PROJECT APPLICATION

The deadline for receipt of applications by the Secretary-General and the President of the sponsoring Commission is **January 31st of the year in which funding is requested**. Please read the funding guidelines on the INQUA webpage before completing this document. We encourage you to consult the appropriate Commission President at an early stage in the development of your proposal or if you have any queries about eligibility. Please enter information in the allocated boxes, taking note of the length restrictions, and add rows to tables as required.

DETAILS

1. Year of application

2016

2. Name of primary Commission supporting your proposal

TERPRO: Terrestrial Processes, Deposits and History

3. Name of International Focus Group supporting your proposal

Earthquake Geology and Seismic Hazards (EGSHaz)

4. Project title

Geological Earthquake Mapping of recent, historical and paleoseismic events: Quaternary Geology for Seismic Hazard Analyses (GEMAP).

5. Leader(s) (All communications will take place by email unless specifically requested otherwise, in which case a fax number should be supplied.)

Name	Mailing address	Email address

Ioannis Papanikolaou	Geology – Mineralogy Laboratory, Department of Natural Resources Management and Agricultural Engineering, Agricultural University of Athens, 75 Iera Odos Str., Athens, Greece.	i.pap@aua.gr
Pablo G. Silva	USAL. Departamento de Geología, Universidad de Salamanca. Escuela Politécnica Superior de Ávila, C/Hornos Caleros, 50. 05003- Ávila, Spain	pgsilva@usal.es
Luca Guerrieri	ISPRA Istituto Superiore per la Protezione e la Ricerca Ambientale, Servizio Geologico d'Italia, Via Brancati 48 00144. Roma, Italy.	luca.guerrieri@isprambiente.it
Gerald Roberts	Department of Earth Sciences, Birkbeck College, University of London, Room 610D, 6th floor, Malet Street, Bloomsbury, WC1E 7HX, London, UK	gerald.roberts@ucl.ac.uk
Klaus Reicherter	Department of Neotectonics and Natural Hazards, RWTH Aachen University, Lochnerstrasse 4-20, D - 52056 Aachen	k.reicherter@nug.rwth-aachen.de
Petra Štěpančíková	Institute of Rock Structure and Mechanics, Academy of Sciences of the Czech Republic, Dpt. Neotectonics and Thermochronology, V Holešovičkách 41, Prague 8, 182 09, Czech Republic	stepancikova@irsm.cas.cz
Christoph Grützner	Bullard Labs; Department of Earth Sciences, University of Cambridge, Madingley Rise, Madingley Road, CB3 0EZ Cambridge, UK	chg39@cam.ac.uk
Richard Koehler	Mackay School of Earth Science and Engineering, University of Nevada, 1664 North Virginia Street, MS 178, Reno, NV 89557, US	rkoehler@unr.edu

6. **Confirmed international participation.** Please give name and affiliation, and indicate if the participant is a graduate student (PhD), early-career researcher (ECR), developing-country researcher (DCR) or senior scientist (SS), using the table below). Please add rows to this table as necessary!

Name	Institute	Country	Role	Status (PhD, ECR, DCR, SS)	To receive INQUA funding (yes/no)
Dr. Joanna Faure Walker	IRDR - Institute for Risk & Disaster Reduction	United Kingdom	Task 3	SS	no
Dr. Sarah Boulton	Faculty of Science and Engineering, Plymouth University	United Kingdom	Task 1	SS	no
Prof. Dimitrios Papanikolaou	Department of Geology and Geoenvironment, National and Kapodistrian University of Athens	Greece	Task 1	SS	no
Prof. Efthimios Lekkas	Department of Geology and Geoenvironment, National and Kapodistrian University of Athens	Greece	Task 4	SS	no
Prof. Spyros Pavlides	Department of Geology, Aristotle University of Thessaloniki	Greece	Task 1	SS	no
Prof. Ioannis Koukouvelas	Department of Geology, University of Patras	Greece	Task 1	SS	no
Prof. Javed Malik	Indian Institute of Technology Kanpur	India	Task 1	SS	no
Dr. Sotiris Kokkalas	Department of Geology, University of Patras	Greece	Task 2	SS	no
Dr. Alexandros Chatzipetros	Department of Geology, Aristotle University of Thessaloniki	Greece	Task 2	SS	no
Dr. Emmanuel Vassilakis	Department of Geology and Geoenvironment, National and Kapodistrian University of Athens	Greece	Task 1	SS	no

Dr. George Papathanassiou	Department of Geology, Aristotle University of Thessaloniki	Greece	Task 4	SS	no
Prof. Luigi Ferranti	Dipartimento di Scienze della Terra, Università di Napoli "Federico II"	Italy	Task 1	SS	no
Dr. Francesco Visini	INGV	Italy	Task 3	ECR	yes
Prof. Paolo Boncio	Univ. Chieti - Pescara	Italy	Task 1	SS	no
Dr. Raúl Pérez -Lopez	Spanish Geol. Survey (IGME)	Spain	Task 4	SS	no
Dr. Salvatore Barba	Istituto Nazionale di Geofisica e Vulcanologia, Sezione di Roma 1	Italy	Task 1	SS	no
Dr. Valerio Comerci	Italian Geol. Survey (ISPRA)	Italy	Task 1	SS	no
Dr. Sabina Porfido	CNR -IAMC	Italy	Task 4	SS	no
Dr. Rodriguez - Pascua Miguel A.	Spanish Geol. Survey (IGME)	Spain	Task 3	SS	no
Dr. Michalis Foumelis	European Space Agency	Italy	Task 4	SS	no
Dr. Silke Mechenrich	Institute of Geology and Mineralogy, University of Cologne	Germany	Task 1	ECR	yes
Dr. Thomas Manuel Fernandez - Steeger	RWTH Aachen University	Germany	Task 2	SS	no
Dr. Aicha Heddar	Centre de Recherche en Astronomie, Astrophysique et Géophysique	Algeria	Task 4	DCR	yes
Dr. Petr Špaček	Institute of Physics fo the Earth, Masaryk University in Brno	Czech Republic	Task 1	SS	no
Sascha Schneiderwind	RWTH Aachen University	Germany	Task 2	PhD	yes
Jack Mason	RWTH Aachen University	Germany	Task 2	PhD	yes

Aggelos Pallikarakis	Mineralogy – Geology Laboratory, Agricultural University of Athens	Greece	Task 1	PhD	yes
Georgios Deligiannakis	Mineralogy – Geology Laboratory, Agricultural University of Athens	Greece	Task 3	PhD	yes
Marco Meschis	Department of Earth Sciences, Birkbeck College, University of London	United Kingdom	Task 2	PhD	yes
Jennifer Robertson	Department of Earth Sciences, Birkbeck College, University of London	United Kingdom	Task 2	PhD	yes
Zoe Watson	Institute for Risk and Disaster Reduction, University College London	United Kingdom	Task 2	PhD	yes
Luke Wedmore	Institute for Risk and Disaster Reduction, University College London	United Kingdom	Task 3	PhD	yes
Francesco Iezzi	Department of Earth Sciences, Birkbeck College, University of London,	United Kingdom	Task 1	PhD	yes
Francesca Ferrario	Dipartimento di Scienza e Alta Tecnologia, Università dell`Insubria	Italy	Task 1	ECR	yes
Bojan Matos	Faculty of Mining, Geology and Oil Engineering, University of Zagreb	Croatia	Task 1	ECR	yes
Jakub Stemberk	Department of Neotectonics and Thermochronology, Institute of Rock Structure and Mechanics, Czech Academy of Sciences	Czech Republic	Task 1	PhD	yes
Michal Havaš	Department of Physical Geography and Geoecology, University of Ostrava	Czech Republic	Task 1	PhD	yes

Youcef Bouhadad	Earthquake Engineering Center (CGS)	Algeria	Task 3	DCR	yes
Asdani Soehaimi	Geological Agency of Indonesia	Indonesia	Task 3	DCR	yes
Mor Kanari	Tel Aviv University	Israel	Task 2	PhD	yes
Dr. Santiswarup Sahoo	Department of Geology, Utkal University,	India	Task 1	DCR	yes
Dr. Rosa Nappi	INGV	Italy	Task 4	SS	no
Dr. Maddalena Deluccia	INGV	Italy	Task 4	SS	no
Dr. Germana Gaudiosi	INGV	Italy	Task 4	SS	no
Dr. Giuliana Alessio	INGV	Italy	Task 4	SS	no
Ms. Asmita Mohanty	Indian Institute of Technology Kanpur	India	Task 1	PhD	yes
Mr. Frango C Johnson	Indian Institute of Technology Kanpur	India	Task 1	PhD	yes
Serena Forlano	Univ. Naples	Italy	Task 1	ECR	yes
Melania Meccariello	DiSTAR, University of Naples	Italy	Task 1	PhD	yes

7. Proposed overall duration (years or inter-congress period)

2016-2019

DESCRIPTION

1. General description. Please describe the background and long-term goals of the project in terms accessible to a non-specialist. If the application is successful, this paragraph will be used by the sponsoring Commission to advertise your activity on the website.

Traditional earthquake models based on historical seismicity can be affected by biases in the estimates of recurrences of larger earthquakes, that in turns, can lead to biased estimation of seismic hazard, in terms of expected magnitude and intensity distribution in constrained locations. This is the case even in regions where the completeness of historic earthquake catalogues exceeds 100 years for larger events Considering that the recurrence interval of individual faults ranges from a few hundred years to several thousands of years, the historical catalogues are generally too short to accurately represent the recurrence intervals of damaging earthquakes along active faults. The latter implies that the sample from the historical record is incomplete and that a large number of faults did not rupture during the completeness period of the historical record. Further uncertainties emerge due to inaccuracy of the epicentral localities, even for instrumentally recorded earthquakes. The errors in location can reach up to 50 km for the older events and up to 10 km for more recent ones. New Seismic Hazard Assessment methodologies tend to follow fault specific approaches where seismic sources are geologically constrained active faults. These fault specific approaches are used in order to address problems related to the incompleteness of historical records, to obtain higher spatial resolution, and to calculate realistic source locality distances, since seismic sources are very accurately located.
The main objective of the project will be the implementation of new methodologies for seismic hazard mapping that combines Earthquake Environmental Effects (EEEs) with fault specific seismic hazard assessment. Instead of the traditional seismic hazard maps, which are based on the seismicity records' spatial distribution of strong ground motions in terms of PGA or PGV, the new method takes into account EEEs, as described in the ESI-2007 scale. The modelled spatial distribution of EEEs in terms of the ESI-2007 scale follows the previous INQUA 0811 Project (A Global Catalogue and Mapping of Earthquake Environmental Effects), and the corresponding EEE Metrics Project (1229P - Parametrization Of Earthquake Environmental Effects: Relationships between source parameters and ESI-2007 Intensity for Modern, Historic, Ancient and Paleo Earthquakes). This methodology will be applied to highly populated seismically active regions (i.e. Attica Greece, Apennines, Italy and regions in Spain and Germany) and can be widely applied by national civil protection authorities to effectively constrain the hazardous areas. Earthquake catastrophe models used by the insurance industry will also benefit.
(*maximum half page)*

2. Justification for project. Please provide a justification of the need for the project. Please identify the benefits of this activity, both for individuals involved and the wider INQUA community.

Economic losses from natural hazards are out of control, according to the UN. 5 out of the 10 costliest events during 1980-2012 worldwide were earthquakes. Worldwide earthquake Cat Risk models are based on historical earthquake catalogues, with improvements implemented mostly in their statistical elaboration. The so called “surprising events”, which are earthquake events that occurred in areas of low hazard according to the traditional seismic hazard maps, represent the majority of unforeseen losses for the insurance companies. Under these circumstances, more accurate seismic hazard maps are needed for the improvement of the earthquake catastrophe models. The benefits of fault specific seismic hazard mapping have already activated the global insurance industry; especially in countries that earthquake hazard is predominant.

Fault specific approaches provide quantitative assessments as they measure fault slip rates and provide estimates of recurrence from geological data, providing a more reliable estimate of seismic hazard than that estimated using only the historical earthquake record (seismicity data). Geological data have the potential to extend the history of slip on a fault back many thousands of years, a time span that generally encompasses a large number of earthquake cycles and thus elucidates the long-term pattern of fault-slip. As a result, fault specific approaches are becoming very important for seismic hazard assessment, by providing quantitative assessments through measurement of geologically recorded slip on active faults, sampling much greater periods of time and providing a more reliable estimate of hazard than the historical earthquake record. In addition, geologic fault slip-rate data offer complete spatial coverage, providing higher spatial resolution than traditional seismic hazard maps based on historical/instrumental records. **Recent scientific studies indicate the effectiveness and need to use geological data in Seismic Hazard Assessment techniques**. These attempts are separate, published from different researchers worldwide, and are rapidly becoming the international standard of practice for developing seismic hazard maps. **The coordination of these scientific groups through a regularly scheduled communication among the researchers is one of the main scopes of this project and will facilitate the use of common methodologies with the ultimate goal of reducing exposure to seismic risk. Products that are expected to be generated from these meetings include improved integration of Quaternary geologic and paleoseismic data, incorporation of the** ESI-2007 Scale, **and generation of better seismic hazard maps for several regions with noticeable seismic risk including;** Attica (Greece), Apennines (Italy) and different regions in the Iberian Peninsula (SE Spain) and Central Europe (Germany, France, Austria).

Beside the fact that the proposed maps overpass the incompleteness of historic seismic catalogues for large events, they also integrate the ESI-2007 Scale. This is critical for the evaluation of Quaternary Geology and its role on ground motion amplification or attenuation, depending on the local soil conditions. This project is of broad interest not only for the IFG, but also for the INQUA community. The methods that we use to gather fault specific data are also applied in other former TERPRO IFGs and their successors, especially RAISIN and AEOMED, so that project co-operations and joint meetings/sessions are desirable. INQUA will profit from our project as we address a problem of extraordinary societal relevance. The outcomes will have a direct impact on seismic hazard assessment and are the fundaments for better disaster preparedness. This is especially crucial in densely populated and often coastal areas, and in developing countries.

(maximum 1 page)

3. Specific objectives. Please list the proposed concrete outcomes of the project.

- Locality specific shaking recurrence record. The proposed methodology results in seismic hazard maps that provide a locality-specific rather than source-specific shaking recurrence record. To this end, the recurrence record for intensities ≥ VII MSK can be attributed to each location of the map, taking into account all active faults that might affect a particular area. This approach is valuable in settings where more than one fault source exists so that each locality might experience damages from multiple faults.

- Long-term shaking record. The shaking record is represented in a more complete way than the historical/instrumental catalogue. The use of geological data in seismic hazard assessment extends the knowledge about the earthquake history of a fault to thousands of years, while historical and instrumental catalogues are mostly complete for less than 200 years for events M≥6.5. As a result, a large number of earthquake cycles are taken into account and the long-term pattern of fault-slip is elucidated.

- High spatial resolution. So far traditional seismic hazard maps are based on the assumption that historic and recorded earthquake epicenters can be spatially constrained in discrete rectangular shaped areas, within which the seismicity parameters remain the same. These areas are called seismogenic sources and usually cover several thousands of square kilometers. The use of geological data provides higher spatial resolution and calculates realistic source locality distances, since the seismic sources are very accurately located active faults. The accuracy of these maps increases with the use of 1:50.000 scale geological maps in order to model the intensity distribution for each earthquake scenario.

- ESI 2007 intensity scale incorporation. The spatial distribution of the modelled ground shaking provides a qualitative view of the maximum expected intensities, including the objective criteria of the Earthquake Environmental Effects. The conversion of fault throw rates into earthquake distribution along strike faults transforms the hazard map to a map of recurrence intervals and extracts a locality specific long-term earthquake recurrence record. In other words, this deterministic oriented procedure of the ESI-2007 Scale distribution is converted to a locality based probabilistic estimation of shaking recurrence.

- GIS based modelling procedure. Seismic hazard mapping is primarily based on the perception of the spatial distribution of hazard. Final products, such as high spatial resolution seismic hazard maps, are developed using complex GIS techniques. Separate active fault analyses already described in the literature will be elaborated and fault characteristics will be incorporated in a GIS database. This procedure supports the application of various GIS tools and techniques for the creation of the seismic hazard maps and seismic scenarios (i.e. ShakeMaps) recreating past and probable future events. This would benefit strategies of intervention soon after a future strong seismic event and/or recreate past seismic scenarios for historical or ancient seismic events from geological data (ESI-07). This last backfeeds and refines the primary databases used for the elaboration of seismic hazard maps. The GIS based method of seismic hazard mapping allows the permanent archival of the location of fault features and the geographic distribution of earthquake epicenters along strike. The procedure will be automated in order to simplify the whole mapping process. Existing tools will be combined in order to develop a new powerful tool that significantly reduces the time and inherent complexity in spatial analysis techniques, allowing a consistent reproduction of the desired map outcomes. Moreover, modifications regarding faults' activity, attenuation relationships and surface geology can be easily implemented, while a full overview of the errors and assumptions incorporated in seismic hazard mapping is possible. (*maximum 1 page)*

4. **Fit to remit of sponsoring Commission.** Please explain how the proposed project will enhance the activities of the sponsoring Commission and specifically how it contributes to the goals of the sponsoring IFG. Please explain how the IFG and the project will communicate and interact.

Earthquakes are one of the most destructive natural hazards worldwide. Economic losses and human casualties after catastrophic earthquake events are listed among the top most catastrophic events, according to the EM-DAT International Disaster Database and reinsurance industry's ratings. Moreover, insurance companies continue to face escalating losses and global capital flows have transformed the landscape of disaster risk, creating a new pile of toxic assets for businesses and governments that do not currently appear on balance. Unfortunately, major catastrophic earthquakes are usually characterized as "surprising events", illustrating the existing models failures for compensatory seismic hazard estimation. In the aftermath of catastrophic earthquake events the role of Quaternary Geology in ground motion distribution and Earthquake Environmental Effects are well documented. However, these effects are rarely incorporated in hazard models. Furthermore, it is evident that earthquakes are a global hazard affecting many different countries on active tectonic environments around the world. Thus, better and more easily applicable modelling of earthquake ground shaking and Earthquake Environmental Effects are critical products to reduce losses associated with earthquakes.

Under these circumstances, earthquake geology and seismic hazard assessment are emerging topics, attractive to many geoscientists worldwide, who will be highly interested to be involved in a relevant scientific project. Moreover, as from 2016, the PALACTE (Paleoseismology and active Tectonics) IFG has been renamed as EGSHaz (Earthquake Geology and Seismic Hazards), indicating the need to link Paleoseismology and Earthquake Geology with Seismic Hazard Assessment techniques.

This addresses one of our Commission's overarching goals, which is stated as follows: "TERPRO encourages the development of projects that link research on Quaternary continental environments and tectonics together with the mitigation of societal impacts from natural hazards, such as desertification, extreme climatic events, and earthquakes."

(*maximum 1 page*)

5. Detailed description of activity. Please give details of the proposed activity (or activities) including type of activity, where/when it will be carried out and who will be involved. Please identify (by name if possible) any people who will be funded by INQUA to participate in the activity. Please ensure that you describe BOTH the activities during the life of the activity and the specific things planned for the current year.

We propose to apply the following steps in well studied seismically active regions and geodynamic contexts:

1. Identification of Quaternary faults with historical to Holocene activity (on-fault records) covering return periods from 100 to 10,000 years for events M$\geq$ 6.5 ± 0.5 and Holocene paleoseismic records (off-fault records) covering return periods from 100 to 10000 years for events $\geq$ 5.5M ± 0.5 (Gerald Roberts, Klaus Reicherter, Petra Štěpančíková, Richard Koehler, Pablo G. Silva)

2. Extract slip-rates and the corresponding earthquake events for a specific time period (e.g. 15000±3000 years) (Richard Koehler, Gerald Roberts, Klaus Reicherter, Miguel A. Rodríguez-Pascua, Christoph Grützner)

3. Convert slip-rates into earthquake magnitudes, introduce isoseismals and implement attenuation laws for intensity mapping. Convert fault geometry and slip rates, and where possible historical and/or paleoseismological data associated to a fault, into a global budget of seismic moment released in a given time frame to derive time-independent or time-dependent earthquake rates for different magnitude frequency distribution models; introduce isoseismals and implement attenuation laws for intensity mapping (Ioannis Papanikolaou, Christoph Grützner, Francesco Visini)

4. Application of the ESI-07 Scale to the available EEEs (e.g. lacustrine seismites, paleoliquefaction features, slope movements, seismic landscapes, etc), in order to define the corresponding intensity zones and the potential spatial distribution of environmental damage. The final maps will display the spatial distribution of the ESI-07 epicentral and local intensities and their frequency during the last 15000±3000 years (Pablo G. Silva, Luca Guerrieri, Ioannis Papanikolaou)

As damages are directly related to the seismic intensity, these maps could include also the ground site effects (Quaternary deposits) and the topographic amplification of the strong ground motion. Seismic Scenarios for selected past events can be produced following the USGS ShakeMaps guidelines. The USGS ShakeMaps, or Instrumental Intensity Maps, combine instrumental measurements of ground shaking with information about local geology and earthquake location and magnitude, to estimate shaking variations throughout a geographic area. We suggest substituting the instrumental measurements by the paleoseismic records, expressed in terms of the ESI-07 local intensities. This way we will create PaleoShakeMaps (PSM), reverting the methodology used by the USGS, in order to provide ground motion intensity measures for past events.

(*maximum 2 pages*)

6. Workshop/meetings (dates and venues if known).

Workshop meeting in 2016 Aachen, Germany hosted by RWTH Aachen (Klaus Reicherter)

Workshop meeting in 2017 Athens, Greece hosted by Agricultural University of Athens (Ioannis Papanikolaou)

Workshop meetings for 2018 and 2019 will be performed in two of the following 4 sites, to be selected according to the funding availability from Senior Scientists and the outcome of several submitted research proposals:

London, UK, hosted by the University of London (Birkbeck and University College London) (Gerald Roberts/ Joanna Faure Walker)

Prague, Czech Republic, hosted by the Academy of Sciences (Petra Štěpančíková)

Madrid, Spain, hosted by the Universidad de Salamanca and IGME (Pablo G. Silva/ Raúl Pérez – Lopez/ Miguel A. Rodriguez - Pascua)

Rome, Italy, hosted by ISPRA, (Luca Guerrieri)

7. Inclusivity plan. Please give details of how the project will promote its activities, and seek to involve, e.g., early-career scientists and scientists working in low-GDP countries.

The promotion of the project’s activities will be obtained through project meetings which will take place in different countries and venues. The localities will be chosen under the criteria of ease of accessibility and of optimal spatial distribution, in an affordable way for the majority of the young students and early-career scientists, especially for those originating from developing countries. During these workshops, the project participants will act as lecturers, in order to transfer their expertise and up to date techniques in earthquake geology and seismic hazard mapping. Student workshop days will also be established, including lectures on the theoretical background of earthquake geology and paleoseismology and also practical GIS and fieldwork lessons.

In addition, to the project meetings, a scientific session will be organized annually in each of the IFG international workshops planned for 2017 in New Zealand, 2018 in Thessaloniki Greece and in 2019 in Dublin Ireland.

(maximum 1 page)

8. Anticipated scientific results. Please list the anticipated scientific outcomes of the project.

Project outcomes:

- Detailed digital maps of surface geology, categorized according to the average changes they cause to shaking intensity. These maps will also display the Quaternary formations so that intensity amplification is well constrained.

- Qualitative fault specific seismic hazard maps, showing the spatial distribution of the maximum expected intensities, without taking into account the recurrence intervals. These maps will display in detail all regions that were affected from strong ground motions, in terms of ESI-2007 Scale.

- Quantitative fault specific seismic hazard maps. These maps will show the estimated site specific recurrence for different intensities, thus incorporating all active faults that could affect the study areas of Attica (Greece), Central-Southern Apennines (Italy) and different regions in the Iberian Peninsula (Betic Cordillera, SE Spain) and central Europe (Germany, France and Austria).

- Integration of the ESI-2007 Scale in the modelling procedure. The final seismic hazard maps will display the modelled distribution of ESI-07 local intensities. For the first time the ESI-2007 Scale will be modelled and not only inferred from existing earthquake events.

- The fault specific seismic hazard maps will be evaluated and compared to the existing seismic hazard maps based on historic seismic catalogues.

(maximum 1 page)

9. Concrete outcomes. Please specify the likely concrete outcomes of the proposed activity.

- Empirical attenuation relationships for magnitude-intensity and attenuation, for the ESI-07 intensity scale.

- Introduction of the new fault specific seismic hazard mapping methodology, integrating VII – X intensity degrees of the ESI-07 intensity scale.

- ESI-07 based ShakeMaps for specific historic and ancient events.

- Qualitative and Quantitative Seismic hazard maps for proposed study areas and probable seismic scenarios for future events in the more active tectonic structures. Comparison between geological fault slip-rate seismic hazards maps and historical seismicity hazard maps.

- Young scientists training on the proposed seismic hazard mapping methodology through INQUA workshops and project meetings and integration of young researchers from developing countries.

- Publications as stated below.

(*maximum half page)*

10. Anticipated publications. (Project leaders are encouraged to publish project results in *Quaternary International.)*

- Empirical attenuation relationships for magnitude-intensity, for the ESI-07 intensity scale.
- Publication of the proposed methodologies (in addition to the existing publications, enhancement of the initial with the addition of ESI 2007, more intensities)
- Publication of new seismic hazard maps for the selected study areas
- Comparison between historical seismicity hazard maps and fault specific hazard maps
- We aim to publish one special volume in an international, peer-reviewed journal at the end of the intercongress period, probably based on the outcomes of the meeting that the IFG EGSHaz will organize in Thessaloniki in 2018. We aim for Quaternary International, but this remains to be decided later on.

11. Other initiatives addressing this area of science. Please provide details of any such activities and explain how the proposed project differs from or will enhance ongoing initiatives. Please indicate whether you have been in contact with these groups to discuss future synergies/interactions.

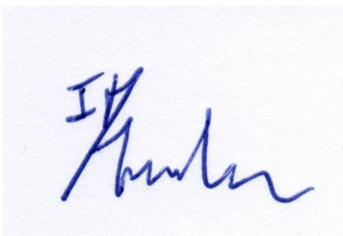
Development of new photogrammetry tools over the last several years (LiDAR, structure from motion) have introduced a new era in tectonic geomorphology and offer high special resolution for active fault mapping. In addition, advances in geochronology offer significant insights into the temporal resolution of the age of faulted deposits which allows higher accuracy and reliability in the assessment of fault slip rates and recurrence. This proposal uses remote sensing, GIS, trenching, geochronology and can indeed cooperate with existing groups within INQUA and as well as outside INQUA. Closest collaboration will be ensured with the other working group of the IFG EGSHaz, led-by Stéphane Baize et al.: SURface FAulting Catalogue – Earthquakes (SURFACE)

Another important outcome relates to the insurance industry and the insurance regulators. The existing Earthquake Catastrophe Models (EQ CAT Models) lack of reliability, as they are mostly or solely based on historic earthquake catalogues, thus failing to incorporate full seismic cycles of active faults or to identify existing faults that have not yet been activated. The modelled magnitudes are converted into intensity in terms of PGA, PGV or SA, which do not take into account the Earthquake Environmental Effects that largely control the damage distribution in case of an earthquake event. In case of the insurance industry, the characteristics of the existing earthquakes models have already caused huge economic losses, due to the “surprising events” that could have been otherwise identified and included in CAT models. The new EU “Solvency II” Directive for the insurance companies demands a more transparent and accurate hazard modelling that would help the insurance industry to reliably respond in the 99.5% of earthquake events. The proposed fault specific seismic hazard mapping is a potential input to EQ CAT Models, as it provides more reliable data on the seismic cycles of active faults and includes the soil conditions in the ground motion distribution.

The Private Insurance Supervision authority in Greece (the Bank of Greece) is already developing fault specific seismic hazard maps for the region of Attica, including all active faults and local geologic conditions. The purpose of this project is to validate the existing EQ CAT

Models used by the local insurance market and propose new methods on seismic hazard assessment. This initiative could be followed by similar authorities in different countries that need to properly model seismic hazard. The already used methodology will be benefited by the validation of modelled events using paleoseismic evidence of historic events or the corresponding environmental effects. For example, the recently published research in the active Milesi fault (Attica region, NE of Athens capital) enhances and validates the outcomes of the fault specific approach in the area, providing more accurate fault slip – rate data and potential earthquake magnitude that this fault can cause.

(*maximum 1 page*)



Signature: Ioannis Papanikolaou **Date: 26 January 2016**

PROPOSED BUDGET

Please complete the table below, giving the full costs (in Euros) in the third column and the amount requested from INQUA for any allowable item in the fourth column. If the item involves funding e.g. travel or subsistence for a specific person, they should be named in the second column.

Item	Person involved (and status)	Cost (in Euros)	Funding requested from INQUA
Travel support for the Workshop meeting 2016 in Aachen, Germany, hosted by RWTH Aachen (Klaus Reicherter)	Georgios Deligiannakis (PhD), Christoph Grützner (ECR), Aicha Heddar (DCR), Bojan Matos (ECR), Marco Meschis (ECR), Jakub Stemberk (PhD), Michal Havaš (PhD), Aggelos Pallikarakis (PhD), further ECRs, DCRs, and PhDs to be determined in 2016	20 x 500 EUR	10 x 500 EUR
Totals		**10000 EUR**	**5000 EUR**

BUDGET JUSTIFICATION

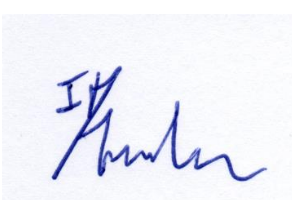
Item	Justification	Link to outcomes/products
Travel support for the Workshop meeting 2016 in Aachen, Germany, hosted by RWTH Aachen (Klaus Reicherter)	The PATA Days 2016 will be in the USA (Colorado), and the main 2017 meeting is planned to take place in New Zealand. It is therefore necessary to hold another project meeting in Europe and to gather a large number of ECRs and PhDs, because there will not be enough travel support for them to join these meetings overseas. RWTH Aachen will provide conference infrastructure, but we need travel support for the ECRs outside Germany.	The workshop will be essential to discuss the progress of the meeting and to plan the upcoming activities. ECRs are expected to report on their research, and we will need to collect, compare and discuss the data. We also need to run internal training sessions for all participants on the ShakeMap software and the other procedures mentioned above.

ADDITIONAL SUPPORT FROM OTHER ORGANIZATIONS

We recognize that INQUA may not be able to provide all the level of support that you need for an activity. Please specify additional sources of funding (in Euros) for this activity in the table below.

Source	**Amount requested**	**Status** Confirmed (C), pending confirmation (P), application to be made (TA)
RWTH Aachen (Klaus Reicherter) for project meeting infrastructure	2000 EUR	Confirmed
Agricultural University of Athens IKYDA project	2000 EUR	Confirmed under way (ending in 2017)
Late Quaternary earthquake history of normal faults revealed by 36Cl, LiDAR and REE analysis and implications on the methodic application, fault slip rates, and the seismic cycle"'. DFG-project ME 4212/3-1. GermanyProject Leader Dr. Silke Mechernich, University of Cologne	500 EUR	Confirmed under way (ending in 2019)
"Earthquake hazard from cosmogenic 36-Cl exposure dating of elapsed time and Coulomb stress transfer". NERC UK. Project Leader, Prof. Gerald Roberts, Birkbeck College, University of London	2500 EUR	application to be made (TA) (ending in 2016)
Total	**7000 EUR**	

Please note: INQUA grants may be held in institutional or non-institutional accounts. Because INQUA requires that its limited funding is specifically used to assist Developing Country and Early Career scientists, it does not allow overheads to be taken off its grants. In the case of institutional accounts, INQUA anticipates that the institution will waive any overheads normally charged. In case of non-institutional accounts, it is the Project Leader’s responsibility to make sure that his/her institution allows this, and that all formalities and legalities are observed. Grants are normally transferred to the Project Leader. However, at the Project Leader's request they can be transferred to a co-leader or local organizer.



Signature: Ioannis Papanikolaou **Date: 26 January 2016**