PROJECT INFORMATION

Project Title: Systemic Seismic Vulnerability and Risk Analysis for Buildings, Lifeline Networks and Infrastructures Safety Gain
Acronym: SYNER-G
Project N°: 244061
Call N°: FP7-ENV-2009-1
Project start: 01 November 2009
Duration: 36 months

DELIVERABLE INFORMATION

Deliverable Title: D1.3 (3) - Project meetings and minutes, General Assembly and International Advisory Committee meetings (minutes of SYNER-G Midterm meeting)
Date of issue: 24 May 2011
Work Package: WP1 – Project coordination and management
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Minutes of SYNER-G Midterm meeting, Oslo, 28-29/04/2011

Summary

Day 1 (Thursday, April 28th): Presentation and discussion on the general methodology to evaluate systemic vulnerability, including the seismic scenarios, socio-economic issues, and typology (Work Package 2). Presentation of the MAEViz platform. Discussion on the selection of the toolbox-software platform for SYNERG. Discussion on the implementation of the methodology in the software (Work Package 7). Presentation of the methodology for evaluating the socio economic losses and vulnerability (Work Package 4), including the definition of indicators, casualty models, accessibility models and examples. Introduction and future work on systemic vulnerability for each network (Work Package 5). Presentation on remote sensing techniques and examples based on Thessaloniki and Vienna satellite images.

Day 2 (Friday, April 29th): Presentations and discussion on the final proposals and deliverables for fragility functions of all elements at risk (Work Package 3). Progress and work plan for Work Packages 8 and 6 concerning the dissemination issues and the case studies. Description and preparation process of the deliverables and of the mid-term report. Discussion of administrative issues. Steering Committee.

The coordinator of the project Professor Kyriazis Pitilakis couldn’t attend the meeting due to a heavy flu. Kalliopi Kakderi, Sotiris Argyroudis and Jacopo Selva have represented AUTH. Sotiris Argyroudis, Kalliopi Kakderi, the project manager (Helmut Wenzel) and the hosting Institute (Amir Kaynia) substituted K. Pitilakis in the coordination of the meeting.

Attendees:

AUTH: Kalliopi Kakderi, Sotiris Argyroudis, Jacopo Selva

VCE: Helmut Wenzel, David Schäfer

BRGM: Hormoz Modaressi, Nicolas Desramaut, Pierre Gehl

JRC: Fabio Taucer, Ufuk Hancilar, Patrizia Tenerelli

NGI: Amir Kaynia, Bjorn Vidar Vangelsten, Juan M. Mayoral

UPAV: Helen Crowley, Rui Pinho, Graeme Weatherill

UROMA: Paolo Franchin, Paolo Pinto, Francesco Cavalieri

METU: Polat Gulkan, Ahmet Yakut, Haluk Sucuoglu, Sebnem Duzgun, Altug Erberik

AMRA: Iunio Iervolino, Simona Esposito

KIT-U: Friedemann Wenzel, Bijan Khazai

UPAT: Michael Fardis, Giorgos Tsionis

WILLIS: Gero Michel

UILLINOIS: -

UKOBE: Yusuke Takayama

Tokyo Institute of Technology: Kohji Tokimatsu

EC project Officer: Denis Peter

All ppt presentations have been uploaded in the SYNER-G web portal.
Day 1: Thursday, April 28th

The meeting began with a short introduction by A. Kaynia from the host institute (NGI) and a welcome message by S. Argyroudis on behalf of the coordinator of SYNER-G, Prof. Kyriazis Pitilakis, who couldn’t attend the meeting due to sickness.

WP2: General methodology for systemic seismic vulnerability assessment (Paolo Franchin, UROMA)

A description of the general goals of task 2.1 and the way they have been implemented through the general framework of the methodology have been presented (general taxonomy, object-oriented framework for the simulation of an infrastructure in a seismic environment and the implementation of a prototype infrastructure for testing the framework, collection of performance indicators at components and systems level and state-of-the-art review of the methods for a “system of systems” analysis). The sample scheme of integration between physical and socio-economic vulnerability models include the flow from raw data to physical and socio-economic indicators. A break-up of the infrastructure and the hazard acting upon it was made in an object-oriented model. The whole methodology and analysis is performed in the sequence of three models: the seismic hazard model, the physical vulnerability model and the integrated physical/socio-economic system model. A Matlab / Simulink code has been implemented as prototype software of the proposed methodology including plain Monte Carlo sampling. Performance indicators (PIs) have been categorized into component-level, system-level, and infrastructure (system-of-systems) level. In most cases even at component level the PIs have a “systemic” character; their value reflects not just the local component physical damage state, but the functional consequence of this damage at the system level. The example of the Buildings within the adopted object-oriented model has been presented through the “Inhabited Area” class. Uncertainties are treated as random quantities and their relationships are established through the flow of the generic simulation run. Epistemic uncertainties (at hazard and fragility level) are included in the model with a hierarchical approach, but not yet implemented in the prototype application. Finally sample results of a pilot application (Little Italy) using the aforementioned prototype software were presented (hazard, physical damage, casualties/fatalities). The validation of the methodology regarding the socioeconomic module will be based on L ‘Aquila case study.

The main issues of the following discussion included the implementation of the code and the need to reach the development of open-source software including all analysis domains and interacting systems. Except for the evaluation of the cascading effects, the possibility to re-calculate the functional states of systems components after the occurrence of seismic damage due to by-directional links and propagated dys-functionality (feedback loops) should be provided in the general framework. The final decision for the implementation of bi-directional links into the SYNER-G software will be established at a later stage. The main prototype elements of the SYNER-G methodology and software will be the European fragility curves, the probabilistic analysis including estimation of uncertainties, the socio-economic model, the systemic inter-dependencies and the European seismic hazard model. The possibility for the treatment of uncertainties related to the system knowledge due to lack of data was discussed. Recommendations for an expert based or probabilistic approach could be included in the general framework of the methodology. The logic model (input-analysis-output) for each module is necessary in order to be used for the implementation of the SYNER-G software. This is further discussed later (WP7).
Further discussion about the implementation in the applications of the treatment of epistemic uncertainties, eventually through a Logic Tree approach, is necessary.

**WP2: Socio-economic issues of the general methodology (Bijan Khazai, KIT-U)**

The overall framework for the integration of physical and socio-economic models for estimating shelter needs and health impacts in the general methodology was presented. The shelter needs model is simulated through a logic model and a decision-making process. The conceptual framework for the impacts of earthquakes on health and health care system was presented including the casualty model, the infrastructure and accessibility model and the health care functionality. The general developed framework and the models used could easily be implemented into the SYNER-G software. Details on the approach and models as well as pilot applications were presented in a separate presentation (see WP4).

**WP2: Typology definitions of European elements at risk (Ufuk Hancilar, JRC)**

An overview of the objectives and outputs of the specific task was given, together with a short review of the past work. The typology definitions for Buildings; Utility Networks; Transportation Infrastructures and Critical Facilities were presented. The proposed taxonomy definitions are aiming to make the classification modular, and allow for expandability in the future. The methods for collecting, archiving and processing data on the typical European elements at risk within systems were classified: census, owner/operator data, ground surveys, remote sensing, aerial photographs. A proposal of a harmonized template for data collection was made which will be finalized due to M24 when is the submission date of the corresponding deliverable (D2.11).

**WP2: Defining seismic scenarios for analysis of risk to lifeline networks in European Metropolitan areas (Graeme Weatherill, UPAV)**

An overview of the methodology to generate seismic scenarios was given. The “Shakefield” framework was outlined, including the data input and needs (source typology, geometry, activity rate, recurrence, maximum magnitude, mechanism). Shakefield is a common methodology for single scenario (one field); single event (multiple fields); probabilistic analysis (single or multiple sources); multiple source typologies; spatial correlation of single ground motion fields (IMs); spatial cross-correlation of multiple ground motion fields; extension to geotechnical hazard consideration. The modelling of the ground motion was described and two possible approaches for the spatial correlation of ground motion were presented: i) sequential simulation and ii) extended LU decomposition. The generic approaches for the site amplification were summarized in three categories: i) GMPE Amplification Factors, ii) Design Code Amplification Factors, iii) Generic amplification models. For the estimation of the permanent displacements the HAZUS methodology is proposed as reference due to its simplicity, however other approaches can be introduced or modifications can be applied as it is proposed. Finally, the general framework of the geotechnical hazard was presented, together with examples for the hazard considerations in the case studies applications (e.g. seismic source model, GMPE selection, correlation models, modelling issues).

“Shakefield” code was proposed to be implemented as add in of the SYNER-G software. In particular, it is important to include in the software a probabilistic seismic hazard approach.
accounting for the simulation of spatially cross-correlated fields of the ground motion. UPAV and VCE need to cooperate on this during the next period.

SYNER-G will make use of what is available (on time) in the ongoing EU project SHARE (i.e. GMPE, seismic zones, site classification and amplification etc) and try to ensure consistency between the projects, avoiding any significant contradiction between the two.

**WP2: Remote sensing for systemic vulnerability analysis (Patrizia Tenerelli, JRC)**

A review of the objectives and deliverables of this task was made. The two main objectives are: i) to couple optical and radar satellite images with census data, localized knowledge, socio-economic and demographic data and ii) to test parameters extraction from remote sensing (e.g. number of buildings; built-up density; building height; built-up spatial patterns; sealed areas, open spaces; location and size of transportation infrastructures; distance between roads and buildings). Thessaloniki, Vienna and Messina comprise the case studies.

A summary of the available data for Thessaloniki (Road network; Building Blocks; Building Footprints; Building inventory; Satellite – Geoeye images) and Vienna (Road network; Building Footprints; Building typologies; Population; Satellite – Quickbird/COSMO) was presented. Data (such as road network, population, land use) that were collected from other sources were also described. An interesting feature of the collected data for the road network is the width of the road, allowing for an easy extraction of the road-building distances. A review of the methodologies for extracting data (building footprint; building height; roof type; sealed areas) was made.

The tests that have been performed by JRC and UPAV through remote sensing techniques were described including automatic algorithms for extracting built-up index and automatic algorithms for extracting the planar view of buildings and the building height from the shadows. Examples were presented for Thessaloniki, Vienna and Messina. The various issues and limitations of these techniques were highlighted. In particular, in case of satellite imagery there is a time gap between acquisition of inventory ground data and satellite images, the sun and satellite orientation should be taken into account; the age of building can be inferred if old imagery or map is available; the recognition of building typologies requires ground information. In case of optical satellite imagery, 0.5m resolution optical satellite data are suitable to provide information on built-up structures, roads and open spaces. Advanced technologies can automatically extract: built-up area; average building size; building density; average height; built-up volume. The automatic mapping produces approximate information that should be aggregated to blocks/census unit or grids. In general the accuracy of fully automatic algorithms is low.

The GIS modelling includes the application of planar based indicators for describing the buildings shape-complexity, aggregation, presence of open spaces and proximity to roads; statistical aggregation of buildings and their attributes; integration of urban maps and demographic data (extrapolation of population density based on spatial proxies); accuracy assessment (validation based on the available reference data).

A modification of the description of work for task 2.5.1 (Integration of remote sensing and inventory data) was proposed together with a revision of deliverables structure, titles, content, and deadlines. This is related to the delay on the acquisition of the satellite images and the availability of data. These modifications do not affect other work packages and will be included in the management report.
The following discussion was mostly for the accuracy of the results based exclusively on fully automatic techniques and the possibility to also use semi-automatic processing techniques. The integration with other WPs, such as the estimation of the socio-economic losses, is constrained basically due to scale of available data. However, the possibility to estimate certain indicators (e.g. open space areas) through the satellite images will be examined.

**WP7: Build prototype software (Helmut Wenzel, VCE)**

The presentation of the general interface of MAEviz was made by VCE. The different modules and capabilities of the software were presented using the available database for the city of Vienna, along with an example of a plug-in that has been programmed by VCE for the simulation of a radio-active cloud covering inhabited areas.

After long discussion it was decided that MAEviz is the best candidate as the platform for the development of the SYNER-G software. The main innovations will include the fragility toolbox, based on the SYNERG synthesis of European and international state of the art, the randomness/variability modelling, the socio-economic approach, the interdependencies/systemic analysis and the European hazard estimation, including the appropriate simulation of ground motion fields from scenario events.

A discussion was made about the condition of open source software, and the potential to use other not open source codes in certain modules of the SYNER-G software, such as Matlab/Simulink and others.

VCE pointed out the strategic interest of MAEviz experts to actively support the development of the SYNER-G software. This collaboration is ensured through the participation of ULLINOIS in this work package.

Two main issues were noticed: (i) how the contribution of the different partners could be implemented in the software and (ii) how the SYNER-G software is customized to be independent from MAEviz.

For the second Helmut Wenzel clearly stated that MAEviz has not any licence limitation and hence the SYNER-G toolbox, using the MAEviz platform, may have a different name and a completely independent management and maintenance structure.

For the first, and after K. Piitlakis was informed the following actions are foreseen:

- A more complete description of systems and their intra and inter-dependencies is needed in order for VCE IT people and – potentially – the people from MAEviz to estimate the volume and complexity of the work needed. AUTH will prepare a complete list of modules with the inputs and outputs and the general flow according to the proposed methodological framework. It will be sent (before May 15th) to all partners for comments and improvement till the end of May.

- BRGM, as leader of WP5, will prepare two templates (a) one for the detailed description of systems (already existing in the different deliverables) and (b) a second one describing and commenting the systems interdependencies and the system intra-. To work on the second table it is necessary to have the first one in a detailed way. The reason is that in the present form of the methodology the intra-dependencies may be seen as the effect of a simple failure of a component of a system (i.e. a simple power-substation) to the global performance of whole systems (i.e. harbour loading facilities i.e. the whole harbour). All relevant partners should fill the tables with their comments and data before early June. What is really needed is the complete list of elements, the relationships between them, the PIs, and the type of "system
analysis” that should be provided for each system to evaluate the performance. In cases where there are doubts, a working assumption could be made.

- In mid of June 2011 a meeting is scheduled in Urbana IL, between MAEviz experts (ULLINOIS), VCE and possibly BRGM and UROMA representatives, in order to discuss in detail the implementation of the SYNER-G methodology into MAEviz platform and to estimate the amount and the nature of the IT work needed.

- After this meeting, VCE will start the implementation of the software with certain scientific support from the other partners.

WP5: Systemic vulnerability specification (Pierre Gehl, BRGM)

The objectives and the organization of WP5 were summarized. The specificities of each system include scale issues, attributes (e.g. geometry), performance indicators and intra and interdependencies, in line with the proposed systemic approach.

For **buildings and aggregates** the basic element at risk for the vulnerability analysis is represented by homogeneous urban zones/units. For each cell the required attributes include: Building typologies; Fragility sets; Demographic indicators (population, households); Economic indicators; Social indicators; Building usage; Built up area. The analysis will be based in methods for the evaluation of building damage, building usability, building occupancy, casualties. The systemic approach integrates the functional with the socioeconomic vulnerability. The proposed performance indicators include casualties, homeless people and proportions of damaged and collapsed buildings. The interdependencies include interactions with electricity, gas, water and transport accessibility.

For the **electric power network** the basic elements are represented by **points** (SlackBus, generator, transformer, distributor), **lines** (links) and **areas** (demand nodes). The required attributes were described, while the analysis will be based on methods for the evaluation of states, damages, connectivity and power. Three levels of analysis were described regarding the performance indicators: (I) vulnerability analysis (percentage of physical damages), (II) connectivity analysis (number of disconnected users) and (III) serviceability analysis (delivered Voltage and Electrical Power vs. required). The interdependencies include interaction with gas (need for the generators) and Buildings, Hospitals, Fire-Fighting, Water, Gas networks, Transport (train, traffic signal, harbour facilities etc).

For **gas-oil network** the main components are pipelines, high-to-moderate pressure transformers and moderate-to-low pressure transformers. The required attributes include properties for nodes and links (geometry, Imtype, flow, PI….), while different methods for the analysis of the system can be used (e.g. Compute: Connectivity of nodes, Flow analysis, leaks/breaks for each link etc). The performance indicators at system level can be defined through connectivity measures and service flow reduction measures. Finally, a table describing the interdependencies was presented.

For **water supply system** the basic elements are represented by **points** (Water sources, water treatment plants, pumping stations, storage tanks), **lines** (pipes, canals, tunnels) and **areas** (demand nodes). The required attributes were described, while for the analysis, methods for the evaluation of repair rates, leakages, breaks, pressure, state, water head are needed. Three levels of analysis were described regarding the performance indicators: (I) Vulnerability analysis (percentage of physical damages), (II) Connectivity analysis (number of disconnected users) and (III) Serviceability analysis (Flow rate and water pressure). The interdependencies include interaction with electricity (need) and buildings, hospitals, fire-fighting, transport (floods?).
The **roadway network** is characterized by *line* and *node* components. The performance of the system is proposed to be described through the connection time between nodes. A pure connectivity (level I) approach is proposed for the functional modelling of the network for the emergency-short term scale. An overview of the required classes for a regional scale analysis was given. The fragility of bridges, tunnels, embankments etc, is the main input in regional scale, while in the urban scale the interaction of roads with collapsed buildings is important. A general scheme for the functionality of road elements was presented, based on the damage states and the number of lanes that remain open.

The **harbour system** is comprised by a variety of components and systems; its functionality depends on: the performance of individual components, their locations, redundancy, and physical and operational connectivity. Performance indicators for the individual port components were defined. System performance measures are defined based on: inventory functions, engineering, operational reliability, economical and financial, demand - traffic volumes and flows, safety and security. Examples of harbour system intra and inter-dependencies were presented. A proposal was made to treat system inter-dependencies according to the general methodology of WP2 simulating port lifelines and infrastructures as “macro-components” of complex port facilities. For the intra-dependencies different methods were proposed to establish a simulation framework of the port’s operations, while an identification of main components with higher levels of dependencies and affecting the most port functionality should be preceded.

The **health care system** is characterized by point-like components, in a local scale, while the systemic analysis concerns the emergency-short term scale. The performance of the system is proposed to be described through the Hospital Treatment Capacity (hourly number of surgical treatments after the seismic event). The functional modelling will be based on fault-tree approaches, FEM analyses and MC simulations, fragility for elements at risk (structural/non structural elements).

The **fire fighting system** can be treated as the water systems, other components except the water ones, include fire-station buildings and fire-faucets. The performance could be described through the efficiency of FFS system or response time.

The main conclusions are focused on the need to define a class diagram for all systems, along with the different modules to be used in the systemic analysis approach (see decisions in WP7). Also the full description of the systems inter- and intra-dependencies should be done in the form of tables and graphs (see decisions in WP7). BRGM is going to lead this task. The question of setting priorities of interdependencies was also raised. A work plan for WP5 was also discussed (see WP7 and steering committee sections).

**WP4: Socio-economic vulnerability and losses (Bijan Khazai, KIT-U; Bjørn Vidar Vangelsten, NGI; Sebnem Duzgun, METU)**

A summary of WP4 objectives was given, along with the general methodology framework of SYNER-G. The inputs, outputs and related models for estimating shelter needs and health impacts were described. In particular, the casualty and accessibility models contribute to the health impact model, while the displaced persons model interacts with the shelter needs model. The inputs for these models include Building Occupancy; Building Damage; Utility Loss; Road Block Possibility; and Healthcare Functionality.

For the shelter needs a logic model to simulate decision-making process for dislocation and seeking shelter was presented. The multi-criteria decision analysis (MCDA) is an indicator
combination model, resulting to indices such as displaced person, shelter seeking and shelter needs. For the health impact the multi-criteria analysis includes models of casualty, health vulnerability, hospital accessibility, hospital functionality and environmental parameters. Details for each one of the developed models were given.

The approach for the data harmonization in Europe was presented, which include five steps for selection of indicators and their importance. The main source of indicators for urban level should come from the European Urban Audit, the only publicly available pan-European socio-economic database. However, there is a lot of missing data in the Urban Audit data set. The principal component analysis (PCA) of data together with examples for Urban Audit data at sub-city level is presented. An extensive literature survey for selection of indicators was made and the suitable indicators for the shelter model were proposed. In the next period an expert elicitation using Analytical Hierarchy Process (AHP) will be performed in order to finalize the selected indicators and suggest weights for each one. In addition, validation of the indicators with L'Aquila data is in progress. Pilot studies and results were presented for the proposed shelter model using Istanbul as case study.

The proposed casualty model for the estimation of deaths (not injuries) was described, which considers all damage states for buildings, as well as the seismic intensity, using semi-empirical casualty ratios derived from three large earthquakes in Italy. A “Building-Casualty” super-class based on the propensity of different building typologies in producing casualties is finally proposed. Comparisons with other casualty models were presented and commented.

The accessibility for healthcare model was also presented, which considers the road network condition after the earthquake and estimates an accessibility index for each administrative unit. The main factors affecting accessibility were outlined and results from a pilot application in Thessaloniki were presented, based on input data that have been provided by AUTH. A comment was made for the relativity of accessibility indicators for the crisis period. Also for the consideration of bridges into the model, their functionality should firstly be defined. Regarding the different accessibility models, a recommendation of the most appropriate one and definition of its feasibility should be made.

Finally, the needs for the implementation of the different modules in the SYNER-G software were outlined. The modules for casualty, displaced populations and accessibility require a GIS platform, while the modules for shelter needs and health impact are based on MCDA codes such as the Logical Decisions (commercial) and Web-Hypre (open source).

Day 2: Friday, April 29th

WP3: Fragility functions for buildings (Helen Crowley, UPAV)

An overview of the completed activities was made: Literature review of existing fragility functions of European buildings; Documentation in a standard form of all fragility functions; Agreed European Building Taxonomy; Syner-G Fragility Function Manager; Framework to estimate epistemic uncertainty of fragility functions; Identification of gaps in fragility functions in Europe. An outline of the submitted deliverables was given (D3.1, D3.2). The final taxonomy for buildings is based on: Force Resisting Mechanism (FRM); FRM Material (FRMM); Plan (P); Elevation (E); Cladding (C); Cladding Material (CM); Detailing (D); Floor System (FS); Floor System Material (FSM); Roof System (RS); Roof System Material (RSM); Height Level (HL)/Number of Stories (NS); Code Level (CL).
An overview of the fragility function manager tool was given. Its main functions are to archive, compare and harmonize different fragility curves. In particular, the harmonization concerns the Intensity Measure Level (various conversion equations are used to covert the curves to PGA with no indication of the variability associated with the different options), the taxonomy (SYNER-G building taxonomy applied) and the limit states (usually first/second (yield) and last fragility function (collapse)). Examples were given, including the estimation of mean and COV of the different lognormal parameters. A brief discussion was devoted to the treatment of uncertainties within this “merging tool”. Uncertainties are not explicitly treated and averaged parameters from the starting fragility curves are evaluated. As regards the homogenization of damage states for buildings, it is proposed (and implemented in the ‘LittleItaly’ prototype application) to use 2 damage states, i.e., collapse and yielding. However, in the presented tool, damage state comparison among different curves is user defined.

The question of excluding some of the proposed fragility functions due to insufficient data and/or lack of validity was raised. A proposal to include a sub-set of the final recommendations (after excluding those which are not trust-worthy) was made. This will lead to a decrease of the variability and uncertainty. A recommended set of fragility functions should be available for all buildings typologies.

The specific fragility function manager tool will be the basis for the development of the fragility toolbox for all elements at risk, which consists a main module of the SYNER-G software (WP7). VCE will lead this task.

**WP3: Fragility functions for road and railway bridges (Georgios Tsionis, UPAT)**

An overview of the existing fragility functions was made based on the literature review. The methodology that was followed for the derivation of new analytical fragility curves was presented. The typology of examined roadway and railway bridges includes regular bridges with continuous deck and monolithic or through elastomeric bearings deck-pier connection. The main typological parameters are: bridge length, span length, pier height, pier cross-section, number of columns per pier, level of seismic design. The intensity measure is the Peak Ground Acceleration, while two damage scales are considered: yielding - limited (emergency) use; near collapse. The damage measures, together with the design and assessment procedure were described. It was noted that simple and efficient computer modules have been developed that construct very fast the fragility curve for a bridge, given its parameters. Representative fragility curves were presented, while the proposed fragility functions for all bridge types will be soon finalized, as minor modifications are still required related with their form and shape. The fragility of single span or simple support bridges was not studied, as they are considered to be of low vulnerability. However, it is proposed to include existing fragility curves based on the literature review. All the proposed fragility curves will be inserted in the fragility toolbox. The possibility to include into SYNER-G software the modules that have been developed by UPAT for the derivation of analytical fragility curves for bridges will be explored (VCE).

Finally, a presentation was made concerning the ongoing research on residual seismic displacements in concrete structures, based on analytical and experimental results. In particular, non-linear dynamic analyses are performed for equivalent SDOF hysteretic oscillators under 122 records to quantify residual and maximum displacements.

It is suggested that the existing manager tool developed by UPAV for buildings should be extended, under the responsibility of VCE, for bridges and all other elements at risk. Partners
responsible for the development or/and selection of the different fragility curves will provide the necessary scientific assistance to VCE.

**WP3: Fragility functions for transportation infrastructures (Juan M. Mayoral, NGI)**

The proposed approaches and fragility curves for each element of road and railway system were presented, together with the structure of the corresponding deliverables which are in progress (D3.7-3.8). For tunnels in rock, existing fragility curves are proposed. For tunnels in alluvial, new analytical fragility functions were developed, considering the soil conditions and the tunnel geometry, based on 1D and 2D numerical analysis for numerous input motions. For embankments (road on) and trenches (road in) new analytical fragility curves are developed, considering the soil conditions and the geometry of embankment/trench. For these components, dynamic analyses were performed using finite element methods, in order to assess their response under an increasing level of seismic excitation. For slopes (road on) the fragility curves that are proposed in SAFELAND project are adapted. They are based on HAZUS approach; the intensity parameter has been modified from PGD to PGA based on an empirical model, considering the slope geometry (critical acceleration, ky) and the earthquake magnitude. For road pavements, the HAZUS fragility curves due to liquefaction and fault rupture are validated, using few recorded damages from recent earthquakes in Greece. For bridge abutments/approach fills, new analytical fragility curves are proposed, based on numerical dynamic analysis, where the soil conditions and abutment geometry are considered. The results of the analytical approach for the road elements are used for the development of fragility curves in case of railway elements, applying different threshold values for each damage state. Preliminary results have been presented for the railway components. The fragility curves for all elements will be finalized soon. The total uncertainty will be estimated based on the variation of the numerical results.

**WP3: Fragility functions for water, waste-water, harbor and fire-fighting systems (Kalliopi Kakderi, AUTH)**

The proposed fragility functions and typologies together with performance indicators for the water, waste-water, harbor and fire-fighting systems were summarized. In some cases (waterfront structures, pipelines) the selection of the fragility functions is based on validation studies using damage data from past earthquakes (i.e. Lefkas and Duzce earthquakes). Also for waterfront structures new analytical fragility functions for ground shaking without the occurrence of liquefaction have been developed. In cases of complex elements (e.g. water sources, water and waste-water treatment plants, pumping stations, lift stations), their fragility is based on fault tree analysis, using appropriate vulnerability functions for the sub-components and mainly for the building structures. Modifications of the functions for complex components (e.g. pumping stations) are possible based on the fragilities of buildings according to the proposals of the related task. The possibility to automatically calculate fragility functions of complex components into SYNER-G software based on fault tree analysis and the specifications of the sub-components will be explored (VCE). A discussion was made for the inclusion or not of the back-up power sub-components. Finally, the same approach used for water system can be used to estimate the vulnerability of the fire-fighting system. The case of the interaction with the building structures (fall of debris on hydrants) will be explored.
WP3: Fragility functions for gas and oil systems (Pierre Gehl, BRGM)

The proposed fragility functions for the gas and oil elements were summarized. For the pipelines empirical fragility models are proposed which take into account both wave propagation and ground failure. For the storage tanks existing fragility curves are proposed which consider the anchorage or not of their components. For pumping/compression stations fragility functions based on fault tree analysis can be used as first approximation for L'Aquila Re.Mi cabins. For valves and SCADA systems no fragility functions are proposed due to their complexity and the lack of relevant information and methods. A discussion on the different properties of pipes in Europe in respect to the ones used in US and Japan (which are the basis for the development of most empirical functions) was made. Unfortunately, the databases of European earthquake damage data are still very limited. The deliverables should though clearly refer to this point and put some warnings on the use of available empirical functions. Finally, it was decided that time-dependent and condition-dependent fragilities of components are out of the scope of this project.

Concluding remarks on WP3

As a general conclusion for WP3, fragility curves are proposed for all the systems’ elements, and all the deliverables will be soon finalized and submitted. The fragility functions manager tool, which has been developed by UPAV for buildings, will be extended in order to include all the elements at risk. The general manager tool will be developed under the coordination of VCE with the active assistance of all partners developing fragility curves. Several curves may be proposed but it is mandatory to propose 1-2 curves (and relevant typologies based on the SYNER-G taxonomy), as the most adequate for Europe.

WP6: Vienna test case (Helmut Wenzel and David Schäfer, VCE)

The test area in the 20th district of Vienna was presented which includes about 30 blocks. A detailed identification of each building within the study area is available as it was illustrated through representative examples. All the lifeline networks are available for the same area. However a main point raised during the discussion was that although the most of the elements at risk are presented in this area, the networks such as water system etc, do not correspond to complete systems for which a flow or systemic analysis can be performed. This will be solved with possible spatial expansion of specific components or some reasonable assumptions will be made during the validation studies. A discussion was also made for the use of one single scenario as it was proposed by VCE (the most probable one), to estimate losses and the characteristics of this event.

WP6: Thessaloniki case study (task 6.1) and Thessaloniki harbour (task 6.6) (Kalliopi Kakderi, AUTH)

The available data for buildings, lifelines, infrastructure, urban indicators and seismic hazard of Thessaloniki were briefly presented. For the water system, electric power network, transportation network, port and buildings, the adequacy of available data was commented based on the information that is needed for the fragility analysis of each component (Deliverables 3.1 to 3.11) and the systemic vulnerability (D2.1). For some elements such as water tanks, pumping stations and substations, certain data is missing. For this reason, reasonable assumptions or updates of the data will be made. The data for transportation network (bridges, roads) and for the majority of the harbour components is complete. For the
seismic hazard, the available microzonation study and estimated seismic scenarios will be updated applying the methodology that is proposed in D2.13, in collaboration with UPAV. The final definition of the application area and networks extent will be based on the systemic vulnerability specifications for each system (WP5) and the data availability. For example it is possible to exclude the secondary pipelines of water system for which information is missing and use the main network for the analysis.

**WP6: L'Aquila case study (Simona Esposito, AMRA)**

The past, ongoing and future activities of L’Aquila case study were presented. Summarizing, the characterization of the gas network and of the wave propagation hazard has been performed, while geotechnical and microzonation data were obtained from DPC. The spatial correlation models for IMs of interest (PGV, PGA) were estimated and the technical/economic reports for the benchmarking (WP4) were processing. Also, a fault tree analysis of Re.mi and Gr was conducted and the final fragility curves are under development, considering the buildings typology. In the next period, the geotechnical hazard characterization is planned to be completed, including the estimation of site amplification and the estimation of PGD due to liquefaction and landslides, together with the network characterization according to WP2 framework. The possibility to estimate empirical fragility curves based on L'Aquila earthquake damage data will be also evaluated. Finally, results from the benchmarking study concerning the building damage and usability, the evacuation rates, the casualties and shelters needs after L'Aquila event were presented.

**WP6: Electric Power System and Health care system (UROMA)**

UROMA had to leave at the end of the first day, and consequently the progress on these two topics has not been presented in the meeting.

**WP6: Conclusions:**

A roadmap was presented for the case studies (see below), proposing kick off and internal meetings for each application between partners (for pilot applications, data preparation etc). The organization of the meetings is under the responsibility of the leaders of the respective tasks.

**WP6 Roadmap:**

- Sept./Oct. 2011: Kick off meetings in each city or system (THESSALONIKI, VIENNA, ROME)
- till Sept. 2011: Final definition of the case study areas/networks
- May to Nov. 2011: Pilot applications (Thessaloniki, Vienna etc)
- Sept-Jan. 2012: Input data preparation and setting according to the SYNER-G methodology and tools
- Feb. 2012: Start the case studies
- June 2012: Complete 1st run of the case studies
- Sept 2012: Finalize the case studies
WP8: Guidelines, recommendations and dissemination (Fabio Taucer, JRC)

The completed tasks and deliverables were outlined, while the coming deliverables were discussed. In particular, for the web server it was mentioned the complete migration of the database and document exchange from JRC to VCE server. The updated public web page already includes Newsletter, Project leaflet and deliverables for public dissemination, while it is proposed to include in the future, the announcement of Project meetings, the Announcement of the Vienna, Thessaloniki and Final Workshops, Reference to Journal Publications, all WP8 dissemination material, including Reference Reports and Results from future workshop questionnaires. It was further highlighted the need for expanding the public webpage by including material such as papers and other reports which are interesting for the public and have been produced in SYNER-G or out of it, related to seismic risk assessment and losses. When a deliverable is completed, AUTH (coordinator) and VCE should be contacted by the responsible partner, in order to archive it under the deliverables folder of the database, which requires administrator access.

The final plan for the use and dissemination of foreground was presented, including the Task description and expected results, Task assignment, Milestones, Deliverables, Graphical representation of WP8 and Planning of activities. The final program for the production of the SYNER-G reference reports was also presented together with the list of editors and reviewers. Possible ways of electronically distribution of the reference reports were described. The Guidelines for editors, reviewers and production were presented, including the Role of Editors, Role of Reviewers, Template and Time Schedule. The Version 1 of the Reference Reports has already been prepared by the responsible leaders, including the structure, contents and contributors. The final version 1 for reference reports 6 and 7 is still missing but will be soon submitted. The work plan for the upcoming deliverables was presented (reference reports, Technical / Final workshop, conclusions and recommendations, Exploitation plan, Brochures, guidelines, manuals for dissemination purposes, Awareness and wider societal implications, Synthetic Document and vision paper).

The preliminary dates for the Workshops have been presented: Thessaloniki (AUTH), 11-12 Oct 2012, Vienna (VCE), 18-19 Oct 2012, Ispra (Final) (JRC), 25-26 Oct 2012. For the technical workshop, focus should be given on inviting local stakeholders and interested parties from European cities with similar levels of seismic hazard, while for the final one stakeholders at European and International level should be invited, in particular DG ECHO, DG ENV and Civil Protection.

The EC project officer proposed the interaction with ECTP and other European projects (for example SERIES) in order to disseminate and validate SYNER-G results, such as the European fragility curves, into the engineering community.

A short presentation of the SYNER-G web page was made by VCE, and an invitation was made to all partners to provide all relative documents that could be uploaded for the dissemination of the project’s outcomes.

WP1: Project coordination and management (Sotiris Argyroudis, AUTH)

An overview of the time schedule, achieved and oncoming milestones was presented. The assignment of responsible partners to the coming deliverables (till month 24) for internal review was proposed and agreed. The next meeting (2nd annual meeting and workshop on systemic vulnerability) will be held in Orleans, BRGM. The dates will be discussed and concluded in the following period by all partners under the coordination of BRGM. By the
time of the production of the minutes the final dates have been agreed: **November 2-4/2011 in Orleans, France**. A 2,5 days meetings is foreseen.

A preliminary discussion for the publication policy that will be followed in SYNER-G was made; a simple and easy to apply framework of rules should be prepared by the coordinator and approved by the partners in Orleans. A tentative list of future publications (journal, conference papers, other) will be asked in the next period from all partners.

**WP1: Administrative issues – Midterm report (Helmut Wenzel, VCE)**

A presentation was given regarding the preparation and needs of the mid term report. Further templates and instructions will be provided by VCE to all partners. The following items are required:

1. Timesheet– all partners
2. Cost Table for Periodic Report) - all partners
3. MoM for Travel costs - all partners
4. Partner Report for Periodic Report - all partners
5. WP Report for Periodic Report - WP leaders only
6. Form C - all partners
7. Deliverables

**Meeting of the Steering Committee (AUTH, VCE, BRGM, NGI, UPAV, JRC, KIT-U)**

The progress in all work packages is satisfactory besides the complexity of the project and its high ambitions.

**Work Package 3** (Proposal of fragility curves for all elements at risk for Europe) is almost completed and all the deliverables will be available within the next month. The manager tool proposed by UPAV for building will be used as prototype for all other fragility curves for all other elements at risk. A general manager tool will be prepared for all elements at risk according to the decision made and highlighted previously.

**Work Package 2** (General methodology for the systemic vulnerability, including the seismic scenarios, typology, and socioeconomic issues) is in the final stage. A short delay and a 6 month shift of one deliverable date is expected in Task 2.5 (Remote sensing techniques) due to the delay on acquirement of satellite images, however this will not affect the progress of other work packages, as it is an independent task.

The progress and results of the **Work Package 4** is satisfactory and according to the work plan. The progress in the software development is also satisfactory.

**Furthermore:**

Based (i) on what we have in hands so far, (ii) the contractual commitments in SYNER-G for the development of an open-source toolbox, and (ii) the time constrains, it was concluded that the MAEviz platform is the most appropriate one for the SYNER-G software. The way that the experts of MAEviz will support the implementation of the software through UILLINOIS partner, remain to be defined.

In the next six months period, (until the next meeting in Orleans early November), focus and maximum efforts should be given in the specification of systemic vulnerability for each network (Work Package 5) and the implementation of the SYNER-G software (Work
Package 7). Both these tasks are crucial for the validation studies (Work Package 6). For this reason a more detailed roadmap has proposed and approved for these three work packages (see conclusions of WP6):

**Work Package 7:**

AUTH will prepare a list of all required modules for the SYNER-G software together with the priorities for their implementation. The existing methodologies and tools will be transferred in an appropriate way for the software engineers i.e. for Hazard (D2.13), Fragility curves (D3.1-3.11), Systemic vulnerability of water system and electric power system (D2.1), Socio economic vulnerability and losses (D4.7). The same will be done (with less details of the exact equations and methods for the systemic analysis if not available) for all other systems. It will be sent (before May 15th) to all partners for comments and improvement till the end of May. Then VCE will be able to start implementing the methodology. Modules developed by partners will be provided to VCE, as well as scientific assistance in the development of other modules, which are not at a level for a direct IT implementation.

When it is finalized VCE and all other SYNER-G partners will be able to estimate better the nature, volume and complexity of the work needed and the kind of support required from MAEviz experts. On June 15th a meeting is scheduled between VCE and possibly BRGM and UROMA representatives with MAEviz experts in Urbana, Illinois, US, in order to discuss in detail the implementation of the SYNER-G methodology into MAEviz platform and to estimate the amount and the nature of the IT work needed.

Within the next months (till September-October) VCE will extend the fragility curves toolbox that has been already developed for buildings by UPAV, including the proposed fragility curves for all elements at risk in Europe (WP3 deliverables). In the same period the socio-economic module will be prepared based on the work of WP4 (including accessibility, casualty, shelter etc), in collaboration with KIT-U and UILLINOIS experts.

A preliminary version of the general software with all modules should be available at the beginning of 2012 in order to start the applications (case studies) in urban and regional scale (BDG, EPN, GAS, WWS, RDN, HRB, HCS, FFS). The implementation of epistemic uncertainties should be included into the SYNER-G software at a final stage, possibly in the form of a logic tree.

**Work Package 5:**

Till end of May 2011 all the intra and inter-dependencies systems will be defined (Table with possible interactions, circulation among partners, prioritization, final decision). For this BRGM, as leader of WP5, will prepare by May 15th two templates and circulate among partners (a) one for the detailed description of systems (already existing in the different deliverables) and (b) a second one describing and commenting the systems interdependencies and the system intra-dependencies. Till end of June 2011 the performance indicators at the component level will be selected (based on D2.2-2.8 proposals) and the systemic approach for each system will be described in a first level. Till September 2011 the modeling of interactions and performance indicators at system level will be finalized, in order to prepare a first draft for each system by the end of October 2011, possibly including the treatment of uncertainties. These drafts will be finalized in the next meeting in Orleans and then will be given to VCE (Nov 2011) in order to be used for their implementation in the software. It is evident that the development of the systemic approach software will be started much earlier (June 2011) based on the agreed MODULES DESCRIPTION (see above) and after the visit in Illinois. The final deliverables for WP5 are due to M24 - M27.
Work Package 6:
The performance of the case studies depends on the availability of the SYNER-G software; however it is planned to start about February 2012, in order to complete a first run of the applications by June 2012 and finalize them by September 2012.
TENTATIVE AGENDA

<table>
<thead>
<tr>
<th>Thursday, April 28th</th>
<th>Responsible</th>
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<tbody>
<tr>
<td><strong>08:30-09:00</strong> Opening of the meeting</td>
<td>AUTH, NGI</td>
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<tr>
<td><strong>09:00-12:00</strong> (15 minutes coffee break)</td>
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<tr>
<td><strong>WP2: Development of a methodology to evaluate systemic vulnerability</strong></td>
<td>UROMA, UPAV, KIT-U, JRC</td>
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<td>Detailed description of the general methodology (Task 2.1) including socio-economic issues (Task 2.2), seismic scenarios (Task 2.4) and typology (Task 2.3). Examples. Discussion on the still open issues and final decisions. Definition of the way that the methodology will be implemented in the prototype software. General structure and road map for the implementation. Detailed description on the way that the uncertainties and the taxonomy are taken into consideration. Deliverables.</td>
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<td>Discussion – Definitive decisions on the methodological issues</td>
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<td><strong>12:00-12:30</strong> Task 2.5: Remote sensing, satellites images-validation progress, modification of DoW.</td>
<td>JRC, UPAV</td>
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<td><strong>12:30-13:30</strong> Lunch break</td>
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<tr>
<td><strong>13:30-15:00</strong> WP4: Socio-economic vulnerability and losses</td>
<td>KIT-U, BRGM, UROMA</td>
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<td>Further detailing of the socio-economic vulnerability and losses: definition of indicators, data harmonization/benchmarking, Urban Audit. Application parameters and preparatory study in the cases of L'Aquila and Thessaloniki.</td>
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<td>WP5: Systemic vulnerability specification</td>
<td>Further description and specification of the SYNER-G systemic approach (methodology parameters etc).</td>
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<tr>
<td>15:00-15:30</td>
<td>Final and definitive decisions on the methodology and all the modules and parameters needed for the implementation in the software</td>
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<td>15:30-16:00</td>
<td>Coffee break</td>
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<tr>
<td>16:00-18:30</td>
<td><strong>WP7: Build prototype software</strong>&lt;br&gt;Presentation of the MAEViz software by VCE. General features, capacities, treatment of the uncertainties. All with a specific example explaining and highlighting all modules.&lt;br&gt;Discussion on the possibility to use MAEViz as the basic platform for the SYNER-G methodology, as it is proposed and developed in WP2-3-4-5. Compatibility issues, difficulties, compromises.&lt;br&gt;Proposition and description of alternative solutions.&lt;br&gt;Definition of the ROAD MAP for implementation of the final decision.</td>
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<td>18:30</td>
<td>Closure of the first day</td>
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<td>19:00</td>
<td>Dinner in NGI restaurant</td>
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<td><strong>Friday, April 29th</strong></td>
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<td>09:00</td>
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<td>09:00-11:00</td>
<td><strong>WP3: Fragility functions of elements at risk</strong>&lt;br&gt;Final proposals-deliverables&lt;br&gt;- Buildings&lt;br&gt;- Utilities (electric power, gas and oil, water, waste-water).&lt;br&gt;- Transportation infrastructures (bridges, roadway, railway, harbor).&lt;br&gt;- Critical facilities (health care, fire fighting).</td>
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<td>11:00-11:30</td>
<td>Coffee break</td>
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<td>11:30-12:30</td>
<td><strong>WP8: Guidelines, recommendations and dissemination</strong>&lt;br&gt;reference reports, workshops leaflets, webpage etc</td>
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<td><strong>WP6: Validation studies</strong></td>
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<td>15:00-15:30</td>
<td><strong>Coffee break</strong></td>
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<td>15:30-16:30</td>
<td><strong>WP1: Administrative issues</strong></td>
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<td>etc)</td>
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<tr>
<td>16:30</td>
<td><strong>Closure of the meeting</strong></td>
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<td>16:30-17:00</td>
<td><strong>Steering Committee</strong></td>
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