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MERGING QUANTITATIVE AND QUALITATIVE ANALYSES FOR FLOOD RISK ASSESSMENT AT HERITAGE SITES, THE CASE OF AYUTTHAYA, THAILAND

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The present paper presents a flood risk assessment approach for urban areas with mixed land-use including cultural sites. Destruction of heritage properties through disasters creates a serious loss for the national and local communities, not only because of the cultural importance of heritage assets but also for their socio-economic value. At the same time, studies have shown that protecting heritage promotes resilience since heritage contributes to social cohesion, sustainable development and psychological well-being (Jigyasu et. al [3]). Although disaster risk management activities have been developed intensively, a very few methodologies are developed specifically for preservation of heritage sites. Economic as well as intrinsic values embodied within cultural assets require combination of both quantitative and qualitative analyses (i.e., holistic analysis) for flood risk assessment. Moreover, it has been acknowledged that community-based and active stakeholder participation approaches are needed to facilitate comprehensive flood risk assessment. The work presented in this paper aims to develop a framework for active stakeholder participation which combines qualitative and quantitative methods for flood risk assessment at heritage sites. It also seeks to provide a base overview of potential benefits from participatory planning process for both stakeholders and flood risk experts.

INTRODUCTION

Urban areas with mixed land-use represent a range of challenges for flood risk assessment. The presence of residential, commercial and cultural areas triggers conflicts of interests of different stakeholders. Moreover, multi-level governance and involvement of various organisations in the management of heritage sites create overlapping responsibilities among different organisations.

Among other issues decision-makers also face ethical questions in order to prioritise areas to be protected: residential, commercial and cultural land-use. Therefore, the holistic flood risk assessment and stakeholders' perception of mitigation measures are needed to facilitate decision-making process.

The need for integrating heritage concerns into national disaster reduction policies and addressing disaster risk reduction within was stressed by The World Heritage Committee at its 31st session in 2007 adopted a Strategy for Reducing Risks at World Heritage Properties (WHC-07/31.COM/7.2).

This paper presents an approach of combining quantitative and qualitative analyses for flood risk assessment within the Ayutthaya Island (Thailand). It reviews the possibilities to consider cultural assets throughout assessment of different dimensions of vulnerability. In addition, a participatory approach was introduced into the flood risk assessment process.

FLOOD IMPACTS AND CULTURAL ASSETS

The evidence to date shows that floods may have different impacts on different land-use types. For rural areas, floods may be less of a problem as the related impacts are not always negative (e.g., spread of sediment containing beneficial nutrients to topsoil), whereas for urban areas the consequences are much more adverse and severe. The focus here is on the negative side of floods.

Flood damages can be divided into two groups, namely tangible and intangible. First group refers to those types of damages that can be expressed in monetary terms. Intangible damages refer to social systems and intrinsic values which are difficult to express in monetary terms.

In the case of cultural assets the damages from flooding may include both tangible and intangible elements. Cultural assets possess both cultural and economic values that can be categorized according to their use (market) and non-use (non-market) characteristics creating the total value of a cultural asset as depicted on the Figure 1.

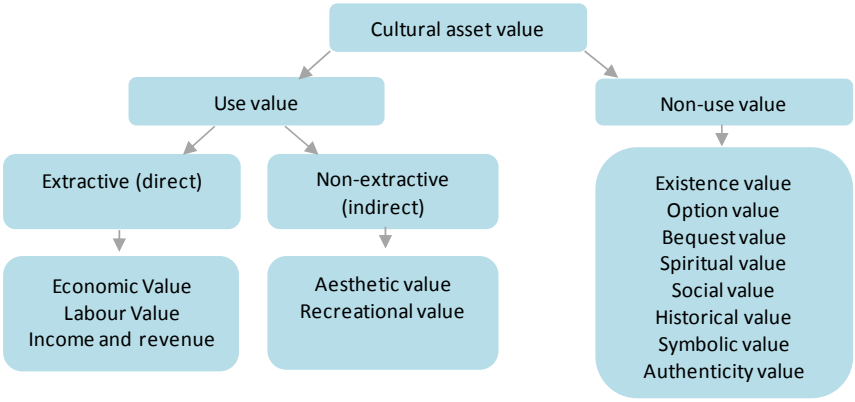

Figure 1: Typology of values attributed to cultural assets. After Vecvagars [7].

The non-use value of a cultural asset covers an important part of its total value and is the most difficult to value. When a cultural asset of national or international significance becomes extinct, many people would feel a sense of loss due to the above values (Frey and Pommerehne [2]). It has already been acknowledged that cultural sector makes a great contribution to education, community welfare, urban renewal and tourism, thus, creating not only an important social, but also economic impact on local, regional and national economies (Vecvagars [7]).

According to research by Mourato and Mazzanti [6] people tend to attribute a significantly positive value to the conservation or restoration of cultural assets.

ASSESSING THE IMPACT FOR THE AYUTTHAYA ISLAND, THAILAND

Ayutthaya Island is covering around 720 acre, more than third of this area is inscribed on the World Heritage List in 1991 as The Historic City of Ayutthaya. The island is located in the central plain of the Chao Phraya River Basin and was subject to an extreme flooding event in the fall of 2011 as part of the worst flooding which Thailand has experienced in decades. Based on the several expert missions undertaken in November-December 2011 the International Council on Monuments and Sites (ICOMOS) and the International Centre for the Study of Preservation and Restoration of Cultural Property (ICCROM) recommended developing an overall disaster mitigation strategy for the Historic City of Ayutthaya. More specifically, experts recommended undertaking a flood risk study that will address issues specific to Ayutthaya and will identify effective flood protection measures for a flood disaster risk management plan.

The Historic City of Ayutthaya founded in 1350, was the second capital of the Siamese Kingdom, and bears a unique testimony to a cultural tradition and to a civilization. In more detail, this city is an excellent witness to the period of development of a true national Thai art (UNESCO/ICCROM/ICOMOS/IUCN [9]). The outstanding universal value is based on integrity and authenticity of the site. The integrity of the property is found in the preservation of the ruined or reconstructed state of those physical elements which characterized this once great city. These consist of first and foremost the urban morphology, systematic pattern of streets and canals throughout the entire island and dividing the urban space into strictly controlled zones each with its own characteristic use and therefore architecture. Authenticity of the Historic City of Ayutthaya is confirmed by many historical records. As one of the world's largest cities of its time and a major political, economic and religious centre, many visitors recorded facts about the city and their experiences there. Also, the testimony of works of art, wall painting, sculpture, and palm leaf manuscripts which survive from the period is an important source of authenticity (UNESCO/ICCROM/ICOMOS/IUCN [9]).

Other important land-use types on the island include residential area with population around 50 000. Also, commercial land-use is well developed; particularly tourism sector is significant for the local economy.

In 2011, Ayutthaya region (as well as many other areas in Thailand) was subject to an extreme flooding event in the fall of 2011 as part of the worst flooding which Thailand has experienced in decades.

In response to the flooding of Ayutthaya, several partners joined to undertake a flood risk study that will address issues specific to Ayutthaya and will identify effective flood protection measures for a flood disaster risk management plan. The present paper describes some of the key aspects of that work.

Methodology

For the purpose of this research the community-based disaster risk management (CBDRM) framework developed by Asian Disaster Preparedness Center was adopted and applied in the present work (see Figure 2). Moreover, the existing framework was enhanced by adding a variety of stakeholders into the analysis and addressing their needs and concerns. According to the work of Manojilovic et al [5] flood risk management planning involves a range of tools

and methods (social, hydrodynamic, learning) and it requires communication among interdisciplinary experts. Furthermore, characterization of communication means and stakeholder analysis in the context of the present work were completed as a part of the groundwork task within the CBDRM framework.

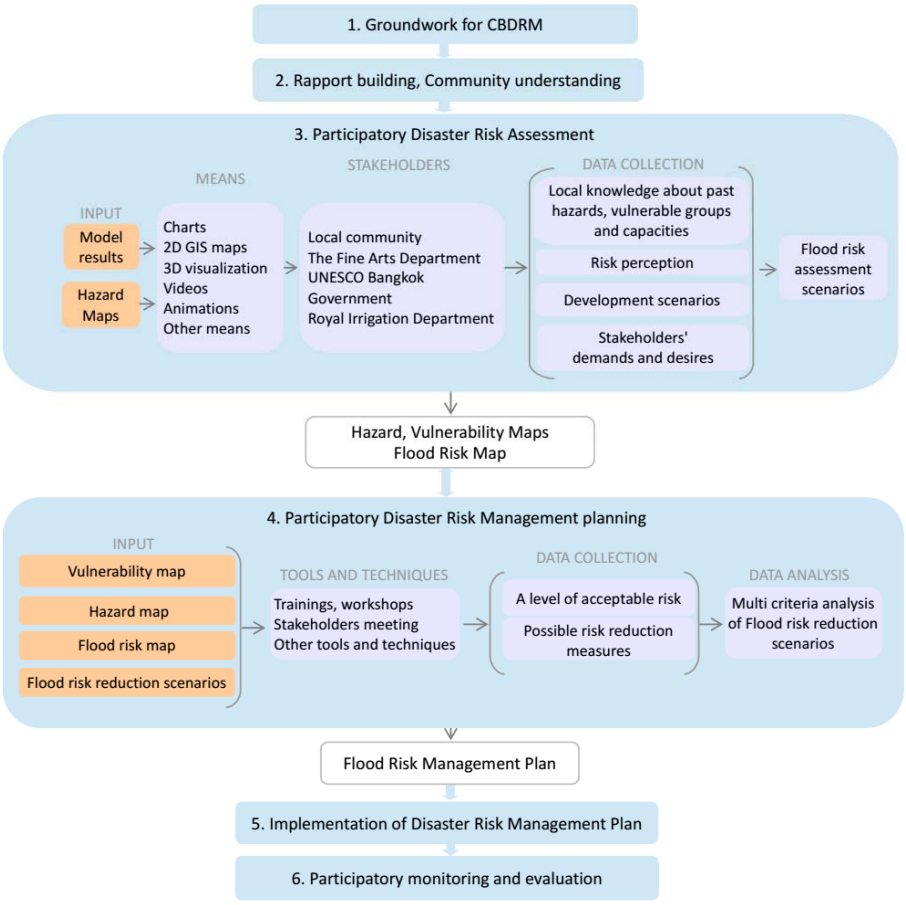

Figure 2: The framework for community-based disaster risk management (CBDRM).

An approach which combines quantitative and qualitative analyses within the flood risk assessment process has been applied in the present work, Figure 3. The essence of quantitative methods is mathematical and probabilistic expression of risk; hence it can be used for hazard assessment through physically-based models, assessment of tangible damages from flooding. Whereas quantitative approach employs perceptive, sensuous-intuitive and phenomenological methods for studying flood risk from signs, statements, experiences and evidences. Therefore, risk perception, level of acceptable risk, vulnerability of cultural assets and society can be assessed exclusively by quantitative approach. As a result, both quantitative and qualitative data and methods are implemented complementary for defining an expression of flood risk through participatory assessment process.

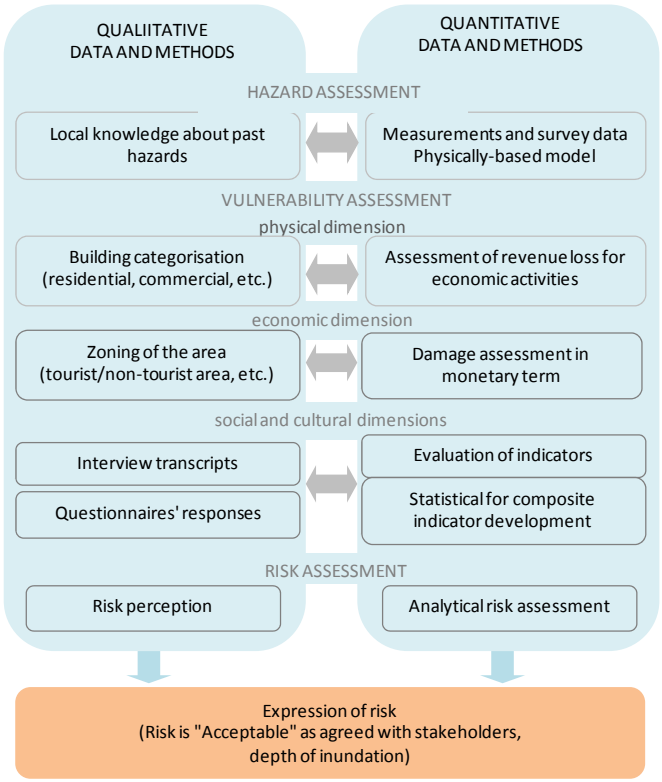

Figure 3: An approach which combines quantitative and qualitative analyses used in the present work.

Hazard assessment

To encapsulate the complexities of the Ayutthaya region, the one-dimensional and two-dimensional modelling packages developed by DHI (MIKEFLOOD - MIKE11/MIKE21) were applied. The work involved definition of catchment characteristics and channel geometry, setting up the scenarios, model simulations and analysis of results. More than 30 simulations have been run in order to analyse effect of different mitigation measures on depth of inundation. Some results of the modelling are presented on the Figure 5.

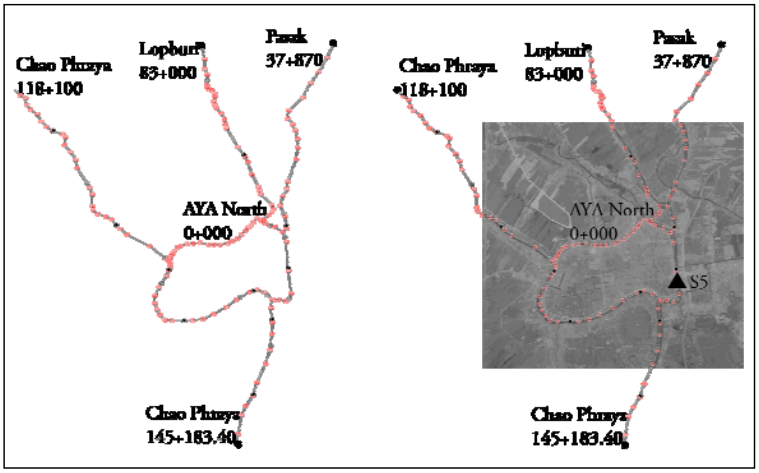

Figure 4: Flood Model Setups, Mike 11 river networks 1D (on the left), Coupled 1D-2D in MikeFlood (on the right)

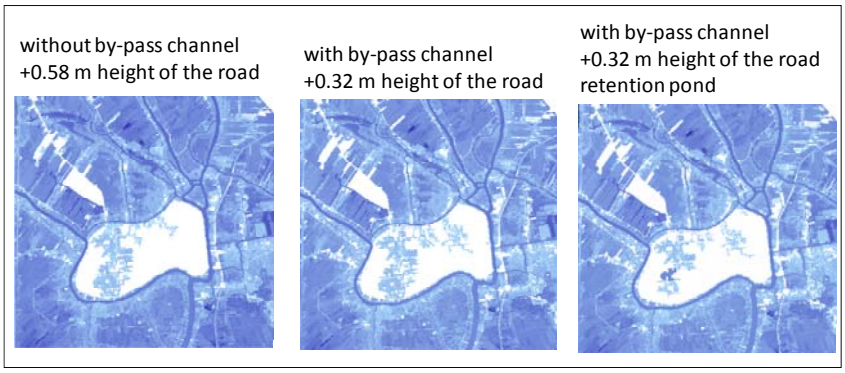

Figure 5: Examples of outputs from numerical models used in the analysis. Model simulations concerned different scenarios and use of different flood protection measures (raising of an existing U-Thong dike, installation of temporary flood walls, improvement of the local drainage system and enlargement of an existing detention storage).

Vulnerability assessment

Vulnerability is usually defined as the state of being prone to or susceptible to harm (Vojinovic and Abbott [8]). According to the United Nation University study, vulnerability determines if the community at risk can cope with or rebound from the hazard event (Tanhueco and Velasquez [4]). Different dimensions of vulnerability can be also differentiated depending on the affected area. For the purpose of the present work four dimensions of vulnerability were identified: physical, economic, social and cultural.

Quantitative methods were used for assessing physical and economic dimensions of vulnerability. The physical vulnerability was assessed for different types of buildings and expressed in terms of a depth-damage relationship. For the economic sectors the relationship between duration of flood and income losses was applied. Social vulnerability was assessed at community level and community-based approaches were introduced in the collection quantitative data from local residents and different stakeholders.

The presence of the world heritage sites can be traced at each dimension of vulnerability. Thus, the specific features of historic buildings were analysed in relation to their physical vulnerability. Damages such as deposition of mud, salt efflorescence, growth of algae and

mosses on the surface of remains have adverse effects on heritage properties and hence may diminish their outstanding universal value. Moreover, in the view of danger of large-scale inclination due to softening of the ground, the soil consistency around the monuments was considered as one of the factors of physical vulnerability.

The social dimension of vulnerability was addressed in relation to coping capacity and resilience of local communities by evaluating the degree of social cohesion and psychological well-being. These parameters were evaluated through interviews and questionnaires. The economic value of assets is reflected through economic vulnerability of the tourism sector. Six economic activities associated with cultural heritage were differentiated, namely accommodation, catering, transportation, guiding services and tickets, souvenirs and other services and each.

In order to assess vulnerability of intrinsic values embodied within cultural heritage site the cultural dimension of vulnerability was also introduced. A set of indicators mirroring the intrinsic values embodied within cultural properties and affected by flooding was developed and then evaluated by experts with architectural and cultural background. More particularly, architectural value, integrity and some dimensions of authenticity were considered. The analysis of work has confirmed that the culture has multidimensional character and judgment of indicators may vary between experts since there is no single definition of authenticity and other intrinsic values.

CONCLUSIONS

Destruction of heritage properties through disasters creates a serious loss for the national and local communities, not only because of the cultural importance of heritage assets but also for their socio-economic value. The current decision-making practice has advanced in many areas but in many cases it is still dominated by the traditional cost-based type of analysis which is very limited when it comes to cultural assets at heritage site. The work presented in this paper described a framework which combines qualitative and quantitative methods for flood risk assessment at heritage sites.

Areas with mixed land-use exposed to flooding experience a range of impacts that cannot be assessed by neither qualitative nor quantitative methods alone. Cultural assets themselves embody tangible and intrinsic values. The collective judgement of many stakeholders working toward flood risk mitigation at the areas with mixed land-use is that qualitative data, especially stemmed from communities at risk, is at least as equally important as quantitative assessment of risk for the holistic expression of risk. Qualitative approaches become even more significant in the context of climate change and uncontrollable land-use changes. With this in mind, a combined approach should be developed to facilitate flood risk assessment which can build upon the strengths of both qualitative and quantitative methods. For urban area with cultural land use in the developing countries this would include physically-based models for hazard assessment (that can be verified by local knowledge about past flood events), physical and economic impacts can be evaluated in monetary terms, whereas social and cultural dimensions of vulnerability are the subjects for perceptive and phenomenological analyses based on stakeholders experience and opinions; and expression of risk should be agreed with stakeholders as "acceptable" and should be defined in quantitative units.

Due to the difficulties to assess flood risk in a holistic way, it is useful to introduce community-based framework to enhance the chance of success. These can include involvement of stakeholders and communities at every step of the risk assessment process in order to

facilitate exchange of data, information and knowledge that may lead to understanding between experts and stakeholders and result in agreed expression of risk. The work presented in this paper demonstrates an approach which combines quantitative and qualitative analyses together with active stakeholder participation in a way that it can address the complexity of flood risk assessment in urban area with a mixed land-use.

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