Improving safety of Cultural Heritage and their users

BST focus and skills on H2020 specific

Building Science and Technology Lab
Construction Civil Engineering and Architecture Department

Università Politecnica delle Marche
Tel.:+39-071-220-4246
e-mail: e.digiuseppe@univpm.it, m.dorazio@staff.univpm.it,
e.quagliarini@univpm.it, g.bernardini@univpm.it

Cultural Heritage at risk: some opportunities…

SU-DRS01-2018-2019-2020

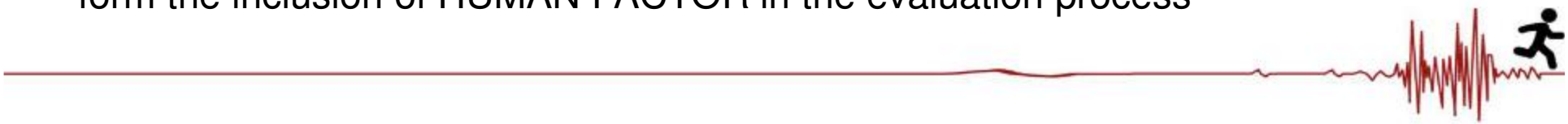
- Focusing on: (flash) flooding and climate-change disasters (multi-scenario in terms of European Country and disaster), as well as on sudden-onset disasters like earthquakes, and multi-risk approach
- By providing: tools for increasing risk awareness, risk assessment and decision support systems, mainly before the disaster, through the inclusion of HUMAN FACTOR (Cultural Heritage users'/ population) in the evaluation process

SU-DRS02-2018-2019-2020

- Focusing on: earthquakes, flooding, terrorist acts in Cultural Heritage
- By providing: tools for Cultural Heritage users'/population support in emergency, self-help and communication between exposed population and rescuers

SU-FCT02-2018-2019-2020

- Focusing on: crime and terrorist acts also in Cultural Heritage
- By providing: tools for Cultural Heritage users' support and safety planning starting form the inclusion of HUMAN FACTOR in the evaluation process



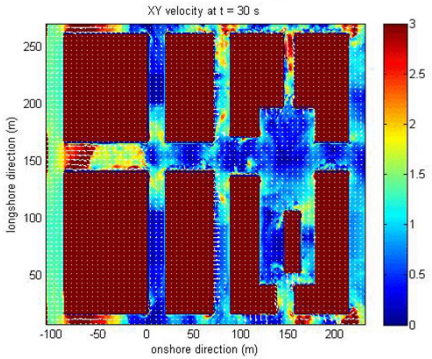
OUR SKILLS #1: Experimentally-based simulation tools for evidencing probable inhabitants' choices in emergency (evacuation) by sharing simulation results with stakeholders (including rescuers, planners and population) in Historical Scenarios

[ref: 1, 5, 6, 8, 10]

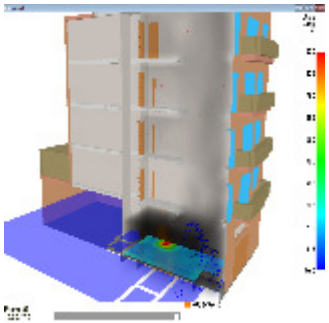
Quick methods to evaluate di vulnerability and damage of Building Heritage

Earthquake (including debris)

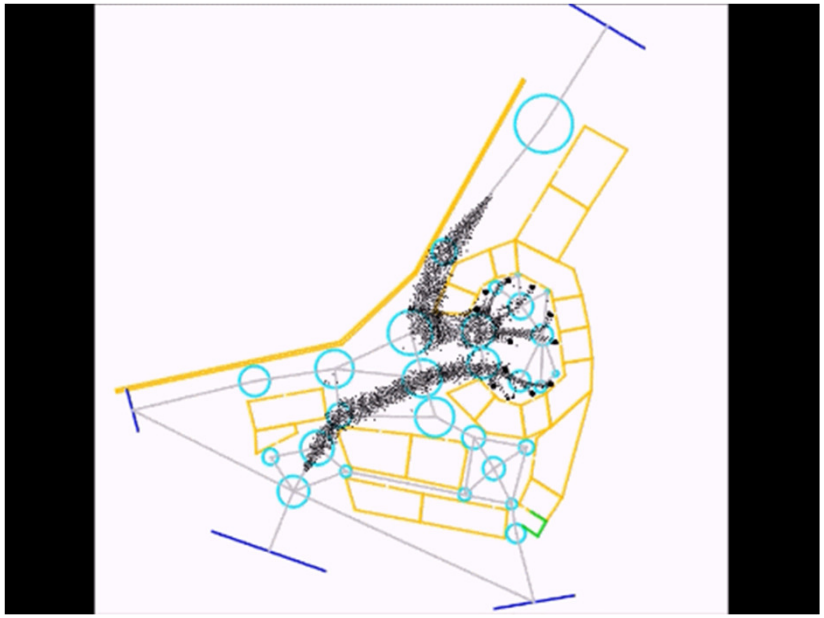
Flooding



Fires



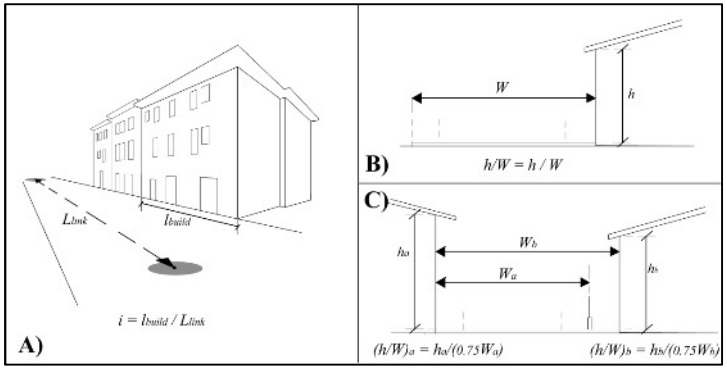
Evacuation process representation including human factors (including crowd, psychological aspects and interaction with rescuers)

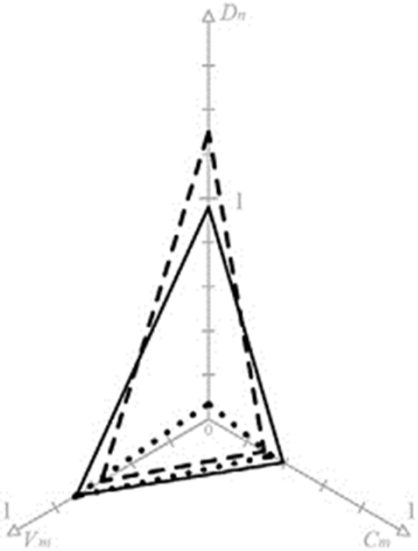


OUR SKILLS #2: Quick indices for emergency evacuation scenario building by using shared data platform, combining:

[ref: 2, 3]

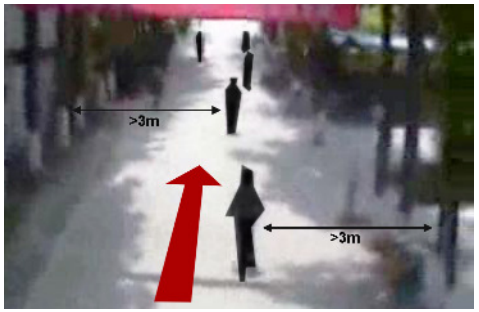
Environmental vulnerability, geometrical data, evacuation flows





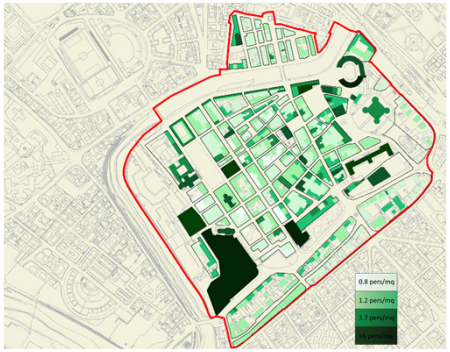
OUR SKILLS #3: Human behaviors analysis for: [ref: 1, 8]

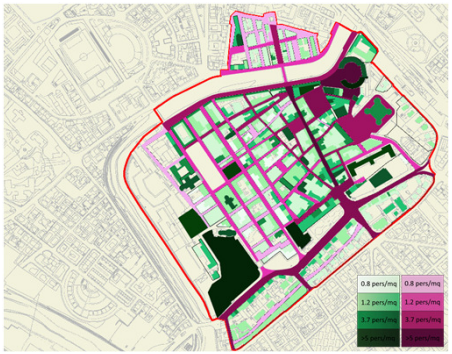
– emergency (evacuation) model definition (for terrorist act, natural disasters)



$$\vec{O}_g + \sum \vec{F}_{rep} + \sum \vec{F}_{attr} + \varepsilon(t) = m_i \cdot \frac{d\vec{v}(t)}{dt}$$

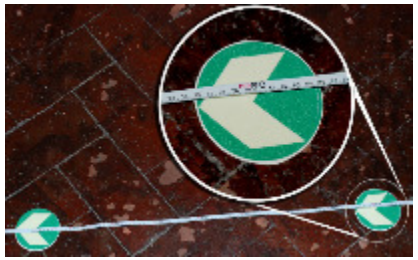
– use of urban space analysis, exposure definition, population scenarios creations

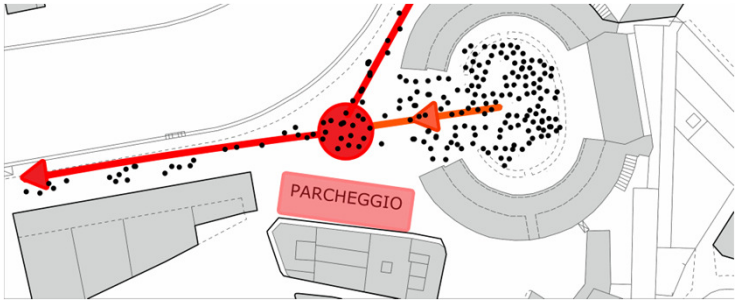




OUR SKILLS #4: Environmental and management solutions for human safety, based on simulation results, stakeholders' requirements/analysis, risk perception; aimed at configuring the emergency layout and the architectural spaces (mainly, temporary ones) for helping people in emergency (including wayfinding and assistance components)

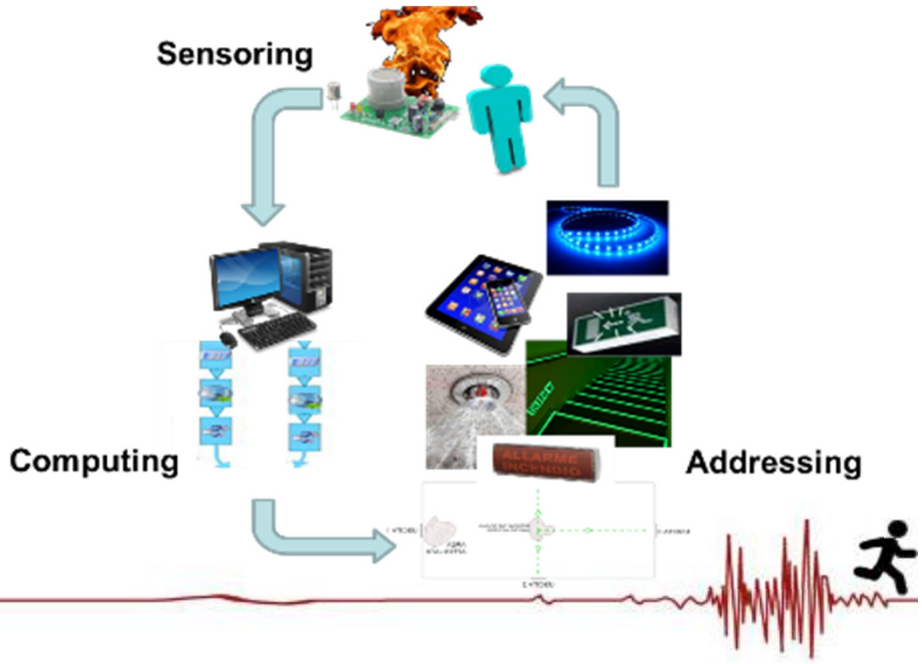
[ref: 2, 3, 4, 7]





OUR SKILLS #5: Emergency support technologies for population and rescuers (evacuation navigation apps, integrated building components)

[ref: 6, 7, 9]



Main research group papers

1. Bernardini Gabriele, Quagliarini Enrico, D'Orazio Marco (2019). *Investigating Exposure in Historical Scenarios: How People Behave in Fires, Earthquakes and Floods.* In: Aguilar R, Torrealva D, Moreira S, Pando MA, Ramos LF, eds. Structural Analysis of Historical Constructions - RILEM bookseries, 2019, vol. 18, pp. 1138-51. ISBN: 978-3-319-99441-3

2. Quagliarini Enrico, Bernardini Gabriele, Santarelli Silvia, Lucesoli Michele (2018). *Evacuation paths in historic city centres: A holistic methodology for assessing their seismic risk.* International Journal of Disaster Risk Reduction, 2018, vol. 31, pp. 698–710.

3. Santarelli Silvia, Bernardini Gabriele, Quagliarini Enrico, D'Orazio Marco (2018). *New indices for the existing city-centers streets network reliability and availability assessment in earthquake emergency*. INTERNATIONAL JOURNAL OF ARCHITECTURAL HERITAGE, vol. 12, p. 153-168, ISSN: 1558-3058, doi: 10.1080/15583058.2017.1328543

4. Bernardini Gabriele, Santarelli Silvia, Quagliarini Enrico, D'Orazio Marco (2017). *Earthquake safety in historic city centres: how to plan evacuation routes by considering environmental and behavioural factors.* In: REHAB 2017. p. 513-522, Green Lines Institute for Sustainable Development, ISBN: 978-989-8734-24-2, Braga, Portugal, 14-16 june 2017

5. Bernardini Gabriele, Postacchini Matteo, Quagliarini Enrico, Brocchini Maurizio, Cianca Caterina, D'Orazio Marco (2017). *A preliminary combined simulation tool for the risk assessment of pedestrians' flood-induced evacuation.* ENVIRONMENTAL MODELLING & SOFTWARE, vol. 96, p. 14-29, ISSN: 1364-8152, doi: 10.1016/j.envsoft.2017.06.007

6. Bernardini Gabriele (2017), *Fire Safety of Historical Buildings. Traditional Versus Innovative "Behavioural Design" Solutions by Using Wayfinding Systems*, 1st ed., Springer International Publishing. doi:10.1007/978-3-319-55744-1

Main research group papers

7. Bernardini Gabriele, Santarelli Silvia, Quagliarini Enrico, D'Orazio Marco (2017). *Dynamic guidance tool for a safer earthquake pedestrian evacuation in urban systems*. Computers, Environment and Urban Systems, vol. 65, pp. 150–61

8. Bernardini Gabriele, D'Orazio Marco, Quagliarini Enrico (2016). *Towards a "behavioural design" approach for seismic risk reduction strategies of buildings and their environment.* SAFETY SCIENCE, vol. 86, p. 273-294, ISSN: 0925-7535, doi: 10.1016/j.ssci.2016.03.010

9. D'Orazio Marco, Longhi Sauro, Bernardini Gabriele, Olivetti Paolo (2015). *Design and experimental evaluation of an interactive system for pre-movement time reduction in case of fire.* AUTOMATION IN CONSTRUCTION, vol. 52, p. 16-28, ISSN: 0926-5805, doi: http://dx.doi.org/10.1016/j.autcon.2015.02.015

10. D'Orazio Marco, Quagliarini Enrico, Bernardini Gabriele, Spalazzi Luca (2014). *EPES–Earthquake pedestrians ' evacuation simulator: A tool for predicting earthquake pedestrians ' evacuation in urban outdoor scenarios.* INTERNATIONAL JOURNAL OF DISASTER RISK REDUCTION, vol. 10, p. 153-177, ISSN: 2212-4209, doi: 10.1016/j.ijdrr.2014.08.002