Progetti di ricerca
Convenzione ProCiv - INGV 2004 – 2006
Decreto n. 387

Rapporto Finale del Comitato di Revisione
Riunione del 10-12 Settembre, 2007

Considerazioni generali

Su mandato del Presidente dell'Istituto Nazionale di Geofisica e Vulcanologia, Prof. Enzo Boschi, é stato istituito il Comitato di Revisione per i 5 progetti di ricerca sismologica S1-S5 previsti dalla Convenzione ProCiv - INGV 2004 – 2006, Decreto DPC n. 387.

Il Comitato di Revisione (CdR) è composto da: Prof. J. Bommer, Imperial College (UK), Prof. D. Giardini, ETHZ (CH) , Prof. M. Ordaz, UNAM (Messico) e Dr. T. Winter, BRGM (F). Direttore del Comitato di Revisione è D. Giardini.

Il CdR si è riunito a Roma in data 10-12 Settembre 2007 per la valutazione finale dei progetti. La valutazione finale si è basata sui rapporti finali dei progetti (1.8.2007), sulla valutazione dei prodotti e deliverables, sulle presentazioni dei Direttori dei cinque progetti S1-S5 e le indicazioni emerse durante la discussione sui progetti, nonchè sulle valutazioni prodotte negli anni precedenti. Il CdR has inoltre preso visione dei risultati finali del Progetto EduRisk e del Progetto S6 (Banca dati accelerometrici), la cui valutazione non era compresa nell'ambito del mandato iniziale del CdR.

Le attività di valutazione dei progetti nella presente Convenzione è stata condotta secondo il seguente calendario:

11.5.2005	Valutazione speditiva preliminare (D. Giardini)
1.6.2005	Inizio progetti
28-29.11.2005	Prima riunione di valutazione del Comitato di Revisione
15-16.6.2006	Seconda riunione di valutazione del Comitato di Revisione
31.7.2007	Conclusione progetti
10-12.9.2007	Valutazione finale del Comitato di Revisione

Il mandato della revisione compiuta nell'arco dei tre anni comprendeva la valutazione complessiva dei progetti di ricerca e della rispondenza alle specifiche previste dalla Convenzione DPC-INGV, la valutazione specifica dell'eccellenza scientifica dei progetti, l'individuazione di eventuali aree di debolezza o lacune, la proposta di approcci alternativi laddove si potesse configurare una migliore corrispondenza alla Convenzione, l'evidenziazione di aree di ricerca e sviluppo dove migliorare la sinergia tra i vari progetti, la definizione di prodotti applicativi per il DPC, la prioritizzazione e integrazione dei vari elementi e prodotti aspettati.

Scopo specifico della valutazione finale è fornire una valutazione complessiva dei progetti, della qualità scientifica dei risultati e dell'impatto aspettato, valutare gli aspetti gestionali dei progetti, e individuare aree di interesse prioritario nei presenti progetti che possano servire come linee guida per lo sviluppo di futuri progetti.

Le attività del Comitato di Revisione previste nell'ambito della convenzione 2004-2006 si concludono con il presente rapporto.

Il presente rapporto di valutazione è suddiviso in due parti, una prima parte di valutazione complessiva e osservazioni pertinenti alla definizione di futuri progetti, e una seconda di revisione più dettagliata per ogni singolo progetto.

Il rapporto è sottoscritto all'unanimità dal Comitato di Revisione.

Valutazione complessiva

I cinque progetti in sismologia S1-S5 realizzati nel periodo 2004-2006 con finto DPC costituiscono un programma quadro integrato di grande respiro, con ricadute di lunga durata e altissimo livello complessivo di competenza.

I prodotti sviluppati sono molto avanzati, e in buona parte di immediato utilizzo secondo i criteri indicati nella Convenzione, e permetteranno un salto di qualità nelle procedure di allerta, informazione e controllo della pericolosità sismica.

Il livello di presentazione, la completezza e la grafica dei rapporti finali, i prodotti operativi, le banche dati e i siti web sono di eccezionale qualità.

L'originalità scientifica dei risultati è comprovata dall'alto numero di pubblicazioni su riviste internazionali.

L'impegno mostrato dai coordinatori e più in generale la capacità dei partecipanti di sviluppare i progetti e perseguire i prodotti aspettati nel breve periodo di due anni operativi del programma, è andato al di là delle aspettative del CdR, che aveva espresso dubbi sulla possibilità di raggiungere tutti gli obiettivi prospettati mantenento al contempo un alto livello qualitativo.

Le attività di ricerca e sviluppo condotti nell'ambito del programma quadro 2004-2006 collocano l'Italia in un ruolo di leadership Europea, con forti aspettative per una ricaduta di lunga durata, nell'ambito della futura programmazione e attività per EC FP7, OECD e ESFRI.

Il compito del CdR è stato facilitato dalla disponibilità, professionalità e assistenza portata dal segretariato istituito dall'INGV e dal Segretario, Dr. Gianluca Valensise.

Osservazioni pertinenti alla definizione di futuri progetti

Sulla base delle osservazioni sull'andamento dei progetti nel periodo 2004-2006, il CdR formula alcune raccomandazioni che possono essere di indirizzo per la definizione della struttura e contenuti dei progetti finanziati dal DPC nel periodo 2007-2009.

Istituzione del ruolo di coordinatore del programma quadro

Il CdR raccomanda che venga istituito il ruolo di Coordinatore per l'intero programma quadro, con ampio mandato di assicurare una visione unitaria dei progetti, il raggiungimento degli obiettivi e risultati previsti, l'attuazione della fase di implementazione dei risultati, il collegamento tra i diversi progetti e le Unità di Ricerca, il coordinamento del gruppo dei coordinatori dei progetti, l'implementazione di procedure comuni di controllo di qualità, il supporto ai coordinatori in caso di difficoltà con l'attuazione di un progetto, lo sviluppo di aree di comune interesse tra i progetti (quali i modelli di attenuazione), l'organizzazione di incontri annuali, la gestione dei rapporti con DPC.

Il ruolo delineato va ben oltre quello di segretario del gruppo dei coordinatori di progetto, attivo nel periodo 2004-2006. Il Coordinatore potrà servire come singola persona di riferimento per il Comitato di Revisione e per il DPC. Si auspica altresì che anche il DPC nomini una persona di riferimento responsabile di mantenere una linea comune e i rapporti con il CdR e il Coordinatore del programma quadro.

Creazione di un Centro per la Pericolosità Sismica

Il Comitato di Revisione nota la marcata differenza di carattere dei progetti S1-S5, laddove alcuni progetti miravano a fornire prodotti e dati di fruizione istituzionale o pubblica (S1, S6, e in parte S5), altri puntavano a ricerche scientifiche e sviluppi tecnici per future applicazioni nell'ambito della pericolosità sismica (S2, S3, S5) o per le attività istituzionali di sorveglianza (S4), altre Tasks erano finalizzate alla compilazione di banche dati e cataloghi. Il CdR ritiene che attività istituzionali di lungo impegno – quali il modello di pericolosità e le banche dati – non debbano essere strutturate come progetti di ricerca triennali, ma vadano inquadrate in un ambito più adeguato e con finanziamenti più duraturi e continuati.

Si raccomanda pertanto la creazione di un Centro per la Pericolosità Sismica, con il seguente mandato:

- creare e mantenere una adeguata infrastruttura hardware, software e IT (cyber-infrastructure) capace di soddisfare alle esigenze scientifiche di ricerca quanto alle esigenze di interfaccia con le istituzioni e il pubblico, per coprire tutti gli aspetti rilevanti nel vasto settore della pericolosità sismica.
- Trasferire al centro le competenze per la gestione e la diffusione delle banche dati di rilevanza per la valutazione del rischio sismico.
- Concentrare o creare le competenze e il personale necessario per sviluppare l'intero spettro e discipline richieste nella valutazione della pericolosità sismica, evitando la frammentazione degli sforzi e la dispersione delle competenze.
- Assicurare una pianificazione di lunga durata e un partner affidabile per DPC e altre istituzioni italiane.
- Promuovere l'applicazione delle conoscenze e risultati scientifici sviluppati nell'ambito dei progetti finaziati da DPC e da altri enti, in una serie di prodotti operativi di alta qualità e robustezza, curando l'industrializzazione del software e delle interfaccie, e operando con criteri di trasparenza e integrazione secondo un modello Open-SHA.
- Implementare meccanismi rigorosi di controllo di qualità e validazione dei risultati scientifici come condizione per l'applicazione in prodotti di pubblico utilizzo.
- Sviluppare il modello di pericolosità in modo dinamico e pronto a recepire le più recenti evidenze scientifiche e ingegneristiche; condurre analisi di de-aggregazione e test di sensitività per fornire indicazioni specifiche sulle future priorità di ricerca, allo scopo di

continuare a migliorare il modello di pericolosità ed essere pronti a fornire sempre un prodotto del piú alto contenuto tecnico.

- Formulare linee guida e partecipare alla formulazione del prossimo programma quadro DPC, sulla base dei risultati acquisiti e dei test effettuati.
- Mantenere uno stretto contatto con i progetti e attività nel campo dell'ingegneria sismica, allo scopo di permettere una incisiva politica di mitigazione del rischio sismico.
- Creare un partner Europeo di riferimento per guidare la programmazione dei programmi europeai.

Il nuovo Centro per la Pericolosità Sismica si colloca idealmente all'interno dell'INGV, ma puó prevedere anche la partecipazione di competenze esterne. Il responsabile del Centro sarà figura di riferimento sia per il Coordinatore del programma quadro che per il DPC.

Accesso ai dati sismologici e accelerometrici

Si raccomanda che DPC e INGV si adoperino quanto più possibile per garantire la disponibilità in tempo reale di tutti i dati e osservazioni delle reti di monitoraggio in Italia, e per coordinarsi con le reti locali e regionali affinchè la mancata diffusione dei dati non nuocia alle attività di allerta e di valutazione della pericolosità sismica.

Programmazione temporale adeguata

Il CdR ritiene che la scala temporale per l'attuazione dei progetti 2004-2006 sia stata irragionevolmente limitata. I ritardi nell'approvazione e partenza dei progetti hanno fortemente limitato la possibilità di realizzare una efficace fase di integrazione e implementazione dei risultati ottenuti. Avendo a disposizione due anni effettivi, i coordinatori e le Unità di Ricerca si sono trovati nella condizione di dover sviluppare progetti di grande complessità in tempi troppo ristretti e vanno encomiati per lo sforzo fatto e i risultati ottenuti.

Una ulteriore conseguenza dei tempi ristretti è la necessità di portare a termine progetti e tasks in parallelo, con il rischio di prodotti incompatibili tra loro e di una mancanza di coordinamento.

Dispiace osservare che ritardi simili sono inevitabili anche per il programma quadro 2007-2009, per ragioni che rimangono inspiegate per il CdR. Il primo anno ufficiale del nuovo programma quadro volge al termine e i progetti non sono stati ancora approvati, le Unità di Ricerca non sono ancora confermate nè pronte a iniziare i lavori.

Si raccomanda di cambiare radicalmente questa impostazione e di attivare le procedure amministrative e decisionali necessarie affinchè la programmazione per il periodo 2010-2012 venga compiuta e approvata entro la prima metà del 2009; ad esempio, l'individuazione delle priorità e dei nuovi progetti potrà essere effettuata sulla base del rapporto di revisione del secondo anno di attività, invece che sulla base del rapporto finale.

Definizione delle Unità di Ricerca

In alcuni progetti, il numero delle Unità di Ricerca è apparso troppo elevato per il conseguimento di un alto grado di omogeneità e integrazione delle metodologie e dei risultati. In futuro si dovrà assicurare che la partecipazione sia limitata a quelle unità che sono indispensabili al conseguimento dei risultati prefissi, e che l'eccessiva frammentazione dei finanziamenti non risulti in uno scarso coinvolgimento di alcune UR. Vanno altresì

previsti meccanismi di controllo della qualità e dell'integrazione dei progetti, nonchè misure amministrative per quelle Unità che non si conformano al piano di lavoro.

Riunioni annuali

In conseguenza della scala di tempi ristretti, il gruppo dei coordinatori ha deciso di non tenere riunioni annuali congiunte di tutti i progetti nel periodo 2004-2006. Il CdR ritiene invece che tali riunioni siano di grande importanza, e raccomanda per il futuro di indire riunioni annuali allo scopo di permettere un'effettiva integrazione dei progetti, incoraggiare la partecipazione di giovani ricercatori anche al di fuori delle UR definite, dare la possibilità ai ricercatori e UR di esporre la ricerca svolta ad una comunità più allargata, permettere un'efficace processo di validazione e accrescere il consenso sugli approcci seguiti e sui risultati ottenuti.

Sviluppo di attività trasversali nel programma quadro

Sono state evidenziate aree di ovvio comune interesse tra progetti diversi, dove UR separate nei vari progetti hanno perseguito obiettivi simili. Queste aree (ad esempio la definizione delle aree sorgente, un modello integrato di attenuzione del moto del suolo, il trattamento delle incertezze statistiche) erano già state individuate nella prima lettura dei progetti, e avrebbero beneficiato da una maggiore integrazione di metodi e obiettivi raccomandata già nel primo anno di attività, con rafforzamento e coordinamento trasversale tra i vari progetti, per un uso ottimale delle risorse e un miglioramento complessivo degli obiettivi. Nel caso specifico del modello di attenuazione è stato formato uno specifico gruppo di lavoro trasversale, che non ha potuto espletare la sua funzione per la ristrettezza dei tempi di lavoro. L'istituzione del Centro di Pericolosità Sismica potrà servire a rafforzare l'integrazione in aree di comune sviluppo.

Mandato del Comitato di Revisione

L'esperienza del Comitato di Revisione nel periodo 2004-2006 è stata molto positiva e di grande soddisfazione scientifica e personale, seppure con alcune limitazioni. Il CdR raccomanda che le esperienze maturate possano essere messe a frutto già nell'impostazione dei programmi per il periodo 2007-2009.

In particolare, si raccomanda di:

- nominare il CdR e impostarne il lavoro già nella fase di definizione e approvazione dei nuovi progetti
- garantire l'interazione diretta del CdR con i ricercatori e le UR coinvolte, per assicurare una migliore comprensione del lavoro svolto che vada al di là della lettura dei rapporti annuali, per esempio con l'organizzazione di riunioni annuali
- fissare procedure adeguate di interazione e risposta dei progetti alle osservazioni e suggerimenti formulati dal CdR
- coinvolgere il CdR nell'attuazione del programma quadro, come supporto all'attività dei coordinatori di progetto e con il mandato di proporre variazioni nei finanziamenti annuali nel caso di significative deviazioni dal programma di ricerca
- dare mandato al CdR di supportare DPC, INGV e il nuovo Centro di Pericolosità Sismica nella formulazione del futuro programma quadro, sulla base dei risultati ottenuti alla fine del secondo anno di attività del programma corrente

- formulare e comunicare da parte di DPC una strategia chiara, con le linee guida e le priorità da seguire nell'implementazione dei risultati, i criteri di valutazioni utilizzati da DPC e la definizione dei ruoli differenziati del CdR e dei rappresentanti del DPC nell'ambito dei l'attività di revisione

Progetto S1 - Proseguimento della assistanza a DPC per il completamento e la gestione della mappa di pericolosità sismica prevista dall'Ordinanza PCM 3274 e progettazione di ulteriori sviluppi

Fase I: Coord. G.M. Calvi e M. Stucchi. Fase II: Coord. C. Meletti

Original description and evaluation

Il progetto presentava la continuazione di attivitá giá condotte dall'INGV e da collaboratori esterni nel 2003-2004 per la compilazione della mappa di pericolositá sismica MPS04. Il progetto si proponeva originariamente di: completare le elaborazioni MPS04 (Task 1), calcolare la pericolositá in termini di intensitá macrosismica (Task 2), contribuire alla definizione di prioritá di intervento per edifici non adeguati sismicamente (Task 3), aggiornare i database sismologici non altrimenti aggiornati da INGV o altri enti (Task 4).

Nella valutazione iniziale, il CR ha sottolineato come il modello di pericolositá sismica vada considerato come un prodotto dinamico dal piú alto contenuto tecnico, pronto a recepire le ultime evidenze scientifiche e ingegneristiche, e come le elaborazioni sviluppate nella preparazione di MPS04 possano essere considerate solo come un primo passo importante verso una completa descrizione della pericolositá. Il CR aveva raccomandato di (i) ampliare la sperimentazione di nuovi metodi e prodotti nella valutazione della pericolositá sismica, (ii) recepire i nuovi input dagli altri progetti (quali nuovi modelli di attenuazione e modelli di ricorrenza), (iii) assumere il ruolo di accreditamento e validazione dei prodotti degli altri progetti, (iv) estendere la durata per un anno oltre il limite della presente convenzione, con lo scopo di assicurare l'applicazione dei prodotti ottenuti da tutti i progetti in un nuovo modello di pericolositá.

Dopo il primo anno, il CdR aveva raccomandato di chiudere i Tasks 2 and 3, anche per ovviare alla scarsa partecipazione di alcune UR.

Final evaluation

S1 is recognized to have met most of its objectives and in this sense it can be qualified as a success, even if there are questions about certain technical details. To some degree this may be the result of the fact that this project was in effect a continuation of the project to derive a new seismic hazard map for Italy that was carried out from 2002 to 2004. There is little doubt that this project now represents the state-of-the-art in seismic hazard mapping in Europe and the coordinators and their associated researchers are to be congratulated for the outstanding work that has been produced.

The activities conducted under S1 should continue, both those devoted to prepare products for public use and those geared to improve the hazard, and should be secured and strengthened in the future under a more stable institutional framework.

Discussion with the project coordinators and open points

A serious criticism that the CdR has regards the fact that although some papers on particular aspects of the work have appeared in the technical literature, a major paper on the new seismic hazard map has yet to be submitted to an international peer-reviewed journal. Since this project in effect could be considered as a prototype for the next generation of seismic hazard maps throughout Europe, and possibly also the kernel for a new pan-European or even pan-Mediterranean seismic hazard map, the CdR believes that there is an onus on the coordinators to submit such a paper to a suitable journal at the earliest possible convenience. The CdR was informed that a manuscript is ready and will be submitted "by the end of the year", but we believe that this is already seriously overdue and would encourage submission at the very earliest possible date.

The coordinators of S1 reported that a constraint on the project was the requirement of compatibility/consistency with MPS04, adopting the same logic-tree approach although this was not actually viewed as a problem in itself. However, for this reason, the main deliverable was not studied in great depth: a project focused on producing maps rather than carrying out research. However, this gave the coordinators ideas for how to go forward in future projects, using new data and input, including alternative seismic zonations. In D5, some tests were carried out using time-dependent models and alternative zonations. The coordinators also report that there was a strong interaction with DPC regarding the progress of the project.

A concern expressed by the CdR was whether INGV now had the internal capacity to continue the work of elaborating and updating the seismic hazard maps, given that this has not been a component of its traditional mission but rather a new task to which INGV has turned its attention since 2002. The CdR has been consistently very impressed by the way Max Stucchi and his team have responded to this challenge and the excellent work that has been produced as a result, but the team has always appeared somewhat fragile since it has depended on a very small number of individuals who became experts in the field of PSHA. The departure of Dr Valentina Montaldo to the USA brought home just how fragile the team was and this has highlighted the need to build a larger and more sustainable seismic hazard group within INGV for the continuation of this work. In annex to the report, INGV make statements to the effect that beyond this point it should no longer be the remit of INGV to provide day-to-day data needs, which is the role they have played during the last few years. There is going to be a new building code; a group is needed, combining Italian and European expertise (and possibly from beyond Europe as well) for the continuation of the work and updating hazard maps.

The CdR had some concerns regarding the generation of seismic hazard maps in terms of intensity, and in particular their comparison – after transformation using empirical relationships between intensity and PGA – with the original MPS04 map. According to the project coordinators, the primary objective of the intensity-based hazard maps was to provide a sanity check on the PGA-based hazard map, requiring empirical conversion of the intensity values to PGA. The view was expressed that more has been asked of the intensity data and intensity prediction models than such uncertain and particular data can actually be expected to provide. The CdR is unconvinced that the procedures followed could actually provide a check on the PGA-based maps since the uncertainties involved in the transformation are so large and it is recommended that caution be exercised in drawing conclusions on this basis.

An interesting point, in passing, is that it was noted that for intensity, regional differences were not found (in contrast to PGA).

The CdR also believes that the logic-tree analysis may not have captured the full range of epistemic uncertainty. This concern arises from the sensitivity exercise conducted for northeast Italy, in which the use of three different models for the seismic sources produced very significantly different hazard maps for the region, whereas such a high degree of variation is not seen in the national study. The coordinators responded that the main contribution to the uncertainty comes from the attenuation equations, for which the uncertainty is greater in areas of lower seismicity (such as Bari as opposed to Campobasso).

Another rather serious concern is with regard to the unusual statistics of the hazard, whereby the median seems to be skewed to higher percentiles and spread of uncertainty appears to reduce with the annual exceedance frequency. This was put to the coordinators, who responded that the hazard curves have been calculated from the statistics of the ground motion at given exceedance frequencies, whereas standard practice is to calculate the statistics on the exceedance frequencies for a fixed ground-motion level. The CdR recommends that the correct statistics be calculated in order to produce standard hazard curves and thereby see if the rather unusual features still persist. This particular example highlights again the need for a strong and stable group that has enough time and manpower to analyze in detail the numerous results coming out of S1.

As noted on previous occasions, and throughout this report, there is very little consistency with regards to attenuation equations used in the different projects. Since S1 is effectively the point at which the output from the other projects is condensed and applied, one might expect this project to establish the norm with regards to such input parameters. The coordinators were asked about this issue and to what extent attempts had been made to achieve some degree of compatibility across the projects in terms of attenuation functions. The coordinators of S1 reported that a coordinating work group was established following the first evaluation meeting to achieve integration of the attenuation models, but it barely met and was not effective at all. For many people, the projects were independent rather than parts of an overall project and hence each was free to choose the attenuation model that was most convenient to their own sub-project. A project specifically on the issue of attenuation models would be scientifically feasible but ineffective since individual researchers cannot be obliged to adopt a particular model.

In terms of the de-aggregation web site, the CdR suggested that as a possible improvement beyond recent correction for distance metrics, the site could show the epsilon contribution as well as magnitude-distance pairs. It is also suggested that an additional future improvement would be to develop the capacity to also provide time-histories tied to the dominant earthquake scenarios.

The coordinators expressed the view that there should have been more interaction with CdR, since in the project for the hazard map (MPS04) this interaction it was very useful. It was not clear, however, whether the CdR's primary function was advisory or review. The S1 coordinators also reported that it would have been useful to have more frequent and/or more intense interaction independently from the other projects. There was bias from outset in so much as the comments were nearly always referring to the future; the main task was to supply data, which was an enormous undertaking and left very little time for consideration of the results, etc.

In terms of overall coordination of the projects S1 to S5, the S1 coordinators reported that this resided with the committee comprising the 10 coordinators of the individual projects, but this group never actually met during the last two years to review the overall coordination of the projects.

Progetto S2 - Sismogenesi e probabilità dei forti terremoti in Italia

Coord. D. Slejko e G. Valensise

Original description and evaluation

Gli scopi di questo progetto sono l'individuazione delle sorgenti sismiche che possono essere sede di possible forte attivitá futura e la quantificazione probabilistica di questa occorrenza.

Il progetto ha essenzialmente tre componenti. La prima componente (T1+T2) riguarda l'acquisizione e omogeneizzazione di conoscenze relative alle zone sismogenetiche in Italia (faglie individuali e aree sorgente). La seconda componente (T3) si focalizza sull'utilizzo del dato geodetico per caratterizzare lo strain-rate a breve periodo associato alle sorgenti sismiche. La terza componente (T4) mira a caratterizzare la probabilitá di occorrenza dei terremoti nelle sorgenti sismiche utilizzando varie tecniche (di cui alcune non ancora stabilizzate).

Il CR aveva sottolineato l'importanza delle linee di ricerca proposte, ed espresso altresí preoccupazione per la frammentazione delle attività e delle UR nei Tasks 2-4, nonchè per la difficultà di arrivare a risultati applicativi nell'ambito di un programma ristretto.

Final evaluation

S2 has been a large and ambitious process with quite distinct (and rather independent) goals, from data collection (T2) and finalized applications (T1) to purely academic research (T3 and T4). The CdR compliments the Coordinators and all the RUs for having worked to develop a unifying vision of where, how and when large earthquakes took place in the past and may take place in the future. The very large number of high-quality journal papers published by S2 is indicative of the scientific quality achieved by the various URs. Nonetheless, the CdR confirms its reservations on the state of maturity of many of the produced results and more generally on the overall process of validation of scientific results for use in application products.

Discussion with the project coordinators and open points

The Coordinators emphasized their difficulties to handle at times the project, due to the large number of RUs, their relative independence, and the focus on their own targets, which made difficult to keep the overall framework and objectives of the whole project S2.

Task 1 *(Organizing a unitary geo-referenced system for the description of seismogenic processes)* has been mainly dedicated to successive implementations of the DISS database. Preliminary releases were made available for various applications within the whole program "Progetti Sismologici". The CdR notes also that (i) a new version of Boxer has been developed and extensively tested, (ii) EMMA database has been implemented with more than 3,300 focal mechanisms gathered from literature. The CdR congratulates the coordinators and their associated researchers for DISS and EMMA which represents the most advanced database for seismogenic sources developed in a European seismotectonic context. A "final" version of DISS Database (v3.0.4) is planned to be made available through the web in September 2007; this version should include most of the findings from Task 2.

The CdR expresses its concern about the validation process used to qualify and include data within the DISS database. In fact, any new investigation of seismogenic sources has (and will) produced highly heterogeneous results and it is not clear how these are (will be) integrated into

the DISS database. All too often, new investigations contrast with past investigations, or different teams working in the same areas arrive to different and opposite conclusions. The CdR stresses the dire need for stringent procedures of transparency and acceptance when qualifying scientific results that will be used for hazard zonation.

The CdR is well aware that the DISS team is indeed working to achieve this transparency. This issue is tackled by comparing the kinematic consistency between geological data with other independent datasets (seismic, GPS,...). Moreover, a conceptual model is developed to assess the quality of the database entries by scoring both epistemic and stochastic uncertainties, the first being inherent with the declaration of existence of a seismogenic source, the second being associated with its characterization. It is expected that this method provides an effective way to compare different database records, to address areas of lack of knowledge, and to perform sensitivity tests to the applications that use the data. Nevertheless, the CdR recommends the formal constitution of an external review panel to help DISS reconcile and integrate the various elements obtained by different groups working in different regions, and identify the focus areas where further work is required.

Task 2 *(Defining the location and geometry of the main seismogenic sources in the Italian peninsula*) involved many RUs working mostly independently on a large number of sites. T2 gathered a significant number of new observations and made new important inferences on seismogenic processes, which are directly suitable for (i) the seismogenic characterization of the Italian peninsula and (ii) the updating of the reference database DISS. The CdR congratulates the task coordinator and the involved RUs for the quality of the collected data, the importance of the results obtained in terms of seismogenic implications and the overall consistency of the final reports.

However, the Coordinators underlined that, with respect to the final goal of T2 (implementing the reference database DISS), not all the RUs made the difference between a study of active faulting and a study for the identification of a seismogenic source (mapping in great detail the complexity of surface processes versus identifying the full set of geological occurrences associated with the activity of a large fault). The Coordinators noted that, with regards to the first approach, DPC might conclude that the study of active faults is a long endeavor which should be supported indefinitely, but that the DPC support should not cover basic scientific investigations which would sooner or later be done with funding from other sources. The CdR agrees with the Coordinators and recommends focusing in future programs on the second approach, concentrating the funds on a reduced number of RUs interacting far more extensively on specific strategic targets and on the overall interpretation and consistency of the results. This integration of the working group should not be only performed through meetings, but also through coordinated investigations on specific faults to (i) prove or disprove their existence and/or activity and (ii) characterize their capabilities with a full set of data obtained with crossed-checked methodologies and techniques.

With respect to the comment already made for Task 1, the CdR emphasizes the need for transparent validation and acceptance procedures of the results of new investigations, which should go beyond the normal publication of scientific results. The CdR for example noted that several of the largest historical earthquakes of Italy are now interpreted to have been the result of complex multiple-segments ruptures. The CdR inquired then on the procedure to go from geological information to seismic hazard input and on the confidence in the segmentation implied by the different sources. According to the Coordinator, the models are based on the assumption of future earthquakes breaking on the same rupture patterns as previous earthquakes (i.e. characteristic events), a model which is hardly compatible with multi-segments ruptures. The CdR used this as example to illustrate how the interpretation

of the data may be influenced by personal beliefs and models, and how a rigorous quality assurance procedure could strengthen the database.

Tsunami hazard assessment has been also carried out in T2 through both mapping of tsunami deposits in Sicily and Apulia and modeling Maximum Water Elevation on the coast of the peninsula induced by the most important tsunamigenic sources of the Mediterranean. This new research has been quite productive. The next logical step of that research would be (i) a deeper resolution analysis of this hazard for highly exposed coastal segments (ii) a collaboration with civil engineers community for developing vulnerability functions of building and (iii) an implementation of first-order damage scenario for the most exposed areas. This goal requires topographic and bathymetric data that apparently are not available along the whole Italian coast.

Task 3 *(Geophysical characterization of main seimogenic structures)* attempted to predict crustal velocities through a geodynamic model blending a large set of experimental data into a single deterministic scheme. A national mapping of geodetic strain rates has been produced. A Finite Elements Model based on a large variety of geologic and tectonic data has been developed (including fault geometries, the orientation of P and T axes from earthquake focal mechanisms, thermal, rheological and frictional properties of crustal rocks, the Moho depth, heat flow maps, and kinematics at the plate scale) in order to derive crustal velocities and strains and fault slip rates.

The CdR congratulates the task coordinator and the involved RUs for this innovative and multidisciplinary approach. Although still in an early stage, the modeling produced has already allowed the involved RUs to derive interesting inferences on the resolving power of the different datasets, providing important elements for the future planning of monitoring networks and campaigns. As anticipated by the CdR in the 1st year review, the research produced results of academic value, which show however that modeling might lead in the future to answer open questions in seismic hazard in Italy. The CdR restates its recommendation to strengthen future modeling efforts, to include all relevant national (and where needed international) expertise and to explore alternative modeling and bench-marking approaches, allowing to test variability analysis of the predictions at different scales (crustal velocities and strains and fault slip rates).

Task 4 *(Characterizing the behavior of seismogenic sources and assigning probabilities of activation)* attempted to parameterize the behavior of a given set of seismogenic sources by using the most updated results released within the project, and to assign each source a probability of generating a significant earthquake, in a time-dependent perspective. The scientific challenge of this task was high and the results can be generally classified as scientifically interesting, but not particularly robust or useful for seismic hazard calculations. The Coordinators failed to succeed in coordinating the work of the RUs toward a homogeneous set of cross-validated results. It remains difficult to assign probabilities to events on particular fault segments because at most 30-40% of the active faults are identified, hence the calculations are fundamentally flawed. In Italy, and probably in all of Europe, the prospects of assigning probabilities to individual faults remains doubtful indeed.

Following earlier recommendations, Task 4 has been re-designed into three items: occurrence of an impending earthquake based on instrumental seismological data, occurrence of a significant earthquake based on physical models, and occurrence of a significant earthquake based on statistical analysis of earthquake and fault data.

By contrast with Task 3, different and sometimes contradictory methods and techniques have been developed and applied, and the results obtained span a rather large range of

values. This fact has to be related to the actual difficulty to reconcile deformation/strain rate data from alternative sources, including geological, seismological and geodetic (GPS); taking into account that each covers a different time period and the assumption of stationarity in each of these periods may not be equally valid.

Another bias may be due to the postulate that future earthquakes necessary break on the same rupture patterns as previous earthquakes (i.e., there has been an assumption that these are characteristic events), which guides not only the time-dependent models of task 4, but also the segmentation of certain fault systems assessed based on historical seismicity. That is, for instance the case for north-eastern Italy.

The CdR recommends that such investigations be continued, but under the condition that the RUs work together to define the appropriate testing environment (i.e. CSEP), the rules for positive and negative validation, the common datasets and a logic-tree structure allowing to combine different models and approaches. Only then a meaningful comparison of different results will be possible. In addition, the CdR recommends that a testing period of 5 years be established, and that the models are mounted to run on continuous data for the whole period, in order to allow independent testing and validation in a controlled environment.

The coordinators expressed the view that inputs, comments and feedback from the CdR have been useful and many things have been changed / corrected all along the way although it has not always been possible to exhaustively respond. The S2 Coordinators reported that the advisory role of the CdR is important and it would have been more efficient and optimized if the CdR had been involved earlier in the project, i.e at the proposal stage. In fact, once a proposal is written and agreed, it is almost impossible to move or modify the research focus of individual RUs.

The S2 Coordinators also commented that the overall coordination of the projects S1 to S5 was done by the committee formed by the coordinators of the individual projects. The committee actually rarely met during the last two years and was not overly effective. Problems also arose because of the timing of the projects. In fact, all the work on source models, attenuation, scenarios, hazard maps, etc. had to be carried out in parallel, and, lacking a central and highly efficient mechanism for rapid updating of results based on new input, it sometimes resulted in incompatible end-products. Although DPC organized common ‘tables’ across projects, focusing on specific common topics (such as seismogenic sources, attenuation relationships, etc.), this cross-project coordination has not been effective, with few exceptions such as site effects.

Progetto S3 - Scenari di scuotimento in aree di interesse prioritario e/o strategico

Coord. F. Pacor e M. Mucciarelli

Original description and evaluation

Il progetto S3 si poneva come obiettivo generale il calcolo di scenari di scuotimento in alcune aree italiane nel caso di accadimento del terremoto massimo credibile (MCE).

I tasks proposti sono: 1. Scenari di scuotimento, 2. Effetti di sito, 3.-6. Scenari aree specifiche, 7. Interfacciamento con l'ingegneria e il DPC. Le aree prescelte per la validazione sono la zona Molise-Abruzzo danneggiata dalla sequenza iniziata il 31.10.2002 (M=5.6), il bresciano per l'evento del 24.11.2004 (M=5.2); le aree di previsione proposte sono i comuni di Gubbio e Potenza.

Il CdR aveva valutato il progetto come ben ideato, con una sequenza logica di progressione dei tasks e chiari obiettivi programmatici. La suddivisione del progetto in aree di validazione e aree di previsione era considerata un elemento molto positivo. Tuttavia, il CR aveva mantenuto riserve in tutte le fasi successive di valutazione, sull'apparente mancanza di collegamento con l'implementazione dei risultati di S3 in ambito ingegneristico.

Final evaluation

Project S3 met most of its goals, with results of high quality. It is clear that the capabilities of the RU's to define shaking scenarios and compute the associated ground motions, including site effects, improved very much, as the reports and peer-reviewed papers indicate.

Task 7, (Interface with the engineering community and DPD) however, can not be considered a complete success. In general, the results obtained by S3 are too complex to be used in practical loss-estimation applications. In spite of this, there were significant advances in establishing a common language with the engineering community and understanding its abilities and needs.

Discussion with the project coordinators and open points

Regarding the structure of project, the management structure was simple and the number of URs was in the whole appropriate to the research objectives of the project. This degree of success is due to the fact that the project Coordinators chose most of the RU's, with a clear idea of which tasks every RU should carry out . The working overall was effective, with very direct management structures.

In the opinion of the project coordinators, the main obstacle for making the results of the project useful and interesting was the interaction with the engineering community and the DPC. It was difficult to define and establish a common language and common points of interest.

This observation is not surprising for the CdR. It was clear from the beginning, and so was highlighted during the previous annual evaluation, that more weight was given in the project to understanding methods and to developing computational capabilities than the weight that was given to aspects concerning the practical applications of the results.

Therefore, from the beginning, greater interaction between the project and the engineering community would have been very useful to ensure the project success.

However, even the limited dialogue that was conducted with the engineering community proved to be very useful, for both sides, to start sharing a common language and to obtain insight into priorities and needs of the engineering community.

Another important issue is the distinction between how to characterize site effects for the purpose of constructing scenarios to evaluate potential damage to existing buildings and how to characterize site effects for the seismic design of new buildings. Although the techniques and approaches required in both cases are clearly different, it was difficult to transmit the correct ideas to the engineers. The distinction becomes particularly important where one encounters unusual site conditions and site effects that are not contemplated in the rather broad characterizations used for building-code purposes. From the outset it would have been very useful to have a dialogue between the scientific researchers (seismologists) and the end users (engineers) on this topic.

As it has been mentioned, the main goal of S3 was to develop the capabilities to compute realistic representations of ground motion during large seismic events, including source, trajectory and site effects. There were, undoubtedly, great advances in the developing of such capabilities. But, again, the relative lack of knowledge of the project coordinators about the needs and current abilities of the engineering community prevented the results obtained from being more useful in loss evaluation, even when the places chosen as test sites were selected on the basis of being locations for which vulnerability data were available. Some examples are the following:

- Many of the vulnerability relations currently applied in Italy are parametrized in terms of macroseismic intensity. Therefore, before being useful for loss estimation, the very detailed ground motion descriptions furnished by the project (time histories computed at many sites) should have to be translated into macroseismic intensity. This translation is, on one hand, full of uncertainties; on the other hand, it is a pity and a waste of resources to be obliged to summarize a very detailed ground acceleration time history into a very rough proxy, as macroseismic intensity. It is worth noting that, when working with macroseismic intensity, care must be taken in order not to include site effects twice in the loss computation
- Only for Potenza was there a full simulation from scenarios through to shaking through to damage estimation This was a case in which the engineers had the appropriate data and were prepared to participate in the project. The engineers in Potenza then selected sub-sets of the ground motions which later were used in the time-history analysis of generic models of medium-rise RC structures, which were not specific to Potenza. The exercise of testing generic building models with realistic extreme ground motions is, without any doubt, interesting. It also contributes to carry forward the risk-estimation capabilities of the engineers involved. However, the results are of academic interest but of limited practical use, since they do not constitute general Italian fragility curves, nor risk curves specific to Potenza.
- Some engineers are developing fragility curves to be used within the framework of an equivalent of HAZUS for Italy, in which spectral representations of the ground motions are enough to produce robust loss estimations. Project S3 was not looking in this direction but rather trying to provide more sophisticated seismic input to the engineering analysis of buildings. Again, these sophisticated descriptions might be unnecessarily complex for practical applications.

These examples point out the following conclusion: the degree of information required by the engineers from the seismologists depends, to a large degree, on the definition of the

vulnerability. Therefore, the complexity of the scenario results, to be of practical use, must be commensurate with the complexity of available risk-estimation methods.

Another concern of the CdR is whether the ground-motion simulation codes are producing the same degree of variability as found in recorded ground motions or not. In some cases, certain combinations of input parameters were rejected because they produced ground motions that were considered unrealistically high (PGA ~2g). This brings the following questions: How to select a specific realization of a set of simulated ground motions as the appropriate loss scenario? How to attach a return period to a specific realization of a set of simulated ground motions? How to account for simulation-to-simulation variability in a rational way? Will it be feasible, in the future, to carry out loss estimations with this approach? It would have been very useful to have at least partial answers to these questions as outputs from S3.

A very interesting result of the project was the following question, posed by Dr. Mucciarelli. When examining in detail an area of interest, like the locations chosen by S3, it is likely that the presence of conditions for extreme site effects would be discovered by field investigations. But this approach is very time and resource consuming. Are there ways, simple methods, by which extreme site effects can be discovered? Dr. Mucciarelli would recommend a project focusing on 100 randomly chosen localities in order to ascertain the probability of encountering unusual site-source combinations which lead to anomalously strong site amplifications. This discussion points once more to the need to accurately characterizing the statistical properties of earthquake scenarios.

A point of discussion with the CdR was also the skepticism of the S3 Coordinators towards advanced visualization tools, which may be used to show in 3D the full waveform fields (see for example the tools developed by SCEC, USGS and UCSD). The CdR maintains that efficient visualization allows a better understanding of characteristics of the wavefield which may go unnoticed in individual waveforms or spectra, and even more provide a very powerful tool to convey difficult concepts of site amplifications to authorities and general public. The CdR recommends that state-of-the-art visualizations be generated as soon as possible from the results of S3.

Progetto S4 - Stima dello scuotimento in tempo reale e quasi-reale per terremoti significativi in territorio nazionale

Coord. L. Malagnini e D. Spallarossa

Original description and evaluation

Lo scopo di questo progetto era di sviluppare i metodi per una rapida caratterizzazione del moto del suolo intorno alla faglia che lo ha generato, e piú generalmente la derivazione di parametri per caratterizzare la sorgente sismica e il campo di scuotimento per scopi di sorveglianza e allerta. I Tasks proposti sono:

1. Organizzazione, integrazione e scambio dati
2. Definizione di modelli crostali
3. Stima rapida delle caratteristiche della sorgente sismica, implementazione di ShakeMap
4. Caratterizzazione regionale del moto del suolo
5. Stima degli effetti di sito alle stazioni

Il CdR aveva valutato S4 come progetto importante, di chiaro utilizzo e beneficio per le attività di monitoraggio e allerta sismica dell'INGV e per DPC. Il CdR era rimasto favorevolmente impressionato dalla chiarezza e competenza della presentazione e soprattutto dalla mole di ricerca e dai significativi avanzamenti presentati.

Final evaluation

S4 rappresenta un importante passo avanti nello sviluppo di metodologie innovative e di prodotti per una caratterizzazione rapida e accurata di parametri sismici per attività di sorveglianaza e allerta. Lo sviluppo e l'applicazione di nuove metodologie di monitoraggio procede di pari passo con l'installazione delle nuove reti digitali e sta portando le procedure di sorveglianza e allerta sismica in Italia ai vertici Europei e mondiali. Questi sviluppi devono continuare in futuro, ed essere accompagnati da una piú efficace fase di implementazione operativa.

Discussion with the project coordinators and open points

In the view of the coordinators, most of the goals were achieved and the results are good. ShakeMaps are now available on the web, and moment tensor inversions have been automated.

Task 1 – information flux – suffered from the lack of access to real-time accelerometric data, as the real-time access to the RAN network of SM instruments operated by DPC, required for real-time products such as shakemaps, has not yet been achieved. For the future of this project as well as for the quality of the national monitoring, access to all real-time data is required as is the integration of the data into a single national centre.

The CdR considers the calibration tests presented so far as significant, but recommends that new data-assimilation methodologies be applied retroactively to the whole period for which high-quality waveform data are available, in order to obtain more precise calibrations and regressions, and ensure that new methodologies are validated on as large statistical datasets as possible.

Most important is a phase of "industrialization" of the software, to migrate from innovative, experimental software to robust operational tools embedded in the integrated earthquake monitoring system for Italy. Such transition will be ever more important in the future, as more technologies become mature to be added to the monitoring infrastructure, and it should accompany the successful development of all new methodologies. For example, the CdR was disappointed to learn that S4 has no plans to implement in operational applications the results of various tomography investigations financed under S4. In this sense, given more time S4 could develop more mature applications. Future projects in this domain will have to devote sufficient resources and time to ensure a successful implementation phase.

S4 needs to pay also more attention to ensure the integration and consistency of the many methodologies developed; for example, in ensuring that the ground-motion models used would be compatible or comparable, not only among the different projects, but even only within S4 (indeed, a coordination meeting was held in Trieste to discuss the coordination of this issue across the projects, but it was not followed further).

The CdR discussed with the coordinators the possibility of rendering the ShakeMap tools faster, in order to use them for alert and early warning. To this purpose, access to real-time data, but also a more effective implementation strategy, will be required.

When discussing the activities of the CdR, the S4 coordinators argued that more meetings and direct contacts with the CdR would have been beneficial to allow a more efficient feedback to the URs. The advisory role is useful but the CdR could also play a role in supporting the management of the project. Finally, the coordinators pointed out that early feedback at the beginning of the project would be very beneficial.

Progetto S5 - Definizione dell'input sismico sulla base degli spostamenti attesi

Coord. E. Faccioli e A. Rovelli

Original description and evaluation

Scopo del progetto era la definizione di un modello dell'azione sismica come spettro di risposta elastico di spostamento (SRS) adatto per la normativa sismica, e la creazione di mappe di pericolosità in termini di spostamento spettrale.

I seguenti Tasks specifici sono identificati:

1. Perfezionamento ed integrazioni del modello iniziale di riferimento per lo SRS
2. Valutazione dell'influenza di diverse forme di dissipazione sullo SRS; definizione di spettri di verifica per costruzioni monumentali
3. Introduzione di effetti near-field nel modello di riferimento
4. Attenuazione dello spostamento su basi osservazionali
5. Attenuazione dello spostamento – modellazioni numeriche
6. Mappe di pericolosità

Il CdR aveva considerato S5 un progetto importante e un avanzamento nel modo di assegnare i parametri di progetto nel futuro. Il progetto è ben ideato e ben strutturato, con un buon collegamento dei tasks e chiari obiettivi programmatici. Gli obiettivi apparivano realizzabili nell'ambito del progetto.

Final evaluation

The CdR judges S5 to have fulfilled all of its stated objectives and was probably the most efficient of all the projects in terms of the large amount of high-quality work produced for a relatively limited budget. Through interaction with the DPC, the results may well be included in the new version of the Italian seismic design code.

Discussion with the project coordinators and open points

The overview of the project expressed from the point of view of the coordinators was that this was an enjoyable experience and a lot of work. The project was organized on the smallest scale of all the projects, with very few research units (URs), and consequently a much lower budget. One consequence of the way in which S5 was organized was a very high degree of interaction amongst the URs, with all participants feeling involved in all aspects of the project. An example of this, which was beyond the originally foreseen scope, was the application of the S5 results to the DBELA technique for loss estimation developed by Dr. R Pinho and co-workers at Pavia. Another outcome of this was that the project led to a training component that may not have been envisaged at the outset. The limited number of URs was achieved by a brutal selection process.

The coordinators expressed the view that they would have benefited from more interaction and cross-links with some of the other projects would have been desirable; attempts were made to promote such interaction but the outcome was limited. It would also have been desirable to make the application to the entire country rather than a limited area. There was an interaction between S1 and S5, for which the same source zonation was employed. Closer

interaction with S2 would have been desirable but that project was too far away during the project period.

One concern of the CdR was the results of the project are not compatible with short-period (T < 2 seconds) spectral ordinates from project S1. The coordinators reported that this was mainly because of the use of different attenuation models in the two projects, with new project-specific equations being produced in S5 whereas S1 adopted existing national, European and regional equations. A recommendation by the coordinators, with which the CdR broadly agreed, would be to incorporate the new S5 equations (the latest version of which includes style-of-faulting) together with other equations, for updating of the seismic hazard map.

The CdR asked the coordinators about their views on European harmonization of seismic hazard mapping and code representations of seismic actions in light of their experience on the project. The main observation made by the coordinators was that at least within Italy, excluding very special locations such as Mount Etna, there is very little evidence to support the hypothesis of regional differences.

The coordinators considered the role of the CdR to be very significant, and stated that increased (i.e., more frequent) interaction would have been useful, including at the inception phase when the projects were being formulated.

The CdR noted with pleasure that this project has already resulted in a number of high-quality publications and that several others are currently in press or in preparation.

Progetto S6 – Banca dati accelerometrici

Project S6 covers the Italian strong-motion database, for which data were collected from various organizations (ENEA, ENEL and DPC) and then compiled into a single collection of Italian accelerograms. The records have been uniformly processed and uniform metadata have been determined for the records. Site investigations were carried out at a limited number of strong-motion recording stations, selected on the basis of having more than 5 records and/or which recorded large PGA values.

Interactive database http://itaca.mi.ingv.it