Application of spatial analysis in post-disaster resettlement

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DECLARATION

This thesis is submitted under the University of Salford rules and regulations for the award of a PhD degree by research. While the research was in progress, some research findings were published in refereed conference papers prior to this submission.

The research declared that no portion of the work referred to in this thesis has been submitted in support of an application for another degree of qualification of this, or any other university or institution of learning.

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ABSTRACT

Post-disaster resettlement programmes are being conducted by governments and other relevant organisations to relocate displaced people to provided safe places; considering the original land standards to subsequently improve the standard of living. Although resettlement programmes have been broadly implemented within several communities who were exposed to hazards, it appears that numerous intricate problems were identified throughout their implementation. These results illustrate unsuccessful resettlement programmes which require a more effective solution. According to previous works, vulnerable hazard areas have been rarely studied in terms of displaced persons' activities correlated between spatial and socio-economic aspects. With respect to the interaction between human and locations, humans perform their activities based upon their locations; likewise, displaced people also perform their activities based on the resettlement areas.

Effective applications integrated with the theoretical knowledge-base in Geoinformatics help mitigate the problems associated with the interaction between human and locations. Specifically, the spatial analysis techniques employing several scenes of high-resolution images that are carefully applied in this research in order to present an effective method to minimise the spatial and non-spatial problems in resettlement programme. A case study of Ban Nam Ko sub-district is used to gain knowledge from the resettlement activities associated with displacement locations. The explored results of this research present appropriate functions and specific conditions for displacement locations used in resettlement activities. The explored results propose potential solutions of achieving a successful resettlement programme response to debris-flow disasters. With consideration of physical, socio-economic, and administrative factors of residents and surrounding environment, this study is beneficial to governments and relevant organisations to establish displacement locations associated with activities in each resettlement phase and to setup the spatial and non-spatial database in resettlement plan for other vulnerable debris-flow hazard areas.

CHAPTER 1

INTRODUCTION

1.1 BACKGROUND TO THE RESEARCH

An increasing number of disaster events cause a large number of people homeless annually around the world. According to the recent number of victims and affected people from natural disasters, it was recorded that 73,954 people were killed and approximately 2.9 million people were made homeless in 2013 (EM-DAT, 2014). Over the last decade, Asian countries have recorded the largest number of victims from natural disasters (Guha-Sapir et al., 2012; EM-DAT, 2014). Considering the sharp increase of natural disaster events during the last decade, hydrological disasters, i.e. floods and wet-mass movement, are incidents frequently causing displacements, particularly in Asian countries (IDMC, 2011a). Debris flow can be noted as one of the most destructive wet-mass movement types of hydrological disaster. Within this type of a disaster, a surging flow of water and debris runs rapidly in steep channels into catchment areas and potentially attacks all obstacles (Hungr, 2005). Particularly many Asian countries have suffered from debris-flow occurrences due to the lack of warning systems caused by the triggering factors such as deforestation and high-land encroachment. As a result of debris flow events, more than 23 million people were made homeless over the last decade (2000-2013)(EM-DAT, 2014).

In 2004, the residents of the Ban Nam Ko village in Thailand has experienced a massive debris-flow disaster, affecting 1,749 families, of which 215 houses were completely destroyed and 499 houses were partly damaged. After this tragic event many researchers came to this area in order to study the nature of debris-flow, to examine the potential ways to protect this area, and to produce a debris-flow risk map illustrating landslides and debris flows susceptible areas over Thailand (i.e. Honda, 2007; Yumuang, 2005a; Yumuang, 2006; Prasertburanakul, 2012; Suriyaprasit, 2008; DMR (Department of Mineral Resources), 2008). This disaster has also alerted many vulnerable people, who are living in hundreds of potential catchment areas in Thailand. After this disaster, the Government established resettlement programmes to move the victims away from these hazard areas. Although there were several collaborations between various organisations which attempted

to organise and manage these resettlement programmes, the displaced communities faced may difficulties while going through various resettlement phases (Arunothai, 2010).

Resettlement programmes have been implemented by many governments and organisations to relocate people from the hazard areas to other safe places where they are expected to have normal or better lives. However, often the resettled communities face numerous difficulties while going through the relocation process and beyond, some of which challenges even rights of affected communities. In their guidelines for resettlement programmes, the United Nations (UN) outline the basic rights of the resettled communities, particularly in emergency period of time in a Handbook for Emergencies (UNHCR, 2007). Accordingly, the resettlement programmes should consider the safety, security, accessibility, affordability and habitability (Batra and Chaudhry, 2005). Despite these guidelines, it appears that many social and humanitarian problems exists in most of the resettlement programmes (Menoni and Pesaro, 2008). Many researchers have studied these problems in resettlement programmes in detail (for example, Kinsey and Binswanger (1993), and Bartolome et al. (2000)) and often found that the social, economic and humanitarian problems faced by resettlement communities are linked with the spatial aspects of the resettlement area (Dikmen, 2002; Corsellis and Vitale, 2005; Muggah, 2008). For example, often the livelihood issues faced by the resettled communities are linked with the poor selection of relocation sites. Kinsey and Binswanger (1993) stated that displacing re-settlers into other areas without recognising their original settlement characteristics causes many problems. Additionally, it is clearly stated that there are many problems linked with the provision of basic essentials by the government in resettlement areas due to the issues arising from location of the resettles and storage / distribution locations (Kinsey and Binswanger, 1993; Bartolome et al., 2000).

As noted, *social problems exists when there is a sizable difference between the ideals of society and its actual achievements* Economic problems are also often considered within the remit of social problems considering the link between the social issues, resources and money at different levels, i.e. international, national, and individual level (Coleman and Cressey, 1987). As studied by Coleman and Cressey (1987), at individual level, socio-economic issues are often linked with education, family conflict, poverty, ethnic minorities, illness, sexual harassment and abuse, mental disorders, drug use, crime, crowd, and violence. These socio-economic issues feature in many of the resettlement

programmes hindering the success of such programmes in many parts of the world (Pathiraja and Tombesi, 2009). As noted above, since many of these socio-economic issues are linked with the location / physical surrounding within a resettlement scenario, a clear link could be established between the socio-economic problems and spatial aspects of resettlement programme planning and management.

Although the social issues and the spatial conditions in resettlement programmes have been studied by many authors (O'Hare, 2001; Gall, 2004; Schmidt-Soltau and Brockington, 2007; Li et al., 2007; Elliott et al., 2006; Strand, 1993; Petit et al., 2001; Heggelund, 2006), the interrelationship between these two aspects have not been studied in detail within the context of resettlement programmes. Additionally, the lack of an in-depth study covering entire process of resettlement programmes and the complexity of socio-economic issues is a great barrier in achieving success in resettlement programmes. It is evident from the above statements that it is essential to explore a potential method to analyse the spatial conditions related to socio-economic issues in resettlement programmes.

1.2 RESEARCH NEED AND THE JUSTIFICATION

The complexity of socio-economic issues in resettlement programmes is a great barrier to achieve success. In order to explore those issues, it is essential to look into the perceptions from the displaced people's point of view within the context resettlement practice. Based on the previous studies and the perceptions of displaced people, it is visible that there are close links between the socio-economic issues and spatial aspects within the resettlement programmes.

Fischer and Wang (2011) summarised that there is a growing number of social scientists using new geographical methodologies and technologies, i.e. geographic information systems, global positioning systems, remote sensing, spatial statistics and spatial econometrics) in their research work. The integration between spatial analysis and geoinformatics has been intensively studied in many disciplines and subjects in social sciences since the 1960s. With respect to the era of personal computer revolution, spatial analysis has been extensively applied to overcome many spatial and social problems (Parker and Asencio, 2009). Those studies, confirmed that spatial analysis and the

Geoinformatics consisting of Photogrammetry, Remote Sensing, and GIS, can be used to so explore and solve issues in social and applied sciences.

Therefore, spatial analysis is a useful tool to investigate the socio-economic issues within resettlement programme implementations. The spatial analysis has been used to identify and explore problems and minimise the identified barriers of achieving successful resettlement programme in this research. Accordingly, Spatial Analysis application in ArcGIS software of the ESRI enterprise, Photogrammetry and Remote Sensed Image Processing modules in ERDAS IMAGINE software of ERDAS Inc. are used within this research to analyse the links between the socio-economic and spatial issues in resettlement programmes.

1.3 RESEARCH PROBLEM

Based on the research need identified above, this research was developed to answer the following research problem:

"How can the spatial analysis be used to analyse and address the socio-economic issues in resettlement programmes?"

Considering the statement of the research problem, this research aims to investigate the application of spatial analysis tools and techniques to analyse and address socio-economic issues in resettlement programmes.

This aim is further expanded into five objectives:

1. To understand different phases and activities in resettlement programmes
2. To investigate the socio-economic issues and spatial aspects in resettlement programmes
3. To explore the relationships between spatial aspects and socio-economic issues in resettlement programmes
4. To apply the spatial analysis techniques in analysing and addressing the socio economic issues in resettlement programmes
5. To develop a spatial database design to help designing and managing the resettlement programmes to minimise the potential socio-economic issues.

The next section presents the methodology conducted in this research to answer the research problem systematically.

1.4 RESEARCH METHODOLOGY

The methodology for this research was designed mainly on the concepts of the "Nested approach" (Kagioglou et al., 1998). With the respect to the nested approach, all processes in this study were exercised rigorously with an attempt to show the validity and reliability aspect in overcoming the explored issues in resettlement programme. Following the nested approach, the philosophical stand of this research was established, which showed the continuum of the research philosophies based on the ontological, epistemological and axiological foundations. The philosophical position of this study moves more towards subjectivism on the ontological continuum, based on the nature of this research which mainly attempts to investigate the perceptions of displaced people with regard to a resettlement programme. On the other hand, a transformation of all spatial aspect terms derived from the respondents onto the maps instantly becomes objective, measurable in realism and capable of being examined spatially. For these reasons, this research does not adopt an extreme subjectivism assumption on the ontological continuum. Considering the epistemological stance, this research is closer to social constructionism or interpretivism than the positivism assumption, as it attempts to understand the situations and explore the complex social issues that occur in a resettlement programme. This study also partly takes a positivism approach to examine the spatial aspects mentioned by those respondents. Therefore, this research does not take an extreme interpretivism assumption on the epistemological continuum. Considering the value of the research, this study inclines towards the value-laden stance due to its focus on displaced person's perceptions of the provision of the basic essentials. However, the research also remains partly value free from the provision of the basic essentials in terms of their spatial positions and aspects, which are unaffected by the research activities. The identified research philosophy guided towards identifying the appropriate research approach. This study considers the induction approach to gain the information from respondents regarding the issues that arose related to the resettlement programme. In order to gain the deep insight of the real situations in post-disaster resettlement programme, a case study strategy was conducted to follow the information from a single case study with embedded units of analysis. This research employs three data collection techniques to gain knowledge from documentary review,

interviews, and observations. These techniques are triangulated to increase the validity and reliability of the data. Finally, the collected data were analysed by the content analysis, cognitive mapping, and spatial analysis. This research was largely a theory building attempt rather than a theory testing attempt. It presented the explored techniques in minimising the complex issues due to the interaction between displaced persons and displacement locations.

1.5 ORGANISATION OF THE THESIS

This study consists of six chapters as:

Chapter one: Introduction; Presents the background to the research and the research need and justification.

Chapter two: Literature review; Describes the literature and previous work regarding the barriers to achieving a successful resettlement programme and justifies the selection of spatial analysis to solve the complex issues in a specific aspect in order to mitigate the impacts of those issues.

Chapter three: Research Methodology; Addresses the adopted concept of the "Nested approach" to achieve the research aim using systematic approaches regarding the research objectives.

Chapter four: Analysis; Demonstrates the research techniques for analysing the collected data and examines the results by applying spatial analysis.

Chapter five: Findings; Proposes feasible solutions from the analysis results, showing good practice in using spatial analysis as a bridge to balance between the requirements of displaced people in resettlement programmes and the resettlement policy conducted by the government.

Chapter six: Conclusion; Compiles all of the chapters and summarises the explored key results response to the research objectives. The limitations and future research were also noted at the end of this chapter before discussing the final notes at the end.

CHAPTER 2

LITERATURE REVIEW

2.1 INTRODUCTION

This chapter reviews the literature on the role of spatial analysis in post-disaster resettlement programmes. In particular, this literature review focuses on two major areas of study: resettlement programmes and spatial analysis.

- The first section begins with an exploration of the relevant terminology of the resettlement followed by a discussion of the causes that trigger displacement and resettlement. This section also synthesises the characteristics and activities of resettlement programmes. At the end of this section, researcher explores the previous works regarding the implementation of post-disaster resettlement programmes, highlighting the challenges and barriers related to achieving success in this field.
- The second section explores the context of spatial analysis and its components. It further synthesises the previous work on the application of spatial analysis, particularly the applications of this technique to address social problems in resettlement programmes. The next section focuses on the level and extent of spatial analysis techniques applied in resettlement programmes. At the end of the chapter, the emphasis is on the applications of spatial analysis in resettlement programmes, the challenges and the gaps in implementing the spatial analysis in the resettlement programmes.

2.2 RESETTLEMENT PROGRAMMES

2.2.1 Terminology

The term resettlement has often been used synonymously with terms such as “relocation”, “rehabilitation”, and “displacement”. As well as the term “displaced persons”, it is alternatively replaced by several terms such as “refugees”, “settlers”, etc. The terms “resettlement” and “displaced persons”, as used in this research, are described in Table 2.1. Also, the terms used to refer to those who have been displaced from their original land and

resettled in a new land are discussed in more detail. Essentially, it is crucial to use a specific term to define affected people or victims in order to target appropriate individuals for potential post-disaster management.

In order to understand the scope of a resettlement programme, definitions of the terms used in this study are provided in Table 2.1.

Table 2. 1: Terms used in studies associated with resettlement programmes and related subjects

Term	Definition	References
Resettlement programmes	Procedures ranging from finding a place of temporary shelter to constructing permanent houses in the original or in a new area.	Deruyttere et al. (1998)
Resettlement	Process whereby people leave their original settlement site to resettle in a new area.	Woube (2005)
Resettlement	The planned and controlled relocation from one physical place to another of populations of individuals or an entire community.	Muggah (2008)
Resettlement	Covers all direct economic and social losses resulting from taking land and the restriction of access, together with the consequent compensatory and remedial measures.	World Bank (2004)
Relocation	Transportation of a family or colony to a new settlement after an upheaval of some kind.	Fellbaum (1998)
Displacement	A phenomenon whereby people are forced to leave their initial land involuntarily.	Bartolome et al. (2000)
Rehabilitation	An outcome of resettlement that is conceived not as a physical relocation or merely a restoration of income, but as development.	Bartolome et al. (2000)
Internally displaced persons	People who are forced or obliged to flee or leave their place of habitual residence.	IDMC (2011a)
Internally displaced persons	Persons or groups of persons who have been forced or obliged to flee or leave their home or place of habitual residence, usually as a result of, or in order to avoid, the effects of armed conflict, human rights violations or natural or human-made disasters, and who have not crossed an internationally-recognised state border	OCHA (1999)
Displaced persons	All those people who lose land or their right to use land, or who lose access to legally-designated parks and protected areas, resulting in an adverse impact on their livelihood.	World Bank (2004)

As noted above, Woube (2005)'s definition of "resettlement" only covers the physical relocation aspect of displaced persons whereas, within the definition provided by the

World Bank (World Bank, 2004), the term "resettlement" covers not only the physical "relocation" aspects but also the socio-economic aspects of displaced persons (DPs). In fact, people have an inherent socio-economic background which consists of social, economic, cultural, psychological and spiritual ties with their environment of origin. Similarly, a report by the World Bank clearly addressed that resettlement can, depending on the case, which includes: (a) the acquisition of land and physical structures on the land including businesses (b) physical relocation, and (c) the economic rehabilitation of displaced persons improve (or at least restore) incomes and living standards (World Bank, 2004). Therefore, considering the physical aspects alone would miss some vital issues associated with the socio-economic context within the term of the resettlement. It is also shown in a study that socio-economic issues were essentially studied in a resettlement context because they can potentially minimise various problems, such as drought, famine, population pressure, shortage of land, conflict, boarder security, etc (Dubie, 2005).

Regarding the previous studies, this study considers resettlement to be "*a process by which people relocating temporarily or permanently in original or new area with regard to the specific interest in physical environment, socio-economic schemes and political policy of the state"*. According to the definition of the term involved with resettlement mentioned in Table 2.1 by some researchers, i.e. Bartolome (2000) and Fellbaum (1998), therefore, this study also differentiates between the terms "relocation" and "displacement" as the process in the resettlement which considers mainly physical aspect.

Beyond the process of physically relocating displaced people, some crucial processes, for example finding a place for the relocation through ensuring that the displaced people permanently settle down, are included in "resettlement". This programme consists of several crucial tasks which are described explicitly in section 2.2.4. In light of a study by Dubie (2005), the investigation procedure of finding a resettlement location is initially included within "resettlement", and the provision of agricultural support and services, i.e. water supplies, soil fertility for agriculture. For this reason, the actual activities of relocating displaced people have been expanded and have later been defined as a resettlement programme. Obviously in divergence from the resettlement terminology, Deruyttere et al. (1998) defined a resettlement programme as the procedures ranging from finding a place of temporary shelter to constructing a permanent house in the original or in the new area. This definition precisely affirms the scope of the study of resettlement as a complex process associated with several determined issues. Within the resettlement

paradigm, the UNDP outlines the standard of the resettlement programme as not only considering building it back but also building it better, which can create safer and better lives (UNDP, 2009). This resettlement paradigm must also be carefully determined to ensure that fair and adequate compensation is offered to those affected (Deruyttere et al., 1998).

Focusing on the aspects associated with the resettlement programme, this research considers the socio-economic, administrative, and physical aspects through the procedures within the resettlement paradigm. The socio-economic aspects have been controversially debated as the essential factors by many researchers (i.e. Vatikiotis, 1987; Jackson and Sleigh, 2000; Davidson et al., 1993; Cernea, 1991), in addition to the consideration of the physical factors within the context of effective resettlement programmes. Also, together with the administrative aspects, the government and authorities concerned who have performed an important role in organising the resettlement programmes are also considered in this study. Regarding these crucial activities as an entire programme, therefore, this research considers that the term "resettlement programme" covers all procedures from the site selection to the provision of livelihood support and services for displaced persons and the sustainability of their lives.

Focusing on displaced persons, Muggah (2008) summarised the names allocated to them, depending on the cause of their displacement; for example, people who are displaced by development projects are called "Ousters", "Evictees", "Project-affected persons (PAP)", "De-housed", "Settlers", "Re-settlers" and "Colonisers": people who are displaced by conflicts are called "Refugees", "Internal Refugees", "Evacuees", "Inmates", "Internal-displaced-persons (IDPs)", and "Conflict-displaced persons"; while people displaced by natural disasters are called "Disaster Refugees", and "Internal-displaced-persons (IDPs)". However, the difference between refugees and IDPs depends on the crossing of an international border. Unlike refugees, IDPs have not crossed an international border, while they legally retain all of their rights and protection under their country's human rights laws and international humanitarian laws (UNHCR, 2013). With respect to the terms defined by the above authors, a common term, "Internally Displaced Persons (IDPs) or Displaced persons" is used to refer to people who have been forced or obliged to flee or leave their home or place of habitual residence, which is also appropriately addressed in this research (IDMC, 2011a). In conclusion, this study uses the term "displaced persons" differently depending on the cause of their displacements; for example, people who have been

displaced due to conflicts are often called *Refugees, Internal refugees, Evacuees, Inmates, Internal-displaced-persons (IDPs), and Conflict-displaced persons*, while people who have been displaced due to natural disasters are called *Disaster refugees, and Internal-displaced-persons (IDPs)*.

In order to understand the characteristics of resettlement programmes, it is essential to understand the varying nature of those triggered by different causes of displacement. The following section describes the general characteristics of all type of resettlement according to their cause of displacements in more detail.

2.2.2 Causes triggering displacement

Considering the events related to the resettlement of residents worldwide, it can be summarised that there are three major causes triggering displacements, i.e. development projects, conflicts, wars and violence, and natural disasters (Brun, 2005; World Bank, 2010; Muggah, 2008). The following context highlights the major causes triggering displacement all over the world, in order to provide an understanding of the distinctive characteristics of the different types of displacements.

- **Displacement triggered by development projects:**

A wide variety of development projects trigger displacement, e.g. urban relocation, slum clearance/renovation, the installation of infrastructure for water projects, road and rail construction, forestry projects, mining, and the creation of biosphere reserves and national parks (Koenig, 2001). As reported by the World Bank, four million people were forced to flee their land due to 300 large dam construction projects between 1986-1993 (Bartolome et al., 2000). Currently, dam construction remains a major cause for development projects displacing residents involuntarily from their homeland (World Bank, 2000).

There are some distinctive characteristics related to the resettlement programmes for the development projects triggering displacement. For instance, residents who were affected by the construction of Kotmale Dam in Sri Lanka had a chance to decide between living on small plots of their original land near the reservoir or moving to a new area with larger plots of land far away from their original village (Takesada et al., 2008). Additionally, displaced persons often cannot obtain compensation from the development projects that trigger displacement (Bartolome et al., 2000). Furthermore, as an instance of displacement triggered by a mega hydro project in China, the Three George Dams, the government spent

more than 17 years relocating the affected residents to other areas (Tan and Yao, 2006). The long time span of this resettlement programme includes the time spent engaged in a preliminary study of the resettlement's area response to the re-settlers' backgrounds. As also summarised by Bartolome et al. (2000), it seems that development projects that trigger displacement take a long time in implement resettlement programmes.

- **Displacement triggered by conflicts and wars:**

Conflict, war and violence triggering displacement is a human-made disaster triggering displacement of residents from their original habitat to other places internally or externally (World Bank, 2013). The conflict and war disaster may be defined as "armed conflict" which always involved with the use of weapons. According to the global record of the IDMC (Internal Displacement Monitoring Centre) in 2010, 27.5 million people had been internally displaced by conflict or violence as of December 2010. The largest number of IDPs is in Africa (11.1 million), followed by the Americas (5.4 million), South and South-East Asia (4.6 million), the Middle East (3.9 million), and Europe and Central Asia (2.5 million), respectively (IDMC, 2011b). The number of people displaced due to this cause has increased by 400,000 since 2009.

The distinctive characteristic of this type of displacement is that political issues are always involved, and its impact always has political connotations. As emphasised by the World Bank, "*Displacement triggered by violence and conflict is not only a humanitarian crisis, but is likely to affect political stability if left unattended or poorly governed, or unresolved politically through peace-building"* (World Bank, 2013). Although displaced people may be forced to flee their homeland involuntarily, they may return once the conflict or war has ended (Ferris, 2008). However, some governments regard the citizens' right to return home as a means of reclaiming state territory, while displaced people may solely desire to return to their homeland and livelihood (Brun, 2005).

- **Displacement triggered by natural disasters:**

Natural disasters constitute a serious disruption to the functions of a community or society, causing widespread human, material, economic and/or environmental losses which exceed the ability of the affected community or society to cope using its own resources (Yonetani, 2011). A natural disaster is also defined as a destructive event by nature that causes great damage and human suffering, overwhelms the local capacity and leads to the need for national or international assistance (Below et al., 2009). Regarding the number of reported

disasters in EM-DAT, the overall number of natural disasters has appeared more than 200 events each year over two decades since 1990 to 2000 and approached to more than 300 events each year since 2001 to 2012 (Guha-Sapir et al., 2013). It is noted that the largest number of people displaced by natural disasters since 2007 have been in Asian countries (Argenal et al., 2008; IFRC, 2008; Guha-Sapir et al., 2011; Guha-Sapir et al., 2013). Focusing on the types of natural disaster, hydrological disasters, particularly sudden-onset disasters such as floods, hurricanes, cyclones, and landslides, are subject to occurring more frequently and their aftermath is more severe (Cohen and Bradley, 2010). According the huge numbers of victims has been made homeless; consequently, resettlement programmes have been implemented in order to respond to the immediate requirements.

The general nature of this kind of displacement starts with the evacuation of affected or vulnerable people to other, safe places, far away from the possible aftermath. Relying on the level of hazard in the area, the government or authorised organisation will decide whether to return all of the displaced people back to their land or relocate them in temporary or permanent resettlement areas. In Mozambique, for instance, affected people were relocated to a permanent resettlement area after a flash flood event. Nevertheless, a large number of them attempted to return to their original land to maintain their land ownership and livelihood (Warner et al., 2008). Regarding this displacement phenomenon, affected people may enrol on a resettlement programme either voluntarily or involuntarily (Dikmen, 2002). Therefore, there may appear to be a decreasing number of re-settlers due to major concern about the resettlement policy and practices implemented by the government and authorised organisations (UN-HABITAT 2008).

Based on the literature reviewed regarding the causes triggering displacement, it is clear that natural disasters have caused displacement for a colossal number of residents worldwide, particularly in Asian countries. Focusing on natural disasters, it is likely that sudden-onset hydrological disasters have been threatening a large number of people who live in vulnerable areas. In developing countries, where the disaster warning systems are insufficiently established in the remote rural areas, an incident of sudden-onset hydrological disaster frequently affects residents who live in the lower catchment areas (Sena and W/Michael, 2006).

This research will study resettlement programmes triggered by those sudden-onset disasters for three main reasons, i) the effectiveness of resettlement plans in preventing loss and suffering among affected people, ii) the restoration of the vanished background

and culture of displaced people, and iii) the standard maintenance of the dynamic transformation of displacement places. These reasons for conducting this study show the particular characteristic of resettlement programmes due to sudden-onset disasters, which differ from resettlement due to development projects and conflict and war. Firstly, the number of displaced persons affected by these sudden-onset disasters can be decreased by applying effective resettlement plans. The resettlement plan must include the identified risk levels and vulnerable hazard areas regarding well-defined geographical characteristics, such as low-lying areas prone to flooding or high-sloping areas prone to landslides. Secondly, these sudden-onset disasters, by their nature, occur suddenly, and can sweep away all physical constructions together with the local people's culture/background. A well-designed dataset about the physical environment, residential characteristics and background is able to restore the vanished background and culture of displaced people. Thirdly, evacuation and transitional displacements can be implemented in some instances of physical relocation. Within all stages of physical relocation, the basic essentials must be provided according to protection standards and human rights principles. For these reasons, resettlement programmes that are triggered by sudden-onset disasters are studied carefully in order to protect vulnerable people, mitigate their suffering, and decrease the number of lost and displaced people under the programme.

Additionally, there are some uncontrollable factors that also trigger these sudden-onset disasters, such as land encroachment on mountains, deforestation, land-use change on hillsides, intense rainfall, stream course alteration, and excavation (Correa et al., 2011). For these reasons, it is rarely possible to forecast the time of the disaster and the impacted areas, including the affected people, as mentioned, in remote rural areas. Often, these serious disruptions caused by natural disasters displace affected communities from their original settlements and force them to resettle (Keraminiyage and Piyatadsananon, 2013). A resettlement programme, therefore, is applied by the government immediately after a disaster occurs, without careful consideration. It has been emphasised that "resettlement is not merely a housing solution, but a complex, multi-dimensional process, with potentially very high negative impact if not properly planned and implemented" (Correa et al., 2011). This research attempts to use this rationale and intensively explore in more detail the good practices of resettlement programmes triggered by sudden-onset hydrological disasters that cause displacements to residents in remote rural areas.

2.2.3 Resettlement phases

Generally, a resettlement programme consists of several activities across the relocation sites. Colson (1971) classified resettlement activities into four categories, i.e. phase i) before the displacement; phase ii) the immediate post-displacement period; phase iii) transitional rehabilitation; and phase iv) the handing-over. Until the early 21st century, resettlement programmes had slightly been distinguished from the previous study. As mentioned, Scudder (2005) categorised the procedures for resettlement activities, from the beginning of the programme until it became sustainable, i.e. phase i) identify the exposed victims; phases ii) construct the sites and remove the processes; phase iii) develop the resettled communities; and phase iv) hand over through the next generation. However, the activities of resettlement programmes have been denoted broadly into two major phases i.e. phase i) the emergency response; and phase ii) a durable solution (Argenal et al., 2008).

Beyond the activities of a resettlement programme, the time period was also used to define their framework; such as, phase i) Pioneer stage (0-5 years): during which displaced people move into an area and establish basic life support systems, such as water, food, shelter, and access to consumption goods, markets, and credit; phase ii) Consolidation stage (5-10 years): during which community organisations; educational and health services; transport improvements; and permanent housing are established and better use is made of landholding and credit; and phase iii) Growth stage (duration unspecified): during which farms are capitalised; permanent agricultural systems are established; related agro-industries are developed; credit becomes generally available; and supply and marketing systems are firmly grounded (Nelson, 1973).

Since the previous studies attempted to classify resettlement activities into phases, it is clear that the resettlement phases start with activities that precede the physical relocation of affected or displaced people into the provided areas. This can be seen from a study by Scudder (2005), in which the resettlement programme began with identifying the exposed victims. The first phase classified by Colson (1971) is too ambiguous to distinguish between resettlement activities and post-disaster management activities.

Focusing on the timeline defined by Nelson (1973), it has been suggested that the timeline of all resettlement phases should be flexible to accommodate significant changes in the rate of growth, age structure and social composition of the population (UN-HABITAT,

1983). This statement was also affirmed by a study by Piyatadsananon et al. (2011), which found that the timeline for the resettlement phases is flexible due to resettlement activities taking place over transitional resettlement relocations. Furthermore, it is noticeable that the sustainability of a resettlement community is one of the major concerns during the last resettlement phase of these mentioned authors. Therefore, it is summarised that a potential resettlement programme must establish a resettlement community that can be inhabited by the next generation.

Within the scope of the sudden-onset disasters triggering displacements, such as flash floods, debris flows, and landslides, there are some major phases addressed in the previous works (i.e. Ollet, 2008; Corsellis and Vitale, 2005; UN-HABITAT, 2010b; Naewna, 2001; khaosod news, 2001; Piyatadsananon et al., 2011; Ashmore et al., 2010) as the following context. Therefore, this study classifies the resettlement phases as follows:

Phase i) Emergency response in the evacuation centres; Evacuation centres are generally used as temporary shelter, which provides several emergency response activities, such as a registration point for displaced persons, a rescue centre, and a distribution base for donated items. This centre may provide a location for the social services for the community, such as schools, temples, evacuation centres, and community public areas where have sufficient space and facilities available for displaced persons (Corsellis and Vitale, 2005).

Phase ii) Transitional processes in temporary displacement centres; Displaced persons whose houses have been completely demolished by the disaster are relocated to a temporary displacement centre. This centre is possibly the same place as the emergency collection centre, where all basic essentials and an infrastructure are available for displaced persons to stay in until permanent housing is reconstructed. The reconstruction of permanent houses can take a long time, particularly in cases of large scale devastation due to a major disaster. For example, the permanent house reconstruction project in Rwanda took two years to build 220 houses, and a case in Indonesia took three or more years to resettle 2,000 families in the constructed buildings (Ashmore et al., 2010). In this resettlement phase, some affected persons may return to their homeland to salvage their property, salvage their cultivable land, and reconstruct and repair their damaged houses and sheds. Displaced persons who are temporarily staying in the provided displacement area may also return to their homeland to collect essential items, construction materials, and personal belongings.

Phase iii) Sustainable development in a permanent resettlement area; The government and related authorities are in charge of finding a relocation site for displaced persons. Regarding the scope of resettlement programmes, as defined in the terminology, permanent houses must be fully reconstructed with the basic essentials and infrastructure in the resettlement areas in order to facilitate the re-settlers. This long-term phase attempts to provide permanent safe places for affected people on the available land; offer people a basic infrastructure; improve the living standards of re-settlers; and develop a resettlement environment that is appropriate to hand over to the next generation.

An attempt to classify activities into phases within a resettlement programme is essential in order to define the framework of a programme for effective organisation and management. Displacement locations have been shown to be a common determinant of all studies regarding the resettlement phases. Additionally, the definition of resettlement programmes explicitly considers the places for relocation in every single term. Therefore, this research classifies resettlement into three major phases by specifically considering the resettlement activities associated with the displacement locations. Regarding the classified resettlement phases associated with displacement locations, this research has presented a comprehensive diagram of the resettlement phases that shows the activities in more detail in the Analysis Chapter. This exploration of the resettlement phases associated with displacement locations can precisely define the resettlement activities in all phases which may assist any potential resettlement management.

2.2.4 Factors considered in resettlement programmes

Resettlement programmes have been implemented in an attempt to improve displaced people's living standards, generating the ability to obtain a higher income, increasing production levels, or at least restoring their original life-format levels (World Bank, 2010). However, the initial decision to implement a resettlement programme is also important.

Focusing on the tasks within the framework of the resettlement plan, there are other authorities that organise programmes responsively, such as the local government, community organisations, the host government, non-government organisations, donors, charities, suppliers/contractors, etc. (IDMC, 2011a). Among these stakeholders, the local government normally performs a crucial role in improving the conditions of human settlements and collaborating with government to organise programmes in order to mitigate the suffering due to those causes that trigger displacement (El-Masri and Tipple,

2002). The local government also has a responsibility practically to transform the resettlement policy, i.e. to expand the infrastructure and residential zoning, improve public transport, develop new employment opportunities, improve access to financial sources, and secure the right to land from the central government to make available to displaced persons (El-Masri and Tipple, 2002).

Focusing on the practices within the framework of the resettlement plan, several good practices are ideally followed in order to realize the programme. Theoretically, applying a resettlement programme must concern, i.e. planning for human settlement in disaster prone areas, considering the appropriate location of market places, community centres, the water supply, health and education facilities, and transport services, including loading terminals; the respect for local customs and traditions as well as new needs and requirements; and the use of local resources and the traditional techniques and style of construction (UN-HABITAT, 1983). This shows that the processes of planning and preparing an appropriate resettlement site that provides the basic essentials are fully included in the programme. Beyond the selection of a resettlement site, Oliver-Smith (1991) added housing and population information as essential key factors for a successful resettlement programme. This information about vulnerable displaced persons and hazard areas must be frequently updated to maintain the quality of the data and so achieve further effective analysis (IDMC, 2011a). For this reason, some basic information about the residents of vulnerable hazard areas, such as density; population size; livelihood; houses; land use, etc., must be prepared in advance in order to cope with sudden extreme hazard events (Yonetani, 2011).

Considering the above discussion regarding the ideal resettlement frameworks and the practical approaches demonstrated in the reviewed literature, it can be summarised that the key principles considered to underlie a successful resettlement programme include:

1.) Physical factors of the resettlement environment:

The physical factors of the resettlement environment are considered to consist of the infrastructure, facilities, and social service buildings. Regarding the relevant elements of the community's infrastructure, transportation (roads and bridges); health care (clinics, hospitals and pharmacies); water and sanitation (water supply, surface-water drainage, sanitation in communal areas or for communal services); schools (crèches, primary, secondary, tertiary institutions); the generation and transmission of power; food production and food security (grain stores); police stations, prisons, courts, and places of worship

(churches, temples, mosques, etc.) must be intensively considered (Corsellis and Vitale, 2005). According to the resettlement paradigm in terms of the physical factors, it is summarised that these infrastructures, facilities, and social service buildings must be restored or reconstructed to a high standard if these elements need to be utilised in hazard or resettlement areas (Heggelund, 2006; Ahmed and Hossain, 1990; Cernea, 1991; World Bank, 2001; IFC, 2002). As recommended by Arshad and Athar (2013), these elements should be established as they functioned in the original location. Beyond the restoration in hazard areas and the reconstruction in resettlement communities, it is also recommended to establish a link between the original location and the resettlement community (Arshad and Athar, 2013; Dubie, 2005). Eventually, the basic elements of the infrastructure, facilities, and social service buildings must be regularly assessed and evaluated within the resettlement community.

In conclusion, this key principle covers the available facilities and infrastructure, the accessible transportation, the appropriate location of market places and community centres, the provision of a water supply and electricity, and health and education facilities. Local resources can be used in the construction processes, with an awareness of the advisability of applying the traditional techniques and style. The provision of the basic essentials in the resettlement area can be similar to that in the original residential area.

2.) Socio-economic factors related to the re-settlers' backgrounds

Background information about re-settlers, particularly socio-economic factors, is also considered a vital factor. Socio-economic status focuses on an individual or family's economic and social position based on education, income, occupation and ethnicity (Yonek and Hasnain-Wynia, 2011; ASE, 2013). Based on the literature mentioned above, good practice for a resettlement programme is for the socio-economic information about the residents' background to be collected and regularly updated (Oliver-Smith, 1991; IDMC, 2011a; Yonetani, 2011). In terms of this focused scheme, a financial support strategy for individual requirement loans and financial availability for disbursement for resettlement environment development are recommended to be added to a potential resettlement programme (Arshad and Athar, 2013). The good practice for these socio-economic factors covers a focus on the impacts that tend to decrease the income of displaced people after a disaster occurs. Additionally, occupational training and skills improvement is alternative techniques implemented by the government and involved organisations to help affected people to gain more income after a disaster. Therefore,

affected people rely not only on compensation, donation or disbursement. With government and the relevant organisations' support, the financial compensation needs to be well-managed during the resettlement programme with a spare amount for disbursement towards maintaining a sustainable resettlement community.

In conclusion, this key principle includes the assistance in financial availability for the disbursement in costs and savings, loans, and remittances beyond assistance with obtaining income, re-launching the displaced people's careers, and restoring the background of displaced people. It also includes the disbursement on migration and livelihoods. Certainly, this principle also considers the sustainable approaches to increasing the household income or occupational training. The characteristics and background of displaced people must also be carefully considered to restore their background.

3.) Administrative factors related to the government and involved organisations' management

In an overview of the resettlement paradigm, the government always authorises the local government, involved organisations and stakeholders to deliberate about the tasks regarding the resettlement policy. It is certain that the local government, as an authorised governmental organisation, will be in charge as the representative of the central government who works closely with the local people in the hazard area. For example, in a construction task, it is recommended in the previous studies, discussed above, that the local government should acts as a representative to procure a reliable construction team; a local construction team is preferred to reconstruct re-settler's houses in the resettlement area. In term of administering the data required to analyse some of the processes of the resettlement programme, the government should also apply some advanced technology, such as GIS (Geographic Information System), GPS, remote sensing images, and spatial analysis, to increase the virtual vision in the resettlement area. Furthermore, it is emphasised in the previous work (i.e. Arshad and Athar, 2013; Dikmen, 2002) that the government should be able to adjust the resettlement policy according to the re-settlers' requirements.

In conclusion, a successful administration would be reflected by the creation of a balance between the responsibility of the undertaken stakeholders and the displaced people's requirements. It is likely that an optimum balance concept is a good practice which is able to maintain the balance between the absolute power of the top-down policy implemented

by the government and the diversity requirements of the bottom-up approach insisted on by the re-settlers.

Therefore, it is essential to identify the predominant factors in each key principle to further the exploration in more detail. According to the first key principle regarding the provision of the basic essentials, it focuses on the physical factors of the resettlement area. The second principle regarding the income and background of displaced people is represented by their socio-economic factors. The third principle considers the administrative factors of the government in organising the tasks and authorised organisations/stakeholders. Regarding the nature of those essential factors, there is plentiful information about the physical, socio-economic, and administration factors.

In conclusion, a lesson learnt from these successful cases shows that an effective resettlement programme requires the consistent implementations of three factors, i.e. *Planning the resettlement programme based on reliable and sufficient information before implementing it. Implementing resettlement practices by recognising the key factors of resettlement programmes, and evaluating the satisfaction of re-settlers with the programmes.* Due to the limited number of successful cases of resettlement programmes, our knowledge is insufficient to identify the successful key-principles which can act as guidelines for implementing effective programmes. Due to our insufficient knowledge of the key factors for each phase for achieving a successful resettlement programme, it is challenging to explore many cases of such programmes. From the viewpoint of a researcher, an effective resettlement programme presents some challenges, which are described in detail in the next section, such as the knowledge-base about the resettlement programme, the existence of barriers obstructing the resettlement programme, and the potential solutions to overcoming the problems related to resettlement programmes.

2.2.5 Challenges related to achieving successful resettlement programmes

According to the studies on resettlement programmes by many researchers (i.e. Dikmen, 2002; Bartolome et al., 2000; Kinsey and Binswanger, 1993; Karimi et al., 2005; Argenal et al., 2008; Dwivedi, 2002) and several reports by the United Nations (i.e. UN-HABITAT, the World Bank, UNDP, UNHCR, and UN-ESCAP), there are numerous issues related to implementing resettlement programmes. Although a few recent studies (i.e. Arshad and Athar, 2013; Dikmen, 2002) have attempted to define the good practices

and solutions to mitigate the problems associated with the reconstruction factors, other problems related to the entire process of the resettlement programme have yet to be studied. Based on the discussion of the previous topic and the defined scope of the term "resettlement programme", this study concentrates on the challenges across the entire resettlement programme. This includes the process during the periods prior to, during, and following the implementation of the resettlement practices. The following context summarises the challenges associated with these three different periods of resettlement programmes.

2.2.5.1 Challenges during the period before resettlement is implemented

- *Resettlement plans are required for vulnerable hazard communities*

The nature of sudden-onset hydrological disasters, which are the particular focus as a cause of resettlement in this research, such as flash floods, debris-flows, and landslides, typically happen and powerfully destroy all obstacles very quickly. Therefore, sudden-onset disasters are of greater concern than slow-onset ones, such as drought and epidemics (Yonetani, 2011). Without a disaster prevention plan, resettlement programmes have always been applied immediately, without any careful consideration. Considering the disadvantages of unconsidered resettlement programme, Correa et al. (2011) confirmed that resettlement is not merely a housing problem, but a complex, multidimensional process, with potentially a very high negative impact if it not properly planned and implemented. Bayulke (1983) added that the lack of a resettlement plan has been the cause of the failure of resettlement programmes so far, while Vatikiotis (1987) pointed out that the lack of an initial plan regarding the selection of a suitable resettlement site without considering the water supply and soil fertility cannot support the agricultural activities of displaced people on a long-term basis. The resettlement plan must be associated with the scale of application. Certainly, a regional resettlement plan cannot be appropriately applied with a local hazard community which is suited to a community that requires a resettlement programme on the local scale (Dwivedi, 2002).

Apart from the regime and framework of an effective resettlement plan, the information about every element contained in the plan must be available for further analysis. It has been noted that fast data acquisition, visualisation, and analysis can accelerate the process of disaster management (Zhang et al., 2007). Certainly, it also expedites the process of resettlement programmes according to a module of disaster management. Focusing on the

collected data, Corsellis and Vitale (2005) recommended the regular collection and updating of the basic information about vulnerable displaced people in terms of their ethnic group, religion, social background, occupation and skills, house number, number of members in the household, location of the household, and options for transitional displacement, in order to ignore any discrimination problems between the local and the resettlement communities. In fact, obtaining data about hazard areas is one of the greatest difficulties in the data collection process for analysis (Zeil, 2002). This also includes the lack of a sufficient dataset about the vulnerable hazard community for further analysis of the resettlement programme. For this reason, the dataset required on resettlement programmes is a challenge for further study. According to the number of victims of sudden-onset disasters, the developed database could be intensively designed in order to decrease the number of displaced people in resettlement programmes.

For this reason, it is essential to design the database of residents' information in vulnerable hazard areas, such as density; population size; livelihood; houses; land-use, etc. The original residential area must be carefully studied and identified in order to establish the basic needs of the displaced people in the resettlement area and their likelihoods.

2.2.5.2 Challenges during the period when resettlement is being implemented

- *Complex relationships of problems related to the spatial aspect of resettlement programmes*

Although resettlement programmes have been considered a solution to relocating displaced people in other, safe places, their implementation has caused several problems, both during and after the resettlement. Based on the reviewed literature, it appears that resettlement programmes always cause problems for re-settlers, such as the lost livelihoods, impoverishment, difficulties due to uninstalled infrastructure, and discrimination between the host and new communities (Dikmen, 2002; Bartolome et al., 2000; Kinsey and Binswanger, 1993; Karimi et al., 2005; Argenal et al., 2008). Dwivedi (2002) listed several problems that arose due to the implementation of resettlement programmes, such as job losses, the breakdown of social and food security, credit and labour exchange networks, social capital and kinship ties, people's socio-political disempowerment, loss of cultural identity and heritage, impoverishment, and abysmal environmental conditions and inadequacies in resettlement sites. Considering the key-factors to achieving a successful resettlement programme, it is clear that the issues related to the physical, socio-economic,

and administration factors need to be either mitigated or solved effectively. Therefore, those issues that obstruct the resettlement programmes must be identified according to the categories of the key factors. Certainly, these explored issues are great barriers to achieving successful and effective resettlement programme, as described in the following.

- *Barriers to the physical resettlement environment and the associated impacts*

Considering the physical issues related to resettlement programmes, Dikmen (2002) found that a long distance and inconvenient accessibility between the original and new resettlement communities tended to destroy or diminish the relationship between these two communities; insufficient space in which to construct cattle sheds and straw sheds diminish the re-settlers' income and livelihood; un-expandable housing limits the space for multiple-families, causing the over-crowding of households; abandoned reconstruction work causes dissatisfaction among re-settlers who are forced to stay longer at the temporary displacement site. Additionally, Pankhurst and Piguet (2004) found that an inaccessible infrastructure in the relocation site can cause the spread of malaria, limit health services, and terminate children's primary education. Dubie (2005) also added that the under-construction/under-restoration of the infrastructure (i.e. roads, clean water, transport, electricity, sanitation) and social service centres lead to living difficulties and lower income and products for re-settlers. The unconnected roads and transportation network between a hazard community and its neighbouring areas cause delays in receiving assistance from outside the community (El-Masri and Tipple, 2002). Regarding displaced persons' livelihood, making a decision about on which site to establish a resettlement area may consider safety from the reoccurrence of the disaster without considering sufficient irrigation for re-settlers who mainly rely on agricultural products (Oberai, 1986). This definitely causes low productivity of agricultural products and leads to impoverishment. More seriously, an inadequate infrastructure (i.e. drinking water supply, electricity), the provision of temporary housing, and a shortage of medicine and staff in hospitals are major reasons for abandoning resettlement sites (Magadza, 1994). An example of an unsuccessful resettlement programme is the Dujuma Project in Somalia, where displaced people abandoned their resettlement areas after five years due to the unsuitable cultivation of their resettlement land (Pole, 2004).

- *Barriers to the residential socio-economic backgrounds and associated impacts*

Generally, the socio-economic issues certainly consist of social issues and economic issues. *Social problems are exists when there is a sizable difference between the ideals of society and its actual achievements*, therefore, they are simply shown as the gap between the way people want things to be and the way things really are (Coleman and Cressey, 1987). On the other hand, economic problems are literately included into the same category of social problems involving the resources of money in different levels, i.e. world, nation, and person (Coleman and Cressey, 1987). Focusing on the various socio-economic problems in personal level studied by Coleman and Cressey (1987), these problems consist of various issues in education, family conflict, poverty, ethnic minorities, illness, sexual harassment and abuse, mental disorders, drug use, crime, crowd, and violence. These problems have transformed to the resettlement programmes as several cases. For instance, impoverishment is spontaneously derived from long-term debt of the unaffordable cost from housing construction, transportation, basic essential items, and agricultural equipment (Pathiraja and Tombesi, 2009). Although the disbursement is commonly paid to affected people after the disaster, impoverishment; financial impacts; and money constraints continue to be major issues to these people. Economic problems and impoverishment are associated with land-use quality in resettlement areas by many researchers. With a high demand for reconstruction materials for building permanent housing in the resettlement area, displaced people may encounter significant transportation costs due to the materials being ordered from remote suppliers (Arshad and Athar, 2013). For this reason, it is suggested that materials should be collected wherever possible from the devastated area in order to save costs (Argenal et al., 2008; El-Masri and Tipple, 2002). Furthermore, the traditional cultural characteristics of displaced people should be considered a vital module of resilient resettlement strategies (Correa, 2010; Burnell, 2010). It was also stated that a lack of understanding of the traditional value system of displaced people can cause immense destruction in terms of human lives and livelihoods in resettlement programmes (Muggah, 2008). For example, a lack of consideration of cultural characteristics destroyed the relocation programme of Mayan descendants in Guatemala (Correa, 2010). To reduce stress and conflict, it is recommended that the background of displaced persons should be identified based on close relationships, similar ethnic backgrounds and the political groups of local and displaced people (Corsellis and Vitale, 2005). Considering the barriers to successful resettlement programmes caused by socio-

economic issues, these may be further investigated, based on the limited studies conducted in this area to date.

- *Barriers to the administrative management of the government and involved organisations*

UN-HABITAT clearly stated that resettlement programmes are always performed centrally under the authority of the President or Prime Minister, whereas the local government is the responsible authority that works closest with the community (UN-HABITAT 2008). In fact, the local government and agencies play a significant role in enabling displaced people to achieve cultural recovery, identity, place, and the maintenance of local knowledge and expertise (Burnell, 2010). Based on the studies by UN-HABITAT dating back to the mid-80s, it is possible to summarise that community and people's basic processes and decentralisation have been able to construct a more sustainable resettlement than the centralisation organised by the Central Government (Noda, 2008). For this reason, the collaboration between displaced people, the local community and the local government is very important in driving a successful resettlement programme. It is clear that there are several significant advantages associated with taking account of displaced people's requirements with regard to resettlement programme, such as; (a) people can address their own particular needs rather than receiving aid packages that do not necessarily meet these; (b) it creates employment and income generating opportunities for the affected people; and (c) it can optimise the resources available to achieve a better output rather than standardised packages (Noda, 2008). However, the great difficulties of this potential administration derive from the difficulty associated with organising community participation in any decision making, including the fact that the government always ruins the process by jeopardising the regime created by the community (Burnell, 2010). Regarding the centralised administration, a resettlement policy that is implemented by the government cannot fulfil the real requirements of displaced persons (Bayulke, 1983). However, it is impossible to fulfil every need of displaced persons perfectly even by applying the decentralisation approach. For this reason, the local government and involved authorities have to work with displaced people closely in order to fulfil their true needs through the resettlement programme. This pattern presents a challenge in optimising the balance between the top-down policy established by the government and the community-based process as the bottom-up approach response to displaced people's requirements.

Considering the above barriers within the scope of these three key factors, it is clear that various complex links exist between the problems that need to be minimised. An effective solution to overcoming these sophisticated problems is to investigate the threads of the problems in order to use the appropriate methods. Table 2.2 presents the sophisticated links between the explored issues according to the key factors and the associated impacts on the resettlement programme.

Table 2. 2: Relationships between the problems and impacts of resettlement programmes

Impacts / **Issues**	**Physical impacts (1)**	**Socio-economic impacts (2)**	**Administration impacts (3)**	**Relationships**
Physical Problem (A)		A long distance between the original and resettlement areas breaks down/diminishes the relationship between displaced persons and their relatives or former neighbourhoods (Dikmen, 2002)		(A) & (2)
		Insufficient space to construct cattle sheds and straw sheds in resettlement housing areas decreases income and livelihoods (Dikmen, 2002)		(A) & (2)
		Inaccessible infrastructure at the relocation site to hospital or communal health centres spreads malaria, deceases the health services in the resettlement area, and terminates primary education (Pankhurst and Piguet, 2004)		(A) & (2)
Physical Problem (A)	Uncultivable resettlement land causes the resettlement area to be abandoned (Dubie, 2005; Pole, 2004)			(A) & (1)

Impacts / Issues	Physical impacts (1)	Socio-economic impacts (2)	Administration impacts (3)	Relationships
	Inaccessible roads between the hazard community and its neighbouring area delays assistance from outside (El-Masri and Tipple, 2002)			(A) & (1)
		No irrigation/water supply decreases agricultural productivity. (Dubie, 2005; Magadza, 1994)		(A) & (2)
		An inconsistent electricity system in the resettlement community causes living difficulties. (Dubie, 2005; Magadza, 1994)		(A) & (2)
		The lack of public transportation increases long term debt due to purchasing personal vehicles. (Magadza, 1994)		(A) & (2)
Socio-economic Problem (B)		The high reconstruction costs cause long term debt and impoverishment. (Pathiraja and Tombesi, 2009)		(B) & (2)
		The high cost of buying basic essential items causes long term debt (Pathiraja and Tombesi, 2009).		(B) & (2)
		Loans to buy agricultural equipment (i.e. agricultural trucks, water pumps for cultivation activity) cause long term debt (Pathiraja and Tombesi, 2009)		(B) & (2)

Impacts / Issues	Physical impacts (1)	Socio-economic impacts (2)	Administration impacts (3)	Relationships
		High construction material costs cause long term debt (Arshad and Athar, 2013)		(B) & (2)
		High transportation costs for delivering construction materials from remote stakeholders due to high demand from a large number of displaced persons causes long term debt (Arshad and Athar, 2013)		(B) & (2)
		The failure to consider displaced people's background causes conflict and violence. (Correa, 2010; Burnell, 2010; Muggah, 2008; Corsellis and Vitale, 2005)		(B) & (2)
Administration Problem (C)		The lack of government leadership[in ensuring that the displaced persons have trustworthy builders causes construction work to be abandoned, leading to lost money/ time. (Arshad and Athar, 2013)		(C) & (2)
	A lack of a land development process in the resettlement area causes re-settlers to invade public areas. (Levine et al., 2007)			(C) & (1)

Impacts / Issues	Physical impacts (1)	Socio-economic impacts (2)	Administration impacts (3)	Relationships
		Mixed groups from the host community and re-setters cause conflict and discrimination. (Corsellis and Vitale, 2005)		(C) & (2)
			Applying ordinary administrative action to re-settlers causes the loss of some benefits from the post-disaster area.	(C) & (3)

The above table shows the relationship between the explored problems and associated impacts in previous work due to the implementation of resettlement programmes. These relationships, as the matrix shows, confirm the complexity of the links between the explored issues. In order to affirm the key-factors for achieving successful and effective resettlement practices, it is essential to explore the issues related to resettlement programmes in more detail. This exploration requires a systematic approach to identifying more hidden barriers which have obstructed resettlement programmes so far. Therefore, it is important to define the issues and complex links between these factors in more detail. As a result, the explored threads may make it possible to determine potential solutions to overcoming these issues effectively.

2.2.5.3 Challenges during the period after the resettlement has been implemented

- *Sustainability of the resettlement community*

It is apparent that the administrative and organisation support from the government leadership always drops over time when a resettlement programme is being implemented (Arshad and Athar, 2013). The lack of administration over land improvement and development creates several difficulties for displaced persons in resettlement programmes (Levine et al., 2007). A failure to study the land-use development by the government and related authorities pushes displaced persons to intrude into the public or natural areas (Correa, 2010). Additionally, house reconstruction projects may be abandoned due to

builders breaking their initial verbal contracts made with the displaced persons (Dikmen, 2002). Without trustworthy, reliable contractors guaranteed by the government, displaced persons may lose money while their houses are never completely reconstructed. Additionally, meetings among displaced persons and between the displaced and host communities can lead to discrimination by the host community. The displaced people will be strangers to the host community and may create a competitive community also (Corsellis and Vitale, 2005).

All of these situations often arise in resettlement communities. An effective assessment or evaluation protocol had not yet been established to investigate the efficiency of the resettlement's implementation. However, recent work (i.e. Arshad and Athar, 2013) assesses the construction programme after natural disasters. This study proposes some good practices for construction programmes alone, while the good practices related to resettlement programme remain a challenge to the researcher. With the limited number of resettlement cases evaluated in the last phase of resettlement programmes, little knowledge of good practices based on the re-setters' attitudes has been developed. Therefore, resettlement programmes have been applied without considering the real requirements of displaced people.

In conclusion, it is clear that a resettlement plan is required in the period before the resettlement is implemented. The increasing number of sudden-onset disasters challenges researchers and involved organisations to establish effective resettlement plans that might apply to the large number of vulnerable displaced people all over the world. Focusing on potential resettlement plans, the preparation of the information about the vulnerable people and potential hazard communities is essential. Nevertheless, the delay in analysing the available data in several cases clearly shows the lack of the designed database and systematic data collection. Moving onto the second period of the resettlement programme, the sophisticated links between the problems pose a considerable challenge. In order to minimise the explored problems effectively, it is essential to investigate the threads and explore the roots of those problems explicitly. After the resettlement is implemented, the sustainability of the resettlement community is a major concern in resettlement programmes. It is likely that the resettlement community will remain unrecognised as part of the host community due to the lack of provision of the basic essentials within it. These challenges to resettlement programmes are illustrated in figure 2.1 below.

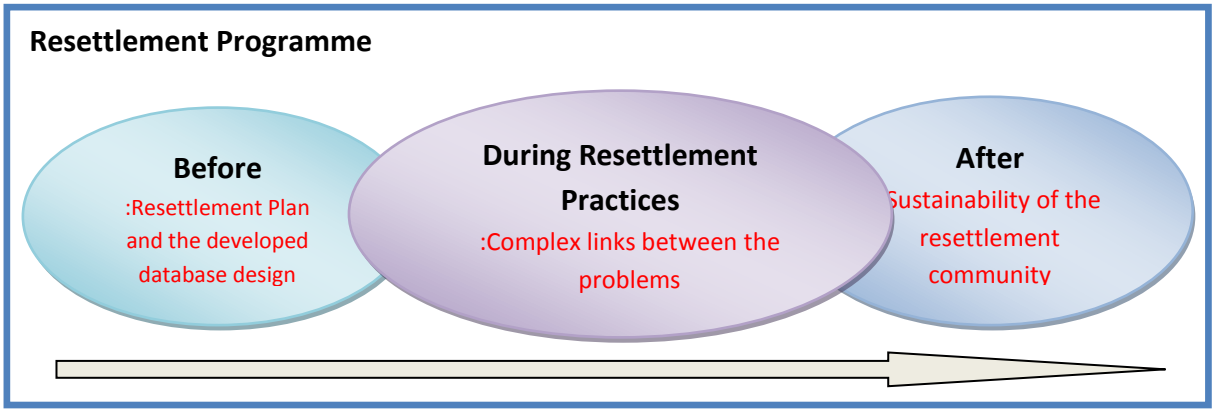


Figure 2. 1: Challenges related to achieving successful resettlement programmes

This study also proposes a technique for overcoming the barriers in the form of physical, socio-economic, and administrative factors. Regarding the relationships explored in the above discussion, all of the problems are clearly linked together. Physical factors contain the perspective dimension of the spatial aspect, which is feasibly measured and examined geographically. On the other hand, the socio-economic and administration factors, generally complied as the *socio-economic problems* in a study of Coleman and Cressey (1987), are linked in a sophisticated manner. However, it is confirmed that the notion of the socio-economic content could be linked to the spatial interaction (Massay, 1990). For this reason, the threads between spatial interaction and socio-economic content can be investigated by using spatial analysis techniques. This argument has been proposed in this research to shed light on a feasible method for overcoming the explored problems, particularly socio-economic ones. The next section presents the general context of the application of spatial analysis in post-disaster resettlement programmes.

2.3 SPATIAL ANALYSIS

Human cognisance of the world's spatial properties is generally regarded in terms of location, size, direction, shape, pattern, movement, and inter-object relations (Montello, 1997). According to the reviewed literature in section 2.2, this shows the relationships between displaced people and locations through resettlement programmes. These cases confirm that humans have strong relationships with locations which can be geographically analysed. Janelle (2004), explains the spatial relationship in which humans take place in space, simultaneously with how human behaviour is controlled in space that can be defined within a geographical referencing system. Additionally, Smith et al. (2007b) studied the relationships between humans and locations in term of co-location and

distance-direction. These studies confirm that humans perform their activities related to locations showing several patterns in distance and direction. In order to understand the spatial relationships between the human and spatial aspects, spatial analysis tools can be used effectively to investigate them in depth.

Apart from potentially analysing location and spatial interaction in particular, spatial analysis is also well known and widely exercised to analyse socio-economic issues (i.e. Li et al., 2007; Steinberg and Steinberg, 2006; Parker and Asencio, 2009). The role of spatial analysis has increasingly focuses on measurement, hypothesis development and the validation of theoretical constructs, activities that are crucial to the development of new scientific knowledge (Anselin, 1999). Regarding one of the knowledge gaps in social science emphasised by Anselin (1999), it has been suggested that social science requires new developments in spatial analysis in order explicitly to treat the socio-economic issues related to location and interaction geographically. With the limited knowledge-base of spatial analysis to minimise those socio-economic issues, several socio-economic issues, as addressed in section 2.2.5, remain throughout resettlement programmes. This research presents the general context of spatial analysis, beginning with its definition followed by the evolution and tendency regarding the application of the spatial analysis technique in order to present the feasibility of these potential analysis techniques for overcoming certain barriers in resettlement programmes.

2.3.1 The terms and capacity of spatial analysis

Spatial analysis consists of two terms of interest, "spatial" and "analysis". The term "*spatial*" represents a geographical reference in which each case occurs on a map based on its referencing system (Haining, 2004). The term "*analysis*", generally, is the process of considering something carefully by using a specific skill with either a descriptive or prescriptive method (Chan, 2011). Haining (2004) defined the term "spatial analysis" as a collection of techniques and models that systematically process data values with reference to a geographical co-ordination system. Focusing on the activities of human on locations, Câmara et al. (2004) defined "spatial analysis" as a set of techniques that present the relationship between spatial aspects and human interaction with their location. Alternatively, spatial data analysis has been used interchangeably with the term "spatial analysis" to emphasise the aspect of location during analysis (Goodchild and Janelle, 2004).

According to the nature of this research, this study attempts to explore the potential techniques for overcoming the complicated socio-economic issues related to location in resettlement programmes. Focusing on the research framework of this study, the perspective of interaction between displaced persons and displacement locations has been intensively studied. In the light of the definitions of spatial analysis given by those scholars, therefore, this study defines "*Spatial Analysis*" as *a set of techniques that systematically process the data from the relationship between spatial aspects and human interaction to location with the reference to geographical co-ordination system.*

Spatial analysis can be used to examine events from the performed virtual perspective based on the Earth's surface reference. These tools can extract and create new information from geographical features, evaluate the suitability of a location, and estimate and predict the events associated with locations (Kaitsa, 2006). The advantages of applying spatial analysis include the ability to gain new information from existing data, explore suitable locations, identify the best possible pathways, perform distance and cost analyses, perform statistical analysis based on the local environment, interpolate data, and generalise data (ESRI, 2007). As an effective tool, spatial analysis is able to analyse locations and objects by using either conventional applications or modelling to process the complex relationship between the focused features. Focusing on the conventional applications of spatial analysis, these are conducted to analyse spatial features with basic functions, such as buffers, clips or windows, overlay: interest and union, identity, near or distance (proximity) and dissolve (Dunsford and Gokhale, 2007). Also, spatial modelling can be developed to predict the complex relationship between human and locations which is performed through dynamic simulation (Goodchild, 2005).

The next section presents the evolution of spatial analysis in several disciplines. Since this study is social research, the trends in socio-economic issues are particularly discussed to assess these developed techniques. Also, the attempts of software developers and enterprises have demonstrated the increasing capacity of this tool by integrating it with other powerful analysis software in the following section.

2.3.2 Evolution of spatial analysis and practices

The interest of this research involves the applications of spatial analysis in resettlement programmes. The following topics, therefore, intensively focus on the implementation of spatial analysis in social researches. The initial section presents the early work of

researchers who attempted to explore spatial conditions. The evolution of spatial analysis has rapidly developed through the advent of computer based analysis, as described in the following section.

- ***Early work on implementing spatial analysis***

Spatial analysis has played an important role since the early 19th century in many fields, such as the geographic, medical, hydrological, biological, economic, ecological, urban and regional sciences (Smith et al., 2007a). As clear evidence of this, spatial analysis has contributed notably to epidemiology due to a physician, Dr John Snow, who analysed the outbreak of cholera in London in 1854 (Snow, 1854). Almost four decades later, in 1893, a pioneer in integrating geographic variables into a study of social inequality showed survey maps illustrating the slums of great cities. Further, Florence Kelly, a women's rights activist, recorded the geographic location of the respondents whom she interviewed on maps of the city to illustrate the geographical patterns of poverty (Steinberg and Steinberg, 2006). The spatial analysis technique was also used to represent the geographical division of land use and space by mapping ethnic communal patterns of settlement. In 1925, Park et al. (1925) used geographical spatial data to discover the similarities between the social characteristics which influence human settlement patterns in cities in Chicago. Later, a social scientist, Mark Jefferson, noted the influence of the railway on settlement patterns by drawing 10-mile wide buffer zones around the rail tracks in different countries around the world (Jefferson, 1928). Jefferson's study confirmed the applicability of spatial analysis to the social sciences in terms of the modernisation or civilisation of different societies based on rail networks (Steinberg and Steinberg, 2006).

- ***Trends in applying spatial analysis in social researches***

Fischer and Wang (2011) summarised that there is a growing number of social scientists using the new geographical methodologies and technologies, i.e. geographic information systems, global positioning systems, remote sensing, spatial statistics and spatial econometrics) in empirical work. Social researches are apparently assumed to be the new direction in the application of spatial analysis according to the great demands for using this technique to perform several social studies (Anselin, 1999). For this reason, it is obvious that there is an increasing number of developed applications of spatial analysis configured on the GIS software that are responsive to the diversity of users and demands. Also, it is emphasised that the application of spatial analysis has moved away from primary simple

spatial data and visualisation towards exploratory and confirmatory analysis (Anselin, 1998). The current trend of applying spatial analysis is based on the following aims (McCoy et al., 2002):

- To create new information from the terrain analysis, such as watershed delineation, surface estimation and classification, distance from road measurement, etc.
- To identify the spatial relationship between layers through weighted overlay and combinations.
- To determine suitable locations for particular objects such as evacuation areas from high risk flooding and landslides.
- To calculate the travel costs by considering economic and environmental factors, and other objects.

Beyond the tendency to apply spatial analysis, addressed above, internet-based services have been developed and played a pivotal role in the 21st century. It is criticised that the emerging internet and web-based technology influences the methods of data modelling, processing, formalisation, analysis, and data distribution (Abdul-Rahman and Pilouk, 2008). Regarding these technologies, it is easier to obtain and share the data worldwide. On the other hand, it might decrease the security of the displayed data on the web-based technologies. An advantage of this technology is clearly shown with the rapid and effective process of spatial data transfer. Furthermore, the free downloadable maps from satellite images, such as Landsat, Quickbird, IKONOS, and Google Maps, have shortened the distance between social researchers, data collection, and preparation in spatial analysis. Currently, the trend of applying spatial analysis to social researches extends far beyond 2D and 3D visualisation. Drummond et al. (2006) projected that 4D presentations, which contain length, width, depth, (or X, Y, Z) and time, will completely modify the conventional mapping paradigm. This tendency is also addressed by Berry (2007), who assessed a full cycle of multimedia mapping in 2010. Berry (2007) discussed whether GIS technology, particularly in terms of spatial data structures, will accommodate time as a stored dimension in the 4D visualisation, which is becoming increasingly important to the illustration and presentation of the results from spatial analysis.

- ***Integration of spatial analysis to increase the effective analysis capacity***

Spatial analysis has been extensively implemented in several disciplines and developed by integrating computer programmes and statistical methods over the past half century by

both commercial and non-commercial organisations (Smith et al., 2007a). Generally, spatial analysis is applied with geographic information technology, image processing and vehicle routing (GPS). This integration has shed light on the knowledge-based development of Geoinformatics. Therefore, Geoinformatics were introduced as the science and technology of gathering, analysing, interpreting, distributing, and using geospatial information which includes the topics of spatial databases, mapping and visualisation, analysis, ontologies, distributed geo-processing, location-based services, and management (Karimi, 2009). The multi-disciplinary subject of "Geoinformatics", which consists of GIS (Geographical Information System), Photogrammetry and Remote Sensed image processing, enhances the capability of spatial analysis in both the physical and social sciences (Konecny, 2003).

GIS is a computer-based system for integrating, storing, editing, analysing, sharing and displaying data and their associated attributes which are spatially referenced to the earth (Foote and Lynch, 2000; Fotheringham and Rogerson, 2005). Prior to the computer-based analysis, the first analysis techniques were free-hand mapping and map layer transparency. These techniques led to the development of GIS technology. The first wave of GIS application was widely used to record and analyse the 1960s U.S census. However, several applications of GIS were subsequently developed by many companies in the late 1970s (Parker and Asencio, 2009). Furthermore, with the implementation of the Photogrammetric technique, a remote sensed image is geographically adjusted to present the captured image of the terrain details. Remote sensing is defined as the acquisition of information about an object without being in physical contact with it (Elachi and Zyl, 2006). As the invention of photography in 1839, remote sensing was fully implemented in 1859 for military applications (Konecny, 2003). Recently, it has become clear that an airborne platform for capturing remote sensing images has been developed for space-borne platforms in an attempt simultaneously to improve the resolution of the captured image (Rees, 2001).

In conclusion, the integration between spatial analysis and geoinformatics has been intensively addressed widely in the social sciences since the 1960s. With respect to the era of the personal computer revolution, spatial analysis has been extensively applied to overcome many spatial and socio-economic problems including contributing new knowledge about locations since the 1990s (Parker and Asencio, 2009). These studies have confirmed that spatial analysis and Geoinformatics, consisting of Photogrammetry, Remote Sensing, and GIS, can be implemented widely in the social and applied sciences.

- ***Software and Enterprises related to spatial analysis***

GIS has been developed by many enterprises with specific trade names; for example, ArcGIS by ESRI, GIS Design Server by Autodesk, GeoMedia by Intergraph Corporation, and IDRISI by Clark Labs (Chan, 2011). Also, the image processing software has been fully developed by several enterprises; for example, ERDAS imagine by ERDAS Inc., TerraLook by U.S. Geological Survey, and GVAR by Dartcom, including the organisations that legally capture remote sensing images; for example, HEG by NASA, and SamplePoint by NASA Goddard Space Flight Center (Chan, 2011).

Apart from the licensed GIS software, there is now a wide range of open-source software and freeware available for users. The Open Source geospatial software of Computational Infrastructure for Operations Research (COIN-OR), founded by Open Source Geospatial Foundation (OSGeo), allows users to access these programmes free of charge (Chan, 2011). However, this open-source software could be withdrawn at any time by developers who may be leaving it in a "frozen state" (Chan, 2011). This disadvantage has locked the functionality of GIS practices at the professional level. Some examples of popular GIS freeware, such as GRASS and MapServer, are also widely used by many users with continuous development (OpenSourceGIS.org, 2013). However, these programmes are rich with intense command lines and bugs, and are commonly based on UNIX.

Considering the efficiency of those advanced components of Geoinformatics, ArcGIS of the ESRI enterprise and the ERDAS image of ERDAS Inc. are the prominent leading enterprises. The ESRI enterprise provides full-featured application support for the capability module in spatial analysis functions with continuous development (Chan, 2011; Konecny, 2003; Fischer and Getis, 2010). Regarding the requirements of this research, spatial analysis is the technique used to minimise several socio-economic issues and enhance the efficiency of resettlement programmes. This study considers further the following criteria concerning the regulations defined by Chan (2011) for selecting appropriate GIS image processing software.

- Operating Systems: compatible with Windows, Mac OS, Unix.
- Applications: support multiple objective decision analysis; able to input, analyse and represent the results completely; support other algorithms for further development; widely compatible with several file types; unlimited number of states of a tree node; enabled to display unlimited file sizes; enabled to analyse results

geographically; compatible with the spatial data and non-spatial data available from the involved providers.

Since resettlement programmes involve many stakeholders and organisations, the operation systems have to be accessible by personal users and Local Area Network users. The selected software must be typically compatible with Windows and Mac operating systems for personal use, as well as with Unix for the Local Area Networking system. The selected software must provide full capacity for analysing the data with the basic conventional functions, i.e. buffers, clips or windows, overlays: interest and union, identity, near or distance (proximity) and dissolve. Furthermore, the selected software can be developed to incorporate advanced function in spatial modelling in order to support other algorithms. As licensing software, it is commonly compatible with a wide range of file types and can work with enormous file sizes. The selected software must be robust and trustworthy, with continuous development.

This research aims to apply spatial analysis to investigate the socio-economic issues related to displacement locations. Spatial analysis has been used to identify the explored problems and minimise the identified barriers to designing and implementing a potential resettlement programme. Regarding the objectives of the study, this research requires robust and trustworthy software which is compatible with several file types, without a file size limitation, for all analysis processes and display. Therefore, this research justifiably uses the Spatial Analysis application in the ArcGIS software of the ESRI enterprise, and the Photogrammetry and Remote Sensed Image Processing modules in the ERDAS IMAGINE software of ERDAS Inc. to generate all of the results of the study.

2.3.3 Spatial analysis components

The term “spatial analysis” includes spatial data and analysis techniques with a geographical referencing system. For this reason, this section explains the spatial analysis components by focusing on three major aspects, i.e. spatial data, spatial analysis techniques, and visualisation.

2.3.3.1 Spatial data

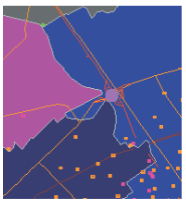
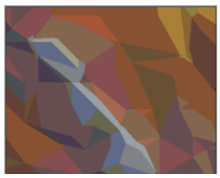
Spatial data concern location and attribute information. Longley et al. (2001b) described spatial data as interlinking geographic locations (place), time, and some descriptive property or attribute of the entity. In term of attributes, these are defined as the details of

the identified location or socio-economic conditions (Fischer and Wang, 2011). The typical sources of spatial data are derived from primary and secondary data. Firstly, the *primary data* are collected by observation which generates a set of spatial data with geographical dimension from field work (Haining, 2004). Considering the classification of spatial data sources by Haggett et al. (1977) and the main frame of data sources by Haining (2004), it is recognised that primary data can be collected from field observations, which consist of *quantitative measurements* or *qualitative observations*. As a result, distance and direction are traditionally measured by tapes and chains. In the 1980s, the traditional measurement eventually evolved into the Global Positioning System (GPS) by the US Navy Navigation System using the Time and Ranging-Global Positioning System (Navstar-GPS)(Konecny, 2003).

Secondly, the *secondary data* are derived from maps, satellite images, aerial photos, census data, and official records from relevant organisations. Furthermore, they can be generated from the generated data to be a model. The secondary data are also derived from theoretical work, simulated deterministic data and mathematical models, such as statistics and probability, which always involve extensive computation (Chan, 2011). The utilisation of this data source avoids difficulty in accessing data or expensive collection methods associated with field work (Haining, 2004).

Focusing on the characteristics of spatial data, there are two different types, based on the consequent procedures. Firstly, "*continuous data*" are taken from a set of locations on a continuous surface; for example, soil characteristics, air pollution, snow depth, and precipitation levels (Haining, 2004). Secondly, *"discrete data"* are points or area objects taken individually as discrete values according to their place of residence; for example, retail outlet locations in towns, and towns scattered across a region (Haining, 2004). Apart from the characteristics of these addressed spatial data, spatial analysis is interlinked with geographic data models, such as vectors, raster, and TIN. The definitions of the data models are listed in table 2.3, with illustrations and comprehensive expressions.

Table 2. 3: Data models and definitions (Booth and Mitchell, 2001)

Data Models	Definitions	Characteristics
Vector	represents using points, lines, and polygons. Useful for presenting discrete features such as buildings, pipes, or parcel boundaries	
Raster	represents the world alike in the form of a surface which is divided into a regular grid of cells	
TIN (Triangulated Irregular Network)	represents a network of triangles drawn between irregularly spaced points with X, Y, and Z values	

It is important to select the source of and define the type of spatial data required for the spatial analysis appropriately. Aerial archives are the main sources of information that are widely used at present with the available images and information from the remote sensing technology. Remote sensing imagery, derived from space-borne platforms, contains both captured terrain images and an electromagnetic spectrum showing the reflectance of different kinds of objects to the sensor (Lillesand et al., 2004). Beyond the human eye's visible spectrum (0.4-0.7 μm), satellite images provide rich information which can distinguish between objects in the image by using specific techniques, such as image enhancement, composite classification, and band combination (Lillesand et al., 2004).

Selecting an archival source not only relies on repeatability to obtain updated data, but also the resolution and specific information from the image, which have to be considered for a particular purpose. Repeatability is very useful for monitoring spatial changes in the focused object. On the other hand, scale and resolution also play important roles in implementing the data appropriately. Therefore, appropriate archival sources, repeatability to obtain updated images, and the resolution of the image must be carefully considered when selecting images to use in resettlement programme activities. Planning for a

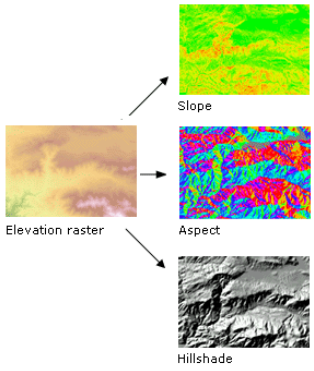
resettlement programme requires a series of images illustrating the pre and post conditions of the hazard community. For example, the distinction between the pre and post conditions of a hazard area destroyed by a tropical hurricane in India represents a decision to select a series of Landsat images to investigate in depth the changes across the hazard area (O'Hare, 2001). A space-borne platform has been used by several researchers (i.e. Petit et al., 2001; Müller and Zeller, 2002; Elliott et al., 2006) in order regionally to investigate the land-use changes after implementing a resettlement programme. On the other hand, aerial photos from airborne platform provide very fine resolution images which are useful when studying a community of particular interest (Rees, 2001).

Apart from the visual details of the image, remote sensing images can generate data models, i.e. vectors, rasters, and TIN models, which can help to investigate the features of the image effectively. With regard to the discussion about the database required for vulnerable hazard areas in the literature review chapter, various data, for example; houses, land-use, social service buildings, and roads, need to be generated from the remote sensing images for further analysis. That is to say, houses, social service buildings, and roads will be generated as vector models which are overlaid upon the images representing the raster models as the based map layers. The TIN model derives from the photogrammetry techniques used further to generate the DEM (Digital Elevation Model) which can extract the pixel codes to obtain the virtual terrain of the study area. In term of resettlement programmes triggered by sudden-onset disasters, such as debris flows, the elevation height is crucial when selecting a safe place for displacement. For this reason, a fine resolution image must be considered in order to make an accurate terrain response to select the displacement location.

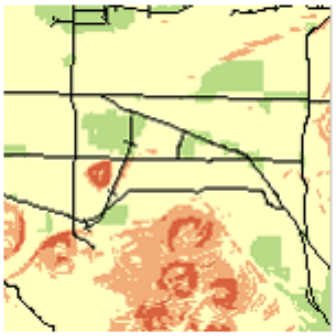
2.3.3.2 Spatial Analysis techniques

With the integration of GIS and Image processing techniques, spatial analysis has progressively enhanced its capacity through the addition of several useful functions (Goodchild et al., 1992). The spatial features on earth are presented in three basic forms, i.e. points, lines, and areas, which can be examined in terms of distribution, density, distance, and pattern respectively through numerical values (Smith et al., 2007b). Considering spatial relationships, the examined values which are presented as spatial dimensions such as space-area, length, proximity, and orientation, can be statistically calculated to define the spatial relationships associated with the patterns of these spatial

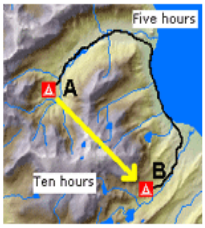
features (Fischer and Getis, 2010). Spatial analysis provides a distinct perspective by offering several effective applications which can examine the events and patterns taking place upon the earth's surface. Spatial analysis can analyse the locations and objects using either the conventional applications or modelling to process the complex relationship between the spatial features. There are many advantages to applying spatial analysis (Figure 2.2), such as: gaining new information from existing data, finding a suitable location, identifying the best path, performing distance and cost analyses, performing statistical analysis based on the local environment, interpolating data, and generalising data (ESRI, 2007).

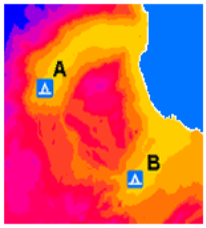


(a) Derive new information from existing data

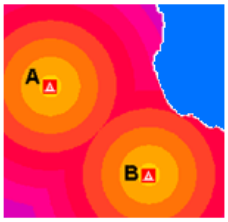


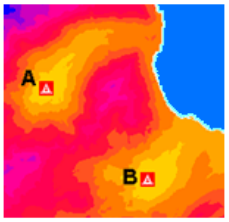
(b) Find suitable locations



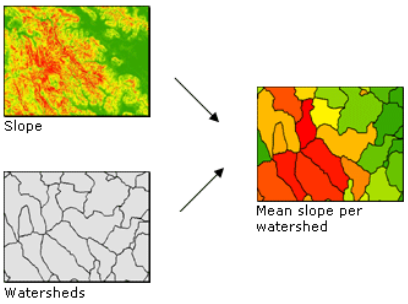


(c) Identify the best path between locations

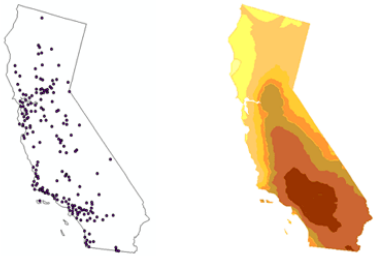




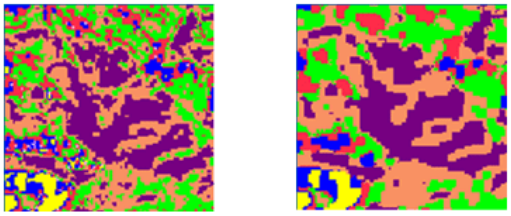
(d) Perform distance and cost-of-travel analyses



(e) Perform statistical analysis based on the local environment, small neighbourhoods, or predetermined zones



(f) Interpolate data values for a study area based on samples



(g) Clean up a variety of data for further analysis or display

Figure 2. 2: Powerful capacity of spatial analysis on the GIS platform (ESRI, 2007)

The above functions are used to analyse the spatial features associated with the explored problems in order to present an optimum balance to solving problems associated with spatial conditions by applying spatial analysis techniques to a resettlement programme.

More specifically, those functions consist of several methods which have to be chosen in accordance with the type of spatial relationship concerned. Accordingly, spatial relationships between features and locations, which are measurable in terms of distance, distribution, density, and pattern through numerical results or statistical value, can be examined according to those features (Smith et al., 2007b). Therefore, these functions will be used to analyse the spatial features' response to objective 4 of this research.

Regarding the above addressed concepts related to these analytical techniques, Fischer and Wang (2011) highlighted that the dramatically increasing number of social researchers has challenged many enterprises involved in geoinformatics to invent and develop an applications response to the diversity of these researchers' demands. ESRI has developed several essential features for examining spatial relationships that are compatible with the ArcGIS platform (ESRI, 2001; ESRI, 2007). For this reason, Spatial Analyst, an extension function of spatial application in ArcGIS software, was used to analyse the spatial data and spatial problems' response to the nature of this research. Apart from the Spatial Analyst extension, ArcGIS, as shown in figure 2.3, also contains other useful extensions that enhance the potential implementation of this application.

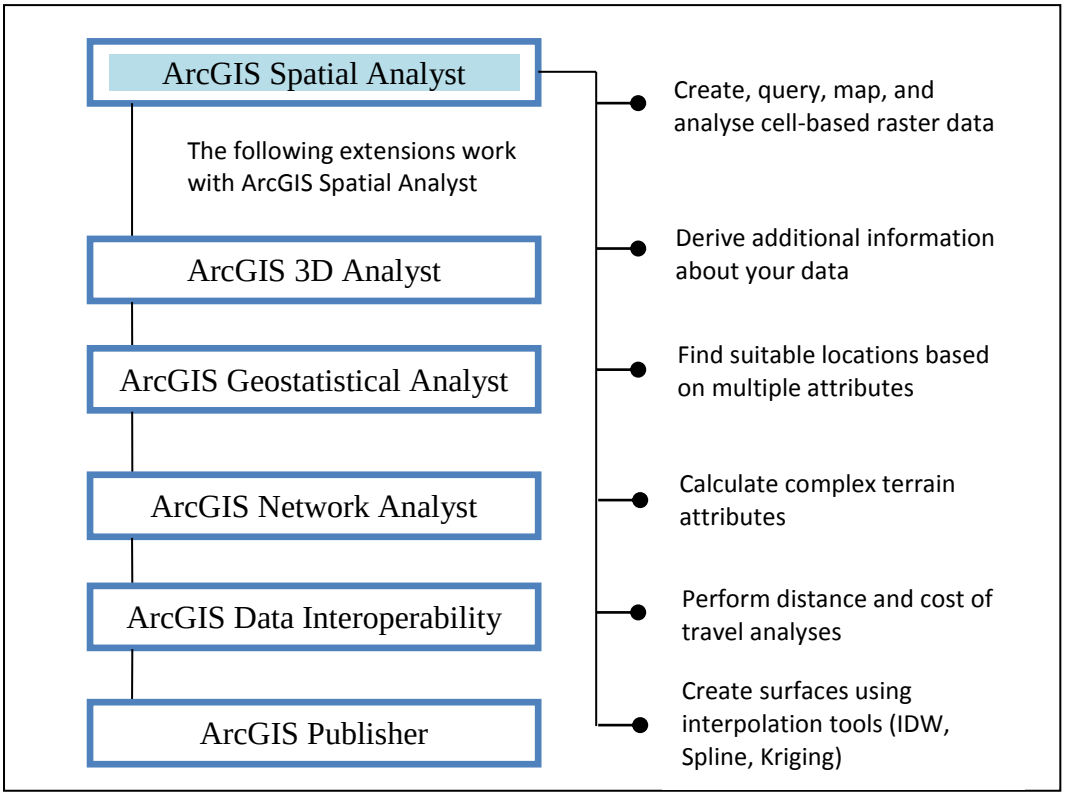


Figure 2. 3: ArcGIS extensions (ESRI, 2001)

ArcGIS applications have been applied via three distinctive functions, such as ArcCatalog (an access to manage geographical data, metadata and a way to edit data before viewing the map), ArcMap (an easy transition from viewing a map to editing its spatial features), and ArcToolbox (embedded tools that perform geoprocessing operations in ArcCatalog and ArcMap) (ESRI, 2011). ArcGIS Spatial Analyst provides more than 150 tools and functions which are contained within the key features as listed in the Table 2.4. (Available at: http://www.esri.com/software/arcgis/extensions/spatialanalyst/key-features)

Table 2. 4: Key features and functions of ArcGIS Spatial Analyst

Key Features	**Functions**
Suitability Modelling	Select the best location for a new site.
Surface Analysis	Build and analyse complex surfaces to identify patterns or features.
Distance Analysis	Calculate the cost of travel, cost-weighted distance, least-cost path and shortest path using ArcGIS Spatial Analyst.
Density Analysis	Calculate a density value for each cell in an output raster.
Solar Analysis	Calculate incoming solar radiation to model and analyse its effects.
Hydrologic Analysis	Derive new information from hydrologic and landscape data.
Statistical Analysis	Apply cell, neighbourhood, zonal overlay, and multivariate statistical analysis techniques in the modelling of spatial data.
Map Algebra	Use map algebra to combine multiple maps, perform suitability analyses, assign weights, and identify relationships.
Scripting and Customisation	Create custom models and analysis functions with ArcGIS spatial analyst customization options.
Graphic Modelling	Use Model Builder, a graphic modelling tool, to create advanced procedures and workflows.
Raster Generalisation	Generalise data to omit unnecessary detail.

2.3.3.3 Visualisation

Visualisation considers presenting the results from spatial analysis based on the geographical referencing system. It can be performed as illustrated on a cognitive map in hard or soft copy. Cognitive mapping is a rich source of both empirical findings and theoretical research (Karimi, 2009). Spatial data are applicably illustrated in two dimensions as the coordination reference system including surface data in three dimensions (Booth and Mitchell, 2001). Zhang (Zhang et al., 2007) concluded that a low resolution raster map image from space borne sources, such as Landsat images and DEMs, allow the development of online colour 2D and 3D visualisation, while a high resolution raster map image from QuickBird, Ikonos, and aerial photo maps are appropriate for the detailed visualisation of specific areas.

In conclusion, spatial analysis is used to analyse the spatial problems associated with resettlement programmes due to natural disasters. The next section describes the level and extent of the spatial analysis techniques used in resettlement programmes and the challenges related to applying spatial analysis in these programmes.

2.4 LEVEL AND EXTENT OF SPATIAL ANALYSIS TECHNIQUES IN RESETTLEMENT PROGRAMMES

Humans interact with their surrounding environment in terms of territory, places, scales, and networks (Jessop et al., 2008). Likewise, displaced people have multiple interaction forms with the territory, places, scales, and networks in resettlement areas. Spatial analysis has been used to solve numerous socio-economic issues and has been widely studied by researchers (i.e. Bahrenberg, 1984; Bahrenberg et al., 1984; ESRI, 2001; ESRI, 2007; Goodchild et al., 1992; Goodchild et al., 2000; Goodchild and Janelle, 2004; Goodchild, 2005; Haining, 1990; Haining, 1993). It has been suggested that this analytical technique might be integrated with mapping and GIS in order to apply resettlement planning in disaster and conflict areas (UN-HABITAT, 2010a). This research presents the application of spatial analysis throughout the various stages of resettlement programmes in order explicitly to study the level and extent of this technique.

2.4.1 Application of spatial analysis in the emergency response phase in evacuation centres

Evacuation centres are established to collect and provide emergency services to affected people. For this reason, they are normally located in a safe place far away from any further disaster. This centre has an installed infrastructure and facilities which are accessible by the displaced persons. Spatial analysis is used in this phase in order to analyse suitable places for shelter and to identify the hazard areas. Spatial analysis was applied to identify the hazard areas caused by a topical hurricane in India (O'Hare, 2001). Additionally, with the application of this technique, the vulnerable communities in a hazard area can be exposed and safe places identified for the suitability of additional emergency shelter sites using the weighting technique based on Landsat images (Gall, 2004). Considering both spatial and socio-economic determinants, Schmidt-Soltau and Brockington (2007) applied spatial analysis to investigate the suitability of resettlement sites with the specific criteria regarding the location conditions. For instance, if people affected by a sudden disaster have scattered across the vicinity before receiving emergency help from their government and organisations, in order to locate them and provide help, spatial analysis and satellite images play an important role. The few sensors that operate at night in the visible/near infrared spectrum of satellite images were used to detect ephemeral light from the bonfires that had been lit in order to cook and keep warm in order to locate those displaced people (Li et al., 2007).

Based on the above studies, it is clear that spatial analysis has been applied to investigate suitable locations for evacuation centres based on both airborne and space-borne images. However, using the technique of spatial analysis to cope with the problems related to evacuation centres during emergencies has not yet been studied. Evacuation centres have always been utilised as registration points, to distribute donated items, etc., and to provide the infrastructure and facilities essential for meeting the basic needs of displaced people. The real situation regarding the provision of the basic essentials must be carefully studied in order to provide information for further analysis.

2.4.2 Application of spatial analysis related to temporary displacement areas

Generally, affected people whose houses have been completely demolished by a disaster are relocated to temporary displacement areas. These displaced people may stay in the temporary displacement area for a long time while a permanent resettlement area is reconstructed or restored. Regarding the impact of a long stay in a temporary displacement area on the surrounding environment, spatial analysis was conducted to analyse landscape changes over the period of time during a resettlement programme (Elliott et al., 2006), and also to identify adjacent areas in resettlement areas to assist the decision makers to propose alternative sites for new resettlement areas (Strand, 1993).

In light of potential long stays within temporary displacement areas, the implementation of spatial analysis in this resettlement phase investigate landscape and land-use change in the area over time. However, the function of temporary housing/shelter has never been clearly studied by carefully considering all of the activities organised in the area. This lack of comprehensive study causes disorder and chaos in the location. Although there is a handbook for emergencies (see more details in Appendix 1) guided by the UNHCR (2007), the government and involved organisations have never adopted this guideline in temporary displacement areas. According to the specific conditions of the guideline, it is used during the emergency period alone. Regarding the explored situation related to the space utilisation of displaced people and relevant organisations in temporary displacement areas, spatial analysis can help us to examine the problems associated with spatial aspects in this area effectively.

2.4.3 The application of spatial analysis in permanent resettlement areas

This resettlement phase considers the improvement to the quality of displaced people's lives. Regarding the concept of resettlement programmes, mentioned above, the permanent resettlement area is expected to maintain the community's culture and liveable conditions, which can be handed down to the next generations. Spatial analysis plays a significant role in evaluating land-use changes following permanent resettlement. Spatial analysis and image processing techniques have been implemented to investigate land-cover changes after a large number of displaced people relocated to a resettlement area in south-eastern

Zambia. As a result, Petit et al. (2001) were able to discriminate between the percentage of hazard area and investigate the rates of land-cover change due to the 6,000 re-settlers' activities by interpreting multispectral SPOT images and spatial analysis. Spatial analysis was used to identify land-use dynamics in the central highlands of Vietnam where land-intensive agricultural expansion occurred following resettlement programmes (Müller and Zeller, 2002). Heggelund (2006) also examined the environmental capacity and livelihoods of re-settlers in a reservoir area. Furthermore, spatial analysis was implemented to present the fast-growing informal settlement and simulate the dynamics of developing nations by utilising a cellular automata model in a GIS environment that illustrated the better simulation of the spread of the settlement in Cameroon (Sietchiping, 2004).

To sum up, spatial analysis has been integrated with the GIS and image processing techniques mainly to investigate the land-cover changes in neighbouring areas during the final resettlement phase. Sustainability would be, at least, anticipated as a result of applying resettlement programmes in the last phase. Regarding the previous work, spatial analysis has mainly been implemented to investigate land-use change after relocation, to date; while the provision of the basic essentials, i.e. infrastructure, facilities, and social services, has never been studied for sustainability purposes. Nevertheless, the provision of the basic essentials in term of facilities and infrastructure is one of the significant issues which has been widely debated and possibly linked to several conflicts and severe issues in resettlement communities.

2.5 CHALLENGES OF SPATIAL ANALYSIS IN RESETTLEMENT PROGRAMMES

Regarding the challenges to achieving successful resettlement programmes, as discussed in section 2.2.5, there are some major barriers: i) the lack of resettlement plans with a developed database design for vulnerable hazard areas before resettlement programmes are implemented, ii) the complex links between problems associated with spatial aspects during resettlement practices, and iii) the sustainability of the resettlement community after a resettlement programme has been implemented, preventing the resettlement programmes from being accomplished effectively. Focusing on the technique to overcome the explored issues related to resettlement programmes in the previous work, spatial analysis can be used in the analysis of the spatial and non-spatial features of the locations

successfully. The following details describe some of the major challenges faced when applying spatial analysis to fill the gaps in resettlement programmes.

2.5.1 Challenges related to developing the spatial and non-spatial database used in resettlement plans before implementing a resettlement programme

Based on the reviewed literature, the delay in collecting spatial and non-spatial data (e.g. socio-economic data and administrative data) for further analysis, such as statistical and spatial analysis, proves a great hindrance to achieving successful and effective resettlement programmes. However, these data have never been developed into a dataset for the analysis of a resettlement programme. This circumstance may distort and delay the efficiency of resettlement programme implementation. Corsellis and Vitale (2005) suggested that the information about a community and the affected people required during an emergency situation would constitute:

1.) Updated information for all stakeholders.
2.) Ethnic, religious, social background.
3.) Specific assistance for vulnerable hazard areas.
4.) Income opportunities.
5.) Availability and capacity of sheltered areas.
6.) Registration list of displaced people.
7.) Emergency health-care treatment.
8.) Supplementary feeding centres.
9.) Transport, including roads and bridges.
10.) Health care, including clinics, hospitals and pharmacies.
11.) Water and sanitation, including water supply, surface-water drainage, and sanitation in communal areas or for communal services.
12.) Schools, including crèches, primary, secondary, and tertiary institutions, where available.
13.) The generation and transmission of power.
14.) Food production and food security, such as grain stores.
15.) Police stations, prisons, and courts.

Considering the processes involved in an entire resettlement programme, several datasets are required about the programme for further analysis purposes. For instance, the initial process aims to investigate suitable sites for all displacement areas, i.e. evacuation centres, temporary displacement areas, and permanent resettlement areas. The second major process is to establish these resettlement areas together with the provision of the basic essentials. The last major process is to evaluate the provision of the basic essentials in the permanent resettlement area. These three major processes require a systematic dataset which consist of three kinds of data, i.e. i) thematic map layers of the vulnerable hazard areas, ii) a spatial dataset of the environment in vulnerable hazard areas, and iii) a non-spatial dataset of the vulnerable people and the organisations involved in the resettlement activities.

The thematic maps can be prepared with multiple scales in order to present the vulnerable hazard areas from the regional to the local scale. As a result, the explored potential-areas for resettlement sites must have the provision of the basic essentials installed at those sites to facilitate displaced people. The spatial dataset about the provision of the basic essentials in the evacuation centres, temporary displacement areas, and permanent resettlement areas can be adapted from the standards and guidelines established by UNDRCO (1982) and UNHCR (2007) (see more details in Appendix 1).

Furthermore, the information about displaced people is another crucial source about the availability of the basic essentials in these resettlement areas. The sustainability of the permanent resettlement area can be evaluated by determining the satisfaction of the re-settlers with the installed basic essentials in that area. Problems and vital issues regarding their stay in permanent resettlement areas must be highlighted to develop the designed database of spatial and non-spatial data for resettlement programmes.

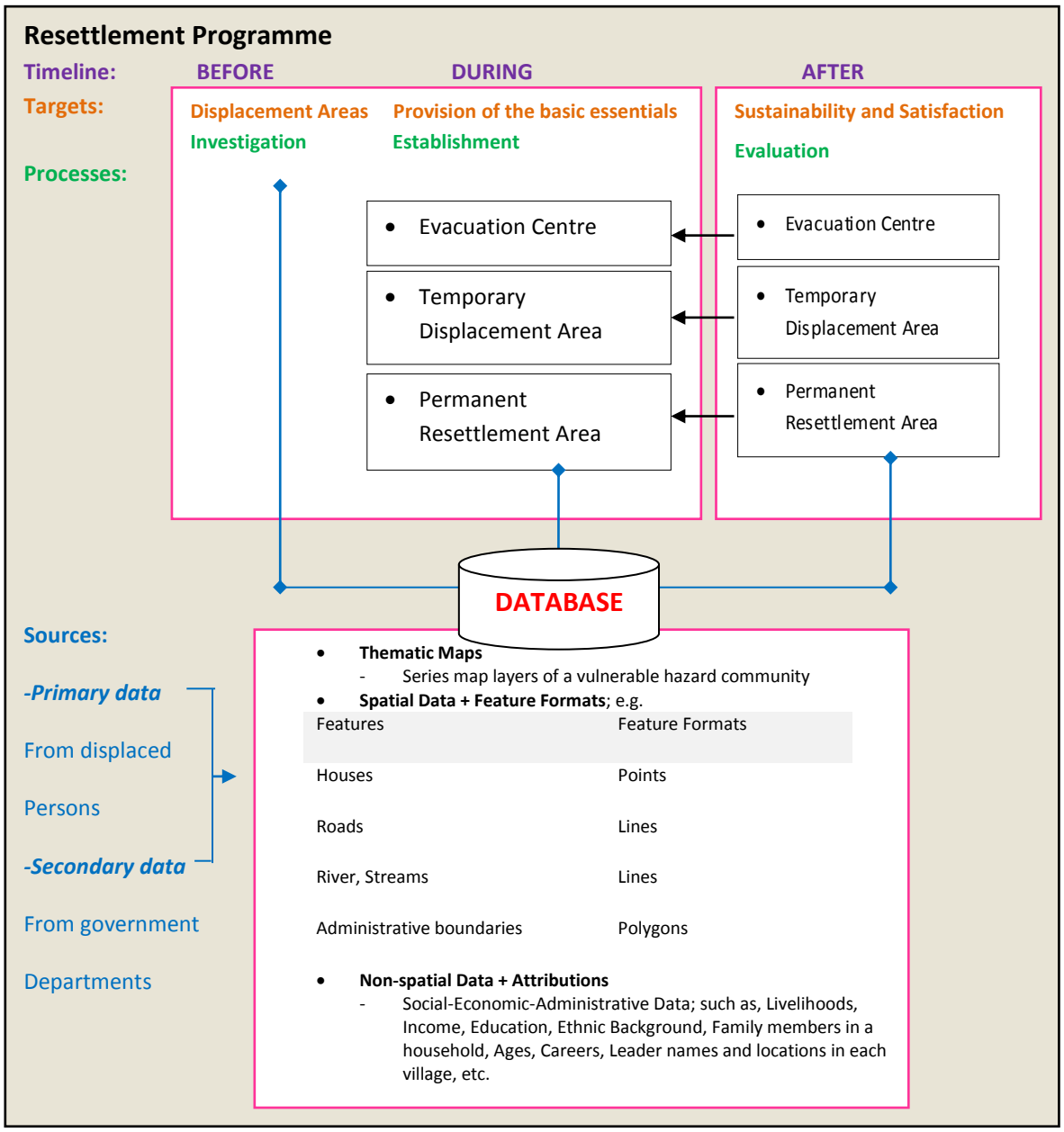


Figure 2. 4: Developed database design for vulnerable hazard areas

2.5.2 Challenges when applying spatial analysis to minimise the complex links between the problems associated with spatial aspects during resettlement practices

During the implementation of a resettlement programme, all displacement areas would be expected to serve displaced persons and helpers who utilise the space in those places. Nevertheless, the problems associated with space and the provision of the basic essentials still exist throughout all phases in the resettlement areas, from the evacuation centre, to the temporary displacement area, and permanent resettlement area. Accordingly, the situation

within the evacuation centre after the disaster occurs is chaotic. Overcrowding is a major problem in evacuation centres, although the available space has been roughly estimated in advance to serve those people (Kinsey and Binswanger, 1993). The actual space utilised by people in evacuation centres has never been examined while a handbook for emergencies clearly states standards and guidelines for providing space for affected people during emergencies (UNHCR, 2007). The purpose of the UNHCR standards and guidelines is to avoid long term issues, such as conflicts with the local community, ensure a safe environment for refugees and deliver humanitarian assistance. The details of the standards related to the context of this research are addressed in Appendix 1. In terms of space utility in the evacuation centre including all other temporary and permanent resettlement areas, a basic function of spatial analysis is to estimate the density of the space that the people occupy. This technique requires very high resolution imagery integrated with an expert interpretation system which clearly defines the functions and criteria of the buildings and their feasible utility.

Apart from the insufficient space in the evacuation centre, inaccessibility is another major concern that causes several difficulties for affected people who are seeking to fulfil their basic needs; such as safe areas, water, fuel for fires, food, and community services (Corsellis and Vitale, 2005). Several techniques of spatial analysis can be used to minimise these issues effectively. The shortest path analysis was developed to discover the shortest route by which to access the target under the defined criteria, such as avoiding main roads and avoiding submerged routes. This technique requires high resolution images with a rich database in order to generate reliable and precise results. Beyond the literature reviewed about the problems associated with inaccessibility in the hazard community, there are definitely several problems waiting to be explored and solved by the application of spatial analysis.

- *Techniques used to extract the complex relationship between problems associated with spatial aspects in displacement locations*

In order to minimise the complex issues associated with displacement locations, the links between these issues and the locations must be carefully extracted. This can be derived from the experiences of displaced people regarding displacement locations. Regarding people's perception of the place, it appears that a sense of place is a controversial issue. Several scholars (Bott et al., 2003; Cantrill and Senecah, 2001; Steele, 1981) have noted

that a sense of place is a feeling that is dominated by an individual's perception rather than the place itself. The importance of a sense of place has been shown in several studies that suggest that a lack of this sense may lead to poor development and a lack of improvement. For instance, Chigbu (2013) found, from in-depth interviews and historically informed observation, that a weak sense of place lead to poor development in Uturu, Nigeria. The sense of place was studied by Diaz and Dayal (2008) within the psycho-social discipline in relation to supporting victims against the impact of natural disasters in order to re-establish their sense of place by using a model of community based psycho-social support programmes. People's qualitative perceptions of a place express a real sense of place beyond the physical dimension of the geographical place. This means that an understanding of the recognition and awareness of a sense of place may help to minimise the problems associated with locations more effectively.

However, the implication of extracting the subjective sense of place is a major problem that exceeds the physical characteristics of a place. Based on a study by Xu (1995), it is possible to adopt solutions for mitigating the implications of the subjective sense of place in three respective ways, i.e. firstly, by studying people's perceptions of the place; secondly, by recognising the history of the place; and, lastly, by developing the place based on people's perceptions of it. People's subjective perceptions of a place can be extracted by carefully focusing on the terms associated with the objective space and its dimensions (Basden, 2004):

- Continuous extension
- Here, there, between, around, inside and outside, continuity, near, far
- Spreading out in a continuous manner
- Shapes
- Occupying space
- Identified by x,y coordinates
- Dimension
- Size, slope, volume, area

Based on the explored perceptions of displaced people regarding the displacement locations, this qualitative information may either confirm or contradict the physical conditions of these locations. Therefore, it is challenging to study people's perceptions of the provision of the basic essentials and the utility in displacement areas throughout resettlement programmes. Also, it is challenging to analyse the displacement areas'

response to the issues arising in those areas by applying spatial analysis to examine the statement of problems visually. This challenge supports Bahrenberg (1984)'s question of whether the future trend in applying spatial analysis will proceed to focus on the link between the constraints on human behaviour and the decision making approach to socio-economic factors.

With respect to the limitations and criteria of displacement areas organised by the government and relevant organisation, this technique sheds light on the optimum balance technique for implementing resettlement programmes in practice. As the explored results from the above analysis technique shown, the perceptions and requirements of displaced people with regard to utilising the displacement areas can be balanced according to the limited space and criteria related to the displacement areas. This optimum balance will be discussed in the next section.

2.5.3 Challenges when evaluating the provision of the basic essentials established in resettlement areas for sustainability after resettlement programmes have been implemented

It is emphasised by several researchers that the differences between resettlement areas and the original land can prove a serious hindrance to achieving successful resettlement programmes (i.e. Dikmen, 2002; Bartolome et al., 2000; Kinsey and Binswanger, 1993; Karimi et al., 2005; Argenal et al., 2008; Dwivedi, 2002). Apart from the differences between these areas, these researchers have also highlighted how a lack of sustainability is also a major problem associated with resettlement programmes. According to the descriptive criteria summarised by Jain (2010), a sustainable environment for resettlement programmes can be determined by: engagement in productive and creative work in communities, affordable homes, low pollution levels, a satisfactory infrastructure and social services, a low unemployment rate, productive livelihoods, standard incomes, affordable community living costs, easily accessible throughout the community, green or open spaces, provisional public venues, and cultural identity. Although the criteria for determining sustainability has been established in the literature, currently, only a few researchers have evaluated the efficiency of the applied resettlement programmes (i.e. Elliott et al., 2006; Müller and Zeller, 2002).

Due to the limited number of effective methods for engaging in good practice when implementing resettlement programmes, the problems addressed in the previous sections, e.g. physical, socio-economic, and administrative issues, remain throughout these programmes. The evaluation process generally relies on the perceptions of displaced people. However, give the limited location conditions and place allocations, these programmes rarely fulfil displaced people's requirements ultimately. Therefore, it is challenging to develop a concept of the optimum balance to cope with this situation.

2.6 CHAPTER SUMMARY

Based on the reviewed literature, it is clear that unsuccessful post-disaster resettlement programmes are due to a failure to recognise the socio-economic and administrative factors of resettlement communities. The problems that arise during resettlement programmes are influenced by spatial factors such as land availability, and accessibility to the provision of the basic essentials. Certainly, the methods for overcoming those problems might be implemented differently, depending on the factors under focus. In this study, we explore the use of spatial analysis techniques for minimising sensitivities related to the socio-economic factors that are influenced by spatial factors related to displacement locations of the resettlement phases.

According to the sophisticated problems, it is recommended to implement resettlement programmes with the expression of coercion and a high degree of social control related to the spatial conditions (Corsellis and Vitale, 2005; Muggah, 2008; Dikmen, 2002). In particular, the serious social and economic situations of resettlement communities were addressed as the key factors affecting the failure of resettlement projects (Oberai, 1986). Considering the innovative nature of this research, this study, therefore, attempts to explore a technique for elucidating these complex issues.

Based on the reviewed literature, it is clear that the challenges associated with resettlement programmes, as illustrated in Figure 2.10, generally consist of three major topics: i) the lack of a developed database for the further analysis of resettlement programmes related to vulnerable hazard areas, ii) the difficulty associated with elucidating the complex links between the problems associated with spatial aspects when applying resettlement programmes, and iii) the lack of knowledge developed from the elucidated issues associated with the spatial aspects to enhance the capacity of potential resettlement programmes for sustainable resettlement communities. These explored challenges have

been intensively studied in the Analysis chapter in relation to the systematic research methodology which will be described in the next chapter. Therefore, the conceptual framework of this study is displayed in Figure 2.11, presenting the process of achieving effective resettlement programmes.

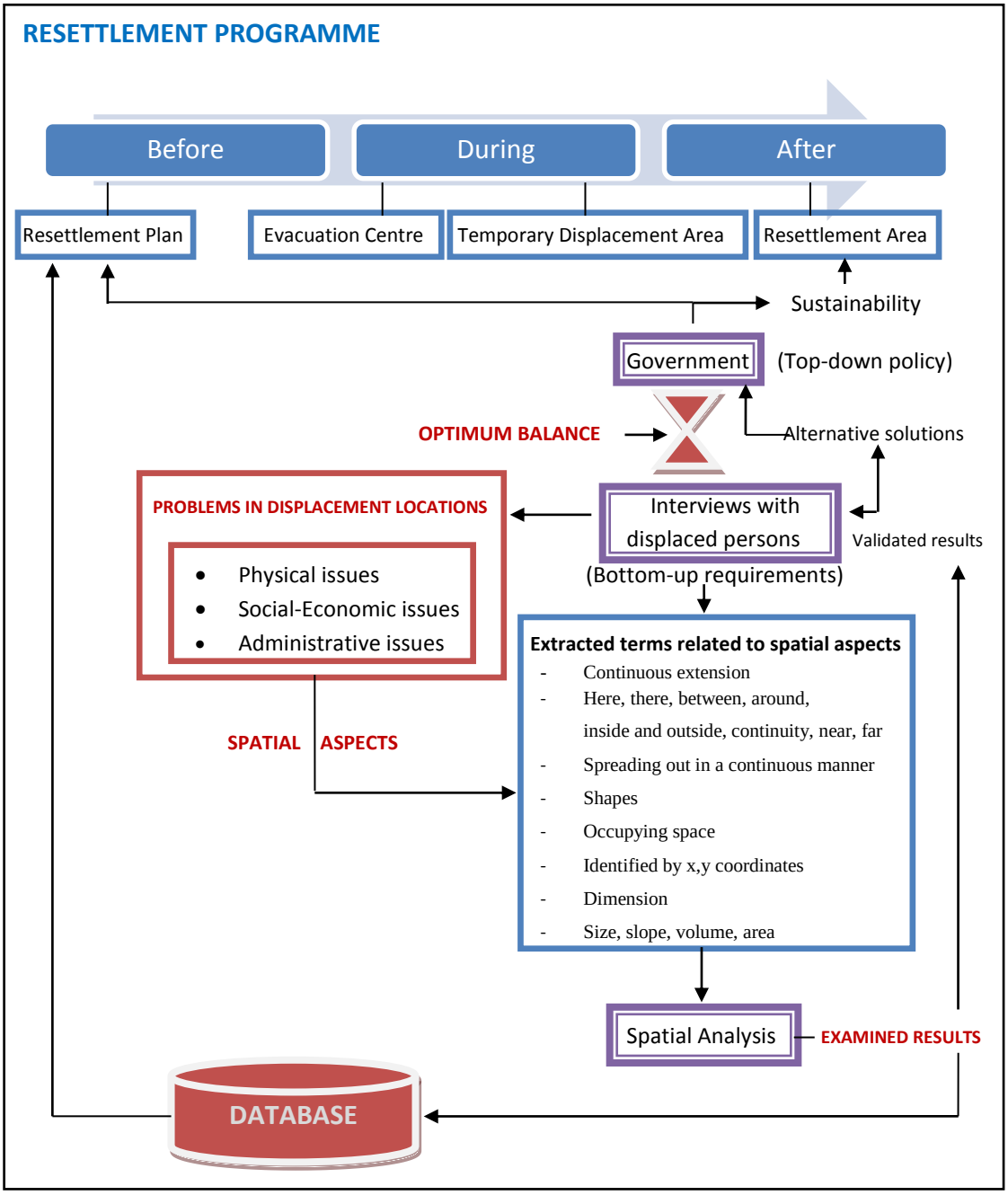


Figure 2. 5: Conceptual framework of the study

Regarding this rationale, it is essential to study the real situations associated with a resettlement programme and present the systematic procedures for extracting those sensitive issues associated with spatial aspects by applying spatial analysis.

CHAPTER 3

RESEARCH METHODOLOGY

3.1 INTRODUCTION:

The effort to close the knowledge gaps identified from the reviewed literature requires a systematic research method. This chapter reviews the research methodology adopted in this research which is justified logically. This chapter is organised into five parts: the 'nested approach' to research methodology, the research philosophy, the research approach, the research techniques, and the validation of the study. This research uses the nested approach as its overall research framework to present the systematic processes for conducting the research rigorously. This nested approach was used to guide the research design into a holistic perspective of the research philosophy, research approach, and research techniques. Within the research techniques, the data collection and data analysis were described, showing the procedures for collecting and analysing the data logically. Finally, the methods for validating the findings are discussed, in order to increase the validation and reliability of the research.

3.2 RESEARCH FRAMEWORK

Research methodology is a thematic framework used to conduct research systematically (O'Leary, 2004). The research methodology justified in this research consists of procedures that were followed in order to explore reliable and valid answers to the research questions. For this reason, a framework which presents the narrowed-down approaches to conducting the research systematically is considered in this section. Regarding the nature of this study, this research intensively requires an established framework, leading to some specific research techniques in order to gain knowledge from the study.

Regarding the requirement of a hierarchical model for this study, the "nested approach" (Kagioglou et al., 1998) is used in this research to present a holistic research methodology. Therefore, this research encompasses the research philosophy, research approaches, and research techniques. The research philosophy presents the dominant stand of the study.

Narrowed down to the research approaches, this study justifies the selection of a potential approach to study the focused elements. More specifically, the research was designed to select the most appropriate technique to gain knowledge from the focused elements of the research interest.

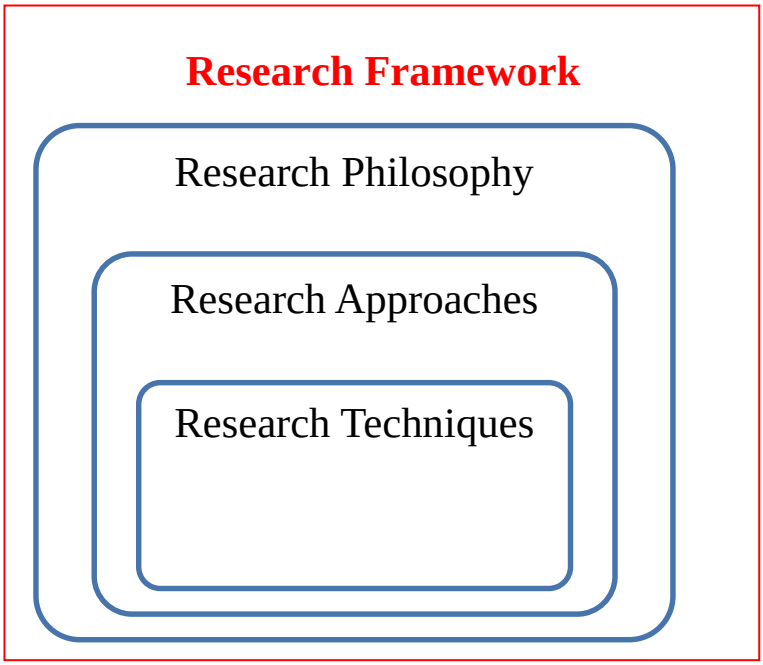


Figure 3. 1: Nested research methodology framework (Kagioglou et al., 1998)

Focusing on the outer element of nested research, the next section presents the research philosophies considered in this study.

3.2.1 Research Philosophies

A research philosophy is essential to evaluate different methodologies and methods in order to avoid inappropriate use and unnecessary work by identifying the limitations of particular approaches at an early stage (Easterby-Smith et al., 2002). Philosophical positions describe views about reality. In order to conduct research systematically, it is essential initially to understand the nature of reality of the research. Considering the nature of reality, there are generally three major ways of thinking about research philosophies; namely, ontology, epistemology and axiology,. These philosophical stances present the acceptable knowledge in the field of study, assumptions made about the nature of reality, and the nature of values respectively (Saunders et al., 2007).

3.2.1.1 Ontology, Epistemology, and Axiology

Ontology is the theory of the nature of social entities (Bryman, 2001). It provides a way to investigate theory-based elements or a social entity, and how to study the nature of existence (Walliman, 2007; Gray, 2009). Ontology describes "what knowledge is" and assumptions about reality (Miles and Huberman, 1994). The nature of reality, as defined by ontology, consists of two different natures, i.e. objectivism and subjectivism (Easterby-Smith et al., 2002). *Objectivism* is focused on the social entities that exist in reality, which are external to the social actors concerned with their existence (Saunders et al., 2007). Conversely, *subjectivism* considers the reality of existence through experience, which is internal to the social actors (Flowers, 2009). Likewise, Collis and Hussey (2003) concluded that objectivism is objective and external to the researcher, whereas subjectivism is subjectively understood by examining the perceptions of human actors.

Epistemology focuses on the theory of knowledge, especially with regard to its methods, validation and the possible ways of gaining knowledge in the assumed reality (Sutrisna, 2009). Briefly, epistemology describes "how we know it" and assumptions about how knowledge should be acquired and accepted (Miles and Huberman, 1994). There are two different stands for these effective methods: positivism and social constructivism (interpretivism). Positivism is a way to observe the object systematically, based on knowledge as theory testing; on the other hand, social constructivism (interpretivism) is a way to study how human beings who are socialised individuals create their own reality as the theory builds (Weber, 2004; Pathirage et al., 2008; Sutrisna, 2009).

Axiology is a branch of philosophy that studies judgments about value. It is also concluded that axiology is "what researcher values go into it" and assumptions about the value system (Miles and Huberman, 1994). Axiology is divided into two different types: value free and value laden. Value free is the choice of study in terms of what/ how to study the objective criteria which are unaffected by the research activities, while value laden is determined by human beliefs and experiences (Easterby-Smith et al., 2002).

3.2.1.2 Philosophical stance of this research

The philosophical stance shows the position within the research philosophies' continuum, based on the ontological, epistemological and axiological foundations. Regarding the world and reality of social entities, the philosophical stances were justified differently within each research paradigm and methodology. In Figure 3.2, the research paradigm of

the three philosophical stands was illustrated showing the direction of the research conducted with regard to the ontological, epistemological, and axiological assumptions.

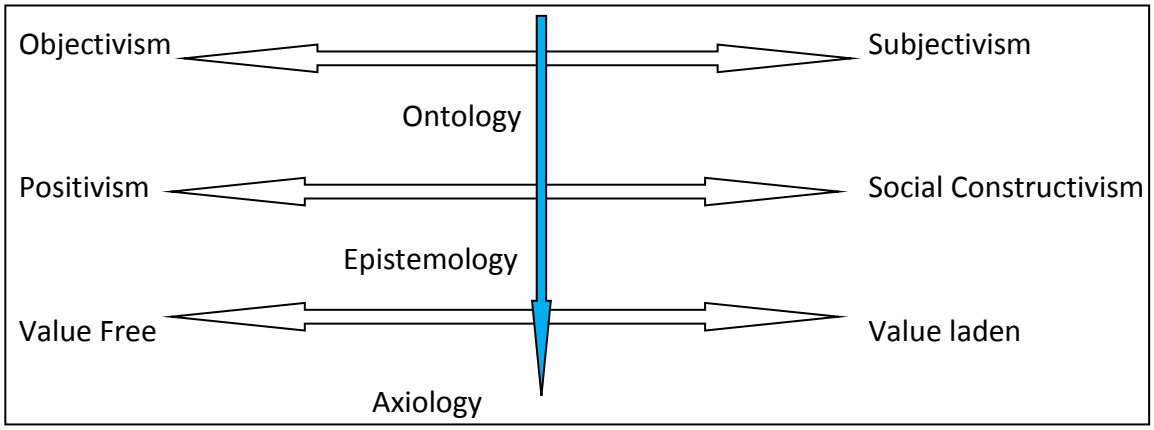


Figure 3. 2: Research positioning within ontology, epistemology and axiology.

Focusing on the ontological assumptions, the philosophical position of this study moves more towards subjectivism on the ontological continuum, based on the nature of this research which mainly attempts to investigate the perceptions of displaced people with regard to a resettlement programme. The knowledge derived from the perceptions of displaced people is subjective in terms of the experiences of this group with regard to the real circumstances of a resettlement programme.

Apart from the main focus being on the perceptions of displaced persons in a resettlement programme, the nature of this research also investigates the spatial aspects of displacement locations addressed in the content of this perception. With a transformation of all spatial aspect terms derived from the respondents onto the maps, these explored issues instantly become objective, measurable in realism and capable of being examined spatially. For these reasons, this research does not adopt an extreme subjectivism assumption on the ontological continuum.

Considering the method of gaining knowledge in this research, this study is closer to social constructionism or interpretivism than the positivism assumption, as it attempts to understand the situations and explore the complex social issues that occur in a resettlement programme. For this reason, it is essential to study the perceptions of these displaced people extensively. This study takes a mainly interpretivism approach to gain knowledge derived from displaced people's perceptions and experiences, and partly takes a positivistic approach to examine the spatial aspects mentioned by these people. For this

reason, this study does not take an extreme interpretivism assumption on the epistemological continuum.

Focusing on the value of the research, this study leans towards the value-laden stance. According to the clear conclusions of Easterby-Smith et al. (2002), it was emphasised that value laden research is determined by human beliefs and experience. This value laden stance, therefore, corresponds to the nature of this research which considers mainly the perceptions and experiences of displaced people in a resettlement programme. In terms of identifying the axiological stance as moving towards being theory laden, Pathirage et al. (2008) further described how "theory laden is the way in which the prior theories and values of the observer influence what the individuals "see"".

This study inclines towards the value-laden stance due to its focus on displaced person's perceptions of the provision of the basic essentials. However, the research also remains partly value free from the provision of the basic essentials in terms of their spatial positions and aspects, which are unaffected by the research activities. According to the descriptive rationale in research philosophies applied in this study, this research will feasibly construct knowledge of the interaction of re-settlers to the provision of the basic essentials in resettlement areas by following the research approach and techniques.

3.2.2 Research Approach

The identified research philosophy guided the researcher towards identifying the appropriate research approach. Regarding the nested approach, this study was organised to collect data in appropriate ways in order to achieve the research aim. The research approach presents the different ways of conducting research. Firstly, the inductive process refers to the process of constructing theories from empirical data by searching for themes and seeking to make meaning from the evidence (Somekh and Lewin, 2005). The nature of the inductive approach is that it commonly moves from the particular (sample) towards the general (universe) which is known as statistical induction or statistical inference (Kothari, 2004). On the other hand, the deductive process refers to the process of using established theories as a framework from which to develop hypotheses (Somekh and Lewin, 2005). The deductive approach considers a population or universe (finite or infinite) and investigates the behaviour of the samples drawn from this universe applying the laws of probability (Kothari, 2004).

Table 3. 1: Major differences between the inductive and deductive approaches to research (Pathirage et al., 2008)

INDUCTION	DEDUCTION
Moving from data to theory	Moving from theory to data
Common with social sciences	Common with natural sciences
Flexible structure to permit changes	A highly structured approach
Understanding of meanings humans attach to events	Explain causal relationships between variables
Less concern with the need to generalise	Select sample of sufficient size to generalise conclusions

Considering the nature of this research, this study considers the induction approach to gain the information from displaced people regarding the issues that arose related to the resettlement programme. Using this induction approach, it is possible to understand the issues of the displaced people and displacement location explicitly. Additionally, the rich information drawn from the data obtained from the respondents can provide a broad view of the resettlement programme and resettlement activities.

3.2.2.1 Research strategy

A research strategy is defined as a general plan for answering the research questions within the philosophical conditions of epistemology, ontology and axiology (Saunders et al., 2007). Under the umbrella of research strategies, Yin (2003) explained that a research strategy consists of an experiment, survey, archival analysis, history and case study, while Saunders et al. (2007) suggested that it contains an experiment, survey, case study, action research, grounded theory, ethnography, and archival research. With regard to the Research Onion studied by Saunders et al. (2007), the predominant characteristics of all research strategies are summarised in the following context.

Experiment research owes much to the natural sciences, in which the researcher can manipulate behaviour in controlled environments (Saunders et al., 2007). It is where variables are arranged for events to happen in the controlled environment, and this is the

prominent characteristic of experiment research. *Survey research* normally studies a large number of samples within a particular timeframe, via describing, recording, analysing and interpreting the existence of the phenomena (Kothari, 2004). Additionally, survey research is predominantly used to answer "who", "what", "how many" and "how much" questions (Yin, 2003). *Action research* requires high participative observation from the researcher in a partially controlled environment (Saunders et al., 2007).

Grounded theory research is defined as an analysis strategy that is used to generate an inductive theory about a substantive area (Glaser and Strauss, 1967). Noticeably, grounded theory requires a comparative analysis of different groups or subgroups of people to build a theory.

Archival research involves materials created or received by a person, family, or organisation, public or private, in the conduct of their affairs and preserved because of the enduring value contained in the information they contain, or as evidence of the functions and responsibilities of their creator (Pearce-Moses, 2005). Archival research acquires the generated data either formally or informally. Additionally, archival research prominently allows the investigation of research phenomena over the time spans by adopting the generated data from the primary and secondary sources (Saunders et al., 2007).

Ethnography research involves studying the phenomenon within the context in which it occurs and not using data collection techniques that oversimplify the complexities of everyday life (Saunders et al., 2007). The researchers, therefore, may need to immerse themselves in the social world, which is very time consuming.

Case study research is a strategy for understanding the dynamics present within single settings or events (Amaratunga and Baldry, 2001). A case study involves an empirical investigation of a particular contemporary phenomenon within its real life context using multiple sources of evidence. Case study research is common for both testing and building theory (Pathirage et al., 2008). The case study is an intensive investigation, an in depth study of the particular unit(s) under consideration rather than in breadth (Kothari, 2004).

Based on Yin's (2003) study, it is possible to justify selecting an appropriate research strategy in order to investigate the notion from the scope of interest by considering the forms of research questions as well (as shown in Table 3.2).

Table 3. 2: Research strategies for different situations

Strategies	**Form of research questions**	**Requires control of behavioural events?**	**Focuses on contemporary events?**
EXPERIMENT	How, Why	Yes	Yes
SURVEY	Who, what, where, how many/much	No	Yes
ARCHIVAL ANALYSIS	Who, what, where, how many/much	No	Yes/No
HISTORY	How, why	No	No
CASE STUDY	How, why	No	Yes

(Source: *COSMOS* Corporation cited Yin (2003))

Accordingly, this research does not take place entirely or partially in the controlled environment or laboratory with the logical experimental establishment, and the researcher has neither manipulated any behaviour nor controlled any behavioural events. Therefore, the experiment and action research approaches were rejected for this study. In addition, this research does not deal with exploring a static story about the past situation of resettlement programmes, but focuses on the dynamic development of a resettlement programme since the disaster event occurred in the recent past. Therefore, the history or ethnography strategy was also rejected in this research.

Based on the nature of this research, a case study strategy is the most appropriate, since it attempts to answer the following research question: "How can the spatial analysis be used to analyse and address the socio-economic issues in resettlement programmes?"

Considering the statement of the research problem, this research aims to investigate the application of spatial analysis tools and techniques to analyse and address socio-economic issues in resettlement programmes. This aim is further expanded into five objectives in order to answer the current research question:

1. To understand different phases and activities in resettlement programmes
2. To investigate the socio-economic issues and spatial aspects in resettlement programmes
3. To explore the relationships between spatial aspects and socio-economic issues in resettlement programmes
4. To apply the spatial analysis techniques in analysing and addressing the socio economic issues in resettlement programmes
5. To develop a spatial database design to help designing and managing the resettlement programmes to minimise the potential socio-economic issues.

It was found from the reviewed literature and previous work that several issues arise related to resettlement programmes. For this reason, the perceptions of displaced people must be studied intensively in order to propose an effective approach to minimise these complex issues effectively.

- ***Case study strategy***

One of the advantages of applying the case study is it that is provides a full understanding of a behaviour pattern of the concerned unit (Kothari, 2004). Theoretically, case studies can follow one of four types of design; single-case (holistic) design, single-case (embedded) design, multiple-case (holistic) design, and multiple-case (embedded) design (Yin, 2003). This is to say, the sub-categories of the case-study strategy mainly consist of single-case study and multiple-case study. Drawing a distinction between single- and multiple-case designs when designing a case study is important prior to making a decision about the data collection.

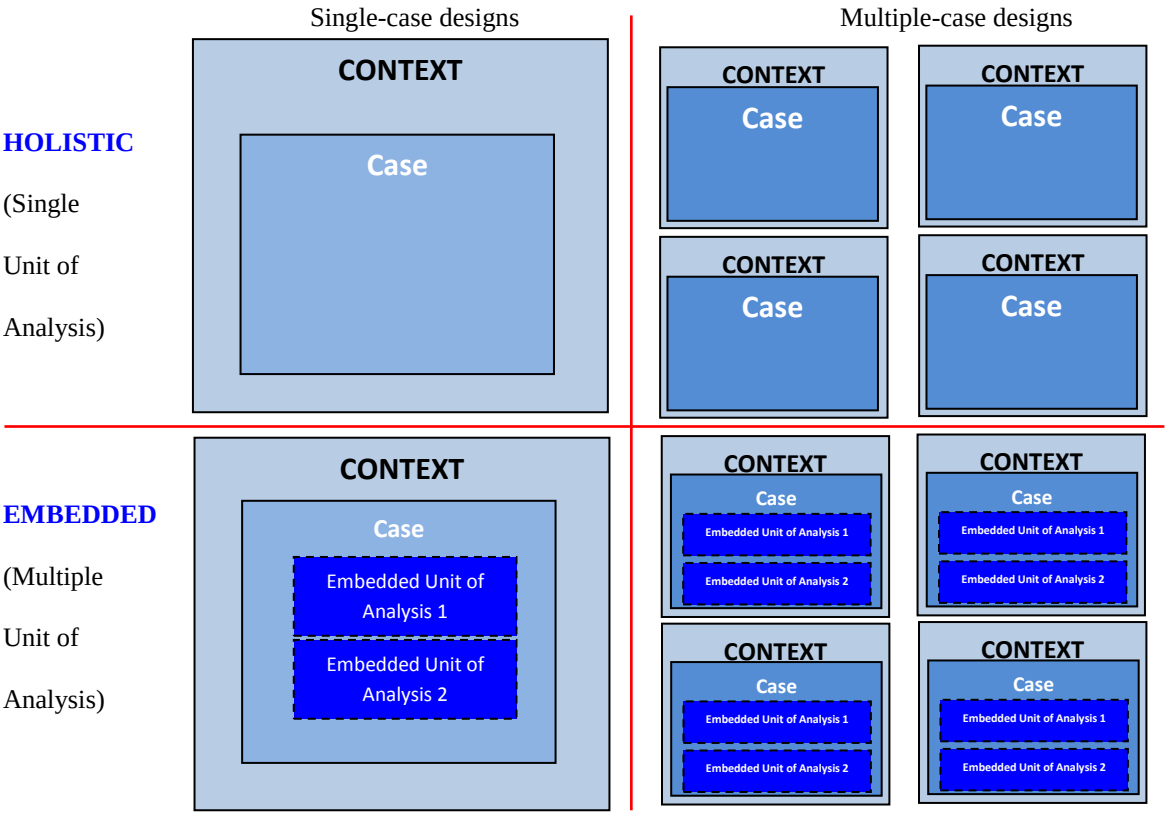


Figure 3. 3: Fundamental designs for case studies

(Source: *COSMOS* Corporation cited Yin (2003))

There are certain rationales that are considered to distinguish a single-case design from a multiple-case one that will be addressed in the following context. The single case is considered when it represents the critical case for testing a well-formulated theory, is extreme and unique, is representative or typical, is revelatory, thus giving the investigator an opportunity to observe and analyse a phenomenon, and is longitudinal in nature (Yin, 2003). However, the same case study may involve more than one unit of analysis, so that an embedded case-study design is developed. The subunits are studied in order to explore the opportunities for analysis and enhance the insights into the single case (Yin, 2003). Although a multiple-case design is considered to differ from the single-case design, every case in the multiple-case design must serve a specific purpose within the overall scope of the inquiry and follow the replication logic (Yin, 2003).

This research adopts the single case study as a research strategy for the following reasons. Initially, it is noticeable that the study area is the first place to apply an official, full resettlement programme after the sudden-onset disaster of debris flow in Thailand. From the pilot observations and interviews conducted by the researcher in 2010, it was found that displaced people were evacuated to emergency centres, transferred to temporary

housing in the established areas, and resettled in a permanent resettlement area (Arunothai, 2010; Supap, 2010). Comparing the types of the mentioned case study as the justified research strategy for these circumstances, this research uses the single-case (embedded) design to analyse a single resettlement programme based on the varying perceptions of the respondents who have experienced different destructive conditions (e.g. partially or completely damaged houses) due to the major debris flow event in 2001. In order to explore the real situations associated with the displacement locations, displaced people and the local government are the main sources of information, reflecting the real circumstances which have occurred since the disaster occurred more than 10 years ago. This timeline is useful for the whole framework of the resettlement programme, which continues to influence displaced people down to the present day. For these reasons, this research uses the single case study with embedded units of analysis as the research strategy.

With respect to the above rationale for justifying the choice of a single-case study, embedded with multiple units of analysis, as noted by Yin (2003), it was designed to gain knowledge about the perceptions of two different sources, e.g. from the resettlement policy conductors (local government and shelter providers) and the displaced persons. Therefore, the local government, who implemented a top-down policy, was considered as the first group in the embedded unit of analysis 1. Secondly, displaced people who enrolled on the resettlement programme were considered as the second group in the embedded unit of analysis 2. Focusing on displaced persons within the unit of analysis 2, there were also two groups of affected people involved in the resettlement programme: i.e. displaced persons whose houses were partly destroyed, considered as group A, and displaced persons whose houses were completely destroyed, considered as group B. This classification is illustrated in Figure 3.4:

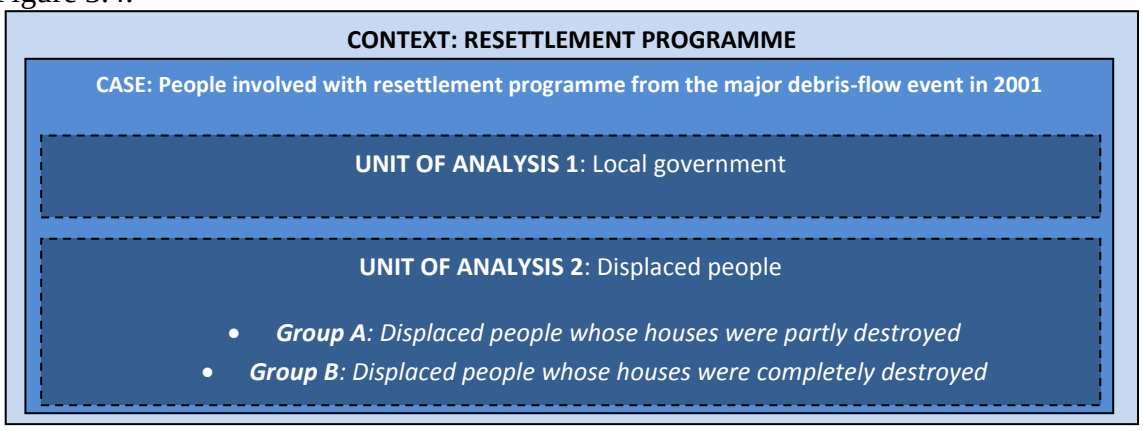


Figure 3. 4: Research strategy of the study: single-case design with embedded multiple units of analysis

3.2.2.2 Research Choices

Research choices highlight the option available for researchers to consider using the mono method or multiple methods of quantitative and/or qualitative study. Following the guideline of the Research Onion, Saunders et al. (2007) illustrated the hierarchal categories of research choices, shown in Figure 3.5:

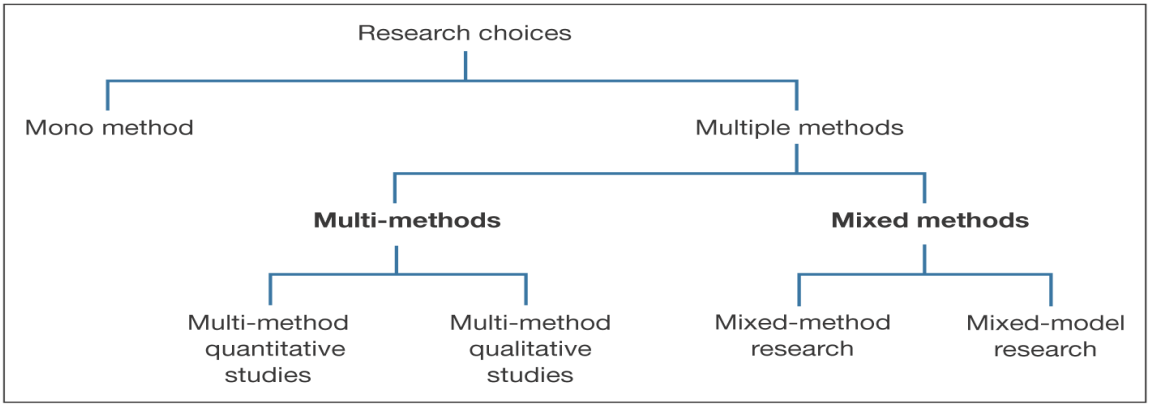


Figure 3. 5: Research choices (Saunders et al., 2007)

A study by Saunders and colleagues (2007) described how the mono method is considered for use with one data collection technique and one corresponding data analysis method, while multiple methods are considered for use with more than one data collection and analysis technique.

Typically, quantitative research is conducted to examine "what is happening", while qualitative research is applied to determine "why events occur" (Black, 2002). Quantitative research is conducted by mainly considering the numbers and statistics to quantify the findings of the research. On the other hand, qualitative research inclines towards investigate stories and narratives (Kalof et al., 2008). The strengths and weaknesses of the quantitative and qualitative paradigms were discussed controversially by many researchers. For instance, Amaratunga et al. (2002) emphasised the advantages of the mixed approach to see whether "quantitative data can help with the qualitative side of a study during design by finding a representative sample and locating deviant samples, while qualitative data can help the quantitative side of the study during design by aiding with conceptual development and instrumentation". Also, Black (2002) advocated implementing mixed methods in social research as this enables a contribution to a greater body of knowledge due to the lack of extreme ideology from the subjective generalisation in qualitative study and the trivial findings in normative study in quantitative study.

Regarding the research choices, this research adopts the qualitative approach due to the desire to explore the problems associated with resettlement programmes through the qualitative data of the respondents' perceptions. These descriptive results from the qualitative study are able to provide in-depth reasons supporting the objective conditions (i.e. availability, capacity, and dimensions) of the spatial aspects of the displacement locations.

3.2.2.3 Time horizons

Time horizons, as classified in a study by Saunders et al. (2007), are focused on two types, i.e. cross sectional and longitudinal study. Longitudinal study is adopted to discover elements over time, whereas cross sectional study considers the element at one period of time (Kalof et al., 2008). Based on the research strategy paradigm, it is shown that content analysis, archival research, field research, surveys, and interviews consider the time horizons both in longitudinal and cross sectional periods, whereas historical research considers only longitudinal study, yet experimental research commonly takes a snapshot of cross sectional study (Kalof et al., 2008). However, it is considered that the case study strategy can be a cross sectional and/or a longitudinal study (Kothari, 2004).

Focusing on the time horizons in this study, this research attempts to explore the development of a resettlement programme through time since the disaster in 2001 until the present day. As this study was undertaken to present the perceptions of displaced people over time, therefore, this research adopts longitudinal study as the time horizon.

3.2.3 Research Techniques

Considering the innermost frame of the research framework designed by Kagioglou et al. (1998), research techniques are emphasised to specify the justified techniques for conducting the research logically. Research techniques typically consist of those employed within data collection and analysis procedures. This topic discusses the principle concepts of data collection and data analysis before describing the specific techniques employed in response to the objectives of the research.

3.2.3.1 Data collection

Under the umbrella of the case study, this research strategy employs several collection techniques, such as interviews, observation, documentary analysis, and questionnaires (Saunders et al., 2006). Interviews involve the technique of asking questions and eliciting

answers orally (Thomas, 2003). Observation is the technique of collecting information by means of watching and/or listening to events, then recording the occurrences (Thomas, 2003). Documentary analysis is the technique of analysing documents and texts to quantify their content into categories systematically (Bryman, 2001). A questionnaire consists of a series of questions that the respondents read and answer by themselves (Kalof et al., 2008). One of the advantages of engaging in rigid data collection is the opportunity to return to the raw data by investigating the chain of evidence, which makes the case study more reliable, from the research question formation to the conclusion (Yin, 2003).

This research employs three techniques to gain knowledge from the data collected in three different ways i.e. *documentary review*, *interviews*, and *observations*. These techniques are triangulated to increase the validity and reliability of the data collected (Figure 3.6).

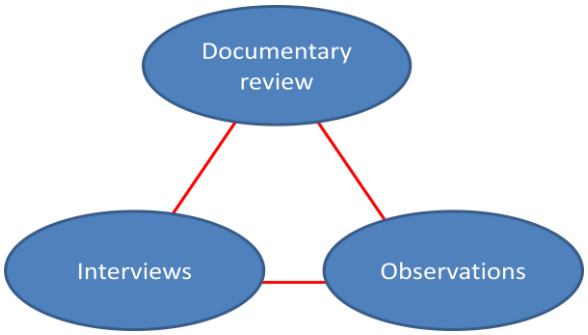


Figure 3. 6: Triangulation of data collection

The rationale for justifying the use of these three techniques is provided in the following.

- ***Documentary review***

This research reviewed the context regarding the historical events recorded in a book with a Thai language version by an ex-local governor, Mr Preecha Ruangchan (Ruangchan, 2001). In addition, news reports from different sources highlighting the situation of this hazard area were used in this documentary review (i.e. Naewna news, 2001; khaosod news, 2001; Daily news, 2007). The reviewed information derived from the information of the Royal Foundation, "Friends in need of "PA" volunteer foundation" the Red Cross website, published online at www.princess-pa-foundation.or.th. Moreover, some useful information appeared on www.mirror.or.th, the website of the Mirror foundation. These various sources of information are a vital resource for the document review.

- ***Semi-structured interviews***

The documentary reviewing technique and pilot interviews were considered prior to conducting the semi-structured interviews. This evidence was carefully studied to establish a series of formed questions regarding the reviewed circumstances. This study attempts to explore the barriers within resettlement programmes and the characteristics of the programme from the perceptions of displaced people. For this reason, the respondents were interviewed orally. Given the time series, it is quite rare for the respondents to be able to recall the events precisely, since the disaster happened in 2001. In addition, the complexity of the barriers to achieving a successful resettlement programme is linked in a complex way with socio-economic, physical, and administrative issues. Given the nature of semi-structured interviews, the queries were predetermined according to the guidelines, whist the order and wording could be modified, where appropriate. For these reasons, semi-structured interviews were considered, due to all of the questions being broad, which meant that they could be adjusted spontaneously. This technique also made it possible to vary the sequence of questions in response to the interview situation. Therefore, semi-structured interviews were chosen for this research.

- ***Observation***

Observation is an empirical technique exercised in this research. Regarding the specific interest in spatial conditions related to the barriers to resettlement programmes, the existing conditions of the infrastructure, facilities, and social service buildings were observed throughout the resettlement and hazard areas. The observation was conducted by picturing, recording, and measuring using a digital camera, video, and tape respectively. Furthermore, the basic essential infrastructure, facilities and social service buildings were positioned by the RTK GPS (Real time Kinematic Geographical Positioning System). This instrument can provide very precise locations, showing the relative height of the observed objects. These relative levels were used to generate a very fine quality DEM (Digital Elevation Model). A high-resolution generated DEM of the study area and its vicinity is illustrated in Figure 3.7.

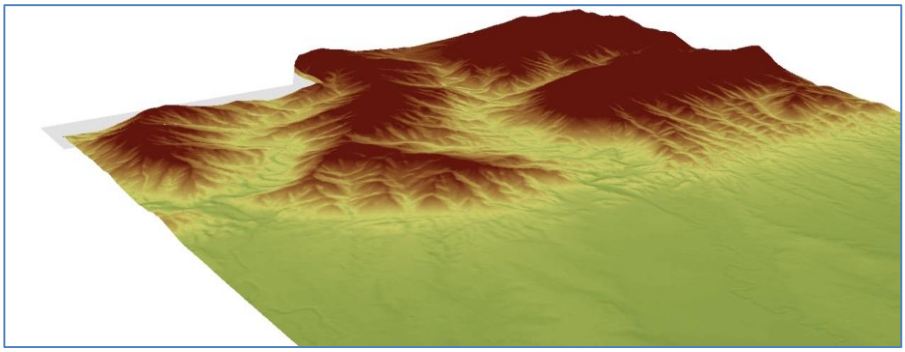


Figure 3. 7: Topographical terrain of the study area generated by DEM

Since the hazard community was destroyed by the debris flow, the post-disaster management on a local scale is meaningful for every potential organisational level. Therefore, such a disastrous incident requires very fine based maps on a local scale for further analysis and management. From the overview, the space-borne images, as Landsat Images, were used to investigate the land-use activities and land-use changes over the study and proximity areas. More specifically, airborne images, such as ADS images from LiDAR technology and aerial photos, were used to identify the positions of all observed objects. All base maps were produced using cartographical and photogrammetric techniques based on the available archives from space-borne and airborne platforms, as listed in Figure 3.8.

- Black & White aerial photos (1:25,000) in 1995
- Landsat Image resolution 30 m. in Jan 2001
- Landsat Image resolution 30 m. in Nov 2001
- Colour other photos (1:4,000) in 2002
- ADS image from LiDAR resolution 5 m. in Dec 2007
- ADS image from LiDAR resolution 5 m. in Nov 2010

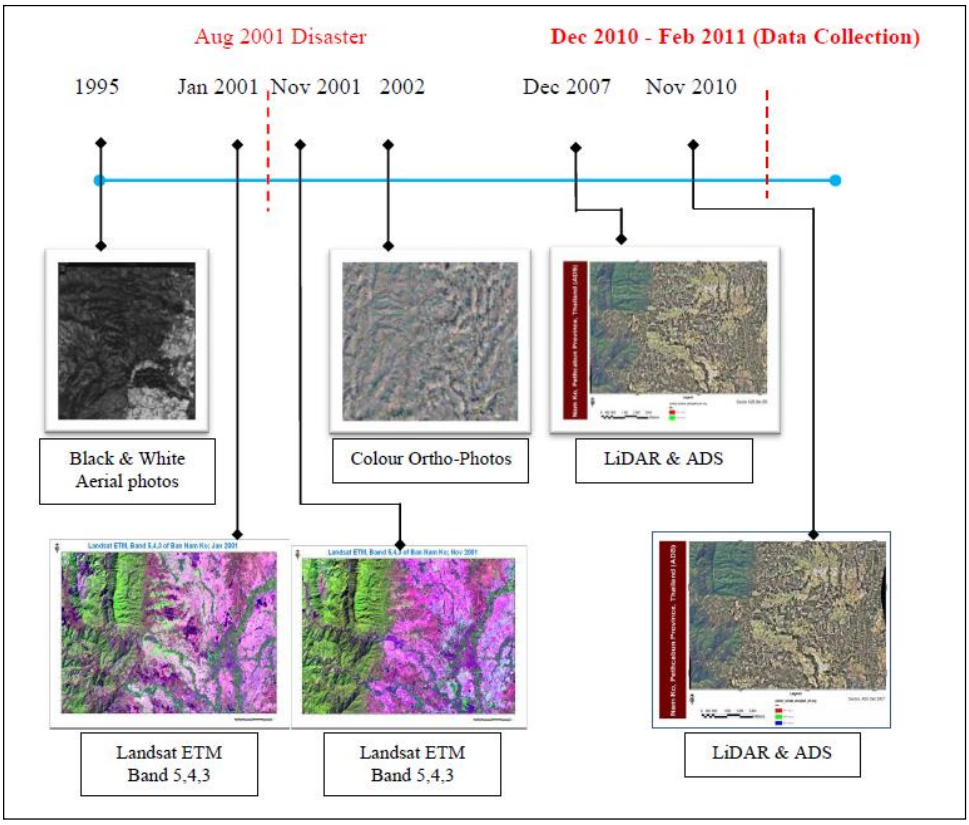


Figure 3. 8: Series of base maps used in this research

By applying the base maps illustrated in Figure 3.8, several layers of thematic maps were prepared in order to present the essential information about the hazard area, the proximate areas, and the displacement locations. These base-maps were derived from the extracted data from satellite images and cartographical techniques. Eight thematic map layers employed in this study are listed below, associated with the techniques of preparation.

1) Housing map: digitised houses from photo interpretation techniques based on high resolution digital aerial photos.
2) Infrastructure map: digitised roads, canals, bridges, public telephone, provisional electricity and wells from photo interpretation techniques based on high resolution digital aerial photos.
3) Land-use map: discriminated vegetative types from image classification of Landsat images.
4) Administrative map: digitised municipal boundaries from topographical map.
5) Social service map: digitised schools, temples, hospitals, health centres, social centres, and bus stations from the photo interpretation techniques based on high resolution digital aerial photos.

6) Soil map: digitised from soil series map of the department of natural resources and forestry.
7) Slope map: generated from high resolution DEM from LiDAR technology.
8) Land parcel map: digitised from the hard copies of land parcel maps, Department of Land.

Based on the thematic based map preparation, a virtual topographical terrain with the delineated boundaries of the debris flow hazard community is generated, as shown in the 3D image in Fig.3.9, which represents the terrain form of the study area.

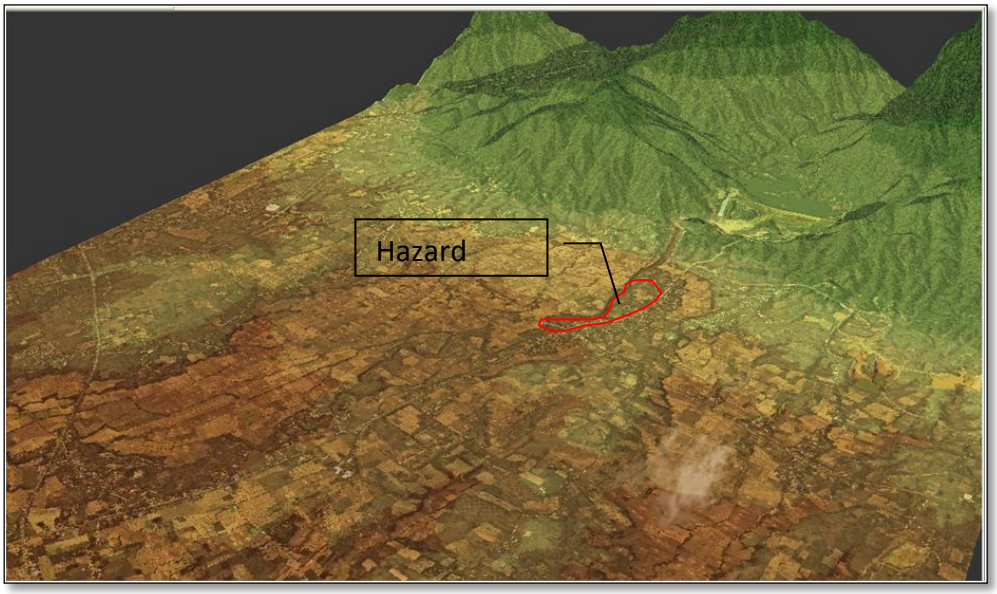


Figure 3. 9: Hazard area in 3D terrain

Based on the essential materials and techniques mentioned above, it is certain that the quality of the data derived from the respondents and the sufficient quantity of samples of existing objects can provide rich information for further analysis and ensure reliability due to the triangulation of the data collection.

3.2.3.2 Data analysis

Generally, data analysis consists of examining, categorising, tabulating and testing data to address the initial propositions of a study (Easterby-Smith et al., 2002). Qualitative data analysis often consists of a two-stage process, involving: (1) making analytic memos in a research diary or field notebook, and (2) undertaking a more systematic process by fragmenting the data and attaching concept labels to each separate piece as a first step in the construction of theory, or interrogating data to search for answers to questions and

evidence that either support or refute the emerging theories (Somekh and Lewin, 2005). Nvivo is an example of computer software for qualitative data analysis which allows users to attach concept labels to sections of text, although it may not be feasible for smaller scale studies to use this software (Somekh and Lewin, 2005).

Focusing on an umbrella of the case study strategy, the data analysis is described in the form of transcribed taped interviews and extensive field notes (Somekh and Lewin, 2005). The strategies for establishing data analysis are clearly addressed in a study by Yin (2003), who stated that the construction of data analysis relies on the theoretical propositions regarding the research questions, concerns rival explanations, and develops a case description. In terms of social science research, data analysis initials are assigned to make sense of, interpret, and make meaning from the collected data before moving towards the larger process of generating knowledge (Somekh and Lewin, 2005). As this is qualitative approach research, the researcher used the descriptive analysis method in the form of transcribed taped interviews with the respondents in order to process the content analysis, cognitive mapping and spatial analysis.

- ***Content analysis***

Content analysis is a technique used to analyse texts, whether written, spoken or visual, into a series of meaningful categories which can present either qualitative or quantitative outcomes (Kalof et al., 2008). Content analysis is always used with in-depth interviews, which consist of a series of open-ended exploratory interviews, where the researcher has little or no control over the issues that arise (Crano and Brewer, 2002). Several materials which contain the time correspondent series are also considered as crucial sources for content analysis, such as newspaper summaries, case records, and personal letters (Crano and Brewer, 2002). This research adopted content analysis to match the transcribed words from the semi-structured interviews to key themes (concepts) regarding the spatial aspects and conditions that emerged from the interview transcripts. Based on the procedure conducted during the content analysis, firstly, the data from the semi-structured interviews were transcribed electronically into a Microsoft Word document. Secondly, the context was carefully explored in order to investigate the key themes or concepts linked to the spatial aspects and conditions within resettlement programmes. It was found that the coded content showed the relationships between the situation and the emerging problems associated with spatial conditions of the respondents.

This study carefully investigated the transcribed data obtained from the semi-structured interviews with the respondents by intensively focusing on the key concepts which contained the meanings of the space and the dimensions of the provision of the basic essentials in the displacement locations and proximate areas. Based on a guideline summarised by Basden (2004), some key words which contain the meanings of dimensions and spatial aspects were decoded from the transcriptions.

The word "spatial", as used within geographical studies, concerns where and why things are sited where they are in term of location, interaction, region, place, and movement. These five themes are the fundamental elements that have been broadly applied in the guidelines on geographical education since 1984. After transcribing the explored issues occurred in all displacement locations from the interviews, some key words addressed as relevant to spatial aspects by Basden (2004) have been intensively studied further using the process of content analysis. According the spatial aspects addressed by Basden (2004), it is concluded that some key terms contain the spatial dimension, such as:

- Here, there, near, far
- Shapes, size, position, slope, volume
- Lines, areas, volumes
- Dimension

The information regarding activities and barriers to achieving a successful resettlement as described by the interviewees was transcribed by focusing on three different displacement locations, initially from evacuation centres to a temporary displacement area and later to a permanent resettlement area. The terms hidden with the spatial aspect characteristics were defined within the scope of the research interest regarding the situations within the resettlement programme, such as:

- Here, there, near, far

These terms express the sense of distance of the critical issues. Some terms, which have a sense of distance hidden within their meanings, were also considered such as between, around, inside and outside. These key terms were determined from the content provided by the interviewees, showing the distinctive distance between the original homeland and the resettlement areas in each phase. These terms also highlighted the distance between the resettlement places and community service places, such as markets, hospital, temples, etc.

- Dimension

The occupying space and dimension are importantly divided for displaced persons and the organisers in resettlement areas. From the announcement of the emergency until the resettling in the permanent resettlement area, dimension is involved in several activities. It is essential to be certain that the dimension is sufficient for the involved people's usage. Therefore, dimension and density were carefully analysed in the content provided by the interviewees.

- Size, position, slope, volume, shape

The topography of the areas occupied by the resettlement programme and hazard area was intensively studied and compared by considering the content provided by the interviewees. All of the places associated with resettlement activities were explored by determining the information obtained from the interviewees. The location of these places was later identified precisely using the coordinates on the rectified based map. For reasons of safety, slope is determined by the interviewees' experiences. The displacement areas were intensively defined in terms of the shapes of the space, location, and boundaries. It is also crucial to review the continuous extension of these resettlement areas in all phases. The expansion appeared in terms of a physical extension regarding the requirement of additional space for any post-disaster activities, including resettlement activities.

- Lines, areas, volumes

Focusing on the topographical features determined in this context, the line features of the transportation networks were studied, such as roads, pathways, etc. Areas focused on the content mentioned the environment surrounding the displacement areas. Volumes studied the amount of focused objects; for example, lost houses in hazard areas and houses in resettlement areas. These issues were explored via the content of the interviews.

This research decided to conduct the content analysis manually due to the following reasons;

1) The small number of respondents: Considering the data collected in this study, the overall information regarding the problems within the resettlement programme were saturated within a small number of respondents. Therefore, this study focused on the deep insights of the respondents regarding the resettlement programme rather than on the tendency of the information provided by a large number of

respondents. The content analysis was conducted by investigating the deep insights of 13 respondents, who were classified into the following two groups: Group A; displaced people, comprising (a1) displaced people whose houses had been completely destroyed (7 respondents), (a2) displaced people whose houses had been partially destroyed (4 respondents) and Group B (2 respondents), those who organised the resettlement area.

2) Barriers to the local language and subtle meanings: the spoken language of the local people in the study area, including the displaced people, is their own traditional language (Lao-Lom language) which is normally used in their daily life. The specific ethnicity of local people is shown as a dialect or local language, culture and beliefs. The local people in the study area speak a dialect called "Lom", which has specific vocal meanings differ from official Thai language (Munying, 2011). Regarding the specific dialect of the local people, these interviews were conducted with an interpreter who was born in Petchabun Province, who has been working in a government department in the province and is familiar with the local dialect. Her mother tongue is Lom, which is the local dialect in Ban Nam Ko. In order to avoid misleading information arising from the collected data, the researcher repeated the interviewees' comments to the interpreter, who was present in person and explained the statements in the official Thai language.

In order to avoid mistakes arising from using automatic decoding systems in a computer-aided analysis programme, the researcher decided to analyse the content manually. As a result, it was possible to identify the hidden verbal meanings of the respondents and the links in their cognitive maps precisely.

- ***Cognitive mapping***

Cognitive mapping is "a process composed of a series of psychological transformations by which an individual acquires, stores, recalls, and decodes information about the relative locations and attributes of the phenomena in a spatial environment" (Downs and Stea, 1973, p. 7). This analytical concept was developed based on the original work of Edward C. Tolman (1948), who defined a cognitive map based on an experiment in 1947, showing the cognitive map of a rat's brain. As a spatial consideration, the cognitive map represents a structure within the central nervous system that is geometrically related to spatial relationships through the environment (Jacobs, 2003). However, the cognitive mapping concept has also been applied to a non-spatial environment, and also been used to show

how memory mapping can help when processing a task (Kitchin, 1994). Kitchin (1994) also summarised that a non-spatial environment refers to the awareness, impressions, information, images, and beliefs that people have about environments. Cognitive mapping can present the relationships between places and psychological transformation by being performed with delineated networks in the space within a geographical system (i.e. Wagner, 2007; Zheng and Weimin, 2010; Montello, 2002; Kwan and Hong, 1998; Hirtle, 1998; Zipf and Richter, 2002; Troffa et al., 2009). As the specific concerns of this research are related to spatial aspects, spatial analysis was conducted to identify the statements of the explored links from cognitive mapping.

- ***Spatial analysis***

After obtaining the links between the obstacles and barriers to achieving the resettlement programme from cognitive maps, the statements of the explored problems related to the key concepts associated with the spatial aspects were transformed onto high resolution map layers in order to present the identified spatial conditions. According to the potential of spatial analysis, as mentioned in the literature review chapter, a spatial analysis application in ArcGIS software was employed to identify and examine the spatial conditions of the problems explored in this study. Longley et al. (2001a) summarise the functions of spatial analysis and GIS into six categories as follows, together with a summary of the functions as used in this research:

1.) Queries and reasoning: basic analytical operations are used to answer simple questions posed by the user. Notably, this function does not cause any changes in the database and no new data are produced.

    This research employed this function to query the situations and delineate those situations from the analysis results onto the thematic maps.

2.) Measurements: simple numerical values derived from the measurement of objects, such as the area, shape, capacity, distance or direction of objects.

    In this case study, all of the features presented on the based map can be measured in terms of their area, length, shape, capacity, distance, and direction, in response to the information provided by the respondents about the barriers associated with spatial conditions.

3.) Transformations: this method can change the dataset by combining or comparing them in order to obtain new data sets. This technique uses simple geometric, arithmetic, or logical rules to convert raster data into vector data, or vice versa.

    This technique was used to convert the DEM (Digital Elevation Model) in the raster format to generate the vector format of the contour lines used in identifying the hazard areas and topographical terrain of the residential zone in this study. Also, the spatial aspects features addressed by the respondents were transformed as points, lines, and polygons on the layer maps for any further analysis.

4.) Descriptive summaries: this technique uses descriptive statistic in statistical analysis, including the mean and standard deviation.

    The statistical results from the spatial analysis functions were presented, accompanied by a summary in this study.

5.) Optimisation: the technique designed to select ideal locations from the defined criteria.

    This research considers implementing this concept to optimise the location-based problems and identified criteria explored in the resettlement programme.

6.) Hypothesis testing: this technique generates the results based on the available information in order to answer the established assumption.

    This function was used to examine the issues associated with displacement locations, as demonstrated in the Analysis chapter.

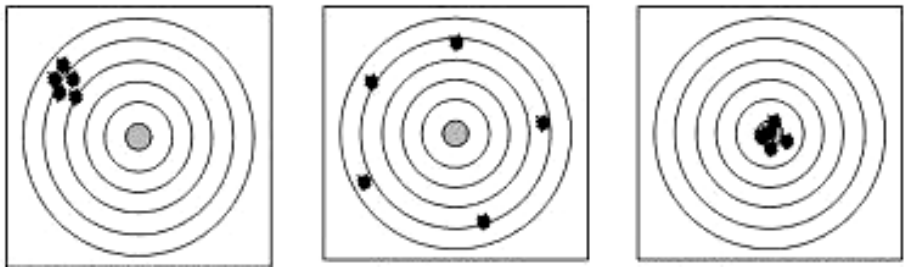
In conclusion, spatial analysis applications are employed with regard to the explored problems associated with locations within the entire resettlement programme. The data analysis techniques are listed in Table 3.3 below, in accordance with the research objectives of the study.

Table 3. 3: Spatial analytical techniques in accordance with the research objectives

Research Objectives	Data analysis methods	Expected outcomes from analysed techniques
1. To understand different phases and activities in resettlement programmes	Content analysis	Resettlement phases and descriptive information
2. To investigate the socio-economic issues and spatial aspects in resettlement programmes	Content analysis	List of the explored barriers to achieving successful resettlement programmes
3. To explore the relationships between spatial aspects and socio-economic issues in resettlement programmes	Cognitive mapping	Links between the relationships between the explored barriers associated with spatial aspects and impacts
4. To apply the spatial analysis techniques in analysing and addressing the socio-economic issues in resettlement programmes	Spatial analysis applications	Thematic maps illustrating the examined results of location-based problems Thematic maps illustrating the feasible solutions to overcoming the location-based problems
5. To develop a spatial database design to help designing and managing the resettlement programmes to minimise the potential socio-economic issues	Spatial database design	A list of spatial databases and criteria developed for resettlement programmes for vulnerable debris-flow hazard areas

3.2.4 Research validation

The terms ‘validity’ and ‘reliability’ are occasionally misused, causing ambiguity in the measured result. These terms are defined explicitly, with illustrations, below (Figure 3.10).



(a) Good Reliability Poor Validity

(b) Poor Reliability Poor Validity (on average)

(c) Good Reliability Good Validity

Figure 3. 10: Validity and reliability quality (Source: (NM-IBIS, 2010))

3.2.4.1 Validity

Validity is an indication of the quality of the research. Validity in data collection means that the findings truly represent the measured phenomenon. Any instrument used to operate a study must be logically consistent. In order to ensure the validity, four common types (construct validity, content validity, internal validity, and external validity) are proposed to confirm validity through alternative and independent observation.

- ***Construct validity*** is concerned with the measurement of abstract concepts and traits, such as intelligence, anxiety, logical reasoning, attitude, social class, or perceived efficiency (Black, 2002). Simply, this term is defined as the consideration of the validity of the measure for the construct of a particular interest. A condition of constructing the validity is a reality of a psychological concept establishment which can predict the relationships with other constructs (Crano and Brewer, 2002). The measurement of this kind of validity is conducted by constructing a focused instrument to apply with different groups of people, which are expected to give responses with different scores (Crano and Brewer, 2002). Likewise, construct validity is processed to confirm the predicted correlations with other theoretical propositions compared with using the constructed measurement instrument (Kothari, 2004).

In order to increase the validity and reliability of research, triangulation is strongly recommended, which involves adopting multiple approaches towards the study of a particular topic (Kalof et al., 2008). This research, therefore, triangulates several elements to increase the research validity, such as:

- Multiple sources of data; this research adopts interviews, observations, and documentary review
- Multiple data analysis techniques; this research adopts content analysis, cognitive mapping, and spatial analysis techniques. The explored findings from the content analysis will be identified on the high resolution based maps. Mapping the identified results on the high resolution based map enables the approval of the spatial conditions of locations and areas in response to the analysed content. This technique can prove the validity of the information associated with spatial aspects gained from the respondents.

- ***Content validity*** is considered a measuring instrument that provides adequate coverage of the studied topic (Kothari, 2004). Also, Kothari (2004) suggested that a good test of content validity is whether the instrument contains a representative sample of the universe that is primarily judgemental and intuitive. The examination of the content validity might be carried out by comparing the topic's coverage and cognitive emphasis on an examination with the original specifications in a syllabus (Black, 2002).

In this research, the content validity was assessed by carefully investigating the similarity of context and issues between the information obtained from the interviews and documents, such as newspapers and a book that recorded the real situation following the disaster in 2001, written by Mr Precha Ruangchan (Ruangchan, 2001). The information provided by the respondents must show the same direction as the context of the mentioned historical documents.

- ***Internal validity*** concerns the application of the data analysis techniques to the issues being investigated. With respect to internal validity, the theoretical propositions have been linked to the data appropriately. There are some factors that affect the internal validity, such as subject variability, the size of the subject population, the time available for the data collection or experimental treatment, history, attrition, and maturation (Seliger and Shohamy, 1990).

The internal validity was addressed in the research in several ways. Firstly, the careful choice of research design enabled the choice of an appropriate research approach and techniques based on the modified nested model. In particular, multiple units of analysis of the embedded single case study have strengthened the results and increased the confidence in the robustness of the explored results in this research. Secondly, this research applied theoretical reviews regarding resettlement programmes broadly across the world. Several

previous works were reviewed to confine the resettlement activities and resettlement phases, in particular the relationships between the explored problems associated with the displacement locations. For this reason, the theoretical propositions were linked to the explored findings from the study appropriately. The chain of evidence is therefore established in this study to ensure the validity of the collected data at all stages.

Apart from the theoretical propositions, the accuracy of the resources is another crucial concern at this stage. Basically, the collected spatial data commonly contain errors from many sources, such as consistency, accessibility, accuracy, sources of errors in data, and sources of error in derived data (Burrough and McDonnell, 1998). The acceptable accuracy of the generated results from spatial analysis must be between 95% and 99% (Fotheringham et al., 2000). Therefore, it is crucial initially to control the accuracy of the generated results from spatial data within the acceptable ranges in order to maintain the validity and reliability of the research. Root mean square errors (RMSEs) were used to represent the positional error at the interval or ratio scale (Haining, 1990). The RMSE for a map can be based on the discrepancy between the measured co-ordinates $(S_1(i), S_2(i))$ for *n* objects, and their true co-ordinates as $(S_1(i; true), S_2(i; true))$ that are obtained from a higher-quality measurement system. Therefore:

$$RMSE = \left[(1/n)\sum_{i=1,\ldots,n}[(S_1(i) - S_1(i; true))^2 + (S_2(i) - S_2(i; true))^2]\right]^{1/2}$$ .....Eq.1 (Haining, 1990)

For this research, the precision of all objects geographically shown on the base maps was strictly identified as 95%. This means that the errors that appear on the base maps are acceptably less than 5% of the RMSE. This controlled RMSE was controlled in every procedure associated with mapping in cartography.

- ***External validity*** denotes to what extent the research findings can be generalised.

As Yin (2003) explained, the case study leads to analytical generalisation rather than theoretical generalisation. Considering the single case study, Yin (2003) recommended validating the external validity by relying on the theoretical base of the study. There are seven important factors that affect external validity, which are: population characteristics (subjects), interaction of subject selection and research, descriptive explicitness of the independent variable, the effect of the research environment, researcher or experimenter effects, the data collection methodology, and the effect of time (Seliger and Shohamy, 1990).

This research concerns a unique case study to present a very detailed analytical generalisation, which contributes to the systematic process of analysis and comprehensive knowledge of this prominent case. In order to prove the external validity, the resettlement schemes from previous work were used as the main frame to which the explored findings adhered. All dissimilarity or conflict between the explored results and the context of previous work must be re-studied in order to ensure the external validity of the research.

In term of the generalisability of the information generated from the respondents, it can be used to make statements about the larger population. Regarding the background of the affected people, the major group of interviewees are farmers who normally have a small income. This general type of people has lived in the remote areas within the catchments which are prone to debris flow. For this reason, it can be assumed that the prototype of vulnerable people in other vulnerable debris flow hazard areas is as same as those residents in the study area. In addition, the resettlement programmes in Thailand typically begin by evacuating affected people to other safe places, then transferring displaced people to temporary housing, and finally relocating these displaced people to the permanent resettlement area. In particular, the development projects organised by the government and local government are always established after the disaster occurs. Regarding the same pattern of the livelihood of vulnerable people and resettlement activities, it can be summarised that the information generated by the respondents of this research can represent the information generated from vulnerable people in potential debris flow hazard areas across Thailand.

This study was designed to control the errors derived by applying the spatial analysis in Table 3.4. Commonly, spatial data require verification for error identification and corrections to ensure the data's accuracy before analysing them. There are numerous ways in which errors may arise during the spatial analysis processes, such as the data capture process, data transformation process, data scaling process, and the illustration process. This study presents the data verification into groups according to the details and verification methods.

Table 3. 4: Errors and verification techniques for applying spatial analysis for this research

Causes of errors	Effects	Verification techniques
Incompletely input vector data	All parts of the vector data are not joined up	Run the clean line model that trims, extends, snaps, and splits lines after inputting all vector data
Poor quality of scanned raster data	Gaps between pixel line on raster map	Use a photogrammetric scanner which generates a high resolution based map
Wrong scale digitised data	Wrong scale map	Set the maximum scale for digitising
Wrong geo-referencing process	Missed location of features	Check the geo-referencing data of all map layers
Distorted based maps due to topographical terrain, i.e. relief and tilt displacements	Based maps contain systematic errors	Add more ground control points and select a suitable mathematic algorithm to rectify the based maps
Data conversion between vector data and raster data	Shifted positions of the features on the map layers	Avoid data conversion by planning the data types for the analysis of the entire project

3.2.4.2 Reliability

Reliability is generally concerned with issues of consistency of measures (Bryman, 2001). Additionally, reliability also considers the extent of the results which are consistent over time and whether these accurately represent the total population by implementing a similar methodology (Joppe, 2000). It is claimed that reliability is how research results can be reproduced (Weber, 2004). Amaratunga et al. (2002) concluded that the goal of reliability is to minimise the errors and biases in a study.

It is clearly suggested that a case study protocol can be used to improve the reliability of the research. Therefore, three groups of respondents were selected to test the reliability by

conducting the case study protocol. Three types of respondents were represented: (i) local government, (ii) displaced people whose houses had been completely destroyed, and (iii) displaced people whose houses had been partially destroyed. The method used to collect the data was the semi-structured interview containing the same questions as used in the primary interview.

The quality of the research design can be judged by considering four tests in order to minimise such criticism. The development of the case study design needs to be maximised for conditions related to design quality, which are listed in Table 3.5 (Yin, 2003).

Table 3. 5: Research design tests

Test	**Description**	**Case Study Tactic**	**Phase of Research**
Construct Validity	Establishing correct operational measures for the concept being studied	• Use multiple sources of evidence • Establish chain of evidence • Have key informants review draft case study report	• Data collection • Data collection • Composition
Internal Validity	Establishing causal relationships, whereby certain conditions are shown to lead to other conditions, as distinguished from spurious relationships	• Do cognitive mapping • Do content analysis	• Data analysis • Data analysis • Data analysis
External Validity	Establishing the domain to which study's findings can be generalised	• Use theory in single-case studies in multi-case studies	• Research design • Research design
Reliability	Demonstrating that the operations of study can be repeated with the same results	• Use case study protocol • Develop case study database	• Data collection • Data collection

(Source: (Yin, 2003))

3.3 CHAPTER SUMMARY

The research methodology was carefully justified in response to the nature of the research in order to answer the research questions effectively. Furthermore, the research design was planned to ensure that the research techniques were employed to increase the validity and reliability of the research. A summary of the approaches and techniques is presented in Table 3.6.

Table 3. 6: Summary of the justified research methods of the study

RESEARCH SCHEMES	JUSTIFIED APPROACHES
Research philosophies	
• Ontology	Inclines to the Subjectivism approach
• Epistemology	Inclines to the Social constructivism/Interpretivism approach
• Axiology	Inclines to the Value laden approach
Research approaches	
• Research strategy	Case study research (Single case with embedded units of analysis)
• Research choices	Qualitative study
• Time horizons	Longitudinal study
Research techniques	
• Data collection	Documentary analysis, observations, interviews (semi-structured interviews)
• Data analysis	Content analysis, cognitive mapping, spatial analysis
RESEARCH TEST	**TACTICS**
Validity	
• Construct validity	Multiple-sources of evidence
• Content validity	Content analysis
• Internal validity	Theoretical review Multiple units of analysis Control the error of rectified base maps
• External validity	Use a theory based review as coverage of the findings in a single case study
Reliability	Case study protocol conducted with different groups of respondents

This chapter reviews the research methodology and the justification for pursuing the study in the designated way. In order to ensure the quality of the research, the research validity has been tested using the techniques listed in Table 3.6. The next chapter will address the analysis techniques and procedures in more detail, together with the explored findings.

CHAPTER 4

ANALYSIS

4.1 INTRODUCTION

According the heuristic methods from the research methodology chapter, the techniques in collecting and analysing data are systematically described in this chapter. Analysed techniques and results are structured in association with the research questions of this study. With an attempt to identify the complexity of the explored problems associated with spatial aspects, the spatial analysis technique has been used to explicitly examine the statement of problems derived from the interviews, documentary review, and observation. It is clearly seen from the examined problems of this chapter that there must be several criteria essentially concerned in planning a resettlement programme in order to avoid potentially complicated problems.

In order to present an effective method of extracting the complex links between the problems and spatial aspects, a case study was selected with the rational justification in conducting the research to comprehensively study the real situations in the resettlement programme. The data collection techniques are justified to bring out the information from interviewees by strictly following the systematic research methodology. The highlights of this chapter consist of three major sections which are:

Section 1: Background of the study area. This section describes the general information of the study area. Firstly, it contains the basic information on the geography, communities, environment and infrastructure in the study area, and local people characteristics. Secondly, this section also describes the incident after the debris-flow disaster in 2001 which attacked the study area and triggered the displacement and resettlement programme.

Section 2: Key elements of analysis. The collected data is analysed and demonstrated regarding each research question. The highlighted topic of each research question, contains data collection technique and analysis technique accordingly. At the end of each topic, the explored results with respect to the reviewed literature are discussed to present the connection between the initial findings and either the previous works or the existing knowledge in the resettlement programme.

Section 3: Conclusion. This final section also discusses the capacity and limitations of the spatial analysis techniques used to analyse the explored problems associated with spatial aspects in this research.

4.2 BACKGROUND OF THE STUDY AREA

The lack of knowledge base in organising a potential resettlement programme causes several issues such as administration, socio-economic and physical problems mentioned in the literature review chapter. Of those barriers, spatial aspects have been previously synthesised in the literature review chapter sophisticatedly showing the links to other issues. In order to gain a better understanding in organising a potential resettlement programme, a single case study represents an entire resettlement programme that is carefully studied in this chapter. The following section presents the basic information of the study area geographically, including communities and social service units in the village, local people and livelihoods, and natural disaster triggering the resettlement programme in order to perform the general ideas regarding the situation and information of the study area.

4.2.1 Basic information of the study area

A case study of Ban Nam Ko village, where suffered debris flow in 2001, was selected according to the following rationale:

- It was the first official resettlement programme in Thailand; the government took care of the displaced people by providing them with places to stay and living temporarily and permanently.
- It was the first place where the prototype of temporary housing of durable materials was applied; this prototype has been applied nationwide for people displaced from their homes due to a disaster.
- It covered an appropriate timescale; the resettlement programme was conducted in 2001. For more than ten years, it provides a clear picture of the entire resettlement programme, making it possible to investigate the sustainability of a resettlement community.
- It was the first resettlement programme triggered by a major sudden-onset disaster; the numerous numbers of loss, displaced persons, and deaths due to the event,

which was announced a “disaster”, showed the severity of the most tragic debris flow in Thailand’s history.

4.2.1.1 Geography of the study area

The study area, named Ban Nam Ko, is a village in Petchabun province in the North of Thailand (Figure 4.1). As a well-known volcanic province, Barr and Cooper (2013) indicated that Petchabun province is situated on volcanic rocks and sediment-volcanic rocks. It was also noted in a study of Dosseto and other (2012) that the volcaniclastic bedrock has high weathering rates over some lithologies: such as granite or shale. Focusing on the climate of the study area, Ban Nam Ko is also affected by monsoon rains typically from May to July. The monsoon and heavy rainfall may last longer than expected until October in some years. The high intensity of heavy rainfall may induce the weathering rates of the bedrock in this area. Naturally, the high weathering rates have increased the thickness of soil which is easily moved by the intensive rainfall.

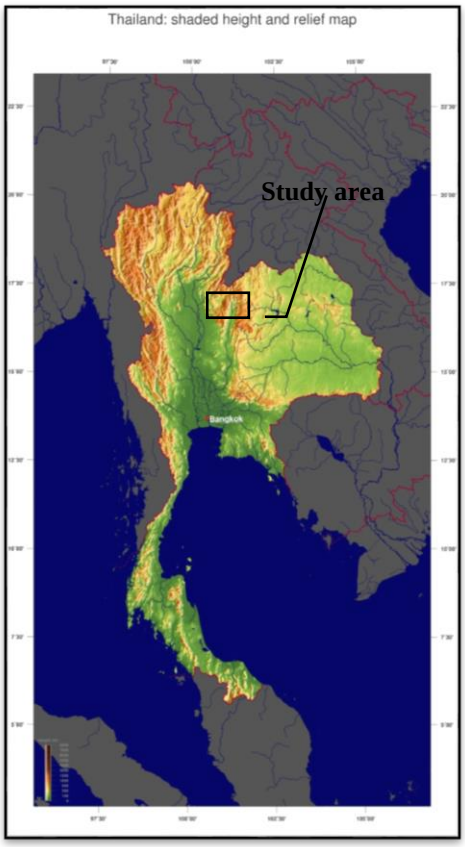


Figure 4. 1:Topographic map of Thailand and study area

(Source: http://www.ginkgomaps.com/maps_thailand.html)

The original river channel drains from the steep mountain range over 1,000 m high on the western side through a village, called Ban Nam Ko, located in a catchment area. Ban Nam Ko village is located in Nam Ko Yai sub-catchment, a small catchment of approximately 75 km^2, which makes up and provides water into a larger catchment area, Pa Sak catchment, of approximately 15,779 km^2. Communities in sub-catchments are located densely in Nam Ko and Nam Chun sub-catchments along the terrace, talus and alluvial deposits, approximately 200 m above MSL.

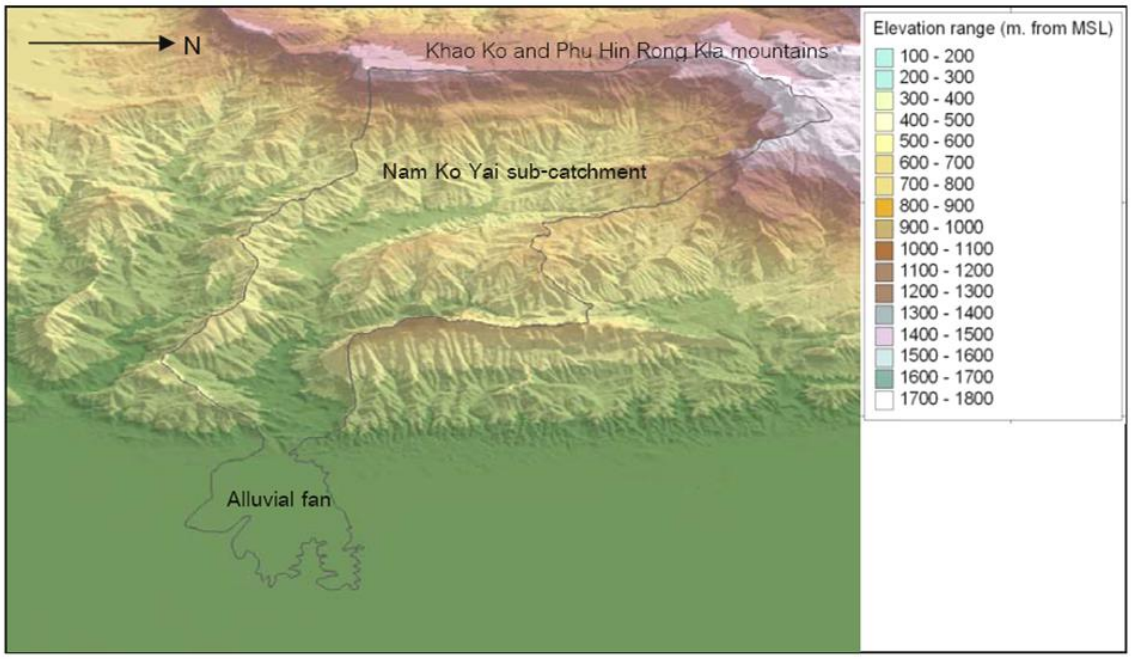


Figure 4. 2: Three-dimension terrain of Nam Ko Yai sub-catchment area (Yumuang, 2005a)

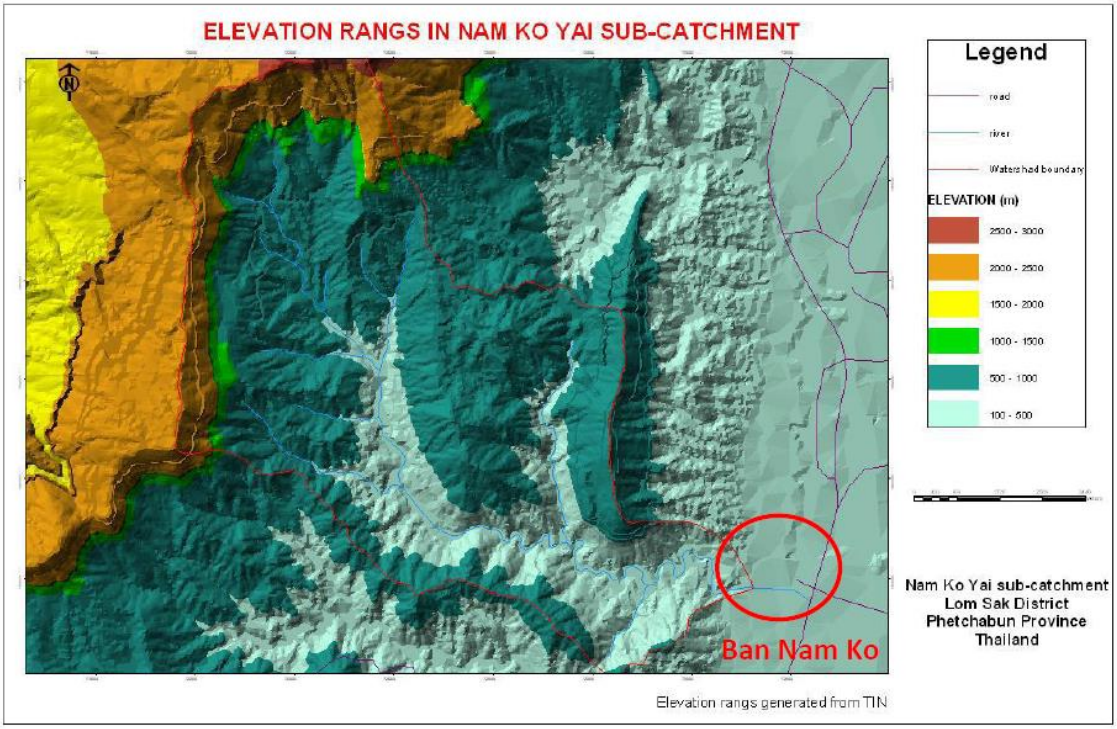


Figure 4. 3: Ban Nam Ko location and surrounding topography

4.2.1.2 Communities and social service units in Ban Nam Ko village

Ban Nam Ko village consists of 5,032 residents living in 1,361 households of 13 communities (SAO, 2011). All 13 communities of Ban Nam Ko village are listed with their common names of the communities (or so called as “Moo” means Community) as:

Community (Moo) 1: Ban Huay Pun

Community (Moo) 2: Ban Nam Ko Moo 2

Community (Moo) 3: Ban Nam Ko Moo 3

Community (Moo) 4: Ban Nam Ko Moo 4

Community (Moo) 5: Ban Nam Ko Moo 5

Community (Moo) 6: Ban Nam Ko Prong

Community (Moo) 7: Ban Nam Ko Kok

Community (Moo) 8: Ban Nam Ko Fai

Community (Moo) 9: Band Nam Ko Thai

Community (Moo) 10: Ban Nam Ko Set

Community (Moo) 11: Ban Rong Cheuak (include host and resettlement community)

Community (Moo)12: Ban Muang Mai Pattana

Community (Moo) 13: Ban Huay Pao

Within Ban Nam Ko village, there are several social service units listed in Table 4.1:

Table 4. 1: Social service units in study area

Social service units	**Quantity/Name**
Gas stations	10 stations (local and small gas station services)
Schools	1 primary school (Ban Fai school) 1 primary-secondary school (Ban Nam Ko school)
Temples	13 Temples: 1) Wat Santi (located in Moo 5) 2) Wat Sri Chom Cheun (located in Moo 4) 3) Wat Nhong Kok (located in Moo 6) 4) Wat Rong Nam Sai (located in Moo 10) 5) Wat Rad Sattratham (located in Moo 8) 6) Wat Pho Ngam (located in Moo 7) 7) Wat Huay Pun (located in Moo 1) 8) Muang Mai Pattana Monastery (located in Moo 12) 9) Pa Sio Monastery (located in Moo 9) 10) Huay Pao Monastery (located in Moo 13) 11) Huay Tao Cemetery (located in Moo 4) 12) Udom Samakkhi Monastery (located in Moo 11) 13) Ban Piem Somboon Meditation Centre (located in Moo 11)
Police station	1 Police Booth
Local radio broadcasting stations	13 stations
Hospital	1 community health service hospital
Community Administration	Nam Ko Sub-district Administration Organisation

4.2.1.3 Local people and livelihoods

The majority of local people in Ban nam ko are agriculturist cultivating tobacco, rice, and corn. An average income of those people varies between 35,000 – 65,000 baht per annum (approximate £700 - £1,300 per year; where £1 equals to 50 baht), or 2,900 – 5,500 baht per month (£58 - £108 per month)(SAO, 2011). The second largest group of people is the group of employed workers working in farmlands within the village. The average income

of this group is approximately 11,000 – 26,000 baht per annum (around £220 - £ 520 per year; whereas £1 equals to 50 baht).

The specific ethnicity of local people has shown as dialect or local language, culture and beliefs. Local people in the study area speak their dialect called "Lom" language. This dialect has different specific vocal sets and meanings to which others may not understand (Munying, 2011).

4.2.2 Natural disaster triggering resettlement programme of the study area

The torrential debris flow and flood from high range mountains in the Westward of Kao Ko Mountain ran through Nam Ko Yai sub-catchment and attacked Ban Nam Ko around 3 am on 11th August, 2001. This incident caused the death of 147 residents (The Mirror Foundation, 2008). It further affected 1,749 families, in which 188 houses were completely destroyed and 411 houses were partly damaged. According the tragic event of Ban Nam Ko, many researchers came to this area in order to study the nature of debris-flow, to examine the potential ways to protect this area, and to produce a debris-flow risk map illustrating susceptible areas for landslides and debris flows over Thailand (i.e. Honda, 2007; Yumuang, 2005a; Yumuang, 2006; Prasertburanakul, 2012; Suriyaprasit, 2008; DMR (Department of Mineral Resources), 2008).

Figure 4. 4: Hazard area at Ban Nam Ko village (Source: The Mirror Foundation, 2008)

Debris flow, classified as a category of landslide, torrentially ran down the high steep mountains to the catchment area where Ban Nam Ko village was located. An exceptional amount of rainfall was claimed as one of the triggering factors that induced this disaster (Yumuang, 2006). Generally, Thailand has a tropical climate dominated by the annual monsoon rainfall. Although there are five local-rainfall stations located around the study area, those stations are situated in community areas while most debris flows originally occur on the sloped area on the mountain ranges. The sharply increasing daily rainfall amount recorded at those local rainfall stations on 8th to 11th August is illustrated in Figure 4.5. The highest flow rates recorded by the Royal Irrigation of Thailand in Nam Ko and Nam Chun river were 843 m^3/s and 537 m^3/s, with a 1,000 years and 100 years return period respectively. Yumuang (2005b) concluded that the continuous heavy rainfall was one of the crucial factors triggering the debris-flow event in the Nam Ko Yai sub-catchment area.

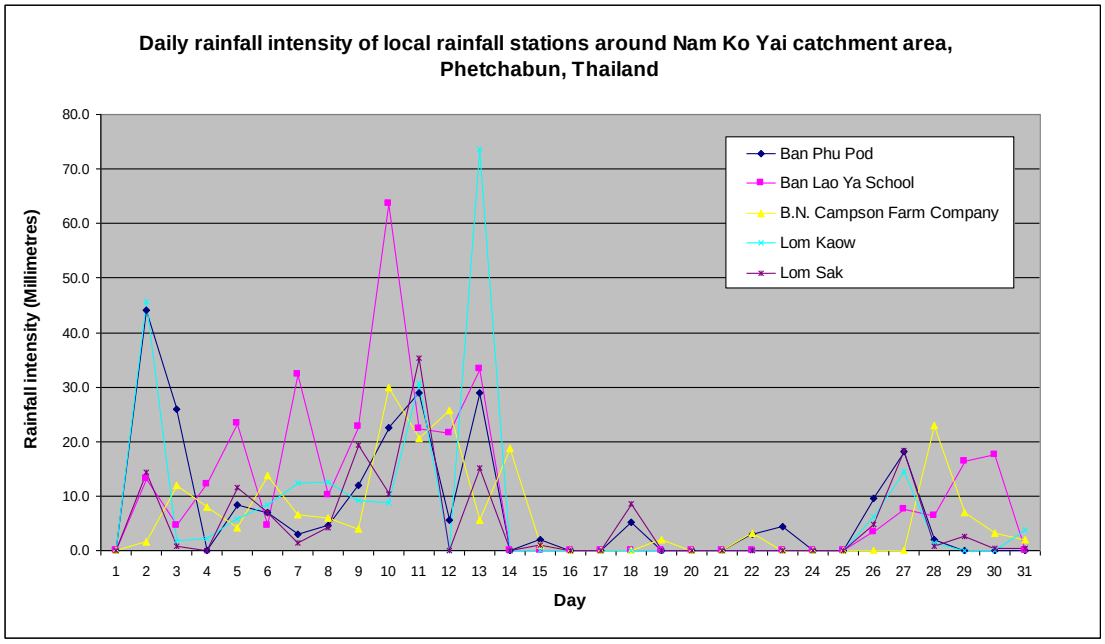


Figure 4. 5: Daily rainfall data in August, 2001 from the rain stations around the study area

In addition to the intense rainfall, deforestation on the mountains surrounded Nam Ko Yai sub-catchment was claimed as another major factor triggering this tragic incident (Yumuang, 2005a; Yumuang, 2006). Similar to other areas in Northern Thailand, this study area also faced land-use change, with gradual deforestation since the 1990's (RFD, 1997).

Due to the severe devastation of this area, the Thai government initially established a resettlement programme in this area to provide all displaced people relocation into safe places with a standard of provision of the basic essentials. Among all major sources of funding and support, the Royal Family took a crucial role to support the funding for innovatively constructing the model of temporary houses for those people made homeless from this disaster. The characteristics of the temporary houses are easily and quickly constructed with durable material. The advantages of this construction are mobility to (re)construct for displaced people instantly. They provide a hygienic durable living place, flexibly enables expansion for single- or multiple-family units. Soon after, these temporary houses have also been used with several other disaster events over Thailand.

Prototype of temporary house in Ban Nam Ko hazard area in 2001

Temporary house in Ban Nam Kem, Phang Nga province, Tsunami hazard area in 2004

Figure 4. 6: Temporary houses constructed for displaced people in Thailand

This temporary house was invented to initially serve displaced people in Ban Nam Ko hazard area. Later this prototype had been adjusted to suit several requirements with specific conditions in mitigation services. The temporary house, for instance, was urgently delivered into the temporary displacement area for displaced people from a major tsunami incident in 2004 (Figure 4.6).

Ban Nam Ko has given various memories and created many challenging circumstances along the resettlement programme from the disaster event until present day. Those incidents have represented some vital historical evidence through the timeline of the resettlement programme. Among general problems in resettlement programmes, socio-economic problems play important complicated roles and affect several impacts. Apart from providing clear processes in applying a resettlement programme with this study area,

this study area has also encountered changes from development projects showing the dynamic land-use of an area after disaster occurrence. For this reason, this focused study area was selected to intensively study an approach to minimise socio-economic problems associated with spatial aspects.

4.3 PATTERNS OF ANALYSIS

The patterns of data and analysis techniques explained in this section are described in accordance to the research questions of the study. In order to present a comprehensive research, there are two topics essential to describe as follows:

4.3.1 Data collection techniques

4.3.2 Key elements of analysis

These two main topics are described according to the information from the case study and the knowledge based from the reviewed literature. The analysis techniques are strictly justified from the systematic research methodology by carefully considering the research questions of the study.

4.3.1 Data collection techniques

This research takes three data collection techniques to gain the knowledge from the data collected in three distinctive techniques, i.e. i) observation, ii) interviews, and iii) documentary review. The information received from these three approaches can be triangulated in order to increase the validity and reliability of the data collection.

- **Observation**

Observation involves the direct investigation of the focused incidents in their natural setting. Based on the information from the pilot interviews (i.e. Arunothai, 2010; Supap, 2010), an observation was conducted over the study area by intensively observing the existing conditions of all physical elements, such as the provision of the basic essentials, infrastructure & facilities, which have been utilised since the debris-flow event in 2001. These physical elements are positioned geographically on based maps within a set of spatial database.

- *Equipment:*

The equipment used in observing the study area thoroughly consists of a hand-held GPS, a RTK GPS set, a digital camera, and series of high resolution aerial photos. A hand-held GPS (Global Positioning System) installed in a car running through the study area was used to collect all objects for the whole area. Apart from general observation by the hand-held GPS, a set of Real Time Kinematic (RTK) GPS was carefully used to identify all observed elements precisely with the geographical coordination system. All positions of the observed objects were transformed on the maps which were rectified correctly in their positions and elevation levels. To present the elevation levels over the study area, DEM (Digital Elevation Model), DTM (Digital Terrain Model), and TIN (Triangulation Irregular network) were generated to perform the virtual elevation levels. As a result, the prepared base maps were mostly produced in hard copies at scale 1:1,000 used from this observation task. The base maps from airborne and space-borne images were used in this study with various functions as:

Table 4. 2: Based maps and functions

Based Maps	**Scale/Resolution/Year**	**Functions**
Black & White aerial photos	1:25,000/1995	Investigate the study area before the debris-flow disaster event
Landsat Image	Res 30 m./Jan 2001	Investigate the land-use and topographical characteristics of the study area before the debris-flow disaster event
Landsat Image	Res 30 m./Nov 2001	Investigate the land-use changes and debris scars of the study area after the debris-flow disaster event
Colour ortho photos	1:4,000/2002	Investigate the study area after the debris-flow disaster event
ADS image from LiDAR	Res 5 m./Dec 2007	Investigate the study area after the debris-flow disaster event
ADS image from LiDAR	Res 5 m./Nov 2010	Investigate the study area after the debris-flow disaster event and used to generate the high resolution DEM

With the application of GIS, several thematic maps can be generated for specific purposes based on the high resolution based maps as:

Table 4. 3: Thematic maps and functions

Thematic maps	**Based Maps**	**Techniques**	**Contains**	**Functions**
House Map	Colour ortho photos (1:4,000 / 2002) ADS Imgae from LiDAR (Res. 5m./Nov 2010)	Digitising	-Houses: Point features	• Investigate the lost houses • Analyse the distribution around the social service centre
Infrastructure Map	Colour ortho photos (1:4,000 / 2002) ADS Imgae from LiDAR (Res. 5m./Nov 2010)	Digitising	-Roads, Canals, Bridges: Line features -Public telephone, Lighting Lamps, Wells: Point features	• Investigate the accessibilities over hazard community • Investigate the provision of the basic essentials over the hazard community
Land-use Map	Landsat image (Jan 2001 and Nov 2001)	Image enhancement and classification	-Land-use activities: Polygon features	• Investigate the Land-use changes of the hazard community after the disaster event • Investigate the debris scars over the hazard area after the disaster event

Thematic maps	Based Maps	Techniques	Contains	Functions
Administrative Map	Topographic Map	Digitising	- Administrative boundaries: Polygon features	• Define the political boundaries and responsibility
Social service Map	Colour ortho photos (1:4,000 / 2002) ADS Imgae from LiDAR (Res. 5m./Nov 2010) Topographic map	Image interpretation and digitising	-Schools, Temples, Government offices and buildings, Markets: Polygon features -Hospital & Health Centres, Bus stops: Point features	• Identify the social service buildings for alternative communal utility
Land parcel map	Land parcel Map from the Department of Land	Digitising from hard copied map	-Land parcels: Polygon features	• Investigate the land-right and land allocation for resettlement area • Investigate the abandon lands for park lots in emergency time

Thematic maps	Based Maps	Techniques	Contains	Functions
Contour Map	DEM from ADS-LiDAR (Res. 5m./Nov 2010)	Generated from the LiDAR data	Contour lines, 1m. and 5 m.: Line features	• Investigate the slope over the hazard community and resettlement area

Based on the thematic based map preparation, a virtual topographical terrain with the delineated boundaries of debris-flow hazard community was generated by referencing a risk map produced by Prasertburanakul (2012) and the empirical observation in the study area.

Based on the most recent risk map, Prasertburanakul (2012) classified the risk levels of the study area by using high resolution Lidar image and weighted factors analysis (Figure 4.8).

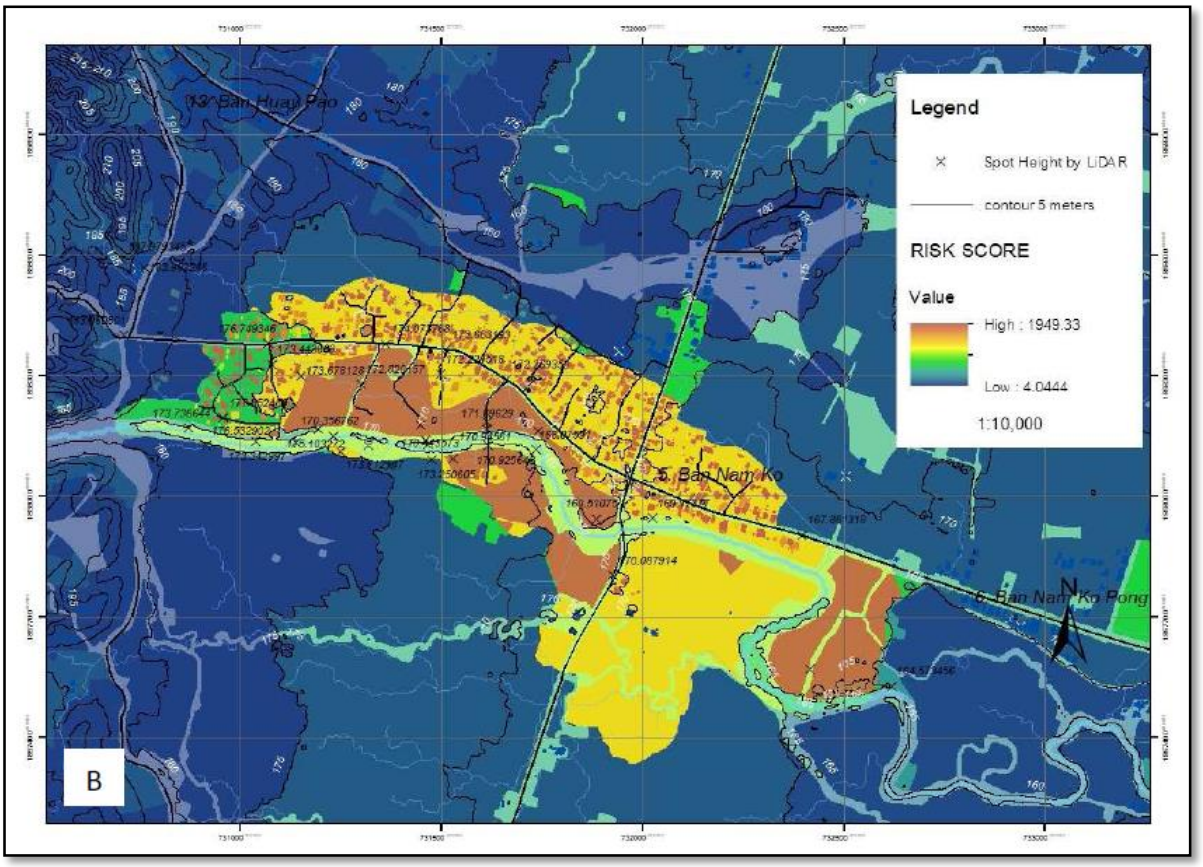


Figure 4. 7: Risk levels in hazard community, Ban Nam Ko (Prasertburanakul, 2012)

According risk levels in Figure 4.7, it is clearly shown that the highest risk level (brown colour) is close to Nam Ko Yai river. Focusing on the high risk boundary, the series of aerial photos (B&W aerial photo in 1995, colour ortho photos in 2002, and ADS image from LiDAR in Nov 2010) were merged to identify the lost houses from the disaster event. As a result, all lost houses in hazard area presented in red dots were identified on the line map (Figure4.8).

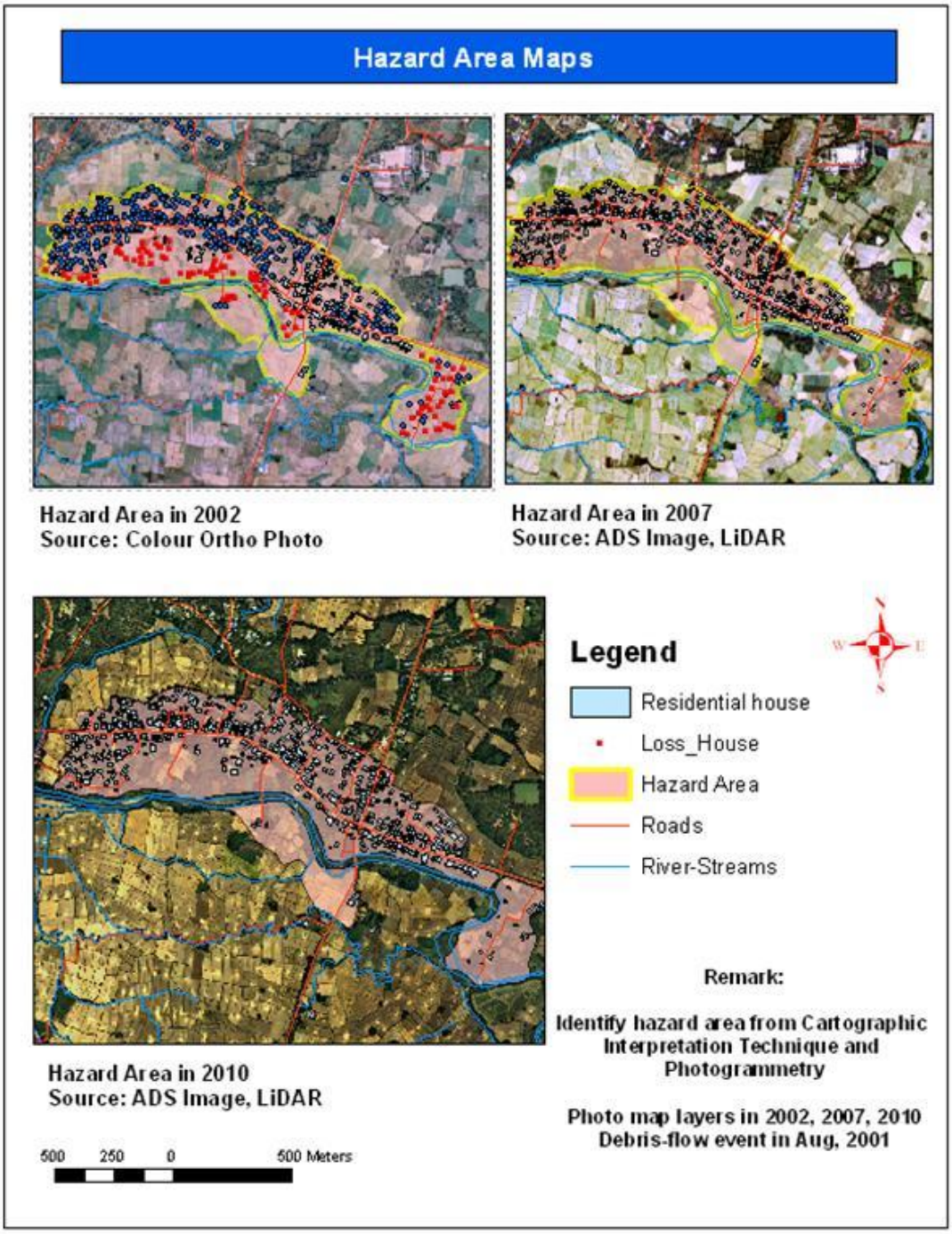


Figure 4. 8: Lost houses in hazard area from the debris-flow event in 2001

- *Observation from the field work:*

In order to verify the analysed result correctly, an observation was conducted in the field work. Although many residential houses were completely destroyed or disappeared from the hazard area, some buildings still exist and displayed the remarkable submerged levels. These submerged marks on the buildings in hazard area highlighted the true extent of the submerged situation from the debris-flow event in 2001.

Submerged mark, 1.80 m. high on a pavilion wall of a temple in the hazard area

Submerged mark, 2.00 m. high on a building in the hazard area

Submerged mark, 1.20 m. high on the wall of a house along the main road in the hazard area

Figure 4. 9: Submerged marks on the buildings in hazard area, pictures from the field work observation

- **Interviews**

The perception of people involved with displacement and resettlement programme in the study area is one of the major sources of information used in this research to gain knowledge of the resettlement programme. The deep insights from people involved with the resettlement programme are used intensively. This research considers determining the particular issues regarding the resettlement phases, resettlement activities, and problems

faced in each resettlement phase. In order to clarify these ambiguous topics, a single case study with units of analysis was conducted in this research. The way to gain the knowledge from local people was conducted using semi-structured interviews.

To ensure full understanding of the dialect used by the local people, the interviewer conducted every interview with an interpreter who was born in Petchabun Province. She has been working in a government department in the province and familiar with several local people in the study area. Her mother tongue is Lom language, the same dialect with local people in Ban Nam Ko. The interviewer had repeated the received messages from interviewees with the interpreter who accompanied and checked every single message for accuracy from the interviews. This method prevents inaccurate information from being noted during the interviews and protects from misleading information.

As two major scopes of people involved with the resettlement programme, this study considers these two units of analysis as the major categories in the case study. The unit of analysis 1 consists of persons who directly took responsibility to organise the resettlement programme in the study area. For this reason, a local governor who conducted the resettlement programme and a monk who provided the space in a temple as an evacuation centre were interviewed to show the perspective of the top-down authority. On the other hand, the unit of analysis 2 consists of displaced persons who participated in the resettlement programme. Within the scope of the unit of analysis 2, it is able to classify those displaced people into two major groups, i.e. Group A: displaced people whose houses were partly destroyed by the 2001 debris-flow event, and Group B: displaced people whose houses were completely destroyed by the debris-flow event in 2001.

The interviews were conducted to empirically investigate 13 persons involved with the displacement and resettlement programme in 2001. Each interviewee was assigned a letter from A to N to maintain the anonymity in this research. The snow balling approach was adopted to select the next interviewees through the recommendations and introductions of the previous interviews. This study considers two units of analysis to gain the knowledge from the interviewees which are listed in the Table 4.4.

Table 4. 4: Interviewees and roles

Interviewee	Prominent characters and roles
Unit of analysis 1: Policy maker's driven top-down approach (2 interviewees)	
• A	A local governor authorised by the Government, implemented the resettlement programme and post-disaster management. He worked closely with other government departments and officers who were in charge of several activities in the post-disaster resettlement programme. The local governor had taken a major role since the debris-flow occurrence until establishing the resettlement area.
• B	A monk, a place provider for emergency shelter in an evacuation centre. As the leader of the place, he authorised and facilitated people in the centre. He also applied the public space in his temple and pavilions for emergency shelters.
Unit of analysis 2: Community driven bottom-up approach (11 interviewees)	
- *Group A: Displaced persons whose houses were partly destroyed by the debris-flow event in 2001 (4 interviewees)*	
• C	A farmer, 46 year-old lady lived next door to a temple. Her house was partly destroyed by the debris-flow. She was displaced and living in the evacuation centre until her house was completely fixed. She and her neighbours helped the community and monks to restore the temple that was severely destroyed by the debris-flow disaster.
• D	An old lady who ran a local bus business and green grocer shop was not home when the debris-flow occurred. She went back from the morning market in town and tried to get back to her house after the disaster. She gave a point of view in the perspective of a person who tried to access the hazard community after the disaster. She stayed in the evacuation centre until the house reconstruction was complete.
• E	A 69 year-old merchant lady ran her own grocery shop on the rental land in the hazard community. She was displaced to the evacuation centre. After a few weeks she moved away from the centre because she wanted to watch and protect her belongings and property over her land. She explained the situation in the evacuation centre pushed her to make a decision to leave the centre. However, her family members were still living there until the house restoration was complete. She had to go to the evacuation centre several times a day to collect the donated items and compensation money.

Interviewee	Prominent characters and roles
• F	A 54 year-old former agriculturist gave up her career due to the chronic illness derived from the disaster since 2001. She had run a small business as a butcher selling pork on a mobile car. She was moved to the evacuation centre then she decided to stay with her relative due to the crowded and poor sanitary conditions in the evacuation centre. She described the advantages and disadvantages and the frustration from choosing this option of staying with relatives in the mean time.
- *Group B: Displaced persons whose houses were completely destroyed by the debris-flow event in 2001 (7 interviewees)*	
• G	A 56 year-old lady earned her money from being a temporary employee cultivating tobacco on farmland. Her house was completely destroyed by the disaster. She had enrolled in the resettlement programme. As selected by the villagers as a disaster victim who has been well-behaved, she received the funding from the Royal Family to reconstruct the house on her land. However, the house is not yet completely reconstructed.
• H	An agriculturist who used to live in the hazard area. He decided to stay in a government office adapted as another evacuation centre. He had enrolled in the resettlement programme. He explicitly described the situation of the processes in reconstructing his house and resettlement community.
• J	A 50 year-old farmer had been working really hard on his farmland and also personally selling his agricultural products. He used to stay in the hazard area but eventually moved to a temporary house in the resettlement area. He gave his perspective, in particular, on the sustainability of resettlement community. As one of the core leaders of the resettlement community members, he had proposed to the government to separate the resettlement community from the host community for the deserved benefits of re-settlers.
• K	A four month pregnant woman drifted away with her family over the torrential debris-flow. Her house was completely destroyed by the disaster. As a local government officer, she moved to stay in the dormitory of her office; however her old mother decided to stay in the evacuation centre in order to receive compensation money and donated items for the family. She decided to receive the compensation money to reconstruct the house on other land far away from the hazard area rather than moving

Interviewee	Prominent characters and roles
	to the resettlement area. She remarkably described the situations in the perspective of displaced people's requirements and the response from the government.
• L	A 20-year-old employee lost his pregnant mother from the disaster. Also, his house was completely destroyed so his father decided to move to another land rather than move to the resettlement area. The family's livelihood and mental status has decreased dramatically since the disaster occurrence in 2001. A major impact from the loss and impoverishment was that he had to cease his education, therefore, he went to Bangkok to find work after the harvest season. He gave a point of view of a teenager about the lifestyle of displaced people who received a large amount of compensation money for their lost ones.
• M	A17 year-old high school student explained the impacts on her family from the disaster. Her house was completely destroyed then all members in her family needed to move to the evacuation centre. Her father refused to move to the resettlement area but decided to receive the compensation money to buy a new land which was opposite the evacuation centre. She and her sister recalled the memory in the evacuation centre and the temporary housing. Her sister added the situation that the schools had closed for a long time and activities that helped children to recover from the sufferings were lost.
• N	A 33 year-old lady lived in a multiple family within a household lost her house in the hazard area. Her family moved to the evacuation centre and temporary housing provided by the government. Regarding the non-ownership of the land and property, her family was not able to move to the resettlement area. She asked for a job as a janitor from the head of the school. Fortunately, the owner of the high school allowed her to also construct a small house within the school area.

- Equipment and processes:

The interviews were conducted using a semi-structured interview (enclosed in appendix 2) which is flexible, allowing to reorganise the topics of interest accordingly. The interviews took approximately 2-3 hours in each case to cover all queries. The information received from the interviews is concentrated on these essential key topics;

- Resettlement phases; activities and timeline
- Problems in each resettlement phases and the solutions (if any)

- Perception in resettlement community, development projects over the village, recent livelihoods of local people

The number of interviewees was determined by considering the saturation of information given by the interviewees. According this criterion, there was in total 13 interviewees responding to the interviews and provided information covering all key topics. The information from the interviews was recorded and transcribed to further the encoding process. The locations of the interviewees were also recorded with GPS in order to plot these positions on a base map (Figure 4.10).

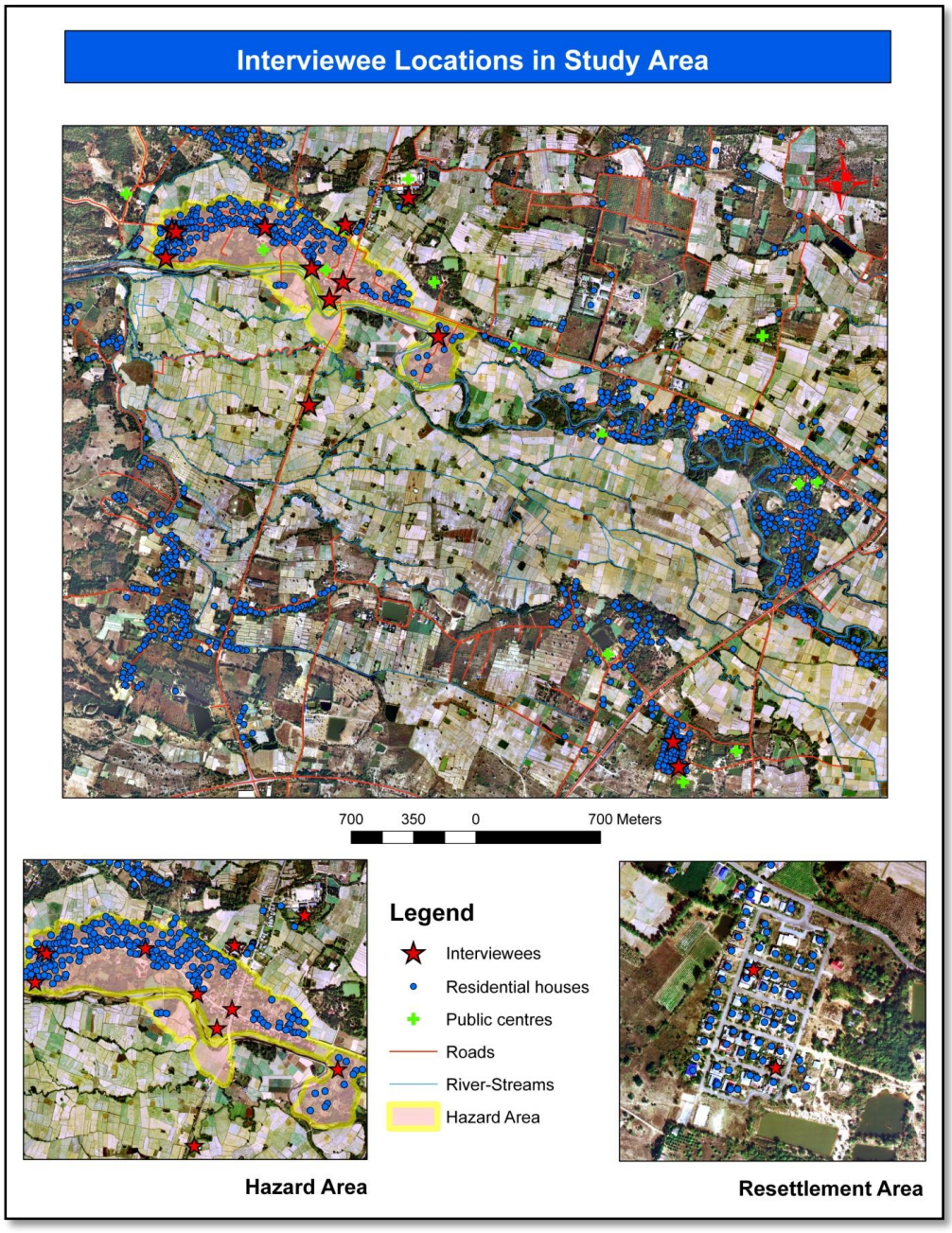


Figure 4. 10: Locations of interviewees

- **Documentary review**

Apart from the crucial information of the interviews, real situations of the debris-flow and flood disaster in 2001 which attacked Ban Nam Ko village were also described on the news, in research articles and books. Among the resources of evidence, a pocket book written by Mr Preecha Ruangchan is a crucial historic source recording the situations in the Ban Nam Ko hazard area (Ruangchan, 2001). Mr Precha Ruangchan, an ex-provincial governor, had encountered the situations and problems in Ban Nam Ko himself after the debris-flow event in 2001. In addition, news from different sources reporting situations of this hazard area, were used in this documentary review (i.e. Naewna news, 2001; khaosod news, 2001; Daily news, 2007). The reviewed information derived from the information of the Royal Foundation, "Friends in need of "PA" volunteer foundation", the Red Cross website, published online at www.princess-pa-foundation.or.th. Furthermore,, useful information appeared on www.mirror.or.th, a website of the Mirror foundation. These various sources of information are the vital resource of the documentary review.

4.3.2 Key elements of analysis

The analysis procedures initiated with content analysis where key words related to spatial aspects were noted from the information given by interviewees. Later, those links were mapped in order to illustrate the patterns of the relationships between the explored barriers and spatial aspects. Finally, spatial analysis was applied in response to the statement of problems associated with spatial aspects in order to examine the explored barriers and introduce feasible solutions on the available base maps and thematic maps in the next chapter.

The key elements of analysis have been presented respectively to answer all research questions of this study. The key elements are structured in the following Figure 4.11.

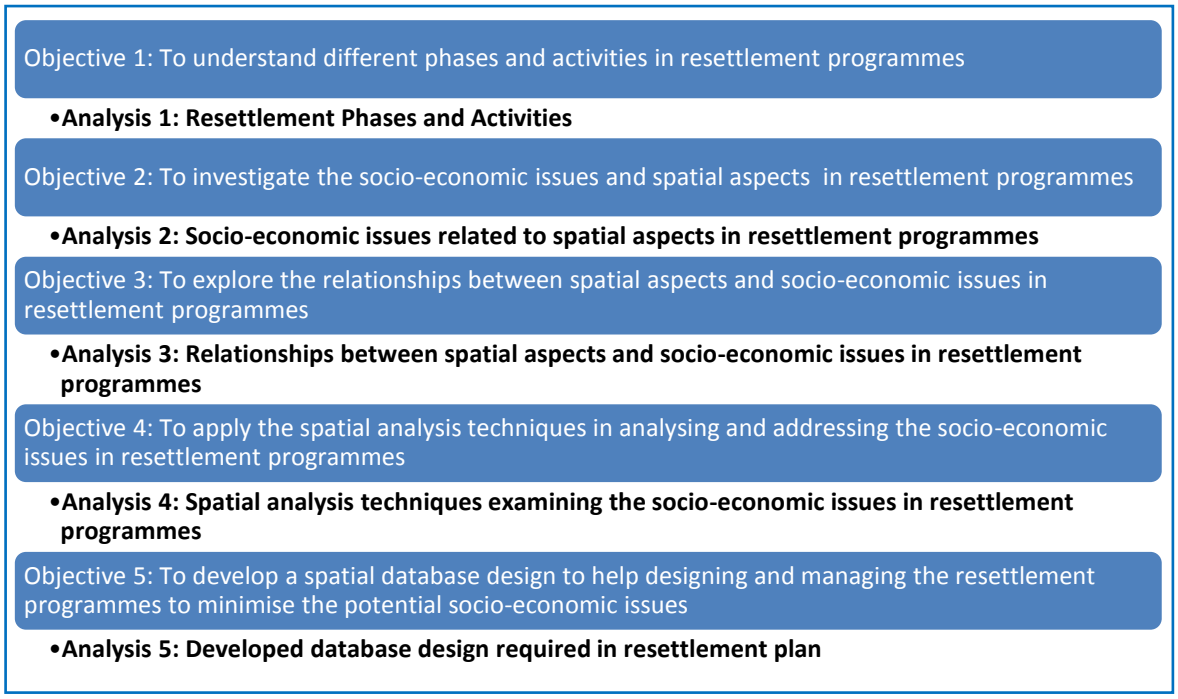


Figure 4. 11: Key elements of analysis

The following sections attempt to explain research questions 1-4 in this chapter. The developed database design required in resettlement plan has been listed in the findings chapter in response to research question 5.

4.3.2.1 Resettlement phases and activities

Based on the information from the interviewees, the resettlement programme in this case study is classified into three major phases regarding displacement locations, i.e. Phase 1: Emergency response in evacuation centre, Phase 2: Transitional processes in temporary displacement area, and Phase 3: Sustainable development in permanent resettlement area. With the classification criterion regarding displacement locations, those resettlement phases clearly defined all activities associated with the displacement places. According to the information given by all interviewees, there are five scenarios of displacement in the Ban Nam Ko case study. These five scenarios of displacement in Ban Nam Ko village can be classified as:

Scenario 1: Displaced people staying in evacuation centres then moving to temporary houses constructed by the government and eventually relocated to the resettlement area. This pattern shows the entire resettlement programme of this study area. Displaced people who enrolled this entire programme were people whose houses were completely destroyed by the debris-flow and they did not own other land or property, just the land in the hazard area.

Scenario 2: Displaced people staying in evacuation centres then moveingto temporary houses provided by the government and eventually resettling in other lands, such as lived in by their relatives or lived on their other own lands. Displaced people who chose this pattern were the people whose houses were completely destroyed by the debris flow; however they still had other lands giving further options. Accordingly, this group of displaced people did not ensure the quality of the provision of the basic essentials in the permanent resettlement programme provided by the government. Therefore, they chose to receive the compensation money from the government to rent/buy the lands from their relative, or to reconstruct their houses on their agricultural lands.

Scenario 3: Displaced people staying in evacuation centres then moving to temporary houses provided by the government and eventually moved back to their original lands. This pattern shows displaced people whose houses were mainly destroyed by the disaster; however their houses were still able to be restored over a period of time. They received the compensation for reconstructing the houses from the donors and the government.

Scenario 4: Displaced people staying in evacuation centres then moving back to their original lands. This group of displaced people were slightly affected by the disaster. Their houses were partly destroyed by the disaster. They stayed in the evacuation centre during the announcement of the emergency time and moved back to clean the house, remove the debris and fragments, and restore their houses.

Scenario 5: Displaced people resettled to live with their relatives then rented/ bought the land from relatives for permanent stay. In this pattern displaced people stayed in the evacuation centre then they relocated to live with their relatives as they no longer wanted to own houses in the hazard area. With the help from relatives, they chose to receive the compensation money from the government while residing with their relatives and decided to rent or buy the lands from their relatives later.

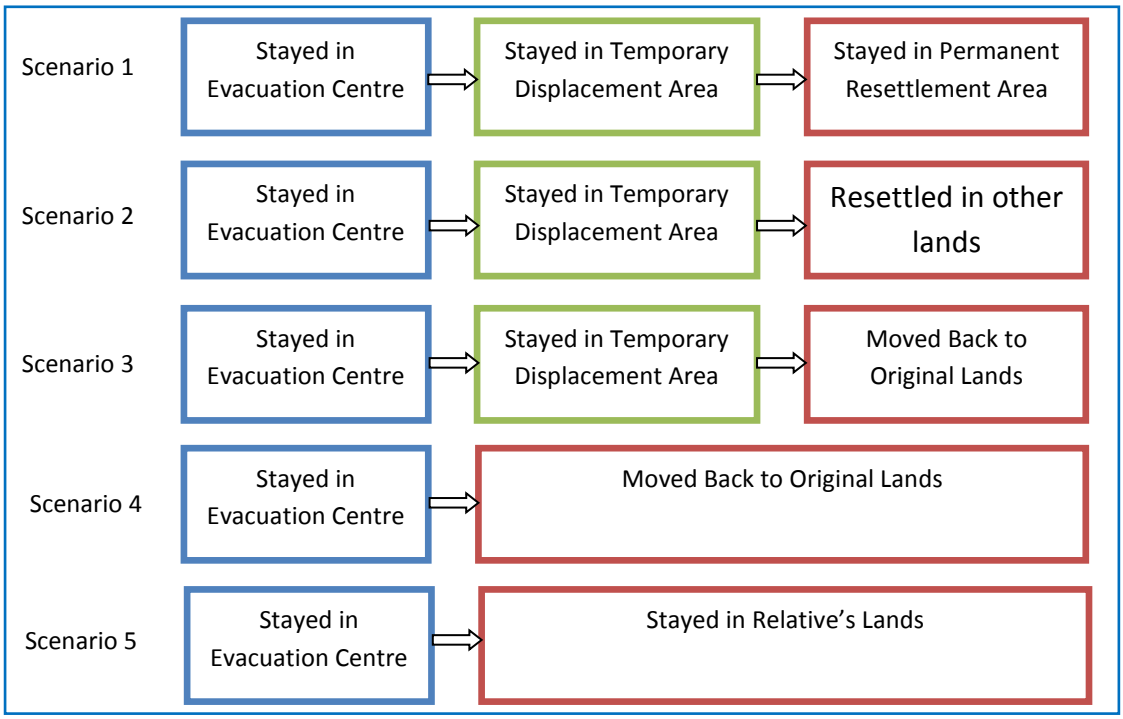


Figure 4. 12: Scenario of displacements in study area

Of these five scenarios of displacement, scenario 1 shows all phases of the resettlement programme. Certainly, this scenario is the absolute pattern of the resettlement programme essential to study and perform the whole process of the programme. Considering the actual number of displaced people who enrolled in the resettlement programme, it is noted that the actual number of evacuees had decreased dramatically in the resettlement area (UN-HABITAT, 2008). For this reason, it is crucial to understand the perception of displaced people who have various attitudes and thoughts of the resettlement programme. Therefore, the information given by displaced people from the five scenarios of displacement can be applicable to other real situations and analysis of the highlighted problems can potentially help achieve a successful resettlement programme.

The following context is summarised from the information given by interviewees, documentary reviews, and observation over the displacement locations in Ban Nam Ko village. The information derived from the data collection techniques classified the resettlement programme into three major phases associated with displacement locations. The timeline addressed in parentheses is the estimated duration derived from interviewees and the documentary reviews of Ban Nam Ko village case study.

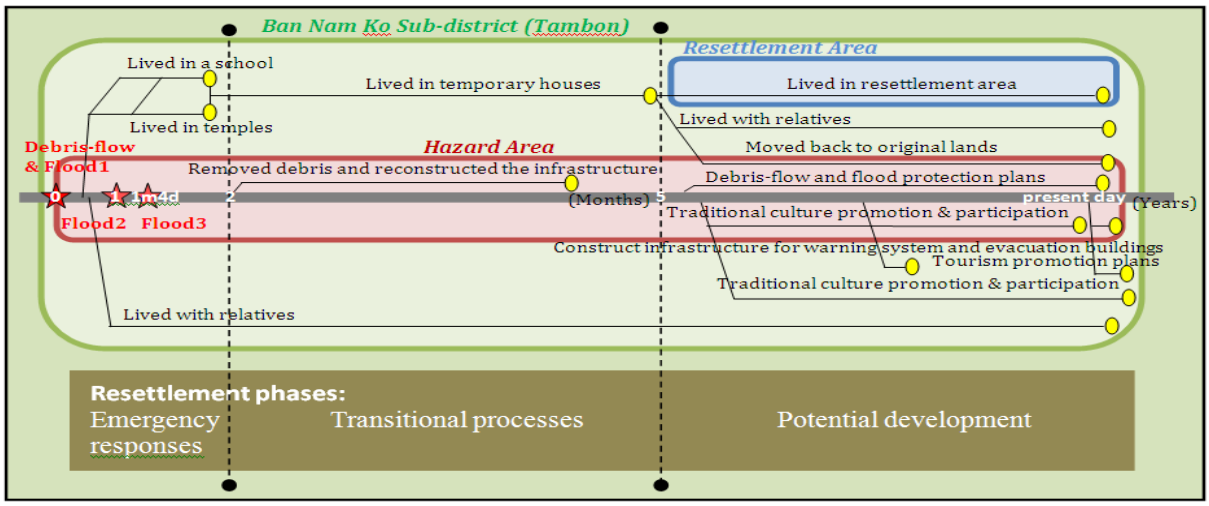


Figure 4. 13: Resettlement phases and timeline of Ban Nam Ko resettlement programme

The resettlement phases and timeline are described in the following details.

Resettlement phase 1: Emergency response in evacuation centre (From 0th-2nd month; 2 months)

After the debris-flow disaster around 3 am on 11th August 2001, survivors and affected people were collected and moved to the evacuation centres. Considering the scenarios of displacement, it is clearly shown that evacuation centres are the initial places mostly used by affected people. Therefore, potential social service units were carefully estimated to accommodate the number of affected people in the hazard community including over the village. Typically, community service areas with available infrastructure, such as: schools; community centres; mosques and medical centres; are recommended to apply as multi-purpose emergency shelters for people in emergency time (Akhand, 1996). In this case, evacuation centres in Ban Nam Ko village were adapted from social service places in the community, i.e. school and temples, according to three main reasons, such as: i) safe place from disaster, ii) available space capable to serve the large number of people, and iii) available infrastructure and facilities in the centre. Therefore, there were three collecting points of social service centres applied for evacuation centres in the emergency time, i.e. Wat Santi Wiharn, Ban Nam Ko school, and Wat Nhong Kok Thep Nimitr (Figure 4.14). These social service centres were selected as the evacuation centres because of their locality to the hazard area, the open space for utilisation and fully established basic infrastructure and facilities.

Wat Santi Wararam, Evacuation centre

Ban Nam Ko school, Evacuation centre

Wat Nhong Kok Thep Nimitr, Evacuation centre

Figure 4. 14: Community service places applied as evacuation centres after the disaster in 2001

The functions of those evacuation centres were far beyond the assembling places of affected people after the disaster. Due to the devastation in the hazard and adjacent areas, those affected had to rely on these centres in the initial stages. Local government officers initially registered the survivors and identified lost persons from the people who lived in the evacuation centres. The records also categorised displaced people into two groups according their destructive house conditions as: i) group of people whose houses were partly destroyed by the disaster and ii) group of people whose houses were completely destroyed by the disaster. These records were used by the local government in considering an appropriate level of compensation money for those groups of affected people.

These centres are normally equipped with the basic essentials such as electricity, water, toilets, common rooms, and open space area. Since these buildings are used for a different purpose during this time, the local government needed to add more basic essentials to

facilitate those displaced people who utilised these evacuation centres . The relevant organisations were requested by the government to supply clean water, electricity, and mobile toilets to the centres. Therefore, many heavy goods vehicles contained these additional services and equipment to provide the basic essentials running to the evacuation centres after the disaster. Apart from the delivery of the basic essentials, food and donated items were delivered in great quantity to the evacuation centres also. Since the government announced the hazard area as 'an area severely attacked by the greatest debris-flow event of Thailand history', donors and helpers over the country tried to access the centres to deliver food and items to affected people.

To provide effective medical and mental treatment, doctors, nurses, physical therapists, and psychologists were also urgently required in the evacuation centres. The clinical units in evacuation centres were able to provide basic treatment for minor injuries, while the severe cases were sent to the provincial hospital. In the meantime, survivors still kept looking for their family and relatives for up to seven days after the disaster. Rescue units from non-government organisations and military forces took the major role of discovering and delivering the found bodies. Dead bodies were delivered to the local temple for the investigation and identification procedure before proceeding to the funeral ceremony.

All common rooms in evacuation centres were full to capacity with people sleeping everywhere. The local officers arranged for ladies and gentlemen to sleep separately in the common rooms and tents around temple and school areas. Guards and security volunteers were patrolling the centres through the night.

The general functions of the evacuation centres were similar to the recommendation in the study of Corsellis and Vitale (2005) which noted that the evacuation centres are generally used as multi-function centres which consist of several activities such as a registration point for displaced persons, a rescue centre, a distribution base of donated items. Considering the case of Ban Nam Ko village, it is likely that the evacuation centres would serve several activities as the multi-function centres, however, it really requires space organisation to be managed wisely in order to avoid conflict and dissatisfaction. The details of conflict and dissatisfaction in space utilisation are addressed in section 4.3.2.2 in more detail.

Phase 2: Transitional period in temporary displacement area (From 2nd- 7th month; 5 months)

The evacuation centres, sooner or later those areas must be returned to their original functions. In the case study, the evacuation centres, being temples and a school, were later used for cremation ceremony activities and teaching respectively as their original functions. For this reason, the government had relocated displaced people from evacuation centres to assemble in the temporary displacement area which was located in Ban Nam Ko school. This clearly shows the first movement from the evacuation centre to another place organised by the government. This transitional period in temporary displacement area consists of several activities starting from displaced people's transfer to temporary shelters or houses. Apart from the original functions of the evacuation centres adapted from the social service centres, time taken in post-disaster resilience is also a factor considered for relocating displaced people into a more safe and comfortable area.

Typically, temporary shelters and houses are constructed for displaced people who have been waiting for the rebuild of their permanent houses in either resettlement area or original lands. In the case of Ban Nam Ko village, the post-disaster resilience and house reconstruction also took longer time than expected. Similarly to an argument in the study of Ashmore et al. (2010), it is urged that the reconstruction after the disaster attacks a large area may take three or more times than expected. However, a small hazard area that has not been well-organised in post-disaster management may also take longer time than expected like the case of Ban Nam Ko village. Several activities in the resettlement phase are considered within this period such as the debris and fragment removal procedures in hazard community, the house and public buildings restoration in hazard community, the temporary house construction in temporary displacement area, and post-disaster resilience and improvement.

In the hazard area of Ban Nam Ko village, communal public areas were cleaned up by empowering government officers from outside the hazard community. The local governor asked displaced people to participate in removing debris from the hazard community. These activities could help those people to reduce their tension and sufferings from loss and tragedy. The machines, for example excavators and earthmovers, used in removing debris and fragments from hazard and adjacent areas were borrowed from governmental departments and private owners. Ultimately, the lack of a potential waste management plan, including processes for removing debris from hazard and adjacent areas, took many

months simply due to people, such as affected people, strangers, rescuers finding precious belongings in submerged lands and not knowing what to do with them.

Figure 4. 15: The military helping to remove debris from devastation area

For a standard displacement scenario some displaced people who lived in evacuation centres decide not to stay in the temporary displacement area. For this reason, the number of displaced persons who transferred to this area was expected to decrease from the registered numbers in evacuation centres. It is necessary to recount the number of displaced people who decided to move to the temporary displacement area in order to provide the actual number of temporary shelters or houses. In the case of Ban Nam Ko, displaced people, whose houses were completely destroyed by the disaster, were transferred to this area and replaced in temporary houses. The temporary houses sponsored by a Royal Princess Foundation named “Ban Phung-Pa” were constructed in Ban Nam Ko school. The temporary houses were made of durable material adjustable for either single or multiple families. The toilets were built separately at ground level for communal usage. These temporary houses can be easily deconstructed and moved to use in other hazard areas.

Figure 4. 16: Temporary houses

As the time spent in the temporary displacement area was likely to be substantial, a learning development centre was established to support mental health and develop the

intelligence for children in Ban Nam Ko village. This centre was very useful for all orphans who lost their parents and family in the disaster. This centre is also beneficial for parents to drop their children off before going to do their tasks regarding the impact of the disaster.

Figure 4. 17: Learning development centre for children from disaster in temporary displacement area

Donors, helpers, entertainers, and celebrities still visited and created several activities for displaced people and affected people in the village. A lot of entertainment activities were organised almost every day and night before fading away after the first few months.

Phase 3: Sustainable development in permanent resettlement area (From 7th month – Recent day)

Government plays a major role in finding a location for establishing the permanent resettlement for displaced persons. In the Ban Nam Ko village case, the resettlement area was selected from unused land approximately 5 km away from the hazard area or residency of those displaced people. With the overlaying technique of GIS, the available abandoned land belonging to the Treasury Department is displayed on the Map (Figure 4.18). The land parcels were readjusted associated with the number of displaced people.

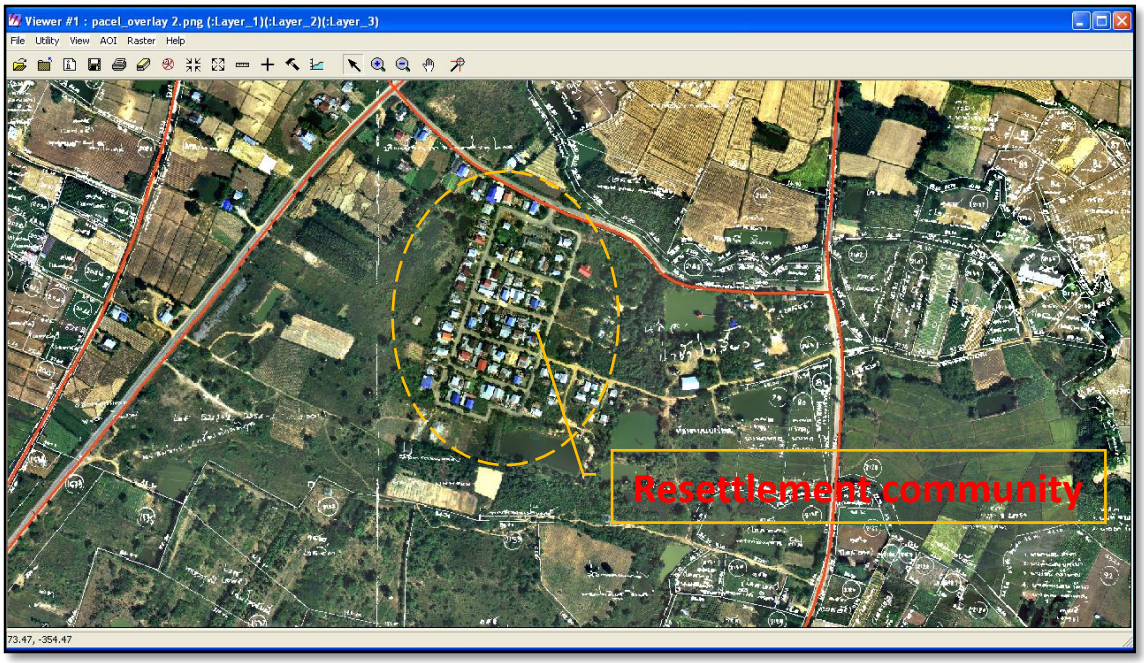


Figure 4. 18: Land parcels over the resettlement area

Displaced people, with the assistance of the military, took responsibility in reconstructing their own houses within the land plots readjusted by the government. Displaced people had the right to stay in their land in the resettlement area; however they didn't have the right to trade the land. The government selected this available area next to a host community named Ban Rong Cheuk in order to keep costs low when constructing new infrastructure and facilities for this resettlement community. Therefore, all infrastructure and facilities, i.e. electricity, water, telephone lines, etc. of the host community had been shared to the resettlement community. The information given by displaced people shows that the provision of the basic essentials had been gradually installed into the resettlement community. It means the infrastructure and facilities were not fully prepared for those displaced people since they moved into this area. Although this resettlement area is able to protect displaced people's lives from the possible debris-flow disaster, displaced people have never been satisfied with the local administration and organisation.

Regarding the resettlement paradigm outlined by the UN organisations and researchers, it is noted that "The provision of the basic essential must be provided in this area for people to live and improve their quality of lives. This area is expected to maintain community culture, which is capable to handover to the next generations (Scudder, 2005; UNDRCO, 1982; UN-HABITAT, 2006; UN-HABITAT 2008; Ashmore et al., 2008; Burnell, 2010).

However, the sustainability of this resettlement community is likely not continually considered.

In conclusion, it is evidently shown that there was a wide range of problems obstructing the achievement of the resettlement programme in all phases. These barriers challenge the researcher to explicitly explore the details of the problems in order to find the solutions for those problems. The next section addresses the information from interviewees regarding the problems in each phase of the resettlement programme.

4.3.2.2 Socio-economic issues associated with spatial aspects in resettlement programme

The perceptions and the deep insights from interviews provided rich information about real situations including the barriers from the local government who conducted the resettlement programme and from the displaced persons who were directly affected from the implementation of the resettlement programme. The given information was transcribed and encoded showing the barriers in achieving the success in resettlement programme. The transcribed texts were processed by content analysis in order to determine the relationships between the explored issues and spatial aspects in displacement locations. Furthermore, the reviewed documents were used to validate the information given by the interviewees accordingly. These processes are the key elements of analysis response to research question 2 attempting to explore the barriers to achieving success in resettlement programme. Furthermore, the relationships between the explored issues and spatial aspects in displacement locations were presented by cognitive maps regarding the resettlement phases. These processes are the key elements of analysis response to research question 3 attempting to determine the connections between the explored issues associated with spatial aspects in the resettlement programme. These key elements of analysis are described in the details below regarding displacement locations in resettlement phases.

- **Socio-economic issues in evacuation centres**

Considering the scenarios of displacements (Figure 4.17), the evacuation centres were typically heavily used by displaced people, affected people, relevant organisations, government officers, donors and volunteers. For this reason, those evacuation centres, i.e. Wat Santi Wiharn, Ban Nam Ko school, and Wat Nhong Kok Thep Nimitr, were inevitably full with people , according to the reviewed documentary from Ruangchan (2001). The issues represented a statement of problems and their impacts by considering the issues in evacuation centres including the issues directly impacting the evacuation

centres in the meantime. These evacuation centres had been utilised as multi-functional centres similarly to the recommendation of Akhand (1996). The explored issues in these centres are described in the following context.

Information given by displaced people: Crowding was one of the most serious issues causing multiple problems in evacuation centres. Displaced people were assembled in evacuation centres where the space was shared with several other activities operated by numerous organisations and government officers. Displaced people also encountered with several difficulties from the adequate provision of the basic essentials in those centres. Furthermore, they were extremely impacted by suffering from lost and depression from staying within the forensic zone.

Interviewee D, who stayed in Wat Santi Wiharn, a temple adapted as an evacuation centre, commented *"there were many organisers, volunteers, government officers working in the pavilions. It was very difficult to live in the temple in the first week after the disaster. Almost all activities had to be done in the pavilions due to the days of rain. It was a very tough time, particularly in the first week. The officers could not work outside the pavilions because the rain kept pouring so the pavilions were packed with people and equipment. Volunteers, organisers, government officers came with their operational equipments, desks, desktop computers, speakers, printers, etc. Several activities, such as; donation processes, registration procedure, even cooking was conducted in the pavilions because nobody wanted to get wet. We had very little space to sleep at night.*

Interviewee C reviewed the space in Ban Nam Ko school adapted to be an evacuation centre as follows *"A week after the debris-flow event, tons of donated items were delivered to the centres. Many classrooms were occupied by the donated items before being distributed to displaced and affected people. We were told we could collect the donated items all day and night. We kept our items aside where we slept in the hall. It was becoming a problem when the pile of our donated items was bigger and higher. We, sometimes, fought for our individual space and the missing items. It was a daily occurrence! Somebody sold the obtained items to grocery brokers and gained a very small amount of money from their unwanted items. Truly, we really wanted some space and of course money was very important for our house reconstruction."*

Although many affected people did not stay in evacuation centres, they also had to go there every day to collect the donations and compensation money. It was

revealed by interviewee F, who did not live in evacuation centre; *"Many people, indeed, lived in Wat Santi Wiharn temple and Ban Nam Ko school. The space for living in Wat Santi Wiharn was smaller than Ban Nam Ko school. I decided not live in the temple because my house was partly destroyed and I had to restore the submerged belongings as much as I could. Although there were few items I found on my land because most were swept away with the torrential debris flow. I had to keep the collected belongings in my damaged house and ran to Wat Santi Wiharn several times a day to collect the donated items and compensation money when I heard the announcement from local government officers. Of course, many strangers came to the village. They intruded everywhere digging and taking our lost items away. I could not leave my home where I kept my found belongings. For this reason, I decided to run between the temple and home all the time. We had to run through mud and debris in the first couple of days. There were sharp fragments, poisonous animals, etc underneath the mud! Many of us got wounds that became infected, some were killed later by diseases and others had spent a long time recovering"*

As considered regardless on the original function in evacuation centre, displaced people inevitably had to relocate to other evacuation centres. Interviewee G expressed the reason of relocating from one evacuation centre to another centre as: *"We lived in the Wat Santi Wiharn temple. The situation went bad when the volunteers brought dead bodies into the temple for the identification and investigation processes; and the cremation ceremonies. Hundreds of bodies were brought here with a putrid smell!! We had to move from the hall and pavilions to stay outside because the police, forensic, and medical doctor team had to do their investigation duties. All identified bodies had proceeded to the cremation ceremony according our religious beliefs. On the other hand, the unidentified bodies needed to be stored and held until they were formally identified. The hygiene in the temple was worse due to the smell of corpses, rotten dead bodies, and rotten food and donated items. Displaced people had eventually been moved to Ban Nam Ko school because of these hygienic reasons."*

The information given by all interviewees as displaced people confirms that all routes in hazard area were submerged in mud, debris, and other fragments. All interviewees mentioned that everyone had to assemble in the provided evacuation centres. Therefore, residents in the hazard area had to walk through the submerged areas that were full of sharp fragments and also poisonous animals in order to get through the evacuation centres. People arrived to the evacuation centres with bloody wounds over their bodies.

Interviewee N expressed that: *"People walked to evacuation centres with wounds to receive treatment here. It was too difficult to walk to the evacuation centre every day to receive regular treatment. Additionally, affected people had so many things to do, it would become late or in some cases too late to receive the proper treatment in time to save their lives."*

Interviewee E added that *"The main roads over the hazard area were reinstated in the first few days but they could not be efficiently used due to accidents on the main roads. It was difficult to get help from the outside communities and also difficult for the organisers to provide help to those affected people. For this reason, the donated items, food, clean water, essential items, etc could not be delivered to the evacuation centre due to the accidents and lack of usable roads. Displaced people in evacuation centres were starving and suffering. Apparently the accidents from the massive vehicles blocked the main road and the donated items were damaged and spoiled."*

Affected people who lived in the hazard area and decided to live in their houses rather staying in the evacuation centres had to walk through the submerged area to evacuation centre to collect the donated items and compensation money several times a day.

The information from interviewee F expressed the situation regarding the inaccessibility to the evacuation centre created some serious situations. *"I had to run to Ban Nam Ko School several times a day, while there were no convenient footpaths to easily access the school. I and my neighbours had to walk through the mud and debris. It was not possible to walk there safely. We had wounds, some had tetanus, and one was bleeding seriously. Someone was bitten from poisonous animals as they also escaped from the disaster. I had a severe injury from slipping when I rushed to the school to collect the donated items and compensation money as announced by the government officers. After the emergency period, I had back and leg pain. I could not carry out my job as an agriculturist anymore so I had to quit. I consequently loaned the money to buy a used car and sell pork on the mobile car over the village."*

Information given by local governor and shelter provider: On the other hand, the information from local government shows that the capacity of the halls in evacuation centres was roughly estimated by the local governor and officers, mainly in respect to the number of displaced people in hazard area.

The governor revealed that *"The evacuation centres were packed with displaced people in the first few weeks because people were afraid of an aftershock. We announced to all villagers to stay in a safe place and provided the basic assistance at Ban Nam Ko school and Wat Santi Wiharn temple, while Wat Nong Kok was mainly used for the cremation ceremonial services. These safe places were identified by the local government officers as the safe places from the debris flood. The evacuation places were initially established in order to provide a safe place for displaced and affected people throughout the village. We roughly estimated that these places would be able to conveniently serve the helpers, donors, and organisations. There was an underestimation on the number of helpers, donors and organisations coming from across the country to the evacuation centres to provide help to the affected people. Those places were unbelievably overwhelmed by people everywhere. We tried to move some activities to process outside the halls and pavilions, however the tents we requested could not be delivered to the evacuation centres as expected due to the submerged or slippery roads, and road accidents along the roads. For these reasons, the evacuation centres were still packed with people and activities for the first few weeks."*

The governor commented about the situation of providing more basic essentials to the evacuation centres that *"Mobile toilet cars accessed the evacuation centres a few days after the disaster event. This delivery was essential because the number of toilets in the centres was not adequate for the number of people in the centres. Clean water was also requested but there was a delay in delivery due to traffic jams in the hazard area. Due to the large amount of people in evacuation centres, vast amounts of garbage piled up within a few days! We could not burn it because it may have created toxic fumes and air pollution over the centres. The garbage trucks could not access the centres, same as the larger vehicles. This poor hygiene could have caused the diarrhoea outbreak found in evacuation centres. The hygiene was getting worse, particularly in Wat Santi Wiharn, where we had to collect the dead bodies to further the investigation"*

The governor expressed the main difficulties in conducting the administration in the emergency period that *"It was troublesome and hectic to authorise several things in the short emergency timescales required. We had no knowledge or experience on how to handle this type of situation before. All officers were busy with the emergency incidents which we had to sort out initially. As it was called the disaster area, the prime minister, ministers, royal family, and senior government officers came to this*

hazard area in order to investigate the situation and provide help. Although those visits were really useful to affected people, we needed to leave our tasks to welcome those honoured visitors and report the situations several times a day."

A monk also explained the situations after the disaster in particular at Wat Santi-Wiharn temple that *"All pavilions had been occupied by affected people. People came here with sufferings and loss. Monks were mainly working hard to console and preach a sermon to those affected people who lived in the temples at that time, while there were psychologists healing the mental sufferings of those affected people in Ban Nam school. Monks were in charge of mitigating the mental sufferings and committing the cremation ceremony. We had to ask for help from other monks from other temples in the community to help us deal with the cremation ceremonies to pay the last respects to the dead bodies and also help the survivors to recover mentally.*

The monk also explained that; *displaced people were later moved out from the pavilions of the temple according to the necessity to use the pavilions for cremation ceremony. Some monks were invited to go to Ban Nam Ko school to preach a sermon to displaced and affected people instead. It was worse to let displaced people stay in the temple because of trouble with the vision and smell of the dead bodies. Displaced people were pushed into deep depression. Therefore, displaced people were relocated to Ban Nam Ko school. The school was suddenly crowded with people who never used to temporarily stay here. It was very hectic from this unexpected relocation."*

After the disaster event, the local governor rushed to the hazard area so they could access the area, while the governors could not get through to the hazard area after few hours after the disaster occurrence due to blocked roads submerged in debris.

The governor explained that *"Only few main roads were restored in the first few days in order to deliver injured people to the hospital as the first priority. Other main roads in the community were gradually restored to increase the alternative routes for transportation. As the debris covered the hazard and adjacent areas, all roads were submerged. Although the main roads were restored, the surface of the roads was very slippery causing road accidents in several areas. It was a big mistake to let the trucks delivering donated items and people to pass through on the slippery roads. Consequently those large vehicles had the road accidents and blocked the transportation channels. It was very hectic and hindered the local people from clearing the roads."*

The governor also added that *"The main roads were intensively used in the first few weeks, while the minor roads and footpaths were restored by the cooperation among volunteers, the military, and local people. The debris and fragments were piled on the shoulders of the roads in wait for collection by the garbage trucks to dispose away from the community. The equipment used to remove debris and fragments from the roads across community were borrowed from government offices, private stakeholders, and personal agricultural equipments."*

Information from the reviewed document: The document of Ruangchan (2001), noted the number of houses destroyed by the debris flow event in 2001, there were 188 houses completely destroyed and 411 houses partly destroyed. Considering merely the numbers of affected households, the evacuation centres established by the local government would be able to supply those people effectively. It is also noted in the document of Ruangchan (2001) that the donated items were delivered into the evacuation centres using approximately 1,000 truck loads, while the helpers, donors and relevant organisations came to the centres and hazard area amounted to more than 5,000 persons. Moreover, there were more than 10,000 daily visitors who came to this village to observe the situation, visit their relatives, and enjoy the entertainment performed by celebrities and superstars (Ruangchan, 2001). These additional un-expected people accessing the evacuation centres and hazard area compounded the crowding problem and traffic jams which were identified as the major problems associated with spatial aspects in emergency time. Therefore, the information derived from the reviewed document of Ruangchan (2001) validates the information given by interviewees in these focused issues.

The texts encoded from these interviews and information can be listed and mapped in order to show the links between the explored problems associated with spatial aspects and the relevant impacts.

Table 4. 5: Socio-economic issues and coded texts related to spatial aspects in evacuation centre by content analysis technique

Socio-economic issues	Impacts	Decoded texts related to spatial aspects
Crowding	Conflicts from individual space requirement and missing donated items	Occupying space, area, size, volume, capacity, accessibility
	Unfair trade from selling donated items to gain a very small amount of money	
	Smuggling, Robbery	
	Flee from evacuation centre • Death from severe infection • Injury from walking to evacuation centre to collect the donated items and compensation money -Quit the job due to the chronic pain -Long term debt	
Inadequate provision of the basic essentials	Difficulties in living in evacuation centre	Provision of the basic essentials in evacuation centre
Suffering from lost and depression from staying within the forensic area	Mental illness and depression	Residential zone, location
Traffic jam and road accidents due to the submerged area	People starved from undeliverable food and donated items to evacuation centre	Accessibility, accident point and location
Difficulties from walking through the submerged area to evacuation centre	Suffering from not receiving the provisional services	Distance, accessibility

Considering the issues in evacuation centre related to the spatial aspect terms, it is able to map these relationships on a cognitive map (Figure 4.19). The cognitive map in Figure 4.19 presents the sophisticated relationships of the problems associated with space utility in evacuation centres causing barriers in achieving a successful first phase of resettlement programme.

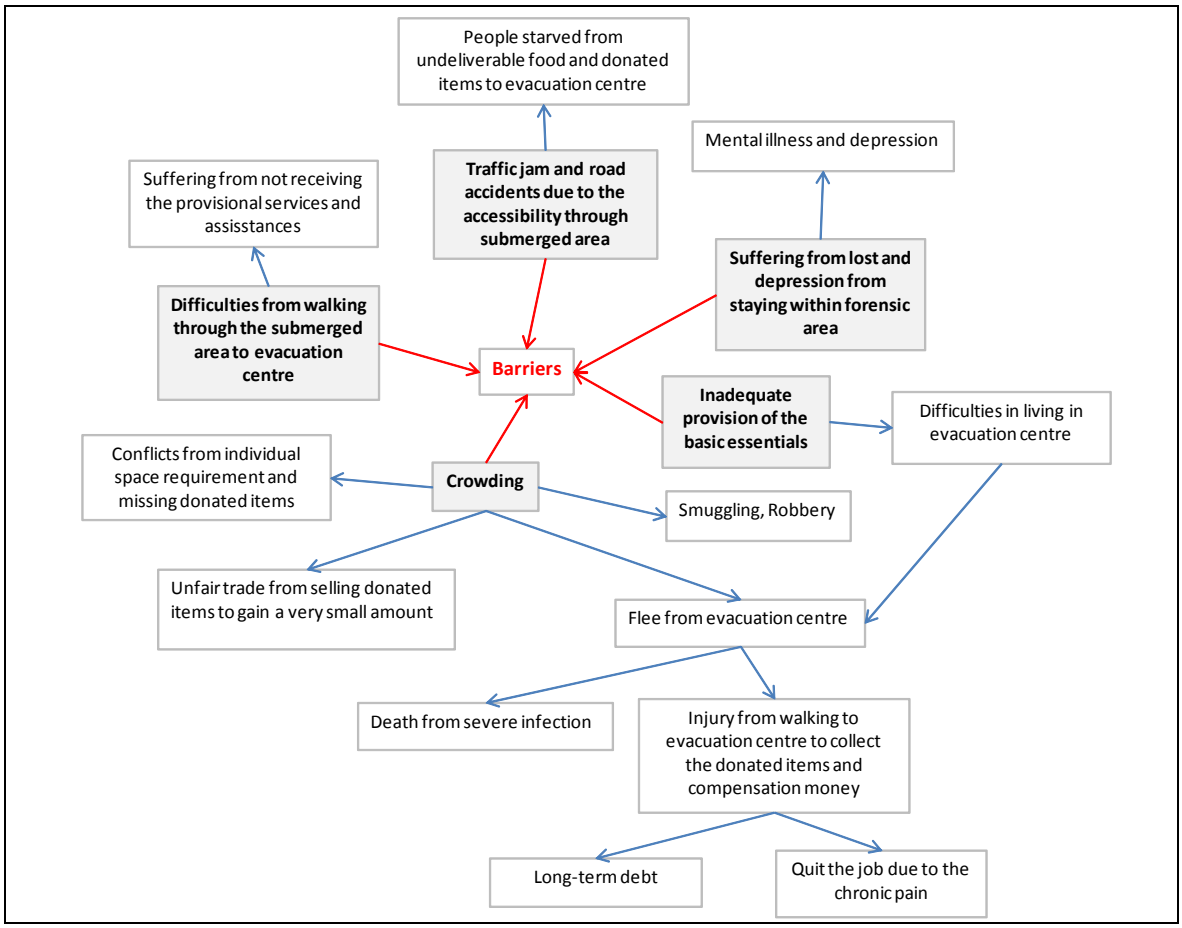


Figure 4. 19: Cognitive map showing the barriers associated with spatial aspects in achieving a successful resettlement programme in evacuation centres

The cognitive map in Figure 4.19 shows that there are several impacts derived from those explored socio-economic issues. The problems were carefully transcribed by considering the spatial aspect terms. After determining the spatial aspect terms, the impacts of the issues were identified using blue arrows.

From the information received by interviewees, reviewed documents and other available sources, it can be concluded that there were several complex links derived from the issues associated with spatial aspects shown on the cognitive map (Figure 4.19). The spatial aspect key words were determined in the encoded messages to define the impacts associated with spatial aspects of the issues explored in evacuation centres.

The evacuation centres have to serve several activities in emergency time. The case study of this research shows that there are also some important determinants considered when applying the community service centres as the evacuation centres. These criteria must be

carefully considered in order to avoid several impacts regarding the unexpected impact issues, such as:

- ***Original function of evacuation centre***

Those community service centres must provide multiple functions and also maintain their original functions. For example, a temple which is used as the evacuation centre also has the original function as a place for cremation. Without considering this original function, displaced people have to relocate to other kinds of community service centres. In addition to use a temple as the evacuation centre, the shelter space must be well organised and clearly partitioned between the living areas and the cremation ceremony area.

- ***Space utilisation estimation***

An estimation of the space utility must be a concern not only the number of affected people, but also the helpers and organisations who are authorised to provide the emergency assistance to those affected people. In the announced "disaster event", the evacuation centre and hazard area may be full with a vast number of people who come to provide assistance. For this reason, it is suggested to consider the flexibility of the space expansion as another option for good practice in order to reduce the overcrowding situation. To manage crowding due to the unpredictable number of affected people and helpers using the centres, an extended area of the outdoor space could effectively mitigate the crowding issue in evacuation centres. Therefore, tents and temporary shelters are recommended to be stored in the community service centres within the village for any immediate application.

Space in evacuation centres is not only utilised by people, but also occupied by donated items of displaced people. It can be seen from the cognitive map that the crowding problem regarding spatial aspects links to several impacts such as the conflicts from insufficient shared space which enforced displaced people to sell the donated items to grocery brokers to gain more space and money. This controversially created criticism from many donors and helpers.

- ***Centralisation of administration and organisation***

Evacuation centres are centres of collecting and distributing the donated items and monetary compensation. All affected people, displaced people, and relevant organisations inevitably have to access these centres. Also, considering the number of visitors in the hazard area, evacuation centres are also utilised as meeting and assembly places for all

helpers. This evidently increases the number of people in those centres and also compounds the crowding problem. A high density of people live within the evacuation centres, but there are a large number of affected people choosing to walk to evacuation centres daily rather than stay in the overcrowded centres. However, this group of people had to walk between their homes and evacuation centres to receive the donated items and compensation money from dawn till dusk. Regarding the inconvenience from un-restored footpaths, accidents from slippery surfaces, cuts, and poisonous animals often harm this group of people. The impacts of these issues cause the chronic illness and also death to affected people linked to inaccessibility to evacuation centres. It is recommended from this study that allowing multiple centres of administration and organisation would mitigate the crowding issues which are directly linked to several impact issues as addressed above. Other social service bases would be organised and prepared as other centres provide the basic functions in distributing the donated items, providing clean water, food, toilets, and basic essentials to affected people. As a result, affected people whose houses were partly destroyed by the disaster would not need to walk to the evacuation centres several times a day to collect their donated items and receive the basic essential services. This would reduce the likelihood of accidents regarding submerged paths.

- ***Accessibility to evacuation centres***

Focusing on vehicle transportation to evacuation centres, all submerged main roads which are linked to the outside community show critical impacts associated with spatial aspects to people across the hazard area. These impacts inevitably also affect the people in evacuation centres. When facing inaccessibility to evacuation centres due to the road accidents and traffic jams, displaced people encountered several difficulties such as starvation and urgent requirement of all basic essentials such as emergency treatment from the doctors and nurses. Although the main roads which are linked to the outside community were rebuilt to take injured people to the provincial hospital, bring several doctors and nurses to the evacuation centres, and bring the donated items to evacuation centres, those roads had never been apportioned for fast vehicles, emergency transportation or footpaths for pedestrians. To compensate the disappearing footpaths and endangered routes over the hazard area, people had to walk on the main roads which caused disruption to the emergency response vehicles. This situation delayed the emergency response vehicles and also endangered pedestrians walking along the main roads. This situation later decreased family incomes due to the disability of family members from the road accident.

Along with diarrhoea, clostridium was a severe infectious disease that attacked people during the emergency period (Ruangchan, 2001). It was also noted in the documentation that a large number of people were infected because they needed to walk through the mud and debris. This disease could kill an infected person within a couple of days. M.D doctors and nurses administered the vaccination to x infected people in the village (Ruangchan, 2001.

Accessibility is a significant parameter applicably measured by using spatial analysis. The application of spatial analysis can solve several problems associated with the accessibility of spatial aspects from the basic functions and extension functions in GIS programme. Focusing on a study by Corsellis and Vitale (2005), they concluded that displaced people frequently require access to acquire the basic needs, such as

- Access to land for settlement and agriculture
- Access to water, fuel wood, and construction material
- Access to security
- Access to food aid in the emergency phase
- Access to community services, such as health centres and schools

Generally, affected people access the hazard community in the emergency stage by walking since most of them lost their vehicles from torrential debris-flow and flood. Local government was in charge to restore all essential main roads for transportation. The scope of accessibility of people since the disaster occurrence in the study of Corsellis and Vitale (2005) can be applied to this case study as:

a) Access to land for settlement and agriculture;

Displaced people had to travel to evacuation centre and stay there until it was ensured that the severe situation was under control. In this case, the evacuation centre was crowded with affected people in the first couple weeks. Displaced people whose houses were entirely destroyed normally stayed longer in evacuation centres than other groups of people. Displaced people whose houses were partly destroyed generally stayed in the evacuation centre for a week before leaving again to restore their homes. Displaced people whose houses were not destroyed generally stayed in the evacuation centre for few nights to ensure that the situation was in control. They then moved back to their homes to remove debris, mud, and stain. In this case, people rarely accessed their farm lands due to the

difficulty in transportation during this emergency phase. In addition, people merely relied on donated items to survive in this period.

b) Access to water, fuel wood, and construction material;

Water and fuel wood were provided by local government in the emergency phase. These resources were sufficient and provided in the evacuation centre. Therefore, the access to those resources did not play any significant role in this case. The reconstruction task was the third priority after removing debris and mud from the submerged lands. This mission was not only carried out by affected people and their families, but also by assistance from neighbours, hired workers and military forces. Local government was in charge to restore all public infrastructure, facilities, and social service buildings. For this reason, there were a number of vehicles and construction machinery running through the destructive lands to transport construction material and labour.

c) Access to security;

Security service was set by police and volunteers who were in charge of monitoring the evacuation centres. However, displaced people from partly damaged houses and non damaged houses were not fully protected by the police and volunteers due to the broad residential area. These groups of affected people displaced to evacuation centre and stayed there at least a few nights due to security reasons. They were terrified of another possible disaster occurrence. For this reason, displaced people randomly walked from their lands to the evacuation centre for safety and security.

d) Access to food aid in the emergency phase;

Affected people accessed feeding centres for food and donated items in the emergency phase. This accessibility showed a very important pattern of travelling throughout the hazard community. As dependent status, affected people had to rely on donated food. In this case, the feeding centre was established in the evacuation centre. Displaced people had access to this feeding centre in the first few weeks by using main roads and some secondary roads. Affected people had to travel from their homes to the feeding centre several times a day to collect donated items from donors, The Royal Family, and charities.

e) Access to community service, such as health centres and schools;

There were several community services serving affected people at the evacuation centre such as mobile health units, mobile toilet units, etc. In case of a severe accident from this event, affected people were transferred to their nearest district hospitals outside the hazard community. At the local school in the hazard community, students returned to their classes

after the emergency phase. During the emergency phase, all classes were cancelled since class-rooms had been applied as temporary living space, storage rooms, and administrative areas in response to a large number of people and the urgent requirements.

- **Socio-economic issues in transitional process in temporary displacement area**

A prominent phenomenon showing the second phase of the resettlement programme of the study area regarding displacement location and activities is the relocation of displaced people to the improved residential places. Ban Nam Ko school was selected as the temporary displacement centre at the end of the emergency phase. Displaced people were moved from the halls and classrooms to temporary houses which were constructed by military forces. This built-up area fully equipped with all essential infrastructure and facilities for living during the transitional period. It means displaced households were able to stay in durable houses for a period of time before moving to resettle permanently in the resettlement area. However, there were some issues concerned in this area as described below:

Information given by displaced people: Interviewee L explained the situations and space utilised in temporary displacement area that *"The military were mainly in charge of constructing the temporary houses in Ban Nam Ko school. The temporary houses were laid in a U shape with an open space in the middle for activities organised by relevant officers. There were gaps between the blocks of houses sufficient for leisure, small gatherings, and chatting with neighbours. The communal toilets were on ground floor and separated from the temporary houses. Also, the mobile toilet cars were supplied within the area according the large number of visitors from the daily entertainment programmes. The entertainment performed by celebrities and superstars ran all day and night particularly for the first couple of weeks in this displacement area."*

The issues in temporary displacement area were revealed by interviewees expressing some important situations in this built-up area. Interviewee H explained that *"Displaced people were so stress and trying to forget all sufferings. Nevertheless, displaced people chose different ways to release their tensions. Some chose to talk with their neighbours, while some chose to spend their compensation money and rely on spirits and drugs. They sneaked out from the displacement area by using an open-wilderness area in the backyard of Ban Nam Ko school to buy those illegal products. Certainly, alcoholic drinks were prohibited in the centre. Later, the shop vendors approached this channel to*

sell their products including alcoholic drinks to displaced people directly. It was too difficult to prevent this situation because there were a lot of people mingled with displaced people within this temporary displacement area. We had the compensation money and we were fragile, therefore, we were prone to spend this money to release our tension. As a result, people who became addicted to alcohol and illegal drug could not go to work properly as seen during this time. It was almost too late for the local government officers to recognise this problem. After the disaster event in 2001, some affected people became alcoholics, incapacitated from drug addiction. More surprisingly, the alcoholism and drug problems became a serious problem in this village transforming from using among displaced people to teenagers in the village."

It was added by interviewee N that *"This disaster made a difference to many people's lives in this village. Some people were impoverished due to their loss. Some people were richer from the compensation money gained from the death of family members. It was shameful seeing some teenagers grow up with a large amount of money and spending their money on drugs. At the weekend, we noticed that there were some teenagers always riding the motorcycles through Ban Nam Ko school, gathering in some points next to the school to use the drugs in wilderness area of the school backyard."*

Interviewee M was involved with another illegal activity in the temporary area and revealed her feelings about the situation in the temporary displacement area: *"I was young and saw many elders gambling in their houses and I heard that they also played in the wilderness area at the school backyard. My father decided not to relocate to the resettlement area because he was not convinced with the government organisation to address alcohol, drugs and gambling issues in the temporary displacement area."*

Interviewee J added that *"Some strangers came to the temporary displacement area to join in the gambling, to sell alcoholic drinks and drugs, and to buy the donated items from displaced people. With a number of brokers secretly approached to this displacement area, the stealth problem increased, and sometimes we saw our items were on the van of those brokers and intruders which were parking in the wilderness area in the school backyard."*

Interviewee K claimed that *"The problems in the temporary displacement area derived from displaced people inability to spend the obtained money wisely, they were tempted by convincing advertisements from brokers and intruders. If we would like to*

keep the money safely, we had to travel to the town to deposit the money at the banks. The round trip from this area to the town took about an hour. It was not convenient at all to travel to the town every day to deposit the donation money in the banks, in particular for the elderly. In some case, the elders asked their relatives to manage this task for them and later were cheated by their relatives. This situation had never happened since we stayed in the evacuation centres. Therefore, we preferred keeping the money ourselves while there were several kinds of people who tried to draw the money from our pockets. It could be seen that displaced people spent the compensation money impractically on alcoholic drinks. It was true that many displaced people had moved to the resettlement area with the remaining amount of money just enough for the house reconstruction proposes."

***Information given by local government**:* The local governor explained the situations and atmosphere in the temporary displacement area that *"Local government and military forces had worked closely with engineers and architects of the Royal Princess Foundation to construct the temporary houses with durable materials. Leisure activities were organised everyday to entertain displaced people and local people over village by entertainers, celebrities, and superstars over the country. These activities were organised to reduce people's depression from the tragedy of the debris-flow event. However, there were many people approaching the temporary displacement area every day, so it was very difficult to investigate all suspects. The local government officers, with the cooperation of volunteers and local police attempted to protect the displaced people lives and belongings. Displaced people also needed to be responsible for their own security by watching out for each other in the area and urgently inform the guards about any potential suspects."*

Information from the reviewed document: The document of Ruangchan (2001), indicated that there were 173 temporary houses constructed for displaced people over Ban Nam Ko school and Wat Santi Wiharn temple. The temporary houses were designed according to the weather of Thailand. The temporary houses were expandable suitable for agricultural families which is a single or multiple family staying in a household. According the post-disaster resilience programme, the government were extremely concerned about the physical and mental health of displaced and affected people. Therefore, there were many activities and entertainment performed during the day and night in this area. It was noted that those activities in particular concert and stand-up comedy drew many visitors to this area. This inevitably brought an element of chaos to the displacement areas.

The information received from the interviewees and documentary review, problems in displacement location are listed in the Table 4.6 showing the hidden terms in spatial aspects.

Table 4. 6: Socio-economic issues related to spatial aspect in temporary displacement centre

Socio-economic issues	Impacts	Decoded texts related to spatial aspects
Alcohol and illegal drug approached from opened boundary of displacement area	Incapacitated from drug addiction • Lost job • Impoverishment	Approach, access, enter, channel, way, place, location
Gambling in temporary resettlement area	Impoverishment	Hidden place, location
Stealth: money stolen	Robbery, Crime	Place (of keeping money), accessibility
Smuggling, intruders, strangers mingled with displaced persons in residential zone in temporary displacement area	Robbery, Crime	Residential area, zone, accessibility, channel

The coded messages of problems with the existing spatial aspect terms link to several impacts from the explored issues associated with spatial aspects. These relationships are presented in the cognitive map in Figure 4.20 showing the complexity of problems in temporary displacement centres.

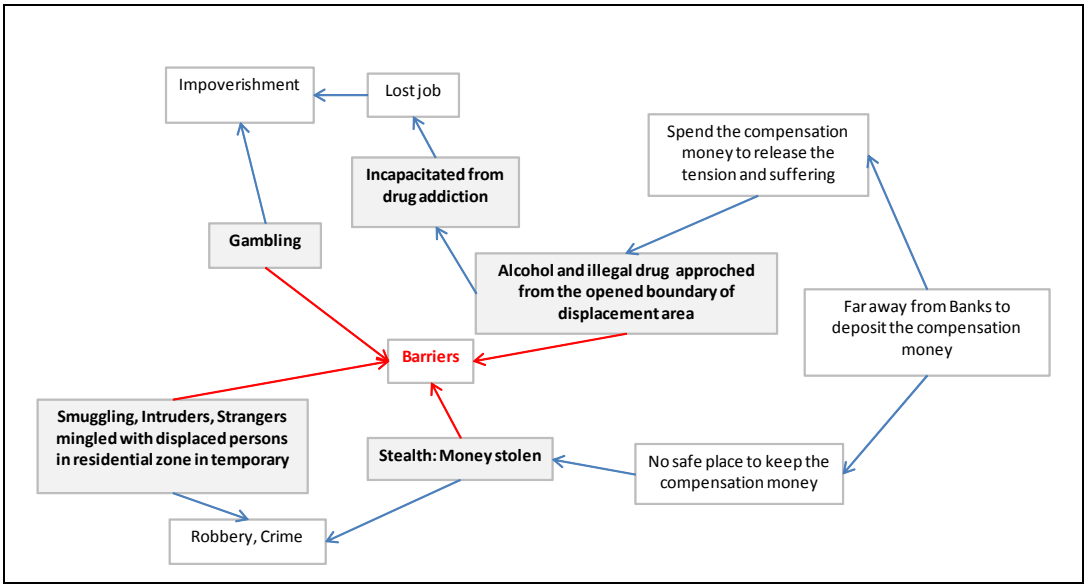


Figure 4. 20: Cognitive map of barriers associated with spatial aspects in temporary displacement centre

It can be seen that the major issues in temporary displacement area of this case study derived from the mix up between visitors and displaced people in the residential zone of the displacement area, and the open-wilderness area in the school backyard that became a channel prohibited activities. In the temporary displacement area, the encoded messages were detected by investigating the spatial aspect terms in the problems. The spatial aspect terms consist of "open space to wilderness area, channel, sneak-out way, and hidden place".

It can be seen that the issues in the temporary displacement area directly linked with the condition of the displacement location. The open-wilderness area at the back of the temporary displacement area allowed several illegal activities where exchanges between displaced people and brokers took place. Also the lack of a clear boundary defined between the entertainment area and residential zone in the displacement area increased the complexity in overcoming these existing problems. Surprisingly, the alcohol and illegal drug are still big problems in this village in this current day.

- **Socio-economic issues in permanent resettlement area**

Establishing a permanent resettlement area for displaced people is the final resettlement phase of the resettlement programme. This phase mainly consists of the selection of the resettlement land, the establishment of infrastructure and facilities in the area, and the maintenance of the resettlement area into liveable conditions. Displaced people and military forces took the major roles in reconstructing permanent houses in the provided land for this resettlement community. The government supported displaced families by paying compensation money and providing the resettlement land. However, it was an agreement between displaced people and the government that the displaced people cannot sell the land rights to any other. The situation after the displaced people had relocated to the resettlement area is explained in the following information received from the respondents and reviewed documents.

Information given by displaced people: The information given by interviewees shows the significant factors that were not considered for the sustainability regarding the resettlement paradigm as noted in the UN reports. Interviewee H informed that *"This community was not properly prepared. Initially, the electricity was shared from the host community, while the water was sometimes running. The insufficient water problem was not resolved for over two years. We had to rely on a small amount of running*

water for our daily lives. As the original homeland, we used to live close to the river. We had to adapt ourselves so much.....Politicians came to our community with some promises to improve our living quality; nevertheless, nothing has been improved as they said. We had to fight for ourselves. This area was dry, and we had to rely merely on the ground water. The local governor provided us some big jars to collect the rain water for our daily use."

Interviewees H and J expressed that *"Our farmlands are approximately 5-6 km from this resettlement community. The lack of decent transportation to this community causes a big inconvenience to our daily travelling. This also cut off the connection between our community and our former home lands and neighbours. We have to walk more than 500 metres to wait for an hourly local bus to travel to our farm lands or to town."* They added that *"Almost all of us are agriculturists. We have to bring along some heavy agricultural equipment with us to the farmlands. We used to have our trucks and equipment but they were flooded away and broken. Living far away from the farmlands without public transportation is very difficult in this area so we decided to loan some money from private finance to buy the used trucks and essential equipment."*

Interviewee J reflected on his decision and solution in transporting from the resettlement community to his farmland as *"We initially asked for a lift from our neighbours to the farm lands. However, we could not bother our neighbours that much. So we decided to loan the money from private finance using our farmlands as the guarantee to buy a used truck for our convenience. Some private finance companies do not require any guarantee but the interest of the loan is extremely high. The interest of the private finance is ten times higher than the interest of ordinary financial institutions. We mainly spent the loaned money to buy vehicles such as trucks or motorcycles and equipment used in the farmlands. Without any better solution, it has definitely created a long term debt to most residents in the resettlement community. Money gained from our income has mainly been paid to the private finance for the interest.*

Interviewee J added that *"There are many blind spots and insufficient lighting on streets in the resettlement area. Multiple road accidents have occurred, particularly at the entrance into the resettlement community during the night. We asked the local government to install street lights in our community; however, we have never received a response. The injured people were mostly teenagers working for their families. The impact of those accidents causes chronic illness, disability, or death to the victims."*

Interviewee J participated in the community meetings several times before giving up on joining those events. He gave the reasons and revealed his feelings that *"The most frustrating problem in this community is the lack of budget to develop the resettlement community. According to the administration, the government gives the budget under the name of the host community. Therefore, the received budget always goes to the host community, while the resettlement community has never received the money to efficiently improve the community. For this reason, we, residents in the resettlement community, requested to separate our community from the host community, but the request was denied due to insufficient numbers of residents and households that was required in the regulations for setting up a new community. We have been treated like the minority group of people. We have never had the right in requesting anything so we decided not to join the community meetings anymore.* This inevitably caused conflict and jealousy between the two communities.

As the same opinions of both interviewees, i.e. interviewee H and interviewee J, they agreed that: *Without the landownership, insufficient facilities, and being the minority group of people, we told our children to collect the money and resettle somewhere else!*

Information given by local governor: The local governor explained that *"Displaced people received the compensation money and support from the government to reconstruct their houses in the provided resettlement area. Although there was a large amount of money from donors, government, and NGOs to help affected people and displaced people in the hazard area, the post-disaster resilient programme also required a large amount of money to drive the long-term management. The majority of donation money from the donors was paid directly to affected people and displaced people, while several projects, in particular the establishment of the resettlement area had to wait for the money from the government. An abandoned area under the authority of the Treasury Department was selected for the displaced people. We tried our best to install the essential infrastructure to facilitate those displaced people. However, with the limitation of budget, we tried to fulfil the basic essentials as requested by re-settlers but it takes time to achieve those tasks. The resettlement area was established close to a host community to save costs in setting up a new community establishment."*

The governor commented that *"Actually, we had never had much knowledge on dealing with several of the issues in the applied resettlement programme.*

Problems along the application of the resettlement programme occurred everyday so we had to handle those problems daily. In terms of the proper way of applying the resettlement programme, we found that we had been learning by practicing. Surely, there were many mistakes along our practices but we tried our best just to protect people's lives in the vulnerable hazard area in our village." Therefore, there are several development projects constructed in this village in order to mainly protect villager's lives in the vulnerable debris-flow hazard area.

To understand the complexity of the problems in resettlement area, all explored issues were carefully listed and terms considered related to spatial aspects. In order to identify the links between problems and conditions in spatial aspects, problems in resettlement area are listed in the Table 4.7.

Table 4. 7: Problems related to spatial aspect in permanent resettlement area

Socio-economic issues	**Impacts**	**Decoded texts related to spatial aspects**
Different environment between original homeland and resettlement area	Difficulty in living and adaptation	Location, topography
Inadequate provision of the basic essentials	Difficulty in living: Water shortage Died or Incapacitated from road accidents • Blind spots and inadequate light from street lamps at night • Speed unlimited zone • Frequently used as shortcut to other communities	Distance, accessibility, route, (accident) points/locations, connection, link, sharp curve, blind spot, provision of the basic essentials
Far away from original homeland and no public transportation linked to other places	Isolated community from original homeland and other places Money loaned to buy vehicles • Long-term debt • Impoverishment	Distance, isolation, accessibility, route, location, connection, link

Based on the details in the Table 4.7, the relationships between the barriers associated with spatial aspects and their impacts in achieving the success in resettlement programme can be presented. The complexity of existing problems is illustrated in the cognitive map in Figure 4.21.

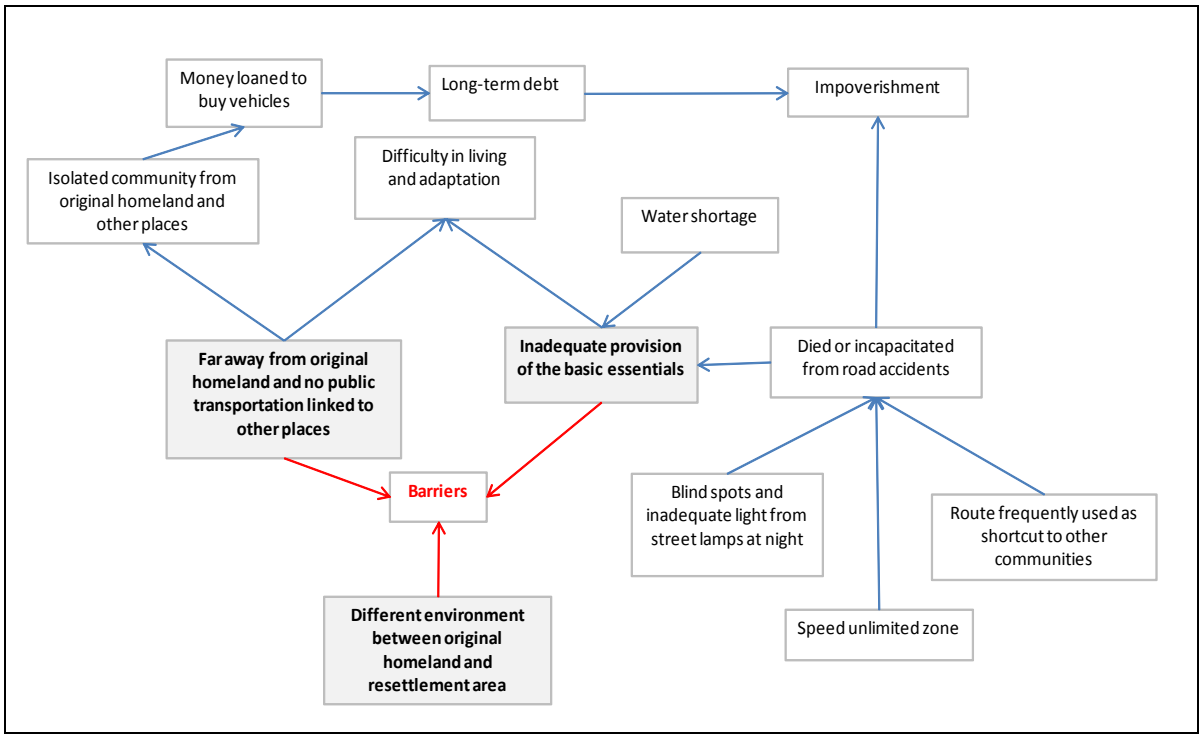
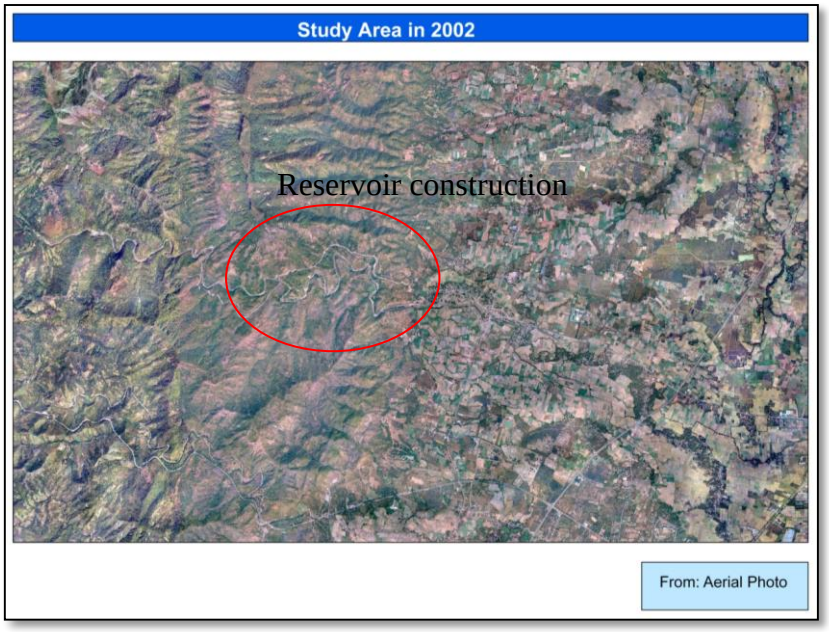


Figure 4. 21: Cognitive map showing barriers associated with spatial aspects in permanent resettlement area

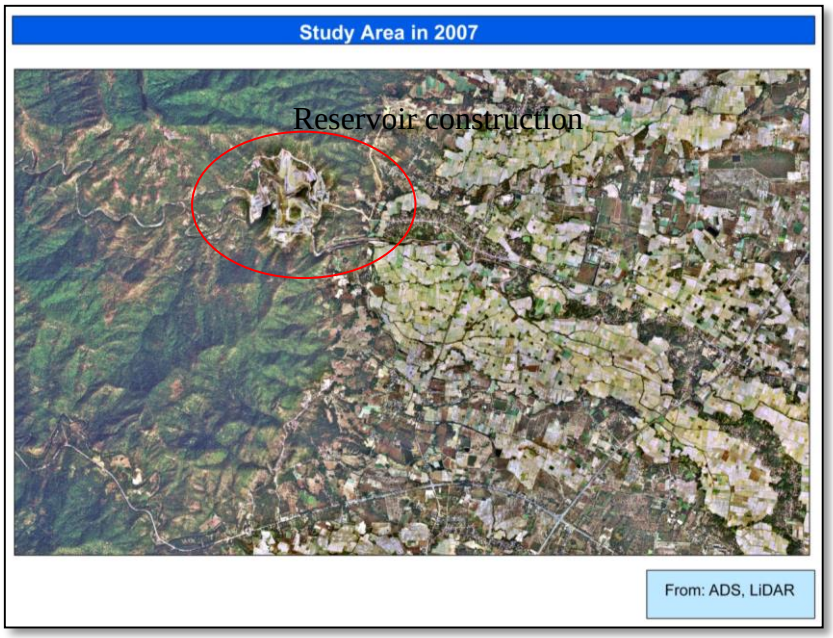
Focusing on Figure 4.21 the impoverishment and the dissatisfaction in resettlement area are the major issues in the final resettlement phase. The impoverishment derives from the unsuccessful attempt to improve their lives according with their primary occupations during this difficult time. On the other hand, the dissatisfaction derives from the ignorance of the government in continuously developing the resettlement area according response to the basic requirements of those re-settlers. Being treated like a minority without any special input to the community, those re-settlers have to put up with these problems since moving to this area. Furthermore, the budget in developing this village tended to be invested in several projects in order to protect merely the hazard area, while the resettlement area has never had any long term development project so far. This is certainly confirmed the lack of sustainable plan to develop the resettlement area as addressed in any resettlement paradigm of the UN reports.

The local governor received a large amount of budget almost five years later to construct a reservoir to protect the village and adjacent area from further possible

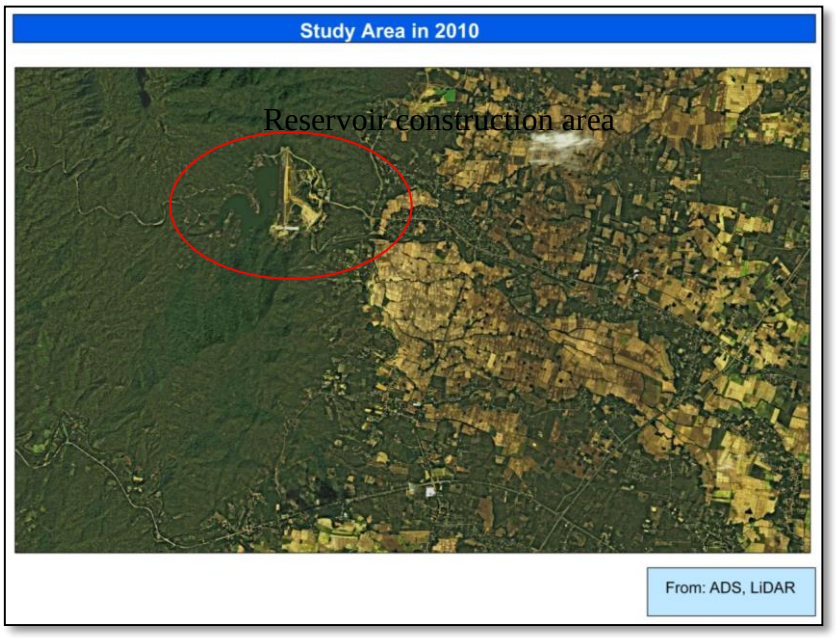
debris-flow disaster. The surrounding area of the reservoir has also been diversified to be a leisure zone for tourism. The area of reservoir construction is illustrated in Figure 4.22.



Aerial photomap in 2002



Aerial photomap in 2007



Aerial photomap in 2010

Figure 4. 22: Reservoir construction project illustrated on the series of maps

From the observation over the hazard area, most highlighted projects of the hazard village are land improvement projects while the resettlement community has never been determined as a part of any plan. The sustainability is far beyond the expectation of residents in the resettlement community. Apart from the reservoir construction project, there are several projects constructed to protect the village from debris flow and flood disaster such as the canal excavation and flood buffering zone, the establishment of permanent evacuation building, and the installation of the automatic weather station. The canal excavation and flood buffering zone are expanded projects from the reservoir construction on the mountain over the catchment area. The enlarged water canal would be able to contain large volume of water from intensive rainfall.

Canal excavation and flood buffering zone

Overview of canal excavation

Permanent building for evacuation in Wat Santi Wiharn temple

Automatic weather monitoring station, detected rainfall amount by the solar radiation, located in Wat Santi Wiharn temple

Figure 4. 23: Disaster protection projects in Ban Nam Ko village

The Rotary Association of Thailand also gave funding to construct a permanent building for evacuation as an emergency shelter for people in the village. Furthermore, an automatic weather monitoring station was installed in Wat Santi Wiharn temple to inspect the rainfall intensity of the village and automatically report to the local government directly to determine the emergency response and evacuation.

According the land development projects, the vulnerable debris-flow hazard area has been protected efficiently, while the government still has no plan to improve the quality of re-settler's lives. The problems in resettlement area still exist with the dissatisfaction of re-settlers. In addition, land development after the disaster event has been conducted over the water source on the mountain. There was a big project to construct a reservoir on the mountain to protect the hazard area from debris flows and flood, whereas the resettlement area has been ignored for any sustainable development plan.

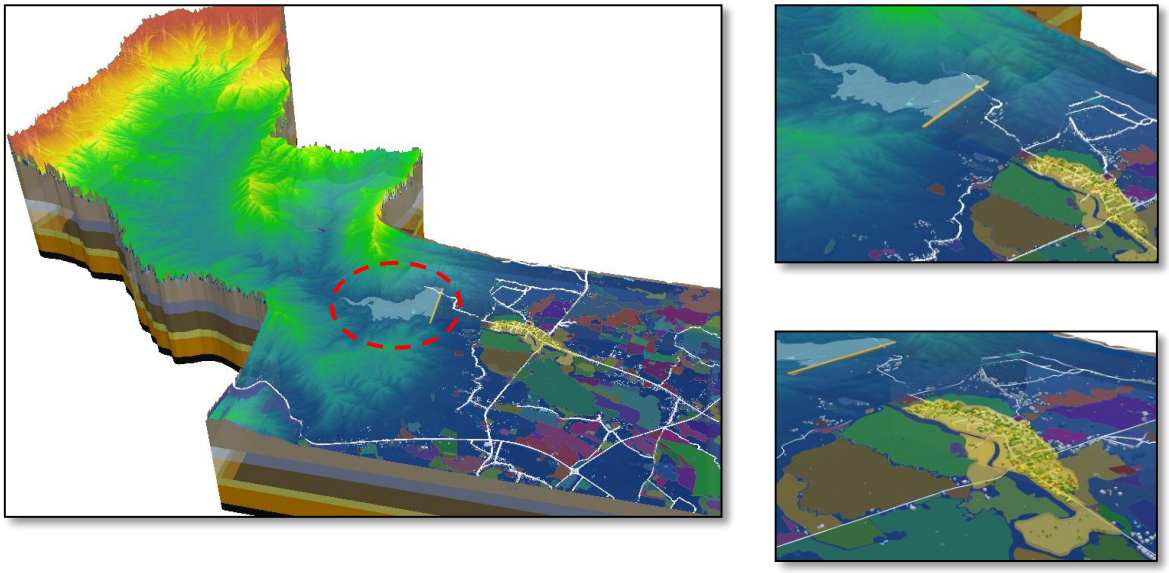


Figure 4. 24: Three-dimension image of the dam over the hazard area (image from Prasertburanakul (2012))

Based on the remarkable capability of spatial aspects, the coded terms found in the information and reviewed document analysed in the content analysis enable it to be virtually presented in an earth like manner using the geographical coordination system. Using the application of spatial analysis, the statement of problems explored from this study was examined. These analytical techniques are able to present feasible solutions to minimise the barriers associated with spatial aspects in resettlement programme in the next section.

4.3.2.3 Spatial analysis techniques in examining the statement of problems associated with spatial aspects

The key elements of analysis explored in this section explain the capacity of spatial analysis in examining the statement of problems associated with spatial aspects in a resettlement programme. Regarding the previous section, the problems associated with spatial aspects have been initially explored and addressed according to the resettlement phases respectively. Later, this section presents the technique in examining the explored problems associated with spatial aspects over the series of thematic based-maps by applying the spatial analysis in order to confirm the reliability of the received information and the feasibility in overcoming those complicated problems.

- **Spatial analysis techniques in examining the statement of problems associated with spatial aspects in evacuation centres**

Considering the cognitive map in Figure 4.19, it was found that crowding and inaccessibility are the main problems intrinsically linked to several impacts. In order to identify these problems associated with spatial aspects, spatial analysis techniques were applied in this section. Therefore, the explored problems were examined and the statement of problems related to spatial conditions in evacuation centres was presented.

- ***Crowding Problem*:** Considering the capacity of the evacuation centre solely on vulnerable displaced people, the areas of the available evacuation centres were estimated by investigating from the thematic map produced from high resolution aerial photo maps (Figure 4.21). All houses in the hazard area were identified and classified into two categories: i) affected houses shown in cyan and ii) loss houses shown in red. The number of houses has been calculated using the number of people in those households. Regarding the identified houses in the hazard area, the owners of those houses were also displayed according the records from the census information of residents in the village. This information shows that the total number of residents living in the houses in the hazard area was 1,764 people. On the other hand, two evacuation centres were digitised in order to investigate the space utility in those centres on the thematic based-map. The estimated space utilised in those centres is equal to 17,153.70 m^2. As a result, the density of space utility in evacuation centres can be calculated with the following threshold.

Density of displaced people per utility place = Space utilised in evacuation centres / displaced people

Therefore, the density of space utilised by a displaced person = 17,153.70 / 1,764

= 9.72 m^2

Regarding the estimated result from spatial analysis technique, it shows that the average displaced person occupied 9.72 m2 of space in the evacuation centre. However, the crowding problem was one of the major problems in the evacuation centre which contrasts with this estimation. This result could not be confirmed applying purely the spatial analysis in estimating the space utility response to the number of displaced people accordingly.

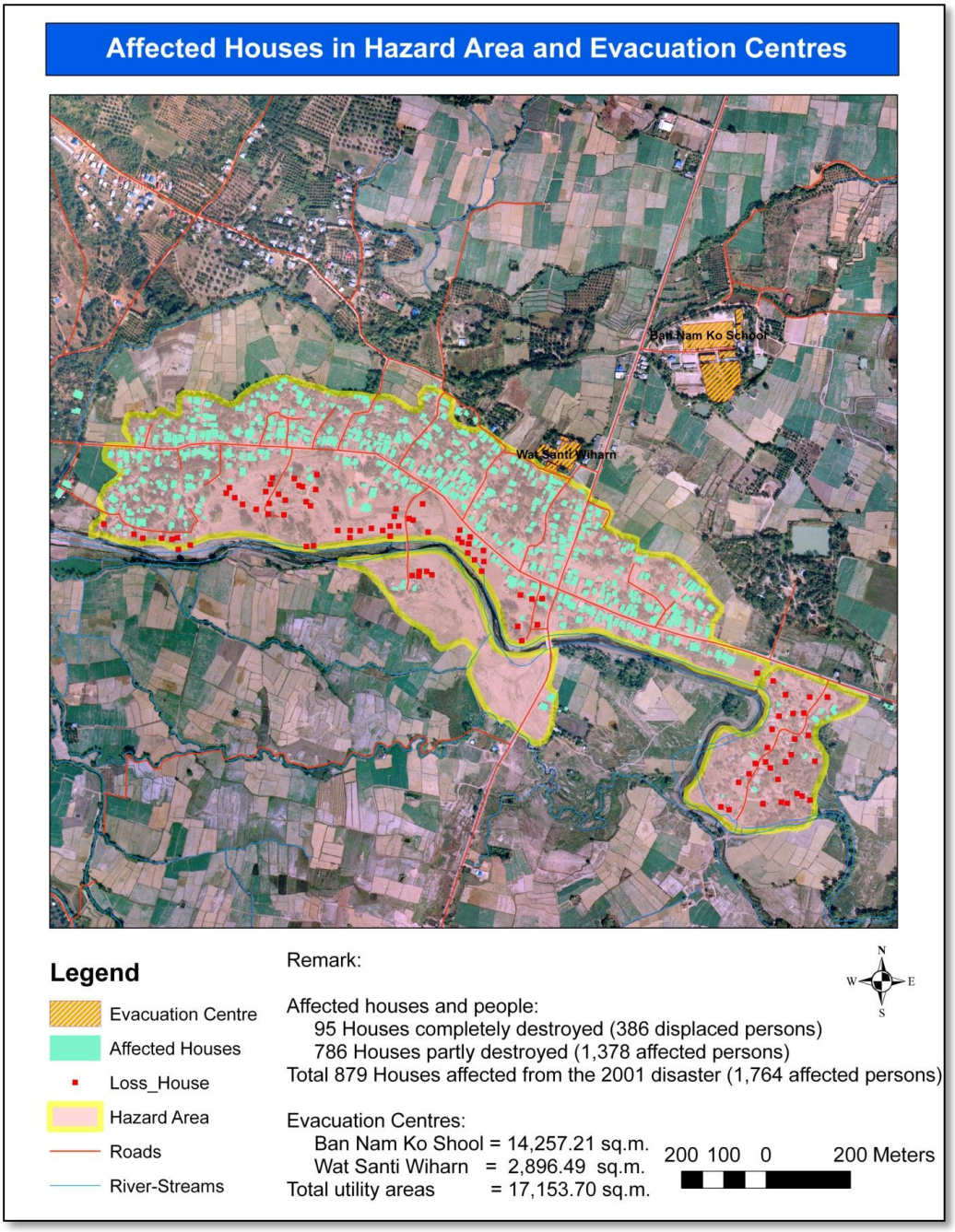


Figure 4. 25: Destructive condition of houses in hazard area

It was clearly addressed in the reviewed literature of Ruangchan (2001) that the evacuation centres were applied as the headquarters in the emergency time. There were approximately 5,000 helpers and donors within the limitation of space utilisation in evacuation centres. Upon wet weather and rainy days, the space utilisation in the buildings was definitely necessary in these periods. The evacuation centres were also places to assemble helpers and donors because there were local government officers standing by to give the useful information before they went out to response their tasks. Additionally, it was noted in the reviewed document that there were approximately 1,000 trucks delivering the donated

items to these evacuation centres. Those donated items were stored in the buildings in evacuation centres waiting for distribution (Ruangchan, 2001). Actually, the items in one truck consume 16.92 m^2 regarding the size of a truck (for more details of the size of the 10-wheel truck used in delivering the items:

http://www.vcargo.co.th/English/WebSiteVcargo_En/Vcargo_web_template_En/type_truck.html).

It means the donated items delivered by 1,000 trucks to evacuation centres totally require 16,920 m^2 of storage space before being handed out to affected people. Therefore, the actual space personally utilised by people in evacuation centres has decreased dramatically. Regarding the information from the reviewed literature and interviewees, the density of space utilised by people in evacuation centres can be recalculated as:

Density of displaced people per utility place = Space utilised in evacuation centres / displaced people

Therefore,

Density of space utilised by a displaced person = 17,153.70 / (1,764 + 5,000 + 16,920)

= 0.724 m^2

Therefore, a person in evacuation centre could only occupy the space around 0.7 m^2. It is likely confirmed that the crowding problem was the main problem in evacuation centre after the debris-flow disaster in 2001. In addition, this space occupied by displaced people may be reduced according the obtained donated items which were placed aside them in evacuation centres.

- ***Inaccessibility problem:*** Inaccessibility is another major problem affecting relevant helpers, officers, and organisers to access the hazard and evacuation areas in order to provide help to affected people. Some parts of the main road were submerged in debris and mud which could not be used by any transportation in the first few days. These main roads were restored and heavily used by mixed-up predestines and vehicles. All people who had to go to the evacuation centres had to use these main roads because the other accessible routes had yet to be restored in the emergency time.

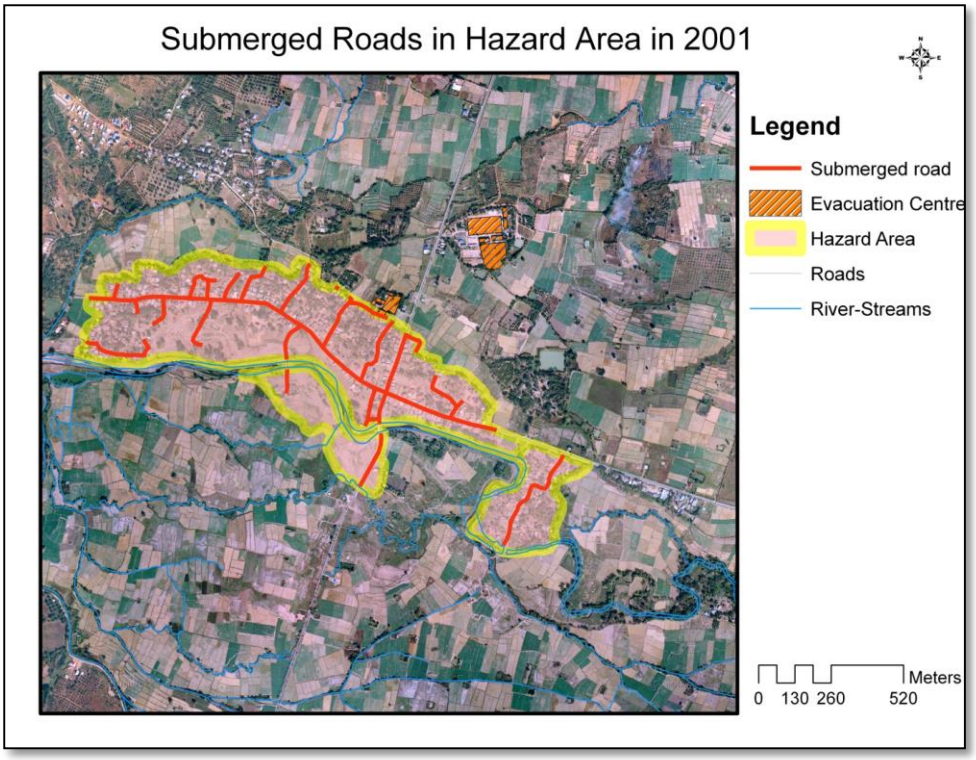


Figure 4. 26: Submerged roads in hazard area

- **Spatial analysis techniques in examining the statement of problems associated with spatial aspects in Temporary displacement area**

It is clear from the interviews and reviewed document that the illegal activities were major issues in the temporary displacement areas. With the extraction of the coded spatial aspect terms, the open-wilderness area of the school backyard expectedly shows the significant link to the explored problems. As the channel to escape to outside the temporary displacement area, displaced people would be able to conduct illegal activities and it is also convenient to the intruders to access this area and offer illegal products.

The information attained from the interviewees and reviewed document led the observation to be conducted over those temporary displacement areas. The observation integrated with the photo interpretation is able to prove that the problems explored in this resettlement phase related to the open-wilderness area of a temporary displacement area, Ban Nam Ko school. The boundaries of those temporary displacement areas were delineated on the map in Figure 4.26 by the expert technique in photo interpretation regarding the information of the observation in the field work.

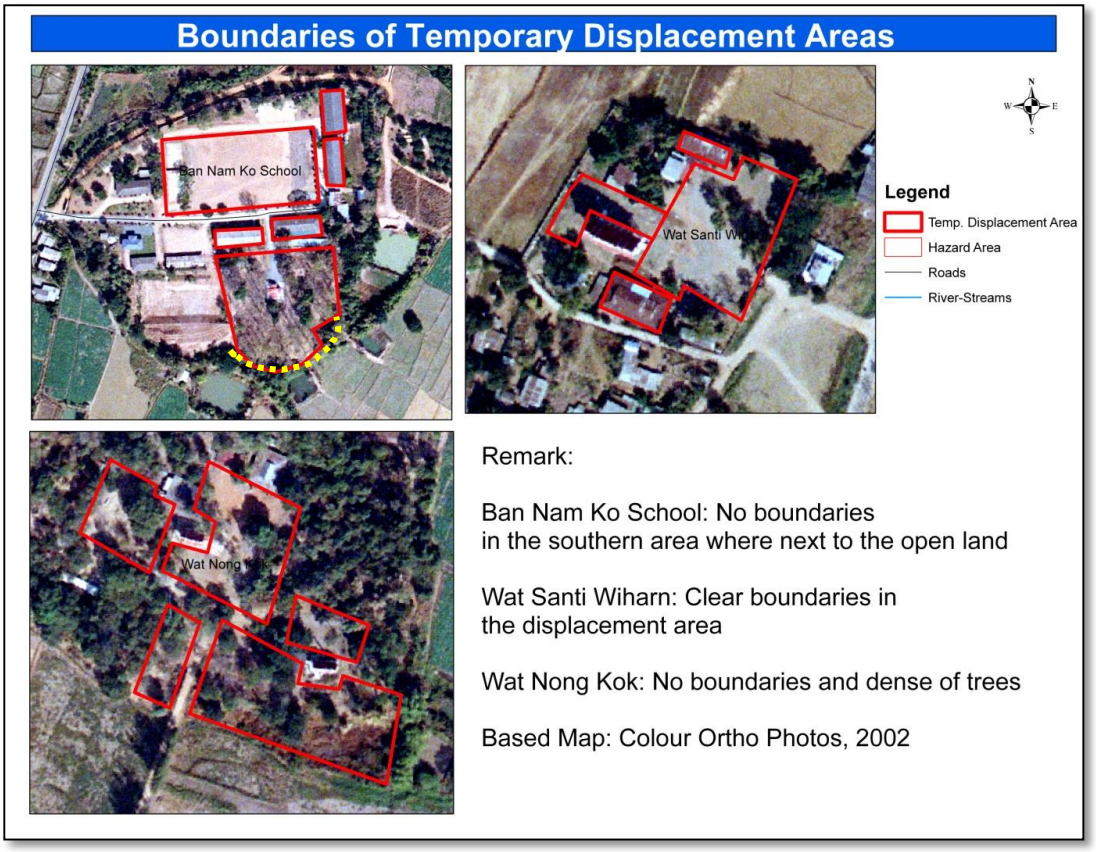


Figure 4. 27: Defined boundaries of temporary displacement area

From the information obtained, the explored problems were not found in Wat Nong Kok temple and Wat Santi Wiharn temple. Accordingly, Wat Nong Kok temple was mainly used for the cremation centre during the emergency period and was only applied as temporary displacement area for a short time. Considering the boundaries as mentioned as the source of the problem found in Ban Nam Ko school, Wat Santi Wiharn temple has closed boundaries in contrast to the open boundaries of Ban Nam Ko school (delineated in the yellow dash line in Figure 4.27). According the information received from the interviewees and the reviewed document, there was no mentioned problems associated with spatial aspects in the Wat Santi Wiharn temple. For this reason, the closed boundary of the temporary displacement area is another spatial factor considered in constructing a temporary displacement area in order to practically protect this area from certain illegal activities.

- **Spatial analysis techniques in examining the statement of problems associated with spatial aspects in permanent resettlement area**

This issue contains several problems regarding facilities provided in resettlement areas. The provision of basic essentials in resettlement area and sharing facilities with the host

community was an option that government chose to facilitate for all re-settlers in this resettlement area. However, they still encountered several issues associated with spatial aspects which are:

1.) Non-expanded public transportation between resettlement area and former residential area
2.) Poor infrastructure causing road accidents in resettlement area
3.) Insufficient running water in resettlement community

These three issues relate directly with the spatial aspects and conditions of the established resettlement location. With the application of the spatial analysis, these three statements of problems can be examined and presented visually for proposing the feasible solutions.

1) Non-expanded public transportation between resettlement area and former residential area

Distance between the resettlement area and former residential area was a commonly mentioned spatial term used by the interviewees. The non-expansion of public transportation meant that re-settlers were completely cut off from their former residential areas and farmlands. The difficulty in approaching the distant former residential area and farmlands was compounded by the public transportation never expanding to the resettlement area. These situations unnecessarily increased the difficulty for re-settlers to travel to those places.

As measured on the aerial photo by spatial analysis application, re-settlers have been moved to relocate in the resettlement area approximately 5 kilometres away from their former residential areas. In order to travel to the farmlands next to their former residential areas, re-settlers have to walk approximately half a kilometre and often have to carry the agricultural equipment with them to the bus stop in front of the host community (Ban Rong Cheuak) to take the public transportation. This examined measurement on the map (Figure 4.28) validates the information from the interviews.

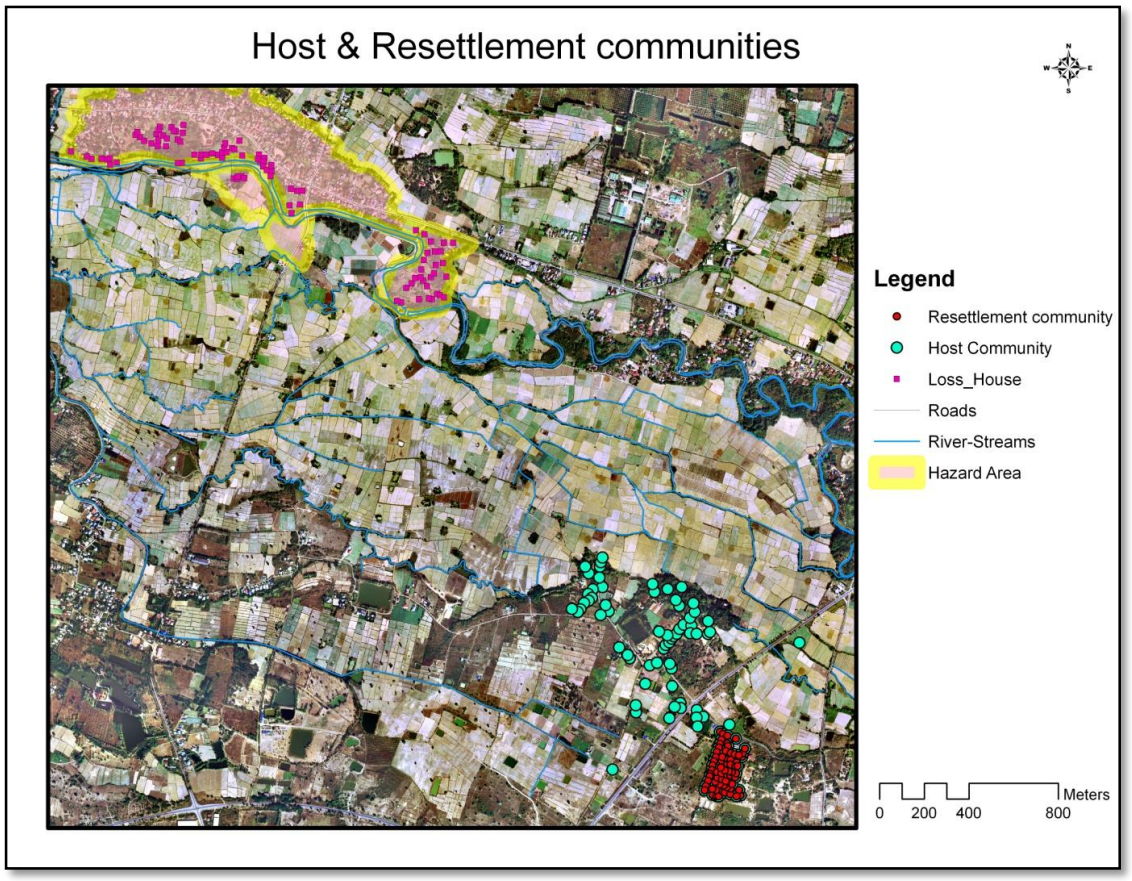


Figure 4. 28: Host and resettlement communities

2) Poor infrastructure causing road accidents in resettlement area

The information provided by interviewees who have been living in the resettlement community emphasised the number of road accidents occurring in front of the resettlement community. It was claimed by interviewees H and J that the sharp curves causing blind spots and insufficient lighting along the street in the community were the predominant causes of those accidents. These claims can be verified by focusing on the details on the high resolution aerial photo with photo interpretation techniques. These techniques show there are indeed the sharp curves causing the blind spots at the entrance of the resettlement community. Additionally, it can be investigated on the high resolution aerial photo that there is no street lighting around those sharp curves which is possibly the cause of the blind spots as mentioned by the interviewees. Therefore, the examined result validates the information given by the interviewees.

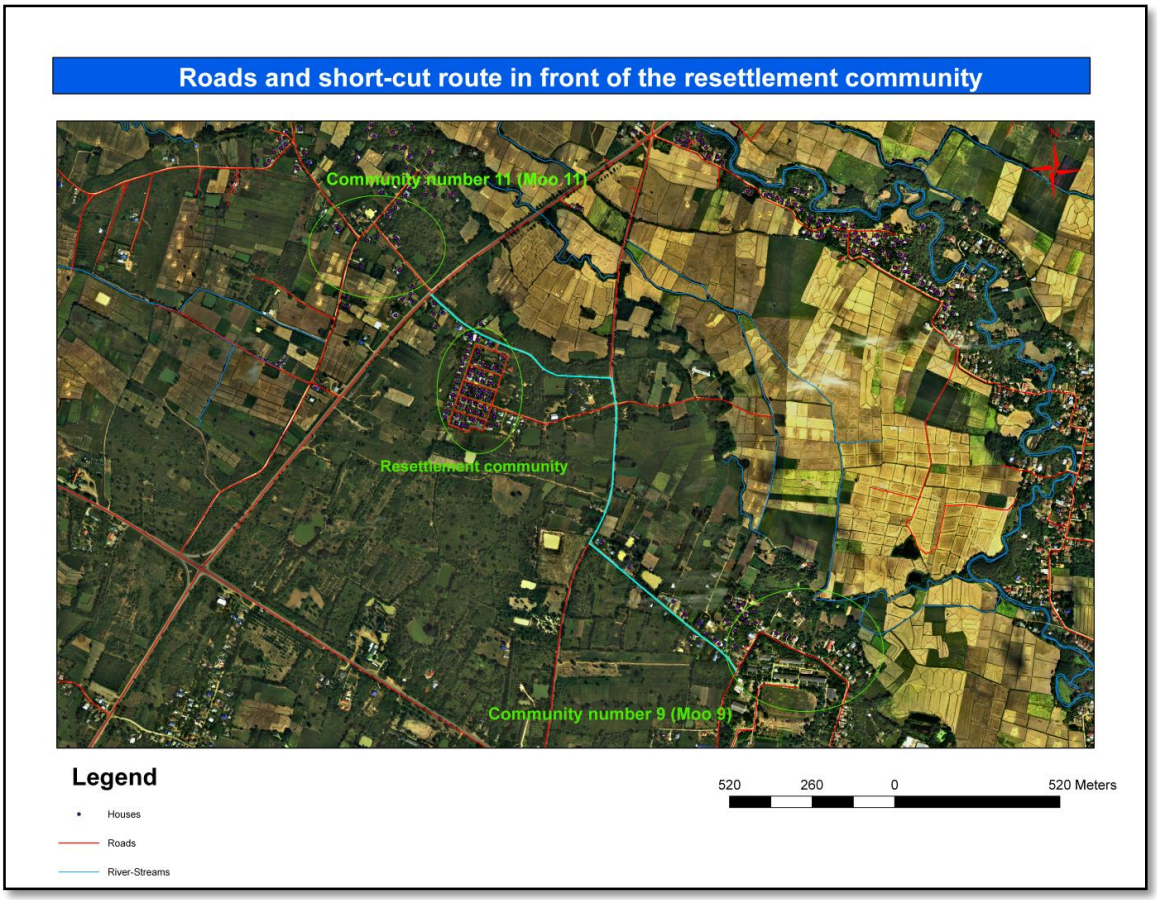


Figure 4. 29: Road and short-cut route in front of resettlement community

Further to the blind spots mentioned by interviewees, causing road accidents in front of the resettlement community, the field work observation shows that the road in front of the community has been used as a short-cut (delineated by the cyan colour in the map, Figure 4.29) between community number 11 and community number 9. This short-cut, approximately 1.5 km in length, passes the front of the resettlement community. Without any traffic lights and traffic calming measures, the road accidents are said to occur mostly due to speeding vehicles. The drivers and riders did not reduce their speed, even when passing the entrance of the resettlement community. This examined result on the illustration map supports the statement regarding frequent road accidents in front of the resettlement community.

3) Insufficient running water in resettlement community

Running water was one of the major problems on the resettlement community causing hardship to re-settlers. This resettlement area was dry in contrast to the former residential area. Typically, re-settlers used to live by the river, they then had to encounter the limitation of water usage in their daily lives when moved to the resettlement area. With the

application of spatial analysis, the available sources of surface water were identified by photo interpretation technique. For this reason, the supply water around the resettlement area can be examined by using the spatial analysis technique and photo interpretation. This analysis validates the statement that there was insufficient running water in the resettlement community as mentioned by the interviewees.

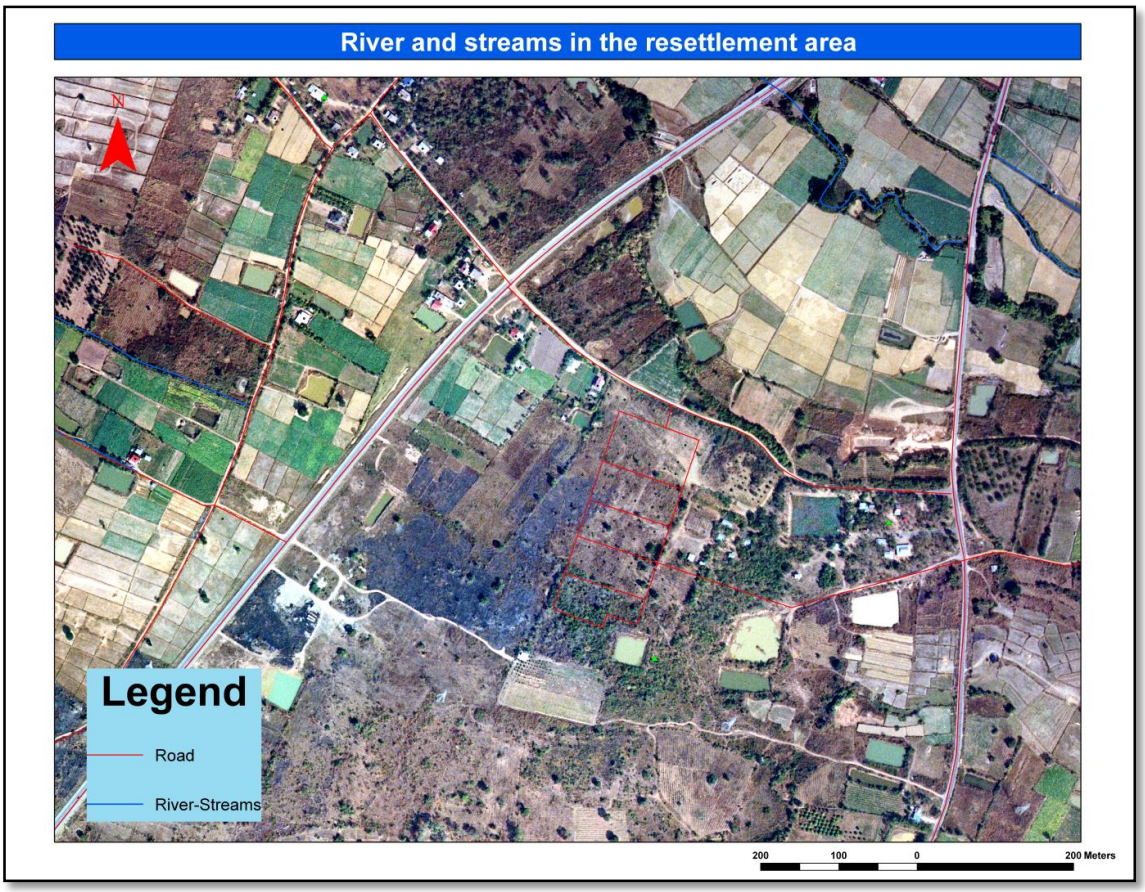


Figure 4. 30: River and streams in the resettlement area

The high resolution aerial photo taken in Nov 2001 (Figure 4.30), clearly displays that the resettlement area and proximate area are not surrounded by rivers and streams. As stressed by some interviewees, this photo interpretation technique confirms that this area was dry and there was no supplied surface water for daily use.

4.4 RESEARCH SUMMARY

The explored problems consist of socio-economic, administrative, and physical problems in resettlement programme and were examined by the application of spatial analysis techniques. Spatial aspects have shown to be a bridge connecting several impacts sophisticatedly on the cognitive maps. The cognitive maps displayed the barriers and

several impacts associated with spatial aspects and were linked together according to the displacement areas. It identified some common issues such as crowding, inaccessibility, the open boundary, unprepared resettlement site, that lead to several severe impacts creating an unsustainable resettlement community and dependent re-settlers.

As the capacity of applying the spatial analysis techniques, the explored problems associated with spatial aspects can be examined and presented on thematic maps. Those maps present the explored problems associated with spatial conditions in the same results and aspects as the information from interviews and documentary review. The results from the spatial analysis can summarise that there must be several factors essentially considered before conducting a resettlement programme. Those factors can be found in the next chapter. These revelations can also be very useful in other resettlement plans for vulnerable debris-flow hazard areas.

The application of spatial analysis techniques also has some slight limitations such as, the validity of information received from the vulnerable people and the limitation of the availability of land identified as potential debris-flow hazard areas at local scale over Thailand. The information or datasets stored in some departments of the government offices may not be completely accurate; therefore those datasets need to be validated before being used for any further analysis. As found from this study, it is recommended to validate the collected information of vulnerable people by observation before conducting the analysis techniques. In case of planning a resettlement plan, the obtained data of vulnerable people must be validated also. It is found that the information from the community hospital had been collected correctly and was well updated due to the regular task of looking after all patients in every single household unit in the village. Therefore, the basic information of people from the community hospital is recommended to be used as validated information for this purpose. Furthermore, the lack of identified potential debris-flow hazard areas in vulnerable communities at local scale in Thailand is a big barrier in planning the resettlement programme. It is recommended to produce a high resolution map illustrating the potential debris-flow hazard areas at local scale in advance. This base map can help the government and relevant organisers to plan an effective resettlement programme.

With the support of rich information and effective spatial analysis application, the problems associated with spatial aspects can be mitigated which can reduce tension and sufferings of affected and displaced people. , This study finally introduces some feasible

recommendations to minimise the problems associated with spatial aspects in the findings chapter.

CHAPTER 5

FINDINGS

5.1 INTRODUCTION

This chapter contains the findings from the analysis and validation techniques which provide assurance regarding the quality of this research. The findings of this study present an effective technique for minimising the socio-economic, administrative, and physical problems associated with resettlement programmes by applying spatial analysis applications. The structure of this chapter consists of two major sections. Section 1 discusses feasible solutions based on the application of spatial analysis to minimise issues associated with spatial aspects in resettlement programmes, while Section 2 focuses on the database designed for resettlement programmes in vulnerable, debris-flow hazard areas

Feasible solutions for minimising the identified problems in resettlement programmes are visually presented in detail in this chapter. These feasible solutions correspond to the requirements of displaced people and are also applicable by the government in order to organise resettlement programmes more efficiently. That is to say, these feasible solutions form a bridge between the top-down policy implemented by the government and the bottom-up requirements proposed by displaced people. These feasible solutions provide an optimum balance between the two different approaches at the end of the first section.

The second section presents the spatial dataset, with its criteria that have been developed specifically for vulnerable, debris-flow hazard areas. Along with the spatial dataset, non-spatial datasets are also indicated in order to present the entire dataset required for analysing the situations associated with displacement locations for vulnerable, debris-flow hazard areas. The final section of this chapter concisely summarises the key points arising from the findings in order to disseminate the knowledge gained from this study.

5.2 FINDINGS

- Feasible solutions arising from the application of spatial analysis to minimise the spatially-related issues that arise with regard to resettlement programmes

Various impacts associated with spatial issues have been derived from the analysed results presented in the analysis chapter. These impacts were mapped on cognitive maps to illustrate the complex relationship between the issues arising in resettlement programmes and spatial aspects. In order to minimise these issues, spatial analysis integrated with GIS has been applied to respond to the issues that occur in each resettlement phase.

1) Feasible solutions for minimising the explored issues associated with spatial aspects in evacuation centres
    - Feasible solutions for minimising the problem of overcrowding in evacuation centres

The overcrowding problem is an influential factor that has several types of impact on evacuation centres, i.e. hygiene, conflict, and dissatisfaction. Since only a few locations were selected as centres for all purposes, affected people had to walk long distances to these centres several times a day. This situation increased their susceptibility to sustaining injuries due to travelling between the evacuation centre and their home. Accidents caused by walking along submerged paths could lead to chronic illness and even death from tetanus. These impacts were described and mapped in the analysis chapter.

Considering that the situation regarding space causes the overcrowding problem in evacuation centres, a simple solution is to increase the utility space to a sufficient level for those within the centres and decrease the number of people utilising the evacuation centres for other purposes at the same time. Tents were installed to expand the external space from the residential hall for flexible functions outdoors. This concept might increase the utility of the available space effectively. However, the alternative solution of reducing the number of people who accessed the centre was not considered at all.

In terms of the number of people assembling in the evacuation centres, the number of affected people outweighed the number of displaced people. One hundred and eighty-eight

houses were completely destroyed and 411 were partially destroyed by the debris-flow disaster. Figure 4.12 highlights the patterns of displacement explored in this study. It identifies that affected people whose houses had been partially destroyed by the disaster tended to stay in their house rather than moving into the evacuation centre. However, a large number of affected people had to travel to the evacuation centre to collect the donated items and compensation money several times a day.

The information provided by interviewees who had walked from their home to the evacuation centre showed both satisfaction and dissatisfaction regarding the distance involved. The distance from the interviewee's home and the evacuation centre was measured via a spatial analysis application. The distance between their home and the evacuation centre was also raised with the interviewees. It was found that none of the interviewees who had to walk less than 300 meters several times a day to the evacuation centre complained about the distance at all. Furthermore, all of the houses in the hazard areas were analysed in order to establish the average distance between these and the nearest evacuation centre. The average distance from the houses in the hazard area to the nearest evacuation centre was calculated to be, using spatial analysis, 260.380 m. (Figure 5.1).

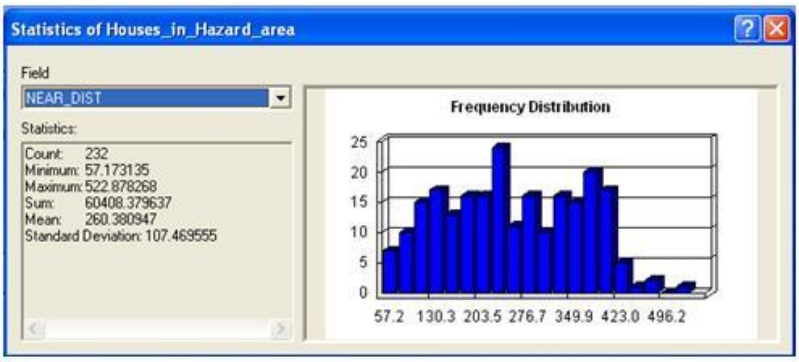


Figure 5. 1: Distances between houses in hazard area to the nearest public centre

The concept of multiple centres for distributing donated items and compensation money to affected people is proposed in this study. In order to reduce the number of people accessing the evacuation centres to collect donated items and compensation money, the density of the residential houses in Ban Nam Ko village was calculated and mapped (Figure 5.2). The density of those houses was overlaid by the coverage service areas of the community service centres for Ban Nam Ko village. This spatial analysis technique

identifies potential service areas if these multiple centres are to respond to houses within 300 metres.

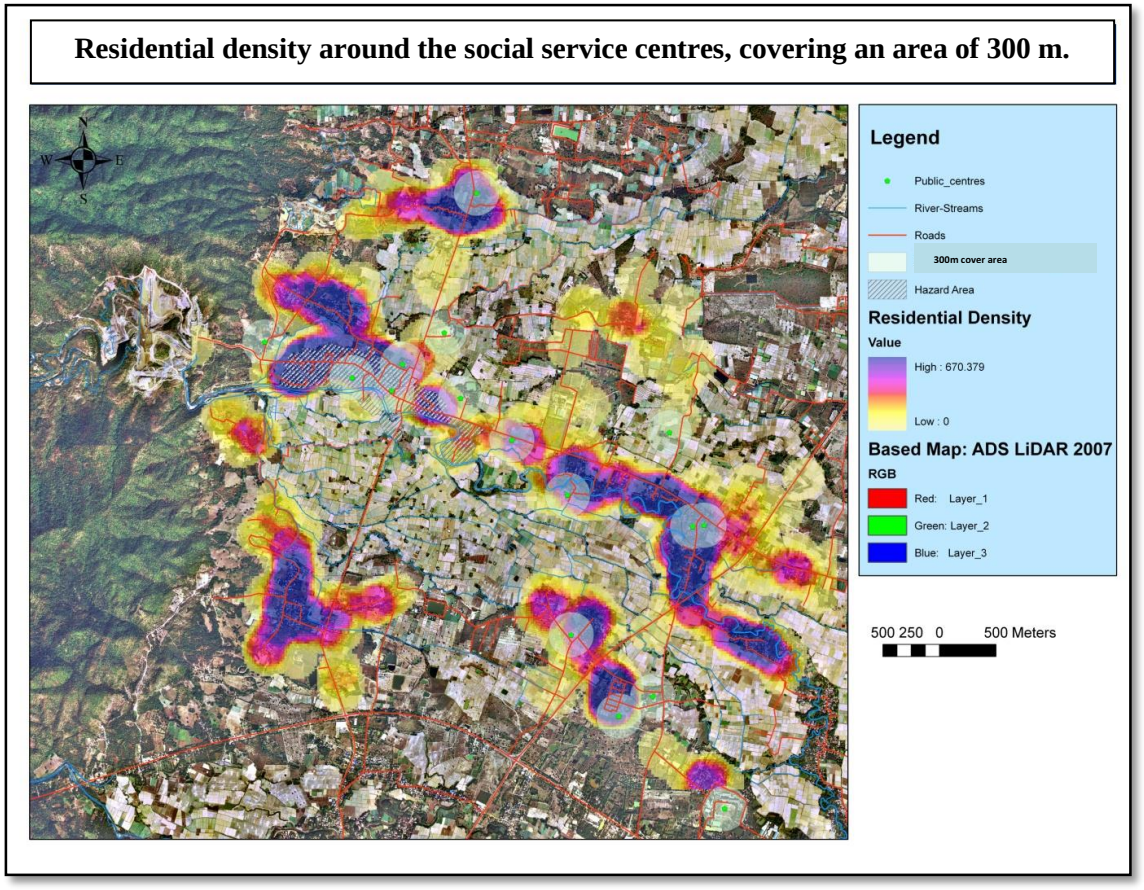


Figure 5. 2: Density of houses and coverage service area of community service centres within 300m

Considering the analysed density in Figure 5.2, the residential density in Ban Nam Ko village was coloured in dark blue to yellow to reflect the decreasing density of the houses, from high to sparse, respectively. Specifically focusing on individual houses within the 300 metre-coverage service area of the community service centres in Figure 5.3, it appears that the green dots show that the social service centres' coverage service is 300m. It is also remarkable that several areas with a high residential density, shown as red dots, are not covered by the social service centres. For this reason, it is recommended that temporary service centres might be established to support the concept of multiple centres for distributing donated items in order to minimise the overcrowding problem in a single evacuation centre.

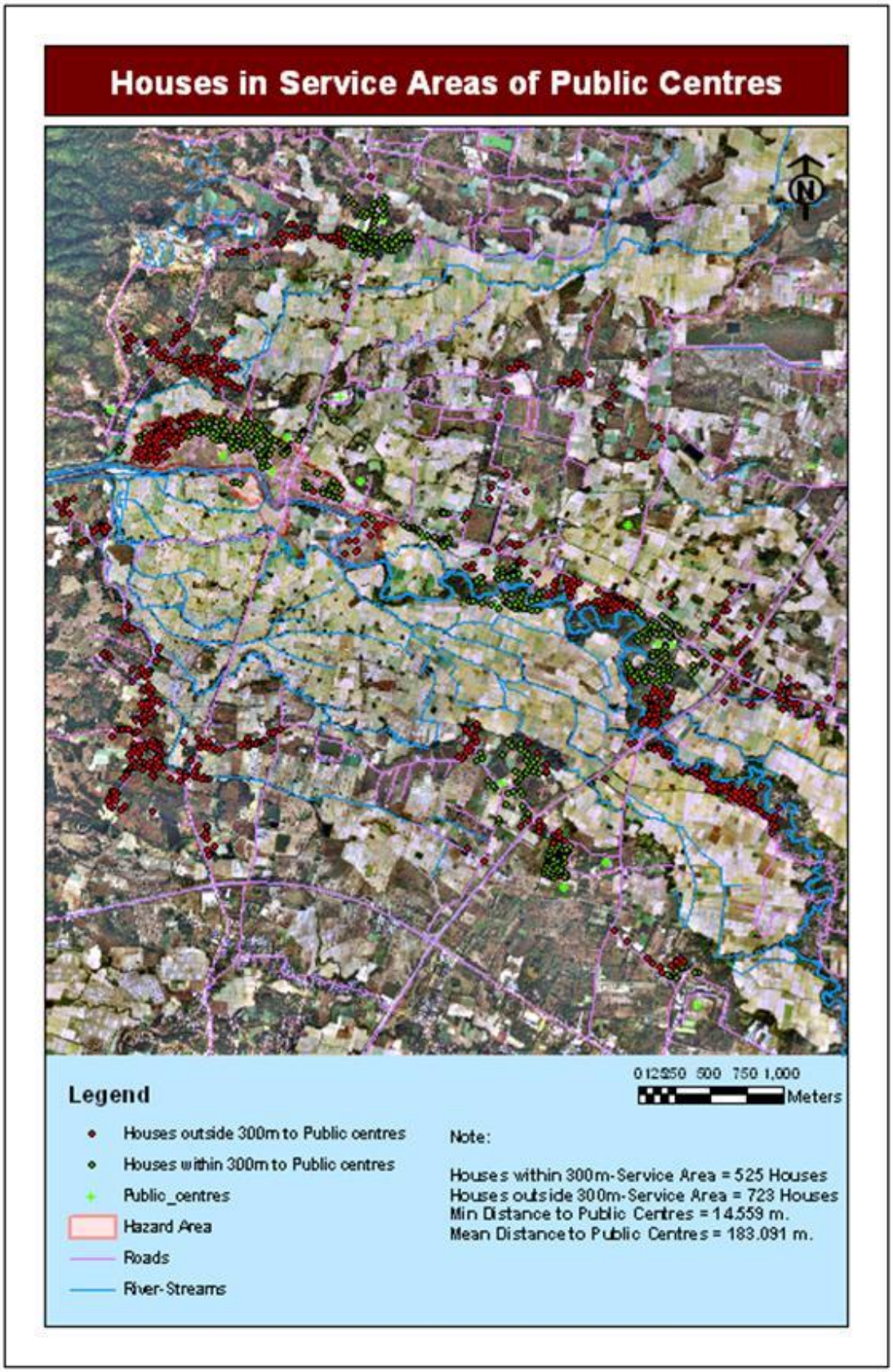


Figure 5. 3: Houses in service area of community service centres

Based on this analysed result, it is possible to identify every single household that is located outside the service areas. As it was proposed to establish a temporary centre for distributing donated items to these groups of houses outside the service areas, this solution would ensure that every single household could receive the donated items and compensation money without any difficulties or negative effects arising due to walking through the submerged area.

- Feasible solutions for minimising the inaccessibility of the evacuation centres

Based on the information provided by the interviewees and the reviewed documents, the inaccessible routes in the hazard and surrounding areas caused several socio-economic, administrative, and physical problems for the displaced people. These inaccessible routes delayed the transportation to take patients to hospital. This increased both the death toll and the severity of other injuries. On the other hand, helpers, organisations, the local government, and donors were unable to access the evacuation centres due to submerged roads in the hazard area. The displaced people and affected people who assembled at those two evacuation centres were starving due to delayed food deliveries, and the traffic was overly congested, with critical problems such as large vehicles skidding and blocked main roads.

Restoring the main roads is the first priority in terms of transportation management after this type of disaster. The submerged main roads leading to the evacuation centres must be restored to allow emergency transportation. Through this solution, emergency vehicles are able to access the hazard area to transport patients to the emergency locations, such as health centres, communal hospitals, and provincial hospitals. This fast action could save people’s lives and mitigate the severity of their injuries.

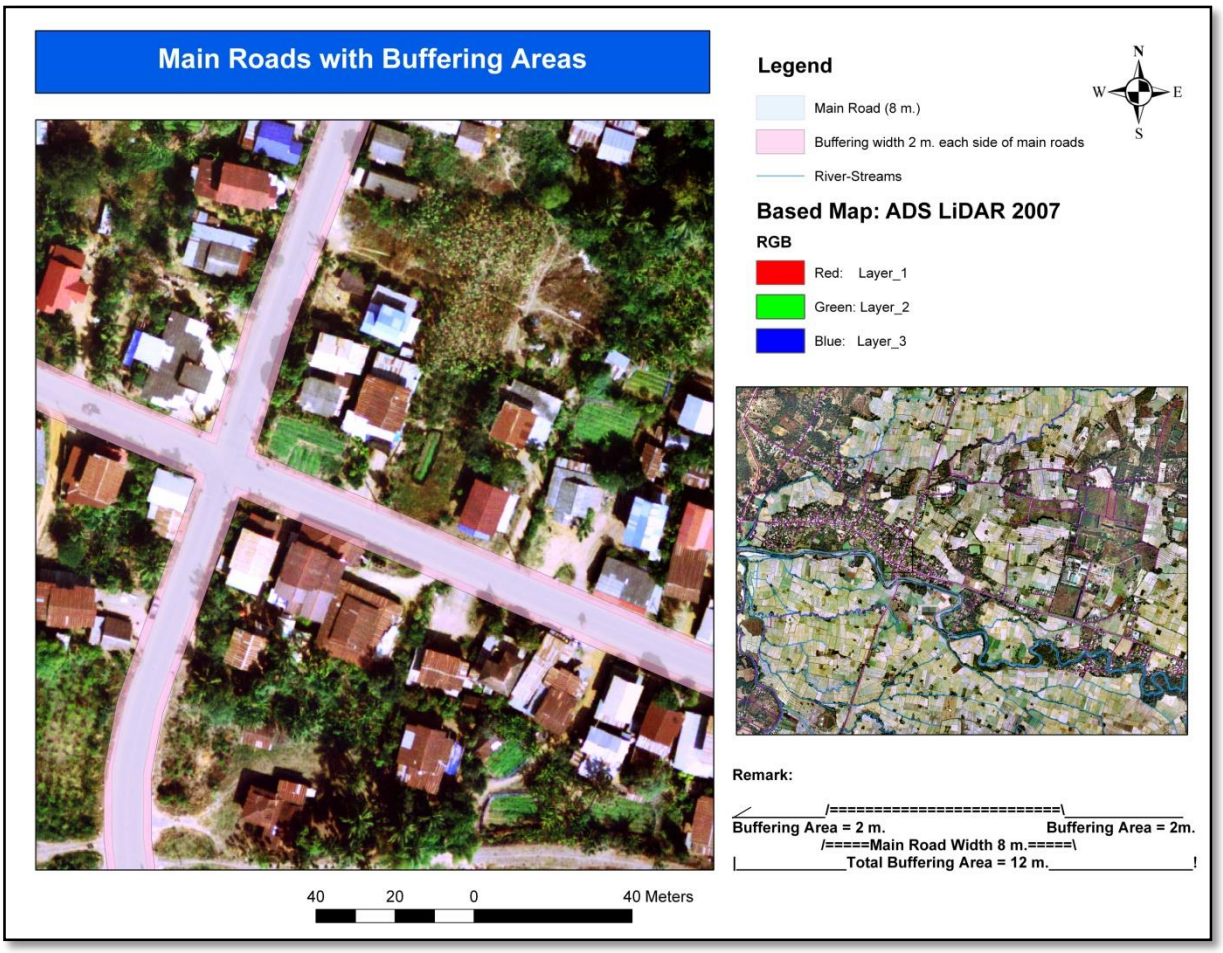


Figure 5. 4: Main roads with buffering areas at the roadsides

Buffering areas at the side of main roads are useful for parking vehicles when collecting patients and for separating volunteers or relevant people from the emergency channels. Through the application of spatial analysis, the buffering areas are identified on the main roads across the hazard area, showing a feasible solution to transportation management issues in the hazard area following the debris-flow disaster.

The second priority regarding the restoration of accessible routes to the evacuation centres would be to consider the routes along which vehicles can move smoothly at a medium speed. Here, all helpers can use the restored roads to reach the evacuation centres with the least delay. Considering the statement of the problems in the hazard area, it is recommended to identify routes that avoid passing through the hazard area itself. Therefore, the concept of restoring the minor roads with certain criteria is proposed in this study. Through the application of spatial analysis, shortest path analysis with a set of criteria has been used to identify appropriate routes for this transportation purpose. The criteria considered in the shortest path analysis consist of:

- *Routes linked to outside communities*

According to the links with outside communities, there are three directions (from the east, north and south) through which to connect to the outside communities. To the west is a large mountain range that makes connection with other communities in that direction difficult (Figure 5.5).

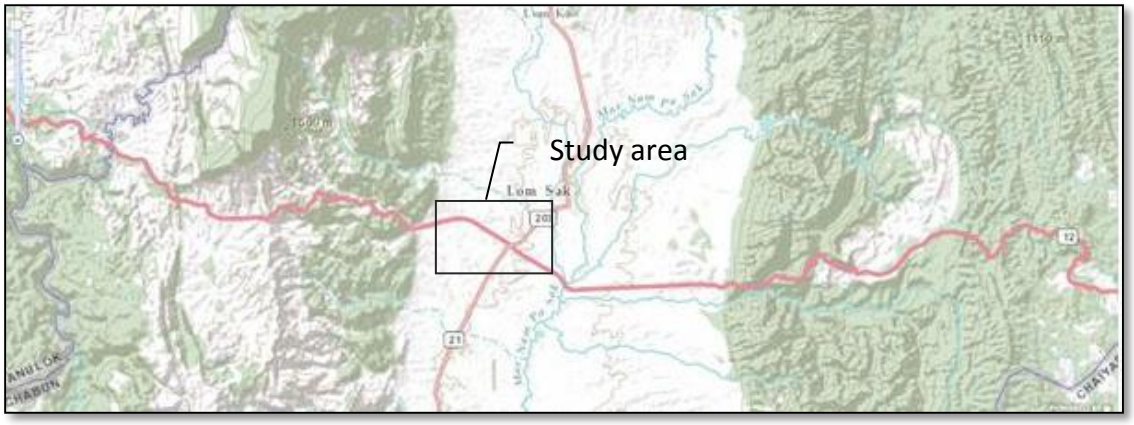


Figure 5. 5: Main roads connected to outside communities

- *Avoid the submerged roads in hazard area*

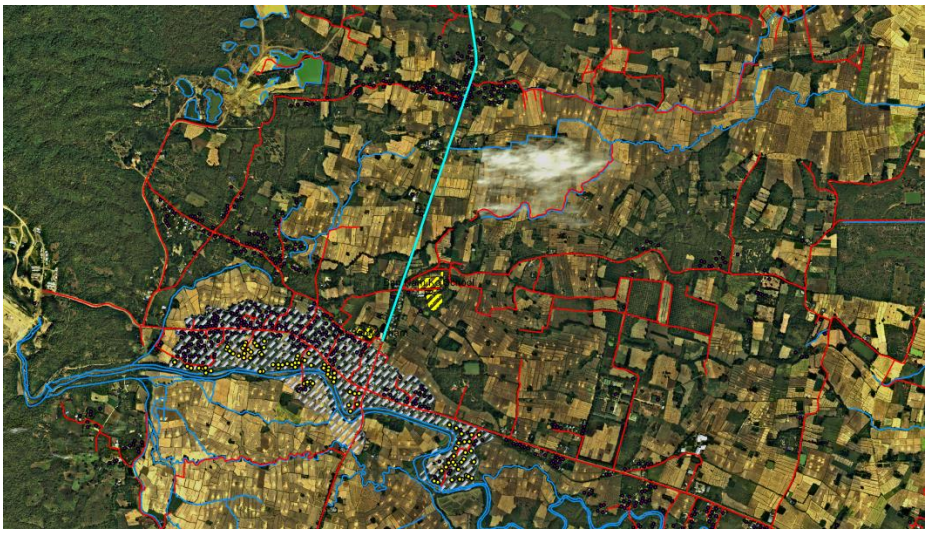
After the debris-flow disaster, all of the routes in the hazard area were submerged in mud and debris, preventing access through the hazard area. For this reason, all of the submerged roads in the hazard area must be identified in order to avoid transportation accessing those routes. Although the main roads in the hazard area were restored immediately for emergency vehicles, to deliver patients to hospital, etc., a lot of transportation on those roads might delay the emergency vehicles due to traffic jams. Therefore, the use of routes which could access the evacuation centre without using the main roads in the hazard area would be highly beneficial.

- *Hard surfaces and available channels for transportation*

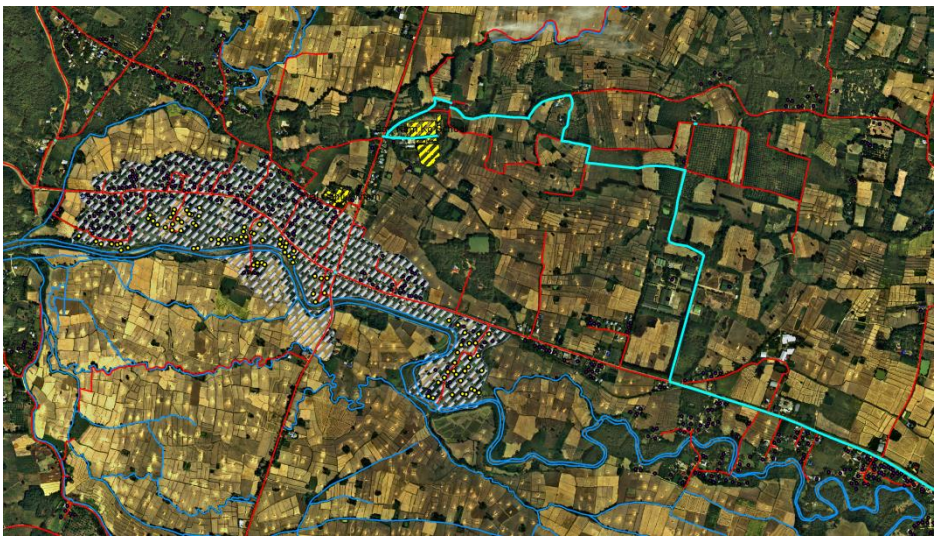
The hard surface roads outside the hazard area which are connected to the outside communities were investigated using photo interpretation. The photo interpretation considered the use of concrete surfaced minor roads as channels for transportation into the evacuation centres. These are shown in high contrast on the photomaps, and are easily identified by this technique. Additionally, the width of the roads is considered with regard to the suitability of two-way channels of transportation.

Regarding these three criteria, the accessible routes to the evacuation centres have been delineated using shortest path analysis. This technique presents the application of shortest path analysis generated on the hazard map layer, and the evacuation centre locations with the specific criteria mentioned in the above context. Therefore, the two-way channels of hard surface routes suitable for transportation between the outside communities and evacuation centres, that avoid passing through the hazard area, are presented on the map in Figure 5.6.

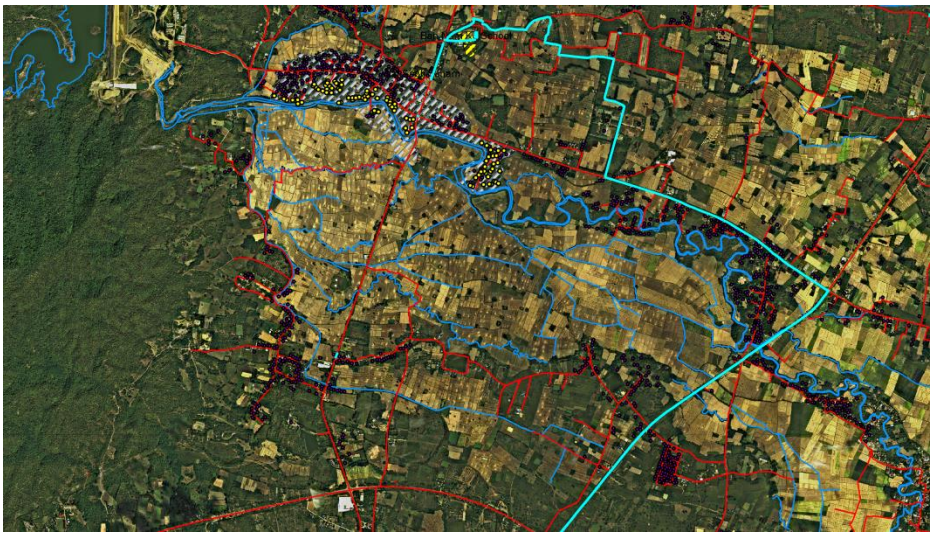
Roads and directions connected between evacuation centres and outside communities



Northern route



Eastern route



Southern route

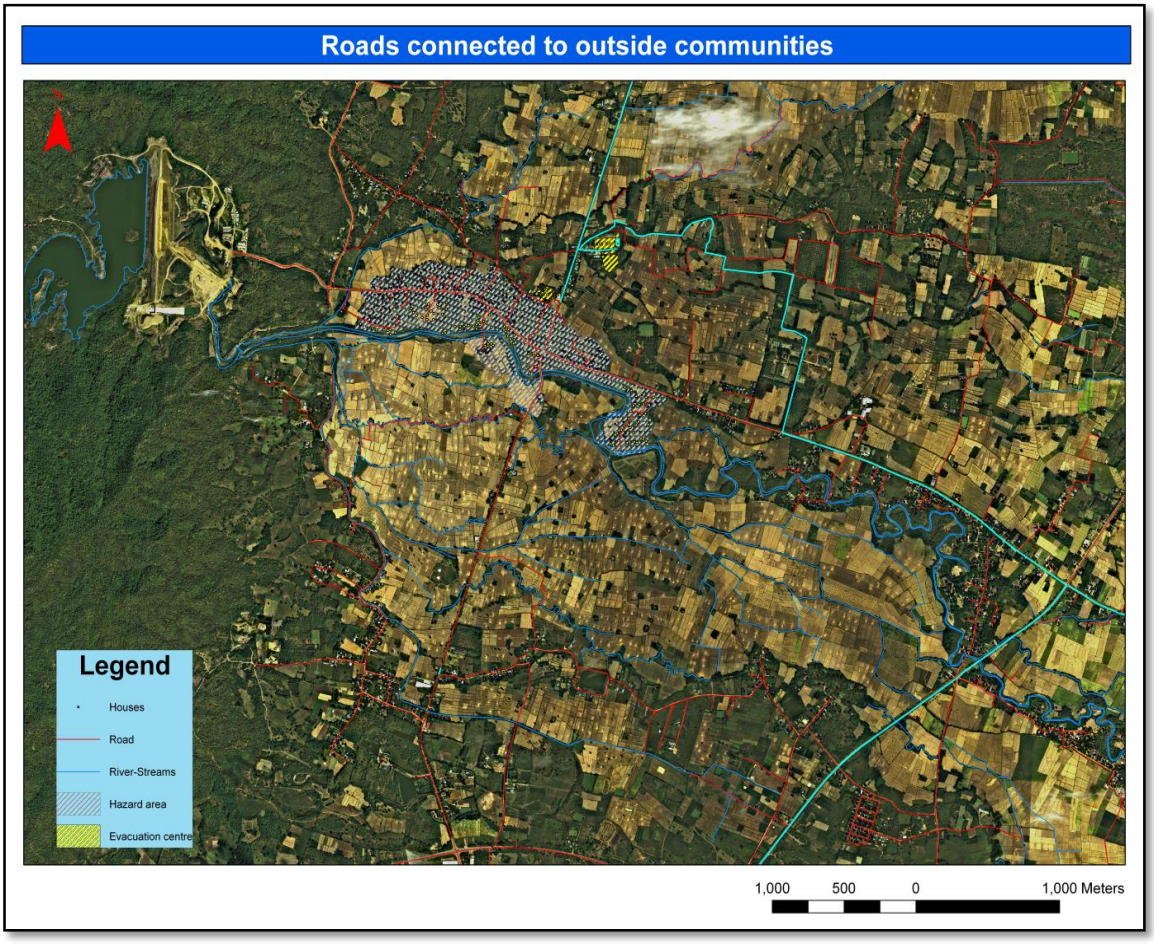


Figure 5. 6: Shortest paths connecting the outside communities with the evacuation centres

To minimise this problem using spatial analysis, the shortest path analysis function was applied to identify the shortest routes along all of the roads to the evacuation centres using the addressed criteria. These routes were validated by the observation made after the analysis. The observation showed that those routes can be used for delivering people and items between the evacuation centres and outside communities.

2) Feasible solutions for minimising the explored issues associated with spatial aspects in the temporary displacement centres

Temporary houses had been built in the temporary displacement areas, with the basic essentials installed. The design of the temporary houses was influenced with reference to Thai families, lifestyle and culture. The houses are adjustable for both single and multiple families, with separate bathrooms on the ground floor. A sufficient number of communal bathrooms were built with regard to the number of house units in the displacement centre. Displaced people stayed in this temporary displacement area for a while until their house in the resettlement area was completely reconstructed.

- Open-wilderness area prone to illegal activities

After the temporary houses were completely constructed in Ban Nam Ko school, Wat Santi Wiharn temple and Wat Nong Kok temple, displaced people were relocated to those houses in the temporary displacement areas. Although the relocation sites were well-established, as confirmed by the interviewees, some problems associated with illegal activities were mentioned in a temporary displacement area. It was found that drug abuse, smuggling, alcoholism and gambling were occurring among some groups of displaced people in Ban Nam Ko school. Spatial analysis was applied to identify the spatial conditions mentioned about the open area in the school yard in the Analysis chapter.

The feasible solution to this issue is to reduce the channels available for committing illegal activities by considering the spatial conditions. The feasible solutions are:

2.1) To investigate carefully the boundary of the temporary displacement area, apart from its well-established infrastructure and facilities. This solution might prevent intruders and illegal exchanges between the outside and the temporary displacement area.

2.2) To separate clearly the residential and leisure zones in the temporary displacement area. This solution could keep the displaced people and visitors separate. The entrance to the residential zone should be guarded for security and to prevent theft.

2.3) To reduce the chance of the residents spending their compensation money on illegal and prohibited activities, such as alcohol, drugs, gambling, etc. This can be done by facilitating a mobile ATM service where displaced people in temporary displacement areas can deposit their compensation money rather than keeping it with them. The "KTB (Krung Thai Bank) on the move", the mobile ATM service, is already available throughout the country (64 Units).

Figure 5. 7: Mobile service ATM

3) Feasible solutions for minimising the explored issues associated with spatial aspects in permanent resettlement areas

Several differences between the original residential land and the resettlement area had various effects on the re-settlers in the resettlement area. In their original homeland, the re-settlers lived by the canal and spent their lives in a big community with their relatives and neighbours. It was easy to travel outside the former community due to the public transportation which ran through their community. Their farmland was located within walking distance of their house. However, the resettlement area was extremely different from their original homeland. The resettlement area was dry and far away from any waterways. This resettlement area was isolated from the original and also other communities. It was difficult to go anywhere due to the non-expansion of public transportation. These extreme differences has several effects on the re-settlers, as displayed in the cognitive map (Figure 4.19, 4.20, 4.21) in the analysis chapter.

A feasible solution to mitigate this problem is to investigate the resettlement site carefully and adjust the resettlement area according to the original homeland of the displaced people. The original homeland of the displaced people must be comparable to the resettlement area in terms of the following points:

3.1) The topography or natural features of the area, i.e. waterways, the levelling of the residential terrain, the environment, and land-cover.

3.2) The provision of basic essentials, i.e. infrastructure and facilities, such as roads, electricity, irrigation, waste disposal, and public transportation linked to outside communities, workplaces, marketplaces, schools or universities, places of worship, hospitals or health centres, government offices, and banks and financial institutions.

The purpose of considering the natural features of the original homeland compared with the resettlement area is to reduce the differences between the two areas. Therefore, the displaced people will require less time to adapt. Additionally, the purpose of considering the provision of the basic essentials in the resettlement area is to provide a decent quality of life for the re-settlers living in this area, to help them to conduct their personal activities and maintain the connections between the original community and the resettlement community sustainably.

Using the basic function of photomap interpretation and classification, the resettlement sites must be investigated in light of the above criteria. In the case of the existence statement mentioned in the analysis chapter, it is summarised that the resettlement area had encountered the poor provision of the basic essentials, which frequently caused road accidents in front of the community. Spatial analysis was applied to identify the spatial problem relationship to road accidents in the Analysis chapter. Therefore, it is clear that the application of spatial analysis is able to identify the statement of problems associated with spatial aspects effectively. As a feasible solution to this case, it is recommended that barriers or speed bumps might be installed to reduce drivers' speed. Furthermore, streetlights should be installed on the roads in front of the community to reduce the dangers arising due to darkness.

As the explored findings show, it is apparent that the application of spatial analysis can enable us to examine the issues associated with spatial aspects and also propose feasible

solutions for minimising those issues effectively. The statement of problems was explored explicitly relating to issues associated with spatial aspects in the resettlement phases on the cognitive maps (Figures 4.19, 4.20, 4.21) in the analysis chapter, showing the situations and barriers to achieving a successful resettlement programme.

The bottom-up approach and long-term development, which have been advocated in the literature since 1978 and empirically proven since, have been implemented within several resettlement areas including hazard communities (Burnell, 2010). This approach channels people's cooperation and participation as the main mechanism for resettlement activities. Likewise, Bahrenberg et al. (1984) suggested that it is crucial to study people's increasing demands and the deep insights into the social and economic context that cause critical constraints in a close-knit environment. On the other hand, considering the recommendation of good practice in the top-down policy, Kinsey and Binswanger (1993) suggested that the government and authorities should employ the top-down policy by decentralising the administration, as this can make resettlement programmes more flexible and successful. In an excessively centralised administration, the government can allocate responsibility to the local administration for the feasible long-term development management of effective resettlement programmes.

It is impossible for a government to respond to every requirement of displaced people in the resettlement area due to limitations such as the land allocation, the lack of money for installing the facilities and infrastructure, and the mixing of different ethnic groups. Ignoring these problems means that they persist in the resettlement area and can destroy the sustainability of the resettlement programme. Regarding the nature of those problems associated with the spatial aspects of the resettlement area, a potential technique for understanding and overcoming these problems was presented through the applications of spatial analysis. Longley and Batty (1996) commented that the applying spatial analysis to solve the location issues could provide a comprehensive perspective for both policy makers and individuals.

Regarding the explored results, it presents the bottom-up requirements of displaced people. On the other hand, the resettlement policy implemented by the government shows several failures to achieve a successful resettlement programme. These situations present the top-down policy of the government. This study has presented the capacity of spatial analysis for mitigating the issues associated with spatial aspects that is useful to both continuums of

the government and displaced people. That is to say, spatial analysis plays an important role in producing the optimum balance between the top-down policy of the government and the bottom-up requirements of displaced people's requests.

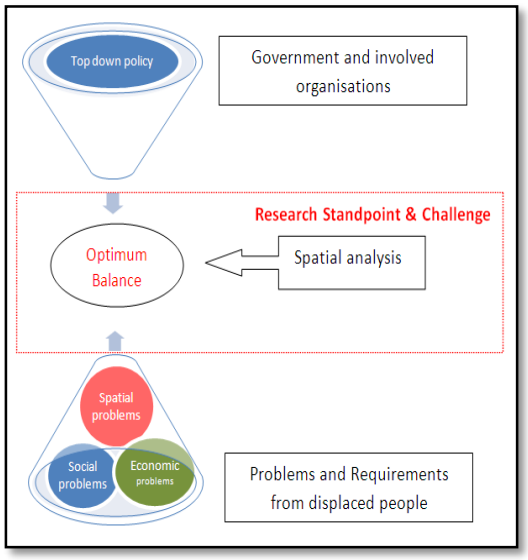


Figure 5. 8: Application of spatial analysis for the optimum balance approach

Bahrenberg (1984) stated that the future trend of applying spatial analysis should focus on the link between the constraints on human behaviour and the decision making approach regarding social schemes. The bottom-up approach and long-term development are recommended as effective management techniques for resettlement programmes (Burnell, 2010). This suggestion has been advocated literately since 1978 and empirically proven since then. Burnell (2010) also recommended that evoking people's cooperation and participation is the main mechanism in resettlement activities.

On the other hand, Kinsey and Binswanger (1993) considered the top-down policy by suggesting a decentralised administration which can lead resettlement programmes to be flexible and successful. Furthermore, they proposed that an excessively centralised administration must distribute authority to the local administration in order feasibly to process long-term development management in resettlement programmes. However, these administrations are often slow in many resettlement areas, causing a variety of problems related to resettlement programmes. This situation entails several problems which are rarely considered by the government in any great depth. Longley and Batty (1996) suggest that the application of spatial analysis for solving location problems will provide a comprehensive perspective for both policy makers and individuals. The challenge is to

create the optimal balance between the actual situation and the implementation plan in resettlement strategies.

The capacity of spatial analysis to mitigate the socio-economic issues associated with spatial aspects in each resettlement phase is presented in Figure 5.9, which illustrates the crucial role of this application in creating the optimum balance between the top-down and bottom-up approaches.

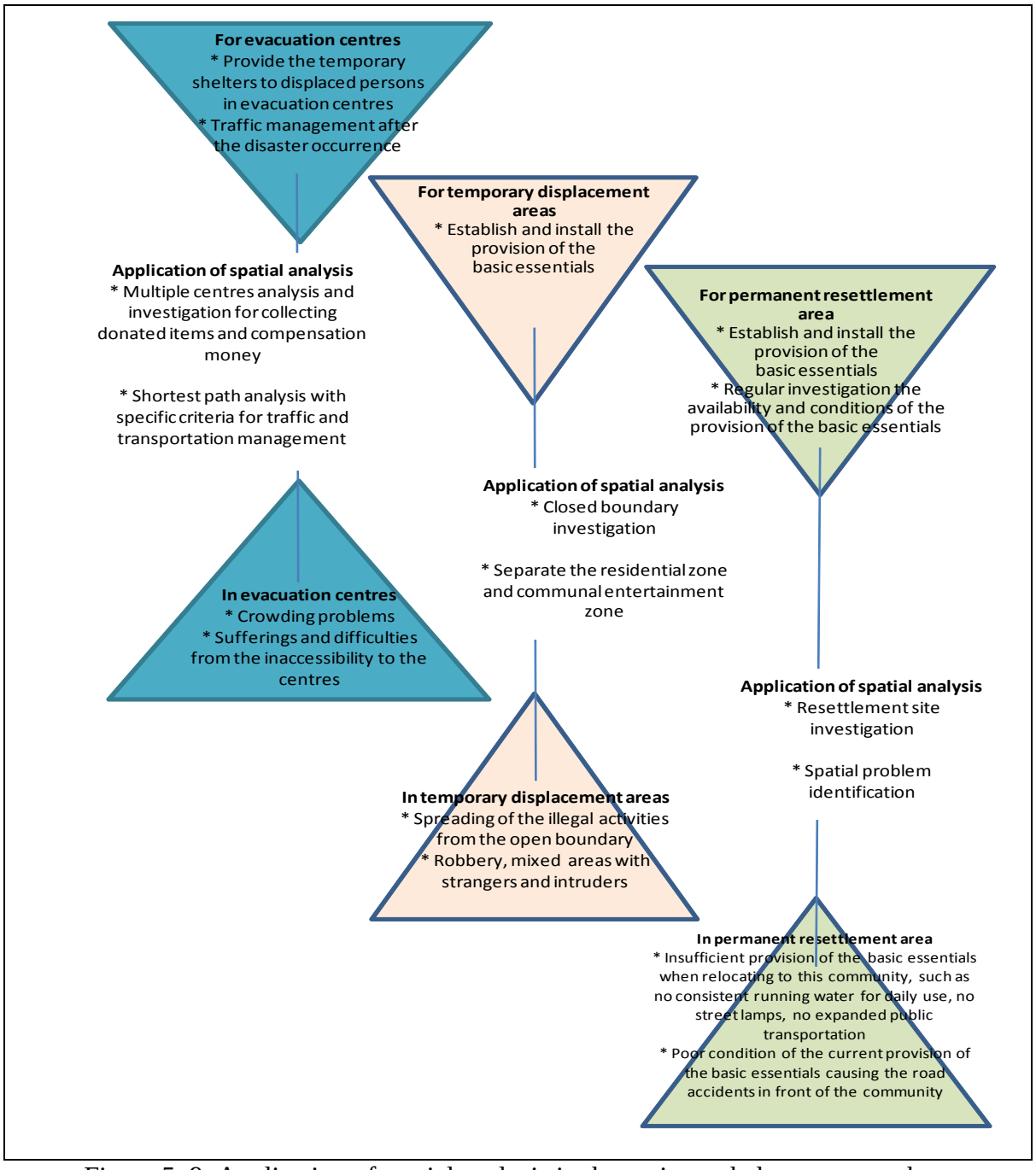


Figure 5. 9: Application of spatial analysis in the optimum balance approach

Extraordinarily, impoverishment was one of the critical problems for many re-settlers. Impoverishment derived from the non-expandable public transportation and individual vehicle requirements to facilitate their agricultural career. Before the disaster in 2001, most of the houses in the hazard area had their own car or motorcycle, but those vehicles drifted away or were broken by the debris-flow. Vehicles are essential for rural lives where the local buses are unreliable and seldom run throughout the day. Even when the public transportation was diverted to the resettlement community, these re-settlers would still attempt to buy their own vehicles for family and career purposes. For this reason, they went to the banks in town to ask for a loan.

Unfortunately, they were refused by the banks because they could not provide any evidence, such as land deeds, to guarantee their money. Many re-settlers could not use their farmland deeds as a guarantee because they rented it from a landlord. The land of the resettlement area belongs to Ratchaphatsadu land, under the treasury department of the Ministry of Finance. Ratchaphatsadu land means every kind of immovable property which is state property, except for the following domain public of state (Chularat, 1975):

- Wasteland and land surrendered, abandoned or otherwise reverted to the state according to the land law;
- Immovable property which is in use for the people or reserved for the common use of the people, such as foreshores, water-ways, highways, and lakes.

Re-settlers have the right to live in the resettlement area, but not either to occupy or sell their land legally.

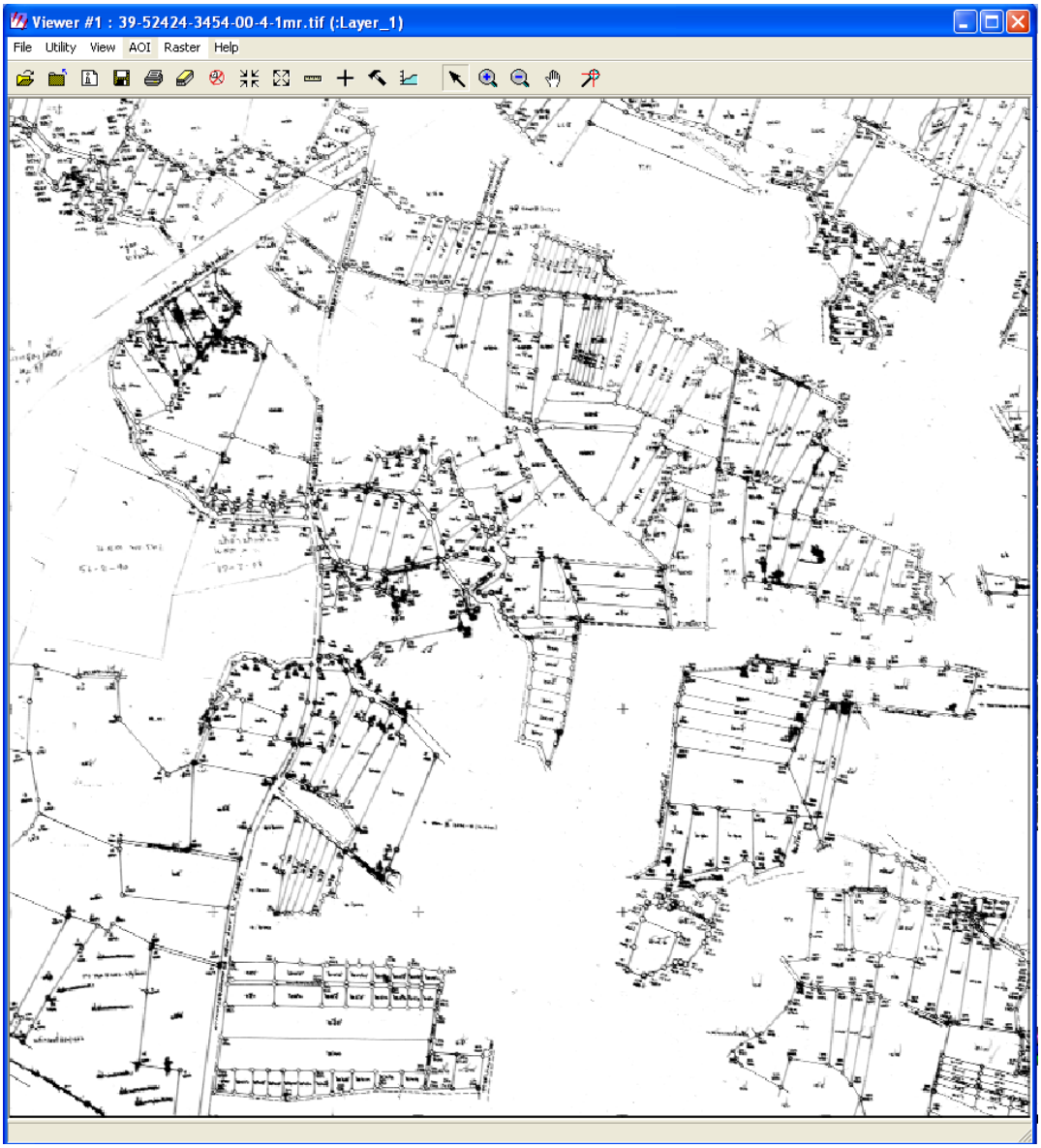


Figure 5. 10: Land parcel map of Ban Nam Ko village

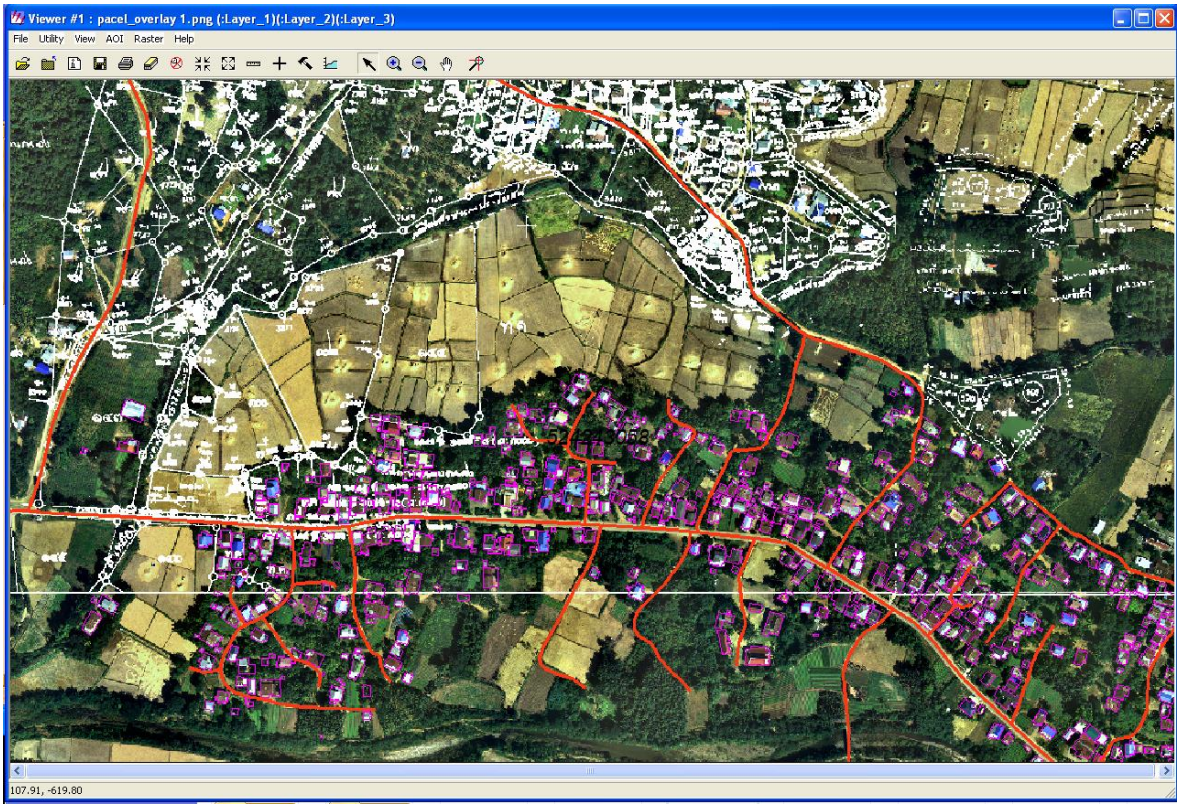


Figure 5. 11: Land parcel map of the hazard area

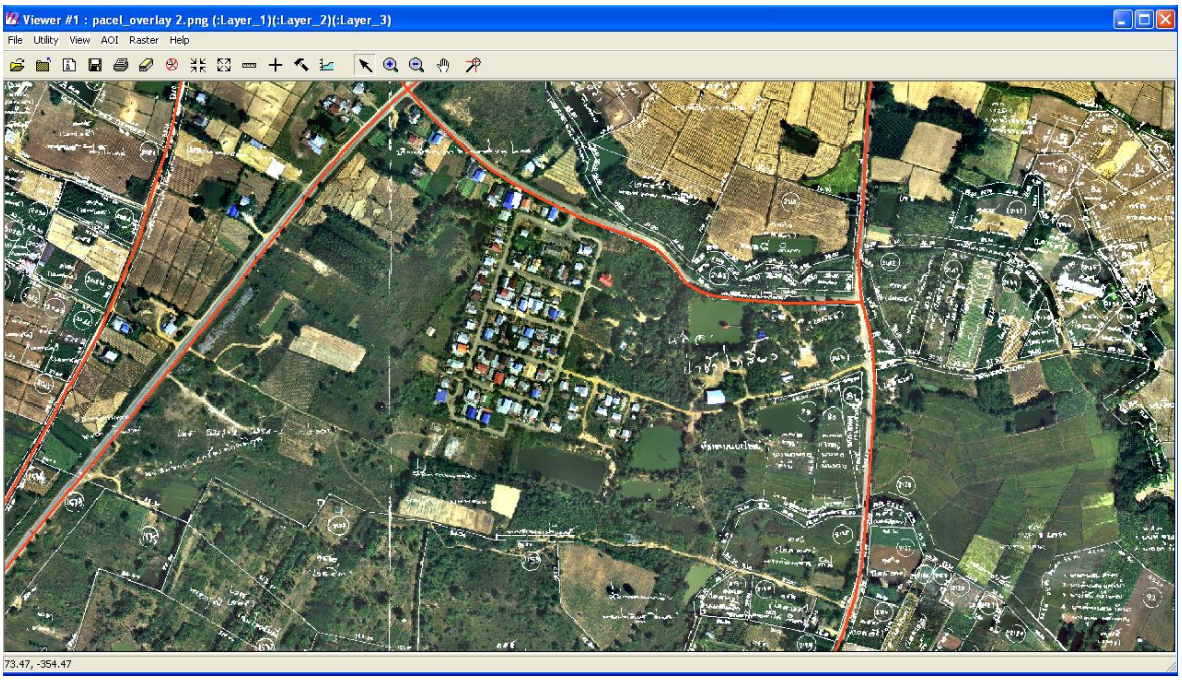


Figure 5. 12: Land parcel map of the resettlement area

Due to this requirement, private financers, who were acquainted with the re-settlers (some groups are tyrants or influential persons), offered loans at very high interest rates. According to urgent financial requirement, they accepted this option from the private

financers without careful consideration. For this reason, they had to spend the majority of their income repaying the interest on the loan. The agents of the private financers came to the resettlement community to collect the interest daily and monthly.

The current financial institution, Tisco Bank mobile car, promoted loan against auto license “Tisco Auto Cash” to expand its leasing customer over the country. This option makes it possible for a trustworthy financial institution to access the resettlement community. However, the local government may need to discuss with the financial institution the possible options for re-settlers in the resettlement community.

Figure 5. 13: Mobile auto cash

- Developed database design for resettlement programmes for vulnerable debris-flow hazard areas

Due to the destructive nature of debris flow, vulnerable, debris-flow hazard communities are unprepared for this sudden-onset incident. As a contingency, an available database from the relevant providers and organisations could be used to analyse the site selection for the resettlement locations associated with the resettlement phases. However, it is likely that several specific criteria have yet to be considered in resettlement programmes.

Accordingly, a problem-based study of resettlement programmes, spatial databases and some crucial information have yet to be systematically collected for this particular purpose. Based on a study by Corsellis and Vitale (2005), the following factors are considered key tasks by the government:

1.) Updated information for all stakeholders
2.) Ethnic, religious, social background
3.) Specific assistance for vulnerable hazard areas
4.) Income opportunities
5.) Availability and capacity in the sheltering area
6.) A registration list of displaced people
7.) Emergency health-care treatment
8.) Supplementary feeding centres
9.) Transport, including roads and bridges
10.) Health care, including clinics, hospitals and dispensaries
11.) Water and sanitation, including a water supply, surface-water drainage, and sanitation in communal areas or for communal services
12.) Schools, including crèches, and primary, secondary, and tertiary institutions, where available
13.) The generation and transmission of power
14.) Food production and food security, such as grain stores
15.) Police stations, prisons, and courts.

Considering the above list, this information can be collected from the primary data sources via observation and interviews, including from secondary sources via remote sensing data and images. In order to provide the fastest response for resettlement programme management in other vulnerable hazard areas, the database used during the spatial analysis must be already collected by following the protocol for database design in this study.

This section initially lists the databases typically used for analysing all common purposes in resettlement programmes, such as the site selection for displacement locations in all phases. The developed database design for planning a resettlement programme for vulnerable, debris-flow hazard areas consists of two significant categories; (A) Basic information about the residents in the vulnerable, debris-flow hazard area, (B) Spatial data about the vulnerable, debris-flow hazard area for planning the resettlement programme, and (C) A developed database design according to the criteria in resettlement programmes for vulnerable, debris-flow hazard communities. The details of these categories are listed in tables 1 and 2. Furthermore, this section contains lists of the criteria of concern in the resettlement programme. In order to minimise these challenges to achieve a successful resettlement programme, these criteria must be contemplated by focusing on the spatial

conditions associated with the resettlement programme. The database design for planning resettlement programmes for vulnerable, debris-flow hazard areas contains:

(A): Basic information about the residents of the vulnerable, debris-flow hazard area

Basic information about the residents of vulnerable, debris-flow hazard areas is categorised according to their characteristics, households and livelihoods. This information can be obtained from the census information stored by the provincial administration and the Sub-district Association Organisation.

Table 5. 1: Basic information about the members of the households for planning a resettlement programme

Basic information about the members of the household	Data Properties and Options
1.) Home address	Text
2.) Number of members in the household	Numeric
3.) Dates of Birth	Date
4.) Ages	Numeric
5.) Education levels	Non-education Primary school level Secondary school level High school level Undergraduate level Graduate level Doctoral level
6.) Study places	Text
7.) Occupation	Agriculturist Farmer Hired labour Merchant Company officer

Basic information about the members of the household	Data Properties and Options
	Government/Local government officer Livestock farmer Other (Specify.....) Unemployed
8.) Workplaces	Text
9.) Salary/Household income	Digit
10.) Welfare/Hospital membership registration	Text
11.) Vehicles	Bicycle Motorcycle Truck Van Car Agricultural truck Other (Specify.....)
12.) Land ownership status	Rent Owner None
13.) Career co-operation membership	Text
14.) Financial membership and financial status	No debt Debt (estimated amount....., from.....)
14.) Ethnic background	Text
15.) Religion	Buddhist Christian Muslim Hindu Other (Specify....)

(B): Spatial database of vulnerable debris-flow hazard areas for planning a resettlement programme

A spatial database is required to analyse multiple resettlement activities, such as the site selection in all resettlement phases, provisional infrastructure and facility management in all displacement areas, accessibility management, and statement of the spatial problems. High resolution aerial photos must be rectified and used as digital based maps for spatial data analysis at the local scale.

Table 5. 2: Spatial database for vulnerable, debris-flow hazard areas

LAYER MAP	GEOGRAPHIC FEATURE	CLASSIFICATION	ATTRIBUTES
1) Land Cover	Point	1.1) Houses	-Home address
	Polygon	1.2) Land use	-Land use types
2) Infrastructure and facilities	Line	2.1) Roads *2.1.1) Main roads* *2.1.2) Minor roads* *2.1.3) Communal paths/tracks*	-Road name -Route number -Road surface types
	Line	2.2) Public transportation *2.2.1) Surface; Coach, Bus, Van, Tram, Train* *2.2.2) Water; Boat, Ferry, Ship* *2.2.3) Air; Aeroplane*	-Transportation number -Destination -Running routes -Stops
	Polygon	2.3) Community service areas *2.3.1) kindergarten, school, university, college, public library, playground* *2.3.2) temple, cemetery, mosque, church*	-Name -Functions -In-functional duration time or period -Open space area -Building area

LAYER MAP	GEOGRAPHIC FEATURE	CLASSIFICATION	ATTRIBUTES
		2.3.3) local government offices, government offices, *2.3.4) communal hospital, health centre, provincial hospital,* *2.3.5) public sports club, public association offices* *2.3.6) Fire station*	-Availability of water, electricity, and toilets -Entrance & Exit channel
	Point	2.4) Public telephone box	-ID
	Point	2.5) Market *2.5.1) Meat market* *2.5.2) Specific goods market, i.e. hardware, appraisal, used items*	-Name -Open/Closed days and times
	Point	2.6) Bank and financial institution	-Name -Business type -Open/closed days and times
	Point	2.7) Gas station	-Name -Petro types
	Point	2.8) Post office	-Name
3) Topographic	Line	3.1) Contour lines	-Elevation
	Raster	3.2) Digital Elevation Model (DEM)	-Systematic attributions
	Raster	3.3) Digital Triangulation Model (DTM)	-Systematic attributions
	Raster	3.4) Slop and Aspect	-Degree
4) Land right	Polygon	4.1) Residential land	-Parcel number

LAYER MAP	GEOGRAPHIC FEATURE	CLASSIFICATION	ATTRIBUTES
		ownership	-Owner name -Parcel size
		4.2) Public land	-Organisation name -Parcel size
5) Administrative	Polygon	5.1) Community boundaries 5.2) Village boundaries 5.3) District boundaries 5.4) Provincial boundaries 5.5) Regional boundaries	-Names

(C): Developed database design according to the criteria for resettlement locations for vulnerable, debris-flow hazard communities

Table 5. 3: Specific criteria considered in the resettlement programmes

Resettlement Phase	Displaced person activities	Gov./ Organisation administration	Data preparation	Analysis Techniques
Emergency response in evacuation centre	Short-term stay in evacuation centre	Site selection	Social service centres: -Name -Area -Expandable options	-Identify potential evacuation centres -Estimate the available area in the evacuation centres -Identify the expandable areas or options around the evacuation centres
		Install basic essentials in evacuation centre	Available basic essentials -Water -Toilets -Waste disposal areas -Physical/mental health treatment service	

Resettlement Phase	Displaced person activities	Gov./ Organisation administration	Data preparation	Analysis Techniques
	Registration and identification	Personal identification in evacuation/assemble centre	Identification approval: -Name -Instant photo -Home address -Effects -Home damage -Loss (e.g. family member, cattle, vehicles)	-Classify the data into two groups: 1) Affected person 2) Displaced person -Assign affected person to the collection centre nearest to their home -Share the data with the collection centres
	Collect the donated items and compensation money	Multiple-centres for distributing donated items and compensation money: -Safe from hazard -Accessibility	Potential social service centres: -Name -Area -Service area	-Identify potential collection centres -Estimate the available space for storage -Define the cover service area -Identify the households within the service areas
	Wait for the incoming help in the	Road restoration: -Avoid submerged roads	Accessible routes: -Main roads -Minor roads	-Shortest path analysis with the set-up criteria

Resettlement Phase	Displaced person activities	Gov./ Organisation administration	Data preparation	Analysis Techniques
	evacuation centre	in the hazard area -Hard surfaces with two-way channels -Connect to outside communities	-Vulnerable hazard areas -Other transportation channels to evacuation centres (e.g. river, canal)	consideration -Share the analysed data with a transportation management officer
Transitional period in temporary displacement areas	Temporarily stay in a temporary displacement centre	Site selection	Social service centres: -Name -Area -Expandable options -Closed boundary	-Identify the potential temporary displacement areas -Estimate the available area in the temporary displacement area -Identify the expandable areas or options surrounding the temporary displacement area -Define the boundary around the temporary displacement area
		Install basic essentials in evacuation	Available basic essentials: -Water	-U- or H-shaped site plan for constructing

Resettlement Phase	Displaced person activities	Gov./ Organisation administration	Data preparation	Analysis Techniques
		centres	-Electricity -Toilets -Waste disposal areas -Communal leisure area -Nursery/learning centre -Physical/mental health treatment service	temporary houses in the displacement area -Separate the residential zone from the communal leisure zone -Define the entrance by posting security guards
	Relocate to the temporary centre	Install people in temporary houses	Household information: -Single/multiple family -Number of members	-Identify the temporary houses' correspondence to family size
Sustainable development in the permanent resettlement area	Permanently stay in the resettlement area	Site selection	Potential resettlement area: -Gov. unused land -Topographical characteristics similar to displaced people's homeland: -Waterways -Levelling of residential terrain -Environment -Land-cover -Establish the basic essentials	-Photomap comparison for site selection -Identify the infrastructure and road connections on high resolution images -Identify the available landmarks in the community and connections

Resettlement Phase	Displaced person activities	Gov./ Organisation administration	Data preparation	Analysis Techniques
			-Electricity -Water/Irrigation -Waste disposal areas -Roads and public transportation linked to outside community, workplaces, marketplaces, schools, universities, religious places, hospital or health centres, government offices, banks and financial institutions	-Note the incidents that occur within the resettlement community and examine if the problems are related to spatial aspects

5.3 CHAPTER SUMMARY

It is clear from the findings that spatial analysis can be applied to examine the statement of problems associated with spatial aspects, as presented in the Analysis chapter. Additionally, spatial analysis applications can propose feasible solutions by determining both resettlement policy and the requirements of displaced persons. For this reason, it is clear that the consideration of information from continuums, the government and displaced people is good practice for achieving a successful resettlement programme. This technique can mitigate the socio-economic issues associated with the resettlement programme by determining the true requirements and also considering these within the scope of the resettlement policy. Apart from the capacity of this application for mitigating the statement of the problems associated with the spatial aspects, it is also able to plan a potential resettlement programme regarding the developed database from this study.

CHAPTER 6

CONCLUSION

6.1 INTRODUCTION

The study set out to explore the technique of overcoming the problems related to spatial aspects in displacement locations for displaced persons. This conclusion chapter consists of four distinctive parts. Initially, a summary of the key results is addressed in response to the research objectives respectively. The second part of the chapter defines the limitation of the scope of study. The third section suggested ideas for future research which might use a similar scenario to this study in order to examine and minimise the location-based problems. The final section summarises the final notes, which contains the recommendations and requirements regarding applying the results of this study to other vulnerable debris flow hazard areas.

6.2 SUMMARY OF RESEARCH PROBLEM AND RESEARCH OBJECTIVES

This doctorial research was conducted to address the following research problem:

“How can the spatial analysis be used to analyse and address the socio-economic issues in resettlement programmes?”

In order to answer the research problem, this research proposes the application of spatial analysis to minimise the identified problems related to the locations in resettlement areas. According to this aim, this research attempts to pursue the following objectives:

1. To understand different phases and activities in resettlement programmes
2. To investigate the socio-economic issues and spatial aspects in resettlement programmes
3. To explore the relationships between spatial aspects and socio-economic issues in resettlement programmes
4. To apply the spatial analysis techniques in analysing and addressing the socio economic issues in resettlement programmes

5. To develop a spatial database design to help designing and managing the resettlement programmes to minimise the potential socio-economic issues.

The next section contains a summary of key results in response to the research objectives in order to answer the research question rigorously.

6.3 SUMMARY OF THE KEY RESULTS

6.3.1 Objective 1

Objective one was to understand the different phases and activities associated with resettlement programmes. The overall activities of resettlement programme were reviewed through the literature review in Chapter 2. It was clear that the regulations for classifying the activities of the resettlement phases varied according to the timeline and incidents concerned. For this reason, these resettlement phases were defined differently. With respect to this research interest, all resettlement activities were clearly classified into phases according to the displacement locations. Therefore, the resettlement phases regarding the resettlement locations were classified as:

Resettlement phase 1: Emergency response in evacuation centre

This resettlement phase commences from the affected and displaced people being evacuated into the provided evacuation centres. All affected and displaced people have been registered and classified according to their needs, loss, and impacts. The affected people, who have encountered physical and mental illness resulting from the disaster, can receive basic aid and treatment in this centre. Displaced people can stay in the centre temporarily in the hall or in the provided tents before moving to the temporary displacement place. The social or community service centres are recommended for use for this purpose according to the available space and (fully/partially) installed provision of the basic essentials, i.e. infrastructure and facilities for short-term living.

Regarding the explored problems in the Analysis chapter, it is recommended to establish multiple centres for collecting donated items and compensation money with a 300 m. coverage area around those centres in order to reduce the impact of the problem of overcrowding at evacuation centres. These multiple centres may reduce the number of

affected people who have to travel to the evacuation centre several times a day merely to collect donated items and compensation money.

It is also recommended from the explored results of this study that the main roads in the village would be the first priority to be restored in terms of transportation. These main roads are useful for all deliveries which require swift movement. The second priority is to restore the minor roads that connect the evacuation centres with the outside communities. There are some criteria identified in this study, i.e. hard surface roads, links to outside communities, avoiding submerged roads in hazard areas, and sufficient channels for two-way transportation. Regarding these criteria, affected and displaced people may avoid encountering delays in the transportation of essential deliveries.

Resettlement phase 2: Transitional period in the temporary displacement area

This phase is the transitional phase during which the affected and displaced people are moved from the evacuation centres to stay temporarily in the provided temporary houses to await the completion of the housing reconstruction either in the resettlement area or back in their homeland. Displaced people may need to stay in this area for several months due to this reconstruction. The temporary houses are built of durable materials within a displacement area with fully installed infrastructure and facilities.

There are a lot of activities and entertainment programmes organised in this displacement area, particularly physical and mental recovery treatment programmes. Cleaning up and restoring houses and public areas are the major tasks outside this displacement area. Displaced people may be hired to remove debris or clean up submerged areas. Therefore, a nursery or learning development centre for children is established in this displacement area. Children who have been orphaned by the disaster or who may have been left unattended by their parents, who have to work in the hazard area, are taken care of in the nursery or learning development centre.

It is recommended, based on the findings of this study, that the temporary displacement area should have a closed boundary in order to control any unexpected disorder, particularly any illegal activities. According to the numerous visitors in the communal public area of this displacement area, it is recommended to discriminate clearly between the residential and the leisure zone. 24hr guards are suggested to be in charge at the entrance to the residential area in order to prevent strangers from intruding there.

Resettlement phase 3: Sustainable development in the permanent resettlement area

Displaced people are finally moved to the permanent resettlement area. They are persuaded to co-operate over building their houses with the military forces or house builders in the occupied land. The permanent resettlement area is abandoned land that belongs to the Treasury Department. This area is established and installed with a basic infrastructure and facilities for displaced people.

Regarding the findings from the previous chapter, it is summarised that the resettlement area should have a similar topography to the displaced people's original homeland and be fully installed with the basic essentials, such as electricity, water, irrigation, waste disposal, roads and public transportation, which are linked to the outside communities, workplaces, marketplaces, schools and universities, religious places, hospitals and health centres, government offices, and banks and financial institutions. This resettlement area must be considered the extraordinary settlement area, where people administer their own budget to maintain the infrastructure and facilities and improve the life quality of re-settlers within the resettlement community sustainably.

6.3.2 Objective 2

Objective two was to investigate the socio-economic issues and spatial aspects in resettlement programmes. In order to achieve this objective, the previous works were initially reviewed and summarised to highlight the explored problems. A case study of Ban Nam Ko village, where suffered debris flow in 2001, was studied in term of the socio-economic issues and spatial aspects regarding the resettlement programme implementation. The perceptions and deep insights of interviewees were a major source of information, showing the situations during the entire process of the resettlement programme. The socio-economic issues associated with spatial aspects explored in this research consist of;

Table 6. 1: Socio-economic issues and spatial aspect in resettlement programmes

Socio-economic issues	Impacts	Spatial aspects
Crowding	Conflicts from individual space requirement and missing donated items	Occupying space, expandable area, size of displacement area and residential hall
	Unfair trade from selling donated items to gain a very small amount of money	
	Smuggling, Robbery	
	Flee from evacuation centre • Death from severe infection due to walking through the submerged area • Injury from walking through submerged area to evacuation centre to collect the donated items and compensation money -Quit the job due to the chronic pain -Long term debt	
Inadequate provision of the basic essentials	Difficulties in living in evacuation centre	Provision of the basic essentials in evacuation centre, available infrastructure and facility, additional installed-infrastructure and facility
Suffering from lost and depression from staying within the forensic area	Mental illness and depression	Residential zone, displacement location, original function of evacuation centre
Traffic jam and road accidents due to the submerged area	People starved from undeliverable food and donated items to evacuation centre	Accessibility, accident point and location, hazard area, transportation routes
Difficulties from walking through the submerged area to evacuation centre	Suffering from not receiving any services	Distance, accessibility, walking path, available routes
Alcohol and illegal drug approached from opened boundary of displacement area	Incapacitated from drug addiction • Lost job • Impoverishment	Leaking point, approaching channel into displacement area, area, accessing way
Gambling in temporary resettlement area	Impoverishment	Hidden place, location

Socio-economic issues	Impacts	Spatial aspects
Stealth: money stolen	Robbery, Crime	Place (of keeping money), safe place
Smuggling, intruders, strangers mingled with displaced persons in residential zone in temporary displacement area	Robbery, Crime, unidentified people in displacement area	Residential area, zone, accessibility, channel
Different environment between original homeland and resettlement area	Difficulty in living and adaptation	Location, topography, resettlement site, original homeland site, geography
Inadequate provision of the basic essentials in resettlement area	Difficulty in living: Water shortage Died or Incapacitated from road accidents • Blind spots and inadequate light from street lamps at night • Speed unlimited zone • Frequently used as shortcut to other communities	Provision of the basic essentials, distance from waterways, available water resource, conditions of infrastructure and facility, accessibility, route, accident points/locations, connection, link, sharp curve, blind spot
Far away from original homeland and no public transportation linked to other places	Isolated community from original homeland and other places Money loaned to buy vehicles • Long-term debt • Impoverishment	Distance, isolation, accessibility, route, location, connection, transportation link

The explored socio-economic issues related to spatial aspects link to several impacts which were displayed in the cognitive maps (Figure 4.19, 4.20, 4.21) showing the complicated links between the problems in a resettlement programme in Analysis Chapter.

6.3.3 Objective 3

Objective three was to explore the relationships between spatial aspects and socio-economic issues in resettlement programmes. The information regarding the barriers to achieving a successful resettlement programme was transcribed and encoded by focusing on the terms related to spatial aspects, dimensions and locations. The reviewed documents and observations of the study area were used to validate the information provided by the interviewees. As a result, these explored relationships were presented in cognitive maps,

showing the links between the location-based problems and the socio-economic, administrative, and physical impacts explicitly.

6.3.4 Objective 4

Objective four was to apply the spatial analysis techniques in analysing and addressing the socio economic issues in resettlement programmes. Regarding the explored location-based problems, spatial analysis, an application for analysing location and spatial interaction, was applied for this purpose. For this reason, the explored barriers were deliberately examined in order to present the location-based barriers on the thematic maps visually. Regarding the identified location-based barriers on the maps, the techniques used to analyse and address the socio-economic issues discovered from this study are:

Table 6. 2: Spatial analysis techniques for minimising socio-economic problems

Resettlement phases	**Spatial analysis techniques**	**Socio-economic problems**
Emergency response in evacuation centres	1. Density Analysis 2. Buffering area 3. Shortest path analysis	1. Crowding problem 2. Inaccessibility (Affected people travelling to evacuation centres) 3. Inaccessibility (Vehicles delivering donated items and assistances to evacuation centres)
Transitional processes in temporary displacement area	• Photomap interpretation • Image enhancement	1. Open-boundaries of the temporary displacement area prone to conducting illegal activities 2. Mixed areas between residential zone of displaced people and leisure zone of visitors
Sustainable development in permanent resettlement area	• Surface analysis • Photomap comparison • Photomap interpretation • Image enhancement	1. Extremely different residential characteristics and land forms 2. Isolation from original land 3. Poor infrastructure and facilities

6.3.5 Objective 5

Regarding the explored results of objectives 1 to 4, they progressively built some criteria that are essentially considered in resettlement programmes. Objective 5 was to develop a spatial database design to help designing and managing the resettlement programmes to minimise the potential socio-economic issues. According to the delay in collecting spatial

and non-spatial data, it definitely hinders the success of effective resettlement programmes. In order to mitigate the problems arising from the interaction between displaced people and the displacement locations in the resettlement programme, spatial and non-spatial data must be collected and prepared in digital format, ready for urgent analysis. Based on the findings of this study, there were some specific criteria considered when developing the dataset for the resettlement plan.

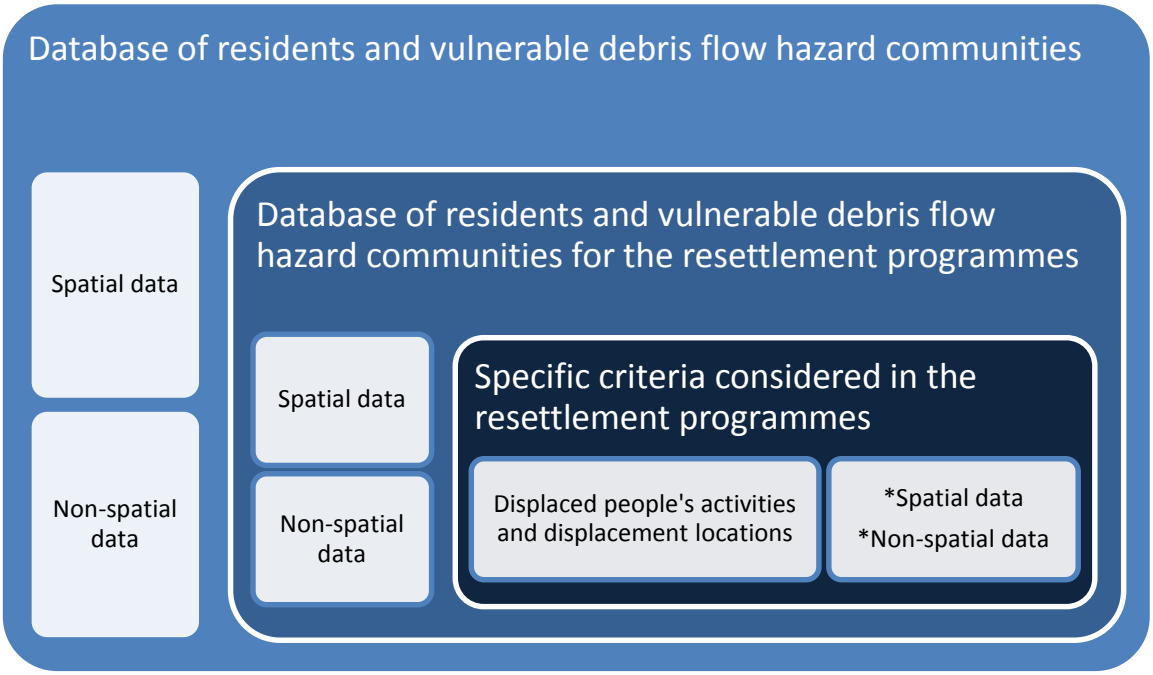


Figure 6. 1: Developed database design for the resettlement programme

A framework specifying the developed database response to the activities and displacement locations in the resettlement programme was designed in Figure 6.3. The details of the developed database are listed in Table 5.3 in the findings chapter. Furthermore, the developed database design for vulnerable debris-flow hazard areas was installed in the CD enclosed at the end of this thesis in order to present the structure of developed database design with the collected data of this research.

6.4 LIMITATIONS OF THE RESEARCH

A particular interest of this research focuses on the resettlement programme triggered by the debris-flow disaster. According to the unpredictable impacts of this sudden-onset disaster, numerous residents in the catchment areas are endangered and prone to sudden attacks which can lead to deaths caused by tons of debris and solid waste. Given this particular aspect of this disaster, the patterns for examining and analysing the data in this

research aimed to determine the specific nature of debris flow mobilisation and submerged areas. For this reason, other kinds of disasters have not been studied in this research. The scenarios and spatial database with criteria explored from this study are suitable for application with the resettlement programme triggered by the debris flow disaster.

Regarding the various issues that arise in resettlement programmes, spatial aspects are involved in several location-based problems, which were specifically examined and presented in this research. However, there are numerous problems in resettlement programmes which are not linked with spatial aspects directly. Regarding the research interest, these issues were not examined within this research regime.

6.5 CONTRIBUTIONS

The contribution to knowledge of this study is a technique in minimising the complex socio-economic problems associated with spatial conditions in resettlement programmes. By following the technique established from this study, the complex links between socio-economic and spatial aspect were discovered and identified to set up the important criteria which must be considered in planning a successful resettlement programme. This technique is fulfilled the insufficient knowledge considered in minimising several socio-economic issues in resettlement programmes. Furthermore, the developed database design from the findings can be implemented for planning the potential resettlement programme for vulnerable debris-flow hazard areas by carefully considering the sub-category data according the context of the study areas. This contribution is beneficial to all relevant practitioners, such as government and organisation who are responsible to plan the effective resettlement programmes. As the nature of sudden-onset disasters, it is crucial to prepare the database of vulnerable hazard areas in advance. Especially, all high risk areas prone to the sudden-onset disasters must be firstly prioritised to collect the data as developed from this study. With the developed database design of this study, it was identified clearly about the data required for planning a successful resettlement programme response to the urgent implementation. For this reason, this study could influence practitioners, relevant organisations, and governments to consider preparing the data required in the developed database design to prevent several impacts, specifically from socio-economic problems from conducting the urgent resettlement programmes.

6.6 FUTURE RESEARCH

It is clear that spatial analysis applications were able to examine the location-based problems and to applicably propose feasible solutions to overcoming these effectively. Regarding this technique, it is expected to mitigate the conflicts and dissatisfaction of displaced persons through the resettlement programme conducted by the government. As a result, the concept of this optimum balance was introduced and shed light on the more sophisticated location-based problems of mega disasters, such as flash floods.

Regarding the techniques of this study, the examined scenario could be applied to flash flood events with larger impact areas. However, the data collection technique might need to be adjusted slightly due to the number of affected people and tremendous requirements. Although the questionnaire would be appropriate to use as a data collection technique to obtain information from numerous respondents about the flash flood, the semi-structured interview is still useful for constructing an effective set of questions for the questionnaire. As a result, spatial analysis can also be applied to examine location-based problems. Furthermore, it is possible to propose feasible solutions for virtually overcoming the location-based problems arising from the flash flood.

6.6 FINAL NOTES

The effective management of resettlement programmes requires application at the local community scale. This is to say, the more detailed information in terms of both spatial and non-spatial data in the developed database design, the more precise the analysis results will be, which can help to achieve a successful resettlement programme. Therefore, two kinds of information used in spatial analysis are used in this research, i.e. the resolution of based maps and accurate secondary data. High resolution based maps of the vulnerable debris flow hazard areas are basically required for the spatial analysis for resettlement programme. This image provides both a high resolution digital photo scene and digital data that are crucial for generating the contour lines using photogrammetry techniques. The accurate contour lines from this high resolution image are useful for identifying the virtual topographical terrain which is used for the site selection of all displacement locations in the initial stage of planning a resettlement programme. Additionally, the correct data from the database providers or relevant offices is another crucial determinant that requires careful consideration by the researcher. However, it is found from this study that the most

trustworthy data were derived from the community hospital. Due to the regular visits of nurses to every single household, the information at the household level is correctly updated regularly. Therefore, the data from the community hospital would be the valid secondary data that are applicable to the spatial analysis.

Apart from the quality of information required for the spatial analysis, a phenomenon that coincidently happens on the timeline of applying the resettlement programme with the re-settlers is the land development projects in hazard and proximity areas. The land development projects are possibly created by the government in order to protect the residents in the hazard area from the next possible debris flow disaster. However, the land development projects may cause a lot of changes and possibly transform the role of the residents and land-cover distinctively from their original state. For instance, in the case study, the role of the residents and land in the original hazard area is an agricultural community, while the land development after the disaster inclined to change from an agricultural community into a tourist attraction. Accordingly, leisure areas have widely replaced the forest area, with a big project of reservoir construction on the mountain. Several forest areas on the mountain have been silently intruded on and changed into resorts by investors. This situation increases the run-off speed of the rainfall which can cause debris-flow scars on the deforested areas of the mountain. Although the reservoir was built to reduce the speed of flash flooding and debris attacks on the community in the catchment area, the deforestation of the mountain by investors and land-development projects are consistently changing the land cover on the mountain without any awareness of this impact. This situation may cause debris scars on the mountain across the catchment community again. Therefore, it is recommended to monitor regularly the land-cover change in the mountain areas surrounding the hazard community and update the resident information and environment at intervals. This practice could prevent the hectic, urgent implementation of a resettlement programme that is triggered by a possible debris flow disaster in the future.

APPENDIX 1

Standards and guidelines of resettlement programmes in term of spatial regulations

Standards and guidelines of resettlement programmes in emergency period of time were clearly described in a Handbook for Emergencies by the UNHCR with various interests and schemes (UNHCR, 2007). The aims of this handbook are to avoid long term issues such as conflict with local communities and to ensure a safe environment for displaced people and deliver humanitarian assistance. These guidelines contain several scopes and aspects. For this study, the context of the handbook is revised, particularly in spatial conditions of the provision of basic essentials, which have to be facilitated by the government and relevant organisations. Accordingly, the details associated with spatial aspects such as: ***Site selection***, which consists of *size of camp sites, site plan, topographic conditions and land use, and land right*; and ***Infrastructure and facility management***, which consists of *water supply and lighting, sanitation, roads, fire prevention, communal services,* are described in a Handbook for Emergencies by the UNHCR as:

i) Site Selection

Size of camp sites: It is defined that there are minimum standards for floor space, a single person requires 3.5 m^2 in tropical warm climates, excluding cooking facilities or kitchen (it is assumed that cooking will take place outside), whereas a single person requires 4.5 – 5.5 m^2 in cold climates or urban situations, including the kitchen and bathing facilities. It is noted that an ideal minimum bare surface area is 45 m^2 per person (including kitchen/vegetation gardening space); however, the actual surface area would not be practically less than 30 m^2 per person. Additionally, storage is essential to collect donated items and also to store belongings from the original destructive area. It is recommended to provide 150 – 200 m^3 per 1,000 persons. A site location has to be prepared to facilitate a number of families affected by the displacement. This principal is useful to displaced families in order to gain any appropriate benefit from the administrative registration. The number of displaced people collected in a group is classified orderly in Table 1:

Table i: Approximated number of persons in classified module (UNHCR, 2007)

Module	Consisting of	Approx. No. of Persons
Family	1 Family	4-6 persons
1 Community	16 Families	80 persons
1 Block	16 Communities	1,250 persons
1 Sector	4 Blocks	5,000 persons
1 Camp	4 Sectors	20,000 persons

Site plan: It is recommended that the bottom up approach would be used to express the characteristics of activities and needs of individual families. Notably, the community are not recommended to establish in a closed form, e.g. square-shaped, but resembling more of an H-shape (a U-shape is also acceptable), where both sides are open for better interaction with other communities.

Topographic conditions and land use: An area located on gentle slopes (2 -4 %) is preferably considered, whereas, a site on steeper than 10% gradient is difficult to use due to a high site preparation cost. Importantly, there is possible conflict between the displaced community and original proximate community in terms of land-use. Local groups may disagree with the site being used, even temporarily, therefore, clarification of access rights and land-use restrictions are also necessary to define the rights of the refugees to:

- Collect fuel-wood, and timber for shelter construction as well as fodder for animals;
- Graze their animals; and
- Engage in agriculture or other subsistence activities.

Land right: Government and local government play an important role to identify the available public land for displaced people. Any use of private land must be based on formal legal arrangements through the Government and in accordance with the laws of the country. Land ownership must be clarified after identifying the site selection.

ii) Infrastructure & facility management

Water supply & lighting: An adequate amount of water on a year-round basis must be considered in this criterion. It is strongly recommended that "A site should not be selected on the assumption that water can be found merely by *drilling, digging, or*

trucking. Drilling may not be feasible or may not provide water in an adequate quantity and quality. No site should be selected where the trucking of water will be required over a long period." The water distribution point should be not more than 100 m. It is also addressed that a small group of 80 – 100 persons per water distribution point considerably reduces water wastage and destruction of taps, stand-posts and concrete aprons. Lighting should be provided throughout the resettled community area in order to increase the security and safety of displaced people.

Sanitation: Basically, a latrine is provided for a family on the site, however, it would need to exceed twenty persons per latrine facility. In the case of establishing communal latrines for public use, there should be accessible and sufficient space left around the facility. It is noted that very sandy soils which are good for infiltration are, sometimes, poor for the stability of the pit. Where drinking water supplies are drawn from ground water sources, special attention must be given to preventing contamination by pit latrines. The pit latrines must not reach into the ground water table. Additionally, garbage collection points and services must be sufficiently provided in the resettlement community.

Roads: Types of roads must be "all-weather roads" above flood levels, which provides year-round access. Short access roads to connect to the main road for the site can be constructed as part of the camp development. It is recommended that road construction would follow contour lines in order to reduce erosion, preserve topsoil, and avoid the creation of dangerous gullies. In the case of a significant amount of vehicle traffic on the site, a pathway must be separated for specific pedestrian traffic. Additionally, family plot fences should be set back approximately 5 – 7 m from roads to provide adequate visibility for pedestrians and vehicles.

Fire prevention: Generally, it is noted that a 30-metre wide firebreak, as a form of an open space area, must be provided for every single 300 m of built up area. This firebreak area would be ideal for growing vegetables or recreation between blocks. If space is sufficient, the general regulation of the provisional firebreak would be applied. With respect to that regulation, the distance between structures (should be a minimum of twice the overall height of any structure), the inflammable building materials, and wind direction, are also crucial considerations.

Communal services: A crowded displaced community is always faced with a high number of infectious diseases or health hazards such as Malaria, Onchocerciasis (river

blindness), Schistosomiasis (bilharzias), or tsetse fly, Cholera, Tetanus, Conjunctivitis. A mobile health service is recommended for the remote displaced area where is rarely accessible to the adjacent health centre. Additionally, a market is also recommended to establish to supply people requirements in the displaced area.

These topics, which contain the guidelines associated with spatial conditions, are applicably used as a standard of the government practices in providing the basic essentials to displaced people.

APPENDIX 2

Semi-structured Interview

The application of spatial analysis in resettlement programmes

1) Background Information of respondent:

Name: .....

Religion: .....

Family size, family members: .....

Education levels of family members: .....

Home address

Current house address (location on based map): .....

Former house address (location on based map): .....

Land ownerships

Land right

Previous land right: .....

Current land right: .....

Size of land

Previous land pot size: .....

Current land pot size: .....

Occupation of family members: .....

Former occupation of family members: .....

Household income

Former income: .....

Current income: .....

2) Resettlement Activity Phases:

Destructive conditions after the debris-flow:

..... Partly destroyed ..... Completely destroyed

What were the relocation patterns from emergency period of time until permanent resettlement? .....

2.1) Emergency responses:

Where was the respondent living in emergency time after the debris flow in 2001? .....

Length of stay: .....

How was the displacement place look like? .....

Who was the organisers or place provider? .....

How sufficiency and availability of the provision of the basic essentials in displacement place? .....

What were the activities in displacement place? Who organised those activities? .....

Were there any problems in displacement place? .....

What were the essential requirement(s) in displacement place? .....

What were the difficulties and sufferings in term of living in displacement place? .....

How did respondent family do for living during the emergency time in displacement place?.....

What were the requirements asked from government assistances? .....

What would be the good practices suggested to the government to overcome the problems in displacement place? .....

2.2) Transitional processes:

Where did the respondent live after relocating from the evacuation centre? .....

Length of stay: .....

How was the displacement place look like? .....

Who was the organisers or place provider? .....

Who built the temporary houses in displacement area?.....

What was the layout plan of the displacement area? .....

Where was the communal and temporary house zone? .....

Had the displacement area been guarded? .....

How sufficiency and availability of the provision of the basic essentials in displacement place? .....

What were the activities in displacement place? Who organised those activities? .....

How far of travelling from the displacement area to the original community and how to get there? .....

Were there any problems in displacement place? .....

What were the essential requirement(s) in displacement place? .....

What were the difficulties and sufferings in term of living in displacement place? .....

How did respondent family do for living during the staying in displacement place?.....

What were the requirements expecting from government assistances in displacement place? .....

What would be the good practices suggested to the government to overcome the problems in displacement place? .....

2.3) Sustainable development:

Where did the respondent live after relocating from the evacuation centre? .....

Length of stay: .....

How was the resettlement place look like? .....

Who was the organisers or place provider? .....

How far of travelling from the displacement area to the original community and how to get there? .....

How different between the resettlement area and original land (please describe)?.....

Who reconstructed the house? .....

How is the economic efficiency of respondent in resettlement area?.....

How is the social equity of resettlement community compared with other communities in Ban Nam Ko village? .....

How is the environment of resettlement area? .....

How sufficiency and availability of the provision of the basic essentials in displacement place? .....

Were there any problems or difficulties in living in resettlement area? .....

What were the essential requirement(s) in resettlement area? .....

What were the requirements expecting from government assistances in displacement place? .....

What would be the good practices suggested to the government to overcome the problems in displacement place? .....

APPENDIX 3

List of researcher's publications

KERAMINIYAGE, K. and PIYATADSANANON, P. (2013) 'Achieving success in post-disaster resettlement programmes through better coordination between spatial and socio-economic/cultural factors', *International Journal of Disaster Resilience in the Built Environment*, 4 (3), pp. 352-372.

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APPENDIX 4

CD

- Developed Database Design and Model for vulnerable debris-flow hazard areas
- Database designed of Ban Nam Ko study area

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