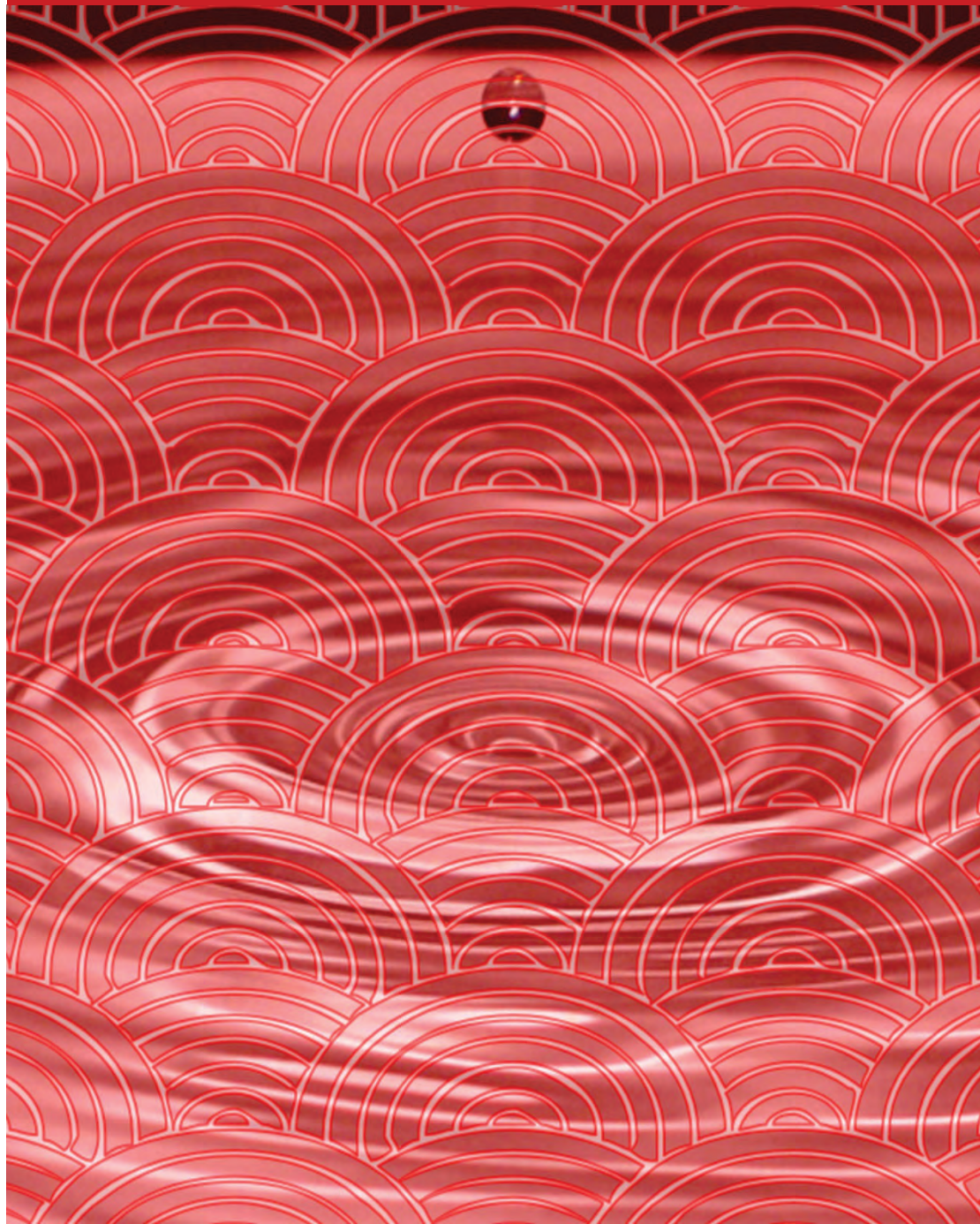


Volume 6, 2021



GeoPatterns

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Center for Risk Studies, Spatial Modelling,
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EDITURA UNIVERSITĂȚII DIN BUCUREȘTI
BUCHAREST UNIVERSITY PRESS

2021



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BUCHAREST UNIVERSITY PRESS

Editura Universității din București – Bucharest University Press
folosește sistemul de peer-review dublu anonim.

Desktop Publishing: *Meri Pogonariu*

ISSN 2501-7837
ISSN-L 2501-7837

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<https://editura-unibuc.ro/>

B-dul Mihail Kogălniceanu 36-46, Cămin A (curtea Facultății de Drept),
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Green-synthesized Ag-MnO₂ nanoparticles as plausible non-invasive antimicrobial treatment of cultural heritage

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Abstract. Green-synthesized Ag-MnO₂ nanoparticles were tested for their antimicrobial capacity. Two important plant extracts were used for synthesis: *Vinca minor* and *Chelidonium majus*, with well-known pharmacological activities. After the determination of the minimal inhibitory concentration against two bacterial strains (one Gram-negative and one Gram-positive model), the plant extracts were used to form three types of metal nanoparticles. The antimicrobial effect of the nanoparticles was assessed against *E. coli*, *Staphylococcus aureus*, and the yeast *Candida albicans*. The results indicated that the Ag-MnO₂ nanoparticles synthesized with *V. minor* plant extract were the most efficient against all tested pathogens. As a future perspective, these nanoparticles are suited to design a non-invasive applicator to treat biodeteriorated cultural heritage, such as archives, sculptures, or paintings.

Keywords: Ag-MnO₂, green synthesis, antimicrobial effects, image processing, cultural heritage

INTRODUCTION

The rapid ascension of nanomaterial production as a response to the increased demand, attracted numerous funds at industrial levels (Cvjetko et al., 2017). Consequently, the environmental impact was major due to the pollution generated by the industrial processes required for mass production. An alternative solution to this could be ‘green’-synthesis of nanoparticles (NPs) with the help of plant extracts (Ahmed et al., 2016; Kamran et al., 2019).

NPs are new generation, technological tools with various applications from biomedical to food industry or cosmetics. Together with the fast development of NP synthesis, the demand for alternative treatment of diseases increased as well (Jyoti et al., 2018).

Microbial diseases are widespread, and they affect not only living organisms, such as plants or mammals, but they deteriorate the cultural heritage as well (Borrego et al., 2018; Doud et al., 2020). It is important mention that art objects, especially old ones, are prone to deteriorate due to several

physical, chemical, and biological factors. Apart from poor handling and storage conditions, that lead to a physical degradation of paintings, archives, or sculptures, biodeterioration is a real concern. If not inhibited properly, bacteria or fungi present on the cultural heritage recur and cause irreparable damages (Karbowska-Berent et al., 2011; Kavkler et al., 2015).

Although prevention is the optimal solution, non-deteriorating techniques should be employed for the treatment of existing patrimony. Such an alternative could be provided with the help of antimicrobial NPs that can be applied both prior the use of materials (paper, clay, cloth, etc.) and for the treatment of infested art objects (Gutarowska et al., 2012).

The current work explored the alternative of using previously obtained NPs through green-synthesis as antimicrobial agents. In this preliminary study, the Ag-MnO₂ NPs were tested against *E. coli*, *Staphylococcus aureus*, and *Candida albicans*. The obtained NPs have a great antimicrobial potential and a possible solution to

treat the already affected cultural heritage is to develop a non-invasive applicator with targeted treatment of microbial infestations, without affecting the art objects.

MATERIALS AND METHODS

Nanoparticle synthesis

Three types of nanoparticles were obtained as described in a previous study (Ciorîță et al., 2020). Briefly, MnO₂ nanoparticles were synthesized from KMnO₄ in presence of *Vinca minor* and/or *Chelidonium majus* plant extracts. The obtained nanoparticles were combined with AgNO₃ and the same plant extracts to obtain core-shell Ag-MnO₂ nanoparticles: Ag-MnO₂-Vm (obtained with *V. minor* plant extract), Ag-MnO₂-Cm (obtained with *C. majus* plant extract), and Ag-MnO₂-M (1:1 mix of plant extracts).

Preliminary antibacterial effect of the plant extracts

The effect of the *V. minor* and *C. majus* plant extracts against *E. coli* (ATCC 25922) and *Staphylococcus aureus* (ATCC 25923) were assessed through scanning electron microscopy (SEM) and through the microdilution method, according to EUCAST protocols and to a previous study (EUCAST, 2020; Ciorîță et al., 2021).

A computational method was employed to determine the effect of the extracts against the length of *E. coli* bacilli using a MATLAB script, according to (Belean et al., 2020). Based on the scale bar, the software estimated the bacterial dimensions (length and/or width), after a rigorous determination of the bacterial contour.

Antimicrobial effects of the Ag-MnO₂ nanoparticles

The antimicrobial effect of the nanoparticles was assessed against *E. coli*, *S. aureus*, and *Candida albicans* (ATCC 90028) through the agar diffusion method, according to EUCAST protocols.

Statistical analyses

Each experiment was conducted in triplicate and the mean and standard deviation were calculated. One Way ANOVA, Tukey, and Student's t test were used to determine the level of significance.

The difference was considered significant at values of $p \leq 0.05$.

RESULTS AND DISCUSSIONS

The chosen plant extracts had a great antibacterial effect, inhibiting both *E. coli* and *S. aureus* (Figure 1 a). The morphology of the bacterial cells was not significantly affected as indicated by the SEM analyses (Figure 1 b). However, the length of the *E. coli* bacterial cells measured with the help of a MATLAB script (Figure 1 c) was significantly smaller compared to untreated control (Figure 1 c).

Once the antibacterial effect was established, the reducing capacity of the plant extracts was assessed. Hence, three types of Ag-MnO₂ nanoparticles were obtained and their polygonal aspect was observed thorough transmission electron microscopy (Figure 2 a-c). The antimicrobial effects of the nanoparticles were assessed through the agar diffusion method (Figure 2 d).

The antimicrobial properties of *Vinca minor* and *Chelidonium majus* had been previously reported, and these results are consistent with our findings (Gilca et al., 2010; Özçelik et al., 2011; Pârvu and Pârvu, 2011; Grujić et al., 2015). Moreover, the inhibitory effect of silver against bacterial or fungal strains are thoroughly documented (Du et al., 2018). The plant extracts present on the surface of the synthesized Ag-MnO₂ NPs lead to a synergistic activity of the nanomaterials against the tested strains (Ciorîță et al., 2020).

Although *C. majus* had a slightly increased inhibitory capacity against *E. coli* (MIC = 5%) and *S. aureus* (MIC = 10%), compared to *V. minor* (MIC = 15% and 10%, respectively), Ag-MnO₂-Vm were significantly more potent against the tested strains.

After this initial assessment of the green synthesized Ag-MnO₂ NPs against microbial strains, the NPs obtained with *V. minor* plant extract are suited for further investigations. Therefore, a non-invasive applicator could be developed where NPs are left to interact with the microbiome present on cultural heritage for 24h and inhibit the development of biodeteriogens, without affecting the integrity of the art objects.

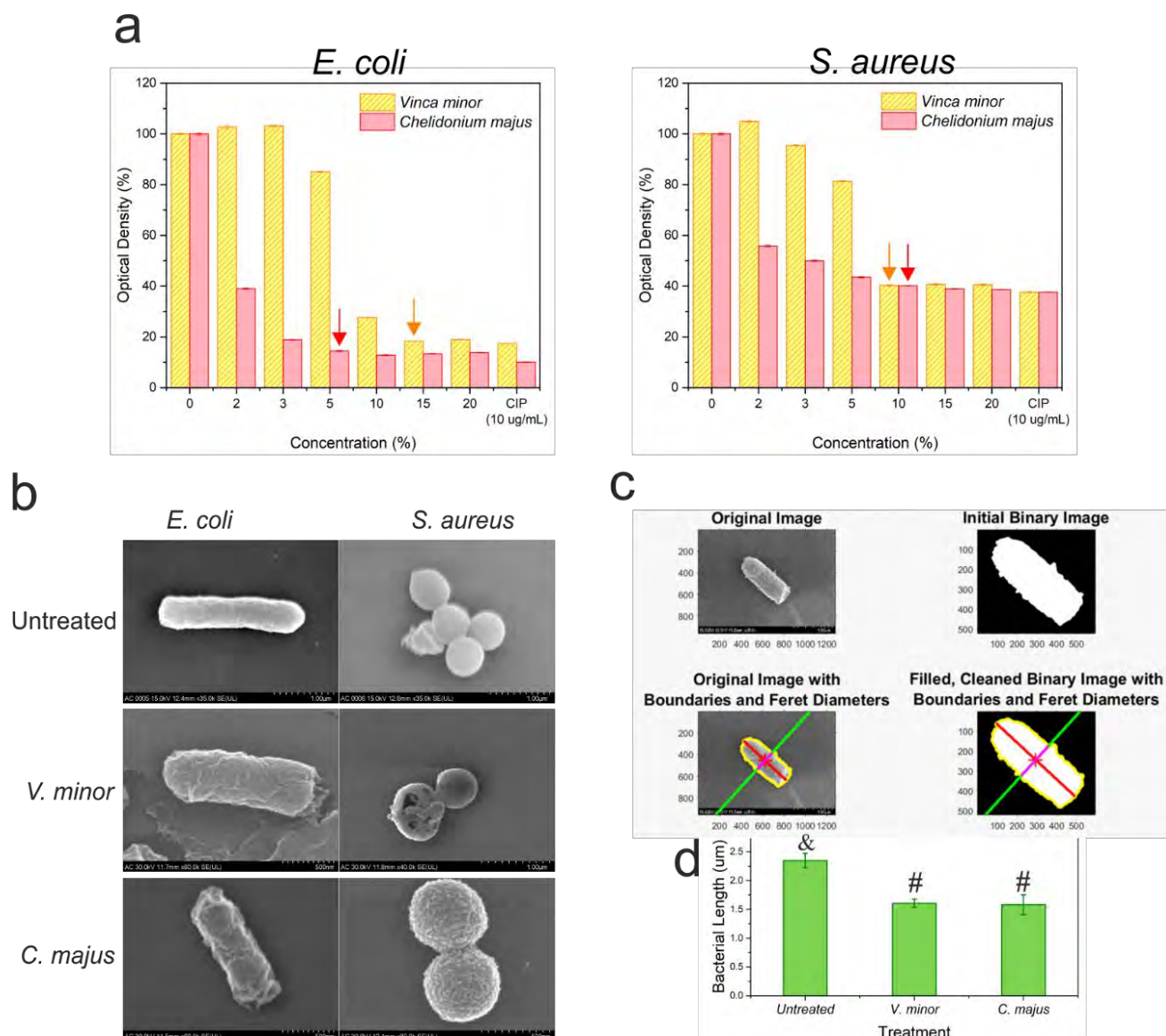


Figure 1. The antibacterial effect of the *V. minor* and *C. majus* plant extracts against *E. coli* and *S. aureus*.

The minimal inhibitory concentration (MIC) was determined thorough the microdilution method (a);

the arrows indicate the MIC in %. Morphological examination of bacterial cells treated with plant extracts and compared to untreated control (b); no significant alterations were observed.

Length measurement of the *E. coli* cells with the help of a MATLAB script (c) and its graphical representation (d);

The columns marked with the same symbol are significantly different than the control at significance level of $p < 0.05$, according to the One Way ANOVA and Tukey's tests

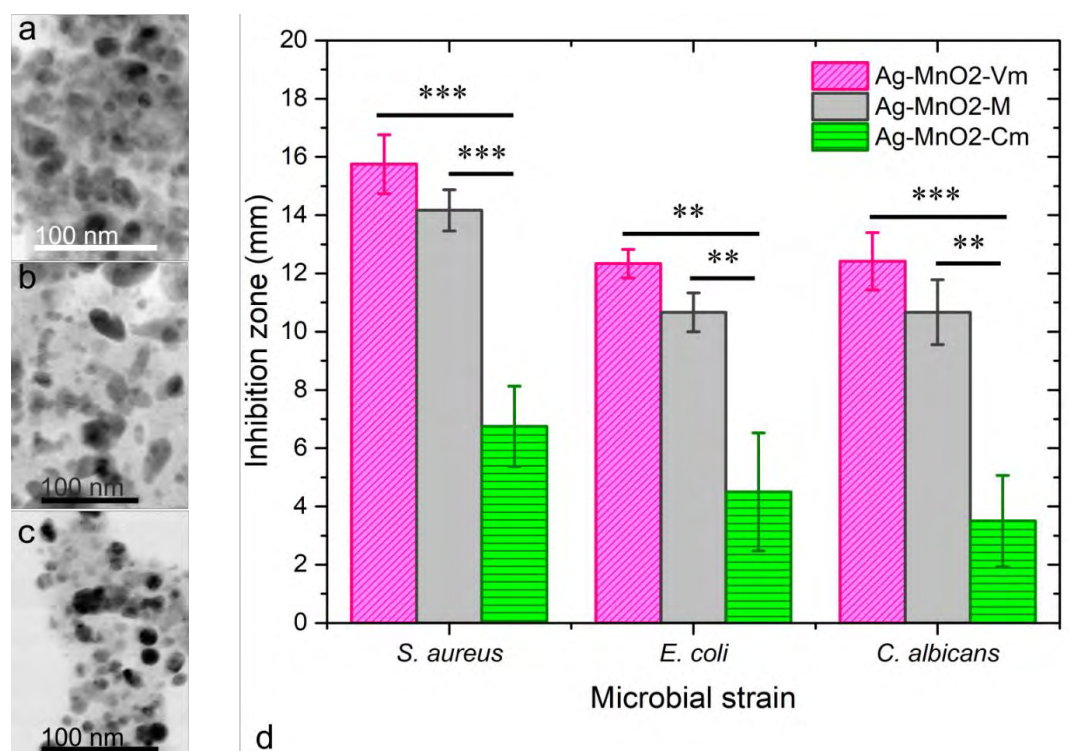


Figure 2. Morphological examination of Ag-MnO₂ nanoparticles synthesized with *V. minor* (a), *C. majus* (b), and a 1:1 mix (c) plant extracts. The agar diffusion method examination of antimicrobial effects of nanoparticles against *E. coli*, *S. aureus*, and the yeast *Candida albicans*;

Student's *t* test was performed and the significance levels are scaled as follows:

*** $p < 0.001$, ** $p < 0.01$, * $p < 0.05$

ACKNOWLEDGMENT

The author Alexandra CIORÎȚĂ would like to acknowledge the project POC A1-A1.2.3-G-2015, UBB-TeMATIC-Art - ID P-40-374 - „Partnership for transfer of innovative technologies and advanced materials in visual arts (production, conservation, restoration)”.

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Gilort river channel dynamics economic impact assessment in the 2010-2019 period

Study case: The segment between Bălcești and Târgu Cărbunești

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Abstract. The importance of analyzing river channel dynamics is granted by the scientific need of knowing the way of evolution in order to elaborate more accurate evolution patterns and also because the river proximity always constituted an area for developing settlements due to its resources. Therefore, river channel dynamics is closely related to population dynamics in its vicinity and has direct effects towards them through active processes. This paper aims to identify the Gilort river channel dynamics economic impact on local communities development, using a GIS-based analysis and high resolution spatial data.

Keywords: *Gilort, river channel, dynamics, economic impact*

INTRODUCTION

River channel dynamics is based on its characterizing fundamental elements, such as morphology and morphography of the watershed, relevant indices revealing the changes in channel configuration (braiding index, sinuosity, morphological quality index), historical evolution patterns (this patterns can be identified using analysis such as river channel occupancy or delineation of the historical migration zone) and river channel topography changes, based on the river hydrographic characteristics (liquid and solid flow volumes, drainage rate and water levels). Regarding channel dynamics, it was shown large interest on a national (Armaș et al, 2013; Feier and Rădoane, 2007; Ioana Toroimac, 2009; Grecu et al., 2014; Perșoiu et al., 2011; Rădoane et al., 2013; Zaharia et al., 2011) and international (Grovve et al., 2013; Lane et al., 1997; Langat et al., 2019; Lawler et al. 1993; Lawler et al., 1999; Pyle et al., 1997; Thakur et al., 2012; Winterbottom et al., 2000) through the relationship between local communities development and river channel dynamics. Analyzing successive cartographic data to

obtain river planform changes was used (Rădoane et al., 2013) as a methodological approach. Gilort watershed was also studied by a hydrological (Pisleaga et al, 2019) and biodiversity point of view (Pecingina and Popa, 2017).

This paper aims to identify river channel dynamics economic impact on local communities development. As a study case, Gilort river in the Subcarpathian area, between Bălcești and Târgu Cărbunești was chosen. This area is characterized by a high population density, therefore a high impact on river channel through different economic activities. Study area is located in the Gorjului Subcarpathians, south-west of Romania, Gorj county. The length of the river, measured on thalweg is approximately 15 km.

To identify the economic impact, the study focused on identifying the erosion processes in the channel. Through lateral erosion, land surfaces located in river proximity are lost. These land surfaces have a land use, therefore an economic value.

METHODOLOGY

For analyzing the changes in river channel configuration were used two types on analysis:

- a semi-quantitative one, to show the spatial distribution of erosion and accumulation processes along the river channel;
- Topography Change Detection for the river channel in 2010-2019 period of time.

The spatial distribution of erosion and accumulation processes was realized based on river bank delineation for 2010 and 2019 (the delineation was realized using a Sentinel-2 satellite image for 2010 and an orthophotomap for 2019 – Figure 1). Data used for the bank delineation have high spatial resolution (10m for Sentinel-2 images and 0.15m for 2019 orthophotomap), therefore the delineation process have an increased accuracy. On the vectorial layers resulted, vectorial analysis tools were applied (*Difference and Intersection in QGIS 3.4*), following the principle: surfaces between river banks existing in 2010 and not existing in 2019 are considered accumulation areas; surfaces between river banks existing in 2019, but didn't exist in 2010 are considered erosion areas; surfaces existing in both years are considered not changed. Distribution of river channel processes map was the main result of this analysis. Based on the results, a series of spatial differences and processes alternation can be identified.



Figure 1. Example of bank delineation (2019 – near Bălcești)

The next step in river channel changes recognition is Topography Change Detection (TCD) analysis. It was realized using the Geomorphic Change Detection standalone software, which focus on differences and volumetric calculations between two or more raster datasets (with terrain altitude information). Primary analysis was run for the

entire Gilort floodplain, using two high-resolution raster datasets (1 m spatial resolution): a Digital Terrain Model (DTM) for 2010 and a Digital Surface Model (DSM) for 2019. First result was a changes distribution map, with values between -4 m to above 20 m. This altitude difference is a result of the datasets construction: the DTM shows only the terrain irregularities, ignoring the objects on the terrain surface (such as vegetation, constructions), while DSM shows all the irregularities (including vegetation and constructions). Therefore, the differences of +20 m most likely concur with vegetation patches.

For relevant volumetric calculations, the analysis was run a second time, only for the surface between the river banks (river channel), to reveal the changes occurred through dynamic processes (erosion or accumulation). The database and applied methods are shown in Table 1.

To identify the economic impact, erosion surfaces have been overlapped to Corine Land Cover (CLC) vector layer from 2006 (this was the most recent CLC layer before the study period of time and it was important to know the previous land use), to obtain the previous land use of these surfaces. Afterwards, a cost standard was applied for the specific land uses. Based on the cost standard an approximate economic impact was calculated.

Table 1. Data base and applied methods

Data sets	Data Source	Data Type	Method
Satellite image 2010	Sentinel-2	Raster	River bank delineation (2010)
Orthophoto map 2019	LIFE16 NAT/RO/000778	Raster	River bank delineation (2019)
DTM 2010	LIFE16 NAT/RO/000779	Raster	GCD analysis
DSM 2019	LIFE16 NAT/RO/000779	Raster	GCD analysis
Corine Land Cover	European Environment Agency	Vector	Land use identify

DISCUSSIONS

Processes spatial distribution analysis (Figure 2) reveals a series of sections where the erosion

process is prevailing: in proximity of Bălcești locality (north of study area), between Bălcești and Bengești localities, between Bengești and Mirosloveni (Figure 3) and in proximity of Bolbocești locality (south of study area). In the study area it can be observed an alternation of erosion and accumulation processes. Upstream, near Bălcești, erosion and changes in river course are prevailing, through meandering or meander closing and creation of a new course. The causes for this configuration may vary. First, upstream to Bălcești is the Galbenu confluence (one of the main tributary river). Thus, both river flow and competence grow, so the erosion capacity grows. Second, the river bed is characteristic to a Subcarpathian area, with a higher slope and a higher flow rate, therefore a higher erosion capacity. To these a flash-flood event is added. It was recorded in 28 - 29 July 2014, when the flood wave exceeded 4 m height. This event determined significant changes in river channel configuration, through course alteration, meander

closing and modelling a new channel or activation of old channels.

Based on this semi-quantitative analysis, the vector layer was used in order to calculate the erosion and accumulation surfaces. The results show a total of 0.5 km² affected by erosion and 0.4 km² affected by accumulation, approximately.

The Geomorphic Change Detection (GCD) analysis reveals the prevailing of lowering surfaces in the river channel, going to a maximum of -4 m. The most affected section is located between Mirosloveni and Albeni localities.

Beside the spatial distribution of lowering and rising surfaces (Figure 4), a series of calculations were made with the GCD standalone (Figure 5), such as the volume of sediment eroded and accumulated, rising and lowering surfaces, average values of topographic rising and lowering. The lowering surfaces are about 0.52 km² and rising surfaces are about 0.39 km². The results are comparable to those obtained using the previous method, therefore there is a mutual validation.

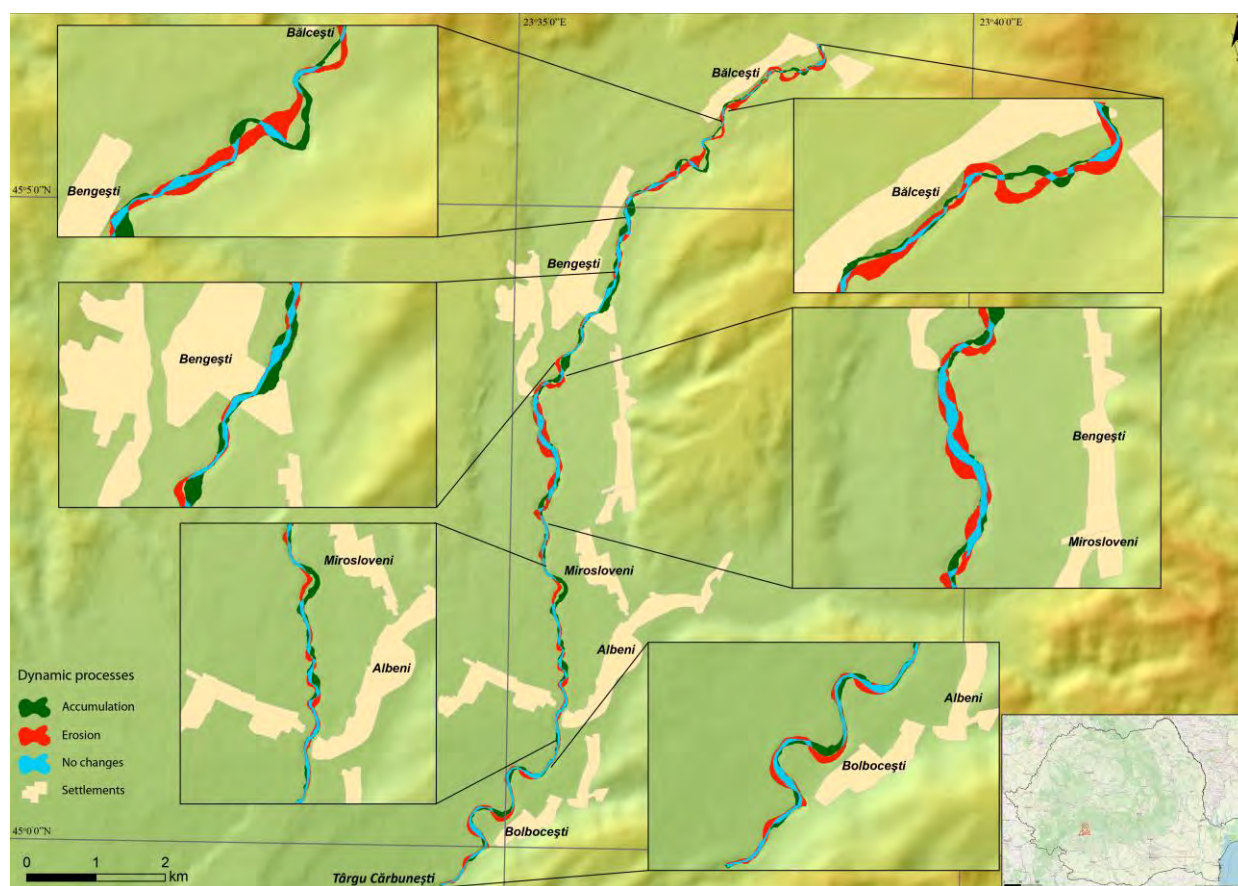


Figure 2. Spatial distribution of erosion and accumulation processes



Figure 3. Erosion example between Bengesti and Miroslaveni. Photo 2019

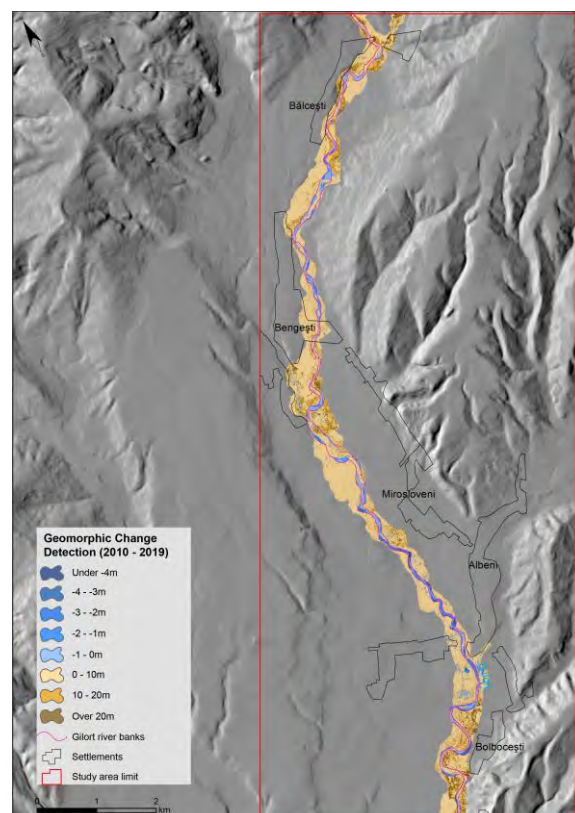


Figure 4. Spatial results of GCD

Change Detection Results				
Name: dem_malun1_dtm_malun1 MinLoD at 0.10m				
Tabular Results Graphical Results Analysis Details				
Attribute	Raw	Thresholded	Error Volume	% Error
AREAL				
Total Area of Surface Lowering (km ²)	0.55	0.52		
Total Area of Surface Raising (km ²)	0.42	0.39		
Total Area of Detectable Change (km ²)	NA	0.91		
Total Area of Interest (km ²)	0.97	NA		
Percent of Area of Interest with Detectable Change	NA	94.35%		
VOLUMETRIC				
Total Volume of Surface Lowering (m ³)	636,837.30	635,462.31	±52,335.40	8.24%
Total Volume of Surface Raising (m ³)	1,015,052.00	1,013,682.73	±39,012.00	3.85%
Total Volume of Difference (m ³)	1,651,889.30	1,649,145.04	±91,347.40	5.54%
Total Net Volume Difference (m ³)	378,214.70	378,220.42	±55,275.80	17.26%
VERTICAL AVERAGES				
Average Depth of Surface Lowering (m)	1.16	1.21	±0.10	8.24%
Average Depth of Surface Raising (m)	2.43	2.60	±0.10	3.85%
Average Total Thickness of Difference (m) for Area of Interest	1.71	1.70	±0.09	5.54%
Average Net Thickness of Difference (m) for Area of Interest	0.39	0.39	±0.07	17.26%
Average Total Thickness of Difference (m) for Area with Det...	NA	1.81	±0.10	5.54%
Average Net Thickness of Difference (m) for Area with Dete...	NA	0.41	±0.07	17.26%
PERCENTAGES (BY VOLUME)				
Percent Elevation Lowering	38.55	38.53		
Percent Elevation Raising	61.45	61.47		
Percent Imbalance (departure from equilibrium)	11.45	11.47		
Net to Total Volume Ratio	22.90	22.93		

Figure 5. Statistic results GCD

The volume of the eroded sediment (635462.31 m^3) is lower than the one accumulated (1013682.73 m^3), so is the average depth of surface lowering/raising (1.21 m compared to 2.6 m) as a result of tributary rivers contribution. Correlated with the surface data

(higher for lowering surfaces), then the sediment is accumulated in sections with transition towards a new channel configuration (sections with lower river bed slope, pools with lower drainage rate).

Overlapping the results with Corine Land Cover land use vector layer showed that the main surfaces lost by erosion were covered with forest patches (0.7 km^2), agricultural land (0.1 km^2) and pastures (0.1 km^2). The standard costs were applied (forest patches – 5000€/ha; agricultural land – 5000€/ha; pastures – 2500€/ha) and the Gilort river channel dynamics economic impact in 2010 – 2019 is evaluated at approximately 425 000€ (Table 2).

Table 2. Surfaces lost by erosion and their cost

Land use	Surface (ha)	Standard cost/ha (€)	Cost/land use (€)
Forest patch	70	5000	350,000
Agricultural land	10	5000	50,000
Pasture	10	2500	25,000
Total	90		425,000

CONCLUSIONS

The importance of analyzing river channel dynamics is granted by the scientific need of knowing the way of evolution in order to elaborate more accurate evolution patterns and also because the river proximity always constituted an area for developing settlements due to its resources. Therefore, river channel dynamics is closely related to population dynamics in its vicinity and has direct effects towards them through active processes. Developing and impact analysis requires current data sets with high resolution which can be modelled using specialized software.

Gilort river channel has an active dynamics, predominantly through erosion processes to the detriment of accumulation processes (given the surfaces calculated in GCD). Surfaces lost through erosion process in the period of time given are up to 0.5 km², while the accumulation surfaces are up to 0.4 km². However, the volume of sediment eroded is half the sediment accumulated, so the contribution of the tributary rivers is significant.

By the economic point of view, the impact can be quantified through the land use of the eroded surfaces. For the period of time given, Gilort river economic impact is evaluated at approximately 425 000€.

The methodological approach can be used in any study area, as long as there are high resolution data sets available (DTM, DSM, DEM) and recent satellite images, so necessary for this type of analysis. Limitations of the method are related to the availability of high resolution data sets, necessary for the Geomorphic Change Detection. Also, the surface calculation are approximately and may vary, depending on the quality of the data sets. Given the river channel dynamics in the 2010 – 2019 period, most likely the erosion processes will continue to affect the unprotected river banks (especially in areas where the predominant land use is agricultural). Therefore, in order to limit the economical impact of river dynamics, the local authorities should take into consideration actions to reduce river erosion in areas of interest. This can be done either with gabion walls or embankments, in order to reduce the effects of erosion, or using Engineered Logged Jams (ELJ). The latter is more

eco-friendly and can also be used in order to restore natural habitats for the aquatic species in the Nature2000 site (ROSCI0362).

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Overview of the seismic vulnerability problem of the urban settlements in Romania

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Abstract. Seismic vulnerability is of particular interest to the scientific community, authorities and general population in Romania, given the fact that the territory of the country is mainly subject to strong intermediate-depth earthquakes that originate in the Vrancea Seismogenic Zone. However, little has been done to strengthen the resilience of urban settlements, which are especially vulnerable to earthquakes. This paper represents a summary of the seismic vulnerability problem in Romania that focuses on its various sources and on the scientific works elaborated on this topic. Also, several proposals that target both future earthquake vulnerability research and modelling actions are presented, in the endeavour to stress out the necessity of using scientific findings as grounds for decision-making.

Keywords: *vulnerability, seismic vulnerability, vulnerability assessment, Romania*

INTRODUCTION

Vulnerability is a multifaceted, protean concept that covers a wide range of definitions (Cutter 1996), referring to one common point: the propensity to register loss and damage as a result of natural or anthropogenic hazards (Coburn et al. 1994). The lack of a standard definition may be traced back to the integration of vulnerability into various scientific fields and to its scale-dependent character (Hufschmidt 2011, Izquierdo-Horna and Yopez 2022). The variety of vulnerability definitions may be regarded as a source of detrimental research fragmentation (Hufschmidt 2011) and meaning-related discrepancies (Cutter 1996) or, on the contrary, as a proof of research vitality (Adger 2006).

According to the official definition provided by UNDRR (2017), vulnerability represents “The conditions determined by physical, social, economic and environmental factors or processes which increase the susceptibility of an individual, a community, assets or systems to the impacts of hazards.”. This underlines the multidimensionality of vulnerability, corresponding to the last stage in the evolution of the concept described by Birkmann (2013).

In the last few decades, the concept has been placed more and more often at the core of risk reduction strategies, as it represents the one element in the equation of risk that may be generally modelled. The development of vulnerability into a valuable research topic is proved by the large number of literature reviews (Cutter 1996, Adger 2006, Villagrán De León 2006, Fuchs et al. 2011, Hufschmidt 2011) and also by the fact that more than a half of the global targets mentioned by the Sendai Framework for Disaster Risk Reduction (2015-2030) concern the vulnerability of human communities (UNDRR 2015).

Vulnerability should to be studied in relation to certain hazards or in a multi-hazard context, due to the fact that its particularities are strongly linked to the ones of the hazard. What is the extent of the link between the two components of risk is a matter of debate, as some scientists consider that vulnerability and hazard magnitude are independent elements; vulnerability being dependent on the physical, social, and cultural context in which the destructive event occurs (Rashed and Weeks 2003, Albulescu 2021), while others argue that vulnerability is directly influenced by the magnitude of an

earthquake (Dwyer et al. 2004, Hufschmidt 2011, Armaş 2012). This division springs from the variety of vulnerability and risk definitions, and it is important to clarify and to properly operate with the two notions: vulnerability represents an underlying condition that refers to the susceptibility of being harmed (Coburn et al. 1994, Rashed and Weeks 2003, Barbat et al. 2010), while risk is defined as the degree of potential loss and damage that may be caused by all levels of hazard severity (Coburn et al. 1994); that is the product of vulnerability and hazard (Rashed and Weeks 2003, Birkmann 2013). Other debatable aspects refer to the relations between vulnerability, exposure, and resilience (Birkmann 2013).

As earthquakes are one of the most destructive natural forces on the planet, seismic vulnerability reduction is of utmost importance when it comes to the development (and even survival) of the human communities that live in earthquake prone areas, especially in the case of developing countries. Representing complex and fragile systems that function as economic growth poles, urban settlements are particularly vulnerable to earthquakes; a propensity which has been augmented by the increase in exposure associated with urban growth. This stresses out the necessities to evaluate the models that describe the interactions of the physical and social urban environments under seismic impact, and to visualise urban vulnerability (Armaş et al. 2017b).

This paper aims to present the problematic situation of the seismic vulnerability specific to the urban settlements in Romania, highlighting its sources and the contribution of the scientific community to its understanding and reduction. The overview provides a basis for the outlining of several proposals regarding future vulnerability related research and modelling actions.

SEISMIC VULNERABILITY IN ROMANIA

Romania is mainly subject to intermediate-depth earthquakes originating in the Vrancea Seismogenic Zone, being one of the European countries with the greatest seismic hazard (Vacareanu et al. 2013,

Toma-Danila et al. 2018). Several seismogenic areas lie on the territory of Romania or in proximity (Figure 1): the Vrancea Seismogenic Zone, Predobrogean Depression, Făgăraş-Câmpulung Seismogenic Zone, Danubian Seismogenic Zone etc. The earthquake nest of the Vrancea Zone (Radulian 2014) is considered the most threatening both in terms of earthquake magnitude and extension of the potentially affected area: it was estimated that 2-3 major seismic events may occur per century, and that 2/3 of the country's territory is subject to subcrustal earthquakes (Vacareanu et al. 2013). The destructive force of the intermediate-depth Vrancea earthquakes was proven by the events of 1802 (7.9 MW), 1940 (7.6-7.7 MW) and 1977 (7.4-7.5 MW); that determined considerable human loss and damage (Oncescu et al. 2000, Georgescu and Pomoniş 2008, 2012).

The situation of the seismic vulnerability in Romania may be considered a true predicament, as the World Bank (2020) reports. The analysis of the legislation and the technical regulations that should reduce seismic risk in this country identifies certain points that contribute to the problem, which may be summarised as follows:

- A lack of correlation between i) the legislative framework and the technical regulations that coordinate construction practices, and ii) the urbanism plans and the territorial planning strategies.
- The misuse of terminology (confusion regarding the seismic risk and seismic hazard).
- The inefficiency and ambiguity of O.G. 20/1994, the legislative document that should have coordinated the identification, evaluation and retrofitting of degraded, at-risk buildings. Failures of the current national retrofitting programme, the social and cultural factors that contributed to them, and possible solutions are thoroughly presented by Luca et al. (2016).
- The out-of-date technical assessments that should support retrofitting proposals, but that do not include budget related aspects or other practical plans. The validity of such assessments is hard to prove, and it is often contested in court in the endeavour to obtain results that would facilitate the access to funds that support energy efficiency improvements.

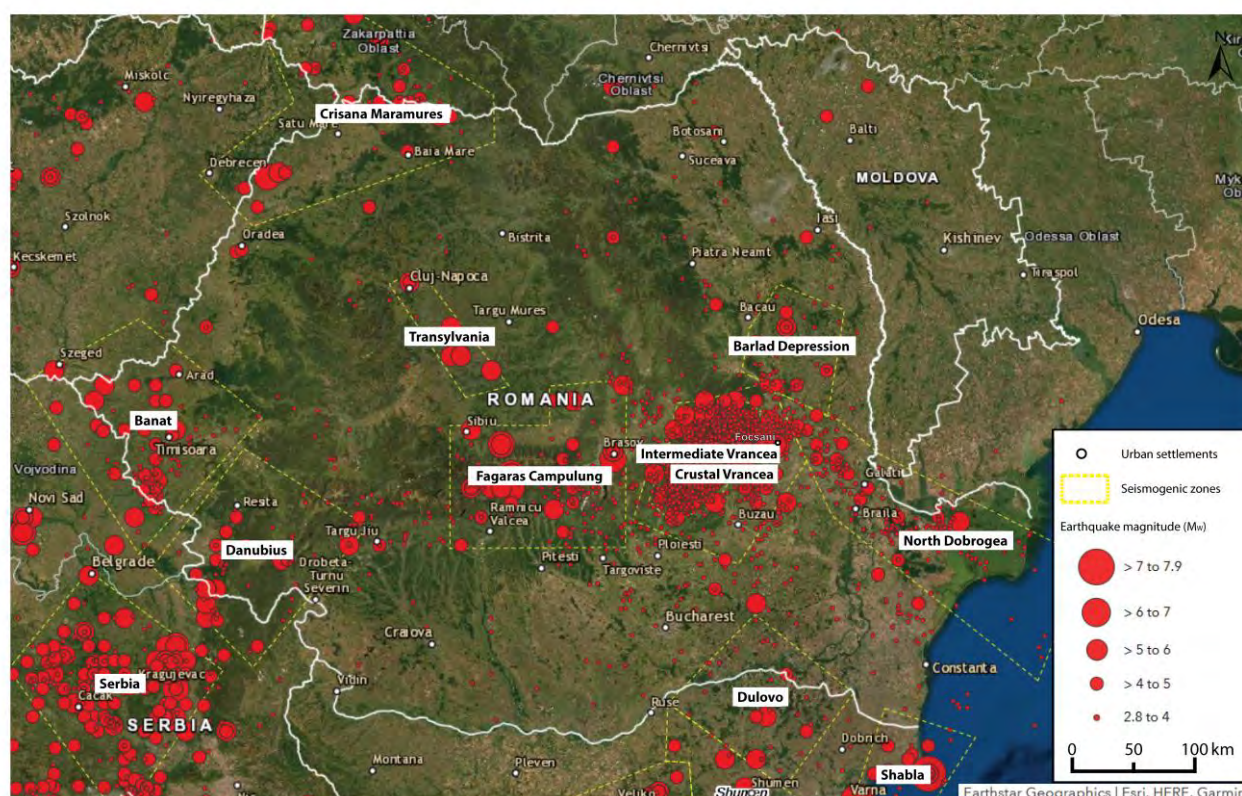


Figura 1. The seismicogenic zones within or in proximity of Romania, and the locations of the BIGSEES Earthquake Catalog 2022

- Difficulties in monitoring the progress of the retrofitting process, combined with the lack of updated, comprehensive and organised data concerning the buildings that were assigned seismic risk classes (World Bank 2020).

It may be asserted that the main sources of the seismic vulnerability in Romania are of physical, geotechnical and administrative nature, but it is important to bring to attention the social ones too: the concentration of vulnerable population (i.e., the elders, unemployed or low-income individuals) in certain urban areas, the increase in exposure associated with socio-economic progress, the scarcity of educational/informative programmes concerning earthquakes, protective and preventive actions etc. Additional vulnerability sources may be included in the equation, when we take into account the various effects of the Covid-19 pandemic: health problems, increased pressure on medical services, instability of employment, changes regarding on-site/online work patterns that determine where do people spend a large part of working days, social tensions, chronic stress, etc.

The high-seismicity area located at the bending of the Carpathian Mountains, together with the aforementioned vulnerability sources, transform the reduction of seismic risk into a matter of acquiring national security. This calls for extensive research efforts oriented towards the understanding, assessment, visualisation and modelling of earthquake vulnerability, but also for proper use of scientific findings, which may be obtained only with the genuine implication of the political and economic stakeholders, emergency services and individuals.

RESEARCH OF SEISMIC VULNERABILITY IN ROMANIA

Research on seismic vulnerability is essential for the elaboration and implementation of vulnerability reduction strategies, as it aims to provide accurate answers to fundamental questions: Who/what is vulnerable and to what extent? What contributes to this level of vulnerability and to what extent? How did the vulnerability and its sources evolve over time? What can be done to reduce vulnerability, and what are the financial and time costs?

The diversity of vulnerability definitions has been fuelling the development of a multitude of assessment methodologies (Izquierdo-Horna and Yepez 2022), each with its own strengths and limitations, that fit specific purposes. Moreover, vulnerability represents an ill-structured problem (Rashed and Weeks 2003), meaning that there are many possible solutions and no ways to identify an objective optimal solution. These are only a few arguments that testify to the difficulty of operationalising the concept of vulnerability. Seismic vulnerability, as any other type of vulnerability, may not be directly measured, but indirectly analysed (Villagrán de León 2006) through proxies of the physical, social and cultural contexts. Thus, the accuracy of vulnerability assessments is conditioned by the quality and quantity of the integrated datasets, as they are based on data-driven methodologies

At the beginning of the century, Calvi et al. (2006) identified two types of methodologies: i) the empirical methods (e.g., damage probability matrices, Vulnerability Index Method, continuous vulnerability curves, screening methods) and ii) analytical/mechanical methods (e.g., analytically-derived vulnerability curves, analytically-derived damage probability matrices, hybrid methods, collapse mechanism-based methods, capacity spectrum-based methods, fully displacement-based methods). It is obvious that all of them address the structural vulnerability of buildings; which emphasises the early tendency to study seismic vulnerability only relating to its physical dimension and to overlook its social, economic, systemic, institutional or political components (Birkmann 2013). This one-dimensional focus of vulnerability studies leads to biased perspectives and to “partial solutions” (Izquierdo-Horna and Yepez 2022). In time, seismic vulnerability assessments grew to encompass the aforementioned dimensions – that form what is called “comprehensive seismic vulnerability” (Barbat et al. 2010), and to be performed via new methodologies, among which multi-criteria, GIS-based methodologies and Principal Component Analysis (PCA) are the most common (Izquierdo-Horna and Yepez 2022).

Studying the scientific works that focus on the triad related to earthquakes (seismic risk, hazard

and vulnerability), it appears that the vulnerability component has been explored the least in the Romanian scientific literature. This section refers only to case studies of urban settlements in Romania, because research on the seismic risk or vulnerability of rural areas has not been elaborated yet. Vulnerability represents a dynamic, multi-scalar concept, and its evaluation needs to be adapted to the scale of analysis. The methodologies used to assess the vulnerability of particular elements (e.g., buildings, individuals, groups) differ from the ones that aim to estimate the vulnerability level of cities or of their component urban areas (Tables 1, 2).

Usually, seismic vulnerability assessments of certain elements focus on a single type of vulnerability – the “building-by-building assessment” in the case of physical vulnerability, but the methodologies used to identify spatial clusters and the multi-criteria ones take into account more than one side of the concept (Table 1). The former may be considered a very technical, pioneering approach of seismic vulnerability evaluations, which determines vulnerability curves for the buildings in question (Calvi et al. 2006). Also, there are index-based methodologies that aim to estimate the physical vulnerability of the analysed buildings (Apostol et al. 2019, Mosoarca et al. 2019). In the Romanian scientific literature, the “building-by-building” approach has been used to evaluate the physical vulnerability to earthquakes of several buildings in the historic areas of Bucharest City (Vacareanu et al. 2004, Georgescu et al. 2014 are only a few of the scientists that developed this type of evaluations), Timișoara City (Roverato 2015, Valotto 2015, Taffarel et al. 2016, Chieffo et al. 2018, Apostol et al. 2019, Mosoarca et al. 2019) and Iași City (Atanasiu et al. 2008, Toma and Atanasiu 2010).

There are only a few scientific works that address the spatial clusters of high seismic risk buildings (Leon and Atanasiu 2006, Bănică et al. 2016) or that assess the seismic vulnerability of certain building types dealing with more than the structural aspects (Albulescu et al. 2019, 2020). These studies focus on Moldavian urban centres: Iași, Vaslui and Galați Cities (Table 1). It should be highlighted that the international scientific literature provides many examples of evaluations regarding the seismic vulnerability of basic facilities (the

educational and health ones) – like the Sendai Framework for Disaster Risk Reduction 2015-2030 recommends, but the autochthonous literature includes only one paper on the topic (Albulescu et al. 2020).

Referring to the evaluation of seismic vulnerability at urban scale, three main approaches may be identified: one of them targets structural vulnerability (the deterministic approach), while the other two treat seismic vulnerability as a many-sided concept (the semi-quantitative and the comparative semi-quantitative assessments) (Table 2). The deterministic approach consists in damage estimations that rely on vulnerability curves (Trendafiloski et al. 2009, Lang et al. 2009), whereas the semi-quantitative vulnerability assessments are more complex, because they integrate more than one dimension of the seismic vulnerability. These are expressed using a multitude of indicators (Izquierdo-Horna and Yopez 2022) that simultaneously fulfil the conditions of relevance and data availability. The approach may be implemented focusing on a single urban centre – in the endeavour to identify its most vulnerable urban areas (Armaş 2012, Armaş et al. 2016a, Bănică et al. 2017), or on several cities, in order to determine which is the most vulnerable and what leads to this situation (Albulescu 2021). The comparative semi-quantitative approach of vulnerability assessments is an emergent one, which must be improved and performed in combination with semi-quantitative assessments of each urban settlement included in the analysis, in order to obtain salient results.

Multi-Criteria Decision-Making (MCDM) methods – more in their classical versions than in the fuzzy ones, are frequently applied to weigh the indexes and/or indices that operate as proxies of physical, social, economic, systemic vulnerability; the Analytic Hierarchy Process (AHP) being the most frequently used method (Armaş 2012, Armaş et al. 2016a, b, Armaş et al. 2017b, Bănică et al. 2017, Albulescu 2021). Also, Technique for Order of Preference by Similarity to Ideal Solution (TOPSIS) and Weighted Product Model (WPM) have been implemented to evaluate and rank the alternatives (i.e., the cities included in comparative semi-quantitative assessments) in relation to the criteria and sub-criteria that converge to form the overall seismic vulnerability (Albulescu 2021). In

some cases, MCDM methods were combined with analytical methods (e.g., the Improved Displacement Coefficient Method) that create custom-defined vulnerability functions used for building damage estimation, leading to more robust frameworks (Armaş et al. 2016b, Armaş et al. 2017b).

Tables 1 and 2 pinpoint the spatial disparities of the scientific works on seismic vulnerability in Romania. Most of these articles analyse the seismic vulnerability of Bucharest, which is the EU capital with the greatest earthquake risk (Armaş et al. 2016a, 2017b) – partly determined by the great seismic hazard associated with the Vrancea Seismogenic Zone, partly by the ongoing degradation of its building stock (Armaş et al. 2017b). Besides the most populous city of Romania, other urban settlements that have been studied in terms of seismic vulnerability are Timișoara, Iași, Vaslui, Galați and Focșani Cities.

“VULNERABILITIES” OF THE SCIENTIFIC RESEARCH

The literature review on the seismic vulnerability of urban settlements in Romania shows that the topic has drawn more and more scholarly interest since the beginning of the century, and that the last decade brought momentous scientific progress. However, all the cited references, regardless of their approach, present one major objective drawback: the integration of out-of-date population and building stock datasets. Some scientific articles rely on data provided by the Population and Housing Census of 2002 (Trendafiloski et al. 2009, Armaş 2012, Armaş and Gavriş 2013, Armaş 2016a, b) or 2011 (Armaş et al. 2016a, 2017b, Albulescu 2021), which do not properly illustrate today's reality. The integration of updated data, part of which can be obtained via remote sensing and GIS processing, would increase the accuracy of the seismic vulnerability assessments.

PROPOSALS CONCERNING SEISMIC VULNERABILITY RESEARCH AND MODELLING

The overview of the sources that contribute to the seismic vulnerability of the urban settlements in

Romania and the study of the existing scientific literature elaborated on this topic point out the bottlenecks that hinder the implementation of vulnerability reduction vulnerability reduction plans. To address the issue, several proposals concerning seismic vulnerability modelling may be set up. These can be divided in actions that directly reduce seismic vulnerability and proposals referring to research, that supports and coordinates ameliorative actions.

The former category includes the following proposals:

- To update the technical assessments of old buildings (especially the ones that were affected by the 1940 and/or the 1977 earthquakes).
- To modify the legislative framework and the associated technical regulations in order to facilitate the retrofitting/demolition process of high-risk buildings (Luca et al. 2016).
- To modify the legislative framework that coordinates the construction of buildings in areas with geological settings that are subject to liquefaction/landslides, aiming to ensure that the new buildings can withstand powerful seismic shocks.
- To develop near real-time software that run emergency intervention scenarios based on the near real-time seismic damage estimation programme (i.e., SEISDARO) developed by Toma-Danila et al. (2018).
- To develop educational programmes regarding earthquakes, seismic adjustments, preventive and protective behaviour. These should target not only pupils and students, but also the active population and the elders.

The proposals concerning the enhancement of vulnerability related research are:

- To provide the scientific community with updated, reliable, spatial and statistical data regarding the technically assessed buildings, the number and characteristics of their residents. The integration of these datasets into vulnerability assessments would translate into a leap of progress that would properly support decision-making. Also, the public should be granted access to data concerning the building stock, so that one can make informed decisions about their residence.

- To improve the accuracy of Population and Housing Census data and to create spatial datasets that correspond to the statistical ones. This would enhance the reliability of social vulnerability assessments.
- To identify the institutional and political sources of vulnerability (preferably at local scale) and to integrate them into seismic vulnerability assessments.
- To perform Sensitivity Analyses or other validation methodologies that can support the reliability of the results, given the inherent uncertainties that appear in vulnerability assessments.
- To use the findings of seismic risk perception studies (Armaş and Avram 2008, Armaş et al. 2017a, Albulescu et al. 2021, Ionescu et al. 2021) as proxies of individual vulnerability, focusing on psychological aspects and seismic adjustment implementation at household scale.
- To increase the use of GIS techniques in the visualisation of urban vulnerability (Toma-Danila et al. 2017). Moreover, remote sensing may be used to acquire up-to-date building stock data.
- To continue to perform seismic vulnerability assessments at local scale, targeting the identification of the most vulnerable neighbourhoods and human communities, and to use these findings as a basis for urgent vulnerability modelling actions.
- To perform comparative multi-criteria seismic vulnerability assessment at county and regional level in order to identify the most vulnerable urban settlements, to prioritise seismic risk reduction-oriented funds, and to plan in advance the terminal points of the potential flux of human and material resources that may be needed to reduce the seismic impact of a future major earthquake.
- To use the scientific studies on seismic vulnerability as a cornerstone for emergency management plans, including the red intervention plans that ought to be implemented in the aftermath of a major earthquake.

CONCLUSIONS

Vulnerability is an underlying ever-changing condition of human communities and their assets,

which must be assessed at different scales and moments, considering distinct dimensions, if the society wants to model it towards acceptable levels. Ultimately, it may be asserted that the effectiveness of vulnerability assessments and modelling actions dictate the development of the communities in question. The overview of the urban seismic vulnerability in Romania brings to light the gap between the progress of the scientific work – which

provides results that may bolster seismic vulnerability reduction, and the actual actions that are implemented to reach this goal. This implies that authorities, emergency services and stakeholders should integrate practical knowledge on seismic vulnerability into legislative frameworks, technical regulations and local scale seismic risk reduction plans, using scientific findings as grounds for decision-making.

Table 3. Vulnerability assessments of certain elements in urban settlements

Approach	Methods	References	Study area/Assessed elements
Building by building assessment	Out of plane local mechanisms of collapse	Roverato (2015)	Timișoara City (Cetate and Iosefin areas)
		Taffarel et al. (2016)	Timișoara City (Historical Centre and Iosefin areas)
	In plane and in plane mechanisms of collapse	Valotto (2015)	Timișoara City (Unirii Square)
	EMS-98-based physical vulnerability assessment	Chieffo et al. (2018)	Timișoara City (Unirii Square)
	Vulnerability Index Method, Nonlinear seismic analysis	Apostol et al. (2019)	Timișoara City (Fabric historic area)
	Vulnerability Index Method, Vulnerability Index Method modified to include the cultural value of the buildings	Mosoarca et al. (2019)	Timișoara City (Fabric and Iosefin historic areas)
	Artificial intelligence and GIS-based non-linear analysis	Atanasiu et al. (2008)	Pilot study on several damaged buildings in Iași City
	Deterministic approach, Finite Element Model Description	Toma and Atanasiu (2010)	P+4 residential buildings in Iași City
	HAZUS and ATC-40 methodologies, Monte Carlo simulations	Vacareanu et al. (2004)	Pantelimon Building (Bucharest)
	Mean Damage Degree method	Georgescu et al. (2014)	Bucharest (Civic Centre)
Spatial cluster identification	Supervised clustering based on the k-nearest neighbour graph method	Leon and Atanasiu (2006)	Pilot study on several damaged buildings in Iași City
	Cluster analysis, Principal Component Analysis of the buildings that were assigned seismic risk classes	Bănică et al. (2016)	Iași City
Semi-quantitative vulnerability assessment	Multi-criteria assessment of the buildings that were assigned seismic risk classes (based on Fuzzy AHP and TOPSIS)	Albulescu et al. (2019)	Galați City
	Multi-criteria assessment of school units (based on AHP and WPM)	Albulescu et al. (2020)	Vaslui City

Table 4. Vulnerability assessments of urban settlements

Approach	Methods	References	Study area
Deterministic damage and loss assessment	Loss estimation model based on building stock vulnerability curves and soil conditions	Trendafiloski et al. (2009)	Bucharest
	Damage and loss estimation model based on building stock vulnerability curves	Lang et al. (2012)	
Semi-quantitative vulnerability assessment and Index construction	Multi-criteria analysis of social vulnerability (based on AHP): Social Vulnerability Index Improved Displacement Coefficient Method, custom-defined vulnerability functions: building damage estimation	Armaş et al. (2016b)	
		Armaş et al. (2017b)	
Semi-quantitative vulnerability assessment	Multi-criteria methods: - Social Vulnerability Index (SoVI model) - Spatial multi-criteria Social Vulnerability Index (SEVI model)	Armaş and Gavriş (2013)	Iaşi City
	Spatial multi-criteria analysis (based on AHP)	Armaş (2012)	
		Armaş et al. (2016a)	
		Bănică et al. (2017)	
Comparative semi-quantitative vulnerability assessment	Comparative multi-criteria assessment of 4 urban centres in Moldavia Region (based on AHP, Fuzzy AHP, TOPSIS and WPM)	Albulescu (2021)	Iaşi, Vaslui, Galaţi, Focşani Cities

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Evaluating seismic risk perception and preparedness in Romania through questionnaires designed to reveal geopatterns and attitude profiles

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Abstract. In order for strategies in seismic risk mitigation to be effective, they need to consider both the level of risk but also the needs and attitude of people subjected to the desired change. Questionnaires are one of the most common tools to assess the perception and preparedness of people to earthquakes, however we found that many designs and interpretations are limited to the obvious remarks and are not conceived or analyzed in ways enabling the determination of sociological profiles and geospatial patterns. Through this paper we show the potential of new questionnaire-based approaches and interpretations, highlighting aspects such as i) how well prepared in case of an earthquake people think and actually are depending also on their age, ii) does living in an area with high hazard values influences perception of risk and what is the difference between risk in locality versus individual risk, iii) is there a difference between how people with earthquake knowledge would behave in case of having an earthquake early warning solution compared to people with less knowledge or iv) which ways of communicating risk is considered more appropriate for different age groups. As input, we use more than 410 responses collected for most of Romania (out of which around half are for Bucharest Area), through two easy-to-fill online questionnaires: one focusing on earthquake perception as well as the level of knowledge and vision toward preparedness strategies, and another shaped as a checklist test, related to the individual level of preparedness.

Keywords: *earthquake, seismic risk, perception, Romania, preparedness, questionnaire*

INTRODUCTION

Attitude toward risk induced by natural hazards refers, in our view, to the way people perceive a certain risk (based on affective and cognitive response) and behave in order to mitigate its effects. This definition can be considered an adaptation of the theory of attitude proposed by Rosenberg and Hovland (1960). The fact that natural hazards such as earthquakes are unpredictable leads to ambiguity, which complicate the analysis of attitude, as compared to other domains where risk can be contained in more measurable parameters (economics for example). Event-relevant time-window analysis is of great importance, as attitudes toward natural hazards constantly change very much based on risk

experiences – lived or heard – and their lessons reflected in practice. The assessment of the knowledge level toward the phenomenon, its damage potential (both at a general and individual level) but also of measures taken to prepare can reveal important information regarding the willingness to mitigate the risk (Shou and Olney, 2020). When considering also location of the respondent and best possible hazard and risk estimates, attitude patterns can be further identified and justified.

By finding proper tools and methods to investigate the attitude of people toward seismic risk and the way they perceive and are prepared or willing to be prepared, we believe that we can aid in understanding how to design more efficient

measures for communicating, mitigating the risk and building resilience. The key to effective measures lies in understanding sociological profiles (e.g., what makes people not take immediate measures to reduce seismic vulnerability, in correspondence with what they know about earthquakes and where they reside) and trying to make a difference not only at the level of perception (e.g., educate people about high-risk exposure) but more at the level of reaction (e.g., convince people that they need to act immediately at personal and community level for increasing reducing the risks).

Various studies aiming to evaluate seismic risk perception and preparedness – some talking also about attitude toward risk – were performed worldwide. Among the most representative we mention Paul and Bhuiyan (2010), Vicente et al. (2013), Crescimbeni et al. (2015), Nicoll et al. (2016) or Oven and Bankoff (2020). These relied as starting point on one of the most common methods for collecting data – questionnaires. When looking at the analysis methods however, we found important limitations in design and interpretation (highlighted also by Bird, 2009), with few studies using cross-correlations to determine sociological attitude profiles or respondent location correlated with hazard and risk maps to identify geographical differences and the influence of living in high-risk areas.

In this study we present two questionnaires designed and interpreted in a manner to surpass the identified deficiencies. Responses were collected from only from Romania – European country with one of the highest seismic hazard and risk levels (Pavel et al., 2016, Toma-Danila et al., 2018 or Crowley et al., 2021), mainly but not only due to ground motion generated by intermediate-depth Vrancea earthquakes occurring at depths between 60 and 180 km, with magnitudes higher than 7, which can generate (considering also the high exposure and vulnerability) more than half of its territory. The straight-forward goal for these was to reveal the level of knowledge, preparedness and perception of Romania's population regarding earthquakes, but the research goal was to enable us, though statistical pivot analysis and geospatial analysis, to understand the public attitude toward risk, assisting to designing strategies with a more consistent impact on seismic risk mitigation. This

initiative aims to fill-in the gaps of previous recent investigations, such as Armas (2008), Armas et al. (2017), Armas and Gavris (2016), Calotescu et al. (2018) or Ionescu et al. (2021), limited either in terms of location (many focusing solely on Bucharest), number of respondents or methodological approaches. Nevertheless, there are compatibilities with these (common questions such as “Do you have an emergency backpack?”, among respondent profile typical questions such as age), setting premises for a joint response database analyzable also with reference to time dimension.

METHODS AND DATA

Responses were collected through two online questionnaires in Romanian, translatable as **“Earthquakes and You” (Q1)** and **“How well are you prepared in case of an earthquake?” (Q2)**. Both can be viewed and filled-in on the Earthquake Mobile Exhibition (MOBEE) webpage, at <https://mobee.infp.ro/chestionare>. Figure 1 shows their overall aspect. Google Forms was used to create and manage the questionnaires, being an easy to implement, free, reliable and responsive solution, allowing also spreadsheet download of individual responses.

Q1 is intended to reflect the perception, level of knowledge and preferred sources of information of Romanian people when it comes to earthquakes. It consists of 18 questions (among which 4 for determining respondent profile) and it has a 6-minute average filling time. Almost all questions are mandatory – with only 4 more complex (therefore potentially making the responder more reluctant to continuing the questionnaire) being optional. For this article we had 423 answers from all over Romania, with a distribution shown in below figures. A removal of duplicate answers was performed (pre-filtering), leading to the erase of 4 answers. Some answers were designed to act as validation or invalidation of self-evaluation, leading to the development of a sociological profile; by asking “How much you know about earthquakes?” and then asking three questions aimed to evaluate if the respondent does really have knowledge regarding earthquakes in Romania (“How soon you think that a next major earthquake could happen?”),

“What is earthquake magnitude?” and “In which areas are there earthquakes with damage potential?”), checks upon the confidence in earthquake knowledge were able to be performed. For this purpose, qualitative responses were turned in quantitative values based on an expert-judge based ranking system from 1 to 5, averaged and compared. By then making links with respondent location, age, perception of risk in their locality and

on themselves or declared reaction to an earthquake early warning alert, important observation regarding the perception and attitude toward seismic risk of specific groups of people can be revealed. Q1 also has questions referring to the preferred ways to receive information about earthquakes and what could convince respondents to take immediate actions toward preparedness – a critical issue in Romania.

The figure consists of three screenshots from a questionnaire. The left screenshot is titled 'Tu și cutremurele' (You and earthquakes) and asks 'Care sunt riscurile de care ți-e cel mai frică, în zona în care locuiești?' (What are the risks that scare you the most in the area where you live?). It lists various risks with checkboxes: Accidents rutiere, Accidents industriale/mine, Atacuri teroriste, Epidemii/boli contagioase, Inundații, Cutremur, Alunețări de teren, Incalcare globală, Căderi de meteo, and Altele. The middle screenshot is titled '10. Cât timp crezi că ai ține în primărie mesajul și reacția ta, așa cum ai descris-o la întrebarea anterioară?' (How long do you think you will keep the message and your reaction as described in the previous question?). It shows a scale from 0 to 15 seconds. Below it is a map of Romania divided into regions: Nord-vest, Nord-est, Centru, Sud-est, Sud, Vest, and Sud-vest. The right screenshot is titled 'Cât de pregătit ești în caz de cutremur?' (How prepared are you in case of an earthquake?). It shows a scale from 0 to 10 and a section titled 'Acum să vedem cum pe unde te situezi față de:' (Now let's see how you position yourself relative to:). It includes a question about having an emergency backpack and a small icon of a backpack.

Figure 1. Screenshots of Q1 and Q2

Q2 comes in the form of a test, with mandatory answers. At the beginning, respondents are asked to auto-evaluate themselves (on a 1-to-10 scale) in terms of how well prepared to an earthquake they think they are. Then, 10 questions are given, requiring a simple “yes” or “no” answer – each “yes” accounting as one “preparedness” point. Questions to the test are:

1. Do you have an emergency backpack?
2. Do objects in your home which could cause severe injuries (furniture, TV, central heating systems, paintings etc.) are well fixed?
3. Are heavy objects in your library or office placed on the bottom shelves?
4. Can you quickly shut-down the gas, water and electricity supply?
5. The bed where you sleep is away from falling objects (including the closet) or windows?
6. Can you tell in 5 seconds which is the safest place in your home, in case of an earthquake?
7. Have you got a functioning fire extinguisher in your home?
8. Do you have basic first-aid knowledge?

9. Prior to this test, were you informed about what to do in case of an earthquake?
10. Do you and your family have a joint plan in case of emergency situations?

Q2 has a 3-minute average filling time. 625 answers were available upon writing this article, making it more popular than Q1 (we almost always disseminated both links to audiences). Questions were initially tested against experts in the field who should have a higher preparedness level, and it proved to be very difficult for them to get the maximum of 10 points; this aspect is considered by us as positive, given that no one should consider themselves as perfectly prepared for a disaster, but acknowledge instead the need for continuous preparedness. The difficulty of getting the maximum points also set premises for identifying potentially malicious respondents. Given that 30 respondents (out of which 23 between 14 and 18 years old) had 10 points both in auto-evaluation and in the test or 0 points in both, their answers were removed, being rendered as false.

For both questionnaires, we asked at the end 4 questions referring to respondent profile:

- Two about county and locality of residence; a limitation in our collecting of geodata was not to add geolocation features, which would have provided a benefit, as long as the location would have been correct (as people not always fill in the questionnaire from their locality of residence). Since the launch of questionnaires, multiple script editors or plugins enabling the use of geolocation in Google Forms were launched. Also, other platforms have this capability, more and more important as respondents use mostly mobile devices with GPS.
- One referring to age group: <14, 14-18, 19-25, 26-34, 35-50, 51-70, >70 years
- One referring to sex: male or female

Although typical for most questionnaires, a question related to respondent's level of education

was not added, since we considered that in Romania the discrepancy between similar forms of education in various institutions can be considerable and our evaluation regarding the level of knowledge regarding earthquakes can provide a more relevant insight on the actual preparedness of the individual, with age also providing info to make differentiations.

Figure 2 shows the age distribution of the respondents, which has a good proportion of young, middle age and old people. There are 1.5-1.6 times more answers from females (which are generally more conscious in providing feedback to questionnaires); male respondents tend to have older ages than females, which might show the lack of interest for younger male on the topic of questionnaires. There can be seen the wider interest for Q2, which reflects preparedness evaluation to be the first priority for most respondents.

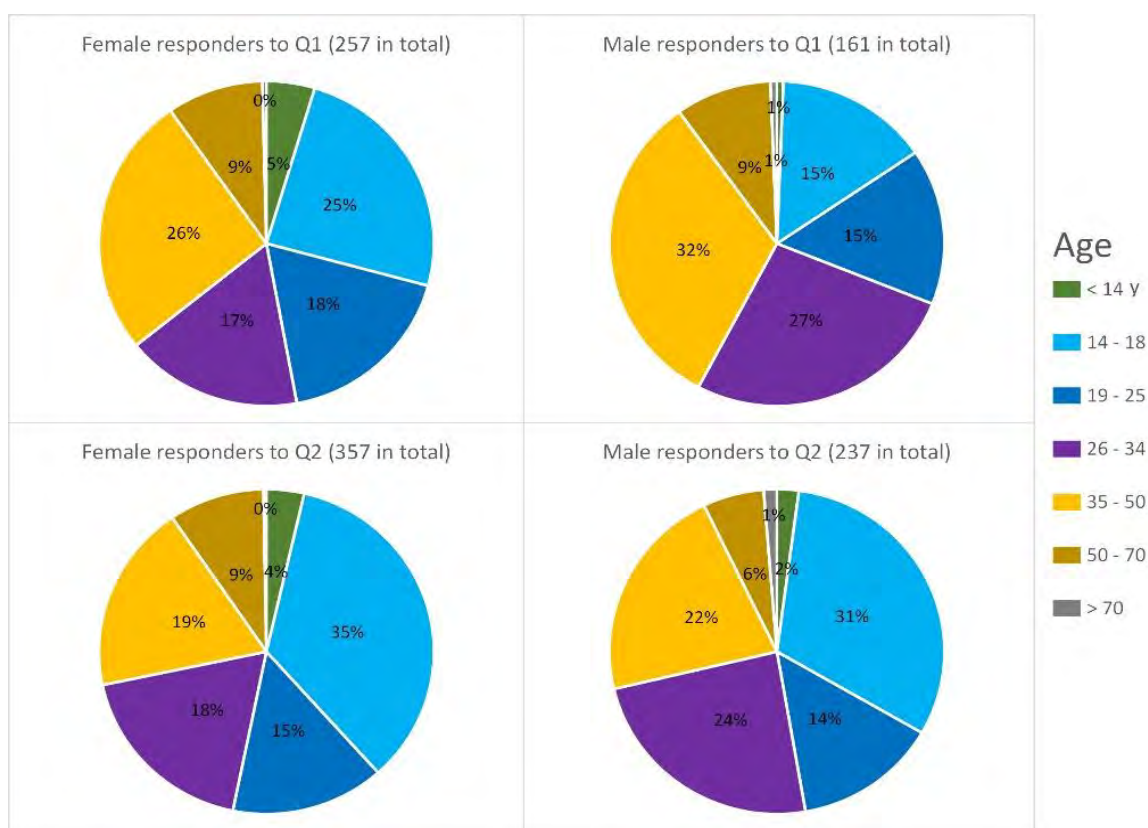


Figure 2. Distribution of respondents according to their age intervals and sex, for Q1 and Q2, as well as the total number of pre-filtered responses

The questionnaires were initially promoted on the INFP and partners social-media pages in 2018 (that is why 42% of Q1 and 38% of Q2 responses are from April 2018), but also later through

educational webinars and events. As such, the main sources for responses were Facebook subscribers of the INFP page, school students and teachers, participants to science fairs and scientific events or

people searching for earthquake preparedness information on the MOBEE webpage. By using the individual response timestamp (date when the answer was sent) and location, patterns related to events in particular schools, followed by surges of answers (or local scale advert), can be and were identified. For example, 50 answers in Bucharest and Teleorman county in January 2021 for Q2, after months with small and dispersed number of answers. No major or moderate magnitude earthquake occurred in Romania in the 2018-2021 period for which most questionnaire data is available; the interest after a considerable earthquake would have probably resulted in many answers from multiple counties. It can be considered that among the target audience are people more prone to have fresh information regarding earthquake and preparedness, providing a bias on the results; answers to the question “Where did you get and would get info regarding earthquakes?” provides some hints, about 65% of respondents declaring that they have information regarding earthquake from websites or initiatives of authorities. However, results interpreted through our methods showed that either some people weren’t paying attention to the information that they had just received, either they did not had time to prepare for an earthquake, answers to Q2 showing the level of preparedness before (hopefully) applying the mitigation measures just found out.

In order to analyze results and draw conclusions regarding the mentality of respondents we processed

spreadsheets with individual responses for the questionnaires with two software: Excel from Microsoft (relying heavily on PivotTable for cross tabulations) and ArcMap from ESRI for maps and geospatial analysis.

RESULTS

For Q1, the distribution and number of respondents (after removing duplicate answers) can be seen in Figure 3, in which we take advantage of the information regarding county of residence to perform statistics referring to the fear toward earthquakes and self-evaluated level of preparedness, in relation with seismic hazard. It can be clearly seen that people in areas with high hazard levels (usually similar also in terms of risk levels, given the overall high vulnerability of buildings in Romania) fear more about the earthquake. However, they did not declare to be more prepared in terms of information they have about earthquakes; on this aspect, people are generally modest. The fact that respondents in Timisoara and Arad counties, where earthquakes in 1991 generated significant panic and localized damage and loss of lives, do not report a moderate or high fear of earthquakes shows that, compared to well-known wide-spread dangerous intermediate-depth earthquakes in Vrancea, crustal earthquakes taking place not so often are of lesser importance in the perception of people (we would have said young, but all respondents in these counties were older than 25 years).

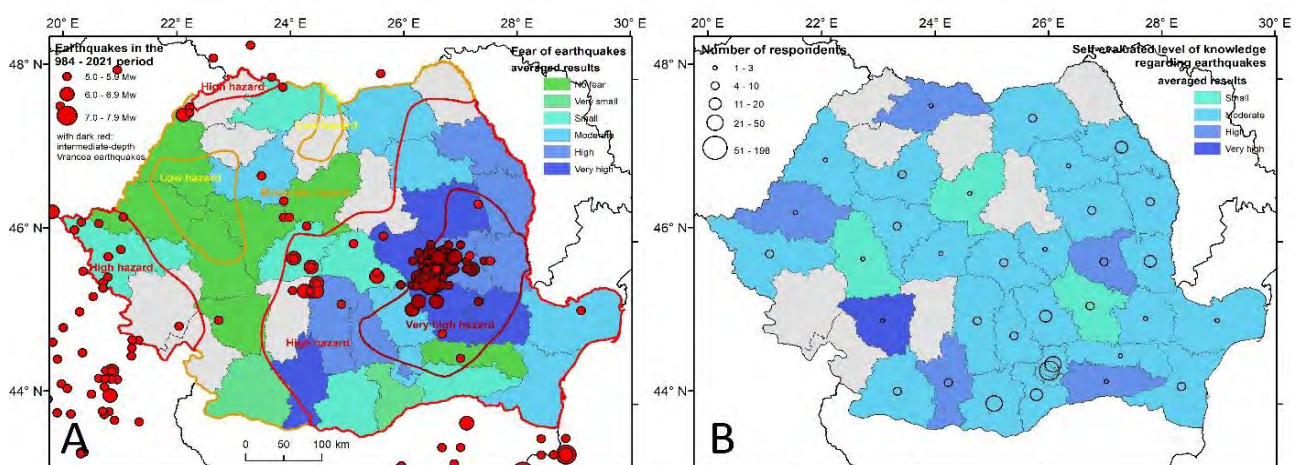


Figure 3. Maps showing averaged results for (A) the question “Which natural hazards are you most afraid of?”, overlapped with moderate or major earthquake epicenters (source: BIGSEES, 2017) and qualitative probabilistic seismic hazard results of the Ro-Risk Project (IGSU, 2017), for the 1:1000 period, and (B) the question “How much you think you know about earthquakes?”

Figure 4 shows results of averaged responses referring to the perception of earthquake effects in the locality of residence and at individual level. Especially in counties closer to the Vrancea seismic source, people acknowledged the higher damage potential; but many considered their situation to be better than the overall level of their locality – which partially shows a limitation in perceiving the non-neglectable influence of indirect damage.

As stated earlier, a validation or invalidation of self-evaluation, helping in the understanding of perception toward personal preparedness and the development of a sociological profile, was performed. Figure 5 shows the results. The averaged ranking

values from 1 to 5 were further reclassified in qualitative terms reflecting the level of knowledge, with further work being needed to justify some of the subjective decisions in the ranking process. It is interesting to see that most people considered that they have little or significant knowledge regarding earthquakes, but most were a level lower after answering three relevant earthquake-related questions. This generally shows that respondents were not influenced so much by the teaching or relation with INFP and its educational resources, even though for younger age groups, the distribution toward knowledge acknowledged is better.

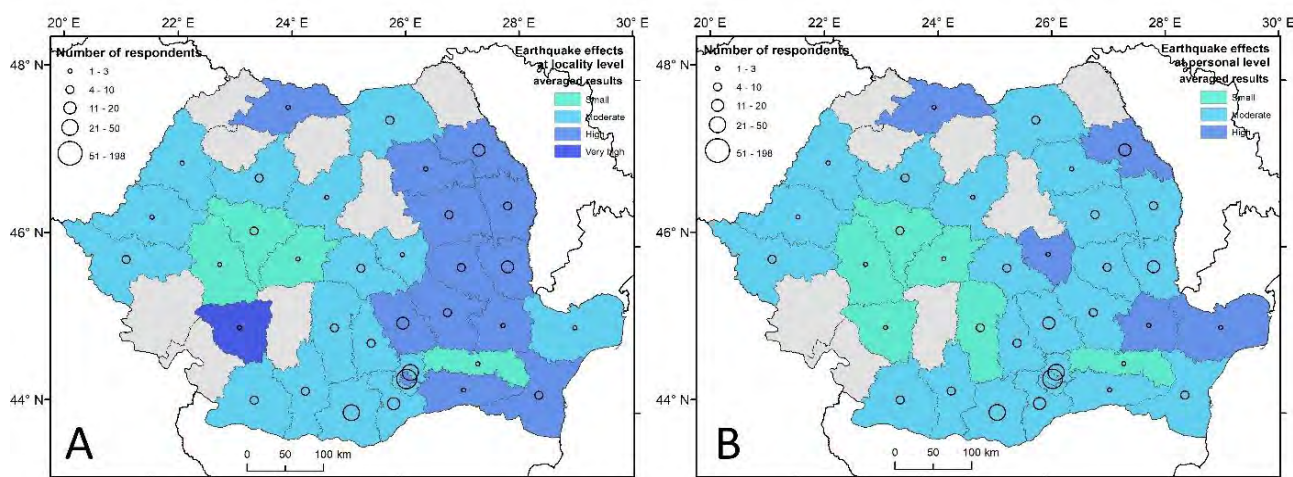


Figure 4. Maps showing averaged results for (A) the question “How significant could the effects of an earthquake be in your locality?” versus (B) “How significant could the effects of an earthquake be at personal level: on you, your family and residence building?”

The statistics showed in Figure 5 were used to analyze more in detail the profile of respondents to the question “You receive on your phone a message from the Romanian Earthquake Early Warning System (REWS; documented in Marmureanu et al., 2021), mentioning that an earthquake with magnitude 7.7 had just occurred in Vrancea Area; you know you should have around 20 seconds to do something. How do you react (if at ground floor, 2nd and 5th floor)?”. Our supposition was that people with a good knowledge regarding earthquakes would not declare to leave the apartment, even if at ground-floor level, this being a considered a dangerous behavior given also the limited notification time-window. However, there are more complex aspects to take into account. Regardless of knowledge about earthquakes, living in a vulnerable building clearly favorites the decision of leaving the building, so answers to the previous question (“How

significant could the effects of an earthquake be at personal level) would be relevant to also consider.

Responses, reflected by Figure 6, show that quite many people (40% in total) would be tempted to leave the apartment, if living at ground floor. People with a higher level of knowledge regarding earthquakes actually declared to be more in favor of leaving the apartment (also a visible maximum for the living at the 2nd floor situation), which shows both that they trust in their quick reaction, but also the limitations of their knowledge toward preparedness. Also, there is a conflictual believe in them, given that they also mentioned taking shelter under the door frame or under a table as good options. Fortunately, many people, regardless of their knowledge regarding earthquakes, declared that living higher in the building would not make emergency evacuation upon receiving REWS notifications suitable – at least declaratively.

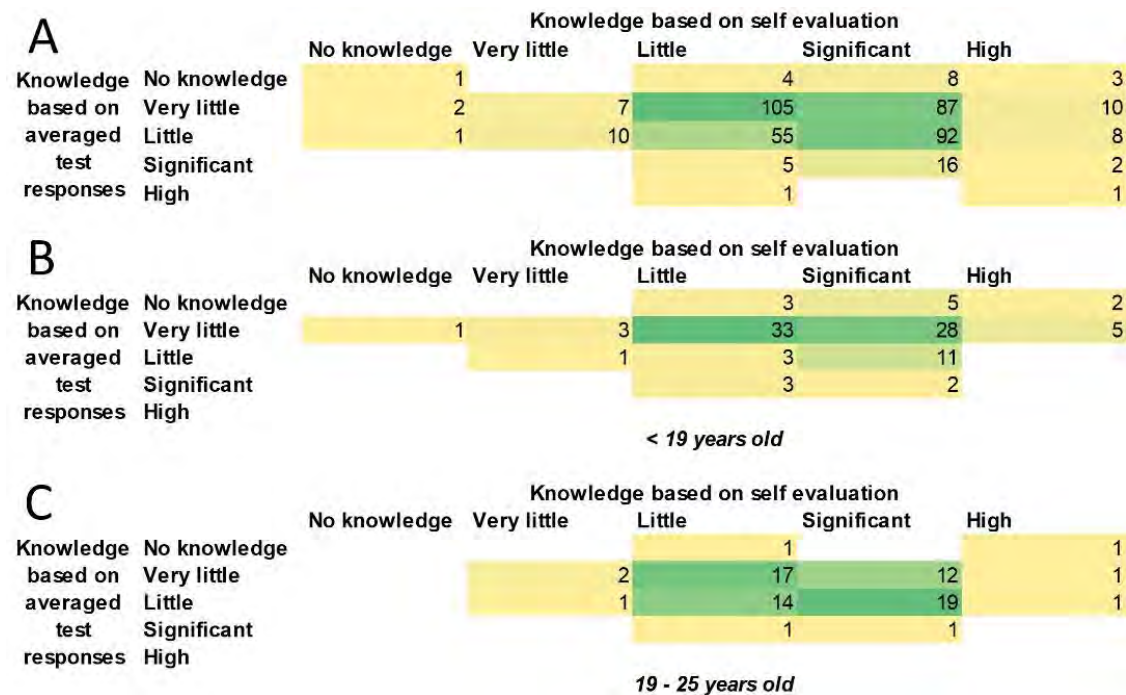


Figure 5. Relations between self-evaluated level of knowledge versus test-based evaluation of knowledge, for all respondents (A), for people younger than 19 years old (B) and between 19 and 25 years old (C). Values represent number of responses.

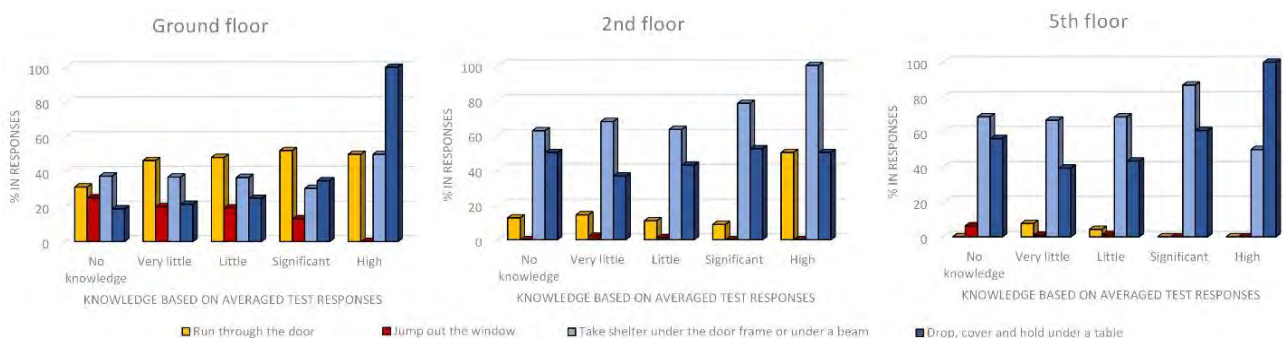


Figure 6. Responses to the question “You receive on your phone a message from REWS, mentioning that an earthquake with magnitude 7.7 had just occurred in Vrancea Area; you know you should have around 20 seconds to do something. How do you react (if living at different floor heights)?”

Figure 7 presents responses referring to what would convince people to take immediate measures to improve their safety to earthquakes. As it turns out, earthquake preparedness exercises are a top choice but also online risk awareness campaigns and a better understanding of earthquakes. Brochures, speeches or TV spots seem to be among the forms with the lowest mobilizing impact (TV especially for the young generation). A major or at least moderate earthquake in Romania would probably shake things also toward preparing for other earthquakes, but to see so many responses declaring that such an event would start what should be started in advance is worrying. In Figure 8 are

analyzed the answers to the question “Where did you get and would get info regarding earthquakes?”. Most answers refer to official websites of research and disaster management institutions (with a dominant role in the future) and YouTube videos, and not so many to museums or TV news. The impact of NGO and government initiatives seems very small in present, being more desired in the future by all age categories. Again, books or newspapers are less preferable as a source of information, also in the future, as digital devices take over. Real experiences – in schools, earthquake exercises or museum, are requested, but not as much as digital resources apparently which are instant to access.

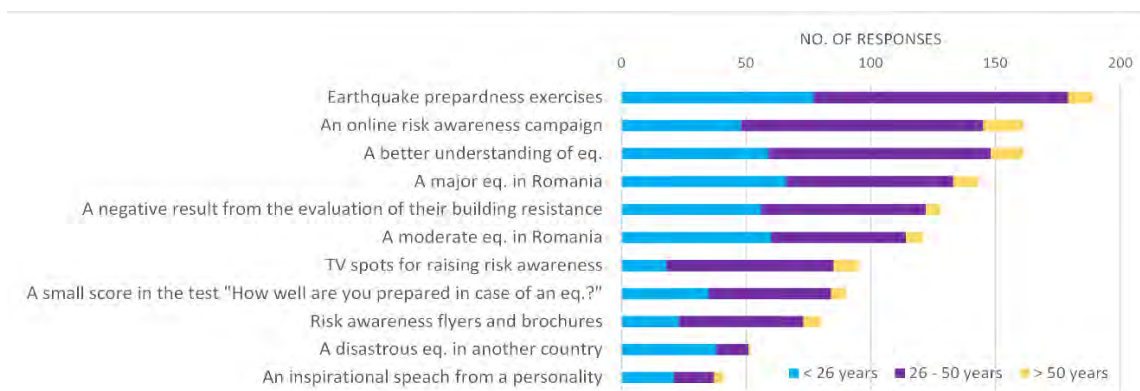


Figure 7. Responses to the question "What would convince you immediately to take measures to improve your safety to earthquakes?"

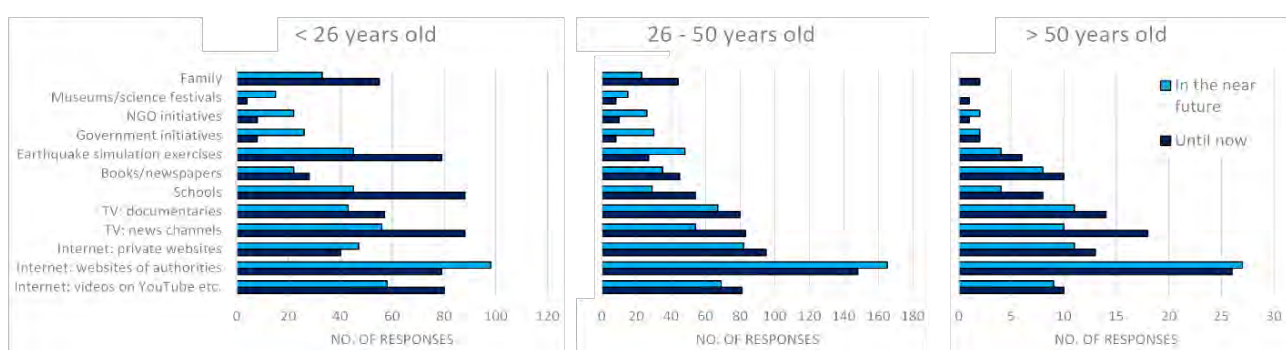


Figure 8. Answers to the question "Where did you get and would get info regarding earthquakes?"

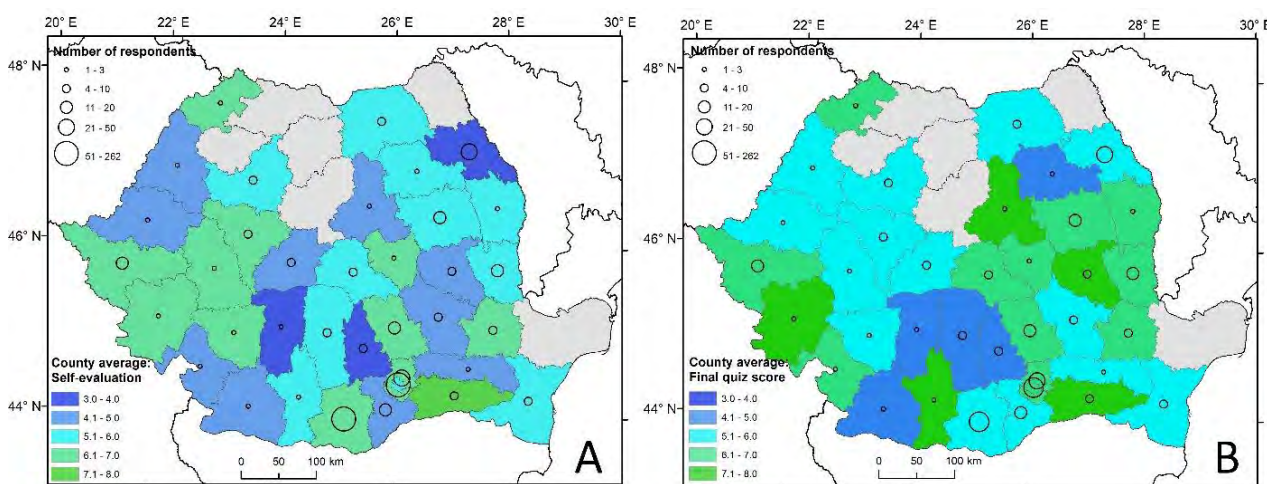


Figure 9. Average self-evaluation scores collected before the test (A) versus average scores obtained after the test (B)

For Q2 we had at least 3 respondents in 25 out of 41 counties plus Bucharest, making possible a preliminary evaluation of spatial correlations between the awareness and preparedness of people to seismic risk and their exposure. 44.1% of the total number of answers were from residents of Bucharest, 7% from nearby Ilfov county and 12% from Teleorman county; these are areas highly affected by the 1977 Vrancea earthquake and with a

significant level of seismic risk nowadays, so there are interesting conclusions to draw. Figure 9 shows, in comparison, averaged results of self-evaluation and averaged test results. As it can be seen, people are generally less confident about their preparedness level than they prove to be after the test – at least if they answered honestly. In many counties near the Vrancea Seismic Source (such as Vrancea, Bacău or Galați), this phenomenon is more evident, showing

that, at the level of perception, people are aware that they are not well prepared against a seismic hazard that they acknowledge.

Figure 10 reveals in more detail the distribution of scores as one compared to the other or per age groups. As mentioned earlier, the 28 answers with 10 and 10 scores seem a false information to be removed in interpretation – especially also because it belongs to very young responders which cannot possibly be so well prepared for an earthquake, especially since they did not experience a major one and can hardly imagine what needs to be done in critical moments. The typical self-evaluation score is 5, which corresponds to the trend which has been seen in Q1. Young people tend to consider themselves to be more prepared to an earthquake than they seem to be. For the majority of respondents, there is no significant difference in the self-evaluated score and their results (no more than

2 points), and the roughly linear distribution and the concentration of values in the 5-8 range proves that our test is well designed.

Through Q2 the analysis of frequently missed questions we can tell which are the least taken preparedness measures:

- **“Have you got a functioning fire extinguisher in your home?”: 85% answered „No” on average**, with no significant distribution per age group.

- **“Have you prepared an emergency backpack?”: 79% answered „No” on average**, although 61% of respondents under 14 years and 66% of respondents between 14 and 18 years old said so.

- **“Do you and your family have a joint plan in case of emergency situations?”: 68% answered „No” on average**, although people over 26 years old had lower percentages, around 63-66%.

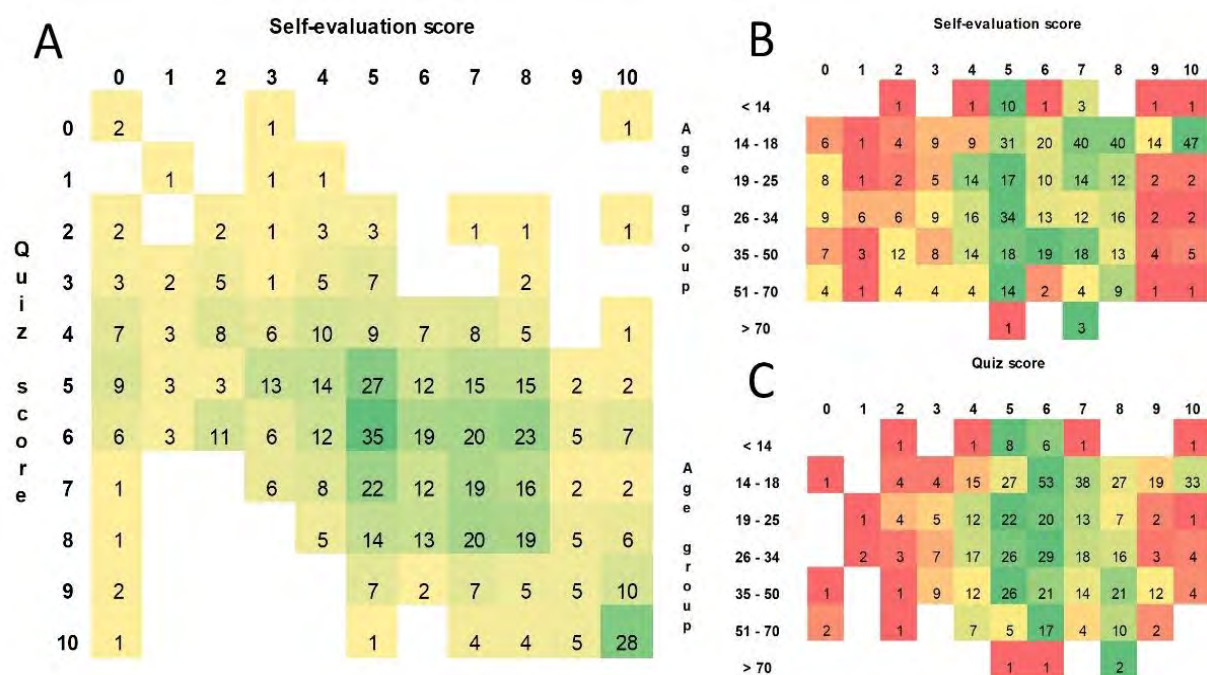


Figure 10. Matrix visualization of cumulative answers to A) self-evaluation scores versus final results and these scores depending on age group, colored according to min and max values distinctively per row (B and C)

CONCLUSIONS

This study introduces a new way of looking at perception and preparedness to earthquakes, showing its potential in telling a more complete story (also from a geographical perspective) about the people attitude toward risk and risk reduction.

Questionnaires have a long tradition in the field, but we show that new design (not necessarily making them long and complex) and interpretation can reveal important patterns which can contribute to better targeted and of greater impact mitigation efforts. By evaluating for example what people think they know and really know about earthquakes,

how well they are anchored in the seismic risk problem, considering their exposure, or what they consider to be of impact considering their age, we can be able to understand how to approach the “resilience to change” in terms of earthquake preparedness.

Results based on our two questionnaires can be considered preliminary and further responses, also from multiple target groups and a wider national focus, are needed. Still, there are important findings to mention, which we expect to be stable also after more data is collected:

- people closer to Vrancea seismic source (up to 200 km epicentral distance) are, as expected, more afraid of earthquakes. However, their level of preparedness is not higher compared to others. Many declare that at personal level they will not be as affected as the overall level in their localities, but even if this statement sustains, making them understand that their involvement in forming a resilient local community is highly needed is an important next step.
- respondents tend to be modest in self-evaluating their level of knowledge and preparedness to earthquakes (with young people overestimating their level a bit); generally, they prove to be right – with not many answering basic questions regarding earthquakes in Romania and preparedness adequately, even if some form of information prior to the test (from the MOBEE website or INFP initiatives for example) is to be suspected.
- if notified prior to 20 seconds that an earthquake is going to be felt (by the Romanian Earthquake Early Warning System), many people (regardless of knowledge level about earthquakes) answered that they would quickly leave the building, if being present at ground floor. If they would be at 2th or 5th floor, much fewer would try to leave. That is an important indication of why REWS notifications for large public is a risky decision, clearly needing to be accompanied by proper preparedness campaigns and regular emergency exercises, but also research toward the real behavior of people in earthquake situation.
- people answered that earthquake preparedness exercises, online risk awareness campaigns and resources and a better understanding of earthquakes would convince them to take

immediate measures to improve their safety to earthquakes. Classical forms of communication, via TV or flyers and brochures, doesn't seem to be relevant in the future, at least in terms of mentality.

This study doesn't stop here. By collecting more answers (also trying to reveal time-dependent differences), refining our interpretation process and making links with other similar initiatives in Romania but not only, we hope to better understand the seismic risk problem in Romania and proper ways to address it.

ACKNOWLEDGMENTS

The study was partially financed by the Pre-Quake project (number PN-III-P1-1.1-PD-2019-0969), supported by a grant of the Romanian Ministry of Research, Innovation and Digitalization, CNCS – UEFISCDI, within PNCDI III and by the MULTIRISC Project within the NUCLEU National Programme. We acknowledge the contribution of the MOBEE Project.

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Perception of medical resources during home isolation due to direct contact with confirmed positive patients with SARS-CoV-2

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Abstract. The COVID-19 pandemic started in December 2019 in Wuhan, China and the first cases in Romania were registered in February 2020. Those in the front line in the fight against the pandemic, the medical staff, were the most affected from a psychologically and physically point of view. This study examines the perception of medical staff in isolation after coming into contact with confirmed positive patients with the SARS-CoV-2 virus. The study identifies psychologically differentiated patterns of reaction and behaviour based on social and professional determinants.

Keywords: *perception, anxiety, social distance, SARS-CoV-2*

BACKGROUND

In May 2020, a patient diagnosed with intestinal occlusion due to a malignant colon tumor was admitted to the general surgery department of an important hospital in Bucharest, Romania. The patient came by transfer from a gastroenterology clinic, where she had been hospitalized for abdominal pain, being on cancer treatment. Arriving at the surgery department, the patient is identified positive for SARS-CoV-2 virus infection and dies shortly afterwards as a result of the associated diseases. In this situation, all medical personnel in direct contact with the patient in question, approximately 30 people from the clinics of gastroenterology, surgery, operating room and intensive care, are subjected to PCR-SARS-CoV-2 testing, starting on the first day, the 7th day and the 14th day of contact. The present study aims to identify the mental state and perceptions of isolated medical staff at home for 14 days. Fortunately, due to the wearing of individual equipment according to the protocol adopted by the hospital, no medical staff in this situation was infected with the SARS-CoV-2 virus.

METHOD

The research is based on semi-structured interviews with 5 open-ended questions. The questions were aimed at capturing the conditions experienced by the medical staff involved in contact with a patient infected with the SARS-CoV-2 virus. Out of the 30 people considered direct contact with the patient confirmed positive, 24 people answered this questionnaire. The professional categories that responded to the interview were primary care physicians (4.16%), resident physicians (12.52%), nurses (41.66%), nurses (25%), stretchers (16.66%). Of these, 75% are women and 25% are men, aged between 28 and 55 years.

The interviews were conducted on-line, through the WhatsApp application, or face to face, between June 15, 2020-July 2, 2020.

The questions on which the interviews were conducted are listed below:

1. When you found out that you were in direct contact with a positive confirmed patient with SARS-CoV-2 infection, what were your first thoughts?
2. What conditions did you go through when you found out that you could be contaminated or that the test could be positive?

3. What emotions did you experience when you waited to get the SARS-CoV-2-PCR test?

4. Do you believe that you have taken all precautions responsibly, for the safety of yourself and your family during the exercise of your duties?

5. Has the head / management of the unit or colleagues been interested in your health?

RESULTS

Based on the interviews, the following emotional states of those isolated at home were identified as a result of a possible infection with the SARS-VOC-2 virus:

- Increased anxiety from the first moment of the news of the infection.
- The alternation of fears and worries about the possibility of infection throughout the isolation.
- Periods of intensification of negative emotions that led to a deterioration of the mental and physical condition of the interviewed subjects, to a state of continuous alert, with behavioral reflection.

- Prevalence of concern for family or oneself.
- Differences in status in the manifestation of social cohesion and support from colleagues and hospital management.

In order to be analysed, the open responses were classified into response categories summarized in the following tables, supplemented with suggestive examples.

Regarding the question “What emotions did you experience when you waited for the SARS-CoV-2 PCR test to be performed?”, Most people experienced fear, up to fear (84%), tab 1. Others (16%) experienced anxiety, impatience, emotions, such as butterflies in the stomach (4%), while 4% felt alone (especially women) or looked at the situation with detachment (4%), predominantly female. In an analysis of the distribution by sex, men went mainly through states of anxiety and impatience when finding the answer (16%), while women went through more nuanced states of fear, loneliness, sadness (68%).

Table 1. Frequently asked questions:

“What emotions did you experience when you waited for the SARS-CoV-2 PCR test”?

R1	a	b	c	d	e	f	g	h
Frequency (%)	40%	8%	4%	16%	20%	4%	4%	4%

Where: a) Fear, b) Fear of the unknown, c) Sadness, loneliness, d) Impatience, anxiety, e) Fear, f) Strong emotions and somatizations like: “butterflies in the stomach”, g) I looked forward to the result, h) Detachment

Here are some examples that illustrate the above statements:

- “I felt very sad, alone, as if it wasn't me ..., I didn't represent anything for the other colleagues, except for a number, an application code ..., as if I was a stranger you wouldn't want to have anything to do with ...”
- “a very unpleasant experiment, I sat with fear in my chest ..., fear and worry ..., feelings of panic and fear ..., feelings of horror ...”
- “the feeling was of fear, not necessarily for me, but for those at home ..., anxiety, fear, frustration ...”

Some respondents focused more on fear of procedure, emotional “freezing,” or even interest / curiosity (men). E.g: “I waited with interest ..., a little uneasy, because I understood that the harvesting procedure is quite unpleasant ..., a feeling of detachment ..., I had no anxiety, but no happiness ...”

To the question: “How did you feel when you found out that you could be contaminated if the test was positive?” most people (40%) experienced fear and powerful emotions such as fright, while others experienced fear and worry (24%) at the thought that they may be contaminated. Few people 4% felt angry, especially women, and experienced feelings / emotions described as terrible and somatizing (“I felt very bad”, 24%). Only a small proportion of those affected experienced an 8% sense of acceptance, and they were all female.

16.66% of the interviewed people showed a feeling of guilt towards the family, that it could contaminate them, and these people were all female. A higher percentage of men went through fear and anxiety (44%), while women went through more depression (28%), a small part accepting the situation as such (8%).

*Table 2. Frequency of answer categories to the question:
“How did you feel when you found out that you could be contaminated if the test was positive?”*

R2	a	b	c	d	e	f	g
Frequency (%)	20%	20%	24%	4%	8%	16%	8%

Where: a) Dissatisfied, b) Scared, c) Fear, worry, d) Angry, e) Terrible, desperate, f) Depressed (sometimes with somatization), g) resigned

We present below some selected examples that reproduce the respective states as expressed by the respondents:

- “a little scared, afraid for the family ..., I froze, very scared, afraid that I might make my family sick ..., I felt terrible, my family could be contaminated, I am being directly responsible ..., fear and concern for one's own health but also that of the loved ones ...”
- “at that moment, it was even harder, when I found out that I was in direct contact ...”
- “if I sneezed sometimes, I thought that I must have been positive ..., sometimes I didn't seem to have a taste anymore ..., I tested the perfumes ..., what can I say: an indescribable fear, it continues ...”
- “For a short time at first, I was anxious for fear that if I became infected, I could spread the disease if I was asymptomatic, if I became infected and symptomatic I would give in to God's will ...”

All these answers were given predominantly by women, respectively 76.66% of the total women

who answered the questionnaire, but also by men (stretchers – 16.66%). Those who felt guilty about their family were mostly nurses (41.66%), between 35 and 48 years old, with 1-2 small children at home. The subject who showed a completely altruistic attitude was a 32-year-old unmarried female doctor. Few answers were as follows: “Honestly, I felt safe as long as I had the necessary protective equipment ...”, “I accepted this possibility without anxiety or fear ...” These types of responses belonged to subjects aged 35-40 years, married, nurse, without children, both women and men.

The next question was about the emotional states experienced by the subjects. Negative emotions that overwhelm us at some point, such as those in the event of a pandemic, also have consequences for our behavior and relationships with others. Identifying negative emotions allows for better control of them with physical and mental benefits.

Table 3. Frequency of answer categories to the question:

“What were your first thoughts when you found out that you were in contact with a confirmed positive person?”

R3	a	b	c	d	e	f	g	h
Frequency %	8%	48%	4%	12%	12%	4%	8%	4%

Where: a) Sadness, b) Thinking about family, c) Panic, d) Security emotions, e) Contamination, f) Feelings of fear, g) Feelings of fear, h) No thoughts

Taking into account the fact that 75% of the interviewees are women, it is observed that most of the women were thinking about the family (48%), and of these a percentage of over 16% had reasoning that showed a strong attachment to the family, for example, “I have to stay away from my family, and I can't stand separation.” Among men, 12% had first thoughts about family or experienced feelings of panic or fear. Only 4% of those surveyed did not experience any thoughts or emotions, perhaps indicating a mental block as a result of the shock created by the news of the possible danger of infestation, so they could not think of anything.

Some of the responses also highlighted proactive “test me” behaviors. The first thoughts identified by the participants were in the following register: “I kept in mind the protection measures taken and the people I came in contact with, I identified all those I had contact with, to warn them and to isolate myself”. Rational thoughts such as “I thought I was equipped at the entrance to the operating room, and the possibility of infection was still lower” were expressed by women doctors, aged 30-32.

One person, a woman, a 32-year-old doctor, who lives alone, with the possibility of isolation, experienced optimism and confidence: “I was glad

that I could rest more at home, and if I had come out even symptomatic, I would have received it just like any other disease, God willing, obviously it would not have been a pleasure, but I would have resigned myself to the disease and taken treatment”.

Answers to the question “Do you think that you have taken all the necessary precautions with responsibility for the safety of your family?” are shown in Table 4, showing that only a small percentage, 24% of respondents consider that they have not been adequately protected.

Table 4. Frequency of answers to the question:

“Do you think that you have taken all the necessary precautions with responsibility for the safety of your family?”

R4	no/ not always	yes
Frequency (%)	24%	76%

Regarding the ratio between women and men, it is 3 / 1.6, women showing a more responsible behavior (22.22%). Taking into account the professional categories, the doctors stated that they took all the precautions and behaved in a proportion of 50%, and the nurses reached a share of 85%, probably also as a result of the closer contact on who have it with the sick, 25% stretcher bearers and 25% nurses.

Examples of answers are given below:

- “No, it could have been better, but I chose to be with my family, because it was too late to make any decision to isolate myself from my family.”
- “yes, I think I took the necessary measures, the best, I equipped myself properly, according to the established protocol”, “I isolated myself in my room.”

- “I have tried and continue to try to protect myself and those around me as much as I can, this is the only way we can keep this very aggressive virus under control, which has changed the meaning of life for all of us to an unimaginable extent. !”
- “not always ... the suit is impossible to wear for more than 2-3 hours ... I preferred the thought that it is possible to get infected than to have syncope or lipotomy due to lack of air!”

To the question “The head of the unit / the management of your unit or your colleagues were interested in your health, how did you feel during this period of isolation at home?” the answers drew attention to a situation of disharmony and attitude split at the level of the hospital units in question, showing a weak valorization of certain professional categories.

Table 5. Frequency of answer categories to support questions:

“Did the head of the unit / management of your unit or colleagues take an interest in your health?”

R5	no	yes
Frequency (%)	54.16%	45.83%

The vast majority of subjects with the position of nurse, stretcher bearer or nurse experienced a lack of support from management and colleagues. Respondents argued their lack of support as follows:

- “no, the management probably stayed at home!” Suggesting a hostile attitude toward the management in response to the perceived indifference, or
- “no one called me, I was very sad” or “no, unfortunately, which made me even more depressed”, highlighting disappointment and loneliness.

On the other hand, all the doctors, and especially the resident doctors, answered in the affirmative to this question, indicating the support of the hospital management and colleagues.

This result is not only a reflection of prejudices and attitudes still operational in society, but also draws the attention of hospital managers to the inconsistency and lack of cohesion of work teams. On the other hand, we have only one positive example, that of the *Anesthesia Care Team* – operating room, which shows solidarity, cohesion and support for their colleague, a nurse, in isolation at home (“yes, colleagues called me every day to

encourage”). At the level of gender reaction, young men, doctors, mostly showed a proactive attitude, stating that they kept in touch with their bosses or colleagues, while 55.55% of women had a passive behavior, withdrawal and loneliness.

CONCLUSIONS

The case study looked at the conditions experienced by medical staff in an exceptional situation of possible COVID-19 contamination due to direct contact with a patient confirmed positive for SARS-CoV-2 infection. The interviews revealed a growing concern and constant anxiety in most of the respondents, although most of the interviewees considered that they were adequately equipped during their interactions with the patients.

There was a predominance of negative thoughts, fears and worries throughout the period of isolation at home, especially among female subjects, who preferred to withdraw from the community. Looking at things from the perspective of social relations, with colleagues, with direct bosses, a difference was observed depending on the professional status of the subjects. For example, all doctors responded that they kept in touch with their colleagues and direct bosses (they called and were called by them), while the other professional categories involved (nurses, nurses and stretchers) had negative experiences regarding the relationship with their bosses or colleagues. The latter were even more concerned about family safety.

Gender and diversity in geosciences related Union session at the European Geosciences Union General Assembly in Vienna 2019-2021

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Abstract. Review of the sessions related to gender and diversity at the EGU Gas in Vienna, both on site and online.

Keywords: *Women in science, geoscience, inclusion*

OVERVIEW

The European Geosciences Union (EGU) is an international academic association in the fields of Earth (geo), planetary and space sciences. Its forerunners were the European Geophysical Society and the European Union of Geosciences, which merged in autumn 2002. Each year, a General Assembly is convened for a week, featuring sessions proposed in a bottom-up manner by conveners together with co-conveners, in line with the 22 scientific divisions. The first author attended the General Assemblies of the European Geophysical Society in 2001-2003 in Nice, France, and, since 2004, many of those held by the EGU, in 2004 in Nice, and since 2005 in Vienna, Austria. In 2020 and 2021 there were online editions. Attendance exceeds 15 000 from over 100 countries. There is a strong sub-division on Natural Hazards and Society, where the first author's session (on natural hazards and urban planning) was featured. In addition to this session, the first author held one in 2006 on materials of cultural heritage, and another in 2017 on role model women in geosciences. The most long-lasting series of sessions on women in geosciences was that on the initiative of the European Research Council (ERC), although there were other sessions in parallel, and

in 2017 both were featured on the same day in EGU flyers.

There was a Union Session in 2019 (Promoting and supporting equality of opportunities in geosciences, Co-sponsored by AGU – American Geosciences Union – and JpGU – Japan Geosciences Union, Convener: Claudia Jesus-Rydin | Co-conveners: Alberto Montanari, Robin Bell, Chiaki Oguchi, Lily Pereg (deceased)), after being held several times in 5 years. The session was opened by Alberto Montanari, JpGU and AGU representatives. Since 2014, gender data are collected on EGU nominations and awards. The session has been held since 2016. In 2018 there was also a Splinter meeting. Since 2018, there has been an EGU working group. In the strategy, in addition to several other measures, there is one on naming medals and awards after women. The target is to have women exceed 30% of nominations and awardees. Alongside the Union symposium, there was also an ordinary session (Diversity and Equality in the Geosciences, Co-sponsored by AGU, EAG, and JpGU, Convener: Claudia Jesus-Rydin | Co-conveners: Holly Stein, Liviu Matenco, Jill Karsten, Tim van Emmerik). Badges with gender-related symbols were distributed. The Union session was live-streamed. Information on the ordinary session is featured here.

FIRST PART OF THE UNION SYMPOSIUM – GENDER

The first speaker (Erika Marín-Spiotta) #MeTooSTEM stated we should treat our people better than our data. After that, AGU devised a diversity and inclusion strategic plan (December 2018). ERC contribution features women as 17% of submissions. Success rates for women were presented.

Jill Karsten presented her career. AGU – 40% of membership from outside the USA. Members were asked about the topic via the annual survey. Goal 1 “change the culture”. Goal 2 “Improve the climate”, Goal 3 “Empower the membership”, Goal 4 “Be leader for Diversity&Inclusion”, Goal 5 “Be a model organisation”. There is a new standing and advisory committee on D&I.

In the discussion it came out that leadership is important. Other topics were: reverse bias (women more easily accepted?), the role of societies, one is valued on grants and publications and not on how inclusive teaching is, and how to encourage non minorities to attend events about minorities.

2ND PART OF THE UNION SYMPOSIUM – WIDENING

There was an introduction by EGU’s president Robin Bell, who has been working in geophysics for 35 years and has been seeing the change.

The 1st talk (Giulio di Toro) tackled underperforming countries in research, and featured an example sourced from ERC data. There are no Italian universities in the top 200. 50% of researchers remain in Italy with ERC-related activities. 15 years ago, ERC awardees got permanent positions and direct calls to bring researchers from abroad. Discussion: the problem with strict research sector designations, what to do to attract residents from Eastern countries.

The 2nd talk (Barbara Romanowicz) touched on women under-representation in the submission stage: success rate is not a problem, underperforming countries at both submission stage and success rate from over 10 years of data. The gender equality plan includes sessions at EuroScience Open Forum; EGU; EMBO,

participation to gender summit. There is a widening working group (ERC visiting fellowships – national initiative of 9 countries, costs are covered by sending institutions). Women tend to be underestimated. FP7 Grantees: 20% are women. H2020 – 27%. The success rates now became comparable. In life sciences, women still have a poorer performance. Panels aim to stimulate dialogue with scientific societies. The majority of evaluated proposals are from EU15 and PL HU RO from EU13. Mobility does not mean brain drain, but brain circulation. Major losers of ERC are TR and RO (no inflow), many grantees are already abroad. Winners are CH and AT. Closing of the speech was on how to encourage women and EU13. This means concrete measures at EGU: courses during lunch breaks when most people can attend.

The 3rd talk (Liviu Matenco – Romanian, now in Utrecht) covered normalised publications, authors etc. for East and West, EU15 and EU13. People from the East have 6 times higher collaboration rates with the West than the other way around. There is scientific integration and scientific nationalism (recently in the East). Publications are high in the East despite up to 0.3% GDP investment in research. Participation in the EGU is questioned and not all authors come to EGU. The problem of funding is also questioned. The East goes to Scopus listed conferences. There are very few Eastern EGU leaders (West selects West). There is only 1 of 133 in leadership positions from the East. But the East represents more than 30% of Europe. The correct name would be Western European Geosciences Union and guests. Western colleagues consider those in the West with an Eastern passport to be the solution.

THE ORDINARY SESSION

This time it included role models, but papers were still largely statistical. The contribution of professional societies was highlighted, such as Institut de Physique du Globe (IPGP) Equality Group (EG) (where an MCAA event also took place).

The EGU awards committee was featured with a poster.

There was a paper on AGU Fall Meeting showing women are more rarely oral and one on

AGU 2014-2018 compared with membership. One more paper with AGU members was mentioned.

A role model paper was oral.

“Experiences when trying to manage two ambitious careers and a family” by Ylona van Dinther from Utrecht University was on international mobility and dual career.

Posters

Two more role model papers were presented in poster format.

“Reclaiming the memory of pioneer female geologists – digging deeper” by Aude Vincent, ENSEGID Bordeaux INP. Help to women came more often from parents than from husbands, and many times this ended in celibacy and having female mentors.

“Being a mother and a scientist: the experience of a senior scientist” by Catherine Chauvel Institut de Physique du Globe de Paris, Paris, France – professor and mother. Some women look for a more stable position before having children.

“Examples of recommendations in the hiring process of professors” by Frédéric Herman, Université de Lausanne, presented the fact that if less than 30% are female candidates, the position gets readvertised.

“In Austria, there is no female full professor in any field of geosciences” told Franz Neubauer.

Other topics included the education of girls in Israel and a festival programme for minorities in the green city of Bristol. A workshop on gender issues in hydrology was held in Bristol in February 2019.

didthisreallyhappen.net: Promoting gender equality in academia through comic strips (from more countries) gathered 40 testimonies.

According to JpGU, women hold fixed term positions up to 5 years longer than men.

This time, the Splinter meeting could only be attended via invitation. A reception took place.

There was a short course on unconscious bias attended by 40% men.

DIGITAL EDITIONS (2020 AND 2021)

EGU2020: Sharing Geoscience Online (#shareEGU20) was open to anyone, the authors just had to cover the abstract fee, but there was no

registration. Two sessions were featured in Educational and Outreach symposia (EOS).

The first session was the traditional EOS6.1 “Promoting and supporting equality, diversity and inclusion in the geosciences”, co-sponsored by AGU, JpGU, and EAG, Convener: Claudia Jesus-Rydin | Co-conveners: Raffaele Albano, Lisa D. White, Liviu Matenco (who presented again the East-West differences and discussed with the first author), Chiaki Oguchi, over two blocks, which were featured as chat. One month before the conference and one month afterwards, it was possible for anyone to comment the displays and get answers from other commenters and the authors. The first author followed the session and wanted to highlight that there was a display on the MCAA (Marie Curie Alumni Association) GEDI (Gender, Equality, Diversity, Inclusion) group by Ira Didenkulova, who is running a Humboldt Networking Initiative on role models including women in geosciences at the EGU. EGU policy and facts and figures were presented on several displays. Another noteworthy display aimed to realise an exhibition of posters on role models of pioneer women in geosciences. Another highlight was “Moving from Latin America to Germany: challenges for a geoscientist family” talking of fixed term positions, like “Mind matters” on mental health connected to this (the first author now participates in a COST action on “Researcher mental health”, which deals with these problems). The second session was EOS6.2 “Enabling Women in Geoscience: Inspiration, Challenges and Best Practice”, Convener: Madeleine HannECS | Co-conveners: Sarah Boulton, Jodie Fisher, Daisy Hassenberger. The format was the same.

#vEGU21: Engage • Discover • Inspire was different. This time there was more time to prepare the virtual conference, and zoom presentations were permitted. The diversity and equality programme was richer, and to a certain extent also focused on obtaining the overseas perspective. Firstly, a short course on “Promoting diversity in geosciences” took place.

Similarly to 2019, there was a great debate, namely a union wide session “Challenging discrimination in the geosciences: amplifying unheard voices” showing the EGU policy.

Volume 6, 2021



GeoPatterns

“Science is the millennial endeavor to identify the underlying patterns that form our world and explains the interconnectedness of the natural and social systems.”



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Convener: Helen Glaves | Co-conveners: Hazel Gibson, Claudia Jesus-Rydin. Like the 2019 Great Debate, this one was also recorded and made available on the conference webpage (egu2021.eu; for the previous egu2019.eu). The EGU policy was visible from 2021 in the EDI label to sessions (equality, diversity, inclusion), which reflected if a session had conveners from different countries, genders and career stages.

The traditional session “Promoting and supporting equality, diversity and inclusion in the geosciences”, Co-sponsored by AGU and JpGU, Convener: Claudia Jesus-Rydin | Co-conveners: Anouk Beniést, Chiaki Oguchi, Billy Williams, featured vPICO presentations. PICO is a presentation format promoted by the EGU as an alternative to traditional oral and poster formats, where an oral presentation is seen as higher recognition than a poster (and this is also a topic discussed during this session, namely gender diversity in oral presentations). In-person PICO presentations used a tablet-like screen with a touch surface to present the different slides on screen while the speaker stood next to it as during poster presentations, after a short oral introduction of 2 minutes. With the vPICO format, each presenter had one image slide like a poster for a 2-minute presentation, followed by zoom rooms for discussion with session participants. Since the first author was a conference participant as well as a presenter in other sessions, this format could be experimented with and compared to PICO attendance in other years in Vienna. However, in 2021, participation to the EGU was restricted to registered participants, although there were huge

reductions for low income scientist categories depending on career stage and country.

But the real highlight of the vEGU 2021 was the screening of the film on gender and diversity. In previous years, the geocinema concept was used. This was discontinued several years ago, but had a comeback in 2021, among other elements. The film titled “Picture a scientist” was screened twice over several days. It was not unknown to the first author, a Marie Curie alumna, as it was also screened by the GEDI working group of the Marie Curie Alumni Association (MCAA) previously. MCAA GEDI is the successor of the MCAA GEMS (Gender Equality for Mobile Researchers in Science) working group, on behalf of which the first author organised said session on role model women in geosciences. “Picture a scientist” is a 2020 documentary on gender inequality in geosciences, biology, and chemistry (the latter associated to racism as well) mainly overseas. Geoscientist Jane Willenbring took part in the panel at the great debate recorded at the conference, and the film was discussed after the screening. While the women scientists were at different stages of their careers, having tenure gave them the courage to speak up. Jane Willenbring’s complaint made the Marchant glacier get renamed due to early harassment exercised by David Marchant on her trip to Antarctica as postgraduate student. The film is available on Netflix, as is the recording of the great debate on the webpage. Although they are not as interactive as the projection and the event held at the conference, where participants were able to ask questions to the speakers, they provide anyone interested in the topic the chance to passively enjoy one of the conference’s highlights.