



PROJET COFINANCE  
PAR L'UNION EUROPEENNE

# CARTODATA: risk maps of heritage

Meeting of Palermo  
24-25 October 2006

# Different operators



**Operator 1 / Coordinator:** Centre National de la Recherche Scientifique / Université de Nice Sophia-Antipolis (CNRS CÉPAM - UMR 6130)



**Operator 2:** Università Degli Studi del Molise / Dipartimento di Scienze e Tecnologie per l'Ambiente e il Territorio



**Operator 3:** Soprintendenza per I Beni Architettonici e per il Paesaggio, per il Patrimonio Storico, Artistico e Etno antropologico del Molise (BAP-PSAE)



**Operator 4:** Consiglio Nazionale delle Ricerche - Istituto per le Tecnologie delle Costruzioni - sede L'Aquila (CNR-ITC)



**Operator 5:** Câmara Municipal do Porto / Direction Municipal de la voie Publique (CMP-DMVP)







**Operator 6:** Comune di Sortino

# Objectives

- Different institutional situations for European operators but a common objective = **organise communication of the information between several services** (municipal, heritage, prevention, intervention...) for a best protection of heritage objects against natural risks.
- This objective involve:
  - the **inventory and the description of current methodologies and tools** (databases, GIS) used for knowledge of heritage and natural risks;
  - the **enrichment** of the present situation and/or the proposition of **new models and solutions**.

# Projected schedule 2006 - 2007

Marsh – May 2006	Implementation of the activity 1: inventory and technical analyse of current databases (CÉPAM, Molise) 
August – September 2006	Implementation of the activity 2: identification of sensibility areas for heritage objects (all operators) ; production of scenarios for the adaptation of databases (CÉPAM, Molise) 
November 2006	Activity 2 : Integration of assistance plans (CÉPAM, Molise, Porto)
February 2007	Implementation of the activity 3: Identification of conceptual tools and realization of prototypes (CÉPAM, Molise) 
Marsh – May 2007	Activity 3: Realization of specifications and/or conceptual tools (CÉPAM) ; Realization of a GIS platform with integration and put in relation of the data (Molise) 

 action realized

 action in realization

# Work progress - University of Molise

- The necessary activities for the realization of the “SITRA” (Territorial Informative System for the Environmental Risks) are in progress : recuperation of data in territorial organisms, homogenization of all information and creation of all informative layers of SITRA.
- The informative layers have been separated in informative layers of base and informative layers of work (C=completed, IP= in progress):
  - The **informative layers of base** are: land use (C), geology, geomorphology and hydrogeology (IP), lifelines (C), infrastructures of public utility (IP), architectural-historical buildings (IP with CNR), environmental resources (C), industries and productive firms (C), works of captation for hydrogeological resource (C).
  - The **informative layers of work** are: map of seismic hazard (C), map of landslide hazard (C), map of flood hazard (C), map of vulnerability of hydrogeological resource (IP), map of coastal erosion (in progress with ENEA).

# Work progress – CNR ITC

- Methodology of inventory of heritage objects based on 3 levels:
  - **Level 1 = Check list** contain general and minimal information on vulnerability of cultural objects with geographical reference → transfer of GIS information, regional geographic level.
  - **Level 2 = Cartography of historic centres** integrating informations on situations known (anterior damages).
  - **Level 3 = Study in detail** of monuments and their vulnerability.

**LIVELLO 0**  
livello territorio

CHECK-LIST

PRIORITA': livello di attenzione alla qualità ambientale e al pericolo, propensione al degrado

PERICOLOSITA' DI BASE

CATALOGO BENI STORICO-ARCHITETTONICI

GEOREFERENZIAZIONE



**LIVELLO 1**  
livello centro storico

SCHEDA VULNERABILITÀ SPEDITIVA

MAPPE DI VULNERABILITÀ

PERICOLOSITA' SISMICA LOCALE

MAPPE DI RISCHIO

PERICOLOSITA' DI BASE

**LIVELLO 2**  
livello edificio

SCHEDA VULNERABILITÀ 2° Livello

SCENARI DI DANNO

PERICOLOSITA' del sito di appoggio (amplificazione locale)

GRADUATORIE DI RISCHIO

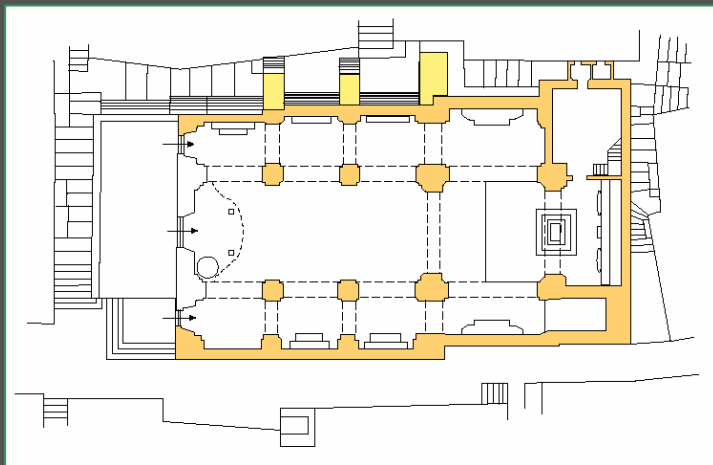
PROGRAMMAZIONE INTERVENTI

**PREVENZIONE**

PREPARAZIONE EMERGENZA

# Work progress - Soprintendenza Molise

**EXAMPLE : Preliminary analysis of “S.PIETRO IN VINCOLI” – Castellino on the Biferno (Molise – It). Strongly damaged during seismic events of 2002**

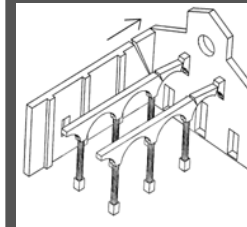
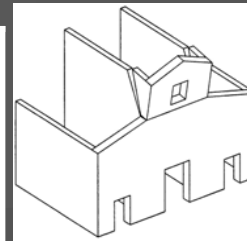


SISMA  
MOLISE  
2002



# VALUATION OF THE SEISMIC VULNERABILITY : Damage analysis

PRINCIPAL DAMAGE MECHANISM : ACTIVATED AND POSSIBLE	DAMAGE LEVEL: 0 to 5 (collapse)
Turnover of the facade and of the perimetral walls	Strongly : 4
Turnover of the top of the facade	Strongly : 4
Mechanism in the plan of the facade and of the perimetral walls	Strongly and Medium : 3-4
Transversal and longitudinal seismic response	Strongly : 4
Vaulted, Dome and arcs cover	Strongly and Collapse : 4-5
Tower and cell-bell	Strongly : 4



**DAMAGE INDEX  $I_d = 0,82$  (level 4-5)**



# VALUATION OF THE SEISMIC VULNERABILITY

## PRESENCE OF INDICATORS OF SESMIC PROTECTION

Adjacent attached bodies

External buttresses to the arcs

Stocky Piers in cell bell

Chains in the tower

## PRESENCE OF INDICATORS OF VULNERABILITY

Pushing elements in cover

Windows in the lateral wall near the facade

Top Sail of the facade

Thin vaulted

Great windows in the facade

$$i_v = \frac{1}{6} \frac{\sum_{k=1}^{28} \rho_k (v_{ki} - v_{kp})}{\sum_{k=1}^{28} \rho_k} + \frac{1}{2}$$



## VULNERABILITY INDEX :

Before intervention:  $i_v = 0,67$ ; PGA (Peak Ground Acceleration) = 0,12 ;  $I_s\text{-St} = 0,47$ ;  $I_s\text{-Gm} = 0,30$

After intervention:  $i_v = 0,17$ ; PGA = 0,35 a/g –  $I_s\text{-St} = 1,18$ ;  $I_s\text{-Gm} = 0,80$

## Phase C – S.Pietro in Vincoli - CAstellino on the Biferno

### Variation of the costs of intervention with the vulnerability for the sequences A1 and A2

X axis : interventions , Y axis : costs/mq \* 100 and index vulnerability

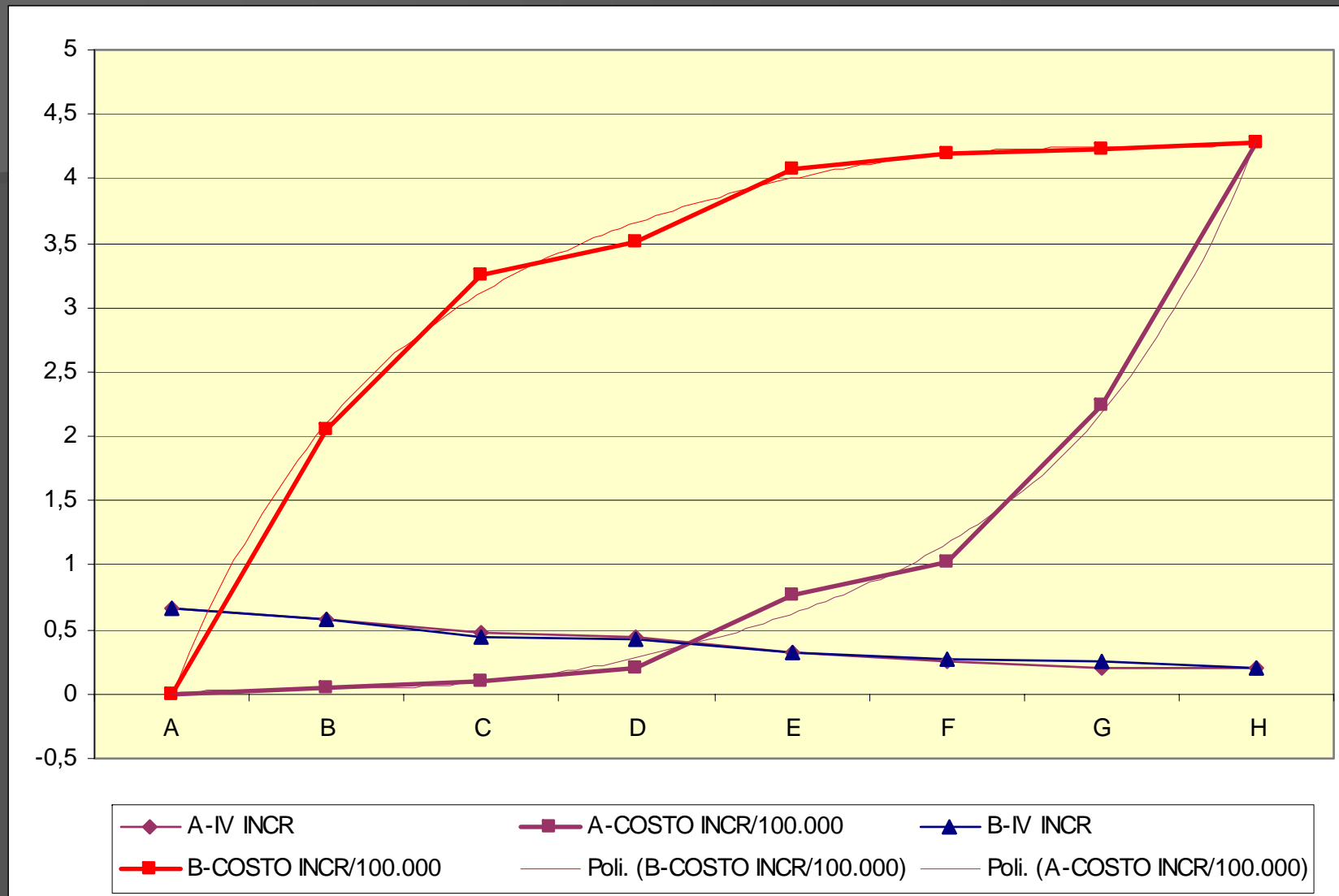
Interventions sequence A1	Single intervention		Sequence A1		Costs	
	Variation index V	Variation % index V	Incremental reduction of Vul	Incremental reduction of V %	Single intervention - euro	Sequence n.1 euro
<b>INITIAL VULNERABILITY</b>	0,67	0	0,67	0	0	0
1- longitudinal chains	0,57	0,15	0,57	0,15	5.296	5.296
2 – Trasversal chains	0,53	0,21	0,48	0,28	4.350	9.000
3 - Chains at the tower and the cell bell	0,62	0,07	0,43	0,35	10.848	20.000
4 – cover	0,54	0,19	0,33	0,51	56.678	77.000
5 – cover – stringcourse in steel	0,53	0,21	0,25	0,62	26.083	103.000
6 – Consolidation vaulted	0,54	0,19	0,21	0,68	120.624	220.000
7 – consolidation masnories	0,57	0,15	0,21	0,68	204.462	<b>428.000</b>

Interventions sequence A2	Singolo intervento		Sequence A2		Costs	
	Variation index V	Variation % index V	Incremental reduction of Vul	Incremental reduction of V %	Single intervention - euro	Sequence n.2 Euro
<b>INITIAL VULNERABILITY</b>	0,67	0	0,67	0	0	0
7 – consolidation masnories	0,57	0,14	0,57	0,14	204.462	204.462
6 – Consilidation vaulted and arcs	0,54	0,19	0,44	0,34	120.604	325.086
5 – Coverage	0,53	0,21	0,42	0,37	26.963	351.169
4 – Cover	0,54	0,19	0,32	0,52	56.678	407.847
3 – Cover – stringcourse in steel	0,62	0,07	0,27	0,59	10.848	418.695
2 – Trasversal Chains	0,53	0,21	0,26	0,61	4.350	423.045
1 – Longitudinal Chains	0,57	0,15	0,20	0,69	5.296	<b>428.341</b>

### Phase C – S.Pietro in Vincoli - CAstellino on the Biferno

Variation of the costs of intervention with the vulnerability for the sequences A1 and A2

X axis : interventios , Y axis : costs/mq \* 100 and index vulnerability



# SEISMIC RISK ANALISYS



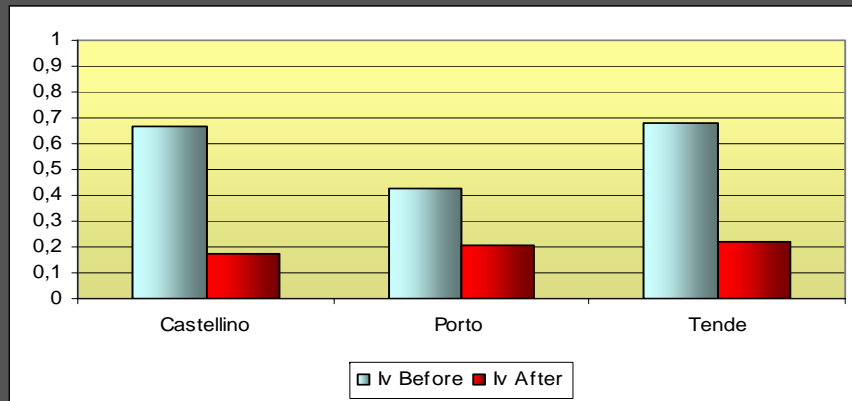
CASTELLINO



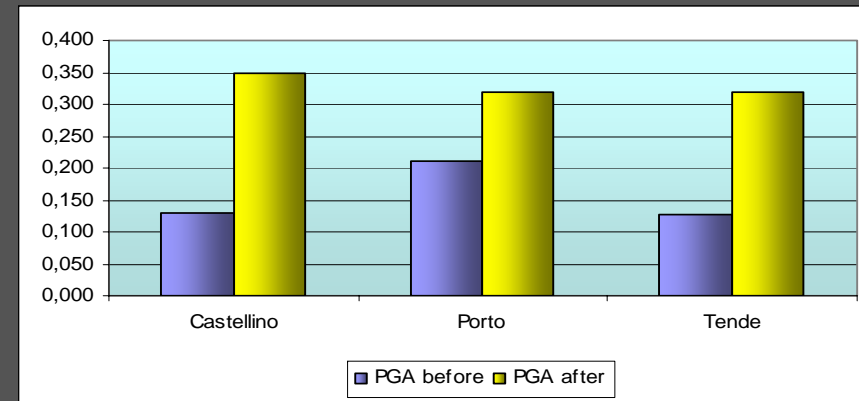
PORTO



TENDE



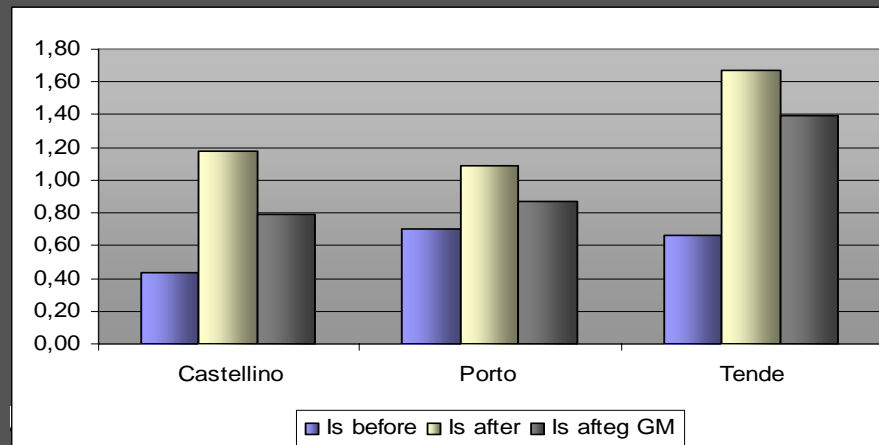
Index Vulnerability



PGA (Peak ground acceleration)

A = Structural condition  
 B = Structural and geo-morphological condition

Index security



# Work progress - CÉPAM

<b>AccessibiliteSite</b>	0 Route, chemin carrossable
	1 Sentier pédestre < 200 mètres
	2 Sentier pédestre > 200 mètres
	3 Sans accès
<b>PropietaireSite</b>	0 Etat, collectivités (public)
	1 Eglise, édifice privé ouvert au public (fondations)
	2 Propriétaire privé
<b>Frequentation</b>	0 Non utilisée
	1 Fréquentation du public occasionnelle
	2 Edifice d'habitat
	3 Fréquentation du public quotidienne
<b>Voisinage</b>	0 Isolé
	1 1 côté accolé
	2 > 1 côté accolé
<b>EtatConservation</b>	0 Bon
	1 Moyen
	2 Mauvais
	3 Ruine
<b>Elevation</b>	0 Plein pied
	1 1 étage
	2 2 étage
	3 > 2 étages
<b>QuantiteBienMobile</b>	0 Absence de mobilier
	1 Objet isolé
	2 2 à 10 objets
	3 > 10 objets

- The **French check-list** = a testing tool which uses the Italian concept of the level 0 enlarged to :
  - all categories of heritage items (archaeological sites, all kind of buildings, museum collections);
  - all kinds of risks (fire, flood, rock fall, seism, slide).
- Moreover, we try to take in count the general morphology of the field and the presence / absence of collections in the structure.

# Work progress - CÉPAM

SitesCartodataGeneral

IdSite  
183

nom  
Village, l'église paroissiale Notre-Dame de l'Assomption

Morphologie  
Versant

RisqueLittoral

AccessibiliteSite  
1

EtatConservation  
2

ProprietaireSite  
0

Elevation  
0

Frequentation  
3

QuantiteBienMobile  
3

Voisinage  
1

DocHistorique

Remarques  
L'église N-D de l'Assomption fut commencée en 1764 et achevée et consacrée en 1772. La façade est influencée par le néo-clacissisme. Le ravallement des façade extérieur est très récent, néanmoins des taches d'humidité apparaissent déjà sur la face sud. Vu l'emplacement des taches, l'humidité semble remonter par capillarité. Quasiment toutes les chapelles latérales de l'église (autels, boiseries, plâtres) sont attaqués par l'humidité, la salpêtre se forme sur les supports de bois et de plâtre et des lézardes sont visibles dans la partie inférieure. En revanche, les peintures situées sur le plafond du chœur, sont en bon état (restauration récente?)

Enr : 4 sur 194

- Test of the French check-list with the general inventory of heritage items along the littoral of Alpes-Maritimes : villas, dwelling buildings, hostels, museums, castles, observatories, archaeological sites...

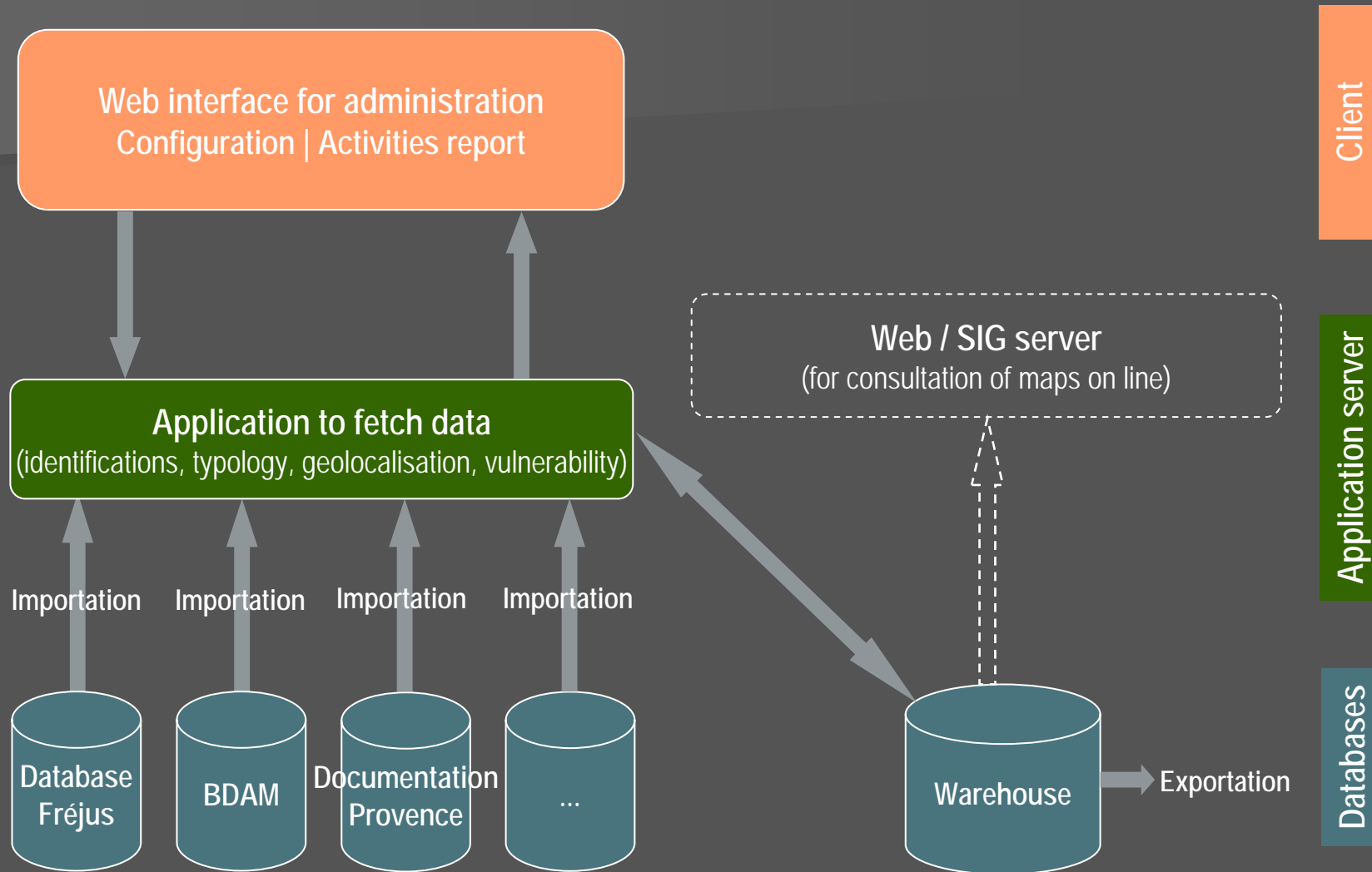


# Work progress - CÉPAM

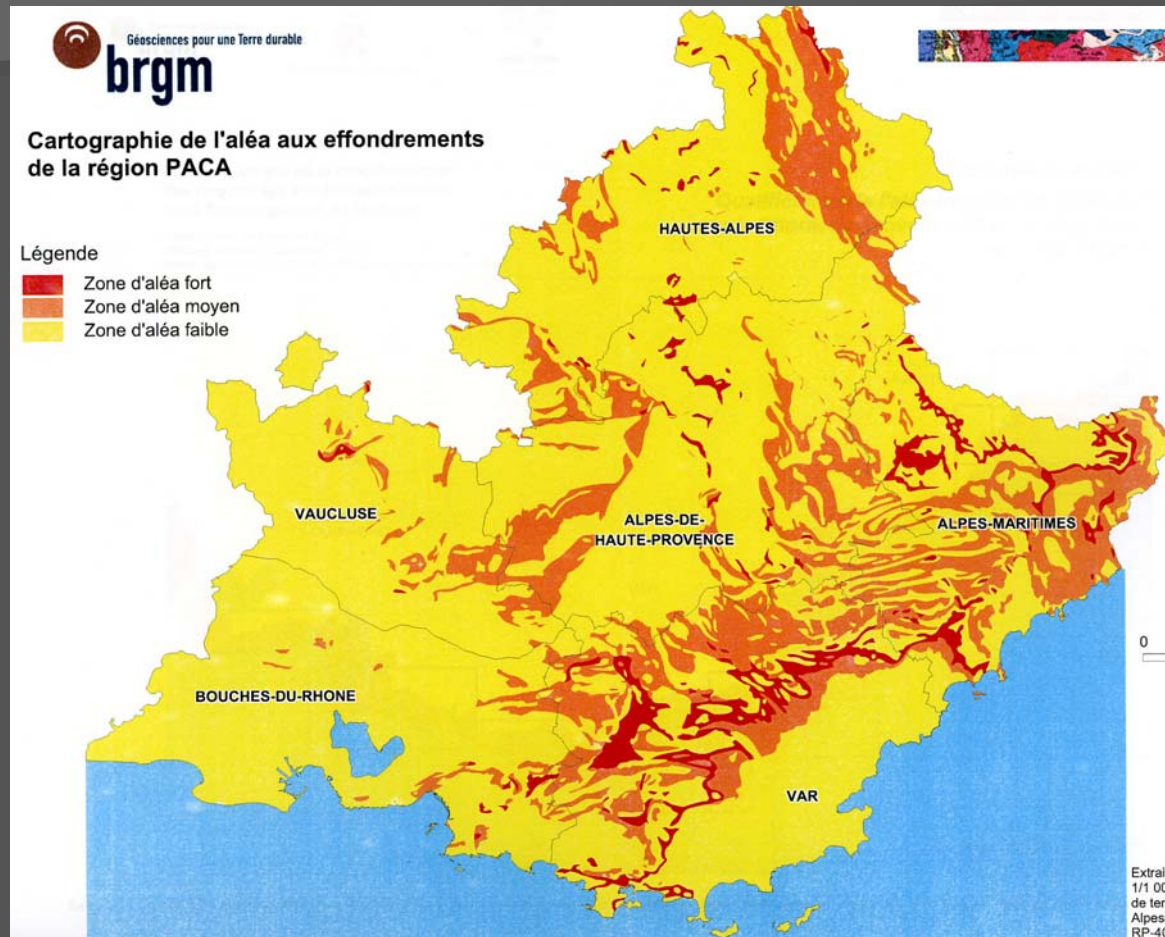
- Informatics developments with the **conception of a data "warehouse"**
  - The aim is to collect information automatically from heterogeneous databases.
  - Collected informations will be directly introduce, in a normalized format, in a warehouse.
  - Data of this warehouse will be in a format compatible with all GIS software (sharp file format).



# 3-tier architecture proposed





# Work progress - CÉPAM



- The aim of the utilization of the check-list and of this informatics system is the realization of a **global map of evaluation of risks on heritage in PACA region** with :
  - the superposition of different maps of "alea";
  - the localization of heritage places;
  - the selection of heritage places most visited (human factor).

# Work progress - Porto

Zona Histórica do Porto						
Decreto 67/97, DR 226, de 31 de Dezembro						
Ficha de Inquérito - Edifício						
<b>Catálogo</b>	Séc. XVII-XVIII	Nº: 000	NR: 186	DP: 24.07.06		
<b>Identificação</b>						
Nome da obra: Casa de Santo António do Penedo/ Palácio dos Condes de Azevedo				Freguesia: Sé		
Morada: Rua Saraiva de Carvalho,						
Propriedade do prédio: Estado						
Protecção legal: IIP51			PDM			
<b>Caracterização</b>						
Enquadramento urbano		Datação:		Séc. XVII-XVIII		
		<p>Descrição: Casa Nobre na Rua Saraiva de Carvalho "Casa dos sécs. XVII-XVIII, com piso térreo e andar nobre, actualmente sede da Direcção de Finanças do Distrito do Porto. Foi comprada pelo primeiro Visconde de Azevedo -, que nela viveu. Na frontaria, no andar nobre, as sacadas têm grades de tipo seiscentista, com ornatos de frente, sendo os tímpanos destas, alternadamente, triangulares e quase semicirculares, o que se repete nas aberturas do piso inferior. Este edifício é dos melhores entre os de arquitectura de transição dos sécs. XVIII para o XVIII".</p>				
<b>Morfologia construtiva</b>						
Tipologia:	Implantação	Isolada	Arçabois	Materiais	Elementos	Cores
	Ocupação	Residencial		Madeira	Caixilhariás	Verde
	Função	Casa Nobre	Sistemas construtivos	Cerâmica		
Cércea:	10,00m			Ferro	Gradeamento	
n.º de pisos:	r/c+1		Elementos significativos	Pedra	Cantaria	
Ocupação actual:	Direcção de Finanças do Distrito do Porto			Outros		
Estado de conservação:	Bom (aparente)		Cantaria/alvenaria de pedra			
Integridade:	Arquitectónica	s/ Alt. sign.	Feros seiscentistas			
	Construtiva	—	Desenho das cantarias			
Notas:						
<b>Informação Adicional</b>						
Observações:						
Tem remo.						
Referências arqueológicas			Referências bibliográficas			
Muralha Fernandina demolida no séc. XVIII.			QUARESMA, Maria Clementina de Carvalho - <i>Inventário Artístico de Portugal. Cidade do Porto - XIII</i> . Lisboa: Academia Nacional de Belas-Artes, 1995, pág. 142.			

- Making of a database integrating the characterization of the Historical Centre and the definition of the geological risk that may affect it.
- The files produced covers several items in which the built heritage of the Historical Centre can be characterized.
- The file "building" contain: historical context, dating of various constructive events, licences, typology, dominating pattern, number of storeys, type of occupation (initial and present), state of preservation, integrity, materials, constructive system, additional information.

# Common works for Cartodata

- Elaboration of a **common methodology for the inventory of heritage's objects** (for a better utilisation in tools of services of prevention and intervention) = Italian methodology based in the constitution of 3 levels of knowledge on heritage.
- **Reflexion on databases and GIS:**
  - Take good information on cultural objects, prepare this information for his use in GIS tools of prevention and intervention services, comparison of the situation in each country.
  - Elaboration of a minimal file of data (works Molise and PACA).
  - Choice of the extraction of data from current databases and put at disposal of these data for GIS of different services (PACA) or the creation of a central database with one GIS (Molise and Porto).
  - Constitutions of maps of "aleas" and risks with the integration of a level of information "heritage objects" (Molise and Porto).
- **Field works:**
  - Study of 3 church with the Italian methodology = S Pietro in Vincoli (Molise), Tende Cathedral (PACA), Porto Cathedral (North Portugal).
  - Comparison of databases from urban level (Porto and Fréjus).
  - Micro-regional inventory in Roya valley and town of Fréjus (PACA) and preparation of plans of prevention.

# For more informations ...

**noé** Patrimoine et prévention des risques naturels

Ned Est SUD Ouest  
**INTERREG III C**

PROJET COFINANCE  
PAR L'UNION EUROPEENNE

Région  
PACA

Accueil | Cartodata | Comptes-rendus | Documentation | Liens utiles | Photos | Plan du site | Espace privé

## Éditorial

Le sous-projet Noé Cartodata vise à mettre en œuvre une réflexion pluridisciplinaire sur les méthodologies et les outils documentaires et d'information géographique nécessaires à l'optimisation de la protection de l'ensemble du patrimoine culturel face aux risques naturels.

Ce site collaboratif vous est proposé dans cet esprit d'interdisciplinarité et d'échange d'informations. Il permettra à tous les membres du groupe de travail Noé Cartodata d'être régulièrement informés de l'avancement du projet mais aussi d'apporter facilement de l'information.

Le système de publication SPIP utilisé ici permet par une interface très simple d'écrire des articles, de joindre des fichiers de différents formats ou encore de proposer des liens web. Il vous suffit de taper votre nom et votre adresse email sur le formulaire d'inscription disponible sur la page de login de l'"espace privé" et vous recevrez rapidement votre identifiant et mot de passe de connexion à l'interface d'édition du site.

## Localisation des partenaires

FRANCE

ITALIE

PORTUGAL

SICILE

Porto

Sophia-Antipolis

L'Aquila

Isernia

Campobasso

Sorbito

© Microsoft Encarta 2006

Site réalisé avec SPIP

Site officiel Noé | Haut de page | Contacter la webmestre

- See the website of the sub-project :  
<http://noe.cartodata.free.fr/>