ANALYSIS AND SPATIAL APPLICATION OF HUMAN SECURITY INDICATORS IN PERSPECTIVES OF SUSTAINABLE DEVELOPMENT

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ABSTRACT

Title of Dissertation	Analysis and Spatial Application of Human Security Indicators in Perspectives of Sustainable Development
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This study aimed to analyze the implications of human security indicators and sustainable development, in perspectives of economic, social, and environmental aspects for investigating development opportunities in Thailand, focusing on the central west region. The Human Achievement Index (HAI) from the National Economic and Social Development Board (NESDB) was applied as a based case of human security indicators for a mixed-method research in this study. The data collection was conducted by a purposive sampling method via the Delphi technique, which 18 participants were invited to deliver their opinions as the panelists. After that, the significant indicators were integrated with the spatial application to verify development opportunities further. This analysis applied various statistical measurements, including Mean, Median, Mode, and Interquartile to pursue central tendency and implication levels of variable relationships. The findings expressed a series of implications, which human security affected to sustainable development, for instance, the top three rankings of significant indicators in each perspective could be ordered, as follows: 1) economic security--family income, consuming debt, and poverty rate, 2) social security--unemployment rate, social insurance, and high school and vocational training opportunity, and 3) environmental security--serviceable main road, greenhouse emission rate, and house and land owner, respectively. The study also derived various indicators from the panelists via the Delphi technique, for example, sufficiency economic village, drug-trafficking case, immigration rate, medical personnel rate, and air quality index. Furthermore, the panelists contribute

some recommendations for further study, including ecological and creative tourism, local business mechanism, smart city, empirical indicator, multi-dimensions of social and environmental issues. Nevertheless, the panelists also suggested that the political vote rate in the year 2016 should be dismissed from the HAI.

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ABBREVIATIONS

Abbreviations	Equivalence
CRF	Common Reporting Formats
GDP	Gross Domestic Product
GHG	Greenhouse Gas Emissions
GIS	Geographic Information Systems
GISDA	Geo-Informatics and Space Technology Development Agency
EIA	Environmental Impact Assessment
ESI	Environmental Sustainable Index
HAI	Human Achievement Index
HDI	Human Development Index
HDR	Human Development Report
IPA	Individual Provincial Achievement Value of the HAI
IPCC	Intergovernmental Panel on Climate Change
INRM	Integrated Natural Resource Management
LCA	Life Cycle Assessment
NESDB	National Economic and Social Development Board
NESDP	National Economic and Social Development Plan
NSDS	National Sustainable Development Strategy
OECD	Organization for Economic Co-operation and Development
PA	Provincial Achievement Value of the HAI
PI	Provincial Indicator of the HAI
RS	Remote Sensing
SDGs	Sustainable Development Goals
SI	Sub Index of the HAI
SPI	Sustainable Process Index
UNDP	United Nations Development Program

CHAPTER 1

INTRODUCTION

1.1 Background and Significance of the Study

Sustainability means the ability of system to keep going over time. Meanwhile, sustainable development refers to change over time in a direction of sustainability. However, the world would be unsustainable if people depend on fossil energy sources, especially in industrial processes and social arrangements that cannot keep doing what people usually do, without wrecking the planet. Then, the world has increasingly been emphasizing global sustainability, in which the entire world can keep doing what it is doing as the preconditions of developing or for better world in a sustainable manner (Atkisson, 2008, pp. 3-4).

Regarding the Brundtland agreement (OECD, 1996), it was noted that the integration of concerns about development and environment has also been fundamental to the conceptualization, interrogation, and operationalization of sustainable development since there is synergy between the objectives of development and environmental conservation. Moreover, there was the attempt at conceptualizing and assessing the integration between development and environmental governance, the so-called Millennium Ecosystem Assessment (MA), which linked ecosystem services and the benefits providing for human wellbeing. It showed how provisioning, regulating, supporting, and cultural services lead to security, basic materials for a good life, health, and good social relations. Its framework defined human wellbeing as a set of opportunities and capabilities, rather than simply assets and income (World Resources Institute, 2003, p. 5).

Since people's security was basically considered as people's freedom from fear and freedom from want; then, human security was adopted to measure and evaluate a complex issue of human dimensions. However, human security was assessed in various approaches as to different priorities and values from diverse localities. Therefore, many

countries have been undertaking human development to enhance human security for their citizens as well, by integrating human elements of security, rights, and development together (UN Commission on Human Security, 2017). At the outset concept of human security in the 1994 Human Development Report (HDR), human security was implied not only the security from violence and crime but also the security of people's likelihood, including economic, community, environmental, food, health, personal, and political dimensions (Gomez & Gasper, 2020).

Thailand also emphasizes these issues, especially in perspectives of society, economy, and environment to achieve the Sustainable Development Goals (SDGs) for the country. It is highly concerned with demographic growth, socio-economic problems, and resources available to achieve human security for the country, based on the National Sustainable Development Strategy (NSDS). However, to maintain and enhance national interests along with socio-economic and environmental concerns, Thailand is to understand human security to reach sustainable development clearly. Therefore, the challenge to cope with sustainability of human security still exists and needs to be implemented in proper approaches.

This research, therefore, determines reliable approaches to fill the gap between planning and implementing for the NSDS of Thailand. The significant indicators related to socio-economic and environmental issues that affect to human security are clarified and integrated with spatial analysis further for examining development opportunities in the study areas. The research findings would reflect significant human security indicators via economic, social, and environmental perspectives eventually.

After that, the human security indicators from the National Economic and Social Development Board (NESDB), namely the Human Achievement Index (HAI), is analyzed by the Delphi technique, to assess significant human security indicators in terms of sustainable development perspectives. The human dimensions and physical dimensions of the areas were also integrated via a spatial analysis using the ArcGIS application to visualize their significant indicators in understandable approach. In this study, the ArcGIS program version 10.2.2 is used as a tool of Geographic Information Systems (GIS) to identify a set of human security indicators.

1.2 Problem Statement

Although human security has been introduced to governmental agencies of Thailand for many years, especially in the NESDB, who is also responsible to plan sustainable development in the country; however, there was a puzzle that why the HAI has not been applied in terms of sustainable development. Moreover, even the HAI involve with localities directly, but spatial analysis which is quite related to physical dimensions of global changes has not been applied to the HAI widely though spatial applications.

1.3 Research Questions

The main research questions are to pursue the answers from a research course of actions, as follows:

1) How does human security implicate in sustainable development?

2) What are significant human security indicators for enhancing sustainable development?

3) What contributions does spatial analysis integrate human security indicators with sustainable development?

1.4 Research Objectives

The research intention of this study mainly is to investigate the implications between human security and sustainable development to identify development opportunities in Thailand. The study, then, underlines the research objectives, as follows:

a. To clarify human security implications in perspectives of sustainable development for Thailand.

b. To identify significant human security indicators towards sustainable development potential in Thailand.

c. To verify significant human security indicators for enhancing sustainable development via the spatial analysis model.

1.5 Expected Results of the Study

As human security was an essential element of sustainable development nowadays, this study was expected to benefit policy makers, local authorities, and the stakeholders to plan and implement developments more understanding via visionary perspectives. Stakeholders could exploit multi-layer spatial maps or geographic data to clarify sustainable human security via spatial analysis and its applications.

This study was also expected to identify barriers of human security in various perspectives of sustainable development, including economic, social, and environmental aspects. The Delphi technique was supposed to identify significant indicators of human security, prior to integrate with spatial analysis further.

Human security would be strengthened people's dignity and achievements in sustainable manner via spatial analysis finally. The more balancing human needs and natural resources via spatial analysis, the more human security strengthen sustainable development for the country.

1.6 Limitation

This study was proposed to explain the research objectives and response to the problem statement, regarding human security indicators that implicate to sustainable development in Thailand. Since sustainability of human security in the country is based on existential potentials of development opportunities, which people in various areas could use their strengths to pursue own achievements, regarding social, economic, and environmental perspectives.

However, there were limitations of time and financial supports to pursue a study as a nationwide research; this research had, therefore, been focusing on 8 provinces of the Central West region of Thailand, which may be not reflecting all circumstances of developments in the country. Moreover, the HAI map would have a limitation of delicacy resolution, which this research could not elaborate specific details in small areas as to a constrain of spatial attributes available for the GIS study.

1.7 Structure of the Chapters

The research structure is organized into five chapters, regarding to the research objectives as follows.

1) Chapter 1: Introduction - This chapter introduces and explains the general statements of the research background, problem statement, research questions and objectives, the significance of the research, and limitation.

2) Chapter 2: Literature review - This chapter discusses the concepts of sustainable] development and human security, which reflect various perspectives of human dimensions. Moreover, the utilization of spatial analysis has been elaborated relevant models of physical dimensions, towards its application.

3) Chapter 3: Research methodology - This chapter describes the research method of this study, including the analytical framework, the research participations, the data collection, and the study area.

4) Chapter 4: Analysis of significant human security indicators - The implications between human security indicators and sustainable development have been analyzed by the involvement and focusing processes of the Delphi technique.

5) Chapter 5: Integrations of human and physical dimensions by spatial analysis - The spatial analysis was used to clarify development opportunities, in terms of economic, social, and environmental perspectives to establish sustainable human security.

6) Chapter 6: Conclusion, discussion, and recommendations - This chapter summaries the research outcomes and discusses in which the implications of human security and sustainable development advocate, and also clarify how spatial analysis magnify development opportunities in the study area. Moreover, the recommendations from the study have been suggested for further development and study as well.

1.8 Terms and Definitions

This study has been discussed in various contents, which could define the related keywords in terms of definitions, as follows.

1) Human security: the Commission on Human Security (2003) clarified human security that it was to protect the vital core of all human lives in ways that enhance human freedoms and human fulfilment, while retain people-centred focus but concentrate on threats from poverty and violence. This study had been applied the Human Achievement Index (HAI) as the human security indicators in Thailand.

2) Sustainable development: the Brundtland Commission defined sustainable development as development that met the needs of the present without compromising the ability of future generations to meet their own needs (World Commission on Environment and Development, 1987).

3) Human Achievement Index (HAI): the National Economic and Social Development (NESDB) established the HAI as the human security indicators for expressing achievements of human development at the provincial level of Thailand, in which the people were fulfilled what they needed for life (NESDB, 2019).

4) Spatial analysis: spatial analysis is a process, which an analyst models a problem geographically by deriving results via computer processing, and then exploring and examining those results via Geographic Information System (GIS) (ESRI, 2018).

5) Sustainable Human Security Model: the model of human security for sustainable development, which was applied for integrating human dimension with physical dimension via the involvement process, focusing process, and integrating process to achieve the target of sustainable human security.

CHAPTER 2

LITERATURE REVIEW

2.1 Chapter Overview

This chapter reviewed the background of research study, regarding theories and arguments as the sources of analysis. The main effort of this study was to elaborate the elements of sustainable development and identified significant indicators for assessing human security widely. Sustainable development would be clarified towards economic, social, and environmental elements, based on human capitals and natural resource potentials in each area. The assessments for human security were evaluated, such as the Delphi technique and spatial analysis to verify sustainable human security further.

Furthermore, the Human Achievement Index (HAI) was the composite indicators of human security, which this study used as the base case to assess how the people in Thailand were fulfilled what they needed for their life. The sources of information and the collected year of the HAI were identified, regarding the governmental organizations and methodology of acquisition. Then, spatial application was clarified as a tool for analyzing the potential of the concerned area. This analysis would be an effective measurement for natural resource management to assess specific characteristics of the study area as well.

2.2 Sustainable Development Perspectives

It is a basic nature that people have unlimited wants and needs, while natural resources are scarce. While scholars realize the fact that natural resources are to be protected, maintained, and enhanced for themselves and new generations. However, the study from Daly (1990) also proposed the board concept of development, namely the "Three Es" approach, that it had to combine environment, energy, and economy together to achieve sustainability of developments. Moreover, the recent study about

decision making process in natural resource management asserted that society would encounter with gaining something but losing something (Camp & Heath-Camp, 2009). In this concern, some environmental measures, such as Environmental Impact Assessment (EIA) could constrain economic growth whenever the development has significant effect to environmental degradation.

In the study from Morse (2004), it asserted that sustainable development, although, intended to protect resources and environment for future generations, but in the human development aspect, sustainability means what we meet the needs without reducing capability to develop or our aspirations in the future. Nevertheless, the study of Morse (2010) complied with the World Commission on Environment and Development on the classic definition of sustainable development, as follows:

> "The development process should meet the needs of the present generation without compromising the options of future generations. However, the concept of sustainable development is much broader than the protection of natural resources and the physical environment. It is to include the protection of human lives in the future. After all, it is people, not tree, whose future options need to be protected."

Moreover, there were some arguments about ideology of right for future generations that the overlap of generations was to consent the right of environmental sustainability, security as well as the obligation to protect the common good (McPhail, 2012).

In the study of Dincer and Rosen (2007) stated that the nature of sustainable development could be represented by the overlapping area of three circles among the economy, the community and the environment as shown in Figure 2.1; however, it was noted that despite this interception area intend to protect resources and environment for future generations, but in human development terms, sustainability meant meeting the changing needs without reducing the capacity to develop or aspirations as well.

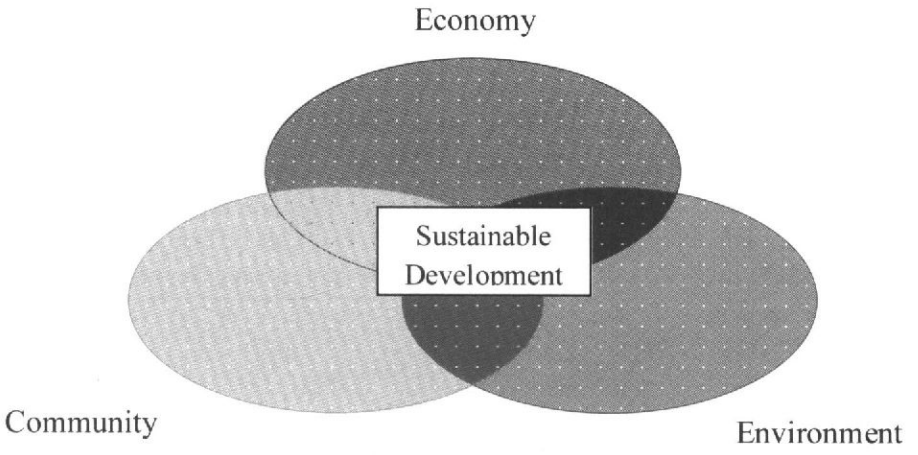


Figure 2.1 Sustainable Development Interlink
Source: Dincer & Rosen, 2007.

Moreover, the World Commission on Environment and Development, regarding to the Brundtland Commission (OECD, 1996), also clarified that sustainable development needed to include environmental, social and economic factors. Nevertheless, the definition in the Encyclopedia of Life Support Systems (EOLSS, 1998) enhanced that global sustainable development was 'the wise use of resources through critical attention to policy, social, economic, technological, and ecological management of natural and human engineered capital so as to promote innovations that assure a higher degree of human needs fulfillment, or life support, across all regions of the world, while at the same time ensuring intergenerational equity'. Some key components for sustainable development were illustrated in Figure 2.2.

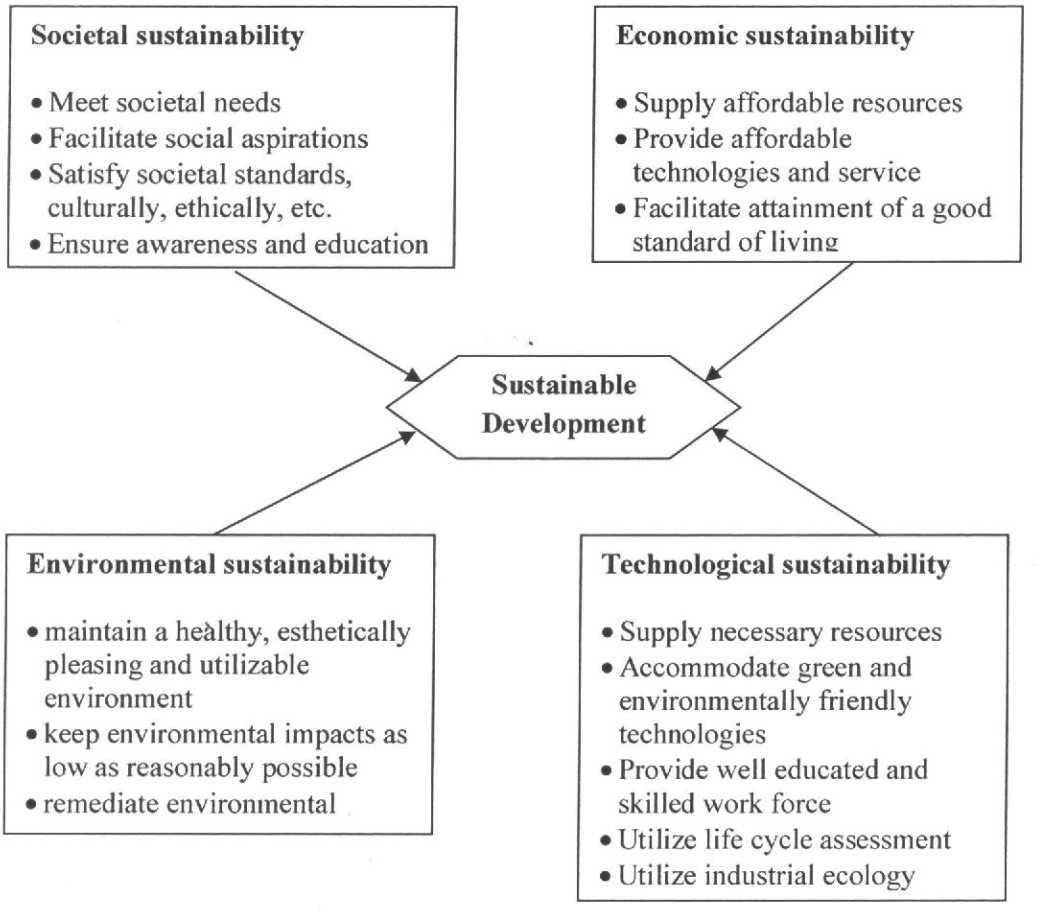


Figure 2.2 Key Components for Sustainable Development

Source: OECD, 1996.

It was widely accepted that sustainable development was involved three main aspects (Dewulf & Langenhove, 2006), as follows.

1) Ecological balance (such as ecosystems, feedstock and climate change).

2) Sustained economic stability.

3) Social development and equity (the activities of current generations do not endanger the opportunities of future generations).

2.3 Elements of Sustainable Development

The classic study from Morse (2004) asserted that sustainable development was focused on protecting resources and environment for future generations; but in human aspect, it meant developing our needs without reducing capability to progress in our aspirations for the future. Moreover, there were some arguments that rights for future generations were to overlap between generations, especially the right of environmental sustainability and security. However, to achieve sustainability, it must satisfy the needs and aspirations of society together with environmental and ecological conservation as well (McPhail, 2012).

It is a basic of human nature that people have limitless needs of what they want, while natural resources are scarce .Therefore, people are to consider the fact that the resources need to be protected, maintained, and enhanced (Camp & Heath-Camp, 2009). However, this concern should reflect the local people perceptions whether their human security is fulfilled in sustainable manner, as the UN General Assembly recently declared "the 2030 Agenda for Sustainable Development" to make progress towards the Sustainable Development Goals (SDGs). There are several key concerns of SDGs, including poverty, famine, health and well-being, sufficient clean energy, value-added employment and economic growth, industrial development with innovation and infrastructure, equality, sustainable urban community, responsible production and consumption, climate change, natural resources, and diversity.

To come up with sustainable development, Thailand's strategy was primarily focused on economic development since the 1st National Economic and Social Development Plan (NESDP) in 1961, and founded the National Sustainable Development Strategy (NSDS) in 2005 to comply with the ratification of Johannesburg Declaration and Agenda 21 (United Nations Conference on Environment and Development, 1992). After that, the 10th NESDP (2007 – 2011) had firmly integrated with sustainable development, covering three main dimensions of economics, society and environment, in order to minimize negative impacts from various developments in the country, such as natural resource degradation, pollution emission and social issues. While the 11th NESDP (2012 - 2016), Thailand had been continuously implementing in sustainable development approach, but focusing more on human security, especially on

natural resources and socio-economic (National Economic and Social Development Board [NESDB], 2011).

Moreover, the 12th NESDP (2017 - 2021) has declared to pursue the SDGs plan (2016 – 2031), focusing on people, global, partnership, prosperity, and peace issues, via 17 goals and 169 objectives (NESDB, 2017). Then, the SDGs Committee has been steering by the Prime Minister, supervised by NESDB, to pursue the 20-year National Strategy (2017 - 2037) and implement sustainable development in 6 dimensions, including security, competitiveness enhancement, human capital development and strengthening, social cohesion and equity, eco-friendly development and growth, and public rebalancing and development (NESDB, 2018). Moreover, the government also delivered national strategy to achieve security, prosperity, and sustainability for the people, in complying with self-sufficient philosophy of the King Rama IX as well.

2.4 Measuring Tools for Indicating Sustainable Development Potentials

One of the famous guidance for measuring the accomplishment of sustainable development was the Bellagio Principles for Sustainable Development principle, established by Rockefeller Foundation in 1996 (Morse, 2004). This principle was arranged by the Joint Research Centre (JRC) of the European Commission and the Organization for Economic Co-operation and Development (OECD), to improve development indices from inter-country comparison. This study has been used the weighting approaches of this guidance to assess the participants' opinion by ranking their opinion scores for statistical analysis. The guidance was used as the best practice for sustainable development, regarding to the categories of composite indicators (OECD, 2008), as shown in Table 2.1, as follows.

Table 2.1 Guidance for Measuring Sustainable Development

Measurements	Guidance
Theoretical framework	Providing for the components that make up the index. This includes how components are to be weighted and how the index feeds into policy.
Data selection	Based of soundness, measurability, country coverage, relevance, inter-relationship with other variables.
Correlation analysis of data	Using of factor analysis to gain insights into the relationships between the variables and an understanding of the phenomenon to be measured.
Standardization methods	Identifying the components of the index to be standardized or normalized to make them comparable.
Weighting approaches	Assigned through expert opinion, techniques (such as principal components analysis and factor analysis), or correlations with dependent variables (such as economic growth rates).
Transparency/Accessibility	Explaining of underlying data sets, standardization techniques, weighting methods, alternative approaches.
Visualization	Including an acknowledgement of their limitations as well as a comparisons of country performance in given areas to be used as starting points for further analysis.

Source: OECD, 2008.

There are several tools used for assessing sustainable development, including the tools proposed by Dincer and Rosen (2007) that were frequently mentioned for assessing and improving a quality of management, as shown in Table 2.2.

Table 2.2 Tools for Sustainable Development Assessment

Sustainability tools	Environmental tools	Risk tools	Thermodynamic tools
Life Cycle Assessment	Environmental Performance Indicators	Risk Assessment	Exergy Analysis Material Flux Analysis
Sustainable Process Index	Environmental Impact Assessment		
Environmental Sustainable Index	Ecological Footprints		

Source: Dincer & Rosen, 2007.

These tools could be clarified more in details about its functional assessment, as follows.

1) Life Cycle Assessment (LCA) is an analytical tool for assessing the environmental concerns and any potential impacts which burden to environment via various methods, for examples:

(1) Life Cycle Inventory

(2) Environmental Fate Modeling - comprising chemical reactions and spatial spread of emissions

2) Environmental Impact Assessment (EIA) is a common tool to assess ecological impacts via several categories in the life cycle system.

3) Sustainable Process Index (SPI) is a measurement of sustainable process for producing goods, calculated in a unit of m2. It is manipulated from a total land area required to supply raw materials, process energy, provide infrastructure and production facilities, and dispose of wastes.

4) Environmental Sustainable Index (ESI) was established by the World Economic Forum (WEF) as an aggregated index of sustainable development. It comprises of a set of 68 variables and 20 indicators in 5 components, as follows.

(1) Environmental systems

(2) Reducing environmental stresses

(3) Reducing human vulnerability

(4) and institutional capacity

(5) Global stewardship

In recent study, Dincer and Rosen (2007) proposed the checklists that were commonly used as sustainable development indicators, including:

1) Specific - must clearly relate to outcomes.

2) Measurable - must be a quantitative indicator.

30 Usable - must be practical.

4) Sensitive - must readily change when circumstances change.

5) Available - must be convenient to collect necessary data.

6) Cost-effective - must not be very expensive to access necessary data.

In Table 2.3, there are criteria used to recheck sustainable development indicators, in terms of the questions to achieve sustainable development, based on the assumptions who is going to use the indicators or how to achieve the goal.

Table 2.3 Criteria of Indicators for Sustainable Development

Criteria	Questions
Community involvement	Were they acceptable by the stakeholders?
Linkage	Do they link social, economic, and environmental issues?
Valid	Do they measure something that is relevant?
Available and timely	Are the data available on a regular basis?
Understandable	Are they simple enough to be understood by local persons?
Responsive	Do they respond quickly and measurably to change?
Policy relevance	Are they relevant to policy?
Representative	Do they cover the important dimensions of the area?
Flexible	Will the data be available in the future?
Proactive	Do they act as warning rather than measuring the existing state?

Source: Dincer & Rosen, 2007.

2.5 Implementation of Sustainable Development in Thailand

To come up with sustainable development, Thailand has focused on economic development since the 1st National Economic and Social Development Plan (NESDP) in 1961, and also founded the National Sustainable Development Strategy (NSDS) in 2005 as to a ratification of Agenda 21 (Rio Earth Summit) and Johannesburg Declaration. Then, Thailand had integrated the concept of sustainable development to the 10th NESDP (2007-2011), covering three main dimensions of economics, society, and environment, in order to minimize negative effects from natural resources degradation, pollution emission and social issues in the country.

Regarding to Thailand's scenario, the Thai government announced the NSDS Guidance Manual prepared by Thailand Environment Institute under the guidance of NESDB to balance all sustainable development concerns including environmental issue (NESDB, 2008). This strategy was to create a green and happiness society, in a good environment and sustainable natural resources. The areas of development were focused on 4 strategies, including: 1) eliminate poverty through sustained and equitable economic growth, 2) enhance environmental security and sustainability, 3) create a knowledge-based society and ethical society, and 4) ensure good governance at all levels of society. This approach was also a basic concept to establish human security in the country afterward. After that, Thailand's National strategy has been continuously implemented the 11th NESDP (2012-2016) by including the concept of sustainable development in the plan as well as focusing on human security as well, in order to minimize negative impacts to natural resources and socio-economic (NESDB, 2011).

Since development practices in Thailand were presumably realized to the patterns of sustainable development, regarding the NESDP and the NSDS; the latest 12th NESDP has, then, declared the Sustainable Development Goals (2016-2031) to focus on people, global, partnership, prosperity and peace, under 17 goals and 169 objectives of socioeconomic and environmental perspectives (NESDB, 2017). The significant indexes in this SDGs consists of various dimensions of human security, including poverty, health and well-being, equality, energy security, employment and economic growth, industrial development, considerable production and consumption and natural diversity. Moreover, the SDGs Committee, who are responsible for the plan

under NESDB, are to pursue the approval from the Prime Minister's authority by complying the plan with the 20-year National Strategy (2017-2037) of the country. On the other hand, the plans are to rely on the concepts of security, prosperity, and sustainability for the people, along with self-sufficient philosophy of the King Rama IX as well (NESDB, 2017).

The structure of this NSDS guidance was summarized into four board strategies which focused on the people-centered development, as shown in Figure 2.3.

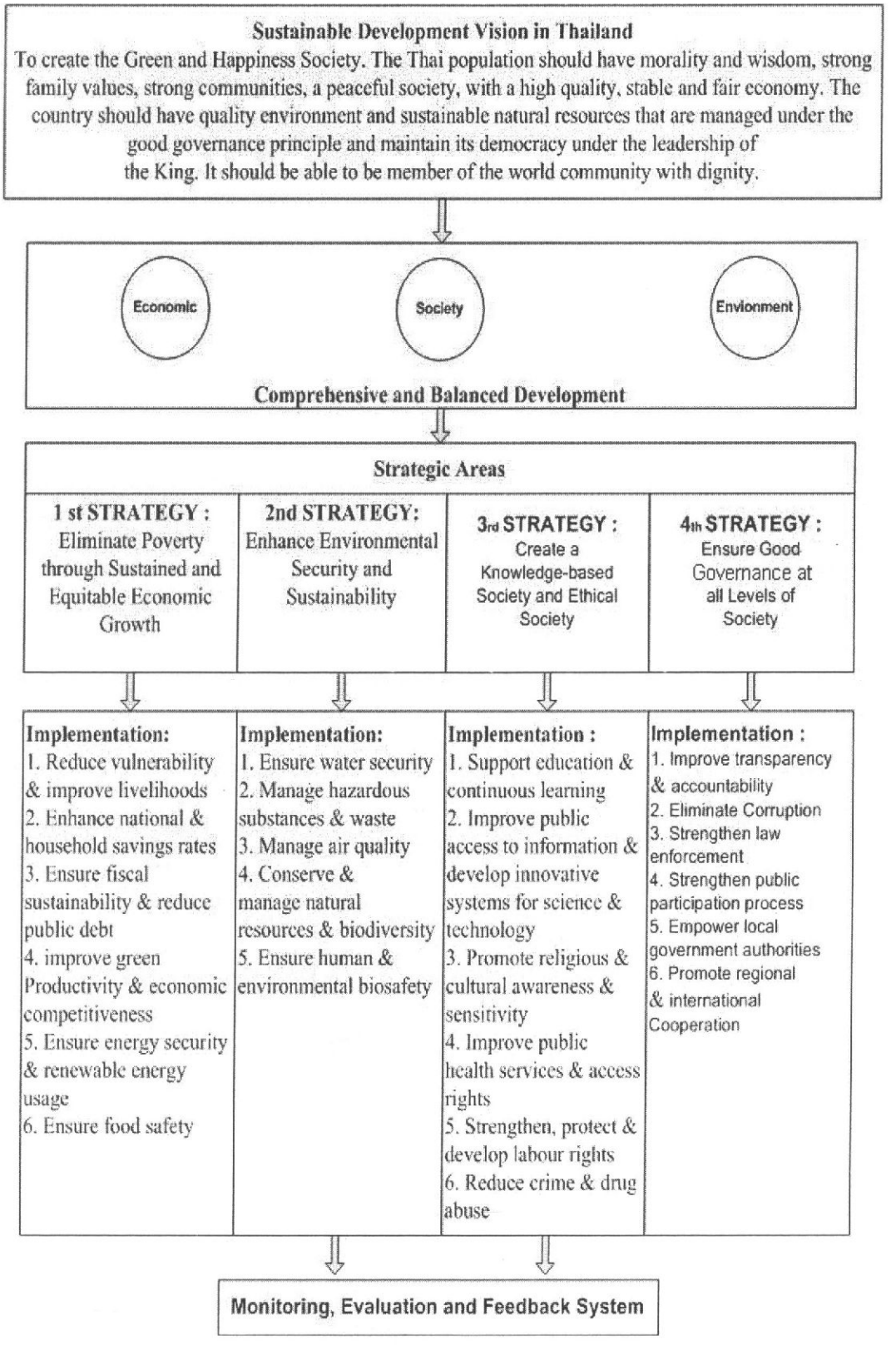


Figure 2.3 Structure of the National Sustainable Development Strategy, Thailand

Source: NESDB, 2008.

2.6 Human Security Assessments for Sustainable Development

There are broad assessments to clarify human security potentials in perspectives of sustainable development, for example, health security, personal security, community security, and political security. However, indicators of each dimension must reflect local circumstances and measurable by matrix procedure of policymaking as well. The key considerations are to understand the fulfillment of life that the people feel that they achieve at their goals (Srinivas, 2017). The indicators of human security may be identified in many aspects of assessments, as shown in Table 2.4.

Table 2.4 Indicators of Human Security Dimensions

Security Dimensions	Indicators
Economic security	Level of Income
	Reliability of incomes
	Sufficiency of incomes
	Standard of living
	Share of employed/unemployed
	Risk of joblessness
	Protection against unemployment
Food security	Availability and supply of food
	Access to basic food
	Quality of nutrition
	Share of household budget for food
	Access to food during natural/man-made disasters
Environmental security	Assessment on pollution of water, air
	Prevention of deforestation
	Land conservation and desertification
	Concern on environmental problems
	Ability to solve environmental problems
	Protection from toxic and hazardous wastes

Table 2.4 (Continued)

Security Dimensions	Indicators
Environmental security (Continued)	Prevention of traffic accidents and related impacts
	Natural hazard mitigation (droughts, floods, cyclones or earthquakes)
Health security	Assessment of the health status
	Access to safe water
	Living in a safe environment
	Exposure to illegal drugs
	Access to housing: shelter from natural elements
	Accessibility to healthcare systems
	Accessibility to safe and affordable family planning
	Quality of medical care prevention of diseases
	Health trends
	Basic awareness and knowledge on healthy lifestyles
Personal security	Fear of violence (physical torture, war, ethnic tension, suicide etc.)
	Prevention of accidents
	Level of crime
	Security from illegal drugs
	Efficiency of institutions
	Prevention of harassment and gender violence
	Prevention of domestic violence and child abuse
	Access to public information
Community security	Fear of multinational/multiregional conflicts
	Fear of internal conflicts
	Conservation of traditional/ethnic cultures, languages and values
	Abolishment of ethnic discrimination
	Protection of indigenous people

Table 2.4 (Continued)

Security Dimensions	Indicators
Political security	Level of democratization
	Protection against state repression (freedom of press, speech, voting etc.)
	Respect of basic human rights and freedom
	Democratic expectations

Sources: Srinivas, 2017.

Moreover, there was a recommended tool for assessing the impacts to human and labor right, the so-called "ILO's Decent Work Agenda", which addressed the issues about local ownership, employment opportunities, diversification of crops to improve local economic for communities, training, value-added products to communities for promoting human security (Energy Center, 2008). This approach had been mainly applied in this study in the social perspective of sustainable development, which involve in the various driving forces of workers. The Human Achievement Index (HAI), therefore, could use this agenda for developing human security indicators, in contexts of social insurance and labor right aspects. Moreover, Schwartz (1991) also proposed the framework of scenario guidance for establishing regional policies for communities by identifying the steps of scenarios, as follows.

1) Identify focal issue or decision
2) Key forces in the local environment
3) Driving forces
4) Ranking of importance and uncertainty
5) Selecting scenario logics
6) Fleshing out the scenarios
7) Implications
8) Selection of leading indicators and signposts

Regarding agricultural development, the HAI could also rely on the major potential impacts to society or community both positive and negative side, as shown in Table 2.5.

Table 2.5 Potential Impacts from Agricultural Development

Positive effects	Negative effects	Societal indicators
Diversification of agricultural output to other crops	Decreased access to commodities due to increased commodity prices	Proportion of starving (measured in children under 5 years old)
Development of infrastructure and employment in the agricultural sector, particularly rural areas	Decreased other commodities availability due to replacement of mono productions	Adult literacy, particularly female
Competition for land and other production factors	Increased environmental pressure due to introduction or expansion of unsustainable productions, leading to water pollution, loss of biodiversity, degradation	Proportion of household income and needs
Diversification of supplies	Pressure on prices of other goods and services related to market drive	Population growth
Increased human security		GDP growth per capita
Rural woman has income earning during household activities, but less child labor		Health expenditure as a proportion of GDP
Access to raw material for rural small and medium enterprises (SMEs)		Proportion of adults infected with HIV
Technological development through new investment		UNDP Human Development Index
Climate change mitigation		Degree of import and/or export dependence
Mitigation of environmental concerns – water pollution, biodiversity, land degradation		Domestic commodities availability
Revenue from the Payment for Environmental Services (PES) of carbon credits		Purchasing power of commodities
		Access to local natural resources

Source: The United Nations Food and Agriculture Organization, 2010.

Generally, the broad physical impacts that influence the outcomes of sustainable development are about land use and biodiversity; since there are various critical issues derived from a large-scale investment of agricultural productions. To establish sustainability criteria, these critical issues have been involved with policy makers, scientists, agricultural industry, and farmers in many aspects, including competition for water, availability of fertilizers and pest control, land use change affecting to biodiversity, soil quality, socio-economic impacts, and greenhouse gas emissions (Junginger, Faaj, Rosillo-Calle, & Woods 2007). However, the study from Ozdemir, Hardtlein, and Eltrop (2009) also asserted that developers should not concern only criterion for determining sustainability of economic security but also include environmental security as well, such as availability of water, fossil-fuel requirement, greenhouse gas from agricultural development, as developments could potentially decrease environmental burden to nature.

2.7 Development of Human Security Indicators to be the HAI

As human security has been related to an achievement of sustainable development, the UN General Assembly stated the declaration of the Sustainable Development Goals (SDG) by the keyword that "transforming our world: the 2030 agenda for sustainable development" to realize well-being and dignity of people in the global community by leaving no one behind. The principle of human security was to identify interconnectivity of humanity and needs that supported achievements of inclusive and peaceful societies (UN Commission of Human Security, 2017).

Human security has been conducted to meet specific needs of vulnerable populations, including women, ethnic minority groups, elder people, and people with disabilities. It was addressed in a full range of actions for challenging economic growth and poverty reduction. It also helped to clarify how food, health, education and employment, peace, stability and environmental sustainability prioritize by comprehensive and context-specific considerations (UN Human Security Unit, 2015).

The UN Trust Fund for Human Security (2019) indicated that the main problem of human security was poverty, which are highlighted by the impact of inequality on people's income, living and dignity. It was noted that human security was a people-

centered approach to achieve sustainable development by eliminating poverty and promoting inclusive and resilient societies. However, there were a number of human security definitions in the international stage, which several organizations and scholars have been defined in a meantime. The famous terms of human security definitions were described in Table 2.6, follows.

Table 2.6 Definitions of Human Security

Sources of information	Definitions of human security
Human security in major reports of international institutions	The UNDP 1994 Human Development Report articulated a universal, preventive, "people-centered" approach to human security that focused on "freedom from fear and freedom from want." The report defined human security as: 1) Safety from chronic threats such as hunger, disease, and repression. 2) Protection from sudden and hurtful disruptions in the patterns of daily life (jobs, homes or communities). The Commission on Human Security (2003) clarified the concept of human security in the Human Security Now that human security objectives were to protect a vital core of all human lives in ways that enhanced human freedoms and human fulfillment. Human security was realized in crafting institutions that protected and empowered enabling people to act on their own behalf.

Table 2.6 (Continued)

Sources of information	Definitions of human security
Human security in major reports of international institutions	The Millennium Report was addressed in the United Nations assembly in 2000 by Kofi Annan that human security in a broadest sense was to embrace far more than the absence of violent conflicts but encompassed human rights, good governance as well accessed to education and health care and ensured that each one had opportunities and choices to fulfil his or her own potential. Every step in this direction was also a step towards reducing poverty, achieving economic growth, preventing conflict, and providing freedom from wants, freedom from fear and freedom of future generations to inherit a healthy natural environment. The International Commission on Intervention and State Sovereignty defined the responsibility to protect human security in 2002, which included security of people, in the contexts of physical safety, economic and social well-being, dignity and worth as human beings as well as protection of human rights and fundamental freedoms. The World Bank announced the World Development Report in 2001 that human security comprised two interrelated concepts: 1) the state's role in protecting its borders from external threats, and 2) the role of human rights, which every person was entitled to be freedom of oppression, violence, hunger, poverty, and disease and to live in a clean and healthy environment.

Table 2.6 (Continued)

Sources of information	Definitions of human security
Human security in Nations and NGOs	The Canadian Department of Foreign Affairs asserted that human security was a people-centered approach to foreign policy which recognized that lasting stability could not be achieved until people were protected from violent threats to their rights, safety, or lives. The Global Environmental Change and Human Security Project described that human security was achieved when and where individuals and communities: - Have the options necessary to end, mitigate, or adapt to threats to their human, environmental, and social rights. - Actively participate in attaining these options. - Have the capacity and freedom to exercise these options. The Japanese Ministry of Foreign Affairs defined that human security comprehensively covered all these menaces that threaten human survival, daily life, dignity, which strengthened efforts to confront all threats.
Human security in literatures	Hampson et al. (2002) elaborated the concept of human security as the absence of threats to core human values, including the most basic human value, the physical safety of the individual. They identified core human values as physical security and the protection of basic liberties, economic needs, and interests. The study from Thomas (2000) described human security as a condition of existence, which basic material needs were met and human dignity was fulfilled together with meaningful participation in community.

Table 2.6 (Continued)

Sources of information	Definitions of human security
Human security in literatures	McRae (2001) expressed the concept of human security was, in principle, quite broad. It took the individual as the nexus of its concern, the life as lived, as the true lens through which we should view the political, economic, and social environment. At its most basic level, human security meant freedom from fear.
	Aroonsrimorakot and Vajaradul (2016) clarified the UN Sustainable Development Goals (SDGs), which related to human security in the future world, comprising of 17 aspects to encounter global problems, such as poverty, equality, global warming, and peacekeeping.

Human security could bring valuable contributions and enhance comprehensive partnerships for eliminating poverty and promoting inclusive and resilient societies. Moreover, it provided understanding approach to how different communities, districts, and groups of people experience various dimension of perspectives (UN Human Security Unit 2015). The various key elements of human security were proposed during a period of time, as shown in Table 2.7.

Table 2.7 Key Elements of Human Security

Sources of information	Key elements of human security
UNDP (1994)	Personal security, environmental security, economic security, political security, community security, health security, and food security.

Table 2.7 (Continued)

Sources of information	Key elements of human security
Buttedahl (1994)	Personal and physical security, economic security, social security, political security, ethnic and cultural security.
Nef (1999)	Environmental security, personal security, physical security, economic security, social security, political security, and cultural security.
Canada (2000)	Protection of civilians, peace support operations, conflict prevention, governance and accountability, and public safety.
Leaning and Arie (2000)	Sustainable sense of home, constructive social and family networks, acceptance of the past and a positive grasp of the future.
Nussbaum (2000)	Life, bodily health, bodily integrity, senses, imagination, thought, emotions, practical reason, affiliation, other species, play, control over one's environment.
Sen (2000)	Survival, daily life, and human dignity.
Thomas (2000)	Basic needs, dignity, democracy.
Hampson (2002)	Freedom from fear, safety of people, liberty/ rights and rule of law, freedom from want/equity and social justice.
Agenda 21	Peace as the foundation, economy as the engine of progress, environment as the basis of sustainability, justice as a pillar of society, democracy as good governance.

Since human security indicators had been widely mentioned as the Human Development Index (HDI), under the United Nations Development Program (UNDP); however, human security in Thailand had been primarily conducted and supervised by UNDP (Thailand) in 2001, prior to transfer this responsibility to the NESDB in 2016 until now. However, the NESDB has been established human security indicators in

terms of a composite index as the Human Achieve Index (HAI) in 2015, in order to identify human fulfillment and well-being of the people in the country (NESDB, 2015). After that, it was and revised in 2017 and 2019, so that decision makers and local authorities could realize their strength and weakness for developments in more comparative (NESDB, 2017; NESDB, 2019).

However, the HAI version 2017 and 2019 were classified similar approach to the HAI version 2015, but amended a number of indicators from 40 indicators to 32 indicators within 8 dimensions of health, education, employment, income, land and housing, family and community, transportation and communication, and participation. This study was elaborated the HAI, based on the latest version 2019, as shown in Figure 2.4.

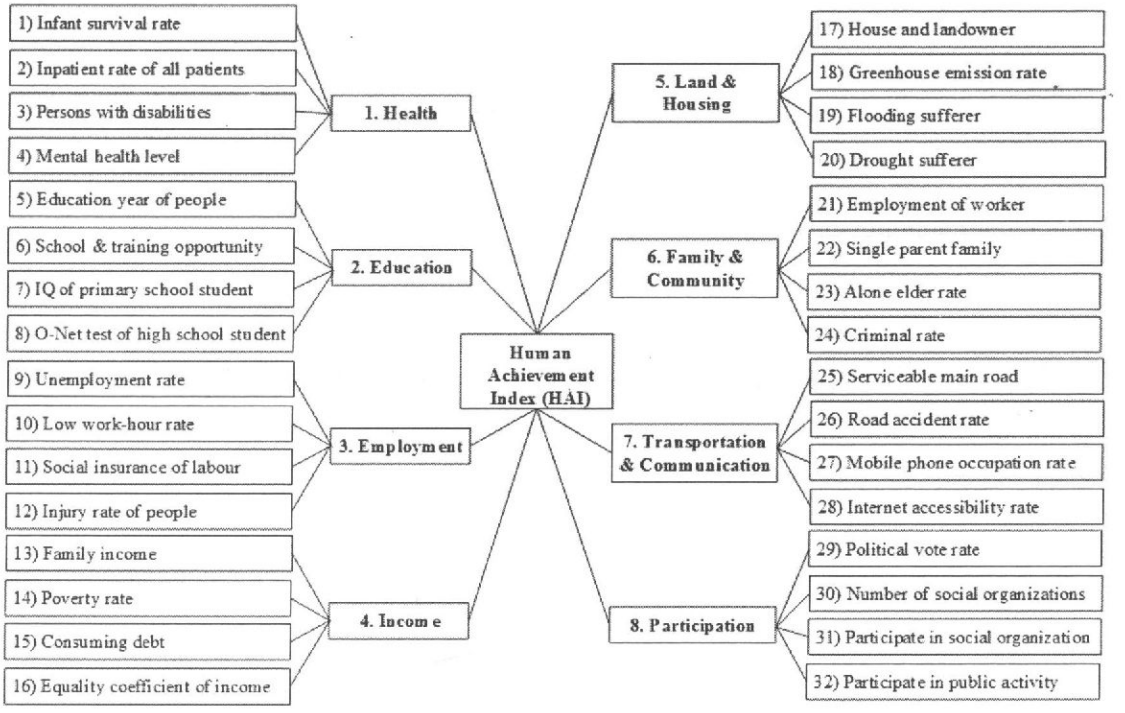


Figure 2.4 The Human Achievement Index (HAI)
Source: NESDB, 2019.

The information for generating the HAI, had been gathered from several governmental publications, such as the annual administration plans, the provincial development plans, and the governmental annual reports. The composite index of the HAI and its sources of information have been illustrated as Table 2.8, follows.

Table 2.8 Sources of the Human Achievement Index (HAI)

Sub-Index	Indicators	Sources	Year
1. Health	1. Infant survival rate (%)	Ministry of Health	2017
	2. Inpatient rate of all patients (%)	Ministry of Health	2017
	3. Persons with Disabilities (%)	Department for Empowerment of Persons with Disabilities	2018
	4. Mental health level (%)	Department of Mental Health	2015
2. Education	5. Education year of people who is 15 years old and above (year)	Ministry of Education	2018
	6. High school and vocational training opportunity (%)	Ministry of Education	2017
	7. IQ of primary school student (level)	Department of Mental Health	2016
	8. O-Net test of high school student (level)	National Institute of Educational Testing Service	2018
3. Employment	9. Unemployment rate (%)	National Statistical Office	2018
	10. Low work-hour rate (%)	National Statistical Office	2018
	11. Social insurance of labor (%)	Social Security Office	2018
	12. Injury rate (people per 1000 labours)	Social Security Office	2017
4. Income	13. Family income (Baht)	National Statistical Office	2017
	14. Poverty rate (%)	National Economic and Social Development Board	2018
	15. Consuming debt (%)	National Statistical Office	2017
	16. Equality coefficient of income (%)	National Economic and Social Development Board	2017
5. Land and Housing	17. House and land owner (%)	National Statistical Office	2018

Table 2.8 (Continued)

Sub-Index	Indicators	Sources	Year
	18. Greenhouse emission rate (GHG Ton per person)	Ministry of Energy	2017
	19. Flooding sufferer (%)	Department of Disaster Prevention and Mitigation	2018
	20. Drought sufferer (%)	Department of Disaster Prevention and Mitigation	2018
6. Family and community	21. Employment of 15-17 years old worker (%)	National Statistical Office	2018
	22. Single parent family (%)	National Statistical Office	2018
	23. Alone elder rate (%)	National Statistical Office	2018
	24. Criminal rate (%)	Royal Thai Police	2018
7. Transportation and communication	25. Serviceable main road (%)	Community Development Department	2017
	26. Road accident rate (%)	Royal Thai Police	2018
	27. Mobile phone occupation rate (%)	National Statistical Office	2018
	28. Internet accessibility rate (%)	National Statistical Office	2018
8. Participation	29. Political vote rate (%)	Election Commission of Thailand	2016
	30. Number of social organizations (per 100,000 people)	Community Organizations Development Institute	2018
	31. Family participation as a member of social organizations (%)	Community Development Department	2017
	32. Family participation in public activity (%)	Community Development Department	2018

Source: NESDB, 2019.

However, the latest HAI version 2019 has been implemented in the country both national and provincial levels, reflecting how the people prefer to their well-being and achievement of life in each area as well (NESDB, 2019). In technical terms, this index has been calculated by the average value of each indicator, such as the provincial HAI, namely the Provincial Indicator (PI) is calculated from the Mean of the Individual Provincial Achievement (IPA), based on the maximum value of the Provincial Achievement (PA) and the minimum value of the Provincial Achievement (PA), as follows.

$$\text{Provincial Indicator (PI)} = \frac{\text{Individual Provincial Achievement (IPA) - Minimum PA}}{\text{Maximum PA} - \text{Minimum PA}}$$

Whereas the Sub Index (SI) and the Human Achievement Index (HAI) have been calculated from the average values of the Provincial Indicators (PI) in each human security indicator, as follows.

$$\text{Sub Index (SI)} = \frac{\sum_{t=1}^{T} PI_t}{T} \quad \text{.....where } t = 0, 1, 2,\ldots, T;\ T = 4$$

$$\text{Human Achievement Index (HAI)} = \frac{\sum_{t=1}^{T} SI_t}{T} \quad \text{.....where } t = 0, 1, 2,\ldots, T;\ T = 8$$

There were 77 provinces of Thailand in the analysis of the HAI, which NESDB has been implementing nowadays. All provinces of Thailand could be arranged in numeric order for analyzing the HAI, as shown in Table 2.9.

Table 2.9 Provinces of Thailand with the Provincial Numeric Order for the Spatial Analysis

No	Province	No	Province	No	Province
1	Bangkok	27	Buriram	53	Lamphun
2	Krabi	28	Pathum Thani	54	Loei
3	Kanchanaburi	29	Prachuap Khiri Khan	55	Sisaket
4	Kamphaeng Phet	30	Prachin Buri	56	Sakonnakhon
5	Khon Kaen	31	Pattani	57	Songkhla
6	Chanthaburi	32	Phra Nakhon Si Ayutthaya	58	Satun
7	Chachoengsao	33	Phayao	59	Samutprakan
8	Chonburi	34	Phangnga	60	Samutsongkhram
9	Chainat	35	Phatthalung	61	Samutsakhon
10	Chaiyaphum	36	Phichit	62	Sa Kaeo
11	Chumphon	37	Phitsanulok	63	Saraburi
12	Chiang Rai	38	Phetchaburi	64	Sing Buri
13	Chiang Mai	39	Phetchabun	65	Sukhotai
14	Trang	40	Phrae	66	Suphan Buri
15	Trat	41	Phuket	67	Surin
16	Tak	42	Maha Sarakham	68	Nong Khai
17	Nakhon Nayok	43	Mukdahan	69	Nongbualamphu
18	Nakhon Pathom	44	Mae Hong Son	70	Ang Thong
19	Nakhon Phanom	45	Yasothon	71	Amnatcharoen
20	Nakhon Ratchasima	46	Yala	72	Udon Thani
21	Nakhon Si Thammarat	47	Roi Et	73	Uttaradit
22	Nakhon Sawan	48	Ranong	74	Uthai Thani
23	Nonthaburi	49	Rayong	75	Ubonratchathani
24	Narathiwat	50	Ratchaburi	76	Kalasin
25	Nan	51	Lopburi	77	Surat Thai
26	Nong Khai	52	Lampang		

Source: NESDB, 2019.

Regarding the data analysis of the HAI from NESDB, the total HAI values of each indicator in Thailand was accumulated and arranged in terms of the provincial numeric order, as shown in Figure 2.5.

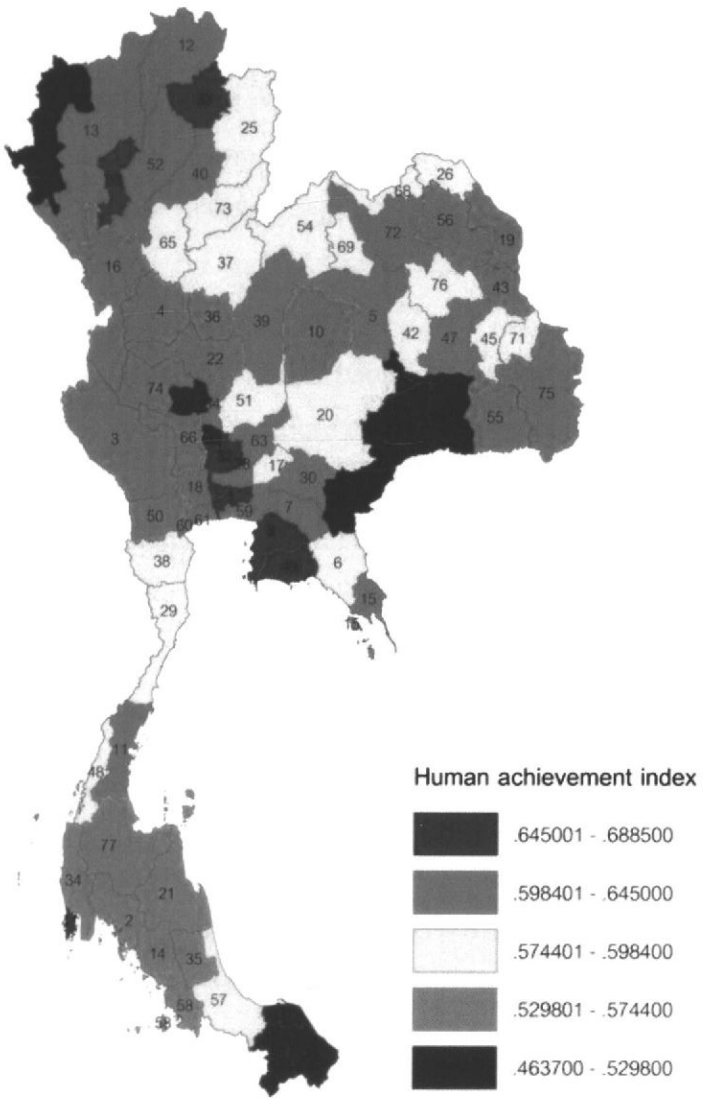


Figure 2.5 Map of Thailand with the Provincial Numeric Order of the Total HAI Values
Source: Ministry of Interior, 2019.

2.8 Spatial Approaches for Sustainable Development

To visualize the implication of sustainable development and human security, spatial analysis could go beyond providing of visualization, data management and simulation of commodity production. Spatial applications would facilitate stakeholders into development processes by identifying significant concerns and transmitting the information from analysts to policy makers and people (Lan, Tan, Lee & Mohamed, 2009). The criteria in each concern was compared and evaluated by spatial analysis via its application. Spatial analysis was an effective tool to execute for multi-criteria evaluation of development and land use (Seppelt, 2003). However, the interaction of development and spatial characteristics, such as geography, cultures and living preferences could illustrate different patterns of developments and potentials. It meant that spatial analysis could orient more understanding views for developing and decision-making.

A spatial problem-solving process has to identify problems, causes, intervention points, and measurement tools so that improve livelihood of the poor, conserve resource quality, and protect environment (Horrington, White, Grace, Hodson, Hortkomb, Voushon, & Meisner, 2003). This approach can elaborate as the spatial analysis in sustainable development, regarding natural resource management, as the process follows.

1) Problems are to set unsatisfactory situations, which agro-ecosystem performance affect to resource quality or environment, such as low productivity, excessive resource degradation and environmental pollution, and low biodiversity.

2) Causes are the factors concerned, which drive a set of problems. This can link policies, institutions, farmer or community, and biophysical processes within livelihood or environment in different scales of analysis.

3) Intervention points are opportunities for addressing a set of problems at any levels of analysis, such as plot, farm, community, watershed, or region.

4) Measurement tools will allow to understand cause-and-effect, consequences of interventions, and biophysical processes in spatial analysis.

The Peter Schwartz's framework clarified that beyond focusing on increasing production of commodities, development is to realize the externality costs of human

health and sustainable biodiversity, which related to social, political, economic, technological, and environmental issues. This concern could influence successful outcome of local decisions to avoid errors in judgment from regional policy (Schwartz, 1991).

Meanwhile, sustainability-oriented development is usually referred to efficient use of scarce resources, such as land, water, or forest. The study of balancing the interaction between socio-economic variables and territorial characteristics, such as cultural, living style, human capital, and geography, would help analyzing different developmental patterns of local development policies. These policies could pursue sustainable development further, as follows.

1) Integrating of all policy instruments oriented to local environment, such as entrepreneurship, human capital, infrastructure, and biodiversity.

2) Conducting geographical selection of intervention areas.

3) Strengthening the existing local know-how and productions.

Signing cooperation and partnership agreements with firms or institutions of other regions, so that the local production entrepreneurs can capture the external technological and organizational know-how.

2.9 Integrations of Spatial Analysis and Global Changes

In the recent study, Murai (1995) proposed the concept of Global Information System, together with the Global Eco-Engineering Framework, which integrated human and physical dimensions using Remote Sensing (RS) and Geographic Information System (GIS). The flow diagram of this integration is illustrated in Figure 2.6.

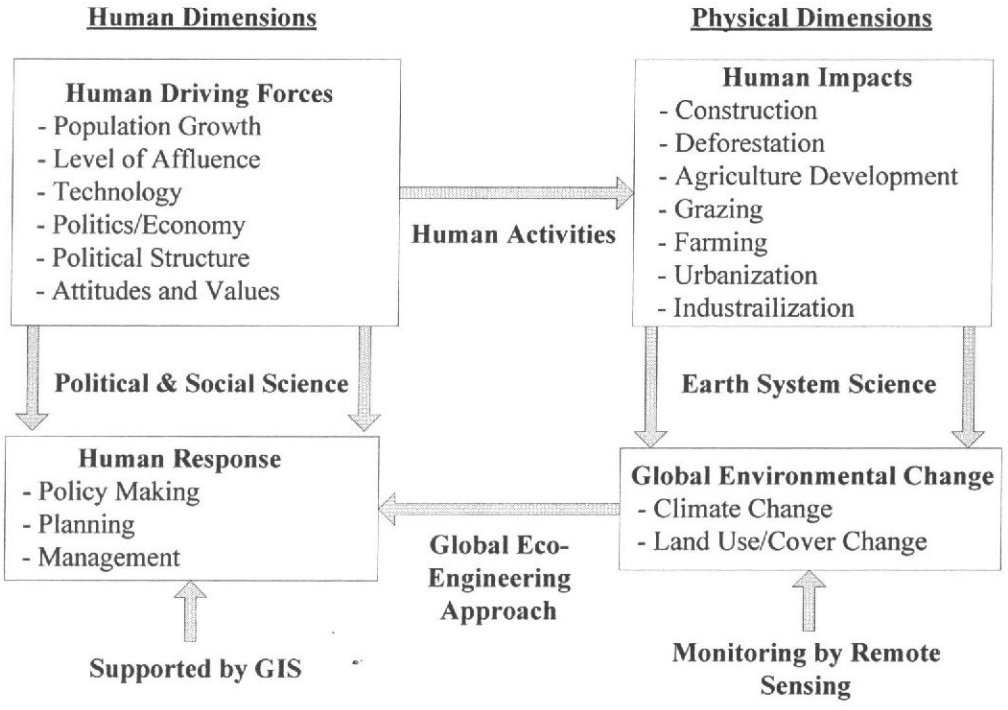


Figure 2.6 Flow Diagram of the Global Information System
Source Murai, 1995.

This framework expressed how human driving forces applied its variables, such as population growth, political and economic pressures, attitudes, and values, which generated human responses and human impacts. While remote sensing provided the data of earth system science to identify physical dimensions, in terms of global environmental changes, Geographic Information System (GIS) could employ political and social science to clarify human dimensions as well. The concept of this framework could form various maps formats, and calculated values of each parameter for certain criteria.

Moreover, there was the linkage among various models of sustainability analysis in the Murai (1995) framework, namely the Global Eco-Engineering, which elaborated an alternative philosophy for sustainable development via global changes. Practically, this framework expressed what should be concerned on human prospects for sustainable development, as shown in Figure 2.7.

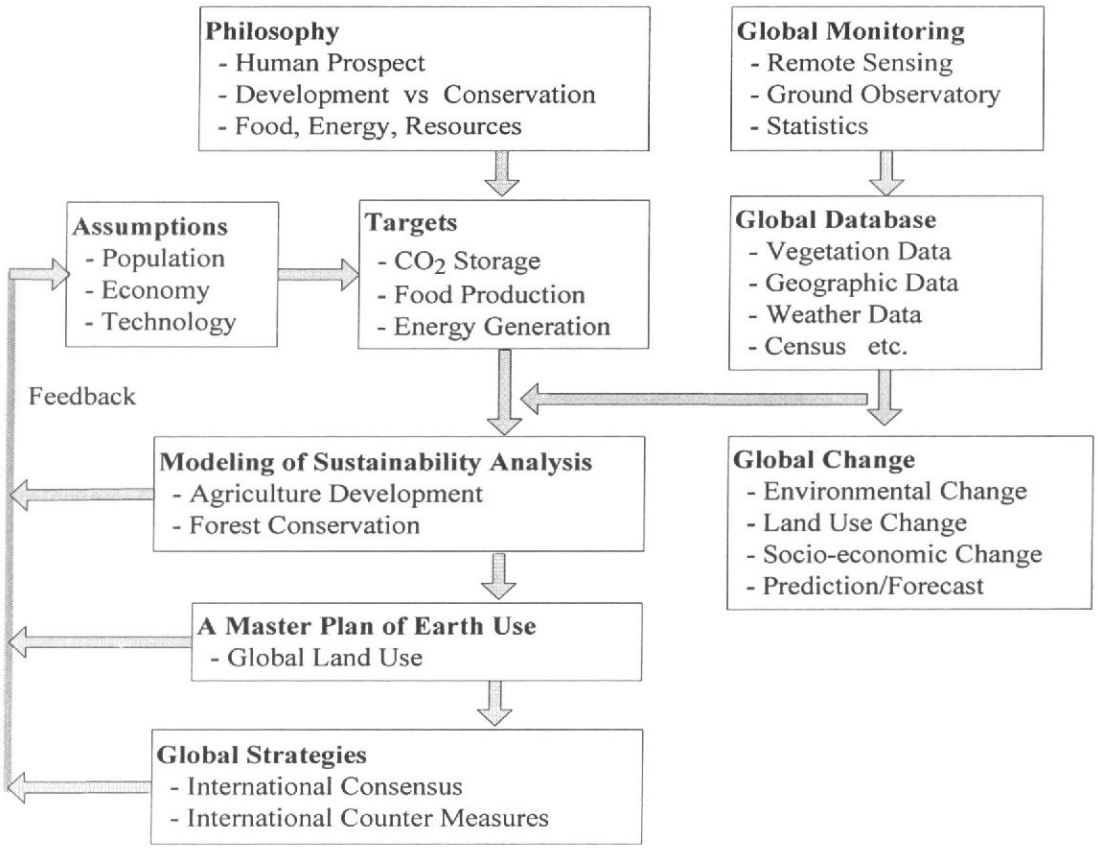


Figure 2.7 Framework of the Global Eco-Engineering

Source: Murai, 1995.

The integration between GIS and development can go beyond a tool for visualization, data management and simulation of commodity production, but involve stakeholders into the development processes as an information tool that could be able to identify and prioritize significant issues and transmit this information from analysts to policy makers and all stakeholders. The idea of spatial analysis could be oriented to make more understanding of decisions whether which investments should be undertaken at the present. However, it should be noted that development is not merely about determining a land for commodity production only, but including other factors, such as availability of water, environmental degradation, socio-economic in appropriation as well, in order to achieve sustainable development in the long term (Lan et al, 2009).

Regarding to spatial analysis, it is a process for clarifying uncertainty of agricultural development via spatial applications, such as Geographic Information System (GIS) and Remote Sensing (RS) to gather a set of information on agriculture, forestry, water resource, and land use to minimize conflicts arising around various features of problems (McCoy, 2006). Although, the environmental model is a tool which helps us understand how ecological processes work in a systematic manner (Seppelt, 2003). However, the acquired information needs to be properly collected, analyzed, and managed to provide significant information, which GIS could support statistical data and facilitate the predictive model further (McCoy, 2006).

2.10 Spatial Analysis for Integrated Natural Resource Management

Natural resource management is about practices for allocating resources towards the uncertainty of development, especially when we consider the modeling related to spatial analysis which have several parameters and variables in the planning processes. A set of information, such as physical conditions, weather, management, economic constraints or conditions, as well as geography data is to be acquired for analyzing with spatial applications. This data must be input, analyzed, estimated, predicted, evaluated by decision support tools, such as the Geography Information System (GIS) or the remote sensing system, in order to minimize the uncertainty arising from various perceptions of decision makers (McCoy 2006; Doppenberg & Aar 2007).

From the Ashby (2003) study, there was the conceptual framework, namely the Integrated Natural Resource Management (INRM), which policies, human behavior, natural resource management practices, biophysical processes, and system outcomes were linked together, in terms of cause-and-effect relationships of scaling issues, as shown in Figure 2.8.

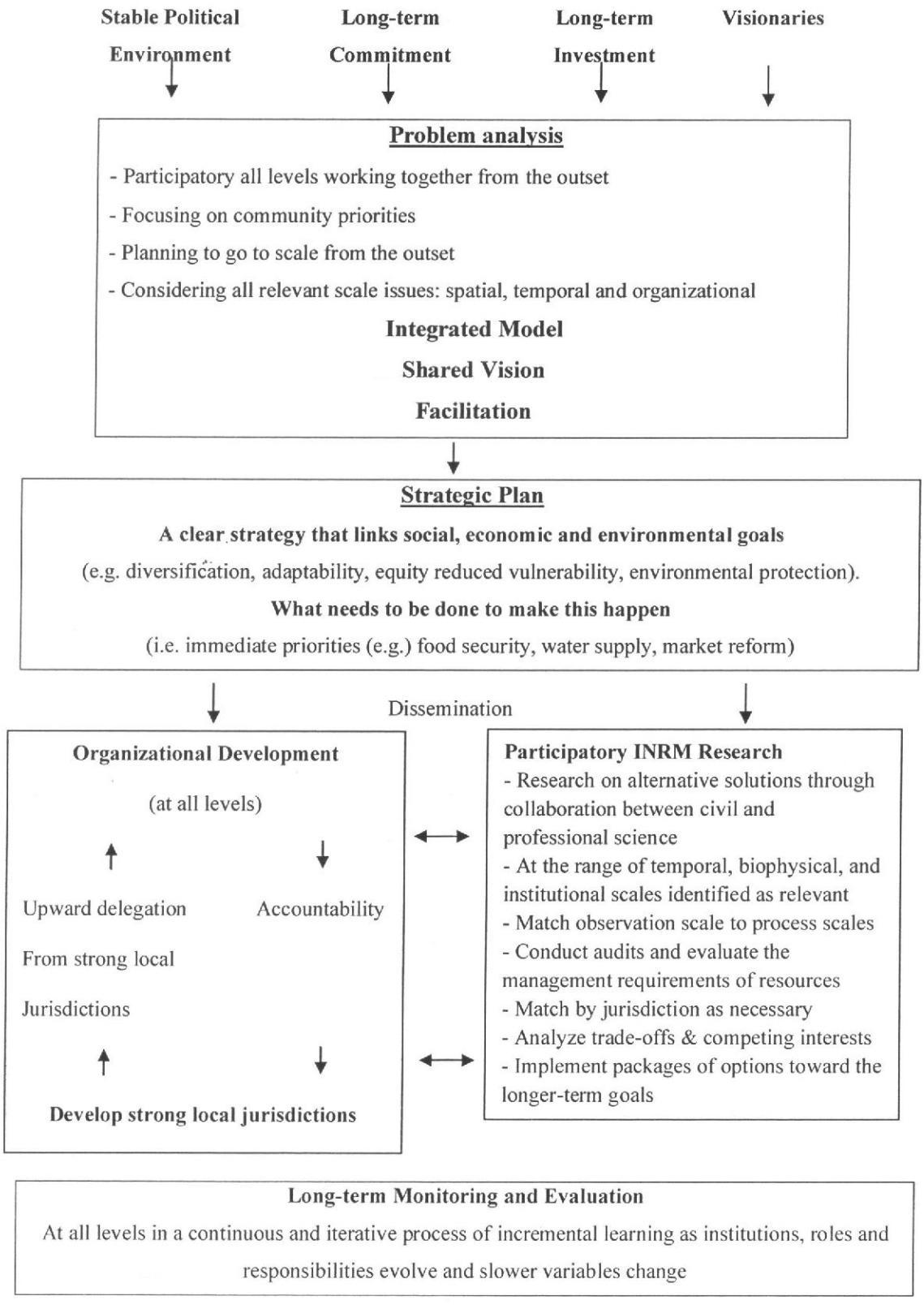


Figure 2.8 Scaling Issues in the Conceptual Framework of INRM

Source: Ashby, 2003.

Practically, the Integrated Natural Resource Management (INRM) workshop in Malaysia could be implied as the framework of sustainable development, based on scaling planning with critical views of evaluation process (Ashby, 2003). Its planning options were also suggested for comparing various alternative possibilities, using multi-criteria methods, while the applications of the framework were employed to guide decision makers to understand the interrelations of the multi-criteria for further policy planning.

Furthermore, there was an adapted version of the INRM package, developed by the CGIAR research center at the meeting in Malaysia during August 2000, which addressed the challenges to natural resource management. The interlink package of this assessment is shown in Figure 2.9.

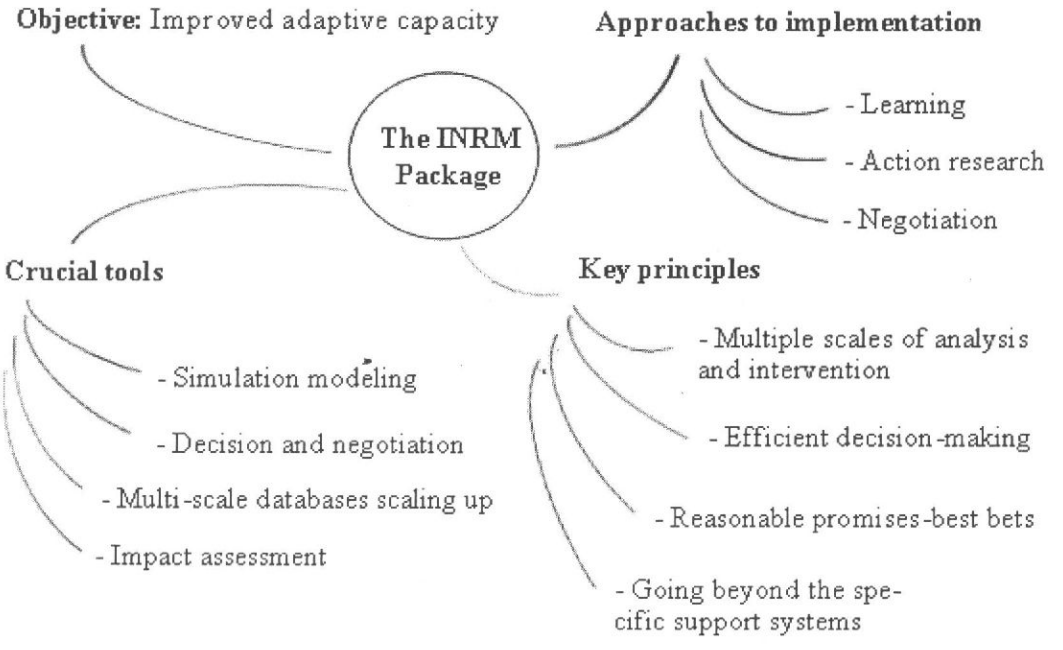


Figure 2.9 Key Features of the INRM Package
Source: Ashby, 2003.

Based on the agricultural development in Malaysia, one of the main productivity requirements is to improve yields of the dominant crops; there are three key elements in the plot-specific approach to implement in the INRM model, as follows:

1) management needs to be adaptive; 2) the INRM package must move further along the research-management scale; and 3) the approach must provide negotiation among all stakeholders (Ashby, 2003). However, this approach may have some difficulties if it is conducted in Thailand as to the country has rigid agricultural structures, which the top-down policies do not get along with stakeholder requirement at the local level simultaneously for some time, and also insufficient funds for launching research-pilot projects in the area of development. Consequently, the agricultural development would be reduced an improved adaptive capability in some manners as well.

As global change affects to biodiversity and environmental degradation, the Intergovernmental Panel on Climate Change (IPCC) also defined land use change that it was the conversion of land to a new land-use category or to new management practices such as changing from natural forest to managed forest (IPCC, 2000). There are two major environmental hazards related to land use change, namely deforestation and desertification. These phenomena have their developing processes differently if it causes by human activity, but likely to be continuous in a period of times if they occur naturally (UNCED, 1992).

2.11 Spatial Analysis and Development

In the recent study, Seppelt (2003) proposed the regionalization of the Spatial Explicit model that was set up by the system of ordinary differential equations with spatial referenced parameters. The concept of this model was conducted by identifying the units of environmental parameters in homogeneous regions. The functionality of GIS would apply the intersections of multi-criteria layers into various spatial maps, such as habitat suitability map, vegetation map, soil characteristic map and land use map. Moreover, Dincer and Rosen (2007) proposed the effective multi-criteria approach, namely the Spatio-Temporal Multi-Criteria Framework, which applied quantitative metrics as composite indicators by ranking and analyzing the information domains towards transformation issues in several methods, as shown in Table 2.10.

Table 2.10 Indicators for the Spatio-Temporal Multi-Criteria Framework

Information domains	Transformation issues	Methods
Individual behaviors and preferences	Representation of individual at resolution of analysis	Transform the survey into statistics and metrics that summarize the tendencies in the population for that spatial unit
Institutional arrangements, government regulations, and incentives	Representation of the influence or likelihood of adoption or compliance	Develop probability models based on prior surveys of impacts and create probability layers
Economic variables	Representation of the influence of likelihood of adoption of compliance	Self-organization of spatial units; temporal trends, metrics, and time period summaries
Social statistics, societal systems, transport and surveys	Conversion to a factor layer-attaching a meaning and a rank	Develop probability models and partial regression models to ascribe some of variation in target issue to the social factors. Create factor layers based on the percentage variation described, direction (+,-) and strength (slope) of trend.

Table 2.10 (Continued)

Information domains	Transformation issues	Methods
Climate	Impact/response an outcome of complex temporal sequences and spatial patterns	Develop impact threshold and security layers, based on multiple scenarios run
Land use	Representation of persistence and change at level of cover type, species, management, practice, seasonal magnitude	Derive metrics that capture pattern, change, persistence, sequence, and all quantitative properties of the change in a hierarchical structure
Bio/geochemical process-hydrology, sedimentation, emissions, consumption	Representation of process in terms of outcome affecting or influencing target issue	Aggregated, averaged, summarized and probability converted outputs from process modeling

Source: Dincer & Rosen, 2007.

Basically, the spatial data, regarding GIS or geographic features, is analyzed by a set of techniques, such as deletion, retention, merging of features, and reduction for representing, which its results are variant under changes at the geographic locations of the analyzed objects (Goodchild, 1995). To deal with physical dimensions, the relation between spectrum measurements and biophysical attributes of the earth surface, such as Photo-synthetically Active Radiation (PAR), absorption capacity, temperature, vapor, moisture, and respiratory demand will be applied to an appropriate model for analyzing and monitoring of the earth's biosphere (Dye & Goward, 1995). Various indicators of spatial analysis are listed in Table 2.11, as follows.

Table 2.11 Indicators of Spatial Analysis

Spatial dimensions	Indicators
Physical indicators	Decrease in soil depth
	Decrease in soil organic matter and fertility
	Soil crust formation/compaction
	Appearance/increase in frequency/severity of dust sandstorms/dune formation and movement
	Salinity/alkalinity
	Decline quality and quantity of ground/surface water
	Increased seasonality of springs and small streams
	Alteration in relative reflectance of land
Vegetation	Decrease in cover
	Decrease in above-ground biomass
	Decrease in yield
	Alteration of species distribution and frequency
	Failure of species successfully to reproduce
Animal	Alteration in species distribution and frequency
	Change in population of domestic animals
	Change in herd composition
	Decline in livestock production and yield
Socio-economic indicators	Change in land use/water use
	Change in settlement pattern (e.g. abandonment)
	Change in population parameters (demographic evidence, migration statistics, public health)
	Change in social process indicators – increased conflict between groups/tribes, marginalization, migration, decrease in incomes and assets, change in relative dependence on cash crops/subsistence crops

Source: Clini, Musu, & Gullino, 2008.

Technically, global earth mapping consists of allotting to the whole land cover an identification class compared to the characteristics of the place. Prior to obtain a map, initial data are divided into named classes. The estimation of land potentially available can derive from the interpretation of existing maps after the relevant land cover categories have been identified. Regarding to land use categories, Iversen, Lee & Rocha (2014) has proposed the concept of the Common Reporting Formats (CRF), which identified the types of land uses from the national greenhouse gas inventory reports, as following: 1) forest land, 2) cropland, 3) grassland, 4) wetlands, 5) settlements, 6) harvested wood products, and 7) other categories.

GIS has been recognized in land development organizations as an effective tool to analyze multi-criteria of resources management and land use patterns. Its procedures are to arrange criteria in each approach by comparing and evaluating various preferences. To clarify various spatial information and multi-criteria, GIS will provide provision of information, as follows.

1) Up-to-dated maps and site plans.

2) Provision of planning histories on-screen for questioning by members of the public at the reception desk.

3) The display of local land use in many dimensions, but minimal searching time, as well as turnaround times.

In Heidhues and Pape (2007) study, it stated that potentials of sustainable development, regarding land use management have been underpinning in two main areas including:

1) The factors of sustainability that corporate natural science and socio-economic aspects.

2) The know-how of technological and institutional innovations that can increase efficiency of resource use and enhance sustainable development.

2.12 Summary

In conclusion, this chapter was firstly described various perspectives of sustainable development and human security and its indicators. It widely discussed that sustainable development elements should involve three main aspects of economic

performance, social issues, and ecological concerns. However, it was noted that having achievement of sustainable development needed to satisfy the needs and fulfill the aspirations of people, together with their dignity as well. Moreover, there were various the measuring tools for indicating sustainable development potentials, which policy makers and stakeholders were to exploit in the assessment properly, for example, the ILO's Decent Work Agenda could be used to clarify the impacts to human and labor rights.

To deal with a variety of developments, Thailand has been initiating several the National Economic and Social Development Plans (NESDP) since 1961, and also founded the National Sustainable Development Strategy (NSDS) with the guidance to focus on implementing of sustainable development in the country. Moreover, Thailand has also been launching 4 strategies, including eliminating poverty, enhancing environmental security and sustainability, creating a knowledge-based society and ethical society, and ensuring good governance at all levels of society, in order to achieve sustainable development in the country as well. Then, Thailand has adopted the Sustainable Development Goals (SDGs) as a framework for the country's development, supervising by the NESDB.

Although human security has been implemented in several approaches in the international stage; the SDGs framework has exploited the composite indicators, namely the Human Achievement Index (HAI), to be human security indicators for identifying strength and weakness of development potentials in Thailand, both national and provincial levels. Consequently, decision makers and provincial authorities could realize development potentials, by comparing their strength and weakness with the other areas, in order to avoid negative impacts in the right direction. Since the root causes of poverty were highlighted by the impact of inequality on people's income, living and dignity; the spatial analysis was exploited to discover various human security factors that the people can access essential public services and economic opportunities.

Practically, a spatial application could also be exploited as a potential tool for assessing an integration of spatial analysis and global changes. It could reflect the significant issues affecting to people and environment, such as land use and natural resource degradation. However, various spatial indicators have to be applied in forms of spatial attributes, in order to manipulate layer maps in each scenario.

CHAPTER 3

RESEARCH METHODOLOGY

3.1 Chapter Overview

This chapter provided the details of research methodology used in this study, which was designed to obtain the data required for applying to the analysis further. After reviewing relevant bibliographical sources, the research approach commenced with identifying the research method strategy and the selected research method. The analytical framework was, then, adopted to conduct the study through the research course of actions. The research methodology in this study was conducted by a mixed-method approach, using the Delphi technique to collect the experts' opinions in the qualitative method and acquire the experts' perspectives in the quantitative method.

The analytical framework was adopted from the Murai (1995) model, which identified national policies, sustainable development goals, and natural resource management as human driving forces. Then, the study invited the experts to participate in the involvement process, regarding to economic, social, and environmental perspectives. After that, the outcomes from involvement process were evaluated to identify significant human security indicators, prior to integrate further with spatial attributes from global database and global change factors via the spatial analysis. Finally, the target of developments would underpin sustainable human security for clarifying opportunities and appropriate directions in sustainable manner eventually.

This study clarified human security as the Dependent Variables (DV) and various sustainable development perspectives as the Independent Variable (IV), including relevant policies as the intervening variable. The sampling selection was conducted by the purposive sampling method, which focused on the experts who were keen in the areas of study. There were 18 experts from 3 organizations joining in the data collection and analysis, including NESDB, the Civil Affairs School, the Royal Thai Army, and the 1st Development Division of the Royal Thai Army.

3.2 The Analytical Framework

This research was designed to investigate the opportunities of development in the context of human security, in order to enhance sustainable development in Thailand. The Delphi technique had been applied to assess the Human Achievement Index (HAI) as the significant indicator of human security in the country. On the other hand, the Human Achievement Index (HAI) was exploited as the base case of the human security indicators in Thailand, which were classified into eight dimensions, including health, education, employment, income, housing and environment, family and community, transportation and communication, and participation dimensions.

Since the HAI was not directly categorized into a sustainable development approach of Agenda 21, which had been defined in economic, social, and environmental aspects. Therefore, this composite index was regrouped towards sustainable development categories, using the Delphi technique in the involvement process. The spatial application based on the Geographic Information System (GIS), such as ArcGIS program, was, then, utilized to assess various indicators of socioeconomics and environmental concerns towards the spatial analysis model. The research analyzed human security both national and provincial levels of Thailand, which stakeholders could compare the development potentials and opportunities available in their area with other areas.

Since sustainable development strongly involve with natural resource management; then GIS applications could be used to analyze spatial data in each land-use potential in the province of Thailand. The study exploited various spatial attributes to address appropriate indicators of human security, regarding the research objectives. Referred to Figure 2.6 and 2.7, the concepts of Global Information System and the Global Eco-Engineering from Murai (1995) were adapted to be the research analytical framework of sustainable human security of this study, as shown in Figure 3.1.

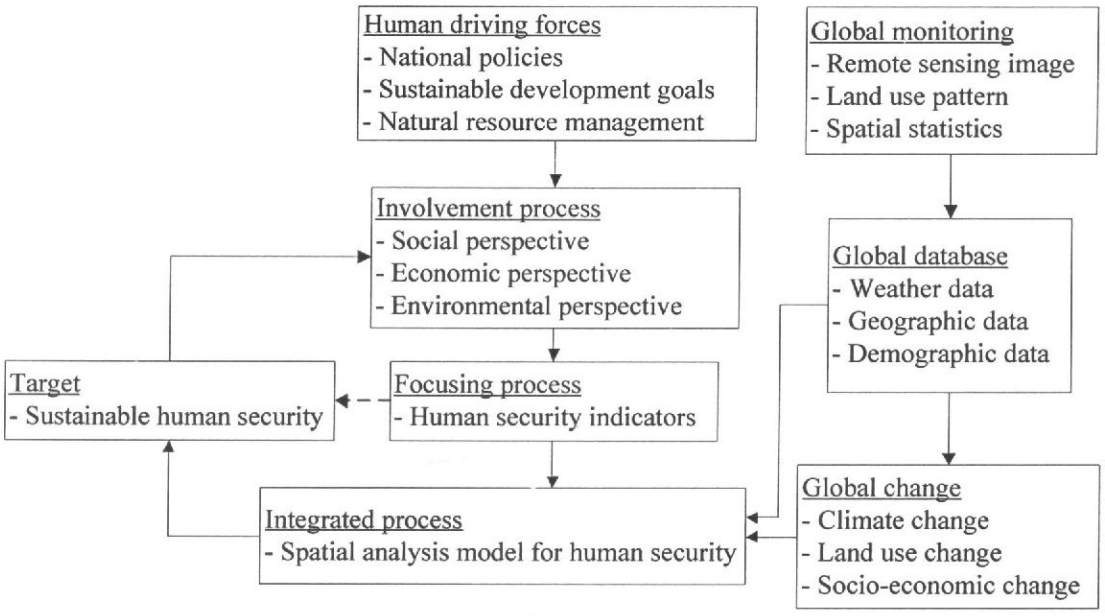


Figure 3.1 Research Analytical Framework for Sustainable Human Security

Moreover, as this research aimed to verify human security indicators for enhancing sustainable development by addressing what human should drive their perspectives towards human achievement in certain areas; the research framework could be explained using the operationalization terms, as follows.

1) Regarding human driving, this research attempted to clarify national policies that directed sustainable development goals and affected to natural resource management. Also, this study was to explore the ways to optimize development, complying with human achievement, based on human potentials and natural resources available. Then, driving forces for human security as to social, economic, and environmental perspectives and human achievements were assessed towards development potential circumstances.

2) While, global monitoring would be conducted by means of remote sensing, land use patterns and spatial statistics. Then, global database was collected the data of weather, geography and demography in the area concerned. Moreover, climate change, land use change and socio-economic change would be studied periodical and interval time, for predicting or forecasting the development opportunities available for the people.

3) The spatial analysis model of human security would be established based on the spatial decision support system to clarify human achievement indicators for development in sustainable manner via stakeholder involving approach. These stakeholders who involved with the subject matters would response to the spatial analysis model of human security, regarding to the people's potentials. Then, social, economic, and environmental perspectives were examined how relevant variables effected to human security in a sustainable manner.

Referred to Figure 2.6, human dimensions could be complied with physical dimensions via the spatial analysis model for human security, in order to balance human needs with natural resource available in the developments properly. At the end of analyzing processes, the study would achieve the target to establish sustainable human security as required. However, some indicators in the focusing process could be reviewed as intermediate indicators if the relevant spatial attributes were not available or the indicators were good enough to achieve the target and had no need to integrate into the spatial analysis further.

3.3 Research Strategy

The research strategy in this study was conducted by means of a mixed-method design, which employ the Delphi technique to collect the experts' opinions by the qualitative method and get the experts' perspectives in the quantitative method. Referred to the research objectives, the economic, social, and environmental perspectives which affecting to human security was classified as the independent variables (IV); likewise, human security was considered as the dependent variable (DV) to explain its relationships with social, economic, and environmental perspectives. Meanwhile national strategies and relevant policies would be identified as the intervening variables if it had influencing impact to the independent variable or the dependent variables. This study identifies the relationships of these variables as outlined on Table 3.1, follows.

Table 3.1 Research Variables

Independent variables	Intervening variable	Dependent variable
Social perspective	National policies	Human security
Economic perspective		
Environmental perspective		

The sampling selection was conducted by the purposive sampling method, which focused on the experts who were keen in the areas of sustainable development and human security. The primary data was, then, collected from relevant policy makers, scholars and operational officers. These experts were invited to join in the Delphi technique as the panelists or the ad-hoc committees, in order to deliver their opinions about human security in perspectives of sustainable development. Whereas, the secondary data was explored mainly via relevant official records and GIS attributes, from NESDB and the Geo-Informatics and Space Technology Development Agency (GISDA). The spatial application, the ArcGIS version 10.2.2, was then used for analyzing a series of attributes to clarify spatial maps in the understandable approach.

As human security involved with sustainable development directly; thus, this research approach was discussed within the contexts of environmental, social, and economic aspects. Moreover, the research was to determine the reliable model for enhancing human security in Thailand. The research approach was primarily conducted to answer the research questions as explained in Figure 3.2, follows.

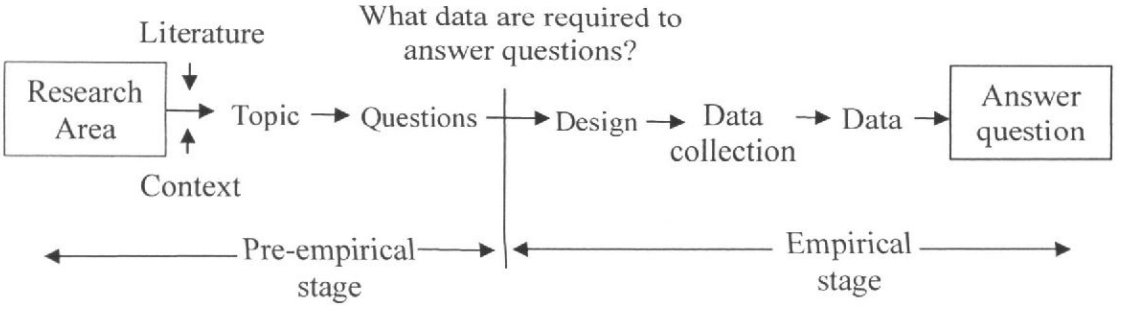


Figure 3.2 The Simplified Model

Source: Punch, 2005.

As this study adopted a three-round Delphi process to gather the primary data; the data collection was, then, conducted in four characteristics, as follows: anonymity, iteration, controlled feedback, and the statistical aggregation of a group response. Practically, this anonymity means that the panelists are not aware of each other but allow delivering their opinions without a pressure within the group. Also, they are free to change their opinions through the further rounds. Once the questionnaire is sent to the participants, they are given the feedbacks by being informed about the other participants' opinions. On the final round, the group judgment is considered as the statistical average of the participations' opinions (Rowe & Wright, 1999). Nevertheless, the research diagram of the Delphi technique could be elaborated the course of actions in the research methodology as the diagram, as shown in Figure 3.3.

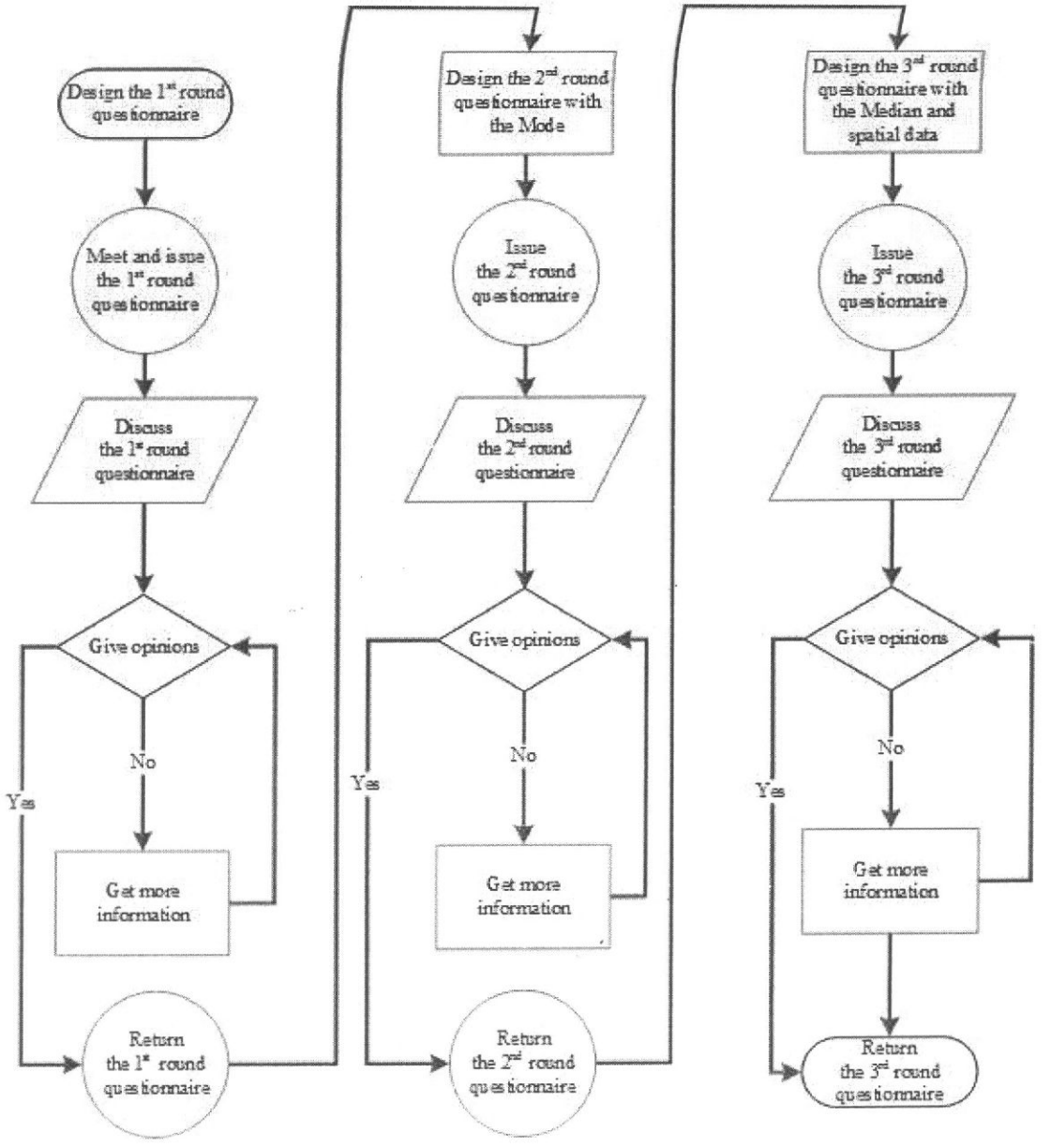


Figure 3.3 The Research Diagram of the Delphi Technique

3.4 Data Collection

In this study, the data collection had been conducted to gather the opinions from the panelists in 2 kinds of data sets, as follows:

1) Primary data – the data was collected by a quantitative method via the questionnaire survey. The participants in the survey were relevant stakeholders, who

have been involving with developing expertise in the government agencies, such as the National Economic and Social Development Board (NESDB), the School of Civil Affair, the Royal Thai Army, and the 1st Development Division. The research gathered data by using the Delphi technique approach, based upon the research objectives, in order to verify relevant indicators of human security in perspectives of sustainable development. The collected data was organized and analyzed by weighting and rating the scores of perspectives from 18 ad hoc committees.

2) Secondary data – the data was mainly collected via relevant publications, such as reports, research studies, official records, and spatial attributes. The Geographic Information System (GIS) application such as ArcGIS version 10.2.2 was used for analyzing all relevant spatial attributes of spatial data, gathered mainly from the governmental agencies and the Geo-Informatics and Space Technology Development Agency (GISTDA). A set of geographic layers were compiled into the series of spatial attributes, as follows.

i) 8 Sub Index (SI) of the HAI dimension.

ii) 9 Provincial Indicator (PI) or the HAI indicator, which had been selected from the top three of significant indicators in each sustainable development perspective (economic, social, and environmental aspects).

iii) Agricultural potential of cassava.

iv) Political vote rate, which was considered by the panelists to be the least significant indicator in the HAI.

The Delphi process will be conducted in this research, using four concepts, including anonymity, iteration, controlled feedback, and the statistical aggregation of a group response (Dalkey & Halmer, 1962). Generally, anonymity in the Delphi means that the group of committees is not aware of each other, but be able to present their own opinions without the pressure of group; while, they are free to change their opinions through the further rounds. Likewise, iteration means resending the questionnaire until a consensus is finished. Every time the questionnaire is sent, the committees are given controlled opinion feedbacks by informing the other committees' opinions. Feedback is basically given in the form of a statistical summary of the group's response, in which the committees are to review their own opinions. On the final round, the group

judgement is taken as the statistical average of the panelists' estimation (Rowe & Wright, 1999).

As the Delphi approach is a procedure to obtain the most reliable opinion consensus of committees by subjecting them to a series of questionnaires in-depth interspersed with controlled opinion feedback. In this study, the participants had been asked the agreements of the implications between human security and sustainable development in the first part of each round to confirm their preferences. It was to clarify these implications, in terms of economic, social, and environmental perspectives respectively. While the questions in the second part of each round were to gain participants' opinions, based on the research objectives. The questions in the first round were, then, related to human security implications towards sustainable development. In the second round, the questions were to identify significant human security indicators towards sustainable development potentials. After that, the questions in the third round was to verify the sustainable human security model so that enhancing sustainable development finally.

However, the questionnaires for the second round and the third round were prepared specifically for each panelist. Each panelist was sent a form of data set that included their own degree of agreements in the previous round for reviewing their degree of agreements again after comparing statistical agreements from the other experts. If they wanted to change their degree of agreement, they were expected to propose a new degree of preference and give the opinions on the open-ended questions as well. There are two important criteria in the Delphi studies: stability and agreement. Stability is the consistency between the given answers in each Delphi round. In the recent study, Scheibe, Skutsch, and Schofer (2002) used the percentage of panelists that changed their answers to move closer to the mode as their stability criteria; they reported that stability can be reached when the change is less than 15%.

In 2002, Scheele's study suggested that the participants should include stakeholders who were directly affected by the study as the panelists, including policy makers, scholars, and practitioners to collect different points of views from various stakeholders. Thus, 18 panelists of committee were invited to join in the data collection process, as follows.

1) Policy maker group: 6 experts who worked as administrative officers and planning analysts in NESDB and involved in the policy planning at least 3 years.

2) Institution group: 6 scholars from the Civil Affairs School, the Royal Thai Army, who were keen in the field of development administration and human security at least 3 years.

3) Operation group: 6 staff officers from the 1st Development Division of the Royal Thai Army, who have input developing experiences in the field of study, as practitioners at least 3 years .

The panelists were invited to participate in a three-round Delphi process and joined in the questionnaire survey. Although, there were 18 panelists involving in the first round; however, there were 17 panelists involving until the rest of study, missing one participant from NESDB in the 2nd round. Nevertheless, the response rate could be considered acceptable number as the panelists were involved in a range of 13-77 members (Torrance et al., 2010). The number of participants from each group, who completed and returned questionnaires in each round, was shown as Table 3.2.

Table 3.2 Participation of the Delphi Process

Number of participants	Round 1	Round 2	Round 3
Questionnaires delivered	18	18	17
Completed questionnaires	18	17	17
1) NESDB	6	5	5
2) The Civil Affairs School	6	6	6
3) The 1st Development Division	6	6	6
Response rate of returning	100 %	94.4 %	94.4 %

3.5 Design of the Questionnaire Survey

As this survey was conducted by a mixed-method design, the panelists were, then, asked two aspects of the questionnaire, including the HAI assessment aspect via quantitative approach and the open-ended question aspect via qualitative approach. The

link of the HAI's definition from NESDB (2019: 213-234) was given at the footnote of each survey, so that each panelist could clarify more the meaning and scope of the relevant indicators in the study. The structures of the questionnaire have been constructed for 3 rounds of the Delphi technique, as follows. (see the forms of questionnaire in Appendix A, B, and C)

3.5.1 The 1st Round of Delphi Technique

The questionnaire survey in the 1st round of the Delphi technique aimed to investigate the significance of human security indicators, in perspectives of sustainable development and assessed the potentials of development opportunities in Thailand via the spatial analysis. The questionnaire consisted of 2 sections, as follows.

1) Section 1: To give a degree of implication between each HAI and sustainable development perspectives, in terms of economic (Ec), social (Sc), and environment (En), by rating each indicator with a score from 1 (less implication) to 5 (more implication), as shown in Figure 3.4.

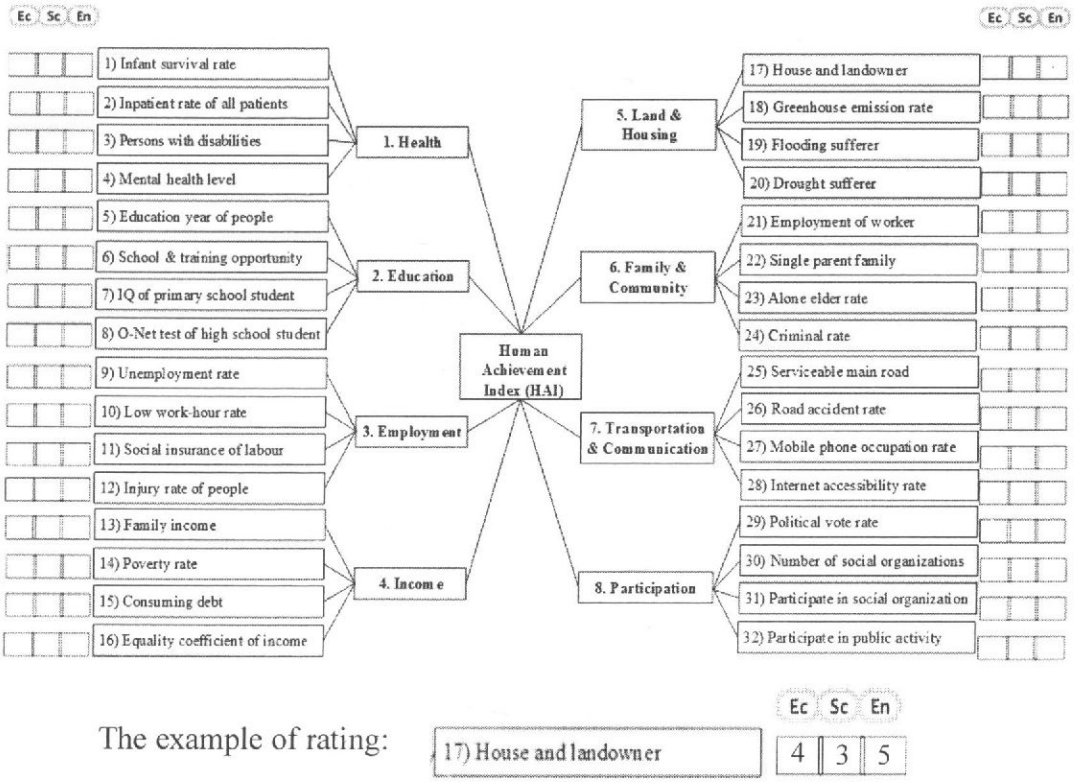


Figure 3.4 The 1st Round Diagram of the Delphi Technique Process

The example of rating in Figure 3.4 would be explained that the indicator of house and land owner had the degree of implications with sustainable development in each perspective, as follows: economic = 4 (strong implication), social = 3 (moderate implication), and environment = 5 (strongest implication), respectively.

2) Section 2: To give opinions, regarding how human security implied to sustainable development via significant indicators and spatial applications, in order to pursue happiness societies and human achievement in Thailand, as the questions follow.

(1) How can human security take part in enhancing sustainable development and which direction would be suitable for Thailand?

(2) Based on the indicators in the Section 1, what are alternative indicators that reflect the contributions of human security in enhancing potentials of sustainable development?

(3) How can the spatial application support human security in perspectives of sustainable development?

(4) Other opinions on the research topic.

3.5.2 The 2nd Round of Delphi Technique

The questionnaire survey in the 2nd round of the Delphi technique aimed to review the implications between human security indicators (HAI) and sustainable development perspectives, regarding statistical preferences from the panelists. Moreover, the survey encouraged the panelists to input additional indicators to pursue sustainable human security as well. The questionnaire consisted of 2 sections, as follows.

1) Section 1: To review the participant's answers from the previous round, after comparing their score of preferences with the popular degree (the Mode) from the other experts, by rating each indicator with a score from 1 (less implication) to 5 (more implication), as shown in Figure 3.5.

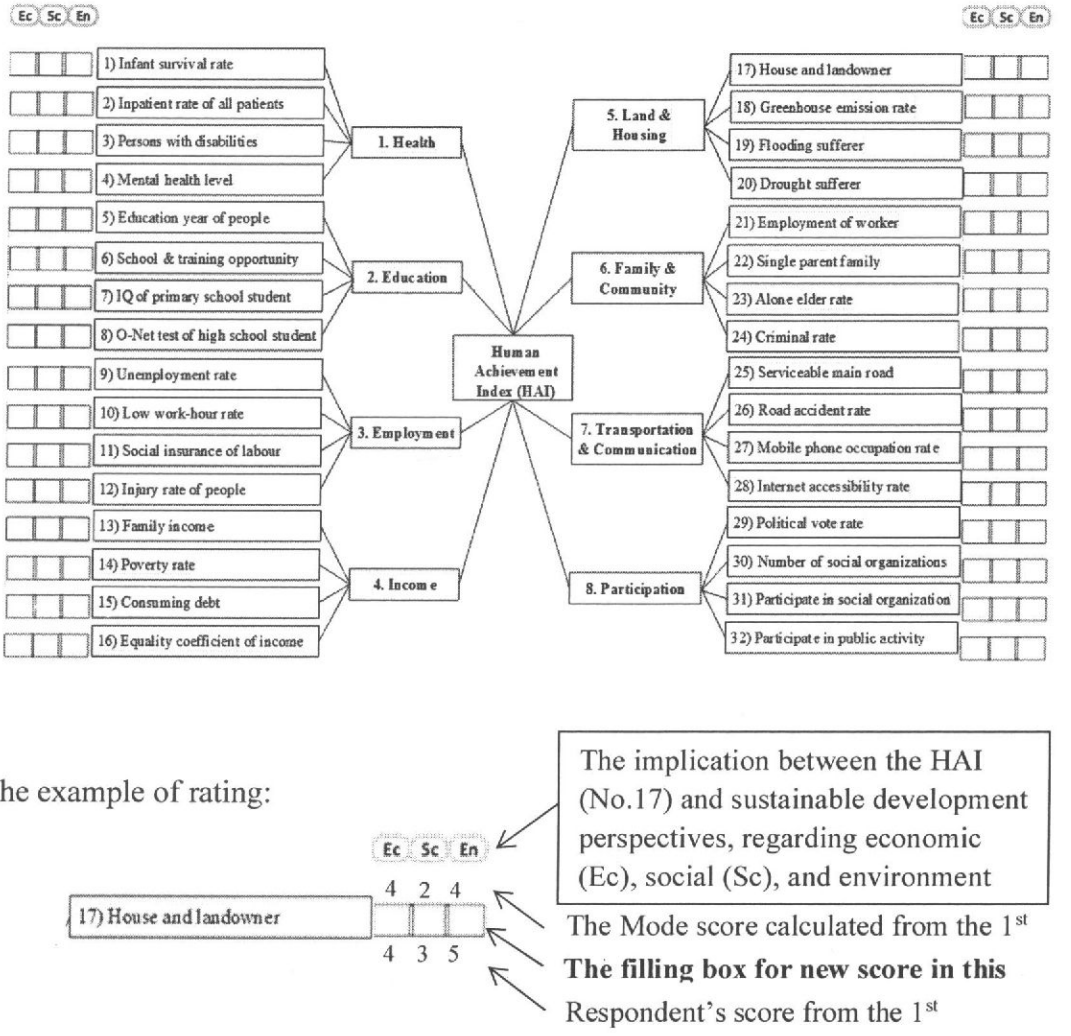


Figure 3.5 The 2nd Round Diagram of the Delphi Technique Process

The example of rating in Figure 3.5 would be explained that the Mode, the most often scores when list the scores, which were collected from all panelists' opinions in the previous round would be shown over the filling box, whereas the previous round answers of the participants were shown under the filling box.

2) Section 2: To add more opinions on human security indicators which reflect sustainable development, as the questions follow.

(1) Please identify economic indicators which reflect how well that the people live with enough income and necessaries of life.

(2) Please indicate social indicators which imply to how cohabitation of people and community come up with happiness and safety.

(3) Please pinpoint environmental indicators which express the *circumstances that the people live environmentally friendly in a balanced ecosystem.*

(4) Other opinions on the research topic.

3.5.3 The 3rd Round of the Delphi Technique

This questionnaire aimed to re-evaluate and asserted the answers from the 2nd round, after learning the point of views from other experts via various statistical analysis, and also, identified barriers and challenges to overcome sustainable human security in Thailand. The questionnaire consisted of 2 sections, as follows.

1) Section 1: To re-evaluate a degree of implication between the HAI and sustainable development perspectives, after comparing the scores of preferences from the other experts by mean of the Midian (the midpoint of agreements). The experts were expected to rate each indicator with a score from 1 (less implication) to 5 (more implication), as shown in Figure 3.6.

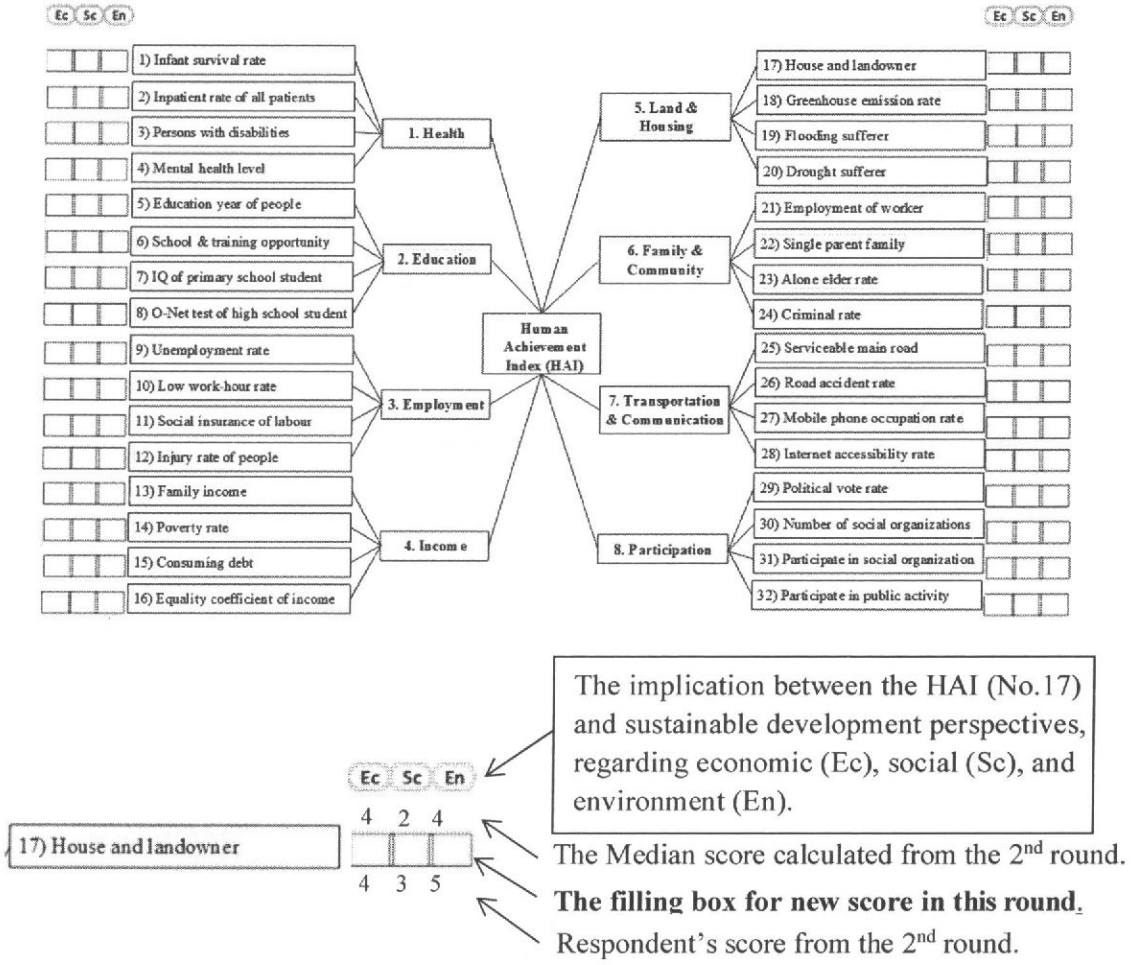


Figure 3.6 The 3rd Round Diagram of the Delphi Technique Process

The example of rating in Figure 3.6 would be explained that the Median, the midpoint in a distribution when listed a set of scores, from all panelists in the previous round were shown over the filling box; whereas, the previous answers were shown under the filling box.

2) Section 2: To assert opinions about concerning issues of human security and the challenges to pursue sustainable development via spatial analysis, in the following questions.

(1) Please identify significant issues of human security, which express human achievement, happiness society, and desirable environment.

(2) What are barriers to exploit spatial analysis for sustainable development in Thailand?

(3) Please elaborate the challenges, which lead sustainable human security for developments in Thailand.

(4) Other opinions on the research topic.

Moreover, a spatial analysis had been integrated into the Delphi technique process by according the implication maps of the concerned HAI attributes into the 3rd round questionnaire to gain the panelists' opinions whether there were any comments among its relationship or not. The implication maps had been included as the concerned issues, which the panelists gave their opinions in the previous round of data collection.

3.6 Data Analysis

In the 1st round of the Delphi technique, the questionnaire in this study was prepared for asking statistical preferences and opinions from all panelist, using the same design of questionnaire. Meanwhile, the questionnaires in the 2nd round was specifically designed for each panelist and resent back to them with the Mode values from the other panelists to review their answers, if they wanted to change the degree of agreements after comparing their statistic values with other experts in the group of panelists. In the 3rd round, the panelists had been asked to re-evaluate the previous answers after learning the Median values from other experts in the 2nd round.

Since each panelist would receive a new form that included their own degree of statistic preferences in the 2nd and 3rd rounds process, the panelist members were expected to re-evaluate their degree of preferences, if they wanted to amend their opinions as well as added more comments on the concerned issues. After finishing the 3rd round of the Delphi technique, the data was analysis in terms of the Mean and the Interquartile Range to identify the significant implication of human security indicators and sustainable development. The collected scores were measured via various statistical analysis to find central tendency or average values, as follows.

1) The Mean – the sum of a set of scores divided by the number of scores summed. In this study, the Mean expressed an average agreement of implication, which each human security indicator related to relevant sustainable development elements. The degree of implication was classified into 4 categories, including:

(1) The average of 4.50 and over express a strong agreement of implication (level 4).

(2) The average between 3.50 and 4.50 express a moderate agreement of implication (level 3).

(3) The average between 2.50 and 3.50 express a weak agreement of implication (level 2).

(4) The average under 2.50 express disagreement of implication (level 1).

2) The Mode – the most often scores when listed a set of scores in numeric order. In this study, the percentage of panelists that changed their answers closer to the Mode was to be less than 15% for acceptable stability criteria (Scheibe, Skutsch, & Schofer, 2002).

3) The Median – the midpoint in a distribution when listed a set of scores in numeric order. In this study, the acceptable value of agreement based on the Median was to be different from the Mode not less than or equal to 1.00 (Privitera, 2019).

4) The Interquartile Range – the range of the middle 50% of scores which differed between the upper quartile and lower quartile (the top and bottom 25% of scores). In this study, the acceptable value of Interquartile Range was to be less than 1.50 (Field, 2014).

3.7 The Study Area

Regarding Figure 3.7, this research had firstly analyzed statistical data of the main HAI dimensions (health, education, employment, income, land and housing, family and community, transportation and communication, and participation) via a spatial application in 77 provinces of Thailand. After that, the study had elaborated a comparison of the HAI in provincial level, focusing on 8 provinces in the Central-West region of Thailand (Kanchanaburi, Petchaburi, Prachuap Khilikhan, Nakhon Prathom, Ratchaburi, Samut Sakhon, Samut Songkham, Suphanburi provinces). This study area had been selected as the research domain because of its diversity of human and physical dimensions, such as a variety of livelihoods in various geographic characteristics (suburb, border, mountainous, low land, and coast), a number of socio-economic factors, and a complex ecological system. For instance, there are 4 provinces have been

lined up along the border with neighboring countries at the outer line, while there are 4 provinces laying down as the inner area of the country, which could express characteristics of the area of study. The purposive sampling method had, therefore, been applied to this selection for the spatial analysis in the study.

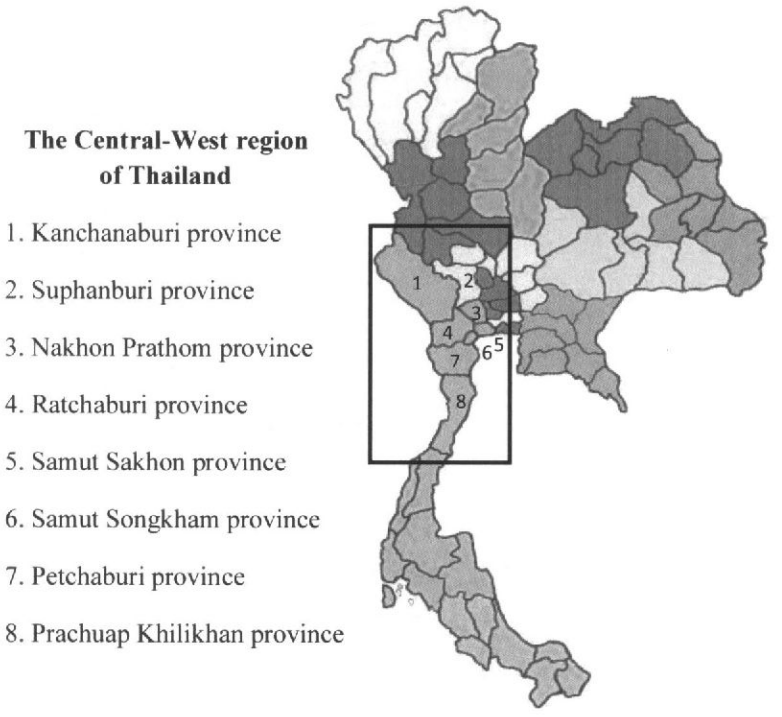


Figure 3.7 The Study Area
Source: Ministry of Interior, the Royal Thai Government, 2017.

3.8 Summary

This research had been conducted in a mixed-method approach, regarding the analytical framework adopted from the Murai (1995) study, which the human dimension could be integrated with physical dimension via spatial analysis. Whereas the physical dimensions, such as global monitoring and global database were expressed in terms of remote sensing images, land use patterns, weather data, geographic data, and demographic data. Moreover, global changes from climate change, land use change and

socio-economic change could be monitored for predicting or forecasting the development opportunities available within the time interval.

This study clarified social, economic, and environmental perspectives as the Independent Variables (IV). While human security was identified as the Dependent Variable (DV). However, national policies were also considered as the intervening variable which exhibited internal influences or caused effects to the DV and the IV in some manners. Since whenever human needs increase significantly; then, socio-economic and environmental impacts would be higher simultaneously as well. Therefore, the HAI was applied towards sustainable development perspectives both positive and negative sides, based upon the impact degree of human perceptions.

The data collection was implemented via 3 rounds of the Delphi technique process to identify the implication of human security indicators and sustainable development. This research had firstly analyzed statistical data of the main HAI dimensions via a spatial application in 77 provinces of Thailand and elaborated in 8 provinces of the Central-West region. This effort would reflect human security in which the people achieve preferable fulfillments in perspectives of sustainable development through potentials of land use and natural resources in their areas finally.

CHAPTER 4

ANALYSIS OF SIGNIFICANT HUMAN SECURITY INDICATORS

4.1 Chapter Overview

This chapter was to analyze the implications between human security and perspectives of sustainable development in economic, social, and environmental aspects. The HAI as the base case of human security in this study was used to reflect human security achievements in Thailand. Referred to the research analytical framework in Figure 3.1, the involvement and focusing processes was implemented via the Delphi technique, which statistical preferences from the panelists were collected via the three-round questionnaire survey.

The ranking of preferences was arranged into the numeric order, in order to classify the significance of human security indicators whether which one should be persisted in the HAI or which one should be reconsidered and dismissed in the existing HAI. Then, this composite index of human security would be integrated with Geographic Information System (GIS) application to examine spatial potentials of human security in perspectives of sustainable development further in the next chapter.

From the focusing process of the research framework, the study could identify the top three highest significant human security indicators in each perspective of sustainable development, as following: 1) economic security--family income, consuming debt, and poverty rate, 2) social security--unemployment rate, social insurance, and high school and vocational training opportunity, and 3) environmental security--serviceable main road, greenhouse emission rate, and house and landowner, respectively.

4.2 Human Driving Forces towards the Involvement Process

Referring to human driving forces which direct human security, the recent 12th National Economic and Social Development Plan of the Thai government has declared the Sustainable Development Goals, focusing on natural resource management. The spatial analysis has been introduced to monitor global change, such as land use patterns, weather, geographic and demographic conditions in various governmental organizations. This information of climate, land use and socio-economic changes is exploited to clarify various developments for predicting or forecasting the opportunities available before proceeding the projects. In the sustainable development, stakeholders will be invited to involve with the project matters of human security will response to the spatial analysis model, regarding to the people's perspectives in sustainable development.

4.3 Involvement of the Panelists in the Delphi Technique

Regarding to the research flowchart of the Delphi technique in Figure 3.3, several panelists changed their answers to get closer to the Mode, due to concerning in stability criteria of the analysis. Since 17 panelists involved in the third round of the study, it was defined that the agreements achieved stability criterion because there were fewer than two panelists moving their responses closer to the Mode from the previous round in each indicator. This study was, then, decided not to repeat the third round, as there were already a large total number of agreed decisions. Consequently, the Delphi process was completed after this third round of the involvement process in the research framework.

As the panelists were involved in the questionnaire survey to clarify implications between human security indicators and sustainable development perspectives in economic, social, and environmental aspects. After the third round of the Delphi technique process, the implication levels between the HAI and economic, social, and environmental perspectives were, then, illustrated via statistical preferences, as shown in Table 4.1, 4.2, and 4.3, respectively.

4.4 Human Security Indicators in Economic Perspective

The findings from the Delphi technique process were ranked, based on the Mean values of the HAI, in perspective of economic aspect, as shown in Table 4.1.

Table 4.1 Ranking of Human Security Indicators in Economic Perspective

Rank	Economic indicators	Mean	Mode	Median	Interquartile range	Implication level
1	Family income	4.94	5.00	5.00	0	4
2	Consuming debt	4.82	5.00	5.00	0	4
3	Poverty rate	4.76	5.00	5.00	0	4
4	Unemployment rate	4.71	5.00	5.00	1	4
5	Equality coefficient of income	4.71	5.00	5.00	1	4
6	Low work-hour rate	4.65	5.00	5.00	1	4
7	Employment of 15-17 years old worker	4.53	5.00	5.00	1	4
8	Serviceable main road of villages	4.41	4.00	4.00	1	3
9	Internet accessibility rate	4.41	4.00	4.00	1	3
10	House and land owner	4.24	4.00	4.00	0	3
11	Drought sufferer	4.24	4.00	4.00	0	3
12	Social insurance of labour	4.12	4.00	4.00	0	3
13	Flooding sufferer	4.12	4.00	4.00	0	3

Table 4.1 (Continued)

Rank	Economic indicators	Mean	Mode	Median	Interquartile range	Implication level
14	Mobile phone occupation rate	4.12	4.00	4.00	0	3
15	O-Net test of high school student	3.94	4.00	4.00	0	3
16	Education year of people	3.88	4.00	4.00	0	3
17	Criminal rate	3.88	4.00	4.00	0	3
18	Road accident rate	3.82	4.00	4.00	0	3
19	High school and vocational training opportunity	3.76	4.00	4.00	0	3
20	IQ of primary school student	3.71	4.00	4.00	1	3
21	Infant survival rate	3.65	4.00	4.00	1	3
22	Persons with Disabilities	3.59	4.00	4.00	1	3
23	Injury rate	3.47	3.00	3.00	1	2
24	Greenhouse emission rate	3.41	3.00	3.00	1	2
25	Inpatient rate of all patients	3.18	3.00	3.00	0	2
26	Mental health level	3.12	3.00	3.00	0	2
27	Single parent family	3.12	3.00	3.00	0	2

Table 4.1 (Continued)

Rank	Economic indicators	Mean	Mode	Median	Interquartile range	Implication level
28	Alone elder rate	3.06	3.00	3.00	0	2
29	Family participation in public activity	2.88	3.00	3.00	0	2
30	Number of social organizations	2.82	3.00	3.00	0	2
31	Family participation as a member of social organizations	2.65	3.00	3.00	1	2
32	Political vote rate	2.35	1.00	2.00	2	1

In economic perspective, most experts asserted that income acquisition was the highest significant indicator, as it was economic power to purchase and fulfill what human wanted. Moreover, many panelists also gave opinions that a local authority and a private sector should establish industrial district, trade center, or distribution center to enhance economic security in the area, since these business mechanisms could significantly raise economic performance to achieve desirable economic outcomes for the people in a large scale of developing area.

However, many experts inserted opinions in the open-ended questionnaire that a quantity of sufficiency economic village could be a new alternative indicator, since it expressed peaceful communities where people could stay happiness in mind, no matter how much they earn but depending on how they feel enough for a moderate life with acceptable risk. Furthermore, the experts also gave the point of views that policy makers should promote sufficiency economy nationwide for fulfilling sustainable happiness in societies for a long term. While local people should receive guidance and supports from governmental authorities or relevant agencies to initiate sufficiency economic villages as well.

4.5 Human Security Indicators in Social Perspective

The findings from the Delphi technique process were ranked, based on the Mean values of the HAI, in perspective of social aspect, as shown in Table 4.2.

Table 4.2 Ranking of Human Security Indicators in Social Perspective

Rank	Social indicators	Mean	Mode	Median	Interquartile range	Implication level
1	Unemployment rate	4.94	5.00	5.00	0	4
2	Social insurance of labour	4.82	5.00	5.00	0	4
3	High school and vocational training opportunity	4.76	5.00	5.00	0	4
4	Criminal rate	4.71	5.00	5.00	1	4
5	Equality coefficient of income	4.65	5.00	5.00	1	4
6	Consuming debt	4.59	5.00	5.00	1	4
7	Poverty rate	4.41	4.00	4.00	1	3
8	Single parent family	4.41	4.00	4.00	1	3
9	Low work-hour rate	4.35	4.00	4.00	1	3
10	Family income	4.35	4.00	4.00	1	3
11	Education year of people who is 15 years old and above	4.29	4.00	4.00	1	3
12	IQ of primary school student	4.24	4.00	4.00	0	3

Table 4.2 (Continued)

Rank	Social indicators	Mean	Mode	Median	Interquartile range	Implication level
13	O-Net test of high school student	4.12	4.00	4.00	0	3
14	Family participation in public activity	4.06	4.00	4.00	0	3
15	Family participation as a member of social organizations	4.00	4.00	4.00	0	3
16	House and land owner	3.94	4.00	4.00	0	3
17	Alone elder rate	3.94	4.00	4.00	0	3
18	Mental health level	3.82	4.00	4.00	0	3
19	Persons with Disabilities	3.59	4.00	4.00	1	3
20	Employment of 15-17 years old worker	3.53	4.00	4.00	1	3
21	Number of social organizations	3.47	3.00	3.00	1	2
22	Inpatient rate of all patients	3.41	3.00	3.00	1	2
23	Greenhouse emission rate	3.35	3.00	3.00	1	2
24	Injury rate	3.29	3.00	3.00	1	2
25	Internet accessibility rate	3.29	3.00	3.00	1	2
26	Infant survival rate	3.18	3.00	3.00	0	2
27	Mobile phone occupation rate	3.06	3.00	3.00	0	2
28	Road accident rate	2.94	3.00	3.00	0	2
29	Drought sufferer	2.88	3.00	3.00	0	2

Table 4.2 (Continued)

Rank	Social indicators	Mean	Mode	Median	Interquartile range	Implication level
30	Serviceable main road of villages	2.82	3.00	3.00	0	2
31	Flooding sufferer	2.59	3.00	3.00	1	2
32	Political vote rate	2.35	2.00	2.00	2	1

Regarding to social perspective, some experts also raised drug-trafficking rate as a new significant indicator since it could cause social problems and ruined the people's health widely, which society should realize that drug could affect to public health severely. Moreover, some panelists agreed with the vital comments to propose a medical personnel rate as a significant indicator as well, because this concern could express public health in the country straightly as the important workforce in health care services. However, many of panelists commented on the political-vote-rate indicator that this indicator should be noticed that it was an out-of-date indicator, and also this participation was highly frustrated from political conflicts at the time of voting during the year of 2016.

4.6 Human Security Indicators in Environmental Perspective

The findings from the Delphi technique process were ranked, based on the Mean values of the HAI, in perspective of environmental aspect, as shown in Table 4.3.

Table 4.3 Ranking of Human Security Indicators in Environmental Perspective

Rank	Environmental indicators	Mean	Mode	Median	Interquartile range	Implication level
1	Serviceable main road of villages	4.94	5.00	5.00	0	4
2	Greenhouse emission rate	4.88	5.00	5.00	0	4
3	House and land owner	4.76	5.00	5.00	1	4
4	Criminal rate	4.71	5.00	5.00	1	4
5	Drought sufferer	4.59	5.00	5.00	1	4
6	Flooding sufferer	4.47	4.00	4.00	1	3
7	Injury rate	4.41	5.00	4.00	1	3
8	Road accident rate	4.35	4.00	4.00	1	3
9	Inpatient rate of all patients	4.24	4.00	4.00	1	3
10	Persons with Disabilities	4.18	4.00	4.00	0	3
11	Mental health level	4.06	4.00	4.00	0	3
12	Unemployment rate	3.82	4.00	4.00	0	3
13	Low work-hour rate	3.76	4.00	4.00	0	3
14	Internet accessibility rate	3.71	4.00	4.00	0	3
15	Family income	3.65	4.00	4.00	1	3
16	Poverty rate	3.59	4.00	4.00	1	3

Table 4.3 (Continued)

Rank	Environmental indicators	Mean	Mode	Median	Interquartile range	Implication level
17	Consuming debt	3.47	3.00	3.00	1	2
18	Equality coefficient of income	3.35	3.00	3.00	1	2
19	Social insurance of labor	3.24	3.00	3.00	0	2
20	Employment of 15-17 years old worker	3.24	3.00	3.00	0	2
21	Family participation in public activity	3.18	3.00	3.00	0	2
22	Single parent family	3.12	3.00	3.00	0	2
23	Alone elder rate	3.06	3.00	3.00	0	2
24	High school and vocational training opportunity	2.94	3.00	3.00	0	2
25	Mobile phone occupation rate	2.94	3.00	3.00	0	2
26	Number of social organizations	2.94	3.00	3.00	0	2
27	O-Net test of high school student	2.82	3.00	3.00	0	2
28	Family participation as a member of social organizations	2.82	3.00	3.00	0	2
29	Education year of people who is 15 years old and above	2.76	3.00	3.00	0	2

Table 4.3 (Continued)

Rank	Environmental indicators	Mean	Mode	Median	Interquartile range	Implication level
30	IQ of primary school student	2.65	3.00	3.00	1	2
31	Infant survival rate	2.59	3.00	3.00	1	2
32	Political vote rate	1.94	1.00	2.00	2	1

Regarding environmental perspective in terms of livelihood for living, an immigration rate was purposed as a new indicator for the HAI as to it might reflect uncomfortable environment, which the people would struggle in one place and wanted to move to other places for better life or preferable environment. Moreover, an air quality index (AQI) was also purposed as a significant indicator since it affected to well-being and health of people directly, especially from PM2.5 particles. Furthermore, some panelists raised a concept of smart city to promote environmentally friendly livelihood with convenient lifestyle, which people would be appreciated to live in a good built environment for life.

4.7 Summary

This chapter expressed the findings of human involvement that the panelists had been participating in in the Delphi technique process. The outcome from this involvement could clarify the implications between human security and sustainable development, in terms of economic, social, and environmental aspects using statistical preferences of human security indicators, namely the Human Achievement Index (HAI), to classified the significant indicators for the focusing process of evaluation further.

This analysis exploited various statistical measurements, including Mean, Median, Mode, and Interquartile to pursue central tendency and implication levels of the data collected. The focusing process expressed the findings as a series of implications, which

human security affect to sustainable development, for instance, the top three highest significant indicators in each perspective could be ranked, as follows: 1) economic security--family income, consuming debt, and poverty rate, 2) social security--unemployment rate, social insurance, and high school and vocational training opportunity, and 3) environmental security--serviceable main road, greenhouse emission rate, and house and land owner, respectively.

Moreover, the study also derived various additional indicators from the panelists via the Delphi technique to assess human security, such as sufficiency economic village, drug-trafficking case, immigration rate, medical personnel rate, and air quality index. Furthermore, the panelists contributed some recommendations, regarding ecology and creative tourism, local business mechanism, smart city, empirical indicator, multi-dimensions of social and environmental issues. Nevertheless, the panelists suggested that the political vote rate in the year 2016 should be dismissed from the HAI as well.

CHAPTER 5

INTEGRATIONS OF HUMAN AND PHYSICAL DIMENSIONS BY SPATIAL ANALYSIS

5.1 Chapter Overview

This chapter was to integrate spatial analysis with human security indicators, the so-called Human Achievement Index (HAI), to verify development opportunities in Thailand, focusing on the Central West region. The study had been analyzed the HAI, in terms of strength and weakness of human security in the study areas using the spatial application, namely the ArcGIS program (version 10.2.2), in order to establish sustainable human security in Thailand. The dimensions of the HAI in this study were classified into eight Sub Indexes, including health, education, employment, income, land and housing, family and community, transportation and communication, and participation.

After the focusing process, the significant indicators of human security were classified by spatial analysis towards the integrated process in the research analytical framework in Figure 3.1, to pursue the research target finally. These human security indicators as spatial attributes were, then, categorized into five ranges of color both positive and negative sides that expressed human security conditions in the study area. Interpreting by the Geography Information System (GIS) application, the green color in spatial maps showed the strong positive perspective, while the red color showed the strong negative perspective of the people.

5.2 Spatial Analysis for the HAI Dimensions

Primarily, this study analyzed the HAI in all 77 provinces of Thailand by comparing overall strength and weakness of human achievement in each area of the country; after that, the analysis would focus on 8 provinces in the Central-West region

of the country as the Provincial Indicators of the HAI (listed in italic letters), as shown in *Table 5.1*.

Table 5.1 Provinces of Thailand in Numeric Order for Spatial Analysis

No	Province	No	Province	No	Province
1	Bangkok	27	Buriram	53	Lamphun
2	Krabi	28	Pathum Thani	54	Loei
3	*Kanchanaburi*	*29*	*Prachuap Khiri Khan*	55	Sisaket
4	Kamphaeng Phet	30	Prachin Buri	56	Sakon Nakhon
5	Khon Kaen	31	Pattani	57	Songkhla
6	Chanthaburi	32	Phra Nakhon Si Ayutthaya	58	Satun
7	Chachoengsao	33	Phayao	59	Samut Prakan
8	Chonburi	34	Phangnga	*60*	*Samut Songkhram*
9	Chainat	35	Phatthalung	*61*	*Samut Sakhon*
10	Chaiyaphum	36	Phichit	62	Sa Kaeo
11	Chumphon	37	Phitsanulok	63	Saraburi
12	Chiang Rai	*38*	*Phetchaburi*	64	Sing Buri
13	Chiang Mai	39	Phetchabun	65	Sukhotai
14	Trang	40	Phrae	*66*	*Suphan Buri*
15	Trat	41	Phuket	67	Surin
16	Tak	42	Maha Sarakham	68	Nong Khai
17	Nakhon Nayok	43	Mukdahan	69	Nongbua Lamphu
18	*Nakhon Pathom*	44	Mae Hong Son	70	Ang Thong
19	Nakhon Phanom	45	Yasothon	71	Amnat Charoen
20	Nakhon Ratchasima	46	Yala	72	Udon Thani
21	Nakhon Si Thammarat	47	Roi Et	73	Uttaradit
22	Nakhon Sawan	48	Ranong	74	Uthai Thani

Table 5.1 (Continued)

No	Province	No	Province	No	Province
23	Nonthaburi	49	Rayong	75	Ubon Ratchathani
24	Narathiwat	*50*	*Ratchaburi*	76	Kalasin
25	Nan	51	Lopburi	77	Surat Thai
26	Nong Khai	52	Lampang		

5.2.1 Accumulation of Overall HAI Dimensions

Since the human security indicators in Thailand have been identified in terms of the Human Achievement Index (HAI), the accumulation of HAI could classify the level of achievements of human security in statistic value by dividing the HAI into 5 equal interval ranges as shown in the legend of each map. Regarding to the HAI structure in Figure 2.4, the HAI was classified in eight dimensions (Sub Indexes), including health, education, employment, income, land and housing, family and community, transportation and communication, and participation, in order to express visual understanding of development potentials in various aspects of the HAI. (see Appendix D)

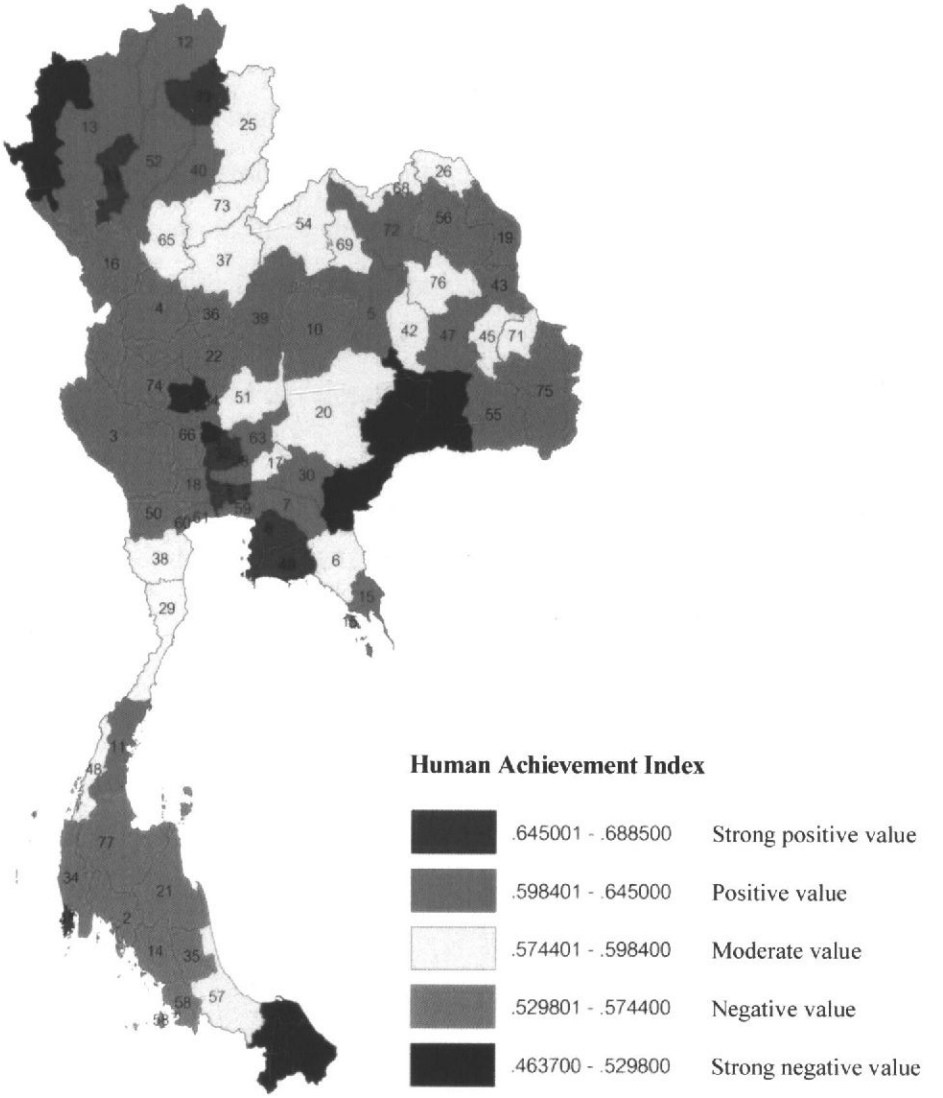


Figure 5.1 Accumulated Values of the Human Achievement Index (HAI)
Source: NESDB, 2019.

From the Figure 5.1, it showed that the top five rankings of positive perspectives were arranged into Phuket, Ayutthaya, Lamphun, Nonthaburi, and Bangkok provinces, respectively. Likewise, the last five rankings of negative perspectives were ordered as Mae Hong Son, Narathiwat, Chainat, Pattani, and Sa Kaeo provinces, respectively. The reasons why Phuket province had the highest accumulated HAI value due to the province got the top five rankings of the HAI dimensions in many aspects, including

health, education, income, and transportation and communication. On the other hand, Mae Hong Son province has the lowest accumulated HAI value due to the province had the last five rankings in several dimensions, including, education, income, land and housing, and transportation and communication.

There was a notice from the panelists that the policy makers or local authorities who took responsibilities in these provinces should look through the HAI status and developed their areas with the appropriate direction. Also, the stakeholders were to identify the strengths and weaknesses of their HAI, in order to understand their potentials and the obstacles of developments clearly.

5.2.2 Spatial Analysis of the HAI in Health Dimension

The first Sub-Index of the HAI, regarding to health dimension was expressed to reflect essentials of lives via infant survival rate (%), inpatient rate of all patients (%), persons with disabilities (%), and mental health level (%). This Sub-Index is a fundamental of well-being of human which everybody wants to have a good condition of physical and mental health to pursue their achievement of life and contribute themselves as capable and competitive means for family or the country.

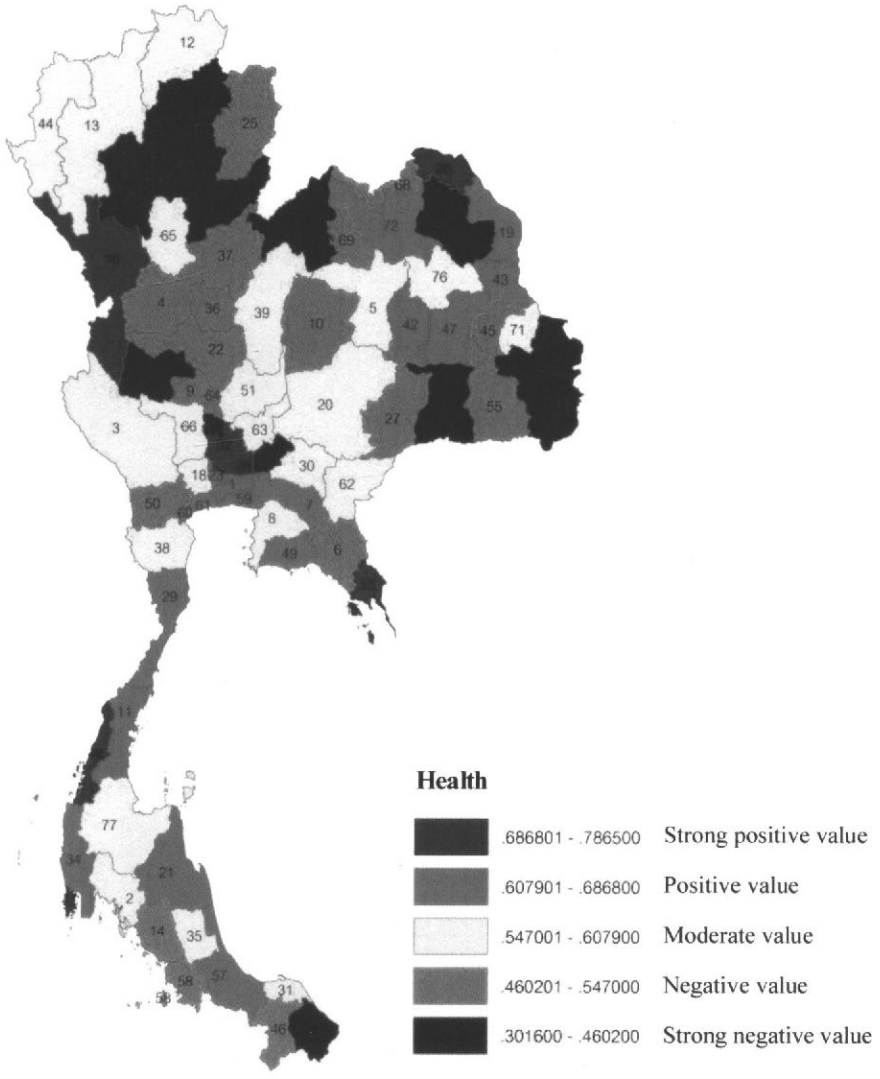


Figure 5.2 The Sub Index of HAI in Health Dimension
Source: NESDB, 2019.

In the Figure 5.2, the spatial map showed that the top five rankings of positive health conditions were Ranong, Bung Kan, Ayutthaya, Pathum Thani, and Phuket provinces respectively; whereas, the last five rankings of negative health status were ordered by Surin, Ang Thong, Loei, Nakhon Nayok, and Phayao provinces respectively (arranged upon the provincial numbers in Table 5.1). There was the panelist in the study giving the opinion that policy makers and stakeholders should put forwards the considerations in the spatial map to the Ministry of Health and local authorities to

enhance health assurance, especially to support persons with disabilities in the country further as well.

5.2.3 Spatial Analysis of the HAI in Education Dimension

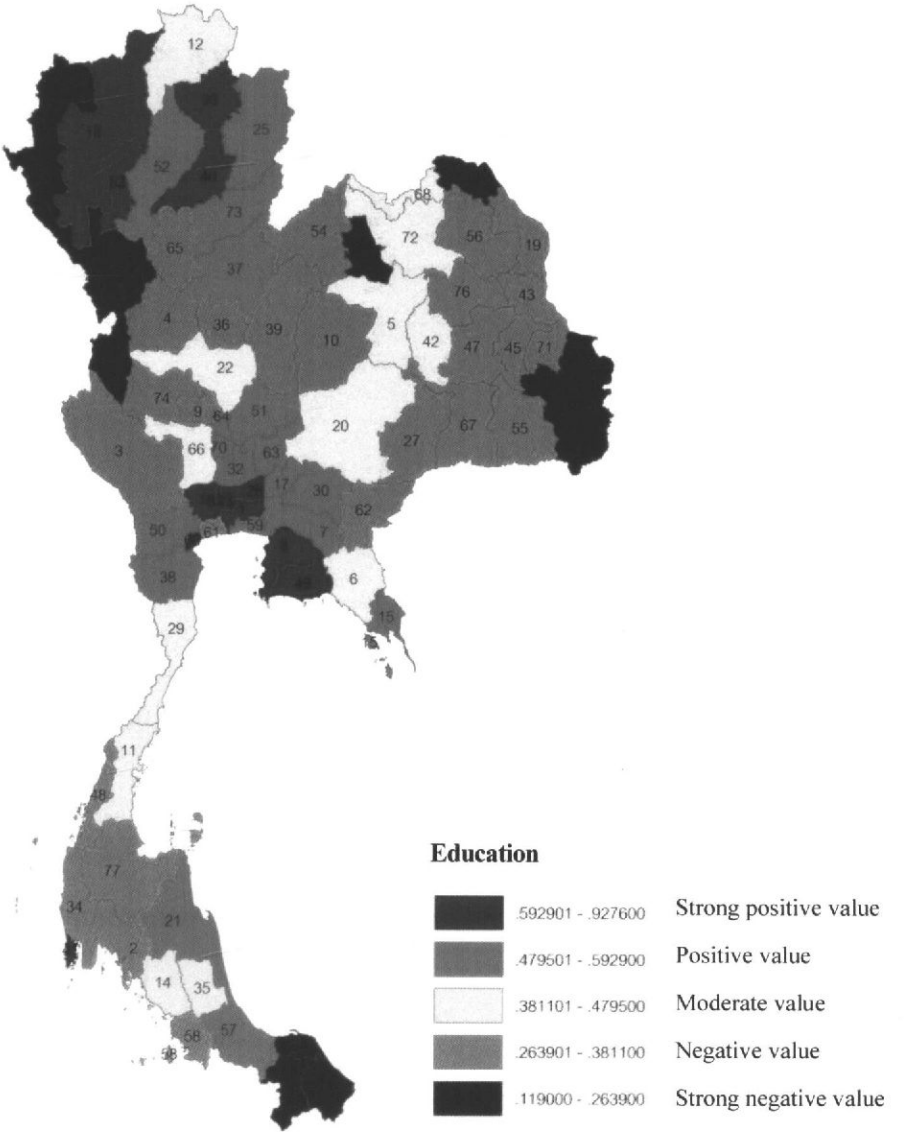


Figure 5.3 The Sub Index of HAI in Education Dimension
Source: NESDB, 2019.

From the Figure 5.3, this spatial map expressed the second Sub Index of HAI, regarding the education dimension which consisted of several indicators, including

education year of people who is 15 years old and above (year), high school and vocational training opportunity (%), IQ of primary school student (level), and O-Net test of high school student (level). The analysis concluded the top five rankings of positive perspectives of education as Bangkok, Chonburi, Nonthaburi, Phuket, and Nakhon Pathom provinces respectively; while, the last five rankings of negative perspectives of education were ranked as Narathiwat, Pattani, Mae Hong Son, Nongbua Lamphun, and Tak provinces, respectively (arranged upon the provincial numbers in Table 5.1).

Some panelists also asserted that policy makers in the education system of Thailand, especially in the Ministry of Education and higher institutes, should provision practical knowledge and moral learning for the people to deliver quality workforces with ethical behavior for the real sector in the country, and also enhance higher degree opportunities for learners who eager to pursue their knowledge.

5.2.4 Spatial Analysis of the HAI in Employment Dimension

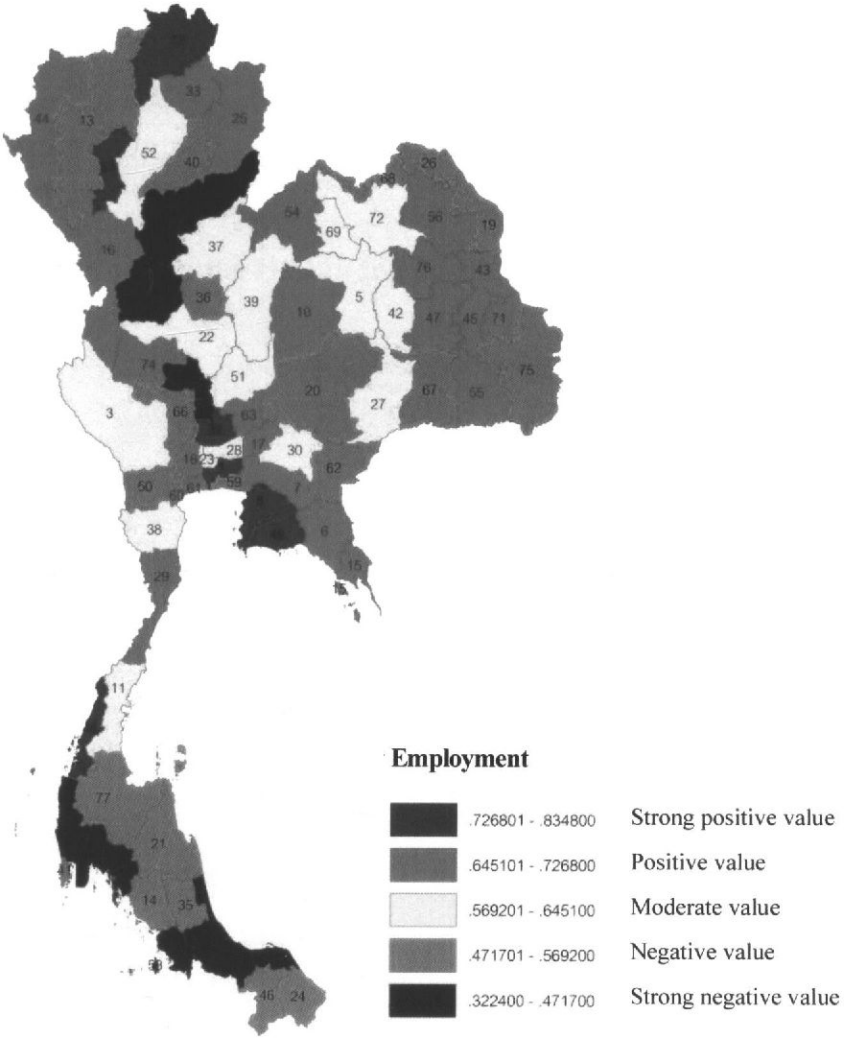


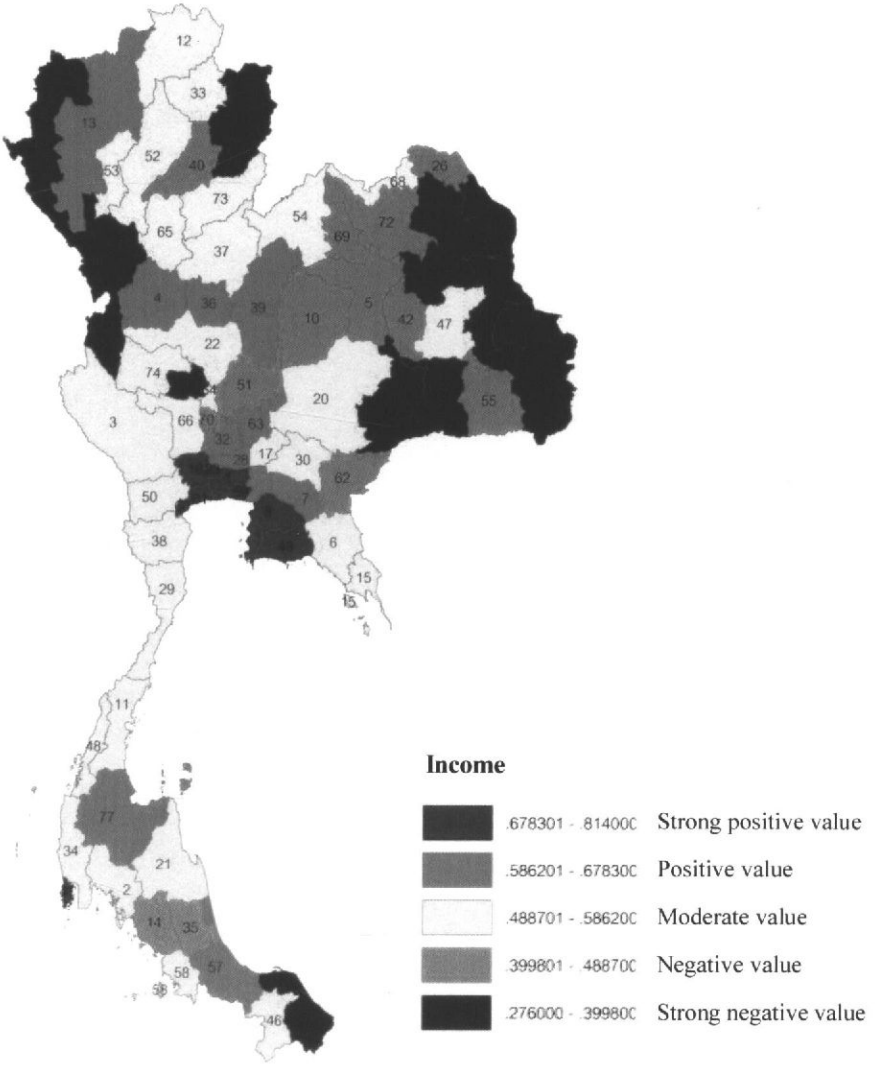
Figure 5.4 The Sub Index of HAI in Employment Dimension
Source: NESDB, 2019.

Regarding to the Sub Index of HAI, regarding the employment dimension in Figure 5.4, this spatial map showed the conditions of workforces in Thailand via the indicators of unemployment rate (%), low work-hour rate (%), social insurance of labour (%), and injury rate (people per 1000 labours). Based on the provincial numbers in Table 5.1, this Figure could illustrated the top five rankings of positive perspectives of employment as Bangkok, Chonburi, Ayutthaya, Rayong, and Lamphun provinces

respectively; while, the last five rankings of negative perspectives of employment were Sukhothai, Phangnga, Chainat, Satun, and Uttaradit provinces, respectively.

Moreover, there were the panelists giving the opinions that an employment rate reflected the country's national competitive advantage; therefore, policy makers should strengthen social insurance system to provide a good living for all workforces so that workers should get an appropriate insurance for themselves in several options.

5.2.5 Spatial Analysis of the HAI in Income Dimension

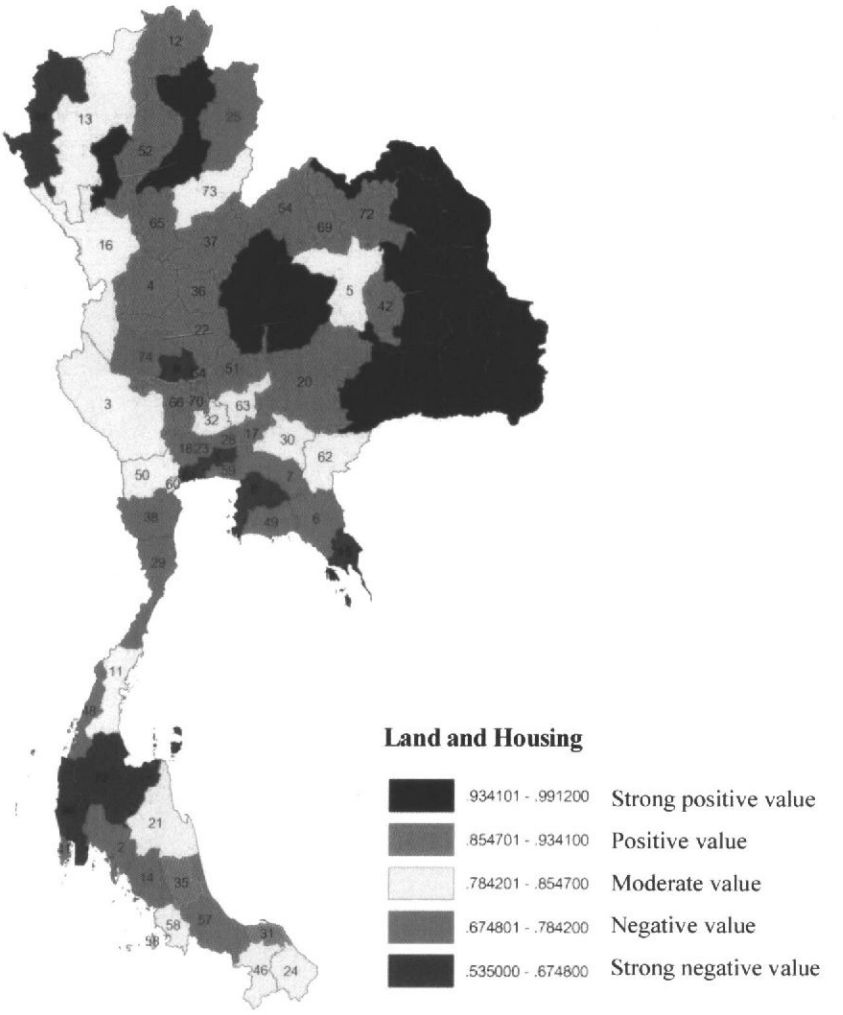


Figures 5.5 The Sub Index of HAI in Income Dimension

Source: NESDB, 2019.

The Sub Index of HAI, regarding the income dimension illustrated economic perspective that the people could maintain their life with minimum standard of living in the society. There were several indicators used to calculate the relationship of income and human security, including family income (Baht), poverty rate (%), consuming debt (%), and equality coefficient of income (%). Most of indicators, especially the equality coefficient of income, had been adopted from governmental agencies which estimated and calculated this information from employments or business activities in each family. Based on the provincial numbers in Table 5.1, the range of income potentials in the Figure 5.5 could be expressed the top five rankings of positive perspectives of income as Bangkok, Samut Sakhon, Nonthaburi, Phuket, and Samut Prakan provinces respectively; while, the last five rankings of negative perspectives of income were ranked as Narathiwat, Pattani, Mukdahan, Mae Hong Son, and Amnat Charoen provinces respectively.

5.2.6 Spatial Analysis of the HAI in Land and Housing Dimension

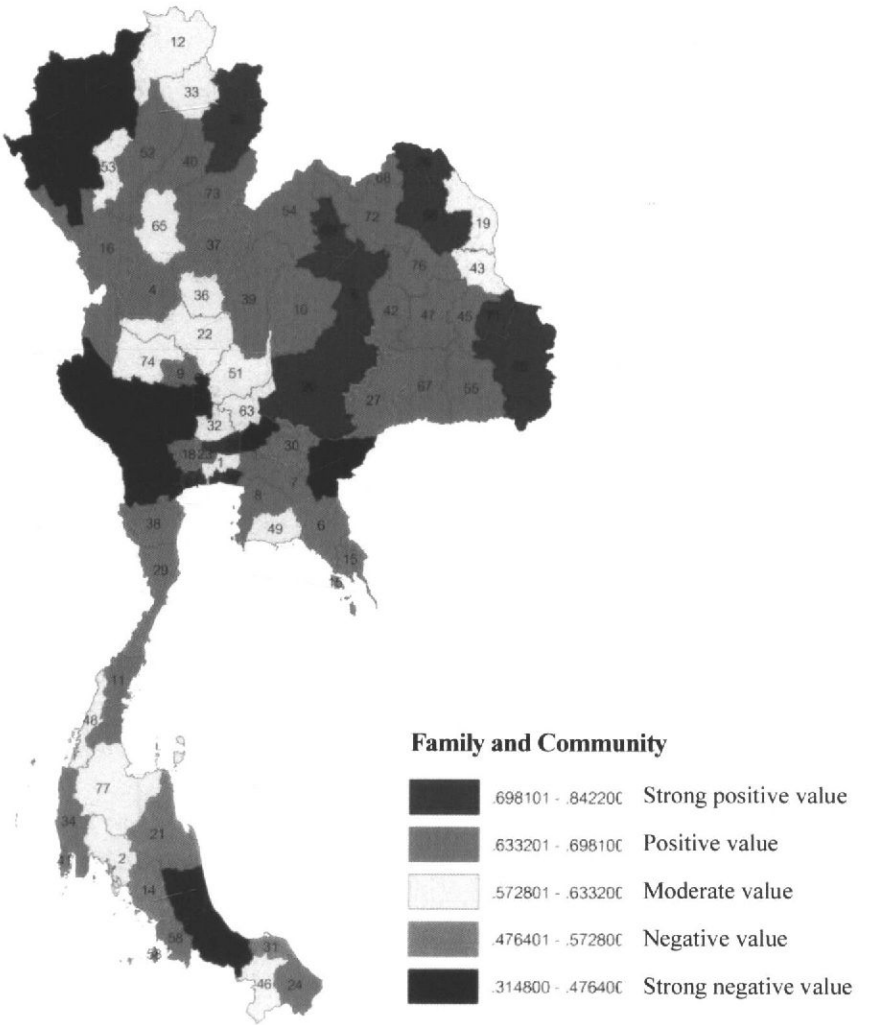


Figures 5.6 The Sub Index of HAI in Land and Housing Dimension
Source: NESDB, 2019.

The Sub Index of HAI, regarding the land and housing dimension was generated from social and environmental indicators that the people could occupy their own assets and secured their security of lives in proper environment. The indicators consisted of house and land owner (%), greenhouse emission rate (GHG Ton per person), flooding sufferer (%), and drought sufferer (%) as shown in the Figure 5.6. Based on the provincial numbers in Table 5.1, this map could express the top five rankings of positive perspectives of land and housing indicators as Roi-et, Sakon Nakhon, Amnat Charoen,

Sisaket, and Bung Kan provinces, respectively; while, the last five rankings of negative perspectives of land and housing were ranked as Trat, Mae Hong Son, Chainat, Chonburi, and Surat Thani provinces, respectively.

5.2.7 Spatial Analysis of the HAI in Family and Community Dimension

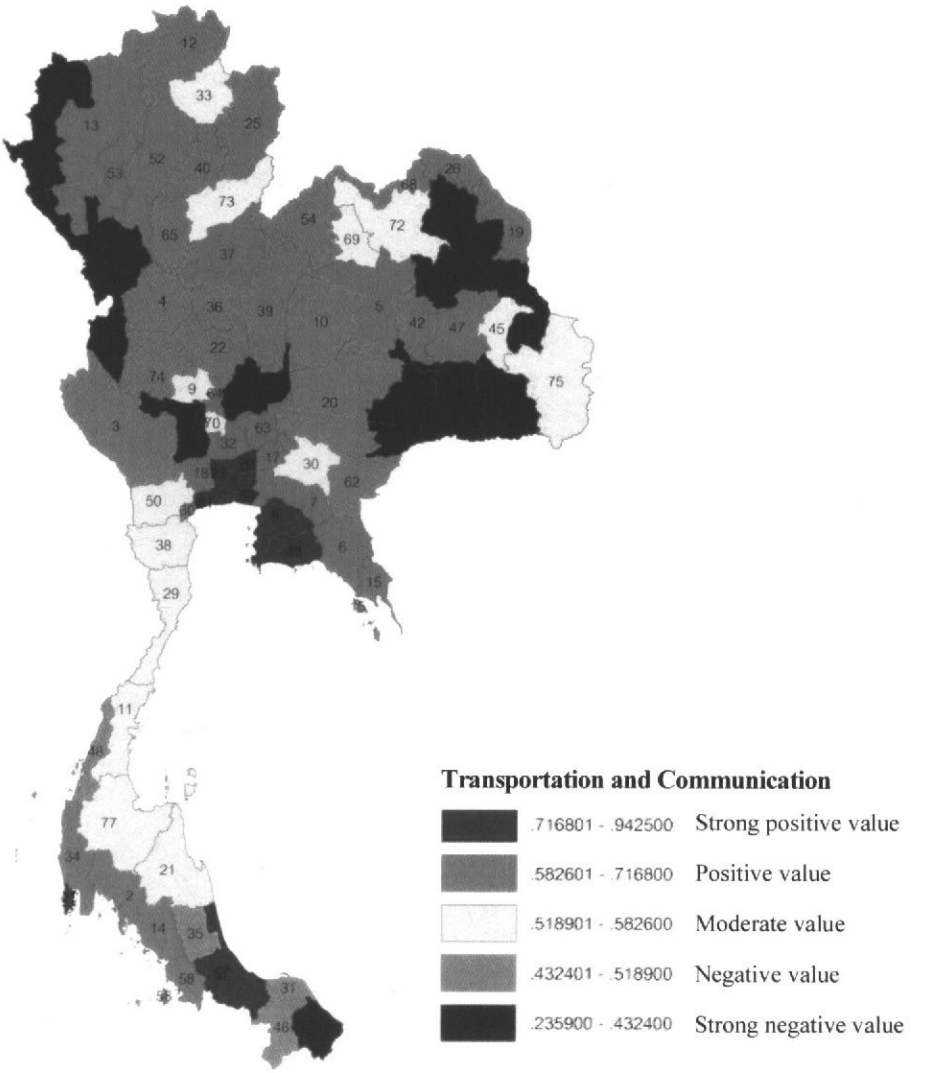


Figures 5.7 The Sub Index of HAI in Family and Community Dimension
Source: NESDB, 2019.

From the Sub Index of HAI in Figure 5.7, the family and community dimension reflected how well family members stayed safety within the society and workplace during the age of workforces. It estimated human security conditions via employment

of 15-17 years old worker (%), single parent family (%), alone elder rate (%), and criminal rate (%). Based on the provincial numbers in Table 5.1, the top five rankings of positive perspectives of family and community dimension could be ordered as Samut Prakan, Sakon Nakhon, Khon Kaen, Nongbua Lamphu and Samut Sakhon provinces, respectively; while, the last five rankings of negative perspectives of family and community dimension were ranked as Suphan Buri, Samut Songkhram, Ang Thong, Ratchaburi, and Nakhon Nayok provinces, respectively.

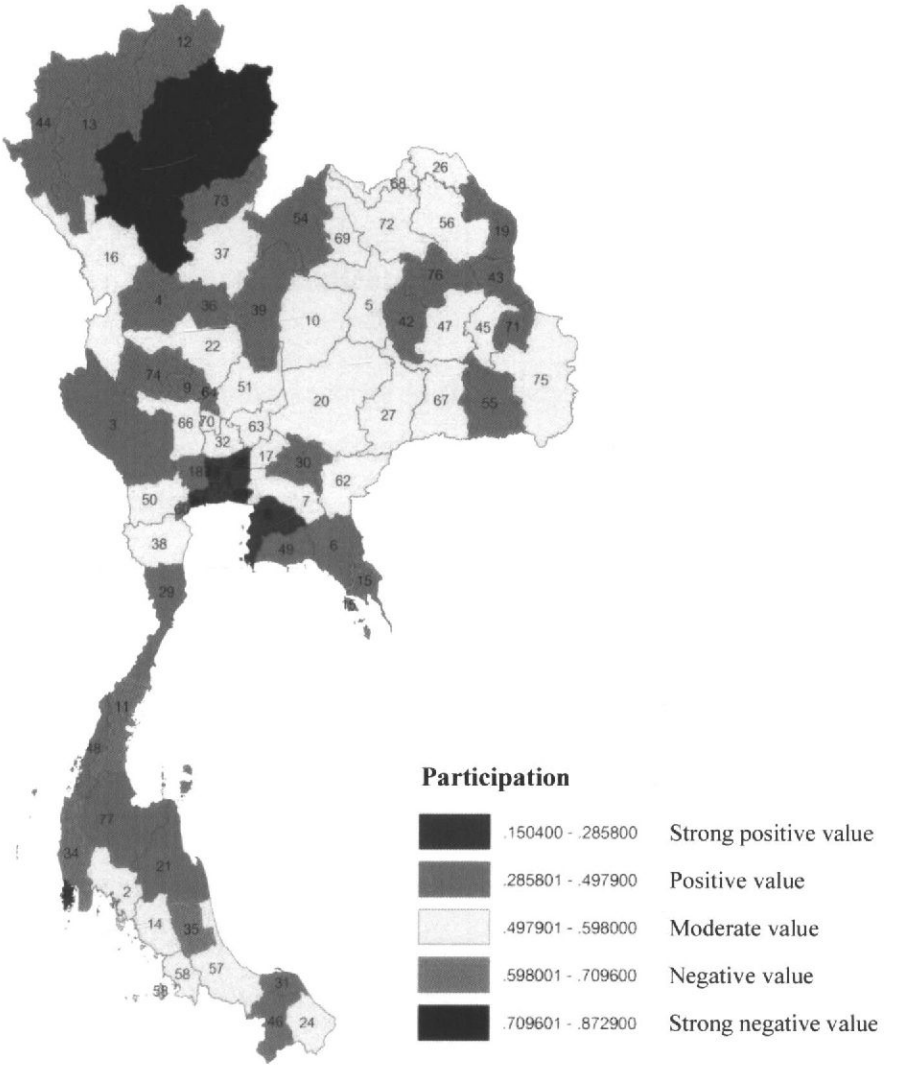
5.2.8 Spatial Analysis of the HAI in Transportation and Communication Dimension



Figures 5.8 The Sub Index of HAI in Transportation and Communication Dimension
Source: NESDB, 2019.

The Sub Index of HAI, regarding the transportation and communication dimension in Figure 5.8, expressed human achievements, which the people could access good public infrastructures or services in Thailand. This dimension consisted of the indicators as to serviceable main road (%), road accident rate (%), mobile phone occupation rate (%), and internet accessibility rate (%). Based on the provincial numbers in Table 5.1, the top five rankings of positive perspectives of transportation and communication dimension could be ordered as Nonthaburi, Phuket, Pathum Thani, Samut Sakhon and Chonburi provinces, respectively; while, the last five rankings of negative perspectives of transportation and communication dimension were ranked as Mae Hong Son, Si Sa Ket, Narathiwat, Mukdahan, and Sakon Nakhon provinces, respectively.

5.2.9 Spatial Analysis of the HAI in Participation Dimension



Figures 5.9 The Sub Index of HAI in Participation Dimension
Source: NESDB, 2019.

As the participation dimension in this study referred to activities, which the people were joining in communities and political involvement and delivering their own opinions as public awareness. It showed social strength that individuals and families could contribute their efforts to play a role in public via social activities and cooperated organizations, including political vote rate (%), number of social organizations (per 100,000 people), family participation as a member of social organizations (%), and

family participation in public activity (%). Based on the provincial numbers in Table 5.1, the map in Figure 5.9 expressed the top five rankings of positive perspectives of participation dimension as Lamphun, Nan, Phayao, Lampang, and Sukhothai provinces, respectively; while, the last five rankings of negative perspectives of participation were ranked as Samut Prakan, Prathum Thani, Samut Sakhon, Bangkok, and Nonthaburi provinces, respectively.

5.3 Spatial Analysis for Significant Indicators of the HAI in the Study Area

As the spatial analysis of human security in this study was conducted via the spatial application to identify strength and weakness degrees of development potentials; the concept of the study was implemented by comparing development opportunities in the study area with other areas, regarding a nature of human that no one was likely to stay behind the others. Therefore, the policy makers or the local authorities who were responsible for each area would try to improve their area if they could visualize the opportunities to do better or equal to others. Consequently, spatial analysis would serve decision-making process with clearer picture of possible options or alternative approach for the stakeholders.

Regarding the focusing process of the research analytical framework in Figure 3.1, the significant indicators of the HAI, classified from the involvement process, had been selected to analyze further, based on the top three rankings of each sustainable development perspective, as follows: 1) economic indicators--family income, consuming debt, and poverty; 2) social indicators--unemployment rate, social insurance, and high school and vocational training opportunity, and 3) environmental indicators--serviceable main road, greenhouse emission rate, and house and land owner.

5.3.1 Spatial Analysis for the Family Income Indicator of the HAI

From Figure 5.10, the spatial map illustrated family income levels of the provinces in the Central West region of Thailand. The figure showed that the people in Nakhon Prathom province had a highest income level but Suphan Buri province was relative low family income level. There were some notices from the panelists that Nakhon Prathom province had high family income due to success in domestic animal

livestock, and also located on appropriate settings of the main routes and economic zone of the country; while, Suphan Buri province had not many significant investments in the province but there were various cultures and unique ways of life in the local area. Therefore, the panelists asserted that Suphan Buri province could promote a potential on creative and eco-tourism within their attractive areas as well.

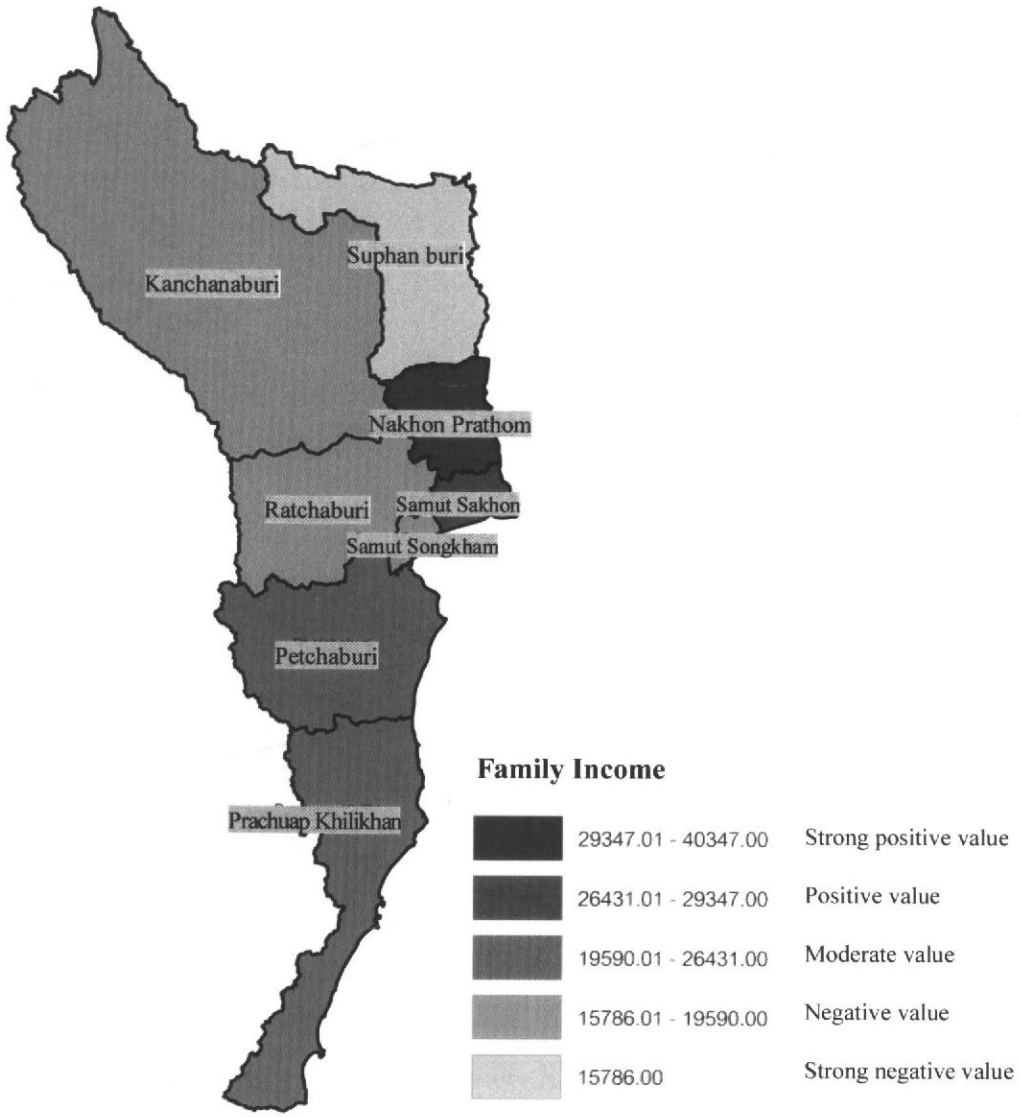


Figure 5.10 HAI of Family Income in Perspective of Economic Security

Source: NESDB, 2019.

5.3.2 Spatial Analysis for the Poverty Indicator of the HAI

Since the poverty indicator in this study was defined that capability to purchase food and important products for survival was lower than a minimum standard of living, whereas the family income indicator was defined that how much the family accumulated regular or non-regular incomes per month. Obviously, the maps in Figure 5.10 and 5.11 expressed contradicted definitions between family income indicator and poverty indicator, which defined strength and weakness of economic security in controversy meanings, for instance, Suphanburi province seemed to be unsuccessful in economic security as it has low family income rate but high poverty rate at the same time.

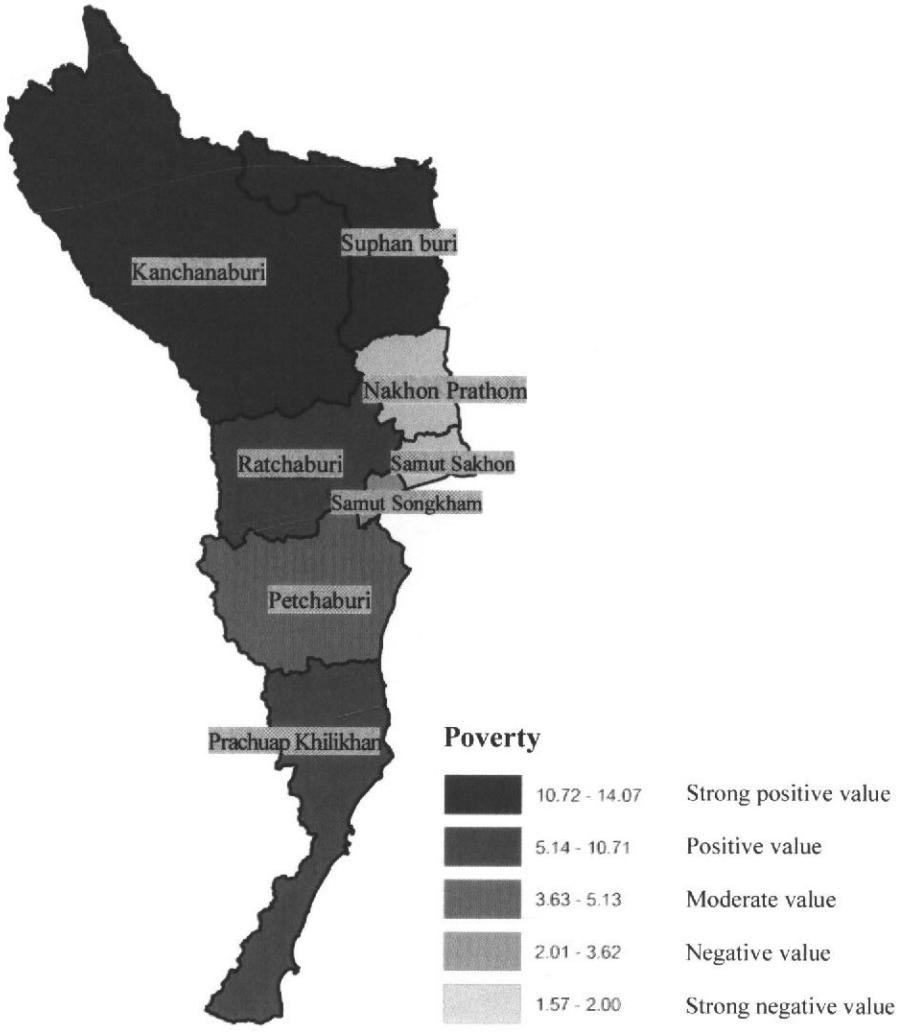


Figure 5.11 HAI of Poverty in Perspective of Economic Security

Source: NESDB, 2019.

5.3.3 Spatial Analysis for the Consuming Debt Indicator of the HAI

Likewise, Nakhon Prathom province had high family income, which was likely to have a strength in economic security, but the people in the province seemed to have some difficulties with relatively high consuming debt as shown in Figure 5.12. Some panelists gave opinions on this incident that it should be observed in various aspects, including equity of income between diverse groups of the people and its cost of living in the province as well.

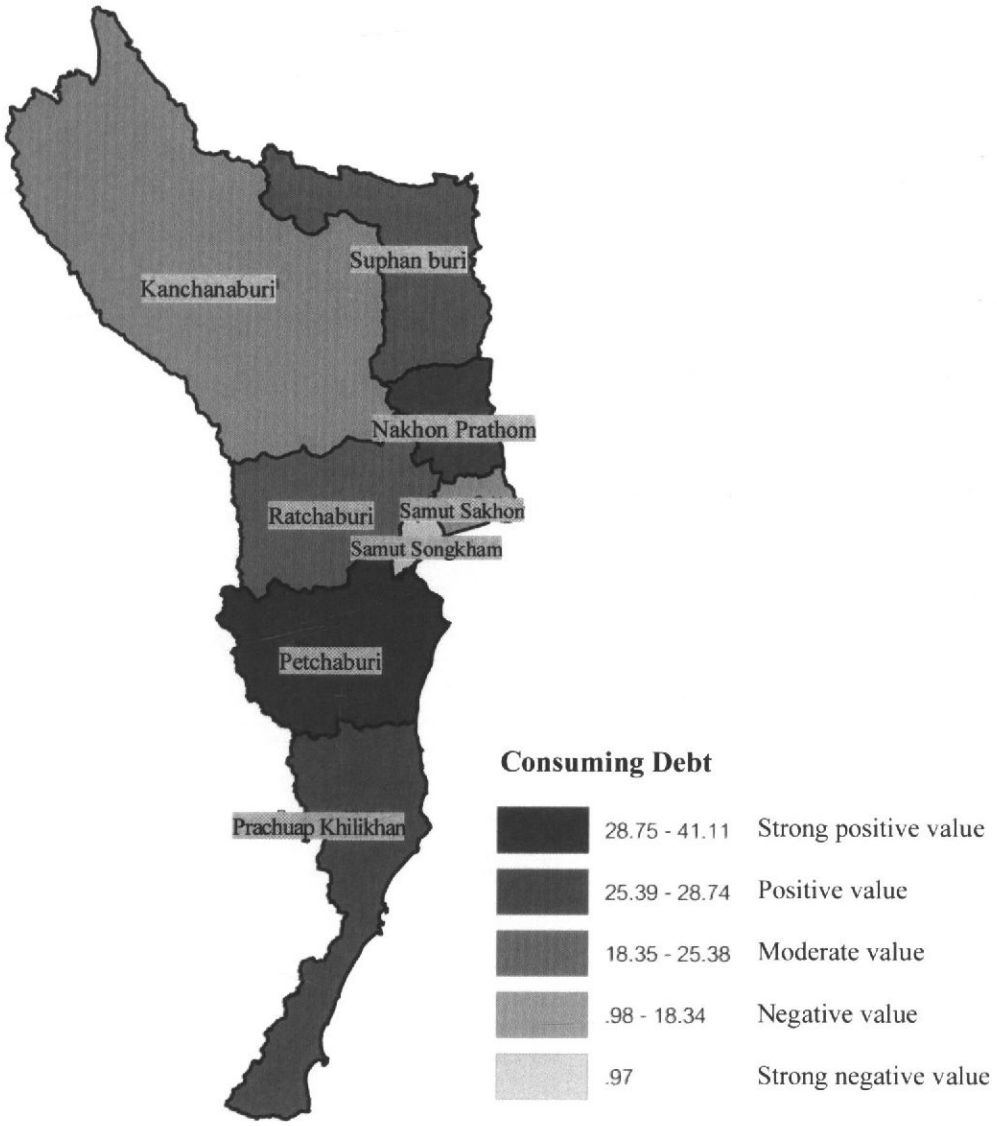


Figure 5.12 HAI of Consuming Debt in Perspective of Economic Security
Source: NESDB, 2019.

5.3.4 Spatial Analysis of the Social Insurance Indicator of the HAI

Whereas the social insurance indicator in the Figure 5.13 reflected how governmental assistances contributed supplement budgets to enhance well-being and security of lives for the people in the area. The figure showed that Kanchanaburi province and Suphan Buri province were fewer social insurances for the people, which the panelist asserted that governmental agencies and concessions were to provide a variety of social assistances or services precisely as the people need and want, especially covering various health insurances for individuals or group workers.

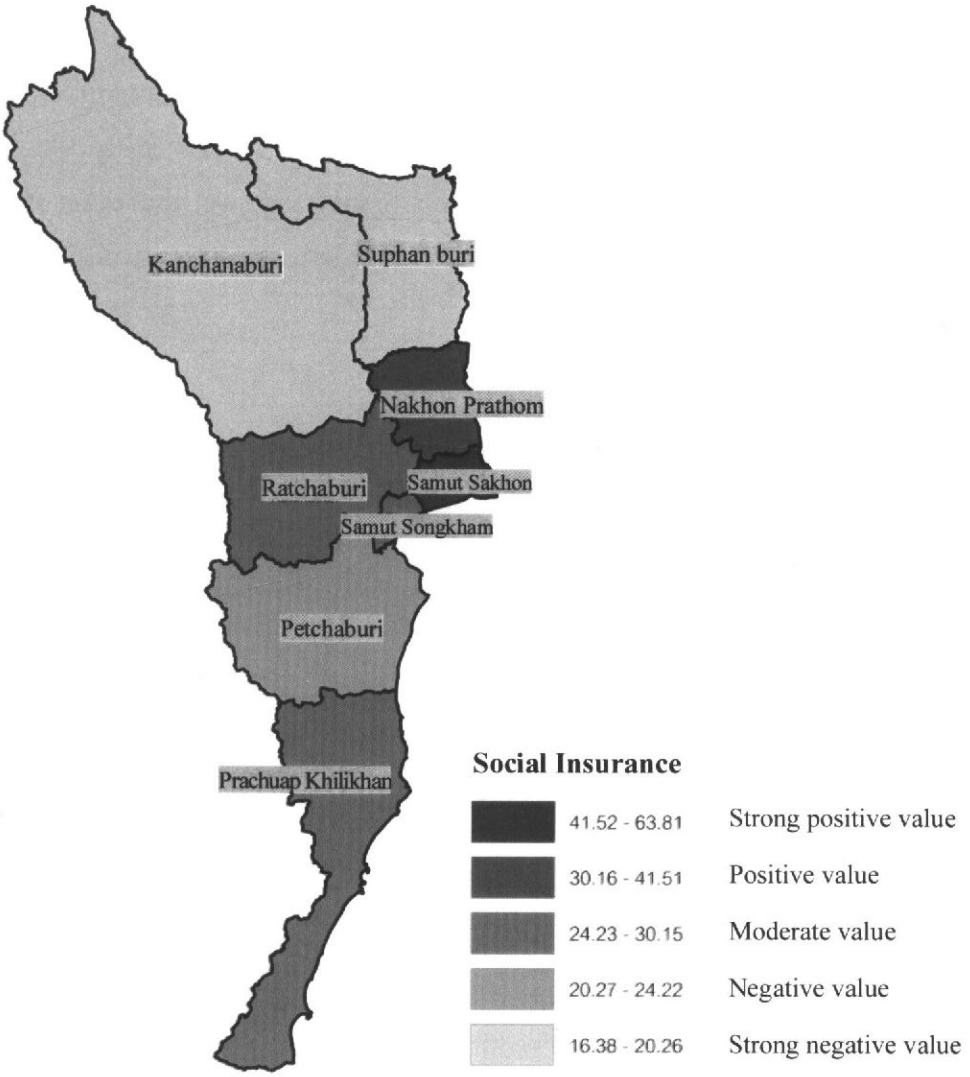


Figure 5.13 HAI of Social Insurance in Perspective of Social Security

Source: NESDB, 2019.

5.3.5 Spatial Analysis of the Unemployment Indicator of the HAI

Since the unemployment indicator related to many perspectives of human security, both economic security and social security. It involved social security as it caused several effects not only to individual financial problems, but also to human's dignity and social problems in a long term. From Figure 5.14, the spatial map showed that Ratchaburi province had the highest unemployment rate in the Central West region of Thailand; however, the unemployment indicator was defined, based on the workers who had no job and reached the age of 15 years old and over only.

Nevertheless, there were a notices from the panelists that the province might have various issues leading a high unemployment rate, such as there were a large number of immigrants from Myanmar contributing as workforces, and also the province was notably as the city of education, which some students might not be taken into account because they have been continuing their study until finishing the bachelor at 22 years old without working, as well as there were fewer job opportunities for the one who wanted to work.

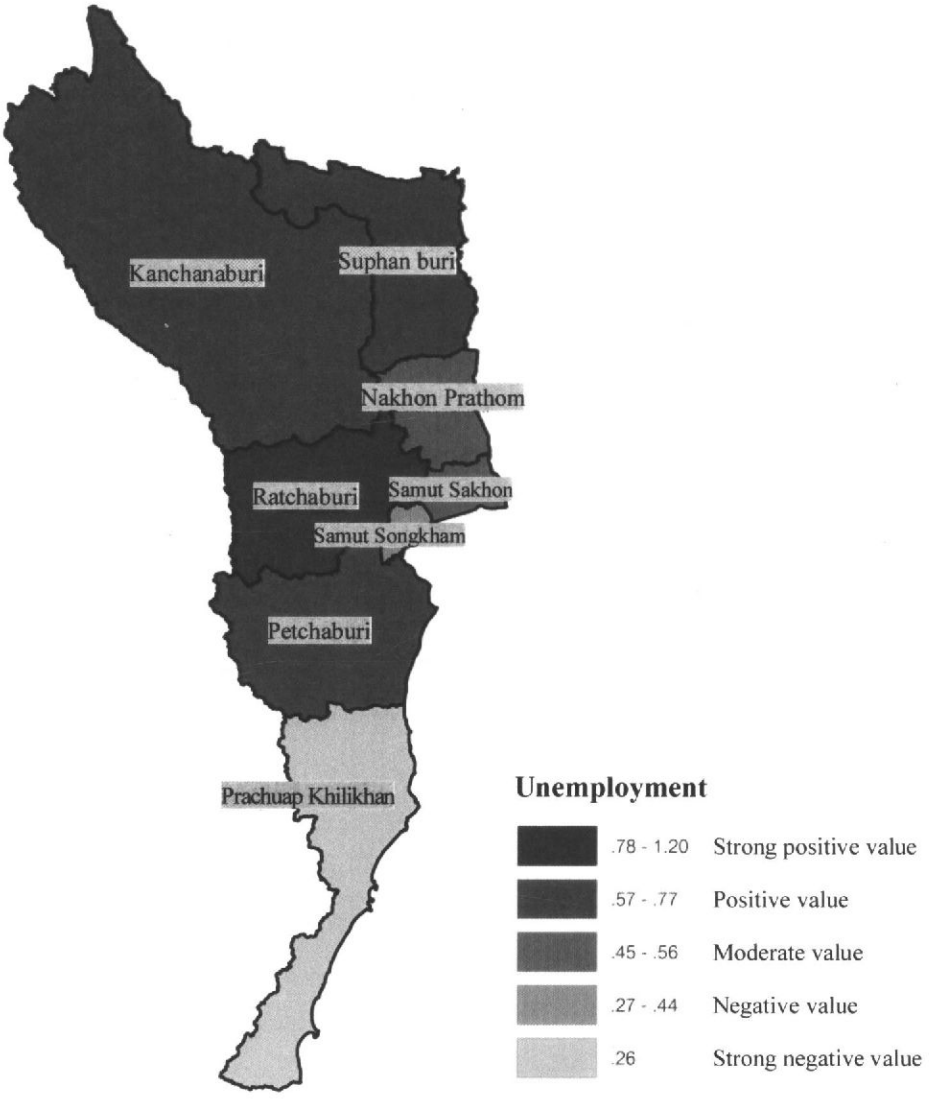


Figure 5.14 HAI of Unemployment in Perspective of Social Security
Source: NESDB, 2019.

5.3.6 Spatial Analysis of the High School and Vocational Training Opportunity Indicator of the HAI

The spatial map in Figure 5.15 showed that Nakhon Prathom province was the most successful province in establishing high school and vocational training opportunities in the Central West region of Thailand. As education is a foundation of national building, high school and vocational training opportunities is, therefore, a

significant element to strengthen social security for the country. Nevertheless, the panelists suggested that Nakhon Prathom province could share their experiences in educational planning to Samut Songkram province, in order to contribute their own educational experiences to the neighboring province as well.

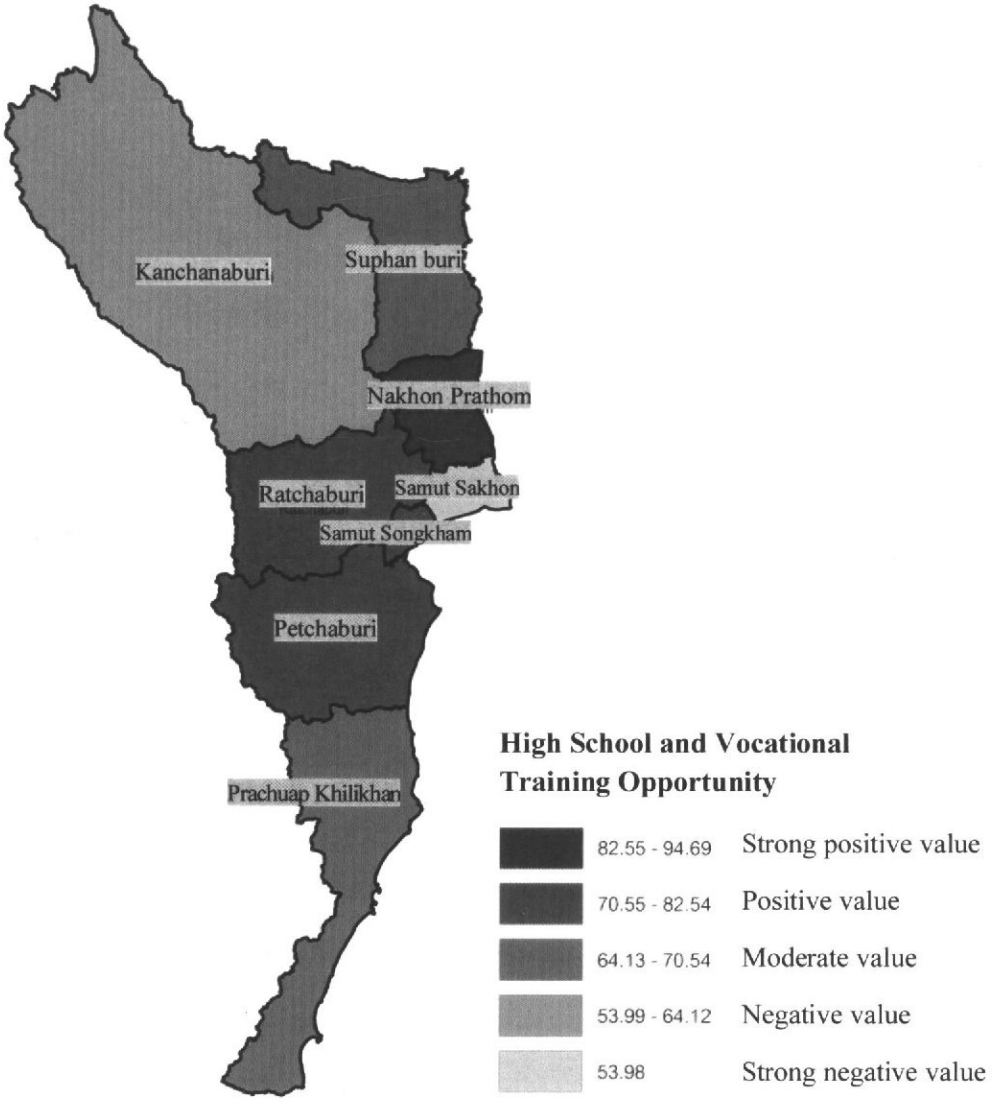


Figure 5.15 HAI of High School and Vocational Training Opportunities in Perspective of Social Security

Source: NESDB, 2019.

5.3.7 Spatial Analysis of the House and Land Owner Indicator of the HAI

From the house and land owner indicator in the Figure 5.16, the spatial map illustrated that the people in Samut Sakhon province had some difficulties about land and housing opportunity, while Suphan Buri was successful in this perspective. Regarding the panelists' perspectives from Table 4.3, the information showed that land and house ownership was the significant indicator that reflected environmental security highly; there were the panelists giving opinions that governmental or private sectors should attend to real estate developments and provided accessible financial supports to the one who preferred to possess own land and house. Therefore, Samut Sakhon province was to response the human need in aspects of built environment and tangible assets for living of their people further.

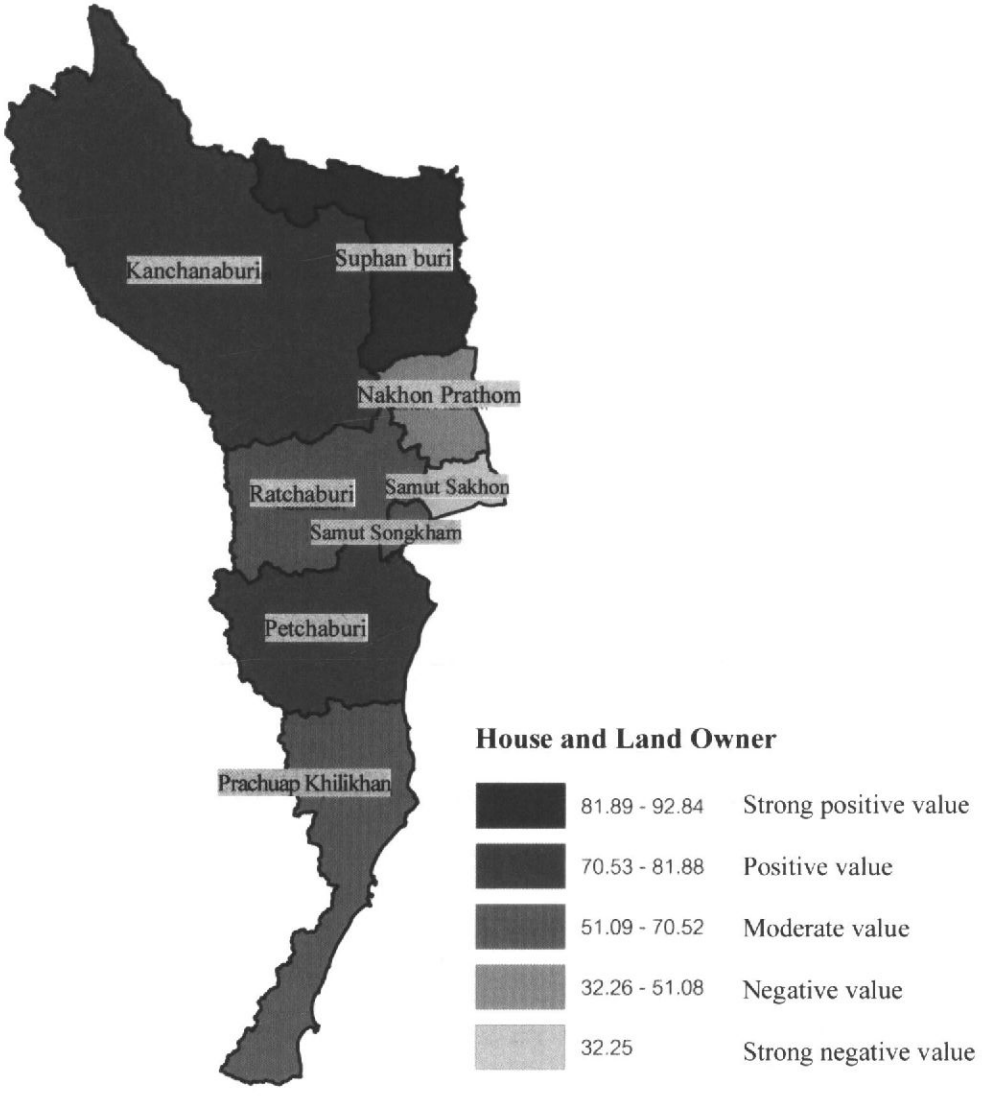


Figure 5.16 HAI of Land and Housing in Perspective of Environmental Security
Source: NESDB, 2019.

5.3.8 Spatial Analysis of the Service Main Road Indicator of the HAI

Obviously, the people in Thailand were familiar with living and running their business nearby the main roads; therefore, most panelists considered the serviceable main road indicator as a significant indicator to serve the people fulfilments in practical, as shown in Table 4.3. In this study, a high value of the serviceable main road indicator expressed that people could utilize transportation system throughout the year as

preferable built environment. The spatial map in Figure 5.17 showed that Samut Sakhon province has the most vulnerable environmental security, comparing with other provinces in the region, since there are a large number of flooding areas, which the people cannot exploit this facility all year long.

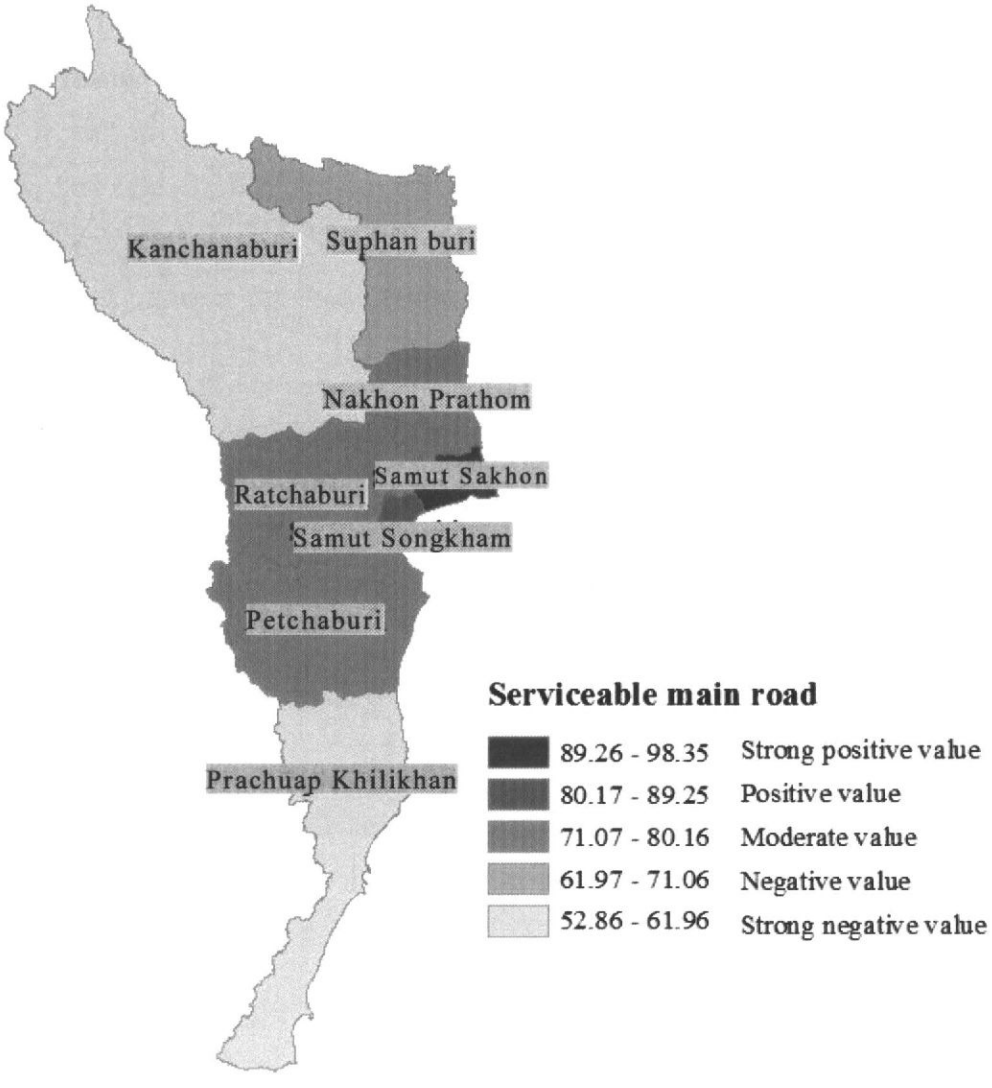


Figure 5.17 HAI of Serviceable Main Road in Perspective of Environmental Security
Source: NESDB, 2019.

5.3.9 Spatial Analysis of the Greenhouse Gas Emission Indicator of the HAI

Noticeably, global warming problems have been substantial environmental issues in the international level nowadays, as it can cause climate change which affects to flooding and droughting incidents in many countries. The spatial map in Figure 5.18 illustrated greenhouse gas emission (GHG) potentials in the Central West region of Thailand, calculated from the GHG emission per head of the population in the province. In this figure, it was noticeably that Ratchaburi province and Prachuap Khirikhan province had less GHG emission, causing environmentally friendly atmosphere for tourism industry in the areas. Therefore, the panelists suggested that it might be a good opportunity to promote the areas as the attractive provinces for air quality zones of Thailand.

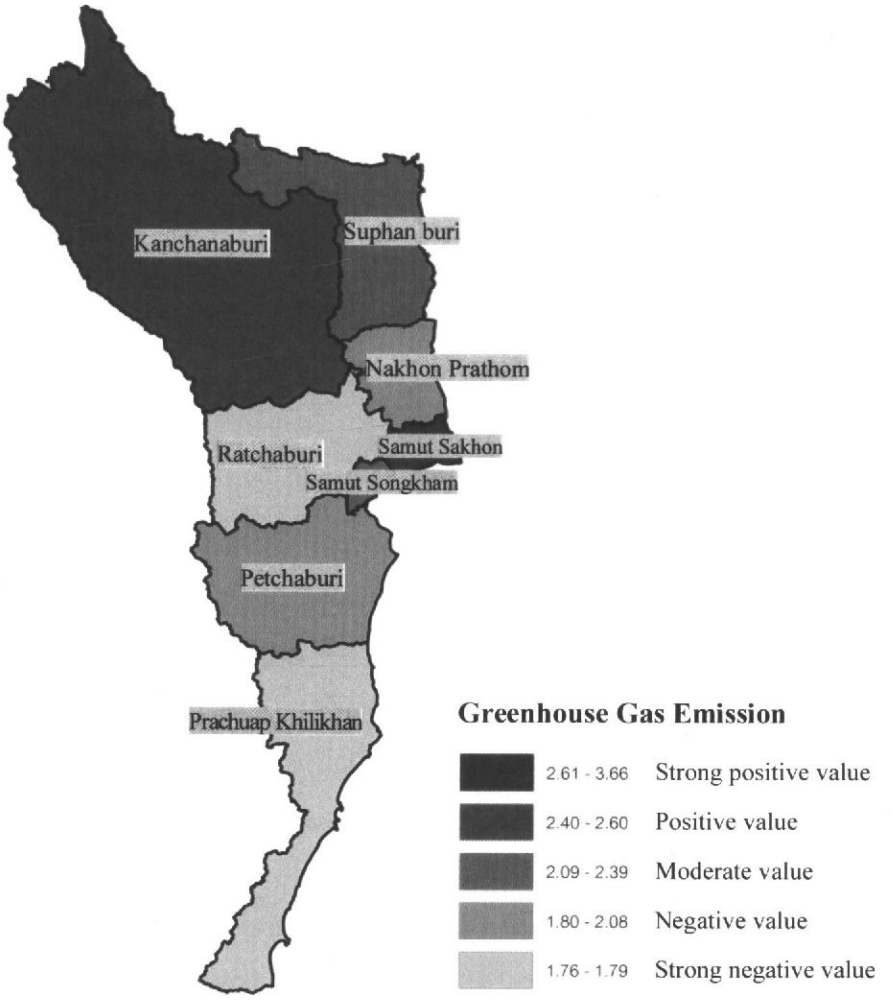


Figure 5.18 HAI of Greenhouse Gas Emission in Perspective of Environmental Security

Source: NESDB, 2019.

5.4 Integration of Multi - Dimensions of Human Security via Spatial Analysis

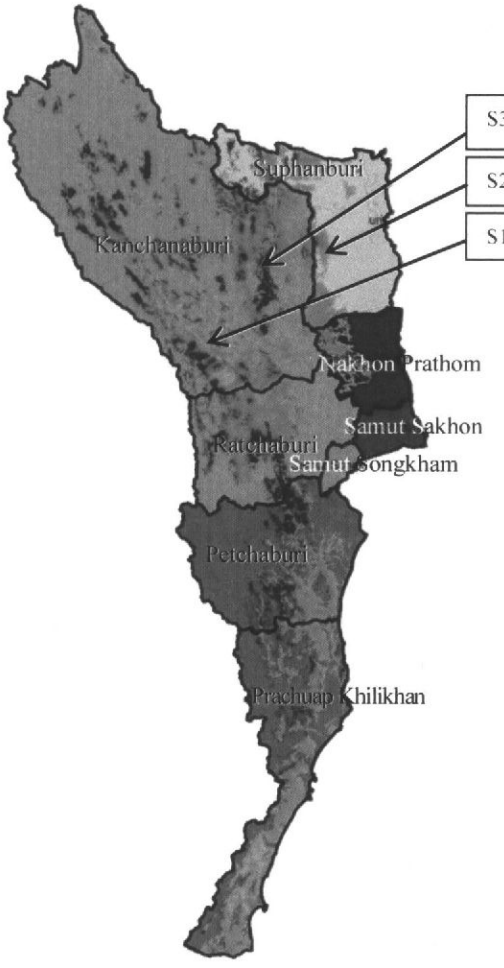
After the human security indicators from the focusing process of the research framework had been assessed by the panelists and the significant human security indicators were integrated towards the spatial analysis, the GIS maps were, then, manipulated in some aspects of sustainable development perspectives.

5.4.1 Enhancing of Economic Security in Perspective of Family Income by Agricultural Potentials

Based on the map of soil suitability in Figure 5.19, the agricultural capability for cassava plantation in the Central West region of Thailand was manipulated into 3 zones of the plantation potentials: S1 (most suitable area for 342,964 Rai), S2 (moderate suitable area for 7,038,734 Rai), and S3 (less suitable area for 1,944,425 Rai). This spatial map showed that Supanburi province had less suitable area for field crop plantations, while there was strong negative value of family income as well.

To increase family income, the panelists asserted that the relevant policy makers and the farmers in Supanburi province should define an alternative strategy to enhance family income, rather than highly projected to field crop plantation in the area, especially in the Eastern of the province where had less suitable area for plantation. Likewise, the experts also commented that Kanchanaburi province and Ratchaburi province had widely S1 areas of soil suitability, the province could enhance their agricultural potentials by integrating these indicators with other relevant indicators for mitigating planting problems from environmental issues, such as drought and flooding in the area as well.

Moreover, the comments from the panelists suggested that the Central West region of Thailand should be developed by large investment projects, such as enhancing economic security by a large scale of agricultural approach, and also made strategic planning of natural resource management via multi-layer maps of GIS.



S3 area = 1,944,425 Rai

S2 area = 7,038,734 Rai

S1area = 342,964 Rai

Site suitability of cassava

S1	Most suitable
S2	Moderate suitable
S3	Less suitable

Family income

29,347.01 – 40,347.00	Strong positive value
26,431.01 – 29,347.00	Positive value
19,590.01 – 26,431.00	Moderate value
15,786.01 – 19,590.00	Negative value
15,786.00 and below	Strong negative value

Province	Family income (Baht)
Kanchanaburi	18,883.71
Nakhon Prathom	40,346.95
Petchaburi	26,430.65
Prachuap Khilikhan	23,522.50
Ratchaburi	19,589.97
Samut Sakhon	29,347.37
Samut Songkham	18,310.15
Suphanburi	15,786,19

Classification statistics	Family income (Baht)
Mean	24,027
Median	21,557
Standard deviation	7,478

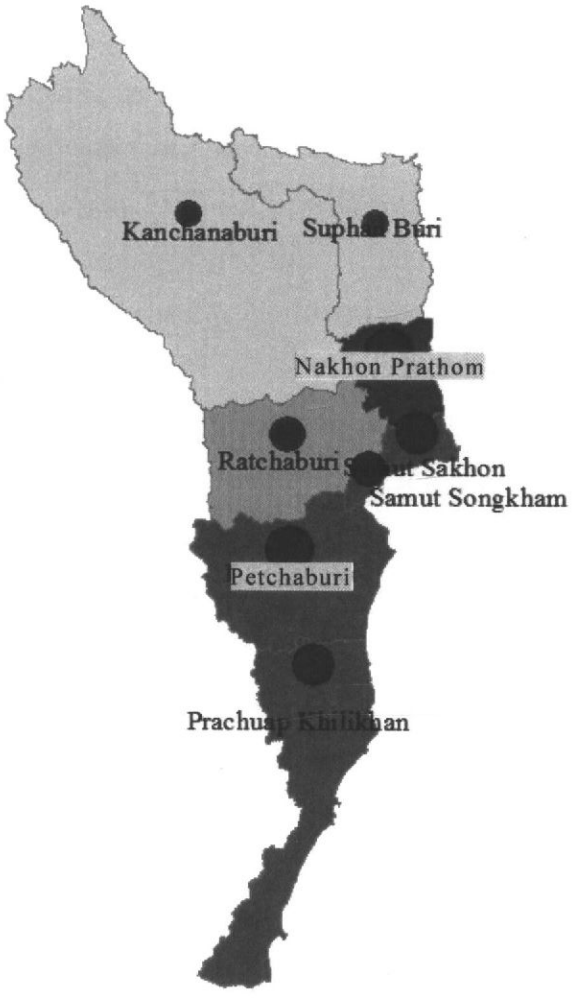
Figure 5.19 Integration of Family Income and Agricultural Potentials

Source: NESDB, 2019; The Land Development Department, 2014.

5.4.2 Poverty versus Family Income via Education Years of Studying

Regarding to the analysis of the 4-years development plan of Nakhon Prathom province during year 2018-2021(Nakhon Prathom Provincial Governor's Office, 2020) and the education year indicator in Figure 5.20, the incident of high family income rate of Nakhon Prathom province in Figure 5.19 would refer to successful developments in exploiting their own strengths, in which the people had high educational knowledge in complying their resources with a good geo-economic location for enhancing own economic performance.

The spatial map in Figure 5.20 showed that Suphanburi province had relatively strong negative value of poverty. There were not less significant investments, but rich in cultures and local commodity in the province (Suphanburi Provincial Governor's Office, 2020). Complying with these incidents, the panelists also agreed with the province's development plan to increase family income and reduce poverty by focusing on promoting ecological or creative tourism. In the meantime, they also proposed that policy makers and local authorities should promote human capital for knowledge-based society to establish value-added economy or creative economy for tourism for the province as well.



Poverty

2.23 - 5.24	Strong positive value
5.25 - 8.26	Positive value
8.27 - 11.27	Moderate value
11.28 - 14.29	Negative value
14.30 - 17.30	Strong negative value

Education year (age 15 years old-above)

8.47 - 8.75	Strong positive value
8.18 - 8.46	Positive value
7.90 - 8.17	Moderate value
7.61 - 7.89	Negative value
7.31 - 7.60	Strong negative value

Province	Poverty
Kanchanaburi	15.14
Nakhon Prathom	2.23
Petchaburi	6.86
Prachuap Khilikhan	7.47
Ratchaburi	11.39
Samut Sakhon	5.31
Samut Songkham	7.25
Suphanburi	17.30

Province	Education (Year)
Kanchanaburi	7.34
Nakhon Prathom	8.57
Petchaburi	8.75
Prachuap Khilikhan	8.46
Ratchaburi	8.04
Samut Sakhon	8.36
Samut Songkham	8.17
Suphanburi	7.31

Classification statistics	Poverty	Education (Year)
Mean	9.12	8.05
Median	7.36	8.25
Standard deviation	4.76	0.55

Figure 5.20 HAI of Poverty, Related to Education Year of People in the Age of 15 Years Old & Above

Source: NESDB, 2019.

Furthermore, Nakhon Prathom province was likely to be successful in economic security; consequently, most experts agreed that educational opportunities was extremely important root cause of economic problems, especially in the higher educational system. Some panelists, then, raised Nakhon Prathom province to be the

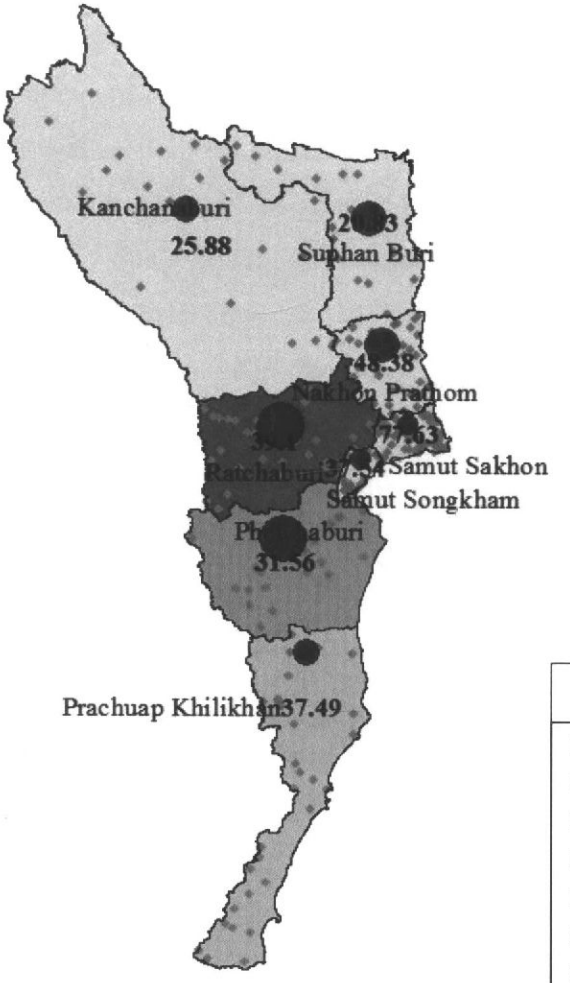
best practice of education system in the region, for learning how to induce their people pursuing in higher degrees, or even investing more in education. They also gave comments that governmental agencies or policy makers were to increase education years of learning for the people to make knowledge-based societies in the area. Furthermore, many experts stated that an educational opportunity in high school and vocational training was also a significant foundation of nation building as well.

5.4.3 Interrelation of Multi-Dimensions of Social Issues

Referred to Figure 5.21, it had the common idea from the experts that there were so many dimensions of the HAI related to social issues, such as health, education, employment, income, family and community, and participation. A variety of these dimensions played complex roles to human security as to it could be implied to human's dignity and fulfillment of life in various perspectives.

For instance, unemployment rate in the employment dimension could express economic potentials of workforces that facilitated competitive advantage for the country; on the other hand, employment of worker in the family and community dimension was likely to reflect on social security more, as it could directly impact to family and society. Nevertheless, it was noted that unemployment might derive from various root causes, such as huge immigrants from neighbor countries, leading high rate of unemployment for native people as well. Therefore, some of the panelists asserted that local authorities and policy makers should take migration rate into account of the proposed indicator as well.

Referred to Figure 5.21, while the social insurance indicator was referred to partial assistances from the government to reflect to a security of safe life; the findings in the study, then, showed that the people in Kanchanaburi province and Suphanburi province were less social insurances, based on the Social Security Act, B.E. 2533 (1990) - Section 33, 39, and 40 (NESDB, 2019). In accordance with these findings, the panelists delivered encouragements to relevant agencies or private sectors for applying the social insurance supports for their people throughout if possible.



Unemployment

.47 - .63	Strong positive value
.64 - .78	Positive value
.79 - .94	Moderate value
.95 - 1.09	Negative value
1.10 - 1.25	Strong negative value

Social insurance

1 Dot = 1.3 As per number in the map

Social insurance

Political vote rate

63.02 - 64.81	Strong positive value
61.21 - 63.01	Positive value
59.41 - 61.20	Moderate value
57.60 - 59.40	Negative value
55.79 - 57.59	Strong negative value

Province	Unemployment
Kanchanaburi	0.47
Nakhon Prathom	0.59
Petchaburi	0.91
Prachuap Khilikhan	0.71
Ratchaburi	1.25
Samut Sakhon	0.61
Samut Songkham	0.55
Suphanburi	0.59

Classification statistics	Unemployment	Social insurance	Political vote rate
Mean	0.71	39.80	59.81
Median	0.60	37.51	59.55
Standard deviation	0.24	16.35	2.82

Province	Political vote rate
Kanchanaburi	58.36
Nakhon Prathom	60.37
Petchaburi	64.81
Prachuap Khilikhan	59.31
Ratchaburi	63.17
Samut Sakhon	55.79
Samut Songkham	56.86
Suphanburi	59.80

Figure 5.21 HAI of Unemployment, Related to Social Insurance and Political Vote Rate

Source: NESDB, 2019.

Regarding to the participation dimension, the concept of this aspect was implied how the people got involvement with a community as public awareness or political activities, as well as delivered their own opinions for better communities. The panelists expressed that indicators of the participation dimension were to reflect a strength of society that individuals or family contributed their efforts to play voluntary roles in societies or communities. However, they also gave more opinions that the political vote rate indicator in the year 2016 should be dismissed from the HAI list as it had the implication with social security in strongest negative manners (Mean 2.35, Mode 2.00, Median 2.00, and Interquartile 2). Moreover, there were some concerns in the participation dimension that human right issues should be existed, in context of social equality in practice, in which freedom and fairness were significant considerations to enhance human dignity as well.

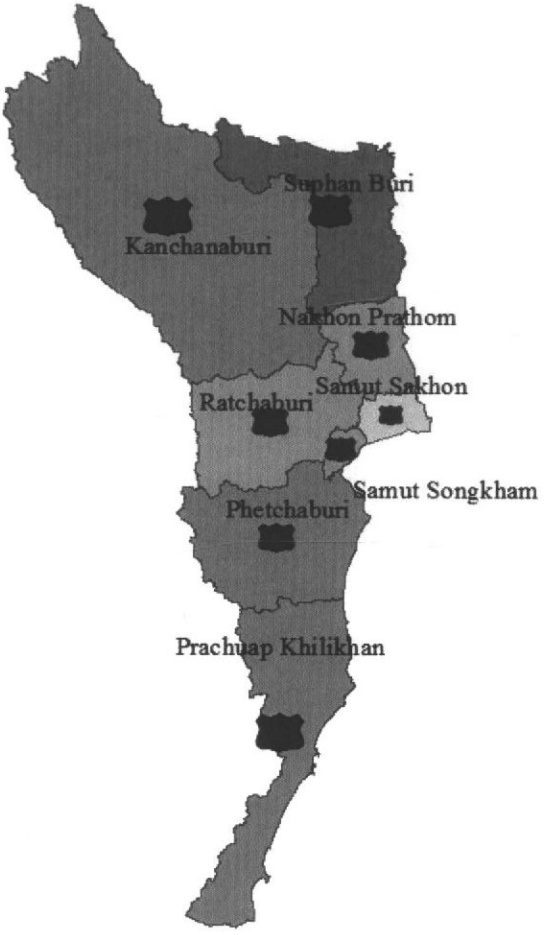
5.4.4 Livelihoods to Global Environmental Issues

Since NESDB (2019) defined the serviceable main road indicator as the available transportation networks which the people could use for logistics and traveling in the area for the whole year. The spatial map of the service main road indicator in Figure 5.22 showed that Kanchanaburi province had the most vulnerable main road, comparing with other provinces in the region. Moreover, the panelists also recommended that policy makers and local authorities should plan to construct new routes or prioritize road maintenances regularly for making a good perception of built environment in the area and benefiting the local people's livelihoods as well.

While the house and land owner indicator expressed that the people in Samut Sakhon province had less house and land owner rate, due to some difficulties about land and housing possession. The panelists, then, critiqued that local authorities, financial institutions, and private developers should promote real estate projects together, by providing incentive financial supports for establishing good environment in the area, based on the local people's requirements and their financial capabilities.

However, there were comments on some HAI definitions that seemed to be vague to understand for various stakeholders or even the panelists, such as the units of household used for calculating the house and land owner indicator, the road standard for calculating the serviceable main road indicator, a reality of GHG calculation in

provincial areas, and the up-to-date information of internet accessibility and mobile phone occupation rate which were dynamic changes rapidly.



House and land owner

92.87	Strong positive value
69.84 - 80.41	Positive value
57.16 - 67.95	Moderate value
55.49	Negative value
30.57 - 43.03	Strong negative value

Serviceable main road

89.26 - 98.35	Strong positive value
80.17 - 89.25	Positive value
71.07 - 80.16	Moderate value
61.97 - 71.06	Negative value
52.86 - 61.96	Strong negative value

Province	House and land owner
Kanchanaburi	80.26
Nakhon Prathom	57.16
Petchaburi	74.35
Prachuap Khilikhan	69.84
Ratchaburi	60.99
Samut Sakhon	30.57
Samut Songkham	60.69
Suphanburi	92.87

Province	Serviceable main road
Kanchanaburi	52.86
Nakhon Prathom	76.86
Petchaburi	75.21
Prachuap Khilikhan	59.56
Ratchaburi	72.79
Samut Sakhon	98.35
Samut Songkham	85.19
Suphanburi	64.53

Classification statistics	House and land owner	Serviceable main road
Mean	65.84	73.17
Median	65.42	74.00
Standard deviation	17.31	13.55

Figure 5.22 The HAI of House and Land Owner, Related to Serviceable Main Road
Source: NESDB, 2019.

5.5 Summary

This study had been integrating human security indicators with sustainable development perspectives using spatial analysis and its application. Firstly, it defined the Human Achievement Index (HAI) as the base case of human security indicators for assessing the strength and weakness of 32 composite indicators via 8 Sub-Indexes of human security dimensions throughout Thailand. Then, the significant HAI indicators, focused from the Delphi process had been analyzed, in terms of positive and negative perspectives of the HAI within the Central West region of Thailand.

In general, the findings showed that there were various aspects of human security in each area, based on human achievement perceptions. For instances, the overall HAI illustrated that Phuket province has the highest HAI in Thailand, while Mae Hong Son has the lowest HAI in Thailand. There was a notice from the panelists that the stakeholders should apply the HAI for developing their areas by identifying strength and weakness to enhance their potentials and minimize the obstacles in developments.

However, regarding 8 Sub Indexes of HAI dimensions, the panelists asserted various considerations with action plans to the main human security indicators, including enhance health assurances to cover all people, especially the persons with disabilities, provision practical knowledge and moral learning, strengthen social insurances for all workforces in several options, promote a potential on creative and eco-tourism within their attractive areas, control immigrants for native workforces, share educational experiences for each other, promote real estate developments with accessible financial supports, promote tourist attraction by a good air quality.

While in the analysis of the significant HAI in perspectives of sustainable development, some panelists suggested that the stakeholders should define an appropriate planning for plantation, based on the areas of soil suitability and agricultural potentials in each areas, for example, Kanjanaburi province had a potential of agricultural development in a large scale. Whereas Suphanburi province had opportunities for establishing value-added economy or creative economy for tourism. Moreover, some experts raised Nakhon Prathom province was the best practice of education system in the region, based on the education years rate and educational opportunity in high school and vocational training center.

In accordance with the interrelation of multi-dimensions of social issues, the findings realized that unemployment and immigrants from neighbor countries could relate a high rate of unemployment for the natives, which should include a migration rate as a proposed indicator as well. Moreover, the panelists encouraged relevant agencies or private sectors for applying the social insurance supports for all people throughout as much as possible. However, the political vote rate indicator should be dismissed from the HAI list as it had less significant implication to social security in practical but should focus on social equality instead.

Finally, there were opinions from the panelists that local authorities, financial institutions, and private developers should promote real estate projects together to initiate real estate projects or provide incentive financial supports for the local people to possession their own assets. However, there also were vague definitions of the HAI, such as the units of household used for calculating the house and land owner indicator, the road standard for calculating the serviceable main road indicator, a reality of GHG calculation in provincial areas, and the up-to-dated information of internet accessibility and mobile phone occupation rate as well.

CHAPTER 6

CONCLUSION, DISCUSSION AND RECOMMENDATIONS

6.1 Conclusion of the Research Development

Although, it has been highly emphasized about implementing of the National Sustainable Development Strategy (NSDS) in Thailand; however, there was unclear in inter-linkages of economic performance and natural resource management, which affected to society and would be the mainstream challenge to policy-makers to cope with the sustainability of human security in the country. To maintain and enhance national interest along with socio-economic performance and environmental conservation, Thailand was to identify significant barriers of human security towards sustainable development, especially in societal perspective in provincial level which may concern in people's achievement and dignity at the same time.

Obviously, socioeconomic and environmental securities have significant concerns on sustainable development, especially continuous economic growth along with key indicators that the country must maintain or enhance national capability via Gross Domestic Product (GDP), import-export, income distribution, inequality, migration rate, and public health condition. However, several challenges have been addressed in national strategic plans, both the 20-year National Strategy and the National Economic and Social Development Plan (NESDP). The national security has reclined on the security of people, rather than the security of territory in the past as the concept "left no one behind and freedom with opportunity." However, concerning with human security, it is to bring human elements of security, rights, and development together; even it has different priorities and values as to its different localities. (Gomez & Gasper, 2020).

Nowadays, Thailand also emphasis in this issue, especially which relates to sustainable development in perspectives of society, economy, and environment since it is a significant element to achieve in the Sustainable Development Goals (SDGs) in the

country. However, there were puzzle that why human security assessment was not so effective, even the National Economic and Social Development Board (NESDB) efforted to cope up with uncertainty of sustainable development in the country. Nevertheless, the challenge of human security recently was that how to imply human security indicators to sustainable development perspectives directly, since NESDB insisted on promoting human security and SDGs together in the country, and also what was a tool to achieve the concept of human security in practice. This difficulty was to be clarified by finding potential indicators to visualize the problems properly with understandable approach. This research was, therefore, conducted to develop alternative indicators as to economic performance, social issues, and environmental concerns that affected to human security.

Regarding to the HAI diagram in Figure 2.4, the human security dimensions had been developed since the first introduction in the 1994 HDR in many aspects, such as extracting economic dimension to income and employment dimensions, extending community dimension to family and community dimension, elaborating environmental dimension for land, housing, transportation, and communication dimensions, and regrouping personal and political dimensions to education and participation dimensions. However, this study was defined the HAI as a base case of human security indicators to analyze development opportunities in Thailand. There were several human security definitions and its elements in the international stage from time to time as to Table 2.6 and 2.7.

Since the spatial analysis could clarify various perceptions of sustainable development via its applications of Geographic Information Systems (GIS); therefore, the relevant indicators of the Human Achievement Index (HAI) had been identified into the Sub-Index, including health, education, employment, income, housing and environment, family and community, transportation and communication, and participation, in order to provide visualizing information and help understanding how human security indicators reflect sustainable development. The GIS was, then, adopted for evaluating spatial analysis by applying relevant variables of human security into its applications. The idea is to form the maps of each approaches in the GIS format to calculate the values of the parameter for certain criteria. The criteria in each perspective will be compared and evaluated in economic, social and political aspects.

6.2 Summary of the Findings

Overall, the findings of the study could be summarized as Table 4.1, 4.2, and 4.3, which expressed the preference of the panelists' opinions after evaluating from third round of the Delphi technique. This research was, then, compiled with the study from Dewulf & Langenhove (2006) that human security was to involve with three main aspects of sustainable development to enhance dignity and fulfillments of the people, as following : 1) ecological balance, 2) sustained economic stability, and 3) social development and equity. In summary, the study concluded the findings in each research objective, as follows.

6.2.1 The 1st Research Objective

From the research analytical framework of human security in Figure 3.1, the first research objective was discussed human security implications in perspectives of sustainable development. The findings clarified the implications of human security towards sustainable development whether how the people were fulfilled in achievements. The study found that human security could be applied to sustainable development perspectives, according to the panelists' participation in the involvement process in Chapter 4. The study had been analyzed the HAI via various statistical measurements, including Mean, Median, Mode, and Interquartile to pursue central tendency and implication levels of the data collected.

For instance, there were the human security indicators that had an implication level of 4 (most relevant) in each sustainable development perspective, as follows: 1) economic perspective--family income, consuming debt, poverty rate, unemployment rate, equality coefficient of income, low work-hour rate, and employment of 15-17 years old worker, 2) social perspective--unemployment rate, social insurance of labour, high school and vocational, training opportunity, criminal rate, equality coefficient of income, and consuming debt, 3) environmental perspective--serviceable main road of villages, greenhouse emission rate, house and land owner, criminal rate, and drought sufferer.

Moreover, various indicators of human security were also elaborated via the open-ended questionnaires in the involvement process of the Delphi technique. This questionnaire survey revealed the alternative indicators in many aspects, such as

sufficiency economic village, drug-trafficking case, immigration rate, medical personnel rate, and air quality index. Furthermore, the panelists also contributed some recommendations for further study, including ecological and creative tourism, local business mechanism, smart city, empirical indicator, multi-dimensions of social and environmental issues.

6.2.2 The 2nd Research Objective

The 2nd research objective was to identify significant human security indicators towards sustainable development potential. The study was dedicated the findings by identifying significant human security indicators in perspectives of sustainable development. The preferences of agreements that the panelists contributed in the focusing process could be arranged in terms of economic, social, and environmental perspectives as Table 4.1, 4.2, and 4.3 respectively.

The top three rankings of significant indicators in each perspective could be ranked, as follows: 1) economic perspective--family income, consuming debt, and poverty rate, 2) social perspective--unemployment rate, social insurance, and high school and vocational training opportunity, and 3) environmental perspective--serviceable main road, greenhouse emission rate, and house and land owner, respectively.

On the other hand, there were considerations about the last three rankings of significant indicators which needed to be dismissed or replaced by alternative indicators, as follows: 1) economic perspective--number of social organizations, family participation as a member of social organizations, and political vote rate 2) social perspective--serviceable main road of villages, flooding sufferer, and political vote rate, and 3) environmental perspective--IQ of primary school student, infant survival rate, and political vote rate. Therefore, many of panelists commented on the political-vote-rate indicator as the lowest indicator in all perspectives that it should be dismissed from the list of HAI, due to it was out-of-dated, and also the situation of voting during the year of 2016 was highly frustrated from political conflicts as well.

6.2.3 The 3rd Research Objective

The 3rd research objective was to verify the sustainable human security model for enhancing sustainable development in Thailand. The meaningful implications between significant human security indicators and sustainable development perspectives in Chapter 4 were defined by spatial analysis via the spatial application, namely the ArcGIS program (Version 10.2.2).

The overall HAI illustrated that Phuket province had the highest HAI value in Thailand, while Mae Hong Son had the lowest HAI value in Thailand. However, the panelists asserted various considerations into recommended actions, such as enhancing health and social assurances for all with various options, providing practical knowledge and moral learning, promoting a potential on creative and eco-tourism, controlling immigrants strictly, sharing successful educational experiences to others, promoting real estate developments with accessible financial supports, and promoting tourist attraction by environmentally friendly atmosphere.

Moreover, some panelists suggested to define an appropriate planning in various aspects, such as enhancing agricultural development by analyzing soil suitability and agricultural potentials and establishing value-added economy or creative economy for tourism. However, there also were vague definitions of the HAI, such as the units of household used for calculating the house and land owner indicator, the road standard for calculating the serviceable main road indicator, a reality of GHG calculation in provincial areas, and the up-to-date information of internet accessibility and mobile phone occupation rate as well.

6.3 Discussions

6.3.1 Interrelations of Human Dimensions and Physical Dimensions

Regarding the research analytical framework, various significant indicators from the human dimension had been applied towards the involvement and focusing processes as driving forces. However, these indicators had not directly categorized in a sustainable development approach, in perspectives of economic, social, and environmental aspects. Therefore, the human security indicators in this study, the HAI, could be considerably classified and regrouped into sustainable development perspectives as the study of

Dincer and Rosen (2007), which stated that sustainable development could be represented by the overlapping area of three circles among economy, community and environment.

Furthermore, it was to state that sustainability of developments had to include the human dimension into all kinds of developments to comply the projects with the people and community for a long-lasting development as the concept of environmental humanities, which stated that human being were not independent of natural world, but were part of the world. It was impossible to separate environmental analysis from industrialization, which together accelerated resource extraction, consumption, pollution, population growth, species extinction, and global warming (Emmett & Nye, 2017, pp. 3-9).

This dimension had been integrated further with physical dimension, in which spatial information from the Geographic Information System (GIS). However, there were several considerations whether develops should integrate human security with GIS or not; since GIS could formulate from a series of GIS attributes, which needed to understand its knowledge base and relevant technology of spatial analysis highly. Moreover, lacking appropriate GIS attributes would be the substantial obstacle to exploit spatial application for analyzing development opportunities correctly. Nevertheless, a spatial data acquisition was really a time-consuming process, which also needed a financial arrangement as well (Santra & Mitra, 2017).

A key issue in human dimensions of global change research and sustainability science was a need to understand how human dimensions and authorities interacted with existing environment in different places (Yarnal, Polsky, & O'Brien, 2009). The spatial analysis would benefit developers to come across disparate locations of developments as well. Stakeholders would learn from each other, by exchanging knowledge and technologies together via spatial planning, as the more use of spatial analysis, the more understanding of human security to achieve sustainable development.

6.3.2 Spatial Analysis for Developing Human Security in a Sustainable Manner

As Scheele (2002) suggested that the panelists should include stakeholders who directly involved with human security issues as a committee of the panelists; this study,

then, assembled the panelists from policy makers, academic members, and practitioners to gain various point of views by inviting 18 committee from the National Economic and Social Development Board (NESDB), the School of Civil Affair, the Directorate of Civil Affair, and the 1st Development Division, the 1st Army Area. However, if the panelists have been included stakeholders from local scholars who lived in the area of study as well, it would extend the study more concrete and reflected the local problems thoroughly.

From O'Neill, Holland, and Light (2008) study, it explained that people regretted the loss of valued landscapes, which caused impairments of species diversity, pollution, and global warming. However, policy makers seemed ill-equipped to capture the dominant approaches for environmental matters. This study illustrated that spatial analysis was also a dominant approach for decision making in sustainable development to provide a path for integrating human needs with environmental protection through an understanding of development potentials at particular places.

Since many communities in Thailand have faced environmental insecurity due to the adoption of industrial development model in 1950s, which this rapid industrialization has been increased pressures on ecosystems since then. While the health and well-being of the people may have improved due to rising living standards as to these developments, the toxic by-product of this affluence has been delivered to the communities as well, such as those near the Map Ta Phut industrial estate (Simpson, 2014, pp. 68-69). The functionality of GIS would collaborate intersections of multi-criteria within developments in a sustainable approach via spatial maps, such as habitat suitability map, vegetation map, soil characteristic map and land use map.

6.4 Recommendations

6.4.1 Recommendations for Application of the HAI

1) Policy makers and relevant stakeholders should consider the strength and weakness of HAI in the specific areas for developing, both human dimensions and physical dimension, in order to understand the potentials and obstacles, prior to implement the development projects.

2) Some panelists commented that socio-economic security was realized as the most important concern; however, the panelists also agreed with Doppenberg & Aar (2007) study that developers, especially who were in agricultural industry, should not merely focus on sustainability of a socio-economic aspect; but they should also concerned about environmental issues, including environmental burden from land use change, competition for water, and GHG effects as well.

3) The sustainability of human security in Thailand normally depends on existential potentials of development opportunities in which the people in the certain areas have to pursue their own business or work without strategy or spatial thinking. If there is a dissemination of spatial analysis and integrate into the strategic programs of the different levels and branches of the government, especially NESDB, these arrangements would certainly provide high strategic impacts to desired outcomes.

4) With the continuing advancement of technology, a study on the application of spatial analysis in the domains of social, economic, and environment will be an interesting endeavor due to the magnitude of benefits that can be derived from this technology. The further study will have significant impact not only in the promotion of human security but also in achieving sustainable growth and development for the country.

5) As the government had been promoting knowledge-based society for sustainable development; the local leaders should, therefore, get an opportunity to attend spatial analysis courses from governmental supports, so that they could plan and implement various developments using spatial analysis by themselves in the meantime.

6) If we could disseminate spatial perceptions and exploited the spatial application for all stakeholders, especially in district and sub-district levels; it would magnify benefits to human security and enhance sustainable growth for the country in overall as well.

6.4.2 Recommendations for the Further Study

1) It is recommended for a further study to apply spatial analysis to various public awareness of volunteer activities that have been implementing in several campaigns in Thailand nowadays, especially regarding to the Volunteer Spirit Projects, Royal Initiative. The study would visualize an achievement of human participations via

spatial applications in a comprehensible manner, in order to enhance sustainable development and strengthen human security in the country eventually.

2) As family income and poverty could be expressed in contradiction meanings of economic security, both positive and negative sides; these redundant or vague indicators should, therefore, be clarified more explicit to be empirical indicators in the HAI, for example, unemployment rate versus employment of worker and poverty rate versus consuming debt.

3) The further study should address potentials of human security in aspect of the people's achievement which affect to sustainable development in the country. However, this research is scoped only in the Western part of Thailand, to specify narrow area for the stakeholders in considering the significant of development potentials.

4) There were limitations of time and budgets to pursue a study as a nationwide research; this research had, therefore, been focusing on 8 provinces of the Central West region of Thailand, which may be not reflecting all circumstances of developments in the country. However, if governmental agencies provide more financial supports to conduct more study areas, spatial analysis would contribute more benefits to enhance human security for the people in the country eventually.

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APPENDICES

APPENDIX A

The Research Questionnaire (the 1st Round of the Delphi Technique)

Analysis and Spatial Application of Human Security Indicators in Perspectives of Sustainable Development

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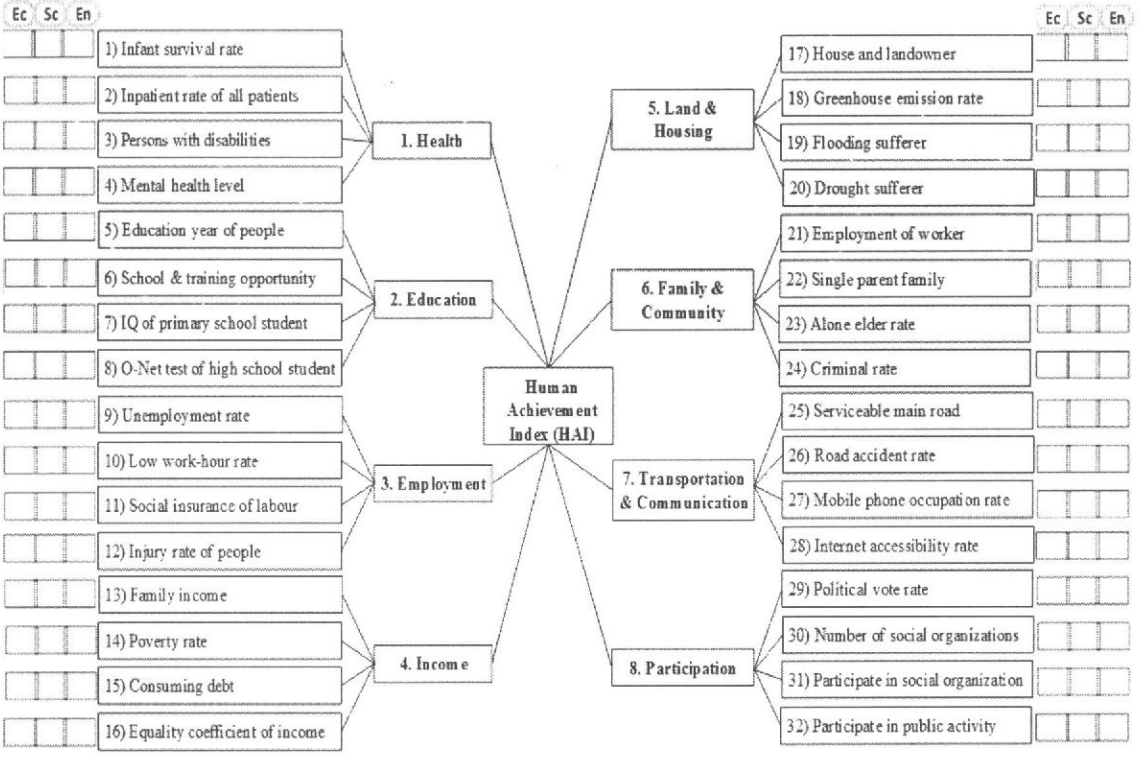
This questionnaire aims to investigate the significance of human security indicators, in perspectives of sustainable development and assesses the potentials of development opportunities in Thailand.

Section 1: Please give a degree of implication between each HAI and sustainable development perspectives, in terms of economic (Ec), social (Sc), and environment (En), by rating each indicator with a score from 1 (less implication) to 5 (more implication) in the Figure, following.



Example: | 17) House and landowner | Ec: 4 | Sc: 3 | En: 5 | mean the indicator of house and land owner has the degree of implications with sustainable development in each perspective, as follows: economic = 4 (strong implication), social = 3 (moderate implication), and environment = 5 (strongest implication), respectively.

Section 2: Please give your opinions in the following questions, regarding how human security imply to sustainable development via significant indicators and spatial applications, in order to pursue happiness societies and human achievement in Thailand.

1) How can human security take part in enhancing sustainable development and which direction would be suitable for Thailand?

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2) Except the indicators in the Section 1, what are alternative indicators that reflect the contributions of human security in enhancing potentials of sustainable development?

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3) How can a spatial application support human security in perspectives of sustainable development?

4) Other opinions on the research topic.

Noted: The definition of the HAI indicators can be clarified at the link: http://social.nesdc.go.th/social/Portals/0/Documents/HAI%202562_290663_2329.pdf (Page. 213-234)

APPENDIX B

The Research Questionnaire (the 2nd Round of Delphi Technique)

Analysis and Spatial Application of Human Security Indicators in Perspectives of Sustainable Development

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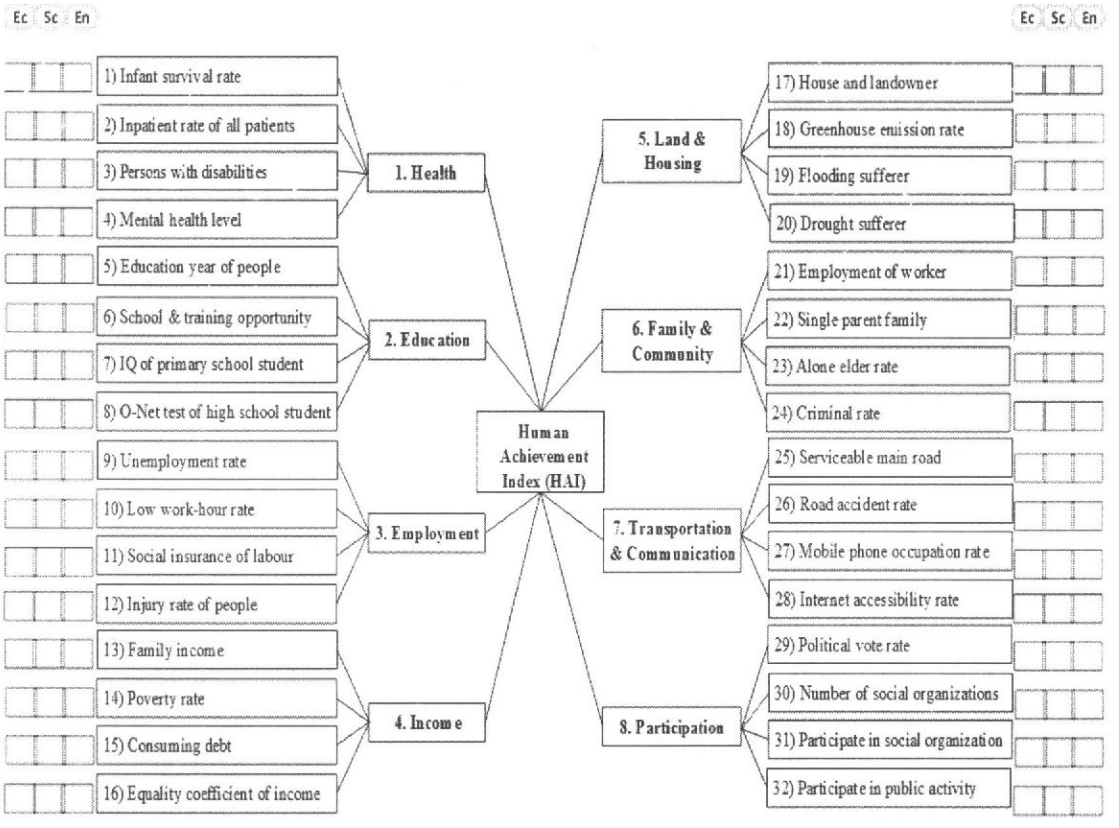
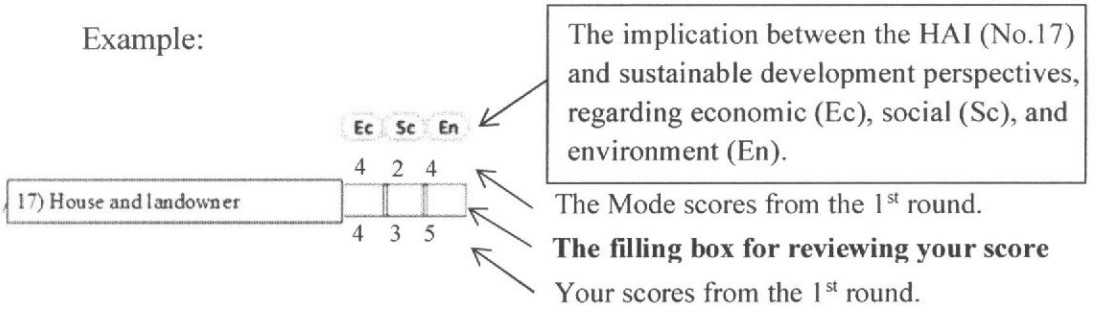
This questionnaire aims to review the implications between human security indicators (HAI) and sustainable development perspectives via statistical preferences from the panelists, and also, consider additional indicators to pursue sustainable human security.

Section 1: Please review your answers from the previous round, after comparing your score of agreement with the popular degree (the Mode) from the other experts, by rating each indicator with a score from 1 (less implication) to 5 (more implication).



Noted: Regarding the figure above, the Mode or the most often scores when list the scores from all panelists in the previous round are shown over the filling box; whereas, your previous round answers are shown under the filling box.

Example:



Section 2: Please add more opinions on human security indicators which reflect sustainable development, as the questions follows.

1) Please identify economic indicators which reflect how well that the people live with enough income and necessaries of life.

2) Please indicate social indicators which imply to how cohabitation of people and community come up with happiness and safety.

3) Please pinpoint environmental indicators which express the circumstances that the people live environmentally friendly in a balanced ecosystem.

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4) Other opinions on the research topic.

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Noted: The definition of the HAI indicators can be clarified at the link: http://social.nesdc.go.th/social/Portals/0/Documents/HAI%202562_290663_2329.pdf (Page. 213-234)

APPENDIX C

The Research Questionnaire (the 3rd Round of the Delphi Technique)

Analysis and Spatial Application of Human Security Indicators in Perspectives of Sustainable Development

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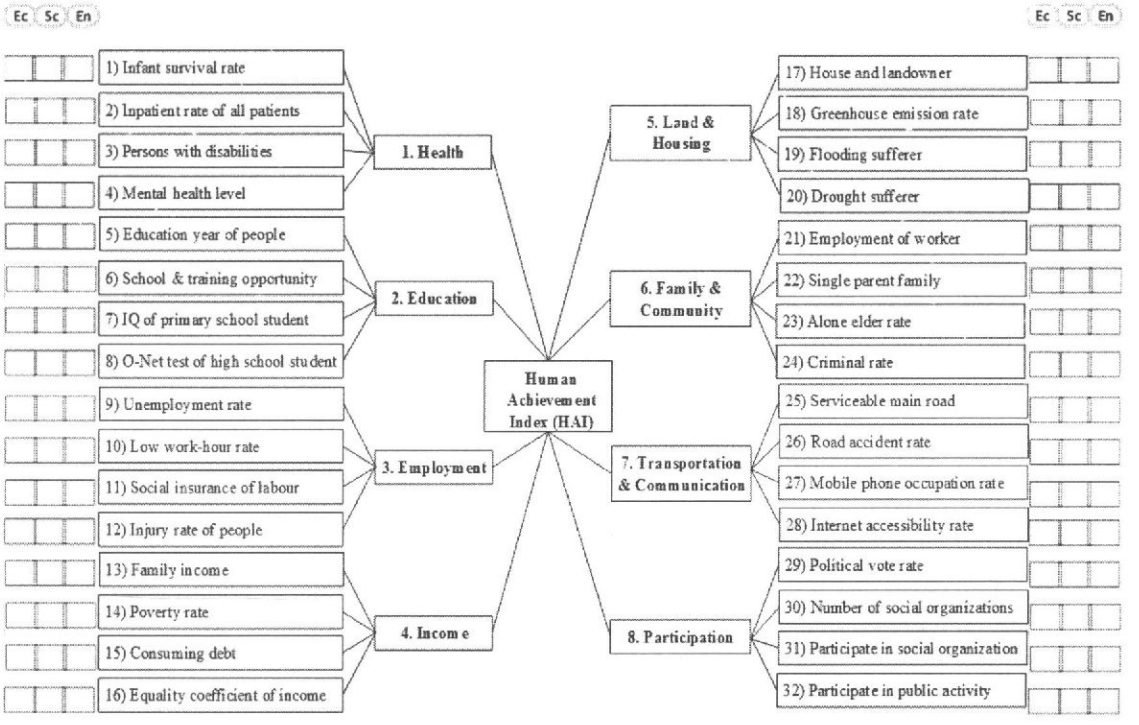
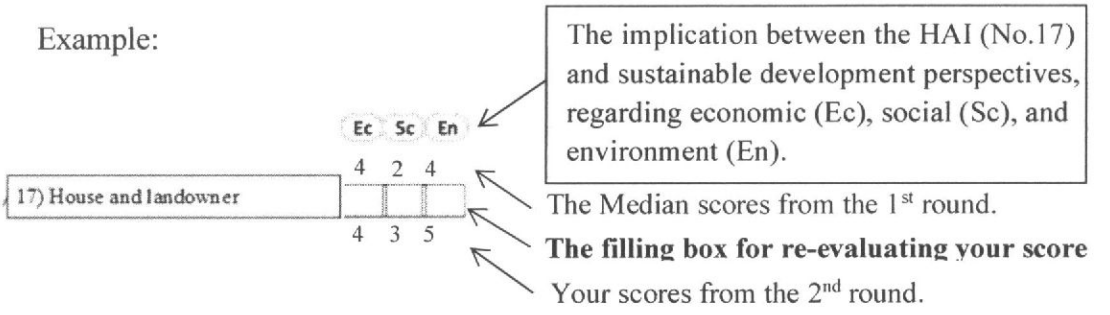
This questionnaire aims to re-evaluate and assert the answers from the 2nd round, after learning the point of views from other experts in various statistical analyses and identify barriers and challenges to overcome sustainable human security in Thailand. Moreover, there are the maps from spatial analysis in this study to verify the HAI potentials in each perspective as well.

Section 1: Please re-evaluate a degree of implication between each HAI and sustainable development perspectives, after comparing your score of agreement with the midpoint of preferences (the Midian) from the other experts, by rating each indicator with a score from 1 (less implication) to 5 (more implication) in the Figure, following.



Noted: Regarding the figure above, the Median or the midpoint in a distribution when listed a set of scores from all panelists in the previous round are shown over the filling box; whereas, your previous answers are shown under the filling box.

Example:



Section 2: Please assert opinions about concerning issues of human security and the challenges to pursue sustainable development via spatial analysis, in the following questions.

1) Please identify significant issues of human security, which express human achievement, happiness society, and desirable environment.

2) What are barriers to exploit spatial analysis for sustainable development in Thailand?

3) Please elaborate the challenges, which lead sustainable human security for developments in Thailand.

4) Other opinions on the research topic.

Section 3: Please verify the spatial maps, attached in this questionnaire, by giving your opinions and recommendations for further developments, regarding to sustainable human security.

Noted: The definition of the HAI indicators can be clarified at the link: http://social.nesdc.go.th/social/Portals/0/Documents/HAI%202562_290663_2329.pdf (Page. 213-234)

APPENDIX D

Province	Health	Education	Employment	Income	Land & Housing	Family & Community	Transportation & Communication	Participation	HAI
Bangkok	0.6530	0.9276	0.8348	0.8140	0.6606	0.5881	0.7347	0.2113	0.6780
Samut Prakan	0.6310	0.5736	0.5678	0.7660	0.6938	0.8422	0.7600	0.1504	0.6231
Nonthaburi	0.6815	0.7246	0.6366	0.7937	0.7564	0.6546	0.9425	0.2403	0.6788
Pattani	0.7694	0.6179	0.6177	0.6431	0.6991	0.7168	0.8926	0.1507	0.6384
Ayutthaya	0.7701	0.5405	0.8140	0.6285	0.8072	0.6161	0.7168	0.5560	0.6811
Ang Thong	0.3424	0.5069	0.4693	0.4664	0.9095	0.3876	0.5584	0.5980	0.5298
Lop Buri	0.6005	0.4996	0.6292	0.4835	0.8974	0.5889	0.4173	0.5212	0.5797
Sing Buri	0.6348	0.5772	0.4717	0.5204	0.9107	0.4396	0.7163	0.6178	0.6111
Chainat	0.5074	0.3175	0.3715	0.3606	0.6151	0.5277	0.5610	0.6113	0.4840
Saraburi	0.6079	0.5052	0.6674	0.6547	0.8014	0.6154	0.6446	0.5762	0.6341
Chonburi	0.5865	0.7592	0.8201	0.7340	0.6323	0.6815	0.7960	0.2808	0.6613
Rayong	0.6458	0.6400	0.7921	0.7177	0.7009	0.5994	0.7660	0.4004	0.6578
Chanthaburi	0.5321	0.4795	0.7036	0.5853	0.7746	0.5160	0.6604	0.4382	0.5862
Trat	0.7385	0.5049	0.6862	0.5434	0.5350	0.5269	0.6639	0.6408	0.6049
Chachoengsao	0.6216	0.5280	0.6630	0.6783	0.7805	0.6404	0.6503	0.5318	0.6367
Prachin Buri	0.5900	0.5368	0.5996	0.5699	0.8350	0.5693	0.5319	0.6459	0.6098
Suphan Buri	0.3860	0.5316	0.6687	0.5551	0.9251	0.4154	0.6570	0.5700	0.5886
Sa Kaeo	0.5759	0.3303	0.5127	0.4323	0.8174	0.4299	0.5013	0.5464	0.5183
Ratchaburi	0.5441	0.5120	0.5621	0.5799	0.8509	0.4079	0.5742	0.5397	0.5713
Kanchanaburi	0.6073	0.3590	0.5911	0.5415	0.8161	0.4634	0.5073	0.4797	0.5457
Suphan Buri	0.5557	0.4416	0.5625	0.5649	0.9341	0.3148	0.4242	0.5244	0.5403
Nakhon Pathom	0.5745	0.6903	0.6695	0.7178	0.7805	0.5636	0.6037	0.4833	0.6354
Samut Sakhon	0.6868	0.3749	0.7037	0.7961	0.6688	0.7420	0.8104	0.1577	0.6175
Samut Songkhram	0.6410	0.6409	0.7268	0.7346	0.8491	0.3407	0.6291	0.3999	0.6203
Prachin Buri	0.5995	0.5594	0.6180	0.5845	0.7739	0.5308	0.5444	0.5763	0.5984
Prachuap Khiri Khan	0.6516	0.4615	0.6751	0.5453	0.7682	0.5391	0.5629	0.4705	0.5843
Chaing Mai	0.5749	0.6197	0.5449	0.6157	0.8534	0.4467	0.6029	0.6693	0.6159
Lamphun	0.4555	0.6140	0.7422	0.5377	0.9541	0.6283	0.6311	0.8729	0.6795
Lampang	0.4497	0.5929	0.6310	0.5138	0.8958	0.6588	0.6190	0.7994	0.6450
Uttaradit	0.4465	0.5007	0.4328	0.5175	0.8300	0.6949	0.5449	0.7086	0.5845
Phrae	0.4195	0.6332	0.5533	0.4887	0.9677	0.6809	0.5141	0.7441	0.6252
Phrae	0.4753	0.5024	0.6481	0.3724	0.7520	0.7119	0.4804	0.8323	0.5968
Phayao	0.4025	0.6282	0.7110	0.5209	0.9797	0.6332	0.5826	0.8087	0.6584
Chiang Rai	0.5534	0.4034	0.7409	0.5515	0.9048	0.6106	0.5088	0.6657	0.6174

Province	Health	Education	Employment	Income	Land & Housing	Family & Community	Transportation & Communication	Participation	HAI
Uttaradit	0.5574	0.2043	0.7195	0.3062	0.5969	0.4522	0.2359	0.6371	0.4637
Nakhon Sawan	0.5113	0.3976	0.5799	0.5575	0.8740	0.6014	0.4946	0.5158	0.5665
Uthai Thani	0.4422	0.3320	0.6543	0.5489	0.7051	0.5953	0.4410	0.6874	0.5508
Kamphaeng Phet	0.5210	0.3083	0.4660	0.6469	0.8862	0.5367	0.4947	0.6545	0.5643
Tak	0.7155	0.2467	0.6844	0.3814	0.8130	0.6850	0.4256	0.5534	0.5631
Sukhotai	0.5698	0.3746	0.3224	0.5491	0.8901	0.5909	0.5098	0.7992	0.5757
Phitsanulok	0.4832	0.5022	0.6031	0.5147	0.8966	0.5728	0.6062	0.5374	0.5895
Phichit	0.5293	0.3501	0.5692	0.6133	0.9004	0.6089	0.4945	0.4979	0.5705
Phetchabun	0.5845	0.3713	0.6116	0.6386	0.9415	0.6673	0.5189	0.6576	0.6239
Nakhon Ratchasima	0.5894	0.3979	0.4964	0.5465	0.8921	0.7107	0.4911	0.5284	0.5816
Buriram	0.4751	0.3378	0.5953	0.3474	0.9454	0.5693	0.4324	0.5093	0.5265
Surin	0.3016	0.3170	0.5638	0.3996	0.9452	0.6733	0.4136	0.5487	0.5203
Sisaket	0.5160	0.3061	0.6644	0.4524	0.9802	0.6981	0.3579	0.6067	0.5727
Ubon Ratchathani	0.4593	0.2529	0.5241	0.3991	0.9630	0.7181	0.5768	0.5754	0.5586
Yasothon	0.4887	0.3496	0.6991	0.3571	0.9788	0.6682	0.5420	0.5485	0.5790
Chaiyaphum	0.5087	0.3167	0.6807	0.4544	0.9552	0.6690	0.4545	0.5561	0.5744
Amnat Charoen	0.5664	0.3009	0.7157	0.3224	0.9891	0.7126	0.4072	0.7096	0.5905
Bung Kan	0.7779	0.2632	0.5359	0.4306	0.9800	0.7260	0.4758	0.5645	0.5942
Nongbua Lamphu	0.5338	0.2400	0.6422	0.4800	0.9294	0.7514	0.5276	0.5814	0.5857
Khon Kaen	0.5800	0.4451	0.6451	0.4861	0.8132	0.7531	0.6239	0.5256	0.6090
Udon Thani	0.6358	0.4277	0.5889	0.4553	0.9065	0.6969	0.5742	0.5646	0.6062
Loei	0.3457	0.3749	0.6954	0.5076	0.9118	0.6923	0.4763	0.6512	0.5819
Nong Khai	0.5470	0.4392	0.5439	0.5549	0.9790	0.6606	0.4755	0.5049	0.5881
Maha Sarakham	0.6678	0.4074	0.5895	0.4160	0.9106	0.6567	0.4720	0.6292	0.5937
Roi Et	0.6268	0.3736	0.6475	0.5660	0.9912	0.6571	0.4589	0.5391	0.6075
Kalasin	0.5967	0.3268	0.6809	0.3392	0.9691	0.6805	0.4195	0.6217	0.5793
Sakon Nakhon	0.4602	0.3194	0.6659	0.3998	0.9905	0.7759	0.3912	0.5845	0.5734
Nakhon Pathom	0.6603	0.3429	0.5458	0.3632	0.9786	0.5940	0.4731	0.6360	0.5742
Mukdahan	0.6243	0.3098	0.6815	0.3060	0.9549	0.6003	0.3837	0.6683	0.5661
Nakhon Si Thammarat	0.6236	0.5065	0.5104	0.5509	0.8329	0.5365	0.5405	0.4481	0.5687

Province	Health	Education	Employment	Income	Land & Housing	Family & Community	Transportation & Communication	Participation	HAI
Krabi	0.5818	0.3213	0.4663	0.5281	0.7265	0.5832	0.6109	0.5540	0.5465
Phangnga	0.6854	0.3602	0.3283	0.5862	0.6748	0.6374	0.6360	0.6107	0.5649
Phuket	0.7692	0.6926	0.6514	0.7701	0.7167	0.6959	0.9262	0.2858	0.6885
Maha Sarakham	0.6026	0.3691	0.5391	0.6288	0.6556	0.6201	0.5760	0.3896	0.5476
Ranong	0.7865	0.3151	0.7355	0.5282	0.7842	0.5978	0.5117	0.4908	0.5937
Chumphon	0.6734	0.4629	0.5985	0.5596	0.8336	0.6508	0.5380	0.6845	0.6252
Songkhla	0.6224	0.5365	0.4503	0.6029	0.7814	0.4764	0.7432	0.5507	0.5955
Satun	0.5418	0.3811	0.4088	0.5787	0.8348	0.6610	0.6026	0.5719	0.5726
Trang	0.5125	0.4413	0.5357	0.4458	0.7390	0.5641	0.6635	0.5223	0.5530
Phatthalung	0.5709	0.4335	0.5401	0.4752	0.9220	0.4629	0.5114	0.6271	0.5679
Pattani	0.5698	0.1933	0.4548	0.3040	0.9317	0.5566	0.4591	0.4906	0.4950
Yala	0.5151	0.2639	0.5379	0.5219	0.8350	0.5784	0.4454	0.4489	0.5183
Narathiwat	0.4549	0.1190	0.5548	0.2760	0.8547	0.6445	0.3646	0.5714	0.4800

Source: NESDB, 2019.

BIOGRAPHY

NAME	Colonel Thanachai Erawan
ACADEMIC BACKGROUND	Bachelor of Science in Electrical Engineering, School of Electrical Engineering, Chulachomklao Royal Military Academy, Nakhon Nayok, Thailand in 1994
	Master of Science in Engineering Project Management, School of Built Environment, University of Northumbria, Newcastle upon Tyne, United Kingdom in 2002
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