
COBRA2010
2nd - 3rd September


RICS
the mark of
property
professionalism
worldwide


DAUPHINE
UNIVERSITÉ PARIS

COBRA 2010

The Construction, Building and Real Estate Research Conference of the Royal Institution of Chartered Surveyors

Held at Dauphine Université, Paris, 2-3 September 2010

ISBN 978-1-84219-619-9

12 Great George Street
London SW1P 3AD
United Kingdom

www.rics.org/cobra

September 2010

The RICS COBRA Conference is held annually. The aim of COBRA is to provide a platform for the dissemination of original research and new developments within the specific disciplines, sub-disciplines or field of study of:

Management of the construction process

- Cost and value management
- Building technology
- Legal aspects of construction and procurement
- Public private partnerships
- Health and safety
- Procurement
- Risk management
- Project management

The built asset

- Property investment theory and practice
- Indirect property investment
- Property market forecasting
- Property pricing and appraisal
- Law of property, housing and land use planning
- Urban development
- Planning and property markets
- Financial analysis of the property market and property assets
- The dynamics of residential property markets
- Global comparative analysis of property markets
- Building occupation
- Sustainability and real estate
- Sustainability and environmental law
- Building performance

The property industry

- Information technology
- Innovation in education and training
- Human and organisational aspects of the industry
- Alternative dispute resolution and conflict management
- Professional education and training

Peer review process

All papers submitted to COBRA were subjected to a double-blind (peer review) refereeing process. Referees were drawn from an expert panel, representing respected academics from the construction and building research community. The conference organisers wish to extend their appreciation to the following members of the panel for their work, which is invaluable to the success of COBRA.

Rifat Akbiyikli	Sakarya University, Turkey
Rafid Al Khaddar	Liverpool John Moores University, UK
Ahmed Al Shamma'a	Liverpool John Moores University, UK
Tony Auchterlounie	University of Bolton, UK
Kwasi Gyau Baffour Awuah	University of Wolverhampton, UK
Kabir Bala	Ahmadu Bello University, Nigeria
Juerg Bernet	Danube University Krems, Austria
John Boon	UNITEC, New Zealand
Douw Boshoff	University of Pretoria, South Africa
Richard Burt	Auburn University, USA
Judith Callanan	RMIT University, Australia
Kate Carter	Heriot-Watt University, UK
Keith Cattell	University of Cape Town, South Africa
Antoinette Charles	Glasgow Caledonian University, UK
Fiona Cheung	Queensland University of Technology, Australia
Sai On Cheung	City University of Hong Kong
Samuel Chikafalimani	University of Pretoria, South Africa
Ifte Choudhury	Texas A and M University, USA
Chris Cloete	University of Pretoria, South Africa
Alan Coday	Anglia Ruskin University, UK
Michael Coffey	Anglia Ruskin University, UK
Nigel Craig	Glasgow Caledonian University, UK
Ayirebi Dansoh	KNUST, Ghana
Peter Davis	Curtin University, Australia
Peter Defoe	Calford Seaden, UK
Grace Ding	University of Technology Sydney, Australia
Hemanta Doloi	University of Melbourne, Australia
John Dye	TPS Consult, UK
Peter Edwards	RMIT, Australia
Charles Egbu	University of Salford, UK
Ola Fagbenle	Covenant University, Nigeria
Ben Farrow	Auburn University, USA
Peter Fenn	University of Manchester, UK
Peter Fewings	University of the West of England, UK

Michael Murray	University of Strathclyde, UK
Saka Najimu	Glasgow Caledonian University, UK
Stanley Njuangang	University of Central Lancashire, UK
Henry Odeyinka	University of Ulster, UK
Ayodejo Ojo	Ministry of National Development, Seychelles
Michael Oladokun	University of Uyo, Nigeria
Alfred Olatunji	Newcastle University, Australia
Austin Otegbulu	
Beliz Ozorhon	Bogazici University, Turkey
Obinna Ozumba	University of the Witwatersrand, South Africa
Robert Pearl	University of KwaZulu, Natal, South Africa
Srinath Perera	Northumbria University, UK
Joanna Poon	Nottingham Trent University, UK
Keith Potts	University of Wolverhampton, UK
Elena de la Poza Plaza	Universidad Politécnica de Valencia, Spain
Matthijs Prins	Delft University of Technology, The Netherlands
Hendrik Prinsloo	University of Pretoria, South Africa
Richard Reed	Deakin University, Australia
Zhaomin Ren	University of Glamorgan, UK
Herbert Robinson	London South Bank University, UK
Kathryn Robson	RMIT, Australia
Simon Robson	University of Northumbria, UK
David Root	University of Cape Town, South Africa
Kathy Roper	Georgia Institute of Technology, USA
Steve Rowlinson	University of Hong Kong, Hong Kong
Paul Royston	Nottingham Trent University, UK
Paul Ryall	University of Glamorgan, UK
Amrit Sagoo	Coventry University, UK
Alfredo Serpell	Pontificia Universidad Católica de Chile, Chile
Winston Shakantu	Nelson Mandela Metropolitan University, South Africa
Yvonne Simpson	University of Greenwich, UK
John Smallwood	Nelson Mandela Metropolitan University, South Africa
Heather Smeaton-Webb	MUJV Ltd. UK
Bruce Smith	Auburn University, USA
Melanie Smith	Leeds Metropolitan University, UK
Hedley Smyth	University College London, UK
John Spillane	Queen's University Belfast, UK
Suresh Subashini	University of Wolverhampton, UK
Kenneth Sullivan	Arizona State University, USA
Joe Tah	Oxford Brookes University, UK
Derek Thomson	Heriot-Watt University, UK
Matthew Tucker	Liverpool John Moores University, UK
Chika Udeaja	Northumbria University, UK
Basie Verster	University of the Free State, South Africa
Francois Viruly	University of the Witwatersrand, South Africa
John Wall	Waterford Institute of Technology, Ireland
Sara Wilkinson	Deakin University, Australia
Trefor Williams	University of Glamorgan, UK

Bimbo Windapo	University of Cape Town, South Africa
Francis Wong	Hong Kong Polytechnic University
Ing Liang Wong	Glasgow Caledonian University, UK
Andrew Wright	De Montfort University, UK
Peter Wyatt	University of Reading, UK
Junli Yang	University of Westminster, UK
Wan Zahari Wan Yusoff	Universiti Tun Hussein Onn Malaysia, Malaysia
George Zillante	University of South Australia
Benita Zulch	University of the Free State, South Africa
Sam Zulu	Leeds Metropolitan University, UK

In addition to this, the following specialist panel of peer-review experts assessed papers for the COBRA session arranged by CIB W113

John Adriaanse	London South Bank University, UK
Julie Adshead	University of Salford, UK
Alison Ahearn	Imperial College London, UK
Rachelle Alterman	Technion, Israel
Deniz Artan Ilter	Istanbul Technical University, Turkey
Jane Ball	University of Sheffield, UK
Luke Bennett	Sheffield Hallam University, UK
Michael Brand	University of New South Wales, Australia
Penny Brooker	University of Wolverhampton, UK
Alice Christudason	National University of Singapore
Paul Chynoweth	University of Salford, UK
Sai On Cheung	City University of Hong Kong
Julie Cross	University of Salford, UK
Melissa Daigneault	Texas A&M University, USA
Steve Donohoe	University of Plymouth, UK
Ari Ekroos	University of Helsinki, Finland
Tilak Ginige	Bournemouth University, UK
Martin Green	Leeds Metropolitan University, UK
David Greenwood	Northumbria University, UK
Asanga Gunawansa	National University of Singapore
Jan-Bertram Hillig	University of Reading, UK
Rob Home	Anglia Ruskin University, UK
Peter Kennedy	Glasgow Caledonian University, UK
Anthony Lavers	Keating Chambers, UK
Wayne Lord	Loughborough University, UK
Sarah Lupton	Cardiff University
Tim McLernon	University of Ulster, UK
Frits Meijer	TU Delft, The Netherlands
Jim Mason	University of the West of England, UK
Brodie McAdam	University of Salford, UK
Tinus Maritz	University of Pretoria, South Africa

The role of spatial analysis in resettlement programmes

Pantip Piyatadsananon
University of Salford, UK
P.Piyatadsananon@pgr.salford.ac.uk

Dilanthi Amaratunga
The University of Salford, UK
R.D.G.Amaratunga@salford.ac.uk

Kaushal Keraminiyage
The University of Salford, UK
K.P.Keraminiyage@salford.ac.uk

Abstract

Number of victims from the disaster has been dramatically increasing around the world. This phenomenon causes a very high demand of emergency and temporary shelters on particular basis including the need of permanent houses in resettlement programmes. Noticeably, those resettlement programmes have shown the success and failure of their activities. For instance, plenty communities have been forced by governments to abandon their lands to the new locations for safety purpose. Inevitably, many suffered people have to stay in the provided areas because they have no place to go (Gall, 2004). Furthermore, there are abundant cases in which people move back to their original land. Certainly, those failures have shown from the total change of life patterns and styles which cause people many difficulties (Dikmen, 2002). These results show the unsuccessful resettlement programmes which require a better solution. According to the previous works, vulnerable hazard areas have been rarely studied in term of people behaviours correlated between the spatial and social aspects. Based on the resettlement paradigm, building a new settlement site better, safer and suitable for suffered people from disaster, traditional lifestyle of people in communities has to be carefully studied before setting a displacement or resettlement plan. Spatial analysis model with employing several scenes of high-resolution images is an effective tool proposed in this study. The applications of spatial analysis techniques in resettlement programmes are introduced to present a crucial integration between human behaviours in hazard areas and the relevant factors. Prescriptive method is employed to describe the current situations due to the advantage of this method in studying the complexity of human behaviours. This study is an initial part of literature review associated with the application of spatial analysis in resettlement programme. An expected outcome of this study is a framework to develop a model for simulating the human interaction between the spatial and non-spatial parameters. Apart from this study, the designed spatial and non-spatial database in geo-

informatics will be suggested to set some factor criteria in the next step of this study. Eventually, this study will be beneficial to other case studies with the similar contexts.

Keywords: Spatial analysis, resettlement programme, high resolution images, vulnerable hazard area, post-disaster management, geo-informatics, prescriptive model

Introduction

Natural hazards can be divided into six groups with their examples of main types: *geophysical group* (e.g. earthquakes, volcanoes and dry mass movements); *meteorological group* (e.g. storms); *hydrological group* (e.g. flood and wet mass movements); *climatological group* (e.g. extreme temperature, drought and wild fires); *biological group* (e.g. epidemics, insect infestations and animal stampede) and *extra-terrestrial group* (e.g. meteorite) (Below et al., 2009). Based on the recorded affected people around the world in these decades, they have shown the enormous number of suffered people affected from hydrological and meteorological group (LSDR, 2006). Those suffered people in vulnerable hazard areas have unavoidably confronted with many problems of resettlement programmes.

Many difficulties from the relocation areas show the failure of resettlement programmes in many parts of the world (e.g. Vatikiotis, 1987, Oberai, 1986, Karimi et al., 2005, Hoogeveen and Kinsey, 2001, Dikmen, 2002, Bartolome et al., 2000, UN-HABITAT, 2006, UN-HABITAT, 2008, UN/ISDR, 2004, Gall, 2004, Dubie, 2005). With regard to those cases, a phenomenon of people moving back to their origin lands proofs the unsuccessful resettlement plans. Despite those problems, suffered people are unable to leave either their origin places or their resettle places because they have no places to go. Although some strategies have been prescribed and implemented to mitigate these problems, number of people suffered from resettlement programmes has still increased.

According to the relevant factors associated with the resettlement programmes, spatial and non-spatial aspects are major two types of factors considered in this study. The spatial factors encompass with topographical, facility, land-use and transportation parameter whilst non-spatial factors comprise with social network, background and economic parameter. These parameters derive from a preliminary study in Thailand including the conclusion from several incidents around the world (e.g. Zahran et al., 2008, Özden, 2006, Cutter et al., 2003, Overton and Ashwood, 2003, Müller and Zeller, 2002, Takesada et al., 2008, Strand, 1993, Abbott, 2001, Yumuang, 2005, Yumuang, 2006, ADPC, 2006, Teerarungsigul, 2006). Therefore, a tool which enables to analyse those spatial and non-spatial parameters, is highly appreciated.

A terrific capacity of spatial analysis application in the Geographic Information System (GIS) provides the feasibility to analyse and identify the result onto a map based on the geo-referencing coordination. Based on the high-resolution images, spatial analysis method is an effective tool applicable to study the phenomena of resettlement programmes in the local

scale. The aim of the initial stage of this study is to present a framework of the developed spatial analysis model based on the integration between spatial and non-spatial parameters. The outcome of this study is possibly applied to general cases in resettlement programmes with the similar contexts. This study also challenges a practical implementation of the application of spatial analysis in resettlement programmes.

1. Resettlement Programmes

Resettlement is the process by which people leave their original settlement sites to resettle in new areas (Woube, 2005). The resettlement programme possibly includes the procedures from finding the places for temporary shelters to construct the permanent house in the origin or new places (Deruyttere et al., 1998). The term of resettlement can be found as *relocation* and also, *rehabilitation*. The framework of resettlement has been remarkably outlined in many regulations of the principles of resettlement by the United Nation in order to determine the compatibility of the resettlement programme and human rights. It also described in the UN comprehensive Human Rights Guidelines on Development-Based Displacement, 1997 that resettlement must ensure equal rights to women, children and indigenous populations and other vulnerable groups including the right to property ownership and access to resources with respect to education, health, family welfare and employment opportunities (Batra and Chaudhry, 2005). The strategies described in risk management noted that an effective resettlement programme must consider the reconstruction and enforcement as safer and better (UNDP, 2009).

As same as a study of Bartolome et al (2000), it was recommended that a potential resettlement programme must be to improve the standard of living and not just restoration of pre-relocation standards of living and it is only possible where development takes place. Considering to the resettlement strategies applied in Somalia, the permanent resettlement project was assigned to substantially improve the internally displaced people protection and security of tenure, to access the basic service and infrastructure (especially water and sanitation) and to provide a solid base for income-generating activities (Ashmore et al., 2008). As a framework of the operational policy, resettlement plan must be prepared to ensure that the affected people receive fair and adequate compensation and rehabilitation (Deruyttere et al., 1998).

1.1 Challenges associated with resettlement programmes

Although those strategies associated with the resettlement programme have been implemented in many devastation areas around the world, many problems still exist along the resettlement processes and from the result of this programme. The resettlement policy has been employed in some countries

to absolutely move those communities out of risk areas whereas the land improvement and land readjustment of the new reconstruction areas have been ignored and investigated from the possible disaster occurrence (Woube, 2005). According to the unpredictable disastrous occurrence and magnitude, strategies, issues and challenges are set differing from locations and countries (Karunasena et al., 2009). Further, poor implementation of prevailing rules and regulations; poor standards of local expertise and capacities, inadequate funds, lack of communication and coordination are identified as key issues encountered.

An urgent primary problem derived from the aftermath is the non-balancing supplied shelters, facilities and a high demand of victims in hazard areas (Argenal et al., 2008). A major problem of resettlement programme is affected people loss their livelihood and income sources from their arable land. It was also found that the lack of some effective social services such as hospitals and schools causes some big problems to people in resettlement sites (Dubie, 2005).

Absolute displacement has been found in many completely destructive areas and all dam construction projects. Moving people from the devastate areas including the dam construction projects causes a huge change to people lives in the new resettlement areas. Lot of dam displacement projects around the world have provided some essential facilities for people in a new place while the livelihood of people has been ignored in the new resettlement (Cernea, 1991). Heggelund (2006) concluded some problems caused the impoverishment from the dam displacement, for instance, landlessness, joblessness, homelessness, marginalisation to social inclusion, health care, food insecurity, non-access to restoration of community assets and services, and social disarticulation to network and community rebuilding. In this case, people will not be able to move back to their original land, on the other hand, in many cases, affected people in some devastate areas from aftermath events can be able to move back to their origins. The movement of affected people can be seen in different ways. Dikmen (2002) found that people, sometimes, refused moving to the new place due to the insufficient provided facility and infrastructure.

The shortage of food from the agricultural communities causes some big problems to affected people in the resettlement sites. Due to the uncultivable areas from the aftermath, people need to hang on a little amount of the donation money. This kind of problem derives from the under-prepared resettlement sites which the basic amenities and essential infrastructure have not yet been provided (Bartolome et al., 2000). It can be concluded that, almost of all general problems in resettlement programme basically derived from the livelihood between the new and origin settlement sites (e.g. the accessibility, land-use applicability, the available space for agricultural activities and multi-families) (Dikmen, 2002).

Some push factors also play an important role to force people move to the provided new resettlement sites. People living in hazard areas in Peru, were forced to move to the new resettlement area because

they could not offer the proof of their land titles (Argenal et al., 2008). It seems to be a usual problem of underestimating the cost of the resettlement activities which the resettlement budget is reduced and under-financed in almost resettlement projects (Bartolome et al., 2000). Some other factors were found from considering the construction design and socio-economic relations in case of Napoli, Italy and Pinatubo, the Philippines, the resettlement programme brought some significant problems to people from the incompatible construction design and urban planning (Menoni and Pesaro, 2008). Additionally, tribal people or ethnic group have been separated from their communities without considering this issue in the resettlement activities (Bartolome et al., 2000).

Based on those examples, suffered people have to encounter with two different sides of resettlement problem (i.e. moving to new resettlement sites then struggling in the ineffective resettlement sites and refusing to move to the new resettlement site by surrendering to live in risk areas). Furthermore, suffered people have no right to participate or even make a decision for any resettlement plans based on the available provided information. Furthermore, network of people in hazard areas as the informal mechanisms of resettlement programme (i.e. staying with relatives, renting the support host families, etc) has never been studied in order to reduce this crisis situation. Considering to the focusing aspects associated with those stated problems, it can be divided the problems occurring in hazard areas as the spatial aspects and socio-economic aspects. Remarkably, based on those considered factors, problems classified in spatial aspects have consequently correlated with socio-economic aspects. The relationship between spatial aspect problems and socio-economic aspect problems can be correlated in table 1.

Table 1: Summary of the correlation of spatial and socio-economic problems in resettlement programmes

Spatial problems	Correlation	Socio-Economic problems
-Unavailable arable land for agricultural activities	←→	-Lack of income sources from uncultivable land -Shortage of food -Affected people survive by gaining a small amount of donation money
-Under-prepared resettlement sites -Insufficient infrastructure -No provided social services e.g. hospitals, schools	←→	-Non standard infrastructure for living -Expensive living & surviving cost
-Unidentified the ethnic group of people in hazard areas	←→	-Separated tribal people or ethnic group
-Unidentified housing in risk area from	←→	-Non balancing supplied shelters

pre and post events practically	-Underestimated cost of rebuilding

In order to present the spatial and socio-economic problems into an advanced computer technology such as Geographic Information System (GIS), those problems must be interpolated to spatial and non-spatial data respectively. The feasibility of the relationship between spatial and non-spatial data has been achieved in several ways such as plans and regulations in urban simulation models (Hopkins et al., 2005), urban growth (Batty and Xie, 2005, Goldblum and Wong, 2000), community characteristics on physical activity in adolescent girl (Overton and Ashwood, 2003). Although there are lot of works developed spatial analysis model applicable with non-spatial data, there is insufficient knowledge to understand human behaviours in vulnerable hazard areas to the resettlement programmes by focusing on the relationship between spatial and non-spatial data.

2. Spatial Analysis

Spatial analysis is a set of procedures presented the relationship between spatial and phenomenon (Câmara et al., 2004). Spatial analysis contains the process of extracting or creating new information about a set of geographic features which is useful for evaluating suitability and capacity, for estimating and predicting, and for interpreting and understanding (Kaitsa, 2006). The increasing power of spatial analysis has been logically developed over the last twenty years presenting sources of data derive from a broad ranges of spatial data such as maps, census material, aerial photographs, field observation and experimental and simulation works through remote sensing images from either satellite or some airborne scanners (Haining, 1993).

Spatial analysis has played an important role from the early of 19th century in many sciences such as geographical, medical, hydrological, biological, economical, ecological, urban and regional sciences and etc. A crucial evidence showed the primary application of spatial analysis contributing notable epidemiology of analysing the outbreak of cholera in England in 1854 (Snow, 1854). Many functions in the spatial analysis methods can be developed from the basic functions to the extensional functions in order to practically perform the spatial phenomena on Earth as realistic as possible. Four traditional types of this analysis: Topological overlay and contiguity analysis, Surface analysis, Linear analysis and Raster analysis, are the basis of this methods generally considered to develop the spatial modelling in several ways (Dunsford and Gokhale, 2007).

Beyond those basic functions, the spatial analysis can be further developed by employing the statistical approaches and model-based approaches in order to present the relationship between the statistical modelling and location effectively (Longley and Batty, 1996). Currently, spatial analysis has been broadly developed in mathematics, artificial intelligence and physics extensively (Sanders, 2007). Simulation and modelling are based on mathematical programme presenting complex patterns and relationships from behaviour and interactions. Simulation and modelling in spatial analysis

application can be divided as two different types such as Cellular automata modelling and Agent-based modelling. The automata modelling dictates the state of a cell based on the states of its neighbouring cells, while agent-based modelling uses software entities to react, interact and modify their environment (Upton and Fingelton, 1985) . The agent-based modelling can be integrated into a common geographic automata system where some agents are fixed while others are mobile.

Generally, spatial analysis modelling can be classified into two major characteristics; *Predictive* and *Prescriptive model*, which both models have been interpreted in various populations in order to generate and utilise spatial behaviours. Predictive models are interpreting the upcoming events, while prescriptive models are describing the existing events (Batty, 2005). According to the complexity of human behaviours, the prescriptive models are broadly prescribed in policy, design and planning processes.

2.1 Application of spatial analysis

Spatial analysis was introduced for applying as the standalone function and the full integration within Geographical Information System (GIS) software from several decades ago (Goodchild et al., 1992). A huge number of advantages from the full integration between spatial analysis and GIS present several effective functions beyond data management to data analysis. Simultaneously, the drop-down price of computer and spatial analysis software provides an admiring channel to users to implement this kind of technology and its useful functions broadly. Spatial analysis within the GIS environment is beneficial to create, query, map and analyse cell-based raster data, integrate the raster & vector analysis, as well as query information across multiple data layers (ESRI, 2001).

The spatial analysis is beneficial to many studies such as hydrological modelling, flood simulation, watershed delineation, drainage networks, soil erosion, sediment transport modelling, landform evaluation, civil engineering, military applications, site and route selection, landslide hazard assessment, visibility analysis, etc (Jordan, 2007). The applications of spatial analysis in GIS environment has been applied and developed in several applications such as the *Socio-economic application* (e.g. urban sprawl (Batty and Xie, 2005), diseases diffusion (Snow, 1854, Bian and Liebner, 2005), retail and service location planning (Birkin, 2005), transport modelling (Israelsen and Frederiksen, 2005)), and *Environmental application* (e.g. hydrologic modelling (Maidment et al., 2005), environmental modelling with PCRaster (Burrough et al., 2005), transition potential modelling for land-cover change (Eastman et al., 2005), modelling the interaction between humans and animals in multiple-use forests (Ahearn and Smith, 2005).

3. Applications of spatial analysis cin resettlement programmes

Although the spatial analysis has been developed outstandingly in analytical and technical ways, there is a fair limitation in theoretical progress of the spatial analysis. As the recent trend of applying spatial analysis within GIS software, this method has been recommended in the context of many areas of human beings activities. Supporting with a study, Bahrenberg et al. (1984) suggested that many critical constraints in tight environment and the increasing demand of people require a careful judgement for deeper insights in the social and economic sciences. Although those applications of spatial analysis have been applied effectively in physical ways, some socio-economic problems associated with people interaction in spatial relationship have been rarely addressed.

Spatial analysis method has been employed in several disciplines including resettlement programme. Geographical Information System (GIS) has been promoted as an operative tool to assist the spatial analysis functions efficiently. Some major lines of methodological developments in the social and economic sciences such as discrete data analysis, discrete choice modelling, which are intensively analysed on the statistical approaches (e.g. probabilistic based measures, chi square based measures, etc.) and spatial dynamics, which have been introduced the dynamic behaviour of socioeconomic system by considering more traditional time series models, play an important role in the spatial analysis development (Bahrenberg, 1984).

Spatial analysis is not only implemented for the physical and spatial problems, but it is also employed to forecast human behaviour upon the time and space. For instance, the utility of a cellular automata model in GIS environment was applied presenting a better dynamic simulation of the spread of fast-growing informal settlement in Cameroon (Sietchiping, 2004). However, the process of physical relocation has been intensively focused in resettlement programmes while the economic and social development is rarely studied in this activity (Bartolome et al., 2000). Spatial analysis method can define the potential locations for the shelters with the appropriately accesses by considering the proximity to major roads or social service places (e.g. schools and hospitals). Spatial analysis was applied to present the destruction areas caused by topical hurricane in India showing an effective bottom-up approach in order to improve the risk awareness and risk avoiding abilities of affected individuals and groups (O'Hare, 2001). The spatial analysis was also implemented to present the land-cover change from residing 6000 people in term of percentage of area affected and rates of change by investigating from the multispectral SPOT images (Petit et al., 2001). As well as other satellite images, Landsat ETM, TM were introduced in several ways to analyse effectively for the land-use change affecting to resettlement programme, for example, the work of Gall (2004), the accessibility to shelters was analysed by weighting technique in the spatial analysis based on these images.

The spatial analysis has been applied in many important schemes including in many vulnerable hazard areas. The tendency of applying the spatial analysis in the vulnerable hazard areas inclines to the analysis method in order to solve and protect some problems occurring in the potential areas. The

future trend of applying the spatial analysis has been focused on the link of constraints of human behaviours and the decision making approach (Bahrenberg, 1984). Therefore, a critical constraint of the resettlement scheme of people in hazard area is a promising study in social and economic sciences which is related directly to the spatial analysis method.

4. Research Context

This research aims to invent a spatial analysis model which is suitable for applying with people interaction to reduce the socio-economic problems associated with spatial problems in resettlement programmes. Therefore, the initial stage of finding the temporary sites for sheltering until the end of processes of displacing to the new resettlement sites or moving back to their origins will be investigated in order to explore people interaction upon the location.

Based on the United Nations comprehensive human rights guidelines, some factors must be considered for human rights to suitable resettlement such as safety, security, accessibility, affordability and habitability (Batra and Chaudhry, 2005). Additionally, it is recommended that the rebuild from the aftermath must be built back better which is creating safer and better communities (UNDP, 2009). For this reason, original community sites must be studied and defined the network of people in common way interacting upon the infrastructures and facilities available in their indigenous communities. Additionally, social network analysis and interaction of people behaviours with the spatial relationship in the original communities must be delineated and identified on the local scale maps. Spatial relationship and people behaviours of the original settlement communities and the resettlement sites will be compared and criticised presenting the success and failure of the resettlement programme.

In order to achieve those targets, spatial and socio-economic database will be specifically designed in geo-informatics and database within GIS environment for analysing the people interaction practically in the original and current communities. Prescriptive modelling describing affected people behaviours in the new resettlement areas will be presented upon the space and time since the aftermath incident until the permanent resettlement site. The dynamic of people behaviours upon the vulnerable area to the safe place of new resettlement sites will be analysed and illustrated in the ArcGIS software.

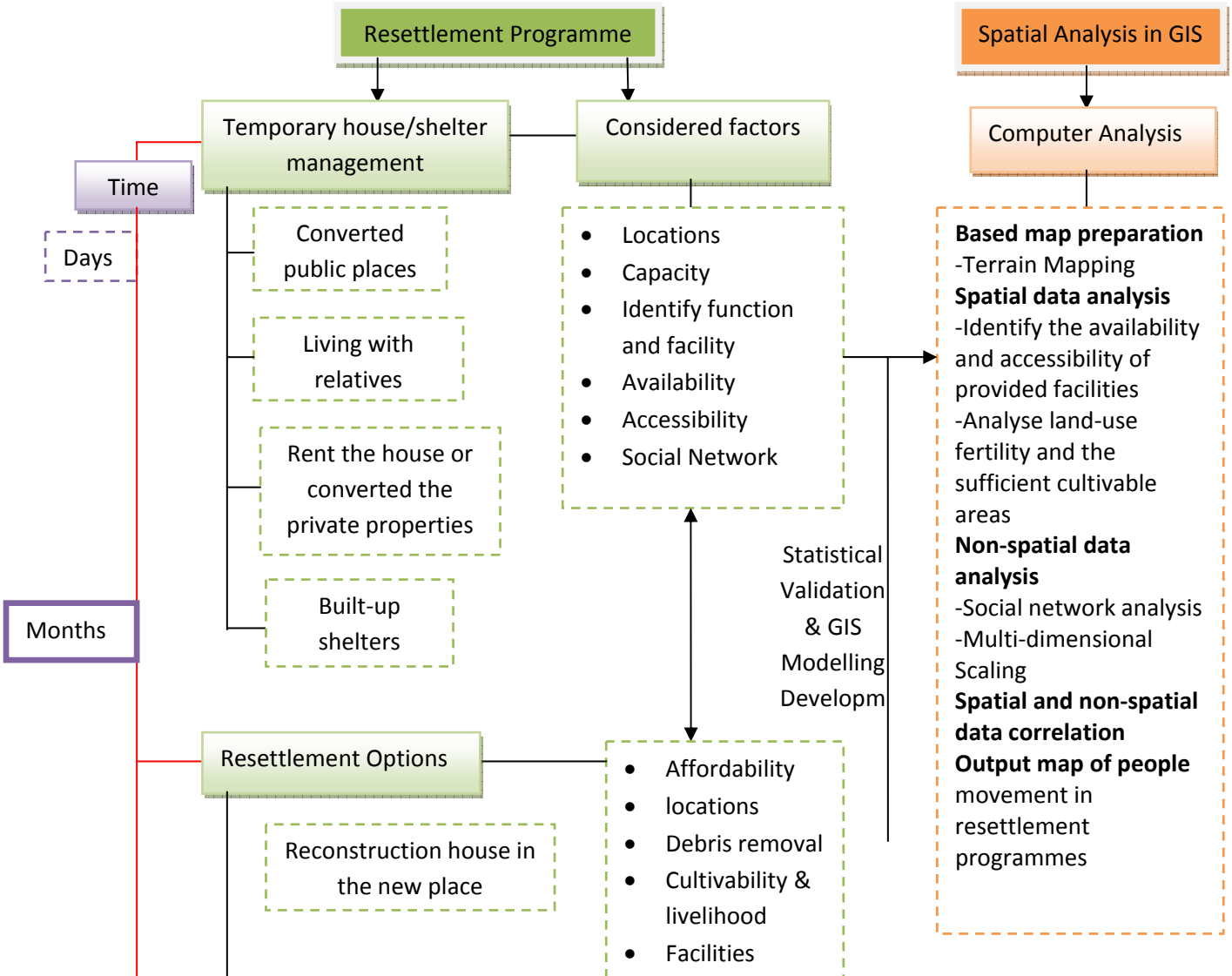
The spatial representation of non-spatial data is generally feasible by converting it into spatial form. Representing spatial problems as spatial data is not a difficult task operated in GIS, on the other hand, converting non-spatial data into spatial references must require some techniques. Basically, at least one attribute must be designed and matched between spatial and non-spatial data. There are alternative techniques recommended in this study: i.e. Multi-Dimensional Scaling (MDS)(White and

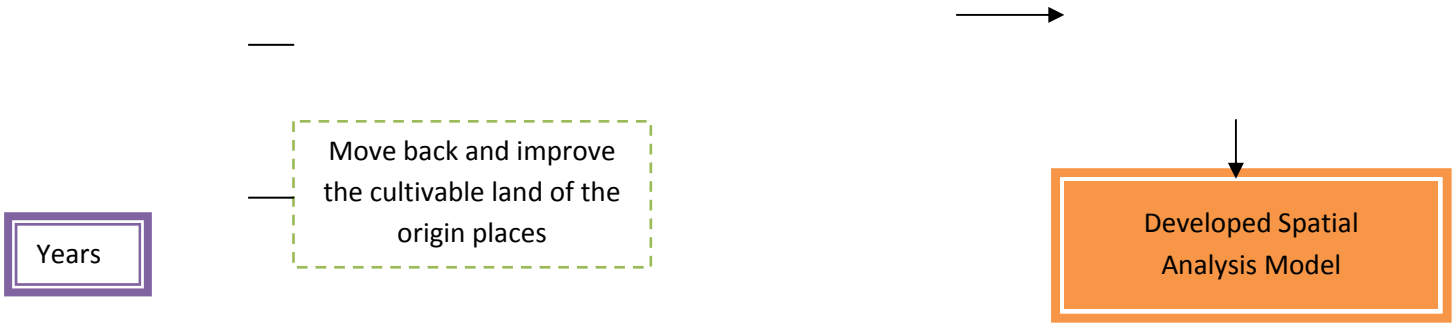
McCain, 1998); factor analysis and Kohonen nets (Small, 1999); clustering and geometric triangulation (Small, 1999).

Considered factors of resettlement activities will be classified as well as the behaviour of affected people in the original communities will be investigated by using the questionnaires and interview. As the result of these initial primary data from interviewees, layer maps based on those queries and interview will be analysed and interpreted showing people networks responding to the available infrastructures and facilities of the original and new communities.

This study represents the resettlement programme in Ban Nam Ko, Petchabun, Thailand. This area was destroyed by the debris-flow/flood in August, 2001 which interested by many researchers as the most destructive area in Thailand. The government set the mitigation plan and policy by using this area as a master plan. Almost ten years, this area has been changed and readjusted in several ways which are both appropriate and inappropriate to affected people. This vital study explores the capacity and applicability of applying the spatial analysis with human interaction and networks which will be able to achieve the target of better and safer new resettlement sites broadly (Figure 1)

Figure 1: The application of spatial analysis and resettlement Programme: Real situation from victims in Ban Nam Ko, Thailand





Source: Interviewed from affected people as preliminary study on 15th – 18th Dec 2009 about the resettlement programme in Ban Nam Ko, Pethchabun Provice, Thailand from the debris flow event in 2001

5. Discussion

Some components associated with the spatial analysis method must be carefully considered such as scale, based map resolution, spatial analysis techniques, and verification and validation of spatial data. One of the most important factors affecting to scale and based map resolution is the Digital Elevation Model (DEM). Basically, the DEM contains height of all aspects as the captured digital data on the terrain presented as raster map pixel. Generally, high resolution DEM can perform the finer terrain for better quality of hydrological networks, clear edges of commutation networks, slope inclination and aspect (Peckham and Jordan, 2007). Therefore, high resolution DEM is definitely very useful to perform any large scale maps appropriate to study the applicability of the relocation in resettlement programme in the community based level.

Apart from the mentioned spatial topology, socio-economic factors must be interviewed to identify the networks of the original and current communities. For this reason, infrastructures, facilities, cultural and ritual centres of communities must be delineated in the large scale maps. These accessible networks will perform the real relationship between people and communities which will be able to create better communities in resettlement sites sustainably.

6. References

ABBOTT, J. 2001. Use of spatial data to support the integration of informal settlements into the formal city. *JAG,* 3**,** 267-277.

ADPC 2006. Rapid Assessment: Flashflood and Landslide disaster in the provinces of Uttaradit and Sukhothai Northern Thailand. Bangkok, Thailand: Asian Disaster Preparedness Center.

AHEARN, S. & SMITH, J. L. D. 2005. Modeling the interaction between humans and animalsin multiple-use forests: A case study of Panthera Tigris. *In:* MAGUIRE, D. J., BATTY, M. & GOODCHILD, M. F. (eds.) *GIS, Spatial Analysis, and Modeling.* Redlands, California: ESRI Press.

ARGENAL, E., FUNES, M., HODGKIN, D. & RHYNER, K. 2008. *Shelter Projects 2008*, UN-HABITAT.

ASHMORE, J., FOWLER, J. & KENNEDY, J. 2008. Shelter Projects 2008. *In:* ASHMORE, J. (ed.) *IASC Emergency Shelter Cluster.* UN-HABITAT.

BAHRENBERG, G. 1984. Spatial analysis: a retrospective view. *In:* BAHRENBERG, G., FISCHER, M. M. & NIJKAMP, P. (eds.) *Recent Developments in Spatial Data Analysis: Methodology, Measurement, Models.* Hants, England: Gower Publishing Company Limited.

BAHRENBERG, G., FISCHER, M. M. & NIJKAMP, P. 1984. Methodology, measurement and models in spatial analysis: some major lines of recent developments. *In:* BAHRENBERG, G., FISCHER, M. M. & NIJKAMP, P. (eds.) *Recent Developments in Spatial Data Analysis: Methodology, Measurement, Models.* Hants, England: Gower Publishing Company Limited.

BARTOLOME, L. J., WET, C. D., MANDER, H. & NAGARAJ, V. K. 2000. Displacement, Resettlement, Rehabilitation, Reparation and Development. *World commission on Dams.* Cape Town, South Africa.

BATRA, B. J. & CHAUDHRY, S. 2005. International Human Rights Standards on Post-disaster Resettlement and Rehabilitation. *UN Comprehensive Human Rights Guildelines on Development-Based Displacement, 1997.* Geneva: Office of the United Nations High Commissioner on Human Rights.

BATTY, M. 2005. Introduction to Section 3: Socioeconomic Application. *In:* MAGUIRE, D. J., BATTY, M. & GOODCHILD, M. F. (eds.) *GIS, Spatial Analysis, and Modeling.* Redlands, California: ESRI Press.

BATTY, M. & XIE, Y. 2005. Urban growth using cellular automata models. *In:* MAGUIRE, D. J., BATTY, M. & GOODCHILD, M. F. (eds.) *GIS, Spatial Analysis, and Modeling.* Redlands, California: ESRI Press.

BELOW, R., WIRTZ, A. & GUHA-SAPIR, D. 2009. Disaster Category Classification and peril terminology for operational purposes. Munich: Centre of Research on the Epidemiology of Disasters.

BIAN, L. & LIEBNER, D. 2005. Simulating sptially explicit networks for dispersion of infectious diseases. *In:* MAGUIRE, D. J., BATTY, M. & GOODCHILD, M. F. (eds.) *GIS, Spatial Analysis, and Modeling.* Redlands, California: ESRI Press.

BIRKIN, M. 2005. Retail and service location planning. *In:* MAGUIRE, D. J., BATTY, M. & GOODCHILD, M. F. (eds.) *GIS, Spatial Analysis, and Modeling.* Redlands, California: ESRI Press.

BURROUGH, P. A., KARSSENBERG, D. & DEURSEN, W. V. 2005. Environment modeling wtih PCRaster. *In:* MAGUIRE, D. J., BATTY, M. & GOODCHILD, M. F. (eds.) *GIS, Spatial Analysis, and Modeling.* Redlands, California: ESRI Press.

CÂMARA, G., MONTEIRO, A. M., FUCKS, S. D. & CARVALHO, M. S. 2004. *Spatial Analysis and GIS: A Primer* [Online]. http://www.dpi.inpe.br/gilberto/tutorials/spatial_analysis_primer.pdf. [Accessed].

CERNEA, M. M. 1991. Socio-economic and cultural approaches to involuntary population resettlement. *Guidelines on lake management,* 2**,** 177-188.

CUTTER, L. S., BORUFF, J. B. & SHIRLEY, W. L. 2003. Social Vulnerability to Environmental Hazards. *Social Science Quarterly,* 84**,** 242-261.

DERUYTTERE, A., RENSHAW, J., ROJAS, E., DAUGHTERS, R., BRANSKI, J., PERAZZA, M. C., SOLORZANO, A. & BURROUGHS, N. 1998. Involuntary Resettlement: Operational Policy and Background Paper. *The sixth IDB-NGO consultative meeting on the environment.* Curitiba, Brazil.

DIKMEN, N. 2002. Relocation or rebuilding in the same area: An important factor for decision making for post-disaster housing projects. Montreal, USA: Department of Architecture, Suleyman Demirel University, IF Research Group, University of Montreal.

DUBIE, M. E. 2005. *The socio-economic dimensions of resettlement programme in Ethiopia: The case of Gololee Nonnoo resettlement scheme (West shewa of Oromiya regional state).* Master of Art in Regional and Local Development studies, Addis Ababa

DUNSFORD, T. & GOKHALE, B. 2007. Principle of GIS: Basic of Spatial Analysis. Fall 2007 ed.: www.giscenter.isu.edu/training/PPT/Principles/Lecture10_BGTD.ppt.

EASTMAN, J. R., FOSSEN, M. E. V. & SOLÓRZANO, L. A. 2005. Transition potential modeling for land-cover change. *In:* MAGUIRE, D. J., BATTY, M. & GOODCHILD, M. F. (eds.) *GIS, Spatial Analysis, and Modeling.* Redlands, California: ESRI Press.

ESRI 2001. ArcGIS Spatial Analyst: Advanced GIS Spatial Analysis Using Raster and Vector Data. Redlands, New York, California, USA.

GALL, M. 2004. Where to Go? Strategic Modelling of Access to Emergency Shelters in Mozambique. *Disasters,* 28**,** 82-97.

GOLDBLUM, C. & WONG, T.-C. 2000. Growth, crisis and spatial change: a study of haphazard urbanisation in Jakarta, Indonesia. *Land Use Policy,* 17**,** 29-37.

GOODCHILD, M., HAINING, R. & WISE, S. 1992. Integrating GIS and Spatial Data Analysis: Problems and Possibilities. *Int. J. Geographical Information Systems,* 6**,** 407-423.

HAINING, P. R. 1993. Issues in analysing spatial data. *Spatial data analysis in the social and environmental sciences.* Cambridge, UK: University of Cambridge.

HEGGELUND, G. 2006. Environment frictions? Dams, Agriculture and Biotechnology. *Development & Change,* 37**,** 179-199.

HOOGEVEEN, J. G. M. & KINSEY, B. H. 2001. Land reform, growth and equity: Emerging evidence from Zimbabwe's resettlement programme-A sequel. *Journal of Southern African Studies,* 27.

HOPKINS, L. D., KAZA, N. & PALLATHUCHERIL, V. G. 2005. A data model to represent plans and regulations in urban simulation models. *In:* MAGUIRE, D. J., BATTY, M. & GOODCHILD, M. F. (eds.) *GIS, Spatial Analysis, and Modeling.* California, USA: ESRI Press.

ISRAELSEN, T. & FREDERIKSEN, R. D. 2005. The use of GIS in transport modelling. *In:* MAGUIRE, D. J., BATTY, M. & GOODCHILD, M. F. (eds.) *GIS, Spatial Analysis, and Modeling.* Redlands, California: ESRI Press.

JORDAN, G. 2007. Digital Terrain Analysis in a GIS Environment Concepts and Development. *In:* PECKHAM, R. J. & JORDAN, G. (eds.) *Digital Terrain Modelling: Development and applicaitons in a Policy Support Environment.* Berlin Springer.

KAITSA, G. 2006. *GIS Glossary* [Online]. Ohio: Delaware County, Ohio, USA. Available: http://www.dalisproject.org/pages/glossary.htm#s [Accessed Feb 2010].

KARIMI, S., NAKAYAMA, M., FUJIKURA, R., KATSURAI, T., IWATA, M., MORI, T. & MITZUTANI, K. 2005. Post-project review on a resettlement programme of the Kotapanjang Dam Project in Indonesia. *Water Resources Development,* 21**,** 371-384.

KARUNASENA, G., AMARATUNGA, D., HAIGH, R. & LILL, I. 2009. Post disaster waste management strategies in developing countries: Case of Sri Lanka. *International Journal of Strategic Property Management*.

LONGLEY, P. & BATTY, M. 1996. Analysis, modelling, forecasting, and GIS technology. *In:* LONGLEY, P. & BATTY, M. (eds.) *Spatial Analysis: Modelling in a GIS Environment.* New York: John Wiley & Sons Inc.

LSDR. 2006. *Disaster statistics 1991-2005: Introduction* [Online]. www.unisdr.org. Available: www.em-dat.net [Accessed 8 June 2010].

MAIDMENT, D. R., ROBAYO, O. & MERWADE, V. 2005. Hydrologic modeling. *In:* MAGUIRE, D. J., BATTY, M. & GOODCHILD, M. F. (eds.) *GIS, Spatial Analysis, and Modeling.* Redlands, California: ESRI Press.

MENONI, S. & PESARO, G. 2008. Is relocation a good answer to prevent risk? Criteria to help decision makers choose candidates for relocation in areas exposed to high hydrogeological hazards. *Disaster Prevention and Management,* 17**,** 33-53.

MÜLLER, D. & ZELLER, M. 2002. Land use dynamics in the central highlands of Vietnam: a spatial model combining village survey data with satellite imagery interpretation. *Agricultural Economics,* 27**,** 333-354.

O'HARE, G. 2001. Hurricane 07B in the Godavari Delta, Andhra Pradesh, India: vulnerability, mitigation and the spatial impact. *The Geographical Journal,* 167**,** 23-38.

OBERAI, A. S. 1986. Land settlement policies and population redistribution in developing countries: Performance, problems and prospects. *International Labour Review,* 125**,** 141-161.

OVERTON, A. & ASHWOOD, S. 2003. Using ArcGIS to analyze the effects of community characteristics on physical activity in adolescent girls. *23th ESRI International User Conference.* USA: ESRI.

ÖZDEN, A. T. 2006. Developing a model for community involvement in post-disaster housing programmes. Ankara, Turkey: Middle East Technical University, Department of Architecture.

PECKHAM, R. J. & JORDAN, G. (eds.) 2007. *Digital Terrain Modelling,* Berlin Springer.

PETIT, C., SCUDDER, T. & LAMBIN, E. 2001. Quantifying processes of land-cover change by remote sensing: resettlement and rapid land-cover changes in south-eastern Zambia. *Int. J. Remote Sensing,* 22**,** 3435-3456.

SANDERS, L. (ed.) 2007. *Models in Spatial Analysis,* Paris, France: CNRS, University of Paris 7.

SIETCHIPING, R. 2004. *A geographic information systems and cellular automata-based model of informal settlement growth.* Doctor of Philosophy, The University of Melbourne.

SMALL, H. 1999. Visualizing Science by Citation Mapping. *Journal of the American Society for Information Science,* 50**,** 799-813.

SNOW, J. 1854. *Snow cholera map*. London: http://johnsnow.matrix.msu.edu/images/online_companion/chapter_images/fig12-5.jpg.

STRAND, G.-H. 1993. Settlement planning with GIS. *Habitat Intl.,* 17**,** 75-85.

TAKESADA, N., MANATUNGE, J. & HERATH, I. L. 2008. Resettler choices and long-term consequences of involuntary resettlement caused by construction of Kotmale Dam in Sri Lanka. *Lake & Reservoirs: Research and Management,* 13**,** 245-254.

TEERARUNGSIGUL, S. 2006. *Landslide prediction model using remote sensing, gis and field geology: A case study of Wang Chin District, Phrae province, Northern Thailand.* Doctor of Philosophy, Suranaree University of Technology.

UN-HABITAT 2006. Habitat Debate: A new start; The paradox of crisis. *Habitat Debate,* 12**,** 1-24.

UN-HABITAT 2008. People's process in post-disaster and post-conflict recovery and reconstruction. Fukuoka, Japan: UN-HABITAT Regional Office for Asia and the Pacific.

UN/ISDR 2004. Living with risk. *A Global review of disaster reduction initiatives.* Geneva: United Nations International Strategy for Disaster Reduction.

UNDP. 2009. A Contribution to the 2009 ISDR Global Assessment Report on Disaster Reduction. *Early Recovery, Vulnerability Reduction and Disaster Risk Reduction* [Online]. Available: http://www.preventionweb.net/english/hyogo/gar/background-papers/documents/Chap5/thematic-progress-reviews/recovery/UNDPBCPR-ERT.doc [Accessed 18 Nov 2009].

UPTON, G. J. & FINGELTON, B. 1985. *Spatial data analysis by example: Point pattern and quantitative data,* New York, John Wiley & Sons.

VATIKIOTIS, M. 1987. Resettlement rethink. *Far Eastern Economic Review,* 138**,** 28.

WHITE, H. D. & MCCAIN, K. W. 1998. Visualizing a discipline: An author cocitation analysis of information science. *Journal of the American Society for Information Science,* 49**,** 327-355.

WOUBE, M. 2005. Effects of resettlement schemes on the biophysical and human environments: The case of the Gambela Region, Ethiopia. Florida, USA.

YUMUANG, S. 2005. *Evaluation of Potential for 2001 Debris Flow and Debris flood in the vicinity of Nam Ko Area, Amphoe Lom Sak, Changwat Phetchabun, Central Thailand.* Doctor of Philosophy, Chulalongkorn University.

YUMUANG, S. 2006. 2001 Debris flow and debris flood in Nam Ko area, Petchabun province, Central Thailand. *Environmental Geology,* 51**,** 545-564.

ZAHRAN, S., BRODY, S. D., PEACOCK, W. G., VEDLITZ, A. & GROVER, H. 2008. Social vulnerability and the natural and built environment: a model of flood casualties in Texas. *Disasters,* 32**,** 537-560.