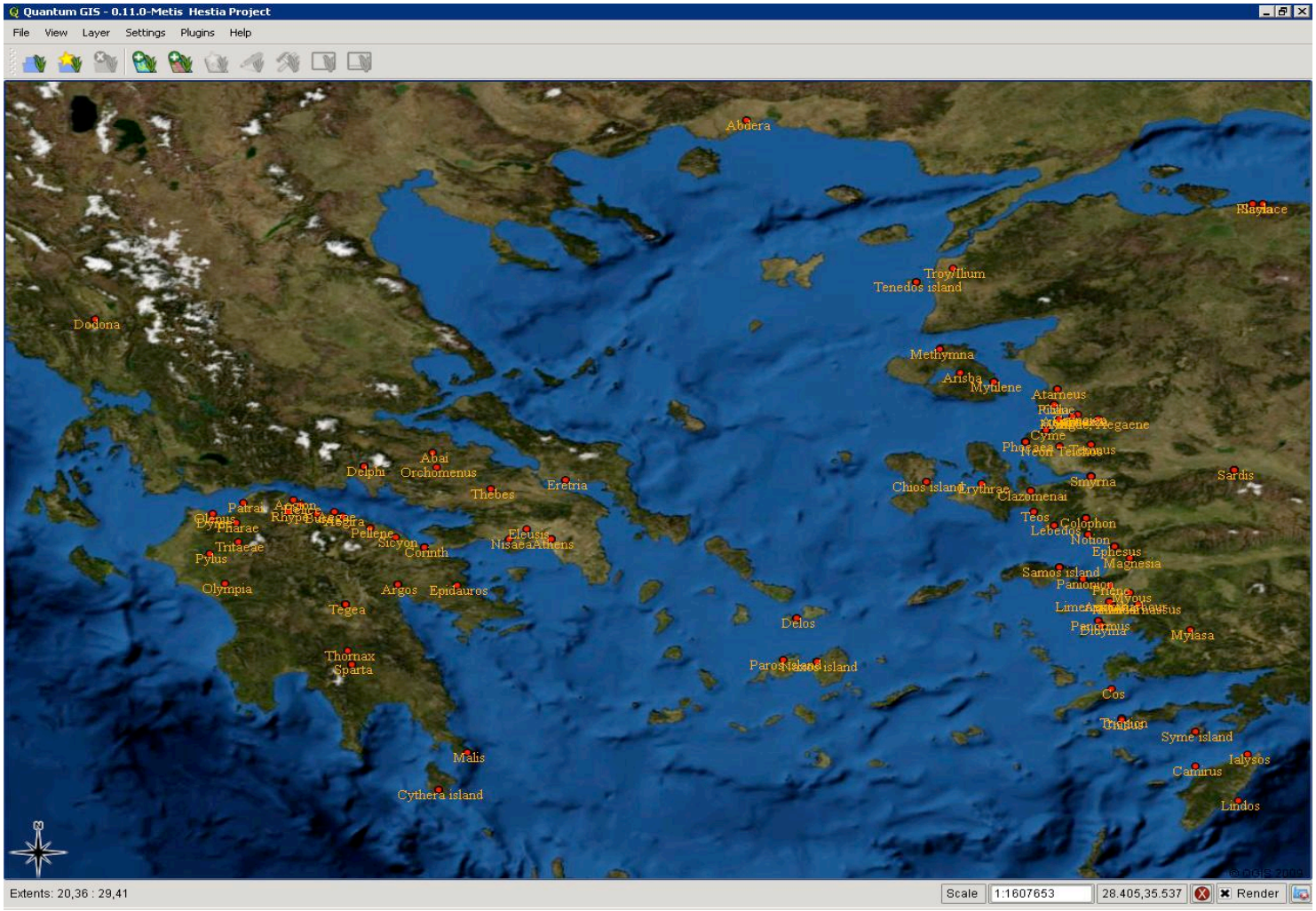

Figure 5: total reference count (settlements)

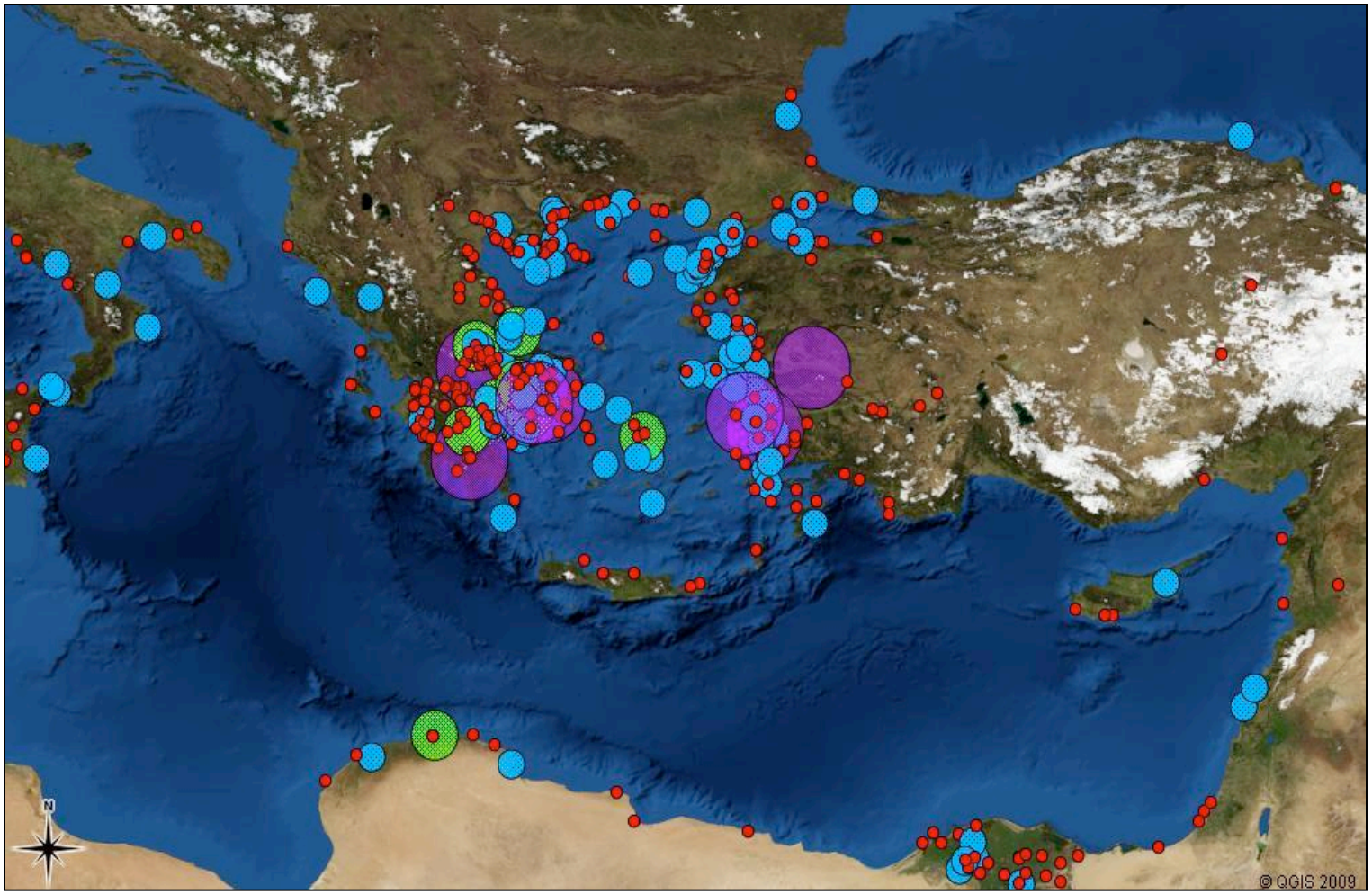

Figure 6: mashup using Google Earth

(http://hestia-geo.open.ac.uk:8080/geoserver/wms/kml?layers=hestia:google_earth)

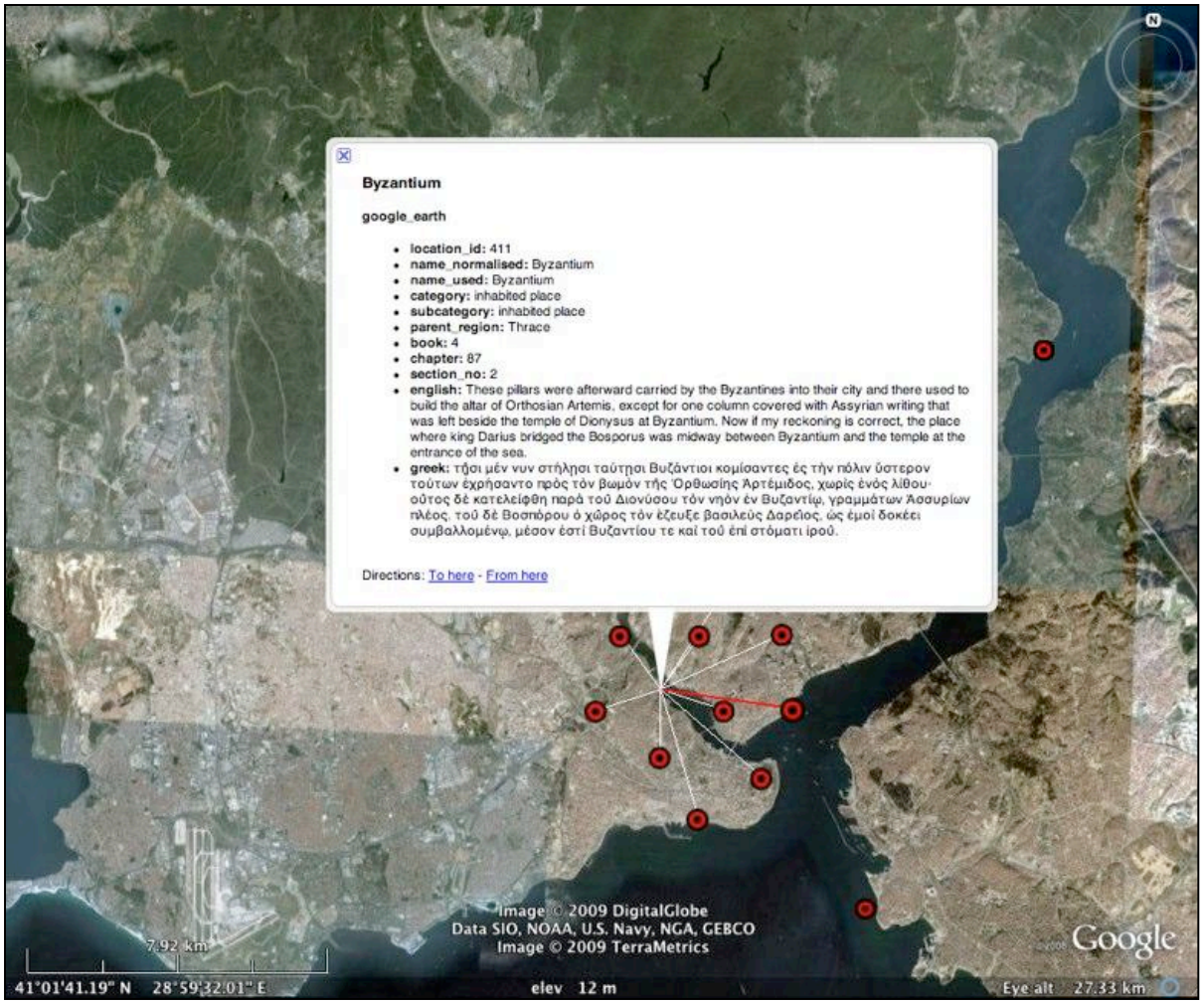

Figure 7: Google Timeline
(http://www.nickrabinowitz.com/projects/timemap/herodotus/basic.html)

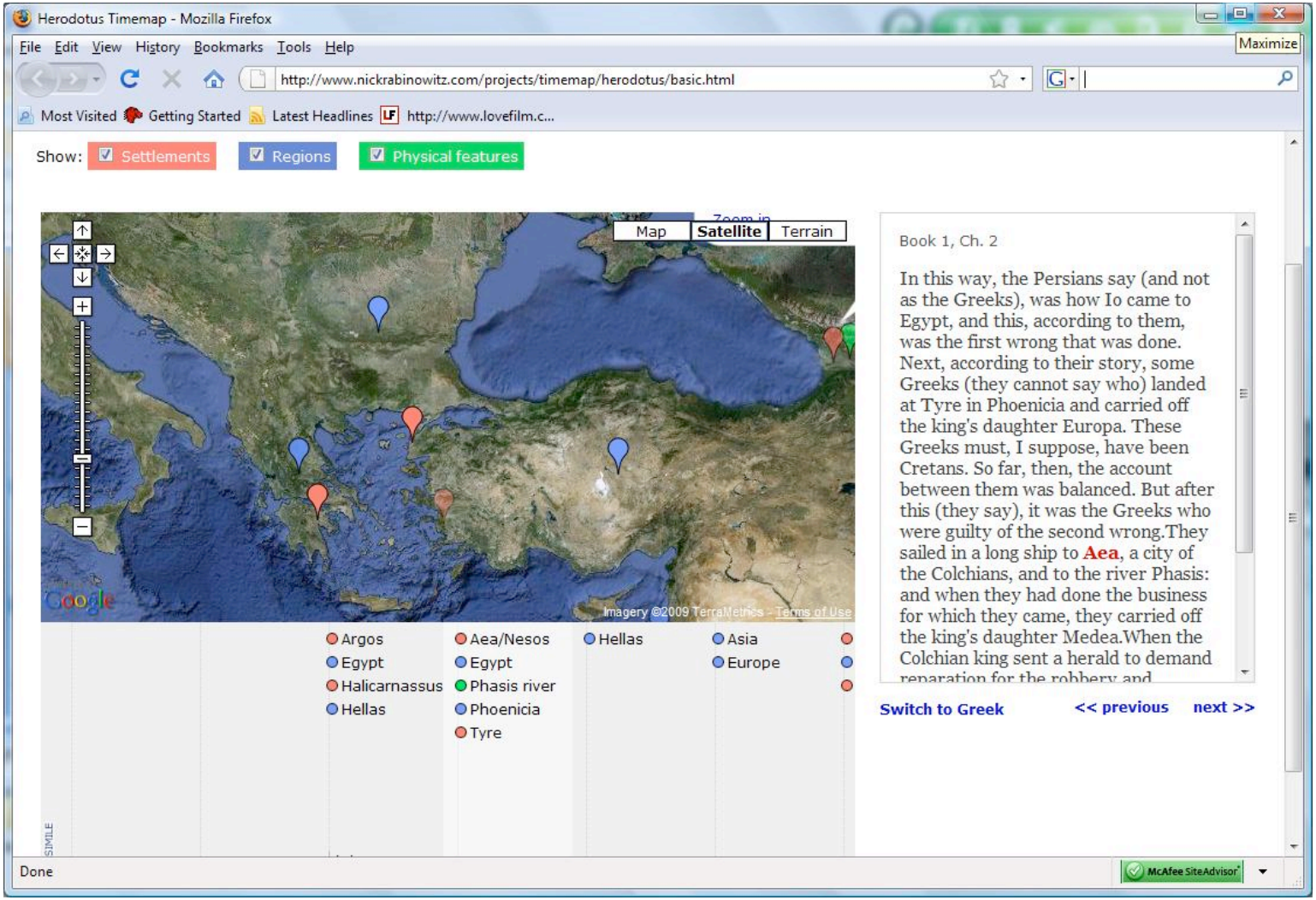

Figure 8: co-reference network density (country)

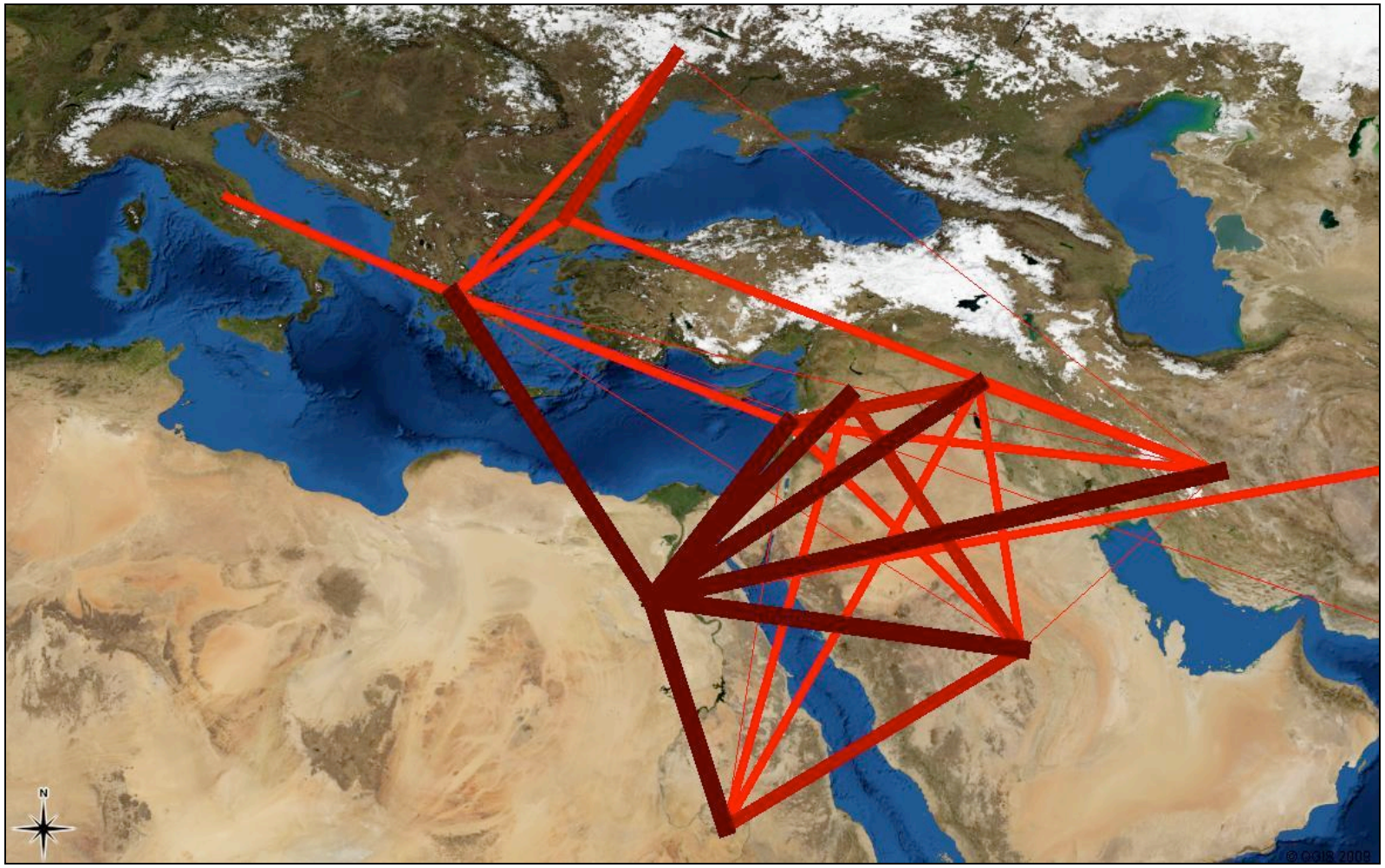

Figure 9: co-reference network density (physical feature)

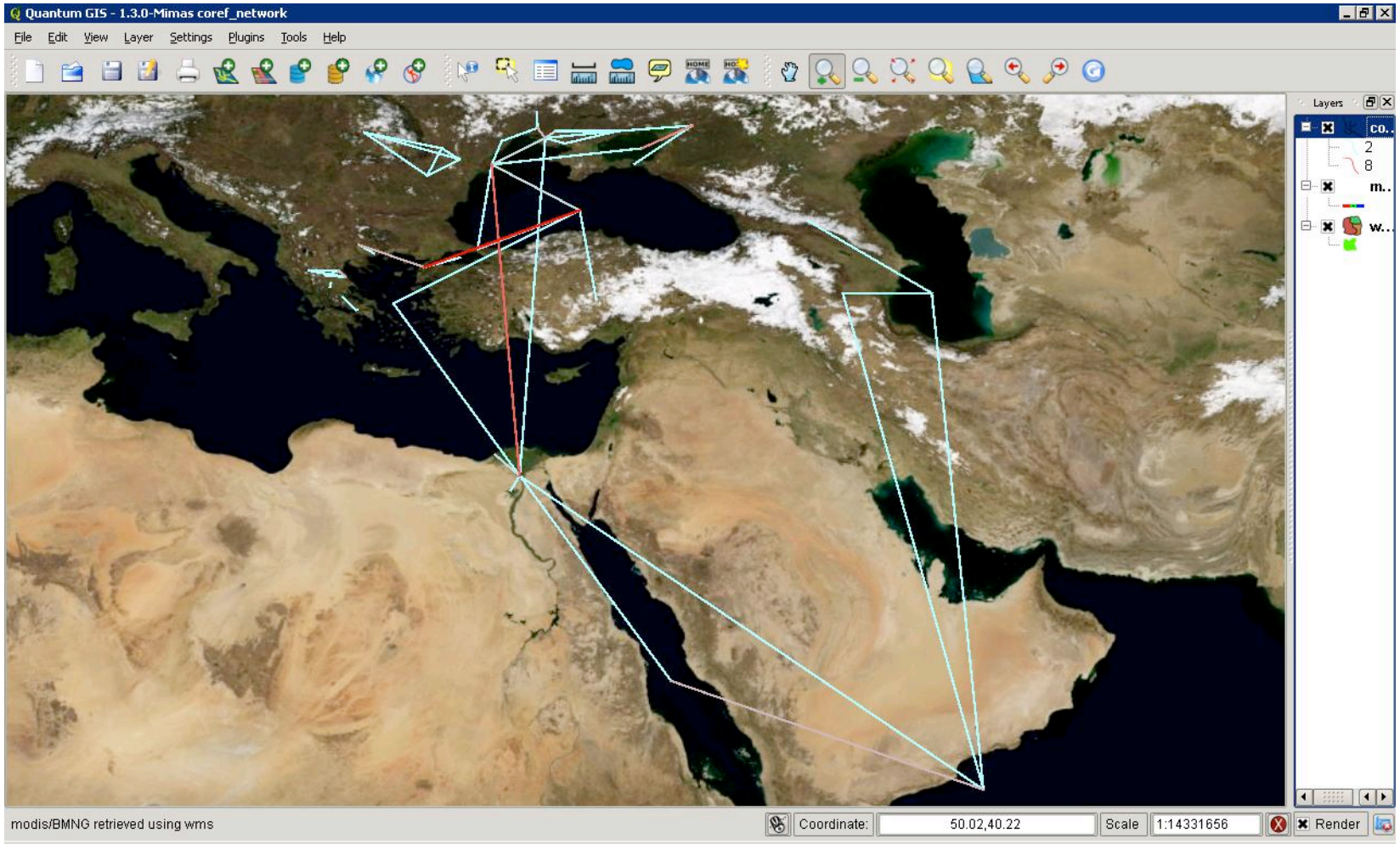
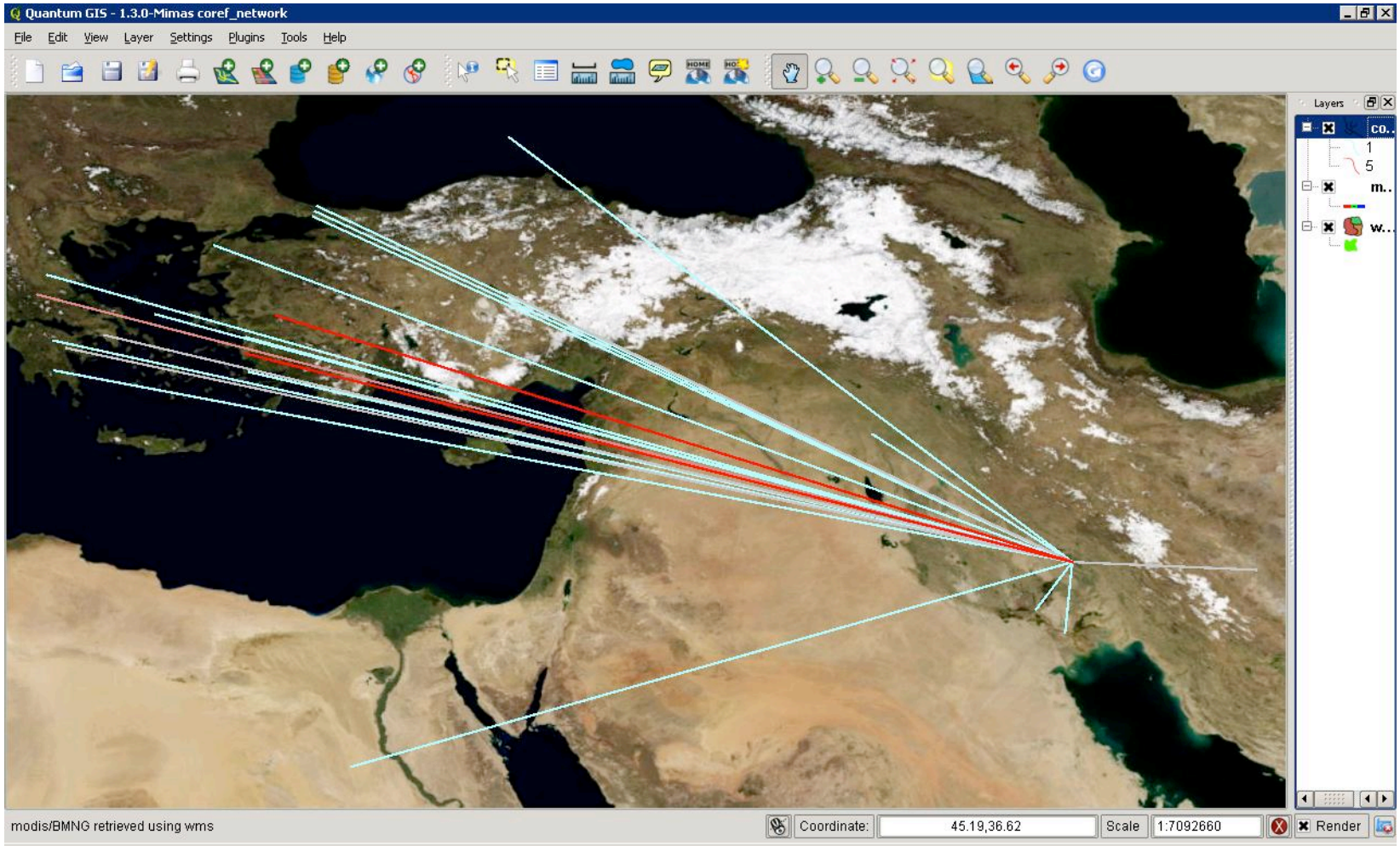
Figure 10: co-reference network density (Susa)