

TAKING
COOPERATION
FORWARD



*International Conference „ Cultural heritage challenges Climate change“
23 June 2020*



Ranking the vulnerability of cultural heritage in a changing environment

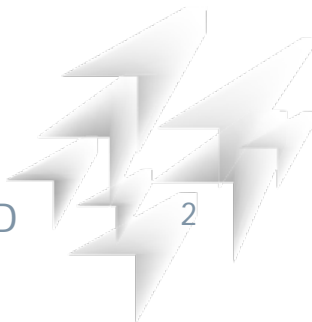


Ing. Riccardo Cacciotti/Institute of Theoretical and Applied Mechanics (ITAM AV ČR)

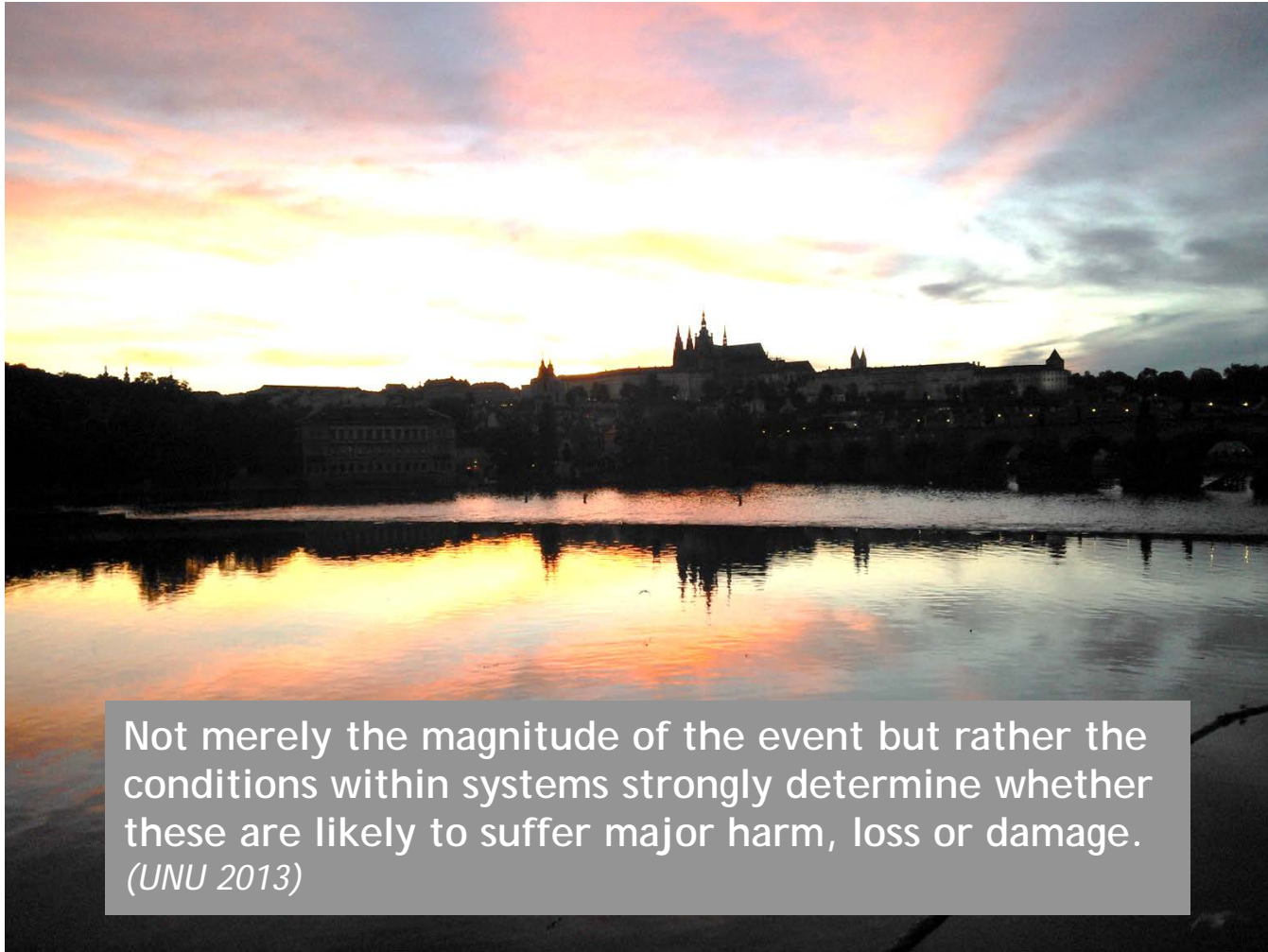
RISK



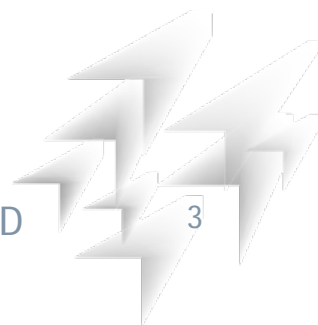
The possibility of something bad happening.
(Cambridge Advanced Learner's Dictionary)



RISK



Not merely the magnitude of the event but rather the conditions within systems strongly determine whether these are likely to suffer major harm, loss or damage.
(UNU 2013)



VULNERABILITY

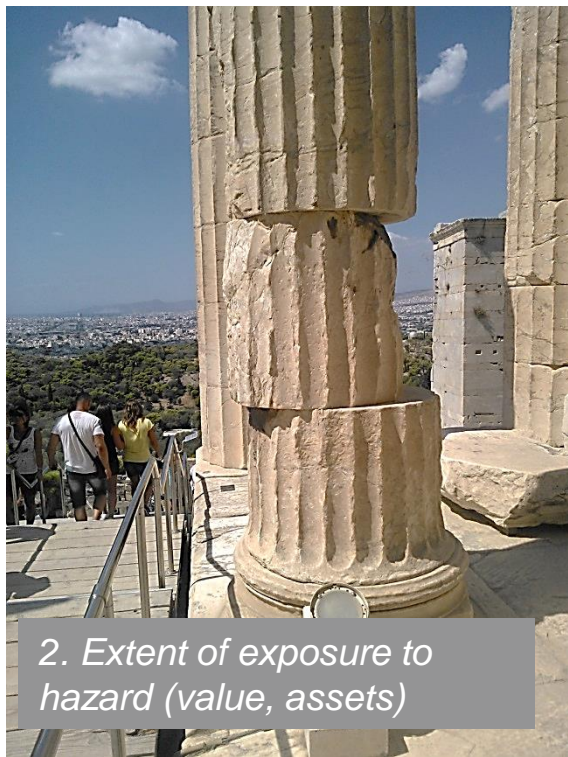
...the extent to which a system is susceptible to damaging action. *(in Green 2004)*



... the extent to which a (...) system is susceptible to sustaining damage from climate change. *(IPCC, 2001)*



$$V = \text{Susceptibility (1)} + (\text{Exposure (2)}) - \text{Resilience (3)}$$



Multiple definitions (context-specific):

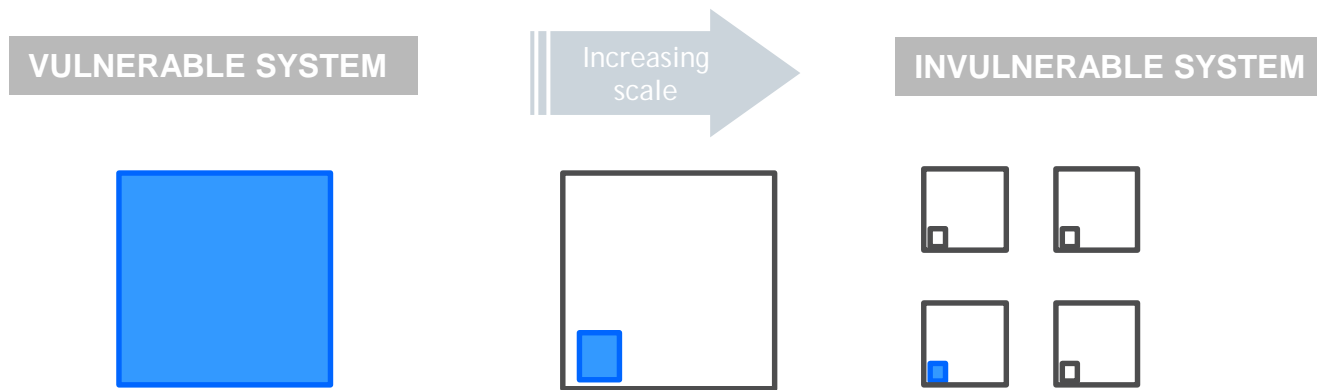
- Subject-object relationship: constructed rather than innate.
- Purposive system: definition as a function of specific purpose.
- Dependent upon the nature of the decision that must be made: primary intent is to reduce vulnerability (modifying subject, challenge and coping strategies).

Multiple dimensions:



Problem of scale

- Invulnerable systems may include vulnerable sub-systems.
- Basic unit definition needed- not universal.



Path and time dependency

- Path- depending on event history (e.g. flood after drought).
- Time- seasonal variations of vulnerability (e.g. flood with or without crop).



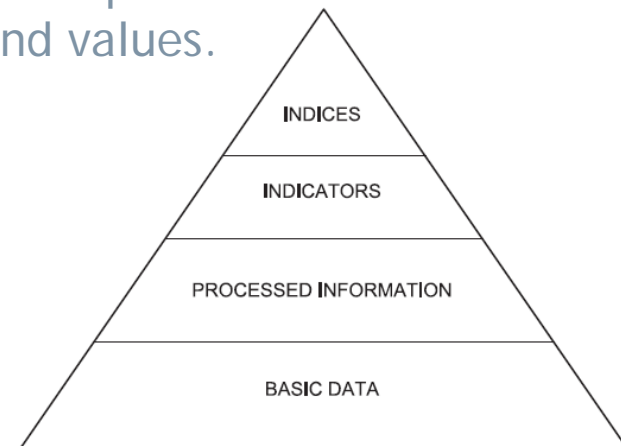
VULNERABILITY ASSESSMENT

Diversity of approaches due to (1) different disciplinary conceptualisations of vulnerability but also (2) a result of the different spatial resolution considered.

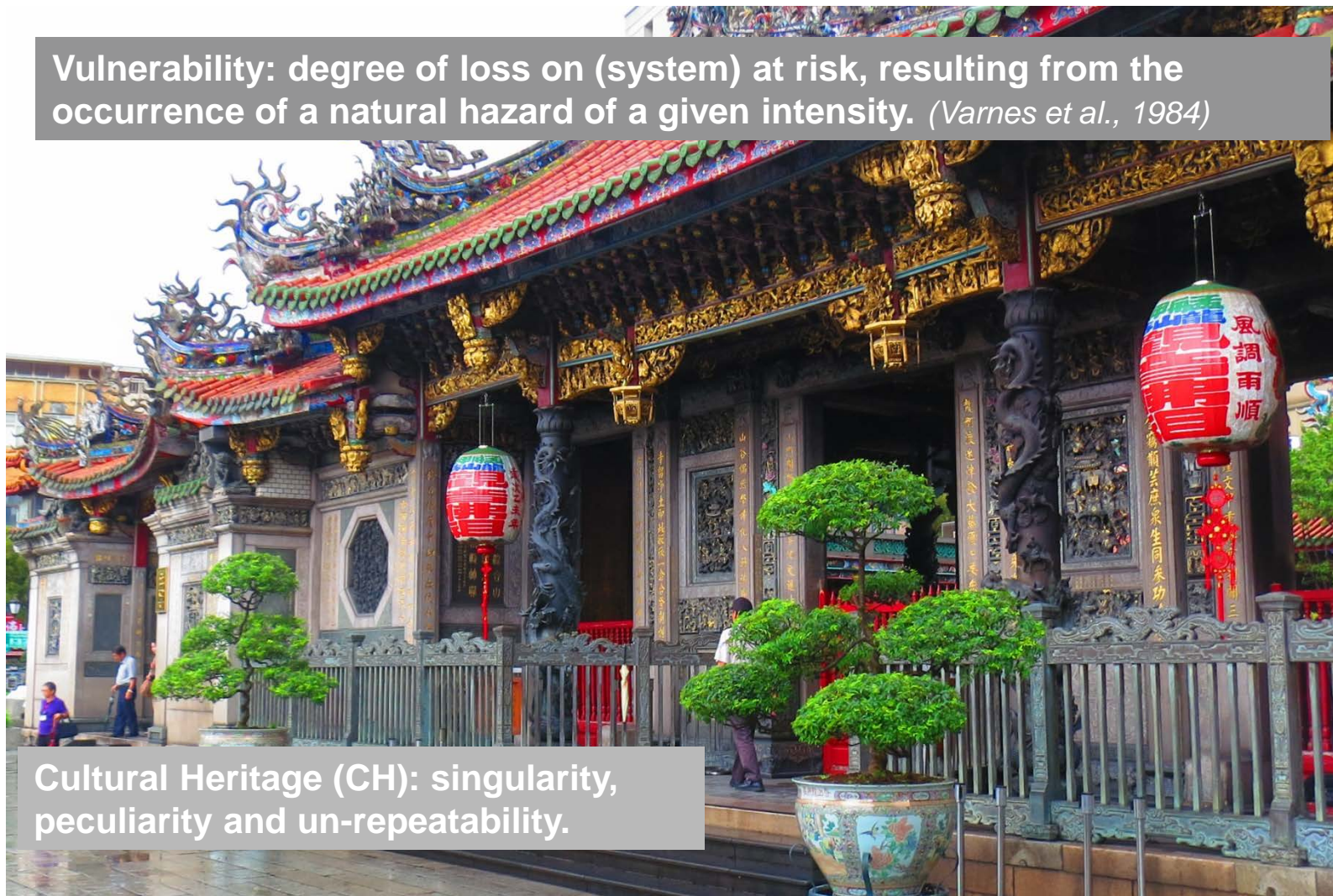


VULNERABILITY ASSESSMENT

- Reduction of potentially gatherable data to a set of indicators and criteria that facilitate an estimation of vulnerability.
- Difficult to reduce the concept to a single equation or to a universal set of indicators that could be applied at all levels and to all hazards.
- (Semi)quantitative vs qualitative assessment: quantitative indicators and qualitative criteria, different scales and values.



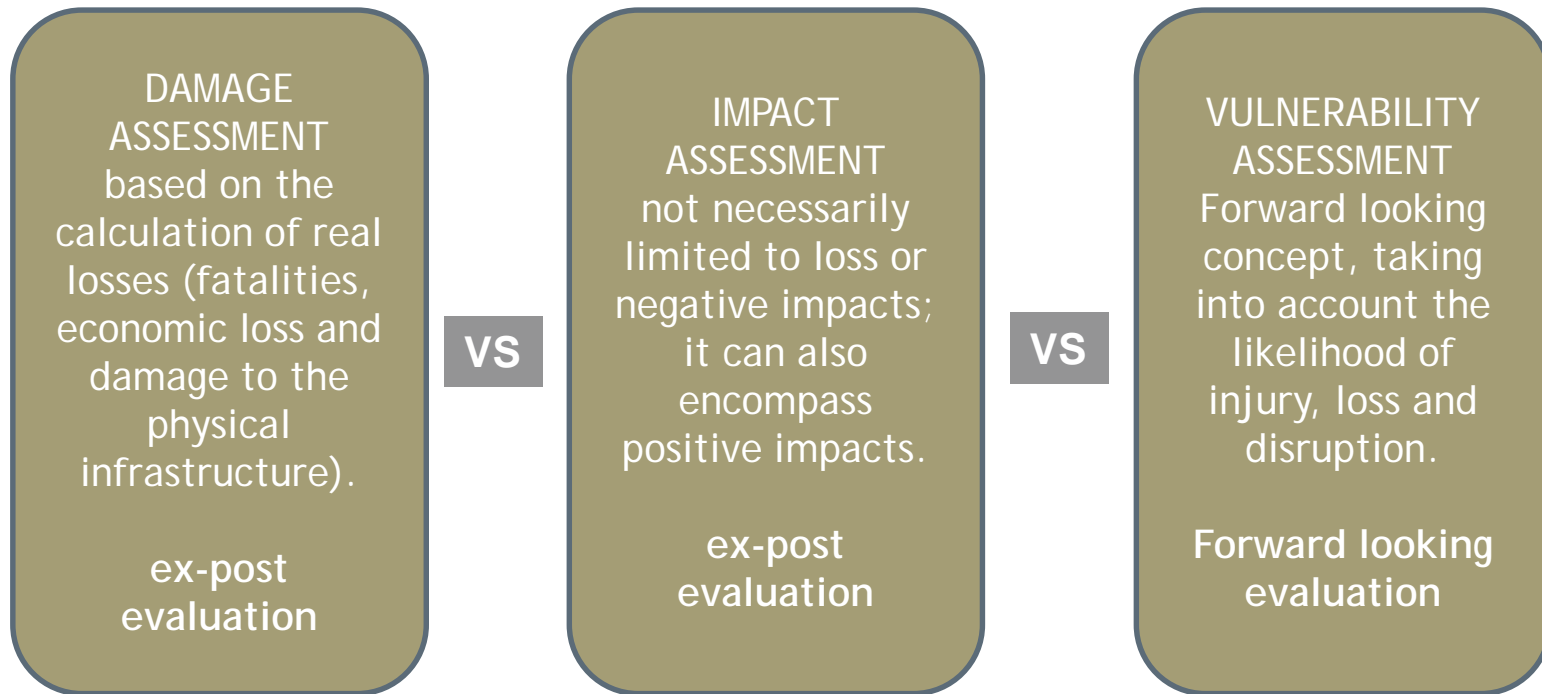
Vulnerability: degree of loss on (system) at risk, resulting from the occurrence of a natural hazard of a given intensity. (Varnes et al., 1984)



Cultural Heritage (CH): singularity, peculiarity and un-repeatability.



CULTURAL HERITAGE SYSTEMS AND CLIMATE CHANGE



CULTURAL HERITAGE SYSTEMS AND CLIMATE CHANGE

Rank	Type	Flood Vulnerability	Examples	Preventive measures and priorities
F0	Flood-resistant structures and buildings	No structural or material damage apparent during and after flood. Typical impacts: water saturation and high moisture of materials and structures, soiling, infection by microorganisms, unhinged doors and similar.	Robust objects made of water resistant materials (e.g. granite or similar stone, metals, good stone masonry, concrete).	No hard measures necessary - only some recommended preparedness facilitating cleaning and drying after the flood,
F1	Structures made of materials with a high volumetric change due to moisture	Damage associated with volumetric change - usually irreversible - change of shape, cracks, and deflections. Spalling layers. Moisture expansion may damage of masonry - origination or even shifting structural parts wooden floors. No dangerous loss strength and load carrying capacity reduction.	i) timber structures and elements, ii) combined structures made of	Prevention of contact with water - if possible (plastic wrapping, protective caps
F2	Structures made of materials that lose their strength to a great extent when subjected to moisture	Materials fast degrading and loss mechanical characteristics due to moisture or water saturation which induces significant reduction of carrying capacity of structural elements or subsoil and may cause fatal failures during flood or after it.	content), iii) decayed timber structures and elements, iv) infill subsoil and fine particle subsoil.	supports or permanent strengthening before flood situations.
F3	Structures susceptible to partial damage due to flooding	Damage is very sensitive to the condition of such objects. Partial loss of cultural heritage is a consequence of water action.	i) timber parts prone to uplifting and floating away, ii) parts of large bridges, namely parapet walls or piers, iii) pavements	Regular inspection and repair of found deficiencies. Provide temporary strengthening and additional supports; Take measures to decrease loads (dismantle bridge parapet walls, make openings to balance the water pressure); Improve the anchoring of sensitive structural parts into supporting structures; Remove floating objects and "dams" from the stream.
F4	Structures and elements vulnerable to overall collapse or displacement due to flooding	Sudden failure and overall collapse of elements due to the static and/or dynamic actions of water.	i) small bridges and walkways, ii) free-standing walls, iii) light, improperly anchored objects (summer houses, etc.), iv) small dams	

PURPOSIVE SYSTEM: damage/flood.
DIMENSION: physical.
GATHERABLE DATA: visual inspection, exp data.
INDICATOR: structural and material susceptibility.
EVALUATION: qualitative.



CULTURAL HERITAGE SYSTEMS AND CLIMATE CHANGE

INDICATOR CODE	INDICATOR MEANING	VALUE MEANING	VALUE
ID 1.1.1	STATE OF CONSERVATION	GOOD	0.00
		FAIR	0.18
		POOR	0.73
		VERY BAD	1.00
ID 1.1.2	EXISTENCE OF WATER DAMAGE	NO EXISTING WATER DAMAGE ON THE BUILDING	0.00
		PRESENCE OF WATER DAMAGE ON THE BUILDING	1.00
ID 1.2.1	GROUND FLOOR TYPOLOGY	PORTICO STRUCTURE	0.00
		CLOSED STRUCTURE WITH NO ACTIVITY	0.50
		CLOSED STRUCTURE WITH ACTIVITY	1.00
ID 1.2.2	EXISTENCE OF BASEMENT	NO BASEMENT NOR SEMI-BASEMENT	0.00
		EXISTENCE OF BASEMENT OR SEMI-BASEMENT	1.00
ID 1.3.1	OPENINGS GROUND FLOOR	NO OPENINGS	0.00
		SMALL OPENINGS	0.49
		LARGE OPENINGS	1.00
ID 1.3.2	ROOF TYPE	PITCHED	0.00
		FLAT	1.00
ID 1.3.3	FAÇADE MATERIAL	BRICK/NON POROUS STONE	0.00
		MORTAR	0.38
		STEEL	0.62
		CONCRETE	0.82
		POROUS STONE	1.00
ID 1.4.1	USE	CULTURAL CENTRES, PUBLIC EQUIPMENT WITHOUT PRIORITY USE	0.00
		COMMERCE	0.22
		RESIDENCE	0.69
		EMERGENCY AND SANITARY	1.00
ID 1.5.1	STRUCTURAL MATERIAL	STONE	0.00
		BRICK	0.33
		STEEL	0.60
		CONCRETE	0.82
		WOOD	1.00
ID 2.1.1	EXISTENCE OF ADAPTIVE SYSTEMS	EXISTENCE OF ADAPTIVE SYSTEMS	
		ABSENCE OF ADAPTIVE SYSTEMS	
ID 2.1.2	DRAINAGE SYSTEM CONDITION	GOOD	
		FAIR	
		POOR	
		VERY BAD	
ID 2.2.1	PREVIOUS INTERVENTIONS	PREVIOUS INTERVENTIONS	
		NO INTERVENTIONS MADE	
ID 2.2.2	NUM. OF DWELLINGS AND SOCIO-ECONOMIC STATUS	X DWELLINGS, Y AVERAGE STATUS	
ID 2.3.1	CULTURAL VALUE	GRADE I	
		GRADE II	
		GRADE III	0.61
		GRADE IV	0.27
		NONE	0.00

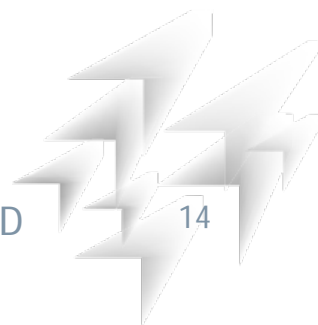
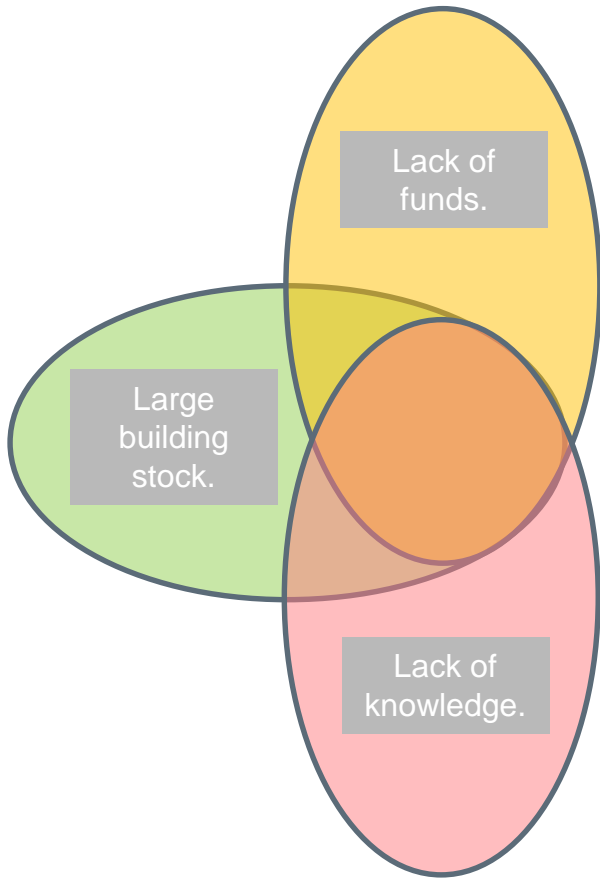
FROM: Vulnerability assessment of cultural heritage sites towards flooding events. Alessandra Gandini et al 2018 IOP Conf. Ser.: Mater. Sci. Eng. 364

PURPOSIVE SYSTEM: damage/flood.
DIMENSION: physical/socio-economic.
GATHERABLE DATA: visual inspection.
INDICATOR: multiple.
EVALUATION: semi-quantitative.



CULTURAL HERITAGE SYSTEMS AND CLIMATE CHANGE

LACK OF VULNERABILITY DATA



Criticality: factor or aspect of CH systems impacting resilience.

1. Resilience- focused.

2. Controllable.

3. Multi-dimensional (management-centred).

4. Measurable.

5. Participatory.



PHYSICAL (hazard dependent)

Intrinsic characteristics of CH systems (e.g. material composition, structural conditions).

MANAGERIAL (non hazard dependent)

Factors related to the operation, administration and care of CH systems.

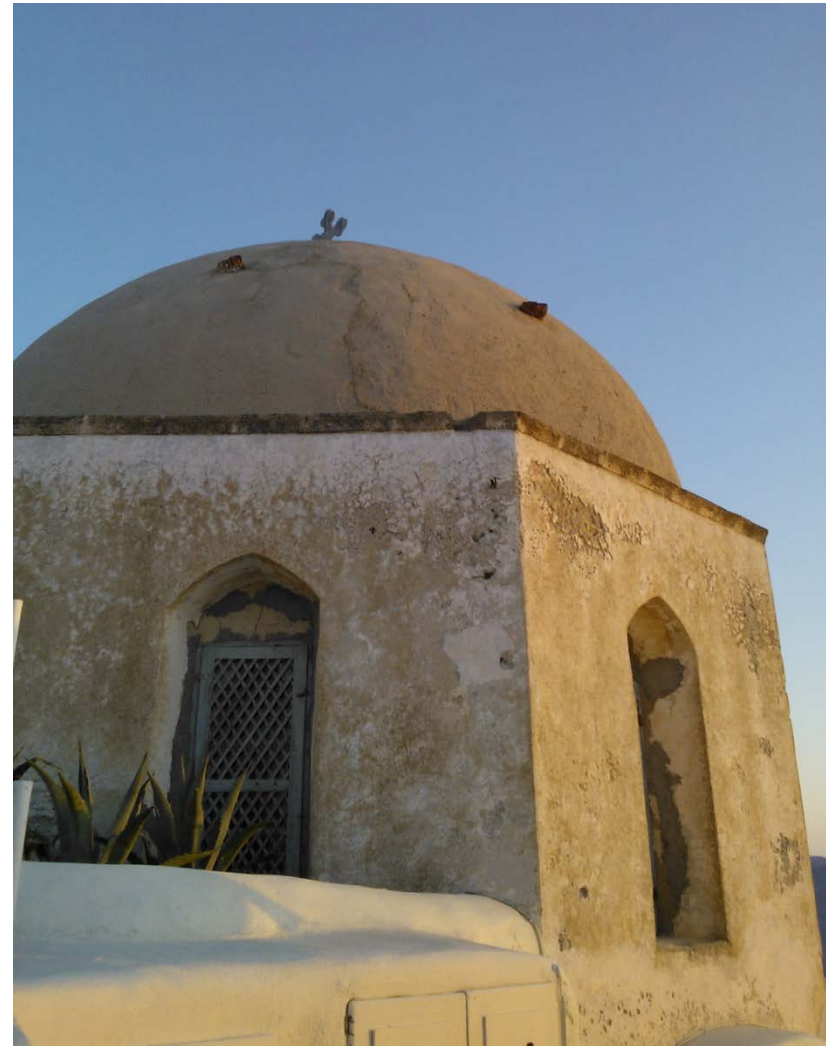


PHYSICAL CRITICALITIES

- PC1. Flood.
- PC2. Fire due to drought.
- PC3. (Wind).
- PC4. Heavy rain.

MANAGERIAL CRITICALITIES

- MC1. Information on CH assets.
- MC2. Funding.
- MC3. Knowledge and awareness.
- MC4. CH protection planning.
- MC5. Policy and regulation.





Crack. PC for different hazards

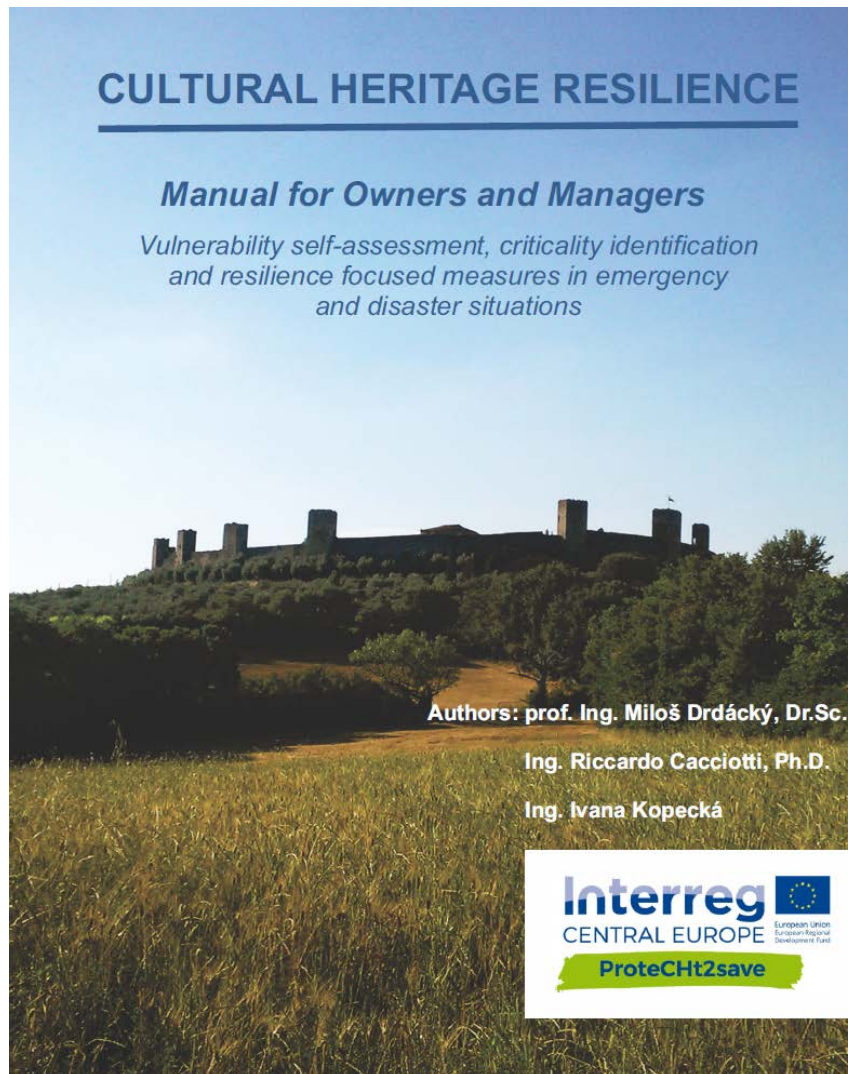


Lack of maintenance, property issues.
MC + PC



Inappropriate repair,
lack of knowledge.
MC + PC





CH RESILIENCE MANUAL

- *In 7 languages + EN.*
- *For managers and owners.*
- *Criticality identification.*
- *Resilience measures.*
- *Maintenance-oriented.*



THANK YOU

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