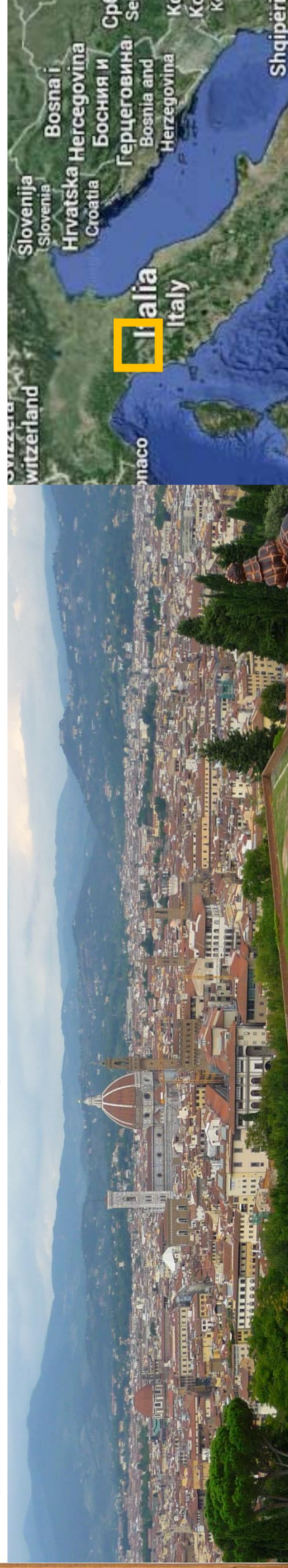


1

## Aims

Flood risk assessment in art cities poses many challenges for the presence of cultural heritage at risk, which is a damage category whose value is hardly monetizable. In fact, valuing cultural asset is a complex task, usually requiring more effort than a rough estimation of restoration costs. The lack of an adequate risk evaluation of the cultural asset may lead to enormous difficulties for the accomplishment of the structural mitigation solutions. The aim of the work is to perform a preliminary analysis of the risk to cultural heritage avoiding the quantification of monetary losses. Here we present a case study of broad importance, which is Florence (Italy), affected by a devastating flood in 1966.

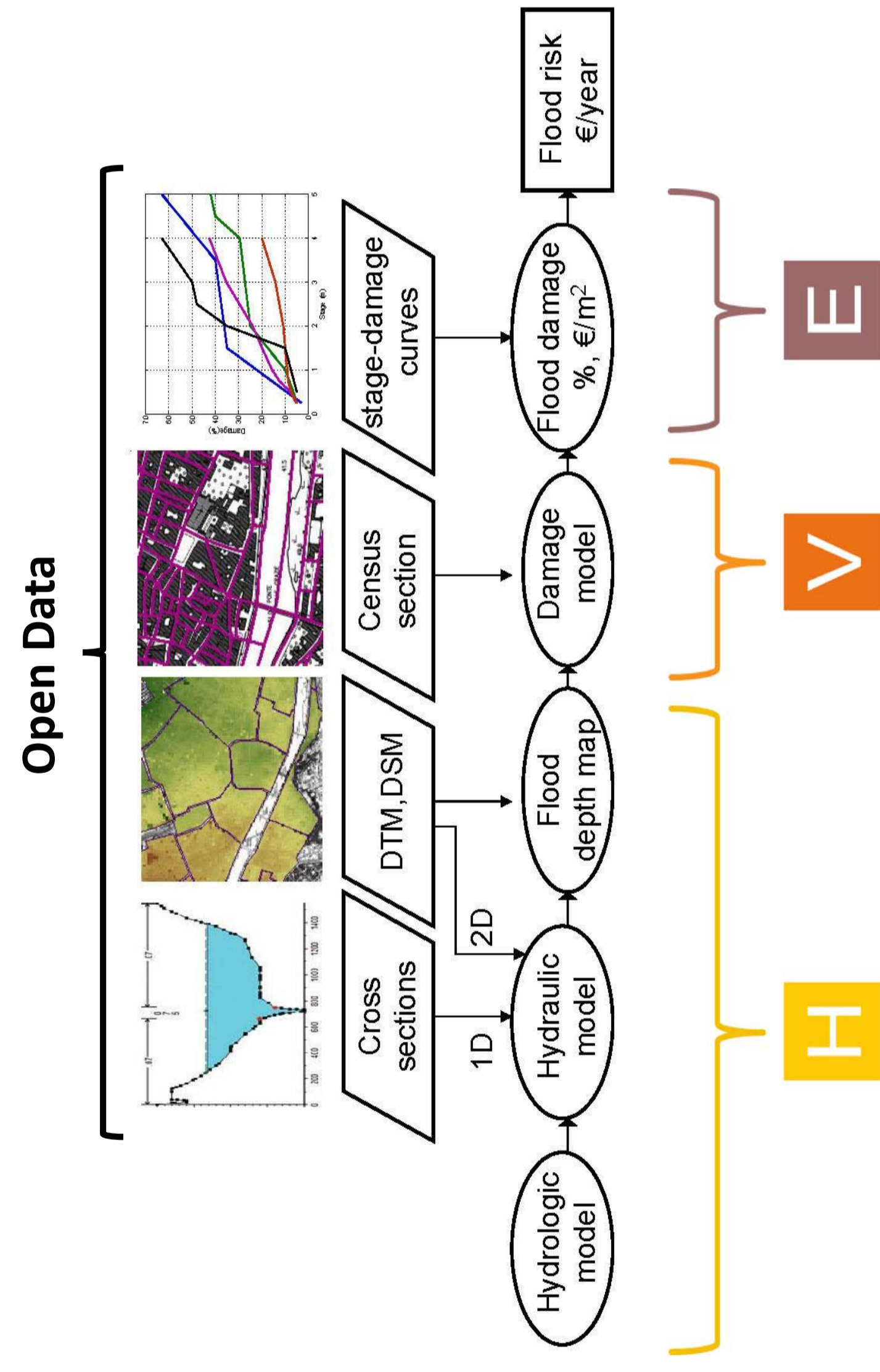


2

## Method

$$R = H \times V \times E$$

How to for cultural heritage?

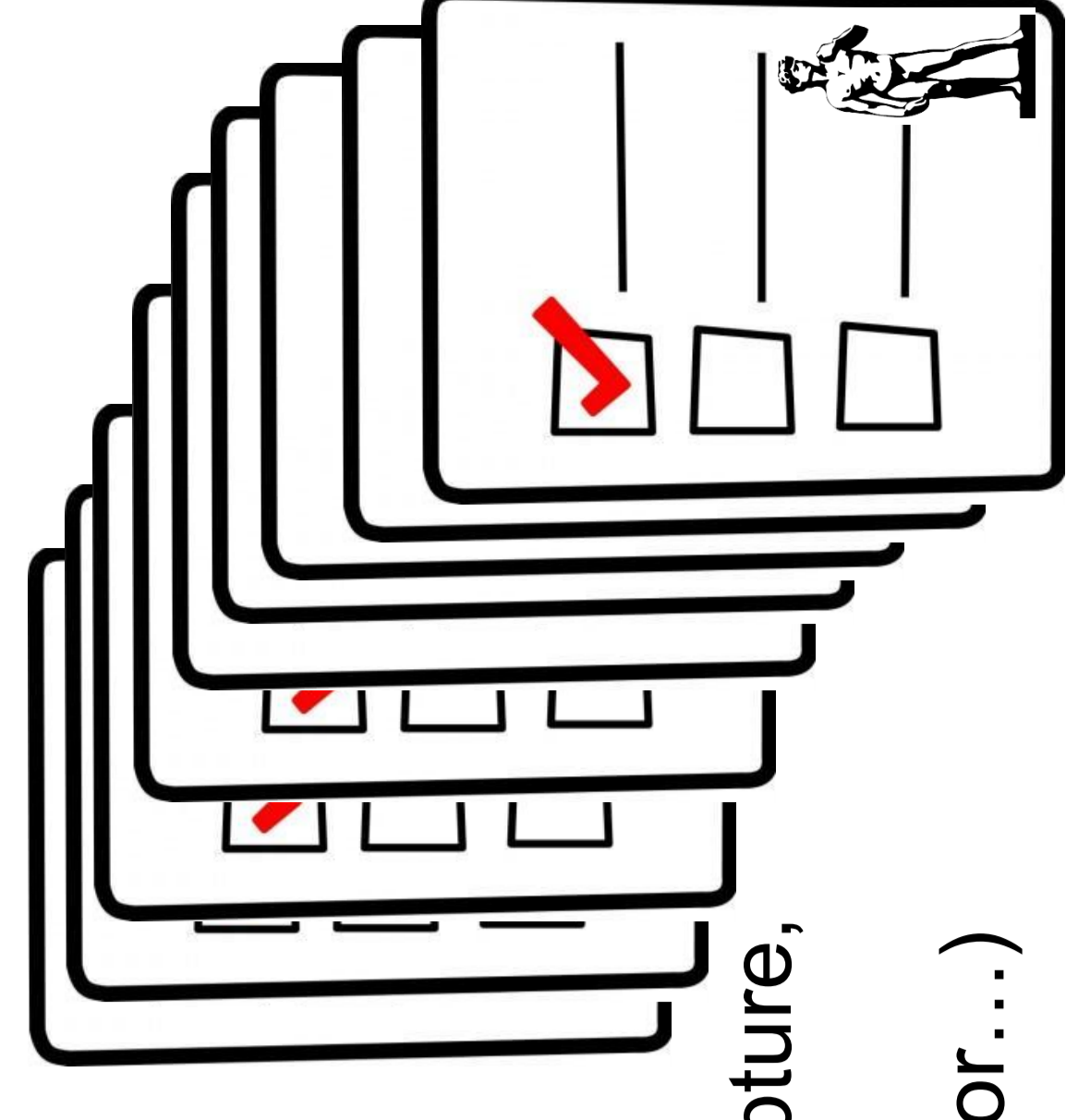


$$R_{cult} = \int_0^1 E_{cult}(T_R) \cdot d\left(\frac{1}{T_R}\right)$$

Risk is the **annual expected number** of damaged cultural buildings or artworks

This requires to:

- 1) Map flood scenarios
- 2) Create a database for cultural heritage



- Expected water depth for flood scenarios
- Type and material of artwork (painting, sculpture, book...)
- Position of vulnerable object (cellar, ground floor...)
- Number of movable objects

3

## 1966 Flood



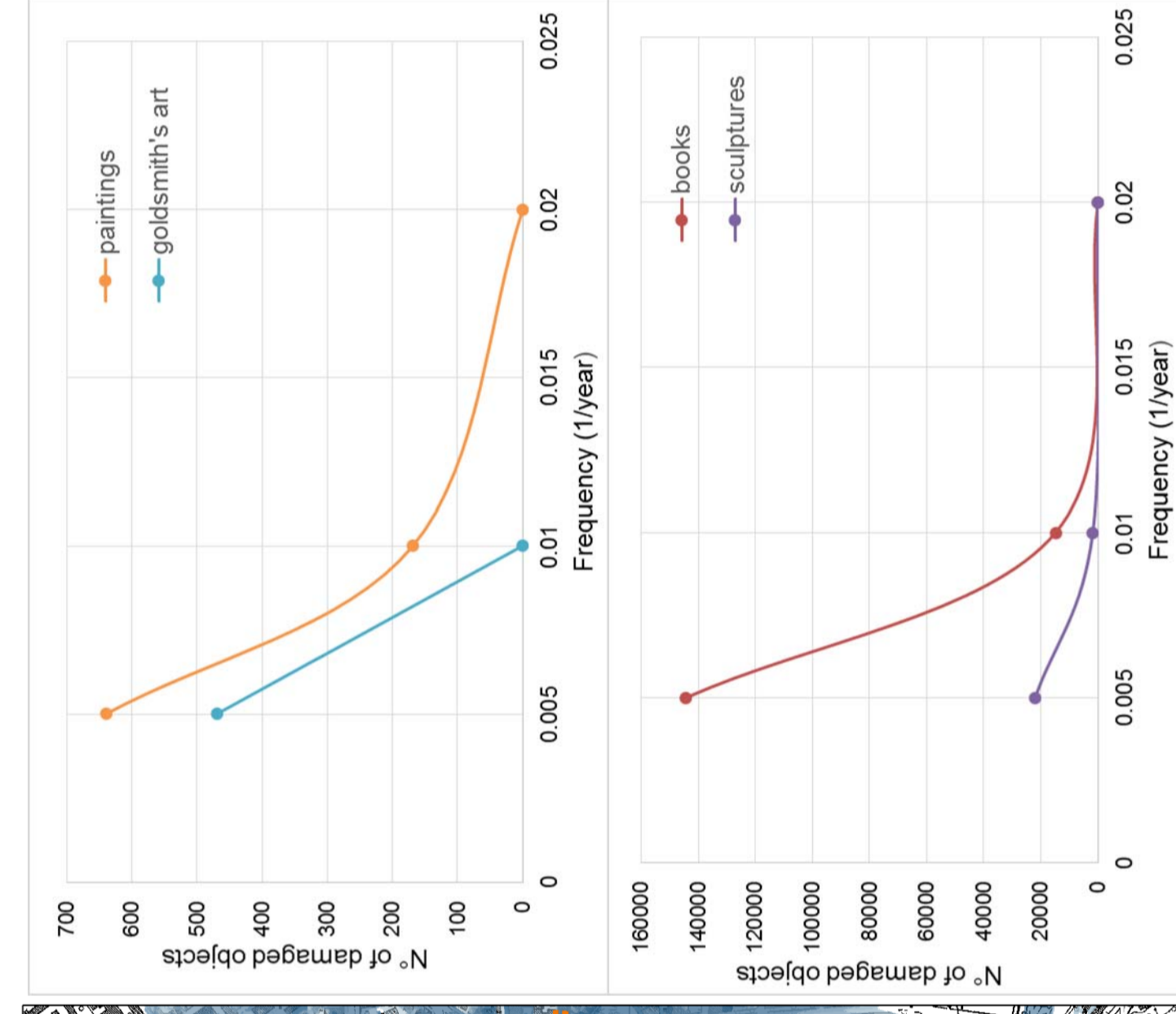
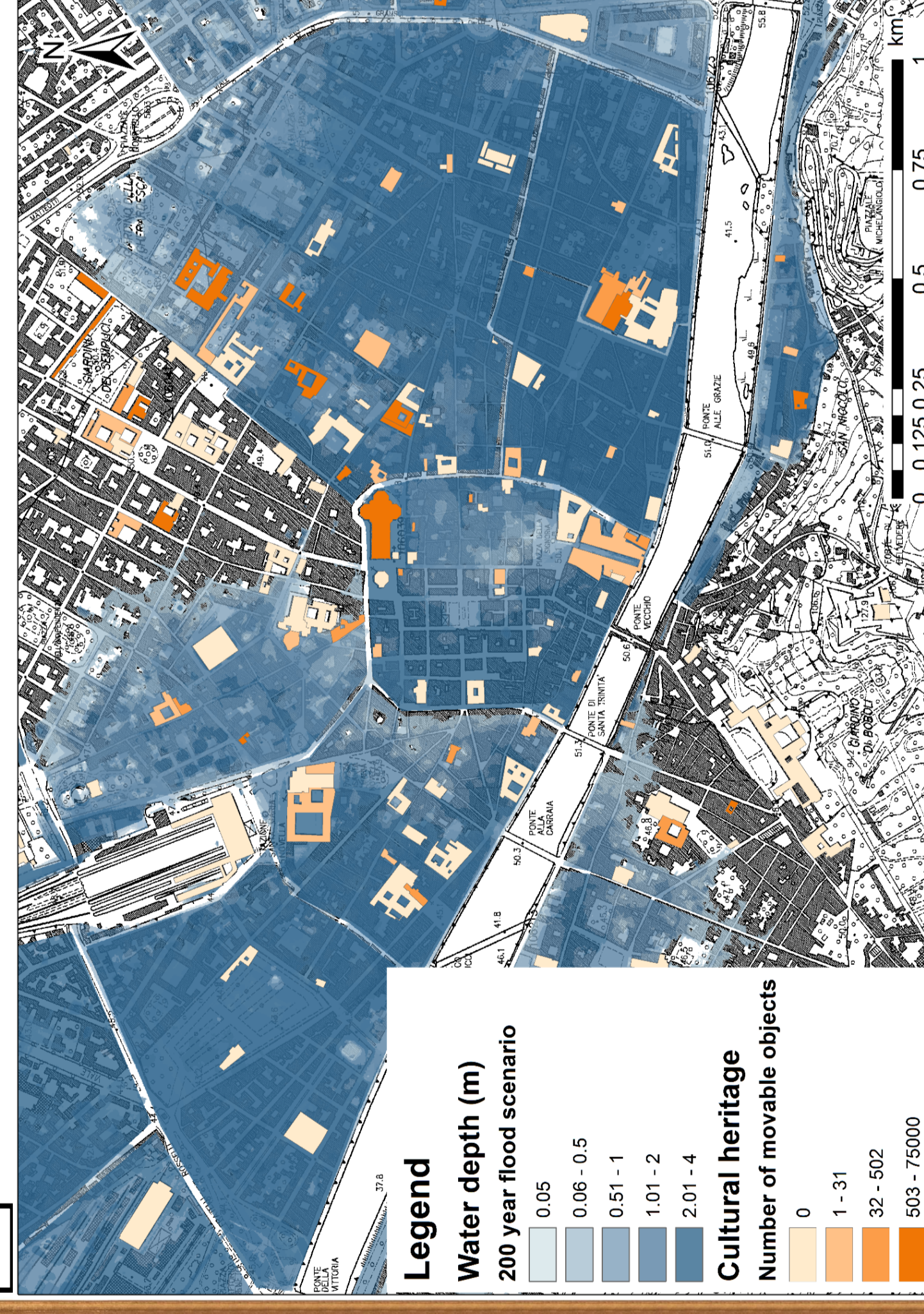
- 1.200 artworks
- 2 million books
- 1.600 m<sup>2</sup> of frescoes were submerged by floodwaters.

The symbol of the damages to cultural heritage is the wooden Cimabue's crucifix, XIII century (448x390 cm).

## References

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- Arrighi, C., Brugioni, M., Castelli, F., Franceschini, S., Mazzanti, B. (2013) Urban micro-scale flood risk estimation with parsimonious hydraulic modelling and census data. Nat. Haz. and Earth Syst. Sci.
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4



176 buildings are classified as cultural heritage (some are storing artworks). For the 100 year flood 46 are affected by the inundation, for the 200 year event the number increases to 126 (about 70% of total).

If we don't adopt any protection strategy....

	Paintings	Books, documents	Sculptures	Goldsmith's art, coins
<b>Risk (damaged artworks/year)</b>	3	472	69	2

## Results and conclusions



An example: the **Bargello Museum**.

- Water depth (1966 flood): 3.0 m
- Water depth (200 year scenario) 2.1 m
- Floors hosting artworks: ground, first and second
- N° of vulnerable objects: 65 sculptures, 20 of them movable.
- Safe shelters for temporary storage: yes



The economy of art cities is often based on tourism, but art cities are in charge of preserving cultural heritage for the future generations. The value of cultural heritage is not only instrumental, because its management state of conservation and access conditions influence human well-being. Risk assessment can stimulate the public debate and foster the adoption of precautionary measures. Florence has a unique historic-cultural heritage which is vulnerable to floods. The actualization of the number of harmed objects weighted by the return period of the flood event returns that each year 0.7 buildings are affected and 0.15% of the artworks is damaged without adopting any protection measure.