The Relationship Between the Land and Buildings Tax Act, B.E. 2562 (A.D. 2019), and the Land Use and Land Cover (LULC) of Bangkok, Thailand

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ความสัมพันธ์ระหว่างพระราชบัญญัติภาษีที่ดินและสิ่งปลูกสร้าง พ.ศ. 2562 (ค.ศ. 2019) กับการใช้ประโยชน์ที่ดินและสิ่งคลุมดิน (LAND USE AND LAND COVER: LULC) ของกรุงเทพมหานคร ประเทศไทย

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พระราชบัญญัติภาษีที่ดินและสิ่งปลูกสร้าง พ.ศ. 2562 (ค.ศ. 2019) ได้ตราขึ้นในประเทศไทยโดยมุ่งหวังที่จะกระจายความมั่งคั่ง เพิ่มรายได้ และลดการใช้ประโชน์ที่ดินที่ไม่ก่อให้เกิดประโยชน์ แต่ทว่าตั้งแต่การบังคับใช้กฎหมายใน พ.ศ. 2563 ในพื้นที่กรุงเทพมหานครมีการเปลี่ยนแปลงการใช้ประโยชน์ที่ดินและสิ่งคลุมดิน (Land Use And Land Cover: LULC) จากที่ดินประเภทที่ว่างไปเป็นที่ดินเพื่อการเกษตรเกิดขึ้นอย่างเห็นได้ชัด การเปลี่ยนแปลงดังกล่าวถูกสันนิษฐานว่าเป็นกิจกรรมที่สัมพันธ์กับการหลบหลีกภาษี (tax avoidance) งานวิจัยนี้มีวัตถุประสงค์ในการสำรวจปรากฏการณ์การเปลี่ยนแปลงที่ดินประเภทที่ว่างไปเป็นที่ดินเพื่อการเกษตรในพื้นที่กรุงเทพมหานคร และทำการวิเคราะห์เชิงพื้นที่เพื่อระบุการเปลี่ยนแปลงการใช้ประโยชน์ที่ดินและสิ่งคลุมดิน

จากการทดสอบทางสถิติแบบ t-test และการสัมภาษณ์ผู้เชี่ยวชาญ งานวิจัยแสดงให้เห็นว่า การประกาศใช้กฎหมายภาษีที่ดินฉบับใหม่น่าจะส่งผลให้เกิดการเปลี่ยนแปลงการใช้ที่ดินในรูปแบบนี้ นอกจากนั้นข้อมูลการสำรวจระยะไกลและการวิเคราะห์เชิงพื้นที่ด้วยข้อมูลแผนที่การเปลี่ยนแปลงการใช้ประโยชน์ที่ดินและสิ่งคลุมดินจาก ESRI และข้อมูลภาพจาก Google ใน พศ. 2561 2562 2563 และ 2564 แสดงให้เห็นว่า (1) การเปลี่ยนแปลงการใช้ประโยชน์ที่ดินและสิ่งคลุมดินส่วนใหญ่เกิดขึ้นในพื้นที่ชานเมือง (2) การเปลี่ยนแปลงการใช้ประโยชน์ที่ดินและสิ่งคลุมดินที่คาดว่าเป็นการหลบหลีกภาษีเกาะกลุ่มกันในพื้นที่ชาญเมืองด้านตะวันออก แต่พื้นที่ใจกลางเมืองไม่ค่อยมีการเปลี่ยนแปลงเช่นนั้น และ (3) การเกาะกลุ่มของกิจกรรมที่คาดว่าเป็นการเลี่ยงภาษีแบบสูงและแบบต่ำมีความสัมพันธ์กัน

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James Anthony Orina : The Relationship Between the Land and Buildings Tax Act, B.E. 2562 (A.D. 2019), and the Land Use and Land Cover (LULC) of Bangkok, Thailand. Advisor: Assoc. Prof. Sutee Anantsuksomsri, Ph.D.

The Land and Buildings Tax Act, B.E. 2562 (A.D. 2019), was enacted in Thailand with the aim of wealth distribution, revenue increase, and discouraging unproductive land use. However, since its implementation in 2020, in Bangkok, a notable increase in land use and land cover (LULC) changes, specifically vacant lands being converted to agricultural lands, has been observed. These changes are hypothesized to be related to tax avoidance activities. This study aims to investigate the phenomenon of vacant-to-agricultural land conversions in Bangkok and employ spatial analysis techniques to identify and locate these LULC changes.

By employing a statistical t-test and conducting key informant interviews, this research shows that the implementation of the new property tax policy is likely contributing to these land use changes. Additionally, remote sensing and geospatial analyses are performed on ESRI LULC maps and Google platform images from 2018, 2019, 2020, and 2021, reveal that: (1) the majority of LULC changes and suspected tax avoidance activities occur in the urban fringes, (2) there is a clustering of suspected tax avoidance activities, particularly in the eastern fringe of the city, while the urban core exhibits minimal such activities, and (3) the clusters of high or low suspected tax avoidance activities demonstrate interrelatedness.

The employed research techniques and the results have implications for the administration of the new property tax policy, as well as for wealth redistribution, urban service provision, and peri-urban dynamics in the city. In addition, the study suggests the improvement of property tax management by providing specific guidelines accompanying the law and fostering the co-creation of urban services and infrastructure.

Field of Study: Urban Strategies		Student's Signature ....
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CHAPTER 1: INTRODUCTION

1.1. Land and Property Taxation

Monetary charges imposed by authoritative bodies on lands and properties, also known as land and property taxation, are considered to be one of the oldest taxation mechanisms (Bird & Slack, 2004). The finances raised through this make the provision of local services and benefits possible despite composing small percentages of national tax revenues (Bird & Slack, 2004; Laovakul, 2016). Although an important local revenue generation source, such impositions may have financial and non-financial impacts (Bird & Slack, 2004) on the persons or groups responsible for paying them, the environment and land itself, as well as other entities inhabiting these properties. Another defining characteristic of land and property tax is that it charges on wealth (which are value stocks), unlike other taxes which take percentages off incomes (flows of value) (Bird & Slack, 2004). Not to mention that the lands and properties that the taxes are based on are immovable assets that add to such a mechanism's reliability for raising local revenues (McCluskey et al., 2022). For these reasons, Kelly et al. (2020) mention that property taxes are able to capture the values created in specific areas that were beneficiaries of investments and services-provision efforts, aside from most likely being based on the owners' "ability to pay," given that these immobile assets are likely indicators of wealth. The introductory chapter by Bird and Slack in their book International Handbook of Land and Property Taxation from 2004 further outlines the supposed characteristics of land and property taxes, aside from the ones already discussed.

The first key characteristic according to Bird and Slack (2004) is that they are *visible* in the perspective of taxpayers, as they are paid personally by the juristic persons, not deducted at the source unlike income tax, and are paid in lump sum amounts- making them even more noticeable. Because of this, they cite that this feature increases accountability on the part of the authoritative bodies (usually local governments) to actually mobilize the revenue generated for local interventions that serve and benefit the public. Secondly, the lands and properties from which the taxes are grounded are *inelastic* or do not expand on their own over time. For the third one, land and property taxes are said to be *inherently arbitrary*, meaning that the value of land and properties are relative, and consequently the taxes that are charged from them. The fourth and last characteristic as per the handbook is that such taxation instrument is *reflectant of local autonomy* as its imposition, and associated activities would show who has the control over the tax's imposition, and generated revenue (Bird & Slack, 2004).

Delving deeper into the concept and related activities for the implementation of property taxes, the discussion now steers into the tax base or what asset is being taxed. The tax bases may vary between countries, and even localities, as some governments may demand contributions just based on lands or may even go to the extent of including buildings, as well as the applied improvements and renovations (Bird & Slack, 2004). To illustrate, according to McCluskey et al. (2022), it is common for low- to middle-income countries like Thailand to treat lands and buildings as separate bases, instead of just one taxable entity. This concept is important as it can be modified by policymakers in order to achieve certain desired outcomes. For example, in trying to incentivize property development, lands can be taxed at higher rates than buildings, which can convince owners to invest in establishing a structure on their lot. Another important facet of land and property taxation is the valuation of these assets, as they are the figures from which the tax payments are calculated and is, therefore, a crucial component of fairness (McCluskey et al., 2022). It was already mentioned earlier that these values are arbitrary (Bird & Slack, 2004) or subjective (McCluskey et al., 2022) and this is precisely because there are multiple factors and perspectives that can be considered in determining the monetary value of lands. These can include market factors like capital or rental values, or non-value factors such as the location of the assets, the size of lands and buildings, population density, and property use, among others (McCluskey et al., 2022).

Moreover, as one may know, taxation policies on lands and buildings are not just conceptualized but would have to be implemented. So, the subject of tax administration shall now be discussed. Bird and Slack (2004) divide the process into three phases: identification, correspondence, and collection. The identification stage includes determining the size and extent of taxable land or property, as well as assessing their values. In the correspondence stage, the relevant authoritative bodies would issue the results of their assessments to the respective land and building owners, whereas in some cases, the taxpayer may appeal if they do not agree with the initially resolved values. Once the asset value and taxes have been agreed upon, then collection can begin by issuing tax bills, accruing the imposed charges, and following up on arrears or unpaid tax dues outside of the set deadline.

However, just like any human system, taxation mechanisms on lands and property have imperfections and may pose some challenges and issues to implementers and taxpayers. For one, if the assessors of land and building values, which are usually from government agencies, look at market values then there might be some inaccuracies and unfairness with the derived tax values because of market distortions that might exist (Malaitham et al., 2020). Other challenges outlined by McCluskey et al. (2022) include insufficient tax bases, faulty taxation structures, difficulty in enforcing the policy (especially on the real estate sector), administrative issues, excessive tax exemptions, outdated assets valuation, and opposition by certain groups. These may result in low collection rates, an increased burden on taxpayers (Bird & Slack, 2004), the local funds needed not being raised on time, or the generated revenue to be misallocated.

1.1.1. Thai Lands and Property Taxation

Out of the 51.2 million hectares of land in the entirety of Thailand, only about a third, or approximately 14.4 million hectares are available for ownership (and consequently taxation). In 2012, there were around 15.9 million owners of land titles or locally known as *chanot* (Phongpaichit & Baker, 2016). Unsurprisingly, Phongpaichit and Baker (2016) found that there is an extremely high concentration of these land ownerships in Bangkok, and Central Thailand with a Gini coefficient of 0.92. This then justifies the focus of this study to be in the capital city as much of the taxable lands are within its boundaries. Further analyses that they conducted indicate that the top 10% of the owners possess around 61.48% of all available land while the bottom 10% own only 0.07%. The high inequality in land ownership was attributed to the lack of provisions for public goods and services such as quality education, transport facilities, and elderly care (Phongpaichit & Baker, 2016). Even so, it would be revealed by later discussion that Thailand not only experiences high inequality in land ownership but also inequities in its existing land-value capture mechanisms.

A common perception is that disproportionate amounts of revenue from land and property taxes can be collected in large urban areas (Bird & Slack, 2004; McCluskey et al., 2022). These yields are well justified since such localities need these funds even more in order to properly deliver the services and infrastructure needed for these places to function (McCluskey et al., 2022). For the year 1997, the former buildings and land tax in Thailand accounted for 80% of taxes raised locally, and it generated 9.7% of the total tax revenues (Bird & Slack, 2004). Despite this, Ratanawaraha (2010), as cited by Anantsuksomsri and Tontisirin (2015), perceives that Thailand is lacking effective land-value capturing policies. True enough, property and land taxes are not the main sources of local revenue in the country, and instead come mostly from property transaction fees, which are only collected once such assets are sold (Anantsuksomsri & Tontisirin, 2015). This then compromises the stability and certainty of local revenues. Moreover, the benefits of investments that are borne out of the generated tax funds are not properly distributed to all the taxpaying public. As Anantsuksomsri and Tontisirin (2015) found in their study, it is mainly the landowners of properties near the public investments that reap the projects' benefits, raising their asset values and easily accessing the provided infrastructure or services. Meanwhile, all the other taxpayers whose properties are farther from these provisions continue to pay their dues without the same benefits. Amendments to the said system are also hard to lobby as majority of the political servants in Thailand's House of Representatives are huge property owners (Anantsuksomsri & Tontisirin, 2015).

1.1.2. The Land and Buildings Tax Act, B.E. 2562 (A.D. 2019)

Ratified on the 9th of March 2019, Thailand's *Land and Buildings Tax Act, B.E. 2562 (2019)* was envisioned to increase the "orderliness and efficiency" of collecting taxes from lands and buildings in hopes of helping boost the economy of the entire country. With the collection cycle starting on the very first day of the following year, the new property taxation policy replaced all previous legislation. The main administrating bodies of this act are the Ministries of Finance and Interior. Here are some major provisions of the new policy. The following land types or characteristics are deemed to be exempted from taxes: (1) public lands, (2) agricultural lands not worth over 50 million baht, (3) residential lands or buildings not worth over 50 million baht, (4) residential building (particularly condominium units) not worth more than 10 million baht, (5) individual owners of agricultural land are exempt from paying from 2020-2023. It should be noted that the policy especially defined agricultural lands to be, "rice farming, crop farming, plantation, livestock farming, aquatic animal farming, and other undertakings," while no other LULC typologies were explicitly defined (State, 2019).

Furthermore, local tax committees can make modifications to the policy with the approval of the administrating Ministries. The law also specifies that taxpayers must cooperate with the land value assessments and may appeal if they do not agree with the government-released values. If the need arises, the taxes may be reduced by a royal decree, or upon request of the landowners if the land or building has been deteriorated or seriously damaged. When it comes to payment, landowners have the option to pay the due amount in whole or in equally divided installments. The taxes that are not paid in time would then be regarded as arrears, and if still left unpaid after 90 days, the assets can be subject to "seizure, attachment, and auction sale" (State, 2019).

The policy assigned a two-year transitionary period from the first collection cycle with lower tax rates to ease in the implementation of the new guidelines and the rates are as follows:

Table 1 Transitionary Tax Rates for Different LULC Types (Adapted from Tachai, 2022)

Property Type	**Appraisal Value (in million Baht)**	**Tax Rate (%)**
Commercial	0-50	0.3
	50-200	0.4
	200-1000	0.5
	1000-5000	0.6
	>5000	0.7
Unused/Vacant	0-50	0.3
	50-200	0.4
	200-1000	0.5
	1000-5000	0.6
	>5000	0.7
Residential	0-50	0.02
	50-75	0.03
	75-100	0.05
	>100	0.1
Agricultural	0-75	0.01
	75-100	0.03
	100-500	0.05
	500-1000	0.07
	>1000	0.1

Once the adjustment phase is over, the following rates will be used.

Table 2 Maximum Values of Regular Tax Rates (Adapted from Medina, 2021)

Property Type	Maximum Tax Rates (%)
Commercial	1.2
Unused/Vacant	1.2
Residential	0.3
Agricultural	0.15

Even if it is not explicitly stated in the legislative document, it can be inferred that some of the goals of the newly-released policy are the economic rent capture on commercial space owners, and perhaps more importantly, the disincentivization of idle land inside the city in favor of residential and agricultural land use (Batt, 2020; Medina, 2021). However, because of the more comprehensive tax base, updated valuation mechanisms, and higher tax rates (especially for vacant lands), there might be some tax avoidance activities that have been arising in order for landowners to minimize charges on their assets.

1.2. Land Use and Land Cover Changes

Once humanity shifted from being hunter-gatherers into agriculturists, through a good grasp of fire and the domestication of certain flora and fauna, the surface of the Earth saw rapid and drastic changes. Globally, croplands and urban areas have been expanding with the consequent decline in forests, steppes, savannas, and grasslands (Lambin et al., 2003). Studying these biophysical characteristics of the earth, how they interact with humans, as well as how they change over time given these relations is not entirely new and has drawn attention from academics in different portions of history. These actual biophysical features are referred to as *land cover* while the functions assigned to these features or how they are altered by anthropogenic activities are considered to be *land use* (Moran et al., 2012). Meyer and Turner (1996) even add that land uses are the ways in which land resources are extracted to meet human demands. It is also described to be ever dynamic as a result of the varying interactions between drivers of land use change and the feedback that these instigated changes send to these same drivers (Lambin et al., 2003).

Changes in these human-assigned purposes of land are mostly spatial in nature and are composed of interactions between various smaller-scale changes. They are said to be induced by either *proximate* or *underlying causes*. The former pertains to the more direct prompts to land use change, which are mainly anthropogenic and local in nature. The latter, on the other hand, refers to the more indirect reasons for land use change that are operating more remotely from the site of changes. Some examples of these underlying causes include larger social, political, demographic, technological, cultural, biophysical, and economic factors (such as taxation policies) (Lambin et al., 2003). These land use changes are then considered to bring about most land cover changes, either through complete conversion from one condition to another or by means of modifying certain features. It should be noted though, that land cover may remain static despite its use being modified, and that there are other variables that can instigate land cover changes such as weather and climatic conditions, ecological succession, and volcanic eruptions, among others (Meyer & Turner, 1996). In the end, the land use and land cover transformations may be perceived through different lenses such as being the result of smaller individual decisions and actions (agents-based), a complex and overlapping interaction of different drivers and entities (systems), or as a product of the aggregated past events and modifications (historical) (Lambin et al., 2003).

1.2.1. Bangkok's LULC Changes

From being a forested area, into being an agricultural plain of canals and rice paddies, Bangkok has come a long way to become the gargantuan urban agglomeration that it is now (Molle, 2005). This rapid and large-scale urban expansion has been found to be related to the loss of vegetative cover in the city, which also means there has been a decline in carbon sinks in the area (Ali et al., 2018), continuous degradation of air quality (Chalermpong et al., 2021), and intensification of the urban heat island phenomenon (Adulkongkaew et al., 2020; Ali et al., 2018; Bonafoni & Keeratikasikorn, 2018; Chayapong, 2010; Chayapong & Dasananda, 2013; Kamchiangta & Dhakal, 2020, 2021; Ongsomwang et al., 2018; Srivanit et al., 2012). To illustrate, Kamchiangta and Dhakal (2020) found that just within the 25-year gap between 1991 and 2016, the urban areas in Bangkok increased by almost 25%, whereas all the other LULC classes in their study decreased in area percentages. Much of these conversions are said to be from agricultural LULC classes into urban, and such expansion of built-up areas is projected to continue even in the year 2035 (Losiri et al., 2016). Lastly, these said expansions were found to be emanating from the city capital's urban core, major roads, and smaller emerging cores (Murayama et al., 2015).

1.3. Study Area: The City of Bangkok

Located in the southern portion of the Chao Phraya River delta, Bangkok is the capital city of Thailand. Its administrative boundaries, which are more formally known as the Bangkok Metropolitan Administration (BMA), enclose an area of 1570 sq. km. Within this highly urbanized megalopolis resides around 9 million people according to a 2016 government census. Given such designation, the city is also the political and economic center of the country, housing the grand palace and the main offices of multiple government agencies, as well as yielding approximately 5 million Thai Baht for its gross provincial product in 2016. As already discussed, it is also the place with the highest concentration of land ownerships in the entire kingdom, while at the same time, experiencing high LULC dynamics throughout the recent years (Kamchiangta & Dhakal, 2020). These characteristics show the significance of Bangkok as a city, and for these reasons, the city-capital has been selected as the study area of this research. Figure 1 shows the designated study site outlined around the bounds of the BMA.

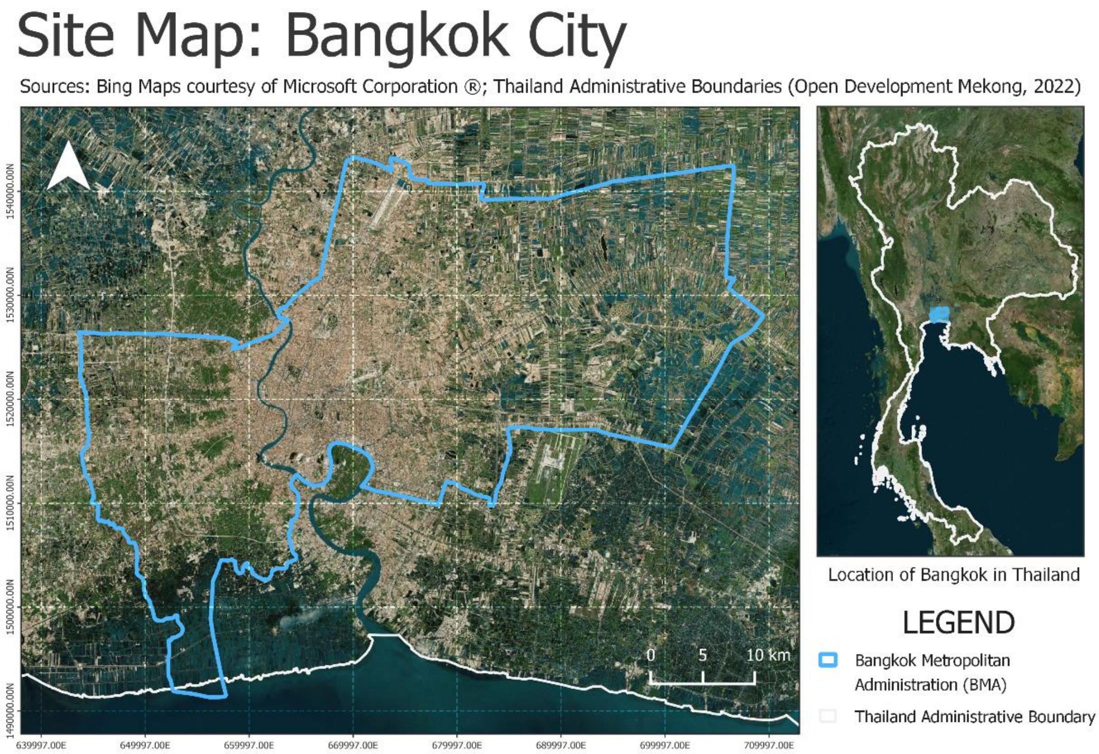


Figure 1 The Study Area within BMA

1.4. Linkages Between Land and Property Taxation, and LULC

Citing the work of Geist and Lambin (albeit from different years) both Osoro (2020) and Redo et al. (2012) mention how politico-economic policies, which include property taxes, influence the majority of LULC changes and this is truer in the context of urban areas (Bird & Slack, 2004). They can restrain particular forms of land use (Redo et al., 2012), as well as affect the density of areas by varying rates and tax bases (Bird & Slack, 2004). As demonstrated earlier, tax structures on different land typologies may encourage or disincentivize certain LULC classes. For example, in the case of the identified study area of Bangkok, it has been noted by Tachai in their 2022 conference paper that numerous land plots in the city have been converted to agricultural uses as a result of the new land and property tax policy enacted by the national government (Tachai, 2022). This can be illustrated by the following cases.

The first example is a land plot owned by the Impact Arena Exhibition and Convention Center in Muang Thong Thani, which is just right outside the northern bounds of BMA.

Figure 2 LULC Conversion in Impact Arena Exhibition and Convention Center Land

The images featured in Figure 2 were inscribed in a recent Facebook post by the mentioned landowner, describing how the 50 rai (8-hectare) parcel used to be vacant land but was recently converted into a banana plantation for the company's sustainability initiatives (IMPACT Arena, 2022). However, the abruptness and timing of the land use conversion raises suspicion whether the sole purpose of these changes are for sustainability or could they possibly be tax avoidance activities, given that agricultural lands have significantly lower tax rates than vacant lands. Furthermore, such activities are not isolated and not just done by large corporations. As the Google Street View images in Figure 3 below would demonstrate, smaller private land owners also seem to implement the same tactics of converting their unused lands into agricultural purposes.

Figure 3 LULC Conversion of Small Land Plot (From top to bottom: 2019, 2020, and 2022)

The parcel of land seen in Figure 3 is located in Prawet District, Bangkok. The top-most image was taken in 2019 (Google, 2019a), when the new property taxation was just signed into law, and one can see how there is just random vegetative growth in the area. Then in 2020 (middle image) (Google, 2020b), when the policy is already effective, the vegetation was cleared to make way for what seems to be a cotton fruit plantation in 2022 (bottom-most image) (Google, 2022).

These cases are just some of the observable changes in the LULC of Bangkok since the implementation of the new property taxation policy. This just shows the possible relationship of economic fiscal mechanisms to LULC changes, especially on incentivizing certain LULC types. They also bring into light possible tax avoidance activities happening in the city as a response to the newly enacted law.

1.5. Problem Statement and Research Objectives

Because of the issues that were mentioned in the previous sections, there is a need to explore the phenomenon of land and property tax avoidance in Bangkok using LULC change detection techniques. To do this, the following objectives were identified:

1. To explore the LULC changes of vacant lands in Bangkok, which may signal tax avoidance activities, and
2. To perform spatial analysis on the conversion of vacant lands into agricultural lands.

1.6. Purpose of the Study

In the context of these research problems and intents, the following questions were formulated.

1. Do the LULC conversions of vacant lands to agricultural lands in Bangkok correspond to tax avoidance activities of landowners?
2. Where are the clusters of these vacant-agriculture LULC conversions situated in the city?

As an attempt to answer these questions, it is hypothesized that,

1. The conversion of vacant lands into agricultural purposes in Bangkok corresponds to tax avoidance of landowners.
2. The clusters of these specific types of LULC conversions are situated in the fringes of Bangkok.

1.7. Significance of the Study

So far, there are not many full-length studies done on the new land and property taxation law in Thailand, its related tax avoidance activities, or even its relation to the LULC of Bangkok. Meanwhile, most of the LULC-related remote sensing studies in the said city relate their findings to the urban environment or investigate the city's urban form. This study then seeks to investigate the land and property tax avoidance activities (considering the new policy) in the city by looking at the LULC changes that may signal them. The research would then feature indirect causes of LULC changes, focusing on politico-economic mechanisms, instead of the more direct environmental parameters that have been extensively studied. Such inquiry would also be important as Bangkok, being the capital, bears the highest political and economic significance of any city in the country, and is even recorded to have the highest concentration of land ownership. In the end, the processes employed in the research will produce land cover change detection maps, apart from the quantitative LULC change metrics that have been produced by other studies. Moreover, the study can provide reliable methods to detect tax avoidance activities and formulate some recommendations in order to reduce them. Finally, after its completion, the research may also be a basis for further studies on Thailand's novel property taxation law, as well as urban land management.

1.8. Research Framework

The research will focus only on the relationship between Thailand's newly enacted law on the LULC of Bangkok (specifically within the administrative bounds of Bangkok Metropolitan Administration or BMA outlined in Figure 1), and no other city or municipality in the country. Furthermore, any other law would not be concentrated on throughout the course of the study. Alternative factors that may have a relationship with the LULC of the study area would also not be covered. In the same manner, no other forms of tax avoidance shall be investigated aside from deliberate LULC change for lower rates. On the other hand, the LULC change detection would be done on Sentinel-2-based LULC maps produced by ESRI from the years 2018, 2019, 2020, and 2021. The LULC classes that are to be considered would be the ones in the sourced maps, namely water, trees, flooded vegetation, crops, built area, bare ground, clouds, and rangeland. The snow/ice class was omitted as they are irrelevant to the context of the tropical study area. It should be noted that the study would implement both remote and on-site data triangulation methods to confirm the accuracy of the results. These include the use of Google Earth Pro, Google Street View, Normalized Difference Vegetation Index (NDVI) time-series data, as well as random site visits.

CHAPTER 2: LITERATURE REVIEWS

2.1. Thailand's New Land and Buildings Taxation Policy and Tax Avoidance

Because of its relative novelty, it is no surprise that there are but a few studies centered on the L*and and Buildings Tax Act, B.E. 2562 (2019)*. However, even when it was just a bill, research has already been done on the said policy. Laovakul (2016) sought to compare the then proposed land and property tax reform to the existing policy, namely the Land and Housing Tax Act, B.E. 2475 (A.D. 1932) and the Local Maintenance Property Tax, B.E. 2508 (1965). The study then concluded that the (currently effective) new policy on land property taxes is overall fairer, has more reasonable rates, and includes broader collections than the previous taxation mechanisms. They also projected that the new law would promote fiscal decentralization and local accountability.

At the time after the new property tax has been signed and put into effect, there are two studies found in this research. The first one was performed by Limteerakul in 2020, wherein they investigated the possible impacts of the new policy on income inequality at a national level. Utilizing Shorrock's index decomposition, it was found that the current taxation policy can generate more local revenue and, at the same time, decrease inequality. On the other hand, varying in scale and objectives is the paper by Tachai (2022). Through the employment of the analytical hierarchy process, the study found the most preferred urban agriculture activities in Bangkok and formulated guidelines on how they can be implemented as a form of response to minimize charges from the new property tax rates (Tachai, 2022). In light of this, the literature related to property tax avoidance shall be discussed.

Generally, there have not been a lot of studies done on the subject of property tax avoidance. In fact, no literature was found at all in the context of Thailand. One of the research projects found is in Indonesia, conducted by Turyatini in 2017. They were trying to look into the determinants of tax avoidance activities by real estate companies all over the country and found through a multiple regression model that a company's leverage and size have significant effects on tax avoidance. The other piece was done by Jones (2020) in the United States, citing loss aversion as the main driver of property tax avoidance activities. Moreover, it was found that property owners tend to look at the *lagged salient values* of their properties (or the values from previous years), prompting these behaviors of trying to minimize their tax bases because of outdated ideations of their property's value.

Overall, it can be observed from the literature on Thailand's new taxation policy that they support the implementation of the new law given its benefits to the public, and how it presents opportunities for positive changes locally and nationally. However, there are not any studies done yet on the possible tax avoidance activities that it may be instigating, how they are related to LULC changes, and how they can be detected by authorities.

Even so, the World Bank released a *Property Tax Diagnostic Manual* in 2020 to serve as a guide in identifying the state of property taxation in different contexts around the world, and provided some action points on how the assessed issues may be addressed. A key insight they provided as a background in property tax implementation is, "When people perceive this connection between taxation and services, they are willing to pay their property taxes." Kelly et al. (2020) also presented an elaborate framework in property tax diagnostics by outlining specific steps and accompanying methods and strategies in each portion of the procedure they suggested. Finally, they provided numerous case studies for readers and practitioners to learn and adopt good practices from. To end, despite the limitation in studies regarding Thailand's new property taxation policy, and the related behaviors in response to it, there are a number of resources internationally that can be consulted to serve as background information on the phenomenon of interest in the study (Kelly et al., 2020).

2.2. Studies on the LULC of Bangkok

Remote sensing via satellite imagery data is one of the most widely used methodologies in LULC mapping and change detection research, especially in Bangkok, and Murayama et al. (2015) site that such techniques are very efficient. Most of the remote-sensing studies found in the said city/region have been done in the past two decades, and are about urban form, as well as applications to environmental sciences. More specifically, the relationship of LULC to the urban heat island (UHI) phenomenon has been extensively featured in these studies. This portion of the study would then focus on assessing the methodologies that were used by the LULC mapping and change detection studies in Bangkok in finding a suitable methodology for a more politicoeconomically inclined study relating LULC changes and the new property taxation policy in Thailand.

2.2.1. A Discussion on Studies Featuring the LULC of Bangkok

2.2.1.1. The Early Years

Very much ahead of its time, the earliest satellite remote-sensing study that could be found on the land use and land cover (LULC) changes in the city of Bangkok, Thailand, was done by Madhavan et al. in 2001. They were trying to track the LULC change dynamics as the Bangkok Metropolitan Area (BMA) was expanding in the years 1988 until 1994 using the vegetation-impervious-soil model. In the process, a classification of the different LULC classes was done, first through the Iterative Self-Organizing Data Analysis Technique (ISODATA), to obtain the LULC types (which were commercial, residential, vegetation, open land, and water bodies), and then through a supervised classification using the maximum likelihood algorithm. Next, for detecting the changes in land features that occurred, the matrix multiplication model of the Earth Resources Data Analysis System (also known as ERDAS) was utilized, identifying noticeable shifts from residential areas to commercial ones, and vegetated lands into residential spaces. No formal accuracy assessment was done for this study, but it is said that a general agreement of the produced maps with JICA-commissioned maps and ground data was achieved (Madhavan et al., 2001). Their results include the conversion of significant tracts of land from residential to commercial use, as well as vegetated areas into residential land uses. It is not until almost a decade later that satellite images would be used again for remote-sensing studies in Bangkok.

The succeeding studies vary a lot in terms of scope and methodology but unite in that they discuss land use patterns and they do not make use of photographs taken from outer space. Murakami et al. (2005)'s research made use of prefabricated land use maps from government agencies to find out urbanization trends in Southeast Asian megacities via the Clark and Newling models. Meanwhile, the study of Hara et al in the same year focused on a specifically delineated area in the southern fringe of Bangkok. Their data sources were aerial photographs that were verified through field surveys. With in-situ data and observations to back them up, Hara et al. (2005) identified eleven (11) land use classes, which are all based on man-made structures and functionalities, as compared to only three (3) by Murakami et al. The more narrowed down, and context-specific study by Hara and company found that elevation and the agricultural past of Bangkok affected the land use of the study area at that time (Hara et al., 2005). On the other hand, the comparative study by Murakami et al. identified belts of mixed land uses in Jakarta and Manila while a full belt was not found in Bangkok because of a protected green zone. They recommended controlling these unbalanced mixtures of land uses as they were said to be causing environmental and health problems (Murakami et al., 2005).

2.2.1.2. Extensive Application on Environmental Studies

The next decade of research featuring the LULC of Bangkok shifted their foci from the urban form into applications in the field of environmental science. Particularly, studies that explore the relationship between the UHI phenomenon and LULC dominated the academic scene. To illustrate, out of the sixteen (16) papers reviewed in this study, 8 focused on UHI-LULC relations, all of which make use of remote-sensing methodologies to extract the LULC (and their changes) as well as the surface temperatures in the area of interest. It should also be pointed out that these articles' study years are mainly in the 90s and the early years of the 21st century, despite having varying intervals between the years of interest. Additionally, the extent of study areas also varies as some consider just the administrative boundaries of Bangkok city (also usually referred to as Bangkok Metropolitan Administration or BMA) (Adulkongkaew et al., 2020; Ali et al., 2018; Bonafoni & Keeratikasikorn, 2018; Kamchiangta & Dhakal, 2020, 2021; Murakami et al., 2005; Srivanit et al., 2012)while some consider the surrounding provinces of Bangkok that are considered to be part of the Bangkok Metropolitan Region (BMR) (Chalermpong et al., 2021; Chayapong, 2010; Losiri et al., 2016; Murayama et al., 2015; Ongsomwang et al., 2018; Thanapet & Kung, 2015).

Starting with research done by Chayapong in 2010, they gathered satellite images from Landsat, commissioned by the United States Geological Survey (USGS). Similar to Madhavan et al. (2001), Chayapong first performed unsupervised classification of the obtained images through ISODATA before performing supervised classification by maximum likelihood algorithm. After this piece, the succeeding studies do not perform unsupervised classification to obtain LULC classes and instead proceed on identifying the LULC types they would use in their respective research, all the while citing previous studies and their objectives to justify such choices. Going back to Chayapong's study, after classifying the scene pixels into urban/built-up, vegetation, bare land, and water bodies, and checking with verified LULC maps, it was revealed that there is a rapid increase of urban areas in the region along with a continuous decline in vegetated land. This was also found to be correlated with the observed increase in surface temperatures in these same areas of LULC conversion. To further expand the study, the researcher also assessed the impact of these phenomena on electric consumption, and once again found a strong positive linear correlation between the rising temperatures and urban expansion (Chayapong, 2010).

Majority of the succeeding studies implement similar methodologies, and yield similar results: there is a continuous increase in urban areas in Bangkok while the vegetative areas are decreasing at the same time, and these are all associated with the intensification of the UHI phenomenon (Adulkongkaew et al., 2020; Ali et al., 2018; Bonafoni & Keeratikasikorn, 2018; Chayapong, 2010; Chayapong & Dasananda, 2013; Kamchiangta & Dhakal, 2020, 2021; Ongsomwang et al., 2018). However, some unique observations and insights include: the conversion of green areas to built-up cover is happening in the transport corridors of the city (Srivanit et al., 2012), land surface temperature peaks have expanded from just the urban core into larger areas of central Bangkok (Chayapong & Dasananda, 2013), the urban density growth of the city can be represented by an s-curve, daytime UHI intensity is higher during the day than at night (Bonafoni & Keeratikasikorn, 2018), there is a need for the optimization of land developments in order to manage LST in cities

(Adulkongkaew et al., 2020), and strengthen the green zone protection strategies of Bangkok to restrict urban expansion and the associated heating (Kamchiangta & Dhakal, 2021).

Despite the general correspondence in the methodologies, there are diversions and developments in the study of LULC-UHI relations in Bangkok. For one, Adulkongkaew et al. (2020) distinguished "above green" and "below green" vegetative covers to account for the differences that canopy and sub-canopy plants respectively have in relation to LST. More than this, they opted to use the minimum distance algorithm (instead of maximum likelihood) in their supervised classification of LULC, which yielded relatively good results for their maps as they achieved accuracies all above ninety percent. Also deviating from the widely used correlation analysis for UHI and LULC relations, they implemented a one-way analysis of variance (ANOVA) in order to form inferences on the associations between the said variables (Adulkongkaew et al., 2020). Another novel methodology implemented in a related study was done by Kamchiangta and Dhakal in their 2020 study as they performed hotspots and cool spots analysis of LULC changes and LST signatures. They were then able to pinpoint that the extreme western and eastern areas of BMA registered lower LST signatures, which are also the lands that are still dominated by vegetation (Kamchiangta & Dhakal, 2020).

Further extending the boundaries of research on the UHI phenomenon and the LULC in Bangkok, some researchers ventured into modelling such phenomena in the hopes of predicting future scenarios. In a study published in 2018, Ongsomwang et al. implemented the Single Channel Method in order to model UHI and urban expansion in Bangkok. The years 2024 to 2026 were predicted to be critically severe in terms of UHI intensity. Moreover, they were able to observe how the increasing trend of UHI intensity is happening more on urban expansion areas and not the city's core anymore (Ongsomwang et al., 2018). Another modelling study was done by Kamchiangta and Dhakal recently in 2021. After performing the usual LULC classification, they built the Spatial Logistic Regression (SLR) model, which integrated existing urban features in the predictions for future urban expansion. They foresee that the green areas in the western part of the city that have been providing cooling benefits would be affected by urban expansion, and consequentially experience warming (Kamchiangta & Dhakal, 2021).

Other LULC studies in Bangkok that were applied to environmental sciences would be for carbon sinks assessment in the city, as well as assessing daily particulate matter concentrations in the expanded area of BMR. The research on the city's carbon sinks was performed by Ali et al. (2018), wherein LULC mapping and change detection were used to validate the existence of carbon sinks inscribed only in statistical data at that time. Despite its difference in research focus from the previously featured papers, Ali, among the other researchers, pointed out that there is a significant loss of vegetation in the cities as they are being replaced by urban areas (Ali et al., 2018). On the other hand, Chalermpong et al. (2021) made use of the land use maps produced by Thailand's Land Development Department (LDD) as input into land use regression models that would reveal the daily particulate matter (specifically PM 2.5) concentrations in the capital region.

2.2.1.3. Continuous LULC Dynamics Research

Even with the predominance of LULC research centered on environmental applications in Bangkok, studies that focus on urban form and LULC dynamics never depleted throughout the years. For example, Murayama et al. (2015), aside from providing comprehensive and extensive discussions on remote-sensing methodologies and LULC dynamics, found that the city of Bangkok has the most built-up density among the megacities of Southeast Asia, and is experiencing urban sprawl and infilling at the same time. Using similar data to Charlempong et al. (2021), Thanapet and Kung (2015) also used LULC maps from LDD to model landscape diversity, where they were able to observe that the city's landscape increased in complexity throughout the study years and that they are generally dissimilar and unpredictable because of improper zoning boundary defining, several adaptation patterns, and data limitations. Finally, Losiri et al. in their 2016 study, utilized the Cellular Automata-Markov Chain and Multi-Layer Perceptron-Markov

Chain methods to model urban expansions, apart from the usual LULC mapping and change detection methodologies. They found that the main change in LULC in the city was from agriculture to urban classes, and they project that the built-up class would dominate the BMA landscape by 2035 (Losiri et al., 2016).

2.2.2. Summary of Discussions on Bangkok's LULC

In order to encapsulate the discussions from the previous sections, Figure 4 is provided below.

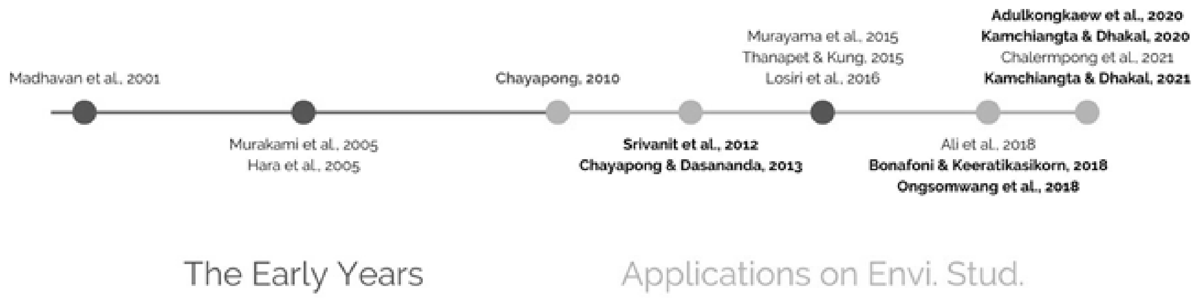


Figure 4 A Timeline of Studies Relating to the Land Use and Land Cover Changes in Bangkok

As mentioned earlier, and as illustrated in Figure 4, the studies that feature the LULC changes in Bangkok can be divided into two groups and periods. The first one, marked in dark circles and lines, includes studies that investigated the urban form of the capital city and were done mostly in the first decade of the 21st century up until 2016. The second group of studies, illustrated in lighter circles and lines, made use of LULC mapping and change detection techniques for applications to environmental studies. All of this work was done in the past decade, starting from Chayapong in 2010, and half of them are on the UHI phenomenon (the authors of which are in bold text in Figure 3). Featuring a combination of different methodologies, the studies progressed from using on-the-ground inspection and aerial photography to solely relying on satellite images because of their increased reliability, accuracy, and efficiency. The focus of the inquiries also evolved from just detecting the LULC changes in Bangkok, to relating them to environmental phenomena in the city/region, and eventually predicting future scenarios.

2.2.3. Conclusion

In essence, this portion of the review found that academic research surrounding the topic of LULC in Bangkok mainly utilize remote-sensing techniques via satellite images, as well as digital software to aid LULC mapping through supervised classification by use of the maximum likelihood algorithm. Thus far, the studies on the LULC of Bangkok are centered on urban and environmental studies applications. So, having one relating to politico-economics is well warranted, especially in exploring the relations of the new land and property taxation policies of Thailand (Land and Buildings Tax Act, B.E. 2562) on the capital city's LULC through the aforementioned methodologies. To add, there are also few studies found on the newly ratified law except one performed by Limteerakul in 2021 to assess its impacts on income inequality for the entire country. For this reason, there is a need to explore more of the possible changes that were or are being instigated by the said legislation, especially in one, if not the most economically and politically significant city in Thailand.

2.3. LULC Change Detection

One of the objectives of this study is the detection of specific fine-scale LULC changes. So, this part of the literature review shall focus on identifying these changes via remote sensing and GIS. It is then revealed through the inquiry of numerous studies that first, comparing the overall area and percent coverages of LULC classes is standard for studies of this nature (Bagwan & Gavali, 2021; Butt et al., 2015; Chugtai et al., 2021; Das & Angadi, 2021; Kafi et al., 2014; Nurda et al., 2020; Puttinaovarat et al., 2021; Saini et al., 2019; Shah & Kiran, 2021; Tian et al., 2014; Vivekananda et al., 2020). In order to further deepen the insight on the quantitatively determined land transformations, some studies used cross-tabulation to know the from-to LULC conversions (Bagwan & Gavali, 2021; Butt et al., 2015; Chugtai et al., 2021; Das & Angadi, 2021; Kafi et al., 2014; Tian et al., 2014). However, only a considerably few studies have sought to visualize the quantitative changes and employed image overlay analysis (Butt et al., 2015; Das & Angadi, 2021; Saini et al., 2019).

2.4. Relating Taxation Policies and LULC Changes

Similar to the preceding section, there is also limited research on relating taxation policies to LULC changes. This may be because economic fiscal mechanisms such as taxes can be considered as indirect causes to LULC conversions, making it challenging to observe and form connections. With a similar research question to this thesis, Redo et al. (2012) explored the possible relationship of several taxation policies on the land transformations that occurred in Uruguay. They made use of logical confirmatory tests to arrive at conclusions, wherein the LULC conversions must coincide with the timeline of the laws' implementation, the intended LULC changes of the laws, as well as the planned trajectory of land transformations. In the end, their results showed that both local and international tax mechanisms affect the LULC changes in the country (Redo et al., 2012). Another body of research found with similar objectives is the study of Osoro in 2012. In order to find the relationship of anthropogenic mechanisms to land transformation, they performed t-tests on the LULC percent cover differences from the different study years, conducted key informant interviews, and went on a field survey. Confirming Osoro's hypothesis, positive relationships were found between the human-induced systems and activities and the LULC changes that were detected in the locality of interest. Given their soundness, it can be said that a combination of both these research procedures would prove to be useful in determining the relationship between the new property taxation policy in Thailand and the land transformations that have been occurring in Bangkok.

CHAPTER 3: METHODOLOGY

3.1. Data Collection and Preprocessing

Remote-sensing and Geographical Information Systems (GIS) would be mainly used in the conduct of the study. Prefabricated LULC maps from ESRI, which are classified out of 10-meter resolution Sentinel-2 data, would be used for better data accuracy, and to allow for detection of changes that happened in finer spatial scales. These images were processed using the producer company's Impact Observatory Deep-learning AI, trained using human-labeled image pixels developed by the United States National Geographic Society (Kontgis, 2022). As for the time frame the maps would be taken from, it would be annually for two (2) years before and after the implementation of the taxation policy of interest (Osoro, 2020; Redo et al., 2012). This means that the images that are to be considered in the study are within the years 2018 to 2021.

Table 3 LULC Classes Definition (Kontgis, 2022)

Class No.	**Class Name**	**Description**
1	Water	Areas where water was predominantly present throughout the year; may not cover areas with sporadic or ephemeral water; contains little to no sparse vegetation, no rock outcrop nor built up features like docks; examples: rivers, ponds, lakes, oceans, flooded salt plains.
2	Trees	Any significant clustering of tall (~15 feet or higher) dense vegetation, typically with a closed or dense canopy; examples: wooded vegetation, clusters of dense tall vegetation within savannas, plantations, swamp or mangroves (dense/tall vegetation with ephemeral water or canopy too thick to detect water underneath).
4	Flooded Vegetation	Areas of any type of vegetation with obvious intermixing of water throughout a majority of the year; seasonally flooded area that is a mix of grass/shrub/trees/bare ground; examples: flooded mangroves, emergent vegetation, rice paddies and other heavily irrigated and inundated agriculture.
5	Crops	Human planted/plotted cereals, grasses, and crops not at tree height; examples: corn, wheat, soy, fallow plots of structured land.
7	Built Area	Human made structures; major road and rail networks; large homogenous impervious surfaces including parking structures, office buildings and residential housing; examples: houses, dense villages / towns / cities, paved roads, asphalt.
8	Bare Ground	Areas of rock or soil with very sparse to no vegetation for the entire year; large areas of sand and deserts with no to little vegetation; examples: exposed rock or soil, desert and sand dunes, dry salt flats/pans, dried lake beds, mines.
9	Snow/Ice	Large homogenous areas of permanent snow or ice, typically only in mountain areas or highest latitudes; examples: glaciers, permanent snowpack, snow fields.
10	Clouds	No land cover information due to persistent cloud cover.
11	Rangeland	Open areas covered in homogenous grasses with little to no taller vegetation; wild cereals and grasses with no obvious human plotting (i.e., not a plotted field); examples: natural meadows and fields with sparse to no tree cover, open savanna with few to no trees, parks/golf courses/lawns, pastures. Mix of small clusters of plants or single plants dispersed on a landscape that shows exposed soil or rock; scrub-filled clearings within dense forests that are clearly not taller than trees; examples: moderate to sparse cover of bushes, shrubs and tufts of grass, savannas with very sparse grasses, trees or other plants.

For the purposes of this study, the *flooded vegetation* class (number 4) and the *crops* class (number 5) were just united into the latter LULC. The reason for this is that for the case of Bangkok, the vegetation situated in flooded lands are actually mainly paddy fields used for agriculture. Since the research focuses on LULC conversions into agricultural uses, it would also be convenient for the succeeding processes to have just one class for these for easier identification and lessened confusion. Moreover, since they are inapplicable and irrelevant to the study, the *snow/ice* (number 9) and *clouds* (number 10) classes were disregarded and deleted from the source maps.

3.2. Initial Accuracy Assessment

Upon acquisition of the LULC maps, they were all cropped according to the delineated area which are the administrative boundaries of the Bangkok Metropolitan Area (BMA) using ArcGIS. After which, an accuracy assessment was done for one of the collected maps (for the year 2017) by having 300 random accuracy assessment points and verifying their true classification through a re-classified official map from the Land Development Department of Thailand from the same year (2017) (Redo et al., 2012). The re-classification of the official map was done such that it would have the same set of LULC classes with the pre-processed maps from ESRI, which are *water, trees, crops, built area, bare ground*, and *rangeland.* Each of the thirty-two (32) classes from the official map was designated to the where they belong in the six (6) more general classes used in this study according to the descriptions in Table 3. The accuracy assessment process produced a confusion matrix containing the producers' and users' accuracies, as well as the Kappa coefficients of the gathered maps. Such values gauged if the gathered maps were accurate and reliable enough in order to proceed and perform further analyses.

3.3. LULC Change Detection

What followed the gathering and initial accuracy assessment of LULC maps was the detection of the changes that occurred between every time period among the study years. The percent cover of each LULC class was first calculated for every map and their values were rendered in graphs with a mark in early 2020 to signify the policy's official implementation phase. Through these, the trends were assessed across the different periods and LULC classes. Once these preliminary quantitative methods were done, the spatial techniques were performed by use of the *categorical compute change* function of ArcGIS (Puttinaovarat et al., 2021). Every pair of chronological time skips between images from 2018 to 2021 were run through the tool. Likewise, the produced change detection maps and tables were analyzed according to the spatiotemporal changes that occurred. This was done by cross-tabulating the LULC conversions to know "from-to" class changes (Butt et al., 2015; Das & Angadi, 2021; Wang et al., 2020). For the purposes of this study, the detected conversions from all other LULC classes into the vegetated ones (namely forest, agriculture, and rangeland) were categorized as suspected tax avoidance activities, and were allocated to separate maps. Then, spatial autocorrelation analyses, namely the Global Moran's Index, the Local Indicators of Spatial Association (LISA) (also known as the Local Moran's I), and the Getis-Ord Gi* (Anees et al., 2020; Chen et al., 2022; Zhang et al., 2015) were performed on these suspected tax avoidance activities maps which compared the years 2018 and 2021. This was done because the map supposedly contains the aggregate of all the suspected tax avoidance plots throughout the study period. The Global Moran's statistic was obtained through the *Spatial Autocorrelation (Global Moran's I)* function in ArcGIS. Meanwhile, LISA was performed through the *Cluster and Outlier Analysis* functions in the same application to know where the LULC conversions are happening and the type of clustering occurring in these areas. Along with this was the *Hotspots Analysis (Getis-Ord Gi*)*, which was likewise performed in ArcGIS, and it revealed the level of spatial relationships that exist between the clusters that were identified in the previous analysis, as well as their statistical significances. It should be noted that the last two geospatial analyses were performed with Bangkok sub-districts as the unit of analysis.

3.4. Change Detection Results Triangulation

As a way to confirm if the changes that were detected and appeared in the maps indeed occurred, data triangulation via Google Street View, Google Earth Pro, NDVI time-series signatures from Sentinel-2A, and site visits were performed in selected transect sampling points as seen in Figure 5 below. These sites were chosen after scanning the tax avoidance activities maps and briefly inspecting certain plots of interest.

After choosing the assessment points of suspected tax avoidance activities, the remote methods of triangulation were first employed. Images of the land plot from crowd-sourced Google Street View and satellite-captured Google Earth Pro would be looked at to verify the LULC conversions detected. These platforms were used as they have relatively expansive databases, and they provide access to imagery taken in the past, allowing comparisons for the aforementioned study years. For the triangulation process via Google Street View, the coordinates of the study site were first obtained and then searched through the said platform. It then automatically places a location marker at the searched point and one could start looking at the various images of the site. Most of the time, there are no images available on the actual point marked by the coordinates (as they are usually not paved with roads) but there are images available that still capture the area of interest even from a distance that allow for observations (Maxar, 2022).

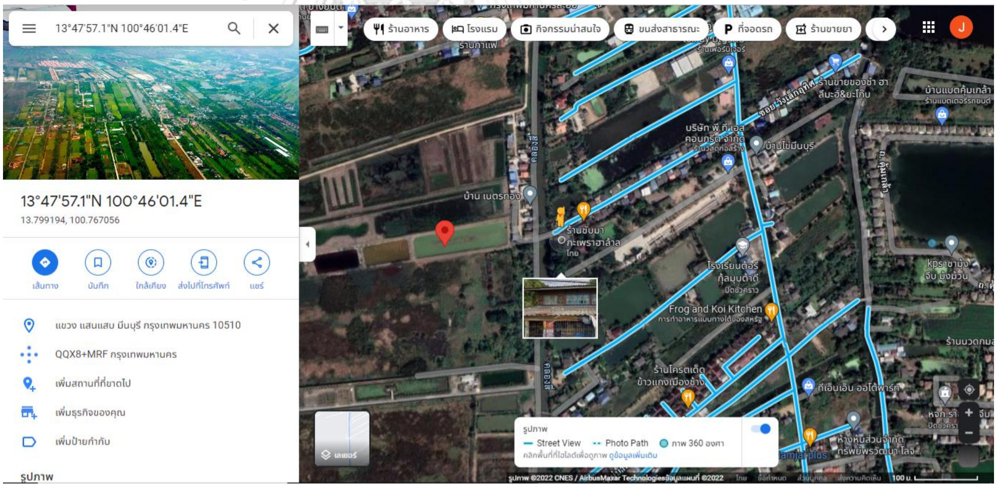


Figure 5 Sample Study Site on Google Street View

The data available on Google Street View varies, wherein there may be limited images in certain sites, while some may have extensive sceneries available even going years back. One may also be able to gauge if the site of interest is public or private-owned with official labels and owners displayed and numerous sceneries available for the former, while there are no proper titles or owners disclosed, and not much sceneries available for the latter. Given that the focus of this study was on private LULC conversions to agricultural lands, the characteristics of such changes were watched out for in the selected sites. Some examples of these features that were sought include clear patterns of vegetation, even spacing, one type of vegetation for a significant area of land, straight boundaries in and around the site, the presence of irrigation, absence of random vegetation close to the ground, among others. Figure 6 is provided to illustrate how these features were identified.

Figure 6 Detection of Agricultural Activities with Google Street View

As one may observe, the image on the left-hand side of Figure 7 (Google, 2018d) shows various vegetation in the frame which are not in an organized pattern. It can also be noticed that there was smaller vegetation near the ground beneath the taller plants. However, the image on the right-hand side (Google, 2020d) shows distinct rows allotted for vegetation, even spacing of what seem to be crops, with the presence a presumable irrigation system, and almost no vegetation near the ground (as these were removed to prevent competition). This is an example of the process of distinguishing “vacant” lands with no clear land use from the ones being utilized or converted into agricultural purposes. After making the observations and confirmations on Street View, Google Earth Pro was consulted next.

Figure 7 Detection of Agricultural Activities with Google Earth Pro

By default, Google Earth Pro also displays the latest imagery available for the locations of interest. However, as the platform utilizes satellite imagery, it is certain that there would be historical imagery available for the study. Similar to the previous process, the coordinates would be pasted and searched on the application. Once panned to the location of interest, the images for the study years were observed. Figure 8 illustrates the LULC changes that occurred from 2018 on the left (Google, 2018d) and 2021 on the right image (Maxar, 2021c), which can be observed. Again, like the process for Street View, the same land features were looked for and compared to distinguish between varying covers and uses. It is just that the images were taken from a "bird's eye view" this time. The earlier image that shows the preceding state of the land displayed a relatively random arrangement of the trees and other vegetation, except for the boundaries which were lined with trees. However, for the latter image, distinct lines of vegetation were seen, along with the presence of the irrigation system as well as the absence of understory vegetation – all of which were also observed from the Google Street View imagery. At this point, comparisons between the findings from the Google platforms could be made to see if they agree with one another. As a final method of confirming the existence of the detected tax avoidance activities, the yearly average NDVI maps were consulted next.

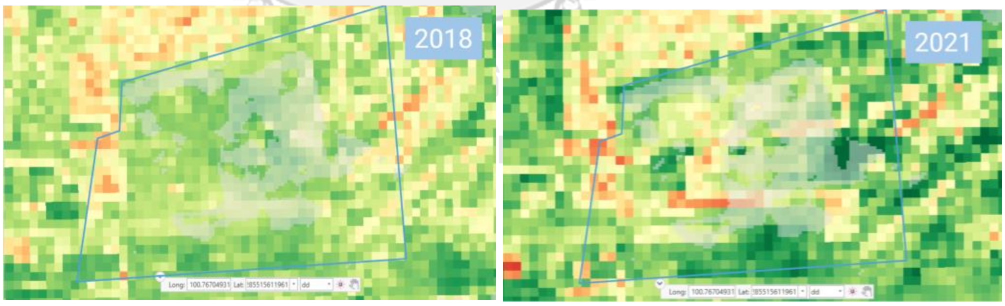


Figure 8 Detection of Agricultural Activities with NDVI Maps

The various imageries of the locations of interest for the study years were inspected and compared with one another once again. The scenes displayed in Figure 8 showed the changes that occurred between the starting and ending study years (Gorelick et al., 2017). In the 2018 imagery, the land in the plot of interest is covered in light green with some yellow and a few red pixels in the surroundings. The light green pixels can be interpreted as smaller, random, and scant vegetation spread across the site with NDVI signatures of around 0.18 to 0.36; while the yellow and reddish pixels can be interpreted as the bare ground or built up areas with NDVI signatures that are a little over zero (0.015-0.18) (Akbar et al., 2019). Then, in the 2021 image, it can be noticed that the presumed bare ground or built areas took over the central portion of the plot, while there are regions of intensified NDVI as indicated by the darker green hue of the pixels. Such pixels mean denser vegetation and are good indicators of agricultural activities that typically have NDVI signatures ranging from 0.6 to 0.7. Aside from this, there are clear and relatively fine-scale delineations between the different LULC classes seen in the maps, where there are lines of bare ground/built areas surrounding the dense vegetation in the plot. With this method, one can confirm the observations made by inspecting images in "natural color" with maps that used light signatures outside of the visible spectrum, that is usually deemed as a good indicator of vegetation health, state, and kind. The agreeance of all the results from the triangulation processes indicate the existence and validity of the suspected tax avoidance activities that were detected through mapping.

3.5. Relational Confirmatory Tests

In order to confirm if the changes observed in the previous steps were indeed influenced by the policy in focus, further analyses were performed. First, a logical confirmatory test was implemented according to Redo et al. (2012)'s approach by comparing the tax policy and the LULC changes' time frames, desired and actual outcomes, and trajectories. If they coincided with these three parameters, then the relationship of the land and buildings taxation policy to the detected tax avoidance activities is confirmed. Next, a statistical analysis was conducted by use of paired t-tests to know if there are significant differences between the total area of suspected tax avoidance activities in each Bangkok sub-district in the years prior to the implementation of the property tax law and the years after its official effectivity date. A positive result in this test means that the policy has a statistically significant influence on the LULC in Bangkok. As a final stage in the methodology, the results from the mapping and confirmatory analyses were further affirmed and discussed by means of key stakeholders' interviews. A summary of the entire methodology is presented in Figure 9 below.

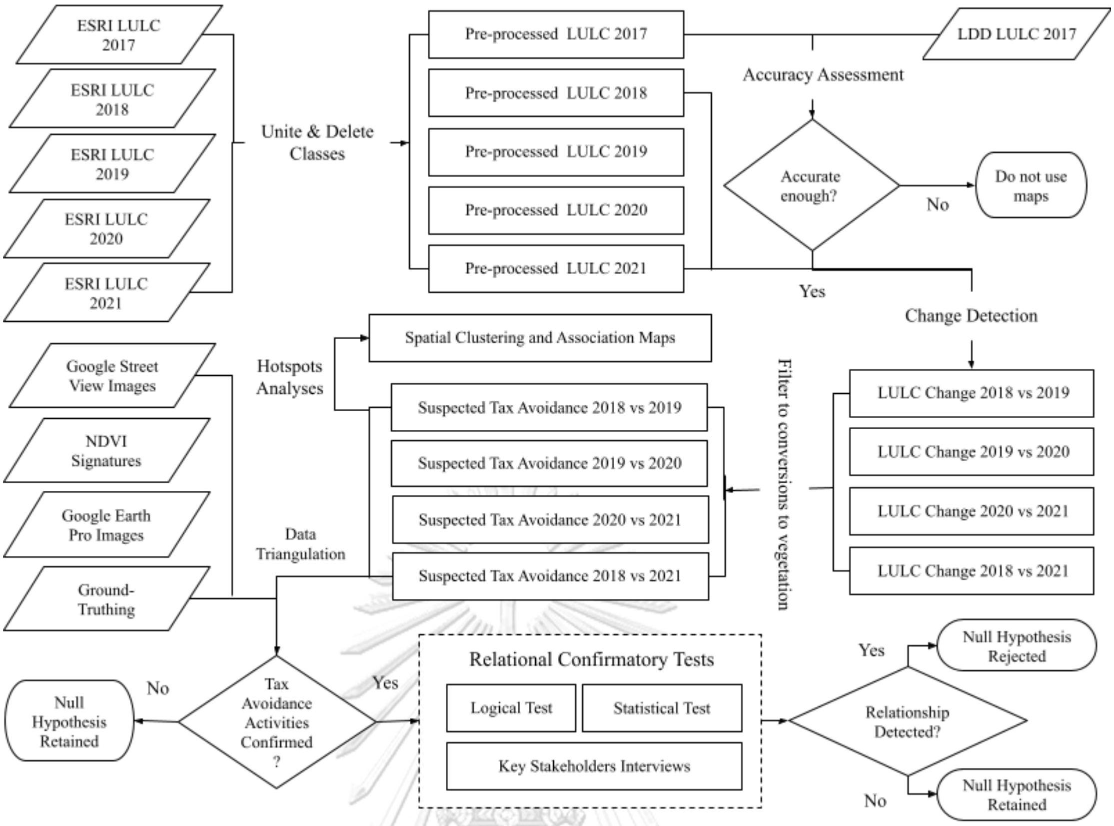


Figure 9 Methodological Flow Diagram

CHAPTER 4: DATA

Chapter 4 features the different preliminary processing and analyses that were performed in the study of the main data source: the ESRI LULC maps. The succeeding text outlines observations and insights made from the said LULC maps, and the derived change detection maps and suspected tax avoidance maps.

4.1. LULC Mapping

4.1.1. Initial Accuracy Assessment

The 2017 LULC data from ESRI was subjected to an accuracy assessment with the 2017 official maps from the LDD as a way to confirm the source's reliability and usability for the study. Three hundred (300) random accuracy assessment points were used for this test. The producer's accuracy represents the correctness of the map from the point of view of the mapmakers, or the likeliness that the features on-the-ground were correctly represented in the created maps. On the other hand, the user's accuracy is the correctness of the images according to the perspective of map users, or the likeliness that the features included in the map are actually present on the ground. Finally, the Kappa Index is a measure of how much better (or worse) the performed classification is compared to randomly assigning values to the respective pixels on the maps. The summary of the confusion matrix is presented below.

Table 4 Summary of Accuracy Assessment for 2017 LULC Maps

LULC Class	Producer's Accuracy (%)	User's Accuracy (%)	Overall Accuracy (%)	Kappa Index (%)
Water	55.56	33.33	72.44	50.64
Forest	42.86	30.00		
Crops	56.52	66.67		
Built-up Area	88.11	89.36		
Bare Land	11.11	10.00		
Rangeland	18.18	20.00		

Upon initial inspection, it can be noticed that the *Built Up Area* class yielded the most accuracy (both in producer's and user's) with 88.11% and 89.36%, respectively. Next to it is the *crops* class that was computed to have 56.52% producer's accuracy and 66.67% user's accuracy. Following the rankings are the *water, forest, rangeland,* and *bare land* classes, which yielded 55.56 % and 33.33%, 42.86% and 30.00%, 18.18% and 20.00%, as well as 11.11% and 10.00% for their producer's and user's accuracy respectively. Looking more closely at these values, it can be seen that the gap between the producer's and user's accuracies for the *water* class is remarkably wide. This may be attributed to the frequent misclassification of flooded vegetation throughout the city, which could have been more appropriately classified as *crops*, into *water.* The surface water cover of such lands may have confused the algorithm and got misled from their uses. For similar reasons, the *forest* class' accuracies exhibited significant gaps between their values as well. Only this time, it might have been challenging for the algorithm to differentiate trees from rangeland cover as they may have like spatial arrangement and spectral registers. Finally, the *bare land* class registered the least accuracies (both producer's and user's) as such lands were easily mistaken for built up class or lands with sparse/minimal vegetation.

Factoring in all of these values, the overall accuracy of the classification done by ESRI on SENTINEL-2 images was found to be 72.44%. Meanwhile, the Kappa Index (a measure comparing to random classification) turned out to be 50.64%, which is considered "moderate" agreement according to Landis and Koch (1977) and "fair" agreement as per Monserud and Leemans (1992)'s scale (Landis & Koch, 1977; Monserud & Leemans, 1992). The overall accuracy and kappa index generated from the assessment of the pre-processed 2017 LULC map from ESRI, being satisfactory, then makes the other maps from the source reliable and usable for further use in the succeeding processes in the study. It should be noted, though, that whatever errors were accrued from this process would be carried on to the succeeding parts of the study and resulting derived maps.

4.1.2. LULC Maps

After going through preprocessing in order to merge and remove certain classes, and modifying the default symbologies, the data from ESRI for the study years were transformed into the following maps.

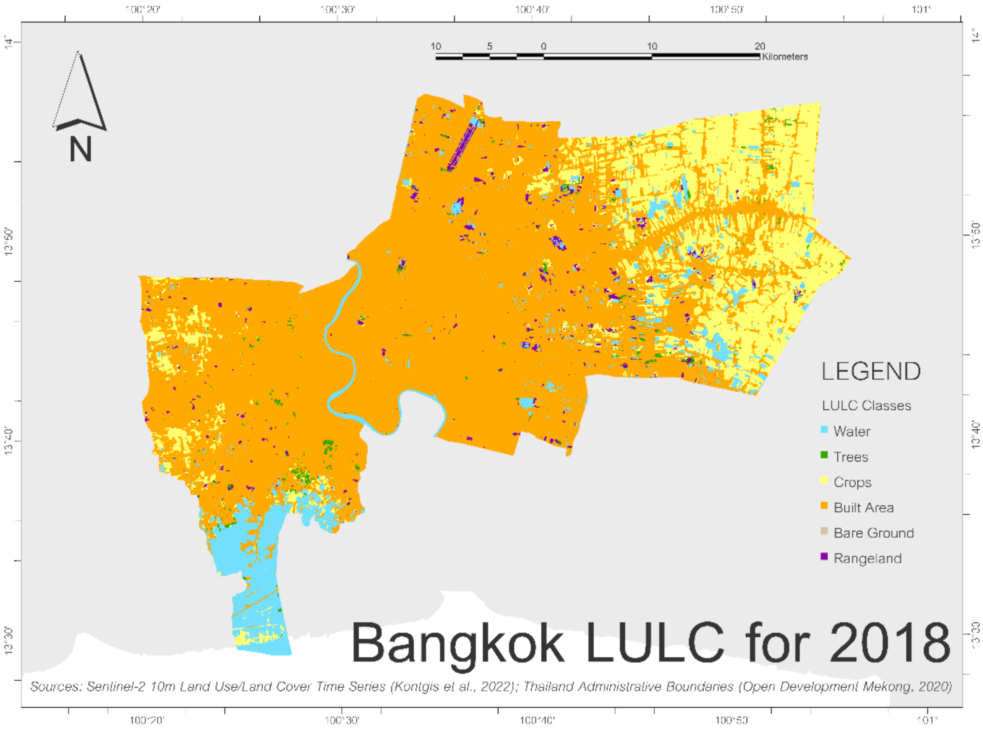


Figure 10 LULC Map of Bangkok in the Year 2018

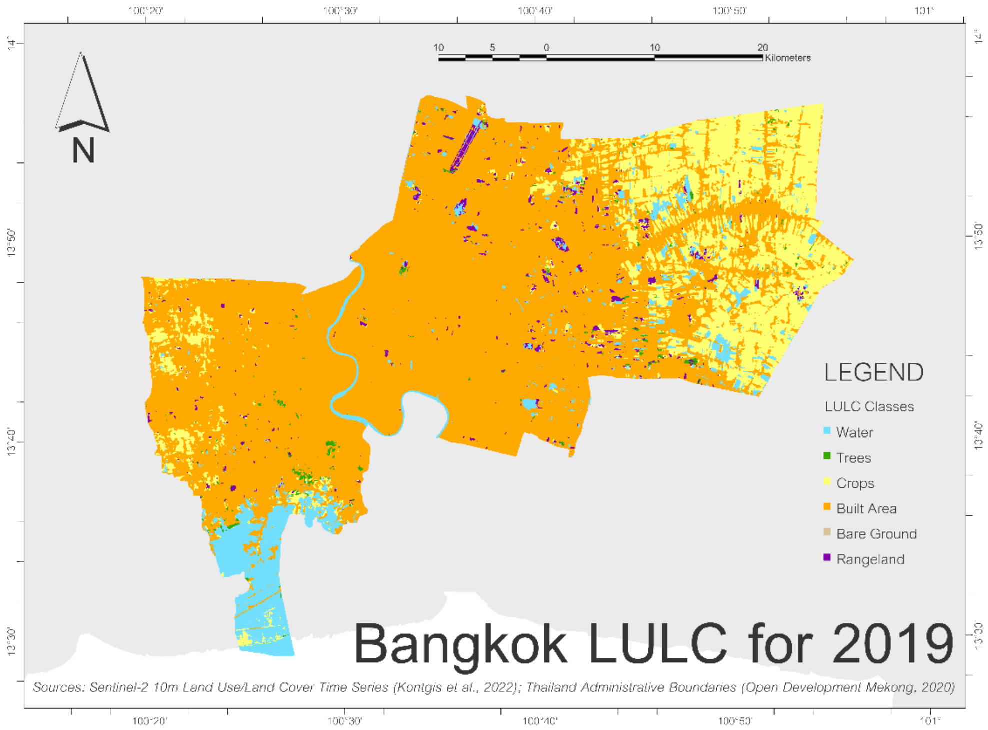


Figure 11 LULC Map of Bangkok in the Year 2019

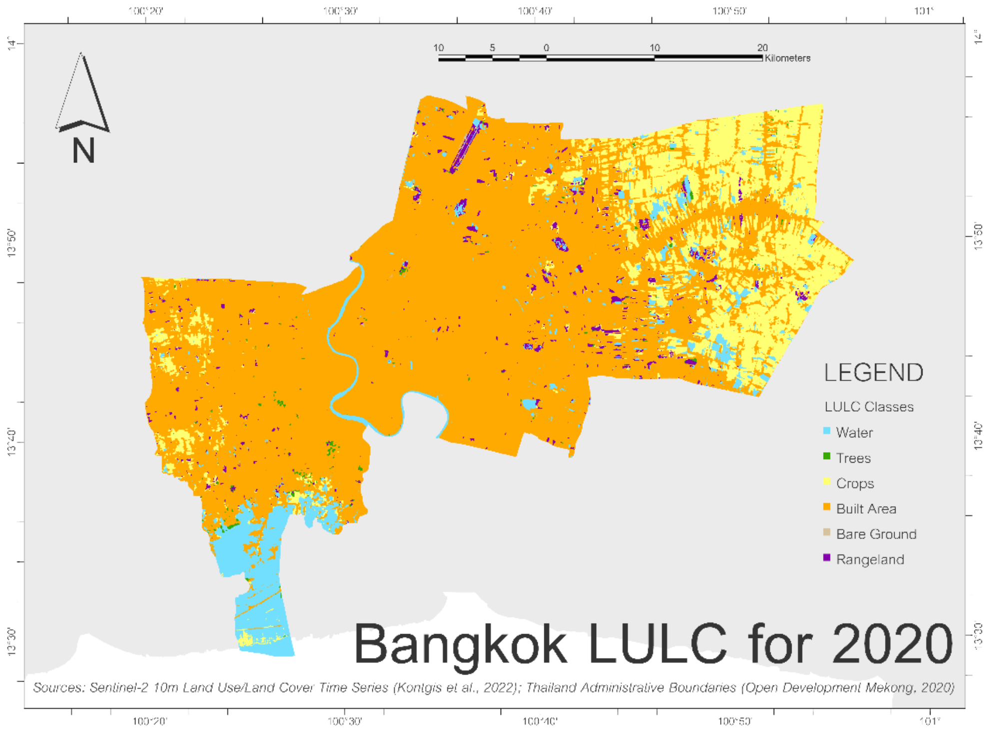


Figure 12 LULC Map of Bangkok in the Year 2020

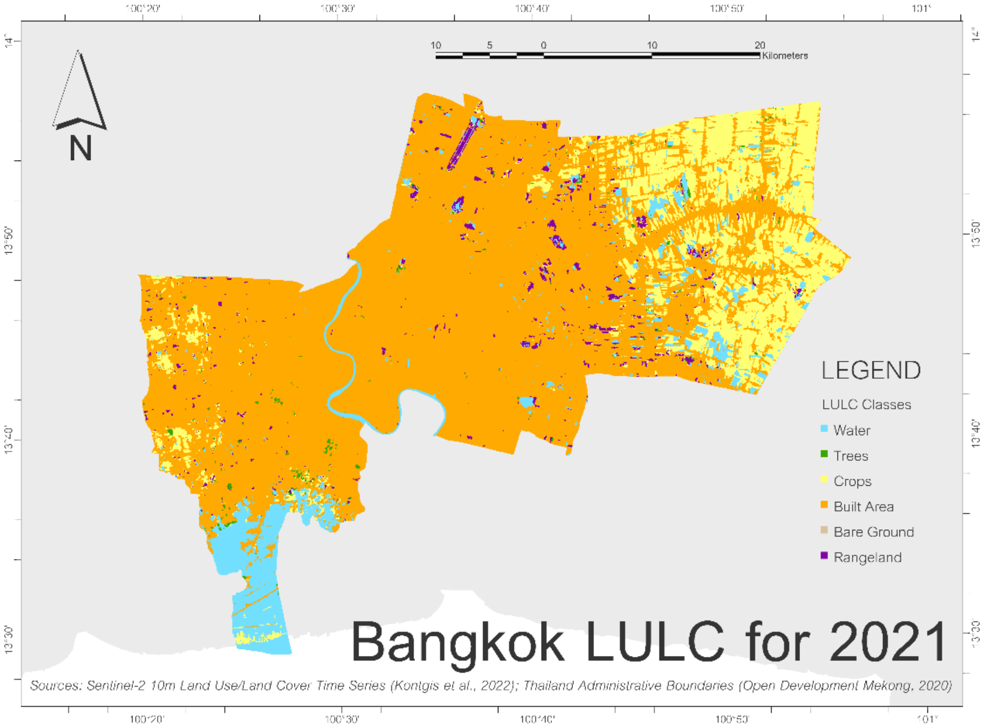


Figure 13 LULC Map of Bangkok in the Year 2021

One of the most prominent features of all the LULC maps would be the dominance of all the built-up areas in almost the entirety of the city. Another consistent and easily recognizable trait of the maps would be the large patches of crop land covering the eastern fringe of the city, with several patches of the said LULC in the western fringe. The southwestern portion of the maps also illustrate a significant portion of Bangkok covered in water, which are actually salt farms that make use of the seawater from the Gulf of Thailand. In the middle of the metropolis meanders a water body that serves as another distinguishing characteristic of the city- the Chao Phraya River. As for the other vegetative covers in the study area, once might notice that there are quite a few patches of rangeland (one of which is the noticeable strip of Don Mueang Airport at the extreme northern part of the maps), and even fewer forest and bare ground classes.

Comparing the LULC maps from the different study years, it can be deduced from close observation how the built areas are increasing with each succeeding year and are especially encroaching on the croplands in the eastern portion of the area. It can also be observed how the rangeland patches are increasing throughout the years, while the forest lands (especially in the mid-southwestern part of the city) are gradually disappearing.

4.1.3. LULC Area Percentages

Quantitatively representing the information showed in the maps that were just presented, the following table provides a summary of the area coverage of each LULC classes relative to the entirety of Bangkok for all study years.

Table 5 LULC Classes Percent Coverages in Bangkok (2018-2021)

LULC Class	**Percent Area (%)**			
	2018	**2019**	**2020**	**2021**
Water	7.43	7.06	7.06	7.17
Trees	0.87	0.66	0.40	0.49
Crops	19.02	18.20	16.82	16.42
Built Area	71.33	72.62	73.83	74.13
Bare Ground	0.03	0.04	0.06	0.05
Rangeland	1.32	1.42	1.83	1.74

Affirming the visual observations from the previous section, the quantitative measures of LULC coverage reveals the consistent increase in built areas during the study years. With each time gap, there is more than 1% increase in the said LULC class from 2018 to 2021. On the other hand, the water and tree percent coverages showed to have the reverse trend, with a continuous decrease in values throughout the study years, albeit a slight increase for the year 2021. The crop class almost follows the same trend as the water and tree classes but its area coverage did not have a recovery for the last study year and instead demonstrated just a slower decrease from the previous year. Finally, again confirming the observations made in the previous section, the rangeland class demonstrated increase in coverage for the study years, with even a slight jump in value for the year 2020. However, the numbers reveal that there was actually a slight decrease in rangeland cover for 2021.

To further aid the visualization of the data and to gain more insights, the line graph below was created, showing the percent coverages of the different LULC for the years of interest.

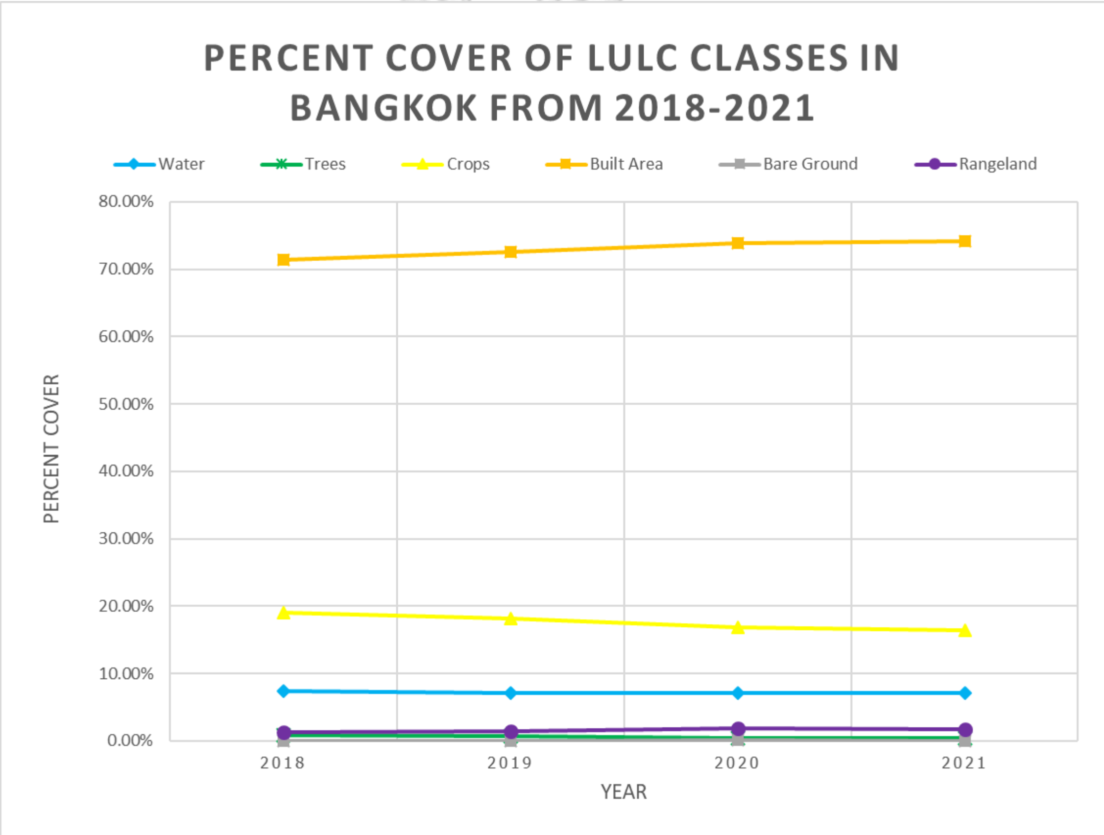


Figure 14. Graph of LULC Percent Coverages in Bangkok (2018-2021)

Looking at the figure above, it is even more emphasized how there is a large gap between the built area cover and all the other LULC classes considered in the study. The graph further reveals that there is a plateauing of the increase in built areas between the final 2 years, 2020 and 2021. Moreover, there is also a considerably significant margin of area coverages for crops and water classes as compared to the three other LULC classifications. Further enriching the insight from the quantitative data, the graph reveals that there is actually a slowed decrease of crop cover from 2020 to 2021, and the rate of its decrease is marginally higher than that of the water class. Similarly, the slight increase in rangeland cover for the first three study years, as well as the slight jump in 2020, and the small decrease in 2021 are all visible in Figure 14.

4.2. NDVI Signatures

Intended to be used as part of the data triangulation process via transect sampling, the following NDVI signatures maps (based on SENTINEL-2 satellite images) were downloaded from Google Earth Engine. The yearly averages of NDVI values were obtained for the study years from 2018 to 2021 as they are common signifiers of vegetative cover; which is the main focus of this study.

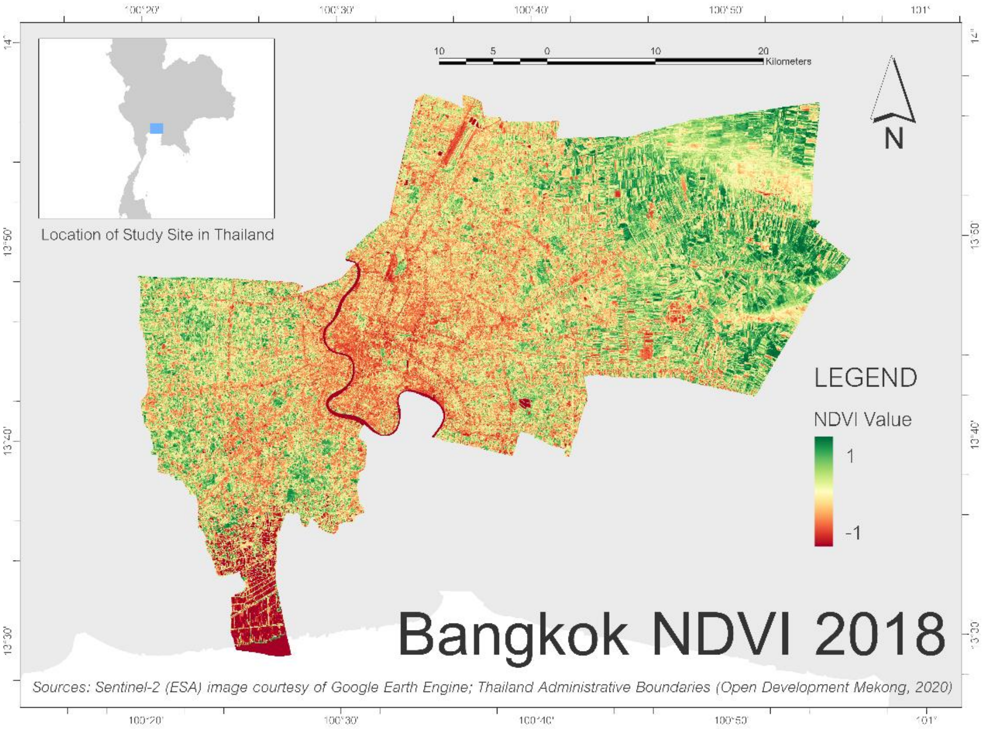


Figure 15 NDVI Signatures in Bangkok for the Year 2018

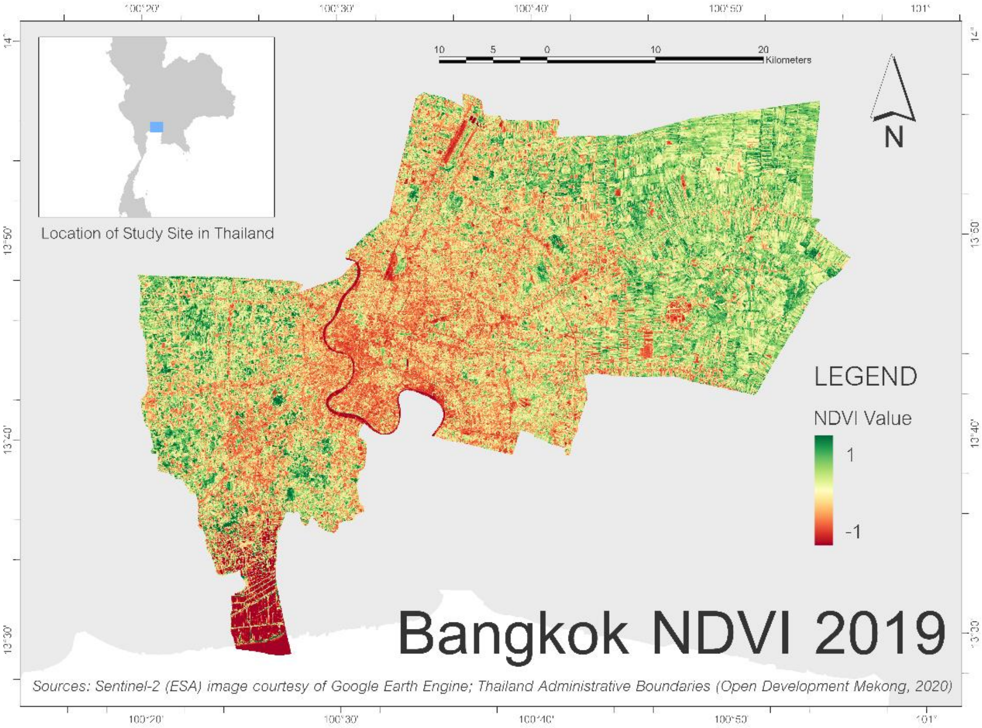


Figure 16 NDVI Signatures in Bangkok for the Year 2019

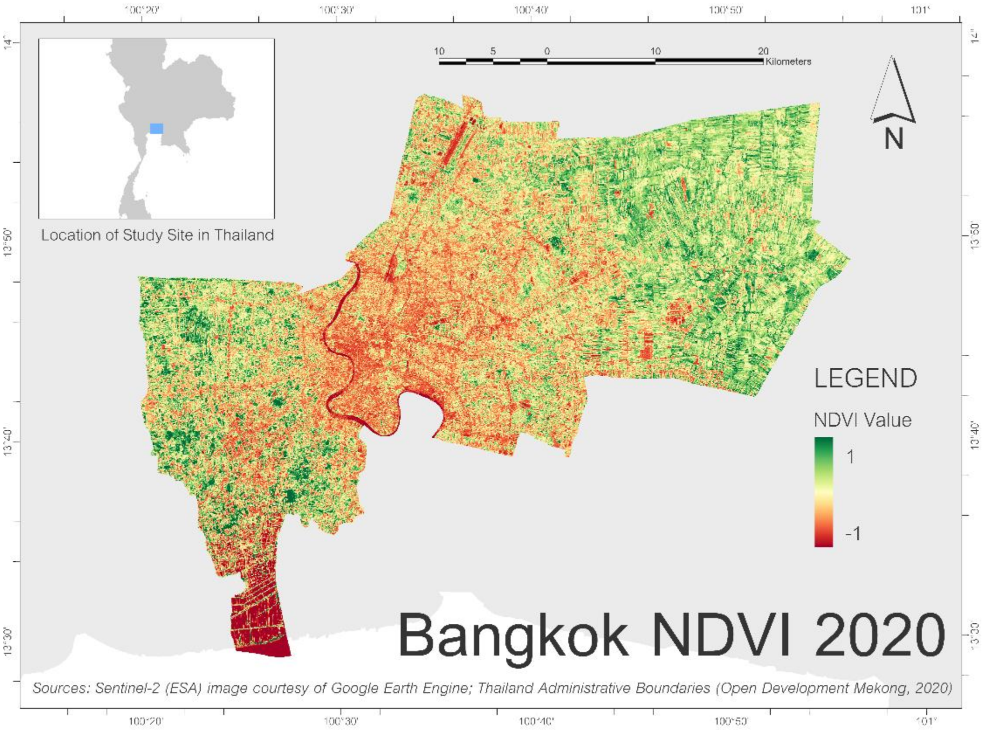


Figure 17 NDVI Signatures in Bangkok for the Year 2020

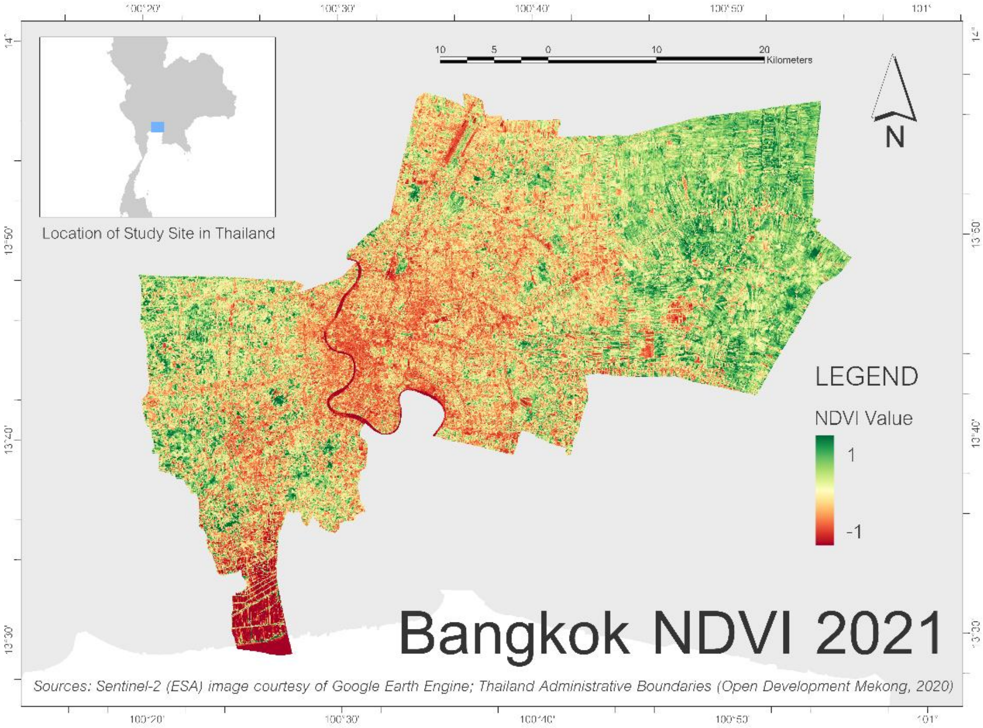


Figure 18 NDVI Signatures in Bangkok for the Year 2021

It can be noticed through all the gathered NDVI maps that one of Bangkok's most prominent features in the Chao Phraya river is distinguishable through its dark red color. This signifies extremely low NDVI values, and consequently, low primary productivity. Surrounding the said water body in the center of the city are pixels with lighter shades of red, which as the LULC maps from section 4.1.2. would verify, are *built areas.* Similarly, the outer areas of the city with yellow and green pixels correspond mostly to vegetative areas such as *trees, crops* and *rangeland.*

4.3. Land Values in Bangkok

For the purposes of a simple analysis to know which factors may affect the tax avoidance behavior of private landowners in Bangkok, the land values along the major thoroughfares in the city was obtained.

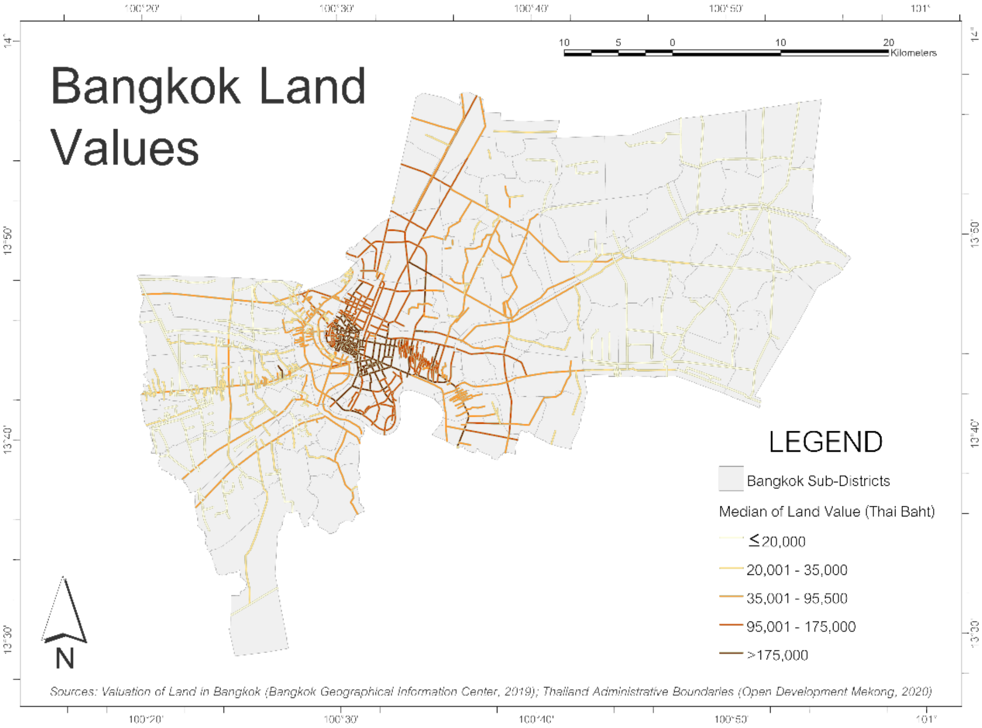


Figure 19 Bangkok Land Values

Upon observation, majority of the highly-valued lands are situated in the center of the city, as signified by the dark orange hue. The land values also tend to go down in the areas located in the outskirts of the city. However, there are still some noticeable areas that are at a considerable distance from the city-center, which exhibit relatively high land values. They are particularly located at the eastern side of the city.

CHAPTER 5: RESULTS

This chapter presents the results of the geospatial analyses and data triangulation methods that were performed throughout the study using the data from Chapter 4 as inputs. It also features the results of the tests that sought to find the relationship between the new land and buildings taxation law in Thailand and LULC changes in the context of Bangkok.

5.1. LULC Change Detection

5.1.1. LULC Change Detection Maps

The LULC Maps from the previous section were then used as inputs for the categorical compute change tool in ArcGIS. The LULC conversion "to" and "from" maps are as follows.

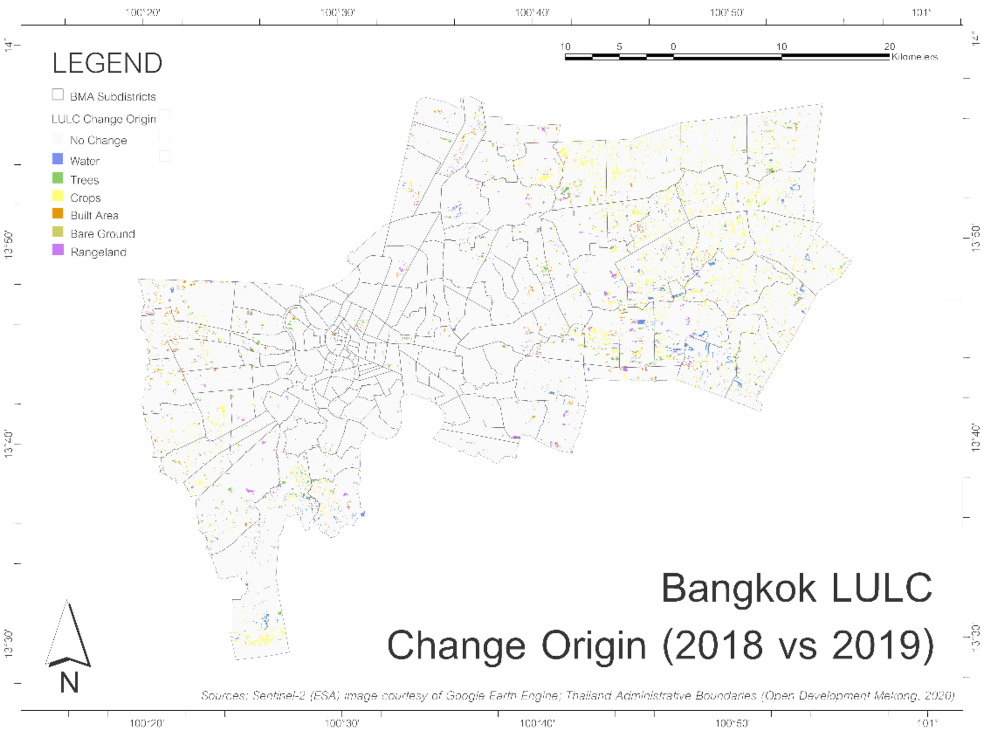


Figure 20 Class Origins of Bangkok's LULC Changes (2018 vs 2019)

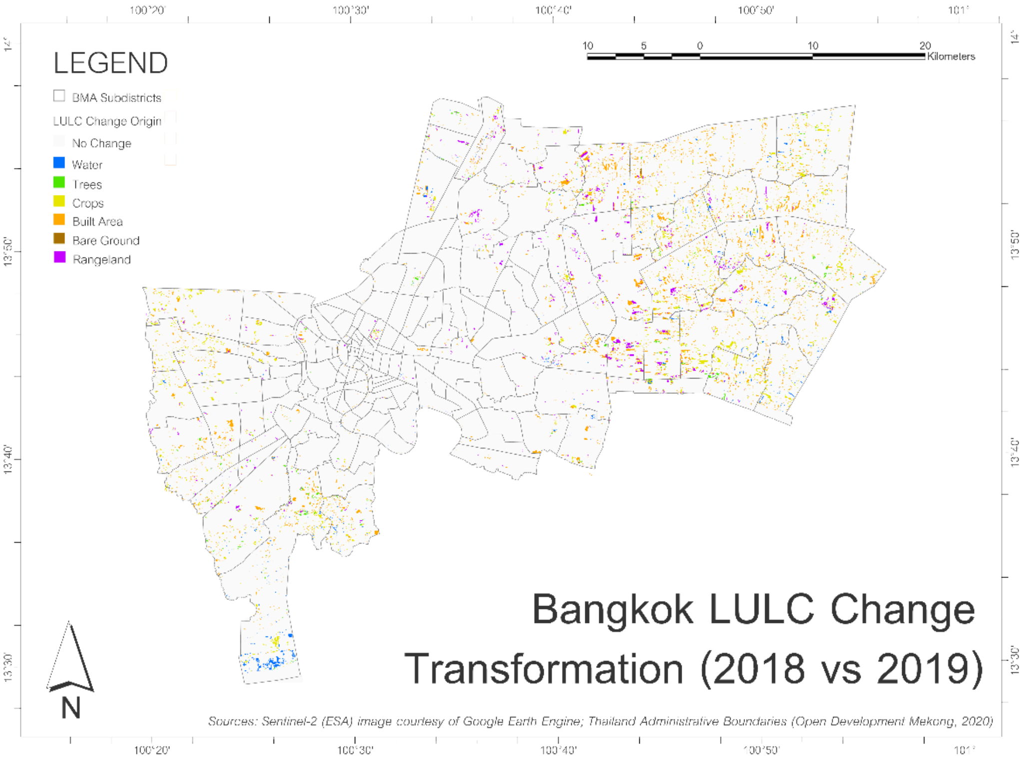


Figure 21 Class Transformations of Bangkok's LULC Changes (2018 vs 2019)

Looking closely at the Change Origin map for the time gap between 2018 and 2019 (Figure 20), it can be observed that majority of the changes detected in the said time period are from the crops class, and a number of changes from the water class. Meanwhile, the Change Transformation map in Figure 21 reveals that most the LULC from 2018 were converted into built areas in 2019, with there are some noticeable conversions into rangeland in the eastern fringe of Bangkok.

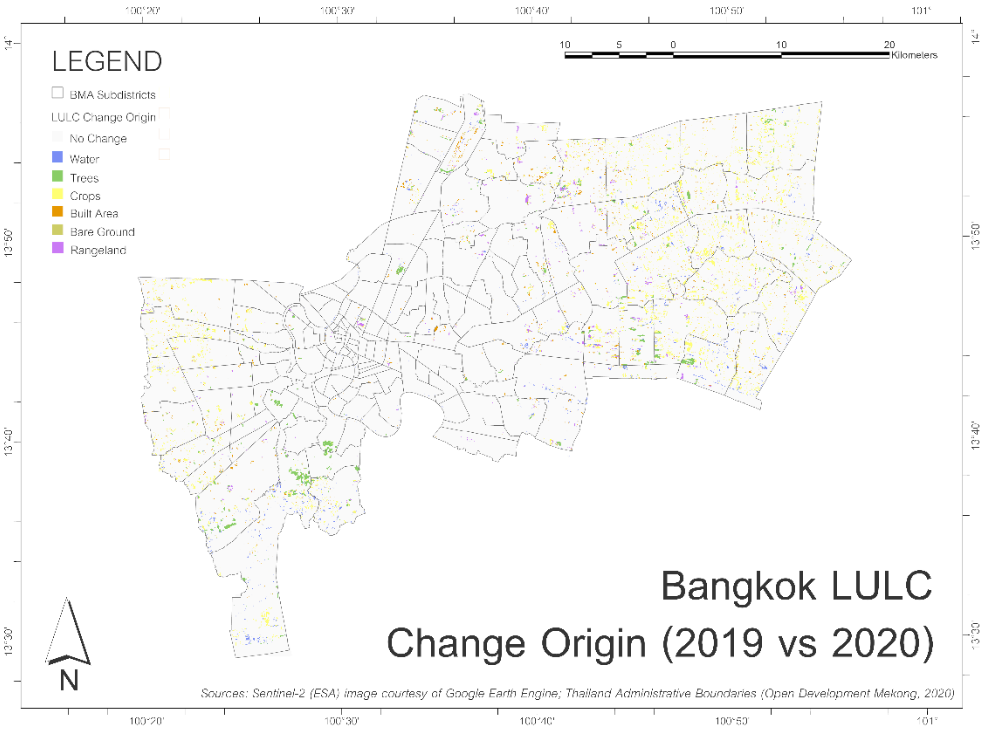


Figure 22 Class Origins of Bangkok's LULC Changes (2019 vs 2020)

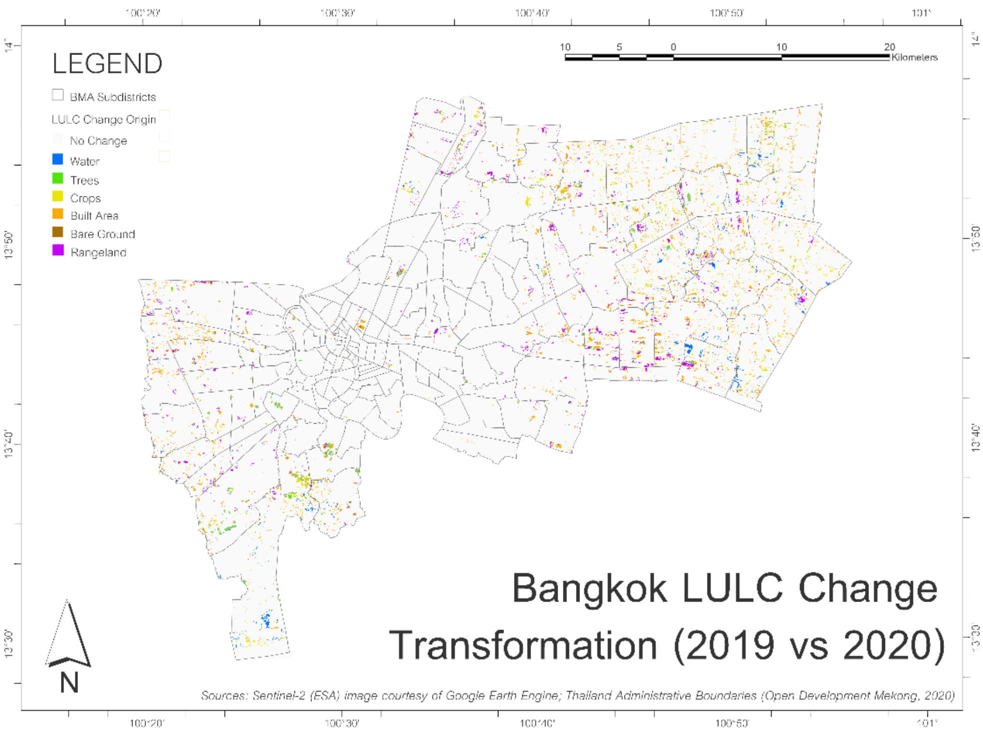


Figure 23 Class Transformations of Bangkok's LULC Changes (2019-2020)

Moving on to the next time period that was inspected, it can be seen that the set of maps for the LULC between 2019 and 2020 have almost the same features as the previous set. However, for the change origin map in Figure 22, it can be noticed that aside from the proliferation of land plots that changed from croplands, there are also a number of lands that changed from the tree cover class.

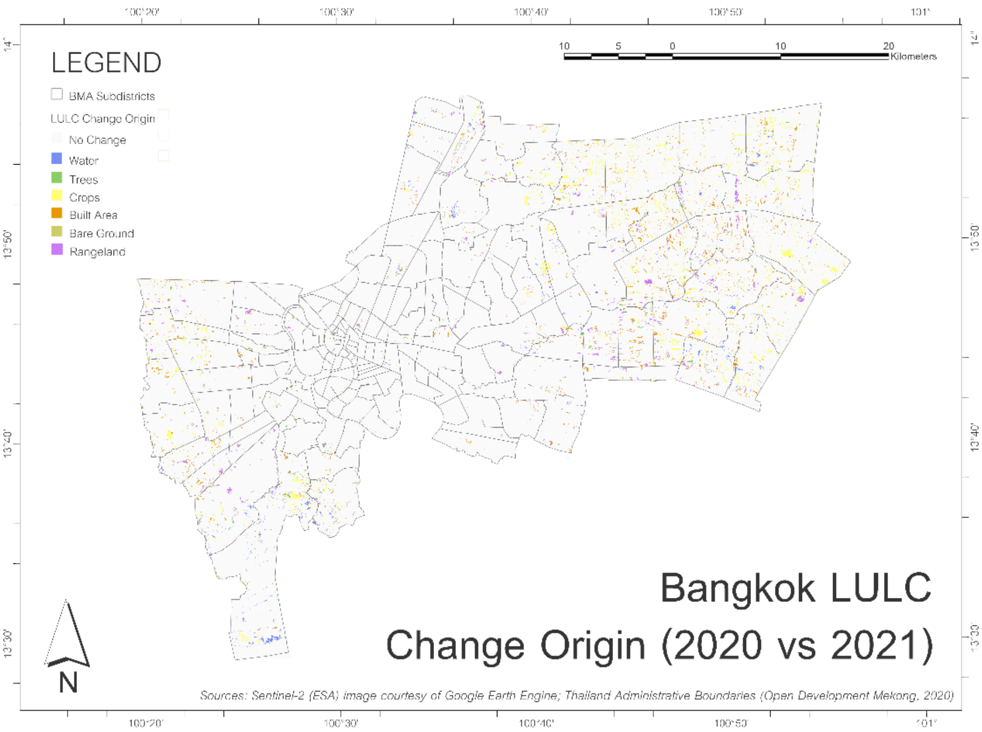


Figure 24 Class Origins of Bangkok's LULC Changes (2020 vs 2021)

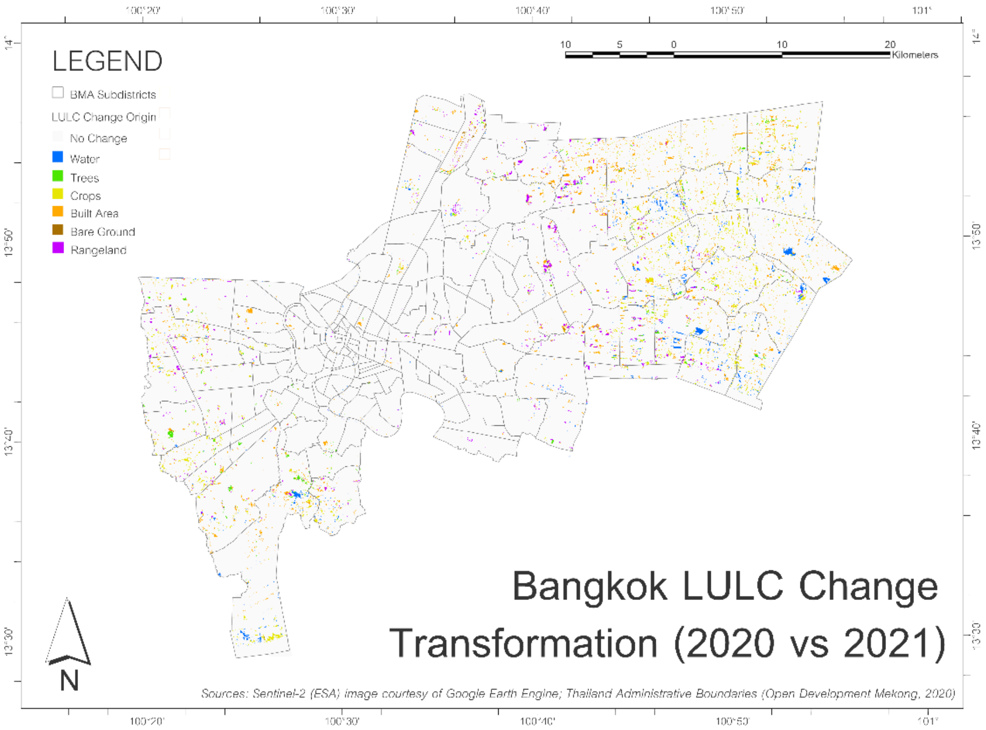


Figure 25 Class Transformations of Bangkok's LULC Changes (2020 vs 2021)

Deviating from the previous sets of maps, the change detection for the time period between 2020 and 2021 presents significantly different LULC changes. For one, the change origin map (Figure 24) shows the minimization of changes from the crops class compared to the previous study periods. Instead, one may observe the increase in changes from the rangeland and bare ground classes. On the other hand, the LULC transformations in Figure 25 shows to be more mixed with the built area, rangeland, water, and trees classes adding in to the usual cropland conversions.

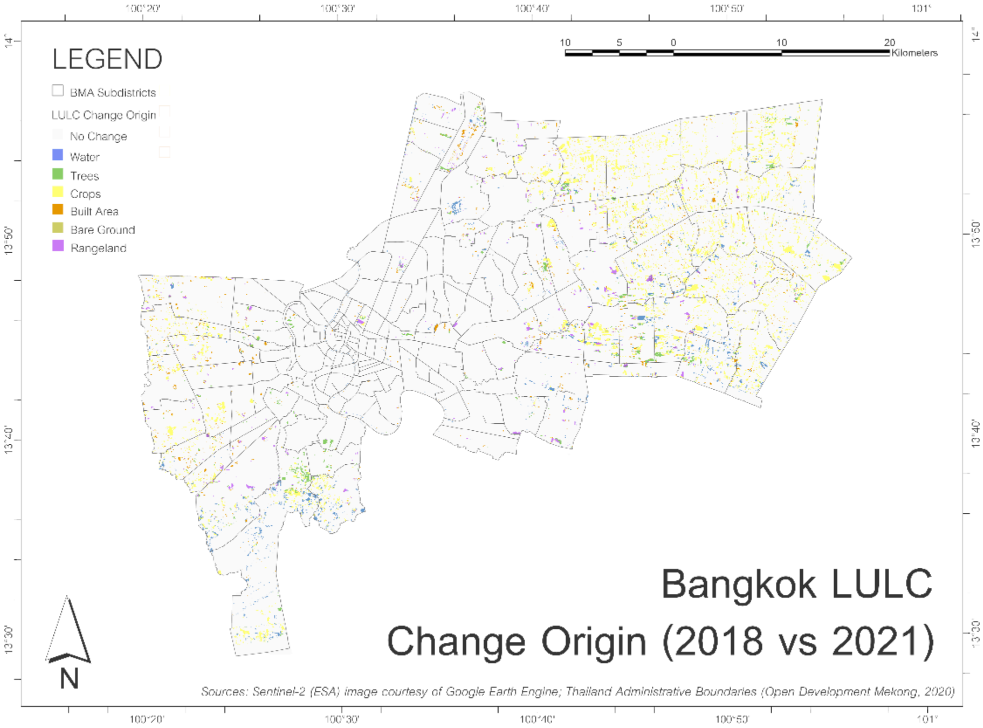


Figure 26 Class Origins of Bangkok's LULC Changes (2018 vs 2021)

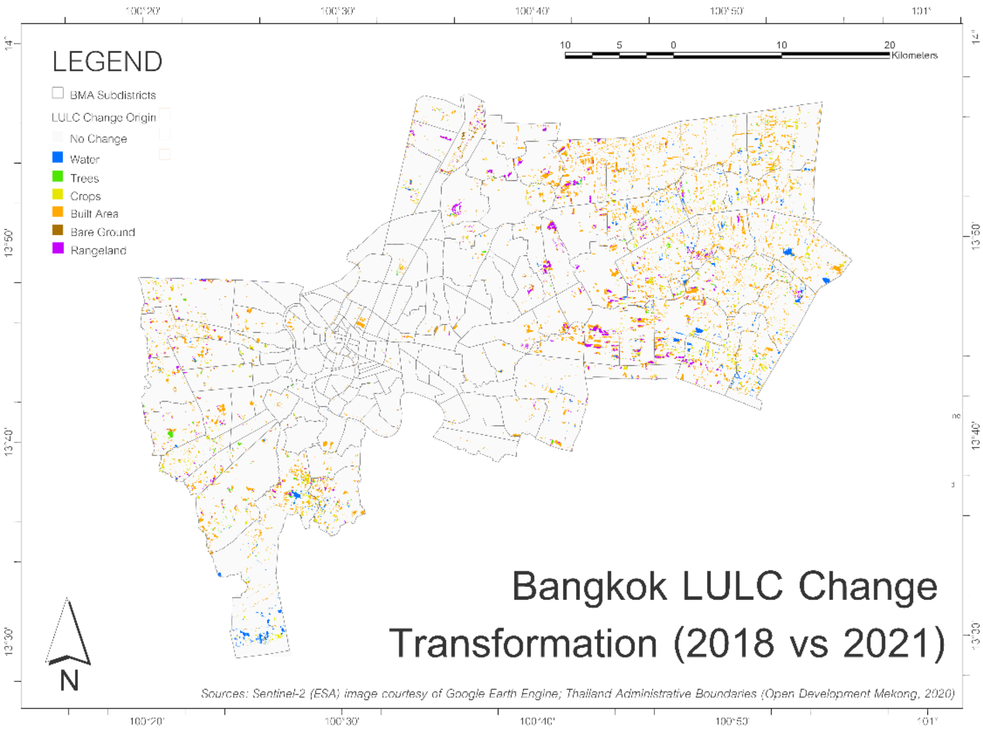


Figure 27 Class Transformations of Bangkok's LULC Changes (2018 vs 2021)

The last pair of change detection maps compare the first and last study years representing an aggregate of the LULC changes that happened all through the time frame of investigation. Through Figure 26, one may observe the prominence of changes from the crop class on both ends of Bangkok, as well as the noticeable changes from water LULC on the southern portion of the city, and the scattered changes from tree cover. Moving on to the transformations that happened to the city's LULC in Figure 27, it can be seen that most of the land were modified into the built up and rangeland classes. Finally, it should also be pointed out that there were still several conversions into the water class detected in the southern and eastern parts of the city.

5.1.2. LULC Change Matrices

Quantitatively summarizing the LULC changes that happened in Bangkok through the time gaps inspected, the following transition matrices were made with area percentages of said changes with respect to the entire city.

Table 6 Transition Matrix for LULC Change Detection 2018 vs 2019

		Change Into							**Net Change From**
	Class Name	Water	Trees	Crops	Built Area	Bare Land	Rangeland	**TOTAL**	
Change From	Water	6.79%	0.01%	0.36%	0.22%	0.00%	0.06%	7.45%	0.65%
	Trees	0.01%	0.49%	0.14%	0.16%	0.00%	0.06%	0.87%	0.38%
	Crops	0.20%	0.09%	17.22%	1.24%	0.00%	0.25%	19.02%	1.79%
	Built Area	0.04%	0.03%	0.33%	70.79%	0.01%	0.12%	71.33%	0.53%
	Bare Land	0.00%	0.00%	0.00%	0.01%	0.02%	0.00%	0.03%	0.01%
	Rangeland	0.02%	0.04%	0.14%	0.19%	0.00%	0.94%	1.32%	0.38%
	TOTAL	7.07%	0.66%	18.20%	72.61%	0.04%	1.42%	100.00%	
Net Change Into		0.28%	0.17%	0.98%	1.82%	0.02%	0.48%		

No change

Table 7 Transition Matrix for LULC Change Detection 2019 vs 2020

		Change Into							Net Change From
	Class Name	Water	Trees	Crops	Built Area	Bare Land	Rangeland	**TOTAL**	
Change From	Water	6.69%	0.01%	0.15%	0.18%	0.00%	0.04%	7.07%	0.38%
	Trees	0.00%	0.31%	0.12%	0.14%	0.00%	0.10%	0.66%	0.35%
	Crops	0.32%	0.06%	16.22%	1.22%	0.01%	0.38%	18.20%	1.98%
	Built Area	0.05%	0.02%	0.23%	72.12%	0.02%	0.18%	72.61%	0.49%
	Bare Land	0.00%	0.00%	0.00%	0.01%	0.03%	0.00%	0.04%	0.01%
	Rangeland	0.01%	0.01%	0.10%	0.17%	0.00%	1.13%	1.42%	0.29%
	TOTAL	7.08%	0.40%	16.81%	73.82%	0.06%	1.83%	100.00%	
Net Change Into		0.38%	0.09%	0.60%	1.71%	0.03%	0.70%		

No change

Table 8 Transition Matrix for LULC Change Detection 2020 vs 2021

		Change Into							Net Change From
	Class Name	Water	Trees	Crops	Built Area	Bare Land	Rangeland	**TOTAL**	
Change From	Water	6.69%	0.01%	0.21%	0.13%	0.00%	0.03%	7.08%	0.39%
	Trees	0.01%	0.26%	0.06%	0.05%	0.00%	0.02%	0.40%	0.14%
	Crops	0.33%	0.10%	15.38%	0.76%	0.00%	0.23%	16.81%	1.43%
	Built Area	0.12%	0.06%	0.54%	72.91%	0.01%	0.18%	73.82%	0.91%
	Bare Land	0.00%	0.00%	0.00%	0.02%	0.03%	0.00%	0.06%	0.03%
	Rangeland	0.03%	0.05%	0.22%	0.24%	0.01%	1.27%	1.83%	0.56%
	TOTAL	7.18%	0.49%	16.42%	74.12%	0.05%	1.74%	100.00%	
Net Change Into		0.49%	0.23%	1.04%	1.21%	0.02%	0.02%		

No change

Table 9 Transition Matrix for LULC Change Detection 2018 vs 2021

		Change Into							Net Change From
	Class Name	Water	Trees	Crops	Built Area	Bare Land	Rangeland	**TOTAL**	
Change From	Water	6.62%	0.02%	0.29%	0.42%	0.00%	0.09%	7.45%	0.82%
	Trees	0.02%	0.30%	0.14%	0.30%	0.00%	0.10%	0.87%	0.57%
	Crops	0.46%	0.11%	15.63%	2.36%	0.01%	0.45%	19.02%	3.39%
	Built Area	0.06%	0.04%	0.26%	70.73%	0.02%	0.22%	71.33%	0.60%
	Bare Land	0.00%	0.00%	0.00%	0.01%	0.02%	0.00%	0.03%	0.01%
	Rangeland	0.01%	0.03%	0.09%	0.31%	0.00%	0.87%	1.32%	0.45%
	TOTAL	7.18%	0.49%	16.42%	74.12%	0.05%	1.74%	100.00%	
Net Change Into		0.56%	0.19%	0.79%	3.40%	0.03%	0.87%		

No change

Scanning the transition matrices in Tables 6 to 9, it shows that an overarching theme for all of them would be that the “no change” cells would always contain the highest values in every column and row they are situated in. This means that majority of Bangkok's lands retain their original LULC through the year, and only a miniscule area of the city was detected to have undergone changes from 2018 to 2021. Looking more closely at the first matrix in Table 6, one can see that the highest conversion of lands between 2018 and 2019 were from the crops class, yielding 1.79% in the "net change from" area percentage. Backtracking to the left side of the values, it can also be seen that the said class yielded the highest change origin percentage for each column. Following the crops class is the water class in the highest area percentage of LULC conversion "from" with 0.65% of the entire city area. In opposition to this, the built area class was calculated to have the highest area percentage of lands being converted into with a rate of 1.82%, while the crops class comes second to it with 0.98%.

Moving on to the years when the new land and buildings taxation law was ratified and made effective, Table 7 (comparing the years 2019 and 2020) displays a similar trend in that the crops class is where most lands change from at 1.98%, and that the built area is still the top LULC that lands change into with 1.71%. However, for this matrix, the built area class took the second spot of the highest percentage of area where lands change from (with 0.49%), as opposed to water from the previous matrix in Table 6, and the rangeland class took the second spot as the highest changed into class with 0.70%. The numerical figures in Table 8 show similar trends for the years 2020 to 2021. Crops remain to be the leading "change from" class, yielding 1.43% area coverage, and the built area follows it with 0.91% area coverage. Similarly, the built area class still leads as the most "change into" class with 1.21% and seconded by the crops class with 1.04%. It should be noted, though, that the margin of difference between the built area and crops classes as the most changed into LULC classifications became slimmer as it changed from 0.84% difference in 2018 to 2019, and 1.11% difference in 2019 to 2020, to just 0.17% difference in 2020 to 2021. In essence, more and more conversions into the croplands happened in the last time period and have almost caught up with the built area growth in the city.

Lastly the matrix labeled as Table 9, supposedly representing the aggregate of LULC changes throughout the years (2018-2021), shows a consistency in the "change from" class leader having 3.39% area coverage. However, similar to Table 7, it is followed by the water class which was computed to have 0.82%. The consistency continues with the built area dominating the "change into" class at 3.40% area coverage but it is followed by the rangeland class with 0.87%.

As a final note for this section, it should be noted that the observations and insights made through the transition matrices further reinforce the major ones mentioned in Section 4.2.1, wherein the crops class appeared to be the most common change origin class and the built area being the most common change transformation class.

5.1.3. Suspected Tax Avoidance Activities

Narrowing down into the actual focus of the study, the LULC change detection maps were refined even further to just reveal the transformations *into* the vegetative covers, namely *trees, crops, and rangeland*. The maps below show the land parcels that are suspected manifestations of tax avoidance activities in Bangkok.

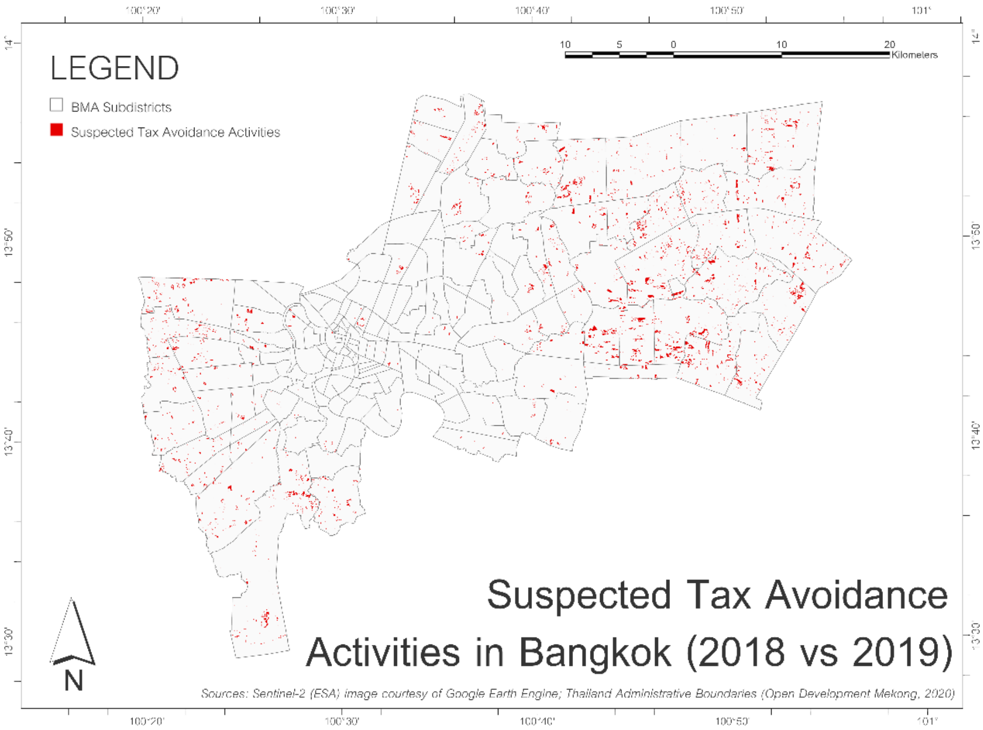


Figure 28 Suspected Tax Avoidance Activities in Bangkok (2018 vs 2019)

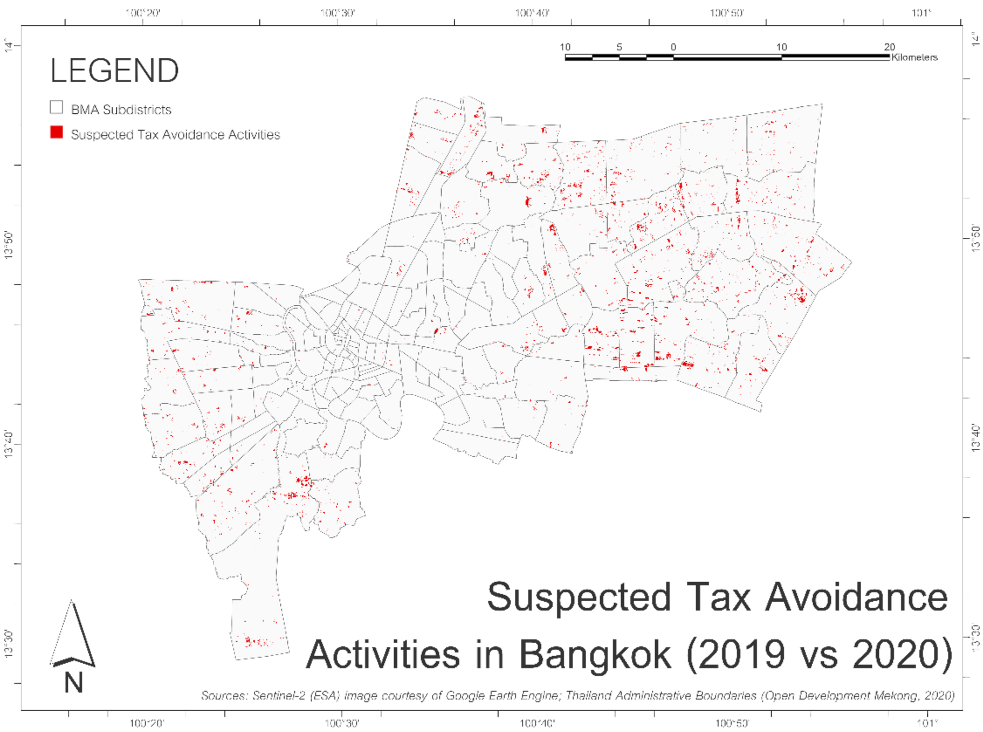


Figure 29 Suspected Tax Avoidance Activities in Bangkok (2019 vs 2020)

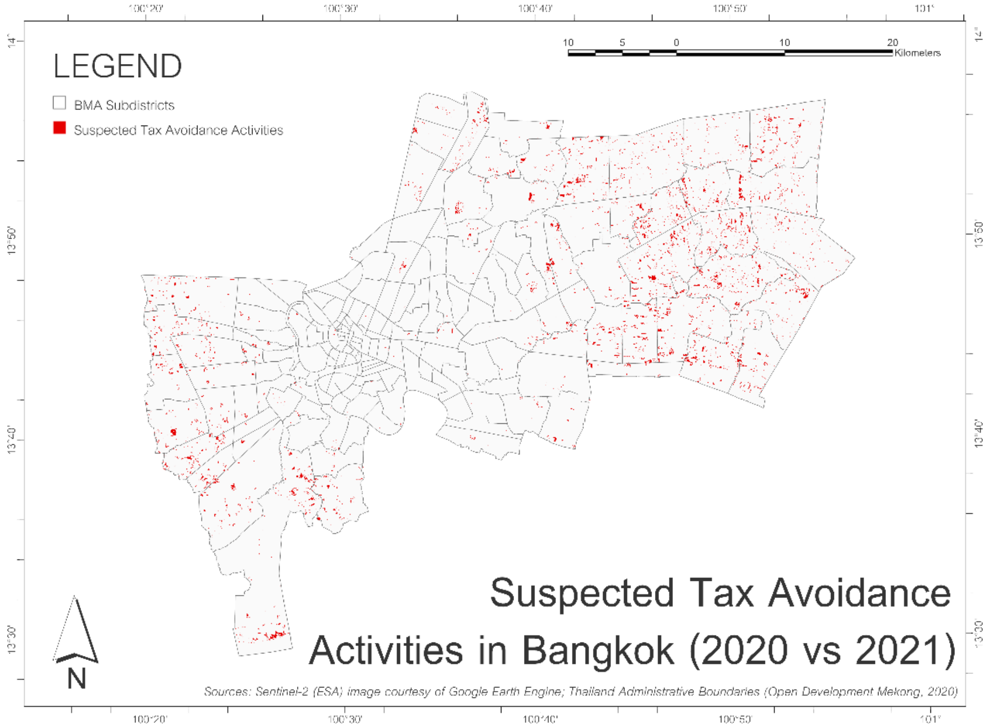


Figure 30 Suspected Tax Avoidance Activities in Bangkok (2020 vs 2021)

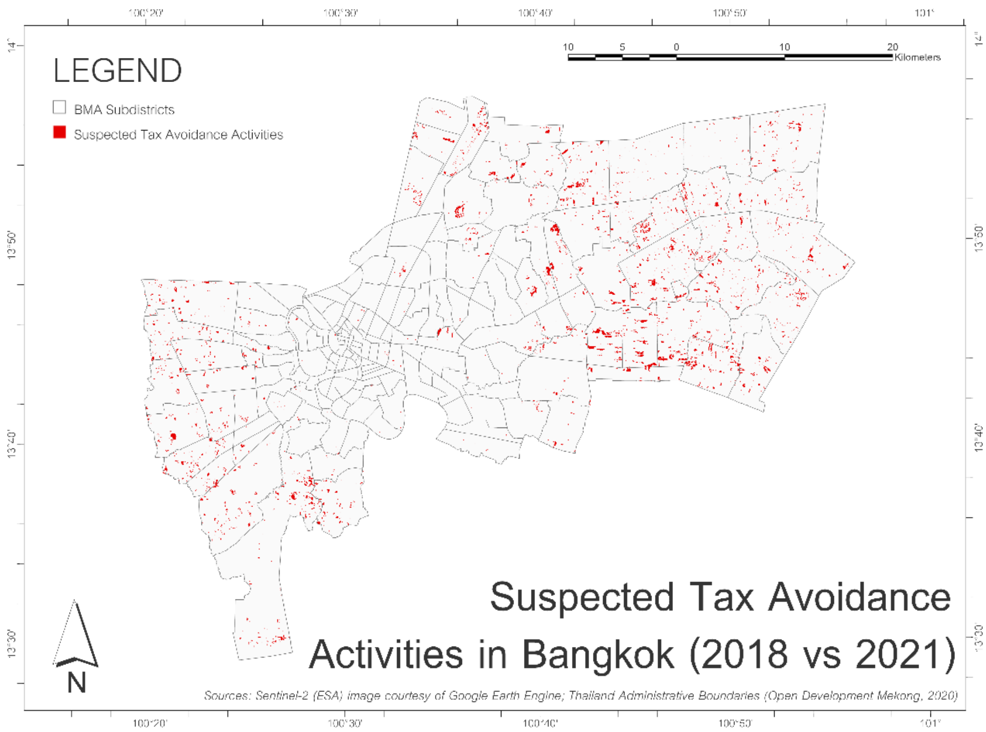


Figure 31 Suspected Tax Avoidance Activities in Bangkok (2018 vs 2021)

A common characteristic that can be seen through all the maps in Figures 28 to 31 would be that the detected suspected tax avoidance activities in Bangkok (marked in red) are mostly in the western and especially the eastern portions of the city, near the metropolis' administrative boundaries to the surrounding provinces. The location of these plots of interest may also be called the urban fringes. In comparison, the center of the city, also termed as the urban core, is noticeably almost empty of these LULC changes for all the time periods investigated. Turning one's focus onto Figure 28, it can be observed that there is a concentration of relatively larger plots of interest on the southeastern portion of the city for the years 2018 to 2019. Such observation proves to be not entirely true, moving on to the 2019-to-2020-time period. This is because the said concentration of larger plots appeared to be not as prominent in Figure 29 and became more evenly distributed throughout the fringes. Moreover, the suspected tax avoidance activities seem to be particularly less for this period compared to the last time span in Figure 28. The trend of having a more dispersed distribution of larger plots of interest continues for the 2020 to 2021 time period. However, it is noticeable how the smaller land plots suspected to be tax avoidance activities increased during this time. Finally, for the map showing the changes from the starting and ending study years, the observations for Figure 31 are mostly similar to Figure 28, as the concentration of larger plots of interest in southeastern Bangkok appeared to be prominent.

5.2. Geospatial Analysis

The Suspected Tax Avoidance Activities maps for 2018 to 2021 (Figure 31) were used to perform geospatial analyses to systematically determine where the LULC changes of interest are happening, as well as the type and level of spatial relations they have with one another. The following figures showcase the results of the said analyses, which were done through ArcGIS.

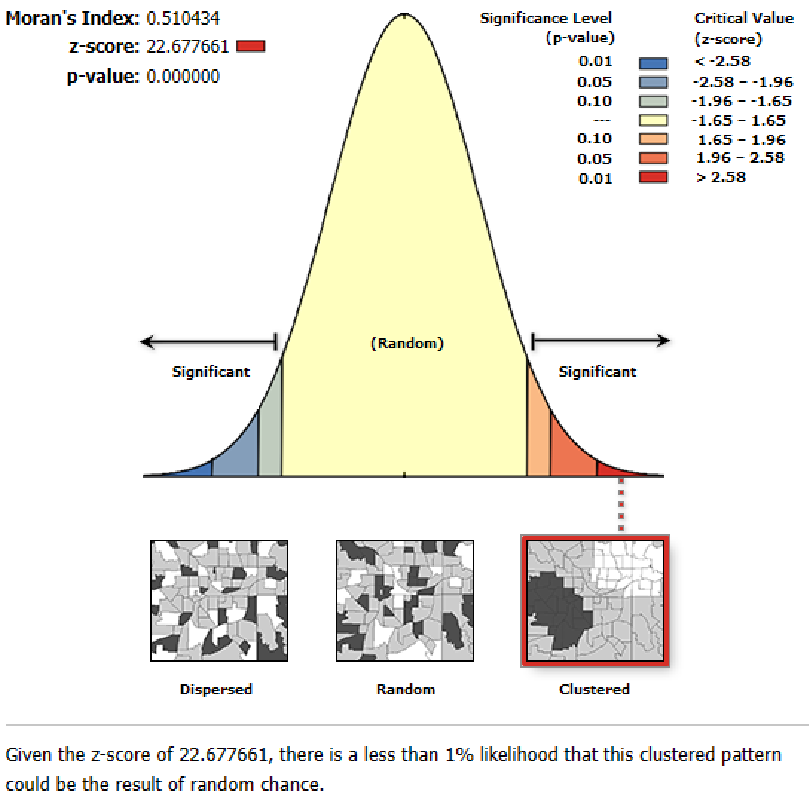


Figure 32 Results of Global Moran's Index

The first spatial autocorrelation analysis performed was the Global Moran's Index through the *Spatial Autocorrelation* function in ArcGIS. With the areas of suspected tax avoidance activity plots in each of Bangkok's sub-districts, the said model was run. Yielding a Global Moran's I of around 0.51, the test statistic of these LULC changes of interest were found to be clustered or occurring in close proximities with one another. The z-score that was obtained also proved to be relatively high at approximately 22.68, and combining this with a p-value which is extremely close to zero, these would mean that the clustering found is statistically significant. Moreover, as inscribed in Figure 32 itself, the said finding has a significantly higher likelihood of being true compared to just random spatial arrangement of the suspected tax avoidance activities.

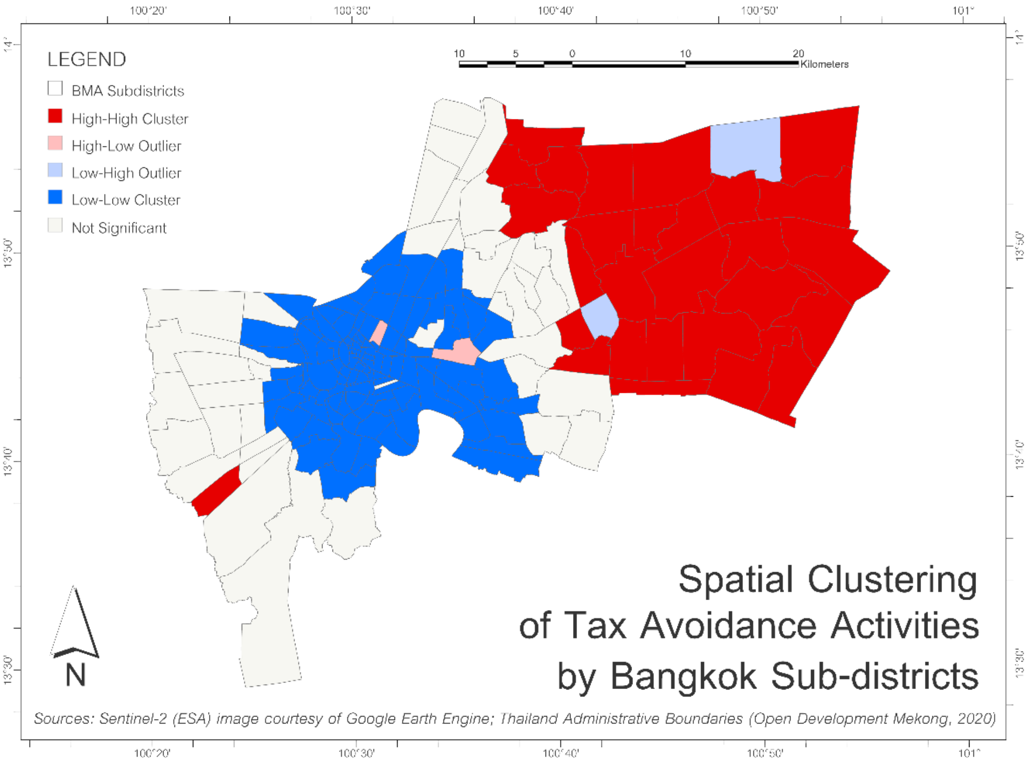


Figure 33 Spatial Clustering of Tax Avoidance Activities by Bangkok Sub-districts

The Local Indicators of Spatial Association (LISA) analysis was next performed on the same tax avoidance activities map. This was done through the *Cluster and Outliers Analysis (Anselin's Local Moran's I)* function in ArcGIS. As the function's name suggests, it identified the clumping together or isolation of the plots of interest in the sub-districts of Bangkok using the k-nearest neighbor algorithm as the method of detecting spatial clustering. Such analysis was done by measuring the extremely high or low calculated areas of suspected tax avoidance activities in each sub-district. The function categorized the spatial clusters in the sub-districts as *High-High* or areas with a lot of tax avoidance LULC conversions that are clumped together, *Low-Low* or areas with few of these LULC conversions of interest, *High-Low* or areas that have some portions with a concentration of the plots of interest but were surrounded lands that are not suspected for tax avoidance, *Low-High* or areas with low concentrations of the plots of interest but were surrounded by lands that were detected as clumps of suspected tax avoidance activities, and finally, *Not Significant*, which are areas with parameters that did not yield statistically significant spatial clustering (Anselin, 1995).

At a glance, one may notice the stark difference of the central portion of Bangkok with its outer areas. There is a notable concentration of the Low-Low cluster in the center of the city. However, there are exceptions to the rule as there are also High-Low outliers detected in the central area such as the Suan Chitlada and Bang Kapi sub-districts. Surrounding the concentration of Low-Low clusters in the urban core are sub-districts with no significant clustering, seemingly forming a wall as a transition to the outer portions of the city that are mostly identified as High-High clusters. These clusters can especially be observed in the eastern fringe of the city, whereas there is a lone High-High cluster in the western fringe in the Khlong Bang Bon Ai sub-district. However, as the eastern fringe is mostly populated by a single clustering type, the Low-High outlier areas, namely the Khlong Sib and Rat Phatthana sub-districts, stood out. In summary, the LISA analysis was able to identify concentrations of high and low tax avoidance activities in the fringes and center of Bangkok, respectively. Although, there are some exceptions to these main observations with the presence of outliers in both the city's center and edges. This main finding then agrees with the results from the global indicator, which found significant clustering of the LULC changes of interest in the city.

To further supplement the findings of the Global and Local Moran's indices in Figures 32 and 33, the following maps present the spatial associations between the suspected tax avoidance activities in Bangkok, with the k-nearest neighbor likewise used as the method of establishing spatial association, and the area of the plots of interest as the parameter to calculate and visualize their relationships with one another. The next two (2) maps were produced through the *Hotspots Analysis (Getis-Ord Gi*)* function in ArcGIS.

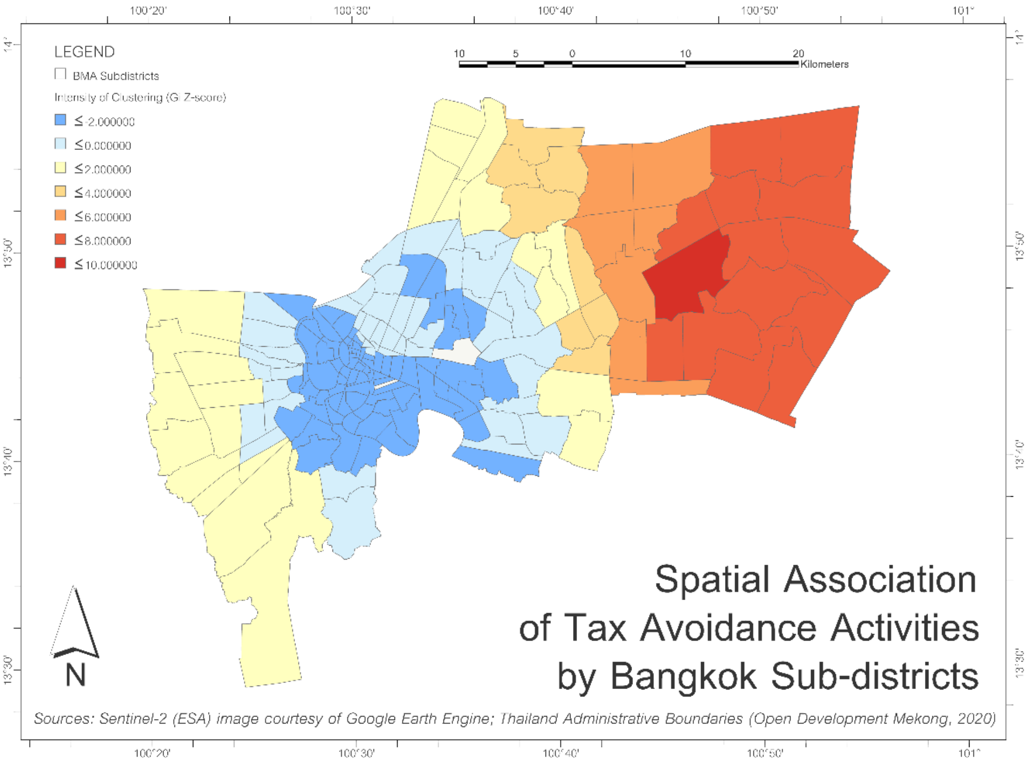


Figure 34 Spatial Association of Tax Avoidance Activities by Bangkok Sub-districts

Figure 34 above shows the results of the hotspots analysis, mapping the Gi* z-scores obtained by each sub-district in Bangkok. Values less than zero mean that they are *cold spots*, or clusters of low tax avoidance activities, while values more than zero mean they are *hotspots* or clusters of high tax avoidance activities The more positive or negative values correspond to greater intensity of the spatial association detected. In coordination to the results of the previously discussed figure, it was found that the inner areas of the city are cold spots, with increasing intensity along the center. The reverse is true for the outer portions of Bangkok as hotspots were identified right outside the cold spot-dominated core, and they tend to increase in intensity as one goes further out into the fringes. Such trend was most starkly observed in the eastern portion of the metropolis. Noticeably, there is a sub district in the area with comparably high z-score than the rest, in the form of the Saen Saeb sub-district that garnered a z-score close to 10.

Accompanying the spatial associations map in Figure 34 is Figure 35, which showcases the hotspots and cold spots that are statistically significant. The latter map was derived from the calculated Gi* z-scores at different confidence intervals.

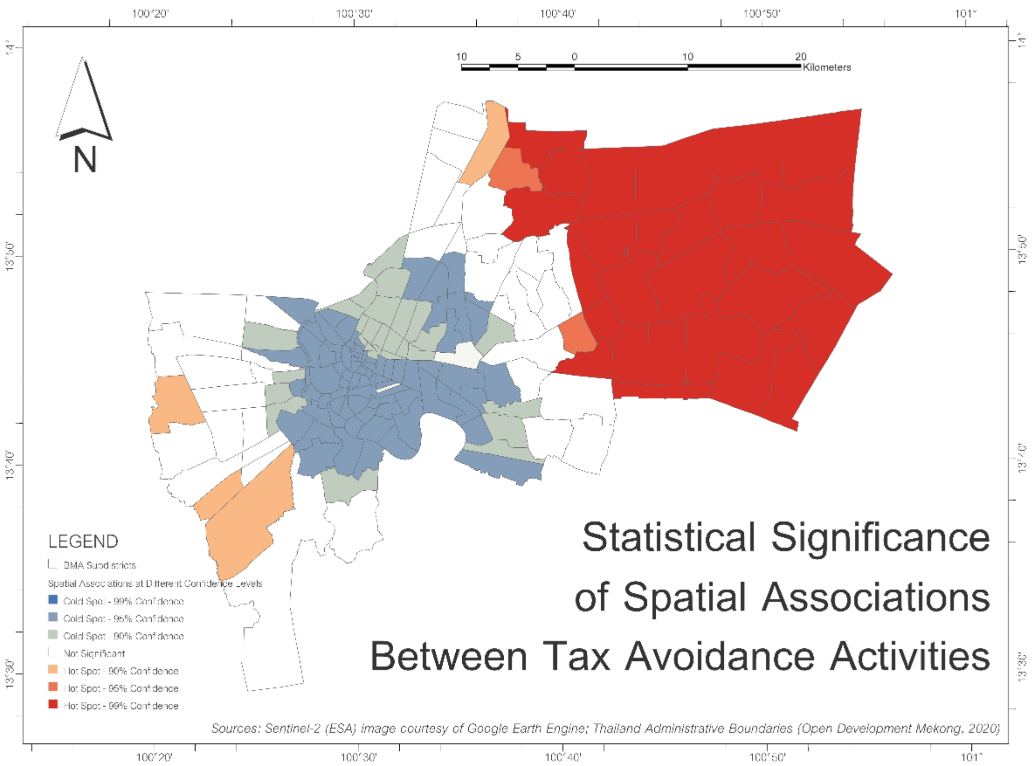


Figure 35 Statistical Significance of Spatial Associations Between Tax Avoidance Activities

As previously pointed out, the center is a populated by cold spot sub districts; only this time they are confirmed to be statistically significant. However, there are areas which were deemed to be non-statistically significant in the transitional areas between the urban core and urban fringes even though they were found to be either hotspots or cold spots with z-scores close to 0 in Figure 34. Varying from the results of the LISA analysis, the Getis-Ord Gi* hotspots analysis showed two more hotspots in the western fringe of the city, having Samae Dam and Nong Khang Phlu added to initially-identified Khlong Bang Bon Ai. Meanwhile, the general observation of the eastern fringe stands in that it is dominated by hotspot districts. In fact, almost the entire eastern section of Bangkok turned out to be hotspots at the highest confidence levels.

Even so, Khlong Thanon and Saphan Sung were detected to be hotspots at lower confidence intervals (95%) and Sanam Bin was calculated to be a hotspot at only 90% confidence.

These detected hotspots and cold spots of spatial association mean that the observed parameters or phenomena in the featured locations are most likely interrelated with one another. In essence, this means that these practices of possible property tax avoidance are apparently not isolated events and they may tend to affect one another, given their high statistical significance. Combining these with the insights from the Global Moran's I and LISA, one may conclude that not only are there concentrations of high or low tax avoidance activities, but these clusters are in fact related with one another. These can now all be driven back to the main basis of these methods- Tobler's First Law of Geography.

Tobler asserted that, "Everything is related to everything else but near things are more related than distant things." The main concept behind this theory is that distance tends to hinder the interactions between places (Tobler, 2004). With the support of such ideations, it can be explained why there are disparities between the urban fringes and the urban core. It may be because the suspected tax avoidance activities in the fringes are losing their influence as one travels towards the city center. This theoretical underpinning may also be used to interpret why there are sub-districts of weaker Gi* z-scores (close to zero) and lower statistical significance in between the urban core and fringes, as seen in Figures 34 and 35. The reason would be that both the influences of the cold spot urban core and urban fringes are decaying with distance, and it is in these transitional areas, there are only weak influences from the cold spots and hot spots, making the models for spatial autocorrelation deem them as areas of non-significance. Finally, the first law of geography unravels why the results for spatial clustering and spatial association coincide with one another. As observations of the tax avoidance activities clump or concentrate in certain areas, it means that they more likely have closer distances from one another, making it easier for them to interact and influence one another.

As a final note, there are some limitations that should be kept in mind in using and interpreting these geospatial analyses results, particularly for LISA. For one, Anselin, the developer of the model itself, warned that spatial heterogeneity may be a natural feature of the study area. This means that the extremely high or low concentrations of certain observations may be the norm and so any hypothesis for the model may be invalid, and interpretations might be misconstrued (Anselin, 1995). Moreover, Grubesic et al. (2014) also pointed out that these approaches for spatial autocorrelation may have the tendency to make type 1 errors or false positives. Finally, they also mention that spatial non-stationarity can prove to be an issue as well, given that the local Moran's I may not account for fine-scale spatial variations (Grubesic et al., 2014).

5.3. Data Triangulation

As a way to confirm the accuracy of the detected LULC changes, tax avoidance activities, and tax avoidance hotspots from the previous sections, a data triangulation process was implemented. By use of Google Street View, Google Earth Pro, NDVI signatures, and Site Visits, the identified transect sampling sites were inspected. They were then numbered from left to right named according to landmarks or their area locations, all which are reflected in Figure 36.

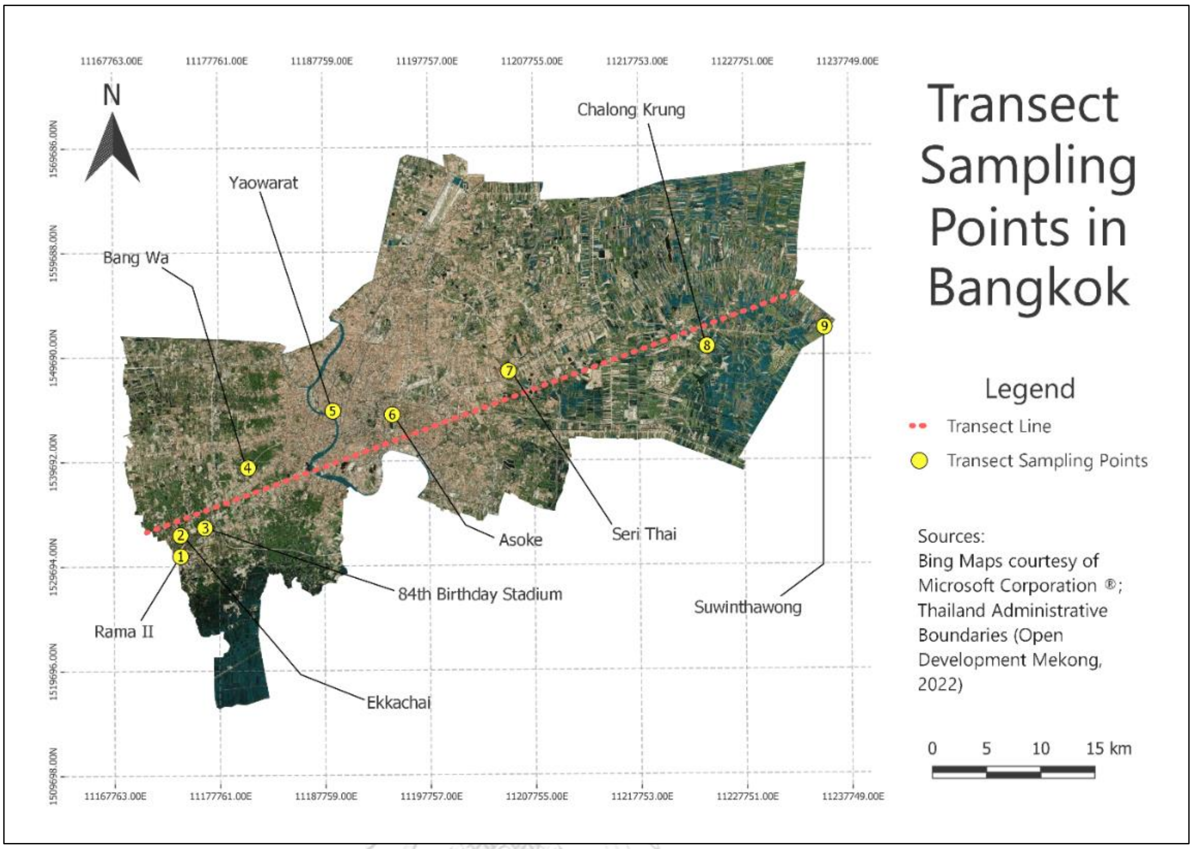


Figure 36 Transect Sampling Points for Data Triangulation

To ensure the consistency of comparison between the different platforms used, specific points in the plots of interest were identified. Their respective coordinates were obtained and used to inspect the transect sites through the online and on-site triangulation methods. The results of the data triangulation process via transect sampling are as follows.

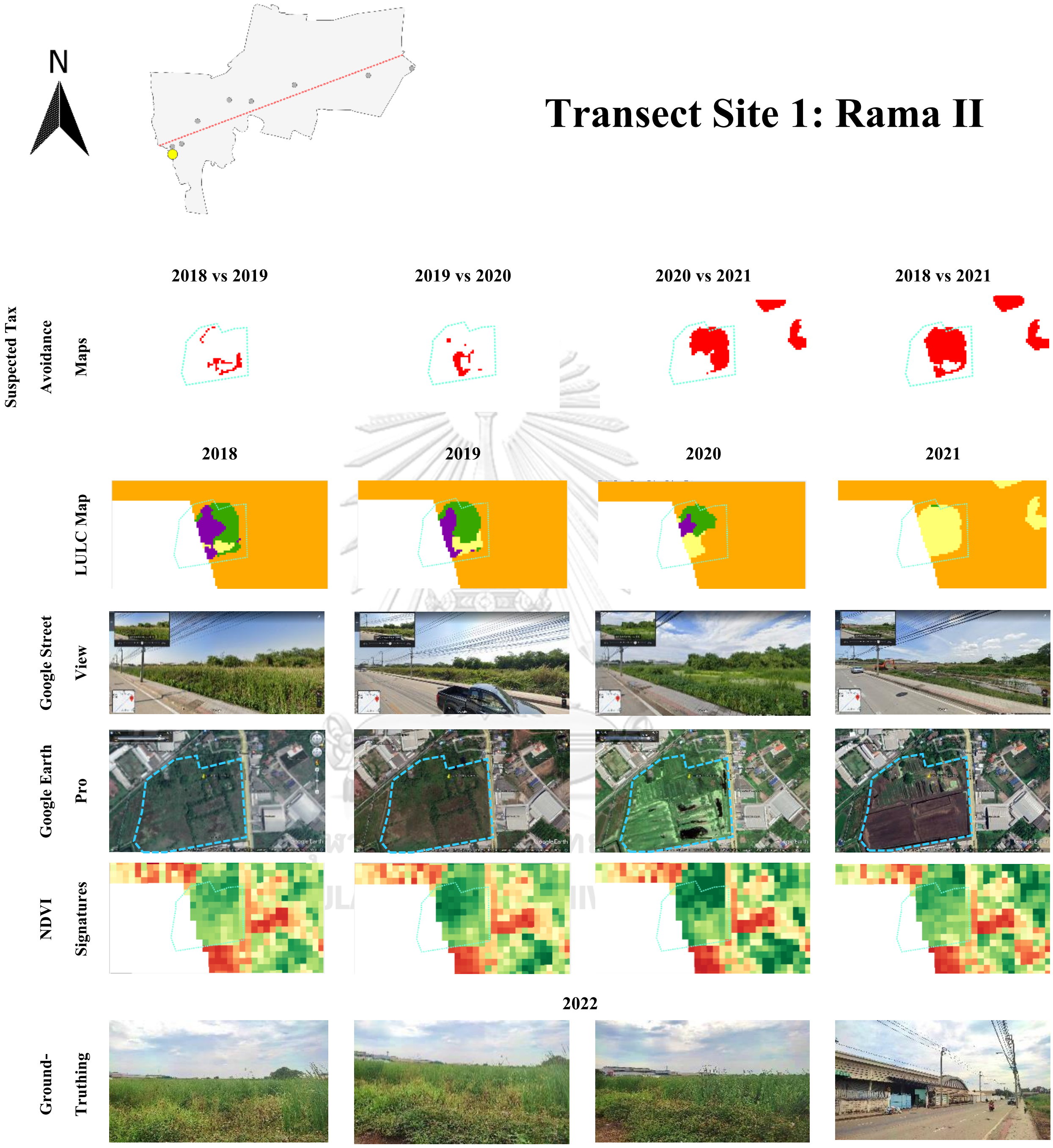


Figure 37 Data Triangulation for Transect Site 1: Rama II

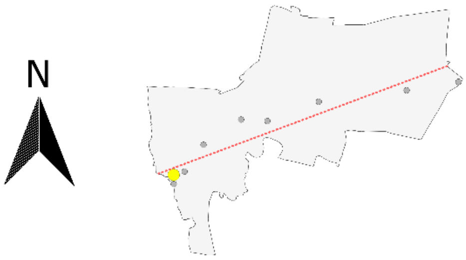
The first site, located near the major road, Rama II, demonstrated a decrease in rangeland at the middle portion of the plot and taken over by forest land and agricultural land for the years

2018 to 2019. This could be seen through the LULC maps and the derived change detection maps. It may not be as noticeable through the Google Street View images but Google Earth Pro provided images that showed more prominent vegetative growth in in the upper central part of the plot in 2019 while the bottom right portion was rid of random vegetative patches (Maxar, 2019e). This was also reflected by the NDVI maps wherein one would be able to observe the dark green pixels in the area of interest at the northern portion of the site in 2019 (Gorelick et al., 2017). Although, it can be seen that even though there are indeed trees in the northwestern portion of the site as seen in Street View and Google Earth Pro, the LULC map was not able to reflect the fine detail of them being in linear patterns and inscribing smaller vegetative patches.

The study period in 2019 to 2020 saw further minimization of the rangeland and also the decrease in forest cover in favor of agricultural land. This could be easily confirmed via Google Earth Pro and the NDVI signatures registered in the area. The 2020 image of Site 1 in Google Earth Pro exhibited more lush vegetation, reflected by the dispersion and further intensification of darker green pixels in the NDVI maps from the same year. It should also be pointed out that for the 2020 Google Earth Pro scenery, the land showed to have stripes of vegetation especially in its western and northern portions- which, as pointed out before, are signs of agricultural use (Maxar, 2020f).

The period between 2020 and 2021 showed an almost complete takeover by agricultural use of the entire plot, as what could be seen in the change detection maps and LULC maps. This time, the Google Street View image (taken from the road running along the right side of the plot) (Google, 2021c)showed the drastic change that happened in the area- the trees and other taller vegetation that were observed in the previous images were almost cleared out and lines of vegetation and irrigation system could be noticed from the sample. This is further confirmed by the Google Earth Pro image (Maxar, 2021d), which showed clearer lines of vegetation in the upper half of the plot and soil-tilling for agricultural purposes at the bottom half. The irrigation system could also be clearly seen running across and around the plot in the same image.

Finally, results from the site visit indicate clear conversion into agricultural land as the plot (although populated by some random plants in the areas facing the road) is almost completely covered in what appeared to be garlic plants, and almost devoid of trees. There is also a land depression at the perimeters, where water runs, which can be inferred to be the irrigation system observed in previous images. So, through these observations, it is clear that Site 1 was converted from vacant land, covered with random vegetation and lined with a few trees, into agricultural land with clear lines of crops, an irrigation system, and evidence of top-soil manipulation.



Transcect Site 2: Ekkachai

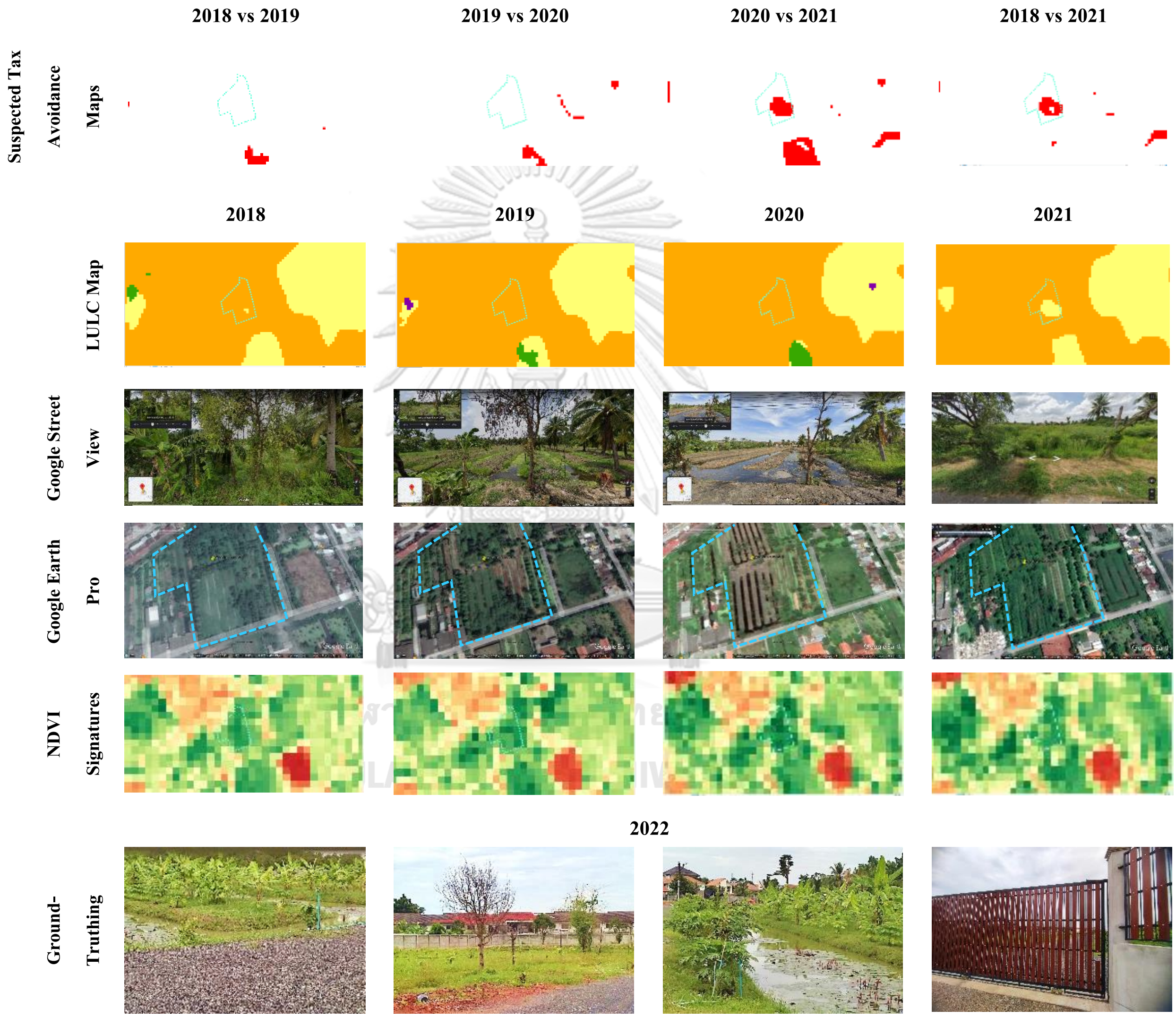


Figure 38 Data Triangulation of Transect Site 2: Ekkachai

According to the change detection maps and LULC maps, Site 2 underwent an abrupt conversion into agricultural use in 2021. In the images, there was only a speck of agricultural land identified in 2018 but no changes were seen until 2021. However, the images from Google Street

View, Google Earth Pro and the NDVI signatures reveal earlier changes. Imageries from the Google platforms in 2018 already feature some lines of vegetation, albeit being slightly unnoticeable. This may not be fully proven by the Google Street View sample in 2018 (Google, 2018d) with high mixing of different plant species, the presence of random vegetation in the understory near the ground, and the randomness of plant body placements with no visible patterns observable in the image. However, moving on to the 2019 Google imageries (Google, 2019e; Maxar, 2019d), the land was clearly transformed with the appearance of crop beds that stretch across the plot, the disappearance of understory vegetation, a more visible pattern of vegetation- which are also observably less diverse. From the Street View scenery, it can be seen that it is mostly coconut trees lining the right borders of the lot and banana saplings populated the crop beds formed in the middle section of the site. There is also now an irrigation system that has been created to support the inferably planted vegetation at the center of the plot. These claims are supported by the darker hues of green that developed in the area as per the NDVI maps. In 2020, the plot demonstrated even more noticeable signs of human modification via agricultural use as the irrigation system became even more prominent with the wider water canals dividing the crop beds (Google, 2020d; Maxar, 2020e), and the NDVI maps displayed darker hues of green in the site. The final study year just continued the LULC from 2020, with the crops and irrigation system observable from the Google-sourced images. (Google, 2021b; Maxar, 2021c) However, there is some noticeable overgrowth of the crops planted in the designated crop beds among other plant species.

Reflecting back to the LULC maps, it can already be concluded that the plot of interest was mostly misclassified into a built-up area despite it actually being vegetated for all of the study years. In fact, the land should have been classified as fully agricultural right from the earliest study year. This can be further confirmed by the results of the site visit, as the land could be said to be still utilized for agricultural purposes in 2022. It appeared that the site is highly modified as the owners already finished putting up walls and gates around their property. They also diversified the crops in their land with the addition of papayas and lime trees to the initial banana trees they have been planting. Another note-worthy observation from the site would be that surrounding plots also exhibit agricultural conversion characteristics that can be backed up by the neighboring suspected tax avoidance activities from the change detection maps. In the end, as Site 3 already displayed signs of agricultural use even before the implementation of the new land and buildings taxation policy, it may not be considered as an actual tax avoidance activity.

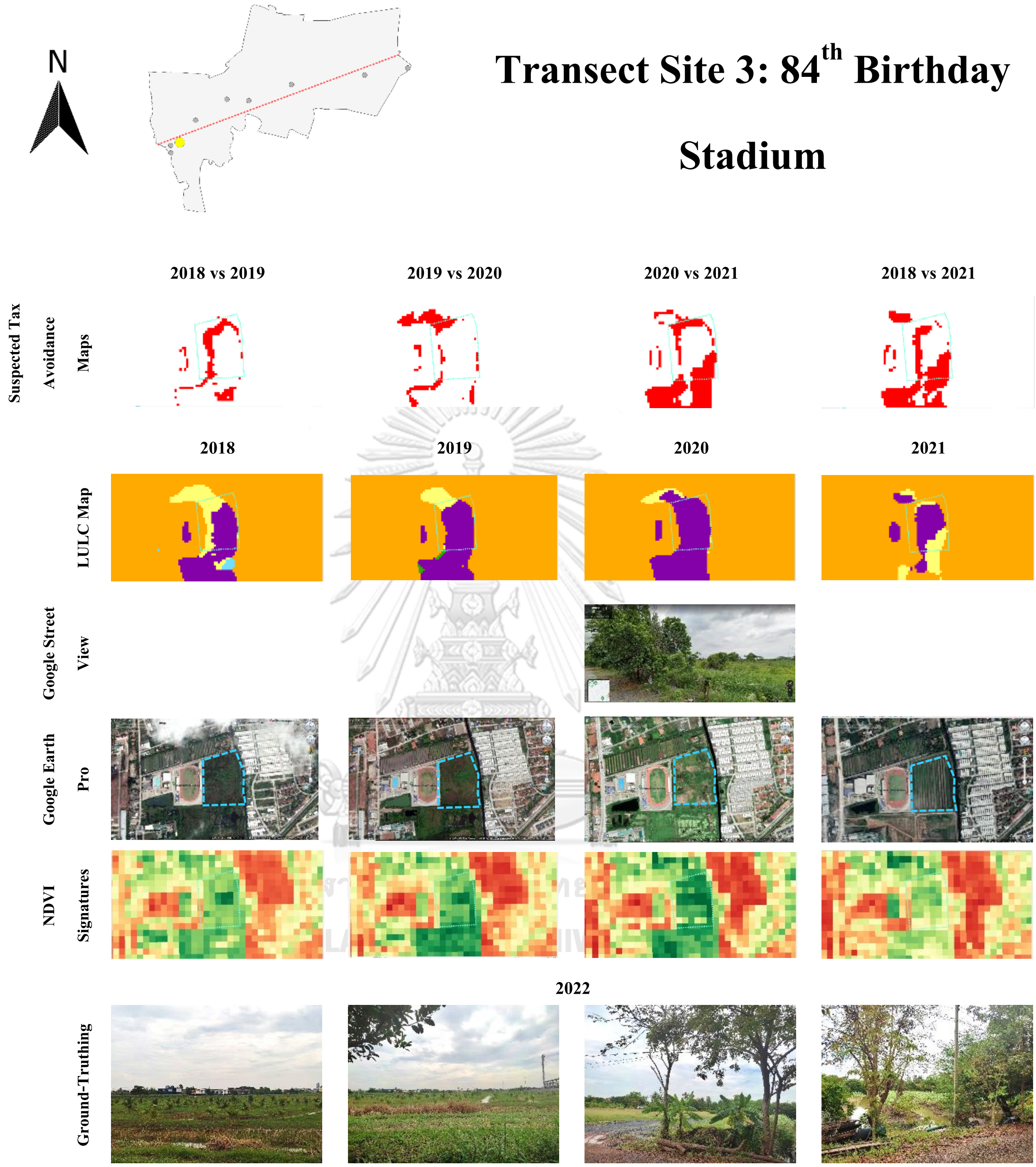


Figure 39 Data Triangulation of Transect Site 3: 84th Birthday Stadium

Throughout the study years, the images of Site 3 in the LULC maps displayed a supposed intrusion of rangeland into crop land, with a re-emergence of the crops LULC in 2021. Even so, the Google Earth Pro images show that there was not any portion of the land used for agriculture in 2018 and that the LULC map was accurate in classifying the land into rangeland (apart from the built area identified on the left edge) (Maxar, 2018a). The reason for this is that from 2018 to 2020, the plot was indeed covered in random smaller vegetation with no clear patterns as per the sceneries from Google Earth Pro (Maxar, 2018a, 2019a, 2020a). This can be further confirmed by the lone Street View image which showcased the plot (Google, 2020a). As previously pointed out, the site was detected to have been partly converted into agricultural use according to the 2021 LULC map. But then again, the Google Earth Pro imagery showed that the entire plot had been converted for agricultural purposes with the sudden appearance of neatly patterned lines of vegetation, along with irrigation canals on their sides.

Looking at the NDVI signatures, it could be said that the trend was disrupted as it appeared lighter green in 2018 and was continually intensifying until 2021. This must have been the random vegetation dominating the plot and continually growing and being more efficient in primary productivity throughout the years. Then in 2021, the pixels suddenly turned mostly yellowish with lighter shades of green, indicating a decrease in vegetation intensity (Gorelick et al., 2017). This correspond to the period when all the random vegetation must have been cleared in favor of crops and the soil was tilled and modified to transform into what was seen in the Google Earth Pro from the same year. Finally, the site visit confirmed that Site 3 has been converted into agricultural purposes with lines of banana trees occupying the land and an irrigation system in place. This could be seen in the first two images from the left in Figure 39. Moreover, the surrounding lands of the site were also observed to exhibit conversions into agricultural purposes as evidenced by the rest of the site visit photographs and even the suspected tax avoidance map clips of the site.

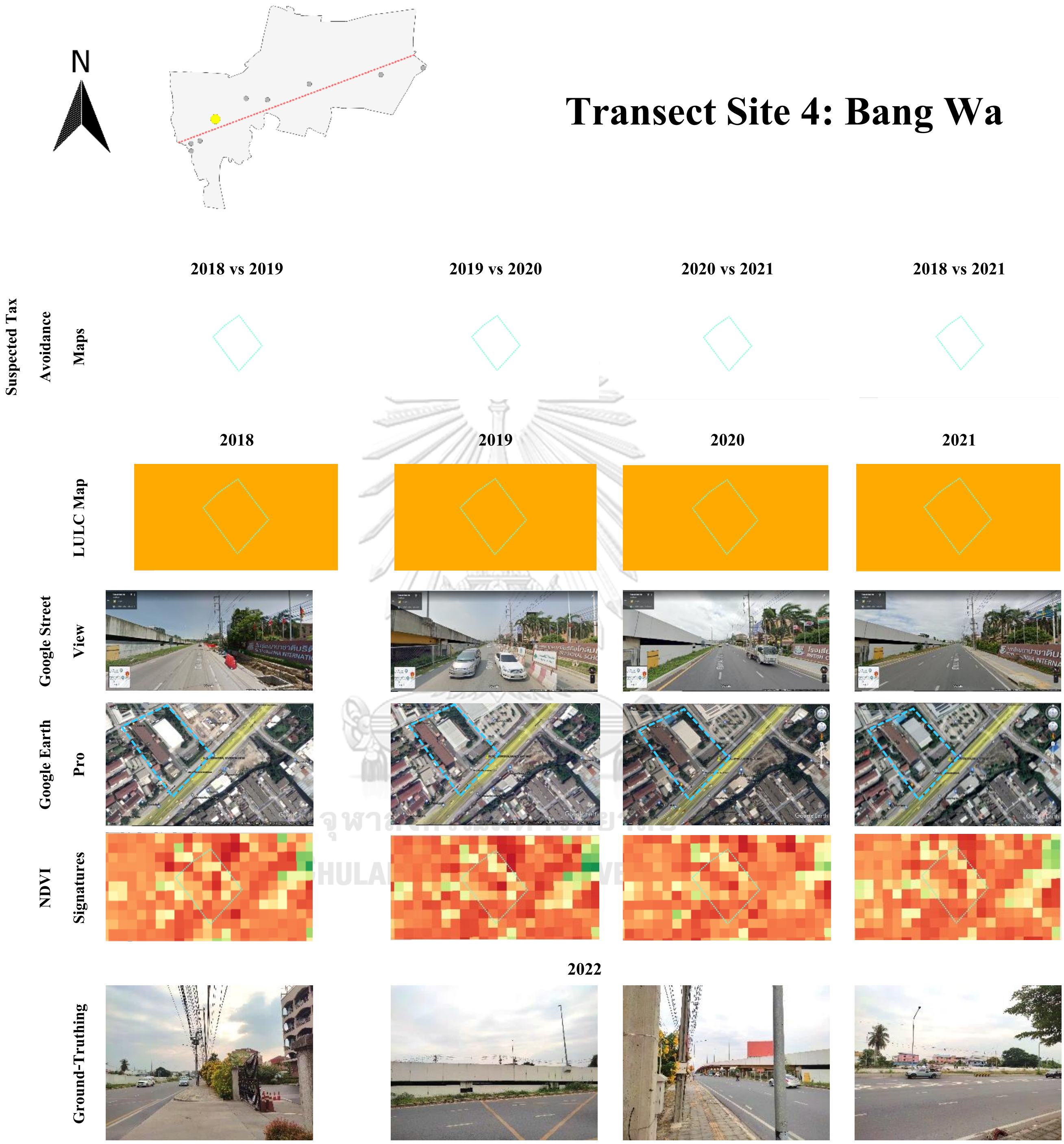


Figure 40 Data Triangulation of Transect Site 4: Bang Wa

Site 4, located along a main road, did not show any LULC changes throughout the study years according to the LULC maps, and consequentially the suspected tax avoidance maps. This was affirmed by the sceneries derived from Google. Through Street View, one would be able to observe that almost no changes happened in the site, except for some construction that happened in the sidewalk located on the southeastern portion of the plot in the 2018 to 2019 period (Google, 2018b, 2019c). The bird's eye view provided by Earth Pro, more or less agree with the previously-mentioned observations. This is because the two large, parallel-aligned buildings that occupied the plot, along with their surrounding vegetation did not show changes from 2018 all the way to 2021 (Maxar, 2018c, 2019c, 2020c, 2021b). It should also be pointed out that the vegetation in the site was a fine-scale detail that the LULC map was not able to reflect. Consulting the NDVI maps next, it could be concluded that the site remained mainly built up in all of the study years as red pixels dominated the clips for all time periods of interest (Gorelick et al., 2017). However, unlike the LULC map, it was able to reflect the vegetative cover in the site with the yellow pixels lining the northeastern and western portions of the land plot. Finally, the site visit confirmed these observations as majority of the plot was indeed mostly covered in concrete, with some occasional vegetation for ornamental purposes. It should be noted, though, that the images and observations were mainly made from the road on the southeastern side of the plot, and the inner areas were not observed as much given it is a private land. Nevertheless, it could still be established through the different data sources that Site 4 did not exhibit visible, significant LULC changes for all of the study years

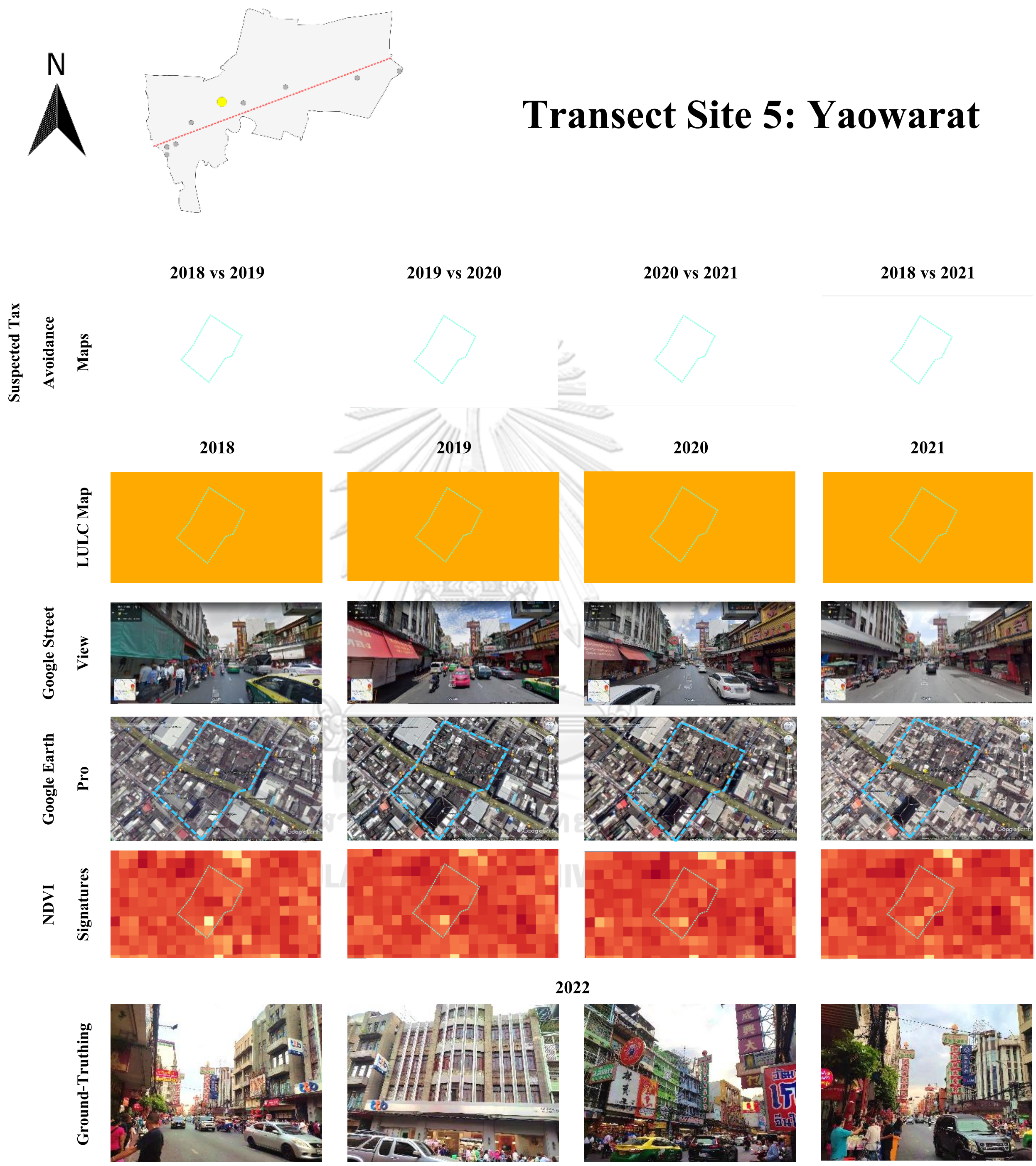


Figure 41 Data Triangulation of Transect Site 5: Yaowarat

The next site inspected is part of a culturally and historically significant part of Bangkok: The Chinatown. Located right in the middle of the city, it is no surprise that the plot did not exhibit any changes in the LULC and suspected tax avoidance maps. With the Google Street View images (Google, 2018f, 2019g, 2020f, 2021f) taken from the road running in the middle of the site, one would be able to observe some changes in the signage and the occupants of the sidewalk. However, it is undeniable that there were no significant changes in LULC and the area stayed commercial, occupied by small-medium food enterprises, and covered by low to mid-rise buildings, and concrete roads and pavements. The more comprehensive sceneries provided by Google Earth Pro (Maxar, 2018g, 2019g, 2020g, 2021f) and the NDVI imageries (Gorelick et al., 2017) do not deviate from these observations as the buildings and roads remained relatively the same throughout the study years. One noticeable characteristic from the NDVI maps, would perhaps be the lone yellowish pixels that was consistently present in all of the images. This can be interpreted to be the white roof of a building, which can be seen in the Google Earth Pro images. Finally, the site visit served as just another confirmation of the unchanged land cover of the site. Even so, it provided more insight on the use of such land as it was observed to be very dense, filled with tourists, and has medium to heavy traffic.

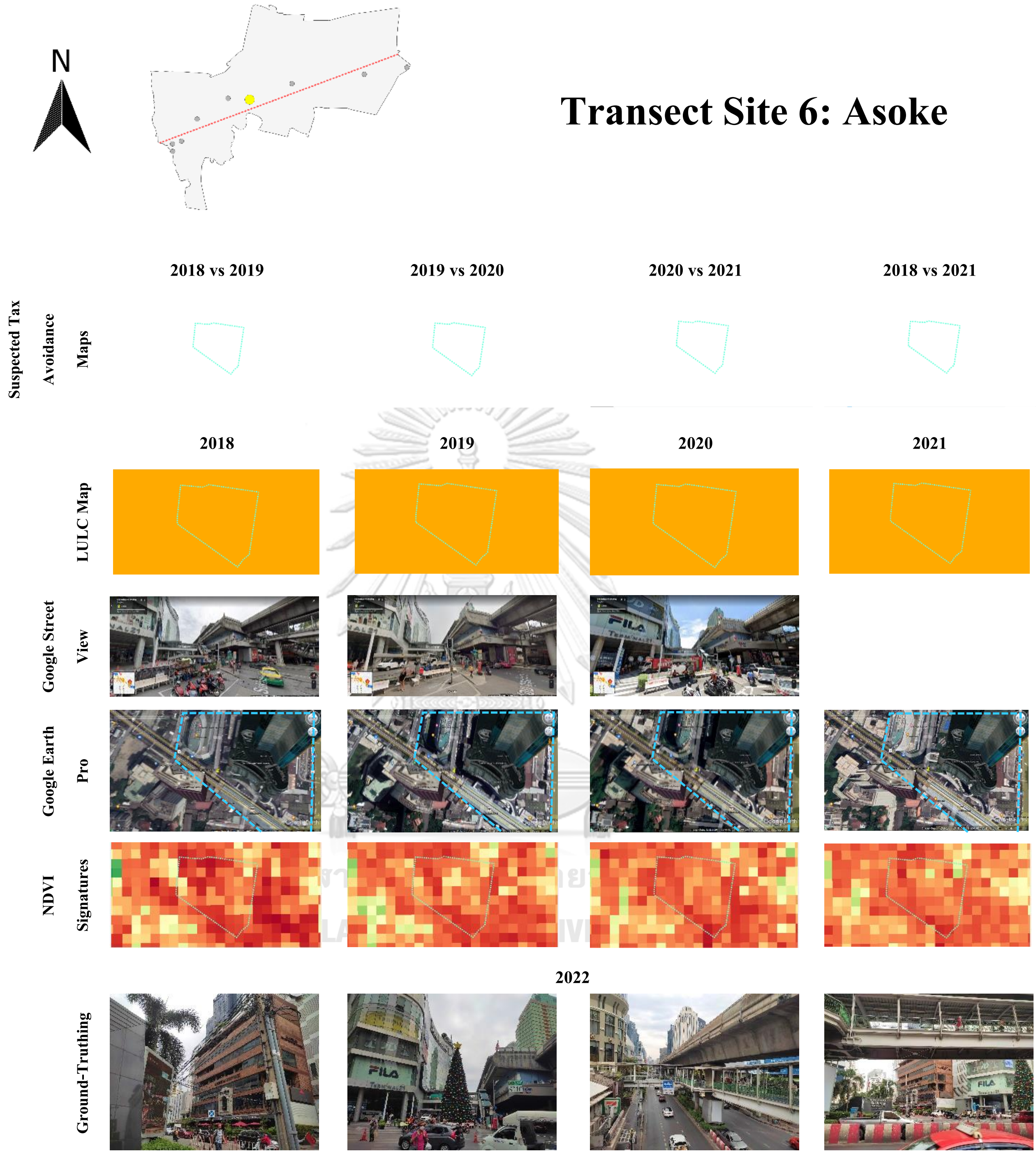


Figure 42 Data Triangulation of Transect Site 6: Asoke

Located in one of Bangkok's business districts the land in Site 6 was also heavily built up. Like the two previous sites, both the LULC maps and the derived suspected tax avoidance maps showed no changes at all. The same is true for the Google Street view images, where only minor changes in the sceneries can be observed, and no significant LULC changes could be deduced (Google, 2018a, 2019b, 2020c, 2021a). The images from Google Earth Pro emphasize even further how built up the area was, as they showed the size and density of infrastructure in the site- having high-rise buildings, a train station and major roads inscribed in it (Maxar, 2018b, 2019b, 2020b, 2021a). The NDVI maps (Gorelick et al., 2017) further support earlier observations of the site staying built-up for all of the study years. They, however, were able to detect some of the few vegetated areas in the site; located at the bottom left of the plot in 2018 and 2019, and in the upper right in 2020 and 2021. The last method of data triangulation- the site visit- merely served as a confirmation of the rigidity of LULC in Site 6. The area was observed to be occupied by massive and expansive concrete infrastructure, with occasional vegetation. With its largely commercial use, there was a diversity of vehicles and peoples populating the area at the time of visit.

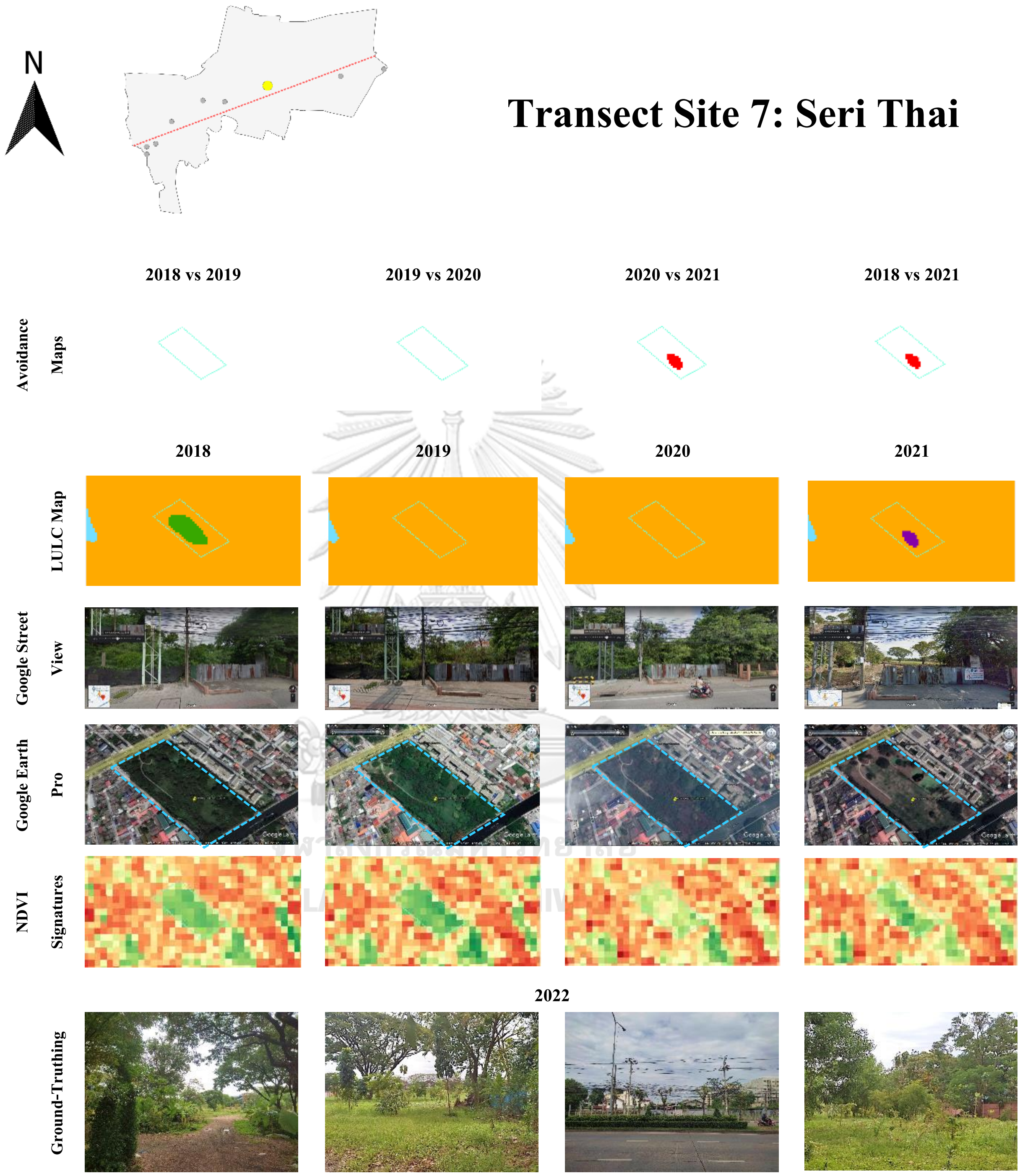


Figure 43 Data Triangulation of Transect Site 7: Seri Thai

From the LULC maps alone, it appeared that Site 3 experienced urban expansion during the study years given that the tree cover in the middle of the land plot in 2018 was converted into built area for the next two years before the re-emergence of rangeland in 2021. As a result, the suspected tax avoidance map clip only displayed the last LULC conversion that was just mentioned. By looking at the Google-sourced imageries, one would be able to confirm that the tree cover in the 2018 LULC map was more or less accurately classified, even though it should have been almost the whole plot that was classified into tree cover (Google, 2018e; Maxar, 2018e). On the other hand, the urban classification in the LULC map could be confirmed inaccurate as both Street View and Earth Pro images consistently showed a continuation of the initial LULC of the plot. For the last study year, the LULC map was correct in detecting the changes that occurred in the site, however, it is most likely not into a rangeland but instead it was transformed into a crop land. The Google street view image of the site in 2021 (Google, 2021d) displayed a clearing out of the random taller vegetation that had been previously observed in the site. Zooming into it, one would be able to see that there are young tree saplings planted on the area. These observations may also be made from a higher viewing angle in the Google Earth Pro images and it is more evident how the planted young trees (which are the smaller green dots in the middle of the site) are actually arranged in clear patterns (Maxar, 2021e).

Moving on, the NDVI signatures indicated slightly different findings. For the most part, they agree with the images from Google Street View and Google Earth Pro for the first two study years. This is a further confirmation of the slight inaccuracies in the LULC maps as the signatures indicate vegetative cover in the plot for these years. But in the 2020 image, the plot displayed weaker NDVI signatures, with yellow pixels dominating the site whilst images from the Google platforms still showed almost full tree cover. Based on the observations from previous sites, most of the study year may have been the period when the land was cleared out to make way for the new LULC and the available images from Street View and Earth Pro may have been taken before all such changes were implemented. Similar to the sites where tax avoidance activities also occurred, there was an observed recovery in the 2021 NDVI scenery as greener pixels started reappearing- indicating a re-growth in vegetation (Gorelick et al., 2017).

The site visit images served as confirmations of the land's conversion into supposed agricultural use with the presence of neatly arranged vegetation, primarily of young tree saplings. The third image from the left was taken as the land across the site was also exhibiting the same characteristics. Although it was not detected in the suspected tax avoidance activities maps as its location in the northern part of the site was constantly classified as built area for all of the study years. To conclude, given that the site remained a rangeland for the study periods before 2020, and showed signs of LULC conversion into agricultural purposes after the mentioned study year, it could be deduced that Site 7 is most likely an exhibition of tax avoidance activity in Bangkok.

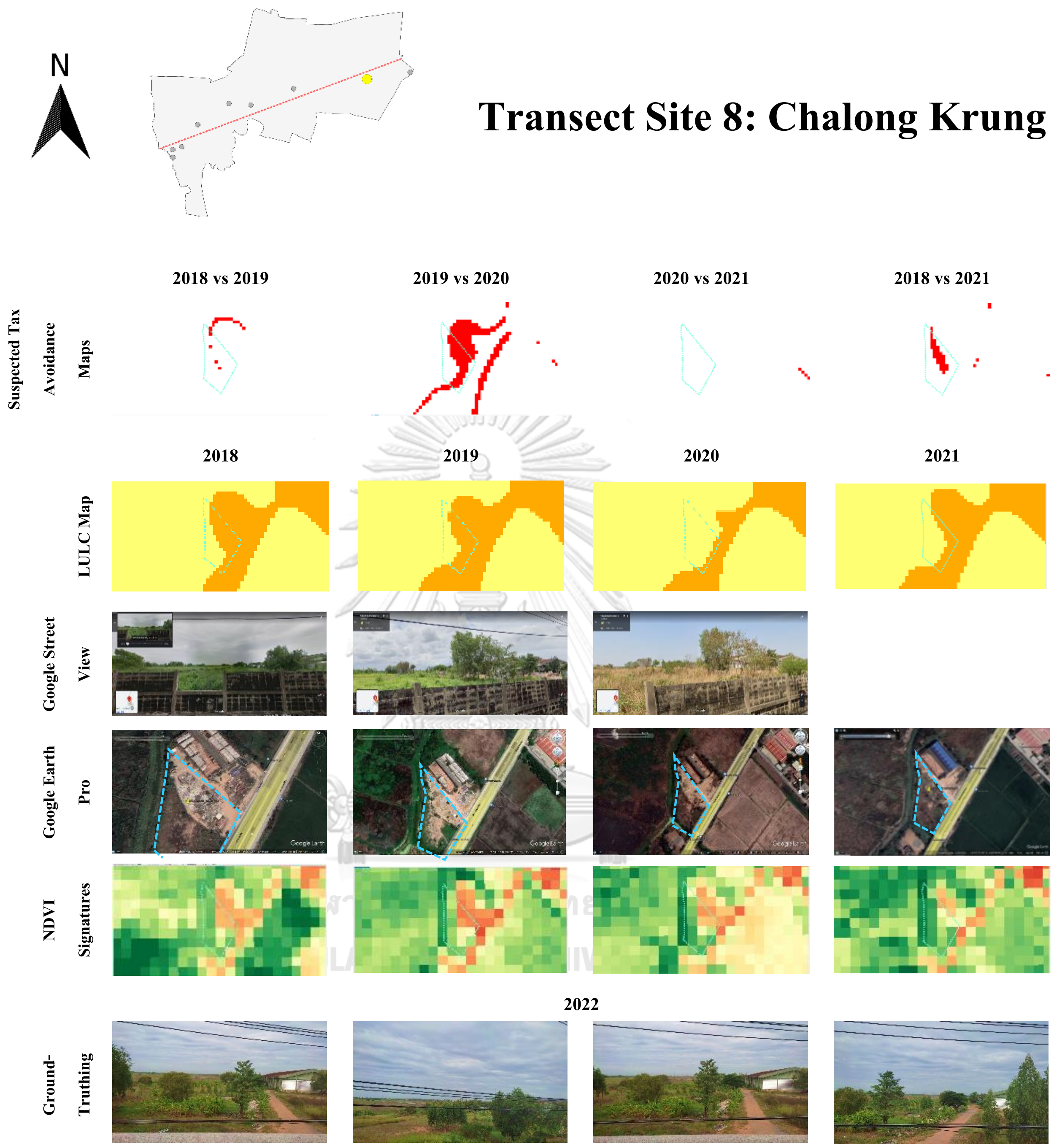


Figure 44 Data Triangulation of Transect Site 8: Chalong Krung

Site 8's LULC maps showed a back and forth between the crops class and the built area class. In the two initial study years, there were no huge changes seen in the plot, which was almost perfectly halved into crop lands and built areas. Then in 2020, there was a sudden expansion of crop land, taking over the vast majority of the plot. The map for the final study year, however, displayed a re-introduction of the built cover. Cross-referencing these observations with the Google Street View images, it was revealed that there had actually been vegetative cover in the area, as well as some built cover in 2018 and 2019 (Google, 2018c, 2019d). But there is a minor discrepancy with the LULC maps because the vegetation present in the Street View scenery are in random spatial patterns, and there are a variety of species intermixed with one another- meaning it would have been classified better as rangeland area. The Google Earth Pro images from the same years then provide additional insight as they further confirm the existence of built area in the plot, which may be inferred to have been used for industrial waste disposal (Maxar, 2018d). This is further confirmed by the NDVI signatures, which reflected the vegetative cover in the western portion of the plot through the green pixels, and the presence of the built area in the eastern portion of the land (Gorelick et al., 2017).

The year 2020 was marked with LULC change of relatively great magnitude as per the LULC maps. This is more or less reflected by the Google Earth Pro image given the visible growth of small vegetation in the previous built area (Maxar, 2020d). However, the NDVI signatures still showed the area to be built area with the red pixels (Gorelick et al., 2017). Now going into the final year, the LULC map indicated a re-emergence of the built area located at the northeastern part of the site. However, the triangulation sources say otherwise. If one could zoom into the Street View picture, there are some lines of banana trees planted in the area of interest. Moreover, the Google Earth Pro image showed vegetative growth with even spacing in the said land portion. This claim is reinforced by the NDVI map as green pixels took over the entire plot. Additionally, the site survey further proved this recent conversion of the plot into agricultural purpose as the plot was observed to indeed house neatly arranged banana trees, along with some perennial trees. The industrial waste that was being dumped in the area was not observed. As a final note, it was observed that there is an abundance of crop lands in the general vicinity of the site (mainly rice fields), and the LULC maps confirm that majority of these agricultural lands have had the same LULC throughout the study years.

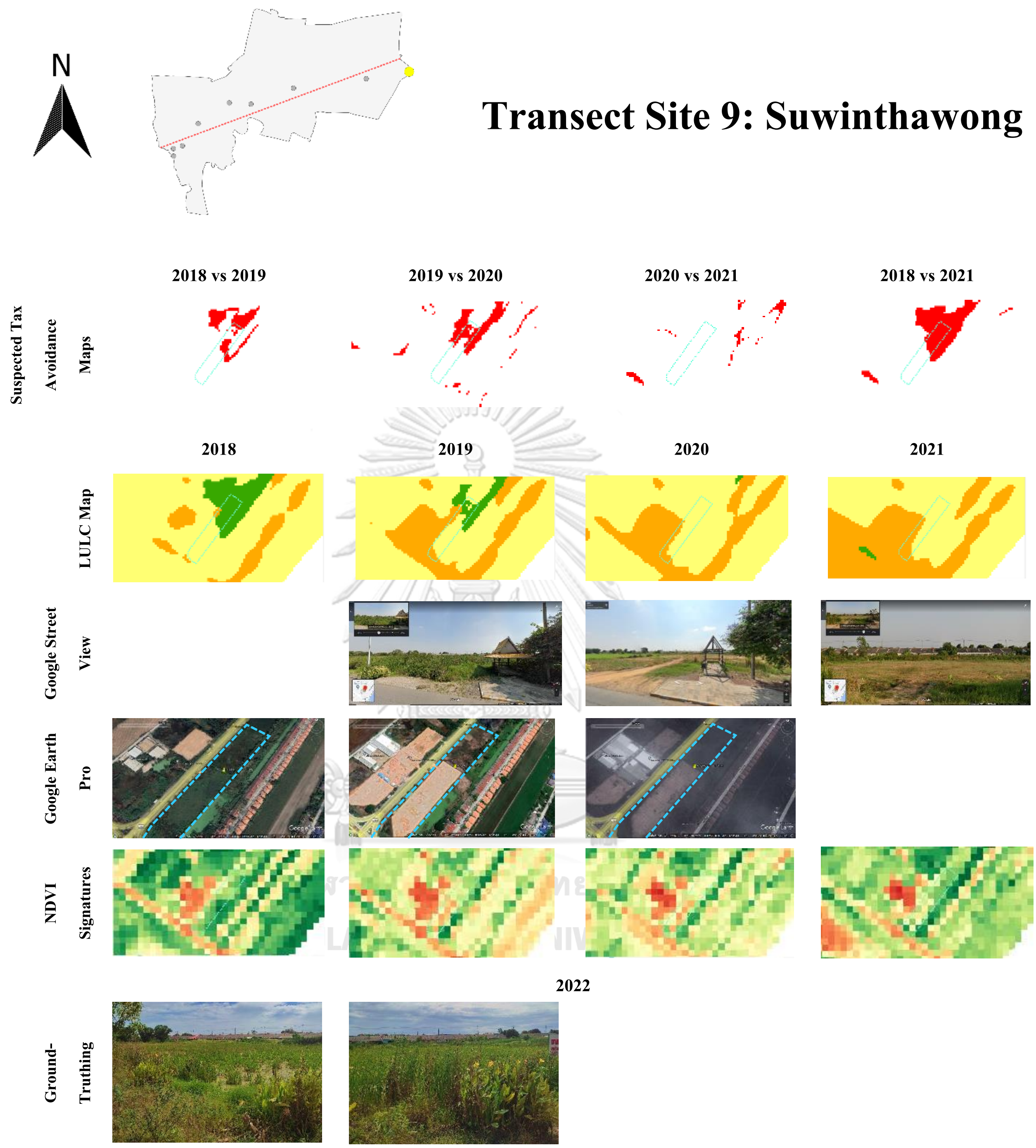


Figure 45 Data Triangulation of Transect 9: Suwinthawong

Starting off again with the LULC maps, it was observed that there was a takeover of forest land by cropland from 2018 to 2019. According to the same source, the site turned almost completely into cropland by 2020 and 2021, with some built area identified in the southwestern portion of the plot. Comparing these with the available Google Street View images of the northern part of the plot, it could be confirmed that there was indeed vegetative cover in the area back in 2019 (Google, 2019f). However, the randomness of the species, and spatial arrangement and height of vegetation indicate that the site was not filled with trees and was more probably a rangeland. The only other Street View images available was for the years 2020 and 2021 (Google, 2020e, 2021e). The scenery was taken at the same place as in 2018. It could be immediately seen that the plants that used to populate the area were almost entirely cleared out to make way for presumable crops, given their clear spatial patterns.

Going now into the data gathered from Google Earth Pro, the vegetative cover in the entire site for 2018 could again be verified (Maxar, 2018f). Moreover, the proposed rangeland classification can be further supported by such image as the plant bodies did not exhibit linear and/or evenly-spaced patterns. With the more comprehensive imagery provided by Earth Pro, the rangeland classification may also be proposed for the southern portion of the site. Moving on to the 2019 image (Maxar, 2019f), it was observed that two-thirds of the plot was cleared out and should have been classified as bare ground while the rest of the land remained to be inhabited by vegetation. Unfortunately, there were no sceneries available in the Google platforms for the year 2021, and so the NDVI signatures were then consulted.

Majority of the observations that were just made actually prove to be true as per the NDVI maps. In 2018, it was evident that the site was completely vegetated as evidenced by the green pixels populating the area. The non-existence of darker green hues in the northern portion of the land also serves as support to the rangeland classification proposal, as trees should register higher NDVI values. The clearing out in the southern portion of the site in 2019 was also reflected in the NDVI signatures with the sudden appearance of orange and yellow pixels in the region of interest. The northern portion could also be confirmed to have stayed vegetated as it still showed green pixels. As the southern part of the plot stayed bared in 2020, all of the data so far point to it being converted to agricultural purposes- and the NDVI signatures are no exception. This is because the 2020 NDVI maps showed a weakening of the signatures in the said study year demonstrated by the yellowish pixels in the area. And in 2021, there was a recovery observed as the northern part's pixels darkened in hues once again, which was previously interpreted as the planted crops growing and thriving. On the other hand, the previously bare southern part of the site also displayed an increase in NDVI signatures for the last study year (Gorelick et al., 2017). Unfortunately, it could not be confirmed through the Google platforms if this was the growth of crops or random vegetation.

The site visit images then provided an approximate of the more recent LULC changes that happened to the plot. The northern part of the plot was indeed observed to be agricultural, except that for the time of the site visit, it was being used as a rice field. Meanwhile, the southern portion of the land indeed ceased to be bare ground, in coordination with the NDVI map. The area was determined to have been planted with garlic, although there may be some random plants in the areas along the edges near the roads, as demonstrated by the bottom-most clips in Figure 45.

In summary, as the study sites provide a cross-section of Bangkok, it can be noticed that most of the confirmed conversions from vacant land into agricultural lands are located in the outer portions of the city. Meanwhile, the sites located in the center of the metropolis were more likely to not experience any LULC changes during the study period (2018 to 2021). This agrees with the results from the hotspots analyses, where the cold spots of suspected tax avoidance activities were mostly concentrated in the urban core and the hotspots were mostly identified in the urban fringes. The presence of some suspected tax avoidance activities in the surroundings lands of the fringe sites also confirm the spatial association results from section 5.2. Such observations emphasize that the LULC changes of interest in this study are not mere coincidences or isolated cases but are individual cases that are most likely related with one another.

Additionally, the LULC maps from ESRI proved to be worthy of use in this study as they were instrumental in detecting crucial change despite the occasional inaccuracies they displayed. On the other hand, the triangulation platforms were also mostly useful as they were able to provide alternative historical imagery, which otherwise could not be confirmed by the site visits.

The timing of when the images were taken prove to be a factor in the triangulation process as it became a source of discrepancies in some cases but it was addressed by looking at the other data sources that provided more insight to help deduce the changes that actually occurred.

Evaluating the triangulation process itself, it was found that the transect sampling method is resource-effective all the while being able to achieve the objectives of the results confirmation. The researcher was able to save a lot of resources (e.g. time, finances, manpower, etc.). Meanwhile, the sampling process was able to provide a cross-section of Bangkok that is supposedly a representative of the lands across the city and was able to confirm majority of the results from the preceding remote-sensing and GIS methods. The researcher did not have to inspect all of the lands in the entire city, as it would be resource-intensive, although it would be recommended for future studies which would want to achieve pinpoint accuracy in their change detection and tax avoidance detection processes.

Moving on, considering all conversions into vegetative LULC proved to be valuable in the study as it was able to account for the inaccuracies from the source maps. By not trimming down the data too much, the process of LULC change and tax avoidance detection was still able to consider the misclassified plots and made them available for further observation and analysis. Going now into the alternative data sources used for the triangulation process, the first one is Google Street View. This platform utilizes crowd-sourced imagery coupled with scenes taken by Google itself. Some disadvantages of this data source include the unavailability of images in certain sites, especially if they were not accessible by road. Their image capture is also fragmented as certain study years did not have sceneries as well. However, when image clips were available, Street View was able to provide images that are similar to how one would encounter the site when doing on-the-ground inspections. Because of this, it is able to show more fine-scale data, allowing for more specific observations of study sites. Next is Google Earth Pro. This platform makes use of satellite imagery and so there is more regular image capture, and consequently more data available. There were still some observable time skips between image captures but they were nonetheless available for the sites in almost all the study years. The downside for this specific data source is that there is minimal to no pre-processing done to the satellite images, and as a result there are numerous images that are hard to observe because of low brightness, extensive shadows, cloud cover, among others. Nevertheless, general observations on patterns of lands were made possible. Google Earth Pro was also deemed to be more useful in confirming the accuracy of the LULC maps and the changes detected via the GIS methods as it provided a similar scale and context for observation. Then, the NDVI signatures provided yearly averages of plant productivity. The maps were able to detect minute changes in LULC, especially the vegetative ones, which is the focus of this study. It should be noted, though, that vacant lands are also usually covered by thriving vegetation, which may in turn register to have high NDVI signatures. For this reason, the inspection of the land plots of interest for multiple years is extremely relevant as one would be able to track the step by step transformation of the land parcels being studied. This is because, as what can be seen in the sites located in the urban fringes, the transition between vacant to agricultural uses means clearing out of the random vegetation occupying the lands to make way for the crops- which coincides with drops in NDVI values before their eventual recovery as the planted crops establish themselves. Overall, this data source was able to confirm the previously identified vegetative LULC changes effectively. Lastly, the site visits provided up-to-date images and observations of the site. The images and observations from this process were able to either confirm or update the results from the above sources and processes, and even provide more insight on the surrounding lands.

As mentioned before, the differences on when and how the imageries from these sources were produced was a source of discrepancies. Some sources feature yearly averages, like the ESRI LULC maps and the NDVI signatures, while some utilize snippets of the sites in specific points in time during the study year. So, there may be mismatches in the data presentation occasionally. However, putting the multiple spatio-temporal images from these sources and observing carefully how the land changed throughout the study years helped make sense of the actual LULC changes that happened. As long as the same sites were observed, the multiple fragments of data were able to reveal the true LULC changes. This then reveals the significance of consulting multiple data sources to arrive at more accurate findings, especially in the context of remote-sensing.

5.4. Logical Confirmatory Test

As one may recall, one of the methods in confirming the relationship between socio-economic policies and LULC changes is through the logical test performed by Redo et al in 2012 in Uruguay. The same was done for this study and it is detailed as follows.

The first logical condition for relating economic policies to LULC changes as per Redo et al (2012) was that the time period of the policy's implementation shall match the time period when the LULC changes happened. The new land and buildings taxation policy in Thailand became officially effective in 2020, and so the said year was the critical time demarcation for observation in this study. Recalling the change detection maps from section 5.1.1., it was pointed out that from the year 2020, the crops class became second to built areas as the most "change into" class. Moreover, the suspected tax avoidance activities maps in section 5.1.3. also showed how in the year 2020, the plots of interest became smaller and distributed throughout the fringes of the city from being concentrated in bigger plots at the southeastern portion of the area of interest. Going into the more specific land plots, the transect sites inspected in the previous section (5.3.), particularly the ones located in the fringes (Sites 1, 2, 7, 8, and 9), displayed LULC changes into inferably agricultural in 2020 or 2021. Almost no conversion into the LULC class of interest was observed in 2018 to 2019. Given these, it can be said that the first logical condition for relationship was met, with the coinciding time periods of the new land and buildings taxation policy and the agricultural LULC conversions observed in Bangkok.

The second logical condition set by Redo et al in their study is that the LULC changes being instigated by the policy must coincide with the actual LULC changes that happened or are happening in the area of interest. Although it may not have been explicitly stated in the law document itself, the high rates set by the lawmakers for unused or vacant lands in the country obviously sought to discourage such land use, in favor of the other more productive uses. At the same time, the low rates set for agricultural lands would consequentially encourage people to turn into said land use for lower taxation liabilities. This can again be confirmed by the insights formed through the change detection maps, the suspected tax avoidance maps, and the data triangulation processes in sections 5.1.1., 5.1.3., and 5.3., respectively.

Finally, Redo et al. set the third logical condition such that the intended trajectory and consequences of the economic policy should be on the same track as the LULC changes to confirm their relationship. As what was demonstrated in the previous conditions, it can be concluded that the trajectory for land use and land cover that were non-directly instigated by the new taxation policy certainly match. However, it was overtly stated in the law document itself that it sought to significantly increase the tax collection for higher revenues. Given the response of the government of Bangkok, wanting to prevent vacant land conversions into agricultural lands, it appears that the intended consequences of the policy are currently not satisfied. This is because ever since the new policy was implemented, the national government has given 90% discounts on taxpayers to mitigate the financial impacts of the COVID-19 pandemic (Bangprapa, 2020). In essence, the new property taxation policy has never collected full tax rates when it has historically comprised majority of Bangkok's self-collected revenue (Jangratsameekan & Phijaisanit, 2017).

Overall, the case of the new land and buildings policy in Bangkok was able to satisfy at least two of Redo et al (2012)'s three logical conditions to establish a relationship with LULC changes in the city. This is because the current circumstance of the city prevented it from satisfying the entirety of the third condition as it actually has not proved to yield greater revenues for the metropolis. Despite this, the logical test is able to demonstrate a positive relationship between the Land and Buildings Tax Act of 2019 and the vacant land conversions into agricultural lands in Bangkok.

Inspecting this method of confirming relationships between land-related taxation mechanisms and LULC changes by Redo et al., it could be said that there are multiple changes that have to be made in order to increase its general usability. Firstly, the condition for matching time periods between the policy and the LULC changes is considerably sound given that the phenomena of interest are time-bound and should definitely coincide in the time periods in which they happen. To illustrate, if a certain property taxation law is not yet effective or was already phased out when the LULC changes occurred, then they have a high likelihood of being unrelated. This is unless there are preemptive or after-effects of the law that may manifest in the LULC changes even before or way after the law's effectivity. Nevertheless, this logical condition is a solid path in confirming the relationship between land economic mechanisms and LULC changes.

Secondly, the condition on matching LULC changes is also relatively sound given that land-related economic laws are purposive and they are often times utilized to encourage or discourage certain LULC types. So, if the government-intended LULC match with the actual land changes in reality, then this condition would be a good relational confirmation indicator. However, this condition may also be seen in the light of taxpayer responses. What if taxpayers do not want to change their land, or convert it into the exactly opposite type compared to the encourage LULC type? It would be better than for this condition to account for varying taxpayer responses. Researchers in the future are then recommended to improve this by changing the completely matching clause into being "related" to account for response differences.

Finally, Redo et al., asserted that there should be matching trajectories and outcomes for the land taxation policies be deemed related to LULC changes that occurred in study areas. They included this logical condition to account for the longer-term policy directions and intended results of the policies put to place. Again, this would be sound if the general direction paved by the policy is being followed and coordinate with the LULC changes. But, as mentioned previously, policies and citizen responses to them can go in directions totally different from prescribed, depending on their respective contexts. Like recommendations for the second logical condition, this test may improve by generalizing the pre-requisite into general relations between the policy and LULC change trajectories and outcomes.

5.5. Statistical Analysis

The total area of the respective tax avoidance activity plots within each of the Bangkok sub-districts were obtained and used for this analysis. The tax avoidance activities from before the effectivity of the new property tax policy in 2020 were compared to the ones that were detected after the said law has taken effect. At 180 degrees of freedom and the alpha value set at 0.05, the test yielded a t-statistic value of 2.54 (t(180)=2.54). Meanwhile, the p-value was computed to be 0.01. Just from the p-value alone, one can already tell that the test yielded a statistically significant result, given that 0.01 is far less than the alpha value of 0.05. Moreover, the t-statistic turned out to be 2.54, which notably exceeded the t-critical value of 1.97. This means that the null hypothesis can be rejected, and a statistically significant difference was detected between the vacant-to-agricultural land conversions in Bangkok before and after the implementation of Thailand's revamped land and buildings tax policy. In other words, the "treatment", which in this case is the implementation of the new property tax law, was able to create notable changes on the test statistic (tax avoidance plot areas). These findings are all summarized in Table 10 below.

Table 10 Results of Paired t-Test

	Variable 1	*Variable 2*
Mean	150505.0489	131372.6633
Variance	99152710139	66693152008
Observations	180	180
Pearson Correlation	0.955938768	
Hypothesized Mean Difference	0	
df	179	
t Stat	2.520235635	
P(T<=t) one-tail	0.006301019	
t Critical one-tail	1.6534108	
P(T<=t) two-tail	0.012602038	
t Critical two-tail	1.973305434	

It should be noted that these results coincide with the observations and findings from suspected tax avoidance maps, the data triangulation process, as well as the logical test. It has been pointed out from the maps presented in section 5.1.3 that the suspected tax avoidance activities in Bangkok dispersed after 2020, increasing in number along the city's edges despite occurring in relatively small land plots. These results from the statistical test also corroborate the findings of the data triangulation via transect sampling showcased in section 5.3. The quantitative results from this section further confirm that the LULC conversions from idle lands to agricultural lands indeed occurred and that they are not just true for the sites chosen; instead, the statistically significant difference calculated means that such phenomenon is most likely happening at the larger city-scale. Finally, such quantitative results further support the logical inferences made from the previous section (5.4). This is because these findings show that the implementation of the new property tax law in Thailand, in one way or another, indeed made significant differences in the suspected tax avoidance activities, which can further support the claim of the former's relationship to the latter.

5.6. Key Informant Interviews

With the goal of establishing a direct link between the LULC conversions of vacant lands into agricultural purposes in Bangkok, and Thailand's new property tax policy, key informants that are directly involved in the said phenomenon were consulted.

5.6.1. Expert Interviewee: Prof. Duangmanee Laovakul

As an expert in the field of economics and a member of the policy formulators of the Land and Buildings Tax Act, B.E. 2562 (A.D. 2019), Assistant Professor Duangmanee Laovakul of Thammasat University was consulted in March 10, 2023. Initially asked about the formulation of the policy, she mentions that the Ministry of Finance was the one that initiated it and that they performed studies in order to inform the drafting of the law. She further explains that the tax rates were set first by looking at how the landowners used their lands, before categorizing them to agricultural, residential, commercial or business, and vacant. As already discussed in Chapter 1, the agricultural land typology was set by the new property taxation law to have the lowest rates. Professor Laovakul says the rationale behind this is that Thailand is an agricultural country and this is a way to take care of the farmers all over the country. Meanwhile, the high rates for vacant lands, which are at par with the commercial/business lands, were intended to encourage the landowners to use their properties for something instead of leaving them unattended and without clear use. As it appears in the promulgated document, they also included a provision that increases the rates for vacant lands by 0.3% for every three (3) years that they remain with the same LULC. She also alludes that land distribution was one of the intended outcomes of the policy of interest, when it was being composed, although strengthening the local government revenue is really its main focus. The professor adds that if the new law proves to be effective, then the distribution of lands in the country can be eventually achieved but the time frame of such is uncertain (Laovakul, 2023).

Regarding the observable conversions of vacant lands into agricultural ones, especially in the city of Bangkok, supposedly a response to the new property tax law, Professor Laovakul confirms their direct relationship. In fact, she even says that she foresaw such kinds of behaviors happening. The professor then proceeds to attribute these tax avoidance activities to the high tax exemptions for agricultural lands, amounting to 50 million baht. She recalls how she proposed the agricultural land exemptions to be set just at 20 million baht so that the policy would be designed to cater just enough to those who do not have the ability to pay tax dues on their lands and/or buildings. However, as it turned out, the higher exemption value was passed into the law. As a result, she cites that landowners who may be holding higher-valued lands can still avoid taxes by implementing LULC modifications on their properties, and the land conversions to farming purposes in the city are exemplifications of this. This is especially true for the case of Bangkok as the higher land values in the city-capital are exceptionally high, which serve as an incentive to perform tax avoidance activities. Moreover, Professor Laovakul believes that loopholes like these should not be present in the law as it would compromise the local government revenues. Even so, she mentions of some benefits that the LULC conversions borne out of the new property tax brings, such as removing the negative externalities of vacant lands. An example she illustrates is in her own neighborhood which she claims to have numerous vacant lands that become sites of wild fire during the dry season. This then results to a fire hazard in the residential area, along with the pollution that the burning of vegetation emits to the air. The new property tax scheme then encourages landowners to take care of their lands, thereby eliminating said externalities of idle lands. The professor also adds that even though the vacant-to-agricultural land conversions can be deemed unproductive and economically inefficient, they are still signs that the law is effective in preventing land speculation and cutting (the previously extended) period of time that landowners have for investment timing. As a closing note for this section of the interview, she mentions of the Bangkok city government's plans to utilize the vacant land as parks but she expresses how these plans may be challenging to implement due to the amount of details that need to be filled in for them to be executed properly (Laovakul, 2023).

Professor Laovakul was next asked about her expert opinion on the future of the new property tax policy's implementation. She first mentions the background of Bangkok having numerous developments, especially in rail and properties. According to her, if the city's economy recovers well from the COVID-19 pandemic, then there would even be more developments, which would encourage landowners (especially those with lands around these projects) to utilize their lands for more productive land use other than agricultural. She then emphasizes on the huge impact that the said health crisis brought on the new property tax law's implementation, citing the possibility that it might have steered the policy into a different direction than intended, as it's execution depends on economic conditions (Laovakul, 2023).

To end, the professor mentions about the ways in which the phenomenon of tax avoidance activities via vacant-to-agricultural land conversions can be more deeply explored. As a response to this study's identified hotpots in certain areas of Bangkok, she suggests comparing the land prices in absolute value in the different parts of the city as high land values can incentivize tax avoidance activities. Another possible analysis she insights is the comparison of the percent changes in price assessments from then and now within the different areas in the city as, according to her, a high rate of change can be another incentive for landowners to avoid paying high tax rates. She further suggests the exploration of the district offices to look for case-specific and on-the-ground phenomena that can explain the concentration of property tax avoidance activities in the outer areas of the city. She ends with the recommendation to also explore some companies or small business that have been established specifically to convert vacant lands into agricultural as their locations may also explain the locationality of the LULC conversions of interest in this study (Laovakul, 2023).

5.6.2. City Government Interviewee: Mr. Oran Asawapalangkul

To gather insights from one of the most important implementing bodies of the new property tax policy, a member of Bangkok's main governing organization, the Bangkok Metropolitan Administration (BMA) was interviewed on March 2, 2023. Mr. Oran Asawapalangkul is the incumbent Director of the Revenue Division of BMA's Finance Department. When asked if the new land and property tax law is achieving one of its explicit goals of achieving higher revenues, he replied that it is hard to tell in absolution because of the large impact that COVID-19 has in the implementation of the said policy. For one, the central government announced a tax reduction to the alleviate the effects of the recent pandemic back in 2020. Going into more detail, he provided the following revenue quantities in recent years right before and after the law's effectivity. In 2019, he reported that the total collection was around 15 billion baht but drastically went down the next year in 2020 with only 1.2 billion baht. For the 2021 collection, the tax revenue slightly increased with 1.8 billion baht and finally in 2022, approximately 14 billion baht was collected from the land and buildings taxes. However, if looked upon more simply, the baseline revenue from 2019 is marginally higher than the funds raised in 2022 by around 1 billion baht. Mr. Asawapalangkul attributed this deficit to the following factors (Asawapalangkul, 2023).

Firstly, there are numerous provisions for tax exemptions, which in turn cut the revenues. To illustrate, there is a pre-existing policy that entitles tax exemptions to an owner of one residential property- allowing multiple persons in the same family (for example) to each have exemptions on residential estates they own. The second factor for the lower collection in 2022 are the conversions of lands into agricultural purposes, which is the main focus of this study. According to the director, the central government thought that the new property taxation scheme would allow for standardized services and policy-implementation but the reverse seems to be happening as local governments were said to have been compelled to refine some of the law's provisions to fit their respective contexts and tie some loose ends. In the case of Bangkok, he says, for example, that they had to clarify what qualifies as agricultural lands and what agricultural plants or products should exist or come from the land in order to prove such use. The third and last factor he mentioned as to why the land and buildings tax revenue was lower in 2022 is the lower tax rates for foreign-owned properties. Director Asawapalangkul also mentions that it is more challenging to collect the tax dues of foreigners as they may go to their home countries from time to time and may be harder to reach. He even mentions of some cases where properties owned by foreigners are registered as residential but are speculated to be used for commercial purposes (Asawapalangkul, 2023).

Moving on to one of the implicit goals of the new law that has been repeatedly mentioned in this study in the form of vacant land discouragement, Mr. Asawapalangkul says that it is being achieved but not to its full extent. This is because there are a lot of conditions, exemptions, and loopholes in the law that may hinder this. He also thinks that the vacant land conversions to agricultural are indeed related to the new property tax law and in their observations, mostly occur in the eastern outskirts of the city. However, he believes that the conduction of such activities is fully legal and within the rights of property owners as part of their tax planning measures. He further adds that these LULC conversions may even serve some benefits for the city as officializing these land modifications would accrue transaction fees that can also contribute to revenue generation for the local government. The Director also mentions of some emerging methods of tax avoidance, which may not be related to land typologies and LULC, and instead concern the land plots' morphology. He cites of numerous instances where large land plots have been divided into multiple irregularly shaped plots, as this would result to lower land values for each of the smaller parcels and make them qualify for property tax exemptions or avail of lower individual tax rates. Despite some additional efforts to register these fragmented pieces of land to supposed different landowner names, he says that they still recognize these efforts to avoid property taxes, and that these activities may also allow them to collect transaction fees to further contribute to the local revenue (Asawapalangkul, 2023).

When asked about the publicized plans of Bangkok's Governor in response to these vacant land conversions, the Director of the Revenue Department expressed that such ideas may be good but difficult to implement. One example of these conceptions from the head of the city government is the provision of public parks within a 15-minute vicinity from where residents live. He said they were considering on utilizing these vacant lands for at least seven years, whereas the landowners who agree to lend their land for public use would be granted tax exemptions after two years of government investment. Even so, there were issues that arose such as the budgetary sources of the said intervention, as well as the specific terms and conditions for the lands to be used as public parks that should be clearly outlined in a memorandum of understanding to legally bind such agreement. Moreover, since announcing this intervention, no landowner has expressed interest in engaging with the government to create public parks in the city. Another plan they expressed and tried implementing is charging the novel property tax according to the city-capital's zoning plan. This would entail, for example, charging higher rates for the commercial zones, and lower rates for the green zones in the extreme eastern and western portions of the city. But he says that when this modification to the policy was proposed to the Ministry of Finance, the said agency did not allow it, forbidding charging different rates in different parts of the city. They further added that if the BMA wants to charge higher tax rates, then they would have to increase it for the entire city (Asawapalangkul, 2023).

As a final portion of the interview, Mr. Asawapalangkul was asked regarding urban services and infrastructure delivery of the city government. He mentions that all of Bangkok's services are supported by revenues from the land and buildings tax. He further explains that out of the overall revenue of BMA, 27% comes from local collection and 20% of this locally generated revenue comes from the property taxes- emphasizing the significance of such policy for the city's budget. Despite being clear with their financial inflows, the director then elaborated that the expenditure of the local revenue is quite unclear and hard to track. It is said that tax expenditure may be challenging to delineate spatially, citing the example of the Value Added Taxes (VAT) in the country (Asawapalangkul, 2023).

The landowner-interviewees granted access to their respective properties to conduct the in-person interviews as well as perform further site inspections. The following sections reveal the results of the dialogues, which both occurred on February 11, 2023.

5.6.3. Landowner Interviewee 1: Mrs. Kitsana Thanaphet

Mrs. Thanaphet's land is 400 sq. m. in size, located in a residential area in the outskirts of the city. It is said that the land used to be a dumpsite of construction effluents from nearby developments before being converted to have agricultural purposes in December 2022. She cites how a contractor was hired to perform such land conversion, who happens to be the same one who did a similar job in a land just at the end of the street. In fact, she further mentions that contacts for such services are being offered at the district office, and are easily searchable on the Internet. When the interview was conducted, the land was already lined with banana saplings, along with two sets of ditches that would serve as water retention structures (Thanaphet, 2023).

Figure 46 Site Photos of Mrs. Kitsana Thanaphet's Land

Figure 47 Nearby Vacant-Agricultural Converted Land

When asked about the factors that led to her decision to implement the said LULC conversion, Mrs. Thanaphet mentions the relatively high amount of taxes she had to pay in the previous taxation cycle. It turns out she paid around 17,000 baht the previous year as an initial charge in compliance to the new Land and Buildings Tax Act. She proceeds to compare this to the amount of tax dues she has for her other properties, such as condominium units that are rented out, which she said only accrues around 1,000 baht of taxes for each cycle. So, with the lack of income streams or benefits from a land that would presumably cost significant amounts of financial resources each year, she then opted to convert the land to agricultural to avail of the lower tax rates. This meant complying to what she says the city government's requirement to have 50 trees per 100 square wah (or 400 square meters) for their land to be considered agricultural. However, she adds another major reason to her decision of doing the discussed modifications to her land- keeping her rights and ownership to it. Mrs. Thanaphet explains that one of the law's provisions is that if a land continues being vacant for more than 5 years, then the government will forcibly acquire it. This then further justifies the high amount of investment that she put into the parcel, amounting to around 30,000 baht, saying that "Growing bananas is better than nothing". The urban agricultural land then evolved to become a source of she and her husband's leisure activities (Thanaphet, 2023).

It should be noted, though, that Mrs. Thanaphet voluntarily went to the district office to pay for the taxes due for her land specifically featured in this study. Interestingly, she says that the office actually did not have any record of her land before at all. Moreover, despite the law being effective since 2020, she was charged only in 2022. She notes that this is because the relevant government institution's database was still not ready for the implementation of the new property tax policy, hence the delay in collection. Even so, she cites that paying taxes is a citizen's responsibility and she believes that the revised property taxation policy in Thailand encourages landowners to visit and take care of their lands. However, when asked if she trusts that the government will deliver the needed services and infrastructure supposedly through the raised revenue from taxes, she just merely gestured ambivalently- signaling a lack of confidence that the said institution would be able to perform such duties. In the end, she indicates that complying to taxes may serve as a “starting point” to something, in the hopes that urban planning laws, among other policies and interventions can help facilitate benefits for citizens (Thanaphet, 2023).

5.6.4. Landowner Interviewee 2: Mrs. Pilarsinee Saraithong

Having a comparably larger land plot in a luxury residential area, with the expanse of 1,600 sq. m., Mrs. Saraithong demonstrates more elaborate forms of agricultural activities. She explains that the parcel used to be rented out to serve as a construction camp for nearby developments back in around 2015 to 2016. However, it was left idle until its conversion in 2020. She says that it started out with just mango and banana trees, which are easy to maintain, and would easily qualify for agricultural land use as per the new property taxation law. From her knowledge, the local government requires 1 acre of land (around 4,000 square meters) to have 20 trees in order to be considered agricultural. Since then, she and her husband have further developed the said land to expand their agricultural activities, such that when the interview and site visit was conducted, they have already developed composting facilities, established chicken coops and a warehouse, and have added crop beds for various vegetables, among other ornamental plants and trees (Saraithong, 2023).


Figure 48 Site Photos of Mrs. Pilarsinee Saraithong's Land

Mrs. Saraithong mentions that the incredibly high tax rates of vacant lands in Bangkok led to her decision to make the modifications on the use and cover of her land. She proceeds with how she would not have done it otherwise, comparing it to cases of other lands owned by some other family members in the countryside that can just be rented out for farming, or can be left vacant respectively because of the lower land values (and therefore the taxes accrued) and the non-beneficiary investment. In spite of getting benefits from the said land in the form of leisure activities and the produce from their crops, as well as tax exemptions ever since the new law's effectivity. she also elaborates on the similar high costs of investment to perform and maintain the LULC change. To illustrate, the water source in her farm almost costs twice the city rates because of the absence of a building permit, the high costs of cutting trees considered as "random vegetation" and they also have to import materials from other areas to continue their farm operations, among others (Saraithong, 2023).

Overall, Mrs. Siraithong believes that the new property tax law in the country is effective in encouraging the development of lands instead of just being idle. Even so, she has some suggestions and concerns regarding its implementation. For one, she points out the lack of land readjustment mechanisms for such activities, which would be helpful in the government's delivery of public services and infrastructure, as well as compensating land owners. Secondly, she sees the alignment of the new law with the local zoning plan, as well as providing more specific guidelines and options for LULC if the government would really like to discourage vacant lands. Finally, she expresses concern over the occurrences of what may be considered undesirable land conversions, having seen a wetland under the jurisdiction of the homeowners' organization become converted into agricultural land to avoid the high tax rates as it was considered to be "vacant". In the end, when asked whether she was concerned of losing rights to her land, she replied with her belief that it would most likely not happen because even if the government acquires it, she explains that they would not have any projects or developments to implement using it (Saraithong, 2023).

5.6.5. Summary

To summarize the results of the key informant interviews conducted, the interviewees confirmed that there is a direct relationship between the new Land and Buildings Tax Act of 2019 and the LULC changes in Bangkok. More specifically, the conversion of vacant lands into agricultural lands in the city was said to be a response to the relatively high tax rates of the former land typology as compared to the latter, incentivizing the farming conversions. Another overarching perspective from the informants is that the new property tax policy has a number of loopholes that need to be addressed for its effective implementation. Furthermore, the testimonies from the interviews point towards another key insight: the lack of connection between the gathered revenues from property taxes and the city developments (Asawapalangkul, 2023; Laovakul, 2023; Saraithong, 2023; Thanaphet, 2023). As an expert, Professor Laovakul reinforced Kelly et al. (2020)'s insight with how visible developments are key in implementing property tax mechanisms. The unique insight from the expert interviewee in this study, though, is that these investments can prevent tax avoidance activities by encouraging more economically productive land use (Laovakul, 2023). However, as articulated by the director of BMA's revenue department, they could not track their expenditures or investments that come from the land and buildings taxes (Asawapalangkul, 2023). So, it is unsurprising that the taxpaying landowners hinted some lack of trust that the city-government can deliver necessary beneficial services and infrastructure (Saraithong, 2023; Thanaphet, 2023). In other words, the tax revenue-city developments loop seems to have gaps that also need to be addressed for the new policy to work.

As a quick exercise to heed Prof. Laovakul's recommendation to explore the land values around Bangkok to see how they may be influencing the tax avoidance activities in the city, the GIS files containing the metropolis' land values were obtained from the Bangkok GIS website (Bangkok, 2019). Although, as the raw data were in the form of line vectors mostly along the major roads in the city, they were further processed using the *Normal Kriging* process in ArcGIS to interpolate the data between the available line figures. The following map illustrates the interpolated median land values in Bangkok in Thai Baht.

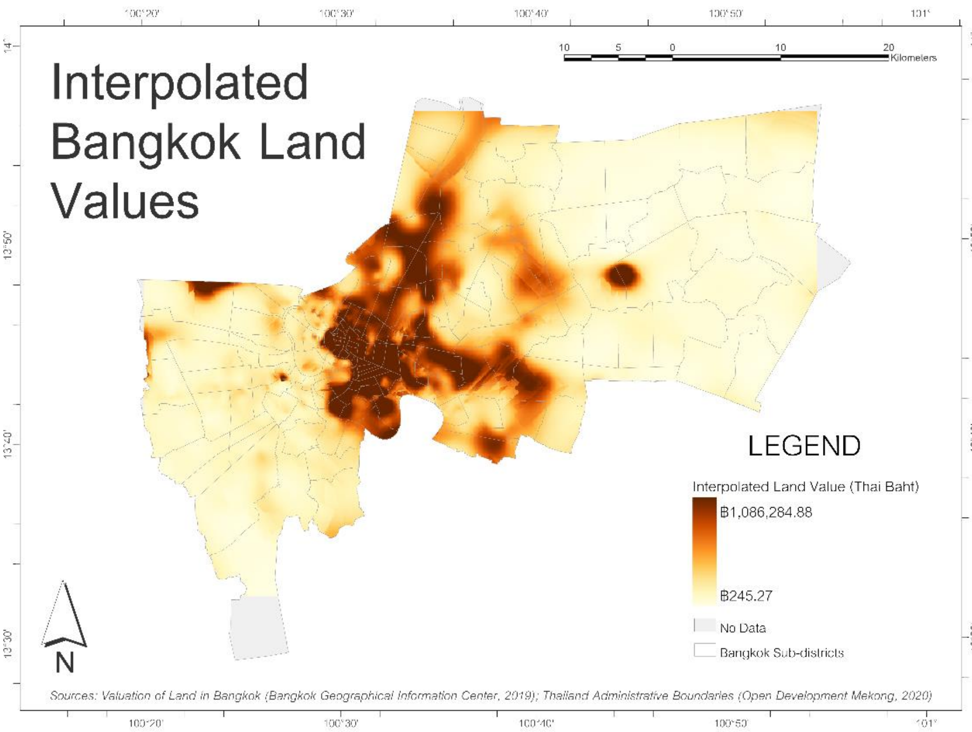


Figure 49 Interpolated Bangkok Land Values

As previously pointed out, there is a concentration of the higher land values in the center of the city while there tends to be lower land values in its outer areas. This is reverse the overall trends that were presented by the spatial autocorrelation analyses in section 5.2., which found a concentration of the tax avoidance activities in the outskirts of the city, and almost none in the city-center. It seems then, that for majority of the parts of Bangkok, land values do not largely influence the occurrence of tax avoidance activities. However, from Figure 49, there are also some perceptible spots in the fringes of the city that have relatively high land values. One example is the Saen Saeb sub-district at the eastern side of Bangkok. Looking back again at the geospatial analyses conducted in Section 5.2., particularly the Getis-Ord Gi* Hotspots Analysis shown in Figure 34, it was mentioned how the same sub-district garnered an exceptionally high z-score in the test for spatial association. It can then be said that for Bangkok's urban fringes that may already have the tendency for tax avoidance activities, high land values may further influence the occurrence and interrelation of such behavior.

Aside from these findings, the interviews also confirm some of the results that have been previously outlined. For one, it is highly likely that the tax avoidance activities of interest in this study are non-beneficial to Bangkok's local revenues, as stated by the academic expert and the representative from the government (Asawapalangkul, 2023; Laovakul, 2023). This then further strengthens the presumption from the Logical Test in section 5.4, which tried to argue that the intended trajectory of the law is not being achieved due to the objective of local revenue increase not being achieved thus far. The informants also confirm the results of this study that identified the concentration of the vacant-agricultural tax avoidance activities in the eastern fringe of Bangkok, as Director Asawapalangkul revealed it from their own records. Finally, the interrelationship between the tax avoidance activities was observed and briefly explained through the interviews and visits to the properties of the landowners interviewed. In both cases, there were nearby properties that have also been converted from being "vacant" to agricultural and they mention about their social network being a factor in making their decision to convert their lands, as well as the presence and accessibility of contractors to make the LULC modifications happen (Saraithong, 2023; Thanaphet, 2023).

The key stakeholders' interviews also reveal some additional insights which have not been explored or found in the preceding sections. For one, Director Asawapalangkul reveals new methods of tax avoidance that they were able to notice in their own inspection of the taxable properties in Bangkok, which is beyond the scope of this study. Moreover, the results from the landowners reveal some differences in their understanding of what qualifies as agricultural land for the city government. If one may recall, Mrs. Thanaphet understands that the requirement is 50 trees per 400 square meters while Mrs. Saraithong believes the requirement is just 20 trees for every 4,000 square meters (Saraithong, 2023; Thanaphet, 2023). This may then reveal a lack of consolidated understanding of the law among the landowners, particularly of the guidelines set by Bangkok's governing bodies. Lastly, Mrs. Thanaphet's mention of how her land was not in the government's records may also reveal the inefficiency or lack of monitoring efforts on the city's lands.

To end this section, the varying perspective of the informants regarding the property tax avoidance activities in Bangkok are presented below. The expert opinion of Professor Laovakul states that these behaviors may be considered inefficient but may have some benefits. On the other hand, Director Asawapalangul of BMA mentions how these activities are well within the rights of landowners to their lands and they should be respected. Finally, both the landowners interviewed stated that the modifications they implemented to their lands are indeed a way to avoid paying high tax rates for non-beneficial land. However, additional insights from them include converting their land's cover and use in the name of keeping the rights to their property (Thanaphet, 2023), as well as some concern over undesirable conversion of perceivable valuable lands like wetlands in their neighborhood (Saraithong, 2023). These are all summarized in Table 11 below.

Table 11 Summary of Key Informant Interviews Results

Key Insights	**Interviewee**			
	Expert: Prof. Laovakul	**Government: Dir. Asawapalangkul**	**Landowner: Mrs. Thanaphet**	**Landowner: Mrs. Siraithong**
Vacant-Agricultural LULC Change are Tax Avoidance Activities	Yes	Yes	Yes	Yes
City Developments from Property Tax Revenue	Prevents tax avoidance	Cannot track developments	Government cannot deliver	Government cannot deliver
Perception on the new Property Tax Law	Has a lot of loopholes	Loopholes need to be filled	Compliance	More specific guidelines are needed
Perception on Tax Avoidance Activities	Inefficient but may have some benefits	Part of rights of landowners	Avoid high taxes; keep land rights	Avoid high taxes; some undesirable LULC changes
Tax Avoidance hurts the Local Revenue	Yes	Yes	-	-
Concentration of Tax Avoidance Activities in the Urban Fringes	-	Yes	Yes	Yes
Spatial Association	-	-	Yes	Yes

- Not found in the interview

CHAPTER 6: DISCUSSION

6.1. Bangkok's Cold Spot Urban Core and Hotspot Fringe

Bangkok is continuously urbanizing- this is one of the primary re-assertions of this study as such finding coincides with other studies found that involved the LULC of the city (Adulkongkaew et al., 2020; Ali et al., 2018; Bonafoni & Keeratikasikorn, 2018; Chayapong, 2010; Chayapong & Dasananda, 2013; Kamchiangta & Dhakal, 2020, 2021). Several authors attribute this steady growth of built areas in the city to economic development and population increase. For one, Moll et al. (2019) mentions that, "[t]his rapid rise in population, capital investment, factories and employees in Bangkok city have caused the community numbers to increase leading to the development of road networks, real estate developments, land value and advanced technologies…" (Moll et al., 2019). Quigley in his chapter in Buckley et al. (2009)'s book *Urbanization and Growth*, adds that urbanization and economic development in general are so closely interrelated with one another such that resources tend to concentrate within cities (Buckley et al., 2008). The results of this research also suggest that this ongoing urban growth in Bangkok is happening at the expense of agricultural areas in the city and surrounding areas, which turns out to be a persistent trend (Moll et al., 2019; Srivanit et al., 2012) that has been detected even in the early 2000s (Srisawalak-Nabangchang & Wonghanchao, 2000).

More recently, though, there seems to have been a resurgence of agricultural lands in Thailand's capital. As the main subject of this study, it was found that these sudden conversions of idle lands into agricultural lands in the metropolis were mostly happening in the urban fringes. Confirmed to be tax avoidance activities (Asawapalangkul, 2023; Laovakul, 2023; Saraithong, 2023; Thanaphet, 2023), their distinct locations in the city may be attributed to the differences in LULC flexibilities and cost-efficiencies, as well as the innate qualities of peri-urban areas, and the disparities in urban services and infrastructure provision.

6.1.1. Varying LULC Flexibilities and Cost-Efficiencies

While the LULC changes and the suspected tax avoidance activities in Bangkok are concentrated in the city's edges, it has also been observed through this study that the core of the metropolis remained rigid- almost devoid of changes in its LULC throughout the study years. This may be due to the actual LULC in these areas of interest. As seen in the LULC maps presented in Figures 10 to 13 in Section 4.1.2 of Chapter 4, the city center is dominated by the *built area* class while the outer areas of the city are mostly agricultural but intermixed with other land classes. The core of the city is observably rigid most probably because it is made of rigid physical structures, mainly made of concrete, steel, and other materials with high physical integrity. On the other hand, the fringes are mostly made of vegetative cover, which can be deemed to have significantly less rigidity.

These differences in the physical integrities of land covers between these different parts of the city may be one of the factors that influence resistance or acquiescence to change. Because *built areas* were made to withstand natural elements for extended periods of time, their rigidity makes land changes difficult logistically and financially for the land owners (Trisurat et al., 2009). For one, the land owners already spent a lot of resources to establish and maintain such built structures, and dismantling them to make way for other LULC would mean securing permits from the city, evacuating the people or valuables within them, hiring contractors to demolish the buildings and clean the debris, among others. Meanwhile, other LULC classes, especially vegetative ones that make up the fringes of Bangkok, are relatively easier to modify and change into other classes due to their lower rigidity. For these reasons, several authors mention that it is highly unlikely for built up areas to be converted into plant-related LULC or any other classes (Schoeman et al., 2013; Seto et al., 2002; Trisurat et al., 2009).

Moreover, aside from being mostly built up, urban centers are also most commonly characterized as having high density and being heavily commercialized- and Bangkok is no exception. As a result, these lands in the economic and social hub of the city most likely generate revenues from businesses, rentals, or their landowners have the high probability of having reliable sources of income such that they can just allocate portions of these income streams borne out of the land in order to pay their tax dues. Whereas, if lands are located in less dense and less commercialized areas, it would most likely be harder to make them productive due to the lower availability of labor forces, as well as less circulating capital and economic activity. Not to mention that urban fringes are also mostly subject to zoning plans that can further restrict the options of landowners in making more productive use of their lands. In the case of Bangkok, the western and eastern fringes are mostly designated as "green areas" supposedly for flood mitigation and controlling urban expansion (Yokohari et al., 2000). So, without the revenue streams from their lands in the urban fringes, land owners would most likely then have to shoulder the taxes of their properties via their own income streams. This then serves as motivation for tax avoidance activities, like modifying LULC, so that these property owners can lessen their dues. To add, as mentioned by Prof. Laovakul in section 5.6.1., and further elaborated on in section 5.6.5., high land prices, particularly in the city fringes may further incentivize tax avoidance behaviors (Laovakul, 2023). This is because the economic inefficiency of paying taxes for vacant lands turns out to be even greater in the perspective of the landowners. In essence, the economic productivity of lands also comes into play in LULC changes, such that the more productive lands that are mostly in the urban core would most likely retain their LULC and their owners would not be concerned much about land and buildings taxation policies, and that the significantly less productive lands that are mostly located in the urban fringes would more likely be affected by property taxation mechanisms and are more susceptible to LULC change. Seto et al. (2002) summarize this by saying that, "[t]here is a higher opportunity cost of converting land with economic returns compared to converting land with no previous economic use.". So, these lower opportunity costs may be attributed for the conversions of idle lands into agricultural ones in the fringes of Bangkok. Bockstael in their 1996 article further adds that developed lands apparently have the tendency to be further developed instead of regressing into less developed LULC- further solidifying the reason for the built-up urban core's high propensity for rigidity.

6.1.2. A Natural Feature of Peri-Urban Interfaces

The previous section mentioned about how the geophysical features of cities such as Bangkok can be factors in the plethora of LULC changes, and in turn the suspected tax avoidance activities in the urban fringes. This section extends the discussion further by zooming out to include broader spaces and concepts in the form of regional dynamics. Another factor that may be deemed to be contributing to the dynamic LULC in Bangkok's urban fringe would be its inclusion in the liminal space and process of the *periurban interface*.

Often regarded as the transitional continuum between the urban and the rural, the periurban has been described to be the process and the place where the opposing regional poles interact (Adam, 2001; Bartels et al., 2020; Fazal, 2013; Woltjer, 2014). This socio-economic, cultural, political, and (as this study emphasizes) physical interactions between the said entities are then said to be making the periurban very dynamic, both spatially and temporally. This means that the changes are ever-occurring, uneven, with no clear locations and boundaries, and can occur in either short or long periods of time (Adam, 2001; Allen, 2010; Bartels et al., 2020; Fazal, 2013; Garschagen et al., 2011). One of the common observable manifestations of such dynamic interaction would be the highly mixed and fragmented LULC in the periurban areas (Garschagen et al., 2011; Woltjer, 2014). Figures 20 to 27 and Figures 28 to 31 in Chapter 5, respectively featuring the LULC changes and suspected tax avoidance activities in Bangkok, demonstrate how these conceptions of periurban interfaces hold true for the city. Although only involving small percentages of land in the metropolis, it has been pointed out that the outer areas of Bangkok showed numerous changes throughout the study period with different LULC class changes happening side by side one another.

However, Fazal (2012) and Walter (2014) cite Rakodi (1998) and Adell (1999) respectively in the latter authors' conception of the urban-rural interaction in the periurban interface as unequal- that the urban is actually dominating such dynamic and is the main driving force of land change. In other words, they argue that the periurban is a process of being more "urban", and it is the city center expanding outwards that is causing these changes. Robinson (1995), as quoted by Fazal (2012), mentions that an example of this dominant influence of the urban is the decentralization of the urban core exemplified by the ribbon development or the built area expansion around major roads happening in cities; which is already happening in Bangkok (Nishiura & Leeruttanawisut, 2022). Even so, this may not be the only outcome of urban influence in the periurban interface as there may be some land use innovations that could come from this dynamic and one example is urban agriculture (Woltjer, 2014). The city of Bangkok then illustrates such land use innovations in its fringes with the conversion of idle lands into agricultural purposes as a response to the politico-economic urban influence in the form of the new land and buildings taxation policy from the central government.

All in all, the dynamic LULC changes in Bangkok's urban fringes, particularly the suspected tax avoidance activities, may be perceived to be natural features of the periurban interface that they are situated in. Although, despite being initially seen as a land use innovation from the urban-dominated peri-urban process, the agricultural land conversions in the city may also be conceived as rural responses to the urban pressures. The urban- and rural-related institutions and people would then be the subject of the following sections.

6.1.3. Disparities in Urban Services and Infrastructure Provision

Aside from the urban-rural geophysical and regional difference being factors to the location of suspected tax avoidance activities in the fringes there may be also socio-political underpinnings to such phenomenon in the form of the differences in urban services and infrastructure delivery. Literature points towards how overall, urban centers are where developments are concentrated, whereas peri-urban areas most often deprived of such growth (Allen, 2010; Jones et al., 2014). According to Yokohari et al. (2000), Bangkok is no exception to this rule. One factor cited to be a reason for this disparity is the higher incentive for investing in the urban core due to the greater accessibility to skilled workers and other resources, as well as the typical high land value in the said location that attracts private investors (Jones et al., 2014). Moreover, the uncertainty regarding the general responsibility over peri-urban areas is also said to contribute to the lack of services and infrastructure in the mentioned zones (Allen, 2010; Jones et al., 2014). In the case of Asian megacities such as Bangkok, it is mentioned that the high rate of urban population growth may be one of the reasons for the inadequate provision of infrastructure (Yokohari et al., 2000), inferring that the local governments may have not been able to keep up with the rising demand.

These concepts may then be boiled down to one of the highly discussed ideations in urban geography: The Central Place Theories, pioneered by Christaller and later refined by Losch, understands cities and even regions as revolving around centers. This is because the *central place* is highly specialized, offering a multitude of commercial, educational, healthcare, and other public services that are mostly unavailable in the surrounding areas. The theories further assert that a hierarchy forms between the center and its surrounding areas, wherein the latter become mere consumers or subjects of the former's activities and outputs; making an organized and effective equilibrium (Malczewski, 2009; Timár & Kovács, 2009). This core theory then summarizes the existence of a disparity between the developments in different parts of the city- that is the higher focus and significance on the urban core compared to its surrounding areas (which includes the fringes).

Now, connecting this discussion to property taxation and avoidance, it has been discussed in the earlier chapters how most local governments source their services and infrastructure budget from taxing lands and/or buildings (Bird & Slack, 2004). This is also the case for Bangkok, as the BMA's revenue department director articulated in the interviews that were conducted (Asawapalangkul, 2023). With the high visibility of such taxes, Bird and Slack in their 2004 handbook on land property taxation mention that only when taxpayers see and feel these developments will they be willing to be held liable for their tax dues. The key informant in Professor Laovakul also added how city developments can incentivize landowners to invest in more productive land use other than tax-avoiding agricultural land conversions. However, with the detection of possible tax avoidance activities in Chapter 5, it is highly likely that Yokohari et al. (2000)'s observation still holds true: Bangkok continues to have inadequate infrastructure. Additionally, since urban fringes tend to be more deprived of these developments, the taxpayers in such areas would most likely be discouraged to pay their dues in full and try to lower them as much as possible. In essence, as the local government did not deliver on its duties to the people, the taxpayers became unwilling to provide the said institution with the financial support they need for their supposed functions.

6.2. The Roots of Property Tax Avoidance in Bangkok

The previous sections have focused on the locationality of the suspected tax avoidance activities in the city of Bangkok. However, as alluded in the latter portion of section 6.1.3 this portion of the study will now focus on the main reasons for the actual existence of these activities in the study area.

In order to do this, a little back-tracking is warranted, starting with the primal objectives and purposes of property taxes. The brief conceptions from the first two chapters of this study outline some of the key rationales on the imposition of property tax systems by governments, which includes regulating the LULC within their areas of jurisdiction, facilitating land economics, land-value capture, re-distributing wealth, as well as being the source for providing local services and infrastructure to their constituents (Bird & Slack, 2004; Kelly et al., 2020; McCluskey et al., 2022).

As for the case of Thailand, especially its capital city, the new property taxation policy is relevant for land value capture- serving as a mechanism to prevent land speculation. As lands in politically- and economically-significant areas like Bangkok continue to experience developments in terms of the available services, infrastructure, and opportunities, their values also tend to appreciate. However, if such lands are privately-owned, then the owners usually reap these benefits accrued by their lands even without direct investment on the developments they are gaining wealth from. Property taxation then becomes a mechanism to capture these generated values so that the government may be able to re-distribute these benefits to the general public usually in the form of public services and infrastructure. This politico-economic instrument is all the more relevant to a highly unequal society like Thailand, where the wealth in the country is concentrated in an extremely small percentage of the population (Kidokoro et al., 2022). Even then, because of the previous property taxation policies that were in place in the country, landowners have been able to continually hold their lands for relatively low values and keep on amassing the wealth and benefits that their assets accumulate over time- a behavior commonly termed as *land speculation*. The reason for this is the low assessed values of lands, which were overly outdated (Srisawalak-Nabangchang & Wonghanchao, 2000). A common indication of speculative behavior would be idle or vacant lands with no clear purpose, which are marked by simple structures (if there are any) and are usually taken over by random vegetation. As this study has illustrated, property taxation policies may also influence these LULC related to speculation to make way for what may be perceived to be more productive uses for land. So, with these goals of wealth-distribution, encouraging productive land use that can benefit the general citizenry, and the landowners most likely having the ability to pay their tax dues (Kelly et al., 2020; McCluskey et al., 2022), why does property tax avoidance still exist in Bangkok?

The answer lies in the people who are performing these activities- the private landowners. It may be that these taxpayers are seeking accountability from the local government. Bird and Slack (2004) and Kelly et al. (2020) all mention that if the tax subjects see the connection with their tax payments and the benefits, then they would have no problem in complying with their tax dues. However, as discussed in the previous section, if they see a discord between their contributions and the services and infrastructure delivered to them (which is the case in Bangkok) then they would hesitate in paying their dues and even try going around them to pay lower rates, if not completely evading them. The landowners interviewed in this study even mention how the investment and maintenance fees of converting their lands into agricultural sum up to even higher amounts than the supposed high tax rates for when the properties remain vacant. This can be interpreted as the landowners seeking accountability from the local government, which has been cited to have not been able to fulfill their part in providing developments for its constituents. This can be illustrated by the expressed lack of trust in the government service and infrastructure provision by the landowner informants from this study (Saraithong, 2023; Thanaphet, 2023). Moreover, the agricultural activities in the converted lands of these same owners have respectively created benefits for them through leisure and crop produce. It can be said then, that the landowners are creating the benefits out of their lands for themselves instead of relying on the government (by contributing to property taxes) to create and deliver these benefits for them. In the end, it can be argued that for the landowners, it may be pointless to contribute relatively high amounts of financial resources to the government revenue if such generated values would more likely not be used for their intended purposes.

Further extending the discussion, the issues outlined can be viewed in the lens of power dynamics. On one hand, the government is trying to impose the new property tax law to prevent land speculation and unproductive land use while on the other hand, the private landowners are seeking accountability from the government to deliver the services and infrastructure fairly across the city. Using the conception of power by Lukes (2005) as cited in Hashimzade & Epifantseva (2017), the act of mandating the new property tax law and enforcing punishment for non-compliance is an exercise of what they call the first dimension of power. This dimension, also known as the *agenda setting approach,* includes the ability to dictate or constrain other's fates, actions, behaviors, and choices. The law, by the decree of the King, is asserting its authority over the private land owners in the entire country and commanding them to pay tax dues. This then affects what these people will do with their income streams, or perhaps more relevantly, what they would do to their land and building assets given such imposition. And so the tax avoidance that is happening in Bangkok as a response to such mandate can be classified as an exercise of the second dimension of power: the *mobilization of bias*. This dimension involves the inclusion or exclusion of entities in the decision-making processes. With the property owners changing their lands to avoid paying the high tax rates, it is revealed that the government's power over them is not absolute and that such assertion of power can be re-negotiated. With such move, they suddenly became part of the conversation regarding property taxation (Hashimzade & Epifantseva, 2017). In conclusion, what can be inferred out of the discussed power dynamics is that the governmental body of Bangkok and the private property landowners are not streamlined in terms of their responsibilities and desired outcomes pertaining to the property taxation system. This misalignment between the opposite poles of stakeholders then manifests in the dynamic and fragmented LULC on the fringes of Bangkok.

6.3. The New Property Taxation Law in Perspective

Overall, by studying the case of Bangkok, it can be said that the inefficiencies in Thailand's revised property tax system may be borne out of the loopholes in the policy, combined with the existing inadequacies in the system. For one, there is a clear lack of specific and properly promulgated guidelines. This is evidenced by the results from the interview with Director Asawapalangkul of BMA's Revenue Division, where he cites their ongoing extensive efforts to fill in the ambiguities of the law to fit the context of Bangkok. The subtle but significant differences in the interviewed landowners' understandings of what qualifies as agricultural lands may also be another exemplification of the same issue. These cases may also be an illustration of how the inefficiencies tend to cascade through the different political levels, seeing the obscurities of the national policy being manifested down to the grassroots level of individual landowner-taxpayers.

This research has also put into light the inadequacies in land monitoring, specifically for Bangkok. As the new property tax system emphasizes heavily on land typologies, it appears that its implementing bodies may not have the capacity to execute their responsibilities. Such claim is proven by the narrative from Mrs. Thanaphet who elaborated on how the local government actually did not have a record of her previously vacant land, and it was actually her who sought compliance to the new property tax law. She also mentions that this is also one of the reasons why the local government delayed its tax collections with the rates of the new policy in place. It should also be pointed out that this new tax law is not connected to any other relevant institution and policies, apart from the ones identified in the promulgated document. For example, its provisions did not mandate integration with existing local zoning plans, nor did it provide guidelines for district offices in administrating the tax collections. This factor is significant as working with or around these *sub-systems*, as termed by Candel and Biesbroek (2016), are one of the essential dimensions for policy integration. To illustrate, such consolidation may have provided more guidance to the local tax implementers and taxpayers to ease in the law into the system. In extension, this may have also allowed for the easier integration of the property tax law into the existing systems and ensure that it is working towards the same goals as other policies or interventions in place.

Moreover, as discussed in the previous section, the stakeholders relevant to the policy of focus in this study may be considered non-harmonized, which contributes to the economic inefficiencies of the property tax system. On one hand, the government is trying to fulfill its equity and economic efficiency functions, while on the other hand, the landowner-taxpayers are trying to minimize costs, protect their assets, and in a way, seek accountability from the government. As a result of these two previous points on the policy's inefficiencies and the conflicts of interests between its stakeholders, the local government (as in the case of Bangkok) seems to have been carrying the burdens of filling in the law's loopholes, working around the existing sub-systems, and catering to the various interests of the different stakeholders from the top through the bottom. These can all be confirmed from the results of Director Asawapalangkul's interview.

In the end, the revised land and buildings tax policy in Thailand may still be considered to be new and is currently traversing its transitional phase. As in any changes, especially in national policies, transition may not always be smooth. The objectives and intended outcomes may respectively be achieved in varying paces, and go in different directions. According to Candel and Biesbroek (2016), this *asynchrony* in policy integration is normal and can be attributed to path dependency and policy layering, the differences in ease and likeliness of different policy parts to change, as well as governments' lack of political will and/or resources to implement policy changes. As a final note, the integration of the new property tax system and addressing its issues as outlined in this study may take some time and possibly even require multiple adjustments. This then merits further investigations to be done in the future as the law enters its latter stages of implementation.

6.4. Recommendations

6.4.1. Addressing the Raised Issues

With the overall underlying issue in the tax avoidance activities in Bangkok being that the stakeholders are not harmonized in terms of their respective goals and duties to one another, Allen in their 2010 study suggests urban services co-production to address such issue. This way, accountability and transparency can be fostered on both sides. Governments would not be solely responsible in creating, delivering, and promulgating their developments, and with the increased involvement of citizens, it can be ensured that such investments borne out of the property tax revenue would be based on the needs and/or demands of the people, and they would immediately see the connection between their tax contributions and the benefits that are generated from the raised revenues. Moreover, it is said that such intervention has the potential to "…create an interface of interaction and feedback…" that can pave the way for easier modifications on the property taxation policy itself or on how it is being implemented and administered (Allen, 2010). In essence, this method of urban services and infrastructure delivery can facilitate systemic learning, which coincides with Kelly et al. (2020)'s recommendation on implementing Problem-Driven Iterative Approach (PDIA) to address such issue. These suggestions all seek to empower the citizens to be agents of change so that co-ownership and co-responsibility may be established to streamline the responsibilities and objectives of the respective stakeholders to make the property taxation mechanism work.

Apart from the more systemic interventions that may be implemented, there may also be more local adjustments that can be made in order to improve the implementation of the new property tax law. The remote-sensing methodologies presented in this study may also be used for more specific aspects of tax administration and implementation such that they can be adopted to remotely monitor lands in the city, aid in performing land value assessments, track the LULC transformations, etc. Since it has been previously identified that there are inadequacies in monitoring Bangkok's lands, all of these techniques may prove to be relevant supplements to on-site inspections, in taxable lands identification, in improving the tax coverage, possibly pave the way for more purposive property taxation schemes, and improve the overall administration of taxing land and building assets. For example, a regular multi-year monitoring scheme may be established by the city government, such that the detected LULC changes and possible conversions of urban land typologies may be easily exchanged between different relevant agencies and trigger mechanisms to confirm, and respond to the obtained information. To be more specific, the city planning office, taking care of Bangkok's zoning may be the one monitoring the lands, and feed the data of these LULC transformations as well as any non-compliance to the zoning regulations to the relevant district offices so that the latter may work to further confirm the remotely-sensed data and make the necessary administrative arrangements. All in all, the use of the remote-sensing and GIS technology presented in this research may prove to make Thailand's property tax implementation more efficient by having faster and more-cost-efficient techniques in inspecting lands and updating the fiscal cadaster. For these same reasons, Kelly et al. (2019) also highly recommend integrating these technologies for property tax administration and reform, citing multiple success stories of their adoption in cities around the world.

6.4.2. Suggestions for Further Studies

In pursuing future research on the same topic, several aspects of the conduction of this study can be done to further refine or extend the methodologies and accuracy of results. Firstly, a more comprehensive and thorough inspection of the suspected tax avoidance activities can be performed instead of a transect assessment so that fine-scale details and observations can be made, which can provide even more specific insights on the phenomenon being investigated. Moving on, a specialized classification of Bangkok's LULC may also be performed to achieve greater accuracy for the derived maps. This is because the worldwide classification schema built by ESRI showed to have some inaccuracies which may be due to the different spectral registers and physical characteristics of different LULC classes in different regions. So, building a classification schema specific to Bangkok or Thailand would prove to be helpful in improving the accuracy of the generated LULC maps as it would most likely be nuanced to the local knowledge about the LULC characteristics existent in the city or country. Also, the data triangulation process may also be improved by streamlining the data sources in terms of the timing of image capture. It is because some of the images considered were yearly averages while some are just snapshots of certain moments in time. Coordinating this aspect of the methodology can further improve and normalize the points of comparison in the study that can minimize interpolation and reduce the possible errors or bias that can come out of such process.

Alternative methods and related topics to this research may also be explored. For one, since the LULC changes inspected in this study are mostly vegetative, a possible extension would be to use a different method in detecting these changes by use of NDVI signatures. The oscillation of NDVI signatures in certain areas in the city can reveal any major changes in vegetative cover that can also signal possible tax avoidance activities. This can also address the limitation of this study that just looked into the yearly averages of NDVI signatures. This finer-scale inspection has the potential to more comprehensively track the transformations that happened in the urban lands. Moreover, as suggested by Professor Laovakul, the economic aspects of the said phenomenon may also be examined further by looking much deeper into the land prices and the rates of their change over the years, and conducting studies in the district offices in order to deepen one's understanding of the phenomenon of interest. Similarly, the negative externalities of vacant lands in the city and their supposed removal by the fiscal instrument of property taxes can also be investigated. Additionally, with Director Asawapalangkul's mention of emerging forms of property tax avoidance by plot shape and size modification, the effect of plot morphology on the law's implementation may also be inspected. As a final suggestion, the influence of the COVID-19 pandemic on the implementation of the new property taxation policy in Thailand may also be investigated. This is because, as cited earlier, there has not been full collection of the taxes ever since the pandemic began as it coincided with the said global crisis. Moreover, the economic decline coupled with the high uncertainty brought by the pandemic may have been driving factors for these tax avoidance activities as well, which was also mentioned by Professor Laovakul in her interview.

CHAPTER 7: CONCLUSION

The study aimed to explore the LULC changes of vacant lands in Bangkok, as they are thought to signal tax avoidance activities, as well as perform a spatial analysis on the conversions of vacant lands to agricultural lands. They were successfully achieved by addressing the questions and accompanying hypotheses as outlined below.

The first research question sought to find out if the LULC conversion of vacant lands to agricultural lands correspond to tax avoidance activities. It was hypothesized that these phenomena do correspond, and the results of the study point towards accepting this hypothesis. The reason for this is that the remote-sensing and GIS methodologies, and the relational confirmatory tests showed positive results for the relationship between the new land and buildings taxation mechanism and the LULC changes in Bangkok. The case of Thailand's capital showed to qualify for two out of three logical conditions outlined by Redo et al. (2012) to confirm relationships between taxation and LULC changes. Bangkok's LULC changes and the new property taxation policy coincide in their time frames and intended land changes, despite having varying outcomes. The statistical t-test also showed a significant difference between the suspected tax avoidance activities before and after the policy's effectivity in 2020, meaning the *treatment* in the form of the law most likely instigated these significant changes in these plots of interest. Finally, the key stakeholders interviewed in this study confirmed such relationships between the new property tax policy and detected tax avoidance activities.

The second research question then asked where clusters of these vacant-agricultural LULC conversions might be situated in the city, and the corresponding hypothesis theorized that they may be clustering in the fringes of Bangkok. Similar to the previous question, the results of the study also instigate that the hypothesis can be accepted. The results of the Global Moran's Index showed that the suspected tax avoidance activities in Bangkok are highly clustered and the Local Moran's statistic revealed that they are actually in the fringes of the city, particularly in the extreme eastern portion. This is further enriched by the interrelationship of these LULC changes of interest that was found through the Getis-Ord Gi* Hotspots Analysis. Such findings are further confirmed by the Data Triangulation process that was conducted, which entailed a transect analysis of the suspected tax avoidance activities in the city. Most of the sites located in the urban fringes that were remotely and physically visited displayed conversions from being vacant to agricultural, while the sites in the city center remained almost exactly the same in terms of their LULC throughout the study years. The interviews with the stakeholders from the Bangkok government and landowners also confirm these findings through their records and the actual locations of their lands, respectively.

Overall, the study contributes to the extensive literature on the LULC changes in Bangkok by demonstrating new methods of inspecting fine scale LULC changes through an extended LULC transition matrix, as well as geospatial change detection through the categorical change detection function in ArcGIS that can pinpoint what changes are happening in the area of interest and where such land transformations are happening through mapping. The study is also one of the first few to extensively utilize other remotely-sensed data sources to confirm the results of initial LULC mapping in order to deepen the inspection of fine-scale details contained in study sites. Furthermore, the study contributes to the limited but reportedly relevant body of knowledge regarding peri-urban areas as this study explored the transitional space because of its results. Lastly, it is also one of the first explorations on the new land and buildings taxation policy's implementation in Bangkok that outlined the geo-physical aspects of politico-economic mechanisms in cities.

Even so, the following limitations of the study should be noted. Firstly, there were some inaccuracies from the LULC maps sourced from ESRI which may have propagated in the latter parts of the study. The remote triangulation methods also contain different types of information regarding the city's LULC because of the differences in the timing and nature of their capture in that some are yearly averages while some are snapshots at certain points in time. To add, the transect sampling method may also render some inaccuracies as it inspected only a few land plots from the thousands suspected to be tax avoidance activities and so this may propagate some bias towards the objectives of the study and make the truth about several sites to be a rule for all other land plots of interest. There also appears to be a limitation on the LULC change detection techniques' ability to identify tax avoidance activities given the new forms of tax avoidance activities that have been revealed through the key stakeholders' interviews. Because the specific shapes, sizes, and values of individual land plots are not publicly accessible, this aspect was not explored in this study.

With these limitations, some recommendations to further improve the conduction of a similar study include the following. For one, the accuracy of the LULC maps may be improved by conducting a specialized classification of Bangkok to nuance and minimize errors from the initial stages of mapping, so they may not be propagated in the latter stages of the studies. Alternatively, one may also obtain better source maps that prove to be more accurate in LULC classification and have higher resolution to provide finer scale analyses and observations The remote-sensing triangulation methods may also be normalized in their timeframes to encourage a fairer and more accurate time-series comparison of the LULC changes being investigated. Furthermore, if data becomes accessible, the phenomenon of modifying land plot morphology to avoid taxes should also be investigated as this may also merit significant repercussions on the property tax law's implementation. Even so, the methodologies used in the study may already be starting positions in improving the administration of property taxation in Bangkok as they can be applied to monitoring LULC changes for any repercussions in tax rates, as well as identifying taxable lands, and assessing impacts of the policy to the geophysical environment in the city. The findings of the research also suggest recommendations from previous authors to apply urban services and infrastructure co-creation and systemic learning to align the respective duties and interests of the property taxation policy's stakeholders to make the said dynamic work and ultimately address tax avoidance at the system-level.

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APPENDIX

Table 12 Total Area of Suspected Property Tax Avoidance Activities per Bangkok Sub-district

No.	Sub-district (Thai)	Sub-district (English)	Total Area of Suspected Tax Avoidance Activities (sq.m.)		
			2018 vs 2019	2019 vs 2020	2020 vs 2021
1	กระทุ่มราย	Krathum Rai	660408.708	723336.228	571489.4168
2	ขุมทอง	Khum Thong	511511.0666	306995.1698	585237.4644
3	แขวงทับช้าง	Khwaeng Thap Chang	209949.4452	78300	125800
4	คลองกุ่ม	Khlong Kum	107500	168700	126700
5	คลองขวาง	Khlong Khwang	27600.17514	48696.13449	71052.73659
6	คลองจั่น	Khlong Chan	9300	3400	1200
7	คลองเจ้าคุณสิงห์	Khlong Chao Khun Sing	0	0	0
8	คลองชักพระ	Khlong Chak Phra	500	0	0
9	คลองต้นไทร	Khlong Tan Sai	0	0	0
10	คลองตัน	Khlong Tan	0	0	0
11	คลองตันเหนือ	Khlong Tan Nuea	0	500	0
12	คลองเตย	Khlong Toei	0	2300	0
13	คลองเตยเหนือ	khlong Toei Nuea	0	0	0
14	คลองถนน	Khlong Thanon	157152.5067	261659.1103	184567.7872
15	คลองบางบอน	Khlong Bang Bon	61600	41053.92072	66503.63138
16	คลองบางบอนใ	Khlong Bang Bon Ai	174119.5425	211938.5704	325596.6623
17	คลองบางพราน	Khlong Bang Phran	24600	10831.43301	16912.68274
18	คลองมหานาค	Khlong Maha Nak	0	0	0
19	คลองสองต้นนุ่น	Khlong Song Ton Nun	935750.5548	673200	522800
20	คลองสาน	Khlong San	0	0	0
21	คลองสามประเวส	Khlong San Prawet	861893.6018	770453.3154	918408.5927
22	คลองสิบ	Khlong Sip	211834.8509	177184.6564	384501.2559
23	คลองสิบสอง	Khlong Sip Song	978583.9738	442516.08	1111141.997
24	คันนายาว	Khan Na Yao	244300	340879.7946	406631.5727
25	คู้ฝั่งเหนือ	Khu Fang Nuea	400976.0927	542102.4891	695979.9756
26	คูหาสวรรค์	Khuha Sawan	0	0	0
27	โคกแฝด	Khok Faet	594914.9533	518926.7501	1080555.024
28	จตุจักร	Chatuchak	88300	87500	86900
29	จรเข้บัว	Chorakhe Bua	83000	117609	89700
30	จอมทอง	Chom Thong	10500	4400	16900
31	จอมพล	Chomphon	0	0	0
32	จักรวรรดิ์	Chakkrawat	0	0	0
33	จันทรเกษม	Chana Songkhram	0	0	0
34	ฉิมพลี	Chimpli	0	42500	8400
35	ชนะสงคราม	Chana Songkhram	0	0	0
36	ช่องนนทรี	Chong Nonsi	12300	7700	21200
37	ดอกไม้	Dok Mai	111700	119800	130400
38	ดอนเมือง	Don Mueang	245709.2327	207700	141485.8417
39	ดาวคะนอง	Dao Khanong	0	0	0

40	ดินแดง	Din Daeng	0	3400	1600
41	ดุสิต	Dusit	14900	18300	2600
42	ตลาดน้อย	Talat Noi	0	0	0
43	ตลาดบางเขน	Talat Bang Khen	700	2500	300
44	ตลาดพลู	Talat Phlu	0	0	0
45	ตลาดยอด	Talad Yot	0	0	0
46	ตลิ่งชัน	Taling Chan	1400	15400	9200
47	ถนนนครไชยศรี	Thanon Nakhon Chai Si	0	0	500
48	ถนนพญาไท	Thanon Phaya Thai	0	0	0
49	ถนนเพชรบุรี	Thanon Petchaburi	0	0	0
50	ทรายกองดิน	Sai Kong Din	235521.6834	269556.2235	317326.2606
51	ทรายกองดินใ	Sai Kong Din Ai	707302.1609	810098.7821	830831.7547
52	ทวีวัฒนา	Thawi Watthana	561861.1729	239705.4022	543132.7769
53	ทับยาว	Thap Yao	1137396.914	702082.7652	1047875.913
54	ท่าข้าม	Tha Kham	1487561.64	1425300.457	1608984.07
55	ท่าแร้ง	Tha Raeng	195783.442	318252.77	303038.5943
56	ทุ่งครุ	Thung Khru	413970.5892	285306.6765	514769.8351
57	ทุ่งพญาไท	Thung Phaya Thai	0	0	0
58	ทุ่งมหาเมฆ	Thung Maha Mek	0	0	0
59	ทุ่งวัดดอน	Thung Wat Don	300	982.131143	8319.195685
60	ทุ่งสองห้อง	Thung Song Hong	224200	245500	151200
61	นวมินทร์	Nawa Min	3800	0	0
62	นวลจันทร์	Nuan Chan	0	5500	100
63	บางกะปิ	Bang Kapi	42600	146300	93100
64	บางขุนเทียน	Bang Khun Tian	18700	20200	16900
65	บางขุนนนท์	Bang Khun Non	0	0	0
66	บางขุนพรหม	Bang Khun Phrom	0	0	0
67	บางขุนศรี	Bang Khun Sri	55400	33900	15800
68	บางค้อ	Bang Kho	2300	8600	11246.45857
69	บางคอแหลม	Bang Kho Laem	0	0	0
70	บางแค	Bang Khae	80999.99639	70667.40302	55087.106
71	บางแคเหนือ	Bang Khae Nuea	136015.6905	141500	182952.5582
72	บางโคล่	Bang Khlo	10500	1300	1700
73	บางจาก	Bang Chak Phasi Charoen	10300	0	4600
74	บางจาก	Bang Chak Phra Khanong	0	0	0
75	บางชัน	Bang Chan	302500	173402.921	101000
76	บางเชือกหนัง	Bang Chueak Nang	132900	64800	87600
77	บางซื่อ	Bang Sue	0	0	0
78	บางด้วน	Bang Duan	99.824861	303.865506	547.263406
79	บางนาใต้	Bang Na Tai	16900	1900	42700
80	บางนาเหนือ	Bang Nuea	6300	3600	600
81	บางบอนเหนือ	Bang Bon Nuea	313099.5654	383028.644	676466.0445
82	บางบำหรุ	Bang Bamru	0	0	0
83	บางปะกอก	Bang Pakok	47176.00806	70720.0275	29060.59667

84	บางไผ่	Bang Phai	312790.6801	151000	218047.8959
85	บางพรม	Bang Phrom	11458.9864	10700	1700
86	บางพลัด	Bang Phlat	0	0	0
87	บางโพงพาง	Bang Phongphang	2800	300	7100
88	บางมด	Bang Mot Chom Thong	31490.725	0	58726.21363
89	บางมด	Bang Mot Thung Khru	0	18879.9725	0
90	บางยี่ขัน	Bang Yi Khan	0	0	0
91	บางยี่เรือ	Bang Yi Ruea	0	0	0
92	บางระมาด	Bang Ramat	248641.0136	196100	46000
93	บางรัก	Bang Rak	0	0	0
94	บางลำภูล่าง	Bang Lamphu Lang	0	0	0
95	บางแวก	Bang Waek	0	0	0
96	บางหว้า	Bang Wa	7897.90762	12800	28194.18571
97	บางอ้อ	Bang O	0	0	0
98	บ้านช่างหล่	Ban Chan Lo	0	0	0
99	บ้านบาตร	Ban Bat	0	0	0
100	บ้านพานถม	Ban Phan Thom	0	0	0
101	บุคคโล	Bukkhalo	0	0	0
102	ปทุมวัน	Pathum Wan	4300	9300	17500
103	ประเวศ	Prawet	127100	58038.48452	42116.34945
104	ป้อมปราบศัต	Pom Prap	0	0	0
105	ปากคลองภาษี	Pak Khlong Phasi Charoen	1.430096	0	0
106	พญาไท	Phaya Thai	0	0	0
107	พระโขนง	Phra Khanong	0	0	0
108	พระโขนงใต้	Phra Khanong Tai	0	0	200
109	พระโขนงเหนื	Phra Khanong Nuea	0	0	0
110	พระบรมมหาราชวัง	Phra Borom Maha Ratchawang	18300	0	27700
111	พลับพลา	Phlapphla	0	2600	0
112	พัฒนาการ	Phattanakan	31100	77300	12500
113	มหาพฤฒาราม	Maha Phruettharam	0	0	0
114	มักกะสัน	Makkasan	0	8400	23600
115	มีนบุรี	Minburi	509467.9198	402840.8765	354076.5807
116	ยานนาวา	Yannawa	3500	11113.30294	5966.67112
117	รองเมือง	Rong Mueang	0	0	0
118	รัชดาภิเษก	Ratchadapisek	0	0	0
119	รามอินทรา	Ram Inthra	290400	187878.6581	278910.0265
120	ราษฎร์บูรณะ	Rat Burana	0	800	200
121	ราษฎร์พัฒนา	Rat Phattana	120800	101900	65600
122	ลาดกระบัง	Lat Krabang	278902.232	215438.302	199030.2948
123	ลาดพร้าว	Lat Phrao	133600	47300	44200
124	ลาดยาว	Lat Yao	0	1600	200
125	ลำต้อยติ่ง	Lam Toiting	752886.0433	544605.9929	665401.2633
126	ลำปลาทิว	Lam Pla Thio	1615511.385	869156.0681	1125190.178
127	ลำผักชี	Lam Phak Chi	923242.8475	842146.4183	1473498.842

128	ลุมพินี	Lumphini	29700	33900	6000
129	วงศ์สว่าง	Wong Sawang	5866.382674	10502.50311	10704.55373
130	วชิรพยาบาล	Wachiraphayaban	22300	0	0
131	วังทองหลาง	Wang Thonglang	0	3400	1200
132	วังบูรพาภิร	Wang Burapha Phirom	0	0	0
133	วังใหม่	Wang Mai	900	2100	0
134	วัดกัลยาณ์	Wat Kanlaya	0	0	0
135	วัดท่าพระ	Wat Tha Phra	5100	1300	200
136	วัดเทพศิริน	Wat Thep Sirin	0	0	0
137	วัดบวรนิเวศ	Wat Bowon Niwet	0	0	0
138	วัดพระยาไกร	Wat Phraya Krai	0	0	0
139	วัดราชบพิธ	Wat Ratchabophit	0	0	0
140	วัดสามพระยา	Wat Sam Phraya	0	0	0
141	วัดโสมนัส	Wat Sommanat	0	0	0
142	วัดอรุณ	Wat Arun	0	0	0
143	ศาลเจ้าพ่อเ	San Chao Pho	0	0	0
144	ศาลาธรรมสพน	Saka Thammasop	815134.3589	616958.3831	563152.8791
145	ศิริราช	Siri Rat	0	0	0
146	สนามบิน	Sanam Bin	373400	492200	455100
147	สมเด็จเจ้าพระยา	Somdet Chao Phraya	0	0	0
148	สวนจิตรลดา	Suan Chitlada	82400	26800	14000
149	สวนหลวง	Suan Luang	1900	17800	8300
150	สะพานสอง	Saphan Song	0	0	0
151	สะพานสูง	Saphan Sung	159800	102300	103500
152	สัมพันธวงศ์	Samphanthawong	0	0	0
153	สามวาตะวันต	Samwatawan To	1030721.56	901700	1110520.497
154	สามวาตะวันอ	Samwatawan O	493713.175	575601.4449	667300.6281
155	สามเสนนอก	Samsen Nok	0	13400	7700
156	สามเสนใน	Samsen Nai	1600	170440.7299	4800
157	สายไหม	Sai Mai	212321.5372	0	143452.963
158	สำราญราษฎร์	Samran Rat	0	0	0
159	สำเหร่	Samre	0	0	0
160	สีกัน	Si Kan	92290.76729	135100	45414.15829
161	สี่พระยา	Si Phraya	0	0	0
162	สี่แยกมหานา	Si Yaek Maha Nak	0	0	0
163	สีลม	Silom	0	0	0
164	สุริยวงศ์	Suriyawong	0	0	0
165	เสนานิคม	Sena Nikhom	0	0	700
166	เสาชิงช้า	Sao Chingcha	0	0	0
167	แสนแสบ	Saen Saeb	1349531.833	872127.3544	1639609.89
168	แสมดำ	Saen Dam	600086.5401	592306.9779	627147.0923
169	หนองแขม	Nong Khem	245006.4997	252047.8498	518659.8711
170	หนองค้างพลู	Nong Khang Phlu	305405.4509	146787.7733	361862.0764
171	หนองจอก	Nong Chok	701501.8634	566696.4106	924645.7982

172	หนองบอน	Nong Bon	70800	55600	60589.884
173	หลักสอง	Lak Song	110858.1041	144362.5451	213476.8523
174	ห้วยขวาง	Huai Khwang	14000	19700	1100
175	หัวหมาก	Hua Mak	113600	176600	86400
176	หิรัญรูจี	Hiran Ruchi	0	0	0
177	อนุสาวรีย์	Anusawari	233800	141700	256400
178	อรุณอมรินทร	Arun Amarin	0	0	0
179	ออเงิน	Ao Ngeun	303808.8722	381906.515	214110.0938
180	อ่อนนุช	On Nut	0	14100	0

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