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## EDITED BY

Derek Keir,  
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United Kingdom

## REVIEWED BY

Karoly Nemeth,  
Institute of Earth Physics and Space  
Sciences, Hungary

## \*CORRESPONDENCE

Giuliana Rubbia,  
giuliana.rubbia@ingv.it

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# Natural hazards and earthquake science: Gender matters

Giuliana Rubbia\*

Istituto Nazionale di Geofisica e Vulcanologia, Milano, Italy

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## 1 Introduction

Gender equality in Earth Sciences is gradually increasing. Looking back at the past twenty years, positive trends have shown an increase in the number of female full and associate professors, like in Italian Universities, from 9.0% to 18.5% and from 23.6% to 28.9% respectively (e.g. [Agnini et al., 2020](#)); the progress seen is steady but slow<sup>1</sup>. In United States universities “the fraction of women in the faculty pool decreases with rank, as women comprise 46% of assistant professors, 34% of associate professors, and 19% of full professors” ([Ranganathan et al., 2021](#)); similar patterns are reported in Australasia, with 26:74 ratio female:male researchers ([Handley et al., 2020](#)).

Like other stakeholders, scientific societies such as the European Geosciences Union through its DEI Group<sup>2</sup> ([Jesus-Rydin et al., 2020](#). Eds., 2020) and the Seismological Society of America–JEDI Task Force<sup>3</sup> ([Velasco et al., 2021](#)) are recently championing this topic with noteworthy programs, that represent a relevant trend compared to the past; the intergovernmental partnership Group on Earth Observations–GEO begun to reflect on the diversity of its organizational structure and to promote networking with other initiatives ([GEO, 2021](#)). Most of the ongoing work is aimed at balancing the current imbalance in the field. The special issue “Women in Seismology 2022” of Frontiers in Earth Sciences itself gives voice and visibility to those who generally have less, both as authors and editors (e.g., [Henriques and Garcia, 2022](#)).

However, counting the figures of male/female researchers and implementing actions to rectify the situation do not exhaust gender issues in (Earth) Sciences. Therefore, shall we continue reasoning about the integration of gender in research content, where the scenario appears still challenging.

Notions of sex and gender need to be preliminarily clarified. Sex refers to biological characteristics while gender refers to socially and culturally constructed norms and behaviors, and the concept varies over time and in different countries. For example, women and men react differently to toxic chemicals. In general, the female body is more

1 “Steady but Slow Progress on the Long Road Towards Gender Parity” by Eric Davidson, AGU Advances Editor, <https://eos.org/editor-highlights/steady-but-slow-progress-on-the-long-road-towards-gender-parity> (Accessed 21 July 2022).

2 EGU Diversity, Equality and Inclusion DEI working group: <https://www.egu.eu/structure/committees-and-working-groups/edi/>.

3 SSA JEDI: Justice, Equality, Diversity and Inclusion Task Force.

vulnerable to these substances. “Females carry greater reserves of fatty tissues than males, making them generally more vulnerable to the impacts of fat-soluble chemicals. On the other hand, in many societies, men may be at greater risk of exposure to toxic chemicals because they are exposed more often than women to such substances in their workplace” (Korsvik and Rustad, 2019, p. 9). More examples can be found in (EC, 2020).

Moreover, to achieve real benefits for science and society, an effective approach should not limit to analyzing a variable only, i.e., gender, but instead should include more sociodemographic factors, overlapping or intersecting categories, such as gender, ethnicity, age, socio-economic status (Tannenbaum et al., 2019), being the approach referred as intersectional<sup>4</sup>. Obviously, this does not mean an ‘add and stir’ approach, but rather requires a full shift in mindset (UNWomen, 2022), with significant achievements (e.g., Lorente-Marrón et al., 2021; Hall et al., 2022; Luna and Hilhorst, 2022).

## 2 Gender in impacts, patterns, and roles

Disaster studies have grown and academic publishing on the subject of Disaster Risk Reduction (DRR) increased (Alexander et al., 2021). In this area, many papers refer to “population” or “people” when dealing with engagement, impact and perception, thus missing the identification of differences and peculiarities regarding biological and social aspects. On the other hand, scholarly papers and reports of various organizations, illustrating case studies and approaches with a gender perspective became more frequent in recent years; specific reviews and bibliographic resources such as CGD, 2021a, CGD, 2021b, Erman et al., 2021 provide a variety of examples. A few case studies follow to frame the discussion.

Regarding exposure and vulnerability, for example, a large-scale survey after the 2009 L’Aquila Central Italy earthquake revealed “a significant association between suicidality and male gender in Post-Traumatic Stress Disease–PTSD survivors, suggesting (...) that men tend to express psychological disturbances through acting out and external behavior, whilst women tend to express their distress by turning their feeling inwards, leading to depression and anxiety” (Carmassi et al., 2020). Modena et al. (2017) observed that clinical events, induced by stress, recorded during and after the Emilian plain of Northern Italy 2012 earthquake were very different between women and men. Moreno and Shaw (2018) discussed

vulnerability and resilience and examined changes in gender relations in El Morro, a fishing village with a patriarchal organization hit by the 2010 Chile earthquake and tsunami: women spontaneously expanded their skills from a domestic/household level to a community level by creating a community kitchen thus “transitioning from a passive role of “victims” and “rescued” during the immediate emergency to the role of “active agents” during the recovery and post-disaster”. Álvarez-Díaz, 2018 attempted to analyze if and how gender had affected the mortality of women during the 2017 earthquake in Mexico City; he inferred that reasons to explain higher mortality among women would be “the division of labour by gender, the type of building that collapsed, the time of earthquake”. Something more than a mention would deserve the ascertained risks that women face in post-earthquake; transactional sex as surviving strategy and assaults in displacement camps are mainly documented. Thurston et al. (2021) provide a review of natural hazards and Violence Against Women and Girls–VAWG.

Regarding risk perception, Avisati et al. (2019) performed a surveys analysis on different risks in Campania (Italy), a densely populated area exposed to multiple hazards; results highlight that historical memory plays a crucial role in hazards perception, knowledge of hazards and responses to emergencies vary with age and gender, the knowledge of men and women being similar in the area, with men tending to have higher values. Di Baldassarre et al. (2021) compared two countries, Italy and Sweden, about public perceptions of multiple hazards including earthquakes. Here again, a greater perception of risk emerges if the phenomena are in recent memory; exploring the role of sociodemographic factors such as gender, age, and orientation, being male and older, in addition to having a center-right or right political orientation, was generally associated with a lower perceived likelihood and impact (Ibidem, p. 3433).

A study in Bangladesh revealed that “female respondents perceived more risks, lack enough knowledge, and will less capable of controlling the upcoming disasters than the male” (Mallick et al., 2022, p. 1651). Luna and Hilhorst (2022) wear gender and intersectional lenses to outline an analysis based on interviews with women who experienced the 2015 Nepal earthquake, and among which Luna herself is a survivor. From their stories, we learned that “the earthquake challenged patriarchy and changed gender norms and roles to some degree. During and after the earthquake, women took on roles previously reserved for men, especially in cases where men had lost their businesses and jobs, were stranded elsewhere, or died in the disaster. Women performed roles both inside the home (taking care of children and family) and outside it (supporting their families’ needs) and gained new confidence” (Ibidem p. 8.). Regarding education, a study in Japan revealed that “formal disaster education alone is not sufficient, and informal (or soft) measures of disaster preparedness are crucial in saving lives” (Petraloli and Baars, 2022, p.3).

<sup>4</sup> An intersectionality lens can help examine multiple intersecting identities. “For instance, a Dalit (untouchable) woman from Nepal will experience the impacts of disaster differently to a Brahmin woman. Likewise, it is not just women. A Dalit man from a poor economic background may be more vulnerable than a rich woman from a higher caste family.” (Yadav et al., 2021 p.4).

Griffin et al. (2020), dealing with expert elicitation for seismic hazard assessment in Australia, argued that a biased distribution of personal attributes such as gender or institutional background in an expert pool invites one to consider the extent to which the distribution of scientific opinions may be similarly biased.

### 3 Gender and citizen science

Citizen Science (CS) in Earth sciences has grown with various applications (Lee et al., 2020) and Citizen Seismology (Chen et al., 2020) as well. In the exchange between experts and non-experts (volunteers, participants, contributors), CS both complements activities run by expert scientists and at the same time has educational value (e.g., Diaz et al., 2020). Patterns of contributions and demography of contributors to CS projects appear not known comprehensively (Ibrahim et al., 2021) nor extensively examined unless a few cases in the United States and United Kingdom contexts (Paleco et al., 2021); an analysis of Zooniverse's CS projects revealed female volunteers' underrepresentation in most countries, while in the online United States platform SciStarter 2.0 the majority of profiles were female aged 35–44, with other CS projects showing higher percentages of white, educated, retired women. To participate in life science CS projects "intrinsic motivation is most important, especially for women and older people", while "extrinsic motivation may, in contrast, prove more helpful when targeting men and younger people" (Lakomy et al., 2020, p.14). The Did You Feel It–DYFI data collection (Quitoriano and Wald, 2020) varies according to internet access and socioeconomic status of participants (Hough and Martin, 2021), and "much more could be done—much of it the purview of sociology—not seismology—to understand both whether and why people choose to submit reports to DYFI" (Hough, 2021, p.7).

### 4 Discussion

The Sendai Framework for Disaster Risk Reduction 2015–2030 - SFDRR (UNDRR, 2015) provided a set of guiding principles, including a call for the integration of a gender perspective in DRR policies and practices across the world. Critiques and recommendations followed, including expanding the definition of gender by overcoming the male/female polarization, taking into account sex and gender minorities (Rushton et al., 2019), and therefore using gender and vulnerability as being pertinent to both sexes and other genders (Gaillard et al., 2017). suggested to reflect on gender minorities in disasters; they show "specific patterns of vulnerability associated with their marginal positions in society, yet, importantly, also possess a wide array of endogenous capacities". "Some "warria", i.e., gay in Indonesian,

on the occasion of Mount Merapi 2010 eruption, reported they "chose not to stay in temporary shelters, but instead to seek help from and stay with friends for fear of facing discrimination and hostility in the evacuation sites". After an initial upset, they offered free haircut and makeup services, receiving appreciation from evacuees and felt hope that "people would change their perspective and attitude towards" them. Widespread use of the term "gender vulnerability" largely about the vulnerability of women contributes to a narrative which is partial and "detracts from the important role of women as agents of resilience and risk reduction and gives the idea of gender vulnerability as being somehow exclusive to women, thereby promoting stereotypical notions of women as "victims" or the "weaker sex"" (Zaidi and Fordham, 2021, p.2).

In literature, weaknesses of current approaches are summarized as: 1) gender "still operates largely as an add-on"; 2) gender "is looked at as binary but often reducing it further to just women and women are seen as a homogeneous category and intersectionality is largely ignored" 3) "the consideration of gender within DRR policies and practices is imagined within traditionally defined gender roles, which serve to promote and reinforce gender stereotypes, such as women as vulnerable victims" (Yadav et al., 2021, p.2). It is recommended to increase "emphasis on the production of sex-disaggregated data and gender statistics, including technical capacity and providing financial support to collect disaggregated data" (Zaidi and Fordham, 2021, p. 5). More disaggregated data are needed, including Sex, Age, and Disability (SADDD), according to UNDRR (2021), collected at the global/local level with the methods suggested by UNWomen (2021), to better understand differential risks and impacts.

In recent reflections on disaster science, Yadav et al. (2022) asked the critical question: "if the faces of global disaster victims are people of the Global South, why have the faces of the disaster scholars remained predominantly Western?" where Global South refers to Latin America, Asia, Africa, and Oceania and Western to Europe and North America. The overriding need includes going well beyond "siloe thinking" (ISC-UNDRR-IRDR, 2021, p.9), legitimizing and mainstreaming all sources of knowledge, and defining research objectives in a participatory process with all stakeholders, "always advocating for more inclusive production and sharing of knowledge in disaster studies and DRR, and fairer relations between scholars regardless of their ethnicity, gender, and socioeconomic conditions" (Cadag, 2022, p.6). Indigenous knowledge has an important role in avoiding undesired impacts from hazards. In Indonesia, local knowledge highlights that the material for building houses needs to be flexible and recommends bamboo, coconut roots, and leaves to withstand earthquakes (Kurnio et al., 2021, p.7)

The adoption of the Gender Equality Plan framework (EC, 2021) in disaster science research has been proposed by Tagliacozzo and Di Tullio (2021), who suggested measures to be implemented for gender equality in the research community,

transposed from those available for research institutes and universities.

In 2022, on the occasion of the Mid Term Review of SFDRR and the stakeholder consultation, UNDRR provided gender guidance (UNWomen-UNDRR-UNFPA, 2022) suggesting questions about progress and trends and related opportunities and good practices, since “inadequate attention has been given to the ways in which gender inequality drives disaster risks and impacts” and because “our collective progress to achieve the goal, outcome and targets of the Sendai Framework can be accelerated by promoting gender-responsive and inclusive disaster risk reduction” (Ibidem, p.1).

Most of the contributions including gender perspectives cited here are first authored by a woman. Women are more numerous in social studies. Some come from feminist studies. And we can wonder if they are more sensitive to these topics. Critical positions, arguments, and suggestions are intended to improve the *status quo*.

Gender dimensions in Earth Sciences span over multiple domains, inherent in the lives of both scientists and citizens and in science-society interactions. Although some basic concepts have been set in the past, we are still at the beginning of the process. Gender must be understood in a broader sense.

What can be drafted from these observations and could help to move forward?

Future research developments will benefit from a variety of perspectives, methods, and transdisciplinary approaches. Scholars should co-share commitment and responsibility to start working on these aspects right away. As stated above, gendered approaches should include a variety of sociodemographic factors and minorities as well, which vary over countries (IPSOS, 2021) and may be hidden (Pachankis and Bränström, 2019). Gender issues must not be considered just women’s issues.

Gender competence should become “a basic competence of all stakeholders” in an institution or project, this competence meant “the recognition of the relevance of gender attributions in one’s own work and sphere of influence”, connected to “the willingness and ability to deal with these issues in day-to-day work and study life—if necessary, supported by gender experts (...) and to take actions (...)” (Wroblewski, 2021, p.6).

We can argue that women scholars in Earth Sciences would foster this transition. It is vital that women scientists—with the

concrete support of male colleagues—contribute to this process and their voices go heard.

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