

**Contract:**

**ENEA – Banco Interamericano de Desarrollo (BID)/InterAmerican Development Bank (IDB)**

# **Manejo de Riesgos en Valparaiso, Servicios Técnicos**

Acronym: “*MAR VASTO*”

**ATN/II-9816-CH**

**Contract n.**

**PRM.7.035.00-C**



## **FINAL PROGRESS REPORT**

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## 1. PREFACE

The activities are foreseen by the Contract n. PRM.7.035.00-C between the InterAmerican Development Bank and ENEA, signed on March 12<sup>th</sup>, 2007 by Dott. Marcello Garozzo, Director of Environment, Global Change and Sustainable Development Department [01].

This final progress report describes the conclusive “MAR VASTO” project conference done in Valparaíso on September 29-30, 2008 and summarizes all the results in simple statements. Reference documents are the general progress reports [02-04] and specific work-package reports [05-13].

The “MAR VASTO” activities are fully in agreement with the “Términos de referencia” requested by BID in the document [14].

The project conclusion is extended until October 31<sup>st</sup>, 2008, as foreseen by the document [15].

Furthermore, after an agreement with the Istituto Italo Latino Americano (IILA), and also with the authorization of the OGP Director Arch. Paulina Kaplan Depolo, 4 Chilean experts (two still belonging to the OGP, and other 2 working for OGP at the time of the Italian missions) have been entrusted of short bursaries in Italy (Spring 2008), specifically targeted on the “MAR VASTO” project activities. They are:

Arch. Claudia Andrea Zuñiga Jara, OGP (2 months);

Arch. Mauricio Sebastian Gonzalez Lodola, OGP (2 months);

Arch. Cristian Ignacio Palma Valladares, Chilean expert (4 months);

Arch. Carolina Avalos, Chilean expert (4 months).

Moreover, an expert functionary of OGP, Arch. Sotero Apablaza Minchel, officially entrusted by the OGP Director, reached Italy in the same period (2 months) and contributed in an excellent way to the “MAR VASTO” project and for the identification of future cooperation.

A specific agreement has been reached between the “MAR VASTO” team and the Intendente Regional, after his welcome address during the final conference (in which he promised special funds for the intervention on the San Francisco Church, see Appendix 4) and some working meetings with the technical staff:

- the church must be partially or totally closed (due to safety reasons) and a prompt emergency intervention should be urgently carried out, in order to avoid the collapse of the building beel-tower and façade, with resources of the Intendencia Regional; for the prompt intervention, the Italian team is going to offer a free project (see Appendix 5);
- the overall rehabilitation intervention of the San Francisco Church has been included in the specific program “Puesta en Valor Patrimonial” foreseen for the Valparaíso Region.

## 2. THE FINAL “MAR VASTO” PROJECT CONFERENCE

The final “MAR VASTO” conference has been organized in the San Francisco del Barón Church in Valparaíso on September 29<sup>th</sup>, 2008, with the agreement of Chilean partners and stakeholders. In fact, this historical monument can be considered the most critical point found during all the investigation (due its critical structural conditions and the possibility of partial/total collapse in case of a medium/high earthquake) and represents surely a symbolic icon for defining Risk Assessment procedures and rehabilitation interventions.

The conference of September 29<sup>th</sup>, chaired by Arch. Sotero Apablaza (Valparaíso Municipality) and Maruzzella Giannini (ICE, Italy) has seen the participation of the following Authorities giving a welcome address:

- Father Fernando Candia, San Francisco Church;
- Mons. Gonzalo Duarte García de Cortázar, Bishop of Valparaíso;
- Dr. Ivan de la Maza Vaillet, Intendente V Región Valparaíso;
- Dr. Omar Jara Aravena, Alcalde Surrogante, Valparaíso Municipality;
- Dr. Roberto Santilli, Italian Embassy and ICE (Istituto per il Commercio Estero);
- Dr. Ana Maria Icaza, Directora PRDUB/BID Valparaíso.

Also Dr. Claudia Cárdenas, BID consultant, gave a contribution to the discussion.

The Appendix 1 shows the final conference program, while the Appendix 2 contains all the Power Point presentations.

Furthermore, the “MAR VASTO” final conference has been joined by the Master Eco-Polis conclusion (September 30<sup>th</sup>, 2008, chaired by Prof. Roberto Barria of the Federico Santa Maria University of Valparaíso, with the welcome addresses by Arch. Juan Mastrantonio, Board of Architects of Valparaíso, and Arch. Paulina Kaplan Depolo, Valparaíso Municipality, Oficina de Gestion Patrimonial), just foreseen in Valparaíso in the same period (see some presentations in Appendix 3), as agreed by the Master Director, Prof. Gianfranco Franz, and the “MAR VASTO” coordinator, Dr. Maurizio Indirli.

. The Eco-Polis International Master in environmental and regional policies for sustainability in local development is an advanced itinerant training program, organized by the Universities of Ferrara and Calabria, Italy, the Pontificia Universidade Católica de Paraná, Curitiba, Brasil, the Universidad Católica de Córdoba, Córdoba, Argentina, and the Universidad Técnica Federico Santa Maria, Valparaíso, Chile, with the support of UNESCO, IILA (Istituto Italo Latino Americano) and Red Alvar (see <http://www.masterecopolis.it/>).

During the conference, another important International training activity has been presented by Marco Munari of University of Padua: the Advanced Master in Structural Analysis of Monuments and Historical Constructions (see Appendix 2 and <http://www.msc-sahc.org/>).

During the conference, Dr. Oscar Acuña Poblete, Secretario Ejecutivo of the “Consejo de Monumentos Nacionales de Chile”, representatives of several universities (University of Chile, Santiago; University Federico Santa Maria, Valparaíso; University of Valparaíso; University of Playa Ancha, etc.), private consultants, Valparaíso local communities people, and many students were present both the days (totally, more than one hundred persons).

Moreover, an exhibition of Italian technical-scientific activities on cultural heritage (“*Yesterday/Tomorrow: 50 years of urban conservation and innovation in Italy*”, sponsored by IILA, Istituto Italo Latino Americano) has been available during the final conference.

The successful result of the “MAR VASTO” final conference has been surely due to the support of many Chilean Organizations, which strongly cooperated with the Italian experts during the project: Church Authorities; the “Intendencia V Region Valparaíso”; the Ministry of Culture (“Consejo Nacional de la Cultura y Las Artes”); various Offices of the Valparaíso Municipality; the Regional Civil Defense (“OREMI”); the SHOA (“Servicio Hidrográfico y Oceanográfico de la Armada de Chile”); the Firemen (“Bomberos”) and the Sea Rescue (“Bote Salvavidas”) Corps of Valparaíso; the Valparaíso Italian Community and city organizations (“Junta de Vecinos” of the Cerro Cordillera and “Gerencia Barrio Puerto”, which is the historical district of the City); the Board of Architects of Valparaíso and other professionals; the Police (“Carabineros de Chile”).

### 3. “MAR VASTO” FINAL RESULTS: “Términos De Referencia (TDR)” accomplishment

The document [14] is taken into account.

#### ***TDR1. Recopilación del “estado del arte” de la información de Valparaíso***

- a) recopilación de cartografía y mapas de Valparaíso y adquisición de imágenes de satélite de alta resolución;*
- b) recolección y análisis de material histórico (fotos, mapas, bases de datos, entre otros);*
- c) recolección y análisis de los estudios e investigaciones existentes respecto de los eventos sísmicos, fenómenos de deslizamiento de laderas, maremotos, incendios y otros hechos que impliquen riesgo a la infraestructura de Valparaíso (en particular en las áreas declaradas patrimonio);*
- d) organización de un archivo digital con soporte en Sistemas de Información Geográfica (SIG) de toda la información anteriormente señalada.*

Points a-d) have been implemented in the Working Package WP01 “state-of-the-art for all the municipality of Valparaíso” (see Table 1) and have been completed, as shown by the General Progress Reports n. 1-3 [02-04].

Specific activities are also described in reports [05-06] (GIS database, see Table 6) and [07-10], including geomorphological and fire hazards (disaster hazards, see Tables 1, 3 and 4).

#### ***TDR2. Control Topográfico de la Información***

- a) ortorectificación de la cartografía e imágenes de satélite adquiridas;*
- b) georeferenciación de la infraestructura representativa del patrimonio de Valparaíso;*
- c) levantamiento y escaneo tridimensional de las estructuras representativas de las áreas declaradas por la UNESCO, para el análisis de su vulnerabilidad estructural.*

Points a-b) have been implemented in WP2 (topographic survey) and WP6 “development of the geo-referenced digital archive” (see Tables 2-6), as shown by reports [05-06].

Point c) has been developed in WP2 (laser scanner 3D survey for three representative Valparaíso churches), as shown by report [11].

#### ***TDR3. Riesgos Sísmicos***

- a) evaluación y análisis de los estudios e investigaciones existentes;*
- b) análisis en profundidad a través de la micro zonificación sísmica y campañas experimentales;*
- c) elaboración y cartografía de escenarios de riesgo sísmico (con uso de SIG).*

Point a) has been carried out in the framework of WP1 “state-of-the-art for all the municipality of Valparaíso” (see Table 1). With regard to point b), it was impossible (due to short time and insufficient funds) to manage specific in situ experimental campaigns.

The definition of the seismic input in the Valparaíso urban area site, i.e. the determination of the seismic ground motion due to an earthquake with a given magnitude and epicentral distance from the site, has been done following a theoretical approach. The realistic modeling of ground motion requires the simultaneous knowledge of the geotechnical, lithological, geophysical parameters and topography of the medium, on one side, and tectonic, historical, paleoseismological, seismotectonic models, on the other, for the best possible definition of the probable seismic source. The initial stage of the work was thus devoted to the collection of all available data concerning the deep and shallow geology, the construction of cross-sections along which to model the ground motion, and the specification of the possible seismic sources. In any case for the urban Valparaíso area, the following four deterministic seismic scenarios have been implemented, taking into account two fault rupture typologies (bilateral and unilateral):

- Magnitude 7.5 Occasional (Occurrence Period  $\approx$  120-140 years, Strong);
- Magnitude 7.8 (1985) Sporadic (Occurrence Period  $\approx$  200-250 years, Very Strong);
- Magnitude 8.3 (1906) Rare (Occurrence Period  $\approx$  500 years, Disastrous);
- Magnitude 8.5 Exceptional (Occurrence Period  $\approx$  1000 years, Catastrophic).

The Magnitude 7.8 deterministic model has been developed and checked considering the experimental data recorded during the 1985 Valparaiso earthquake (two recording stations: Federico Santa Maria and El Almendral); then, the other models have been implemented, elaborating synthetic signals (displacement, velocity and acceleration) for a grid covering all the Valparaiso area and specifically the sites of the three churches (“La Matriz”, San Francisco del Baron” and “Las Hermanas de la Providencia”). Finally, with regard to point c), 96 hazard maps has been created on the GIS database.

A general result of our modeling is that the effect of the local site conditions can cause an increment greater than 1 unit in the seismic intensity experienced with respect to the average intensity affecting the urban area.

The study in detail (see Tables 1-3) is reported on documents [05] and [09].

#### ***TDR04. Riesgo de Tsunamis y Erosión Costera.***

- a) evaluación y análisis de los estudios e investigaciones existentes;*
- b) implementación de modelos matemáticos, elaboración de escenarios y cartografía (con el uso de SIG) de riesgos de tsunamis.*

Thanks to the excellent cooperation with SHOA (Servicio Hidrografico y Oceanografico de l’Armada de Chile), the starting points have been the “scenario events 1985 and 1906” e “source models” taken from SHOA elaborations. Then, other Valparaiso tsunami scenarios have been developed:

- Magnitude 7.0 Frequent (Occurrence Period  $\approx$  70-80 years);
- Magnitude 7.5 Occasional (Occurrence Period  $\approx$  120-140 years, Strong);
- Magnitude 7.8 (1985) Sporadic (Occurrence Period  $\approx$  200-250 years, Very Strong);
- Magnitude 8.3 (1906) Rare (Occurrence Period  $\approx$  500 years, Disastrous);
- Magnitude 8.5 Exceptional (Occurrence Period  $\approx$  1000 years, Catastrophic).

Finally, the maximum tsunami wave heights have been calculated with reference to the tsunami scenarios and the SHOA inundation map stored in the GIS database.

The study in detail (see Tables 1-4) is reported on documents [05] and [10].

#### ***TDR05. Riesgo de Incendios***

- a) evaluación y análisis de los estudios e investigaciones existentes;*
- b) caracterización de los incendios por tipo y efectos;*
- c) elaboración y cartografía de escenarios de riesgo de incendio (incluyendo zonificación en SIG).*

Thanks to the excellent cooperation with OGP of the Valparaiso Municipality, all the points a-c) have been accomplished (see Table 1 and documents [05] and [08]).

#### ***TDR06. Riesgo de deslizamientos y derrumbes***

- a) evaluación y análisis de los estudios e investigaciones existentes;*
- b) caracterización de los deslizamientos y derrumbes por tipo y efectos;*
- c) elaboración y cartografía de escenarios de riesgo de deslizamientos y derrumbes (incluyendo zonificación en SIG).*

Thanks to the excellent cooperation with OGP of the Valparaiso Municipality and other Chilean Institutions, all the points a-c) have been accomplished (see Table 1 and documents [05] and [07]).

### ***TDR07. Análisis de Vulnerabilidad***

- a) identificación de las edificaciones presentes en el área declarada por la UNESCO;*
- b) levantamiento arquitectónico y estructural de las edificaciones del área UNESCO, selección de estructuras representativas de las áreas (mampostería, madera, acero o adobe);*
- c) análisis in situ de las propiedades físico mecánicas de los materiales constituyentes de las estructuras representativas seleccionadas;*
- d) caracterización sísmica de las estructuras representativas seleccionadas:*
  - d<sub>1</sub>) pruebas experimentales de laboratorio;*
  - d<sub>2</sub>) simulaciones numéricas (elementos finitos) de algunos casos indicativos;*
  - d<sub>3</sub>) análisis multicriterio de la vulnerabilidad de las estructuras representativas del área UNESCO.*

With regard to the point a), being impossible to manage deep investigations for all the Valparaíso historical area (due to limited resources in funds and time), a common decision with Chilean partners and stakeholders has been taken on structures/areas to be investigated with highest priority:

- three important historical churches (“La Matriz”, “San Francisco del Barón”, “Las Hermanas de la Providencia”), made by different materials and located in different sites of the city;
- a building stock in the Cerro Cordillera (partially included in the UNESCO zone, area included within Calle Clave, Calle Ramos, Plaza Sotomayor), consisting in more than 230 residential/commercial buildings, 4 open spaces and a network of 50 roads (architectonic and urban planning analyses); in addition, the structural vulnerability has been evaluated for 70 buildings.

This activity is widely described in the general reports [2-4] and the WP reports [5, 6, 11-13] (see Tables 1, 2 and 5).

Due to lack of funds and time, a deep investigation of material properties with in situ and laboratory tests was not possible, as foreseen by points c) and d<sub>1</sub>). In any case, the in situ investigation produced enough data to define the structural vulnerability of the three churches and Cerro Cordillera buildings, as asked by point d<sub>3</sub>, following specific prompt procedures in agreement with Italian codes. Point d<sub>2</sub> has been accomplished for the most significant cases (churches of San Francisco del Barón and Hermanas de la Providencia).

### ***TDR08. Organización de la información en un archivo digital – SIG***

All the data achieved have been stored in the digital GIS database, as shown by all the reports (see Table 6).

### ***TDR09. Elaboración de propuestas finales***

- a) elaboración de los principales elementos del “Codice di Practica” para el área UNESCO;*
- b) documento final, que incluirá propuestas de intervención para la mitigación de riesgos de las edificaciones en caso de: Terremotos, Maremotos e Incendios;*
- c) identificación de debilidades y obstáculos institucionales a la capacidad de respuesta frente a las vulnerabilidades identificadas;*
- d) recomendación de medidas a corto plazo para mitigar los riesgos detectados (por ejemplo, Planes de Respuesta o Contingencia y respectivos sistemas de Alerta y Alarma - prevención, preparación y respuesta);*
- e) elaboración de un plan de acción para dar continuidad y sostenibilidad institucional a los productos de la TC.*

All these points have been discussed in all the general and WGs reports, in particular [11-13] (see Table 7). Here the main statements are briefly reported.

## **Hazards**

The developed hazard maps, even if to be implemented in the future, can provide the first data to better define Risk Assessment procedures and Emergency measures. In any case, the following statements can provide some suggestions for future development.

### Earthquake

The definition of the seismic input provides the complete time-histories in displacement, velocity and acceleration for several scenarios for all the Valparaiso urban area (and specifically also for the sites in which the investigated churches are located), not only the Maximum PGA (Peak Ground Acceleration) values, sometimes not enough accurate for structural calculations, usually taken into account for antiseismic design. Thus, antiseismic projects can be carried out in the future with a more reliable data, in particular for cultural heritage rehabilitation.

### Tsunami

Using as a base of knowledge the inundation map provided by SHOA associated to the 1906 event, the methodology allows to generate a set of tsunami scenarios at the Valparaiso site, associated to different “scenario” earthquakes, i.e. different tsunami heights. Thus, Risk Assessment procedures can be implemented, in order to better define evacuation plans.

### Landslide

The analysis permitted the study of the landslide susceptibility for all the City of Valparaiso. The upstream hill side is characterized mainly by mud-debris flow events. The intensity of those phenomena can vary widely, but the presence of densely populated urban settlements in ravine beds, escarpment sides and valley heads (often artificially terraced) makes the associated risk very high. The coastal flat is reached by moved materials only when the event is intense or when several activated areas merge and flow together in the same bed. Fall events are punctual and characterized by local effects, but often destructive, at the basis of the sub-vertical sides. Future actions for deeper quantitative studies to better identify the hazard level are the following:

- definition of the eluvium thickness, with the aim to evaluate moving materials and flow velocity and then energy and intensity of the expected processes;
- implementation of the historic landslide inventory, gathering information in the periods characterized by absence of data, with the aim to improve time distribution statistics;
- improvement of the GIS database structure, separating two information levels: DTM (Digital Terrain Model) completely dedicated to the topographic ground surface, and DEM (Digital Elevation Model) taking into account only urban settlements;
- identification, on a geomorphologic basis and through specific softwares, of the transit and accumulation areas of moving materials in the susceptibility areas;
- evaluation of the seismic ground shaking as starting point of landslide phenomena, *in primis* falls;
- identification of all the elements subjected to risk;
- design and implementation of a dedicated monitoring system.

### Fire

This work provides the first steps regarding the fire hazard evaluation in Valparaiso. Of course, the GIS database has to be implemented in the future, gathering and incorporating additional information:

- building inventory
  - year of construction;
  - material of construction;
  - building floor number;
  - area of the construction;
  - building maintenance;
  - unoccupied, wild and abandoned areas;
  - etc.
- viability
  - street length;

- street slope;
- street typology;
- etc.
- green and playtime areas
- tree sites;
- location of squares and public areas;
- etc.
- socio-demography variables
- socio-economic level;
- age classes of the population;
- number of persons per building;
- etc.
- physical variables
- hill slope (in percentage);
- sun exposure in function of the day time (hours);
- elevation of the analyzed areas;
- etc.
- utilities
- location of aqueducts and drains;
- location of hydrants;
- location of electric power;
- location of gas pipelines;
- location of phone lines;
- etc.
- commercial variables
- industrial and commercial facilities;
- location and typology of shops;
- etc.

Furthermore, a special attention should be dedicated to fires following earthquakes and connections with other natural hazards.

### **General Guidelines for a Building Inventory**

The activities performed for the Cerro Cordillera building stock can be considered a robust step ahead, having focused, even if for a limited area, architectonic and urban planning analyses, evaluation of structural vulnerability and definition of some intervention proposals. It is hopeful that the core results obtained in this specific study would be considered as a basis for the development of future projects, in cooperation with Local Authorities, enhancing the database and enlarging the followed procedure to the whole Valparaiso urban area.

From the Cerro Cordillera experience, we can create some guidelines for integrated management, applicable to the whole UNESCO area, as well as to the zones not included in this designation, but still contributing to the urban cultural landscape for which the city was nominated by UNESCO.

#### Identification of activities for the proper management of the built cultural heritage

Consistent with the current urban planning and policy tools of Valparaiso's public administration, identification and development of programs (addressing a possible urban revitalization, emerging out of the UNESCO designation), could be the stimulus for the formulation of a unified vision of the city, without creating a conflict between parts perceived as "heritage" and others perceived as "normal".

#### Creation of an inventory (in GIS) for defining the assets of the urban cultural landscape

Consistent with the programs defined by Valparaiso's public administration, this task is used to define what are the "objects" of interest for the urban revitalization project proposal, and which can contribute to the formation of the city image (urban cultural landscape). This process allows the development of useful rules for indentifying, interpreting and describing the families of elements (buildings, urban fabric, open spaces, circulation networks, etc.) that constitute the built heritage. This kind of approach implies the implementation of customized analysis tools, according to the

characteristics of the various typologies of heritage that one might be able to find. The creation of an urban inventory, as a resource for the analysis, implies a choice (one class of object versus another), like the selection of a kind of urban planning project implementation effort.

- Phase 1. Definition of methods. Formulation of a set of useable data, to describe the qualities of the built environment, open spaces, urban fabric and circulation system. In this sense, it is necessary to differentiate data related to monumental buildings and those about less important constructions, but contributing in the same way to the definition of a unique urban landscape.
- Phase 2. Formulation of the analysis forms. As a function of the characteristics of the metadata structure for a set of analysis tools (urban, structural, socioeconomic, etc.), associated with the characteristics of the context and with the characteristics of the programs for urban revitalization and protection of the built environment.
- Phase 3. Verification and use of other existing data banks. Identification of the various existing data sources, to put into relation with the data about the buildings, open spaces and the circulation network. In this area, identification of possible connections between all the city stakeholders is of particular interest.
- Phase 4. Definition of a unified base map. As a function of the choices related to the compilation of the urban inventory, it is necessary to define a base map on which the “objects” to be analyzed must be accurately identified.

#### Structure of the analysis

As a function of the data collected, from the existing data banks and from the identified program expectations, at this point it is useful to define the tools to be used for the formulation of urban analysis models to support the projects. Using the GIS system methodologies, it will be possible to create analytical models taking into account the various aspects related to the management of the built environment.

- Architectonic quality and building structural condition. Analyses demonstrating the existing conditions of the built environment, its relation to the context, the degree of integration with its context and the identification of “sensitive areas” to be dedicated to urban revitalization projects.
- Multiple risks. Analyses demonstrating and interrelating various elements connected to risk. In the case of Valparaiso, and specifically for the Cerro Cordillera, the possible risks are due to earthquake, tsunami, landslide, flood, fires and those involving utilities (electricity, gas, etc.) which don’t conform to the residential standards.
- Quality and safety of the public open space. Analyses related to the existing condition and use of public spaces (streets, squares, parks, etc.), as well as the safety perception by the people using them. This element, of particular importance, is often a result of poor design and maintenance.
- Real-estate and property owners. Analyses related to the identification of the actors (public or private) involved in potential urban revitalization efforts.
- Services structure. Analyses of existing services in the areas of interest related to the projects, for potential coordination of decisions that are inherent to the new activities.
- Socioeconomic structure. Integration of information of a sociological and economic nature; numbers of resident families in the buildings, social conditions, etc.

#### Definition of the working tools

As a function of the defined strategy and the supporting analysis, we should identify “operating tools” helping the development of revitalization and management proposals related to cultural heritage. These tools should be of a variety of types, but closely interrelated one to each other.

- Definition of support regulations. Identification of types of interventions applicable to the buildings and to the urban fabric, integrated into the planning tools currently in place. Identification of easily applied rules, giving a clear indication of the permitted actions for each building or group of buildings.
- Preparation of a risk maps. Identification and integration into the current planning tools, of a general risk factor (integrating those previously identified) for each single building or group of buildings.



- Identification of monuments and buildings of value, that are in urgent need of restoration and stabilization.
- Regeneration of the urban fabric. As a function of the identified regulations, creation of manuals for the self restoration of minor constructions. This work methodology should be principally addressed to the building users (property owners or renters), involving them in revitalization activities, based on the dissemination of appropriate and simple techniques to improve their living conditions, as well as integrity and value of the residence.
- Identification of special projects. Identification of public projects with an emphasis on urban revitalization applicable to cultural heritage (monuments, buildings of interest, urban fabric, open spaces).
- Development of the know-how of local professionals in the field of management and conservation of cultural heritage (workshops and training courses for urban revitalization projects, GIS construction and management, etc.).
- Restoration and conservation of local building and workmanship techniques, as integrated parts in the process of valorization of the buildings and urban fabric. Training courses for the education of young workers to be employed in building restoration projects.
- Involvement of all the stakeholders in the urban regeneration process, focused on the valorization of the building heritage, with particular attention to the development of the concept of cultural heritage as a “value”. Public cultural activities to support these initiatives (neighborhood shows on the concept of “value” of the heritage, publications, etc.)
- Development of economic tools (microcredit), supporting the activities related to the restoration of the built urban fabric.

### **Guidelines for the Cerro Cordillera**

As a consequence of the general guidelines, we tried to identify some possible actions for the restoration of the architectonic heritage and open space system in the Cerro Cordillera study area. The first action has been related to the assignment of an Intervention Class to each building, chosen as a function of the general condition, architectonic interest, degree of integration, and seismic risk. The second action has been devoted to the identification of six special projects developing general themes like transportation, access, open spaces, social housing and innovative services.

#### The Mirador Purcells area

It is an area currently occupied by a series of workshops, used as “informal housing”, located on the slope flanking Calle Villagran, showing small buildings with internal courts and two buildings with historic architectonic value, which can be considered also external landmarks for the Cerro Cordillera. The general problems of the area are connected to low urban safety (Calle Villagran), low quality of the living conditions, (Calle Villagran) and to the general structural conditions of the buildings. This sector of the Cerro Cordillera could be revitalized through different kinds of interventions.

- Urban revitalization of Calle Villagran. A project focused the complete resurfacing of the roadway, a new water drainage system and a public lighting program.
- New access towards Plaza Eleuterio Ramirez and the Lord Cochrane Museum. A project focused the creation of a new vertical access system from Calle Villagran towards Plaza Eleuterio Ramirez. Slope stabilization and creation of spaces like a Mirador towards the Matriz and Barrio Puerto. A new building intended for public activities or tourism.
- Public housing. By way of self-built projects, participation of the Cerro Cordillera inhabitants to revitalization activities regarding the construction of their own houses and associated open spaces.
- Restoration of buildings with historical architectural value present in the project area.

#### The Lord Cochrane Museum (Plaza Eleuterio Ramirez) area

The area of influence of the Lord Cochrane Museum, with the associated park, is Plaza Eleuterio Ramirez and its open space system - completely abandoned building ruins occupying the North-East side of the Cerro Cordillera. The existence of these open spaces and building ruins could be used to realize structures and open spaces to be integrated with the existing ones, as a new Cerro

Cordillera cultural center. We imagined research centers and housing for the associated international researchers; a system integrating the existing open spaces with others connecting Plaza Eleuterio Ramirez to the Mirador of the museum, and extending to the public athletics area of Calle Castillo.

#### The Calle Castillo public open space

The area shows the presence of a space dedicated to sport activities of young people of the Cerro Cordillera. The existing maintenance conditions are not good and, as a result, it is isolated from the context of the study area. The proposal suggests to join this area to the new cultural center of the Lord Cochrane Museum, integrating and redefining the various activities (athletic, social, tourism).

#### A new public district of the Cerro Cordillera

The area, located at the end of Calle Villagran, is used as collective taxis route servicing the Cerro Cordillera; therefore, it is well positioned as a possible arrival and departure center (pedestrian and taxi route for Calle Villagran). In this area, we can imagine the revitalization of two (existing) large public open spaces, to be used as an area for public activities (sport, social, etc.), and the restoration of some building units or parts of blocks, to be dedicated to public housing, commercial activity, etc. To highlight the presence of two buildings of historical architectonic value (now empty), they can be restored to find a new location for the Cerro Cordillera social activities (Junta de Vecinos, etc.).

#### The San Agustin funicular area

This sector is characterized by the presence of a building of historical value (The San Agustin Funicular), residential housing of particular historical architectonic importance, some vacant areas due to collapse or fire, and a large open space that lies on the Cerro Cordillera South side. The proposal suggests the complete restoration of the San Agustin funicular, the creation of tourist activities, possibly in new buildings located in the currently vacant urban areas, completing the urban texture. Close to this intervention, we propose the revitalization of the large open space at the base of the funicular, as a new urban park for the Cerro Cordillera, integrated into the public open space system of the city.

#### Calle Tomas Ramos

It is an area characterized by the presence of many buildings of restoration value and a pedestrian route of particular importance for the Cerro Cordillera, connectin it directly to Calle Tomas Ramos.

- Urban revitalization of the vertical route from Calle Tomas Ramos. A project for the complete resurfacing of the route, new water drainage system and public lighting.
- Restoration of the buildings of architectonic historical value present in the project area.

### **The GIS database**

A proper Risk Assessment procedure should foresee a multidisciplinary approach, foreseeing the integrated use of several tools (hazard models, building classification and inventory database resources, RS and GIS, etc.), the identification of analyses procedures and algorithms, the elaboration of reliable outputs.

The work carried out in the framework of the “MAR VASTO” project allowed to develop a first nucleous of a GIS database platform for the City of Valparaiso, organizing a huge amount of data of general interest. Additional information targeted on specific hazards and building inventory data can be implemented as explained before.

Finally, the database should be flexible, freely available for use by any country and organization through Internet access, open-source, capable to be multi-hazard and international in scope, encouraging the worldwide community to participate to its development and validation.

### **The investigation on the three churches**

#### Status of the churches

The work carried out on the three churches (San Francisco del Baron, Hermanas de la Providencia, La Matriz), even if it can be considered as a first work step to be deepened in the future throughout specific rehabilitation projects, allows to say the following:

- after survey, vulnerability analysis and preliminary Finite Element calculations, the present damage situation of the San Francisco Church must be considered very worrying, because partial or total collapse (especially in the bell-tower and in the façade) can occur in case of

earthquake (i.e. medium to high magnitude seismic excitations, as expected in the Valparaiso area); in fact, the church is unsafe and urgently must be closed partially or totally, planning a strengthening intervention as soon as possible;

- after survey, vulnerability analysis and preliminary Finite Element calculations, the present damage situation of the Hermanas de la Providencia Church must be considered very worrying, because partial or total collapse (in several structural parts, due to widespread weakness) can occur in case of earthquake (i.e. medium to high magnitude seismic excitations, as expected in the Valparaiso area; moreover, the church is located in the X highest Intensity area, as shown by the 1906 seismic event); the church (declared unsafe after the damage subjected by the 1985 seismic event) is now almost completely closed;
- after survey and vulnerability analysis, the situation of La Matriz Church is enough good from the seismic point of view; on the other hand, this building needs surely an improvement of fire protection, together with preservation measures against materials degradation and termite attack (in particular for wooden elements).

#### References for cultural heritage rehabilitation

In order to avoid a possible conflict between the conservation requirements prescribed for cultural heritage structures (integrity, compatibility, reversibility and durability) and the antiseismic improvement, the philosophical approach can be summarized in these following simple statements:

- a) because cultural heritage structural rehabilitation problems are much more difficult to solve than those related to modern r. c. or steel structures, interventions can derogate from the antiseismic design criteria foreseen for ordinary buildings;
- b) in relation to the state limit analysis, the intervention must be defined as a “controlled structural improvement”, i.e. accepting an antiseismic protection level lower than required, in order to reduce invasivity, but depending on the category of use and importance;
- c) for each limit state, the improvement effectiveness must be quantified, evaluating the PGA (Peak Ground Acceleration) levels which generate the local collapse mechanisms, before and after the intervention;
- d) because the cultural heritage structures characteristics (history, material properties, construction details, quality of connections, state of integrity and maintenance, etc.) are frequently not well known, detailed survey, damage assessment and diagnostic campaigns must be carried out, in order to reach a knowledge level as deeper as possible; moreover, each cultural heritage structure is different: therefore, it is necessary to undertake the rehabilitation design in a specific way, use of standardized procedures being not possible;
- e) the observance of the “regola dell’arte”, i.e. the unwritten construction rules for masonry elaborated by architects and bricklayers in centuries of work practice, is fundamental for protection (good overall static and dynamic behavior), conservation (durability in after years) and restoration (avoiding irreversible mistakes); the use of modern techniques and materials can be very useful to reduce seismic vulnerability, but it must be philologically correct, compatible and mechanically effective.

Specific antiseismic guidelines and codes for the cultural heritage protection should be used; in particular, the following references are suggested for cultural heritage structural restoration:

- guidelines for evaluation and mitigation of seismic risk to cultural heritage, recently edited by the Italian Ministry for Cultural Heritage and Activities (July 21, 2006);
- International Standard ISO 13822, Assessment of Existing Structures;
- ICOMOS-ISCARSAH (International Scientific Committee for Analysis and Restoration of Structures of Architectural Heritage, UNESCO), 20051: Recommendations for the analysis, conservation and structural restoration of cultural heritage.

The application of the above said references for cultural heritage structural improvement is, in our opinion, mandatory. Thus, the choice of some emblematic projects, to be exploited in the framework of an International Chilean - Italian partnership, seems highly desirable, also with the aim to disseminate knowledge and experience.

#### Knowledge of the structure

Cultural heritage structures characteristics (history, material properties, construction details, quality of connections, state of integrity and maintenance, etc.) are frequently not well known, due to their

intrinsic complexity. On the other hand, a well done rehabilitation project should need basic data on geometry, structural features, construction details, damage, conservation, mechanical properties of materials, etc., in order to reach a knowledge level as deeper as possible.

The first steps to foresee are the execution of a detailed geometric survey and a reliable damage assessment, by using conventional or innovative (laser scanner) methods.

Diagnostic campaigns requires non destructive (NDT) or minor destructive (MDT) techniques, in order to avoid invasive tests, as follows:

- single flat jack tests, allowing to evaluate the in-situ stress level of the structural material;
- double flat jack tests, used to evaluate the deformability characteristic;
- shear pull out tests, consisting in the insertion of a tensile element (usually a steel bar) into a larger borehole; if used on different material portions, they aim to investigate the sliding behavior of the walls, identifying a local shear value “marking” the wall out-of-plane mechanism;
- borehole with video endoscopy, performed on elevation and foundation walls, giving a general stratigraphy of the wall section;
- sonic pulse velocity tests, based on the generation of sonic/ultrasonic impulses at a point of the structure, useful for different purposes, i.e. to qualify the material through the investigation of the wall section morphology, detect the presence of voids, and find crack and damage patterns.
- absorption tests, to be used to compare different products for mortar injections, aiming to set up the consolidation process parameters;
- mortar analyses, oriented to evaluate the mortar conservation state, identifying composition, resistance and degradation;
- construction details critical survey, which provides important data regarding the connection quality of bearing walls, effectiveness of wall-floor nodes, presence or lack of steel ties, stability of vaults and arches; similar results can be also carried out through the analysis of a generic transversal wall section, aiming to evaluate the voids percentage.

In-situ experimental campaigns for dynamic characterization (performed through ambient vibrations or impulse produced by an impact of a mass dropped on the ground close to the structure), are also recommended, in order to examine the motion in terms of modal shapes.

Both diagnostics and dynamic characterization tests are fundamental to calibrate the Finite Element Model, with the aim to obtain accurate outputs in structural calculations.

In the case of the three churches, we can consider satisfactory the geometric survey, sufficient the damage assessment, while it was not possible to perform experimental tests (due to lack of resources and time). They must be done in any case if a rehabilitation project will be foreseen in the future.

The scarcity of experimental information was replaced by data taken from literature. A supplemental difficulty has been encountered for the Las Hermanas, due to the unicity of the constituent material (a primitive reinforced concrete); in this case, a conservative approach has been followed.

In relation to the depth of the structural knowledge, it is possible to assign a *confidence factor*  $F_C$  to be used in the numerical analyses. In our case, due to the speedy level of knowledge reached, a penalizing  $F_C$  has been chosen.

#### Reasonable anticipations about future rehabilitation projects

- San Francisco del Baron

This construction seems to be (in the façade and in the bell-tower) a very regular masonry brickwork, but showing heavy widespread structural damage and absence of antiseismic protections. The main intervention steps can be foreseen as follows:

- reinforcement of part or all the resistant elements, increasing selectively resistance, stiffness, ductility or a combination of these (always paying careful attention to induced modifications to the structural scheme); it can be done: increasing the strength of masonry, through local repairs to cracked or deteriorated parts; reconstructing masonry unity in the most weak or deteriorated parts, utilizing materials with analogous physical-chemical and mechanical properties; common non-invasive techniques used in Italy are *rip and sew*, *injections of mixed bonding agents*, *redrafting the junctions*; the insertion of post-tightened vertical tie-rods is applicable only in specific cases and when the masonry has been proven to be able to support the increase in vertical load;

- insertion of new elements which are compatible with existing ones, eliminating local vulnerability of certain parts of the construction and improving the overall functionality in terms of resistance or ductility; it can be done mainly through the traditional technique, as the insertion of tie-rods (placed in the two horizontal directions of the structure, at the level of floors and in correspondence to bearing walls) anchored to the masonry; arches and vaults can be strengthened also using tie-rods (normally placed at the rear), put in place with adequate pre-solicitation; other methods (jaketing by concrete or strips of composite materials) should be evaluated with care.

A specific agreement has been reached between the “MAR VASTO” team and the Intendente Regional, after his welcome address during the final conference (in which he promised special funds for the intervention on the San Francisco Church, see Appendix 4) and some working meetings with the technical staff:

- the church must be partially or totally closed (due to safety reasons) and a prompt emergency intervention should be urgently carried out, in order to avoid the collapse of the building bell-tower and façade, with resources of the Intendencia Regional; for the prompt intervention, the Italian team is going to offer a free project (see Appendix 5);
- the overall rehabilitation intervention of the San Francisco Church has been included in the specific program “Puesta en Valor Patrimonial” foreseen for the Valparaíso Region.

- Las Hermanas de la Providencia

Due to the very particular typology of the construction material (a primitive reinforced concrete very rare in the world), a strengthening intervention with conventional techniques can be ineffective or very invasive. In this case, an innovative solution can be imagined:

- introduction of a base isolation system (with all the due precaution, avoiding elevation and foundation wall cutting, by means of the insertion of a new subfoundation system), that seems possible due to the apparent absence of a crypt.

- La Matriz

Very simple strengthening interventions can be done:

- insertion of new elements which are compatible with existing ones, eliminating local vulnerability of certain parts of the construction and improving the overall functionality in terms of resistance or ductility; it can be done mainly through the traditional technique, as the insertion of tie-rods (placed in the two horizontal directions of the structure, at the level of floors and in correspondence to bearing walls) anchored to the masonry; in our case, the horizontal tie-rods connecting façade and nave should be foreseen, in order to minimize out-of plane overturning.
- In addition, this building needs fire protection, preservation from materials degradation and termite attack.

### ***TDR10. Elaboración de presentaciones multimedia, aplicaciones SIG y página web***

The project website (<http://www.marvasto.bologna.enea.it>) is going to be updated with all the final results.

Three presentations of the “MAR VASTO” project have been carried out:

- an invited lecture at the conference “El terremoto de Valparaíso de 1906” in the framework of the VI Chilean Congress of Geotechnics, held by the Pontificia Universidad Católica de Valparaíso, November 29, 2007;
- a specific seminar organized at the Universidad Federico Santa María de Valparaíso, November 22, 2007;
- II Jornadas de Patrimonio, Viña del Mar, October 2, 2008.

The presentation of the following scientific paper has been done at the 6<sup>th</sup> Conference on Structural analysis of historic construction (SAHC), Bath, United Kingdom, 2-4 July 2008:

M. Indirli, F. Geremei, C. Puglisi, A. Screpanti, ENEA, Italy

D. Blersch, L. Lanzoni, N. Lopez Izquierdo, E. Milani, M. Miglioli, G. Simonini, University of Ferrara, Italy

M. Munari, University of Padua, Italy

F. Romanelli, ICTP, Abdus Salam International Centre for Theoretical Physics of Trieste, Italy

*“A GIS platform on main natural hazards for Valparaiso City (Chile) and vulnerability studies for some historical constructions and urban sectors”.*

The presentation of the following abstracts has been done at the PROHITECH 2009 International Conference, “Protection of Historical Buildings by Reversible Mixed Technologies”, Rome, June 21-24, 2009:

- Maurizio Indirli, Sotero Apablaza Minchel, et al.

*“General description of the project MAR VASTO (Manejo de riesgos en Valparaiso)”;*

- Luca Lanzoni, Sotero Apablaza Minchel, Marco Miglioli, Enrico Milani, Marco Munari, Giampaolo Simonini, Cristian Palma Valladares, Claudia Zuñiga Jara, Maurizio Indirli

*“The investigation on a Cerro Cordillera building stock in the framework of the project MAR VASTO (Manejo de riesgos en Valparaiso)”;*

- Marco Munari, Enrico Milani, Daniel Blersch, Sotero Apablaza Minchel, Carola Avalos Avalos, Cristian Palma Valladares, Claudia Zuñiga Jara, Maurizio Indirli

*“The investigation on three important churches stock in the framework of the project MAR VASTO (Manejo de riesgos en Valparaiso)”;*

- Fabio Romanelli, Claudio Puglisi, Augusto Screpanti, Lorenza Bovio, Fabio Geremei, Mauricio Gonzalez Loyola, Sotero Apablaza Minchel, Maurizio Indirli

*“Hazards investigation in Valparaiso stock in the framework of the project MAR VASTO (Manejo de riesgos en Valparaiso)”.*

The MAR VASTO general activity has been also presented and discussed in the framework of the EU COST Action C26, “Urban Habitat Constructions under Catastrophic Events”, (<http://www.civ.uth.gr/cost-c26/>), both in the general meetings and in the WG4 sessions (Working Group 4: “Risk Assessment for Catastrophic Scenarios in Urban Areas”, in which Dr. Maurizio Indirli is Chair). A specific presentation has been carried out by Maurizio Indirli in the Malta Symposium (La Valletta, October 23-25, 2008).

A scientific article regarding the “MAR VASTO” project is in preparation for the “International Journal of Cultural Heritage” (<http://www.tandf.co.uk/journals/titles/15583058.asp>).

Moreover, in the framework of the Master Ecopolis, managed by the University of Ferrara, regarding urban and environmental planning (<http://www.masterecopolis.it/>), the following presentations have been done (May 8, 2008):

- Maurizio Indirli (ENEA): “The MAR VASTO Project”;

- Luca Lanzoni (University of Ferrara): “The urban planning approach in UNECO sites”;

- Sotero Apablaza (OGP Valparaiso): “Valparaiso, world cultural patrimony”;

- Mauricio Gonzalez (OGP Valparaiso): “Urban planning and GIS in Valparaiso”;

- Claudia Zuniga (OGP Valparaiso): “OGP in-progress projects”.

Press conferences during the in-field activities and the final conference have been carried out. Several newspaper (“La Estrella, El Mercurio, etc.) and television reports have been also produced.

Table 1: WP01 activities

<b>WP 01</b>	<b>activity</b>	<b>sub-activity</b>	<b>leader</b>	<b>contributions</b>
	<b>“state-of-the-art” for all the municipality of Valparaiso</b>	<b>1.1</b> collection of cartography and maps of Valparaiso; acquisition of high resolution satellite images and aerophotos	<b>ENEA</b>	<b>ALL</b>
		<b>1.2</b> collection and analysis of historical material (photos, maps, databases, etc.)		<b>-</b>
		<b>1.3</b> collection and analysis of existing studies/investigations regarding natural and anthropic risks (seismic events, landslides, floods, tsunamis, coastal erosion, fire, status of infrastructures and lifelines, etc.)		
		<b>1.4</b> data homogenization and organization of a digital archive of the “state-of-the-art”, in GIS format (Geographic Information System) – see WP6		

Table 2: WP02 activities

<b>WP 02</b>	<b>activity</b>	<b>sub-activity</b>	<b>leader</b>	<b>contributions</b>
	<b>Topographic and Laser Scanner 3D survey</b>	<b>2.1</b> topographic survey of the GCPs (Ground Control Points) to geo-referencing high resolution satellite images and DTM (Digital Terrain Model) implementation for all the municipality of Valparaiso	<b>ENEA</b>	<b>UNIFE</b>
		<b>2.2</b> DGPS (Differential Global Position System) topographic survey in static configuration of the most significant and representative structures		
		<b>2.3</b> 3D Laser-Scanner survey of 1 to 3 significant structures of the UNESCO area in Valparaiso (mainly in Barrio Puerto)	<b>UNIFE</b>	<b>ENEA</b>

Table 3: WP03 activities

<b>WP 03</b>	<b>activity</b>	<b>sub-activity</b>	<b>leader</b>	<b>contributions</b>
	<b>study of seismic hazard</b>	<b>3.1</b> evaluation of existing studies and investigations	<b>ICTP</b>	<b>ENEA, UC, USM</b>
		<b>3.2</b> suggestion of future deeper analysis through new seismic microzoning experimental campaigns, if necessary		
		<b>3.3</b> elaboration of seismic hazard scenarios and maps; digital archive of results; also in GIS format – see WP6		<b>ENEA</b>

Table 4: WP04 activities

<b>WP 04</b>	<b>activity</b>	<b>sub-activity</b>	<b>leader</b>	<b>contributions</b>
	<b>study of tsunami and coastal erosion hazards</b>	<b>4.1</b> evaluation of existing studies and investigations	<b>ENEA, ICTP</b>	<b>-</b>
		<b>4.2</b> implementation of the existing studies and investigation regarding tsunami and coastal erosion risks in the UNESCO area		<b>-</b>
		<b>4.3</b> elaboration of risk scenarios and maps; digital archive of results, also in GIS format – see WP6		

Table 5: WP05 activities

<b>WP 05</b>	<b>activity</b>	<b>sub-activity</b>	<b>leader</b>	<b>contributions</b>
	<b>vulnerability analysis</b>	<b>5.1</b> identification and classification of the structural typologies present in Valparaiso, with particular regard to the UNESCO area	<b>UNIFE</b>	<b>ENEA</b>
		<b>5.2</b> visual quick survey (architectonic/structural) for a representative amount of buildings and comparison with data obtained by satellite image processing		<b>ENEA, UNIPD</b>
		<b>5.3</b> visual deeper survey (vulnerability evaluation) of some representative buildings		
		<b>5.4</b> vulnerability scenarios and maps elaboration		
		<b>5.5</b> identification of interventions reducing structural vulnerability		
		<b>5.6</b> suggestion of future diagnostic campaigns, in situ dynamic characterization and experimental laboratory tests; suggestion of numerical simulations		
		<b>5.7</b> organization of a digital archive for the results and cataloguing, also in GIS format – see WP6	<b>ENEA</b>	<b>UNIFE</b>

Table 6: WP06 activities

<b>WP 06</b>	<b>activity</b>	<b>sub-activity</b>	<b>leader</b>	<b>contributions</b>
	<b>Development of the geo-referenced digital archive</b>	<b>6.1</b> development of the GIS conceptual model	<b>ENEA</b>	<b>UNIFE</b>
		<b>6.2</b> analysis and spatial homogenization of the information provided by existing studies and investigations (« state-of-the-art ») for all the Valparaiso area		<b>-</b>
		<b>6.3</b> ortho-rectification of the satellite images, implementation and actualization of the high definition vectorial base from satellite images of the buildings for all the Valparaiso area		<b>UNIFE, ICTP, UNIPD</b>
		<b>6.4</b> urban classification of Valparaiso from high definition satellite images		
		<b>6.5</b> creation of the GIS digital archive for the results obtained from the risk analyses performed for the UNESCO area		
		<b>6.6</b> spatial elaboration of maps and scenarios (hazard, vulnerability, specific and multiple risks)		

Table 7: WP07 activities

<b>WP 07</b>	<b>activity</b>	<b>sub-activity</b>	<b>leader</b>	<b>contributions</b>
	<b>Principal final proposals</b>	<b>7.1</b> natural/anthropic disasters mitigation and vulnerability reduction in Valparaiso and particularly in the UNESCO area	<b>ENEA, UNIFE</b>	<b>ICTP, UNIPD</b>

Table 8: WP08 activities

<b>WP 08</b>	<b>activity</b>	<b>sub-activity</b>	<b>leader</b>	<b>contributions</b>
	<b>Realization of multimedia products</b>	<b>8.1</b> project and realization of the WEB site, audiovisuals, CD-ROM, WEB-GIS	<b>ENEA</b>	<b>UNIFE, ICTP, UNIPD</b>
		<b>8.2</b> international workshop		<b>ALL</b>



***APPENDIX 1***

***Program of the “MAR VASTO” Final Conference  
and presentation of the Master ECO-POLIS***

***Valparaiso, September 29 – 30, 2008***

**“MAR VASTO” - “Manejo de Riesgos en Valparaiso”**

ENEA, Università di Ferrara, Padova, Trieste  
Universidad Federico Santa Maria, Valparaiso  
Universidad de Chile, Santiago

**29 Settembre 2008**

**CONFERENZA FINALE**

**“ECO-POLIS” – “Master Internazionale per la protezione del Patrimonio,  
lo sviluppo urbano e ambientale”**

Università di Ferrara e di Calabria  
Red Alvar

**30 Settembre 2008**

**CONFERENZA FINALE**

**CHIESA E CONVENTO SAN FRANCISCO, Cerro Barón**

“MAR VASTO” – “Manejo de Riesgos en Valparaíso”

PROGRAM

September 29<sup>th</sup>, 2008

*Chairs:*

Sotero Apablaza, Valparaíso Municipality

Maruzzella Giannini, ICE, Italy



09:00 – 10:00

*Welcome addresses of Chilean and Italian Authorities*



Father Fernando Candia,  
Parroco, San Francisco Church



Mons. Gonzalo Duarte García de  
Cortázar, Obispo, Valparaíso



Dr. Ivan de la Maza Vaillet,  
Intendente V Región Valparaíso



Dr. Omar Jara Aravena, Alcalde  
Surrogante, Valparaíso Municipality



Dr. Roberto Santilli, Italian Embassy and  
ICE



Dr. Ana Maria Icaza, Directora  
PRDUB/BID Valparaíso

10:00 – 13:00

*Technical presentations, interventions and discussion*



Rodolfo Saragoni, Univ. Chile:  
historical seismicity in Valparaíso



Thomas Sturm, Univ. Chile: study of two  
Valparaíso historical buildings



Maurizio Indirli, ENEA: the Project  
“MAR VASTO”, general overview



Claudio Puglisi, ENEA:  
hazard maps for Valparaíso



Luca Lanzoni, Univ. Ferrara:  
the investigation in Cerro Cordillera



Osvaldo Neira Figueroa, Geocom:  
the laser scanner survey on churches



Marco Munari, Univ. Padova:  
the churches vulnerability investigation



Claudia Cárdenas,  
BID consultant



Paolo Ceccarelli, Univ. Ferrara:  
overview on the Master ECOPOLIS

*Chair:*

Roberto Barria, Federico Santa Maria University

09:00 – 09:30

*Welcome addresses of Chilean and Italian Authorities*

Juan Mastrantonio  
Board of Architects, Valparaíso

Paulina Kaplan Depolo  
OGP, Municipality of Valparaíso

09:30 – 13:00

*Technical presentations, interventions and discussion*

Luis Alvarez, Univ. Santa Maria:  
Risk and resilience in Valparaíso  
Paolo Ceccarelli, Univ. Ferrara:  
new challenges for urban planning in Latin America  
Gianfranco Franz, Univ. Ferrara: ECO-POLIS, an  
International Master in environmental and regional  
policies for sustainability in local development

Remigio Rossi, Univ. Ferrara:  
the concepts of conservation and risk in ecology  
Franco Rossi, Univ. Calabria: strategic spatial planning  
to regenerate cities and regions  
Emanuela de Menna, Univ. Ferrara:  
Yesterday/Tomorrow, 50 years of urban conservation  
and innovation in Italy

## ***APPENDIX 2***

### ***Presentations of the “MAR VASTO” Final Conference***



Rodolfo Saragoni Huerta, Univ. Chile, Santiago  
 Terremotos de Valparaíso de 1906/1985 en el Barrio El Almendral

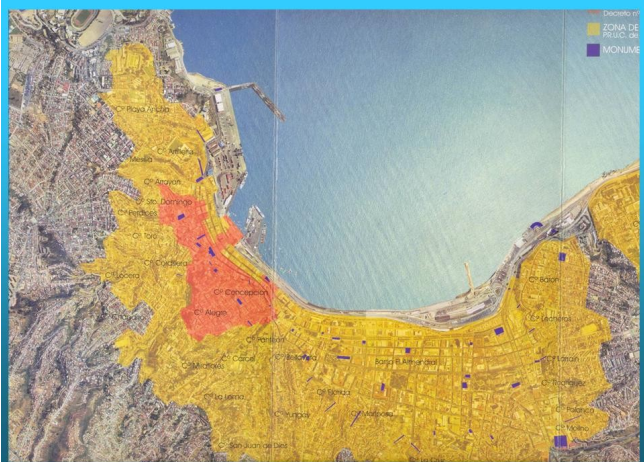
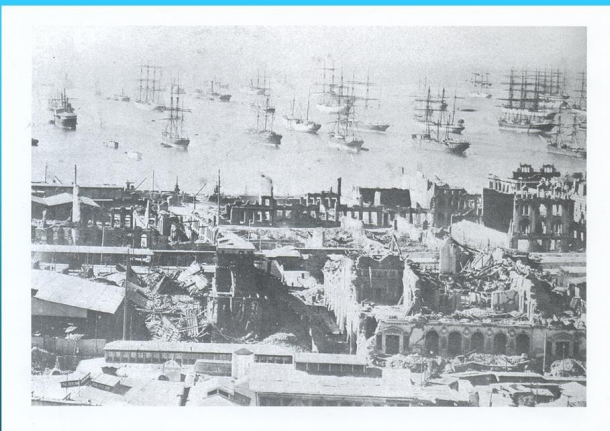


Cuando llegué a Curacautín estaba lloviendo ceniza por voluntad de los volcanes

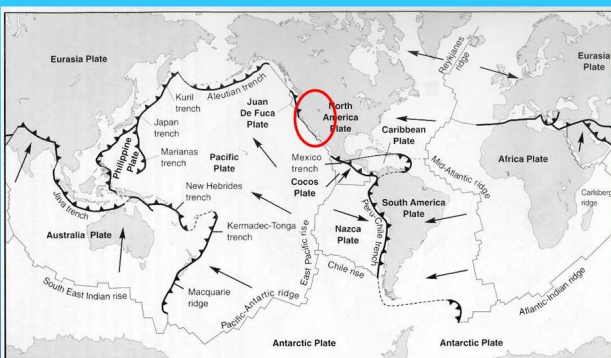
Me tuve que mudar a Talca donde habían crecido tanto los ríos tranquilos de Maule que me dormí en una embarcación y me fui a Valparaíso

En Valparaíso caían alrededor de mí las casas y desayuné en los escombros de mi perdida biblioteca entre un Baudelaire sobrevivido y un Cervantes desmantelado.

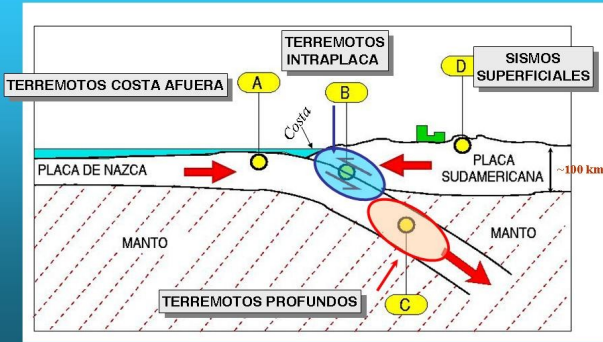
(Pablo Neruda, "Desastres" in "Corazón Amarillo")



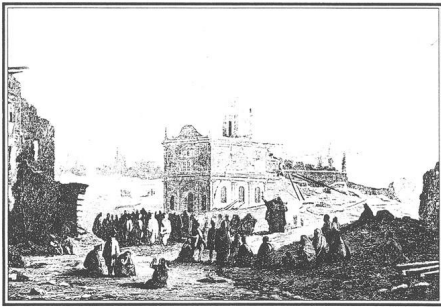
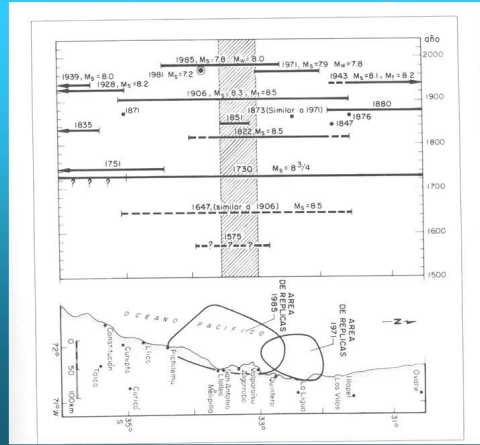
SUBDUCCIÓN EN EL AREA CIRCUMPACIFICA  
 situación dominante



## Tipos de Terremotos de la Zona de subduction chilena



## Terremotos histórico de Valparaíso



TERREMOTO EN VALPARAISO. Según Famin (fig. 3). Describe edificios dañados y muestra a aterrizados personajes durante o poco después del terremoto de Valparaíso de 1822. Se supone que las medidas de Bernardo O'Higgins, a la sazón Director Supremo, para evitar exorcismos y supersticiones precipitaron la crisis que culminó poco después con su abdicación.

## SUELOS DEL BARRIO EL ALMENDRAL

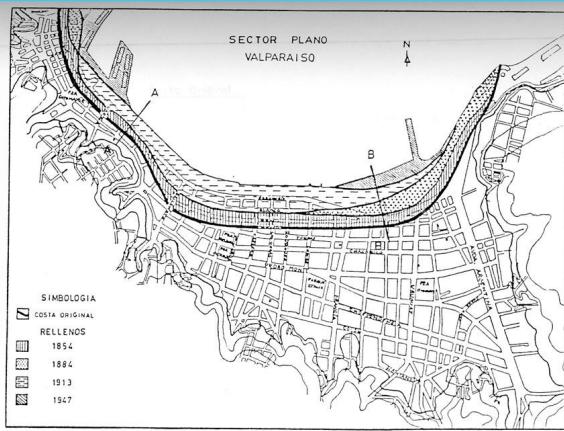


FIG 3.1 Evolución de Depositación de Rellenos en el Sector Plano de Valparaíso (Ref 15)

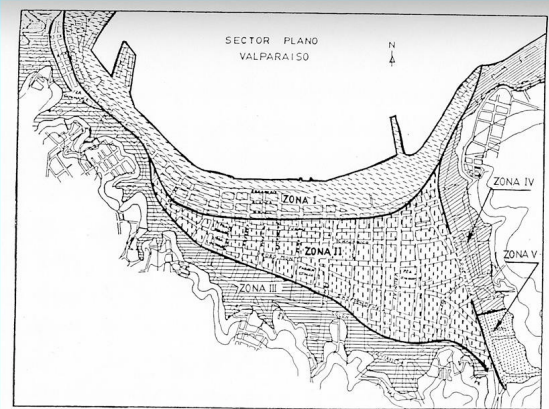


FIG 3.5 Zonificación de Suelos del Sector Plano de Valparaíso (Ref 15)

## TERREMOTO DE 1906

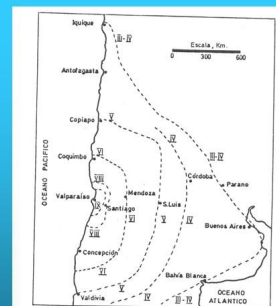
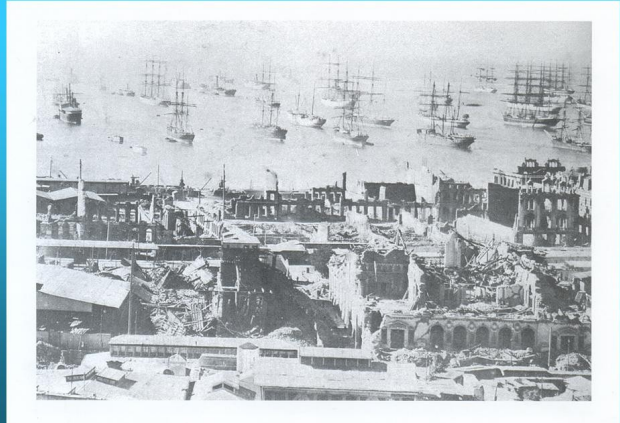
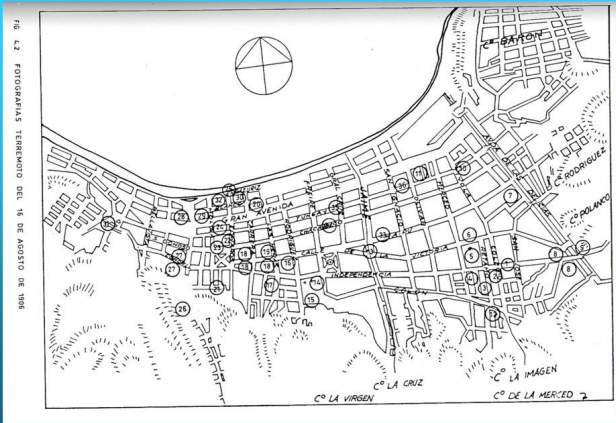
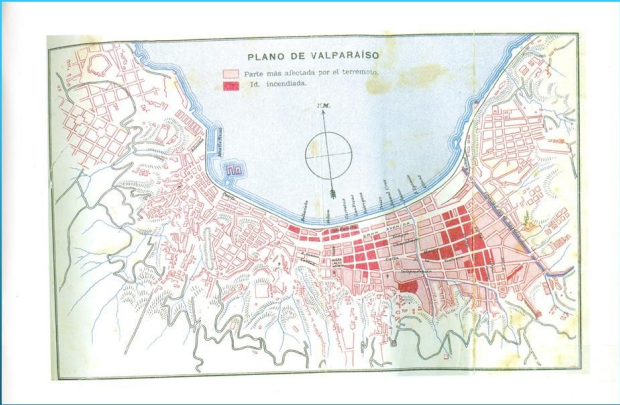
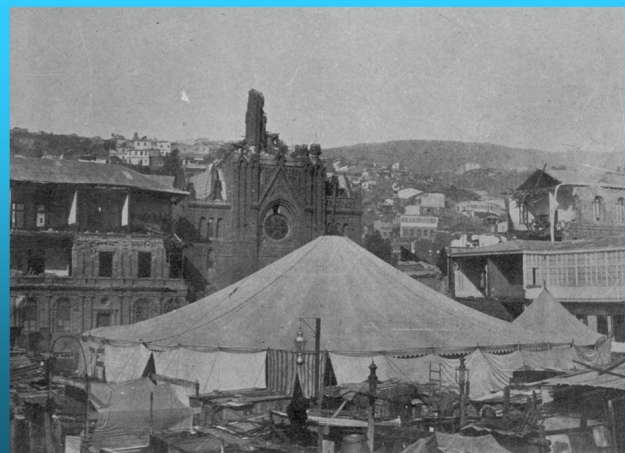


FIG 4.8 MAPA DE INTENSIDADES DEL TERREMOTO DE VALPARAISO DEL 16/08/1906. (Tomada de Rudolph y Tams[32], reproducida por Davidson [33]).





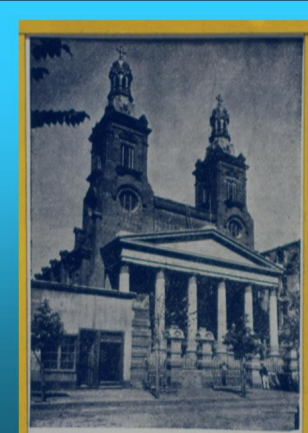




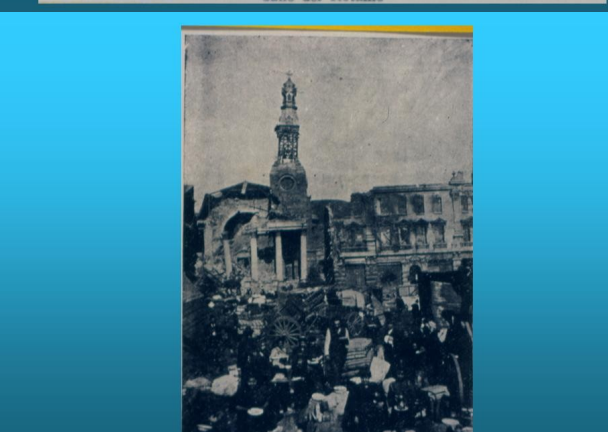




Calle del Retamo



Iglesia de la Merced



Iglesia de la Merced, día 18



Mercado del Cardenal



# EDIFICIOS CENTENARIOS 1906 - 2006

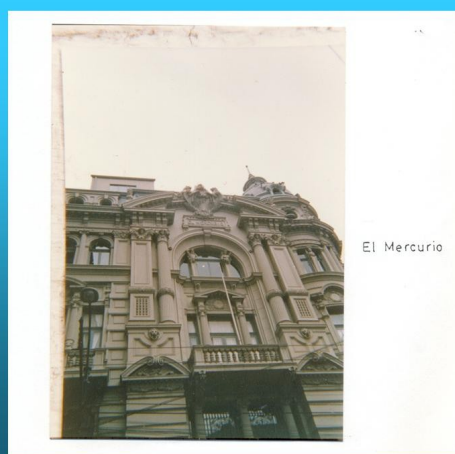
EDIFICIOS DEL ALMENDRAL QUE SOBREVIVIERON EL TERREMOTO DE 1906



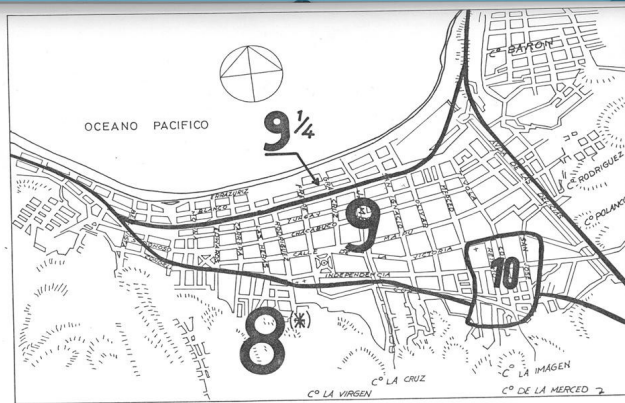
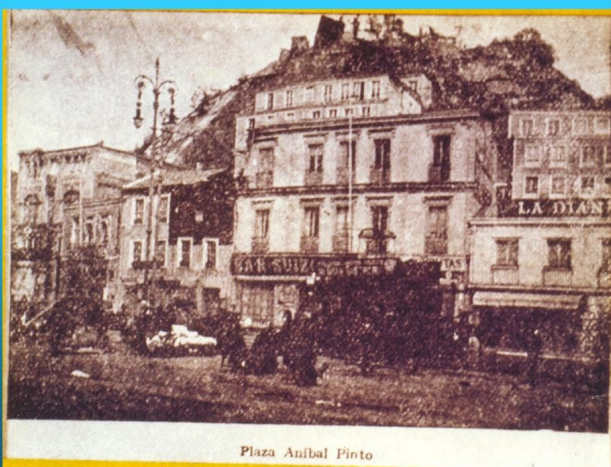
CALLE CONDELL



Edificios calle Condell



## INTENSIDADES IMM PARA CONSTRUCCIONES DE ALBAÑILERÍA BARRIO EL ALMENDRAL TERREMOTO DE 1906



## TERREMOTO DE 1985







Iglesia de los Doce Apóstoles

El Almendral



Plaza Anibal Pinto



Cerros

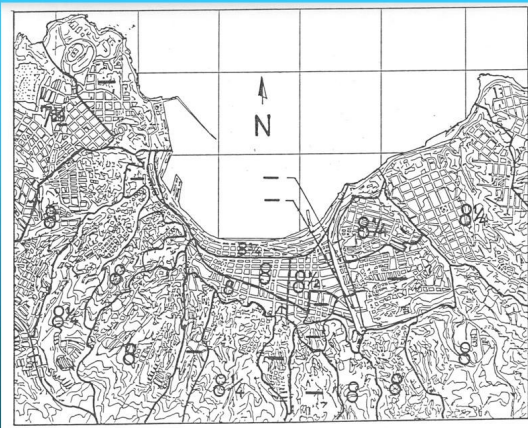


FIG 52 INTENSIDADES MM PARA ALBAÑILERIA SIMPLE. SISMO DEL 3/3/1985.(REF 24)

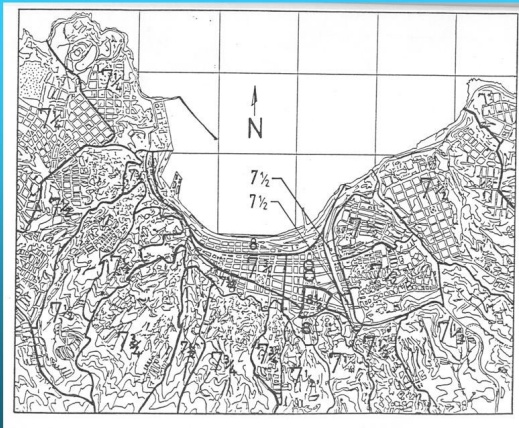


FIG 53 INTENSIDADES MM PARA TABIQUERIA DE ADOBE. SISMO DEL 3/3/1985.(REF 24)

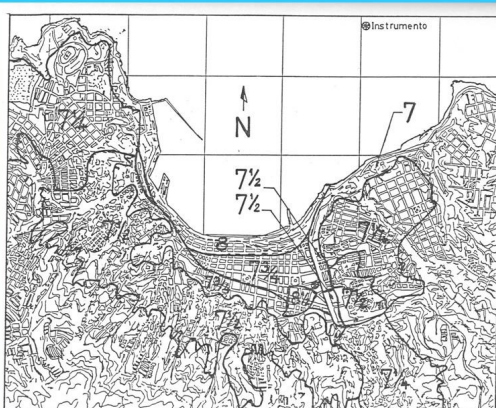


FIG 55 INTENSIDADES MM POR TIPO DE SUELO. SISMO DEL 3/3/1985

## EL REGISTRO DE ACELERACIONES DEL TERREMOTO DE 1985 EN EL BARRIO EL ALMENDRAL

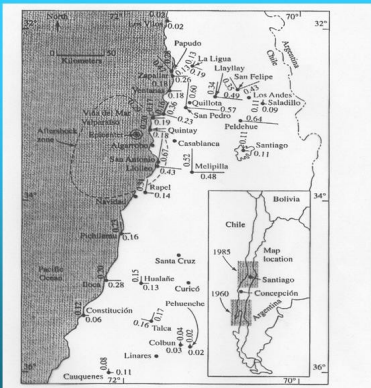


Figura 4.1: Regiones fuente de los terremotos chilenos del 22 de Mayo de 1960 y del 3 de Marzo de 1985. Se muestran las aceleraciones máximas registradas de los dos componentes horizontales, en función de la aceleración de gravedad  $g$ , para el terremoto de 1985. (Cortesía de R. Saragoni y M. Pardo). [Reproducida en Bolt, 1999].

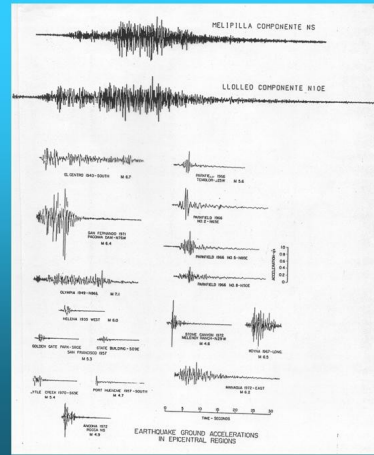
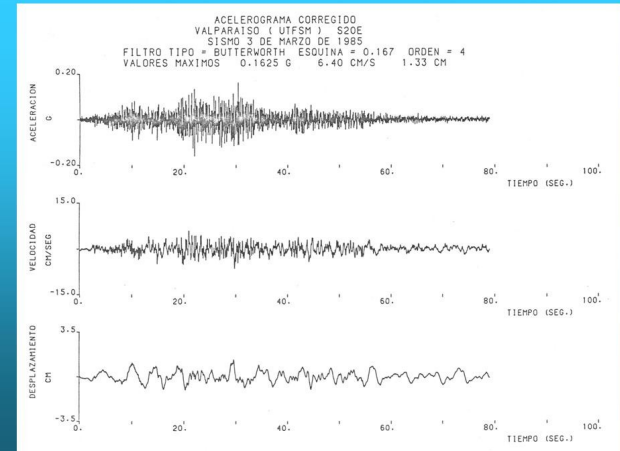
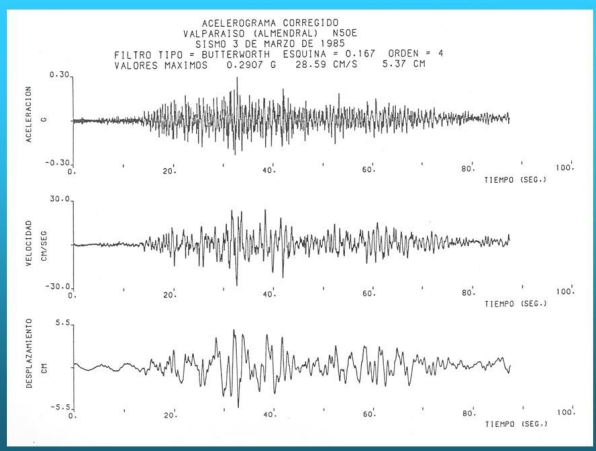


Fig. 3.8. Iglesia de los Doce Apóstoles, barrio El Almendral, Valparaíso. (Avda. Argentina), (nivel de daño después del terremoto). Lugar donde se registró el terremoto en suelo de relleno.



**ESTUDIO COMPARATIVO DEL  
COMPORTAMIENTO ESTRUCTURAL Y  
DE FUNDACIONES PARA LOS  
TERREMOTOS DE VALPARAÍSO DE  
1906 Y 1985**

**Rodolfo Saragoni H.**  
UNIVERSIDAD DE CHILE



## “VALPARAÍSO: SU PATRIMONIO HISTÓRICO Y LOS SISMOS”

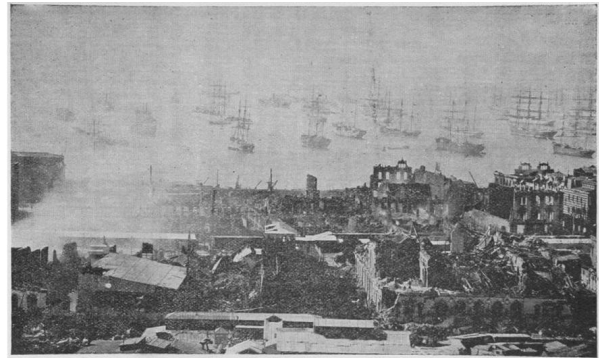
Thomas Sturm M.  
Ingeniero Civil- Universidad de Chile

### MOTIVACIÓN

- Necesidad de estudiar el inventario de edificios centenarios de los centros históricos de las ciudades declaradas Patrimonio de la Humanidad ubicadas en zonas de alto peligro sísmico.
- Aprovechar la información que se ha podido reunir a través de los años debido a la alta sismicidad del país, lo que lo transforma en un laboratorio natural que se activa frecuentemente proporcionando información de excelente calidad.
- Valparaíso tiene edificios centenarios con un estilo arquitectónico proveniente de Europa que es posible encontrar en otras zonas sísmicas del mundo.
- La zona de conservación histórica de la ciudad de Valparaíso ha sido declarada patrimonio de la humanidad el año 2003 por la UNESCO.
- La amenaza de grandes terremotos en la zona es un peligro permanente de nuestros edificios históricos.
- La necesidad de contar con “índices simples” que consideren las características de este tipo de edificios y de las condiciones locales del lugar donde se ubican para hacer un diagnóstico de la vulnerabilidad sísmica de ellos.

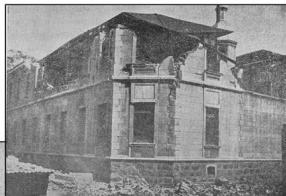
### EFFECTOS DE LOS TERREMOTOS EN LOS EDIFICIOS HISTÓRICOS DE VALPARAISO

Terremoto del 16 de agosto de 1906  
(Ms = 8.2)



“La Catástrofe del 16 de Agosto de 1906” (Rodríguez y Gajardo)

Asilo de las Hermanitas de los Pobres

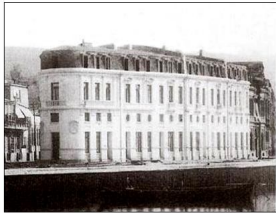


Las ruinas del Teatro de la Victoria

### CASOS ESTUDIADOS

(Edificios que pertenecen a la Ilustre Municipalidad de Valparaíso)

## Dos edificios ubicados en la Zona Típica de Valparaíso

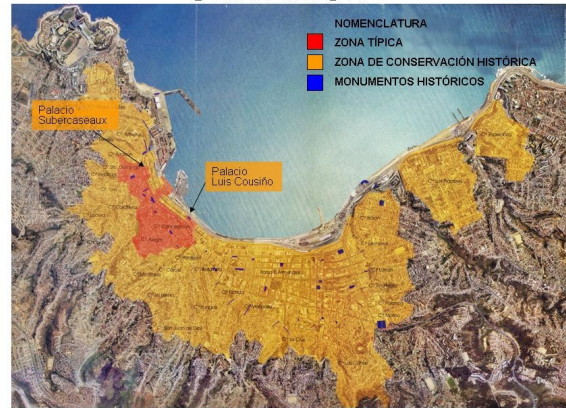


Palacio Luis Cousiño (1881-1883)  
Monumento Nacional 1994



Palacio Subercaseaux (1881-1889)

## UBICACION



## Estado Actual



Palacio Luis Cousiño



Palacio Subercaseaux

## DETALLES DE CONSTRUCCIÓN

### Aspectos relevantes



Muros de subterráneo



Apoyo de sistema de piso



Encuentros de muro

### Terminaciones de los edificios



Edificio El Mercurio (18XX-18YY)



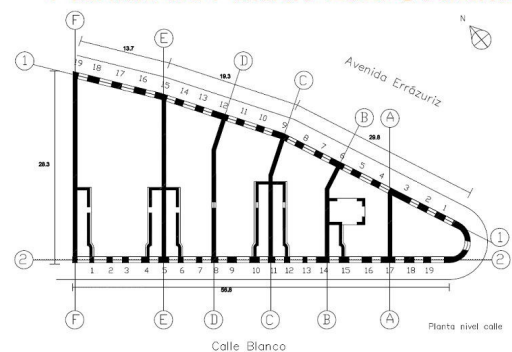
Palacio Luis Cousiño



Palacio Subercaseaux

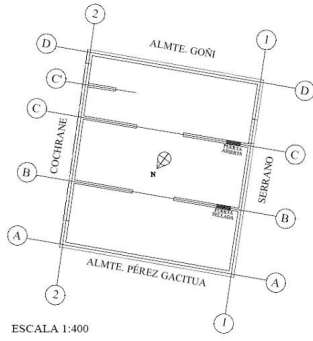
## DETALLES DE LA ESTRUCTURA SISMORRESISTENTE Y DE LAS CONDICIONES LOCALES DE LOS EDIFICOS ESTUDIADOS

### Plantas de Palacio Luis Cousiño

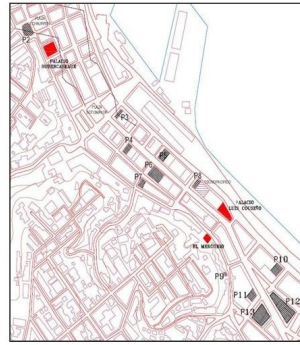




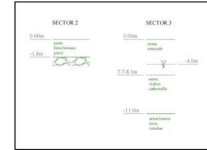
## Planta de Palacio Subercaseaux



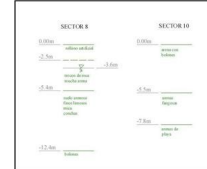
## Ubicación de los edificios estudiados y de los lugares reportados por Ojeda



Palacio Subercaseaux



Palacio Luis Cousiño



## CALIFICACIÓN DE LA VULNERABILIDAD SÍSMICO-ESTRUCTURAL DE EDIFICIOS HISTÓRICOS

## Indices de Vulnerabilidad

### ■ Indices de Primer Nivel

1. Índice de densidad de muros propuesto por Meli ( $d_n$ ).
2. Indices de Lourenco y Roque (Portugal).

### ■ Indices de Segundo Nivel

1. Índice de Gallegos ( $l_o$ ) (Perú).
2. Índice del G.N.D.T. ( $l_v$ ) (Italia)

## Resultados de los índices de Primer Nivel

	Palacio Luis Cousiño		Palacio Subercaseaux	
	Dirección Longitudinal	Dirección Transversal	Dirección Longitudinal	Dirección Transversal
$d_n$	1,55 %	2,27 %	0,53 %	1,85 %
$d, \gamma_1$	4,66 %	6,80 %	1,59 %	5,56 %
$\gamma_2$	$0,022 \frac{m^2}{tonf}$	$0,033 \frac{m^2}{tonf}$	$0,0095 \frac{m^2}{tonf}$	$0,033 \frac{m^2}{tonf}$
$\gamma_3$	1,24	1,81	0,58	2,04
%Am	40,6%	59,4%	22,3%	77,7%

## Resultado de los índices de Segundo Nivel

	Palacio Luis Cousiño	Palacio Subercaseaux
$l_o$	0,46	0,46
$l$	0,39	0,46
$l_v$	0,15	0,11

## COMENTARIOS Y CONCLUSIONES

- Las razones para que se hayan conservado los dos edificios estudiados después de los terremotos de 1906 ( $M_s=8.2$ ) y de 1985 ( $M_s=7.8$ ), son principalmente la alta densidad de muros en ambas direcciones de la planta (Palacio Luis Cousiño) y estar fundado sobre roca (Palacio Subercaseaux).
- Al aplicar los índices de vulnerabilidad que consideran mayor número de factores como son los índices de Segundo Nivel, se pudo comprobar que es necesario revisar el impacto asignado a algunos de los factores o parámetros considerados en los índices propuestos en la literatura. Para ello se debe tener en cuenta los resultados observados después de un terremoto con las características de los terremotos de Valparaíso de 1906 y 1985.





Maurizio Indirli, ENEA Bologna, Italy  
 General description of the "MAR VASTO" project and syntethic information on results

"MAR VASTO" - "Manejo de riesgos en Valparaiso"

**MAURIZIO INDIRLI**  
 coordinatore del Progetto  
 "MAR VASTO"

**ENEA**

ENEA - Ente Nazionale per le Nuove Tecnologie, l'Energia e l'Ambiente  
[www.enea.it](http://www.enea.it)

**CONFERENZA FINALE**

Chiesa e Convento  
 San Francisco del Baron  
 Valparaiso,  
 29 Settembre 2008

**DESCRIZIONE GENERALE  
 DEL PROGETTO  
 "MAR VASTO"  
 E INFORMAZIONE SINTETICA  
 SUI RISULTATI**



"MAR VASTO" - "Manejo de riesgos en Valparaiso"

**CONTRATTO**

BID - Banco InterAmericano de Desarrollo

ENEA - Ente Nazionale per le Nuove Tecnologie, l'Energia e l'Ambiente

FONDO FIDUCIARIO ITALIANO

Contratto n. ATN/II-9816-CH

**PAESE BENEFICIARIO:**  
 Chile; Ilustre Municipalidad de Valparaiso

**INIZIO ATTIVITA'** Maggio 2006  
**FINE ATTIVITA'** Ottobre 2008

**LUOGHI DI ATTIVITA'**  
 CHILE: Valparaiso, Santiago  
 ITALIA: Bologna, Ferrara, Padova, Trieste, Roma

**Piano di finanziamento:**  
 Fondo: US\$ 150 000  
 Contropartita locale: 10 000  
 Totale: 160 000



"MAR VASTO" - "Manejo de riesgos en Valparaiso"

**PARTNERSHIP**

ENEA, Ente per le Nuove tecnologie, l'Energia e l'Ambiente

UNIFE, Università di Ferrara, Dip. di Architettura e Ingegneria

ICTP, Abdus Salam International Centre for Theoretical Physics, Trieste

UNIPD, Università di Padova, Facoltà di Ingegneria, Dipartimento di Costruzioni e Trasporti

USM, Universidad Tecnica Federico Santa Maria, Departamento de Obras Civiles

UC, Universidad de Chile, División Estructuras Construcción Geotecnia, Departamento de Ingeniería Civil, Facultad de Ciencias Físicas y Matemáticas

**SUPPORTO IN CILE**  
 OGP, Ilustre Municipalidad de Valparaiso, Oficina de Gestion Patrimonial  
 PRDUV, Programa de Recuperación y Desarrollo Urbano de Valparaiso



"MAR VASTO" - "Manejo de riesgos en Valparaiso"

**IMPORTANTE COLLABORAZIONE ITALO-CILENA**

INTENDENCIA REGIONAL	GECOM SANTIAGO	AUTORITA' ECCLES.
IL. MUNICIP. VALPO	ALTRE UNIVERSITA'	
OGP MUNICIPALIDAD		
DIR. DESARR. HABIT.		
PRDUV	JUNTA DE VECINOS	
OREMI	JERENCIA BARRIO P.	
POMPIERI		
SHOA	ORDINE ARCHITETTI	LA GENTE DI VALPO (LOS PORTEÑOS)
BOTE SALVAVIDAS	PROFESSIONISTI	
CARABINIERI		



"MAR VASTO" - "Manejo de riesgos en Valparaiso"

**COMPONENTI DELLA SQUADRA ITALIANA A VALPARAISO**

<b>ENEA</b>	<b>UNIFE</b>	<b>UNIPD</b>
MAURIZIO INDIRLI	DANIEL BLERSCH	MARCO MUNARI
FABIO GEREMEI	LUCA LANZONI	
CLAUDIO PUGLISI	ENRICO MILANI	ICTP
AUGUSTO SCREPANTI	MARCO MIGLIOLI	FABIO ROMANELLI
	G. PAOLO SIMONINI	
NIEVES L. IZQUIERDO		
	<b>GECOM SANTIAGO</b>	
	OSVALDO NEIRA F.	
	MARCO QUEVEDO T.	



"MAR VASTO" - "Manejo de riesgos en Valparaiso"

**COLLABORAZIONI SUCCESSIVE**

IILA (ISTITUTO ITALO-LATINO AMERICANO)

borse di studio in Italia (12 mesi)  
 Bologna, Ferrara, Padova Trieste, Roma

Mauricio Gonzalez (OGP, 2 mesi)  
 Claudia Zúñiga (OGP, 2 mesi)  
 Cristian Palma (4 mesi)  
 Carola Avalos (4 mesi)


ENEA

Maurizio Indirli (tutoring)

MUNICIPALIDAD VALPARAISO

Sotero Apablaza (Municipal, 1½ mesi)

**MAR VASTO** **ECOPOLIS** **ATT. FUTURE**





**"MAR VASTO" - "Manejo de riesgos en Valparaiso"**

**habitat urbano e patrimonio culturale**

Radenci, 1998:  
Declaration on the protection of cultural heritage in emergencies and exceptional situations (ICBS, International Committee of the Blue Shield)

Kobe, 2005:  
World Conference on Disaster Reduction (UNESCO, ICCROM, Japan Orgs ...)

➤ habitat urbani e patrimonio culturale sono particolarmente a rischio quando si verificano catastrofi naturali e antropiche

➤ spesso le attività di prevenzione e di emergenza non sono molto sensibili alla protezione del patrimonio culturale

**È necessario integrare al meglio la protezione degli habitat urbani e del patrimonio culturale nelle politiche di prevenzione e gestione dell'emergenza**

**"MAR VASTO" - "Manejo de riesgos en Valparaiso"**

**habitat urbani e patrimonio culturale: esempi di perdite per disastri naturali e antropici**

terremoto: Valparaiso 1980 e incendio  
frana: Valoni 1963 e alluvione  
terremoto: San Francisco 1906  
alluvione: Firenze 1966  
terremoto: Messina 1908 e incendio  
terremoto: Northridge 1994  
terremoto: Kobe 1995  
Praga 2002  
terremoto: L'Aquila 2009  
terremoto: Oki-Dom 2003  
tsunami: Oceano Indiano 2004  
tsunami: Venezia - Trieste - 1511

**"MAR VASTO" - "Manejo de riesgos en Valparaiso"**

anni da terremoto in Italia al patrimonio culturale, anche per eventi di magnitudo moderata

Marche - Umbria 1997-98  
Messina 1908  
Reggio Emilia 1984  
Salò 2004  
Molise e Puglia 2002

**"MAR VASTO" - "Manejo de riesgos en Valparaiso"**

Evento sismico Marche - Umbria 1997-98: chiese, campanili e centri storici

**"MAR VASTO" - "Manejo de riesgos en Valparaiso"**

Evento sismico Marche - Umbria 1997-98: Basilica Superiore di San Francesco di Assisi

**"MAR VASTO" - "Manejo de riesgos en Valparaiso"**

**VALPARAISO (Chile): città molto fragile soggetta a vari hazard naturali e antropici**

storia infinita di una stretta interazione tra società e ambiente

un esempio: terremoto e incendio distruttivi del 1906

**"MAR VASTO" - "Manejo de riesgos en Valparaiso"**

**PORTO E AREA COSTIERA**

diversità architettoniche e strutturali  
edifici in stile coloniale (prevalentemente muratura)  
grandi edifici neoclassici (prevalentemente muratura)  
architetture moderne e edifici in altezza (materiali moderni)  
edifici residenziali con pochi piani (adobe, legno e calamina)  
"ascensori" (parti meccaniche)

tsunami

**PIANO**  
terremoto e amplificazione sismica dovuta al suolo soffice

**CERROS & QUEBRADAS**  
terremoti incendi frane alluvioni

**"MAR VASTO" - "Manejo de riesgos en Valparaiso"**

**HAZARD DA CATASTROFI**  
(terremoti, tsunami, frane, incendi)

**RILIEVI**  
(fotografico, GPS, geologico, laser scanner 3D)

**ANALISI DI VULNERABILITA'**  
(schede sintetiche, calcoli strutturali)

**GIS**  
(geodatabase per la gestione del rischio)

**ATTIVITA' MULTIMEDIALI**  
(filmati, workshop, pubblicazioni)

**PROPOSTE FINALI**  
(linee guida per interventi futuri)

**INDAGINE SPECIFICA SU TRE CHIESE IMPORTANTI (San Francisco, La Matriz, Las Hermanas de La Providencia)**

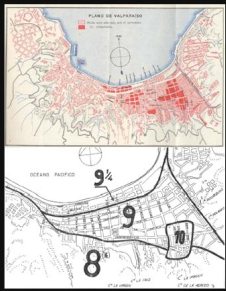
**INDAGINE SPECIFICA SU UN CERRO PILOTA (Cerro Cordillera)**



**"MAR VASTO" - "Manejo de riesgos en Valparaiso"**

**SEISMIC HAZARD**

collaborazione con UC, USM, OGP  
- sismicità storica



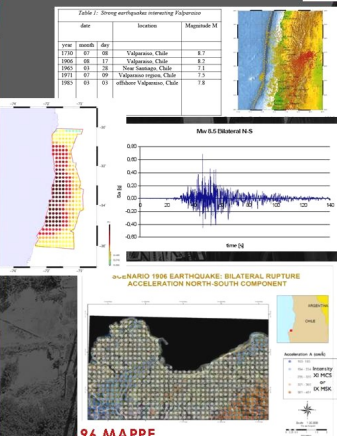
**"MAR VASTO" - "Manejo de riesgos en Valparaiso"**

**SEISMIC HAZARD**

da modelli probabilistici a scenari deterministici  
da una scala regionale a una scala locale

quattro scenari sismici  
 Magnitude **7.5 Occasional** (Occurrence Period ≈ 20-140 years, Strong)  
 Magnitude **7.8 (1985) Sporadic** (Occurrence Period ≈ 200-250 years, Very Strong)  
 Magnitude **8.3 (1906) Rare** (Occurrence Period ≈ 500 years, Disastrous)  
 Magnitude **8.5 Exceptional** (Occurrence Period ≈ 1000 years, Catastrophic)

Per ogni scenario:  
 due tipologie di rottura: unilatera e bilatera  
 segnali sintetici (D, V, A) per le due componenti orizzontali del moto (N-S e E-W)  
 realizzazione di una griglia densa per l'area urbana di Valparaiso  
 input sismici specifici per le tre chiese



**"MAR VASTO" - "Manejo de riesgos en Valparaiso"**

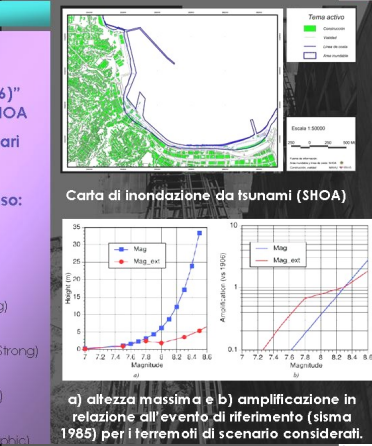
**Tsunami Hazard**

collaborazione con SHOA, OGP

"scenario events (1985 e 1906)" e "source models" da studi SHOA  
sviluppo di altri possibili scenari

scenari di tsunami a Valparaiso:

- Magnitude **7.0 Frequent** (Occurrence Period ≈ 70-80 years)
- Magnitude **7.5 Occasional** (Occurrence Period ≈ 120-140 years, Strong)
- Magnitude **7.8 (1985) Sporadic** (Occurrence Period ≈ 200-250 years, Very Strong)
- Magnitude **8.3 (1906) Rare** (Occurrence Period ≈ 500 years, Disastrous)
- Magnitude **8.5 Exceptional** (Occurrence Period ≈ 1000 years, Catastrophic)



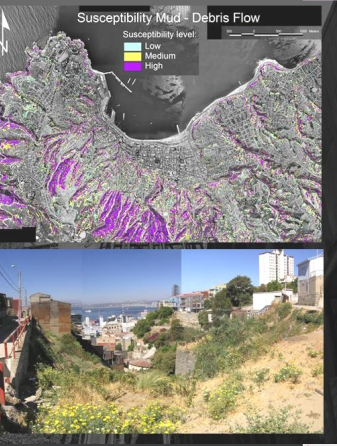
**"MAR VASTO" - "Manejo de riesgos en Valparaiso"**

**LANDSLIDE HAZARD**

collaborazione con UPLA, OGP

- mappe di hazard  
- quebradas Cerro Cordillera

In generale, situazione di rischio molto elevato in tutto l'anfiteatro

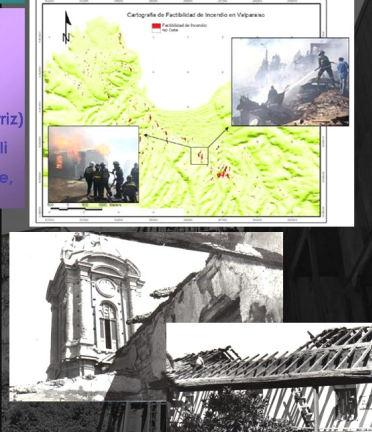


**"MAR VASTO" - "Manejo de riesgos en Valparaiso"**

**FIRE HAZARD**

collaborazione con OGP, OREMI, Pompieri

mappe di hazard  
protezione delle chiese (San Francisco del Baron, La Matriz)  
protezione di edifici residenziali  
miglioramento di linee elettriche, gas, acqua, etc.

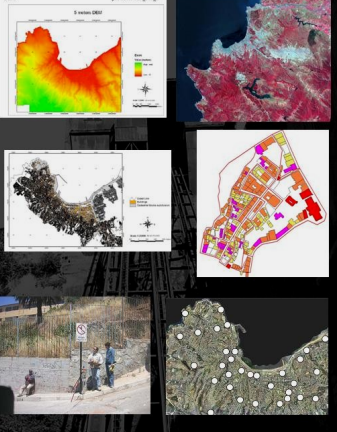


**"MAR VASTO" - "Manejo de riesgos en Valparaiso"**

**GIS DATABASE**

collaborazione con OGP, SHOA

- GIS DATABASE:
- cartografia e batimetria
  - foto satellitari
  - foto aeree (fonti SHOA, MINVU, OGP)
  - GIS urban layers (fonte OGP)
  - realizzazione di un DEM (Digital Elevation Model)
  - rilievo DGPS (39 punti)
- CERRO CORDILLERA:
- analisi architettonico-urbanistica
  - analisi di vulnerabilità

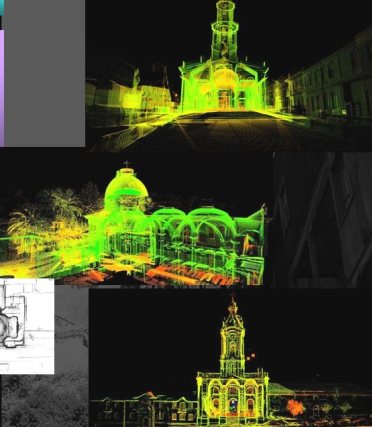


**"MAR VASTO" - "Manejo de riesgos en Valparaiso"**

**RILIEVO LASER SCANNER 3D**

collaborazione con GEOMCOM, OGP, CORPO DEI POMPIERI, AUTORITA' ECCLESIASTICHE

- La Matriz
- San Francisco
- Hermanas de la Providencia



**"MAR VASTO" - "Manejo de riesgos en Valparaiso"**

**INDAGINE ARCHITETTONICA E URBANISTICA DI UN SETTORE PILOTA DEL CERRO CORDILLERA**

collaborazione con OGP, UC, Carabinieri

- 
- Area: Calle Clave, Calle Ramos, Plaza Sotomayor
- 230 edifici
  - 4 spazi pubblici
  - 50 tratti di rete viaria





**"MAR VASTO" - "Manejo de riesgos en Valparaiso"**

**INDAGINE DI VULNERABILITA' SISMICA DI UN SETTORE PILOTA DEL CERRO CORDILLERA**

70 edifici con procedura GNDT semplificata

**"MAR VASTO" - "Manejo de riesgos en Valparaiso"**

Area di studio

Particelle catastali di cui sono disponibili informazioni

Scheda di vulnerabilità sismica

Edifici analizzati con la scheda strutturale

Distribuzione degli indici di vulnerabilità

Analisi di vulnerabilità sismica del Cerro Cordillera mediante schede sintetiche

**"MAR VASTO" - "Manejo de riesgos en Valparaiso"**

**ANALISI DI VULNERABILITA' STRUTTURALE E CALCOLI PRELIMINARI PER TRE CHIESE IMPORTANTI DI VALPARAISO**

collaborazione con OGP, UC, Corpo dei Pompieri, Autorità ecclesiastiche, Carabinieri, altre università, professionisti

**"MAR VASTO" - "Manejo de riesgos en Valparaiso"**

**ANALISI DI VULNERABILITA' STRUTTURALE E CALCOLI PRELIMINARI PER TRE CHIESE IMPORTANTI DI VALPARAISO**

Analisi dei meccanismi di danno con un procedimento studiato in Italia per le chiese

Failure mechanism	
1. COLLAPSE OF THE ROOF	10. COLLAPSE OF THE ROOF
2. COLLAPSE OF THE ROOF AND WALLS	11. COLLAPSE OF THE ROOF AND WALLS
3. COLLAPSE OF THE ROOF AND WALLS AND CHANCEL	12. COLLAPSE OF THE ROOF AND WALLS AND CHANCEL
4. COLLAPSE OF THE ROOF AND WALLS AND CHANCEL AND TOWER	13. COLLAPSE OF THE ROOF AND WALLS AND CHANCEL AND TOWER
5. COLLAPSE OF THE ROOF AND WALLS AND CHANCEL AND TOWER AND CHANCEL	14. COLLAPSE OF THE ROOF AND WALLS AND CHANCEL AND TOWER AND CHANCEL
6. COLLAPSE OF THE ROOF AND WALLS AND CHANCEL AND TOWER AND CHANCEL AND TOWER	15. COLLAPSE OF THE ROOF AND WALLS AND CHANCEL AND TOWER AND CHANCEL AND TOWER
7. COLLAPSE OF THE ROOF AND WALLS AND CHANCEL AND TOWER AND CHANCEL AND TOWER AND CHANCEL	16. COLLAPSE OF THE ROOF AND WALLS AND CHANCEL AND TOWER AND CHANCEL AND TOWER AND CHANCEL
8. COLLAPSE OF THE ROOF AND WALLS AND CHANCEL AND TOWER AND CHANCEL AND TOWER AND CHANCEL AND TOWER	17. COLLAPSE OF THE ROOF AND WALLS AND CHANCEL AND TOWER AND CHANCEL AND TOWER AND CHANCEL AND TOWER
9. COLLAPSE OF THE ROOF AND WALLS AND CHANCEL AND TOWER AND CHANCEL AND TOWER AND CHANCEL AND TOWER AND CHANCEL	18. COLLAPSE OF THE ROOF AND WALLS AND CHANCEL AND TOWER AND CHANCEL AND TOWER AND CHANCEL AND TOWER AND CHANCEL

Global index damage = 30% Local index damage on the facade = 60%

Figure 22 - "San Francisco del Barón" Church and Monastery - Damage Index

**"MAR VASTO" - "Manejo de riesgos en Valparaiso"**

**ANALISI DI VULNERABILITA' STRUTTURALE E CALCOLI PRELIMINARI PER TRE CHIESE IMPORTANTI DI VALPARAISO**

Rilevo e studio del quadro fessurativo

**"MAR VASTO" - "Manejo de riesgos en Valparaiso"**

**ANALISI DI VULNERABILITA' STRUTTURALE E CALCOLI PRELIMINARI PER TRE CHIESE IMPORTANTI DI VALPARAISO**

Calcoli strutturali preliminari

a) Frequency: 2.05 Hz; Mass in X direction: 12.41%    b) Frequency: 4.50 Hz; Mass in Y direction: 11.85%

c) Frequency: 7.60 Hz; Mass in X direction: 2%    d) Frequency: 2.70 Hz; Mass in X direction: 6.52%

e) Frequency: 6.93 Hz; Mass in X direction: 11.89%    f) Frequency: 12.70 Hz; Mass in X direction: 4%

g) Frequency: 7.70 Hz; Torsional Mode    h) Frequency: 7.85 Hz; Torsional Mode

Figure 24 - Vibration modes with a significant contribution to the dynamic response.

**"MAR VASTO" - "Manejo de riesgos en Valparaiso"**

**IGLESIA SAN FRANCISCO DEL BARON**

rischio di **collasso parziale o totale** per sismi medio-alti

interventi di **emergenza** (chiusura parziale o totale, messa in sicurezza della torre)

progetto e intervento **restauro antisismico complessivo**

**IGLESIA DEL SALVADOR, MATRIZ DE VALPARAISO**

piccoli interventi di **miglioramento sismico**

protezione contro il **degrado dei materiali** (fermiti)

protezione contro l'**incendio**

**CAPILLA DE LA PROVIDENCIA**

rischio di **collasso parziale o totale** per sismi medio-alti

La chiesa è stata **chiusa** dopo il terremoto del 1985

Il progetto e intervento di **restauro antisismico** si presenta complesso

**"MAR VASTO" - "Manejo de riesgos en Valparaiso"**

interazione con i cittadini

**IL RISCHIO AUMENTA**

con il peggioramento delle condizioni sociali ed economiche

miglioramento delle abitazioni e delle infrastrutture (gas, elettricità, acqua, ecc.)



**MAR VASTO** - "Manejo de riesgos en Valparaiso"

**interazione tra esperti e popolazione**

**stretta collaborazione tra vari livelli istituzionali (Stato, Regione, municipalità, "juntas de vecinos")**

**"MAR VASTO" - "Manejo de riesgos en Valparaiso"**

**PRESENTAZIONI A CONVEGNI INTERNAZIONALI**

Universidad Federico Santa Maria  
Presentazione dei risultati della missione "MAR VASTO"  
Valparaiso, 22 Novembre 2007

Universidad Pontificia  
VI Congreso Chileno de Geotecnia  
Valparaiso, 29 Novembre 2007

Universidad de Viña del Mar  
II Jornadas de Patrimonio  
Viña del Mar, 2 Ottobre 2008

CONPAT 2009  
Congress of Construction, Pathology, Quality Control, and Rehabilitation of Structures and Construction  
[www.conpat2009.cl/](http://www.conpat2009.cl/)  
Valparaiso, 29 Sett. - 2 Ott. 2009

**"MAR VASTO" - "Manejo de riesgos en Valparaiso"**

**PRESENTAZIONI A CONVEGNI INTERNAZIONALI**

SAHC'08, Structural Analysis of Historic Constructions, Bath, United Kingdom, 2-4 Luglio 2008

M. Indirli, F. Geremei, C. Puglisi, A. Screpanti  
ENEA, Italy

D. Biersch, L. Lanzoni, N. Lopez Izquierdo, E. Milani, M. Miglioli, G. Simonini  
University of Ferrara, Italy

M. Munari  
University of Padua, Italy

F. Romanelli ICTP, Abdus Salam International Centre for Theoretical Physics of Trieste, Italy

**"A GIS platform on main natural hazards for Valparaiso City and vulnerability studies for some historical constructions and urban sectors"**

**"MAR VASTO" - "Manejo de riesgos en Valparaiso"**

**PRESENTAZIONI A CONVEGNI INTERNAZIONALI**

**PROHITECH**  
Roma, Estate 2009

**4 "abstracts" presentati e accettati sul progetto "MAR VASTO"**

Lavoro congiunto Chile-Italia

**"MAR VASTO" - "Manejo de riesgos en Valparaiso"**

**CONCLUSIONI**

Ringraziamento a tutti gli esperti della squadra italiana

Ringraziamento a tutti coloro che hanno collaborato con noi

Fiducia di future collaborazioni italo-cilene per progetti di restauro di monumenti e riqualificazione urbana

**PRIORITA'**

**SAN FRANCISCO DEL BARON**

intervento di urgenza (3 mesi)  
progetto di restauro antisismico complessivo (1 anno)  
esecuzione dell'opera (4-5 anni)

**"MAR VASTO" - "Manejo de riesgos en Valparaiso"**

**CONCLUSIONI**

*"More effective prevention strategies would save not only ten of billions of dollars, but save ten of thousands of lives.*

*Funds currently spent on intervention and relief could be devoted to enhancing equitable and sustainable development instead, which would further reduce the risk for war and disaster.*

*Building a culture of prevention is not easy. While the costs of prevention have to be paid in the present, its benefits lie in a distant future. Moreover, the benefits are not tangible;*

**THEY ARE THE DISASTERS THAT DID NOT HAPPEN"**

Kofi Annan

Introduction to Secretary-General's Annual Report on the Work of the Organization of United Nations - 1999 - Doc. A/54/1

*Claudio Puglisi, ENEA Rome, Italy*  
*Los riesgos naturales en la ciudad de Valparaiso*

**"MAR VASTO" - "Manejo de riesgos en Valparaiso"**  
**LOS RIESGOS NATURALES EN LA CIUDAD DE VALPARAISO**

Para una informacion mas detallada remitase a los siguientes informes oficiales y a sus autores:

- A GIS DATABASE FOR THE CITY OF VALPARAISO ([fabio.geremei@bologna.enea.it](mailto:fabio.geremei@bologna.enea.it))
- EARTHQUAKE HAZARD IN THE CITY OF VALPARAISO ([romanel@dst.unifs.it](mailto:romanel@dst.unifs.it))
- TSUNAMI HAZARD IN THE CITY OF VALPARAISO ([romanel@dst.unifs.it](mailto:romanel@dst.unifs.it))
- FIRE HAZARD IN THE CITY OF VALPARAISO ([mgonzales@munivalpo.cl](mailto:mgonzales@munivalpo.cl))
- GEOMORPHOLOGIC HAZARD IN THE CITY OF VALPARAISO ([puglisi@casaccia.enea.it](mailto:puglisi@casaccia.enea.it))

**"MAR VASTO" - "Manejo de riesgos en Valparaiso"**

**WP 6: Realizacion de un GIS por la ciudad de Valparaiso**

Layers de cartografia basica

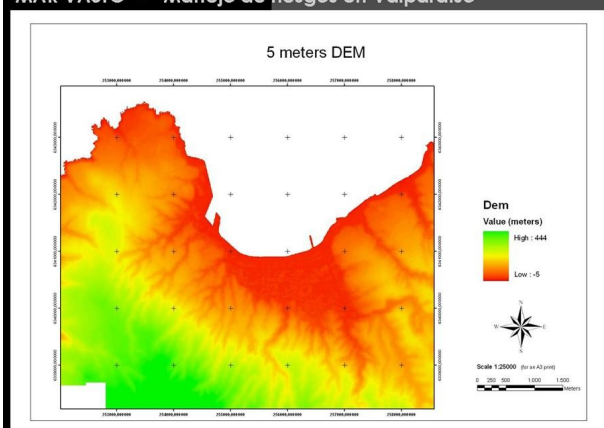
- DEM
- Levantamiento DGPS
- Orthofotos
- Topo-batimetria
- Otros mapas urbanos
- Mapas historicos

Layers de cartografia de peligrosidad natural

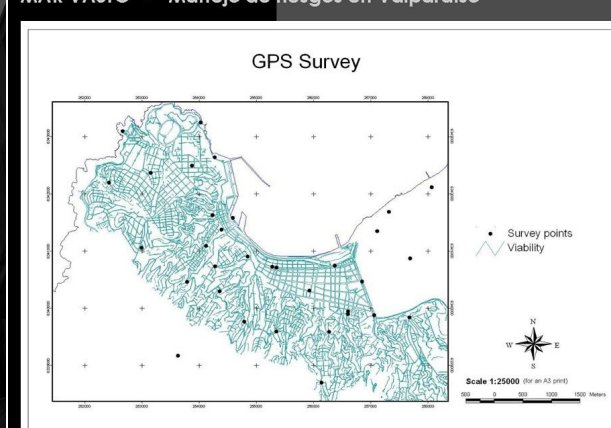
- Sismos
- Tsunami
- Incendios
- Deslizamientos

Layers de datos arquitectonicos, estructurales y de planificacion urbana del area de estudio de Cerro Cordillera

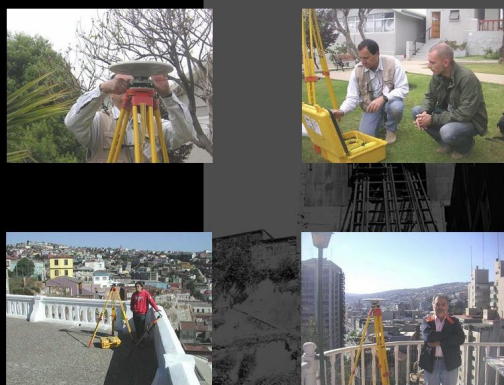
**"MAR VASTO" - "Manejo de riesgos en Valparaiso"**



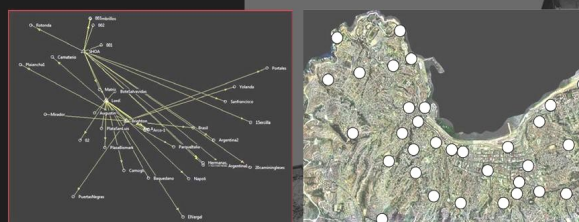
**"MAR VASTO" - "Manejo de riesgos en Valparaiso"**



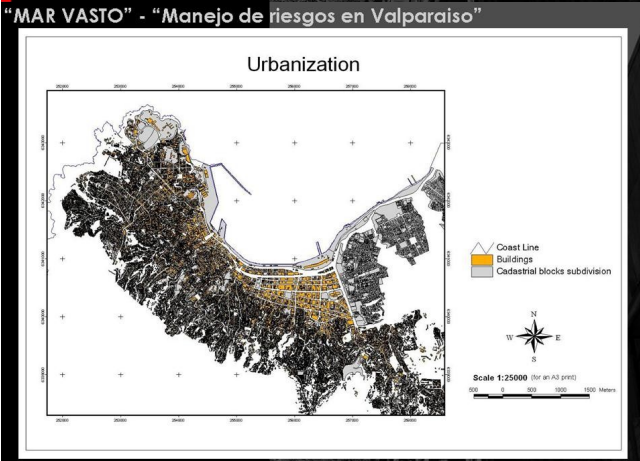
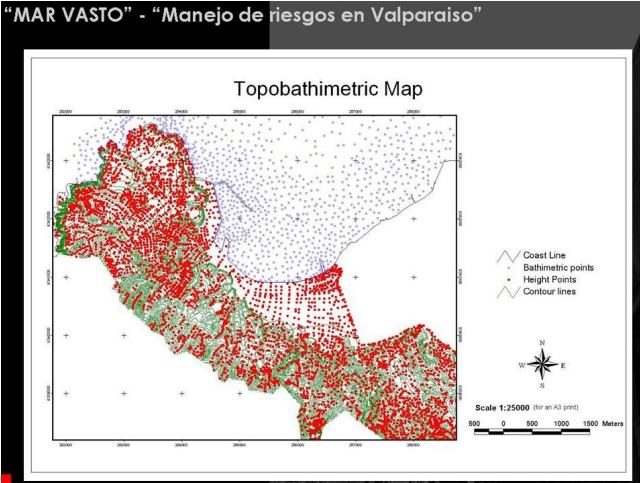
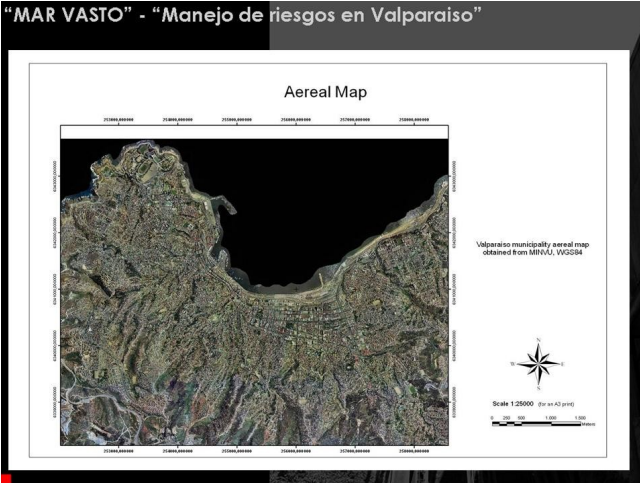
**"MAR VASTO" - "Manejo de riesgos en Valparaiso"**



**"MAR VASTO" - "Manejo de riesgos en Valparaiso"**







**"MAR VASTO" - "Manejo de riesgos en Valparaiso"**

**WP3: Peligrosidad sísmica**

**ICTP Team:**  
 Prof. Giuliano Panza  
 Hoby Raza  
 Elisa Zuccolo  
 Cristina La Mura  
 Dr. Fabio Romanelli  
 Dr. Franco Vaccari

Scientific Coordinator  
 PhD Student  
 PhD Student  
 PhD Student  
 Senior Researcher  
 Senior Researcher

El mayor resultado de este WP es proporcionar un **dataset** representativo del potencial desplazamiento de la roca madre, sobretodo en las iglesias en estudio (**La Matriz, San Francisco, Las Hermanitas de la Providencia**), por distintos escenarios, de manera tal de **predecir los efectos de distintos sismos de distinta magnitud**.

**"MAR VASTO" - "Manejo de riesgos en Valparaiso"**

**PELIGROSIDAD SISMICA**

Sismicidad histórica (1906-1985)

**"MAR VASTO" - "Manejo de riesgos en Valparaiso"**

**SEISMIC HAZARD**

de modelos probabilísticos hasta escenarios determinísticos

desde una escala regional hasta una escala local

cuatro escenarios sísmicos

- Magnitud 7.5 Ocasional (Ocurrencia: cada ~120-140 años, Fuerte)
- Magnitud 7.8 (1985) esporádico (Ocurrencia: cada ~200-250 años, Muy fuerte)
- Magnitud 8.3 (1906) Raro (Ocurrencia: cada ~500 años, desastroso)
- Magnitud 8.5 Exceptional (Ocurrencia: cada ~1000 años, catastrófico)

Por cada escenario:

- dos tipologías de ruptura: unilateral N/S y bilateral)
- Desplazamiento, Velocidad y Aceleración por las dos componentes horizontales del movimiento (N-S y E-W)
- realización de una red densa (20x20 m) por la área urbana de Valparaiso
- input sísmicos específicos por las tres iglesias

Tabla 7: Strong earthquake inventory Valparaiso

year	month	day	location	Magnitud M
1790	07	09	Valparaiso, Chile	8.7
1906	08	12	Valparaiso, Chile	8.2
1906	08	20	New Testam, Chile	8.1
1911	01	01	Valparaiso, Chile	7.8
1985	03	03	Valparaiso, Chile	7.8

**"MAR VASTO" - "Manejo de riesgos en Valparaiso"**

**SEISMIC HAZARD**

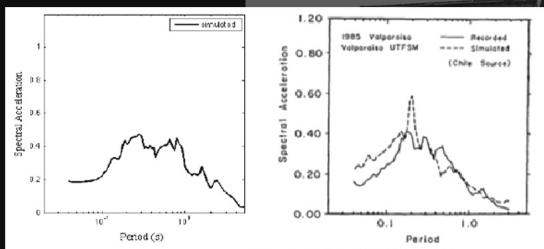
- Peligro a escala regional

PELIGROSIDAD A NIVEL REGIONAL  
 Distribución del componente horizontal del PGA (Máxima Aceleración al suelo) y del máximo periodo en segundos



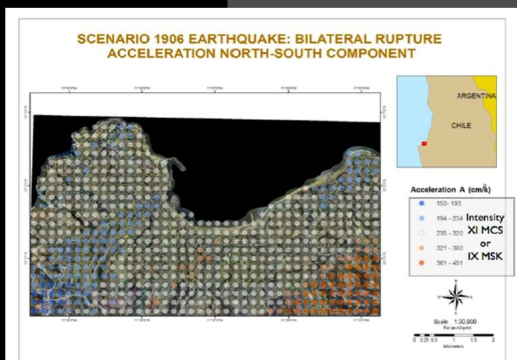
Validacion de los datos modelados con los datos experimentales

El Almendral station: aceleracion, velocidad y desplazamiento por el evento del 1985 event.



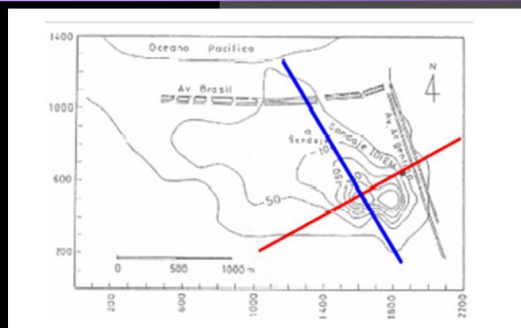
Comparacion del espectro de respuesta entre este estudio (izquierda) y registrado y simulado por Somerville et al., 1991 (derecha).

Input sismico a escala urbana



Escenario del desplazamiento del suelo en la area urbana de Valparaiso por el evento del 1985. Componente NS de la velocidad para ruptura bilateral.

Input sismico a escala urbana: cortes seleccionados & efectos locales



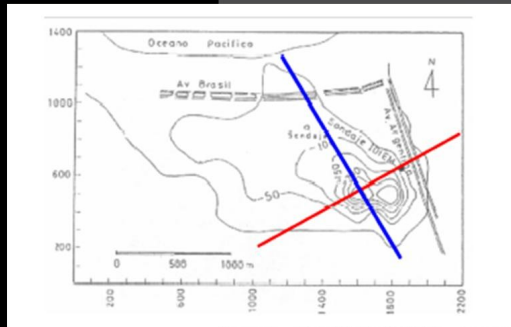
Reconstruccion de la profundidad de la roca madre en la estacion sismica de El Almendral

WP4: Peligrosidad por tsunami

El objetivo del trabajo es complementar el detallado estudio ya desarrollado por SHOA a traves:

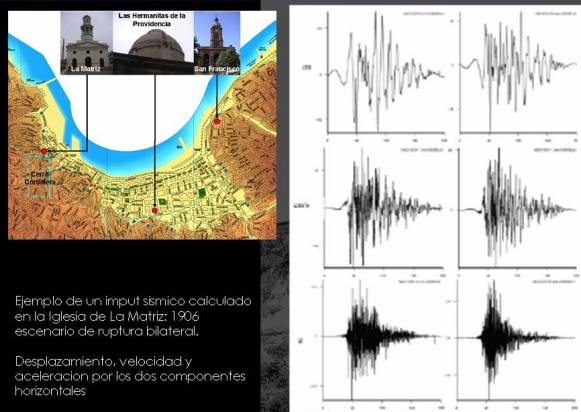
- a) Constuccion de un set de datos parametricos acerca el potencial tsunamigenico de los de los sismos de 1985 y 1906;
- b) modelacion de la forma de la ola de tsunami por distintos escenarios.

Input sismico a escala urbana: cortes seleccionados & efectos locales



Reconstruccion de la profundidad de la roca madre en la estacion sismica de El Almendral y orientacion de dos cortes a la largo de los cuales han sido modelados los input sismicos

Input sismico a escala urbana: las 3 iglesias seleccionadas



Ejemplo de un input sismico calculado en la Iglesia de La Matriz: 1906 escenario de ruptura bilateral.

Desplazamiento, velocidad y aceleracion por los dos componentes horizontales

Input sismico a escala urbana: efectos locales

Por lo tanto, un importante resultado general de las analisis conducidos es que los efectos locales debidos por el espesor de los sedimentos sueltos (mas de 300 m) que estan sobre la roca madre en el area de El Almendral, puede causar una amplificacion mayor de 1 de la intensidad sismica media de toda la ciudad



Figure 11. MSK intensities of 1985 Chile Central earthquake at El Almendral (Somerville et al. 1991).

Figure 12. MSK intensities of 1985 Chile Central earthquake at El Almendral (Somerville 2006).

En particular ha sido calculada la maxima amplitud de la ola y el tiempo de viaje para alcanzar la costa desde la source area.

Han sido adoptado los escenarios determinados por los eventos del 1985 y 1906, y el modelo de source area descrito por SHOA y luego han sido modelados los tsunami por otros posibles escenarios



"MAR VASTO" - "Manejo de riesgos en Valparaíso"

**TSUNAMI HAZARD**

colaboración con SHOA y OGP

- "escenarios eventos (1985 e 1906)" y "source models" por estudios del SHOA

- Desarrollo de otros posibles escenarios

- Escenarios de Tsunami a Valparaíso:

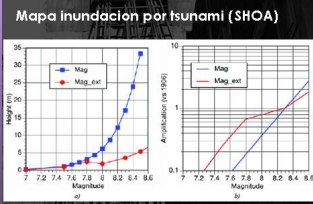
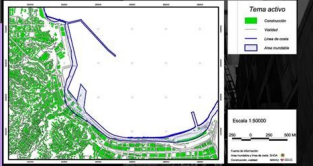
Magnitud 7.0 frequent (Ocurencia: cada ≈70-80 years)

Magnitud 7.5 Ocasional (Ocurencia: cada ≈120-140 years, fuerte)

Magnitud 7.8 (1985) Sporadic (Ocurencia: cada ≈200-250 years, Muy fuerte)

Magnitud 8.3 (1906) Rare (Ocurencia: cada ≈500 years, Desastroso)

Magnitud 8.5 Exceptional Occurrence Period cada≈1000 years, Catastrofico)

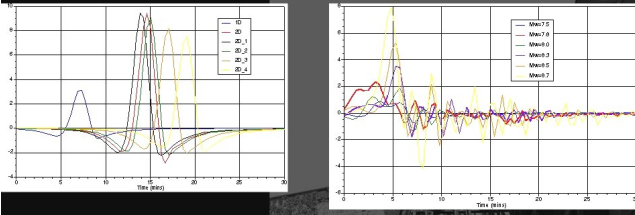


"MAR VASTO" - "Manejo de riesgos en Valparaíso" **TSUNAMI HAZARD**

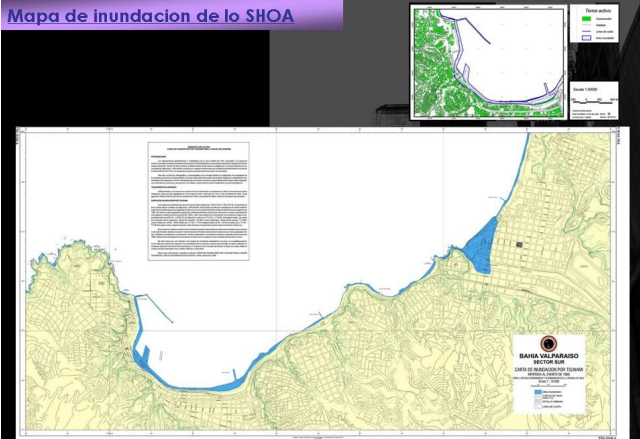
**Modelos del heterogeneidad lateral & source area extensa**

Senales de Tsunami calculado por el sismo de referencia (1D) y distintos modelos de heterogeneidad lateral (2D).

Senales de Tsunami calculado en Valparaíso (cerca 50 km) por distintas magnitudes (desde 7.5 hasta 8.7) con un modelo de source area extensa



"MAR VASTO" - "Manejo de riesgos en Valparaíso" **TSUNAMI HAZARD**



"MAR VASTO" - "Manejo de riesgos en Valparaíso" **TSUNAMI HAZARD**

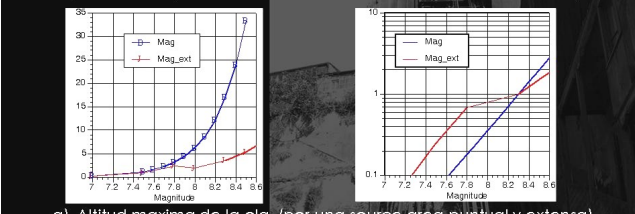
**Conclusiones**

Usando como base el mapa producido por el SHOA (1999) relacionado con el evento del 1906, an upper bound del factor de multiplicación por la peligrosidad por tsunami ha sido usada por distintos escenarios.

La altitud de la ola ha sido calculada por una source area puntual y extensa en relación con la magnitud y la amplificación (usando como referencia el nivel del año 1906)

a) Altitud máxima de la ola (por una source area puntual y extensa)

b) amplificación comparada al evento de referencia (sismo del 1906) por los sismos considerados.



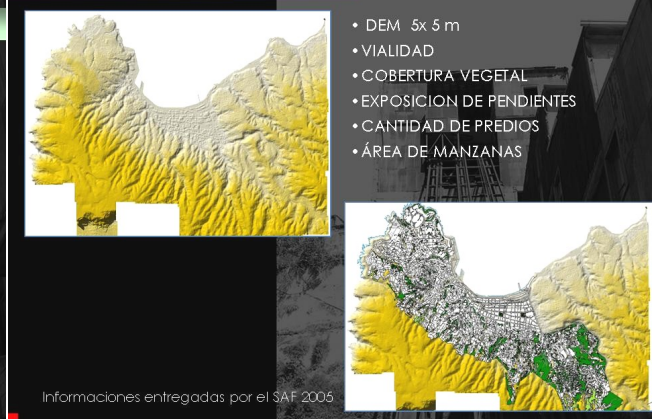
"MAR VASTO" - "Manejo de riesgos en Valparaíso"

WP1: Análisis en Área de riesgo de incendio en Valparaíso

Primera etapa de análisis de acuerdo a un Sistema de Información Geográfica (GIS)

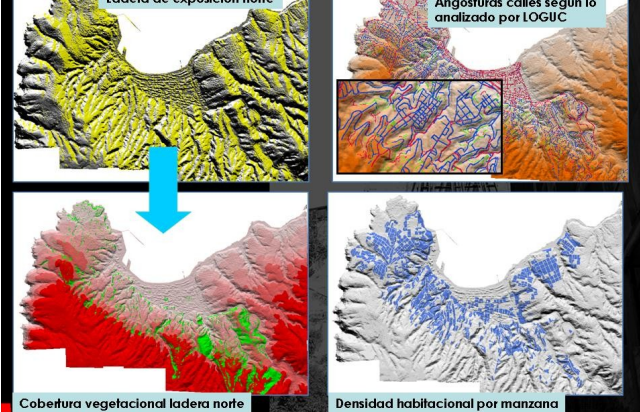
"MAR VASTO" - "Manejo de riesgos en Valparaíso"

**Capas basicas de informacion**



"MAR VASTO" - "Manejo de riesgos en Valparaíso"

**Capas de informaciones extraídas funcionales a la analisis**



"MAR VASTO" - "Manejo de riesgos en Valparaíso"

**Ponderación de variables**

NIVEL DE INCIDENCIA DE VARIABLES	VIALIDAD	VEGETACION	EXPOSICION	MANZANAS	AREAS	TOTAL	POB/CENTRO
0 NULA	0	0	0	3	2		20
1 BAJA	0	3	1	1	1		26
2 MEDIA	3	3	1	0	0		16
3 ALTA	3	3	1	2	3		19
4 MUY ALTA	3	2	1	2	3		19
TOTAL	6	8	5	6	6	31	188

Diagrama de flujo de ponderación de variables:

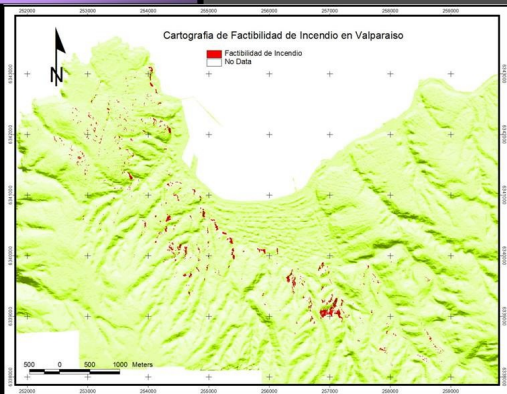
```

    graph LR
        V[Variables] --> P[Ponderación]
        P --> R[Resultado]
        R --> F[Mapa de Riesgo]
    
```



"MAR VASTO" - "Manejo de riesgos en Valparaiso"

CARTOGRAFÍA RESULTANTE

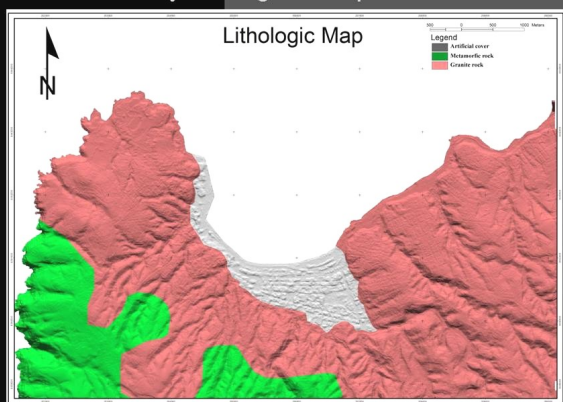


"MAR VASTO" - "Manejo de riesgos en Valparaiso"

Variables SIG, aporte a mayor nivel de análisis

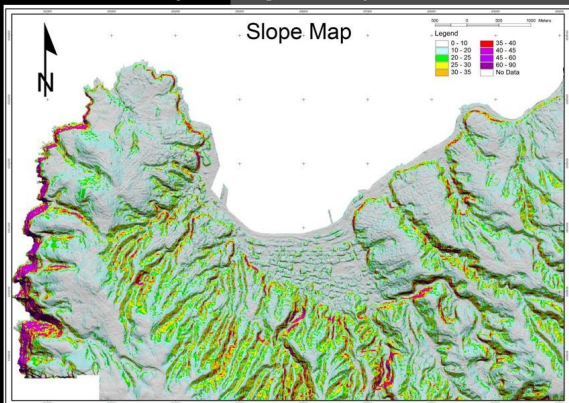
- VIVIENDA**
  - ✓ Año de construcción de la vivienda
  - ✓ Tipo de material de construcción
  - ✓ Altura en pisos de la vivienda
  - ✓ Área de la vivienda
  - ✓ Sitio en lazo
- VIALIDAD**
  - ✓ Largo de calle
  - ✓ Tipología de calles (pavimentada, no pavimentada, huella, pasaje y puente)
- AREAS VERDES Y ESPARCIMIENTO**
  - ✓ Ubicación de árboles
  - ✓ Ubicación de palmeras
  - ✓ Ubicación de plazas y otros espacios públicos
- SOCIODEMOCRÁFICAS**
  - ✓ Nivel socioeconómico
  - ✓ Cantidad de personas por vivienda
  - ✓ Definición etaria según áreas
- EISICAS**
  - ✓ Porcentaje inclinación de Pendientes
  - ✓ Mayor exposición solar según hora del día
  - ✓ Altura de áreas propuestas a análisis
- EQUIPAMIENTO**
  - ✓ Ubicación de alcantarillados
  - ✓ Postes de luz
- COMERCIALES**
  - ✓ Ubicación de comercio y Tipos de comercio
  - ✓ Centros de educación
  - ✓ Fábricas
  - ✓ Empresas
  - ✓ Otros

"MAR VASTO" - "Manejo de riesgos en Valparaiso"



Mapa litológico reconstruido por trabajos anteriores

"MAR VASTO" - "Manejo de riesgos en Valparaiso"



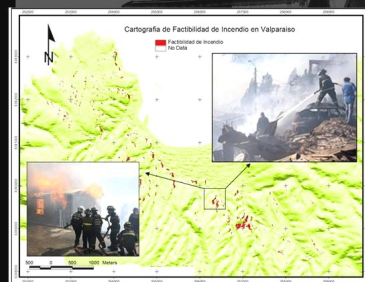
Mapa de pendientes extraída por el DEM 5x5m

"MAR VASTO" - "Manejo de riesgos en Valparaiso"

Análisis regresiva

20:05 Destrucción total de 60 casas, 15 quemados -dos graves- y dos desaparecidos deja el peor incendio, en años, en Valparaiso

Un saldo de destrucción, dramas familiares y graves lesionados, ha dejado hasta el momento un incendio iniciado a las 16:30 horas en el cerro La Cruz, Bomberos, a esta hora, estima entre 60 y 70 las casas destruidas. Hay varias personas quemadas, entre ellas un bombero que tendría un alto porcentaje de su cuerpo quemado y está en riesgo vital. El calor, el fuerte y cambiante viento y, presuntamente una irresponsable quema para fabricar carbón en una quebrada, son las causas principales de este siniestro, el más grande de las últimas décadas (estrella, 15-01-2008)



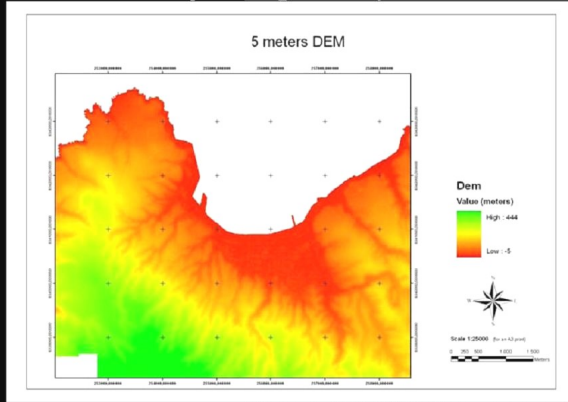
"MAR VASTO" - "Manejo de riesgos en Valparaiso"

WP 1: PELIGROSIDAD GEOMORFOLOGICA DE LA CIUDAD DE VALPARAISO

Metodología para la evaluación de la susceptibilidad por deslizamientos

Para cumplir con esta tarea ha sido necesario producir en ambiente GIS los siguientes mapas temáticos imprescindibles para el desarrollo de toda la metodología que desde la analisis del deslizamiento lleva hasta la evaluación de la peligrosidad por deslizamientos.

"MAR VASTO" - "Manejo de riesgos en Valparaiso"



DEM construido directamente con técnicas fotogramétricas desde las fotos aéreas a escala 1:15.000 y 1:20.000 entregadas por el SHOA

"MAR VASTO" - "Manejo de riesgos en Valparaiso"



Inventario de los deslizamientos construido por trabajo de campo y analisis de las fotos aéreas



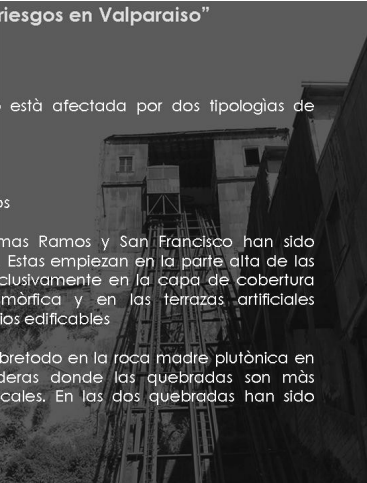
**"MAR VASTO" - "Manejo de riesgos en Valparaiso"**

El área urbana de Valparaiso está afectada por dos tipologías de deslizamientos:

- Coladas de lodo y detrito
- Derrumbes y desprendimientos

En las dos quebradas de Tomas Ramos y San Francisco han sido censadas 41 **coladas de lodo**. Estas empiezan en la parte alta de las quebradas y se desarrollan exclusivamente en la capa de cobertura sobretodo de la roca metamórfica y en las terrazas artificiales construidas para obtener espacios edificables

Los derrumbes se desarrollan sobretodo en la roca madre plutónica en la parte mediana de las laderas donde las quebradas son más estrechas y hay paredes verticales. En las dos quebradas han sido censados 12 desprendimientos.



**"MAR VASTO" - "Manejo de riesgos en Valparaiso"**



Desprendimientos en la parte mediana de las laderas

**"MAR VASTO" - "Manejo de riesgos en Valparaiso"**

**Metodología para la evaluación de la susceptibilidad por deslizamientos**

Después del censo y de la comprensión de los fenómenos de deslizamiento ha sido necesario identificar por cada tipología de deslizamiento:

- los parámetros de la inestabilidad de ladera
- la función de susceptibilidad

Luego han sido redactados los **mapas de susceptibilidad** e identificados los **umbrales pluviométricos** de comienzo de los fenómenos

**"MAR VASTO" - "Manejo de riesgos en Valparaiso"**

**Función de susceptibilidad**

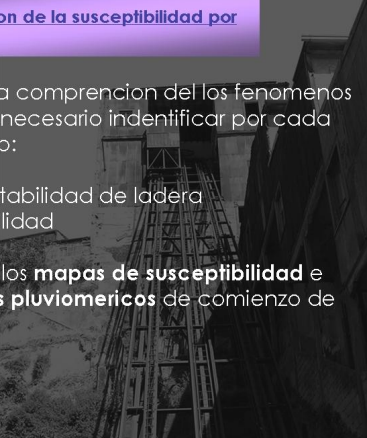
Con esta se atribuyen pesos distintos por cada intervalo de pendiente y para cada tipología de roca en función del número de deslizamientos que se verifican en cada intervalo.

Este enfoque ha conducido a identificar la siguiente función de susceptibilidad

**SUSCEPTIBILIDAD POR LAS COLADAS DE LODO Y LOS DERRUMBES**

$$[(spind) * (litind)] / 9$$

Donde **spind** es el peso atribuido a cada intervalo de pendiente y **litind** es el peso atribuido a la litología



**"MAR VASTO" - "Manejo de riesgos en Valparaiso"**



Terrazas artificiales en la cabeza de las quebradas (sx) para la construcción de edificios (dx)



Efectos de coladas de lodo en la terrazas artificiales

**"MAR VASTO" - "Manejo de riesgos en Valparaiso"**

- 1 Sector alto con quebradas harranchas y pendiente cerca 20° - 30° donde se desarrollan coladas de lodo.
- 2 Sector mediano con quebradas estrechas con pendiente a menudo superior a 30° donde se desarrollan derrumbes a lo largo de las laderas.
- 3 Sector bajo sin quebradas y pendiente inferior a 10°, área de recibos de las acumulaciones de los deslizamientos provenientes en los sectores 1 y 2



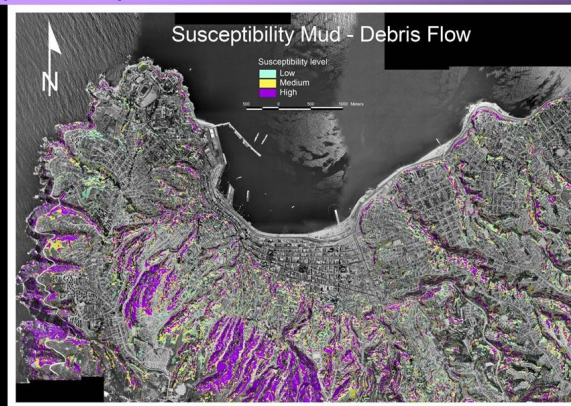
**"MAR VASTO" - "Manejo de riesgos en Valparaiso"**

**Parametros de inestabilidad**

Tipología de deslizamiento	Intervalos de pendiente	
	Roca plutonica	Roca Metamorfica
Coladas de lodo	11-38	11-38
Derrumbes	26-43	28-43

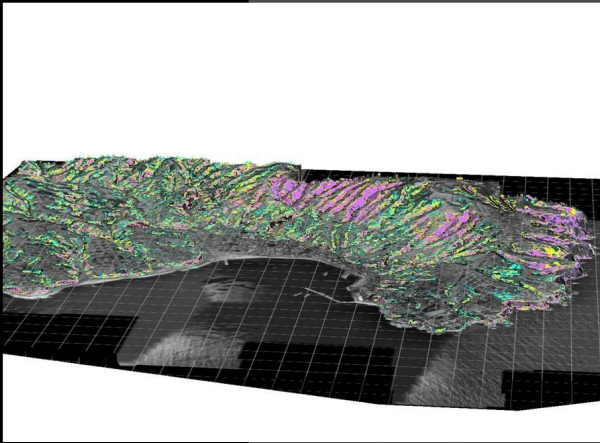
**"MAR VASTO" - "Manejo de riesgos en Valparaiso"**

**Mapas de susceptibilidad**

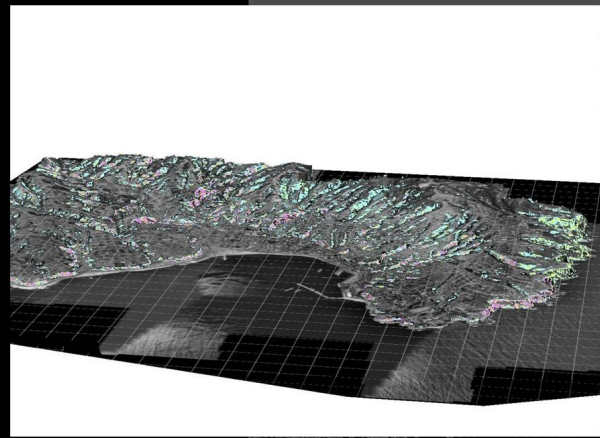




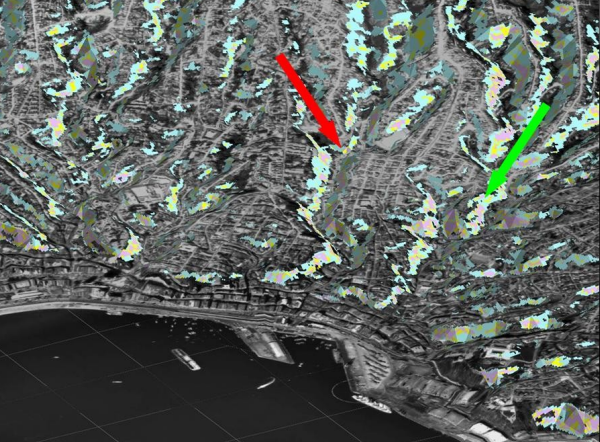
"MAR VASTO" - "Manejo de riesgos en Valparaiso"



"MAR VASTO" - "Manejo de riesgos en Valparaiso"

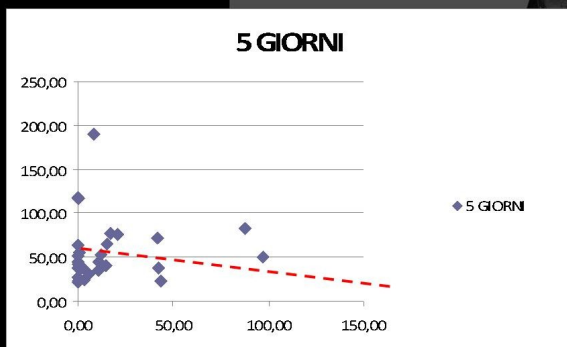


"MAR VASTO" - "Manejo de riesgos en Valparaiso"

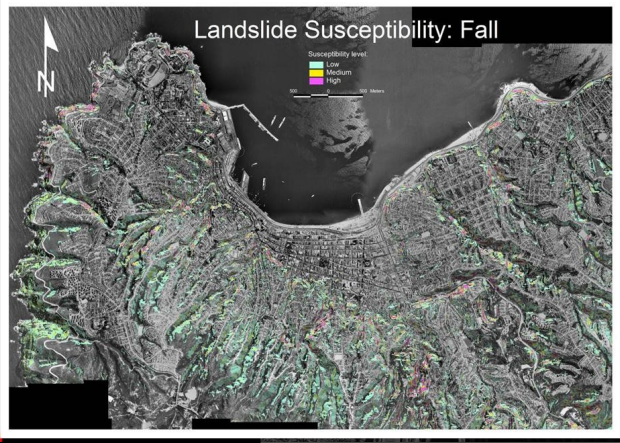


"MAR VASTO" - "Manejo de riesgos en Valparaiso"

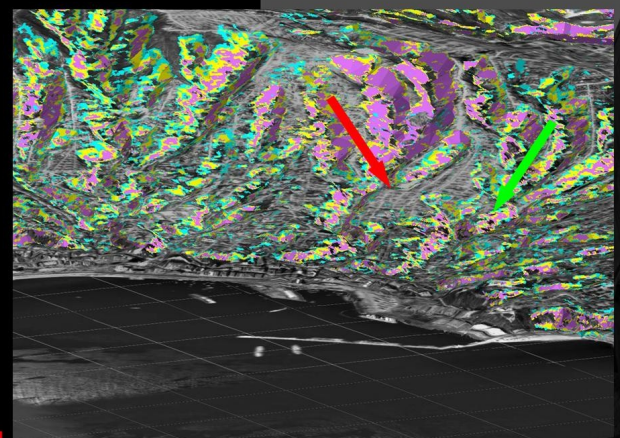
Umbrales pluviometricos



"MAR VASTO" - "Manejo de riesgos en Valparaiso"

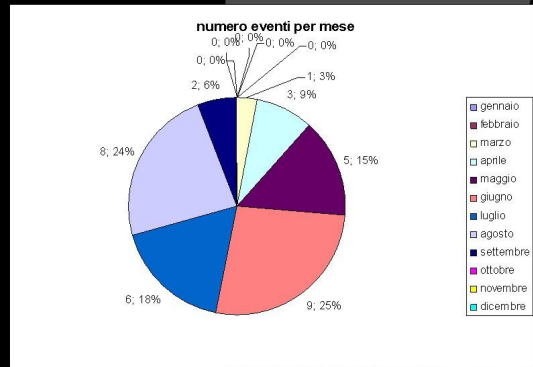


"MAR VASTO" - "Manejo de riesgos en Valparaiso"



"MAR VASTO" - "Manejo de riesgos en Valparaiso"

Umbrales pluviometricos



"MAR VASTO" - "Manejo de riesgos en Valparaiso"

Conclusiones

- Desde el levantamiento de campo, los analisis efectuados y los umbrales provisorios indentificados se puede afirmar que la situacion de estabilidad geomorfologica de la ciudad de Valparaiso es muy grave.
- La desordenada y veloz urbanizacion de la parte alta de los cerros con la costruccion de terrazas y la ocupacion del fundo de las quebradas misma sin ningun ordenamiento territorial empeora muchisimo la ya grave situacion aumentando tambien el riesgo para los ciudadanos.
- Ademas como sucedio hace unos años en Avenida Francia la parte baja de la ciudad que es la mas densamente poblada en eventos de fuerte intensidad puede ser invadida por el lodo afectando la incolumidad de los ciudadanos mismos

## "MAR VASTO" - "Manejo de riesgos en Valparaiso"

### Acciones futuras

- Reconstrucción del espesor de la capa de cobertura para evaluar el volumen y la masa del detrito móvil y la velocidad de los flujos potenciales y sus máxima distancia de propagación al fin de evaluar las energías cinéticas esperados
- Completar el catalogo historico de los fenomenos con la finalidad de mejorar la precision de los umbrales pluviometricos.
- Extender el censo de los fenomenos a toda la ciudad
- Evaluar sobre todo en los derrumbes, la influencia de la aceleracion sismica para el desarrollo de los mismos.

## "MAR VASTO" - "Manejo de riesgos en Valparaiso"

Un gracias particular por el geografo Mauricio Sebastian Gonzalez Loyola por su cooperacion cientifica y tecnica (OGP) y por el Arch. Sofero Apablaza Minchel (OGPI), por la supervision y capacidad organizativo y tecnica.

PERO SOBRETUDO GRACIAS A LOS DOS POR SUS AMISTAD

## "MAR VASTO" - "Manejo de riesgos en Valparaiso"

Muchas organizaciones Chilenas han cooperado estrechamente en el trabajo con los expertos italianos en la evaluacion de la peligrosidad natural de la ciudad de Valparaiso


- Municipalidad de Valparaiso (sobre todo, "Oficina de Gestion Patrimonial OGP" y oficina del Medio Ambiente,
- Regional Civil Defense ("OREMI");
- SHOA ("Servicio Hidrografico y Oceanografico de la Armada de Chile"); en particular el dr. Dante Gutierrez (SHOA) por la peligrosidad por Tsunamis y al servicio fotografico
- Valpomio ("Programa de Recuperacion y Desarrollo Urbano de Valparaiso")
- Bomberos de la Bomba Italiana
- Bote Salvavidas de Valparaiso
- La Universidad Catolica con los Profesores Jorge Heppner Sagulveda y Maria Eliana Portal y los alumnos Francesca Fagandini Ruiz, Antonio Villanueva Vitis, Tomas Matias Andres, Andres Rees Catalan
- La Universidad de Playa Ancha con los Profesores Manuel Muniz Liza y Carlos Romero y el alumno Javier Cañete Valdivia
- Universidad del Chile, de Santiago, con los Profesores R. Saragoni y M. Astroza y los estudiantes S. Ruiz and T. Sturn) for the Seismic Hazard



Luca Lanzoni, University of Ferrara, Italy  
 Proyecto piloto - Cerro Cordillera

Proyecto Mar Vasto  
 Proyecto de investigación "Manejo de riesgos en Valparaíso"

Proyecto piloto - Cerro Cordillera

Luca Lanzoni (Arquitecto)  - Master Ecopolis

Para la salvaguardia y la valorización del patrimonio construido hemos identificado una serie de objetivos:

Construir una base de datos del patrimonio, construido como soporte, para desarrollar una serie de estrategias de salvaguarda y valorización.

Definir una normativa específica para el patrimonio (Categoría de intervención, reglamentación, líneas guías para la recuperación, etc.) en estrecha relación con aquello que existe.

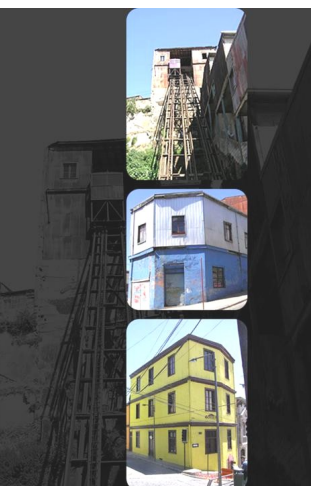
Identificar una serie de herramientas de apoyo que sostengan esta estrategia (económicos, proyecto urbanos, de sensibilización, etc.)

La clasificación de la información

Utilizar instrumentos innovativos para la gestión de la clasificación de la información relacionada con el patrimonio construido (edificios, espacio público, vías, etc.)

Identificar toda la información existente (data base, archivo fotográfico, cartografías históricas, etc.) y las posibles conexiones (IT) que pueden ser utilizadas como soporte de la descripción del patrimonio construido y como base de la clasificación conocida entre los varios actores urbanos que interfieren en la trama urbana de la ciudad.

Construir un modelo de sistema geográfico (GIS) dedicado a la recolección de la información existente y que proviene del análisis en terreno, como soporte a la construcción de la estrategia.

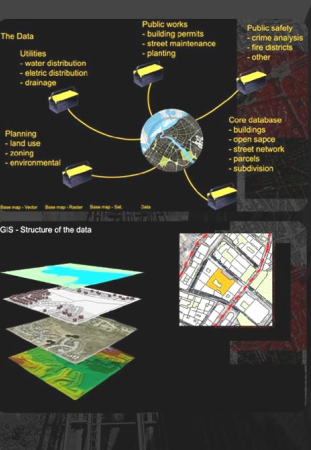


**Estrategia**

**Lectura - Interpretación - Análisis**

**Reglas para el desarrollo**

**Herramientas del trabajo**



The Data

- Public works
  - building permits
  - street maintenance
  - planting
- Public safety
  - crime analysis
  - fire districts
  - other
- Core database
  - buildings
  - open space
  - street network
  - parks
  - subdivision
- Utilities
  - water distribution
  - electric distribution
  - drainage
- Planning
  - land use
  - zoning
  - environmental

GIS - Structure of the data

Los "objetos" considerados patrimonio arquitectónico y urbanístico, no son solo los edificios o monumentos históricos, pero estos si son representantes del conjunto construido, del espacio abierto y de la relación que existe entre estos, al interno de una visión unitaria.



El objetivo de la "conservación" debe ser el de transmitir a las generaciones futuras este valor y la relación de ellos, como testimonio de una identidad cultural, a veces compleja y estratificada, como posible recurso para un desarrollo económico, urbano y social duradero.

Lectura del análisis

Individualizar y analizar el patrimonio construido (edificios, espacio público, vías, etc.) a través de una serie de diferentes indicadores que soportan la estrategia de valorización.



El valor del análisis (científico) realizado sobre el patrimonio construido, el valor específico del estado de construcción, el valor arquitectónico, la relación con los datos socioeconómicos, etc.

El valor de la relación (de vista, de adosamiento, etc.) entre varios de los componentes urbanos, la identificación del paisaje urbano, la dinámica del recorrido del espacio, etc.



Giovanni Astengo – PRG per Assisi, 1955 '57.  
 Giancarlo De Carlo – PRG per Urbino, 1964.

Identificación del área de estudio

El área identificada para el desarrollo del proyecto piloto es una porción del cerro cordillera, ubicada entre calle Clave, Calle Tomas Ramos, y Plaza Sotomayor. Durante el relieve se han identificado:

- 230 Edificios
- 004 Espacios abiertos públicos
- 025 Espacios abiertos privados
- 050 tramos de redes varias









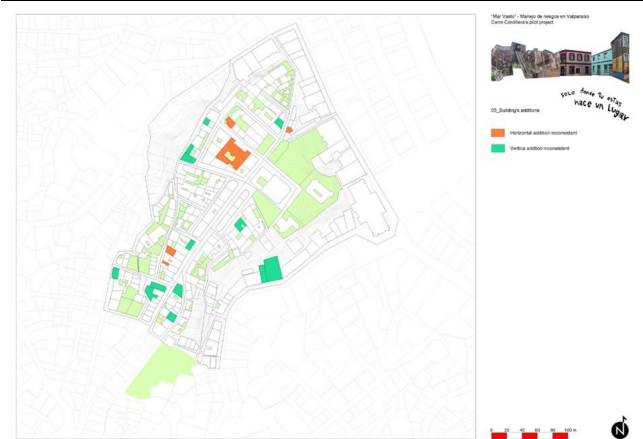
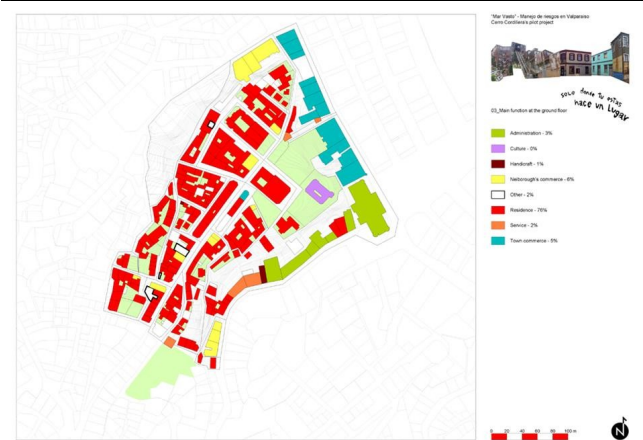
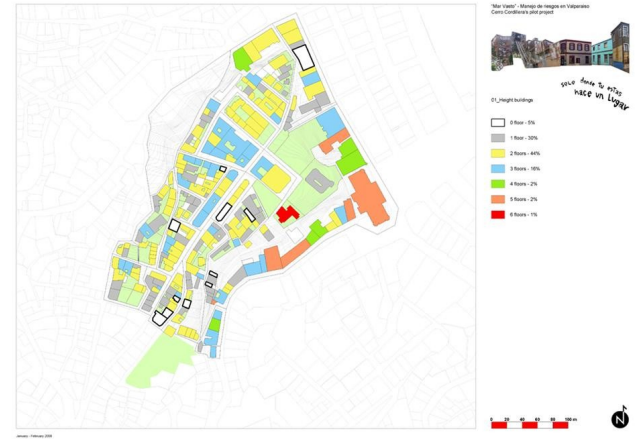
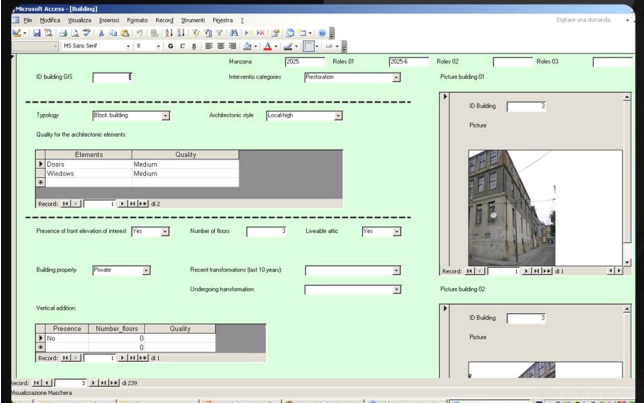
### Manual para el relieve

El análisis en terreno nos han permitido construir un "manual para el relieve" que puede integrarse con otros tipos de información.

El uso de un instrumento de este tipo es importante porque permite a los equipos de relieve de información en terreno, una recolección homogénea de la información.



### Graphical user interface (GUI)





### Nivel de integración y vulnerabilidad

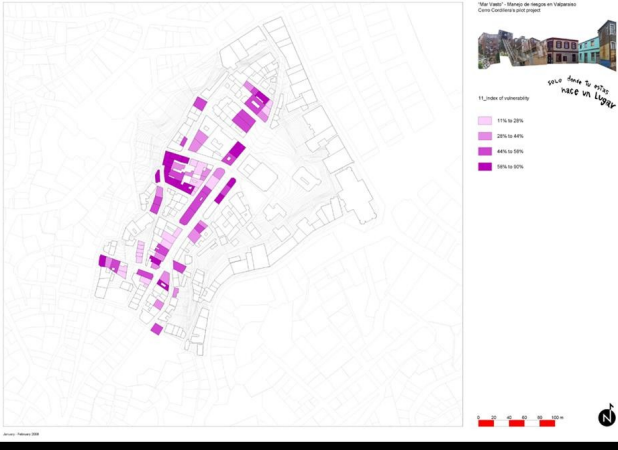
En este primer análisis hemos podido entender el nivel de integración del patrimonio construido respecto a la característica del lugar identificado a través de la topología de habitabilidad, la materialidad de construcción, el grado de utilización, el destino (o uso actual) y el estado de conservación.

El segundo análisis (Vulnerabilidad) deriva de una lectura más profunda de la información proveniente del "estado de conservación". Los edificios en "condición de deterioro", aparecen en evidencia en el sistema SIG y han sido analizados con una ficha de relieve de segundo nivel, para profundizar en los aspectos relativos a la estructura principal, al estado de la fachada y fundación.

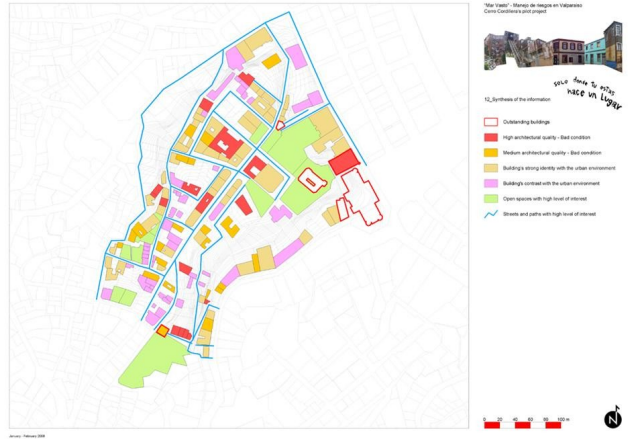
### La ficha de vulnerabilidad

Esta ficha de análisis ha puesto en evidencia el problema relativo a la calidad de la estructura de los edificios (fachada, sistema constructivo, materialidad, etc.).

G.E.M.M. SCHEDA DI VULNERABILITA' SISMICA DI 2° LIVELLO			
Parametri	Classe	Descr. det.	Edificio
1. TIPO DI STRUTTURAZIONE DEL SOLAIO	1	1.1.1	1.1.1
2. QUALITA' DEL S.A.	1	1.1.1	1.1.1
3. RESISTENZA CONVENZIONALE	1	1.1.1	1.1.1
4. PRESSIONI SISMICHE E PUNTEGGIO	1	1.1.1	1.1.1
5. ONDAMENTI	1	1.1.1	1.1.1
6. CONDIZIONE DI PLANI E TAVOLE	1	1.1.1	1.1.1
7. CONDIZIONE DI PARETI E COLONNATE	1	1.1.1	1.1.1
8. SUELI	1	1.1.1	1.1.1
9. CONDIZIONE DI CANTIERI	1	1.1.1	1.1.1
10. ELEMENTI LINEARI STRUTTURALI	1	1.1.1	1.1.1
11. STATO DI FATTO	1	1.1.1	1.1.1





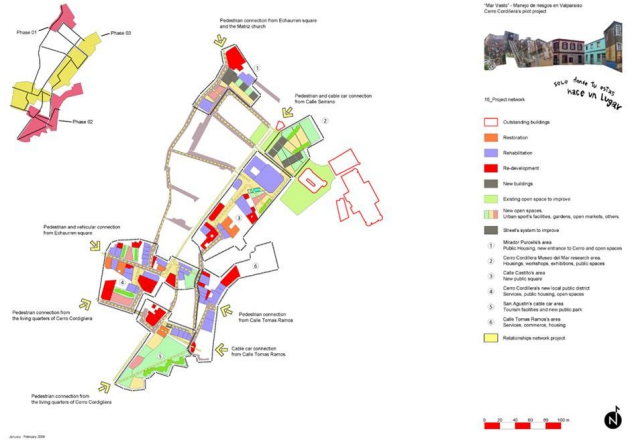
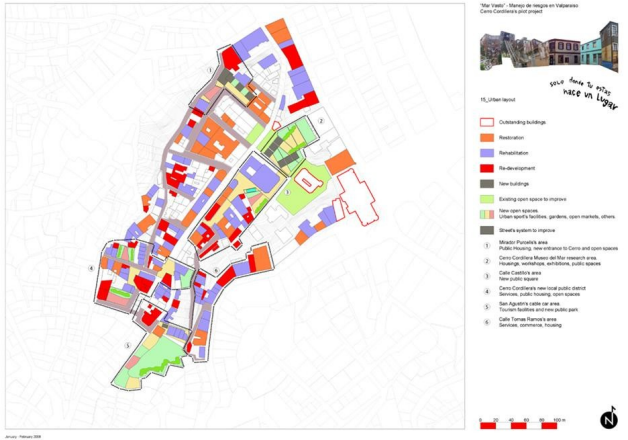


**Categoría de intervención**

La categoría de intervención permitió identificar una serie de posibles intervenciones para cada edificio.

**Restauración**  
 Intervención que garantice la integridad de la tipología arquitectónica, manteniendo intacta la identidad del edificio y su valor como patrimonio cultural.

**Rehabilitación**  
 Intervención que permite la inclusión de nuevas funciones y nuevas actividades dentro de un edificio, mejorando la eficiencia, manteniendo intacta la identidad y valores culturales.












Oswaldo Neira Figueroa, Geocom Santiago  
 The laser scanner survey on the three churches in Valparaiso





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### SCANNER LÁSER SCANSTATION

Características Generales

- ┃ Instrumento de alta precisión, alta velocidad y de gran exactitud - Interfaz de uso Notebook o TablePC
- ┃ Trasmisión Láser. Servo Motor.
- ┃ Visión Óptica. Video Cámara Integrada.
- ┃ Modulo Láser Integrado microchip. Class 3R (IEC 60825-1)
- ┃ Alcance de 300 metros.
- ┃ Promedio de puntos scanneados 4000 puntos/segundo.
- ┃ Campo de visual: 360° en Horizontal, 270° en vertical.
- ┃ Dimensiones Scanner 265mm D x 370 mm W x 510 mm H
- ┃ Peso 16 kg.

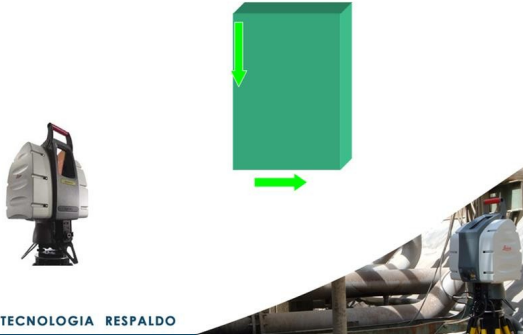


CONFIANZA TECNOLOGIA RESPALDO





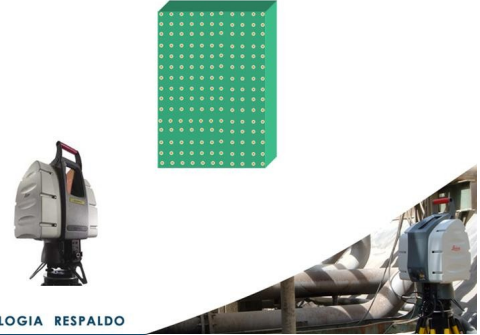
### Los puntos son Escaneados



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### La grilla generada



CONFIANZA TECNOLOGIA RESPALDO



FOTO DIGITAL NUBE DE PUNTOS PROCESADA

**Precision**  
**2mm - 6mm**  
**Punto <= 6mm**



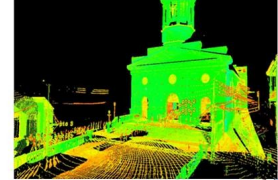
CONFIANZA TECNOLOGIA RESPALDO



### DESCRIPCIÓN GENERAL

Para conseguir un modelo tridimensional válido, es necesario completar una serie de pasos. Se pueden considerar en forma general 3 etapas.

#### 1. TOMA DE DATOS

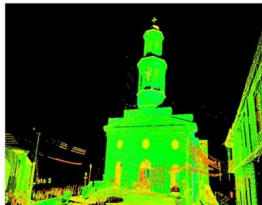
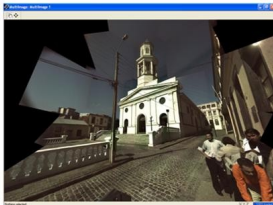


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#### 1. Toma de Datos

a) Primera posición instrumental

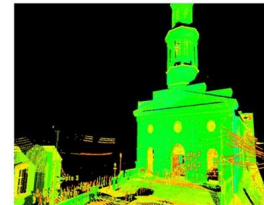
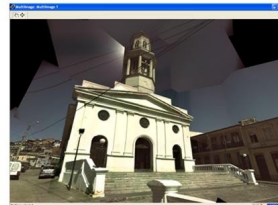


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#### 1. Toma de Datos

b) Segunda posición instrumental

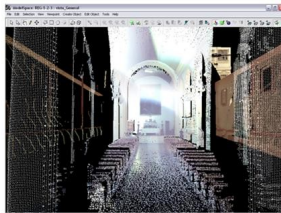


CONFIANZA TECNOLOGIA RESPALDO



#### 1. Toma de Datos

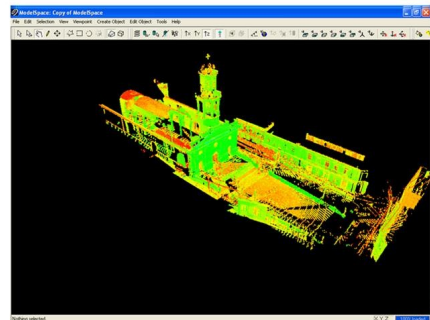
c) Tercera posición instrumental



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#### 2. Creación del Modelo Geométrico



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### PROYECTO IGLESIA LA MATRIZ

CONFIANZA TECNOLOGIA RESPALDO



### LEVANTAMIENTO DE IGLESIA LA MATRIZ VALPARAISO

- OBJETIVO
  - Levantamiento de la fachada de Iglesia La Matriz, utilizando Tecnología de Scanner Láser.
  - Obtención de información estructural para estudios posteriores.

#### Proyecto Iglesia La Matriz (Noviembre 05-07, 2007)

- Escaneado 3 personas.
  - Daniel Bleresch, Universidad de Ferrara.
  - Marco Quevedo, Geocom S.A.
  - Oswaldo Neira, Geocom S.A.

CONFIANZA TECNOLOGIA RESPALDO



### La Matriz



Vista Frontal

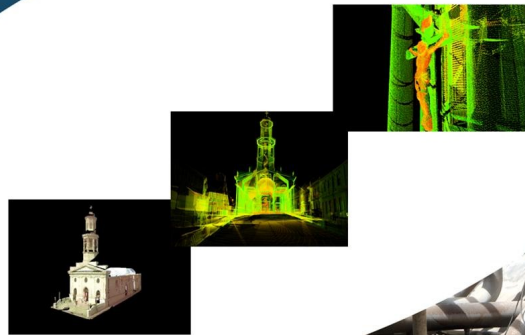


Vista Aérea

CONFIANZA TECNOLOGIA RESPALDO



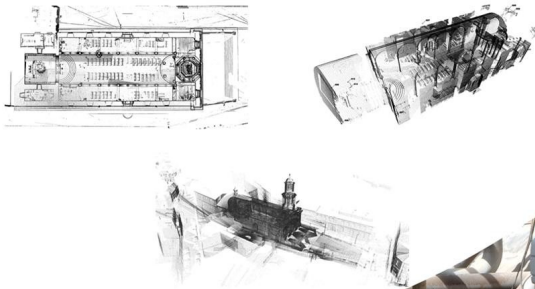
### Tratamiento de Textura y Generación de Planos en 2D



CONFIANZA TECNOLOGIA RESPALDO



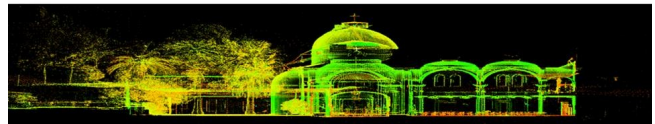
### Tratamiento de Textura y Generación de Planos en 2D



CONFIANZA TECNOLOGIA RESPALDO



### PROYECTO IGLESIA HERMANAS DE LA PROVIDENCIA



CONFIANZA TECNOLOGIA RESPALDO



### LEVANTAMIENTO DE IGLESIA HERMANAS DE LA PROVIDENCIA, VALPARAISO

- OBJETIVO
  - Levantamiento de la total de la Iglesia, utilizando Tecnología de Scanner Láser.
  - Obtención de información estructural para estudios posteriores.

#### Proyecto Iglesia H. de la Providencia (Noviembre 09-13, 2007)

- Escaneado 3 personas.
  - Daniel Bleresch, Universidad de Ferrara.
  - Marco Quevedo, Geocom S.A.
  - Oswaldo Neira, Geocom S.A.



### Iglesia Hermanas de la Providencia



Vista Aérea

CONFIANZA TECNOLOGIA RESPALDO

CONFIANZA TECNOLOGIA RESPALDO





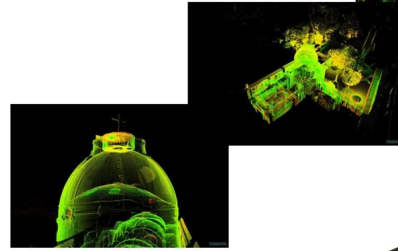
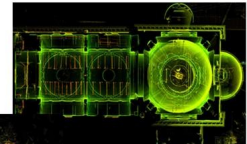
### Tratamiento de Textura



CONFIANZA TECNOLOGIA RESPALDO



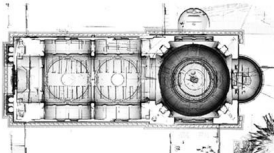
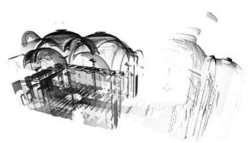
### Nube de Puntos Procesada



CONFIANZA TECNOLOGIA RESPALDO



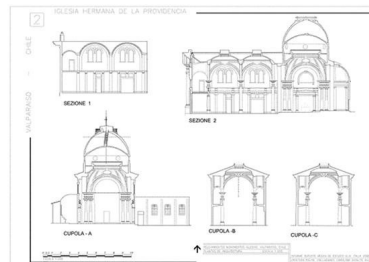
### Tratamiento de Textura



CONFIANZA TECNOLOGIA RESPALDO



### Tratamiento de Textura y Generación de Planos en 2D



CONFIANZA TECNOLOGIA RESPALDO



IGLESIA SAN FRANCISCO

CONFIANZA TECNOLOGIA RESPALDO



### LEVANTAMIENTO DE LA IGLESIA SAN FRANCISCO

#### OBJETIVO

- Levantamiento de la total de la Iglesia, utilizando Tecnología de Scanner Láser.
- Obtención de información estructural para estudios posteriores.

Levantamiento Iglesia San Francisco (7-9 Noviembre, 2007)

Escaneado 3 personas :

- „Daniel Biersch, Universidad de Ferrara,
- „Marco Quevedo, Geocom S.A.
- „Osvaldo Neira, Geocom S.A.

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### Iglesia San Francisco

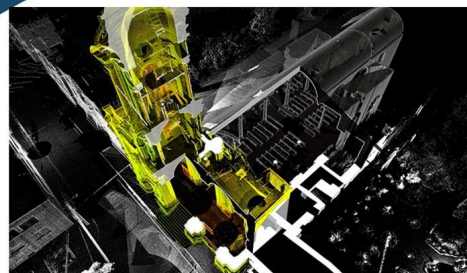


Vista Aérea

CONFIANZA TECNOLOGIA RESPALDO



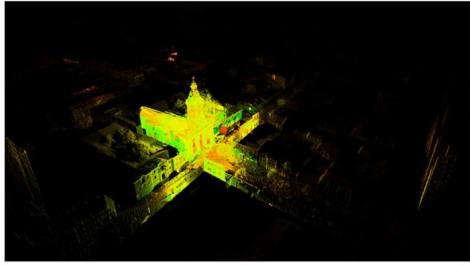
### IGLESIA SAN FRANCISCO



CONFIANZA TECNOLOGIA RESPALDO



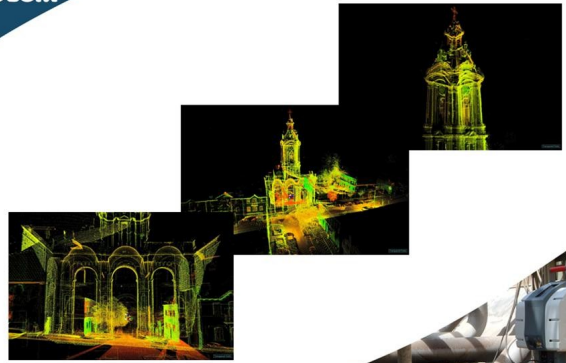
Tratamiento de Textura



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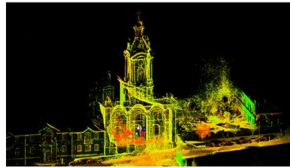
Nube de Puntos Procesada



CONFIANZA TECNOLOGIA RESPALDO



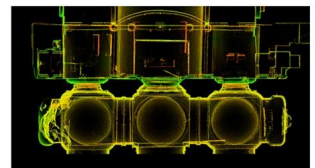
Tratamiento de Textura



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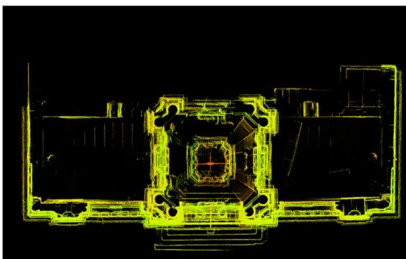
Tratamiento de Textura



CONFIANZA TECNOLOGIA RESPALDO



Tratamiento de Textura



CONFIANZA TECNOLOGIA RESPALDO



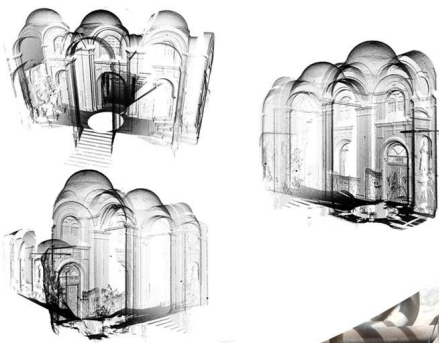
Presentación ModelSpace



CONFIANZA TECNOLOGIA RESPALDO



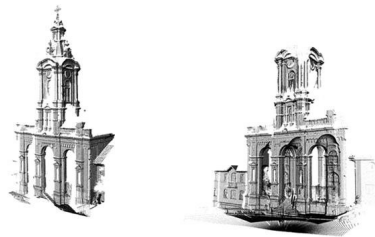
Tratamiento de Textura



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Tratamiento de Textura

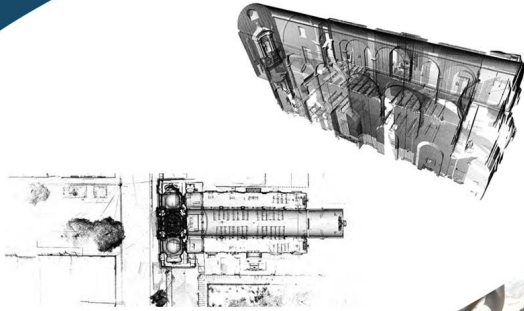


CONFIANZA TECNOLOGIA RESPALDO





## Tratamiento de Textura



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## VENTAJAS

- A partir de la nube de puntos es posible obtener medidas directas.
- Disponer de un modelo 3D geoméricamente correcto que permite el desarrollo consistente de estudios y proyectos.
- Evitar riesgos para operadores, dado que la medición se realiza sin contacto físico con los objetos a medir, de forma automatizada.
- El modelo 3D generado se puede utilizar para Mantenimiento, Operación e Ingeniería.
- Disminuir considerablemente los tiempos de ejecución de estos trabajos.
- Disminución de las personas involucradas en el trabajo de terreno.

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GRACIAS

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*Marco Munari, University of Padua, Italy*  
*The structural vulnerability investigation on the three churches in Valparaiso*

**PROGETTO MAR VASTO**  
**“Manejo de riesgos en Valparaiso”**  
 Conferenza finale del Progetto BID

**Chiesa e Convento di San Francisco, Cerro Baron, Valparaiso, Chile**  
 29 Settembre 2008

L'investigazione sulle tre chiese (San Francisco, Hermanas de La Providencia, La Matriz):  
 indagine di vulnerabilità

Ing. Marco Munari  
 Dipartimento di Costruzioni e Trasporti  
 Università di Padova – Italia

Progetto MAR VASTO – Conferenza Finale  
 Chiesa e Convento di San Francisco, Cerro Baron, Valparaiso, Chile – 29 Settembre 2008

IGLESIA DEL SALVADOR  
MATRIZ DE VALPARAISO
IGLESIA SAN FRANCISCO  
DEL BARON

CAPILLA DE LAS HERMANAS  
DE LA PROVIDENCIA

Progetto MAR VASTO – Conferenza Finale  
 Chiesa e Convento di San Francisco, Cerro Baron, Valparaiso, Chile – 29 Settembre 2008

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 Chiesa e Convento di San Francisco, Cerro Baron, Valparaiso, Chile – 29 Settembre 2008

**Metodologia di studio:**

1. Rilievo fotografico
2. Rilievo laser scanner ed elaborazione dei dati
3. Rilievo mediante la 'Scheda Chiesa':
  - rilievo delle strutture e dei materiali
  - rilievo del danno (quadro fessurativo)
  - studio della vulnerabilità
4. Calcolo strutturale

1)

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2)

Parametri	
1) Ribaltamento della facciata	10) Ribaltamento delle pareti di estremità
2) Meccanismi nella sommità della facciata	11) Ribaltamento dell'abside
3) Meccanismi nel piano della facciata	12) Volte del presbitero o dell'abside
4) Risposta trasversale di aula o transetto	13) Rottura a taglio delle pareti
5) Risposta longitudinale navata centrale	14) Martellamento della copertura
6) Volte della navata centrale	15) Interazioni in prossimità di irregolarità piano-altimetriche
7) Volte navate laterali e transetto	16) Torre campanaria
8) Archi trionfali	17) Cella campanaria
9) Cupola o tiburio	18) Aggetti (Vele guglie, pinnacoli, statue)

Presenza del macroelemento in relazione al meccanismo: SI <input type="checkbox"/> NO <input type="checkbox"/>			
Vulnerabilità	<input type="checkbox"/> No	Preziosi antisismici	<input type="checkbox"/>
	<input type="checkbox"/> Si	Presenza di catene longitudinali	<input type="checkbox"/>
	<input type="checkbox"/> Si	Presenza di efficaci elementi di contrasto (contrafforti, corpi addossati, altri edifici)	<input type="checkbox"/>
Danno	<input type="checkbox"/> attuale	Annoveramento di buona qualità tra la facciata ed i muri della navata	<input type="checkbox"/>
	<input type="checkbox"/> vecchio	Indicatori di vulnerabilità	<input type="checkbox"/>
	<input type="checkbox"/>	Presenza di elementi spingenti (puntoni di copertura, volte, archi)	<input type="checkbox"/>
<input type="checkbox"/>	Presenza di grandi aperture nelle pareti laterali in vicinanza del cantonale	<input type="checkbox"/>	

$$i_d = \frac{1}{5} \frac{\sum_{k=1}^N \rho_k d_k}{\sum_{k=1}^N \rho_k}$$

**indice di danno**

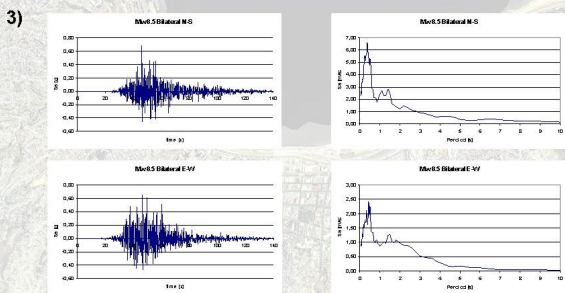
$$i_v = \frac{1}{6} \frac{\sum_{k=1}^{23} \rho_k (v_{k1} - v_{k2})}{\sum_{k=1}^{23} \rho_k} + \frac{1}{2}$$

**indice di vulnerabilità**

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Earthquake scenario: MW 8.5 Bilateral Rupture

Time histories and related acceleration Spectrum Curve for Damping Ratio of 5.0% (vibrational period vs spectral acceleration) for each expected magnitude and for each main direction used for the spectral response analysis (dott. Fabio Romanelli – ICTP Trieste – Italia)

Failure mechanism	
1 OVERTURNING OF THE FACADE	16 OVERTURNING OF THE APSE
2 OVERTURNING OF THE GABLE	18 VAULTS OF THE APSE AND OF THE PRESBYTERY
3 SHEAR MECHANISMS IN THE FACADE	10-22 OVERTURNING OF OTHER WALLS (TRANSEPT, CHAPELS, CHAPELS)
5 TRANSVERSAL VIBRATION OF NAIVE	11-17-23 SHEAR FAILURE OTHER WALLS (TRANSEPT, CHAPELS, APSE, PRESBYTERY)
6-7 LONGITUDINAL VIBRATION OF THE CENTRAL AND LATERAL NAIVE	19-20-21 HAMMERING AND DAMAGE IN THE ROOF COVERING
8 VAULTS OF THE CENTRAL NAIVE	25 INTERACTION BETWEEN ELEMENTS OF DIFFERENT BEHAVIOUR
9 VAULTS OF THE LATERAL NAVES	26 OVERTURNING OF STANDING OUT ELEMENTS
13 KINEMATISM IN THE TRIUMPHAL ARCHES	27 GLOBAL COLLAPSE OF THE BELL TOWER
14 COLLAPSE OF THE DOME AND THE TIBURDO	28 MECHANISMS IN THE BELL CELL

Global index damage = 8%      Local index damage

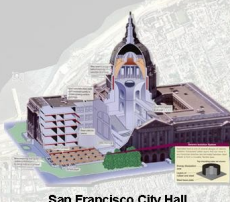


Failure mechanism	
1 OVERTURNING OF THE FACADE	16 OVERTURNING OF THE APSE
2 OVERTURNING OF THE GABLE	18 VAULTS OF THE APSE AND OF THE PRESBYTERY
3 SHEAR MECHANISMS IN THE FACADE	10-22 OVERTURNING OF OTHER WALLS (TRANSEPT, CHAPELS, CHAPELS)
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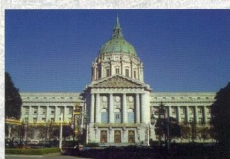
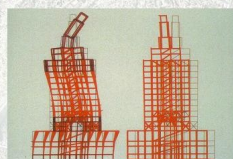
Global index damage = 58%      Local index damage



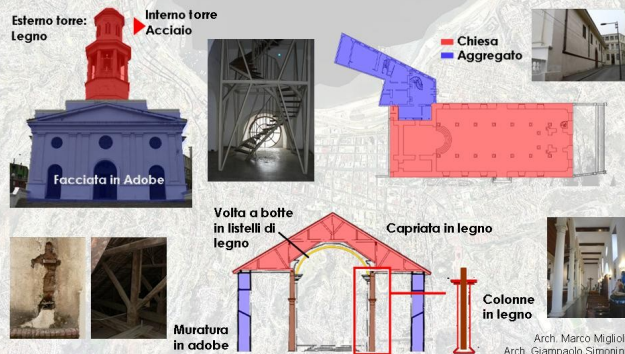
Possibile intervento per evitare la perdita di questo monumento: isolamento sismico alla base



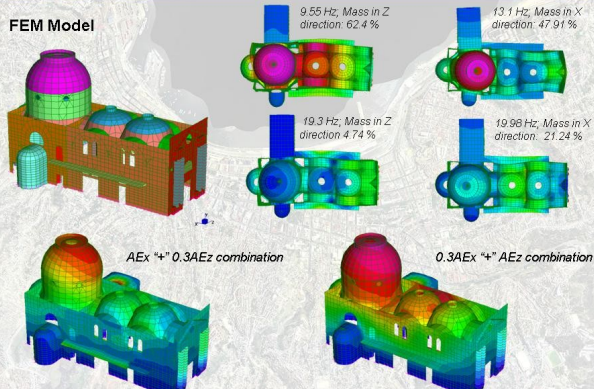
San Francisco City Hall



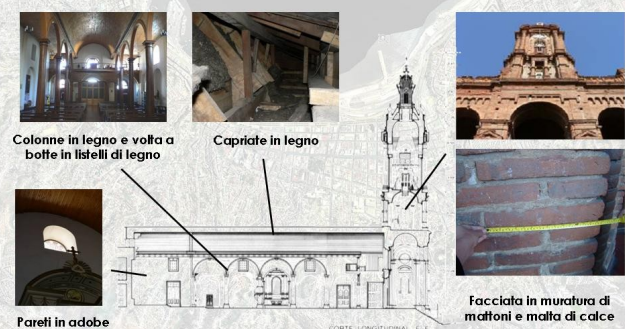
IGLESIA DEL SALVADOR – MATRIZ DE VALPARAISO



CAPILLA DE LAS HERMANAS DE LA PROVIDENCIA  
Arch. Victor Auclair



IGLESIA SAN FRANCISCO DEL BARON  
Arch. Eduardo Provasoli



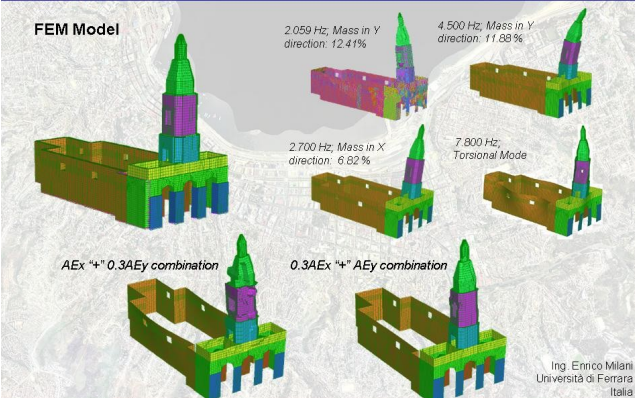




Arch. Claudia Zufiga

Failure mechanism	
1 OVERTURNING OF THE FACADE	15 OVERTURNING OF THE APSE
2 OVERTURNING OF THE CHAPEL	16 VAULTS OF THE APSE AND OF THE PRESBYTERY
3 SHEAR MECHANISMS IN THE FACADE	17-22 OVERTURNING OF OTHER WALLS (TRANSAPT FACADE, CHAPELS)
4 TRANSVERSAL VIBRATION OF NAIVE	23-24 SHEAR FAILURE OTHER WALLS (TRANSAPT, CHAPELS, APSE, PRESBYTERY)
5 LONGITUDINAL VIBRATION OF THE CENTRAL AND LATERAL NAIVE	19-20-21 HAMMERING AND DAMAGE IN THE ROOF COVERING
6 VAULTS OF THE CENTRAL NAIVE	25 INTERACTION BETWEEN ELEMENTS OF DIFFERENT BEHAVIOUR
7 VAULTS OF THE LATERAL NAVES	26 OVERTURNING OF STANDING CHIMNEYS
8 KINEMATISM IN THE TRIUMPHAL ARCHES	27 GLOBAL COLLAPSE OF THE BELL TOWER
9 COLLAPSE OF THE DOME AND THE TIBURIO	28 MECHANISMS IN THE BELL CELL

Global index damage = 33%      Local index damage on the facade = 66%




Normative di riferimento per lo studio e l'intervento strutturale sul patrimonio culturale:


- ISO 13822  
*Bases for design of structures - Assessment of existing structures*
- ICOMOS – International Scientific Committee for Analysis and Restoration of Structures of Architectural Heritage  
*Recommendations for the analysis, conservation and structural restoration of architectural heritage*
- Ministero per i Beni e le Attività Culturali – Dipartimento per i beni culturali e paesaggistici – Direzione generale per i beni architettonici e paesaggistici  
*Linee Guida per la valutazione e riduzione del rischio sismico del patrimonio culturale*





*Marco Munari, University of Padua, Italy*  
*Advanced Master in Structural Analysis of Monuments and Historical Constructions*




**Advanced Masters in Structural Analysis of Monuments and Historical Constructions**

  
 University of Minho  
Portugal

  
 Czech Technical University in Prague  
Czech Republic

  
 University of Padua  
Italy

  
 Technical University of Catalonia  
Spain

<http://www.msc-sahc.org/>

**Political Context – Challenges and Way Forward**

- ❑ European education and training systems to become a world-wide reference for quality and excellence by 2010
- ❑ Intercultural understanding
  
- ❑ Recognize key role of higher education and research
- ❑ Ensure world-wide recognition of European universities
- ❑ Remain at leading edge of developments
  
- ❑ 103 Erasmus Mundus Masters Courses (50% Engineering)
- ❑ About 3000 students & 300 scholars grants for 2007/2008 by European Commission


**Our Vision**

**Erasmus Mundus**

- ❑ A top quality MSc in terms of education for research and practice
- ❑ Establish an enduring European partnership in the framework of conservation and strengthening of existing structures with cultural value
- ❑ Make this partnership global in the years to come
  
- ❑ Involved partners
  - > University of Minho (Coordinating Institution), PT
  - > Czech Technical University in Prague, CZ
  - > Technical University of Catalonia, SP
  - > University of Padua, IT
  - > Institute of Theoretical and Applied Mechanics, CZ

**Advanced Masters in Structural Analysis of Monuments and Historical Constructions (MSc)**

Joint European Master Programme on the conservation of architectural heritage structures, aiming at producing an international platform of competence



  
 Erasmus Mundus

**Erasmus Mundus MSc**

  
 Erasmus Mundus


co-operation and mobility programme in the field of higher education

- supports European top-quality master's courses
- promotes the European Union as a worldwide centre of excellence in learning
- provides EU-funded scholarships for third-country nationals and for EU-nationals studying at partner universities around the world.


**Partners**

**Partners**


The higher education institutions involved in the MSc consortium are:




**University of Minho (Guimarães, Portugal)**  
Prof. Paulo LOURENCO



**Czech Technical University in Prague (Prague, Czech Republic)**  
Prof. Petr KABELE




**Technical University of Catalonia (Barcelona, Spain)**  
Prof. Pere ROCA




**University of Padua (Padova, Italy)**  
Prof. Claudio MODENA

Satellite participant:



**The Institute of Theoretical and Applied Mechanics of the Academy of Sciences of the Czech Republic**  
Prof. Milos DRDAKY



**University of Minho: Schools – Large spectrum**

- ❑ Autonomous Department of Architecture
- ❑ Institutes of: Arts and Human Sciences; Child Studies; Education and Psychology; Social Sciences
- ❑ Schools of: Economics and Management; Engineering; Health Sciences; Law; Sciences

---

❑ Teaching

- > 51 undergraduate courses
- > 140 Diploma specializations / MSc courses
- > 30 PhD areas

❑ Research (31 Research Centers)

❑ Interaction with the community

❑ International cooperation

**Partners**

**Partners**

## Partners

Czech Technical University in Prague

Education System

since 2004/05 CTU offers study programmes

- 15 Bachelor (47 branches)
- 25 Masters (126 branches)
- 9 PhD. (52 branches)

CTU has seven faculties

• Civil Engineering	6568
• Mechanical Engineering	4279
• Electrical Engineering	7005
• Nuclear Sciences and Physical Engineering	1795
• Architecture	1528
• Transportation Sciences	1864
• Biomedical Engineering	337

## Partners



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Campuses in Barcelona and other Catalan cities.

Schools 15  
 School of Civil Engineering  
 Schools of Mechanical Engineering (4)  
 Schools of Architecture (2) and Technical Architecture (1)  
 School of Tele communication  
 School of Aeronautics

Departments 40  
 Research institutes 3  
 Graduate students 6900

Ph. D students 873 (new 2003-2004)  
 Ph. S. Thesis finished 190 (2001-2002)



## Partners

University of Padua

[www.unipd.it](http://www.unipd.it)



<http://www.unipd.it/en/university/history.htm>

► YEAR OF FOUNDATION: 1222

- teaching activities by the Faculties
- research activities by the Dept.
- PhD courses held by the Dept.

Faculties	13
Departments	64
Institutes	2
Service centers	8
Research centers	30
Services Centers	9

► Staff (December 31st 2004)

TEACHING AND RESEARCH STAFF	
Professors	1485
Researchers	679
Others	31
Total	2195
TECHNICAL ADMINISTRATIVE	
Total	2162
GRAND TOTAL	4357



66,000 students in a town totalling about 213,000 inhabitants

Relationship of the partners with ICOMOS International Scientific Committee for Analysis and Restoration of Structures of Architectural Heritage (ISCARSAH):



International Council on Monuments and Sites  
 Conseil International des Monuments et des Sites

- possibility of benefiting from the contact and collaboration of experts from all over the world
- professional experience on aspects such as inspection, diagnosis, monitoring, structural analysis and restoration of world architectural heritage

The partnership includes:

- the Editors of the International Journal of Architectural Heritage: Conservation, Analysis and Restoration
- the Organizers of the series of conferences on Structural Analysis of Historical Constructions (1995-2006)



## Organization of the Partners

## Objectives

- Management Board: Paulo Lourenco, Daniel Oliveira, Petr Kabele, Claudio Modena, Pere Roca, Miloš Drdáký
- UMinho: General Coordinator  
 General Secretariat  
 Selection Process
- CTU: Examination (students assessment of criteria, grading, etc.)
- Unipd: Quality Assurance Board (quality assurance of academics and managerial aspects)
- UPC: Studies Coordination (contents of the MSc courses, syllabus, etc.)

As the built environment ages, conservation of existing buildings and infrastructure is receiving more and more attention: Europe is a world leader in the generation of knowledge, methodology and technology applicable to the conservation and restoration of the architectural heritage structures.

The MSc will address the issue of existing buildings, with a focus on buildings with cultural value (monuments and historical centres):

- advanced education programme on the engineering of conservation of structures (experimental techniques, numerical modelling, structural analysis, seismic behaviour and structural dynamics, repairing and strengthening techniques, surveying, monitoring, etc.), with a focus on worldwide architectural heritage (history of construction and restoration, principles and methodology of conservation, attention to the regional differences, etc.);
- involvement of experts from complementary fields (engineers, architects, materials scientists and others: multidisciplinary understanding of structural conservation) from leading European universities;
- students face top level structural analysis knowledge in an advanced research oriented environment, applying recent development in scientific research to practical applications and problem solving.



## MSc Structure

## MSc Structure

- One year course
- 60 ECTS: 39 coursework concentrated in two countries each year  
 2007/2008 Portugal and Czech Republic  
 2008/2009 Italy and Spain  
 21 Thesis divided by all involved Institutions
- Mobility of students (compulsory)
- Mobility of lecturers from the four partners + satellite partner
- Full time job (8 hours a day):
  - > 09:30-12:30 (lectures)
  - > 14:00-19:30 (individual/group work 70% + thesis / case study 30%)
  - > A tutor will supervise individual/group work

- Modular Structure:
  - > SA 1: History of Construction and of Conservation
  - > SA 2: Structural Analysis Techniques
  - > SA 3: Seismic Behavior and Structural Dynamics
  - > SA 4: Inspection and Diagnosis
  - > SA 5: Repairing and Strengthening Techniques
  - > SA 6: Restoration and Conservation of Materials
  - > SA 7: Integrated Project (case study + external lectures + visits)
  - > SA 8: Dissertation (thesis project to be selected from general proposals or own proposal)
- The degree awarded is a Master's degree, provided as a double degree from the institutions involved.







## ***APPENDIX 3***

### ***Presentations of the Master “ECO-POLIS***



Gianfranco Franz, University of Ferrara, Italy  
 Eco-Polis: Master Internacional en políticas ambientales y territoriales para la sustentabilidad y el desarrollo local

**MASTER INTERNAZIONALE**  
**ecopolis**  
 IN POLITICHE AMBIENTALI E TERRITORIALI PER LA SOSTENIBILITA' E LO SVILUPPO LOCALE

**Eco-Polis**  
**Master Internacional en**  
**Políticas Ambientales y Territoriales**  
**para la Sustentabilidad y**  
**el Desarrollo Local**

Gianfranco Franz - Facoltà di Economia - Università di Ferrara - frz@unife.it

**ALTERNATIVAS DE DESENVOLVIMENTO SUSTENTAVEL NO LITORAL DO PARANA**

Curitiba-Gratopirella  
 13 Agosto - 17 Setembro 2008

**MASTER INTERNACIONAL ECO-POLIS**  
 en Políticas ambientales y territoriales para a sustentabilidade e o desenvolvimento local

**Participación:**  
 Pontificia Universidade Católica do Paraná - Curitiba, Brasil  
 Universidad Técnica Federico Santa María - Valparaíso, Chile  
 Universidad Católica de Córdoba - Córdoba, Argentina

**Cooperación:**  
 Universidad de Ferrara - Italia  
 Universidad de Chile - Chile  
 Universidad de Cádiz - España  
 Universidad de Granada - España  
 Universidad de Sevilla - España  
 Universidad de Valencia - España  
 Universidad de Zaragoza - España  
 Universidad de Murcia - España  
 Universidad de Alicante - España  
 Universidad de León - España  
 Universidad de Burgos - España  
 Universidad de Cantabria - España  
 Universidad de Valladolid - España  
 Universidad de Salamanca - España  
 Universidad de Extremadura - España  
 Universidad de Castilla-La Mancha - España  
 Universidad de Castilla y León - España  
 Universidad de Burgos - España  
 Universidad de Cantabria - España  
 Universidad de Valladolid - España  
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 Universidad de Zaragoza - España  
 Universidad de Murcia - España  
 Universidad de Alicante - España  
 Universidad de León - España  
 Universidad de Burgos - España  
 Universidad de Cantabria - España  
 Universidad de Valladolid - España  
 Universidad de Salamanca - España  
 Universidad de Extremadura - España  
 Universidad de Castilla-La Mancha - España  
 Universidad de Castilla y León - España

**università di ferrara**  
 DA SEICENTO ANNI GUARDIAMO AVANTI.

**crua**  
 centro ricerche urbano territoriali e ambientali

**UNIVERSITÀ DELLA CALABRIA**  
 DIPARTIMENTO DI PIANIFICAZIONE TERRITORIALE

**PONTIFICIA UNIVERSIDADE CATÓLICA DO PARANÁ - CURITIBA, BRASIL**

**UNIVERSIDAD TÉCNICA FEDERICO SANTA MARÍA**

**UNIVERSIDAD CATÓLICA DE CÓRDOBA**

**Red Alvar**  
 Patrimonio y Proyecto

**UNI TWIN**  
 UNESCO Chair on Urban and Regional Planning for sustainable local Development

**United Nations Educational, Scientific and Cultural Organization**

**Eco-Polis es un curso internacional itinerante (y también nómada) poli-disciplinar y generalista**

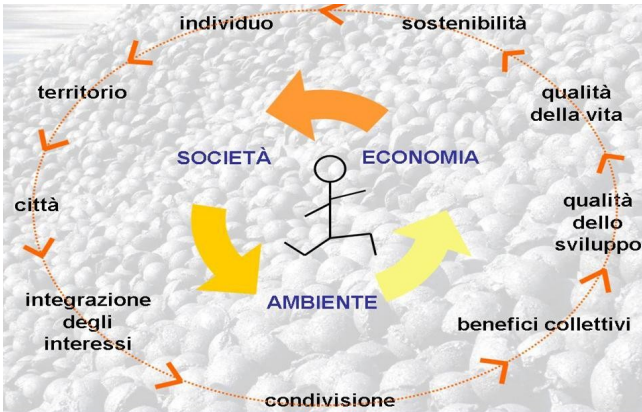


**Eco-Polis utiliza varias disciplinas específicas, distintas culturas locales y distintos lugares para enfrentar problemas generales a un nivel estratégico**

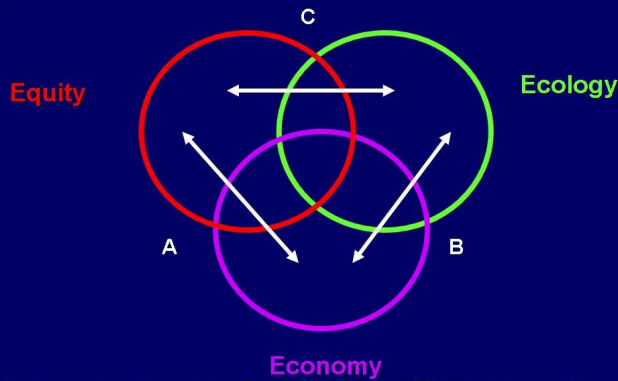


**la problemática de la sustentabilidad,**  
**la problemática del desarrollo local,**  
**la problemática urbana,**  
**la problemática de las políticas públicas,**  
**la problemática de la innovación,**  
**la problemática de la competencia global**





**requieren hoy nuevas competencias profesionales**



**Que sea capaz de hablar eficazmente con empresarios y con instituciones internacionales**

**Necesitamos de algo, muy especializado, capaz de cruzar**

**lenguajes,**

**competencias,**

**técnicas y tecnologías,**

**sectores,**

**disciplinas y herramientas.**

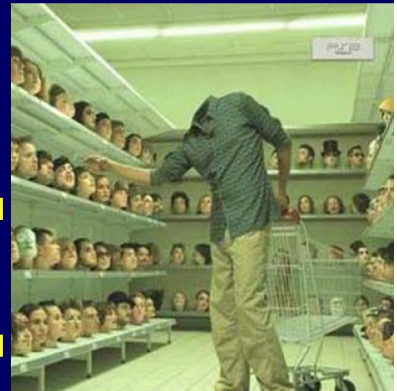


**Lo que necesitamos es un especialista que también sea capaz de hablar y entender otros lenguajes técnicos**

**Que sea capaz de hablar de manera simple con las comunidades y los grupos vecinales**

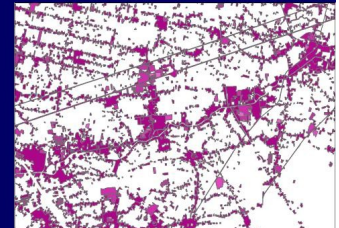
**NECESITAMOS DES-ESPECIALIZACION como escribía Edgar Morin en 1969**

**CRUZAR es la palabras mágica para enfrentar la sustentabilidad y el desarrollo local**



**Cruzar, producir los cruces, es la actitud que necesitamos para reconstruir un pensamiento humano y moderno**

**contra la lógica post-modernista y neo-liberalista basadas en la fragmentación la deconstrucción la separación y la dispersión**



**El desastre financiero de Wall Street es un desastre debido a la lógica**

**de la deconstrucción y de la dispersión,**

**que impide el control**



**La ciudad contemporánea es el resultado de la lógica**

**de la fragmentación  
y  
de la separación,**

**que impide el manejo**

**La ideología de la**

**especialización tecnológica**

**y**

**del saber tecnico neutral**

**ha producido**

**competencias sin conciencia**

**Es un problema politico,  
ma tambien y sobretodo**

**cultural,**

**de lenguaje,**

**de visión,**

**y de nuevas formas de formación e  
educación**

**Los economistas hacen modelos  
matematicos para prevéer en términos  
de 2 años, y generalmente, se  
equivocan**

**Arquitectos e Ingenieros piensan poco:  
hacen**

**Los políticos entienden solo el tiempo  
electoral**

**Los empresarios entienden solo lo que  
le quiere y dicen que esto es lo que  
necesitamos todos nosotros**

**Las arquitecturas**

**post-modernistas  
y las  
de-constructivistas**

**sonos un producto de la lógica**

**de pensar objetos separados del  
conjunto**

**Las crisis son hechos  
necesarios y positivos:**

**la crisis del medio ambiente,**

**la crisis de la ciudad contemporánea  
y su manejo,**

**la crisis de la globalización, así como  
fue manejada hasta ayer,**

**la crisis del nivel de la decisión pública  
respecto al nivel del actor privado,  
el problema del desarrollo sustentable**

**REQUIEREN DISCONTINUIDAD**

**Los especialistas del medio ambiente  
piensan en términos de 20-40 años  
plazo y nadie los escucha**

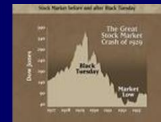
**Los planificadores hacen ejercicios en  
términos de 10/15 años, y el territorio  
se va por su cuenta**

**Los urbanistas tentan de manejar  
las ciudades en términos de 5/10 años  
y las ciudades se van por su cuenta**

**El desafío de Eco-Polis es experimentar  
la des-especialización con los alumnos  
y sus profesores,**



**y por medio de ellos, practicar una  
acción general con varios actores y  
varios lugares donde trabaja el Master**



**Es un ejercicio de pensamiento estratégico, de cruces, en términos generales y no genéricos, en términos teóricos, prácticos, éticos siguiendo la enseñanza que...**



**El medio ambiente, la ciudad, el desarrollo económico y social**

**son problemas generales que requieren**

**especialistas, coordinadores, y visionarios**

**capaces de manejar políticas básicas y políticas complejas e integradas.**

**COMPRENDER LOS PUNTOS DE FORTALEZA Y LOS PUNTOS DEBILES DE UNA CIUDAD Y DE UN TERRITORIO**



**COMPRENDER LOS PUNTOS DE FORTALEZA Y LOS PUNTOS DEBILES DE UN SISTEMA ECONOMICO LOCAL Y DE UN SISTEMA SOCIAL LOCAL**

**EL DESARROLLO ECONOMICO Y SOCIAL DE UNA CIUDAD DEBE BASARSE EN LOS PUNTOS DE FORTALEZA**

**PERO NO SE PUEDE NO ENFRENTAR LOS PUNTOS DEBILES**

**LO QUE NO SE COMPARTE SE PIERDE**

**Y**

**DIVIDIR PRODUCE FALTA DE SIGNIFICADO**

**PARA EXISTIR ANTES QUE PARA COMPETIR A NIVEL GLOBAL SON NECESARIAS**

**VISION**

**Y**

**ESTRATEGIA**

**EL DESARROLLO LOCAL DE UNA CIUDAD PUEDE SER REALIZADO MAS POR DISCONTINUIDAD QUE POR CONTINUIDAD.**

**LA DISCONTINUIDAD REQUIERE**

**VALENTIA,**

**GRAN CAPACIDAD DE VISION,**

**VOLUNTAD DE COMPARTIR**

**VISIONA A LARGO PLAZO**

**LOS PRINCIPALES PUNTOS DEBILES SON CASI SIEMPRE:**

**POBREZA      SEGREGACION      INACCESIBILIDAD**



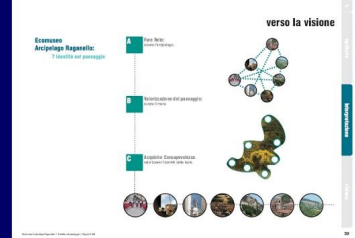
**CORUPCION**



**INEFICIENCIA**



**MEDIO AMBIENTE DEGRADADO**





**LOS PRINCIPALES PUNTOS DE FUERZA CAMBIAN DE LUGAR EN LUGAR, DE UNA COMUNIDAD A OTRA**

**Para planificar y manejar estratégicamente necesitamos conocer a la comunidad, sus empresas, las fuerzas económicas y sociales**

**Producir una vision es necesario para comprender qué hacer hoy para mañana y qué cosas empezar hoy para que se realicen en 10 o 20 años**

**Hacer proyectos urbanos sin vision y sin estrategia significa hacer e invertir en fragmentos urbanos y sociales sin capacidad de crear discontinuidad.**



**Para el pensamiento estrategico, el conocimiento de los valores intagibles es tanto o más importante como el conocimiento del espacio urbano, de la morfologia y las tipologias**



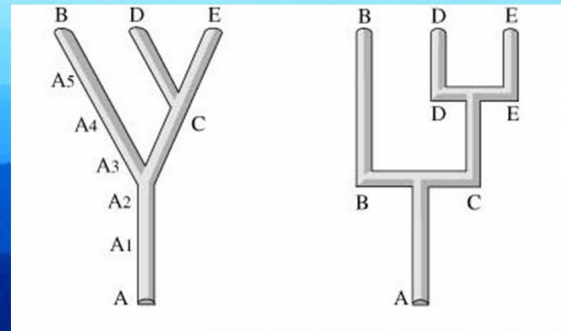
**EL PENSAMIENTO ESTRATEGICO ES NECESARIO**

**PARA MANTENER JUNTAS**

**TODAS LAS VISIONES PARCIALES Y ESPECIFICAS**

**DE LA REALIDAD**

# RISK & CONSERVATION in Ecology



## Ecology who?

Ecology is the science of the functioning of living organisms on the earth.

The use of terms "eco+something" is confusing:  
 in any case meaning something that directly or indirectly reminds "nature" and/or "nature conservation".

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## Wise reflections

### A wise man's reflections

1. we are the result of billions of years of biological evolution
2. conservation is not necessarily a good thing
3. modification can produce something new and better (from bacteria to ... me), but
4. **cultural evolution kills the biological one**
5. So take care of **the risks**, wise man, and make your own evaluations.

For an Ecologist, this is the  
**Environmental Impact Evaluation.**

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## Nature conservation/modification

Conservation is meant as an alternative to the "modification" of the nature as a result of human activities' impact.

Nature (*naturality, naturalness*): resources that **allows the existence/presence of the life and of its maintenance, from sun to water, from air to climate, to food, to landscape...**

We need **quantity and quality** of natural resources to live a decent life

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## Risk what?

### "Risk"

means the possibility of a damage derived from a danger which can provoke

- wounds,
- illness,
- economic loss or
- environmental damages.

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## Risk what?

1. **Cultural risks:** unsafe job or life conditions, smoking, poor diet, drugs, alcohol, car driving, crimes, unsafe sex and **poverty**.
2. **Chemical risks:** mutagenic, teratogenic and carcinogenic effects
3. **Physical risks:** radiations, noise, fire, tornados, earthquakes, volcanic eruptions, floods
4. **Biological risks:** virus, bacteria and parasites, other allergens, animals

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## It is not so simple

An example of how is difficult to evaluate certain risks.

Why did we know so little of the noxious effects of the **chemical compounds**?  
The National Academy of Science of America estimates (1999) that **only 10%** of the 72,000 chemical compounds on the market were thoroughly analyzed for toxicity, and **only 2%** tested to evaluate if they are carcinogenic, teratogenic or mutagenic.

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## The precautionary principle

### The **precautionary principle**

is a moral and political principle which states that **if an action or policy might cause severe or irreversible harm to the public or to the environment**, in the absence of a scientific consensus that harm would not ensue, **the burden of proof falls on those who would advocate taking the action.**

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## The contents

Precaution is caution in advance, or 'caution practiced in the context of uncertainty'.

All definitions have two key elements.

1. **an expression of a need by decision-makers to anticipate harm before it occurs.**

Within this element lies an implicit reversal of the onus of proof.

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## Risk evaluation

**Risk evaluation** is a study which utilizing data, hypothesis or models

(many deriving from Business Analysis, e.g. trade off Analysis, environmental Kuznets' curve, etc.)

estimates the probability that a **damage** would happen **to the human health, the society or the environment** as a result of the exposition to certain dangers and/or as result of nature modification.

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## It is not so simple

The reasons (example of the US)

1. the large majority of the chemical compounds are **considered harmless** from the existing laws till the contrary is proved
2. **a lot of money** is needed to test only a minimum fraction of the chemical compounds we meet during our lifespan
3. **even more money** are needed to test the interactions among the chemical compounds (e.g. for interactions of 3 compounds \$ 20.7 million)

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## The precautionary principle

Only in some legal systems, as the European Union Law, the precautionary principle is also a general principle of law: this means that it is compulsory.

The principle in the face of uncertain risks states that **the absence of full scientific certainty shall not be used as a reason to postpone measures where there is a risk of serious or irreversible harm to public health or the environment.**

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## In practice

2. the establishment of **an obligation**, if the level of harm may be high, **for action to prevent** or minimise **such harm even when the absence of scientific certainty** makes it difficult to predict the likelihood of harm occurring, or the level of harm should it occur.

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## Precautionary principle or approach?

### Precautionary **principle** or precautionary **approach**?

Principle 15 of the Rio Declaration 1992:  
"in order to protect the environment, **the precautionary approach** shall be widely applied by States **according to their capabilities**. Where there are threats of serious or irreversible damage, lack of full scientific certainty shall be not used as a reason for postponing cost-effective measures to prevent environmental degradation."

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## Steps of Risk analysis

We evaluate/estimate the risk through **Risk analysis**

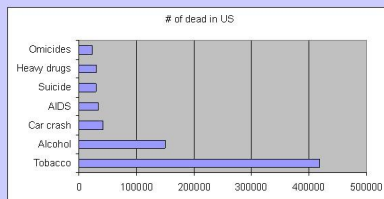
with the following steps:

- danger identification and related risk evaluation
- risk comparative analysis and ranking
- risk management
- risk communication

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## The main perceived risk



What are the greater risks we can face with?  
In terms of reduction of average lifespan the greater risk is by far **the poverty**, the other causes being reduced with a correct life style.

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## % reliability

The safety of each technological system  
**% reliability** = technological reliability (TR) x human reliability (HR) x 100

If you can reach very high level of TR  
"errare humanum est" and the HR is always very low if compared with the TR.

If the TR of a nuclear power plant is 1, and the HR is 0.75, then the total reliability will be 75%...

### **The case of biotechnology**

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## Precautionary principle or approach?

The wording of **the approach**, largely similar to that of **the principle**, is subtly different in that:

- (1) it recognizes that there may be **differences in local capabilities** to apply the approach, and
- (2) it calls for cost-effectiveness in applying the approach, e.g., taking economic and social costs into account.

**The 'approach' is generally considered a softening of the 'principle'.**

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## Risk-benefit analysis

*Are long term estimated risks due to new product or new technology greater than short or long term benefits derived from other alternatives?*

An answer to the question is the **Risk-benefit analysis**, the comparison of the **risk** of a situation to its related **benefits**.

The investigator must assure that the amount of benefit clearly outweighs the amount of risk.

Only if there is favourable risk benefit ratio, an action may be considered

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## To live longer

### **Golden rule to avoid premature death...**

- no smoking,
- not to stay too much in the sun,
- not to drink alcohol,
- not to eat cholesterol and saturated fats,
- to eat on the contrary fruits and vegetables,
- to keep fit,
- loose the weight excess
- to drive safe cars only in a safety conditions

**...is to live in a monastery**

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## Theory and practice

Unfortunately,  
there are **many limitations** as far as risk evaluation and risk-benefit analysis are concerned.

Up to now,

**results of risk evaluation and risk-benefit analysis can be interpreted in a way to support any kind of decision**, which is then sold as "scientific".

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**Open questions**

1. How are data and models for risk evaluation reliable?
2. Are more important short or long term risks?
3. Risk analysis must determine the acceptable level of risk or must define the way to minimize the damage?
4. Very seldom combined effects are considered, instead of separate effects.
5. In the LDC the risk levels for the workers are very high: is this a cost to pay to make money?

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**From the past**

Urban development is responsible of losses of natural value, which too often were not even evaluated.

New urban vision takes now in consideration the ecological structure of a territory, knowing that its conservation is necessary to the **quality of life** in urbanized areas.

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**What is sustainability?**

It is generally agreed upon that town planning schemes must now contain

- the natural heritage map, and
- an estimate of urban and infrastructure development impact on ecosystems

What is generally intended as **ecological sustainability of urban and infrastructural development?**

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**From Bruntland' Report...**

The sustainability is a concept whose meaning depends upon the cultural basis of a single researcher working, e.g., on Ecology, Urban development, Geography, Sociology, etc.

In the **Brundtland' report** of 1987, *Our Common Future*, for the first time the concept of economic development ecologically sustainable is defined

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Among the indicated risks, the activity of a town-planner regards

**urban impacts**

on the environment and/or on the life quality.

In the past, in setting up town-planning schemes, not urbanized grounds were normally considered only as a potential base for buildings, without considering their ecological role.

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**There is an ecological problem**

Today we search for **sustainable town**: something that ranges from the quality of the global production chain to the quantity and quality of its public heritage, represented by culture and natural environments, both around and inside the town itself.

The town planner must be aware of the ecological problem, having in mind the long term effects of urban impacts on the nature.

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**What is sustainability?**

**Ecological sustainability** is a complex concept which is defined through other concepts, like

- degree of naturality
- impact on nature
- mitigation and/or compensation.

To apply these concepts we need quantitative methods of analysis, as

**Indexes** of the degree of naturality, and

a **balance** between positive and negative impacts.

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**From Bruntland' Report...**

**Sustainable development** is that which satisfying the present needs do not endanger the possibility for future generations to satisfy their own needs:

this implies that the ecological resources utilization by the present generation remains below certain levels.

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### ... the concept of sustainability

What are "certain levels" of exploitation?  
It is a question of **intergenerational responsibility**, whose definition is matter of politics and finally of standards and laws.

To fix the threshold a **risk evaluation** is needed, in which some key-concepts can make the difference, as

A) What is the level of responsibility of the present generation compared with the future generations?

B) Is there possible substitution for productive factors?

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### Strong sustainability

A2) "Strong sustainability" condition is met when an action determines positive variations both for the economic welfare and for the natural heritage.

$$d(N) \geq 0 + d(U) \geq 0.$$

where:

N = natural heritage

U = man made capital.

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### A bent for risk

Long term effect of human impacts are part of the intergenerational heredity.

A Risk analysis can result in soft or strong sustainability depending from the bent for risk.

**Soft sustainability accepts** – as a rule – **the natural heritage reduction when there is an increment of the economic welfare.**

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### Can we Substitute..

B) Is it possible to **substitute** what we received through the long history of the evolution **by man made resources**?

The main question is not if the scientific and technological development can allow the maintenance of an acceptable quality of life, but in a scenario of growing demographic and economic problems **if the politics** will be capable of controlling the complex equilibrium of the earth.

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### Soft sustainability

A) Consider two categories.

A1) "Soft sustainability": it is sustainable every action for which there is a positive variation of the sum between the variation of the natural heritage and/or the degree of natural value of the environment, and of the material richness or that of the total economic revenue.

$$d(N+U) \geq 0$$

N = natural heritage U = man made capital

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### Differences

In comparison with soft sustainability, **strong sustainability better corresponds to the general principle of sustainability**, for which the ethics of an ecologically sustainable behavior wants that a generation leaves in heredity to the next generations an economic and ecologic situation at least not worse than that they received from past generations.

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### A bent for risk

**Soft sustainability** trusts in the economic development produced by the scientific and technological one, which will be able to face the problems arose by the decrease of the natural heritage.

**Strong sustainability** sustains that it is now the time to stop reducing the nature value below the level we received from the past generations, which not aware of the risk involved in the natural resources uncontrolled exploitation.

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### Compensation

Both soft- and strong-sustainability **needs a quantitative measure** of

(i) the **naturality** degree of a particular environment, and

(ii) The **variations** induced by the human activities; and

(iii) **balance** between reduction and/or implementation of nature value)

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### Compensation

This process aims at:

All those actions that reduce the naturalness degree need **compensation measures** to increase it (re-naturalization), in order that the balance between nature losses and gains is at least zero.

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### We have no choice

Like many other human activities there is no final answer to the question if, after trade off, **the man modified nature will be always kind-earthed for mankind.**

Even if there is not – at the moment – any theoretical model of the functioning of the earth that can demonstrate that only a NOT-REDUCTION of the naturalness level is the necessary and sufficient condition for the sustainability of the economic and demographic development, the strong sustainability approach must be the choice.

Ecopolis - 30 September 2008

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### Trade off analysis

Since we must accept that mankind (cultural evolution) will continuously change the natural heritage derived from biological evolution,

we need to **define a measure of how can we substitute natural resources with artificial products** able to fulfill an analogous ecological function:

the ecological trade off between artificial products and natural resources must be defined.

Ecopolis - 30 September 2008

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### A social demand

**The nature protection** – besides the ecological questions – is now part of the contemporary cultural values.

All things that – in some way – pay attention to the nature, to biodiversity and that realizes a lifestyle respectful of the natural heritage are the **answer to a widespread social demand.**

Ecopolis - 30 September 2008

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## Metodi ed esperienze di pianificazione strategica

### I PIANI STRATEGICI DELLE CITTA' EUROPEE (1990-2007) La necessità di una strategia

Anni '90 - DALLA PIANIFICAZIONE STRATEGICA AZIENDALE E LA SUA APPLICAZIONE ALLE CITTA' AMERICANE

AD UNA **VISIONE INTERAZIONISTA, PROCEDURALE** DELL'AZIONE PUBBLICA

Il ruolo del soggetto pubblico in una pratica di pianificazione strategica

è di tipo **PEDAGOGICO**, la pianificazione strategica è una forma di **PRATICA**.

### LE QUESTIONI GENERATRICI

- LA FASE DI RIURBANIZZAZIONE E LA RICENTRALIZZAZIONE DI ATTIVITA'
- IL RIUSO DELLE AREE DISMESSE
- L'AVVIO DELLE POLITICHE DI RETE TRA LE CITTA'
- LA DIFFUSIONE DELLE INFRASTRUTTURE MATERIAL/IMMATERIALI DI COMUNICAZIONE
- LA NUOVA NATURA DEL PIANO COME CORNICE E CONTESTO DI AZIONE
- LA NUOVA NATURA DEL PIANO COME PROCESSO ITERATIVO E AGROMENTATIVO

### I CONTENUTI

Dal modello gerarchico autoritativo:

dal **PIANO GENERALE**  
ai **PIANI PARTICOLAREGGIATI**  
ai **PROGETTI URBANI**

Al modello incrementale

**PROGETTI URBANI + STRUTTURE DI AZIONE + STRATEGIE** *viceversa*

**Se la "città per progetti" può condurre alla deregolamentazione**

**la pianificazione strategica fornisce una cornice condivisa ai progetti**

**La necessità di una strategia per l'evoluzione territoriale**

La crisi delle città a forte tradizione industriale è uno dei fenomeni più diffusi dell'origine della PS: molte città europee (Glasgow, Lione, Liverpool, Birmingham, Rotterdam, Torino) e altrettante città nordamericane (Pittsburg, Detroit, Cleveland, Boston) si sono trovate a dover fronteggiare la crisi del settore industriale tradizionale (siderurgia, cantieri navali, settore tessile, automobilistico) unita allo sviluppo insufficiente del settore dei servizi.



L'impatto delle trasformazioni economiche è stato evidente attraverso i seguenti effetti:

- **alti indici di disoccupazione;**
- **degrado dell'ambiente e della qualità urbana;**
- **processo di migrazione, calo demografico, invecchiamento della popolazione;**
- **problemi di emarginazione sociale.**

### Per fronteggiare questa crisi, molte città in declino hanno attuato uno sforzo strategico di rivitalizzazione

Alcune attraverso la formulazione di piani strategici propriamente detti, altre tramite politiche che possono essere assimilate ai processi di PS.

Lo sforzo strategico nasce dalla necessità di effettuare una trasformazione profonda e radicale della città, **unendo energie pubbliche e private.**

**Il piano strategico rappresenta uno strumento di mobilitazione per riunire volontà, formulare obiettivi prioritari e generare partecipazione.**

I benefici del piano strategico sono i seguenti:

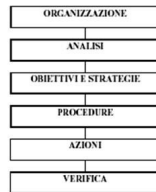
### L'azione strategica richiede di operare a scale diverse

- **A scala globale:** occorre sostenere l'accessibilità a mercati lontani, a sistemi specializzati di informazione, ai luoghi di eccellenza della produzione culturale, per interscambi nelle due direzioni. Gli attori locali devono essere facilitati nella possibilità di **partecipare a reti internazionali di cooperazione economica, scientifica e culturale**, e a loro volta impegnarsi prioritariamente a sviluppare queste partecipazioni; è parte dello stesso obiettivo l'accesso, concordato fra attori pubblici e privati, locali e esterni, a programmi di sviluppo previsti e finanziati da organismi internazionali, in particolare l'Unione Europea.

- **A scala regionale:** è necessario estendere le funzioni organizzative e di promozione della città nei confronti del territorio di riferimento, perché le possibilità di successo dipendono dall'attivazione dell'area nel suo insieme, secondo le sue **vocazioni** (la realizzazione di infrastrutture per lo sviluppo, la localizzazione di università, centri intermodali, aeroporti, ospedali sono questioni che riguardano spesso più comuni dell'area regionale).

- **A scala locale:** alla quale sono definite le principali azioni del Piano. La **cura continua della città** e la capacità di individuare obiettivi condivisi da attori pubblici e privati per investimenti di lungo periodo è l'obiettivo strategico fondamentale.

### L'organizzazione del piano strategico



#### Prima fase: Analisi degli scenari

L'analisi degli scenari comprende:

- La raccolta e la rappresentazione dei **dati** territoriali
- L'individuazione degli **attori** diretti e indiretti
- La selezione delle **decisioni**
- L'utilizzo dei **"benchmarks"**: cioè una metodo che mette a confronto il territorio con i suoi competitori in modo da trarne lezioni per l'azione.

#### Seconda fase: Gli obiettivi strategici e il marketing territoriale

La definizione degli obiettivi condivisi rappresenta il nucleo centrale del processo di pianificazione strategica. Si tratta di obiettivi a medio-lungo termine (10-20 anni) rispetto a cui si ricerca il consenso operativo dei principali attori, e inoltre l'adesione di importanti decisori esterni (Provincia, Regione, Stato, Unione europea, etc.).

La definizione degli obiettivi ha luogo prima entro gruppi tecnici, poi in forum più allargati e infine entro un vero e proprio accordo – un **patto** – siglato dai principali attori agenti nel territorio e a volte anche da rilevanti attori esterni (detentori di risorse o capacità specifiche).

#### Terza fase: mobilitazione e mantenimento dell'attenzione.

Una volta innescato il processo di pianificazione strategica, esso tende a una **mobilitazione selettiva degli attori e degli interessi**. Un primo elemento importante da valutare è quali interessi attorno al piano strategico sono effettivamente mobilitati, quali risultano più debolmente coinvolti e quali infine risultano esclusi.

Quarta fase: previsione dei fattori di criticità e approntamento di misure per rimuoverli o minimizzarli.

Quinta fase: Valutazione e monitoraggio.

La pianificazione strategica non è un processo indolore: come tutte le innovazioni nei processi complessi, essa **crea squilibri e disloca diversamente attori e risorse della città e del territorio**. Questi aspetti vanno previsti e le conseguenze vanno gestite nella misura del possibile.

Ad esempio, di norma si sottolinea la natura di "accordo iniziale" della pianificazione strategica (*plan for planning*): si ricerca cioè una pre-intesa sulle regole, preliminare alla stessa identificazione dei problemi strategici. Nella fase successiva di individuazione delle questioni strategiche, viene sottolineato come per ciascun problema sia opportuno identificare le conseguenze del mancato indirizzo verso una soluzione del problema stesso.

Le metodologie di valutazione nel caso di piani strategici sono:

- orientate alla implementazione e alla decisione,
- orientate alla rappresentanza,
- orientate alla conoscenza.

Le relative tecniche sono approntate e approfondite con lo scopo di fornire una continua valutazione *ex-ante* ed *ex-post* delle azioni che permetta a chi amministra

**quali azioni sono nell'agenda dei diversi attori,**

- quali sono già in fase di progettazione,
- quali sono già in fase di implementazione,
- quali sono in fase di finanziamento,
- quali sono concluse.

GRAZIE

PROF FRANCO ROSSI

UNIVERSITA' DELLA CALABRIA ITALIA

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## APPENDIX 4

### Regional Government news

2008-09-30 10:30:24

noticias



**GOBIERNO REGIONAL APORTA RECURSOS PARA CONSERVACION DE LA IGLESIA SAN FRANCISCO**

El intendente de la Región de Valparaíso Iván de la Maza comprometió alrededor de 260 millones de pesos para reparar y preservar la Iglesia San Francisco del Cerro Barón.

Lo expresó durante una jornada en que el consorcio ENEA, integrado por empresas y universidades, italianas informó de un estudio realizado en Valparaíso, en que se demuestra el estado precario en que se encuentra ese templo al igual que el de La Matriz y el de Las Hermanas de la Providencia.

El intendente asumió de inmediato el compromiso del Gobierno Regional de destinar en los próximos días la cantidad de 60 millones de pesos para efectuar los primeros trabajos de reparación y que a partir del próximo año se sumarían otros 200 millones.

El alcalde subrogante de Valparaíso, Omar Jara, dijo que frente a este estudio es necesario gestionar los recursos para mantener las construcciones patrimoniales de la ciudad dados los costos involucrados.

El Obispo de Valparaíso, monseñor Gonzalo Duarte junto con agradecer el aporte de la autoridad regional recordó que "los lugares más visitados de Valparaíso son sus ascensores, los miradores y también los templos, que están abiertos durante todo el día, a los cuales se ingresa sin permiso y sin pagar".

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<http://www.gorevalparaiso.cl/modules.php?name=News2&file=article&sid=1940>

## APPENDIX 5

### *Letter of ENEA, Universities of Padua and Ferrara to the Regional Government, regarding safety intervention and rehabilitation of the San Francisco del Baron Church*



ENTE PER LE NUOVE TECNOLOGIE,  
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UNIVERSITÀ DEGLI STUDI DI PADOVA



UNIVERSITÀ DI FERRARA

Ill. Dr.

**IVAN DE LA MAZA VAILLET**

Intendente Región Valparaíso

REPUBLICA DE CHILE,  
GOBIERNO REGIONAL  
V REGION VALPARAISO

Bologna, Padova, Ferrara  
20 Ottobre 2008

Illustre Indendente,

Desideriamo informarLa che lo scorso 15 Ottobre 2008 si è svolta presso l'Università degli Studi di Padova una riunione tecnica dei seguenti partner del Progetto "MAR VASTO - Manejo de Riesgos en Valparaíso": ENEA, Università di Padova e Università di Ferrara. Anche a seguito degli incontri avvenuti in Cile presso l'Intendenza, ci permettiamo di comunicarLe alcune proposte per la salvaguardia del patrimonio architettonico di Valparaíso che attualmente si trova in una condizione critica ed altamente vulnerabile: in particolare, come già confermato in occasione della conferenza finale del Progetto "MAR VASTO" a cui Lei ha gentilmente partecipato, facciamo riferimento alla Chiesa di San Francisco del Barón, ma anche ad altri edifici storici e monumentali della città e della Regione, *in primis* quelli oggetto del Programma "Puesta en Valor Patrimonial".

Come già anticipato nel corso delle riunioni tecniche svoltesi presso l'Intendenza, sottolineiamo l'importanza che i previsti interventi di riabilitazione strutturale del patrimonio culturale di Valparaíso e della V Regione siano coerenti con le normative più aggiornate oggi presenti nel panorama internazionale per lo studio e l'intervento strutturale sul patrimonio culturale, ovvero:

- "Recommendations for the analysis, conservation and structural restoration of architectural heritage" elaborate dall'International Scientific Committee for Analysis and Restoration of Structures of Architectural Heritage nell'ambito dell'ICOMOS;
- "Linee Guida per la valutazione e riduzione del rischio sismico del patrimonio culturale" elaborate in Italia dal Ministero per i Beni e le Attività Culturali.



### ***1) Progettazione dell'intervento di emergenza per la Chiesa di San Francisco del Barón***

Come già anticipato personalmente in Cile dall'Ing. Maurizio Indirli, Le confermiamo la nostra disponibilità a fornire a titolo gratuito, anche nell'ambito di un gruppo di lavoro cileno-italiano, la consulenza per la progettazione degli interventi urgenti di messa in sicurezza della Chiesa di San Francisco del Barón. Tale consulenza potrà essere effettuata prendendo come riferimento per i costi la disponibilità finanziaria a suo tempo quantificata da Lei e dai Suoi funzionari e sulla base delle normative internazionali sopra citate.

La progettazione dell'intervento di urgenza, che sarà da noi ultimata entro il 2008, conterrà la valutazione tecnico-economica delle metodologie e dei dispositivi necessari, prendendo in considerazione le seguenti ipotesi tra loro alternative:

- tempi e costi di lavorazione e montaggio dei dispositivi nel caso di una loro effettiva realizzazione in Cile;
- tempi e costi di lavorazione, trasporto e montaggio, nel caso di realizzazione in Italia dei componenti, successivamente inviati via mare a Valparaiso e qui assemblati.

Riteniamo di importanza fondamentale, inoltre, effettuare, anche a supporto dell'intervento di emergenza, una campagna di indagini diagnostiche e dinamiche, sempre di ridotte dimensioni e con costi aggiuntivi molto contenuti, al fine di fornire indispensabili dati sui materiali costituenti la chiesa, ottimizzando il progetto e approfittando della presenza del cantiere per l'intervento d'urgenza sulla Chiesa di San Francisco del Barón, che potrebbe diventare così un vero e proprio "caso pilota", da utilizzare come referenza per altri interventi simili.

La campagna di indagini diagnostiche e dinamiche potrebbe essere effettuata da un'equipe mista cileno-italiana, coinvolgendo laboratori e gruppi di ricerca di Università Cilene con comprovate competenze nel settore; nel caso fosse necessario trasferire conoscenze su alcune tecniche di indagine poco o nulla usate in Cile e integrare l'attrezzatura di prova dall'Italia (ad esempio i martinetti piatti - *flat jacks*), si potrebbe utilizzare la stessa spedizione prevista per i componenti dell'intervento di emergenza.

Per tale ragione, la nostra proposta conterrà anche una quantificazione dei costi e dei tempi della succitata campagna di indagini diagnostiche e dinamiche.

A corredo del lavoro, potrebbe essere quindi elaborato un breve documento di "Linee Guida per le indagini preliminari", da utilizzare come referenza per interventi simili sul patrimonio architettonico, anche da parte di altre equipe di progettazione e intervento.

### ***2) Progettazione dell'intervento definitivo per la Chiesa di San Francisco del Barón***

Come già anticipato in Cile, siamo a disposizione per individuare e partecipare ad un'equipe mista cileno-italiana per la progettazione e la realizzazione dell'intervento



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definitivo di consolidamento strutturale sulla Chiesa di San Francisco del Barón, secondo le modalità previste dalla legislazione del Vostro Paese. In aggiunta, siamo a disposizione anche per un supporto riguardante la scrittura dei “*Términos de Referencia*”, affinché essi tengano conto, riguardo il consolidamento strutturale di edifici afferenti al patrimonio culturale, degli approcci più aggiornati e sviluppati a livello internazionale, secondo le normative sopra citate.

A nostro parere, è infatti molto opportuno che l'intervento sulla Chiesa di San Francisco del Barón possa diventare, a Valparaíso e nella V Regione, il “punto di riferimento” per interventi analoghi sul patrimonio culturale. Come ricaduta del lavoro, riteniamo molto proficua l'elaborazione, da parte dell'equipe progettuale incaricata, di uno specifico documento che abbia la funzione di manuale-guida per i gruppi di progettazione coinvolti in altri interventi oggetto del Programma di “Puesta en Valor Patrimonial” nella V Regione.

### **3) Programma di “Puesta en Valor Patrimonial”**

Abbiamo avuto la possibilità di visionare il Programma di “Puesta en Valor Patrimonial” per la V Regione (in cui è stata recentemente inserita la Chiesa di San Francisco del Barón), che prevede interventi di rinforzo, miglioramento e restauro strutturale in oltre 20 edifici monumentali di notevole pregio.

Tale programma costituisce certamente una grande opportunità di riscatto per il patrimonio della Sua Regione ma, allo stesso tempo, potrebbe presentare notevoli problemi, in quanto prefigura la contemporanea attivazione di un certo numero di incarichi di progettazione, che dovrebbero avere caratteristiche di coerenza e omogeneità nelle soluzioni di intervento, usufruendo di competenze di comprovato valore, in linea con gli approcci più aggiornati al problema e nel rispetto della normativa internazionale già citata.

Il nostro parere è che attualmente in Cile (ma per certi aspetti anche in Italia) le esperienze professionali in grado di realizzare progetti di intervento sui beni culturali nel rispetto dei principi di conservazione non siano molto diffuse. Per tale ragione, un nostro suggerimento è quello di procedere con un certa gradualità, puntando subito alla realizzazione di un progetto pilota (quello sulla Chiesa di San Francisco del Barón), che possa diventare il “punto di riferimento” per tutti gli altri interventi oggetto del Programma di “Puesta en Valor Patrimonial” da licitare successivamente, favorendo un approccio coordinato in fase di valutazione e realizzazione, e stimolando una grande campagna di formazione professionale. La partecipazione di competenze internazionali di provata esperienza, in joint-venture con i migliori progettisti cileni, rappresenta la migliore garanzia di buona progettazione ed esecuzione delle opere.

In aggiunta, ci permettiamo di suggerire quanto sia importante istituire rapidamente una commissione di esperti di grande competenza (sia cileni che internazionali) per la





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valutazione dei progetti oggetto del Programma di "Puesta en Valor Patrimonial" (a cominciare, ovviamente, dall'intervento di riferimento sulla Chiesa di San Francisco del Barón). Tale commissione potrebbe fornire valutazioni di qualità, elevate ed omogenee, nonché indicazioni per il miglioramento delle proposte progettuali e per l'esecuzione delle opere.

Ringraziandola per la cortese attenzione, restiamo a disposizione per tutti i chiarimenti del caso.

Cordialmente,

MAURIZIO INDIRLI

ENTE PER LE NUOVE TECNOLOGIE,  
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CLAUDIO MODENA

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