Challenges in recording disaster damage and loss data for cultural heritage

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Abstract: The Sendai Framework for Disaster Risk Reduction (SFDRR) upholds the development and implementation of measures to reduce hazard exposure and vulnerability to disasters. Among other aspects, the SFDRR recognizes the importance of cultural heritage and its irreplaceable value for society, thus emphasising the need to assess the impact that potential hazards may have on the built cultural heritage. Developing adequate risk assessment and management processes are fundamental towards this end and it is known that systematically collected and robust disaster damage and loss data are essential for such processes. Thus, the development of systems, models and methodologies to collect and handle such data are seen to be a current worldwide priority.

In this context, the proposed paper presents a database framework for the worldwide collection of immovable cultural heritage disaster loss data currently being developed by ICOMOS/ICORP with the support of other organisations, namely the Faculty of Engineering of the University of Porto, Portugal. The concepts and technical aspects related to the data being collected and its structured organisation are discussed, as well as the type and format of the indicators being recorded. Furthermore, challenges and obstacles regarding the possibility of collecting cultural heritage disaster loss data are discussed as well as its benefits for the development of more rational disaster risk management approaches for cultural heritage. Among other features of the database framework, a possible indicator to estimate economic losses representing the loss in value of cultural heritage properties due to damage caused by hazardous events is also discussed. This indicator estimates the loss in value of cultural heritage properties as a function of the (physical) damage they suffered and of the positive estimated economic impact that cultural heritage has in a given country. Details of this estimator are provided along with its potential applications within the SFDRR.

Keywords: Cultural heritage, disaster damage, disaster loss data, economic loss indicator.

1. Introduction

Existing international frameworks and programs for disaster risk reduction (DRR) emphasize the need to develop and implement measures to reduce hazard exposure and vulnerability to disasters. Among other aspects, current DRR initiatives such as the Sendai Framework for Disaster Risk Reduction (SFDRR) (UN, 2015) recognize the importance of cultural heritage and its irreplaceable value for society. Therefore, such initiatives clearly highlight the need to assess the impact that potential hazards may have on the built cultural heritage. Developing adequate risk assessment and management processes are fundamental towards this end and it is known that systematically collected and robust disaster damage and loss data are essential for such processes. The development of systems, models and methodologies to collect and handle such data should, therefore, be a worldwide priority.

Existing disaster loss data recording initiatives such as the EM-DAT/CRED, SIGMA/SwissRe, NATCAT/MünichRe or DesInventar/UNISDR databases are undoubtedly important sources of information in terms of the damages and losses that occurred in worldwide disasters. Recording such data is known to be useful for the purpose of loss accounting, forensic analysis of disasters and disaster risk modelling (De Groeve *et al.*, 2014). For example, this data can provide an objective baseline for vulnerability/risk assessment as well as for mitigation priority setting and decision making. However, the data recorded by these databases does not include damages and losses to cultural heritage. Therefore, without this important component,

current loss estimation procedures are not able to provide a sound and comprehensive quantification of disaster impacts.

There is currently no systematic collection of data about the impacts of hazardous events on cultural heritage properties. Existing data on damages and losses to cultural heritage is scattered among various agencies (national and international) without any coherence and coordination. Furthermore, no standardized methods and tools have been developed for cultural heritage disaster data collection until now. Therefore, specific approaches and methods are required to address these issues. In this context, the proposed paper presents a database framework currently being developed by the International Committee on Risk Preparedness of the International Council on Monuments and Sites (ICORP/ICOMOS) for the worldwide collection of immovable cultural heritage disaster loss data. The concepts and technical aspects related to the data being collected and its structured organisation are discussed herein, as well as the type and format of the indicators being recorded. Challenges and obstacles regarding the possibility of collecting cultural heritage disaster loss data are also discussed. One of the features developed to address one of these challenges is an indicator to estimate economic losses that represents the loss in value of cultural heritage properties due to damage caused by hazardous events. Details of the development of this loss indicator are discussed along with its potential applications within this framework and, more generally, within the SFDRR.

2. Overview of the ICORP Disaster Database for cultural heritage

ICORP/ICOMOS has recently started to develop a database specifically devised for the collection of cultural heritage disaster loss data with the technical support of the Faculty of Engineering of the University of Porto, Portugal. The database aims to provide a standard for loss and damage recording in immovable cultural heritage supported by international institutions such as UNESCO, ICOMOS, ICCROM or ICOM, as well as other organizations dealing with cultural heritage. The main purpose of the ICORP Disaster Database is to record the occurrence of damages and losses in worldwide immovable cultural heritage properties caused by natural or man-made hazardous events. The main objective of this initiative is to develop an efficient tool that will provide institutions managing and protecting cultural heritage with:

- a systematic and standardized recording of cultural heritage disaster-related data, from both natural and man-made hazards;
- a reliable accounting of cultural heritage losses;
- adequate data for the analysis of disaster trends and risk mitigation needs in cultural heritage.

One of the key issues of the database development was the definition of a simple system of categories for the type of cultural heritage properties that are considered by the database. Although several classifications and definitions of cultural heritage categories can be found in the literature, i.e. see (Blake, 2000; Vecco, 2010; Fernández-Freire et al., 2014; Prastakos and Gkadolou, 2015), none of these approaches was seen to be entirely satisfactory in order to accommodate different types of immovable cultural heritage assets in a simple, general and structured way. Therefore, the following system of Heritage Categories was developed which establishes the importance of a certain immovable cultural heritage item:

- UNESCO World Heritage Sites
- Properties Protected by the Hague Convention
- Listed National Heritage
- IUCN Protected Areas
- Properties of Local Significance

Given that some of these categories may overlap (e.g. a UNESCO World Heritage Sites can also be a Listed National Heritage), more than one Heritage Category can be assigned to a certain cultural heritage property. For each of these categories, an additional descriptor is also assigned to describe the type of cultural heritage item. This descriptor establishes that a given cultural heritage item belongs to one of the following Unit Identification types:

- **Single unit property**: an individual monument or a natural landscape
- **Multiple unit property**: a group of monuments, an historic landscape, an historic town, an urban block of cultural significance

It is noted that within this classification for immovable cultural heritage, a museum building together with its collections is treated as a single unit property.

The hazardous events recorded by the database range from small-scale events that only affect a single cultural heritage property to large and widespread ones that affect a larger number of heritage assets. The database records basic identification and information about the main hazardous event (and secondary events that may have been triggered by the main event) such as the hazard type/subtype, the GLIDE number, geographical information (country, continent, location, latitude and longitude) and temporal information (start/end date, local time), (Figure 1). For each event, the database records information about the cultural heritage properties affected by the event. This includes basic descriptions about the cultural heritage properties before they have been damaged along with a description of the damages and losses they suffered. The damage description can be illustrated using additional media such as photos, videos or reports that can be uploaded into the database. Each cultural heritage property affected by an event is then associated to a Heritage Category and an Identification Type (according to the previously referred classifications), to one or more Property Classes (e.g. religious facility, archaeological site, residential facility, landmark, nature reserve, park, marine zone, rock formation, etc.), to a Value (qualitative) and to one or more Construction Materials (only for built properties). The definition of the (qualitative) Value that is assigned to the cultural heritage property is addressed in a later Section. In terms of disaster data, the database records the (qualitative) damage level of each cultural heritage property, a loss of functionality/downtime indicator, available information on economic losses and data regarding emergency procedures that may have been activated following the disaster.

Figure 1 – Main screen of the ICORP Disaster Database where the main hazardous event is identified.

The development of the ICORP Disaster Database is particularly important given the possibility of using the data it collects in different steps of the cultural heritage risk management cycle (Figure 2). Performing a detailed risk assessment of cultural heritage properties is often a difficult task, given the complexity and the multidimensional value of cultural heritage. In these situations, using additional damage and loss data from past events recorded by disaster databases can be particularly helpful. Furthermore, the data collected by disaster databases is also relevant for the analysis and decision-making step, as well as for the risk mitigation and treatment step. Information on past experiences can provide valuable guidance for the definition of the approaches that are best suited to protect a certain cultural heritage asset or to create awareness regarding the need to develop new risk mitigation measures.

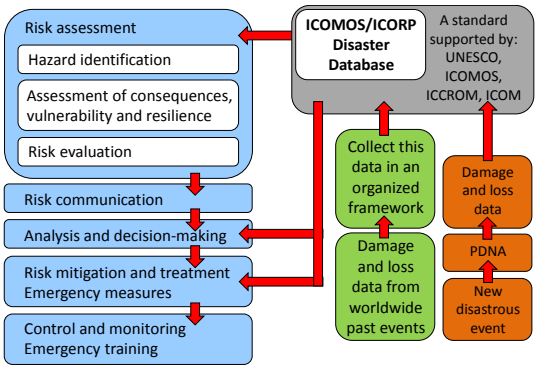

Figure 2 – The ICORP Disaster Database within the risk management cycle for cultural heritage

3. Loss assessment challenges and cultural heritage

The most widely used measures of disaster impacts are (a) direct losses, meaning the hazard's immediate, physical damage to property, infrastructure, agriculture and human life and (b) insured losses. Direct as well as insured losses are largely reduced to monetary damage, fatalities and injuries. At present, the use of direct losses dominates all other loss measures due to the tangible nature of physical damage.

One of the challenges currently faced by the disaster risk management sector is to broaden loss assessments to include other types of losses. For example, the inclusion of indirect costs as well as non-monetized losses into loss estimation is of paramount importance for a sound understanding and quantification of the full impacts of disasters. This relates particularly to the damage of non-monetized resources such as cultural heritage assets and the relationship between them and society (e.g. the economic losses of some sectors such as tourism as a result of damaged cultural heritage). Although disasters adversely affect the cultural sector, those effects are usually not captured in loss estimates and subsequently in loss and damage databases. The lack of this information produces incomplete and skewed risk assessments that are biased toward direct economic and human losses and severely underestimates the effects of hazards.

Therefore, there is a significant potential to advance loss estimation techniques and probabilistic forecasts by including impacts on cultural heritage and by attempting to value (monetize) those impacts. As long as cultural heritage resources are not valued, shocks to these elements will not be reflected in risk assessments and disaster risk management. If valuation cannot be achieved in the near future, an alternative solution could be the establishment of new qualitative, rather than quantitative, loss categories that capture non-monetized losses. Still, the necessary starting point is the efficient recording and identification of those damages and losses. Therefore, the lack of indirect and non-monetized loss data, especially regarding cultural losses, is a major shortcoming of existing loss and damage databases.

Based on this discussion, the following Section outlines a methodology defining an indicator that provides an estimate of economic losses representing the loss in value of cultural heritage properties due to damage caused by hazardous events.

4. An indicator for the economic loss in value of damaged cultural heritage properties

The topic of economic valuation of cultural heritage has been the subject of several studies over the past years and several methodologies have been developed to elicit monetary expressions of cultural values. The most commonly found methodologies are Cost Based Methods (the Replacement Cost Method, the Restoration Cost Method, the Substitute Cost Method or the Preventive Expenditure Method), Revealed Preference Methods (the Hedonic Pricing Method, the Market Price Method or Travel Cost Method), Stated Preference Methods (the Contingent Valuation Method or Multi-Attribute Valuation Methods) and Impact Studies, e.g. see (Herath and Kennedy, 2004; Vecvagars, 2006; Choi et al., 2010; Carson, 2011; Holden and Baltà, 2013) among others. Since most of these methods were developed for other areas, they exhibit strengths and weaknesses when applied to cultural heritage assets. Most of these approaches require

significant amounts of data and many of them also require surveys to be carried out among the population. Furthermore, results obtained from these methods are sensitive to the valuation method that is used and are always specific to a certain cultural heritage asset with little chance of being extrapolated to other (even similar) properties. Therefore, there is currently no single and entirely reliable approach to estimate the economic value of cultural heritage properties. It should also be referred that most of these methods were not developed to estimate the loss in value of damaged cultural heritage properties. The quantification of the loss in value introduces an additional level of subjectivity due to the difficulty in estimating losses across the multiple types of values that are embodied in a cultural heritage property as a result of a certain amount of physical damage in the property.

The proposed methodology builds on the valuation method based on Impact Studies and establishes an indicator that estimates the loss in value of cultural heritage properties as a function of the (physical) damage they suffered and of the positive estimated economic impact that cultural heritage has in a given country. It is noted that this indicator is not meant to reflect the true value of economic losses. Instead, it reflects a standardized measure of potential economic losses that is comparable across countries.

To be able to define the proposed loss in value indicator, the baseline pre-disaster value of each cultural heritage property in a given country must first be established. Given the referred difficulties in valuing cultural heritage, this baseline value BV is defined using qualitative descriptors. As such, to establish the BV of a certain cultural heritage property, the following four types of value are considered, based on (EH, 2008):

- **Evidential value**: Derives from the potential of a place to yield evidence about past human activity (physical remains, written records, archaeological deposits, etc.).
- **Historical value**: Derives from the ways in which past people, events and aspects of life can be connected through a place to the present (divided into (a) illustrative value: the extent to which it illustrates something unique or rare; (b) associative value: the extent to which it is associated with a notable family, person, event or movement).
- **Aesthetic value**: Derives from the ways in which people draw sensory and intellectual stimulation from a place (either as a result of conscious design or the seemingly fortuitous outcome of the way in which a place has evolved and has been used over time).
- **Communal value**: Derives from the meanings of a place for the people who relate to it, or for whom it figures in their collective experience or memory (these can include (a) commemorative and symbolic values: the meanings of a place for those who draw part of their identity from it, or have emotional links to it; (b) social value: places that people perceive as a source of identity, distinctiveness, social interaction and coherence; and (c) spiritual value: emanate from the beliefs and teachings of an organised religion, or reflect past or present-day perceptions of the spirit of place).

It is noted that the unique and rare character of a certain cultural heritage property can be associated with any of the referred types of value. Each type of value then needs to be graded according to the following qualitative ranks V which are based on the National Trust of Australia “Conservation Plan” (Kerr, 2004):

- **Exceptional value**: Features of exceptional/international significance or which contain elements with a significance beyond national boundaries (a score of 20 is assigned to this rank).
- **Considerable value**: Features of considerable/national significance, possibly reflected in statutory designations such listed buildings or equivalent nationally graded sites (a score of 15 is assigned to this rank).
- **Some value**: Features of some significance, important at regional level either individually or for group value (a score of 10 is assigned to this rank).
- **Limited value**: Features of limited/local significance (a score of 5 is assigned to this rank).
- **Unknown value**: Features of unknown significance resulting from a lack of sufficient information on which to base sound analysis of its value (a score of 1 is assigned to this rank).
- **No value**: Features of no significance to the study area (a score of 0 is assigned to this rank).

Therefore, for each cultural heritage property, a matrix similar to the one presented in Figure 3 is then established to define the value of the property.

	Exceptional value (20)	Considerable value (15)	Some value (10)	Limited value (5)	Unknown value (1)	No value (0)
Evidential value		x				
Historical value	x					
Aesthetic value			x			
Communal value		x				

Figure 3 – Example of a matrix with the ranked values of a given cultural heritage property.

The baseline pre-disaster value of a certain cultural heritage property will then correspond to the sum of the scores established for each type of value given by:

$$BV = \sum_{i=1}^{4} V_i \tag{1}$$

After this first step, the next step of the methodology involves defining the cultural heritage capital at the country level. This cultural heritage capital, termed CHC, is defined by:

$$CHC = \sum_{i=1}^{NCHP} BV_i \tag{2}$$

where NCHP corresponds to the number of cultural heritage properties a certain country considers relevant for its CHC. The value of CHC is thus the total pre-disaster qualitative value of the cultural heritage properties in a certain country and needs to be established in a pre-disaster stage. The next step of the methodology involves post-disaster data defined in terms of qualitative damage levels collected for each cultural heritage property affected by the disaster. Based on the damaged state of the cultural heritage property, a qualitative loss or damage level must be assigned to each type of value according to the following four classes of loss/damage D:

- **Undamaged or unaffected** (a score of 0 is assigned to this class).
- **Damaged or partially lost**, but it can be repaired/restored to its initial state (a score of 0.3 is assigned to this class).
- **Damaged or partially lost**, but it can't be repaired/restored to its initial state (a score of 0.7 is assigned to this class).
- **Destroyed or lost** (a score of 1 is assigned to this class).

For each damaged cultural heritage property, a matrix similar to the one presented in Figure 4 is then established to define the damage scores for each type of value of the property.

	Undamaged or unaffected (0)	Damaged or partially lost, but it can be repaired/restored to its initial state (0.3)	Damaged or partially lost, but it can't be repaired/restored to its initial state (0.7)	Destroyed or lost (1)
Evidential value		x		
Historical value	x			
Aesthetic value			x	
Communal value	x			

Figure 4 – Example of a matrix of damage scores for each type of value of a given damaged cultural heritage property.

A qualitative post-disaster loss in value indicator LV for a certain damaged cultural heritage property can then be defined as the sum of the damage scores established for each type of value given by:

$$LV = \sum_{i=1}^{4} V_i \times D_i \tag{3}$$

By analysing the value of LV for all the cultural heritage properties in the country damaged by the disaster, the total relative post-disaster loss in value of damaged cultural heritage properties in the country TRLV can be obtained. This parameter is the sum of the LVs obtained for each cultural heritage property divided by the country's CHC:

$$TRLV = \frac{\sum_{i=1}^{NDCHP} LV_i}{CHC} \tag{4}$$

where NDCHP corresponds to the number of cultural heritage properties in the country damaged by the disaster. All the NDCHP properties must be part of the group of NCHP properties previously defined. Finally, the indicator representing a standardized equivalent economic loss for the damaged cultural heritage properties, I_{LV}, can be defined by:

$$I_{LV} = \frac{TRLV \times GVA + RR}{GDP} \tag{5}$$

where GVA is the country's gross value added associated to the cultural heritage sector resulting from all types of cultural heritage related activities, RR are post-disaster cultural heritage repair and recovery costs, and GDP is the country's gross domestic product. For a given year where a disaster occurs in a country, the considered GVA will have to be that of the previous year or an estimate of that year's GVA based on available trends.

The underlying reasoning for the quantification of I_{LV} according to this methodology is the assumption that the CHC of a given country is able to create a certain amount of revenue in the pre-disaster condition which can be reflected by the country's GVA associated to the cultural heritage sector. The GVA is also assumed to be able to capture a wide spectrum of the economic influence of cultural heritage, namely the influence of both use and non-use values of cultural heritage. Furthermore, if a disaster occurs, the methodology assumes, in a simplified manner, there will be an average loss in the country's GVA that is proportional to the global loss in value of the cultural heritage properties damaged by the disaster. Nevertheless, the proposed methodology might not be able to account for the case where cultural heritage tourism is not overly affected by the damages suffered by cultural heritage (i.e. in the short term, if the safety of people is not an issue, people might still want to see the same cultural heritage properties even though they were damaged).

Finally, it is noted that in order to be able to apply the proposed methodology in a given country, a national inventory of the existing cultural heritage must be available, otherwise the value of CHC will be difficult to define. In such cases, an economic valuation of the losses associated to the cultural heritage sector would need to be based on indirect indicators. A possible approach could be one based on the assumption that a certain percentage of a country's GVA is a result cultural heritage tourism and that part of that percentage is lost, based on the amount of cultural heritage that is damaged.

5. Final remarks

International frameworks and programs for DRR are clear in their objectives of reducing hazard exposure and vulnerability to disasters. Furthermore, the importance of cultural heritage and its irreplaceable value for society is also clearly acknowledged in these objectives. However, how can disaster loss reduction be measured in cultural heritage if there is no reliable loss data on the impacts that disasters have on this sector? Currently, it is clear that existing disaster loss accounting systems underestimate the true cost of disasters as a result of several factors. One of the factors is the inability to account for the disaster impacts on cultural heritage.

Disaster loss databases are important tools to analyse patterns and trends of disaster losses and disaster risk based on past events. By understanding these patterns and trends, future losses can be mitigated by the implementation of efficient targeted measures. Furthermore, disaster loss data can also be used to determine if disaster risk management is actually being efficient in reducing risks as a result of DRR policies and investments. The development of a database specifically devised for the collection of cultural heritage disaster loss data such as the ICORP Disaster Database is therefore fundamental and will provide important data for the development and preparation of better heritage-focused disaster mitigation strategies for the future.

One of the key challenges in cultural heritage disaster loss recording is the quantification of economic losses associated to the damage suffered by cultural heritage properties and to other correlated consequences. Although the economic valuation of cultural heritage has been the subject of several studies over the years, no specific approach is believed to be simple and general enough to be applicable in the context of disaster loss assessment. To address this issue the proposed paper outlined a methodology defining an indicator that provides an estimate of economic losses representing the loss in value of cultural heritage properties due to disaster damage. The proposed indicator is not meant to reflect the true value of economic losses. Instead, it reflects a standardized measure of potential economic losses that is comparable across countries.

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