267

ON THE BORDERS: REORDERING THE PLANNING LANDSCAPE?

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ABSTRACT

Several attempts have been made to bridge the process of comprehensive planning of a city or a region with Space Syntax analytical methodology, for example, Karimi et al (2015). Although the results of such attempts were highly suggestive and led to their consequential impacts on the planning bodies and decisions towards the final comprehensive plans, the processes tend to be somewhat exhaustive. However, it has been acknowledged that Space Syntax is useful for evaluating planning decision. Accordingly, to what extent could the insightfulness providing by Space Syntax study add a more life-like picture towards the comprehensive plan in such a way that the robust evaluation of the plan itself could be proposed for the future?

In the past three years a number of special economic zones have been proposed along the border areas between Thailand and the neighbouring countries by Thai government. One of them is Chiang-rai Special Economic Zone (CHRSEZ), which is a border area among Thailand, Myanmar and Laos, and encompasses an area of 1,521 square kilometres. A Space Syntax study of the existing spatial and socio-economic conditions, some of which are the variables used by and for the proposed comprehensive plan of CHRSEZ, was carried out; and the findings are reported in this paper. Emphases had been made on two issues. One is the technique for studying the syntactic spatial network in relation to the common planning analytical units, spatial and socio-economic related. Another is the reading of the findings which concentrates on the theory of centrality and its relationship with existing socio-economic conditions. The spatial-related variables studied were population, gloss building floor area, commercial land use and traffic flows. The less spatial-related variable studied was poverty gap. Morphological study was also made on three scales of spatial (road) network model: international sub-regional CHRSEZ level,, CHRSEZ sub-regional level and CHRSEZ prominent-town level.

Overall, the life-like pictures built up by the relationships between spatial network and the existing socio-economic conditions can be established. They are markedly visible at the prominent-town level and less so at the sub-regional level. They have some distinctive patterns that could provide some suggestions for land-use types' alteration and re-distribution which have been proposed within the comprehensive plan. Thus, it could be said that the CHRSEZ comprehensive plan might be re-considered prior to announcement.

KEYWORDS

Space Syntax, Chiang-rai, Urban and Regional Planning Process, Spatial Network, Border Towns

1. INTRODUCTION

Space Syntax has been very successful in the study of urban areas and buildings so much so that a vast number of practices, planning and design projects follow the Space Syntax recommendations. The Space Syntax methodology have also been applied to study in other disciplines because of its usefulness in terms of the diagnostic approach to the existing conditions, and their evolution, for instance, archeology. Within the field of Space Syntax itself, there seems to be a growing number of researches extend the subject and the studied area from the urban or the city scale towards the sub-regional or regional scale, for example, Serra et al (2015), Karimi et al (2015 and 2017), Law and Versus (2015), or Mainieri de Ugalde et al (2015). These regional-scale researches can be roughly classified into four groups relating to their research purposes and methods. In term of the research purposes, one is to extend the capability of the Space Syntax methodology at the regional scale by trying to understand the association between the spatial network and socio-economic phenomena (Serra et al, 2015; Law and Versus, 2015); another is to try to apply the Space Syntax methodology to inform the regional planning (Karimi et al, 2017; Mainieri de Ugalde et al, 2015). In terms of the methods, one studies a regional area with a comparative approach, i.e., by comparing spatial characteristics of several towns or cities located within the region; another studies spatial characteristics of an extended metropolitan area. Nevertheless, there are two shared patterns emerged from them: a more detailed development of the research methods, which are more likely to be very technical and highly exhaustive for application, and acknowledgements of the lack of data at the regional level and the limitation of the computation capability to process the data, even if they are available.

The lack of data or the incoherent data availability is often more pronounced in the rural region than in the city or the metropolitan region. The rural region generally consists of a network of a few big towns and a number of small towns, or villages, perhaps. These towns may be considered urbanised to some certain extent, but their distribution is usually sparse. Most often, they are not well connected among themselves which also contributes to the difficulty in obtaining or recording such data. This situation is even worse in the rural region of the developing countries, for example, those regions in the Southeast Asian countries, and particularly in Thailand. Moreover, the regional comprehensive planning in Thailand are normally carried out, first, at the metropolitan or the city scale because of the socio-economic situations which requires urgent planning. However, the rural region also needs a sustainable planning as well, due to the needs to control the encroachment of natural conservation areas from farmlands and the encroachment of farmlands from urban and industrial development trends.

One of the urgent needs for the rural regional planning in Thailand has been exacerbated in the past two years due to the creation of the Association of Southeast Asian Nations (ASEAN) Economic Community (AEC) by the end of 2015, in an attempt to integrate regional economy (ASEAN, 2008). One of the outcomes of the AEC is the establishment of special economic zones (SEZs) along the border areas between two countries, aggressively initiated by Laos and then followed by Thailand, with two objectives — to build production bases connecting with the neighbouring AEC countries and to promote the economic development of the border areas' provinces (NESDB, 2016). Thailand's strategies are: to establish border areas' new economic zones, through the utilisation of the country's connectivity; to develop infrastructure, particularly those relating to logistics; to encourage small-medium enterprises' investment in Thailand's SEZs or Thai investment in the neighbouring countries related with the SEZs' activities; and, to systematise cross-border economic activities, for instance, cross-border labours and trades (NESDB, 2016). Within two years after the AEC integration, ten SEZs from two development phases have been proposed and developed along the borders of Thailand and the neighbouring countries. Their areal sizes vary, raging from 50 square kilometres to 1,500 square kilometres. Thus, the comprehensive planning of those ten SEZs have also been carried out, as they had not been included within the existing regional or provincial plans. However, these border areas where the SEZs locate generally are rural in both spatial and socio-economic characteristics. Most of their areas are forests, majority of which are listed as natural conservation areas.

The study presented in this paper attempt to try to bring the strength of Space Syntax, the effectiveness of studying the existing conditions, to apply to the rural sub-regional planning. It tries to assess a proposed sub-regional comprehensive plan through its land-use plan, by using the Space Syntax methodology in relation to some existing socio-economic and spatial conditions. To what extent could the insightfulness providing by Space Syntax methodology add a more life-like picture towards the regional comprehensive plan in such a way that the robust evaluation of the plan itself could be proposed for the future?

Theoretical framework of this study is Hillier's theories of spatial sustainability and centrality of urban areas (Hillier, 2007, 2009, 2012; Hillier et al, 2007). Hillier proposes that spatial sustainability of city is the outcome of the geometry and configuration ordering of spaces in a city. There is a dual generic form of the city's grids, morphologically and syntactically. One is a foreground network; another is a background network. The foreground network is the linearity structure of the streets, which represents the potentiality of streets that might be chosen more often as a route to pass through between origins and destinations (choice). This type of streets usually is the main streets of the city which tend to sequentially connect to each other at wide obtuse angles. Thus, the foreground network often links city centres of different scales together. The background network is the various patchy areal patterns that are made up by a great number of secondary streets. This type of streets are more likely to be shorter in lengths than those of the main streets forming the foreground network. They are more likely to connect to each other at nearly right angles. These patchy structures are distributed throughout the whole city and linked with the foreground network, and tend to be the origins and destinations of the trips. Hillier suggests that both the foreground and background networks are created by the interaction of economic and social factors of the city through the control of accessibility and the generating of movement types — through-movement, a movement to minimise trip length, and to-movement, a movement from an origin to a destination. These two movements can be measured syntactically. *Choice* measures the quantity of movement passing through each spatial element on shortest or simplest trips between all pairs of spatial elements in a system, represents the *through-movement potential*, and corresponds to mathematical *betweenness*. *Integration* measures the distance from each spatial element to all others in a system, represents the *to-movement potential*, and corresponds to mathematical *closeness* (Hillier, 2012). Through Hillier's suggestions on the control of accessibility and the generating of movement types and the supported findings from a number Space Syntax researches, the foreground network tends to be occupied by the type of land use which benefit from the quantity of movement, i.e., commercial land use, while the background network is generally occupied with residential land use, which requires more control of movement.

With this foreground/background network principle, Serra et al (2015) have proved that the dual characteristic of the spatial network can be extended to the regional level. They studied the road networks of UK's mainland and the Great South-East (GSE) area of the UK. Through two syntactic segment models built up from road-centre lines and the investigations of the correlation patterns between the syntactic measurements and the vehicular movement and socio-economic variables base on GIS platform, they could successfully show the foreground/background networks of the UK mainland and GSE area and the correlation patterns between syntactic measurements and vehicular movement and socio-economic variables. More importantly, their research could identified the scales of the phenomena. The patchy patterns of more central areas of medium and large size settlements, which constitutes the background network, can be best depicted through closeness (integration measurement), particularly at radius 10 Km. A web-like patterns that link them together can be best depicted through betweenness (choice measurement), particularly at radius 50 Km. Both measurements at radius 20 Km. are best correlated with vehicular movement. This is the similar distance to the average distance between urban areas obtained by other GIS data study. The research also identified socio-economic variables which are more likely to correlate with betweenness or closeness, i.e., foreground/background network.

Similarly, Mainieri de Ugalde et al (2015) were able to identify city-regional structures in Rio Grande do Sul, Brazil. The studied area is mountainous and has been under the process of conurbation for some time. This created the difficulty to define urban boundaries for the detailed planning and infrastructure providing. Municipalities within the region tended to expand their boundaries for political gains. By study the road network configuration using the syntactic spatial models and measurements, they could identify the structures of the region as well as the autonomous areas, through the distribution of web-like foreground network and patchy pattern of background network. Furthermore, by simply overlaying the spatial network over geo-referenced water-consumption measure points, they could establish possible relationships between syntactics measures and the basic activities of commerce and services, industry and housing.

With the foreground/background network principle and the suggestively supported studies of Serra et al (2015) and Mainieri de Ugalde et al (2015), against the lack of, and some time incoherent, data of the studied area, the Space Syntax methodology should be able to identify the life-like structure of the studied area, a rural sub-region. The findings then should allow for the proposed comprehensive planning's evaluation. Thus, this could led to a robust suggestion for a future development.

2. DATA SETS AND METHODS

Chiang-rai Special Economic Zone (CHRSEZ) is the studied area. CHRSEZ locates to the north of Chiang-rai province in the northern region of Thailand. It is bordered with Myanmar to the northwest, with Sai and Ruak Rivers being natural boundaries, and with Laos to the northeast, with Kong River (or Mekong River) being a natural boundary. Ruak and Mekong Rivers join at an area called Golden Triangle, marking the meeting point of the three countries and renowned for its beauty and narcotic problem (Figure 1). Mekong River is a transnational river passing through six countries: Myanmar, Loas and China to the north, and Vietnam and Cambodia to the east, of Thailand.

Of the ten recently developed special economic zones in Thailand, CHRSEZ is the biggest in term of area. It has an area of 1,521 square kilometres, while Chiang-rai province has an area of 11,678 square kilometres. CHRSEZ cover three districts, Maesai, Chiang Saen and Chiang Khong (Figure 1), which are further subdivided into 25 local municipalities. Of these 1,521 square kilometres, 560 square kilometres are legible areas for planning. The rest are the natural and cultural heritage conservation areas and the special allocated farmlands, both of which have to be included in the sub-regional comprehensive plan although they are regulated by special laws. Despite of their geographical characteristics, i.e., highly rural and mountainous, and special regulated laws, this type of CHRSEZ areas are populated, though to a lesser extent when their population are compared to the population of the legible planning areas of CHRSEZ. It should be noted that the border areas in Myanmar and Laos are highly rural and mountainous in general as well, even to a greater extent than those in Thailand. There are three important cross-border check points where the marked built-up areas can be found to surround the check points, one in Myanmar and two in Laos. In fact, the two noticeable built-up area in Laos are also the special economic zones of Laos.

According to the data from Department of Public Works and Town and Country Planning (DPT), the overall population who lived in CHRSEZ were at 259,060 persons in 2015 and is expected to grow to 421,700 persons in the next 20 years, 2035. In 2015, the most populated municipality had a population density of 5,956 persons/square kilometres (0.006 person/square metre), while the lest populated municipality had a population density of 65 persons/square kilometres. With a projection to increase to 9,729 persons/square kilometres (1 person/square metre) and 105 persons/square kilometres, for the highest and the lowest population density. These population densities of the local municipalities just re-emphasise the scale of the urban development within the sub-region that it is more of a town scale instead of the city scale. Furthermore, of the 25 local municipalities, there are three more urbanised municipalities than the rest, in term of the population density.

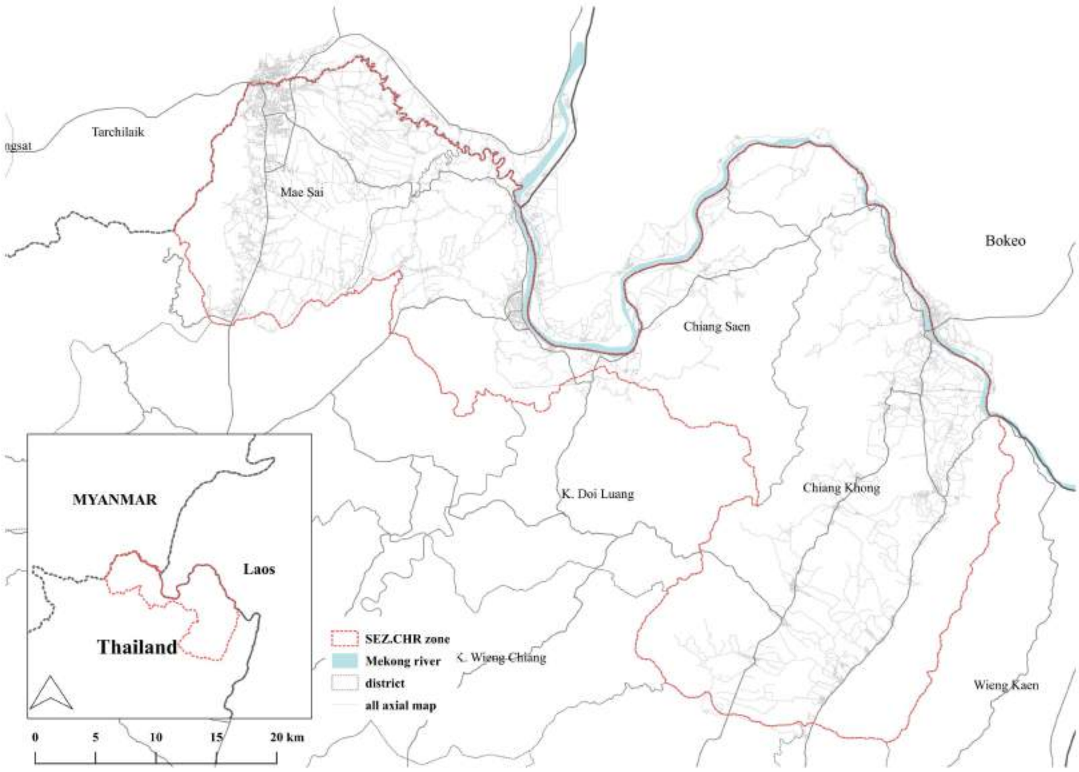

Figure 1: Location of Chiang-rai Special Economic Zone at the border areas among Myanmar, Laos and Thailand, and the three districts comprising the area, Maesai, Chiang Saen and Chiang Khong

The syntactic study of the sub-region of CHRSEZ tries to answer three questions:

a) To what extent can the syntactic study help identify the foreground/background network of the sub-region in a way in which it could help establish and identify the sub-regional spatial structure and the urban settlement boundaries of various degrees? This is because one of the major problems facing the planing process in this sub-region, or Thailand in general, is how to define a more urbanised area from the rural settlements, for an effective planning. Clustering of buildings has been used most often to identify urban areas although these buildings are points in landscape. A critical situation arises when there is a group of buildings distributing on landscape with some proximities to each other but not close and without much accessibility among the buildings. Can the spatial configuration network help identified the more urbanised centres in addition to the common use of building clustering and distribution?

b) Is there any relationship between the syntactic measurements and movement flows that can be established in this context? And, are there any relationships between the syntactic measurements and the socio-economic phenomena? Both of these relationship types are often found in the Space Syntax researches.

c) If there are, to what extent can the syntactic analyses help assess the proposed sub-region comprehensive plan of CHRSEZ?

The methodology was set as followed:

i) Three scales of spatial models of the road network were carried out, based on road-centre lines that provide by Open Street Map on the GIS platform. The first scale is the spatial model of the road network of CHRSEZ and the neighbouring countries, 60 Km. in diameter (3-country spatial model/scale). Among the rural and mountainous border areas of the three countries, the Thai areas are more urbanised than the border areas in Myanmar and Laos. The second scale is the spatial model of the road network of CHRSEZ, i.e., only the road network in Thailand (3-district spatial model/scale). The third scale is the spatial model of the road network of prominent settlements. A prominent settlement is a central area of a centre or sub-centre, depicted by the syntactic measurement of the 3-district model (prominent centre spatial model/scale). There are three prominent settlements, each of which was studied as an independent system. Although a number of sub-centres and their central areas have been depicted by the configuration maps, they are not included in this study. The purpose of these three-scale spatial model studies is to be able to establish the sub-regional structure and the approximated boundaries of the central areas of centres and sub-centres.

ii) The relationship between syntactic measurements and movement flow was investigated through correlation analysis. The movement variable is vehicular quantity of passenger cars per hour (pcu), provided by DPT on 39 observation points. R-squared values given by simple regression analyses between the syntactic values of the segments where the observation points locating at various radii ranging from 200-60,000 metres and the pcu of those points at were studied.

iii) The relationships between the syntactic measurements and socio-economical conditions were carried out though GIS platform. A pattern made up of hexagon grids, each of which has a diameter of 400 metres, was overlaid over the whole area of CHRSEZ. Each hexagon grid was a planning analytical unit. Within each grid and by geo-references, number of population, gross building floor areas, and commercial land use were calculated and allocated. There were three studied variables for commercial land use: commercial area, number of commercial buildings and ratio of commercial area to building area. The values were calculated from the data provided by DPT. The reason to focus on the commercial land use was because of its importance, to be used to mark the urban centres and to be considered to allocate more area to the existing one if needed or to propose a new commercial centre in the planning process. According to Hillier, the commercial land use takes advantage of and benefits from movements generated by the spatial network (Hillier, 2007 and 2009). The reason to use the commercial ratio as a variable was because of the fact that the commercial land use is often found to locate only on the ground floor of a building rather than occupies the whole building within this sub-region. The above floors are more likely to be residential areas. This contributes to a mixed-use type of buildings making up by the commercial and residential uses. Nevertheless, some stand-alone commercial buildings do exist, for example, hardware store, supermarket, or some types of hotel. They usually locate at the edge or out of town due to the regulation of this commercial business types which requires them to locate along main roads.

iv) Two types of syntactic values were studied with the socio-economic variables of the planning analytical units. One was the average value, which was calculated by averaging the syntactic values at every radius studied of all segments located within a planning analytical unit. Another was the maximum syntactic value at every radius studied among all segments located within a planning analytical unit. The investigation was made through the patterns of the r-squared values given from the simple regression analyses of the syntactic and the socio-economic variables' values from two-scale models — the 3-district scale and the prominent town scale. For the 3-district scale, the syntactic studied radius ranged from 200-30,000 metres. For the prominent town scale, the syntactic studied radius ranged from 200-20,000 metres.

v) In addition, an analysis of the syntactic values and poverty gap ratios was also made. The purpose of this analysis is to recheck the association of the syntactic measurements with both the spatial and non-spatial variables. The poverty gap ratio was chosen as an example of the non-spatial variables in a view that it may be of less spatial-related than those population, gross building floor area and commercial land-use variables. The poverty gap ratios are published by Office of the National Economic and Social Development Council (NESDB) and National Statistical Office of Thailand for every province and municipality in Thailand. The values used for this analysis are of 2017. A poverty gap is a difference between a living standard of a poor household which falls below the poverty line of a province. A poverty gap ratio is an average value calculated from the poverty gaps and average monthly income per person of the poor households of a municipality. The higher the ratio is, the poorer the population will be. Correlations between the poverty gap ratios and the average and maximum syntactic values at different radii of 25 municipalities were analysed.

It should be noted that the findings reported here are in the initial state of the study. They are selectively presented for the extent to which the Space Syntax methodology, with simple measurements, could help intelligently present the existing conditions which will led to the capability to evaluate the land-use plan of the sub-region comprehensive plan. A further study of the syntactic measures and the other socio-economic variables are still in progress, for the suggestion of the future comprehensive plan will not only be more robust but feasible.

3. RESULTS

The spatial structure of the sub-region

A comparison between the syntactic maps of the spatial models of the road network of CHRSEZ and the border areas of Myanmar and Laos (3-country model) and the road network of CHRSEZ only (3-district model) shows some significant patterns. Because the number of road segments in CHRSEZ are very much higher than the number of road segments in Myanmar and Laos, the web-like global patterns representing the foreground networks of the 3-country and the 3-district model are similar, as shown by the centrality of angular betweenness (NACH at radius N) in Figure 2. The 3-country model has 40,293 segments; and, the 3-district model has 32,875 segments, 7,418 fewer segments. The main streets within CHRSEZ constitute most of the foreground network of the 3-country and the 3-district model. Giving the maximum NACH value at radius N is at 1.3714 and 1.3732 from both spatial models, all the segments having values equal to or higher than 1.3 of both models are in CHRSEZ. Thus, they are the same segments in both models (Figure 3). This pattern is also repeated for the segments having values equal to or higher than 1.1 and 1.2 within the CHRSEZ, whilst the segments in Myanmar and Laos of these values are depicted in the 3-countries model (Figure 3). It is understandable that when the road segments of Myanmar and Laos were added to make the 3-country model the segments of their main roads should constitute to the foreground network.

Another finding is that it is very clear that the rivers are the significant spatial barrier. The spatial networks of the three countries are not well connected at all. There are only three bridges linking the three countries within this sub-region, two bridges between Thailand and Myanmar and one bridge between Thailand and Laos. Although there are six river crossing piers, the river connections are not included within the 3-country model, for the similarity of the spatial network comparison. Because of the similarity of the patterns of the foreground network of the two models, the overwhelm quantity of the segments in CHRSEZ compared to those in Myanmar and Laos and the difficulty to obtain data from Myanmar and Laos, the further analyses were carried out only through the 3-cities and prominent town models.

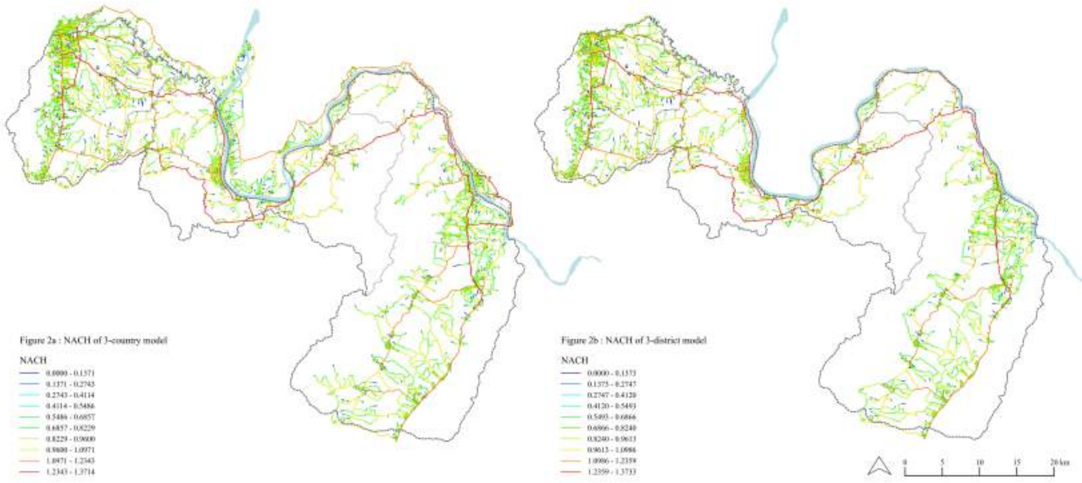

Figure 2: A comparison of the foreground networks, through maps of NACH at radius N of Chiang-rai Special Economic Zone, including and excluding the border areas with Myanmar and Laos

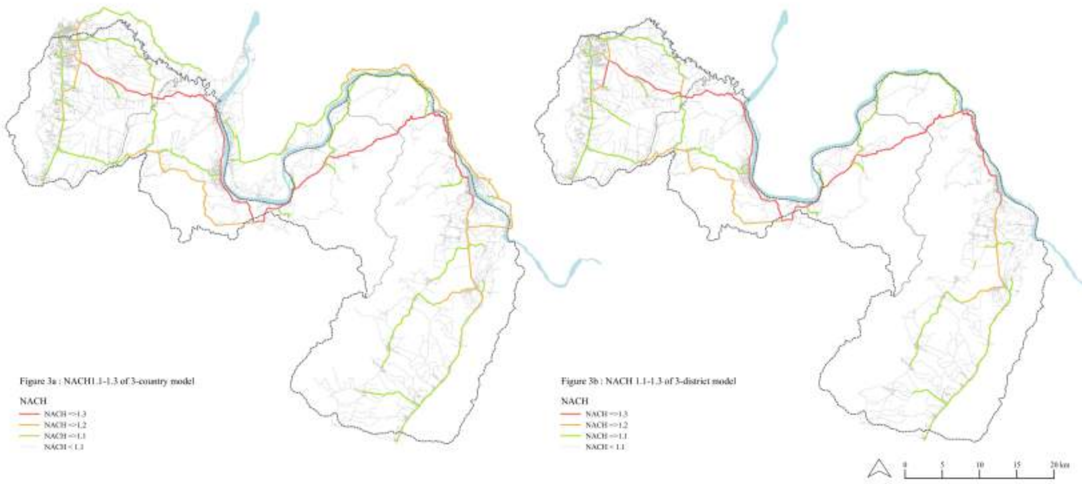

Figure 3: A comparison of segments with values at 1.1, 1.2 and 1.3 of NACH at radius N of Chiang-rai Special Economic Zone, including and excluding the border areas with Myanmar and Laos

As mentioned earlier, one of the critical problems is to identify the more urbanised centres within the rural landscape of the sub-region for a more effective planning. The patchy patterns of the centrality of angular closeness, the background network, should, in theory, be able to identify these centres. This is because roads or segments of roads, i.e., accessibility, are more noticeable and concentrated in the more urbanised areas than the rural areas, while buildings can be dispersedly or clusteringly distributed. The centrality of angular closeness (integration) displays two marked patterns. Firstly, the centrality of angular closeness at radius 8,000 metres (NAIN at r8 Km.) shows the separation and differentiation of the three districts. It also displays that there are three prominent centres, marked one in each district making up the 3-district spatial model (Figure 4). These centres are: Maesai town, to the west; Chiang Saen town, at the centre; and, Chiang Khong town, to the east. Among the three districts, Maesai has highest number of segments, then Chiang Khong and Chiang Saen have respectively. This is highly suggestive that the number of segments and the centrality of closeness can indicate to the more urbanised degree of Maesai, making it the most prominent centre, among the three districts. Figure 4a also shows that Maesai has a large central area. The other two, Chiang Saen and Chiang Khong, have smaller central areas. Majority of the segments within the other two districts are more spread out. However, due to the central location within the spatial model, the centrality of closeness, NAIN at radius N, shows that Chiang Saen are the most central area of the sub-region even though building density and building distribution of Chiang Saen are far more lower than those of Maesai.

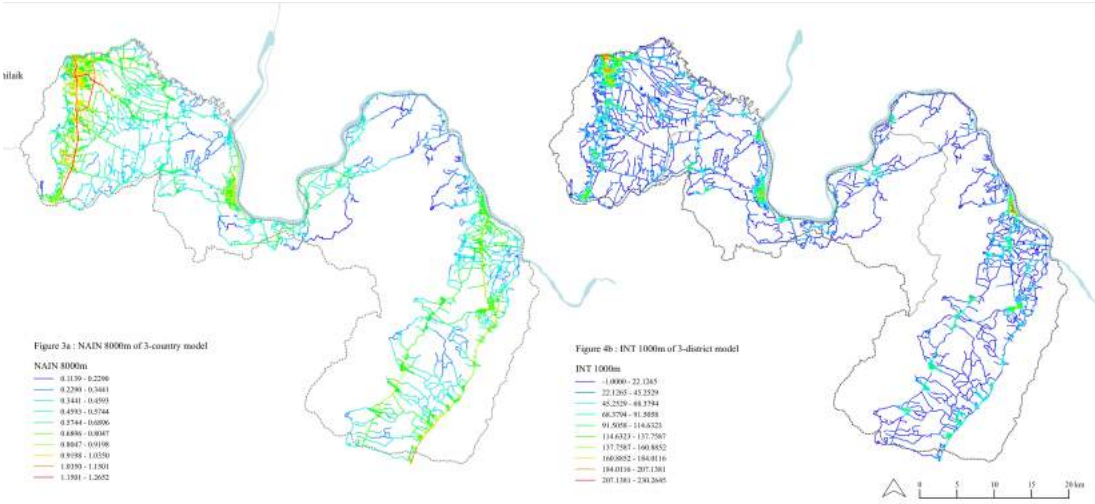

Figure 4: The centrality of angular closeness of the 3-district model: a) NAIN at radius 8,000 metres (8Km); and b; integration at radius 1,000 metres

Secondly on the finer scale, the centrality of angular closeness (integration) at radius 1,000 metres (1 km.) of the 3-district models (Figure 4b) captures the central areas of the three centres, Maesai, Chiang Saen and Chiang Khong, and a number of central areas of sub-centres within the sub-region. Again, overlaid these central areas' patterns on the built up areas of building distribution, it was found that the built up areas of building distribution highly associate with the clustering of the integrated segments within the central areas. We can read these patterns in two-fold. First, it seems that each prominent centre serves the surrounding areas at radius 8 Km. This is 16 Km. in circular diameter, which suggests that the distance between two more urbanised areas is about 16 Km. Second, a core of the centres serves an area of 1,000 metre (1 Km.) in radius, or 2 Km. in diameter. Given the diameter of the sub-region is at 60 Km., 16 Km. is about one-third of the distances that the centres have organically formed; and, the fact that they are depicted in the syntactic map just strengthens the simple effectiveness of the Space Syntax spatial model. The abilities to mark the locational distribution of the centres and sub-centres and to approximate the distances of their central areas give rise to the capability to set the priority for town planning within the sub-region planning process.

Autonomous centres

As the spatial structure of the sub-region can be established, the next step was to investigate the relationships between the syntactic measurements, movement, and socio-economic properties, using the 3-district spatial model as the studied model. For the movement, the r-squared values given from the regression analyses between the syntactic values from various radii and the number of passengers car per hour (pcu) are not very high. The highest r-squared value is at .4 between node counts at radius 1,000 metres and pcu, with the r-squared value at .3 by choice at radius 8,000 and 10,000 metres (8 and 10 Km.) against pcu being the second bests. These low r-squared values just show that the syntactic measurements and vehicular movement are not well correlated. The reason for this poor correlation may be due to the few number of vehicular observation points, 39 points against 32,875 segments. It cannot be concluded that there is no correlation. Should the vehicular observation points be increased, the correlation could and should be improved, as often shown in many of Space Syntax researches. This movement analysis, therefore, needs further study.

For the analyses between the syntactic measurements and the socio-economic properties, i.e., the number of population, gross building floor areas and commercial land use, the patterns of r-squared values given by the simple regression analyses at the 3-district scale, the 3-district spatial model, and the prominent-town scale, the three independent spatial models of three towns, show some distinctive findings. They are sufficient to establish some relationships. It should be noted that the correlation are derived from the r-squared values of the regression analyses between the syntactic variables, the average and the maximum value of choice and integration at various radii against the socio-economic variables of the hexagon grids, i.e., the planning analytical units. Main findings are presented as followed (Figures 5-7 and Table 1):

Firstly, between the two types of syntactic values, the average value and the maximum value, the maximum value produces a slightly higher r-squared value with socio-economic variables than the average value does. This pattern was similarly found for both spatial scales and across the three centres. However, it is not fixed that the highest r-squared value will be of integration or choice for each socio-economic variable.

Secondly, among the studied radii, the values of choice and integration at radii 600, 800, 1000 metres produce higher r-squared values against the socio-economic variables than those values of the other radii. This pattern was similarly found for both spatial scales, for the three centres and for all the socio-economic variables. Thus, the r-squared values of these three radii range from .4-.6, making them neither weak nor strong, jut about sufficient.

Thirdly, if we look at the findings across three types of the socio-economic variables, beginning with the number of population, the r-squared values are not weak from both spatial scales and from the three centres. They range from .51-.66. At the 3-district scale, the maximum values of choice at radius 800 metres are best correlated with population numbers. At the prominent town scale, the best r-squared value in Maesai is produced with the maximum values of choice at radii 600 and 800 metres. In Chiang Saen, it is produced with the maximum values of integration at radius 800 metres, whereas it is produced with the maximum values of integration at radius 800 metres in Chiang Khong.

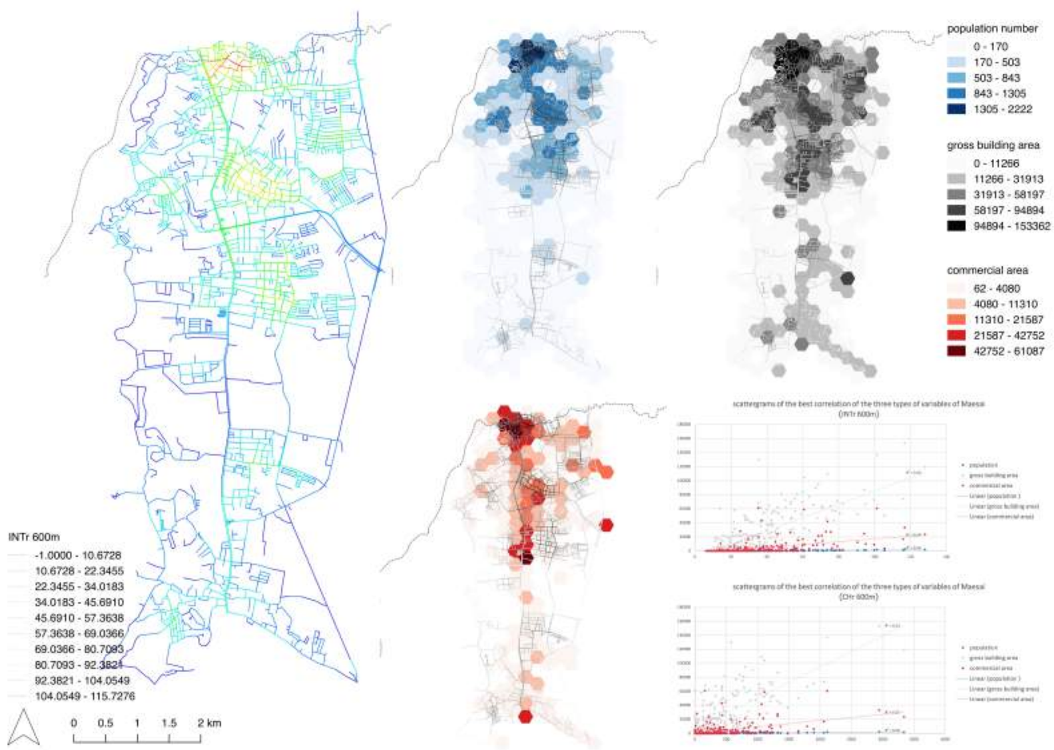

Figure 5: Displaying the integration map at radius 600 metres, the distribution of population number, gross building areas and commercial areas on the planing analytical units, and scattergrams of the best correlation of the three types of variables of Maesai

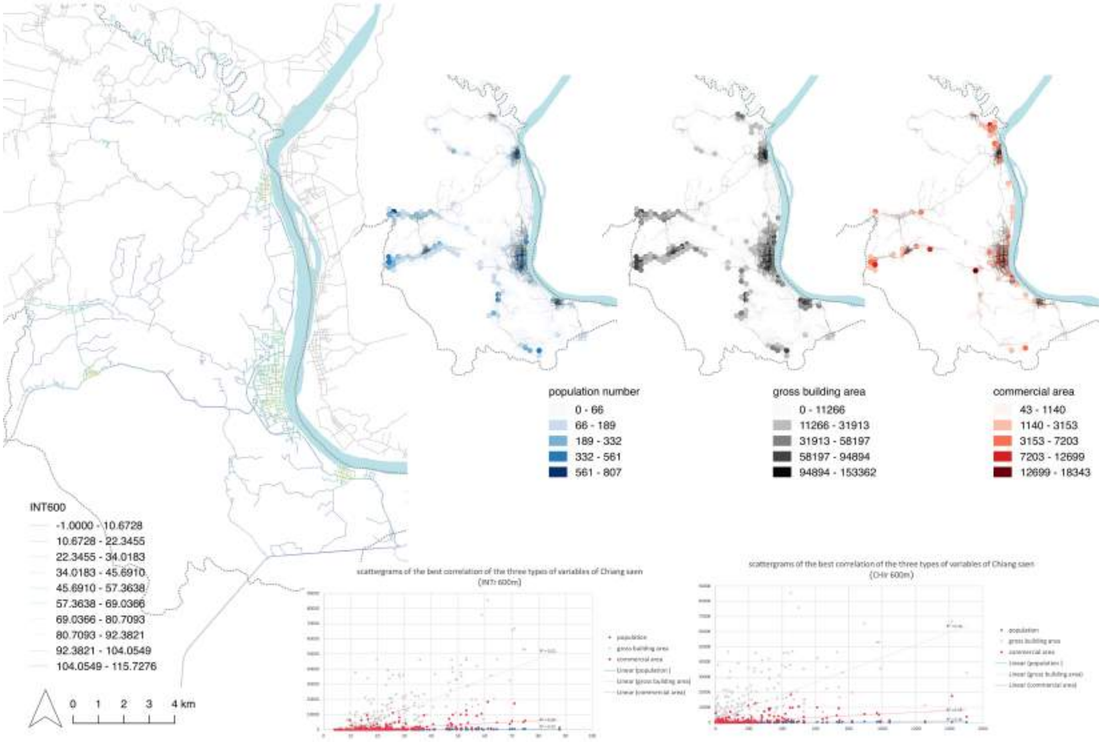

Figure 6: Displaying the integration map at radius 600 metres, the distribution of population number, gross building areas and commercial areas on the planing analytical units, and scattergrams of the best correlation of the three types of variables of Chiang Saen

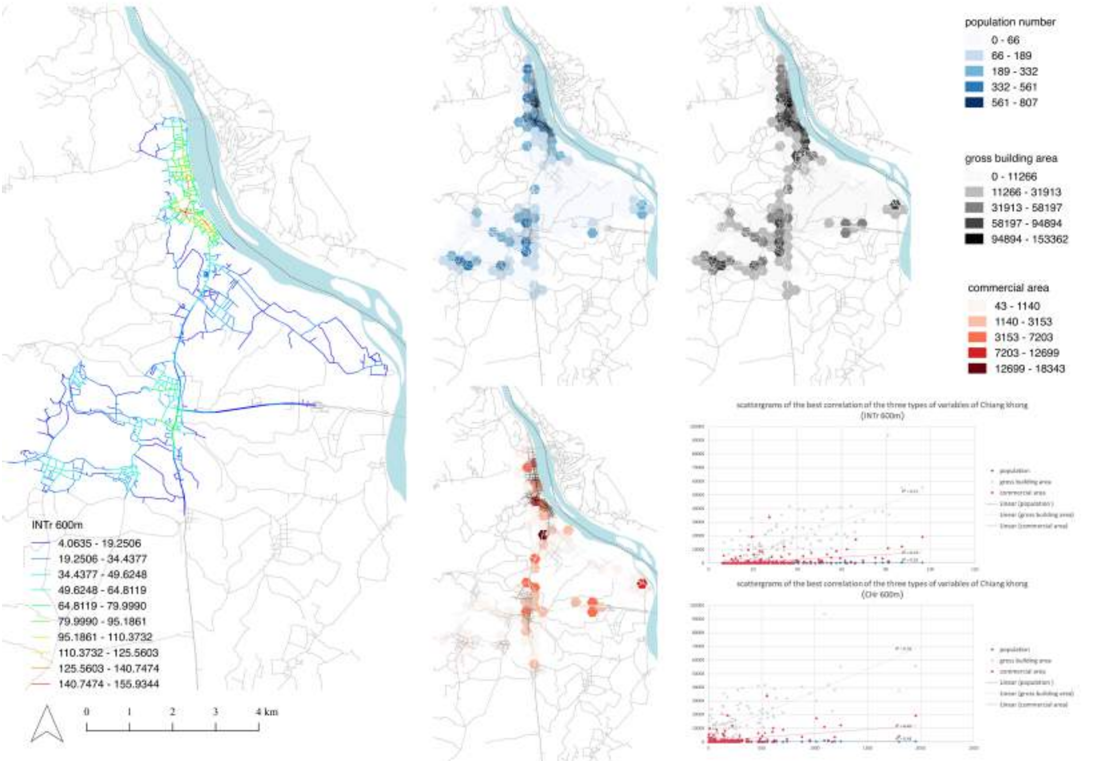

Figure 7: Displaying the integration map at radius 600 metres, the distribution of population number, gross building areas and commercial areas on the planing analytical units, and scattergrams of the best correlation of the three types of variables of Chiang Khong

Chiangrai Special Economic Zone				
population per grid				
Radius (m.)	Choice		Integration	
r-squared	average	max	average	max
1500				
1000	0.52	0.58	0.48	0.51
800	0.53	**0.59**	0.46	0.51
600	0.52	0.57	0.37	0.48
400	0.47	0.51	0.26	0.22
Gross floor area per grid				
Radius (m.)	Choice		Integration	
r-squared	average	max	average	max
1500				
1000	0.52	**0.58**	0.55	**0.59**
800	0.54	**0.58**	0.52	**0.59**
600	0.52	0.55	0.41	0.53
400	0.47	0.50	0.28	0.25
Gross commercial floor area per grid				
Radius (m.)	Choice		Integration	
r-squared	average	max	average	max
1500				
1000	0.24	0.25	0.20	0.21
800	0.54	**0.58**	0.52	**0.59**
600	0.19	0.21	0.13	0.16
400	0.14	0.17	0.08	0.07
number of commercial building per grid				
Radius (m.)	Choice		Integration	
r-squared	average	max	average	max
1500				
1000	0.27	**0.28**	0.21	0.22
800	0.27	0.27	0.19	0.21
600	0.21	0.24	0.14	0.18
400	0.16	0.19	0.09	0.08

Maesai				
population per grid				
Radius (m.)	Choice		Integration	
r-squared	average	max	average	max
1500	0.42	0.56	0.42	0.43
1000	0.56	0.63	0.51	0.52
800	0.59	**0.66**	0.54	0.55
600	0.59	**0.66**	0.54	0.57
400	0.53	0.57	0.49	0.55
Gross floor area per grid				
Radius (m.)	Choice		Integration	
r-squared	average	max	average	max
1500	0.43	0.55	0.47	0.48
1000	0.55	**0.60**	0.55	0.56
800	0.55	**0.60**	0.57	0.58
600	0.54	0.59	0.55	0.59
400	0.48	0.51	0.50	0.56
Gross commercial floor area per grid				
Radius (m.)	Choice		Integration	
r-squared	average	max	average	max
1500	0.24	**0.27**	0.27	0.25
1000	0.25	0.25	0.28	0.26
800	0.23	0.24	0.27	0.26
600	0.21	0.25	0.25	0.24
400	0.16	0.20	0.20	0.22
number of commercial building per grid				
Radius (m.)	Choice		Integration	
r-squared	average	max	average	max
1500	0.25	**0.30**	0.23	0.23
1000	0.26	0.24	0.25	0.25
800	0.24	0.24	0.24	0.24
600	0.21	0.24	0.22	0.22
400	0.15	0.19	0.18	0.20

Chinag Saen				
population per grid				
Radius (m.)	Choice		Integration	
r-squared	average	max	average	max
1500	0.29	0.43	0.41	0.43
1000	0.36	0.45	0.46	0.49
800	0.37	0.42	0.47	**0.51**
600	0.34	0.36	0.42	0.50
400	0.28	0.30	0.23	0.30
Gross floor area per grid				
Radius (m.)	Choice		Integration	
r-squared	average	max	average	max
1500	0.38	0.56	0.54	0.57
1000	0.47	0.58	0.58	0.63
800	0.48	0.54	0.59	**0.64**
600	0.44	0.47	0.52	0.61
400	0.37	0.40	0.28	0.36
Gross commercial floor area per grid				
Radius (m.)	Choice		Integration	
r-squared	average	max	average	max
1500	0.27	0.34	0.36	0.37
1000	0.30	0.33	0.36	**0.38**
800	0.29	0.30	0.35	0.36
600	0.26	0.26	0.29	0.31
400	0.22	0.22	0.15	0.17
number of commercial building per grid				
Radius (m.)	Choice		Integration	
r-squared	average	max	average	max
1500	0.27	0.36	0.40	**0.41**
1000	0.30	0.34	0.39	**0.41**
800	0.29	0.31	0.38	0.40
600	0.27	0.27	0.33	0.35
400	0.22	0.24	0.17	0.20

Chiang khong				
population per grid				
Radius (m.)	Choice		Integration	
r-squared	average	max	average	max
1500	0.32	0.47	0.41	0.46
1000	0.40	0.45	0.46	0.51
800	0.43	0.44	0.50	0.53
600	0.48	0.47	0.56	**0.57**
400	0.49	0.46	0.47	0.51
Gross floor area per grid				
Radius (m.)	Choice		Integration	
r-squared	average	max	average	max
1500	0.41	0.57	0.44	0.51
1000	0.49	0.55	0.49	0.55
800	0.52	0.57	0.53	0.55
600	0.57	**0.61**	0.56	0.57
400	0.48	0.53	0.55	0.55
Gross commercial floor area per grid				
Radius (m.)	Choice		Integration	
r-squared	average	max	average	max
1500				
1000				
800	0.03	0.04	0.02	0.03
600	0.02	0.03	0.02	0.03
400	0.01	0.02	0.02	0.04
number of commercial building per grid				
Radius (m.)	Choice		Integration	
r-squared	average	max	average	max
1500				
1000	0.38	0.41	0.27	0.32
800	0.39	**0.42**	0.29	0.32
600	0.36	0.37	0.30	0.35
400	0.28	0.35	0.23	0.27

Table 1: A comparison of r-squared values of the three studied centres from two spatial scales — 3-district and prominent town

We also found this alternated pattern of the maximum values of choice and integration from the three radii to produce the highest r-squared values against the gross building floor areas. Again, overall the r-squared values are not weak, ranging from .59-.64. At the 3-district scale, the maximum values of choice at radius 800 and radius 1,000 metres are best correlated with gross building floor areas. At the prominent town scale, the best r-squared values in Maesai are produced with the maximum values of choice at radius 800 and radius 1,000 metres. In Chiang Saen, it is produced with the maximum value of integration at radius 800 metres, whereas it is produced with the maximum value of choice at radius 600 metres in Chiang Khong.

With commercial land use, the findings are slightly different from those of the population number and gross building areas analyses. Among the three studied variables of the commercial land use, the r-squared values given from the syntactic values against the gross commercial floor areas and the number of commercial buildings are very much better than those given against the ratio of commercial areas to building areas. Between the gross commercial floor areas and the number of commercial buildings, the patterns of the r-squared values are quite mixed. At the 3-district scale, it is the maximum values of integration at radius 800 metres which produce the highest r-squared value against the gross commercial floor areas, although the maximum values of choice at radius 800 metres almost produce the same r-squared value, .59 and .58 respectively. With the number of commercial buildings, the highest r-squared value is quite weak at this scale, .28, obtained from the maximum values of choice at radius 1,000 metres against the number of commercial buildings. At the prominent town scale, this pattern is reverse. R-squared values of the maximum values of choice and integration against the number of buildings are slightly higher than those values of the maximum values of choice and integration against gross commercial areas. Thus, the effective radii expand to radius 1,000 and radius 1,500 metres instead of radius 600 ad radius 800 metres.

All these mean that there are relationships between the syntactic measurements and the socio-economic properties. It is most likely that the relationships are quite present at radii 600-1,000 metres. These trends are noticeable from both the 3-district and the prominent town scale. Why are these radii? To try to answer, another simple regression analysis was made between choice and integration at every studied radius. It was found that the r-squared values between them at these radii tend to be the highest among the other radii. This is interesting in a sense that it suggests that in this sub-region context road segments which accommodate both the through-movement (choice) and to-movement (integration), at both spatial scales, associate most with the socio-socio-economic properties. It is the spatial optimisation of the socio-economic properties to take the advantage from both purposes of movement one two spatial scales. More importantly, the fact that the patterns of effective radii were found for both the spatial scales studied suggests that these three prominent towns and their urban developments are autonomous, which also implies that these towns are internally focused on the one hand, and self-self-reliant on another.

The analyses by far have emphasised on the spatial-related variables of the existing socio-economic conditions. We could further ask whether there might also be any relationship between the syntactic variables and the non-spatial variables, to recheck the association of the syntactic measurements with both the spatial and non-spatial variables. To do so, an additional analysis on the non, or perhaps less, spatial-related variable was introduced. As previously described, poverty gap ratio was chosen as an example of this variable type. A poverty gap ratio is an average value calculated from the poverty gaps and average monthly income per person of the poor households of a municipality. The higher the ratio is, the poorer the population will be. Due to the data available at the municipality level, the analysis was carried out from the 3-district spatial model. Correlations between the poverty gap ratios and the average and maximum syntactic values at different radii of 25 municipalities were analysed.

It was found that there are two noticeable patterns between choice and integration against poverty gap ratio. For choice, the correlation is positive. The higher the choice value is, the higher the poverty gap ratio will be, with the average values of choice at radius N producing the highest r-squared value against poverty gap ratio at .4 (Figure 8). With integration, the correlation is negative. The higher the integration value is, the lower the poverty gap ratio will be, with the average values of integration at radius 60 Km. (almost at radius N) producing the highest r-squared value against poverty gap ratio at . 3(Figure 8).

Despite of the low r-squared values, the findings demonstrate that those municipalities with high average choice values but low average integration values tend to be occupied by poor people. A closer look at the scattergrams shows that there are two municipalities with very high poverty gap ratios but also having high choice values and low integration values. These two municipalities locates in the natural conservation area, i.e., national forest, with only some few main roads, being the foreground network segments and having high choice values, and a prohibition for settlement setting, having no secondary roads making up the background network. However, if the values of these two municipalities were excluded from the regression analysis, the r-squared values were very much lower in a way that could indicate to a non-association between the syntactic measurements and the poverty gap ratios.

Nevertheless, we could say that people are much better, i.e., less poor, in the municipalities with high spatial closeness, i.e., integration. The spatial accessibility should play some role to their earning capability. Due to the limited of the data available in this sub-region, this poverty gap ratio is the one non-spatial variable that could make possible for the analysis with the syntactic measurements. It is quite sufficiently suggestive that there should be more studies in this direction.

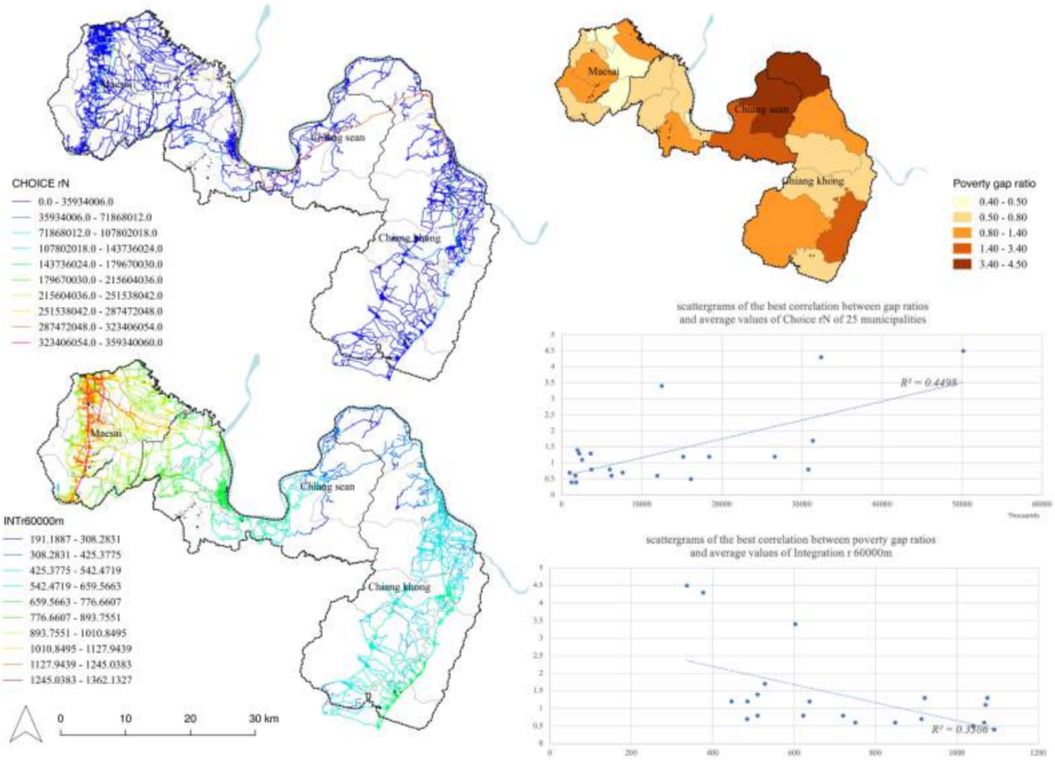

Figure 8: Displaying the choice and integration maps at radius n and 60 Km, the distribution poverty gap ratios, and scattergrams of the two best correlations

4. CONCLUSIONS

The study was set to apply the Space Syntax methodology to understand the existing spatial and socio-economic conditions in order to use the understandings to assess the comprehensive plan of the the sub-region, through which CHRSEZ is the studied area. Accordingly, the spatial structure of CHRSEZ can be identified from the foreground and background networks. The roads or road segments that make up these networks are also marked. The distances between two urban centres and the boundary distances of serving areas of a prominent centre, at 16 and 2 Km. respectively, are specified. More importantly, the relationships between spatial properties and socio-economic conditions can also be established. The socio-economic conditions take advantage of the space, i.e., road segments, to optimise their benefits from two movement types at both the regional and the town scale, particularly at radius 600-1,000 metres. However, this distance optimisation of spaces is of the more urbanised centres. For the less urbanised centres, the distance optimisation has yet to be established.

With these understandings, the next step is to try to assess the comprehensive plan, initially and initiatively the land-use plan, for instance. Figure 9 is the proposed land-use plan of the comprehensive plan of CHRSEZ. The land-use plan displays a number of urbanised centres and sub-centres, seen from their boundary areas of the residential and commercial land-use types — yellow and orange colours are residential land uses and red colour is commercial land use. This network of centres and sub-centres is well depicted by the centrality of closeness as previously presented. However, the land-use plan also shows that for the three prominent towns, Maesai, Chiang Saen and Chiang Khong, the boundary areas of the residential and commercial land-use types are extended far more than the central areas captured by the centrality of closeness. Of course, this is possible because they are planned for the future with a number of developments. However, the understanding of the serving boundaries and the radial optimisation of spaces are called to question this expansion of the central areas whether it is effective and sustainable. As for the number of sub-centres being allocated for the central areas' land uses, the question will be whether they are too eagerly promoted or cautiously controlled. Either cases, a further study is needed to identified their serving boundaries and radial optimisation of spaces. For both centres and sub-centres, carrying capacity and floor area ratio also need a further study.

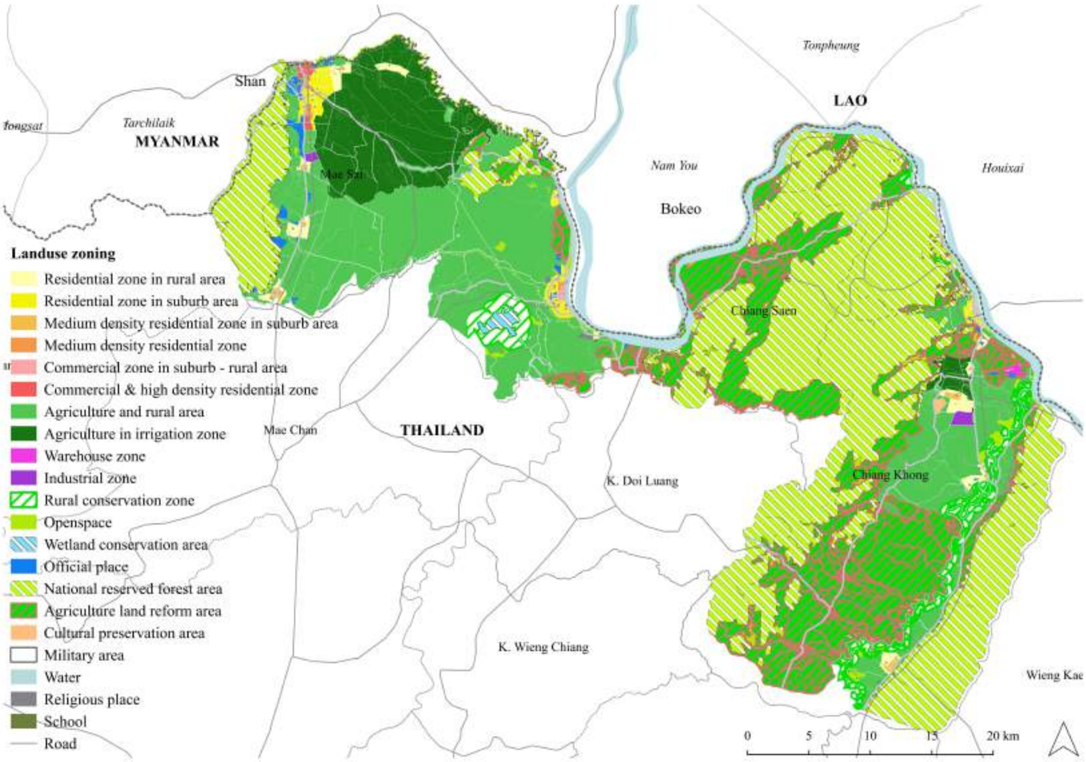

Figure 9: A proposed land-use plan of the comprehensive plan of the sub-region

The syntactic measurements could help intelligently presenting the existing conditions of the relationships between spatial and socio-economic properties. This leads to the capability to initially evaluate the land-use plan of the sub-region comprehensive plan. The abilities to mark the locational distribution of the centres and sub-centres and to approximate the distances of their central areas give rise to the capability to set the priority for town planning within the sub-region planning process. The distance optimisation of space can also help define the expansion of the central areas so that the land-use plan will be effective and sustainable for the future. Although several further studies are needed, by far the findings from the syntactic study are persuasive for the sub-region planning process.

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