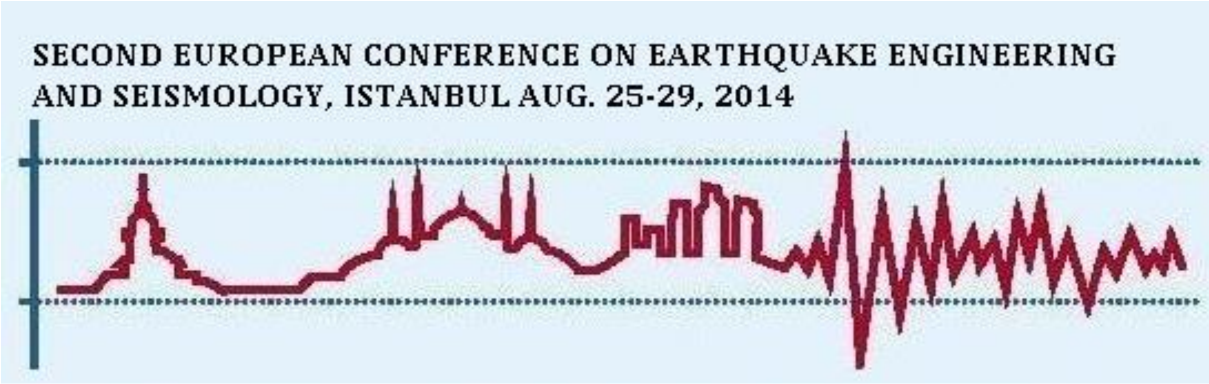

THE DISRUPTION INDEX (DI): CONCEPT, IMPACTS AND APPLICATION TO ALGARVE REGION IN PORTUGAL

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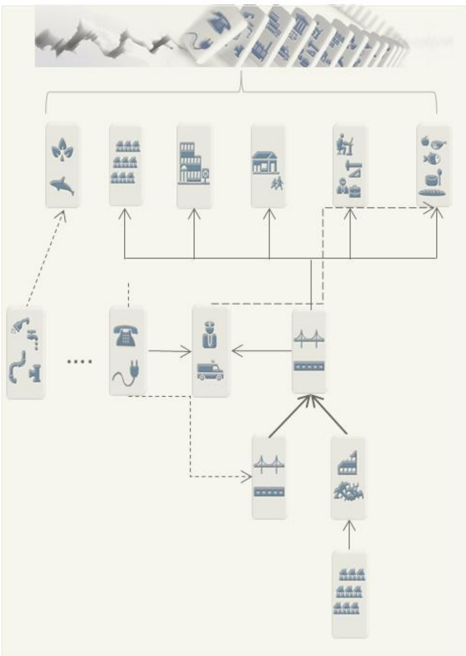
The Disruption Index (DI) was constructed to quantify the state of disorder induced by the disruption of urban structure and its systemic functions [Ferreira, 2012, Oliveira et al., 2012, Ferreira et al., 2014]. When critical services and functions are disrupted for longer time than is reasonable, consequences can be severe. All communities are at risk and face potential disaster if unprepared. The DI is a tool that allows the representation of a complex multidimensional situation in a concise and easier way, providing to institutions and communities a process to identify elements at risk and ways to reduce it (Figure 1). Each level of DI conveys which are the disruptions and influences (physical, functional, social, economic and environmental) that a given geographic area is subjected when exposed to an adverse event.



Impact level	Description of the impact level
V	From a serious disruption at the physical and functional levels to the paralysis of the entire system: buildings, population, infrastructure, health, mobility, administrative and political structures, among others. Lack of conditions to exercise the functions and activities of daily life. High costs for recovery.
IV	Partial paralysis of main buildings, housing, administrative and political systems. The region affected by the disaster presents moderate damage and a small percentage of totally collapsed buildings. Victims and injuries and a considerable number of homeless are present because their houses have been damaged, which, although not collapsed, are damaged severely enough to lose their function as housing. Normal daily activities are disrupted; school activities are suspended; economic activities are at a stand-still.
III	Part of the population may lose their property and need to be permanently relocated, which means strong disturbances in everyday life. This level is characterized by significant dysfunction in terms of equipment, critical infrastructures and losses of some assets and certain damage involving the conduct of professional activities for some time. The most affected areas show significant problems in mobility due to the existence of debris or damage to the road network. There may be some significant problems providing food and water, which must be remedied by civil protection agencies.
II	The region affected by the disaster results in a few homeless (approximately 5%) due to the occurrence of some damage to buildings affecting the habitability of a given geographical area. Some people may experience problems with access to water, electricity and/or gas. Some cases require temporary relocation.
I	The region affected by the disaster continues with its normal functions. No injured, killed or displaced people are registered. Some light damage may occur (non-structural damage) that can be repaired in a short time, and a temporary service interruption sometimes exists. The political process begins with an awareness that the problem exists, and some investments in strengthening policy and risk mitigation are/should be made.

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Figure 1. General overview of DI: Propagation, cascading effects and DI impact scale

On November 1st of 1755, a very large earthquake, centered southwest of the Algarve region, devastated Algarve and Lisbon regions and was felt throughout Europe and North Africa. Hundreds of aftershocks, some severely damaging by themselves, continued for years. A devastating fire following

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the earthquake destroyed a large part of Lisbon, and a very strong tsunami caused heavy destruction along the coasts of Portugal, southwest Spain, and western Morocco.
The Algarve region – a moderate to high seismic urban region according to hazard studies – was selected to demonstrate the regional impact assessment. QuakeIST® software (Mota de Sá et al., 2014) contains detailed information on the geological surface layers, on the building inventory and on population data of the Census, using the statistical sub-section as work unit. Soil influence was included through the analysis of upper soil layers classified into several categories; and vulnerability of the building stock was obtained through the analysis of different classes of construction types (55 classes in total). Finally, a pair of coordinates (longitude and latitude) was provided to define the location of each asset.
Vulnerability was assigned to each typology using the approach of EMS-98 scale. The first level of analysis of the QuakeIST® is based on obtaining analytically intensity distributions corresponding to the repetition of 1755 earthquake (Figure 2) and estimating spatial distribution of the losses (building and lifeline damages) throughout the region of interest. Second level of analysis is intended for propagation effects and earthquake impacts, using DI.

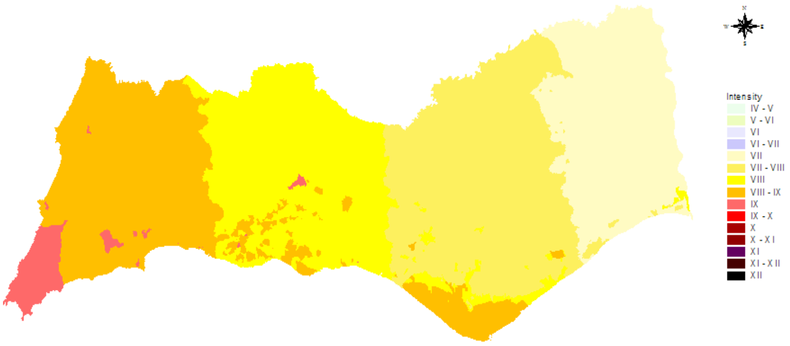

Figure 2. 1755 intensity map of Algarve region

The damages inflicted on bridges and its sphere of influence gathering together with the debris (obtained from the building stock) show the impact on Mobility. The expected disruption on Housing ((obtained from building stock), educational and health care systems combined with the impact on the Employment/business, all these elements and criteria interconnected, reflect the global disruption in Algarve (Figure 3). From this Figure it is quite clear the effect of propagation effects contained in DI, by comparing the areas of disruption with the intensity maps (Figure 2).

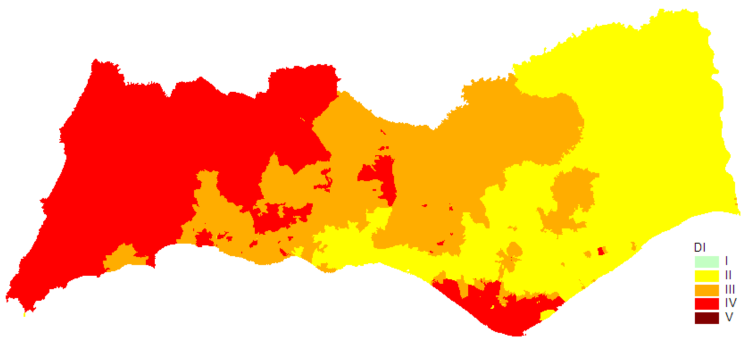

Figure 3. Global disruption in Algarve region.

The purpose of DI is to identify the urban system and critical services or elements disruptions; understand the implications of the scenarios impacts for resilience rank the order of priority of services or elements for continuous operations or rapid recovery; and identify internal and external impacts of disruptions. The UPStrat-MAFA Project (2012) used the DI methodology in several regions of different countries (Italy, Portugal, Spain and Iceland) to identify the most vulnerable assets.

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