Drone based visual inspections, Infrared Thermography investigations and GPR surveys of the Roman masonry bridge Ponte Lucano, Tivoli, Italy

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The objective of this study is to evaluate the cooperative use of non-destructive contactless diagnostic technologies as a tool to enhance the amount of information useful to assess historical assets' structural and material degradation. The case study regards the Ponte Lucano structure in Tivoli (Italy) a Roman bridge located along the Aniene River, the largest tributary of the Tiber. It can be considered as an emblematic iconic structure in synthetizing the needs of structural consolidation and monument conservation. The bridge is, indeed, affected by hydraulic risk due to the floods of Aniene river.

Unmanned aerial (UAV) 3D photogrammetric surveys were carried out to perform visual inspections accounting for those bridge portions that are difficult to be reached directly. Hence, infrared thermography (IRT) and ground penetrating radar (GPR) surveys were considered as complementary technologies useful to obtain information about surface and subsurface structural features [1], [2]. The IRT analysis characterized the thermal profile of the bridge and detected its most humid parts. The GPR investigations were performed to improve knowledge of the bridge subsurface structure.

The results of the analysis demonstrate that, the integration of mentioned diagnostic tools, provide information about the degradation state of the stones and its causes, as well as regarding the evolution of the structure from its construction up to the present configurations. In particular, UAV 3D photogrammetry allowed a very detailed digital map of the bridge, covering almost every part of the structure and revealing precious informations, among which chromatic properties and size characteristics of the bridge areas which are not directly accessible by a human operator. IRT results corroborated the hypothesis that the present degradation condition of the Ponte Lucano is mainly a result of the water retention within its materials. GPR images, provided information about the internal stratification of the materials of the bridge and allowed the localization of two buried arch structures, allegedly located in the northern bank and at the Plautii Mausoleum, whose presence confirms the historical-bibliographical hypothesis about the bridge building processes.