Risk Assessment of Cultural Heritage : Tools & Methodology

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Why Risk Assessment for Cultural Heritage Properties?

Cultural heritage properties are exposed to risks from various natural and man-made hazards. These may be momentary such as earthquakes and cyclones, which can cause catastrophic disasters or may be slow and progressive such as weathering and erosion creating irreplaceable damage to the property in the long run.

The conservation practice until now has been predominantly reactive and remedial, and therefore focussed on interventions that aim at correcting or arresting the damage that has already been inflicted upon the heritage property. However, the emerging paradigm for conservation is preventive and therefore proactive in nature, which includes measures that aim to prevent damage or reduce the risk of damage occurring to the property. Appropriate policy, planning and legislation are strategic tools and day to day maintenance and monitoring are practical tools for preventive conservation of cultural heritage property.

The first step for preventive conservation is risk assessment, which in the context of cultural heritage properties may be defined as an informed judgement about risks, either a specific risk or all risks in the property. In a comprehensive risk assessment, it is the evaluation of the magnitude of all the risks in combination, which affect the property as a whole and its various parts.

Also risk assessment is an important part of cultural heritage impact assessment for large scale development projects in and around the site. This is especially crucial for developing countries, where tremendous development pressure, especially in inhabited areas is posing grave risks to cultural heritage properties. In such situations, risk assessment process helps in developing policies and plans for guiding change by addressing present reality and future needs in such a way that impact on heritage values and their attributes is minimised.

It follows from the above discussion that risk Assessment is an important tool not only for decision makers but also for managers who have direct stakes in the heritage property for its conservation, maintenance and management.

Identifying the "Elements at Risk"

Cultural heritage properties may include monuments, various types of historic buildings and structures; individual or in groups, historic urban areas, archaeological sites and cultural landscapes. Moreover these sites might exist in a living environment as mute testimony to the past, although in an entirely different socio-economic context. The challenge for their protection and management is especially seen in those communities, which are very dynamic and witnessing rapid social and economic transformation processes by choice or compulsion.

From developmental perspective, the most critical risks to heritage properties would be to people, property and livelihoods. However from conservation perspective, risk assessment of these properties would mean consideration for three important heritage elements, which may be at risk in themselves and for their interrelationships, namely local communities (the bearers of heritage), ecology (human-environment relationships that have evolved over time e.g. traditional water systems) and standing as well as buried historic / traditional structures as well as movable objects/collections (physical manifestations of heritage). Therefore cultural heritage at risk would imply risks to one or all of these elements, which threaten the heritage values as well as their qualifiers, namely authenticity, integrity and sustainability of the property (Jigyasu 2005).

For archaeological complexes, these elements would essentially comprise of buried and semi-buried archaeological property, architectural fragments on the ground, historic structures, natural features, landscape pattern, staff, visitors, including pilgrims and tourists, and the environmental setting for the heritage property.

Risk Identification

Risk is a function of hazard and vulnerability. Therefore risk identification is about systematic use of available information from various primary and secondary sources to study risk by identifying hazards and vulnerability factors. The primary sources would include information collected through site observations and interviews with various stakeholders, while secondary sources would include study of existing literature, documents and maps. The identification process would involve the following tasks:-

- Evaluation of existing management systems for the heritage property through study of legislation, policies, planning documents and other tools (such as statement of significance or recognised values of the property), boundaries of the property and its buffer (if any), implementation mechanism and their effectiveness on ground.

- Identification of existing and potential stakeholders and partners, their existing roles and responsibilities, coordination system and conflicts (if any).

- Condition assessment to analyse of potential impact on the heritage property and its components in the future.

- Study of the history of disasters and past conservation and other interventions in the property or in surroundings.

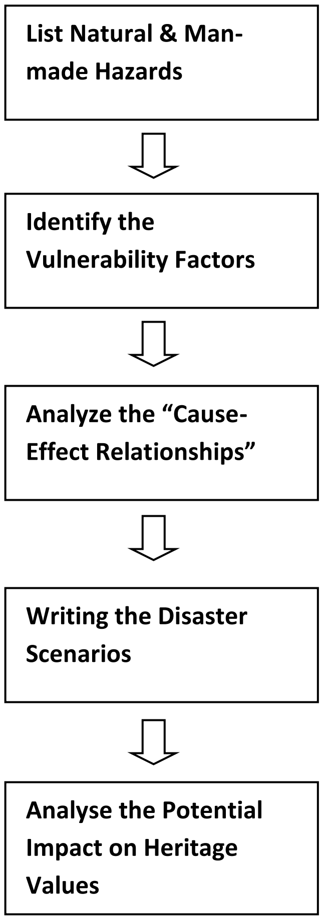

Fig.1 – Risk Assessment Process

- Other information sources of the region in which the property is located, for example geological and geographical aspects, topography, linkages, hazard and vulnerability maps etc.

Analysing Risks

Risk analysis is the scientific and technical study of risks, leading to a full description and model of the processes causing the risks to cultural heritage properties. Based on the information sets collected from various sources, hazards and vulnerability factors can be analysed as follows:-

- Analysing the external sources and agents of risks; hazards. The objective of hazard analysis is to determine whether the available scientific database describes a causal relationship between the environmental agent and potential injury to humans or the environment or heritage values of the property.

- Analysing vulnerability factors that expose various elements of the property to risk from hazards. Vulnerability may be external due to location of the property near the hazard source or it may be internal due to inherent weakness of the property or its components such as poor construction or changes over time, or inherent deterioration processes due to the nature of material or past interventions.

  Conventionally, vulnerability is understood as a 'product'; defined as the exposure of cultural heritage to potential disaster situations at a particular point of time. This well-accepted definition has led to the development of several scientific tools for risk assessment. However vulnerability is not only a 'product' but a 'process' as well, resulting from various factors, which contribute towards its change over time.

  Therefore we need to assess whether vulnerability of the cultural property has increased, decreased or reinforced over time, especially with respect to disaster situations. This will also enable us to test the effectiveness of risk management mechanisms that are put to test in specific disaster situations and thus will serve as monitoring system for policies and programs that are already in place.

  This also implies that we understand the inherent link of physical vulnerability of both movable and immovable components of heritage property to that resulting from social, economic, attitudinal and 'development'[i] processes. For example, in case of risks to museum collections, the vulnerability of the collections are inherently linked to the building in which

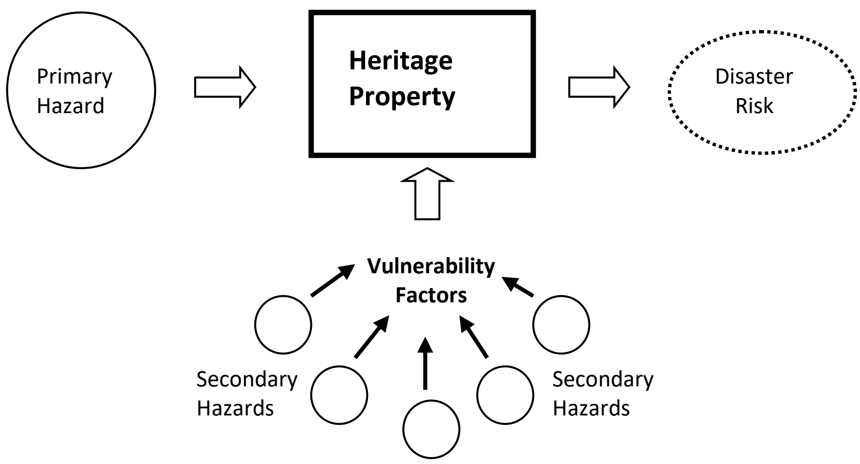

Fig. 2 Relationship between Hazard, Vulnerability and Disasters

they are housed and also the context in which the museum is located. All these factors need to be taken into account for effective risk management of heritage properties.

- Moreover, various components within the heritage property will be vulnerable to various hazards to various degrees depending on the nature of hazards, their intensity and concentration, pathways from hazard source to specific components and systems of the property, whose condition will also determine their susceptibility to these hazards.

- These multiple and lateral linkages between hazards and vulnerability factors can be analysed for their impact on each other through 'cause-effect analysis'.

Building Risk Scenarios

The next step in risk assessment process is to comprehend the complexity of risk situation by developing the scenarios, which are the predictions of the situations after a specified time period based on the current status and the proposed activities/projects gathered through risk identification process. Construction of alternative scenarios helps in the perceiving different possibilities and their potential impacts on various cultural resource components. Scenarios are explained as narratives; as progressive sequence of events affecting each other, thereby unfolding a particular situation. The scenarios can be of various types

- Scenarios caused by one extreme hazard (primary hazard) e.g. earthquake
- Scenarios with follow up hazards (primary and secondary like earthquake followed by fire or landslide)
- Scenarios with two or more hazards acting simultaneously creating cumulative effects for example cyclone accompanied by heavy rainfall and storm surge.

Scenarios are essentially constructed on assumptions and associated uncertainties, which are based on the evaluation of existing situation through risk identification. These are developed for a specified time period and subsequently assessed for their potential impact on the property.

Evaluating the Magnitude of Risks

Evaluation of the magnitude of the risk is the process used to determine risk management priorities by comparing level of a risk scenario against predetermined standards, threshold risk levels or other criteria. (ERM Applications Guide, 2000) This is also called relative risk analysis, which means that risk is evaluated in comparison to another risk.

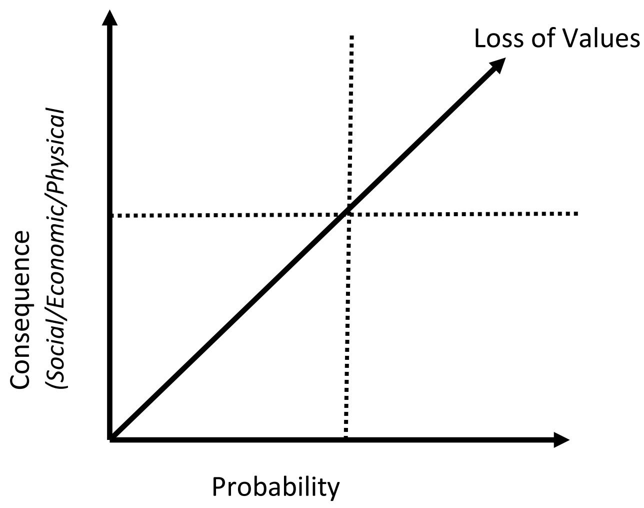

Fig. 3 Assessing the Level of Risk

The main Indicators for evaluating the magnitude of risk are:-

1. Probability of hazards i.e. chance that given event will occur at the site. The probability might be ;
   - Constant e.g. weathering or erosion or insect attack
   - Sporadic like rainfall
   - Rare like earthquake.

   Probability is often expressed in ratios or percentage, for example if probability of fire in the case of a small museum is 0.001 or 0.1% or 1/1000, it would mean that the probability of museum being burnt down in the next 100 years, given its current state of fire prevention and control, may be one in 1000. It means that in a region of the world with 10000 such small museums, with similar conditions, one can expect 10 museums to burn down every 100 years. This is not a guaranteed number but it is the most probable. And no individual museum can predict if they will be the “lucky” or “unlucky” museum. (Michalskey 2004)

2. Severity of consequence on the heritage property and its components, including people, buildings /structures and livelihoods (in physical, social and economic terms). Consequence is the direct effect of an event, incident or accident. It is expressed as a health effect (e.g. death, injury, exposure), property loss in economic terms or number of structures damaged, environmental effect. Consequence might be catastrophic or sphere or mild or gradual and these can be numerically expressed in relative terms within the range of 0 to 1, where 0 stands for no consequence and 1 for catastrophic impact.

3. Likelihood or rate of loss of values and their qualifiers i.e. integrity, authenticity and sustainability. There are two difficult components to this: defining a value which is of concern, and then estimating how much of that value is lost due to a chan/ge in state of the property and its components (such as changes caused by deterioration). In some models, it is the absolute loss of value of the site or its component, within whatever parameter is used for value, such as resale cost. In models, which avoid judgement of absolute value, it is only fractional loss of value.

   Fractional loss of value is the explicit phrase for loss of value if one is expressing it only in fractional terms, such as 1/2 , 50%, 0.5, where 1 is the total value. Usually stated simply as loss of value (Waller 2003, Michalskey 2004)

   However, it is not just a matter of talking about losses in value, but shifts within a spectrum of different values. By looking at how heritage has changed when certain values are at risk from change, one can see these shifts. Identifying critical points for these shifts can help us acknowledge the long term impact of heritage conservation, both positive and negative. The process goes beyond stating whether or not deterioration or conservation affects value but what values they affect, and to what extent (Joel 2008) and whether at the cost of other associated values.

The level of risk to the cultural heritage property for a particular scenario is assessed vis-à-vis the probability, severity of consequence and degree of potential loss of value. For example an earthquake affecting a dense historic urban fabric will represent a scenario with low probability, high consequence on buildings and livelihoods and high loss of value, while same intensity of earthquake affecting an open farm land without any habitation and heritage property/component may represent scenario of low probability low consequence and no loss of value. Minor seepage of water from the roof in a nationally important historic building due to improper slope may represent high probability low consequence scenario with high loss of value, while continuous leakage of rain water through cracks in the roof of vernacular houses in an area with high frequency of rainfall may represent high probability high consequence scenario with no so high loss of value.

Conditions of Uncertainty and Variability

Patton (1993) questions the relevance of numbers in risk assessment. According to him the important point to remember is that the numbers by themselves don't tell the whole story. A numerical estimate is only as good as the data it is based on. Just as important as the quantitative aspect of risk evaluation, then, are the qualitative aspects. How extensive is the data base supporting the risk assessment? Does it include human epidemiological data as well as experimental data? Does the laboratory data base include test data on more than one sample? If multiple samples were tested, did they all respond similarly to the test substance? What are the "data gaps", the missing pieces of the puzzle? What are the scientific uncertainties? What science policy decisions were made to address these uncertainties? What working assumptions underlie the risk assessment? What is the overall confidence level in the risk assessment? All these qualitative considerations are essential to deciding what reliance to place on a number and to characterizing a potential risk. Therefore it is important that uncertainties and associated assumptions in cultural heritage risk assessment process are made explicit.

Likewise variability is an often overlooked but important feature of the risk assessment process. The need to use data from many different disciplines, characterized by data gaps and uncertainties, is one source of variability. Assumptions and policy choices spanning a spectrum of scientific theses about the nature of incompletely understood natural processes are another. These diverse elements can lead to diverse results, an outcome that leads to misunderstanding and seeds many risk assessment controversies (ibid.)

Controversy might be less strident if practitioners and observers recognized that varying interpretations of the scientific information may lead to a range of science-based descriptions of risk for any particular situation. In addition, depending on data selected, scientific assumptions, policy calls and perspectives, different experts or organizations may describe risk differently. For example, a single data set, applied to different populations with different assumptions, may result in different numerical risk estimates for a single hazard such as chemical. However if the risk characterisation identifies data and science policy choices, apparently inexplicable inconsistencies may be recognized as responsible, reasonable descriptions of different aspects of the same problem. The risk characterization process can also aid identification of less responsible, less reasonable descriptions of the problem.

Rarely is there a single "answer" to risk assessment. The risk assessment process has an enormous capacity to expand and contract in line with the available data, science policies and problems. When risk management information, options, and decisions are examined along with the risk assessment, opportunities for variability, misunderstanding, and controversy are even greater. The task is to look behind the process always keeping in mind the multiple sources of information, the several kinds of scientific analyses, and related uncertainties and science policy choices that shape each assessment.

Prioritising Risk Mitigation Options

After all the risks to the heritage site have been identified and their magnitude assessed/quantified, risk mitigation strategies can be explored. According to Waller (1995), three basic means for mitigating a risk are:-

1. Eliminate the source of the risk. For example problem of dampness around a historic structure may be caused by poor drainage. This can be mitigated by installing gutters along eaves and installing drain pipes running to dry wells at a distance and grading the ground level away from the building.

2. Establish a barrier for example, applying waterproof coatings to the foundation may adequately reduce the relative humidity and eliminate the risk. This might be the best possible option than eliminating the source itself.

3. Act on the agent responsible for the risk or on the impacted component of the site is usually done when other means of control have failed to reduce the risk sufficiently. For example, plantation of special species of trees can mitigate the impact of strong winds and appropriate retrofitting techniques might be applied to the vulnerable structure to make it resistant to earthquakes.

Often all the three means can be used to reduce a risk, but one may prove to be most effective. These means may be carried out at various levels ranging from legislation and policy, planning Strategy, structural and material techniques at building level as well as individual object level.

For prioritising the risk mitigation interventions, various considerations include the availability of human and economic resources, immediate priorities of the area in which the site is located and most significant values perceived by the local community and other stakeholders, besides of course the assessment of magnitude of risk undertaken through risk assessment process.

An acceptable level of risk for regulations or exemptions is established by consideration of risk, cost/benefit and public comments. According to Waller (1993), an assessment of the cost and benefits associated with each strategy should be guided by the following considerations:-

- Effect of a proposed strategy on each and all agents of deterioration (or hazards). This is important because in most cases, a strategy to reduce the risk from one agent of deterioration will influence the risk from another agent. For example, fire hydrants may reduce the risk of fire in a wooden historic building but may cause risks to the painted surface from water. On the other hand, changes in location and type of electrical installations may reduce the risk of fire in the first place and at the same time it does not pose any risk from water.

- Cost/Benefit associated with both implementation and maintenance stages. Most people have a tendency to carefully consider the costs associated with implementation or installation but not those associated with maintenance. Numerous examples can be cited where climate control systems in the museum failed to function according to specifications because there was inadequate support for required maintenance.

Conversely, most people have a tendency to think about the future benefits of a risk reduction strategy and neglect to consider, or underestimate, the risks to which the site may be exposed, while the strategy is being implemented. This is especially important when the strategy is expected to reduce risks for a relatively limited period. For example, increased risks involving physical forces, criminal acts, and pollutants (for example, dust) during a large scale excavation work of an archaeological site may exceed anticipated reduction in risk through appropriate land use planning as an archaeological park without an extensive excavation programme but with adequate interpretation strategies for the site as a whole.

- Effect of a proposed strategy on risks to one heritage component at the cost of reducing risks to another component or visitors/staff or environment. For example certain kind of chemical treatments for preventing termites might have harmful effects on humans.

Relative or comparative risk analysis is most often used where quantitative risk analysis is not practical or justified. Public participation is important in risk analysis process, not only for enhancing the public's understanding of the risks associated with hazardous materials transportation, but also for ensuring that the points of view of all major segments of the population at risk are included in the analysis process.

An action plan needs to be formulated outlining the necessary equipment and staff for carrying out these interventions, agencies responsible for their implementation and the required time line for execution. At the same time, procedures and responsibilities for their maintenance and monitoring also need to be devised to ensure sustainability of interventions.

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