Fault2SHA - ESC Working group

Towards a unified representation and a shared methodological approach for the modelling of faults and uncertainties in hazard studies

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The objective of the Fault2SHA ESC Working Group is to build a community of active fault-related researchers to exchange data, tools and ideas on how to best model faults in seismic hazard assessment in specific tectonic contexts.
After a first meeting in Paris in 2014, a second one in Chieti in 2015 and thematic sessions at international conferences in 2016 (https://sites.google.com/site/linkingfaultpsha/) the WG was officially established inside the European Seismological Commission during the 2016 General Assembly (http://www.esc-web.org/working-groups.html); being a non-funded entity, the WG acts on voluntary basis so that the community involved in fault-PSHA activities, made of data providers on the one hand, data modellers and data users on the other hand, can share their needs and methodological approaches. Given the numerous Fault2SHA members that have signed-up this year (>60) an Executive Committee Ballot was set-up. Results will be announced at the meeting.

Snapshot of the Fault2SHA community gathered in Barcelonnette (F) for the Workshop "Role of scaling laws and fault interaction"; the proceedings are online available at https://fault2shablog.wordpress.com/

Fault2SHA WG Milestones

- The first: achieved in 2016, with a short paper (Peruzza et al., 2016) of aftershock probabilistic seismic hazard (APSHA) based on fault information gathered and exchanged by many European teams throughout a discussion forum (https://www.tapatalk.com/groups/earthquake2016/) in the wake of the Amatrice, 2016 M6.0 earthquake.
- The second: achieved in 2017 with the organization of an international workshop in Barcelonette, France (https://fault2shablog.wordpress.com/). Fifty participants from around the world gathered to debate and exchange their data collections and approaches developed for computing fault related seismic hazard. Workshop materials are available online.
- The third: ongoing - preparation of a special issue in NHESS journal (http://www.nat-hazards-earth-syst-sci.net/special_issue864.html) with 11 papers presently under discussion and review.

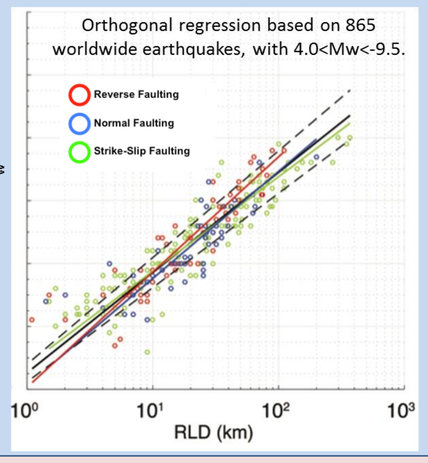
Fault2SHA WG preliminary Results of ongoing Actions

A1: Updating scaling relationships

R1:

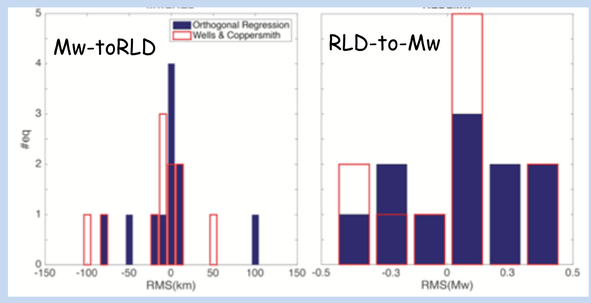
- ❑ orthogonal and linear regressions perform equally well
- ❑ WC94 is still valid
- ❑ However, there is a need to have an orthogonal regressions in seismic hazard analysis in order to have no-discrepancies in the loop "from RLD-to-Mw and from Mw-to-RLD"

Pace et al. (work in progress)



Testing new orthogonal and classical linear W&C94 RLDtoMw regressions using 12 recent earthquakes not included in the regressions .

date	location	Mw	RLD (km)
14/11/16	New Zealand	7.5	180
30/10/16	Norcia	6.5	30
24/08/16	Amatrice	6	21
15/04/16	Kunamoto (Japan)	7	41
15/04/16	Ecuador	7.8	220
17/11/15	Grecia	6.5	23
17/09/15	Cile	8.3	240
03/07/15	China (Pishan)	6.4	40
03/08/14	China (Ludian)	6.5	16
24/09/13	Pakistan	7.8	245
22/07/13	China (Gansu)	6.6	34
06/04/09	L'Aquila (Italy)	6.3	20



A2: comparing rupture scenario models in complex fault systems (e.g. aleatory vs epistemic exploration)

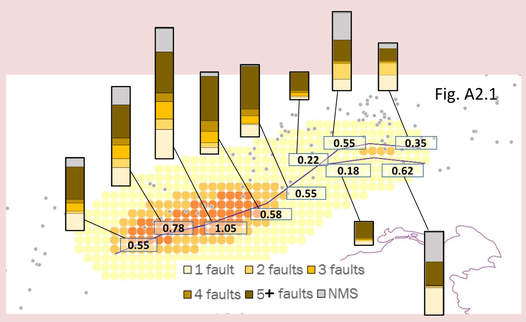
R2.1: In the aleatory approach (Fig.A2.1) the slip-rate budget of each segment is maintained. Colors correspond to the kind of multi-segment rupture the moment budget is spent on. Size of the bar depends of the size of the slip-rate budget of the fault. **In the epistemic approach** (Fig.A2.2) for each possible rupture, average slip rates are computed before computing moment rate budget of faults based on the FiSH procedure (Pace et al., 2016). The difference map (Fig.A2.3) shows that, in spite of an identical definition of fault geometries and slip rates important differences in hazard levels are computed which are due to the different ways the slip rate budget is computed in the two methodologies

Hazard map
10% over 50 years
(475 yr return period)

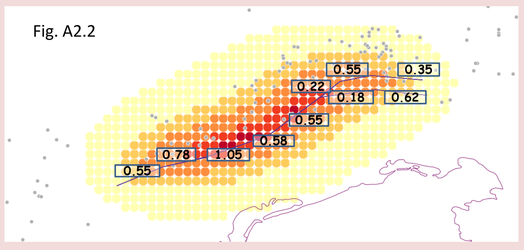
PGA scale (g)
0.05 - 0.1
0.1 - 0.15
0.15 - 0.2
0.2 - 0.25
> 0.25

Calculation run with OpenQuake

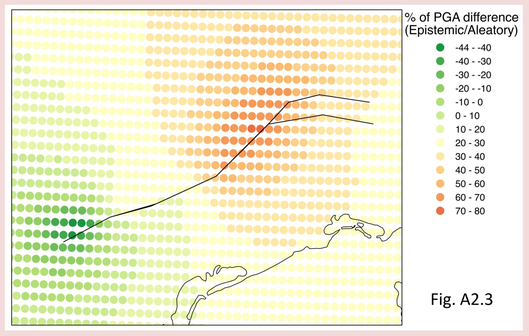
Chartier et al. aleatory approach (submitted)



Valentini et al epistemic approach (work in progress)



% epistemic / aleatory)



Same input data: a fault system composed of 10 segments and associated slip rates (numbers in boxes are in cm/y); any combination of adjacent segments is a possible earthquake rupture. In this case 49 possible ruptures are considered

R2.2: the representation of faults in SHA should reflect the heterogeneities of geologist's and seismologist's points of view. This heterogeneity should in turn be expressed in earthquake rupture forecasts. It is crucial to appreciate in each approach how and why originally detailed seismological/geological/geodetic data is simplified and reduced in fault-SHA models.
R2.3: next step (planned for 2018) : setting up common fault-databases for the purpose of testing aleatory vs epistemic rupture scenario approaches as well as background approaches in focused areas in Spain and Italy.

A3: testing physics-based approaches (e.g. RSQSim platform and complex fault modelling based on a set of slip measurements obtained from cumulative offsets along the central Apennines normal fault system [Faure Walker et al., 2010]. The model **(Shaw et al. submitted)** has the capability to not only model cumulative slip and fault interactions at the geological scale, but also individual ruptures on the dynamic earthquake timescale. Based on a judicious set of approximations of the rate-and-state friction equations, the model events produce complex clustered sequences of events in space and time. The resulting synthetic sequences of events can then be used as tools to improve seismic hazard estimates.

A4 : testing the role of visco-elastic relaxation models on the central Appenines earthquake sequences (ongoing work by Verdecchia et al.)