First-Semester Evaluation of the INGV-DPC Seismological Projects

By the International Evaluation Committee
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Overall project comments

The review panel considers the overall investment in research and product development associated with the S-projects to be of high scientific quality, and that the coordinators have shown, through their presentations, that they are pursuing high scientific standards. There is no doubt that many of the deliverables will be of direct use for DPC applications and also for the community at large.

The S-projects provide an appropriate balance between deliverables that will be of immediate use for DPC (many deliverables in S2, S3 and S4) and fundamental research focused on more long-term deliverables (such as those of S1 and S5). It is worth emphasizing, however, that near-term coordination among the projects will go a very long way toward facilitating the eventual use of results. The synergies that need to be initiated among the S-project community should revolve around fundamental issues of concern for DPC and future seismic hazard map computations. The whole S-community needs to feel part of this primary objective.

The review committee thus strongly encourages DPC to identify early on, if possible, the persons that will be in charge of coordinating future seismic hazard map computations so they can actively participate in transversal activities to insure coherent choices between S-projects today that will be key elements for future SHA calculations. The review committee strongly encourages the “Foreseen Projects Interactions” described in Table 1 of the project proposal. This interaction will help clarify the roles of each participant and the impact their work may have on the finalized project results. These interactions are also an opportunity to share and discuss the arguments behind divergent opinions on specific issues.

Based on the three-day presentations it appears that the following issues may require specific attention early on:

- homogenized instrumental and catalogue procedures,
- homogenized geodetic solutions,

- identification of suitable ground motion prediction equations for Italy (based on different intensity measures: PHGA, PVGA, PGV, PGD, intensity),
- site effect characterization procedures
- consideration of the uncertainties

Concerning more research-oriented issues, the S-projects involve a number of exploratory research topics with potential results that are in a very early stage of development. These should not be incorporated in future seismic hazard maps without proper quantifications of the uncertainties involved and clear identifications of the underlying assumptions. These include:

- time-dependant seismicity models based on a limited earthquake catalogue,
- physical earthquake simulators using the DISS3 database
- Incorporation into PSHA of synthetic probability density functions of ground motions based on a limited deterministic exploration of kinematic earthquake source parameter models (derived from DISS3 database).

This is not to say the above activities are not worthy of pursuit, but rather that expectations should be managed with respect to immediate usability.

To synergize the INGV-DPC community, which will help accelerate progress, the review committee suggests that a Workshop be held at the end of the first year (perhaps the first of an annual meeting). This Workshop would be an occasion to bring together the 5 Projects, leaders and participants alike to discuss and compare respective results with DPC objectives in mind. A suggestion for the Workshop would be for Project leaders of each S-project to briefly present for each Task

- Motivation
- Research
- State of advancement (Preliminary results)
- Expected deliverables, in particular those of use to DPC
- Anticipated impact for future seismic hazard assessments

It would be important to leave at least 50% time at these meetings for group discussions (rather than just a series of presentations). This would give everyone in the community an opportunity to comment on results and future directions, thereby making everyone feel engaged in the process. Also having a debate on one or more controversial topics, such as the characteristic earthquake hypothesis or the regionalization of attenuation relationships, would help keep things lively and generate a “buzz” at the meeting. Finally, having a poster session at night could facilitate socializing, especially among the younger crowd, which would help foster collaboration in a more organic or “bottom up” mode of development, which would nicely balance the “top down” mode where projects are instructed to coordinate.

Recommendation for each project

S1- project

The S1-project covers a wide spectrum of topics (instrumental and historical seismology, earthquake geology, and earthquake geodesy and neotectonics models) aimed at determining the seismic potential over the Italian territory.

The review committee underlines that this is the project which has the most participants, where highly controversial interpretations are anticipated, where internal cooperation and data exchange is most critical and where heated public debates are expected to take place.

The review committee encourages the coordinators to stimulate discussion and interaction. It is also suggested to consolidate the numerous deliverables into 2 or3 deliverables which are of direct use for the other projects (keeping the already proposed as they are)..

Three specific recommendations are suggested for the DISS3 developers, for the geodetic community, and for the seismological community as they appear, to a first order, as key elements for which increased synergy will benefit the S-community at large.

DISS3

The understanding of the review committee is that the present state of the DISS3 database, which is the reference database for the S-projects, contains surface faults (only a few) and many model faults deduced either on the basis of seismological interpretations (yellow boxes – Individual sources) or on the basis of expert opinion and interpretation based on different arguments (red polygons – Seismogenic areas).

The most important comment is that the DISS3 database is an excellent initiative that should be pursued. Reducing the uncertainty in slip-rate estimates, as announced by the coordinators, is one step in the right direction. However, given of the likely prominent use of this information in future hazard maps, it is also important to quantify other epistemic uncertainties such as geometry, styles of faulting, or even completely different, alternative representations for each seismogenic source or fault.

In addition, the review committee strongly encourages S1 participants to populate the DISS3 database, to the extent possible, with the information that was used to infer the existence of each source (e.g., paleoseismological data, river/marine terrace data, active anticlines, available maps of active faults). Ideally, end users would be able to visualize this information as a “surface layer”, but we recognize that this is a tall order with respect to actual implementation.

GEODESY

The important increase in the number of permanent GPS stations at national and regional scales will allow geoscientists to test different kinematic and rheological models throughout Italy in the very near future. However, in combining the different data sets over the Italian territory, it will be important to understand both the associated error and the influence of different methodological approaches. A more accurate quantification of the velocity field, including uncertainties, will enable modellers to distinguish between data driven and model driven results. In this respect, the review committee suggestisthat coordinators focus on data and methodological comparisons on regions where different geodetic measurement techniques are available, as for example in the Crotone Peninsula.

SEISMOLOGY

A reference catalogue containing both instrumental and historical seismicity will be a very valuable deliverable of this community. The review committee strongly encourages a critical

space-time analysis of this reference catalogue at the national scale, assorted with a quantification of the uncertainties involved which will allow defining the limits of such catalogues for use in statistical seismicity studies and models of seismic potential estimates. It is imperative that this be a prominent deliverable of S1.

S2 - project

This project is mainly focused on the development of a dynamical computer code for seismic hazard assessment and for pre-seismic and post-seismic use. It relies on the further development of an existing code, CRISIS, developed in UNAM. It is an ambitious project in that it requires anticipating the variety of data inputs and formats that may be produced in S1. A meeting to ensure format harmonisation between S1 and S2 is highly encouraged. The review committee also recommendss that CRISIS be verified using the PSHA test cases currently being implemented by Pacific Earthquake Engineering Research centre (PEER; Ned Field can help find details on this project, which has not yet been published).

The anticipated use for DPC of such a code concerns the classical approach with seismotectonic zones such as those defined in the previous project (ZS69). DPC may intend to rely on smoothed seismicity approaches with DISS3 sources as well. In this case, it must be underlined that assuming all M>5.5 seismicity can be attributed to DISS3 sources is making a very debatable assumption; for example it implies a better understanding than presently exists in California.

The review committee strongly encourages DPC users to actively participate in the development of this code in order to appreciate the underlying assumptions and to understand the limits of its applicability.

It is the opinion of the reviewers that the following are valuable initiatives, but not likely to produce usable results in the near future: 3D strong-motion simulations, which can't replace empirical GMPEs until the myriad modelling uncertainties can adequately be propagated; and time dependent earthquake forecasts, which remain controversial.

The reviewers underline the importance of critically analyzing the latest GMPE that have recently been produced by the NGA group. Some of the GMPE have evolved towards more and more complex parameterizations, which are in line with the type of detailed information that will be collected by S4. Moreover, the NGA effort was both exhaustive and heavily reviewed, so at the very least the project needs to have a justifiable rationalization for not using any one of these models. It may help to organize a meeting to discuss the applicability of each GMPE (including the NGAs) to the Italian territory. A similar meeting is suggested for the different intensity-based ground motion prediction equations, as one is used in S1 to compute the magnitude of historical earthquakes, another in S2 to predict intensities and yet another in S3 for the Shakemaps. Consideration of such intensity relationships is of particular relevance when it comes to using observed versus predicted intensity data as a way to validate" PSHA results.

The review committee also strongly encourages research on site and soil characterization, topographic effects, and basin effects, all of which may modify considerably the estimated "design" ground motion for buildings and infrastructures. S2 is in the right direction by including these issues in the implementation of the code. However, the knowledge at the present stage cannot permit a definitive answer and consequently it will be rather important to account for the large uncertainties; S2 participants should emphasize this point

S3 - project

This project is divided into two parts. One is the continuation of the existing Shakemap project and the second one is a new proposal to provide a quick estimate of earthquake source parameters and of their tsunamogenic potential for M>6 in the Mediterrenean sea and neighbouring areas.

The Shakemap project is now well underway and already implemented on the websites of the different data centres. The coordinators have set high standards of reliability, accuracy and robustness which should ensure a high quality product. Maps should become available within 20 to 30 minutes from the occurrence of the event.

The review committee underlines the importance of accompanying the maps with an estimate of the uncertainty in order to avoid misuse or misinterpretation by the media. The review panel encourages also common data processing methods for all data centres alike concerning the calculation of intensity measures (PGA, PGV, etc.) in particular concerning the filtering of the raw data which affects the high frequency peaks, for example.

Concerning site effects quantification, the review committee encourages exploring the use of Vs30 instead of the average Vs to the bed-rock and the use of the parameter basin depth which proved to be highly correlated with site response in California and elsewhere even at high frequency. This issue should be discussed in coordination with the S4-project team and maybe with the S2 as well.

The review committee stresses the need for project coordinators to pursue regionalisation schemes and at the same time encourages testing with different schemes and in particular with NGA GMPE. With respect to regionalisation of GMPE the review panel suggests considering the issue of intra- versus inter-event terms in the regression (see reference Abrahamson and Youngs BSSA, 1992 pp 505-510). Not accounting for this could lead to erroneous conclusion with respect to the need for regionalization.

The review committee suggests a closer cooperation with S2 and S4 especially for site characterisation and the selection of attenuation relationships.

The project coordinators have identified the following problems that the review panel agrees should be addressed:

- Direct availability to real-time data (to minimize possible points of failure after a large event). This issue will hopefully be resolved during the course of the project.
- WP5.5 Maregraph data – lack of contact with the data provider. The impact that the inaccessibility of this data will have on the project deliverables will be quantified at the next meeting.

S4 - project

This is the continuation of the existing ITACA strong ground motion database project developed in the previous DPC agreement. This project will soon release the beta version on the website. This is a very important contribution to the end-users community in terms of providing strong-motion records from past and future earthquakes.

We note that the project coordinators indicated a need for additional funding for the following actions:

- 8-10 stations could benefit from in-hole tests
- REXEL interface (quantification of budget ongoing) –requested by the engineering community
- Develop specific tools to automatically update header files (quantification needs to be made)

The last bullet item is particularly important. It consists in updating the monographs that describe the station characteristics. Given the huge amount of work, and therefore resources, involved in developing a monograph for each site, the review committee suggests placing this information in an extensible, relational database (from which monograph-type pdf files could be generated automatically). Furthermore, it may be worthwhile exploring the possibility of a password-protected WIKI-type interface (allowing sanctioned participants to enter or edit data from a web browser). This would enable the managers to employ a broader group in developing this important resource, with all the security and cross-checking that this task entails..

The coordinators identified some problems with the reliability of existing Vs data profiles at certain sites and therefore requested additional in-hole tests. It is suggested to cover in the future all stations with full documentation (building and site-soil characterisation with Vs profile $G - \gamma - D$ curves for the main soil formations etc). This will make the ITACA network one of the most high quality and credible in the world. It will also improve considerably the seismic code with respect to site and soil categories and associated response and demand spectra.

The review committee suggests that ITACA be referenced in the COSMOS and other databases. We would also like to know what the plans are for any coordination with existing European projects (NEIRES for example) in view of long-term maintenance.

The review committee encourages coordination of this project with S3 concerning site-classification schemes.

S5 - project

This project is aimed at supporting ongoing research on selected Italian test sites where advance monitoring geophysical networks are available or under construction. The project deliverables are now mainly focused at providing a better definition of seismic rates and improving the understanding of earthquake generation processes. DPC's contribution to this project amounts to 10% of the overall costs.

Results from the three sites will be of direct use to S1-project deliverables, as they will improve seismogenic source definitions and seismogenic area seismic potential estimates as well as feed into the reference databases of catalogues and 3D crustal models. The review committee encourages interaction with S1 and S4, as the results from these three sites will benefit from the larger scale perspectives that will be discussed in S1 and S4 concerning seismicity rates, accelerometric information, geodetic velocity solutions, focal mechanism computations, etc..