The MERCI Project –Overview

Michael H. Faber

Interdisciplinary Workshop on Management of Earthquake Risks, Zurich, 28-29 August, 2006

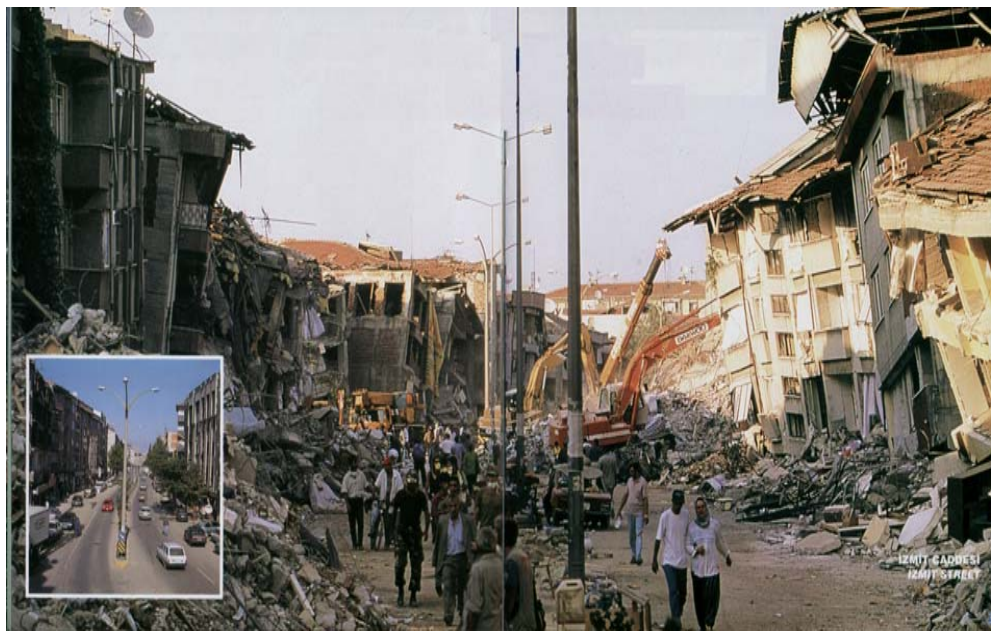
Aim of the Workshop

- Establishing a common basis for the models used in earthquake research.
- Strenghtening communication between involved research groups.
- Exchanging research ideas, results, data and tools.
- Forming a long term platform for achieving and maintaining this basis and thereby enhance the targeted research in the area in the future.

Motivation for the MERCI Project

- The need for consistent and quantitative risk assessment tools for buildings and infrastructure in seismic active areas.

- The limited societal recourses especially in developing countries calls for efficient decision making; facilitating the optimal allocation of available economical resources for the management of risks before, during and after an earthquake.



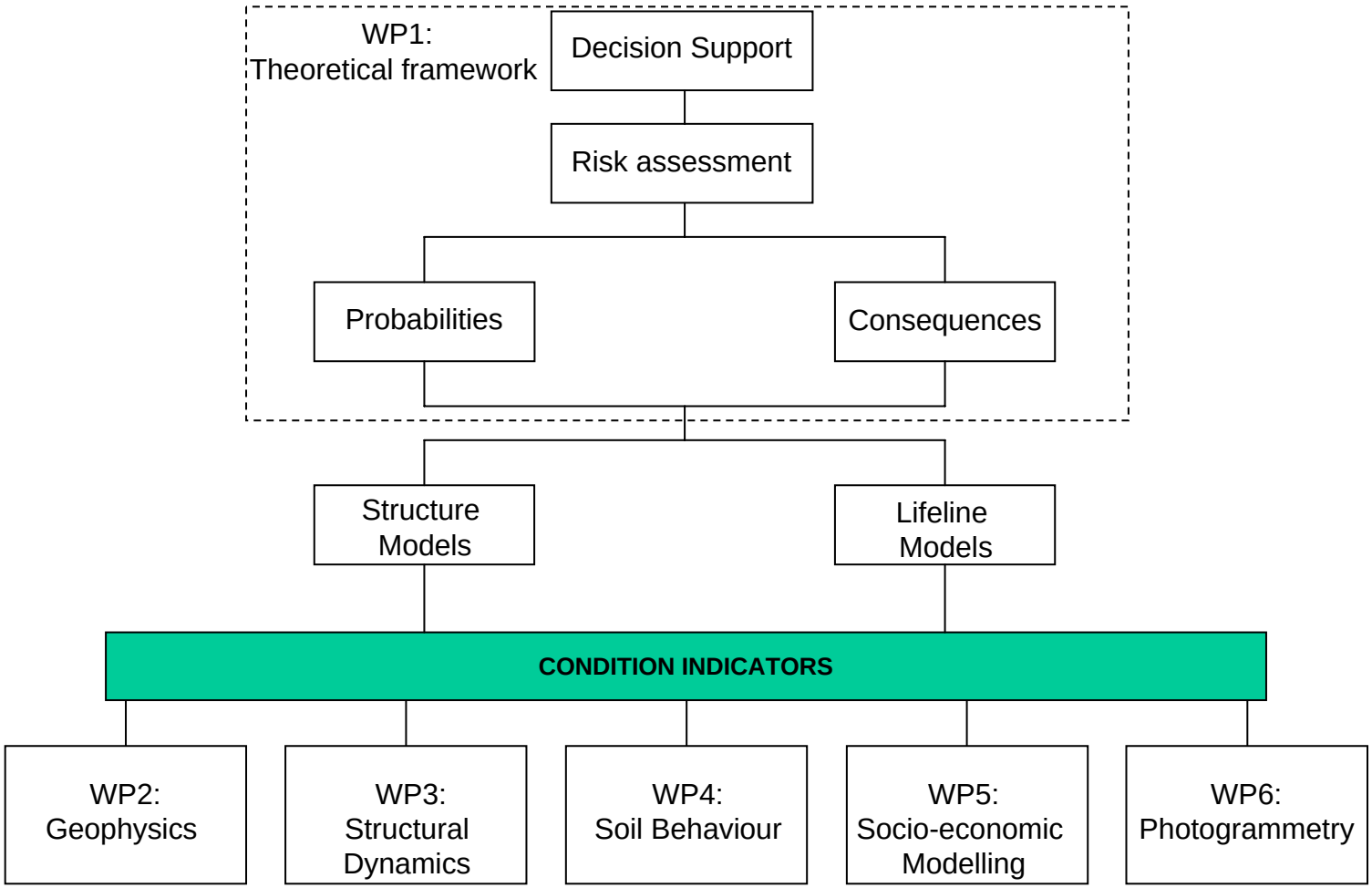
Aim of the MERCI Project

- To develop a generic decision theoretical framework for the consistent quantitative and rational management of earthquake risks.
- The decision support framework is designed for decision makers responsible for the safety of personnel, environment and assets of a region or a city.
- The system is generic in the sense that it is formulated in terms of characteristic descriptors (indicators) which can be observed. It is thus easily adapted to the characteristics of a specific region or city.
- The main emphasis is on the risks due to potential failures and collapse of building structures as well as infrastructure systems such as bridges and tunnels.
- It provides cost efficient decision support on how to optimize investments into risk reducing measures in three situations, prior, during and after an earthquake.

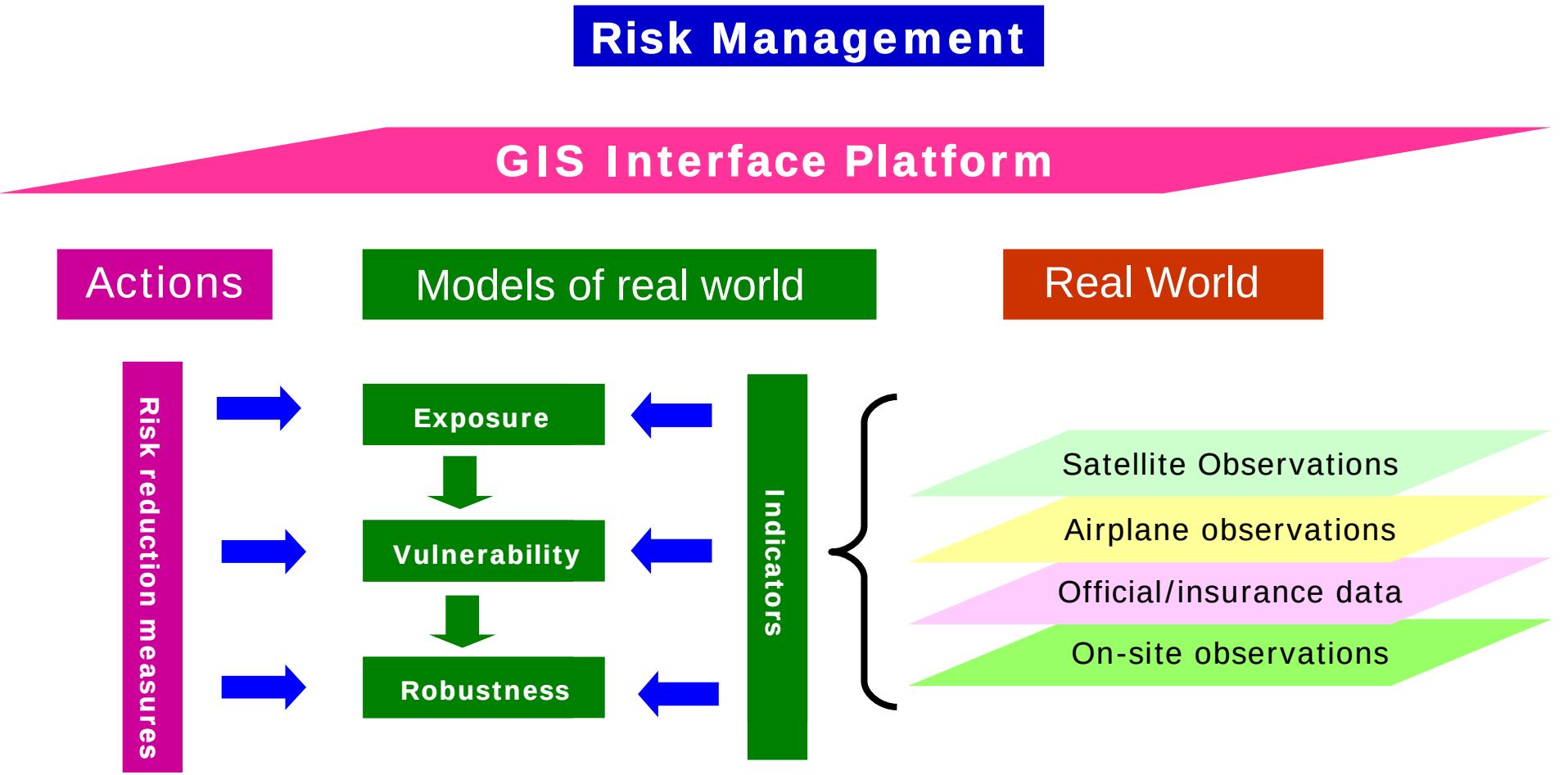
Facts about the MERCI project

- Interdisciplinary research group.
- Project started in June 2004.
- Funded by the Swiss National Science Foundation.
- Participating Institutes from the Swiss Federal Institute of Technology Zurich
  - Institute of Structural Engineering
    - Group Risk and Safety
    - Group Earthquake Engineering and Structural Dynamics
  - Institute of Construction Engineering and Management
  - Institute of Geotechnical Engineering
  - Institute of Geodesy and Photogrammetry
  - Institute of Geophysics

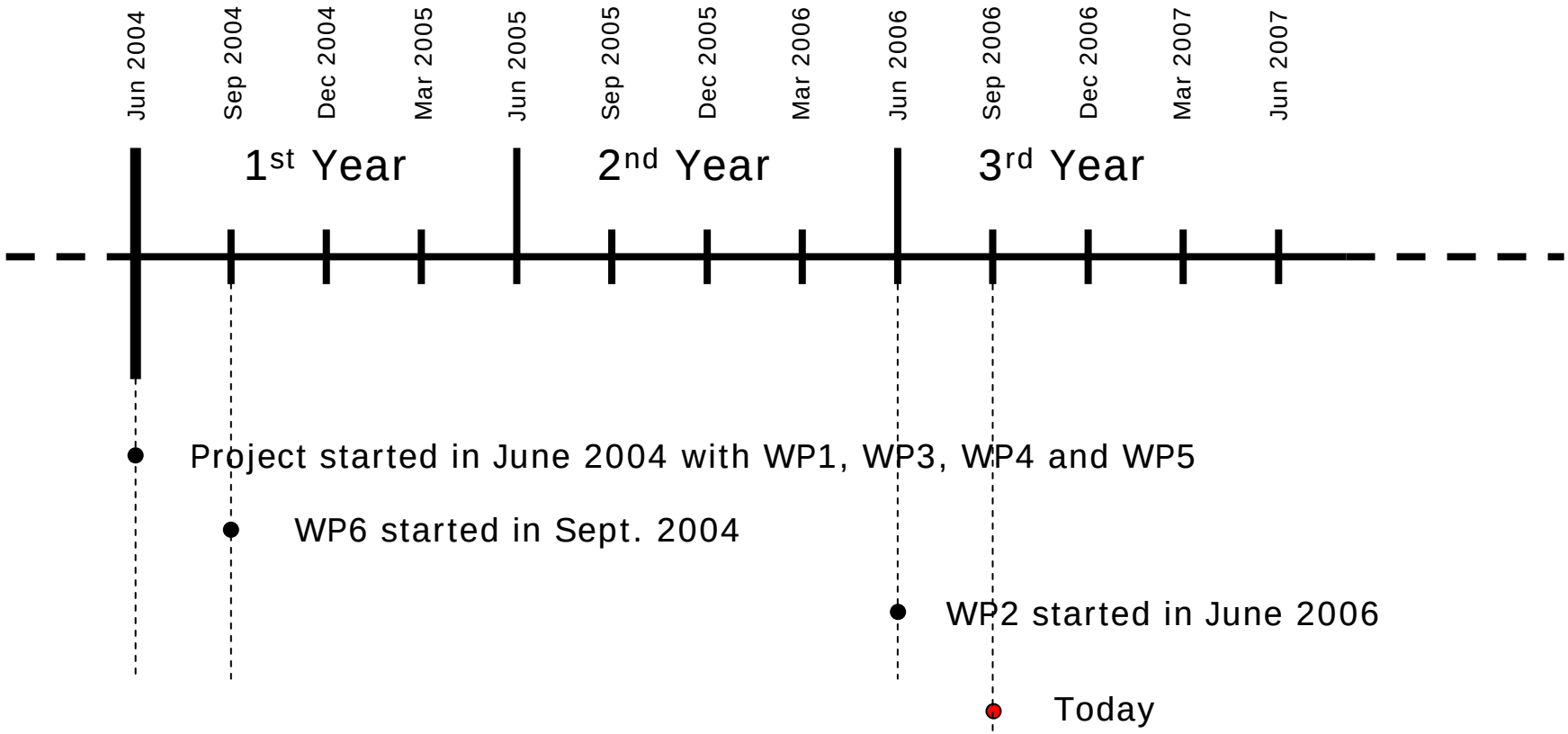
Structure of the MERCI project



The Project Components



Project start and duration



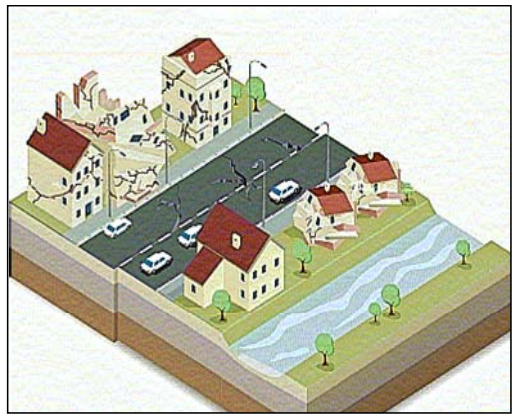
Decision Problems

Before

Optimal allocation of available resources for risk reduction

- retrofitting
- rebuilding

in regard to possible earthquakes



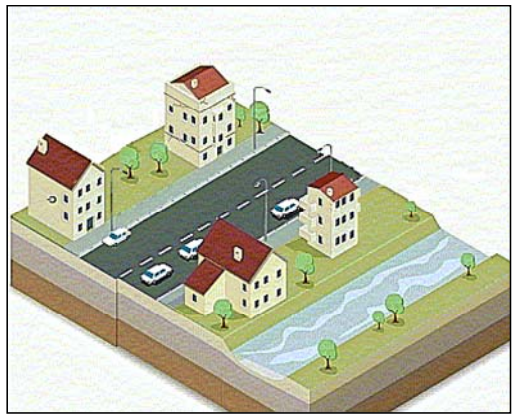
During

Damage monitoring/control

Emergency help and rescue

Aftershock hazard assessment

Identification of the seismic event



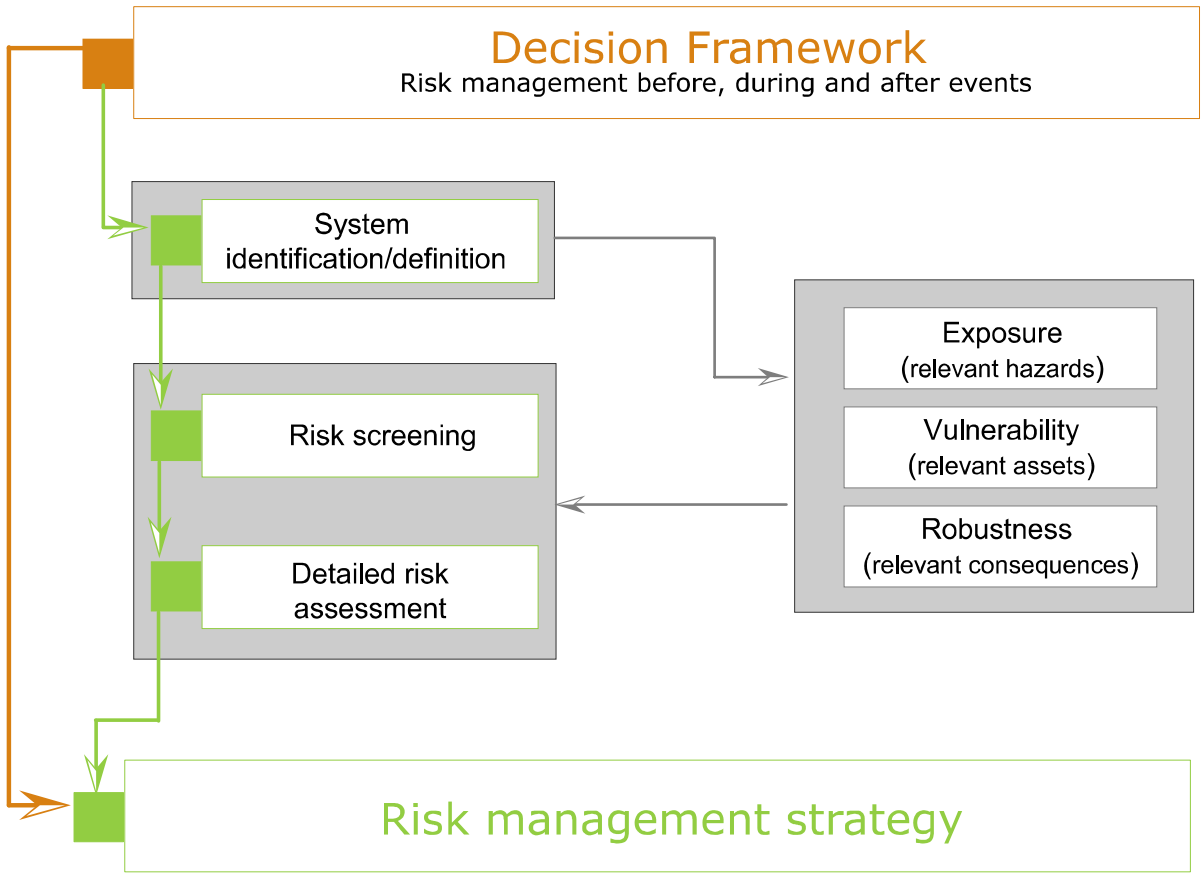
After

Rehabilitation of infrastructure functionality

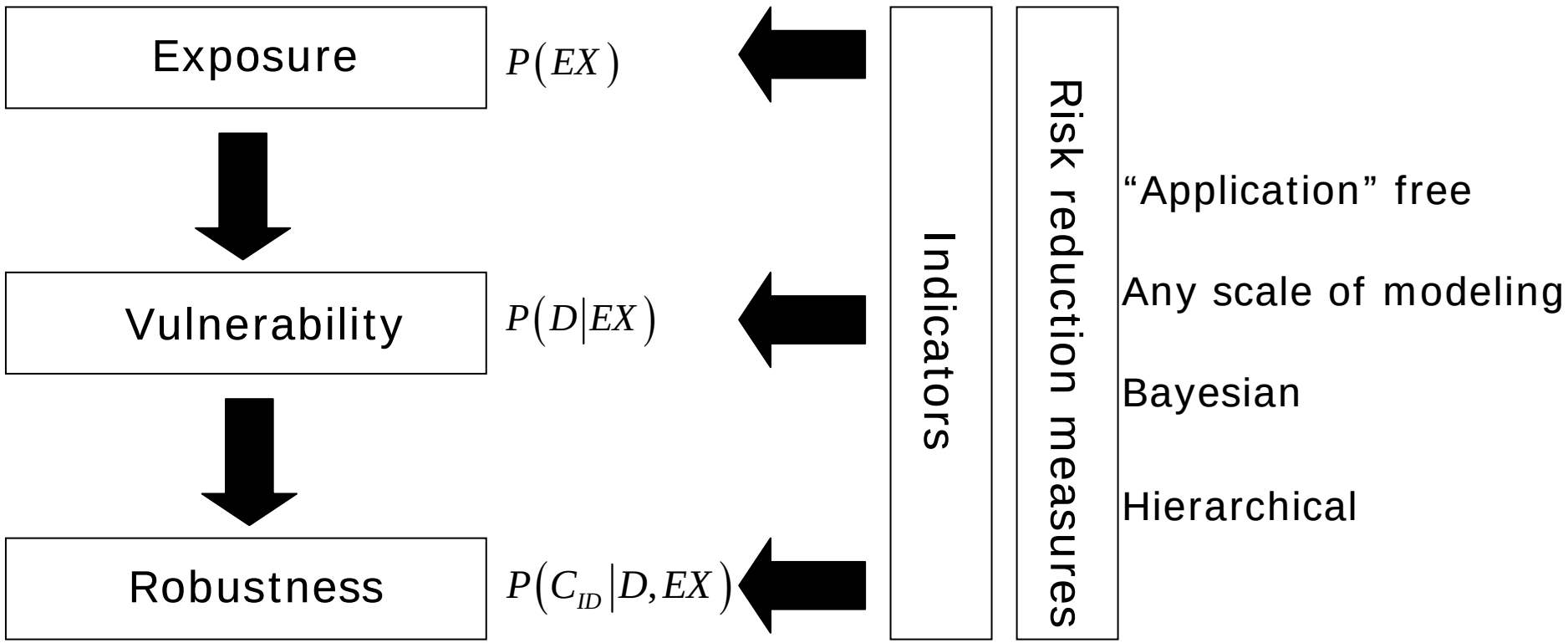
Condition assessment and updating

Optimal allocation of resources for retrofitting and rebuilding

Risk Assessment Framework



Risk Assessment Framework

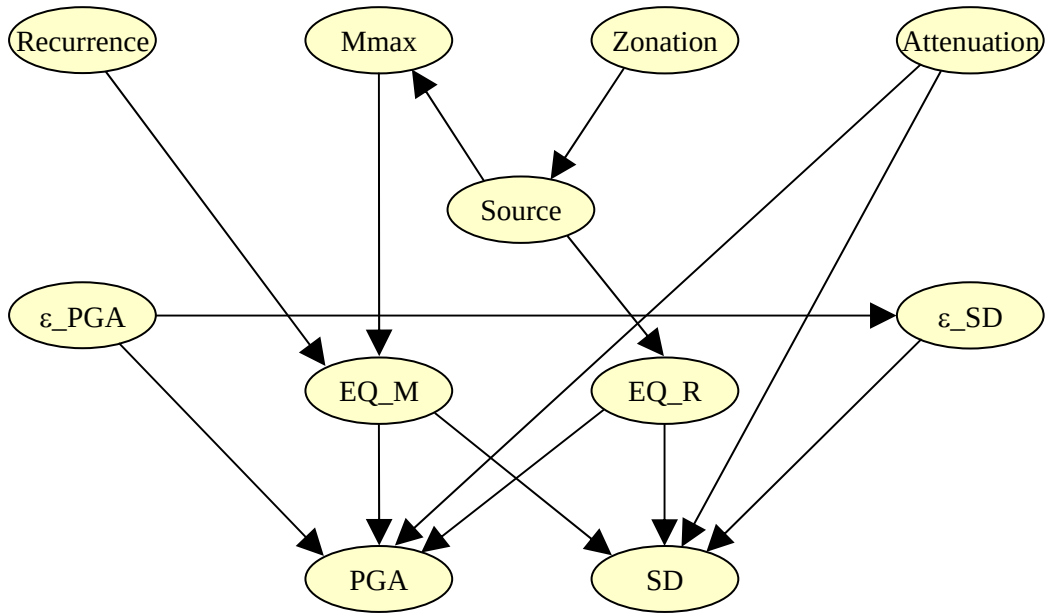


WP1: Theoretical and Methodical Framework

- Identification and formulation of relevant risk management decisions before, during and after an earthquake.
- Development of a generic decision theoretical framework for risk management.
- Identification and probabilistic representation of “risk indicators” i.e. observable characteristics containing information about earthquake risks.
- Development of Bayesian probabilistic networks for quantitative risk assessment and decision analysis - based on indicators.
- Identification and quantification of the “strength” of various indicators on optimal risk management decisions.

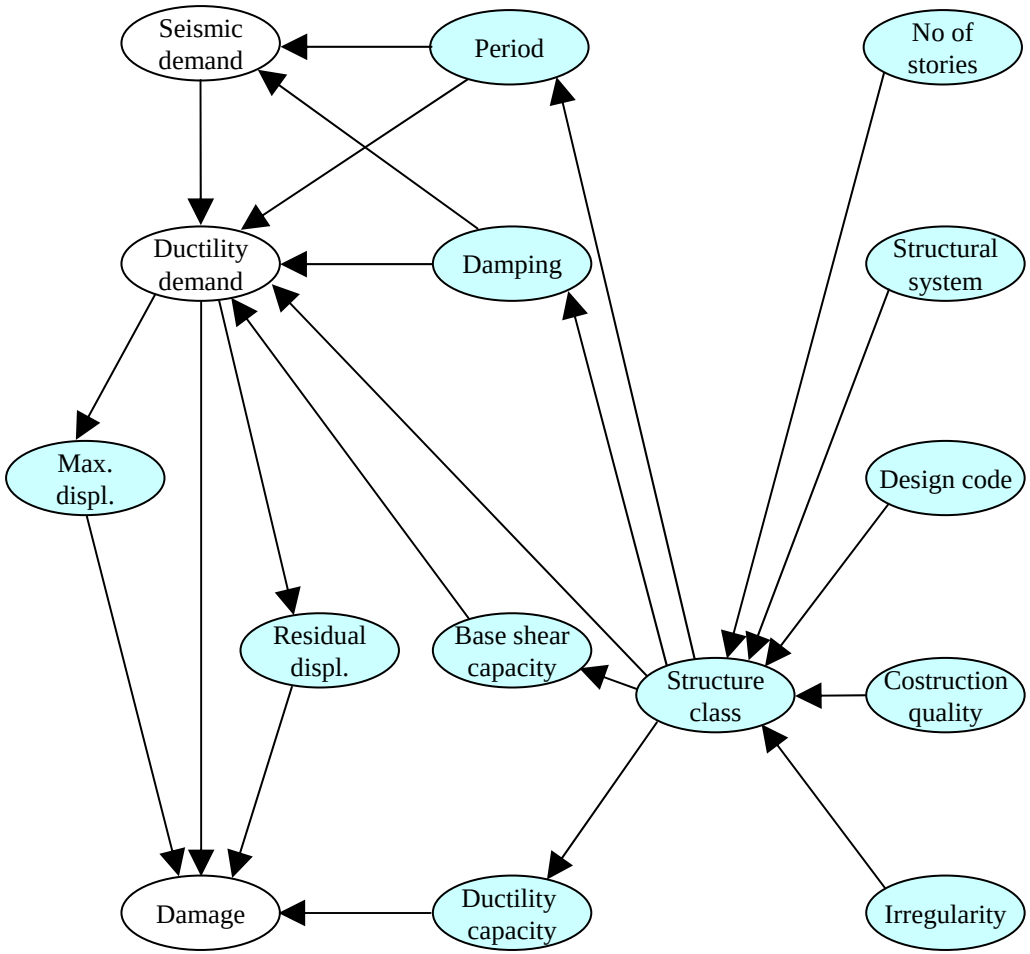
WP2: Near-source ground motion estimation based on condition indicators for earthquake rupture

- Identifying and quantifying condition indicators for earthquake source characterization and ground-motion parameters.
- Develop search engines to extract target ground-motion time histories from strong-motion databases.



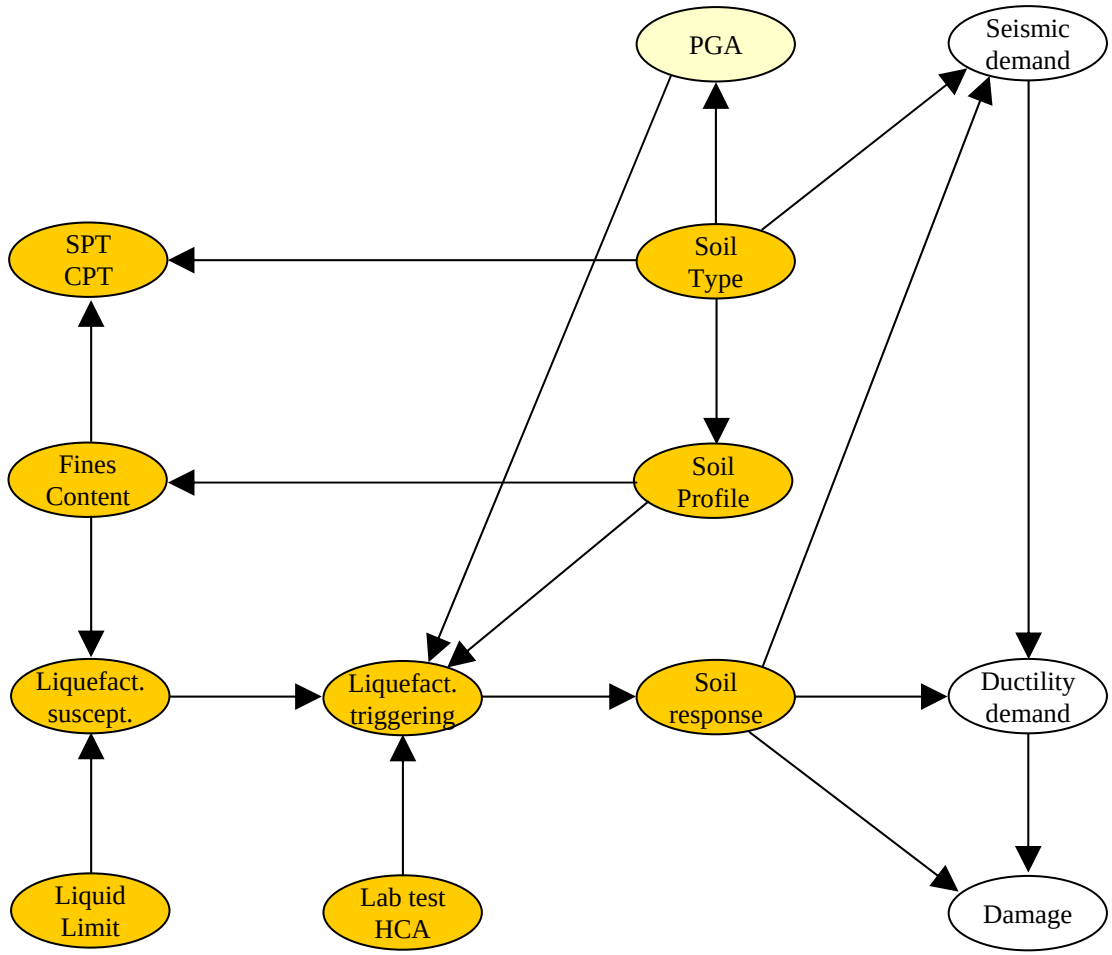
WP3: Seismic performance assessment using residual displacements

- Identification of structural condition indicators for quantitative risk assessment.
- Development and validation of updatable analytical or numerical models for the identified condition indicators during a seismic event.
- Development of a methodology to use residual structural displacements as a damage indicator.



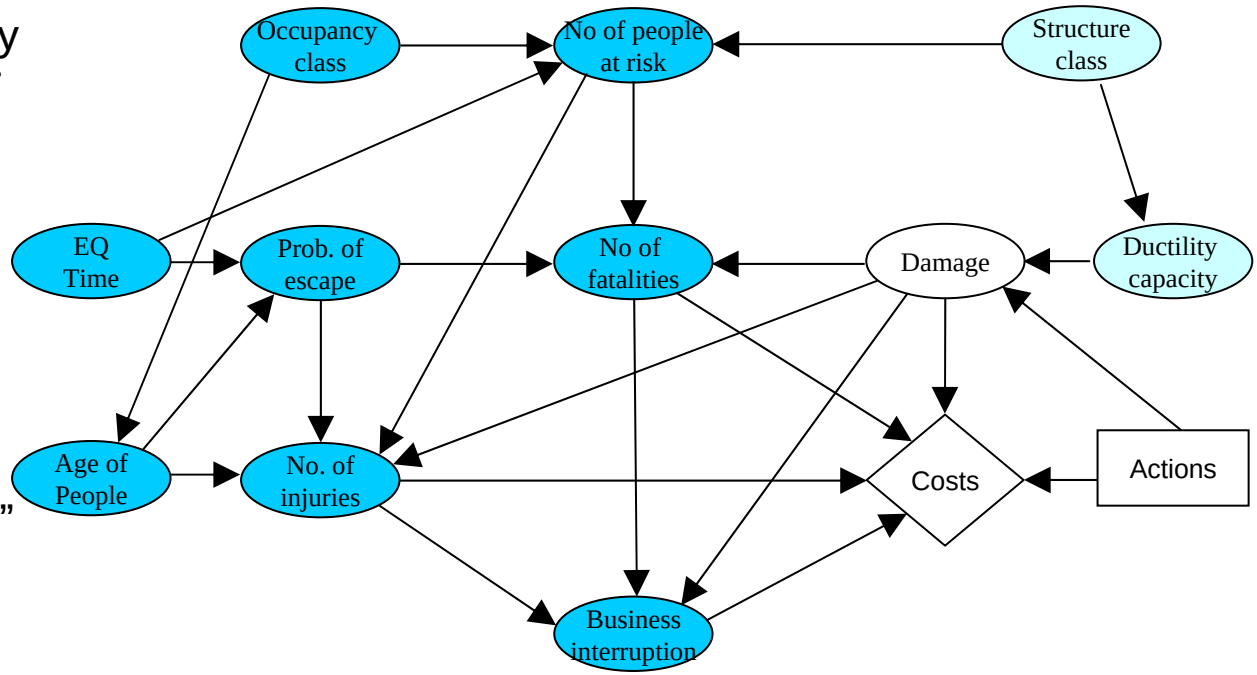
WP4: Condition indicators for liquefaction susceptibility of silty and sandy soils

- Evaluate clearly defined and mechanically valid condition indicators for soil.
- Implementation of new condition indicators, the loading function as well as local stress conditions e.g. different situations for different types of foundation.
- Identification of the influence of structural damage on soil behavior is considered in the formulation of the indicators.



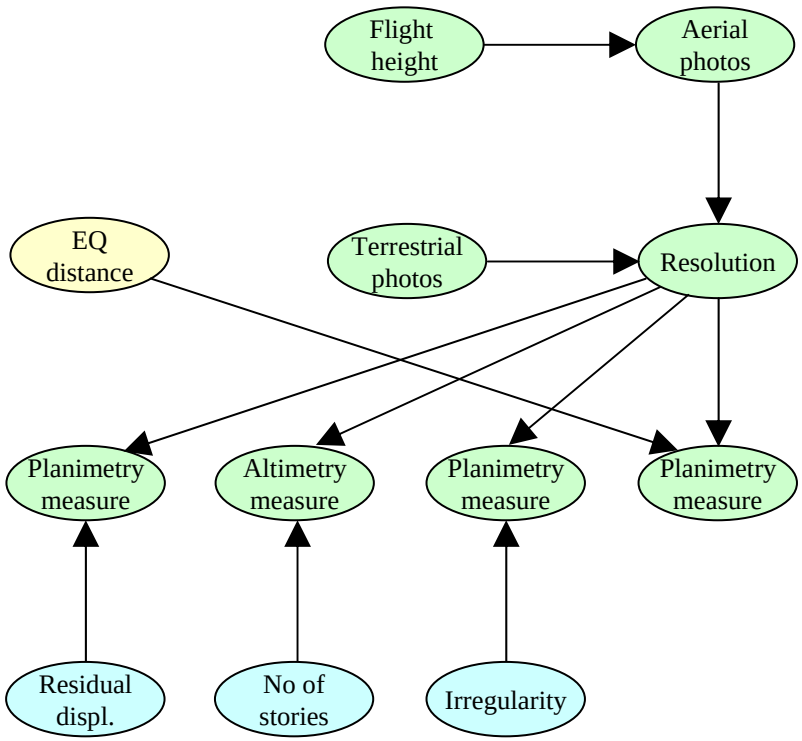
WP5: Consequence assessment in earthquake risk management

- Identification and quantification of indicators for consequence assessment.
- Estimation of fatality and injury ratios for different building types and damage degrees.
- Assessment of
  - direct structural and non-structural consequences and
  - indirect “follow on” consequences.

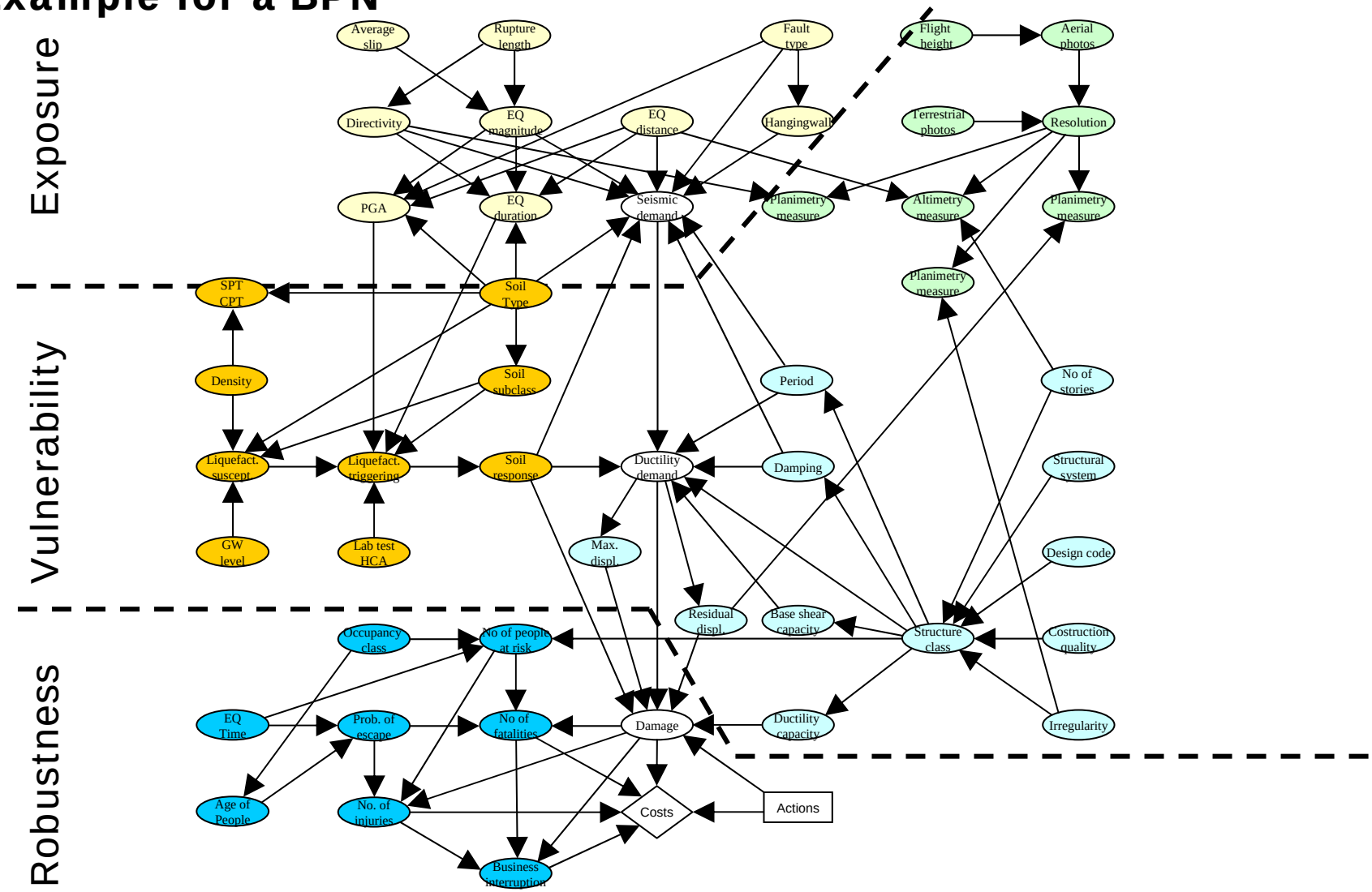


WP6: Methods of photogrammetry for damage assessment and monitoring

- Generate with CyberCity Modeler semi-automatically a 3D city model before the earthquake.
- Develop fully automated object extraction methods to generate a 3D city model after the earthquake in quasi real-time.
- Develop algorithms to compare before/after and to locate areas and amount of damage and obstructions.
- Establish a concept and methodology for the automated processing of terrestrial images taken from a Mobile Mapping platform.

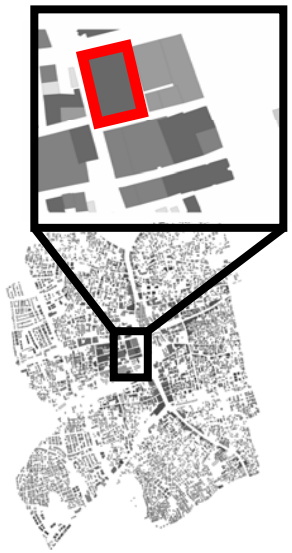


Example for a BPN



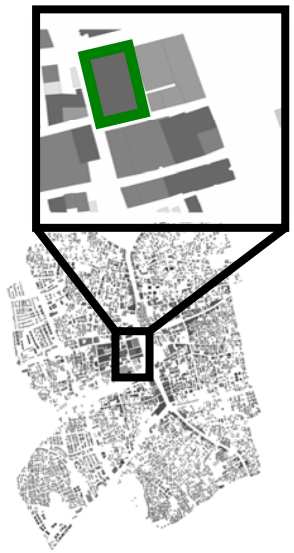
Typical Outputs

BEFORE



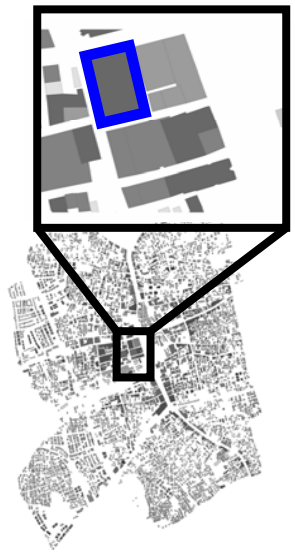
Generic BPN
+
structure and site specific information

DURING



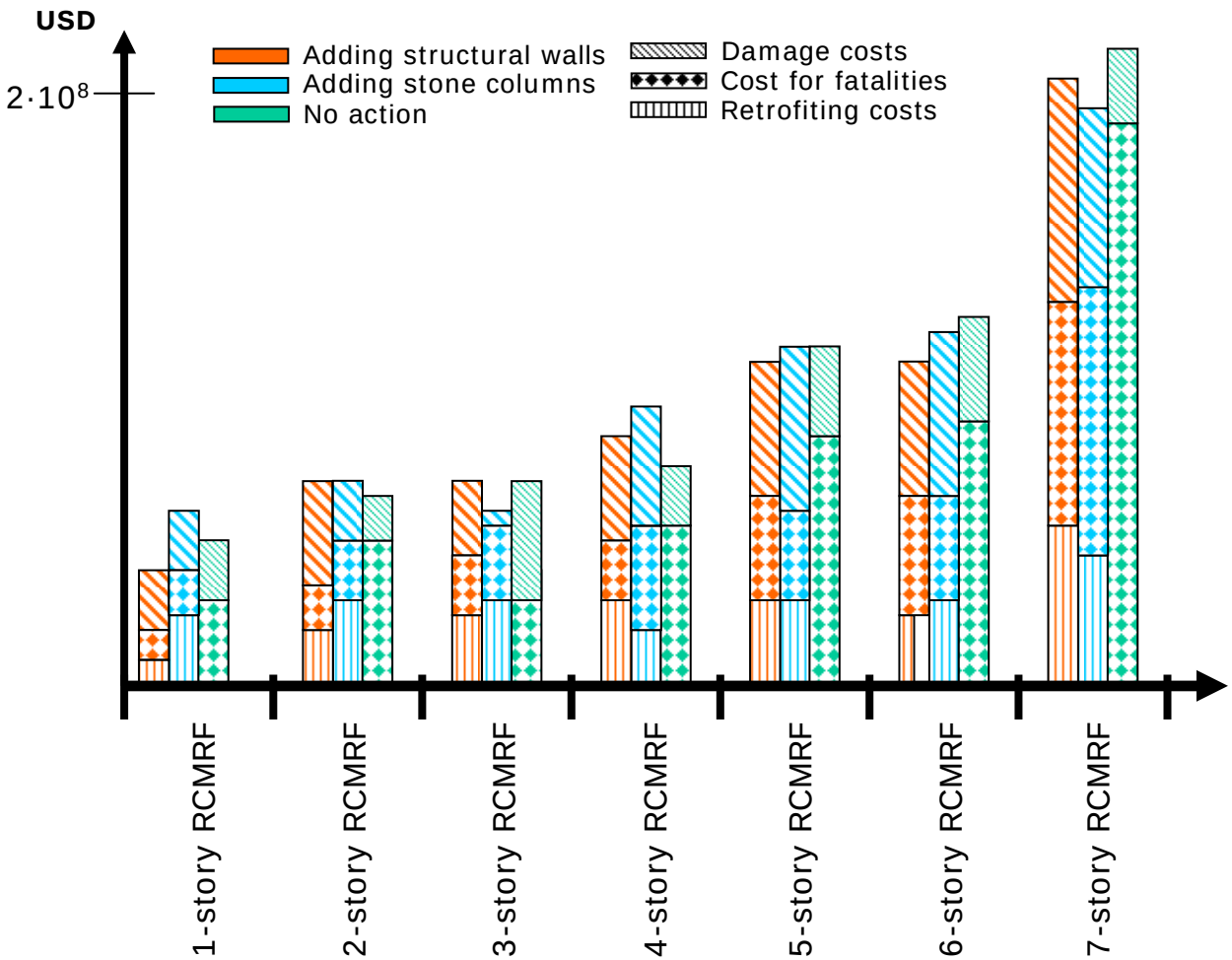
Generic BPN
+
structure and site specific information
+
new data (e.g. aerial photogrammetrical measurements

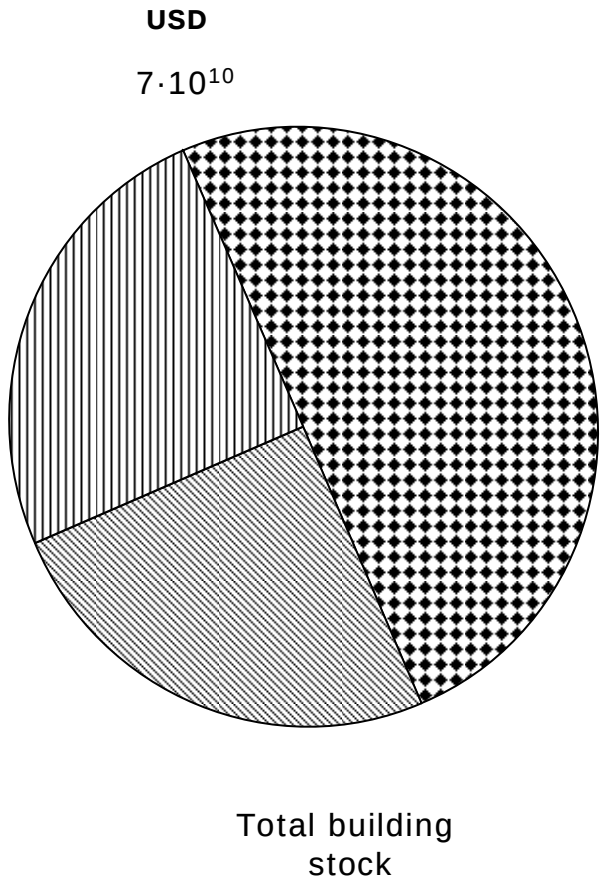
AFTER



Generic BPN
+
structure and site specific information
+
new data
+
updating models

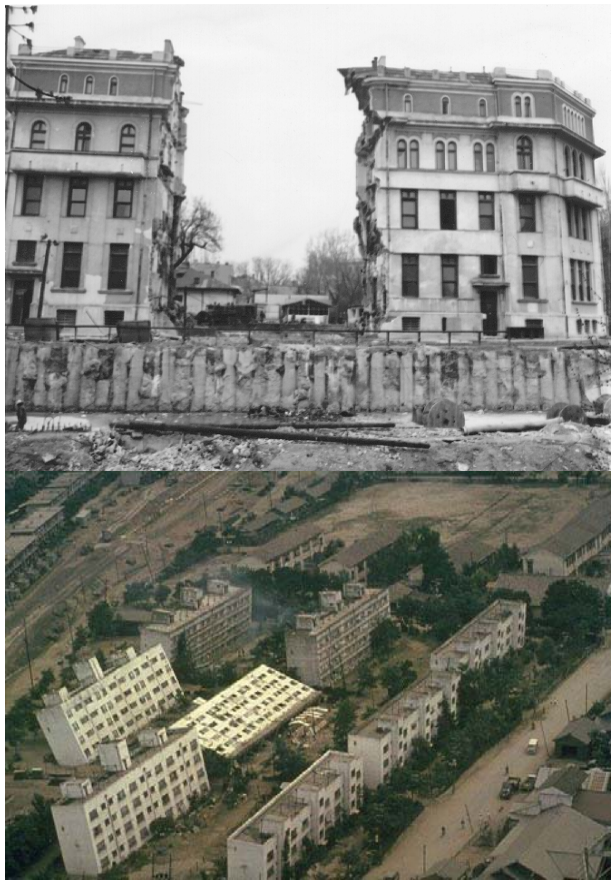
Typical Outputs





Outlook

- At present we are just reaching the stage where all modules have been linked under a GIS database platform.
- We are getting first results on e.g. optimal retrofit decisions for different types of structural classes as well as risk estimates on expected damage costs and loss of lives.
- We still need to develop and check some of the functionalities including the updating features utilizing e.g. aerial photographs and terrestrial measurements.
- The overall framework is highly modular and all modules can be improved or exchanged without any real difficulties.
- We will continue to develop the platform methodically and technically in the future in accordance with the insights gained from use of the platform.
- The framework will be made available for practical use by authorities, planners, insurance companies etc.



The MERCI Project –Overview

Michael H. Faber

Thank you for your attention

Management of Earthquake Risks using Condition Indicators

www.merci.ethz.ch