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GIS TECHNIQUE AS AN INDISPENSABLE TOOL IN THE REAL TIME STUDY OF DIALECT CHANGE: A CASE OF THE NORTHEASTERN REGION OF THAILAND

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Abstract

For linguists, mapping a clear visual display of spatial change of dialects has been a challenging task. This article aims to present an alternative solution by which GIS and linguistics are incorporated to help improve quality of spatial analysis and map display in the study of dialect geography. Applied methodological flow with the exemplified application to the northeastern region of Thailand is illustrated. GIS's spatial analysis functions are demonstrated to create and compare the dialect maps of 1979 and 2002. Result of the study exhibits as change-quantification maps showing the real time spatial change patterns of Thai dialects. The benefit of GIS is obvious as an indispensable tool for assisting linguists to better interpret and understand the spatial pattern of change with more confidence.

Keywords: geolinguistics, dialect change, real time study, GIS, Thailand

LA TÈCNICA SIG COM A EINA INDISPENSABLE EN L'ESTUDI EN TEMPS REAL DEL CANVI DIALECTAL: UN CAS DE LA REGIÓ NORD-EST DE TAILANDIA

Resum

Per als lingüistes, cartografiar una mostra visual clara del canvi espacial dels dialectes és un desafiament. Aquest article té com a objectiu presentar una solució alternativa mitjançant la qual

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s'incorporen els SIG a la lingüística per millorar la qualitat de l'anàlisi espacial i la visualització dels mapes a l'estudi de la geografia dialectal. S'il·lustra el flux metodològic aplicat a través de l'exemple de la regió nord-est de Tailàndia. Es demostra que les funcions de l'anàlisi espacial dels SIG creen i comparen els mapes de dialectes de 1979 i 2002. El resultat de l'estudi mostra que els mapes de quantificació de canvis ofereixen els patrons de canvi espacial en temps real dels dialectes tailandesos. El benefici dels SIG és obvi com a eina indispensable per ajudar els lingüistes a interpretar i a comprendre millor el patró espacial de canvi.

Paraules clau: geolingüística, canvi dialectal, estudi en temps real, SIG, Tailàndia

LA TÉCNICA SIG COMO HERRAMIENTA INDISPENSABLE EN EL ESTUDIO EN TIEMPO REAL DEL CAMBIO DIALECTAL: UN CASO DE LA REGIÓN NORESTE DE TAILANDIA

Resumen

Para los lingüistas, cartografiar una muestra visual clara del cambio espacial de los dialectos es un desafío. Este artículo tiene como objetivo presentar una solución alternativa mediante la cual se incorporan los SIG a la lingüística para mejorar la calidad del análisis espacial y la visualización de los mapas en el estudio de la geografía dialectal. Se ilustra el flujo metodológico aplicado a través de del ejemplo de la región noreste de Tailandia. Se demuestra que las funciones del análisis espacial dels SIG crean y comparan los mapas de dialectos de 1979 y 2002. El resultado del estudio muestra que los mapas de cuantificación de cambios ofrecen los patrones de cambio espacial en tiempo real de los dialectos tailandeses. El beneficio de los SIG es obvio como herramienta indispensable para ayudar a los lingüistas a interpretar y a comprender mejor el patrón espacial de cambio.

Palabras clave: geolingüística, cambio dialectal, estudio en tiempo real, SIG, Tailandia

1. Introduction

Current research works in all fields of study demand reliable and high-quality data to replicate the real world realistically. Some kinds of data inevitably relate to a spatial component and require means of handling them spatially – collecting, measuring, displaying, mapping, or analyzing them with respect to locations on the earth's surface. Dialect geography undoubtedly necessitates the involvement of such data type. Its study concerns spatial variation of linguistic phenomena – mainly lexical and phonological. Dialectologists are interested in studying the locations where dialects are spoken and the changes that occur either in their linguistic characteristics or their usage patterns. The methodology used in the discipline of dialectology includes data collection and recording, linguistic analysis, and spatial display of output, which can be in the form of data display maps, isogloss maps or dialect boundary

maps, etc. If temporal framework is investigated, spatial variation and change pattern in the usage of linguistic features are the key parts to be performed.

GIS (Geographic Information System) which is one of the geographical technologies provides functions for gathering, managing, analyzing and displaying spatial data. Details of GIS capabilities are given extensively elsewhere such as the textbooks of (Steinberg & Steinberg 2006, Wise 2014, McHaffie et al. 2019). GIS has been used worldwide for a variety of applications e.g. urban and environmental studies. However, the applications of GIS to linguistic research have been done just over the last few decades and are limited in number. The work of (Lee & Kretzschmar 1993) was probably the first to use GIS to help analyze data from the Linguist Atlas of the Middle and South Atlantic States (LAMSAS) database. In their work, overlay function using the Boolean AND/OR operations and quantification technique within GIS environment was applied to the linguistic approach to illustrate the spatial pattern of linguistic data. The work of (Luo et al. 2000, Dahl & Vaselinova 2005; Wang et al. 2006, Tingsabadh et al. 2008, Radzi et al. 2014, Zaharani et al. 2018) mainly used GIS for data storage and display of language data while the paper of (Hoch & Hayes 2010) elaborated the way GIS was incorporated to the approach of geolinguistics. Luebbering et al. (2013) applied GIS for visualizing linguistic diversity. In their work, GIS visualizing functions were exploited to symbolize and demonstrate the diversity of language in both 2-dimensional and 3-dimensional map display. According to some of the exemplified research given, GIS was mostly used as a tool for enhancing map display and map making. Only a few studies incorporated GIS in the analysis part.

In this article GIS and linguistic methodology are incorporated to study real time[1] changes in the lexical usage of Thai dialects with the exemplified research in the northeastern region of Thailand. The availability of two sets of comparable lexical data collected 23 years apart (in 1979 and in 2002) in the northeastern region provides us with excellent opportunity to carry out this real time study. Since Central Thai vocabulary is the same as Standard Thai – the official language of Thailand, our

[1] Language change can be investigated using data either from two or more periods e.g. real time study, or from two or more generations of speakers at the same period i.e. apparent time study.

hypothesis is that after two decades Central Thai lexical items would significantly replace the Non-Central Thai ones in the northeastern region.

2. Early GIS applications in Thai dialects

In the past, lack of background knowledge in the techniques for handling spatial data was a major problem for Thai dialectologists. Maps were drawn manually on papers, and the locations of data collection as well as the drawing of isoglosses and dialect boundaries were roughly marked. For almost two decades, combining geography knowledge and GIS techniques with the methodology of dialectology has successfully overcome the central weakness in spatial domain of Thai Dialectology. A new chapter in Thai dialectology began when a dialectologist and a geographer began working together yielding new systematic output. In 2009, the GIS-based Linguistic Geography of Thailand Project under the sponsorship of Chulalongkorn University was initiated to promote the use of GIS in the field of linguistics. The project promotes the integration of scholars from two different fields of knowledge to work together, in this case, geographer and linguist. Several collaborative research works have been produced since then. In the initial stage, GIS was applied for data storage (GIS database), map display, and cartography purposes. Later, GIS was incorporated to be part of the analysis in the traditional linguistic approach. The pioneer work of the project was "Word Geography of Thailand" (Tingsabadh et al. 2008), which applied GIS to develop the geographical database of 170 lexical items in Thai dialects. Data collection was conducted at sub-district level from total of about 7200 sub-districts covering the whole of Thailand. The results were displayed as a set of 170 lexical variation maps.

The subsequent works of Teerarojanarat & Tingsabadh (2011a), which used the 2008 database, showed a way to overlay a bundle of 170 isogloss maps to produce a dialect boundary map – spatially mapping the area of Central Thai and the Non-central Thai usage. In this work, spatial overlay within GIS environment played a key role for the analysis. After succeeding in portraying accurate lexical distribution of Thai dialects

used all over Thailand and locating the area where Central Thai is spoken, this interdisciplinary partnership entered a new area of investigation – the spatial change of Thai dialects. The work of Teerarojanarat & Tingsabadh (2011b) was to study the lexical change of dialect in the northeastern region of Thailand. The focus of this study was to demonstrate the spatial techniques in converting and manipulating dialect data which originated from different sources to be in the same map format and map unit. Then spatial overlay between two data sources was performed and minimal results of lexical change were detected spatially. Another work of Teerarojanarat & Tingsabadh (2012) reported the methodology to integrate linguistic means and spatial technique to create a change map of Thai dialects in the transition area of Central Thai, Northern Thai, and Northeastern Thai. Since 2018 the project has received financial support from the Southeast Asian Linguistics Research Unit, Faculty of Arts, Chulalongkorn University. Our main interest is to continue the previous study of Teerarojanarat & Tingsabadh (2011b) to further investigate the spatial pattern of real time dialect change in the same study site. In 2018 and 2019, preliminary results of the analysis were presented and discussed orally in two closed group's meetings held by Japanese linguists in Japan. This article intends to highlight and elaborate the incorporation of GIS techniques as a tool for the analysis of real time dialect change.

3. Background knowledge to the research study

3.1 Study area

The study area covers the whole northeastern region of Thailand**,** comprising an area of about 169,000 sq. km. The Northeast is also popularly called "Isan" (Figure 1). The Northeast nowadays consists of 20 provinces. It borders Laos to the north and the east, Cambodia to the south, and the central region of the country to the west.

Figure 1. Thailand and the Northeast (so-called "Isan" in Thai)

In terms of language, the four main Thai dialects – Northern Thai, Central Thai, Northeastern Thai and Southern Thai – are spoken predominantly in the North, the Central Plain, the Northeast, and the South of Thailand respectively. As a part of the nation building process the Bangkok variety of Central Thai was set as the standard language for the whole country i.e. Standard Thai. It became the medium of instruction in every school, used in government offices throughout the country and in national mass media. Consequently, Central Thai lexical items infiltrated into the three Non-Central Thai dialects. It is thus interesting to investigate the extent of lexical change in the Non-Central Thai dialects. Only Northeastern Thai is selected as the subject of this study due to the availability of data in two periods – 1979 and 2002.

Northeastern Thai (so-called Isan dialect in Thai) is the major dialect in the study site. Its linguistic characteristics including phonology, vocabulary, and syntax identify it as the same language as Lao, the national language of Lao PDR. However, the political boundary between Thailand and Lao PDR has given them different identity – a major Thai dialect and a language. The dialect status of Northeastern Thai is generally

accepted because all four main Thai dialects belong to the Southwestern branch of the Tai language family (Chamberlain 1975). Northeastern Thai contains many sub-dialects and accents (Brown 1965) but there is "a normalized variety" based on the speech of educated people in the region (Smalley 1994). Speakers of numerous minority languages both in the Tai and other language families also live in the Northeastern region. They speak their mother tongue as well as Northeastern Thai (Akhatawatthanakun 2002).

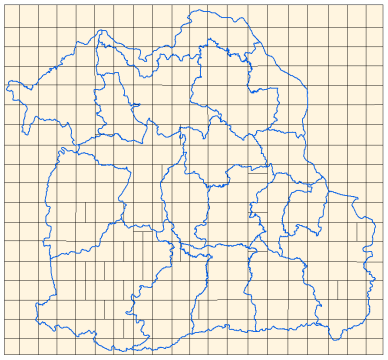
3.2 Dialect data source

Since this research continues the previous study of Teerarojanarat & Tingsabadh (2011b), data used is thus similar to that of the Teerarojanarat & Tingsabadh (2011b) research work. Original data is from two main sources. They are dialect data surveyed in the overlap area of the whole Northeast in 1979 and in 2002. A brief description of the data sources (Figure 2) is as follows.

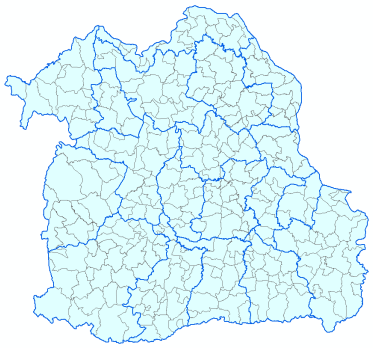
The first data source, namely the 1979 dialect dataset, contains 298 semantic units. This data source was produced by the "Word Geography Maps of the Northeastern Thai Dialect" project carried out by the faculty members of the Department of Linguistics, Faculty of Arts, Chulalongkorn University. The dialect data was collected in 1979 by means of interviews from informants aged 60-70 years old. The data was initially displayed on hand drawn paper maps. The unpublished data was converted and transformed under a GIS environment to be in a version of digital map in 2010, producing a geographic database of 298 lexical variation maps (Teerarojanarat & Tingsabadh 2011b). To represent a map of each semantic unit, the polygon features shaped grid cell (of about 25 km x 25 km) was used as a collection unit portraying the methodology used in the selection of data collecting locations in 1979.

The second data source, namely the 2002 dialect dataset, came from the "Word Geography Maps of Thailand" project, consisting of a geographic database of 170 lexical variation maps (Tingsabadh et al. 2008). The dialect data was collected by means of questionnaires sent to a headmaster in each sub-district via the Ministry of

Culture network and by post between 2002-2003 requesting the respondent to give the lexical item most frequently used in that sub-district for each semantic unit. To represent a map of each semantic unit, the whole area of sub-district, or "Tambon" in Thai, is used as a collection unit and presented as polygon features on the map.



(a) The 1979 dialect dataset



(b) The 2002 dialect dataset

Figure 2. The source of dialect dataset and their collection units in (a) 1979 and (b) 2002, superimposed with province boundaries in 1979

Since both datasets share the overlap area with a common geographically referenced coordinate system, they can be overlaid correctly. Nevertheless, a few limitations exist for our analysis of this study. Firstly, since these two datasets were collected by using different techniques, their scale and spatial resolution of data collection units were totally different. Secondly, the northeastern region comprised 16 provinces during the survey and collection of the first data source, and there were 19 provinces during the collection of the second data source. Therefore, comparison of the two data sources based on the provincial records could not be done.

4. Analysis

According to the two datasets available, analysis was constructed. Out of the 298 semantic units in the first data source and the 170 semantic units in the overlap area in the second data source, only 100 semantic units in the form of lexical variation maps could be completely matched and employed for comparative analysis. The

methodological flow of the analysis is shown in Figure 3, which is divided in two main parts. In the first part (Process A), linguistic approach plays a key role in analyzing and classifying dialect data. In the second part (Process B - E), GIS is used to spatially investigate dialect variation and compare the real time change of dialect vocabularies at two different points of time.

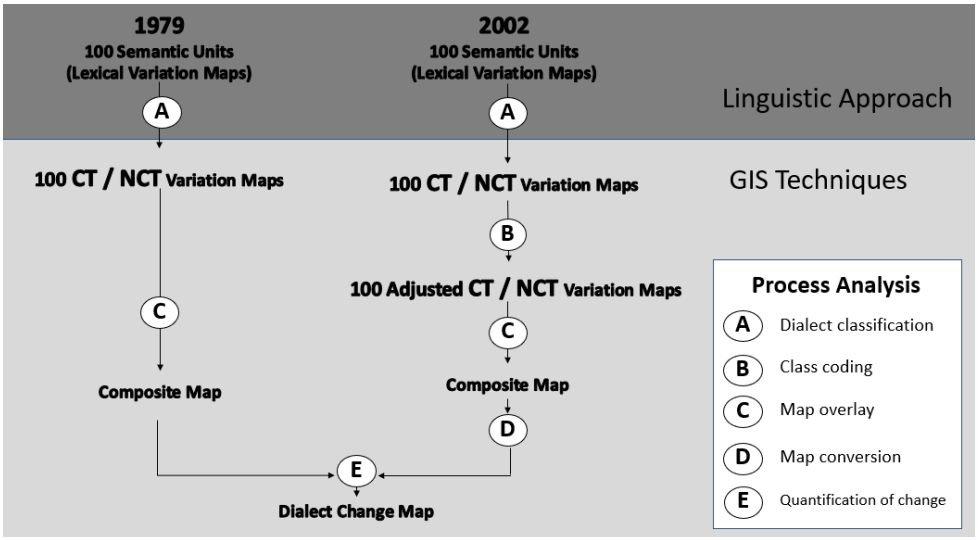


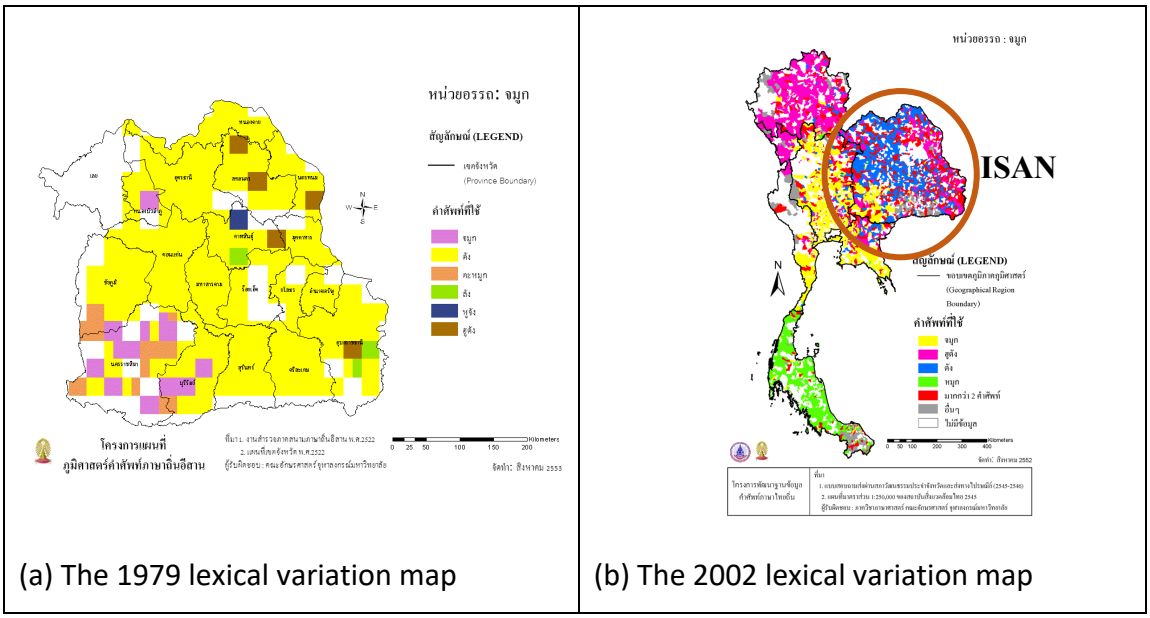
Figure 3. Methodological flow of the analysis for the study

4.1 Dialect classification

To classify, dialect vocabularies from previous Thai research works (e.g. Panupong 1986, Rinprom 1987), as well as Northeastern Thai and Standard Thai dictionaries e.g. Northeastern – Central Dictionary (Somdej Phra Maha Weerawong 1998) were checked and referred. Linguistic criteria were set to identify the separation of lexical items into 2 classes – Central Thai (CT) and Non-Central Thai (NCT). Note that Northeastern Thai together with local dialects and other dialects and languages spoken by minority groups are included in the group of Non-Central Thai in this study. A list of 100 semantic units used in the study is given in Table 1. For each semantic unit, as a result, surveyed and collected lexical items of the 100 semantic units were classified by the criteria set into 2 classes - Central Thai (CT) and Non-Central Thai (NCT).

4.2 GIS as a tool for spatial analysis of dialect change

GIS can integrate many types of data. Data types are stored as layers or themes to be efficiently organized. Dialect data can be stored in GIS as a layer along with other types of features such as topography layer, road layer in the same geo-referencing system e.g. geographic coordinate system. In this study, we had to deal with 100 semantic units of each dataset, or 200 semantic units in total. Each semantic unit is represented as a lexical variation map in the GIS database. Each considers as one GIS layer, containing several records representing geographical-referenced locations where lexical items were collected. Figure 4 illustrates dialect data in the form of lexical variation maps of semantic unit “nose” in 1979 and in 2002 as an example. Such GIS-based dialect maps were used as original data in the analysis of this study. Four main steps for the following spatial analysis in this study includes class coding, map overlay, map conversion, and quantification of change.



(a) The 1979 lexical variation map

(b) The 2002 lexical variation map

Figure 4. An example of Thai dialect usage of semantic unit “nose” in (a) 1979 and (b) 2002 in the form of lexical variation map

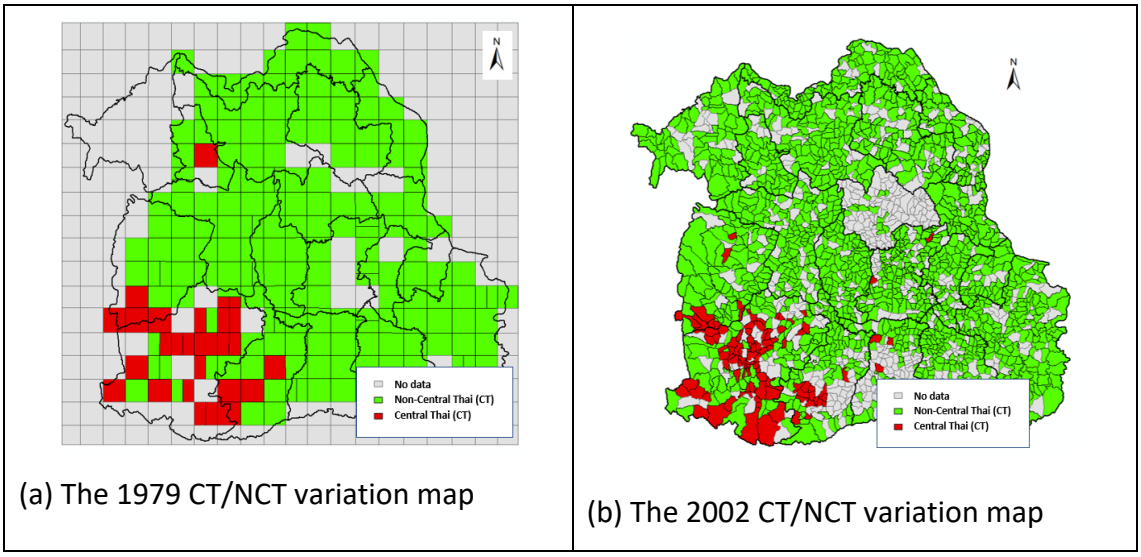
No.	Meaning	No.	Meaning	No.	Meaning	No.	Meaning
1	Nose	26	Lizard	51	Scissors	76	Gossip
2	Tooth	27	Gecko	52	Fan	77	Lie
3	Occipital bone	28	Toad	53	Mirror	78	Spill, fall
4	Body	29	Chameleon	54	Hoe	79	Drizzling (rain)
5	Navel	30	Snakehead fish	55	Cradle	80	Shave
6	Calf	31	Eel	56	Barn	81	Annoy
7	Ankle	32	Mosquito larva	57	Bridge	82	Feel bored
8	Wart	33	Bat	58	Monk	83	Fear
9	Phlegm	34	Butterfly	59	Young person	84	Pity
10	Sweat stain	35	Dew	60	Elder sister-in-law	85	Feel dizzy
11	Asthma	36	Cloud	61	Aunt (younger brother of father)	86	Tingle
12	Urticaria	37	Thai papaya salad	62	Aunt (younger brother of mother)	87	Belch
13	Wound	38	Thai rice noodles	63	Aunt (younger sister of mother)	88	Kindle a fire
14	Papaya	39	Bangle	64	How much?	89	Be angry
15	Pineapple	40	Trousers	65	When?	90	Miscarry
16	Monkey apple	41	Thai Loincloth	66	Tomorrow	91	Delicious
17	Jackfruit	42	Button	67	Day after tomorrow	92	Sour
18	Guava	43	Spoon	68	Today	93	Funny
19	Custard apple	44	Glass	69	Evening	94	Diligent
20	Watermelon	45	Matches	70	Speak	95	Fierce
21	Yam-bean	46	Torch	71	Call	96	Fast
22	Turkey berry	47	Mat	72	See, watch	97	Deaf
23	Bitter gourd	48	Basket	73	Walk	98	Breakfast
24	Pumpkin	49	Broom	74	Run	99	Lunch meal
25	Frangipani flower	50	Paper	75	Delve	100	Dinner

Table 1. The matching 100 semantic units used in the study

4.2.1 Class coding

GIS performed class coding based on the classification scheme set in an earlier process. It should be noted that there were some areas that no data was collected which then was coded as “B” (blank area). Accordingly, one of possible coding of 3 classes – “CT”, “NCT”, and “B” - was set to each location (record) to generate resulted CT/NCT variation maps. Figure 5 demonstrates an example of CT/NCT variation maps created for the semantic unit “nose” in 1979 and in 2002. According to the figure, the

CT/NCT variation maps were symbolized in different colors to represent “CT”, “NCT” or “B”. By applying similar techniques, 100 CT/NCT variation maps for each semantic unit of each data set were created



(a) The 1979 CT/NCT variation map

(b) The 2002 CT/NCT variation map

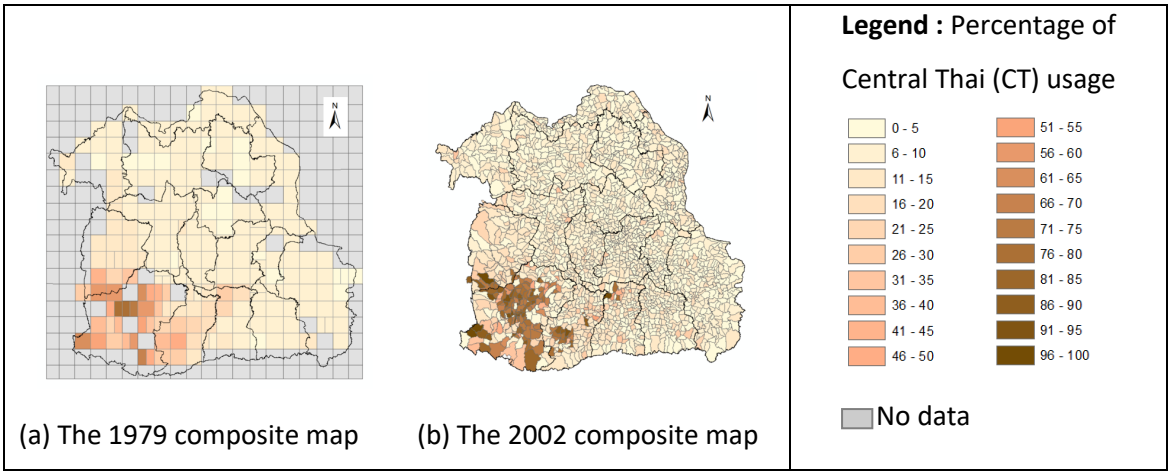
Figure 5. Thai dialect usage of semantic unit “nose” in (a) 1979 and (b) 2002

4.2.2 Map overlay

A spatial overlay of 100 semantic units in the form of CT/NCT variation maps of each dataset was made by using the GIS ‘UNION’ and ‘FREQUENCY’ functions to create a composite map. According to the functions applied, locations in each composite map were produced by counting and accumulating the frequency of language occurrence (the frequent usage of Central Thai and Non-Central Thai) and then calculating their locations as the percentage of Central Thai usage. High degree of percentage (e.g. 80%) means the areas where Central Thai (CT) is frequently spoken while low degree (e.g. 20%) means the areas where people frequently use Non-Central Thai (NCT). Figure 6(a) and Figure 6(b) show the composite map of this process. Each composite map contains the accumulation of percentage of CT usage, shading with the percentage of CT usage with a class interval of 5. The degree of 91 – 100% means the areas where CT is spoken. In contrast the degree of 0 – 10% means the areas where people use NCT.

4.2.3 Map conversion

As previously mentioned, the 1979 dataset and the 2002 dataset were in different collection units. Converting these two datasets to the same collection units was necessary so that the spatial comparison could be made later. To do that, the finer collection unit of the 2002 dataset was generalized to the coarser level by GIS tool to be the same as the 1979 collection unit (the grid cell format). To generalize, the 'Tambon' (subdistrict) collection unit of the 2002 dataset was overlaid to the 'grid cell' collection unit of the 1979 dataset by using GIS 'UNION' function. Then the language usage values of all 'Tambon' within each grid cell boundary of the 2002 dataset were aggregated and summarized by averaging using GIS 'DISSOLVE' function with the arithmetic "MEAN" operator. Then, the generalized 2002 dataset was created as shown in Figure 7. As a result, the 1979 composite map (Figure 8(a)) and the generalized 2002 composite map (Figure 8(b)) can be comparable for quantification of change in the next step.



(a) The 1979 composite map (b) The 2002 composite map

Figure 6. The composite maps created from a bundle of 100 CT/NCT variation maps (a) in 1979 and (b) in 2002

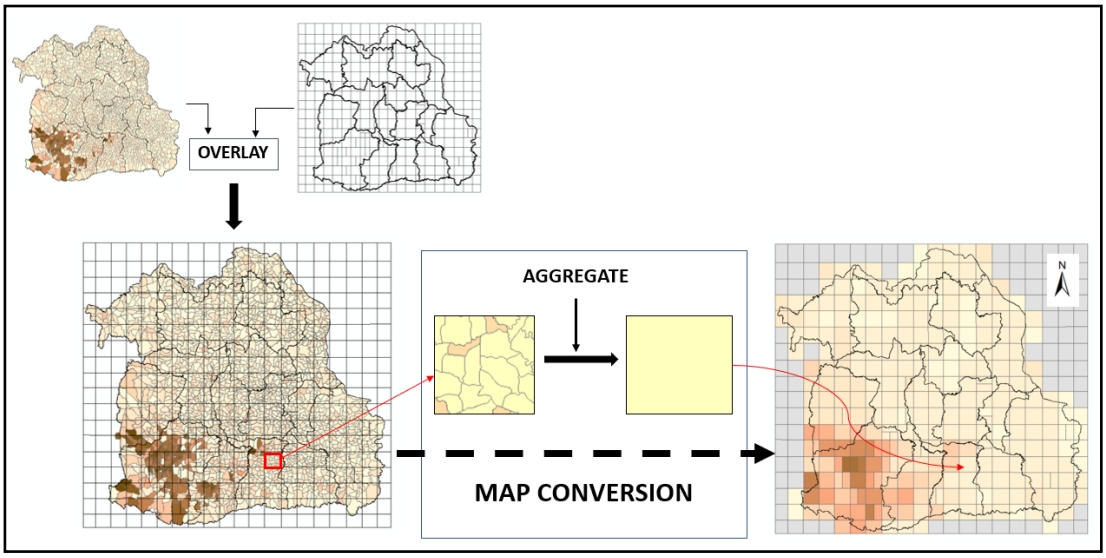


Figure 7. Map conversion process to produce the generalized 2002 composite map

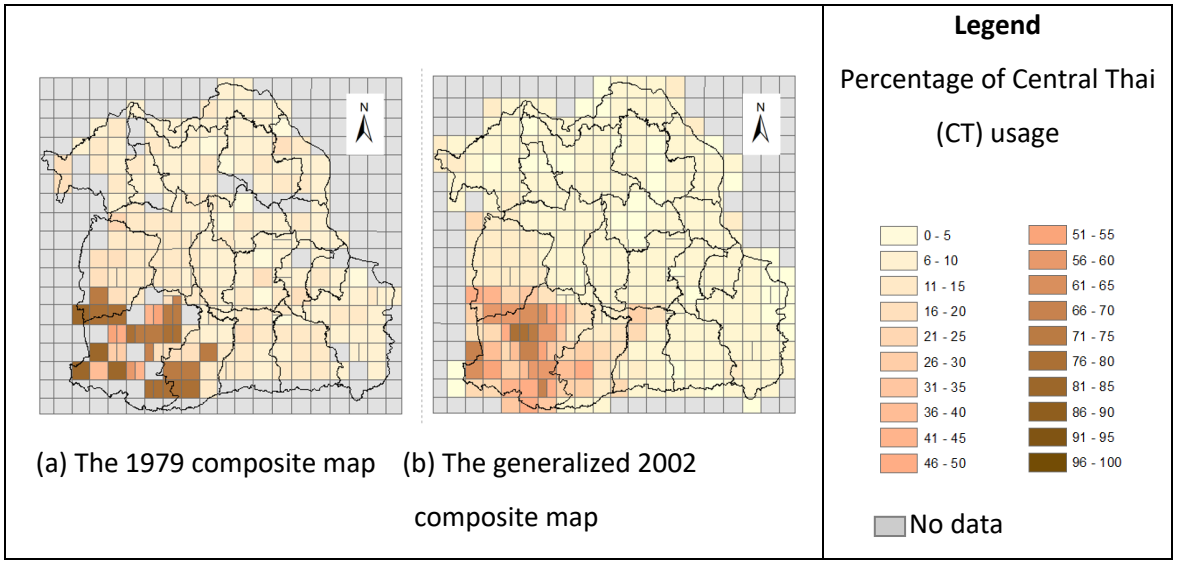


Figure 8. The 1979 composite map and the generalized 2002 composite map, shading with a class interval of 5, in comparison

4.2.4 Quantification of change

According to the composite maps (Figure 8(a) and Figure 8(b)) produced in the previous section, two main steps were performed to create the dialect change maps showing the quantification of change. The first step was to visually explore the spatial variation of Central Thai (CT) and Non-Central Thai (NCT) usage. To do this, two classification levels as shown in Table 2 and Table 3 were set and applied to both

composite maps. The LEVEL 1 classification scheme divided the percentage of dialect usage into three classes while the LEVEL 2 classification scheme divided the percentage of dialect usage into the finer level of five classes. Results of the analysis are shown as maps in Figure 9 and Figure 10.

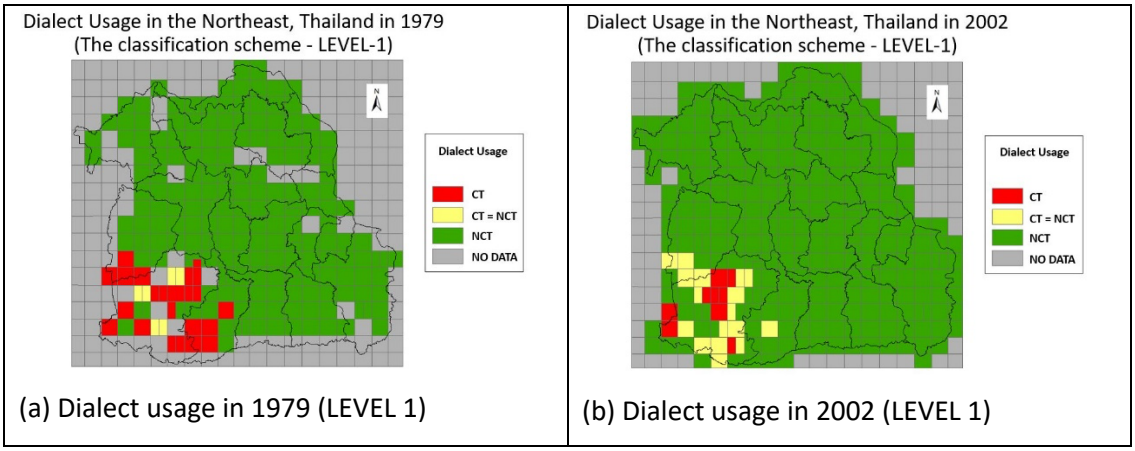
The second step was to quantify the spatial change between the two dates. The two composite maps (Figure 8(a) and Figure 8(b)) were overlaid spatially by using GIS 'UNION' function. Note that when the 'No data' areas of a map were overlaid to another map, calculation could not be made and such areas were left coded as 'No data' in the resultant map. Figure 11 and Figure 12 show the conceptual framework for setting the process of change (stages of change) based on the Change LEVEL 1 and the Change LEVEL 2 scheme respectively. According to Figure 11, for example, the change from 'CT' to 'NCT' or from 'NCT' to 'CT' was set as 'High change', referred to as "Two stages of change". The change from 'CT' to 'CT=NCT', or from 'CT=NCT' to 'NCT', or from 'NCT' to 'CT=NCT', or from 'CT=NCT' to 'CT' was set as 'Low change', referred to as "One stage of change". For Figure 12, the same principle was applied, but the change types were more complicated. By comparing these 2 figures, process of change of Figure 11 was set to detect two stages (high and low change) while that of Figure 12 was set to give more details as it could detect and compare 4 stages of change (low, medium, high, and very high change). Two classification levels of change (Figure 11 and Figure 12) were coded to the attribute table of the overlaid map. Then the dialect change maps, based on the Change LEVEL 1 (Figure 11) and the Change LEVEL 2 (Figure 12) scheme, were produced showing the real time spatial change patterns of Thai dialects.

No. of class	Percentage of Central Thai usage	Code	Description
1	60.01 - 100.00	CT	Usage of Central Thai
2	40.00 - 60.00	CT = NCT	Both usages are equal
3	0.00 - 39.99	NCT	Usage of Non-Central Thai

Table 2. The LEVEL 1 classification scheme

No. of class	Percentage of Central Thai usage	Code	Description
1	80.01 - 100.00	HIGH CT	High Usage of Central Thai
2	60.01 - 80.00	LOW CT	Low Usage of Central Thai
3	40.00 - 60.00	CT = NCT	Both usages are equal
4	20.01 - 39.99	LOW NCT	Low Usage of Non-Central Thai
5	0.00 - 20.00	HIGH NCT	High Usage of Non-Central Thai

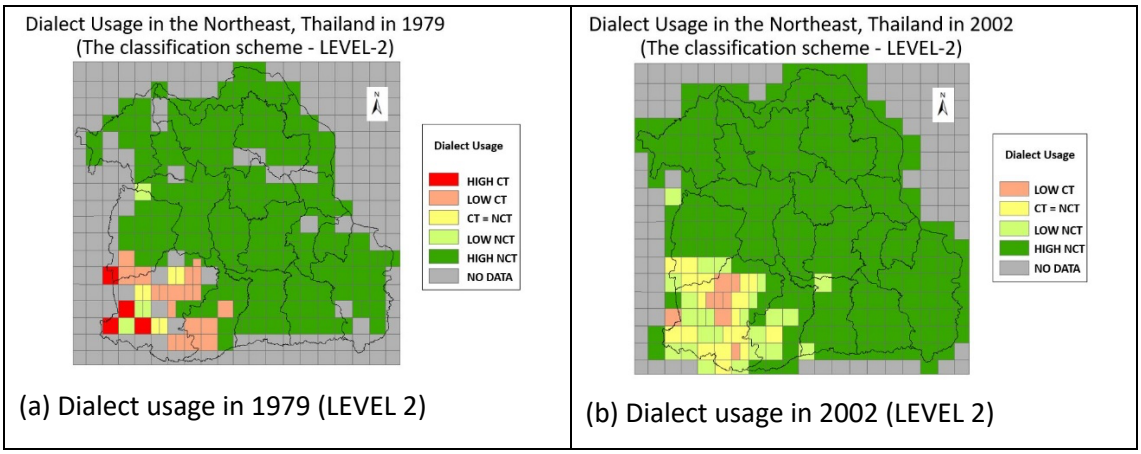
Table 3. The LEVEL 2 classification scheme



(a) Dialect usage in 1979 (LEVEL 1)

(b) Dialect usage in 2002 (LEVEL 1)

Figure 9. Dialect maps in (a) 1979 and (b) 2002 showing the spatial variation of Central Thai (CT) and Non-Central Thai (NCT) usage based on the classification scheme - LEVEL 1



(a) Dialect usage in 1979 (LEVEL 2)

(b) Dialect usage in 2002 (LEVEL 2)

Figure 10. Dialect maps in (a) 1979 and (b) 2002 showing the spatial variation of Central Thai (CT) and Non-Central Thai (NCT) usage based on the classification scheme - LEVEL 2

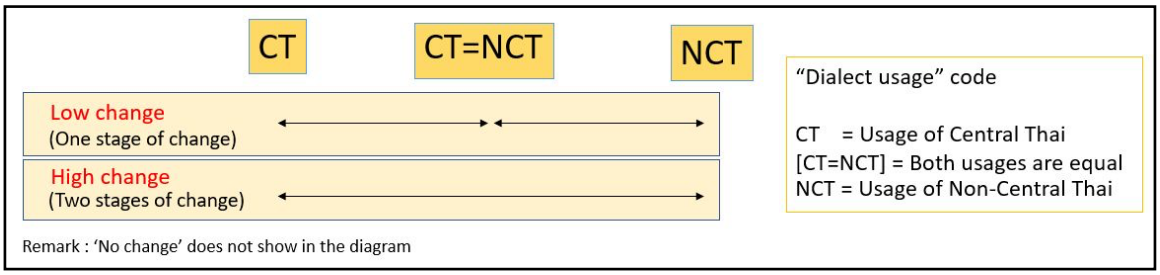


Figure 11. Conceptual framework for setting process of change (Change LEVEL 1)

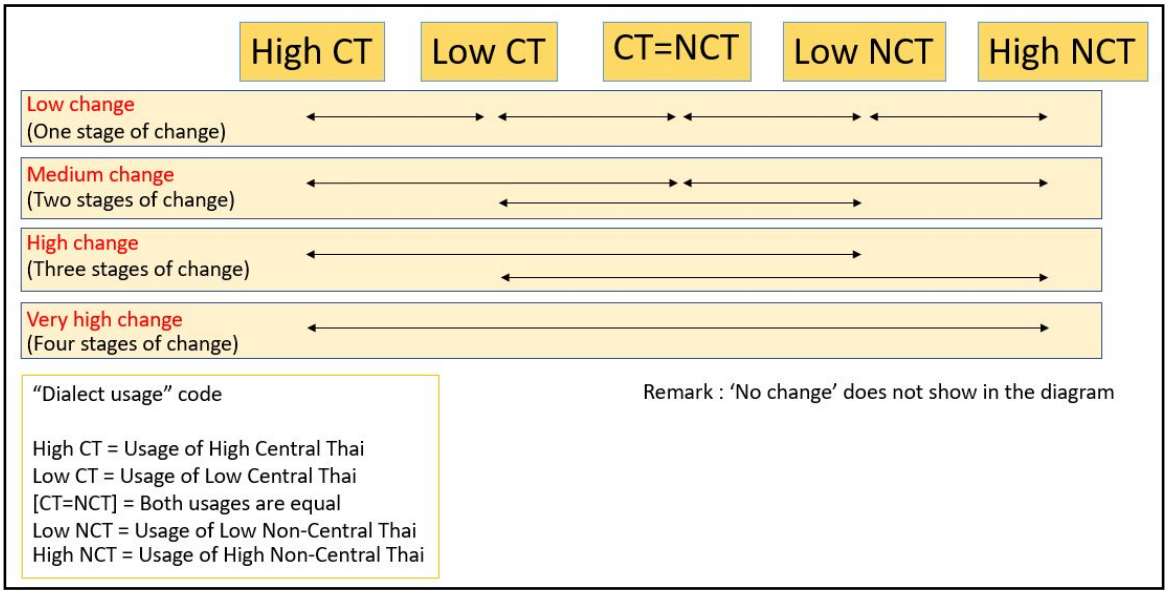


Figure 12. Conceptual framework for setting process of change (Change LEVEL 2)

5. Results

Results of the study are shown as dialect change maps (change-quantification maps) showing the process of real time change in Figures 13-15. Results also summarize as tabular data in Table 4 and Table 5 showing the percentage of change occurred in the study period. Please notice that different classification of change regime (Figure 11 and Figure 12) resulted in different percentage of change, but the value corresponded as shown in Table 4 and Table 5. According to the tables, percentage of 'No change' using the Change LEVEL 1 scheme was 89.4% while that using the Change LEVEL 2 scheme was 86.3%.

Map results created from the two levels of change were compared in Figure 13. It is obvious that the maps created from the Change LEVEL 2 scheme can show the process of change clearer than those of the Change LEVEL 1 scheme. However, overall some types of change could be detected but 'No change' was the most and clearly seen in the northern and eastern part of the study area. According to the Change LEVEL 2 column in Table 4, 'No change' was 86.3% of the total change. If only 'Change' types are considered, the change from Central Thai (CT) to Non-Central Thai (NCT) usage was mostly found (10.1% of the total change) which accounted for low (4.6%), medium (3.2%), and high (2.3%) change respectively. Among the change types from Non-Central Thai (NCT) to Central Thai (CT) usage, only 'Low change' was found (3.6% of the total change). All change types (Figure 13) were clustered along the southwestern part of the study site where Chaiyaphum, Nakhon Ratchasima, and the western part of Buri Ram province locate. Please notice that although 'Very high change' was prior set for the Change LEVEL 2 scheme, no area in the resultant map (Figure 13) found such type of change.

Different views of dialect change maps are shown in Figure 14 and Figure 15. According to the figures, stages of change (process of real time change) can be captured. Within GIS environment, some types of change can be selected and displayed easily. Figure 14(b), 14(c), and 14(d), as examples, show the selection of only one change type to display while Figure 14(a) shows all types of change. According to Figure 15, the finer detail map is displayed, compared to the detailed map in Figure 14(b). All in all, different views of the created dialect change maps help linguists to better interpret and understand the process of change (stages of change) found in the study area.

5. Discussion and conclusion

This article differs from most previous studies in that the spatial-based technique using GIS was integrated to the study of dialect change. In this work, demonstration of methodological flow by which the integration of linguistic and GIS techniques is

highlighted with the key aim to improve the quality of dialect change analysis and presentation. Figure 13-15 and Table 4-5 are shown as results of the study.

No. of class	Description of the Change LEVEL 1[a]	percentage of change	No. of class	Description of the Change LEVEL 2[b]	percentage of change
1	High change from CT to NCT	5.1	1	Very high change from CT to NCT	0.0
			2	High change from CT to NCT	2.3
2	Low change from CT to NCT	4.1	3	Medium change from CT to NCT	3.2
			4	Low change from CT to NCT	4.6
3	High change from NCT to CT	0.0	5	Very high change from NCT to CT	0.0
			6	High change from NCT to CT	0.0
4	Low change from NCT to CT	1.4	7	Medium change from NCT to CT	0.0
			8	Low change from NCT to CT	3.6
5	No change	89.4[c]	9	No change	86.3[c]
	Total	100.0[d]		Total	100.0[d]

Table 4. Percentage of change based on two Change classification schemes (Change LEVEL 1 and Change LEVEL 2)

Remark: a) Classification of change was conducted based on the coding scheme in Table 2 and concept in Figure 11

b) Classification of change was conducted based on the coding scheme in Table 3 and concept in Figure 12

c) Since ranges (intervals) of each change classification were set differently, they resulted in different output values

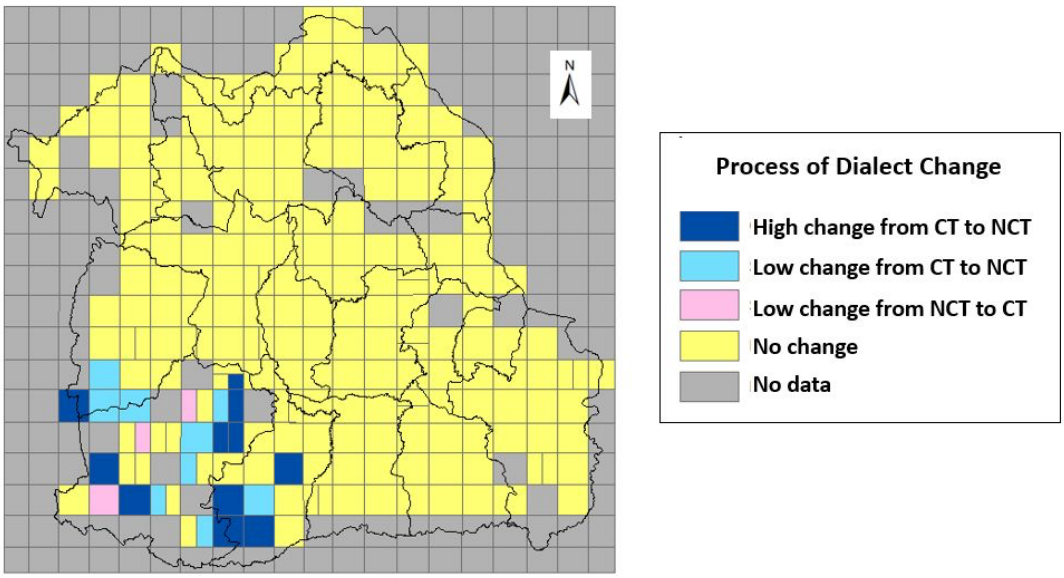
d) 'No data' class was excluded from the calculation

No. of class	Description of the Change LEVEL 1[a]	Percentage of change	No. of class	Description of the Change LEVEL 2[b]	Percentage of change
1	No Change (CT)	1.8	1	No change (High CT)	0.0
			2	No Change (Low CT)	1.4
2	No Change (NCT)	86.2	3	No Change (High NCT)	82.6
			4	No Change (Low NCT)	0.9
3	No Change (CT = NCT)	1.4	5	No Change (CT = NCT)	1.4
	Total	89.4[c]		Total	86.3[c]

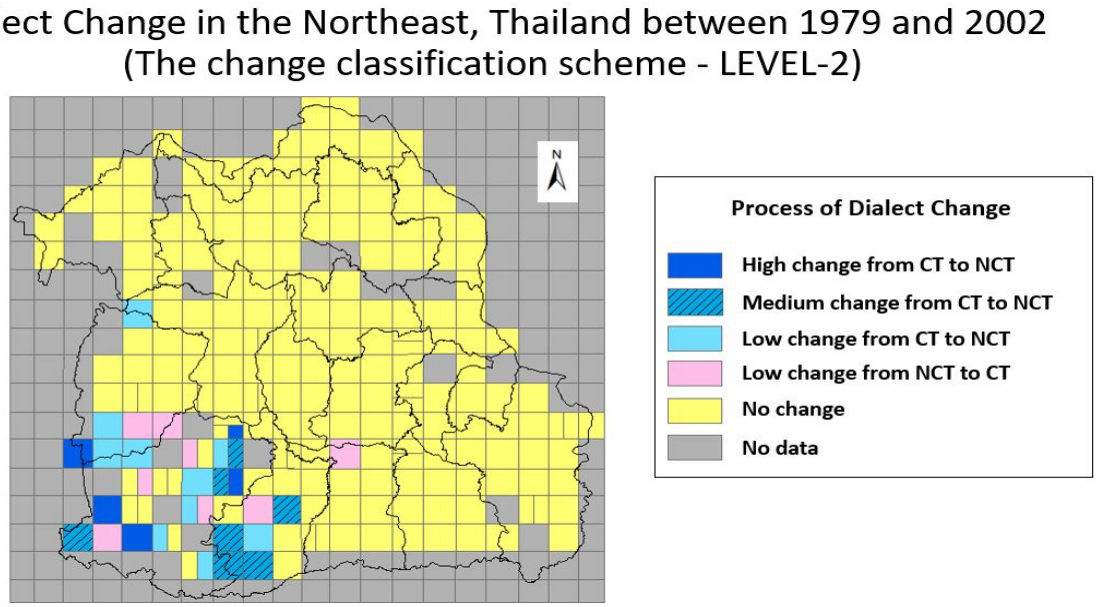
Table 5. Percentage of 'No change' in detail, based on two Change classification schemes (Change LEVEL 1 and Change LEVEL 2)

Remark: a) Classification of change was conducted based on the coding scheme in Table 2 and concept in Figure 11

b) Classification of change was conducted based on the coding scheme in Table 3 and concept in Figure 12



(a) Dialect change map between 1979 and 2002 (LEVEL 1)



(b) Dialect change map between 1979 and 2002 (LEVEL 2)

Figure 13. Comparison of dialect change maps of different details (Change LEVEL 1 and Change LEVEL 2) showing the quantification of change between 1979 and 2002

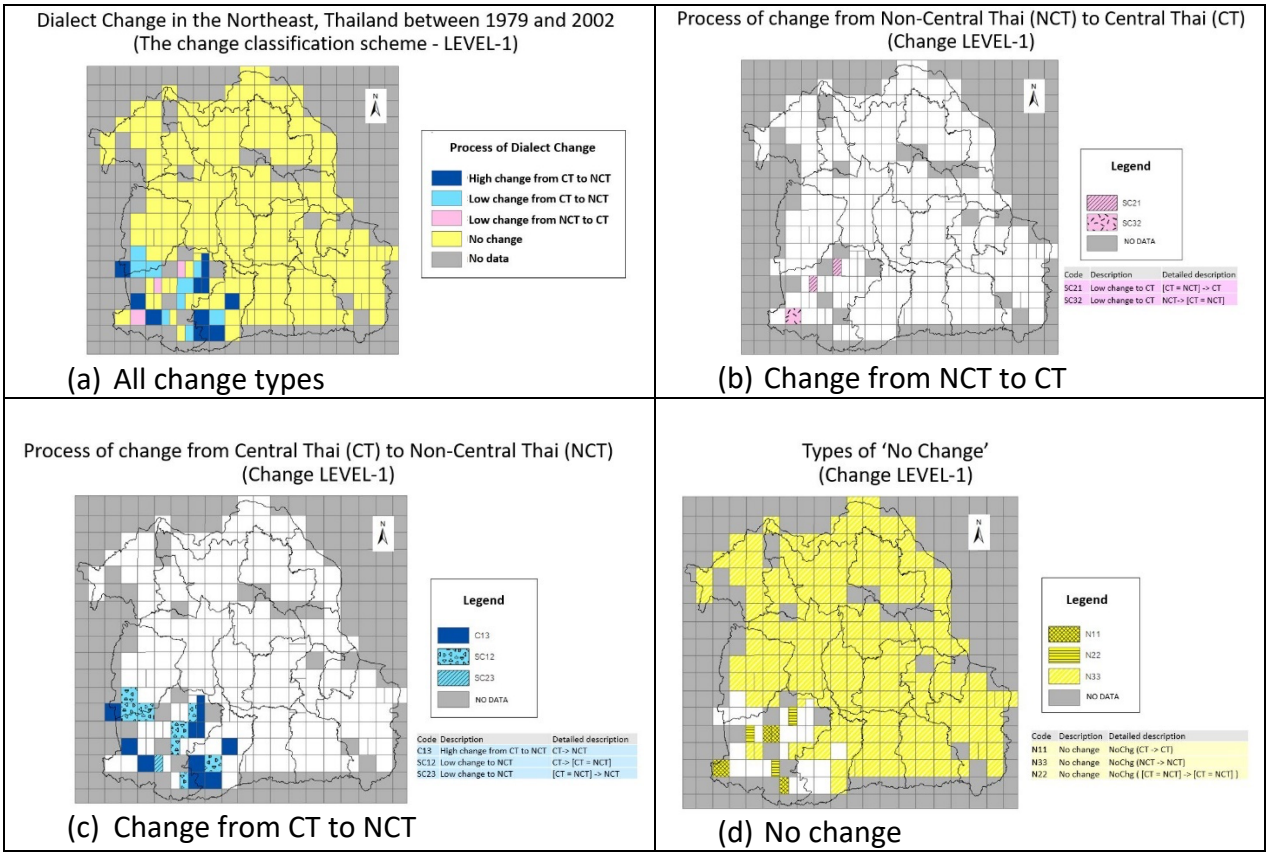
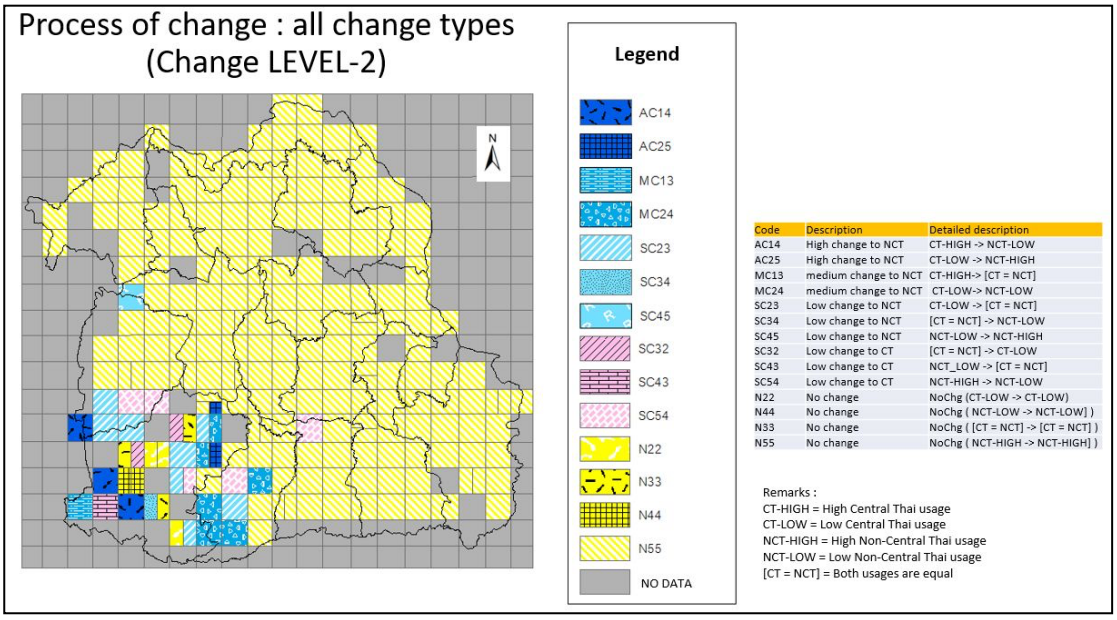


Figure 14. Dialect change maps (Change LEVEL 1) showing the quantification of change between 1979 and 2002 in different views, (a) All change types, (b) Change from 'NCT' to 'CT', (c) Change from 'CT' to 'NCT', and (d) No change (Remark: Figure 14(a) and Figure 13(a) are the same map)



Code	Description	Detailed description
AC14	High change to NCT	CT-HIGH -> NCT-LOW
AC25	High change to NCT	CT-LOW -> NCT-HIGH
MC13	medium change to NCT	CT-HIGH-> [CT = NCT]
MC24	medium change to NCT	CT-LOW-> NCT-LOW
SC23	Low change to NCT	CT-LOW -> [CT = NCT]
SC34	Low change to NCT	[CT = NCT] -> NCT-LOW
SC45	Low change to NCT	NCT-LOW -> NCT-HIGH
SC32	Low change to CT	[CT = NCT] -> CT-LOW
SC43	Low change to CT	NCT_LOW -> [CT = NCT]
SC54	Low change to CT	NCT-HIGH -> NCT-LOW
N22	No change	NoChg (CT-LOW -> CT-LOW)
N44	No change	NoChg (NCT-LOW -> NCT-LOW])
N33	No change	NoChg ([CT = NCT] -> [CT = NCT])
N55	No change	NoChg (NCT-HIGH -> NCT-HIGH])

Figure 15. Dialect change map (LEVEL 2) between 1979 and 2002 showing the quantification of change (all change types) in finer detail, compared to the detailed map in Figure 13(b)

The main finding in this study, however, is that 'No change' in the area of Non-Central Thai usage occupied the most showing how robust Non-Central Thai remained over the 23-year period of this study. It is most interesting that 'Change' is limited to the lower western part of the study site – the main entrance from Bangkok to the Northeast, and the change is predominantly from Central Thai to Non-Central Thai. The results of the study even indicated that Non-Central Thai was gaining strength since its usage significantly increased in different stages. This finding unexpectedly and surprisingly negated the hypothesis of this study. Factors influencing this unexpected result such as ethnicity and migration should be further investigated. Possibly, the rise of community radio in Thailand as a result of the Broadcasting and Telecommunications Services Act 2001 most likely plays an important role in encouraging localization trends including usage of local dialect at the grass root level. It thus suggests that further work should be conducted to investigate factors influencing the change. In so doing attention should also be paid to the result of an ethnolinguistic research on the Isan (Northeastern Thai) identity (McCargo & Hongladarom 2004: 234). They find that Northeasteners are ambiguous on how to present themselves. To quote, "many people clearly choose to present themselves as 'Lao'[2] among friends of the same group, …yet to downplay or to disavow their Lao-ness to outsiders". In our cooperation between linguistics and geography we propose a resurvey of the study site in the next few years (e.g. 2022-2023). It could completely capture the change up to the present and make the work more productive. Another issue that should be aware is that this research is only a lexical study. Phonological variables especially tone should also be investigated. Further in-depth interdisciplinary research will provide better understanding of the dialect change phenomena in this region.

Another issue to be commented on is the incorporation of GIS to the study. The benefit of GIS integration is obvious. While Figure 9 and Figure 10 can help linguists to better understand and interpret the distribution pattern of Central Thai and Non-Central Thai usage in the study area, Figure 13-15 leads us to the discovery of the real

[2] Lao is another term used to call people in northeastern Thailand.

time change process (stages of change) between 1979 and 2002. Quantification of change and different views of dialect map proposed and presented in the study are also the advantage points of the GIS tool. GIS provides intensive spatial functions and spatial statistics functions to be used for the analysis, allowing the creation and comparison of multiple alternative maps. Despite its GIS advantages, one should be aware how to handle spatial data rationally. In this analysis, different map scales and collection units between the two input datasets cause limitation in spatial comparison. As well, designation of different change classification schemes resulted in various outputs. All in all, however, this study suggests that incorporation of GIS for spatial analysis and map display is strongly recommended to help linguists better understand spatial patterns and relationships, providing a range of possibilities for presenting and exploring dialect data and its change. Without GIS, investigating the spatial pattern of change and its change process, for example, could not be done easily.

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