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Original Citation

Piyatadsananon, Pantip, Amaratunga, Dilanthi and Keraminiyage, Kaushal (2015) Spatial data potential for resettlement programmes in local communities vulnerable to debris-flow disasters. Research Report. UNISDR.

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Spatial data potential for resettlement programmes in local communities vulnerable to debris-flow disasters

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Abstract

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. It appears that many social and humanitarian problems exist in most of the resettlement programmes (Menoni and Pesaro, 2008). It has been 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). In order to mitigate the severity of those issues in conducting a potential resettlement programme, the information of vulnerable hazard communities must be prepared for the resettlement plan. However, the limitation of the data, i.e. spatial and non-spatial data, of the vulnerable hazard communities plays an important role to delay the post-disaster reduction tasks. An attempt to obtain and develop the dataset potential for post-disaster risk reduction proceed with the resettlement programme requires a comprehensive statement of situations during the disaster occurrence in the hazard community.

Therefore, this paper presents a technique identifying the relationships between spatial and non-spatial data essential to the post-disaster risk reduction at the local scale. The obtained information derives from the deep insight interviews of affected people regarding issues associated with spatial aspects in a disaster event. The explored issues regarding the interrelationship between socio-economic issues and spatial conditions were presented in cognitive maps showing the complexity of those issues in a resettlement programme. As the outcome of the paper, it presents the developed spatial database for resettlement programmes in local communities vulnerable to debris-flow disasters. The explored result of this paper is expected to apply with the resettlement programme in order to prevent the misleading resettlement programmes and also accelerate the post-disaster risk reduction for vulnerable hazard communities effectively.

Keywords: *Resettlement programme, Spatial analysis, Spatial data, Non-spatial data, Cognitive map*

1.1.1 1 Introduction

The entire process of resettlement programmes contains several aspects, e.g. socio-economic, spatial, and administration issues which are linked sophisticatedly. Although the social issues and the spatial conditions in resettlements 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 never been studied in detail within the context of entire resettlement programmes. The lack of an in-depth study covering entire process of resettlement programmes is a great barrier in achieving a successful resettlement programme. Regarding the social issues associated with spatial aspects, it is obviously shown that spatial databases and some crucial information have yet to be systematically collected for this particular purpose. Without the database prepared for further analysing in resettlement programme, it causes not only the misleading implementation, but also the limitation of this knowledge simultaneously.

Considering 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. Without considering those issues over the entire resettlement programme, it has always found the failure in conducting the resettlement programmes. Therefore, this paper attempts to present the interaction between socio-economic issues and spatial aspects onto the developed spatial database potential to resettlement programmes in local communities vulnerable to debris-flow disasters. This paper considers three techniques to gain knowledge from the data collected in three different ways i.e. *documentary review*, *interviews (semi-structured interviews)* by exploring from the perception of displaced people and local government according the implementation of the resettlement programme, *and observations*. These techniques were triangulated to increase the validity and reliability of the data collection. The resettlement programme of Ban Nam Ko, Petchabun province, Thailand where was attacked by a major debris-flow disaster was used as a case study for this paper.

2 Research design

This section initially describes the distinctive location-based displacements shown in resettlement phases of a case study in resettlement programme followed with the barriers in achieving a successful resettlement programme. Three data collection techniques, e.g. documentary review, semi-structured interviews, and observation were conducted and presented as cognitive maps in the following topic showing the barriers between socio-economic issues and spatial conditions in applying a resettlement programme. The explored results were set as criteria considered in applying a resettlement programme and later developed as the spatial database potential for resettlement programmes in local communities vulnerable to debris-flow disasters.

2.1 Resettlement phases considered location-based displacements

Resettlement phases and activities are applicably identified by considering the locations of displacements. For this reason, a case study of Ban Nam Ko village where was attacked by a major debris-flow disaster in 2001 was intensively studied in term of the resettlement programme. Regarding the physical relocation of this case study, it is found that there were three distinctive displacement locations shown as resettlement phases, i.e. i) Evacuation centres, ii) Temporary displacement areas, and iii) Permanent resettlement area.

The initial phase of the resettlement programme appeared at the evacuation centres where served several emergency response activities such as a registration point for displaced persons, a rescue centre, a distribution base of donated items. The second phase of the resettlement programme showed the transitional process from relocating displaced people in evacuation centres to temporary houses in provided areas. Finally, the last phase of the resettlement programme in this case study appeared when those displaced people relocated to the permanent resettlement area completely. In

order to develop the database design for a potential resettlement programme for vulnerable debris-flow hazard communities, those issues according to the displacement locations need to be explored in order to avoid several problems in resettlement programme.

2.2 Barriers in achieving a successful resettlement programme

- **Phase 1: In evacuation centres**

Evacuation centres are typically used by displaced people, affected people, relevant organisations, government officers, donors, volunteers, etc. For this case study, two temples and a school in safe locations were applied as evacuation centres, i.e. Wat Santi Wiharn temple, Ban Nam Ko school, and Wat Nhong Kok Thep Nimitr temple. Regarding the numerous number of displaced people, affected people and organisations, there were complex problems happening within those evacuation centres as displayed in Figure 1.

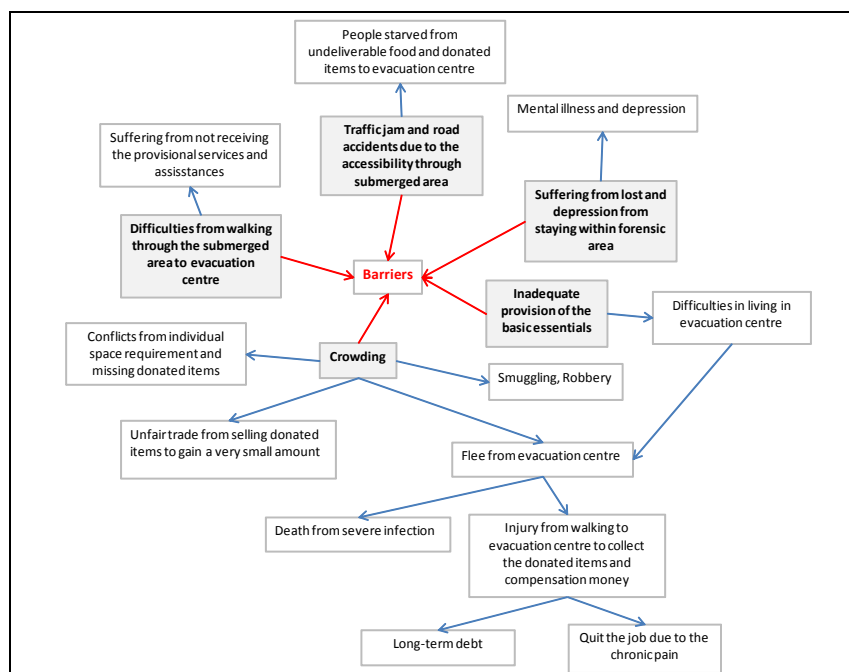


Figure 1: Cognitive map showing the barriers associated with spatial aspects in achieving a successful resettlement programme in evacuation centres

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, which are:

- Original function of evacuation centre; those community service centres, applied as evacuation centres, must provide multiple functions and also maintain their original functions. 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, for example, the shelter space must be well organised and clearly partitioned between the living areas and the cremation ceremony area.
- Space utilisation estimation; 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. 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.
- Centralisation of administration and organisation; evacuation centres are centres of collecting and distributing the donated items and monetary compensation. Without the sufficient space for temporary stay, a number of affected people choosing to walk to evacuation centres daily

rather than stay in the overcrowded centres to receive the donated items and compensation money from dawn till dusk. It was also recorded that clostridium, a severe infectious disease, attacked a large number of people who needed to walk through the mud and debris to those evacuation centres (Ruangchan, 2001). The impacts of these issues cause the chronic illness and also death to affected people linked to inaccessibility to evacuation centres.

- Accessibility to 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.

- **Phase 2: In temporary displacement areas**

The next prominent displacement phenomenon is to install displaced people into the temporary houses. Ban Nam Ko school was selected as the temporary displacement centre after the end of emergency time. Displaced people were moved from the hall and classrooms to stay in temporary houses which were constructed by military forces. This built-up area was fully installed all essential infrastructure and facilities for living in transitional period. Those displaced households were able to stay in durable houses for a period of time before moving to resettle in the resettlement area permanently.

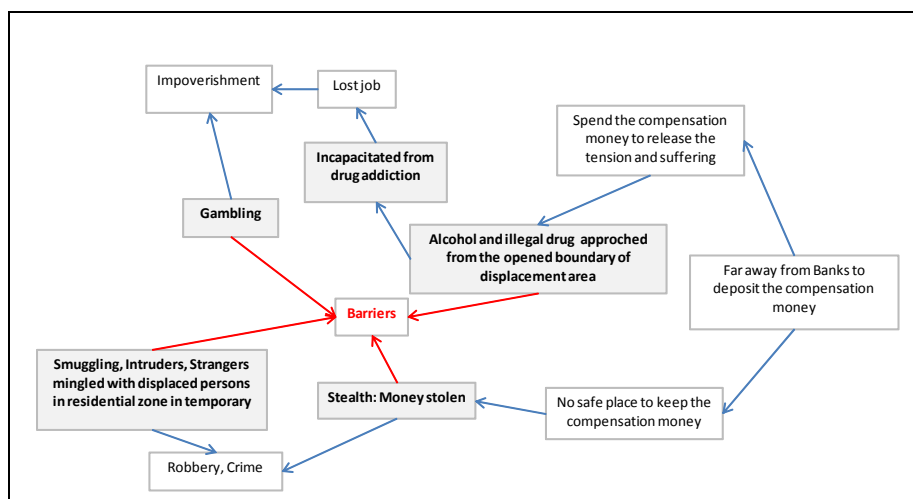


Figure 2: Cognitive map of barriers associated with spatial aspects in temporary displacement centre

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. 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.

- **Phase 3: 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 facility in the area, and the maintenance of the resettlement area into liveable conditions. The government supported displaced families by paying the compensation money and providing the resettle lands. However, it is an agreement between displaced people and the government that the displaced people cannot sell the landownership to other.

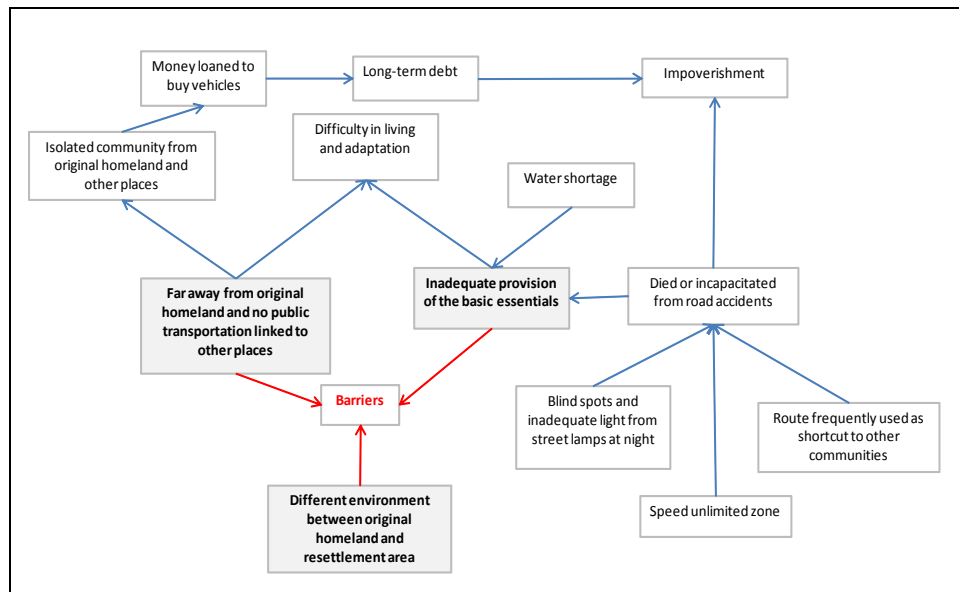


Figure 3: Cognitive map showing barriers associated with spatial aspects in permanent resettlement area

The impoverishment and the dissatisfaction in resettlement area were the major issues in the final resettlement phase. The impoverishment derived from the unsuccessful attempt to improve their lives according with their primary occupations during this difficult time. On the other hand, the dissatisfaction derived 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, for example; the reservoir construction project in the mountain to protect hazard communities from flash flood and debris-flow event, 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 (i.e. Muggah, 2008; UNHCR, 2013; UNHCR, 2007; UN-HABITAT 2008; UN-HABITAT, 1983; UNDRCO, 1982; UN/ISDR, 2004).

3 Findings

Based on the explored issues from this study, there are several determinants essentially considered establishing the spatial database for a resettlement programme. The general information about the residents of the vulnerable debris flow hazard community must be initially prepared to present the characteristics of residents of the community, listed in Table 1. On the other hand, the physical information of the community service centres and the available empty lands has to be collected for the further investigation of potential evacuation centres, temporary displacement areas, and permanent resettlement site, listed in Table 2. Finally, the obtained information is developed specifically by additionally considering the criteria derived from the socio-economic issues of the previous section, listed in Table 3.

(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 1: Basic information about the members of the households for planning a resettlement programme

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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 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 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) <i>Main roads</i> 2.1.2) <i>Minor roads</i> 2.1.3) <i>Communal paths/tracks</i>	-Road name -Route number -Road surface types

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LAYER MAP	GEOGRAPHIC FEATURE	CLASSIFICATION	ATTRIBUTES
	Line	2.2) Public transportation 2.2.1) <i>Surface; Coach, Bus, Van, Tram, Train</i> 2.2.2) <i>Water; Boat, Ferry, Ship</i> 2.2.3) <i>Air; Aeroplane</i>	-Transportation number -Destination -Running routes -Stops
	Polygon	2.3) Community service areas 2.3.1) <i>kindergarten, school, university, college, public library, playground</i> 2.3.2) <i>temple, cemetery, mosque, church</i> 2.3.3) <i>local government offices, government offices,</i> 2.3.4) <i>communal hospital, health centre, provincial hospital,</i> 2.3.5) <i>public sports club, public association offices</i> 2.3.6) <i>Fire station</i>	-Name -Functions -In-functional duration time or period -Open space area -Building area -Availability of water, electricity, and toilets -Entrance & Exit channel
	Point	2.4) Public telephone box	-ID
	Point	2.5) Market 2.5.1) <i>Meat market</i> 2.5.2) <i>Specific goods market, i.e. hardware, appraisal, used items</i>	-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
	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) Slope and Aspect	-Degree
4) Land right	Polygon	4.1) Residential land ownership	-Parcel number -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

Based on the collected database (A) and (B) and statement of problems explored in this study, the spatial database design is developed according to the criteria for resettlement locations for vulnerable, debris-flow hazard communities in Table 3.

Table 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
		Install basic essentials in evacuation centre	Available basic essentials -Water -Toilets -Waste disposal areas -Physical/mental health	-Identify the expandable areas or options around the evacuation centres

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Resettlement Phase	Displaced person activities	Gov./ Organisation administration	Data preparation	Analysis Techniques
	Registration and identification	Personal identification in evacuation/assembly centre	treatment service 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 evacuation centre	Road restoration: -Avoid submerged roads in the hazard area -Hard surfaces with two-way channels -Connect to outside communities	Accessible routes: -Main roads -Minor roads -Vulnerable hazard areas -Other transportation channels to evacuation centres (e.g. river, canal)	-Shortest path analysis with the set-up criteria 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 centres	Available basic essentials: -Water -Electricity -Toilets -Waste disposal areas -Communal leisure area -Nursery/learning centre -Physical/mental health treatment service	-U- or H-shaped site plan for constructing 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 -Electricity -Water/Irrigation -Waste disposal areas	-Photomap comparison for site selection -Identify the infrastructure and road connections on high resolution images -Identify the available landmarks in the community and connections -Note the incidents that occur within the resettlement community and examine if the problems are related to spatial aspects

Resettlement Phase	Displaced person activities	Gov./ Organisation administration	Data preparation	Analysis Techniques
			-Roads and public transportation linked to outside community, workplaces, marketplaces, schools, universities, religious places, hospital or health centres, government offices, banks and financial institutions	

4 Discussion

These criteria are listed respectively in Table 3 according to the displacement locations in resettlement phases. Typically, some data have been normally collected by the governments or relevant organisations which are applicably used for this purpose instantly. However, the correct data from the database providers or relevant offices is another crucial determinant that requires careful consideration by the researcher. According to the observation of this study, it is found 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.

5 Conclusions

Spatial data is used to analyse the aspect of locations (Goodchild and Janelle, 2004). It is clearly shown from the results of this study that several interactions between displaced people and displacement locations were ignored in resettlement programme. These issues cause numerous complex problems in the programme so far. As a result, vulnerable residents in catchment areas would be endangered from potential debris-flow disasters.

This study presents a technique in exploring the complex problems to establish the significant criteria associated with displacement locations of displaced persons in all phases of a resettlement programme. Therefore, the spatial database determined in the study is recommended considering in planning a resettlement programme for vulnerable debris-flow hazard community in advance. However, there are several aspects apart from the spatial aspect essentially considered in establishing the non-spatial database in resettlement programmes. For this reason, it is also suggested to explore the non-spatial data potential for resettlement programme in local communities vulnerable to debris-flow disasters. The future work would consider the procedures from the research design of this paper in order to determine the significant criteria essential to design a non-spatial database used in analysing the focused aspects for a successful resettlement programme.

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