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Spatial Reasoning and GIS in Linguistic Prehistory. Two Case Studies from Lower Fungom (Northwest Cameroon)

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Abstract
Being an ontologically multidisciplinary topic, language change is among the best candidates to be addressed using Geographic Information Systems (GIS). GIS can integrate datasets from diverse disciplines along with real-world geographical information, hence facilitating the investigation of (i) the spatial relations existing between research items and (ii) (past) landscapes. Drawing from an ongoing project focused on the historical development of the extremely diverse linguistic situation documented in the Lower Fungom region (Northwest Cameroon), this article explores the possibility of placing authentic interdisciplinary research pivoting on linguistic issues within a GIS framework.

Keywords
linguistic prehistory; Geographic Information System; language ideologies; Bantoid; Cameroon; ethnohistory and landscape

1. Introductory Remarks

In this paper, we summarize our ongoing research on the historical development of the surprisingly high degree of linguistic diversity observed in Lower Fungom, a small region in Northwest Cameroon. Our principal aim in doing so is to make a contribution to the methodology used in the study of the prehistory of languages by highlighting the great potential of spatial and landscape analyses and, consequently, the usefulness of some digital tools in implementing them. Furthermore, this paper includes our first attempt to propose a new model of language change that could be conducive to expanding the epistemological repertoire of historical linguists, especially of those studying sub-Saharan African languages. Only the basics of this model are sketched here, and we hope to develop it more fully in future publications dedicated to its description.

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Before proceeding, a remark concerning the nature of our case studies needs to be made here. It will soon become apparent that this work can be seen as dealing with "linguistic prehistory" only insofar as one accepts that, in this type of research, there are no fixed scales, whether they be spatial or temporal. On the one hand, the typical millennia-old breadth of linguistic prehistory studies is here reduced chronologically to a time span of no more than four centuries. However, from a non-eurocentric view of prehistory as "the period of time before written records," this time span largely coincides with prehistoric periods in our area, where writing was introduced no earlier than the beginning of the twentieth century. On the other hand, spatially, we will focus our attention on a very small region. This, too, is in striking contrast with what is commonly found in studies of linguistic prehistory, where the magnitude of the problems raised requires that the geography considered be expanded to cover continent-sized areas.

The paper is structured as follows. After describing our approach to space as a diagnostic dimension in the domain of linguistic prehistory (Section 2.1), we outline the potentialities of Geographic Information Systems for this work (Section 2.2) and then introduce the importance of including both geographic space and cultural landscapes in our research, while also briefly addressing some problems connected with the compatibility of spatial and ethnohistorical data (Section 2.3). In Section 2.4, we discuss our method of building a bridge to link linguistic and non-linguistic evidence from a diachronic perspective. Two case studies are then described (Sections 3 and 4), followed by remarks about our methodology (Section 5).

2. Methodological Remarks

2.1. *Towards a "Geography-strong" Approach to Linguistic Prehistory*

Maps are commonly found in studies dealing with the (pre)history of languages. Usually, these representations are set on generally schematic renditions of the earth's surface, where geomorphological reality is simplified to varying degrees. Details in this regard are not required, as the main aim of such maps is to visualize restricted sets of information. Typically, these maps include the researchers' proposals concerning past localizations of languages, their reconstructed movements across regions (see, e.g., the many maps found in Blench, 2006), or the identification of some major environmental or geomorphological features considered to have conditioned the spatial distribution of the target languages (see, e.g., Vansina, 1990: 40–45, and Clendon, 2006: 43, respectively). In other words, in these maps the representation of spatial and environmental features is limited to what are assumed to be objective barriers (e.g., deserts, high

mountains)[1] or means of communication (e.g., cities, rivers, plains)—to the extent that geography and environment in and of themselves are not actually considered as potential sources of historically diagnostic information. Paraphrasing Pred (1990: 7), geographic space is considered to be "a theater for the enactment of history, an unproblematic and unchanging set of surroundings within which practices and events occur, a fixed field for the play of social action." In such frameworks, the relationship between the spheres of knowledge involved in the scientific endeavor is dominated by a strictly one-way flow: from history at large (i.e., a scientific discourse including linguistic, archaeological, anthropological, and genetic evidence) to geography. In this paper we will refer to this (largely dominant) approach as the "geography-weak approach."[2]

By contrast, we adopt here an alternative way of considering spatial information that can be labeled as the "geography-strong approach," that is, an approach that takes the relationship between history and space in a two-way, dialogic fashion. Here, too, "history" is the primary source of the topics to be addressed, and the visualization of historical or linguistic data on a map remains the first step in the attempt to integrate spatial reasoning, where spatial reasoning is understood as a research attitude based on careful consideration of spatial information. In contrast to the other procedure, however, in our approach "space" is acknowledged as having a high informative potential. Graphical representations of geographic space must thus be produced with care. To achieve this goal, cartography should ideally be constructed by exploiting a wide range of data sources, including geomorphological maps of diverse scales, aerial photographs, and satellite imagery.[3]

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1) See Nichols (1997: 374) for the ambiguous status of forest in this regard.

2) A good discursive example of what could be taken to be a very common procedure adopted by historical linguists dealing with geographic data can be found in Nichols (1997: 371). Instances of such approaches, however, are to be found in nearly all research papers dealing with the prehistory of languages or linguistic geography, with no particular areal restriction. It must be recognized that this way of dealing with geographic *realia* appears to be but a sensible choice for studies that, typically by working at very large scales (both chronologically and geographically), would turn out to provide overly dense, unusable maps, should they be required to represent many categories of data. At the same time, however, it must be stressed that the limitations intrinsic to this approach are very rarely, if ever, made explicit by its proponents.

3) If linguists dealing with the prehistory of languages seem to have almost invariably preferred the former approach, the inclusion of a genuine spatial factor is less rarely encountered in historiographic research. Here, however, this methodological orientation seems to have taken rather distinct paths: there are studies in which space has been equated with land and environment (such as Vansina, 1990, and Warnier, 1985, to cite but two prominent names), while others have considered, though in different fashions, the spatial dimension as including

In addition to some advancements in the technicalities of producing and utilizing cartography to perform detailed spatial analyses of social phenomena, the adoption of this approach may have two greater implications. First, by allowing the study of people's interactions in regional settings, it "counters the tendency to interpret the past in ethnic ('tribal') terms" (Howard, 2005: 21). Second, by anchoring information from areas that include linguistics, ethnography, and history to the real world, it facilitates processes of interdisciplinary dialogue (see, e.g., Bender, 2002: 106). The importance of either of these outcomes cannot be exaggerated here.

The first of these issues is particularly relevant to the domain of African linguistics. Though it has long been dismissed as such by anthropologists (see, e.g., Southall, 1970) and hence, presumably, by linguists, the concept of "tribe" as a unit at once territorial, ethnic, and linguistic still resurfaces, albeit somewhat disguised: for instance, when one encounters mentions of internally homogeneous "ethnolinguistic groups" univocally bound with discrete areas (as in Lewis, 2009; see Blommaert, 2007, for a useful review of themes connected to this aspect).

The second outcome, additionally, is of great significance for studies concerned with language change in general, including those focused on linguistic prehistory: although it is described and analyzed in linguistic terms, language change is a process whose historical motivations cannot be elucidated by linguistics alone. Rather, it is ontologically connected with and most often seen as a consequence of other kinds of socio-historical processes ultimately having to do with demography, economy, and "culture" in its largest possible meaning.

2.2. *Spatial Reasoning and Geographic Information Systems*

Besides the number of opportunities it allows for, a geography-strong approach to linguistic prehistory also entails certain risks. In addition to some epistemological problems intrinsic to variations of scale in both spatial and temporal terms—which we will address in sections 2.3 and 2.4—we must also recognize that a multidisciplinary perspective such as the one we propose here can in fact result in the collection of overly large data sets, which then cannot be checked, analyzed, and interpreted productively without enormous difficulty. This paper presents a possible solution in this regard.

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perceptual as well as material factors (see, e.g., the studies contained in Howard and Shain, 2005, Luig and Oppen, 1997, and Bollig and Bubenzer, 2009). If compared with this (rather arbitrary) dichotomy, the work presented here will appear to include both orientations: the number of environmental and geomorphological features represented on maps recall the former subgroup, and they are complemented with information relevant to the exploration, currently still embryonic, of the perceptual realities besides the materiality of land.

Being part of a multidisciplinary team, we have drawn our research from a composite database comprising linguistic, ethnographic, historiographic, archaeological, geomorphological and environmental evidence. This has highlighted the need for an instrument that could help us store, organize, and query our database without losing information relevant to the spatial arrangement of data. This twofold goal could be reached by building a Geographic Information System (henceforth GIS): by combining representations of items of knowledge (a database) with a computer mapping system, a GIS is able to store and handle datasets from different disciplines and integrate them with real-world information. This presents the possibility of assembling and visualizing different kinds of data in separate layers, hence allowing for the detection of a variety of correlations between, in our case, linguistic and non-linguistic variables (see also Section 5). A GIS in and of itself is not a computer application, but rather a network of hardware, software, data, procedures, and knowledge (as well as people) capable of archiving, processing, visualizing, analyzing, interpreting and publishing spatially identifiable (i.e., geo-referenced) information. On the software side, there are different applications that can be used in order to implement a GIS; for this study, we used ArcGIS Esri®. Finally, GIS output data can be made usable in the form of both static layout maps (both paper and digital) as well as interactive maps (web GIS) such as those generated by map explorer engines like Google Earth.

GIS has long been utilized in archaeology and history studies (Allen et al., 1990; Gillings and Wheatley, 2002; Gregory and Ell, 2007; Lock, 2000). The first clear example of its introduction and application to linguistics, though in a much reduced form, is illustrated in the World Atlas of Language Structures (Haspelmath et al., 2005). Recently, it has been used mainly in studies focusing on language-specific categorizations of space (e.g., Berez, 2011; Mark and Turk, 2003) or language mapping (e.g., Veselinova and Booza, 2009). What is probably the largest existing experiment integrating historical linguistic scholarship into a GIS is LL-Map, "a digital mapping project that integrates language data and information from the physical and social sciences" (URL www.ll-map.org; see also Xie et al., 2009). Despite sharing some fundamental methodological aspects with all of these works, our study cannot be directly associated with any one of them in particular, since it relies on GIS to study mainly non-linguistic evidence (unlike Haspelmath et al., 2005, and Veselinova and Booza, 2009) with the aim of reconstructing the history of a given group of languages (unlike Berez, 2011, and Mark and Turk, 2003), and thus venturing to establish an authentic interdisciplinary dialogue (unlike the current stage of development of LL-Map).

2.3. *Landscape, Mixed Methods, and Issues of Scale*

The spatial dimension of what we call "spatial reasoning" here is not limited to geographic space but also includes the cultural landscape. For clarity, it is perhaps convenient to refer here to the first article of the European Landscape Convention:[4]

> *Article 1,a*
>
> "Landscape" means an area, as perceived by people, whose character is the result of the action and interaction of natural and/or human factors

In this paper, we cannot address the complex theoretical scenario lying behind the distinction of "space" as opposed to "place" (see, e.g., Tilley, 1994). We will therefore limit ourselves to a simplified view in which "(geographic) space" is equated with "land" and refers to an objective entity, whereas "(cultural) landscape" indicates people's perceptions and representations of some specific portions of land. Practically speaking, this means, on the one hand, that spatial analyses are based on quantitative data obtained through, e.g., cartography and remote sensing; on the other hand, that landscape analyses are based on narratives collected in the field in an ethnographic fashion from the inhabitants of the target region.

We consider geographic space and cultural landscape to be two mutually informing sides of spatial reasoning: the continuum of quantitative data obtained through spatial analyses (be they, e.g., physical, morphometric, or from a remote sensor) can be used to build up a reference framework through which one can not only contextualize landscape-centered narratives, but also explore the relations existing between perceived and measurable realities. This entails that (objective) land, (subjective) landscape, and their correlations are used as sources of primary and derived data (for a good example, see Jiang, 2003). For its admixture of quantitative and qualitative (e.g., ethnographic) information, this procedure has been called "mixed-methods approach" (see Jiang, 2003; Jung and Elwood, 2010, and references cited therein).

Before making explicit our way of connecting space, landscape, and language prehistory (Section 2.4), and before dealing with some limitations of the

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[4] UNESCO has also focused on landscape in its key role within the cultural heritage of any given human group (see, e.g., UNESCO, 2011: Paragraph 47). This perspective stresses the importance of landscape as an identity-laden factor in "culturally fragile" contexts such as minority groups and other forms of sociopolitically and economically disadvantaged communities. It is clear, though beyond the aims of this paper, that this very perspective may be of great relevance for studies on language endangerment.

mixed-methods approach in historical research (this section, below), it is opportune here to make an important distinction. Throughout the still relatively short tradition of linguistic studies focused on landscape (see Burenhult and Levinson, 2008; Mark et al., 2011a), scholars have been concerned with understanding how landscape is conceptualized in different languages so as to be able to evaluate whether or not "landscape features [...] come, for the most part, presegmented by nature" (Burenhult and Levinson, 2008: 138). Such a cognitive preoccupation (see also, e.g., Mark and Turk, 2003; Mark et al., 2011b) is completely absent from the present paper. As will be apparent from the further discussion, we consider only those portions of cultural landscapes that are diagnostic from a strictly historical perspective, ignoring any cognitive implications they might have. In fact, the kind of data we work on are different from those used by the other studies mentioned above. These concentrate on lexical items and space grammar, while we have based our research on the recollections of places having cultural-historical relevance as they have occurred in spontaneous or elicited narratives. Of course, the two perspectives might be integrated, and, indeed, we hope we will have the chance to do so in the future.

Let us now go back to the mixed-methods approach and to its limited application in historical studies. The degree to which analyses of land, on the one hand, and of landscape, on the other, can be connected to each other is maximal in synchrony but tends to decrease as one tries to go back in time. Being social constructs, landscapes are inherently historical (see, e.g., Bender, 2002, and Ingold, 1993) and may contain items of different age: to take but an elementary example, in a given area some places may have been (re)named recently while others have a much longer story to tell. Moreover, the framework provided by objective analyses is diverse as to the age of its constituents: land cover, for instance, is likely to change much faster through time than, say, terrain morphology does. So, e.g., banana plantations can be found in areas that were covered by forest until only a few decades ago, while the degree of inclination of the hill on which they lie was largely determined several centuries before. This evidently complicates the adoption of our spatial reasoning in the perspective of exploring the diachronic relations between its two constituents. The main problem one encounters concerns the possibility of not only identifying and dating, even in broad terms, traces of actual man/environment interactions, but also evaluating the extent to which cultural landscapes have been determined by environmental and geomorphological features. From a cultural-historical perspective, that is, the more an item of landscape has been determined by geographic context, the less diagnostic it can be taken to be. To provide another imaginary example: if the above-mentioned hill were called "banana hill," the name would not offer us much to build on for going back in time; however, the potential for reconstructing the past of the area would be higher, were it remembered as "timber-and-monkeys" or, even more,

as "X's hill," where X stands for the name of a now disappeared people. But how can one ascertain the degree to which (or the date at which) the establishment of such a cultural item has been conditioned by geomorphological and environmental factors if, as we have said, the two planes are both different and internally diversified as to time depth?

A closer look reveals that it is essential to extend the timeframe within which we can perform objective spatial analyses. Put otherwise, it is necessary to obtain a sort of chronology of the emergence of observed geomorphological and environmental features. Depending on the temporal scale, this is made by complementing existing cartography (in its turn created using recently-collected remote sensing information) with, say, palynological and geological evidence and, for intervals closer to the present time, with environmental information obtained from sources such as old photographs, historical cartography, and survey reports (see Börjeson et al., 2008: 524–527; De Silva and Pizziolo, 2004; Pizziolo, 2005). When, as in our case, the target time interval is not so distant from the present, but the available complementary documentation, as in sub-Saharan Africa in general (see Börjeson et al., 2008), is scarce—both quantitatively and with respect to the time depth it reaches—then the only option left seems to be to evaluate the intrinsic features of the target area. Important factors to take into consideration include its geographic location in relation with (i) important climatic or environmental thresholds, and (ii) regions known to have been greatly affected by non-human factors in the past, such as desertification or volcano eruptions. Although we have not led a thorough paleo-environmental inquiry in this regard, in our case existing literature (among which Greve et al., 2011, and Warnier, 1984) seems to indicate that our target area, Lower Fungom, is located far from current—as well as known past—climatic or environmental major thresholds. Therefore, the continuum provided by objective analyses can be considered relatively stable throughout our present time scale, i.e. about four centuries. This stability has the consequence of allowing us to assume that any past changes in the spatiality of landscapes (i.e. in the spatial distribution of landscape constituents) that we will discover or infer on the basis of our existing documentation can be interpreted as being caused mostly, if not exclusively, by human factors. This, in its turn, will facilitate their interpretation in cultural-historical terms.

2.4. *From Space and Landscape to Language History*

Independently of the approach taken (Section 2.1), from the historical linguist's perspective the relation existing between spatial factors (i.e., space and landscape) and language is no doubt an indirect one. If the main goal lies in the reconstruction of the (pre)history of languages, then there is little option but

to concentrate on the only material (i.e., space-occupying) aspect of languages, that is, their speakers. This is what we do here. We begin by examining the particular kind of landscape narratives Di Carlo has collected in the field, as they appear to be relevant for outlining aspects of the demographic history of our target area for the last three to four centuries. Then we analyze them in correlation with objective spatial facts and, hence, interpret the outcomes in terms of past language dynamics.

At this point, however, a word of clarification is needed. Most work on linguistic prehistory (especially in African contexts) appears to consider, though implicitly, that populations are passive bearers of a language, so language movements are equivalent to demographic movements and vice versa. This interpretation still governs a large part of the historical linguists' epistemological repertoire, although one can find a number of studies (such as, e.g., Donohue and Denham, 2010; Hornborg, 2005; Nichols, 1993; Nichols, 1997) evidencing how the most conservative assumption in this regard should be, in fact, that languages "move" due to language shift. In this study, "speakers" are considered social actors engaging in an ever-changing relationship with the language(s) they speak. As a result, we accord language ideologies a primary role in shaping the historical trajectories of any given language. Put somewhat differently, we have explored the possibility of using geographically-informed evidence of demographic history to reconstruct the development of the ideologies that may have conditioned, in various ways, the history of the language(s) we have targeted. This is the filter through which we will pass our largely non-linguistic evidence in order to be interpreted as bearing some relevance to the understanding of the (pre)history of the target languages.

3. Case Study One: The Languages of Lower Fungom

3.1. *Linguistic Overview*

Lower Fungom is an area of about 240 square kilometers—roughly the size of a city like Amsterdam—located in the Menchum Division, Northwest Region of Cameroon (Figs 1 and 2). Its terrain morphology is characterized by very frequent, abrupt hills whose tops average 900 m altitude. Valley bottoms are often covered with forest galleries but have good water drainage and rarely lie below 600 m, thus warranting the near absence of the tsetse fly in the area. In general, the environment is of the forest-savanna mosaic type, dominated in wooded areas by palm trees and, in grasslands, by elephant grass.

Lower Fungom comprises thirteen villages in which Good et al. (2011) have identified at least seven different Bantoid languages, or small language clusters (see Table 1 and Fig. 3). A rough account of language density would thus

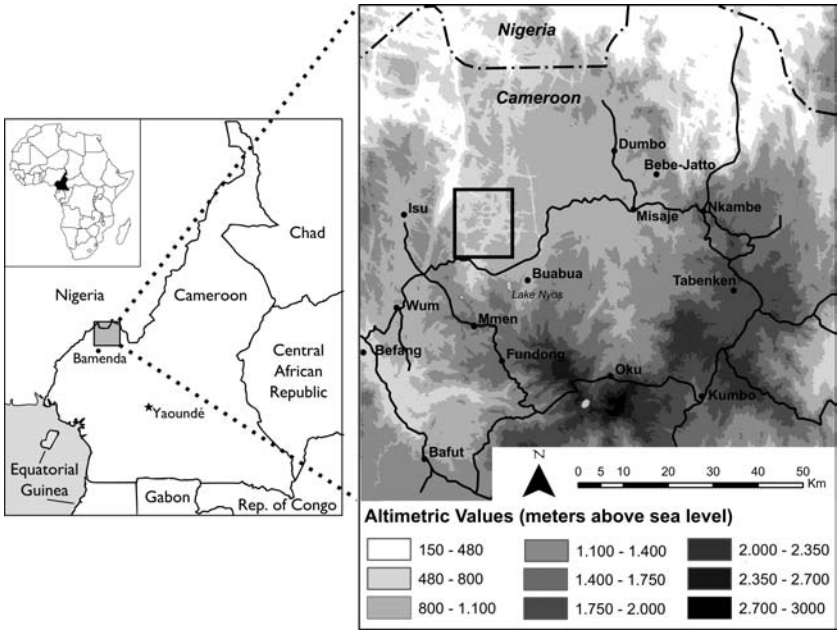

Figure 1. Localization (left) and geomorphological map (right) of the northern area of the Cameroonian Grassfields. The small rectangle in the map to the right locates the research area that will be visualized in the following maps.

apparently yield a figure of about one language per 34 square kilometers.[5] Therefore, Lower Fungom, located at the northwestern edge of the Cameroonian Grassfields—an area itself long known for its striking degree of linguistic diversity (Stallcup, 1980: 44)—would seem to be one of the linguistically most diverse micro-areas of the African continent.

Using Nettle's terminology (Nettle, 1999: 10–11), we observe linguistic rather than phylogenetic diversity here, as Lower Fungom languages can all be reasonably classified as non-Bantu Bantoid (Good et al., 2011: 107–108; see Watters, 1989, for the notion of Bantoid). However, five of them (Ajumbu, Fang,

5) By way of comparison, we can recall that Vanuatu, well known for its linguistic diversity, has about one language for every hundred square kilometers (see, e.g., Evans, 2010: 214). Good et al. (2011: 105) indicate the possibility that two vernaculars, namely Missong and Buu, could ultimately be considered as separate languages and not varieties of, respectively, Mungbam and Ji. If confirmed, this would bring the count of the Lower Fungom languages to nine, and, consequently, their average density would decrease to one language per 27 sq. km.

Figure 2. Physical and political map of Lower Fungom with main paths connecting villages.

Ji, Koshin, Mungbam) do not have any established close relatives outside of the region, nor can they be straightforwardly shown to be closely related to each other. For these reasons, Good et al. (2011) have recently proposed to rename this group of languages referentially as Yemne-Kimbi (from the names of the two water courses delimiting their area of distribution). They thus reject the label 'Western Beboid,' which, advanced by Hombert (1980), connected this group without convincing evidence to the Eastern Beboid languages—for which the label 'Beboid' has now been proposed by Good et al. (2011). Four languages (Ajumbu, Fang, Koshin, and Kung, the last being a Central Ring language) are restricted to a single village, while the remaining three (Ji, Mungbam, and Naki, the last being a Beboid language)[6] are, in fact, clusters comprising more or less divergent varieties (see also footnote 5).

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[6] The name *Mungbam* has been specifically crafted to refer to the speech varieties of this

Table 1. Lower Fungom villages and their linguistic affiliation. Dotted line indicates that the variety is perhaps best considered a separate language (see footnote 5).

SUBGROUP	LANGUAGE	VILLAGE	POPULATION
Yemne-Kimbi	Mungbam [mij]	Abar	650–850
		Munken	around 600
		Ngun	150–200
		Biya	50–100
		Missong	around 400
	Ji [boe]	Mundabli	350–450
		Mufu	80–150
		Buu	100–200
	Fang [fak]	Fang	4,000–6,000
	Koshin [kid]	Koshin	3,000–3,500
	Ajumbu [muc]	Ajumbu	200–300
Beboid	Naki [mff]	Mashi	300–400
Central Ring	Kung [kfl]	Kung	600–800

Specific sociolinguistic inquiries have not yet been carried out in the area, but the data at hand indicate that Lower Fungom, like the Grassfields as a whole (Warnier, 1979; Warnier, 1980), shows signs of a situation of widespread traditional multilingualism. This overall tendency is contrasted, perhaps not only in our area (Fowler and Zeitlyn, 1996: 1–2; Warnier, 1980: 841), by a pervasive language ideology stressing the coincidence between linguistic communities and politically independent units, where each of the latter coincided, in precolonial times, with a single residential unit which we would call "village." For this reason, locals assert that each of the thirteen villages/polities found in Lower Fungom speaks a language of its own—though also acknowledging that some of them 'rhyme' with one another.

language (MUnken, NGun, Biya, Abar, Missong; Good et al., 2011: 114). The label *Ji* references a local isogloss involving the word for 'dog,' rendering it perhaps inappropriate as an actual language name. This, in addition to what we have recalled in footnote 5, drives us to refer to Ji as a *group* rather than a language.

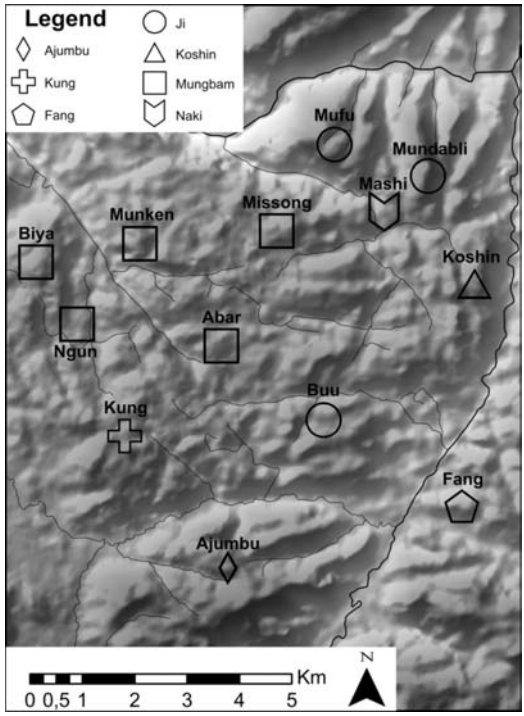

Figure 3. Distribution and affiliation of the languages spoken in Lower Fungom. Mashi is a variety of Naki that is spoken (at least) also in Mekaf and Nse, which are two villages located outside of Lower Fungom proper and, therefore, are not shown on the map.

3.2. *Research Questions*

The co-occurrence in this area of extreme linguistic diversity, on the one hand, and exceptionally localist sociolinguistic stances (Hill, 1996), on the other, gives us reason to suspect that these phenomena might be closely connected. However, before going in this direction (see Section 3.5), and once environmental factors are recognized as having no doubt facilitated, rather than determined, this degree of diversity (see Di Carlo, 2011: 63–65), we must first check whether the diversity can be accounted for in terms of the in-migration of foreign groups. We cannot but marginally rely on linguistic phylogenetic relations as a reliable tool for hypothesis-building in this regard, for two reasons: (i) except for Naki and, to a lesser extent, Kung, our current knowledge of the genealogical relations of the region's languages with outside language groupings is still modest; (ii) as will become clear in Sections 3.5 and 4, our data suggest that a number of cases

of linguistic resemblance cannot be explained in terms of genealogical relations but, rather, of recent processes of change. Thus, our prime source is language distribution.

Figure 3 shows that one-village languages are located along the southern and eastern margins of an area whose center is largely occupied by two language clusters plus one variety (Mashi) of Naki, which appears as an internally highly homogeneous language cluster centered outside of this area. This last fact can be safely interpreted—following a classic approach to linguistic geography such as that instantiated in Diebold (1960), Dyen (1956), or Ballard (1971), all perpetuating the original intuitions of Sapir (1949)—to indicate that Naki-Mashi is a recent arrival in the area. Beyond this, which is our only relatively safe point (see Di Carlo, 2011: 78–79), the same methodology would lead to two broad alternative historical interpretations of the observed general pattern, depending on the aspects emphasized.

The first interpretation focuses on the fact that presence of a diverse periphery coupled with a less diversified center, dominated by two language clusters, may support the inference that the peripheral groups are cultural residues of the area's prior situation. Put more explicitly, our reconstruction would be that two separate ethnolinguistic groups—each speaking an early form of Ji and Mungbam, respectively—entered the region probably from the north and pushed the former settlers, linguistically different, to peripheral areas to the south and east, finally causing their demographic contraction in isolated settlements. From this perspective, (i) Ajumbu, Fang, Koshin, and Kung should be considered today's representatives of the languages spoken by the earlier occupants of the general area; (ii) the Ji- and Mungbam-speaking newcomers colonized most of the better land and then split, settling in separate spots, which led to the differentiation of their idioms up to the observed distinct local varieties.

The second interpretation, by contrast, concentrates on the fact that both Ji and Mungbam seem to have no close relative outside of the area and, at the same time, have a high degree of internal differentiation (see footnote 5). For these reasons, they appear as good candidates for the status of early occupants of the area (Ballard, 1971: 295–296). In parallel, we may also stress that, along the southern and eastern periphery of Lower Fungom, we find distinct languages rather than varieties of groups having a high degree of internal differentiation. If taken from the perspective of the first interpretation, this would imply that Lower Fungom was highly diverse (at the rate of one language per about sixty square kilometers) even in a previous historical phase, which is a non-conservative assumption at the very least. The second hypothesis would then be that the two language clusters resulted from early splitting and subsequent long-term cohabitation of culturally affine communities, whereas the one-village languages entered the area at a later date.

Table 2. Oral traditions of provenance in Lower Fungom. See Fig. 1 for location of places mentioned. (*) = north of Lower Fungom but exact location is unknown. Granularity is at the sub-village level of exogamous unit (here roughly referred to by the English term used by locals: 'quarter'), therefore traditions of provenance limited to one family incorporated into a wider exogamous unit are not considered. In the column 'Number of contacts,' we indicate the degree of reliability of the information shown, on the basis of the percentage of the total number of quarters in the village that was included in Di Carlo's inquiry: H = 'High' = nearly all, M = 'Mid' = more than half, and L = 'Low' = less than half. In Missong, exogamous units (represented in table) lie at the sub-quarter level. In Kung the notion of quarter is somewhat problematic as, unlike in the other villages, exogamous units are defined matrilaterally, and matrilineages are not residential units (see also Chilver and Kaberry, 1968: 31).

Village	Chief's quarter	Other quarters	Number of contacts
Ajumbu	Indigenous	Idem	H
Fang	From Befang area	Idem	H
Koshin	From Buabua area	Idem	H
Kung	From Mawas (Oku)	Not applicable	H
Naki-Mashi	From Bebe-Jatto	Idem	H
Buu (J)	Indigenous	Idem	M
Mufu (J)	Indigenous	Indigenous; some from Dumbo area	M
Mundabli (J)	From Dumbo area	Diverse	L
Abar (M)	Indigenous	Indigenous; one from "Fang side"	L
Biya (M)	Unclear	One from "Fang side"; diverse	L
Missong (M)	From Adjuma (*)	Diverse	H
Munken (M)	From Tabenken area	Idem	M
Ngun (M)	Indigenous	Idem	H

Solution of this apparent dilemma can be attempted only by including information of direct historical significance. Putting aside our currently limited linguistic data, as mentioned above, we must address ethnohistorical, archaeological, and ethnographic evidence, as is the case with most of sub-Saharan Africa (see, e.g., Vansina et al., 1964). Initial outcomes of this holistic perspective can be found in Di Carlo (2011). In this paper we will favor the ethnohistorical dimension, as this will allow us to better introduce the potentialities of a geography-strong approach within GIS.

3.3. *Land and Ethnohistory: Traditions of Provenance*

Each village has a peculiar tradition of provenance of its forebears. In fact, it is quite common to encounter in a village a composite tradition in which different kin groups reproduce partially different ethnohistorical traditions. The complex

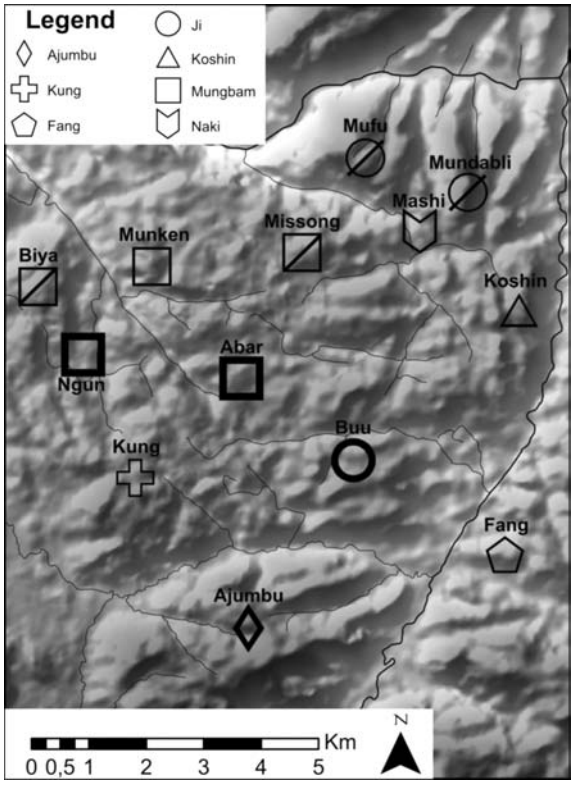

Figure 4. Thematic map representing synoptically, for each village, the affiliation of the language spoken in it and the provenance of most of its exogamous units. As for the latter, the first subdivision between indigenous and foreign ancestors is made through difference in contour line thickness: a thicker contour line indicates indigenous ancestors, whereas a contour line of normal thickness indicates ancestors' foreign provenance. Within the latter subgroup, an oblique stroke indicates that ancestors were of diverse foreign provenance; stroke-less shapes indicate ancestors' uniform foreign origin.

scenario unveiled through field inquiry (and thoroughly reviewed in Di Carlo, 2011) is summarized in Table 2. We can group all traditions of ancestors' provenance collected so far in Lower Fungom around one of three main types: (i) ancestors are mostly indigenous (Abar, Ajumbu, Buu, Ngun); (ii) ancestors are mostly immigrants who moved as a compact group from one specific site (Fang, Koshin, Kung, Mashi, Munken); (iii) ancestors are mostly immigrants who moved as members of groups coming from diverse locations (Biya, Missong, Mufu, Mundabli).

If we visualize the distribution of this "provenance variable" across villages, we obtain a picture such as that reproduced in Fig. 4, where we also represent language affiliation.

Analyzing Fig. 4 we discover that:

1. many, though not all, one-village languages are spoken in villages where a tradition of uniform foreign provenance of ancestors exists;
2. a minority of the language clusters' varieties are spoken in villages where a tradition of uniform indigenousness of ancestors exists.

An analysis of these observations indicates that, although neither is totally correct, the second possible interpretation proposed at the end of Section 3.1 is more likely to be closer to historical realia: most one-village languages appear to have entered the area, while at least some varieties of Mungbam and Ji seem to have had a long history of use in the general area before their arrival. However cogent in historical terms, this perspective encounters a new problem: how can we account for the fact that language cluster varieties such as Missong or Biya for Mungbam as well as Mundabli for Ji are spoken in villages with traditions of mixed provenance (that is, are mostly non-"indigenous")?

Can we explore this failed one-to-one relationship between the tradition of "indigenousness" and multi-village languages (and, vice versa, between tradition of non-indigenousness and one-village languages)? Is there any chance we can achieve a finer level of analysis?

3.4. *Ethnohistorical Landscapes*

Besides the reported ancestral places of origin of kin groups, a number of other sites that are connected with the history of the villages in various ways are also recalled in the available landscape narratives. During the survey, it was possible in the field to geotag many such *lieux de mémoire* (Nora, 1989) (translated in English as 'memory-places'; Flores, 1998, quoted in Kavari and Bleckmann, 2009).[7] The outcome of this geographically informed ethnohistorical inquiry is a first step towards the description of what may be termed "ethnohistorical landscapes," that is, spatial representations that members of a given community (in our case, villages/polities) have of the items of their shared collective memory.

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7) For the concept of temporality of landscape, landscape memory, formation of the concept of place and memory see, amongst others, Lowenthal (1975), Tilley (1994), Muir (1999) and Ingold (1993).

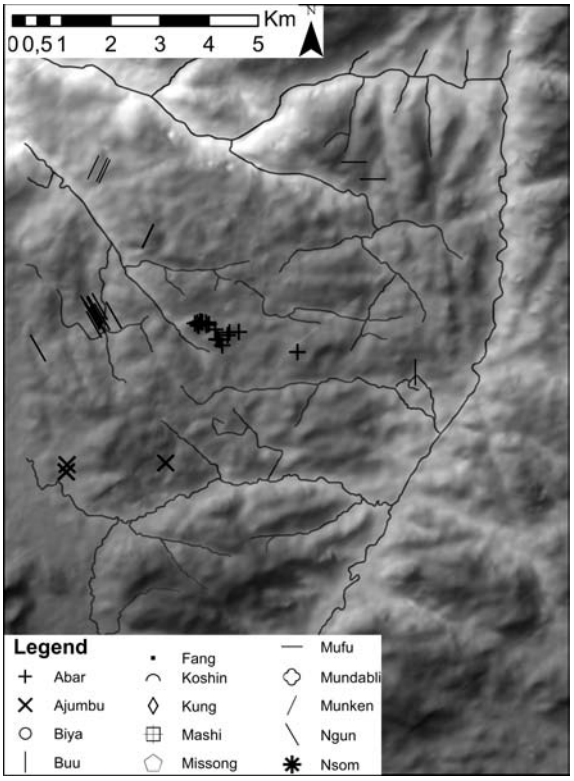

Figure 5. Distribution of the items of memory presumably dating back to circa 1750, collected in village-based ethnohistorical traditions. Nsom (see legend and Figs 6 and 7) is a deserted settlement of some importance for reconstructing the history of Lower Fungom in the 19th century. It is not mentioned in the remainder of this paper for reasons of space, but further information can be found in Di Carlo (2011: 92–94).

Any material items and any places we have geotagged, although located on the land surface, in fact reach different time depths within the ethnohistorical landscape in which they are included. By means of crossing data culled from genealogies, interviews and archival data—at times complemented with informal observations concerning the possible depositional history of a given surface element—it has been possible to propose seven diagnostic chronological thresholds and to arrange the items of memory in this framework according to their reported or reconstructed period of activity (see Di Carlo, 2011: 77–94 for details on the degree of reliability of our reconstruction). As pointed out in Section 2.3, we can combine this time series with our cartography, as we are quite sure the region's

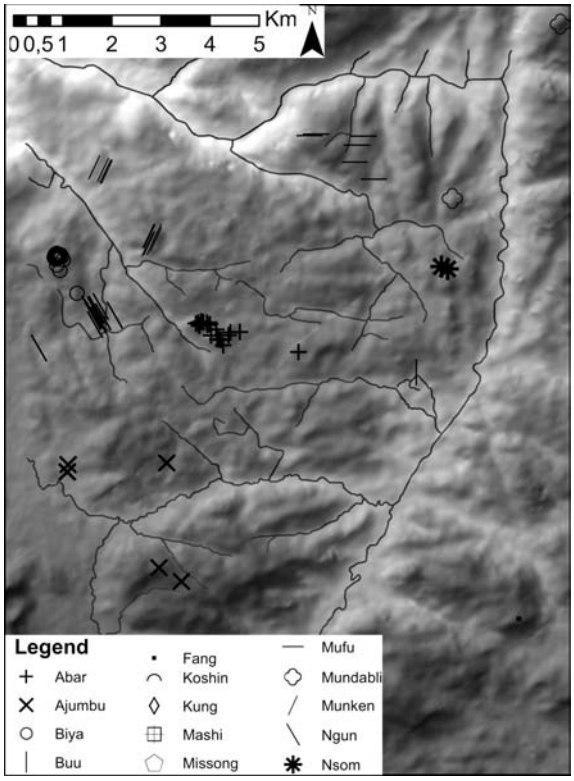

Figure 6. Distribution of the items of memory presumably dating back to around 1830, collected in village-based ethnohistorical traditions.

geomorphology has not undergone significant changes over the last four centuries (see Section 2.3). A selection of the outcomes of such a landscape analysis is shown in Figs 5–8: much like what happens when one discovers successive layers in an archaeological excavation, each figure displays the geographic distribution of the items of memory found in each of the ethnohistorical traditions considered at a broadly isochronic past stage.[8]

[8] The choice of the village as the level at which the different traditions are identified was imposed by the quality and quantity of the data currently available. It is possible, however, that, at least in some cases, the actual dynamics of formation of ethnohistorical traditions might be better captured at the sub-village (i.e., quarter) level.

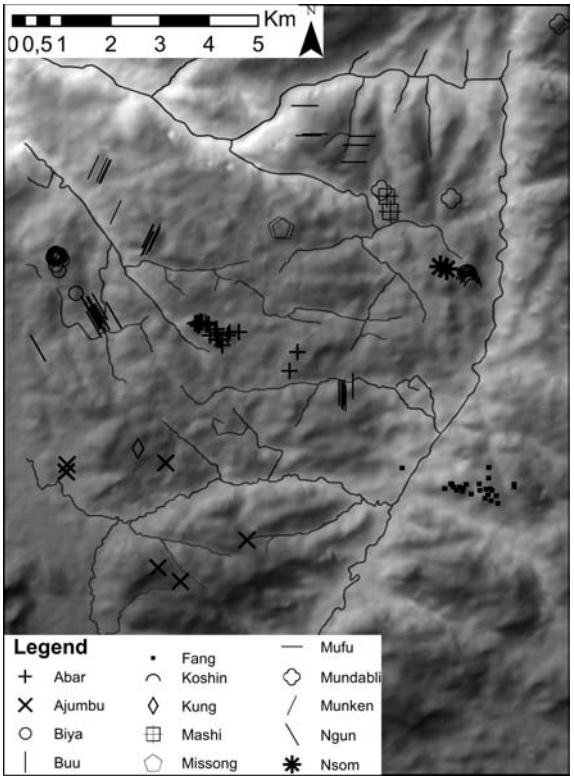

Figure 7. Distribution of the items of memory presumably dating back to around 1860, collected in village-based ethnohistorical traditions.

Let us now briefly analyze Figs 5 through 8 in light of the questions we raised in the previous section. The temporal distribution of village-specific memory-places obviously reflects what we already saw in Table 2: (i) memory-places of most communities having oral traditions of the "foreign-compact" type (i.e., Fang, Koshin, Kung, and Mashi) enter the area only after 1830; (ii) in the earliest phase, we see mostly memory-places belonging to traditions of the "indigenous" type (i.e., Abar, Ajumbu, Buu, and Ngun); (iii) several traditions associated with villages in which varieties of language clusters are spoken (i.e., Biya, Missong, Mufu, Mundabli, and Munken) appear in between these two extremes. If we look at the differential spatial distribution of elements, we discover something that has not been evident thus far: there are traditions that keep a stably nucleated distribution over time (e.g., Abar, Biya, and Ngun, besides all the "foreign-compact"), whereas others appear to be dispersed in the early phases

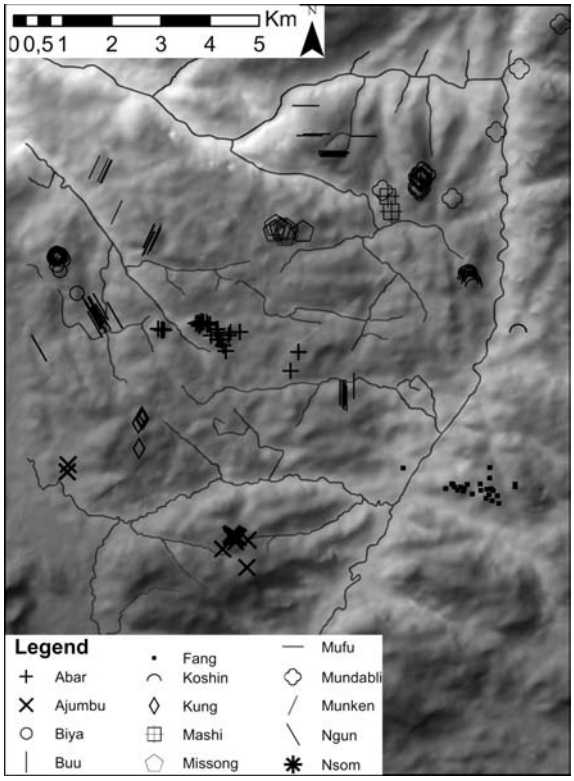

Figure 8. Distribution of the items of memory presumably dating back to around 1900, collected in village-based ethnohistorical traditions.

and to become nucleated in coincidence with the arrival of "foreign-compact" traditions (e.g., Ajumbu, Mufu, Mundabli). Three-dimensional time series representing the spatial distribution of Ngun and Mufu traditions (Figs 9–16) are available in the Online Materials (see Section 7).

If we couple this observation with data on the topography and average altitude at which the memory-places lie, we can make some further minor discoveries. For instance, the average altitude of memory-places undergoes an abrupt increase around 1830 (814.5 meters, as opposed to 784 meters in 1750) and then, again, between 1860 and 1900 (from 815 meters to 834.5 meters, respectively). If considered in the context of the local geography—most valley bottoms lie between 650 and 720 meters and hilltops between 850 and 980 meters—these seemingly minor changes gain their significance in indicating a radical change in settlement patterns. Topography assists us in adding some details to this change: while

in the early phases the overwhelming majority of memory-places lie on smooth flanks of hills or are enclosed within micro-basin-like environments, this pattern becomes increasingly rare in the following phases, when most memory-places tend to concentrate on (nearly inaccessible) hilltops. But what do these memory-places signal in local ethnohistories?

3.5. *Towards a Reconstruction of Lower Fungom Linguistic Prehistory*

Paraphrasing Ingold (1993), we might say that what Di Carlo has recorded are recollections of past taskscapes where the only task remembered was simply that of dwelling. Therefore, the figures displayed here basically represent the distribution of the places where, according to living tellers, bygone people associated with one or the other village have dwelled at different times in the past.[9] This means that the first reading of such maps is demographic and that our analyses can contribute to drawing a demographic history of Lower Fungom. Phenomena of concentration of memory-places are in fact to be considered clues indicating past processes of synoecism, which, as the maps themselves reveal, had been caused by the arrival of foreign compact groups (i.e., bearers of the "foreign-compact" traditions; see Di Carlo, 2011: 89–93) during the second half of the 19th century. Phenomena as such, caused mainly by increased defensive needs, are universally common (see, for Africa, Fleisher, 2010; Jansen, 2005).

Although cross-checking with new data that we plan to collect in the near future is still required, this initial reconstruction in its broad strokes can contribute to our understanding of the linguistic prehistory of Lower Fungom along two lines. In the first place, it is cogent as to the formation of the area's amazingly high language density, as it suggests that about half of the observed diversity can be accounted for in terms of in-migration of languages brought by foreign groups during the second half of the 19th century.

Secondly, it seems to be indicative with regard to the development of the extremely localist language ideology characteristic of Lower Fungom (see Section 3.1). While this, too, is undoubtedly connected with the area's language

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9) Without a doubt, these recollections are potentially subject to distortion according to one or the other speaker's interests (see, e.g., Irvine, 1978: 685 on how these may influence genealogical memories) and, hence, cannot be squarely considered as historical indexes. The reliability of ethnohistorical data has been examined in Di Carlo (2011: 78–88): by maximizing the number of local consultants and through cross-checking evidence coming from diverse sources (such as colonial records and archaeological data), most ethnohistorical traditions collected in Lower Fungom appear to be mutually consistent to a great extent and, hence, can be considered generally reliable.

distribution (as we suggested in Section 3.2), we would like to stress here its potential significance in another respect.

In Section 3.3 we saw that the inclusion of ethnohistories raised the issue of how to justify the fact that varieties of Mungbam (e.g., Missong) and Ji (Mundabli) are spoken in villages reportedly founded by people of non-"indigenous" provenance. In this regard, our historical reconstruction could accommodate the idea that these varieties are, in fact, outcomes of processes of "glottogenesis." This term is normally used to refer to the origin of language in the human species, whereas its intended meaning here is parallel to the term "ethnogenesis"—as the latter indicates the emergence of a discrete "ethnos" out of a hitherto heterogeneous, or at least non-unified, social context, so the former refers to the emergence of the language that is to become the emblem of this new social formation (see Hornborg and Hill, 2011, for a collection of studies concerned with this possibility in the history of Amazonia). In our specific case, our working hypothesis is that outsiders underwent a substantial shift to some local language while also retaining some features of their original idioms, and in doing so created a new variety emblematic of their new, independent polity. A phenomenon as such is not accounted for by phylogenetic or diffusionist models of language change (see Di Carlo and Good, forthcoming, for some initial remarks on this problem).

What we are proposing here is to view the transition between lowland and relatively dispersed to concentrated settlement patterns on easily defensible hilltops as demographic phenomena parallel to both sociopolitical and linguistic processes. If it is reasonable to posit that such a transition may have co-occurred with the development of a much more pronounced attitude, in the newly nucleated groups, towards representing a condition of political and symbolic (i.e., linguistic) "singularity" (Fowler and Zeitlyn, 1996; Warnier, 1980), then it is also possible that the previous scenario of dispersed settlements could coincide with politically "acephalous" societies, a scenario largely dominated, in linguistic terms, by dialect continua rather than by extremely localist ideologies. Cases like Missong, therefore, should be seen as instances of politically-driven, ephemeral "language crystallizations," emerged out of a set of probably related languages through semi-conscious efforts on the part of the speakers (again, see Di Carlo and Good, forthcoming). If confirmed by future research, the availability of this new possible interpretive tool within the epistemological repertoire of historical linguists might prove to be of some importance in contexts, such as the Cameroonian Grassfields at large, where scenarios of high linguistic diversity are coupled with historical demographic processes and sociocultural matrices comparable to those that we have briefly dealt with here.

4. Case Study Two: Ngun

In order to further exemplify what a geography-strong approach actuated within a GIS can provide, we would like to briefly summarize our ongoing in-depth study within the global research on Lower Fungom.

In Figs 5–8 and online Figs 9–16 (see Section 7), we have focused our attention on the items of collective memories indicating a process of synoecism. The maps, however, also show areas that appear to be on the whole stable through time in this regard. A case in point is Ngun. Here the nearly unchanged ethnohistorical time series represent traditions both of ancestors' indigenous provenance and of ancient settlement in the area currently occupied by the village.[10] Moreover, Ngun is unique for two reasons. First, it is the only polity capital located in a lowland environment (we will return to this point shortly). Second, preliminary data collected in 2010 seem to indicate that, in precolonial times, several communities acknowledged that Ngun had a position of ritual prominence throughout Lower Fungom. The latter feature is of particular interest but here, due to limitations of space, will be dealt with only briefly.

Ngun appears to be the principal component in a ritual network that also includes Abar, Buu, and Mufu, and that is countered by a parallel and antagonistic network comprising Biya, Missong, and Munken. Interestingly, the former group includes most of the "indigenous" traditions, whereas in the latter we find only foreign ones (both "compact" and "diverse"). But why should we bother to consider ritual prominence in reconstructing the history of these languages?

Africanist anthropologists have suggested that, in precolonial times, when wandering groups met a welcoming "landowning" community and settled close to it, it was common for the latter to incorporate the former and to preserve a sort of ritual prominence over the newly formed, enlarged group. The former, in turn, would contribute some cultural (including, we would add, linguistic) traits inherited from its pre-incorporation past (see Kopytoff, 1987b, and the studies in Kopytoff, 1987a). In general, the linguistic consequences of incorporation phenomena have been largely ignored by anthropologists. However, it appears highly likely that incorporation of latecomers in a landowners' community would also materialize, especially in stateless societies, in terms of linguistic identity through some form of language shift (Cohen and Middleton, 1970: 23).

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[10] Abar, too, seems to come close to this degree of circumscribed and stable localization of memory-places through time; however, as suggested in Table 2, Abar data are still too incomplete at present to be taken into serious consideration here.

This sketchy contextualization should be sufficient to understand why the ritual place occupied by Ngun in 18th- and 19th-century Lower Fungom could be of some relevance for reconstructing the history of the local languages. Put roughly, if Ngun is confirmed to have exerted some ritual prominence throughout our area at an early date, then there will be some room to hypothesize that at least some of the reported immigrant groups now speaking a Mungbam variety (i.e., Biya, Missong, and Munken) had in fact undergone some degree of shift towards the landowners' language (i.e., Ngun) *ab antiquo*, while still retaining some degree of cultural autonomy.

While we plan to continue collecting information relevant to test this perspective, spatial analyses can help us rough-hew this research question. As mentioned above, there is an environmental characteristic of Ngun that seems worthy of closer examination: if we exclude a handful of settlements that have been founded over the last few decades, Ngun is located at by far the lowest elevation. This appears to be in stark contrast if set against the dynamics of synoecism in easily defensible sites, which, as seen above, probably took place between 1860 and 1900 in particular. How can we account for this puzzling peculiarity? Our GIS can offer some suggestions in this regard.

First, by relying on detailed geomorphological information (available on the Digital Elevation Model; see next section), our GIS has generated a map representing the terrain's inclination, expressed in percentages, using different colors. By itself, this slope map (see Section 5 and online Figs 17–18) reveals very little in our case. However, when adding hydrography and altitude data, we find that Ngun is the only one among the non-recent villages in Lower Fungom (except for another old, now deserted settlement called Lung; see Di Carlo, 2011: 89–90) characterized by (i) low elevation, (ii) surrounding flat or nearly flat extended areas, and (iii) favorable location with respect to availability and quality of water resources.

Second, we can look at some geological features. Since there appear to be no geological studies of this area, we must rely on remote sensing analyses performed on high-resolution multi-band satellite imagery. For instance, distribution and intensity of reflections of both infrared and near-infrared bands can be instrumental in detecting the amount of humidity present in the soil so as to identify sub-areas where different conditions of watering of soils exist. We are still in the process of analyzing these data, but preliminary observations do not counter the idea that Ngun lies in an especially well-watered sub-area within Lower Fungom.

Taken together, the data at our disposal do not contradict the view that Ngun has been founded in an ecological micro-niche that, due to its characteristics of watering, soil composition, elevation, and inclination would seem to be ideal for relatively intensive agriculture. This might have promoted early adoption of sedentary ways of living. Such an environmental and economic context would

seem to fit the image of a community that developed into a nucleated village *ab antiquo*, possibly at a time when many groups in the rest of Lower Fungom were living according to a more dispersed residential pattern. As we have already pointed out in the previous section, such a demographic difference would have been mirrored also in sociopolitical and symbolic terms (see Horton, 1972, for an overview of such correlations in West Africa), which we may legitimately extend to language (see Cohen, 1974, on the close relationship between political and symbolic agency of interest groups). Roughly put, from this perspective, Ngun could be viewed as having achieved an ideological level of strong attitudes towards "singularity" (both material and symbolic) earlier than others in the area. This could be instrumental in explaining why Ngun—today, one of the tiniest villages in Lower Fungom, with no memory of having subjugated any other community—is so prominent in the traditions of several neighboring villages. On this basis, it is difficult to resist the temptation to see these being attracted by the landowning community, thereby promoting intermarriage and a sort of identity shift toward the latter, no doubt channeled—at least in part—through language shift.

What we have summarized in this section is a list of enchained working hypotheses—none of which has been tested thus far—made possible by the dialogue between ethnographic, linguistic, ethnohistorical, geomorphological, geological, and environmental data. The rationale for their presentation here lies in the method that has allowed their generation, rather than in their actual explanatory power. This stands, we believe, as a good example of what we mean by saying that a geography-strong approach within a GIS framework fosters interdisciplinary dialogue. At the very least, these practices can produce new research questions, thereby contributing to the research agenda.

5. Our Workflow: Summary and Discussion

In this section, we provide an overview of the workflow we have adopted during this research. A few additional remarks will expand on aspects that might be novel to many readers.

Once we had collected information in the field (also using a Global Positioning System, henceforth GPS, to geo-reference points or areas of interest), our workflow included the following steps:[11]

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[11] In the following, we include only the steps we have actually taken, without considering the whole array of procedures that could theoretically be performed. To offer but one example, this summary does not include any mention of cluster analysis on the grounds, which, though an important GIS ability, has not yet been performed in our research.

1. Geographic data mining
   We have sought any possible sources of geographic information: topographic maps, aerial photographs, satellite images, geological or land use maps. This phase is ongoing and may never be truly completed. For instance, the satellite image mentioned in Section 4 is just one of a series of images we plan to purchase and examine in the future.
2. Database construction
   Data collected in the field are described according to a research-specific database structure (see point 5 below). They are also geo-referenced and can be related to geometric elements such as points, lines, and polygons. In our case, we have chosen to record cultural features as points (see Dahl and Veselinova, 2005, and Briscoe, 2009: 32–35 for issues related to language mapping).
3. Creation of the Digital Elevation Model (DEM)
   Through a process of interpolation of altitude data—in the form of both points and contour lines retrievable from a geographic map, or from remote sensing data like, e.g., those collected by sensors such as ASTER—a DEM or DTM (Digital Terrain Model) reproduces variation of heights and, hence, terrain morphologies in a digital environment.
4. Data import and initial tests
   The database is imported into the GIS and some tests to check the spatial consistency of data are performed.
5. Generation of thematic maps
   Thematic maps representing uni-, bi- and multivariate data are produced—the difference lying in the number of "themes" (i.e., variables) visualized—in some cases mixing quantitative and qualitative data (see Section 2.3). In this paper, Fig. 4 and the time series in Figs 5–8 (online Figs 5a–8a) are instances of, respectively, bi-variate and multi-variate thematic maps. These are obtained by selecting the relevant data from the database, connected with the associated geo-referenced geometric features (i.e., points, lines, or polygons) and a given set of attributes. The latter usually include information gathered in the field and stored in the GPS. This can also be complemented at a later stage with new attributes derived from other sources. It is therefore essential that the database structure (i) is consistent with the logic of our data, and (ii) follows a uniform though articulated way of classification of items of knowledge. Once sorted, our select data can be visualized by means of different symbols, colors, and dimensions which may best represent the variability of the phenomena analyzed.
6. Spatial analysis
   Through observation of the distribution of our select features, we are able to identify possible spatial patterns among *all* the available variables, be they stored in the database (e.g., language affiliation, presence of given cultural

or linguistic feature) or accessible in the virtual representation of space (e.g., altitude, proximity to water flows, multi-band spectral refractions, etc.). It is important to stress that the information stored in a GIS can generate new data, which can then be used to fill gaps in the original documentation. To provide but one example, suppose one inserts new data points in the database establishing their localization on the basis of field notes, not geo-referenced items stored in the GPS. In a GIS it is then possible to extract the altitude of these new points by interpolating their geographic coordinates with the DEM, which, being a raster image, is subdivided into a regular grid of small pixels with each pixel having values attached to it.

A key tool in performing spatial analysis is the possibility to obtain a correct overlay of different thematic maps. Depending on the chronology of the items displayed in them, such operation may lead to the identification of synchronic or diachronic patterns (as instances of the latter type, see our time series in Figs 5–8).[12] At this stage, analysis can be facilitated by generation of maps emphasizing particular geomorphological aspects, such as in the case of slope maps (see online Figs 17–18 and Section 4).

7. Re-appraisal and hypothesis-making

Original data are re-evaluated in the light of the analyses performed in steps 5–6 above—which are re-iterable and updatable, when needed, with new data or according to new classifications. Now disciplines can interact, and this naturally leads to the development of new hypotheses (see Möhlig, 2010; Charaudeau, 2010). At this stage it becomes clearer that GIS techniques can be used not only to visualize what the historian, the linguist or the anthropologist indicate (as in LL-Map), but also to advance new research questions and hypotheses informed by authentic spatial reasoning. In this paper, this important aspect has emerged twice: first, in Section 3.3 and Fig. 4, when a synopsis of affiliation of local languages with reported provenance of villages' ancestors raised a problem of inconsistency between the two sets of data; second, in Section 4, when evidence gathered from a slope map and a spectral analysis performed on satellite imagery has prompted a set of hypotheses on the (pre)history of Ngun and, consequently, the (pre)history of the Lower Fungom languages. It is opportune to stress at this point the importance of the holistic vision that can be generated through a GIS and the software implementing it. Information coming from different disciplines is of course always retrievable, and the possibility to provide a multidisciplinary synopsis is by no means a GIS's monopoly. However, what can be achieved by GIS

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12) For a successful application of this method in landscape archaeology see, e.g., De Silva (2011).

exclusively is the visualization of a sizable and composite amount of data *simultaneously* on a map, thereby providing the opportunity to examine a "whole of knowledge"—greater than the sum of its constituents—in which potentially unexpected (and even unexpectable) spatial patterns and relationships can emerge.

8. Reliability check and setting research agenda
   Provided that the database has been structured accordingly, in a GIS we can also generate thematic maps highlighting the degree of reliability of data, both in terms of their content and geographic location (see Briscoe, 2009: 16–28 for issues related to data accuracy and uncertainty in GIS applied to linguistic themes). For instance, the degree of reliability shown in the rightmost column of Table 2 can be translated in the form of a map (see online Fig. 19). This procedure is a fundamental step in planning subsequent stages of research, and it can also help selecting the portions of data that are worth more thorough analysis.

6. Conclusions

In this paper, we have taken as a starting point the widely-held idea that explaining patterns of language change and language prehistory requires examining data from both the human and natural world. This, in turn, requires integrating data from different disciplines such as linguistics, anthropology, history, and geography. Such integration is inherently difficult, but here, we have seen that new methods make it more straightforward than it has previously been.

We have presented two case studies in order to illustrate how the inclusion of spatial reasoning and of a powerful analytical tool such as GIS in a multidisciplinary research project focused on language (pre)histories can result in a significantly increased ability to raise new and complex research questions.

Regardless of whether or not all of the details of our analysis of Lower Fungom are correct, we hope to have shown that new technologies can facilitate the adoption of a geography-strong approach to linguistic prehistory and, through this, the oft-cited interdisciplinary dialogue (e.g., Klein, 2005; Charaudeau, 2010; Möhlig et al., 2010). We believe this can represent an important methodological advancement within this area of historical studies, as spatial and landscape analyses like those we have proposed here "enable scholars to avoid simplistic models about the derivation and carryover of culture" (Howard, 2005: 25) and, as we have tried to show, about the prehistory of languages.

7. Online Materials

Any maps aiming at some degree of geomorphological detail need to be drawn and read in color, let alone a complex multi-variate cartography aiming at displaying the possible interplay between geomorphology and other categories of evidence, as we have tried to do here. For this reason the interested reader will find a set of color images at the URL http://dx.doi.org./10.1163/22105832-20120202; http://booksandjournals.brillonline.com/content/22105832/2/2 (click on tab Supplements). This includes (i) color copies of Figs 5–8 (numbered as Figs 5a–8a), (ii) the three-dimensional figures (Figs 9–16) as well as (iii) the slope maps (Figs 17–18) mentioned in Section 4, (iv) a map representing data reliability (Fig. 19) mentioned in Section 5, and (v) a short video file meant to facilitate the inspection of Figs 5a–8a as a time series.

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