SIBYL

(**SeIsmic** monitoring and vulnera**B**ilit**Y** framework for civi**L** protection)

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Deliverable DE2: Report on the potential for the developed system to be transferred to other hazard types

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SUMMARY

One of the intentions of the SIBYL project was that, while the focus of the work was on seismic hazard and risk, the tools and methods developed would need to be able to be transferred/adapted to other hazard types. It is the purpose of this deliverable therefore to present some ideas about how this may be carried out, as well as what issues would need to be confronted.

1. INTRODUCTION

The SIBYL project set out to develop an operational framework for Civil Protection (CP) authorities to rapidly and cost-effectively assess the seismic vulnerability of the built environment. However, it was also an aim of the project to develop the tools and framework in such a way that they could be extended/adapted to consider other hazard types. It is therefore the aim of this deliverable to present some thoughts on how this may be undertaken, and the issues surrounding them. A multi-hazard and risk assessment tool is, obviously, of great value as it is rare for a given area to be affected by only one hazard type. It is also in line with such international development agendas as the Sendai Framework for Disaster Risk Reduction[1]. Multi-hazard and risk has also featured in a number of research projects, for example MATRIX[2] (New Multi-Hazard and Multi-Risk Assessment Methods for Europe) and STRESS[3] (Harmonized approach to stress tests for critical infrastructures against natural hazards). What we therefore outline here is a proposed avenue where by the current tools and framework can be expanded, and be made applicable to a multi-hazard and risk environment.

The first step would be to consider multiple hazard and risk types individually. However, it is well recognized that interactions between different hazard and risk types are the primary complicating factor within such environments, including such issues as cascade effects, and increasing (or decreasing) the likelihood of other events occurring. However, for now we will consider each hazard and associated vulnerability and risk separately. Figure 1 shows a schematic view of how the SIBYL tools/framework could be extended.

[1] http://www.unisdr.org/we/coordinate/sendai-framework
[2] http://matrix.gpi.kit.edu/index.php
[3] http://www.strest-eu.org/opencms/opencms/

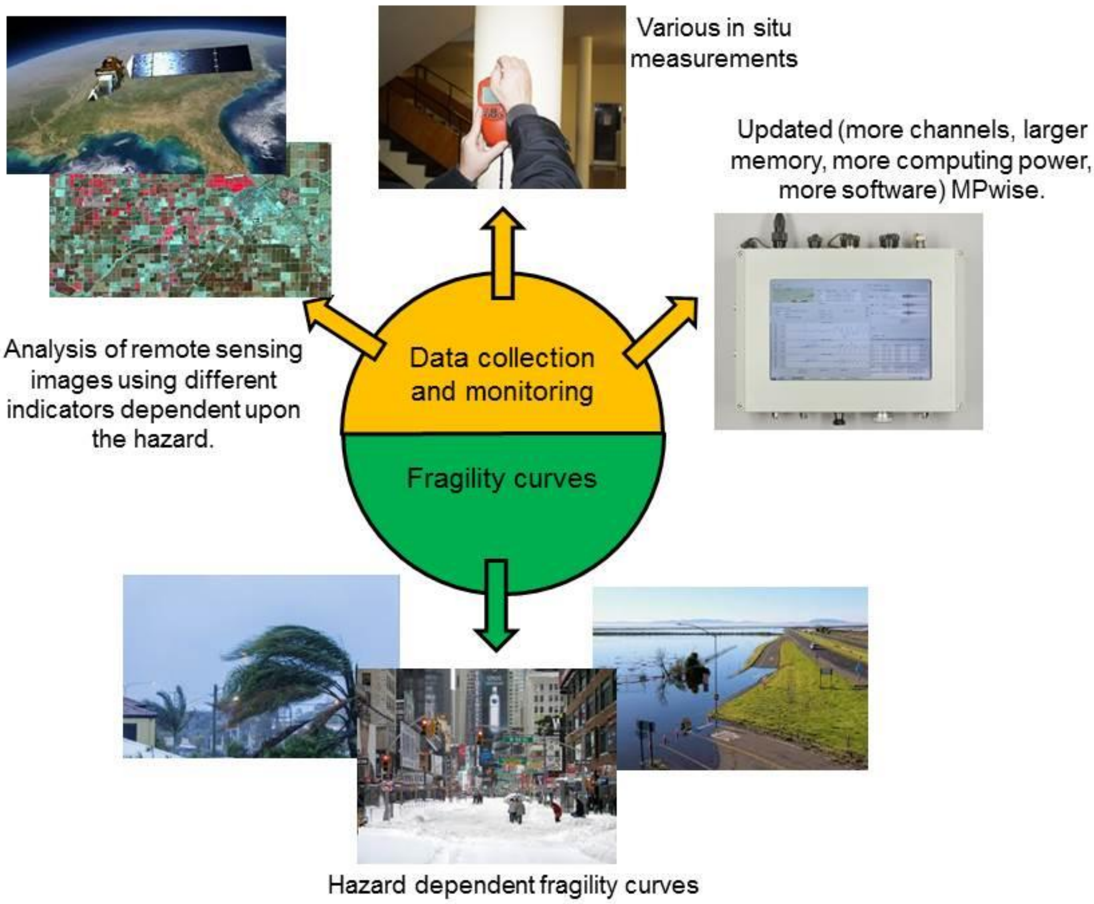

Figure 1: A schematic showing how from the SIBYL products they can be expanded to a multi-hazard and risk framework.

2. DISCUSSION

2.1 General

The first comment to make is that the risk conceptual basis employed is basically the same for all hazards that would be considered. That is, in all cases the same idea of:

HAZARD * EXPOSURE * VULNERABILTY = RISK

would be followed, regardless of the hazard or exposed elements. What is different is the probabilistic framework of the evaluation of the hazard, the fragility (or vulnerability) curves (or other measure) to be used associated with the exposed elements, and the evaluation of the losses with their typology and intensity. Again, while interactions between hazards and other elements would arise within multi-hazard environements, for example potential cascading effects, this would be better dealt with in a subsequent step.

2.2 Data collection and monitoring

The data collection and monitoring framework considered within SIBYL was essentially in three parts.

- Remote sensing and mobile mapping tools.
- MPwise sensing units.
- In-situ/detailed observations.

Considering the remote sensing and mobile mapping tools, on one level, this may require the smallest conceptual step. For example, considering mobile mapping via the direction camera system (see deliverable DB3 “Guidelines of the mobile mapping system and remote rapid visual screening”), the difference will arise from what parameters/characteristics are of interest and what will be identified from the imagery by the interpreter. For example, identifying the level of the ground floor with respect to the street level and the presence of below-street level entrances/windows would be valuable for assessing flood vulnerability. In fact, a data analyst examining the images could classify the buildings within a multi-hazard and risk framework with little more effort than would be required for a single hazard. This therefore brings about the issue of defining taxonomies appropriate for different hazards (especially exposure and its dynamic nature), which, would itself be perhaps the most difficult task.

This would be likewise appropriate for the use of remote sensing imagery (see deliverable DB1 “Guidelines for the remote-sensing assessment methodology”), where it would be the case of defining what parameters are appropriate for each hazard type which, while not at all trivial, is not conceptually removed from what was carried out in this work. The question, however, is whether it would be simply a matter of “bringing together” all the different schemes currently used (and under development) in remote sensing imagery analysis under one tool covering the different hazards remains to be seen.

Next is the use of the low-cost MP-wise units. As these units are designed to be operated in connection with external sensors, one could easily imagine different devices being included, dependent upon the hazard (or hazards) of concern: geophones for earthquakes, wind vanes for storms, tide gauges for floods, etc. It is also conceivable that sensors appropriate for different hazard types be connected to the same unit. For example, a MPwise network may be established along a river´s dike system and be equipped with geophones, tide gauges and pressure meters, where the geophone may detect earthquake-induced ground shaking, the tide gauges monitor water levels (perhaps there is a concurrent flood) while the pressure gauge measures the water pressure inside the dam (provided, for example, it is of an earthen type) to detect any indication of liquefaction. Such an expansion would be comparatively simple, requiring simply an increased number of recording channels and appropriate data flow and processing software which, with ever increasing affordable computing power, makes such schemes more than feasible. The issue then is a matter of including within the MPwise units the capacity to record and process each (and preferably several) data streams appropriate for the hazard(s) at hand. Again, conceptually this would not appear to be a problem, although current units have need to be upgraded to more powerful processing units and memory, but with advances in computer hardware, this is not seen as a major problem.

Finally for this part one can consider the collection of *in situ* observations. Like the mobile mapping and remote sensing activities, this may be considered simply to be a case of expanding/modifying what the inspectors are looking for. This, however, brings up the issue of training, which will be touched upon in a later section of this report. However, again this would not be a problem as the follow-on projects could call upon products such as the Inventory Data Collection Tool[4] developed by the Global Earthquake Model foundation, which has been designed for use by non-specialists, while specialists in a particular branch of hazard-dependent engineering may still incorporate their observations into whatever modelling tools are being developed.

2.3 Fragility-vulnerability curves

The simplified model for buildings (Simplified Integral Structural Model, SISM) exploited within this work can be applied also to wind storms. The wind load distribution over the height should be calculated anew, e.g., from some model of wind hazard, but the assessment procedure could be quite similar, while the before mentioned remote sensing and mobile mapping activities will be able to identify and classify roof types.

2.4 Risk assessment

In terms of the risk assessment within a multi-hazard and risk environment, once the 3 components (hazard, exposure or elements at risk, and vulnerability or fragility) are defined for each hazard, then the risk (in whatever form. i.e., buildings, infrastructure, population, etc.) can be defined in a straightforward way. For example, risk associated with separate non-interacting hazards maybe be estimated by relatively simple statistical means (e.g., Fleming et al., 2016). However, the interaction among hazards, which may significantly alter the resulting risk, needs more advanced methodological approaches, which have been considered in past projects like MATRIX and STREST.

[4] https://www.globalquakemodel.org/what/physical-integrated-risk/inventory-capture-tools/

3. FINAL COMMENTS

The tools and framework developed within SIBYL are believed to be adaptable to be exploitable within a multi-hazard and risk framework. This is partly due to the modular nature of the framework and tools, where each specific aspect can be expanded and/or tailored to the case at hand, for example extending the capacity of the remote rapid visual screening (RRVS) tool (see deliverable DB3 “Guidelines of the mobile mapping system and remote visual screening”) to include typologies relevant to multiple hazards.

A point alluded to above involves the ability of on-site inspectors to be able to identify and measure and features that are most appropriate for more than one hazard. This issue may be extended to the question of the training of Civil Protection (and other stakeholders) in the use of the SIBYL tools and their descendants. It was, in fact, a feature of the SIBYL project, for example the workshop in L’Aquila, Italy in May 2016 (see deliverable DF4 “Report on technical and professional outreach”). Therefore, while the more technical elements of broadening the SIBYL products form simply seismic-related to multi-risk, this will need to consider more intensely the issue of providing training.

References

Fleming, K., Parolai, S., Garcia-Aristizabal, A., Tyagunov, S., Vorogushyn, S., Kreibich, H. and Mahlke, H. (2016) Harmonizing and comparing single risk-type natural hazard risk estimations, ***Annals of Geophysics***, vol 59(2), S0216, doi: 10.4401/ag-6987.