

Sinification of Zhuang place names in Guangxi, China: a GIS-based spatial analysis approach

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Zhuang, the largest minority language in China, is the label given to a variety of Tai languages and dialects spoken mostly in Guangxi. As a result of the process known as Sinification or Sinicisation stemming from the influx of Han soldiers and settlers moving in from many directions, but primarily the north, many Zhuang place names (toponyms) were changed to Han or pronounced with a Han accent or spelled in Chinese in such a way as to obscure the original Zhuang form. The objectives of this paper are to (1) construct a GIS database of toponyms in Guangxi at the township, county and prefecture levels from a comprehensive toponymical dictionary series of China; (2) analyse the spatial distribution of Zhuang vs non-Zhuang toponyms and its association with environmental factors; and (3) examine the historical evolution of toponyms to better understand the process of Sinification. Results show that Zhuang toponyms have the highest concentrations in the southwest Twin-Rivers Basin and the western mountainous area, and decline gradually towards the east. Zhuang toponyms are better preserved in areas that are more remote from major transport routes and major cities, and at higher ground level and with a somewhat steeper slope. Analysis of the limited number of toponyms with time stamps reveals that the Zhuang toponyms on contemporary maps are older in the west but more recent in the east. We speculate that in eastern Guangxi, with larger Han settlements for a longer period, older Zhuang toponyms were likely to be obliterated. The centroids of Zhuang and non-Zhuang toponyms converge towards the centre of Guangxi over time, reflecting the impact of increasingly integrated Sino-Zhuang settlement patterns.

key words toponym GIS spatial analysis Zhuang Tai Sinification Chinese

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Introduction

Ludden (2003) once forcefully and eloquently argued for geographies that are more informative than those that modern national maps can provide – geographies that recognise that national boundaries belie the historical mobility of peoples. The

Tai are surely one of the peoples with settlements across national borders. The irrigated rice culture they refined in southern China some 2000 years ago enabled them to expand far beyond their geographic origins and project their economic and political influence to much of mainland Southeast Asia. Many toponyms (place names) are derived

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from identifiable features of both the natural and manmade landscape that map distinctive features of their evolving history and culture: water sources, landforms and bioforms, rice fields and passage-ways. An environmental record and indigenous knowledge system has thus been preserved in toponyms. However, many of the earlier Tai place names, and the cultural, linguistic and human history they encapsulate, have been obscured by time, political change and the work of official government mapmakers, most notably in China. Many toponyms also document extensive linguistic and cultural borrowing, which is an important, largely undemonstrated, or overlooked, part of the Tai expansion.

Our research seeks to demonstrate the application of GIS and spatial analysis techniques to Tai toponymical studies that could lead to the reconstruction of the fullest possible remote history of Tai origins, expansion and dispersion from southern China into Southeast Asia. Figure 1 approximately shows that the entire Tai language domain covers southern China (Guizhou, Yunnan, Guangxi, Guangdong and Hainan) and Southeast Asia (northern Vietnam, Laos and Thailand). This paper reports on a part of the work from the larger ongoing project, with a focus on Zhuang Tai toponyms in Guangxi, China.

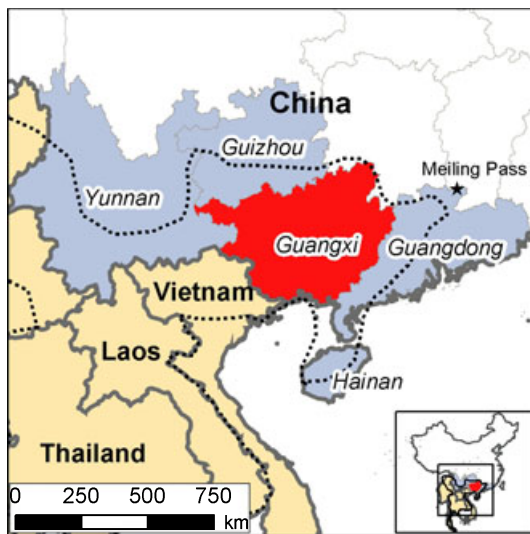


Figure 1 The Tai-speaking domain and location of Guangxi

Zhuang in Guangxi and toponymical studies

For years, anthropologists and historians have written papers on the topic of 'Who are the Tai?' (e.g. O'Connor 2000). Our outlook has been that 'being Tai' is a cultural construct centring on the emergence of irrigated rice technology in southern China that came to be dominated and spread by genetically diverse peoples sharing a basic agrarian vocabulary and naming tradition that linguists identify as Tai (Hartmann 1998). The history of the Tai is one of peasants colonising new lands using waterways for transport, irrigation, ritual, and clearing the myriad *muang* (geographical 'basins' in proto-Tai speech) that in turn became petty kingdoms, and in two instances modern nation states: Muang Thai (Thailand) and Muang Lao (Laos). A study by Luo *et al.* (2000) suggests that the primary candidate of origin for proto-Tai is in the region of Guangxi–Guizhou, not other places as some have proposed (Chamberlain 1997; Watabe 1978). This region has primarily been settled by the Zhuang people, which are the largest ethnic minority in China and who mostly live in the Guangxi Zhuang Autonomous Region (simply referred to as 'Guangxi' in the remainder of the paper). The Zhuang are part of the Tai family (Li 1960).

The origin of the Zhuang can be traced to the 'Baiyue' peoples in southern China, recorded in history as early as in the Eastern Zhou Dynasty (475–221 bc) (e.g. Pan 2005). Historically, the Zhuang were farmers who specialised in growing rice in irrigated fields called *naa* in Zhuang languages. They lived primarily in thousands of villages or small towns in the lowlands close to rivers and streams that were dammed to divert water into the *naa*. The history of the Zhuang, like other minorities in Chinese frontier regions (e.g. Herman 2007), is marked by a relentless series of violent conflicts with their northern neighbour, the Han (the Chinese majority). The Song era (AD 960–1279) is probably the last time during which the Zhuang might have remained an ethnic group organised under an independent state established by the Zhuang 'rebel' leader Nong Zhigao (Barlow 2005). After the Song ruler defeated Nong in 1053, the central government strengthened control over the Zhuang, and the Zhuang have since become a somewhat coherent ethnic group according to 'official' Chinese history (Zhuang 1982). The recognition of Zhuang as a distinctive ethnic group in the Song era by

historians reflects China's historical expansion to the south. As Shin (2006, 5) puts it, the Han migration to the south is not only a story of 'colonisation and acculturation' but also a story of 'demarcation and differentiation'.

Following the Song, the Mongols conquered all of China and established the Yuan Dynasty. Many Han were pushed south and entered Guangdong and neighbouring Guangxi, mostly through the Meiling Pass (see Figure 1 for its location). The incursion of Han people into the Zhuang areas led to absorption or replacement by succeeding waves of Han migrations in certain areas. As a result of military colonisation in the Ming and Qing Dynasties, the westward move of the Han (including soldiers, their families and businessmen) intensified the Han–Zhuang interaction and mixed settlement in Guangxi, including the less accessible western part of Guangxi (Huang *et al.* 1988; Zhong 1999). As a result of the process known as Sinification or Sinicisation that stemmed from the influx of Han soldiers and settlers moving in from many directions, but primarily the north, many Zhuang place names were changed to Han or pronounced with a Han accent or spelled in Chinese in such a way as to obscure the original Zhuang form. One of the major objectives of this research is to uncover some of the process of change in the records of toponyms, often obscured by time, political events and the work of historians and mapmakers.

Toponyms are the 'signposts to the past' (Gelling 1988), and provide a special angle for studying the historical and cultural heritage of particular places and even large regions. Place names are not just linguistic forms, but also cultural and societal artefacts that offer insights into the history, habitat and environmental perceptions of a certain culture (Jett 1997). Some studies used toponyms to illustrate ethnic settlement patterns and help identify discrete periods of population movements (e.g. Kaups 1966; Miller 1969). The spatial pattern of Tai toponyms such as 'Muang,' 'Chiang' and 'Viang' was often a reflection of terrain characteristics and culture practices influenced by Tai wet rice agriculture and river commerce (Luo *et al.* 2010). The naming of places may also reflect the politics of identity and power, as toponyms are often used by the authorities to promote their own ideological and political objectives (e.g. Cohen and Kliot 1992; Hartmann 2007; Horsman 2006; Myers 1996).

Notable Zhuang toponym studies began with Xu (1936 1940), who surveyed the spatial distribution of Zhuang, Dai and other Tai place names in southern China. Most comprehensive studies of Zhuang toponyms were published after the 1980s. For example, Zhang *et al.* (1988) compiled a dictionary on Zhuang place names in Guangxi. Wu (1992) and Yuan (1993) discussed the linguistic properties, classification and changes of Zhuang toponyms. Qin (2005 2006a 2006b) used the methods of comparative-historical linguistics to examine Zhuang toponyms and Han influences. However, these studies are qualitative and descriptive in nature and lack a systematic perspective.

Despite the advancement of Geographic Information Systems (GIS) technology and its great impact in various fields over the past two decades, GIS applications in historical-linguistic-cultural studies are limited. Historical GIS has played an increasing role in advancing research in various fields (Knowles 2002). With exceptions such as O'Kelly (2007) and Dean and Zheng (2010), studies using advanced spatial analysis methods continue to be rare. Kwan (2004) promoted the notion of 'hybrid geographies' to bridge the divides between the social-cultural and the spatial-analytical geographies. Our research will show how modern GIS and spatial analysis techniques can benefit historical-linguistic-cultural studies (Wang *et al.* 2006). By examining the relationship of Tai settlement and migration patterns to both physical and man-made environments, this paper will also demonstrate the benefit of bridging the divide between physical and human geography (Rhoads 2004).

The remainder of this paper is organised as follows. The next section discusses the data sources and processing with a focus on identifying Zhuang toponyms. The research results are presented in three following sections. One section illustrates how GIS helps to visualise the spatial pattern of Zhuang toponyms. It is followed by a section on regression methods used to explain how the pattern is associated with various environmental and human factors. The third component uses the time stamps in some of the toponyms to uncover the historical interactions between Han and Zhuang and the impact on the changing spatial patterns of toponyms. A brief summary concludes the paper.

Data sources for Zhuang toponyms

Guangxi has an area of 236 000 square kilometres, bordering Vietnam in the south. According to the Guangxi Bureau of Statistics (2006), the total population in Guangxi is 46.55 million, including 28.61 million (61.5%) Han, 15.18 million (32.6%) Zhuang, and 2.76 million (less than 6%) other ethnic minority groups. The Zhuang in Guangxi account for the majority (94%) of Zhuang population in China, with the remaining Zhuang in the neighbouring Yunnan, Guizhou and Guangdong provinces. Based on the 2000 census data at the county level (All China Marketing Research Co. 2006), Figure 2 shows that Zhuang are concentrated in the west, particularly southwest, of Guangxi.

Truly Zhuang toponyms are geographic entities named by Zhuang people with linguistic and cultural meanings in the Zhuang language (Zhang *et al.* 1988; Qin 2005). In general, Tai (including Zhuang) toponyms follow the pattern of head noun (or general name), plus one or more modifiers (or special name). Several types of head nouns are used to name places such as a mountain or a hill, regions near a mountain, water resources, woods and forests, settlements and occupations of the landowners, the animals and plants commonly found in the region, and local legends or folktales.

This happened in other Tai areas of China as well. For example, the Dai autonomous prefecture known as Xishuangbanna is called ‘Sipsong Panna’ or ‘Twelve Thousand Rice Fields’ in Dai, but the original Dai meaning has been obliterated by the Chinese transcription (Dai 2004). Some commonly used head nouns for place names are very similar between the Thais and the Zhuang, as shown in Table I (Phromsuthirak 2005). The superscripts in Table I are tone contours. The scale is 1 (low) to 5 (high). Thus, a word like na:³³ is a mid-tone, ba:n⁴¹ a falling tone (4 → 1), pha:²⁴ a rising tone (2 → 4), and so on.

Our primary data source is the comprehensive toponym dictionary series of China (Cui 1999), which was developed by the arduous work of more than 100 editors over 18 years. Several editors for the section on Guangxi were Zhuang. The

Table I Head nouns commonly used by Thai and Zhuang people

	Thai	Zhuang
Field	na: ³³	na: ³¹
Village	ba:n ⁴¹	ba:n ³¹
Pond	bo: ²²	bo: ³⁵
Mountain, cliff	pha: ²⁴	pla: ²⁴
Mountain	dO:yj ³³	doi: ²⁴

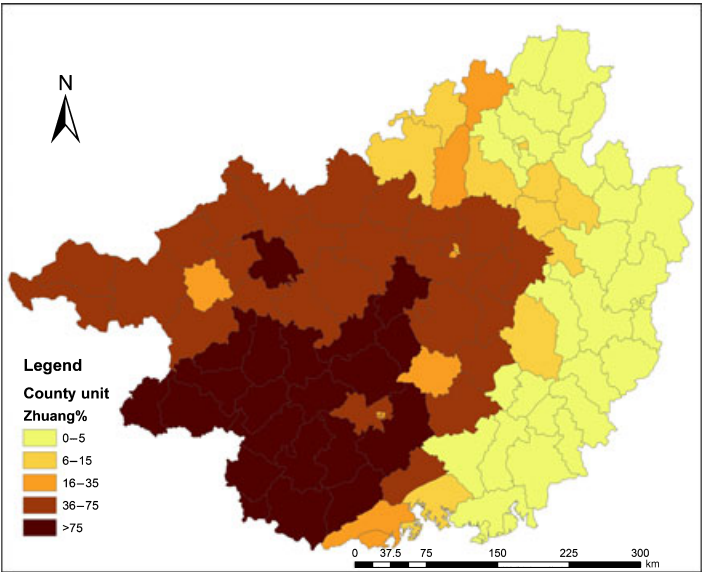


Figure 2 Zhuang population at the county level in Guangxi 2000

foundation for the series was local gazetteers that are compiled and updated regularly by an office of place names in each provincial and county government office in China. A typical entry in the dictionary describes the history of a place, the origin of its name and name changes, if any. Figure 3 shows two examples: a Han toponym 'Ping-fu' on the left means 'peace and happiness' named after a plate on the city wall in 1935; and a Zhuang toponym on the right means 'cloth-washing river mouth' in Zhuang, pronounced as a four-syllable word in Chinese but recorded as 'Bo-se' (condensed to two syllables) in Chinese in 1965. The task of deciphering the dictionary for relevant information (toponym types and date of being first named) and inputting it into a GIS database proved to be a time-consuming process. For some toponyms that needed clarification, we checked alternative data sources (Ding 1990; Zhang *et al.* 1988) and consulted with Zhuang experts including Drs. Pingwen Huang and Xiaoyi Wu of Guangxi University for Nationalities.

Zhuang toponyms can be pure or hybrid. 'Pure' Zhuang toponyms are recorded by trained Zhuang locals in Chinese (i.e. the Han language, used interchangeably with Chinese in this paper). Sometimes they had to create Chinese-like characters (in Zhuang, *sawndip*) because of a lack of appropriate Chinese characters. A *sawndip* character is usually made up of two Chinese characters, with one

representing its Zhuang pronunciation and another indicating its meaning (Li 2004). Toponyms containing any *sawndip* characters are easy to identify as Zhuang toponyms. Hybrid Zhuang toponyms contain both Zhuang and Chinese characters. Some of the hybrid Zhuang toponyms are formed when two administrative units are merged, and the new name uses one character from each name. For example, Na-si (a township in Qinzhou) is made up of a common Zhuang head noun 'na' (meaning 'field'; Zhou and You 1986) and a Chinese letter 'si'. Hybrid Zhuang toponyms represent a certain degree of assimilation of Zhuang by the Han, i.e. Sinification. Even the pure Zhuang toponyms were recorded in Chinese or Chinese-like characters by those who understood Chinese, and thus reflect Han influence, though to a lesser degree. Some Zhuang toponyms were obliterated by constant modern-day administrative changes (redistricting). For example, Si-rong (a township in Rongshui County) is made up of the first characters of two merged townships, Si-an and Rong-an, both Zhuang toponyms. We coded toponyms like Si-rong as Zhuang, since its origins in Zhuang are preserved to some extent in the new names though no longer meaningful in the Zhuang language. In summary, the Zhuang place names in records, though originally fashioned by the Zhuang, are the outcome of Han influence because of absence or lack of sufficient written documentation.

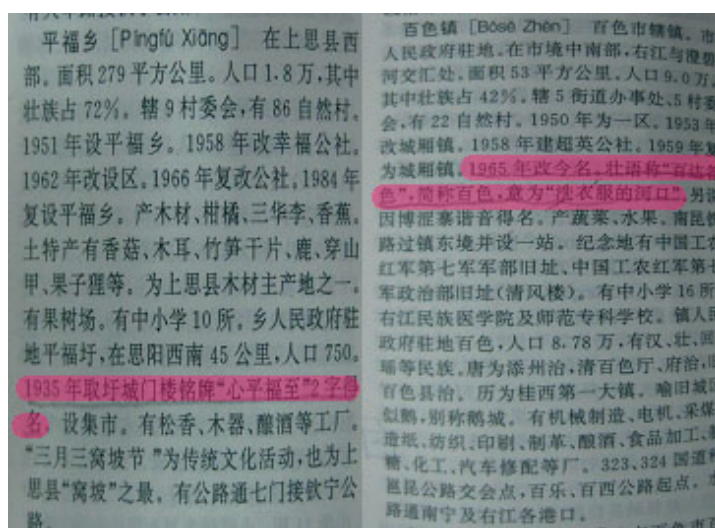


Figure 3 Zhuang and non-Zhuang toponyms in toponymical dictionary (Cui 1999)

Scholars argue that the toponyms of Zhuang (Tai, in general) are best preserved at the *ban* or village level (e.g. Kullavanijaya 1996; Phromsuthirak 2005). Tai toponyms, especially at the village level, are not designed as statements of power, but rather comments on natural surroundings: mountains, cliffs, hills, rivers, streams, ponds, marshes, flowers and fish, and so on. They encapsulate more of what might be considered older Tai vocabularies, spoken rather than written, and coloured by the imagination of the peasants' predilection of taking clues from the environment and creating a cognitive map of their immediate world. We explored the possibility of analysing all village toponyms in Guangxi. However, several reasons prevented this and led us to focus on the toponyms above the village level for this study. The decision was primarily due to limited time and data availability. Complete sets of village names are only available in county-specific gazetteers, often available in the office of place names in each county government. We were able to obtain gazetteers from three counties (Laibin, Lipu and Xincheng) in Guangxi, which contained a total of 1041 village names. For all 90 counties in Guangxi, there would be approximately more than 30 000 village entries, beyond our capacity to analyse. Secondly, written records at the village level are poorly kept and usually of inferior quality. Finally, more toponyms above the village level are admittedly replaced by Chinese names. The name of a place historically settled by Zhuang but recorded by Chinese may not 'report the world' but merely 'names it' (Carter 1987, 175). Such a practice, or Sinification, and its associated spatial pattern are indeed what this paper attempts to reveal.

This project covers place names in Guangxi at three administrative levels: township (*xiang/zhen*), county and prefecture (*dijishi*). These administrative units are chosen for the toponymical analysis for several reasons. First, it ensures that the coverage of geographic places at the same level is complete, and thus offers a systematic perspective. Second, these administrative place names command more in-depth investigations by local toponymical offices in charge of standardisation and archives of place names in China, and thus the descriptions in gazetteers are more accurate and detailed. Finally, by including three administrative levels, we hope to examine whether place names at a lower administrative level are subject to a lesser degree of Sinification than those at a higher level, as suspected by

some scholars (Hartmann 2007). The choice of toponyms of administrative units is also for convenience of geocoding and subsequent statistical analysis of association with environmental factors, since each toponym can be simply geo-referenced to its political centre (city site, county or township seat). Regrettably, this leaves out potentially more valuable toponyms reflecting geographic features such as mountains, basins, rivers and creeks, which are linear or areal units and not suitable to be represented as single points.

The study area has a total of 1427 place names with 14 prefectures (*dijishi*), 75 counties (*xian*) and 1338 townships (*xiang/zhen*). Each toponym is classified as Zhuang or non-Zhuang (mostly Han), and represented as a point (where the prefecture, county or township seat is located) in the GIS data set. The GIS data set of these place names was built by digitising a large-scale map of Guangxi (Guangxi Bureau of Surveying 2003). Table II shows the numbers and percentages of Zhuang toponyms across the three administrative levels. The percentage of Zhuang toponyms increases from 7.1 among prefecture names to 21.3 among county names, and to 25.3 among township names. The lower percentage of Zhuang toponyms in higher administrative units reflects a higher degree of Sinification for these places, which are usually larger cities with more Han influences. Figures 4(a–c) show their distribution patterns.

The concentrations of Zhuang toponyms are in the south and the west, and the pattern is consistent across the three administrative units. It also conforms to the Zhuang population settlement pattern as shown in Figure 2. A direct regression of Zhuang population ratios against Zhuang place

Table II Zhuang and non-Zhuang toponyms at various geographic levels in Guangxi

		Prefectures	Counties	Townships	All
Total	No.	14	75	1338	1427
Toponyms with era record (all) ^a	No.	14	75	171	260
	% ^b	100%	100%	12.8%	18.2%
Zhuang toponyms	No.	1	16	339	356
	% ^b	7.1%	21.3%	25.3%	24.9%
Zhuang toponyms with era record	No.	1	16	18	35
	% ^c	100%	100%	5.3%	10.0%

^a Toponym with record indicating the time when the place was first named. ^b Per cent out of all toponyms. ^c Per cent out of Zhuang toponyms.

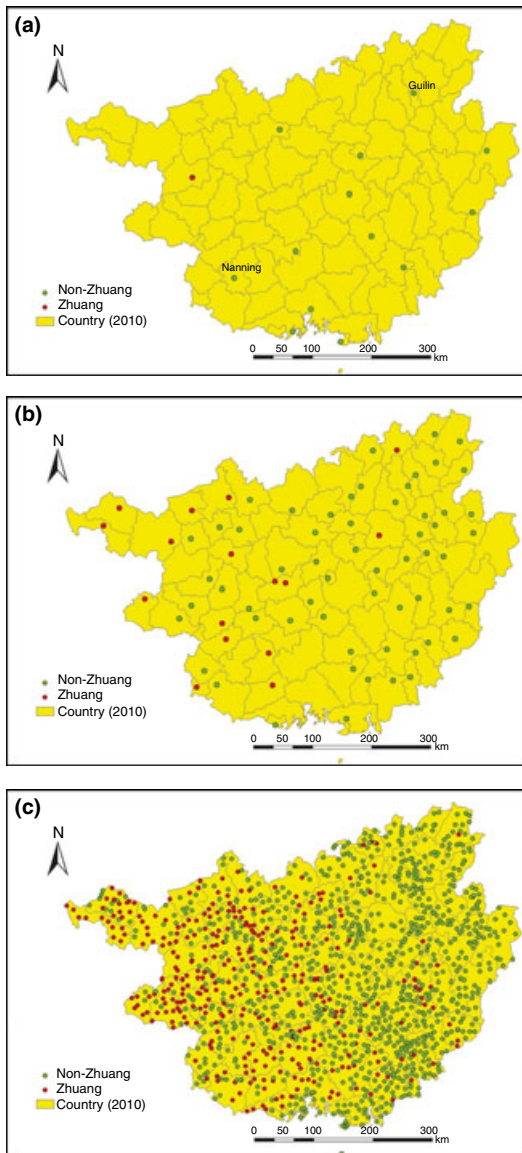


Figure 4 Zhuang and non-Zhuang toponyms in Guangxi: (a) prefectures, (b) counties and (c) townships

name ratios at the county level yields $R^2 = 0.34$, implying a correlation coefficient of 0.58. Many factors may have contributed to the 'not-so-perfect' correlation. The most important one is perhaps that a place name remains unchanged for an extended period of time and does not necessarily reflect the ethnicity or language of modern settlers. In other

words, a place name may better represent the ethnic group that governed the area in the past.

Geo-visualisation of Zhuang toponyms in GIS

Mapping is a fundamental function of GIS. However, direct mapping Zhuang place names as in Figures 4(a–c) has limited value. Spatial analysis techniques such as spatial smoothing and spatial interpolation methods can help enhance the visualisation of the spatial pattern of Zhuang toponyms.

The analysis begins with classification of place names in GIS as a binary variable identifying whether a place name is Zhuang (= 1) or non-Zhuang (= 0). A common spatial smoothing technique is then used to examine the relative concentrations of Zhuang place names (Wang 2006, 35–40). The method draws a circle around a toponym to define a filtering window, and computes the ratio of Zhuang toponyms to all toponyms within the window (or simply 'Zhuang toponym ratio'). The circle moves from one place to another until the ratios are obtained for all places. Each ratio represents the concentration of Zhuang toponyms *around* a place.

After experimenting with various radii, we chose a 20-km radius, as shown in Figure 5. A larger circle (i.e. a larger filtering window) leads to stronger spatial smoothing, and thus better reveals regional than local patterns; and a smaller circle corresponds to reverse effects (Wang 2006, 36). By doing so, the original discrete variable of Zhuang toponyms (0 or 1) is converted to a continuous ratio (any numerical value ranging from 0 to 1). Figure 5 shows the gradual decline in Zhuang toponym ratios eastwards.

The overall spatial trend can be further highlighted by spatial interpolation. The technique uses known values at given locations to estimate unknown values at other locations, and generates a continuous surface for the entire study area. One commonly used spatial interpolation method is trend surface modeling, which assumes that the value of a variable at any location is a polynomial function of its x–y coordinates. In our case, the known values are 1427 toponyms being 0 or 1 to represent a non-Zhuang or Zhuang toponym. Since the variable of interest is binary, a special trend surface method, namely the logistic trend surface model, is used to estimate the probability of a toponym being Zhuang based on its location. The imple-

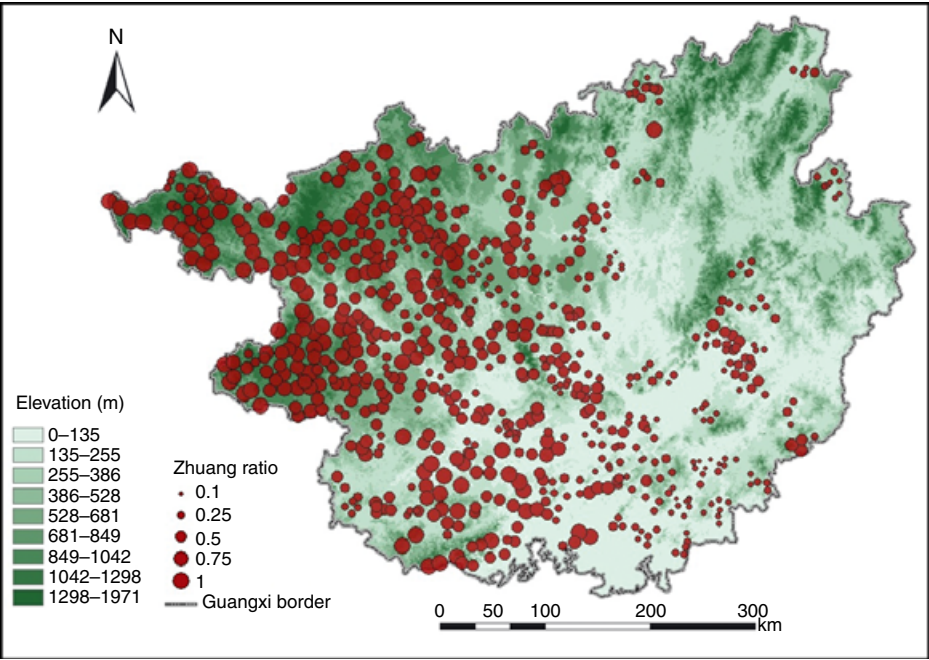


Figure 5 Zhuang toponym ratios (20 km around each place) in Guangxi

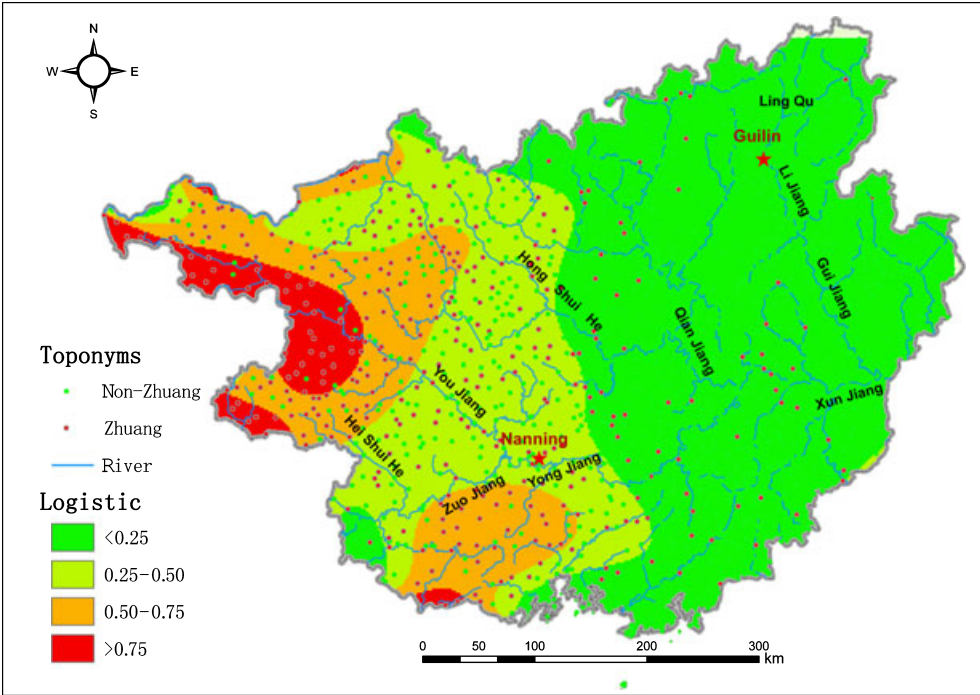


Figure 6 Trend surface modelling of Zhuang toponyms in Guangxi

mentation of this method is straightforward by utilising a built-in tool in ArcGIS (Wang 2006, 46).

Figure 6 shows the result as a continuous probability surface. It shows two clusters of Zhuang toponyms: one in the west mountainous area bordering Wenshan Prefecture of Yunnan Province (one of the largest concentrations of Zhuang population outside of Guangxi), and the other in the southwest corner neighbouring northern Vietnam (also with a significant Tai population). The southwest cluster represents the traditional Zhuang settlements in the Twin-Rivers Basin, i.e. the west cluster along the You Jiang ('Right River') and the southwest cluster along the Zuo Jiang ('Left River').

Zhuang toponyms and environmental factors

Variable selections and data sources

Physical environments can play an important role in settlement patterns. This is particularly true for the Tai people, including the Zhuang, as they grow wet paddy rice, which requires ample supply of water and low-lying flat areas (Husson *et al.* 2001). The first group of factors includes variables related to land forms such as elevation, slope and aspect (direction). These three topographic variables were extracted from the digital elevation model (DEM) data by ArcGIS terrain analysis tools. The DEM data were obtained from the USGS's GTOPO30 global dataset with a spatial resolution of 1 kilometre (<http://edcdaac.usgs.gov/gtopo30/gtopo30.asp>). This is sufficient for examining the effect of topography on overall Zhuang settlement patterns. The wet rice agriculture also depends on particular land types (e.g. paddy and irrigated lands) suitable for wet rice. Many Zhuang toponyms contain the headwords 'na', 'li' and 'tong', meaning 'field'. We downloaded the GIS data set on land types from the National Geomatics Center of China (NGCC) web site (<http://ngcc.sbsm.gov.cn>). For our study, the variable 'land type' is assigned the value '1' for paddy or irrigated land and '0' otherwise. Other environmental factors will be considered in future work when data become available. For instance, a karst geological setting may also affect the vegetation coverage and thus human settlement (e.g. Li *et al.* 2008). The use of contemporary environment data is based on the assumption that physical environment factors have remained relatively stable over the history of human settlement. Such

an assumption may be less problematic for topography than land use. Nevertheless, caution needs to be taken in interpreting the results.

Historians believe that the migration of the Tai (including Zhuang) people has most likely followed the waterways or rivers (e.g. Pan 2001). The river channels in the region have remained fairly stable over time. Due to lack of data sources on historical roads, we hesitantly used major roads (including railways) of the modern era as a proxy, with some consolation derived from that observation by some historians and transportation geographers (e.g. Chen *et al.* 2007, 22; Zhang 2001) that today's major transport routes tend to follow ancient pathways (*yi-dao*) in general. We include three variables such as distance from river, distance from railroad and distance from major road to capture possible effects of transport and trade routes. Each of the three distances is measured as the distance from the nearest feature (river, railway or major road). GIS data sets of the river network, railroads and major roads were also obtained from the NGCC web site.

The historical interaction between Zhuang and Han was promoted by proximity to major political and trade centres (Luo *et al.* 2007). We chose Guilin and Nanning as the major centres (see Figure 4(a) and Figure 6 for their locations). The two cities have alternated as the capital of the region ever since the Tang Dynasty: Guilin in the Song, Yuan, Ming and Qing Dynasties and the Republic of China 1936–49; and Nanning in the Tang Dynasty and the modern era, including the Republic of China 1912–36, and the People's Republic of China since 1949. Migrations of Han people to the region in various eras were often led by the military. Both cities were major military posts established by Han rulers to control and exert influence on the Zhuang people in Guangxi. In terms of location, Guilin is the central city of eastern Guangxi and has traditionally served as the springboard of Han incursion to the region. Nanning in western Guangxi is the central city of Twin-Rivers Basin, i.e. the Zhuang heartland. The variable 'distance from major cities' is measured as the distance from the nearest city (i.e. whichever of the two is nearer) to capture this effect.

Difference in environmental factors between Zhuang and non-Zhuang toponyms

A pooled t-test is used to assess how each environmental factor differs between Zhuang toponyms

Table III Difference in environmental factors between Zhuang and non-Zhuang toponyms

	Zhuang: average (n = 356)	Non-Zhuang: average (n = 1071)	Difference (t-value)
Elevation	444.95	258.84	186.11 (10.7)***
Slope	2.26	1.64	0.62 (4.43)***
Aspect	191.38	180.00	11.38 (1.7)
Land type	0.16	0.36	-0.20 (-6.9)***
Distance from river	9.36	8.46	0.90 (1.8)
Distance from railway	50.38	44.66	5.72 (2.1)*
Distance from major road	11.76	9.13	2.63 (3.7)***
Distance from major city	546.11	459.89	86.22 (11.5)***

Note: t-values are in parentheses; *** significant at 0.001, * significant at 0.05.

and non-Zhuang toponyms, and whether the difference between them is statistically significant (Rogerson 2010, 132–4). In other words, the test is to examine if the averages of each factor in Zhuang toponyms and in non-Zhuang toponyms are statistically different. All 1427 toponyms are used in the statistical analysis. The results are reported in Table III. For example, the average elevation for Zhuang toponyms is 444.95 metres, and the average elevation for non-Zhuang toponyms is 258.84 metres. The difference (i.e. 186.11 metres) between the two is statistically significant at 0.001 according to the t-value (10.7).

From Table III, only two variables are not statistically significant between the two types of toponyms: ‘aspect’ and ‘distance from river’. The non-significance of aspect is understandable as it merely measures the direction of the slope and does not necessarily represent any (dis)amenity for settlement. A shorter distance from the nearest river, on the one hand, may reflect proximity to transport routes (and thus likely to invite more Sinification), but on the other hand indicates easier access to water sources (and thus possibly more Zhuang settlements). This ambiguity may help explain the non-significance of the variable ‘distance from river’.

The following observations are based on the six variables with statistical significance:

- 1 On average, places with Zhuang toponyms are 186 metres higher in elevation with a steeper slope (0.62 higher in slope) than those with non-Zhuang toponyms.

- 2 On average, 16 per cent of places with Zhuang toponyms are located in paddy or irrigated land, i.e. 20 per cent lower than those with non-Zhuang toponyms.

- 3 On average, places with Zhuang toponyms are 5.72 kilometres further from the nearest railroad, 2.63 kilometres further from the nearest major road and 86.22 kilometres further from Nanning or Guilin (whichever closer).

In summary, Zhuang toponyms tend to be preserved at places more remote from major transport routes and central cities and on a higher ground level with a slightly steeper slope. This may suggest that land more suitable for rice farming (paddy or irrigated land) was gradually taken by the Han.

Assessing the joint effects of variables

The analysis on association of spatial pattern of Zhuang toponyms with each individual variable yields some interesting findings. The results should be interpreted with caution as some of the variables are correlated. A more rigorous approach is to use a multivariate regression model to assess the joint effects of all variables together. For similar reasons for using the logistic trend surface model, as discussed previously, the binary nature of the dependent variable (i.e. a place name being Zhuang or non-Zhuang) calls for a multivariate logistic (logit) regression model.

In the logit model, the dependent variable is a dummy variable (i.e. 1 for Zhuang toponym and 0 for non-Zhuang) and the eight environmental variables are used as independent (explanatory) variables. The model is written as

$$L_T = \beta_0 + \beta_1 X_1 + \beta_2 X_2 + \dots + \beta_8 X_8 \quad (1)$$

where L_T is the logit, X_1, X_2, \dots, X_8 are the eight explanatory variables, and parameters $\beta_0, \beta_1, \beta_2, \dots, \beta_8$ are to be estimated by the regression. The model is commonly estimated by the maximum likelihood method (Hamilton 1992). Based on the logit value L_T , a toponym being Zhuang ($T = 1$) is

$$\text{Prob}_{(T=1)} = 1/(1 + e^{-L}).$$

The first two columns in Table IV present the result from the logit model in equation (1). We use an example here to help interpret the result from the

Table IV Multivariate logistic regression on toponyms (n = 1427)

Origin variable	Coefficient	Consolidated factor	Coefficient
Intercept	-3.4401 (0.3373)***	Intercept	-1.2796 (0.0732)***
Elevation	0.0012 (0.0003)***	Topographic factor	1.7214 (0.3703)***
Slope	0.0159 (0.0318)		
Aspect	0.0009 (0.0006)		
Land type	-0.6595 (0.1702)***	Land-type factor	-0.5201 (0.0804)***
Distance from river	-0.0026 (0.0087)	River factor	-0.0228 (0.0753)
Distance from railway	-0.0079 (0.0021)***	Remoteness factor	0.2757 (0.0707)***
Distance from major road	-0.0013 (0.0064)		
Distance from major city	0.0047 (0.0007)***		

Note: Standard errors are in parentheses; ***p-value < 0.001.

logit model, such as a place with the eight environmental variables assuming their average values such as 305.85, 1.80, 182.87, 0.31, 8.69, 46.10, 9.80 and 481.67 (the variables' order as shown in Table IV from the top to bottom). Plugging them into equation (1) with coefficients defined by the regression shown in Table IV, we obtain $L_T = -1.2429$. Therefore, the probability for the place being a Zhuang toponym is $1/(1 + e^{1.2429}) = 0.2239$, which is very close to the percentage (24.8%) of Zhuang toponyms in the whole study area.

The multivariate model yields a result largely consistent with the findings from the previous t-tests. Here we only highlight the minor 'discrepancies'. In addition to aspect and distance from the nearest river, two more variables 'slope' and 'distance from the nearest major road' are no longer statistically significant in affecting the toponyms. This can be explained by the collinearity among variables. The Pearson correlation coefficient between the variables 'slope' and 'elevation' is as high as 0.458, between 'distance from the nearest major road' and 'distance from the nearest rail

road' is 0.361, and between 'distance from the nearest major road' and 'distance from a major city' is 0.363. That is to say, the association of toponyms with the variable 'slope' (or 'distance from the nearest major road') *alone* may be spurious because of its high correlation with other variables, and the impact disappears after the effects of other variables such as 'elevation' (or 'distances from the nearest major railroad and from the major city') are controlled for.

Factor analysis (Wang 2009) can be used to consolidate correlated variables into a few independent factors in order to reveal the true latent factors affecting the spatial patterns of toponyms. The analysis shows that four factors capture most of the information in the original eight variables. The factor pattern, as shown in Table V, indicates that the first three topographic variables (elevation, slope and aspect) are mainly loaded to factor 1; the three distance variables (distances from railway, road and city) are most loaded to factor 2; the variables 'land type' and 'distance from river' are loaded to factors 3 and 4, respectively.

Table V Variable loadings on factors

	Factor 1: topography	Factor 2: remoteness	Factor 3: land type	Factor 4: river
Elevation	0.8999	0.2622	-0.1120	0.0603
Slope	0.9770	-0.0756	0.0438	-0.0946
Aspect	0.9666	-0.0796	0.0309	-0.0822
Land type	-0.0131	-0.0334	0.9787	-0.0342
Distance from river	-0.0780	0.0276	-0.0365	0.9924
Distance from railway	0.0654	0.8041	0.1293	0.0073
Distance from major road	-0.0411	0.7303	0.0047	-0.0357
Distance from major city	0.0454	0.7801	-0.2576	0.0983
Portion of total variance	0.3391	0.2339	0.1322	0.1270

Note: Numbers in bold indicate the highest loading of each variable on a factor among the four factors.

Accordingly, we label factors 1–4 as ‘topographic’, ‘remoteness’, ‘land type’ and ‘river’, respectively.

Feeding the scores of the four factors into the logit model yields the result shown in the two right-hand columns in Table IV. Except for the river factor, the other three factors are all statistically significant. The non-significance of the river factor is explained previously. A Zhuang place name is associated with a higher score of the topographic factor (indicating a combination of a higher elevation, slope and aspect), a higher score of the remoteness factor (with a combination of longer distances from the nearest rail road, major road and major city), and a lower land type factor (less likely to be located in paddy or irrigated land).

We first examine how a more challenging topographic environment might have affected the Zhuang settlement pattern and thus is related to presence of more Zhuang toponyms. As the Han pushed south, the Zhuang were driven towards more marginal land (e.g. mountainous areas and thus possibly higher altitudes and steeper slopes). In addition, the main path for the southward migration of Han was the Meiling Pass (see Figure 1 for the location), which penetrated the barrier of Lingnan Mountain. So it is hypothesised that there was less influence of Han and thus higher presence of Zhuang place names in areas further away from the Meiling Pass. As the influence of the Han followed the major transport or trade routes and the influence declined with distance from major cities such as Nanning and Guilin, it is expected that areas further away from the routes and the cities would experience less Sinification and thus have more Zhuang place names. Barriers to Han settlement were also stronger in remote areas where malaria was endemic and killed the newcomers by the thousands (Bello 2005). The presence of fewer Zhuang toponyms in paddy and irrigated land, which Zhuang traditionally depended on for their wet rice agriculture and sustenance, may appear to be a puzzle. Our speculation is that the Zhuang were forced to leave places bearing Zhuang names near more favourable paddy and irrigated land that eventually were Sinicised. Alternatively, and perhaps more importantly, most of such paddy land is located in eastern Guangxi and thus subject to more Han influence that led to fewer Zhuang toponyms being preserved during the long process of Sinification.

Historical evolution of spatial patterns of Zhuang toponyms

In the toponymical dictionary, our primary data source, some toponym entries contain the time (era) when a place was first named. Figures 7(a) and 7(b) show the toponyms named in various eras by Zhuang and Han, respectively. Among the 1427 toponyms in our study area, only 260 places or 18.2 per cent have such a record (Table II). Among the 356 Zhuang toponyms, only 35 places or 10 per cent have the era recorded. The absence of a clear time mark in many toponyms is due to lack of historical records in places lower than county seats. For instance, all the prefecture and county toponyms have records for eras that were named, but only 171 (12.8%) townships have such records. For Zhuang toponyms, only 18 (5.3%) townships have records for which eras were named. The relatively small sample (35) of Zhuang toponyms with a time stamp (and even smaller breakdowns in various eras) prevents us from replicating the statistical analysis of association of the toponyms with environmental factors during various eras. Our analysis (including the centragraphic method) is rather descriptive, and the subsequent discussion may be speculative. It may be considered exploratory and demonstrates the potential of studies with this type of data.

Two additional limitations of the data warrant discussion before we proceed to analyse and interpret the information. The data set is drawn from records of toponyms at the *present* time. While many toponyms have survived over time, plenty of toponyms have disappeared or have been altered by history. In other words, toponyms labelled by an era (e.g. Ming Dynasty) in Figures 7(a) and 7(b) are those places whose names were first named in that era. By no means were they the only toponyms in that era. A complete survey of toponyms in each era would require effort and expertise targeted on much larger scales, similar to the Chinese Historical GIS project (<http://fas.harvard.edu/~chgis>). Another issue, as pointed out earlier, is that all toponyms are *recorded in Chinese*. This may introduce possible bias into the data set. Many places named by the Zhuang people and popular among them may never show up in gazetteers written in Chinese. This may be attributable to the absence of Zhuang intellectuals literate in Chinese in the area or simple lack of preservation in Chinese records for the area. Nevertheless, the time dimension recorded in the toponyms does shed interesting

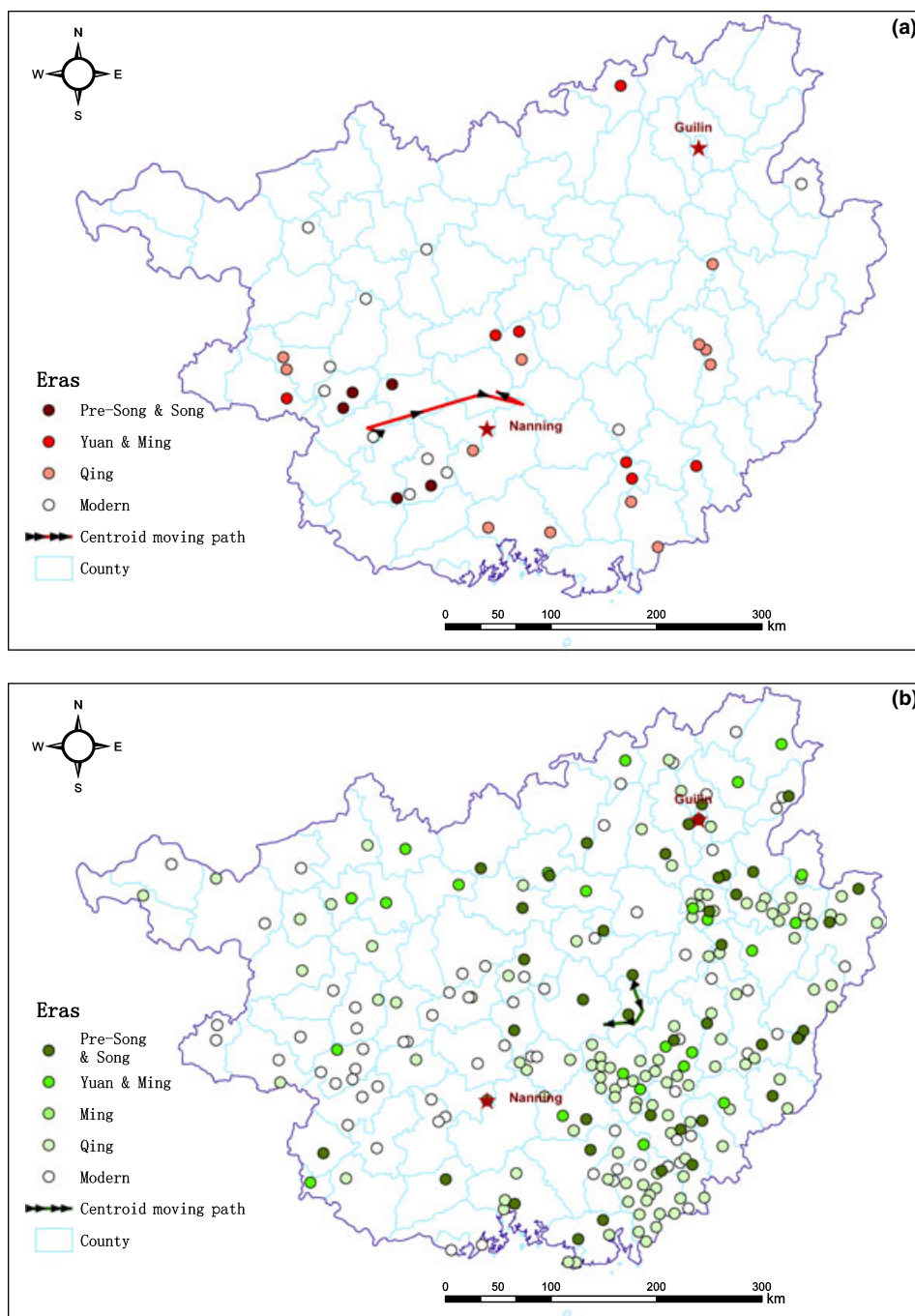


Figure 7 Toponyms named in various eras: (a) Zhuang, (b) non-Zhuang

light on the interactions between the Zhuang and Han in history.

Historical records indicate that the ancestors of Zhuang people settled in Guangxi more than 2500 years ago (e.g. Xu 1990). However, the earliest Zhuang toponyms in our data set were in the Song Dynasty (AD 960–1279). In the pre-Song eras, there were very few Han people in the region, and no Zhuang toponyms were thus recorded. In order to strengthen control over the Zhuang after defeating Nong Zhigao, the Song ruler implemented the 'Tu-si' administrative system. Although most of the administrators in the Tu-si system were Zhuang, some were also Han appointed by the central government. By doing so, Han were able to move into areas dominated by Zhuang settlers and intensified the Sinification process. This also fostered the recording of Zhuang toponyms in Chinese. Five Zhuang toponyms from our data set were first named in the Song Dynasty, and all were in the southwest corner of the region (i.e. Twin-Rivers Basin). One new Zhuang toponym from the same area was added in the Yuan Dynasty (AD 1279–1368) ruled by the Mongols.

Figure 7(a) shows that Zhuang toponyms expanded to the middle and southeast areas (also one in the north) in the Ming Dynasty (AD 1368–1644) by adding six new Zhuang toponyms. This also coincided with the migration of the Han to the middle and eastern parts of the region in this era, which led to a significant increase in the Han population. Much of the migration was spearheaded by the military, followed by businessmen and farmers.

The Qing Dynasty (AD 1644–1912) doubled the Zhuang toponyms to 24, which were scattered across the region. According to historical records (Wang, written in Qing Dynasty and reprinted in 1980), the Zhuang accounted for half of the population in Guangxi, Yao three-tenths and Han two-tenths. The mixed settlements of Han and Zhuang permitted more interaction between the two and thus more recording of Zhuang toponyms in Chinese. The Han migrants were concentrated in major cities and towns along the rivers, and then spread towards the countryside. Massive migration altered the population make-up in the east of Guangxi, particularly the northeast and southeast areas, where the Han accounted for more than 70 per cent of the population in some counties (Liu 1935). The trend continued in the post-Qing modern era, which added 11 new Zhuang toponyms.

In order to capture the overall trend, we used a GIS centrophagic tool (Mitchell 2005) to compute the centroid (i.e. average geographic centre) of each type of toponyms in each era, as shown in Figures 7(a, b). The centroids of Zhuang toponyms in all eras are west of those of non-Zhuang toponyms, reflecting the Zhuang settlement more towards the west than the Han. However, the centroids of Zhuang toponyms have migrated mainly eastwards and slightly to the north, whereas the centroids of non-Zhuang toponyms have moved towards the southwest. The convergence of the two centroids towards the centre of Guangxi over time indicates narrowing difference in spatial patterns of these two types of toponyms (Zhuang more in the west and non-Zhuang more in the east), and reflects the impact of an increasingly integrated settlement pattern.

The westward move of non-Zhuang toponyms can be explained by the general movement of Han people in the same general direction over time. However, the eastward move of Zhuang toponyms takes more reasoning to interpret. The emergence of new Zhuang toponyms began in the southwest corner of the province in the Song and Yuan Dynasties and spread towards the middle and southeast in the Ming Dynasty, and finally scattered region-wide in the Qing Dynasty and modern era. Our theory is that the areas in the east (to a less degree the north) of Guangxi were settled by the Han earlier and longer, and thus the Zhuang toponyms likely to have been present in earlier eras in these areas have been Sinified or obscured. Only those small pockets of Zhuang settlements in more remote areas had place names first recorded more recently and have been preserved up until the present. Consequently, the Zhuang toponyms on the contemporary map are older and represent major cities and large towns in the western part of Guangxi, but the newer tend to be associated with small towns in more remote settings in the east. This once again suggests more intensive Sinification towards the east in Guangxi. A definitive proof of the theory would require reconstructing the historical toponyms in each era and examining their changes over time.

Summary

The Sinification of ethnic minorities, such as the Zhuang, has been a long and ongoing historical process in China. One indication of historical

change is reflected in place names over time. Many older Zhuang names can be recognised because they are named after geographical or other physical features in Zhuang, such as 'rice field', 'village', 'mouth of a river', 'mountain', 'basin', etc. On the other hand, many other older Zhuang place names have been obliterated or modified in the process of Sinification.

By carefully examining the comprehensive toponymical dictionary series of China, this study constructed a GIS database of place names in Guangxi at three administrative levels: township, county and prefecture. Each toponym was classified as Zhuang or non-Zhuang, and coded as a 0–1 binary variable in GIS. Wherever available, a toponym was also marked with the era when it was first named. Using some geo-visualisation techniques such as spatial smoothing and spatial interpolation methods, the study shows that the highest concentrations of Zhuang toponyms are in the southwest Twin-Rivers Basin and the west mountainous area and decline gradually towards the east. Statistical analysis reveals that Zhuang toponyms tend to be preserved in places more remote from major transport routes and major cities, with a slightly steeper slope, and less preserved in areas with paddy or irrigated land. Our speculation is that the southward migration of Han pushed the Zhuang to more marginal land with more challenging environments, leading to more Sinification of toponyms in areas more favourable for wet rice agriculture. By analysing the limited number of toponyms with their time marks, we find that the Zhuang toponyms on contemporary maps are older in the west but more recent in the east. We hypothesise that older Zhuang toponyms in eastern Guangxi with longer and larger Han settlements were likely to be Sinicised and obliterated. Only more remote pockets of Zhuang settlements had their toponyms recorded more recently and preserved up until the present. This suggests more intensive Sinification towards the east in Guangxi. The eastward shift of the centroid of Zhuang toponyms and the westward shift of the centroid of non-Zhuang toponyms led to the convergence of the two centroids towards the centre of Guangxi. This convergence indicates that the difference in spatial patterns of Zhuang and non-Zhuang toponyms has been narrowing, and reflects the impact of an increasingly integrated settlement pattern.

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