

REPORT

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A report on gender diversity and equality in the geosciences: an analysis of the Swiss Geoscience Meetings from 2003 to 2019

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1 Foreword and motivation

The importance of an equal, inclusive and diverse research ecosystem is indisputable. The second half of the twentieth century was characterized by a progressively rising awareness on the necessity to work on a more gender-balanced social structure. As a result, during the last few decades increasing attention has been given to the topic “gender and science”, underlining how much careers in science and academia are still subject to gender discrimination. The growing interest and the urgency for change are attested by the large number of commissions and working groups on the topic in national (e.g., Swiss Federal Council, Swiss National Science Foundation, National Science Foundation, USA) and international organizations (European Commission, UNESCO) together with a flourishing number of publications in international journals addressing the problem (e.g., Bernard and Cooperdock 2018; Fassa and Gauthier 2010; Hong and Page 2004; Medin and Lee 2012; Nelson and Cheng 2017; Studer 2012; Wenham et al. 2020). In Switzerland, programs dedicated to promote gender diversity and equality in academic research are supported by the Swiss Federal Government since the beginning of the 2000s through four successive “Equal Opportunities in University” programs. Targets and recommendations

have been defined by the Swiss National Science Foundation (SNSF), the Swiss University Conference (CUS) and the Rectors’ Conference of Swiss Universities (CRUS) (Dubois-Shaik and Fusulier 2015; Dubach et al. 2017).

The clear and principal observation is that the proportion of women in academia progressively decreases with advancing career stages (Fig. 1a). This phenomenon is known as the “leaky pipeline”, which affects all research field, but is particularly accentuated in the STEM (Science, Technology, Engineering, Mathematics; Fig. 1b) disciplines, with the geosciences representing the least diverse of all (Bernard and Cooperdock 2018).

However, as highlighted by the Swiss committee of the *Gendering the Academy and Research: combating Career Instability and Asymmetries* project (GARCIA project, <http://garciaproject.eu/>), the scarcity of reliable data on the different positions in academic careers makes it difficult to analyze the problem, assess the reasons and provide solutions.

Data availability is therefore essential for establishing a constant monitoring of the gender diversity and equality evolution in the various academic categories.

With this report, we wish to contribute to the understanding of the progress made in the geosciences by looking at the gender representation at the Swiss Geoscience Meeting (SGM). The SGM has been held every year since 2003 and it represents a continuous dataset for gender of participants, providing a portrait of the status and evolution of the gender distribution in Swiss Geosciences over the last 17 years. In addition, participants belong to both fields of geology and geography, giving the opportunity to evaluate both vertical and horizontal gender segregation.

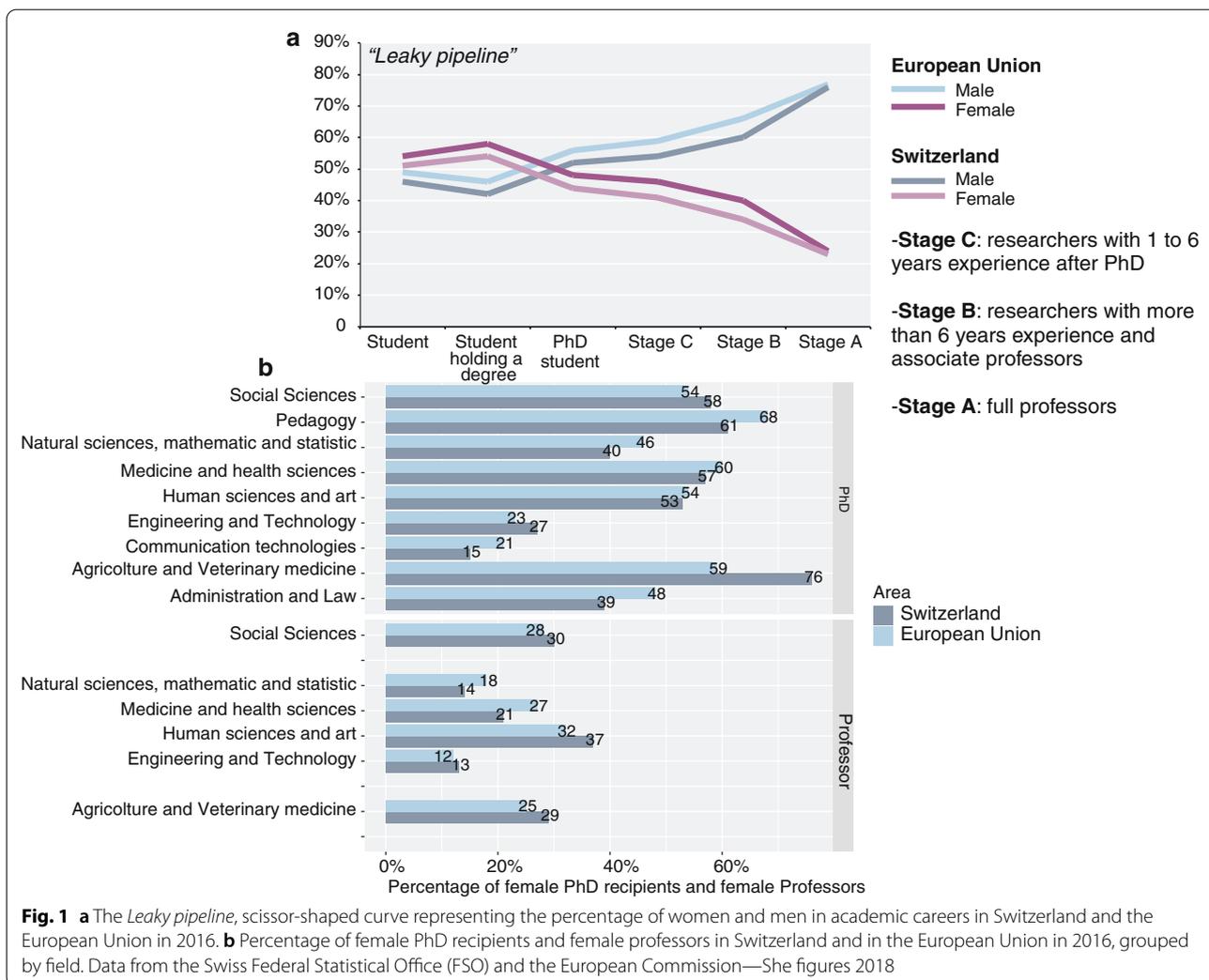
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2 Methods

We compiled the dataset based on the available information on the SGM web pages (<https://geoscience-meeting.ch>), as well as from attendance lists provided by the organizing committee. Unfortunately, information on the academic position of the first authors are incomplete, thus mainly general trends will be discussed. On the other hand, it was possible to gather the total number of students (Bachelor, Master and PhD) attending every year since 2005. Attendance lists (which include both online and onsite registration) are available only since 2005, whereas we could retrieve contributions and session conveners information since 2003. Contributions (talk and poster) have been attributed to male or female considering the gender of the first author. Contributions from the same author (i.e., talk and poster) were accounted as individual contributions. As a consequence, in some case the sum of contributions is higher than the number of participants.

Session conveners/chair persons were accounted only once if chairing more than one block of the same session. Data related to program and local organizing committees were collected from the SGM web page. Unfortunately data of the program committee members of 2015, 2018 and 2019 are missing, whereas the local organizing committee lists are always complete. We noted that sometimes the member listed in the local organizing committee and program committee on the website does not coincide with the list reported in the abstract volume. For consistency, we always use data reported on the website.

3 General observations

Since the first edition of the SGM in 2003, the number of participants has more or less steadily increased, reaching a maximum of 809 in 2018 (Fig. 2a). The total number of students per year (i.e., BSc, MSc and PhD students, Fig. 2b) represents around 40% of the participants each

year with no particular trend with time. The remaining c. 60% consists of advanced career scientists. For the same time period, the number of oral and poster contributions more than quadrupled from 119 in 2003 to over 500 in 2018 (Fig. 2c). The number of conveners and chair persons steadily increased over the years, from around 20 to 30 in the early years (2004 and 2005) to 188 in 2019.

Considering the gender distribution, women are a minority among the participants, though their representation in percentage at the SGM increased from 25% in 2005, to around 30% since 2012, reaching a maximum of 37% in 2019 (Fig. 2a). Noteworthy, female and male populations at the SGM are significantly different in terms of participants, with the first being largely composed of students (BSc, MSc and PhD), and the second by scientists (academics with PhD degree) (Fig. 3a, b). This is also illustrated in Fig. 3c, d, where it can be observed that female scientists are always less than 25% (with two exceptions, 27% and 32% in 2017 and 2019, respectively), whereas female students are ca. 40%. Considering that the percentage of female students (around 40%, Fig. 3d) is in line with the general proportion of female and male students within the geosciences in Switzerland (Fig. 4a–c), this inverted proportion of students and academics in the female population compared to the male population suggests a significant drop out of female students after the PhD.

Female representation in talk and poster contributions has always been higher than 20% and reached 40% in 2019 (Fig. 5). Noteworthy, female representation in talk and poster contributions mimics the trend of total female participation (Fig. 2a), suggesting that females ask for, and are assigned, a talk or poster presentation with the same frequency as their male colleagues. In contrast, among session conveners and chair persons, although increasing, the percentage of female representation has been above 20% only since 2016 for conveners and only since 2018 for chair persons, and has never been higher than 28% (Fig. 6).

4 Role models and decision-making positions: plenary conveners & speakers and program and organization committees

Possible reasons why female students are more likely to drop out from STEM disciplines compared to other disciplines are the lack of female role models and the gender

imbalance in decision-making positions (Herrmann et al. 2016; Kearney 2000). To tackle this point, the gender representation in committees (Fig. 7) and scientists under the spotlight, such as plenary speakers (Fig. 8), has been analyzed. Within the SGM, data are available for the local organizing committee and the program committee. The first one represents the local committee of the hosting institution in charge of organizing the event and the plenary session, and is different every year; the second one represents the scientific committee responsible for organizing the sessions and coordinating the scientific contributions, and its members have limited variations from year to year. In both committees, female representation is in most cases significantly lower than the total number of female SGM participants, especially for the program committee where in 6 out of 14 analyzed years it is below 7%, and is in general always below 20% (with the exception 2012 with 22%), versus a female participation of around 30% at the SGM (Fig. 2a).

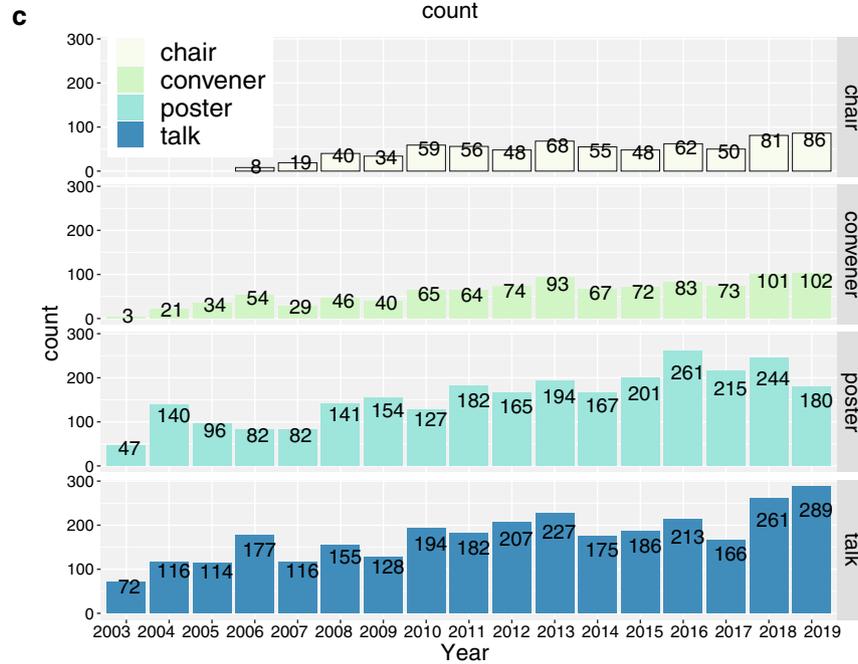
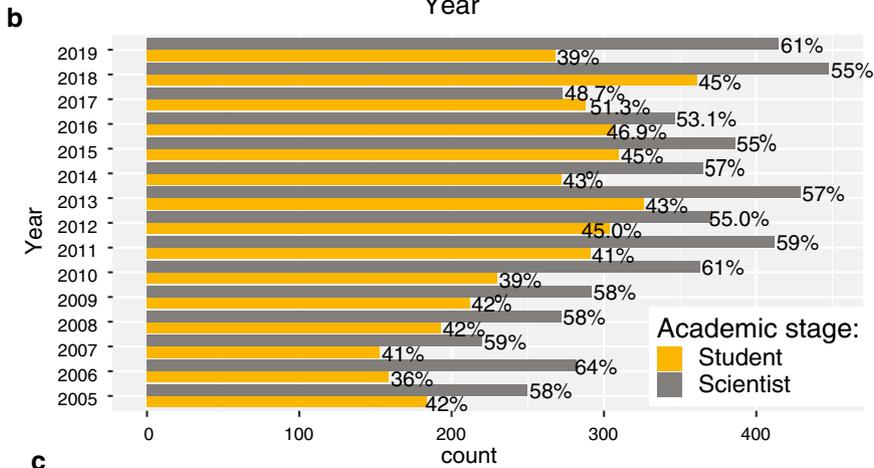
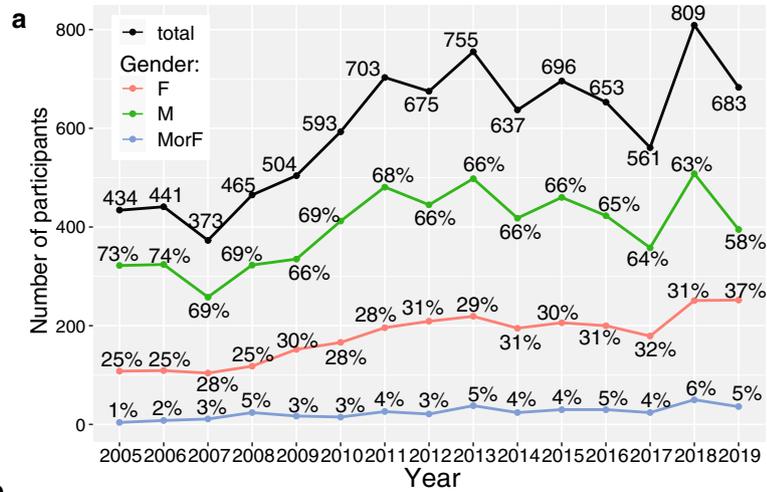
The plenary session represents an opportunity to offer diverse role models to undergraduate students and junior scientists. Data show that in 6 of the 17 analyzed years, the invited plenary speakers were exclusively males. In all but two years, the gender balance was not matched and women were always under-represented both as speakers and chair persons (Fig. 8). The two exceptions are the 2017 edition (hosted by the WSL-Institute for Snow and Avalanche Research SLF, Davos) when 4 of the 5 plenary speakers were female and the 2018 edition (hosted by the University of Bern), where a 50% perfect gender balance was achieved. It is worth to highlight that in 2018, the host institution established a gender quota for plenary speakers and chair persons, showing that achieving this target is indeed possible.

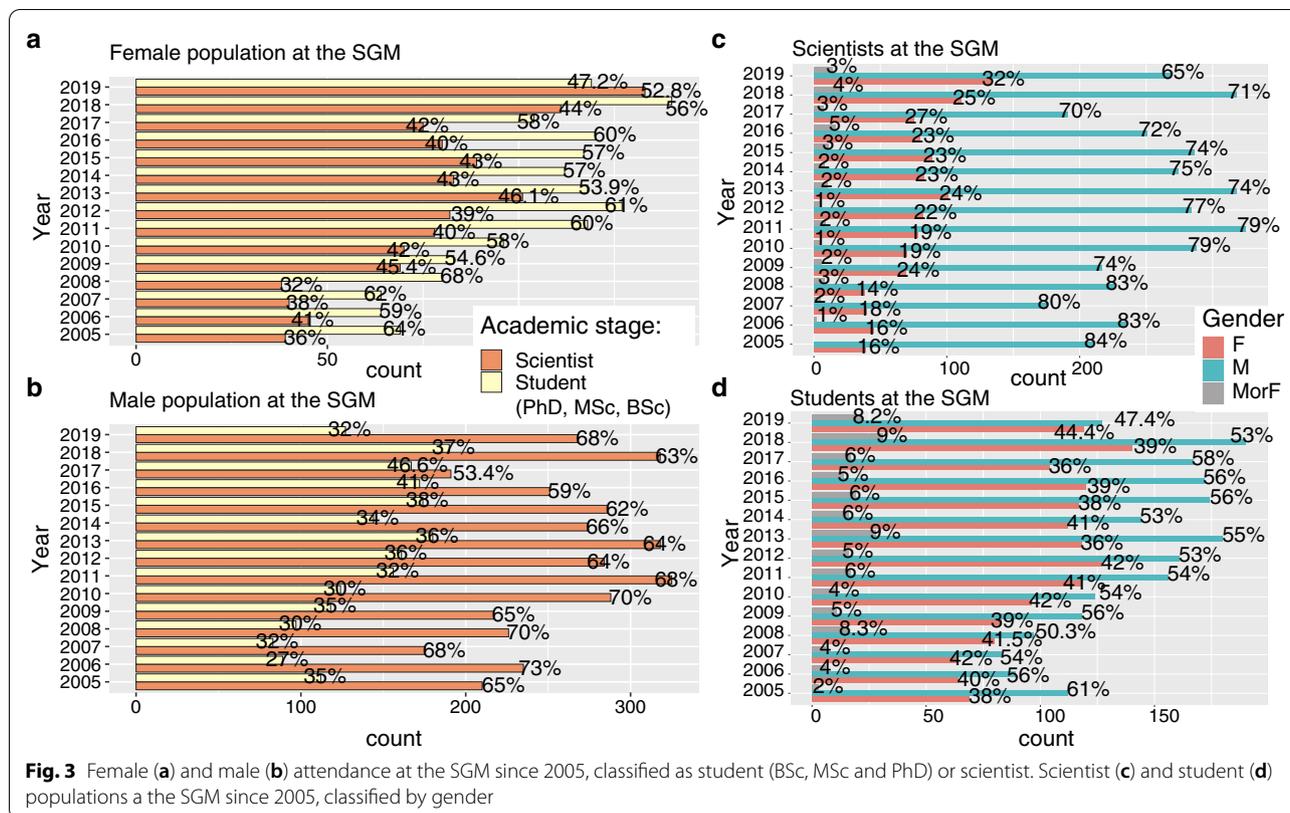
5 Assessment of horizontal gender segregation

The literature emphasizes a prominent horizontal gender segregation in academic disciplines, with almost no improvement in the last 20 years. Gender integration is found to be particularly slow in the STEM (Mann and DiPrete 2013; Thébaud and Charles 2018). Figure 4 shows that gender representation among Earth Sciences students in Switzerland significantly improved over the last 17 years, and the number of female students increased of 10%, reaching a perfect gender balance for BSc and MSc students (close to 50–50) and a good balance (43–57) for

(See figure on next page.)

Fig. 2 Evolution of the participation to the SGM. **a** Number of participants since 2005 (black line) and number of male and female participants (green and red line respectively). Percentages of male and female participants per year are reported on the graph. Participants for which we were unable to retrieve the gender information are classified as Male or Female (MorF, blue line). **b** Total number of participants since 2005 classified as student (BSc, MSc and PhD) or scientist (senior scientists). **c** Bar diagram showing SGM participants classified according to type of contribution (talk or poster) and role as chairperson or session convener





PhD students. However, in our survey, we found a great deal of variability in the gender diversity in the different geoscience fields, suggesting that horizontal gender segregation still persists in the geosciences.

We provide here two examples of sessions that have been held for more than 10 years: the Quaternary Sciences session and the Structural Geology, Tectonics and Geodynamics session (Figs. 9, 10). These two sessions represent a good example of how variable the gender distribution can be among different geoscience fields because the long sampling period prevents possible bias due to annual variability in the number of contributions and number of female and male authors. Absolute numbers of male and female scientists in these two disciplines are not available. However, the number of contributions and associated authors represent a good proxy of the general population in these two disciplines in Swiss Academia. From Figs. 9 and 10 it can be observed that the sessions with higher female representations among conveners and chair persons (Fig. 9a, b) also record a higher proportion of female contributions (Fig. 10a, b), likely reflecting a higher proportion of female students and scientists in this field. In contrast, in the Structural Geology, Tectonics and Geodynamics session, the gender distribution is less diverse (Figs. 9c,d, 10c, d), and session

conveners mostly did not change over time (cf. <https://geoscience-meeting.ch>). At the same time, a significantly lower fraction of contributions made by female authors is observed when compared to the Quaternary Sciences session (Fig. 10c, d), suggesting that this field is less capable of attracting female students and/or retain female scientists than the Quaternary Sciences (see also Bubeck and Farrell 2019).

6 Prizes

Prizes and awards are a viable method for encouraging students and young scientists to pursue an academic career in scientific and technical fields. We considered seven prizes awarded at the SGM for different fields for a total of 130 recipients: Paul Niggli medal, Prix Schäfli (only awarded to PhD students in geosciences), Schnee-Eis-Permafrost (SEP) award, Atmospheric Chemistry and Physics (ACP) award, best MSc thesis award (MSc Prize in Earth Sciences), Amanz Gressly award (for major contribution in the field of paleontology), and the Swiss geologist association (CHGEOL) award. Overall (Fig. 11), there are 37 female recipients (28.5%), and 93 male recipients (71.5%). However, when looking at individual prizes, an even more prominent gender segregation is observed (Fig. 12). For example, if the Schnee-Eis-Permafrost (SEP)

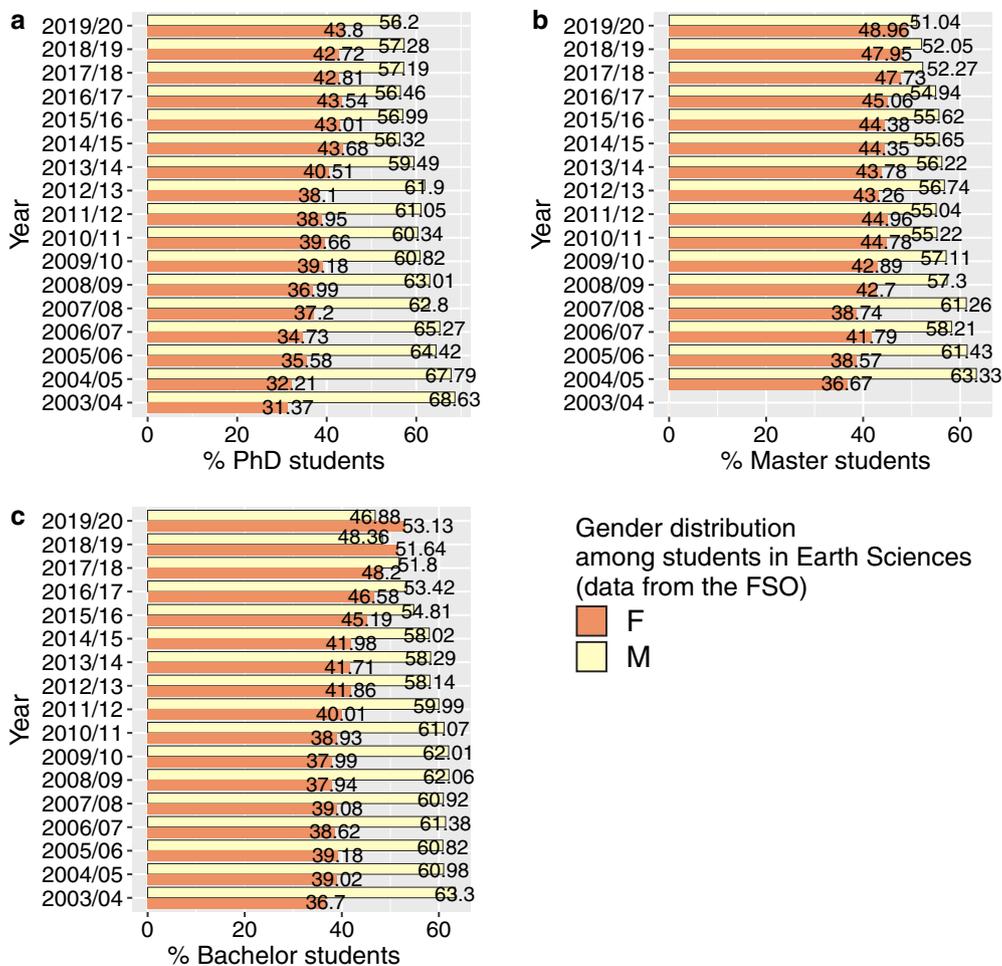


Fig. 4 Percentage of PhD (a), Master (b) and Bachelor (c) students in Earth Sciences in Switzerland classified by gender (data from the Swiss Federal Statistical Office (FSO), <http://www.pxweb.bfs.admin.ch/sq/b2e478b2-be7a-425d-b4a8-953fc4116227>)

award (awarded since 2008), the CHGEOL award (since 2004) and the Paul Niggli medal (awarded since 1988) are considered (for a total of 32, 18 and 26 recipients, respectively), the difference is striking. While for the SEP and CHGEOL award, a close to 50% gender balance is achieved, for the Paul Niggli medal only 2 recipients are female (7.7%). Such a large gap is also present in the best master thesis prize (awarded by the Swiss Geological Society since 2008), where only 17% of the recipients are female. This very low percentage cannot be explained by lower female representation among master students, since data show that at this academic stage, student gender balance is close to 50–50 (see Fig. 4b). Both the Paul Niggli medal and the best master thesis prize are based on proposals from the scientific community (supervisors), hence data suggest that female MSc and PhD students are less likely to be nominated for these awards. Nevertheless, criteria of eligibility for the Paul Niggli

medal (Swiss citizenship or at least two degrees obtained in Switzerland) might significantly restrict the number of potential nominees, especially considering the very high number of foreign PhD students in Switzerland (Dubois-Shaik and Fusulier 2015).

7 Conclusions

The importance of acquiring and discussing data concerning the gender distribution in different scientific contexts highlights the evidence of a relevant gender inequality and at the same time supports the monitoring of an evolving society. A solid dataset also provides a useful instrument to promote changes towards a more inclusive system.

The analysis of the 17 years-dataset of the SGM reveals a positive trend towards a better gender balance since the first meeting in 2003. Furthermore, virtuous cases such as the 2017 and 2018 meetings, together with the SEP

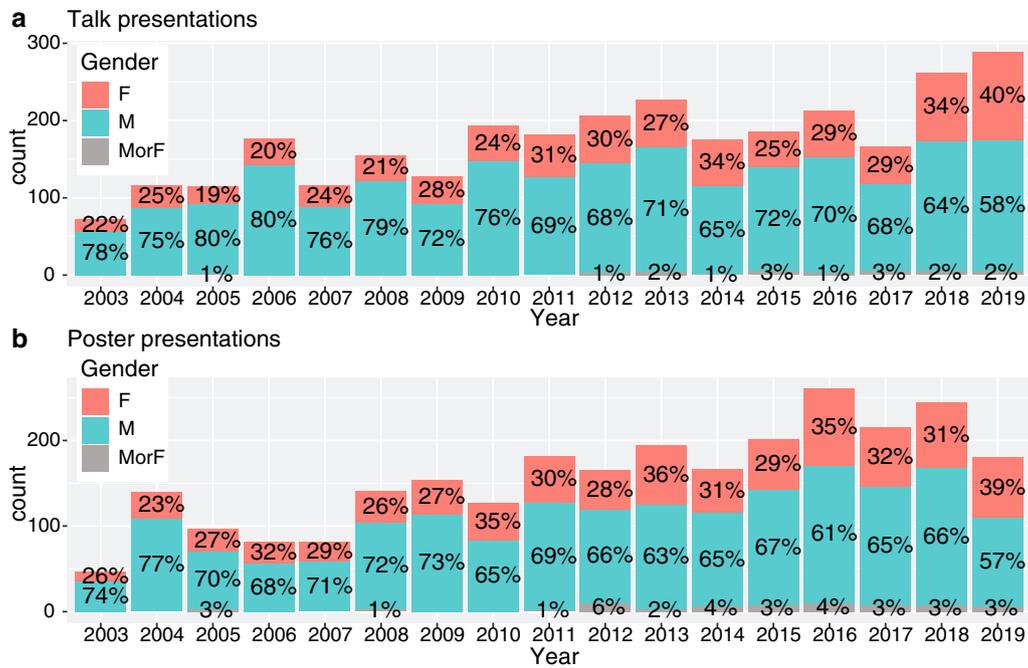


Fig. 5 Number of talk (a) and poster (b) presentations per year classified by gender. Percentages are reported on the graph. Contributions for which we were unable to retrieve the gender information are classified as Male or Female (MorF)



Fig. 6 Number of session conveners (a) and chair persons (b) per year classified by gender. Percentages are reported on the graph. Conveners and chair persons for which we were unable to retrieve the gender information are classified as male or female (MorF)

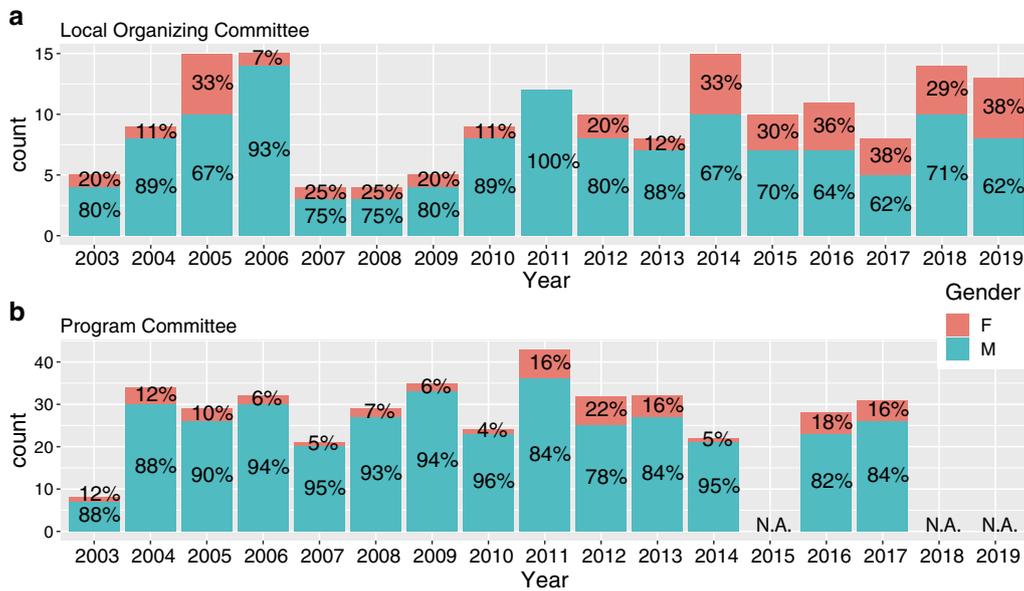


Fig. 7 Number of people in the **a** Local Organizing Committee and **b** Program Committee, classified by gender (N.A. not available)

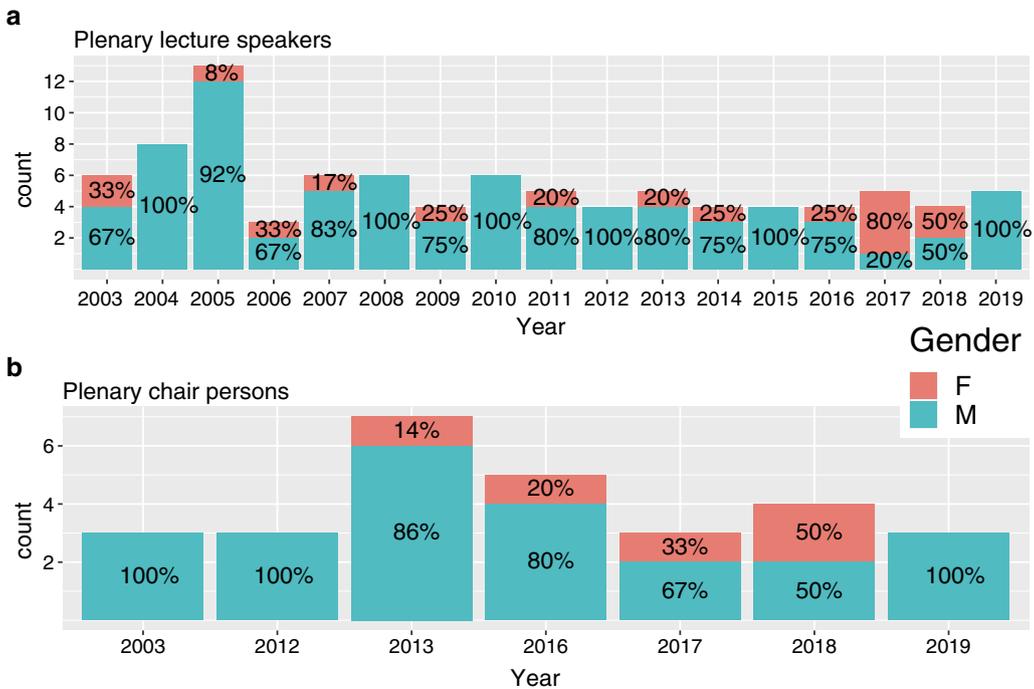
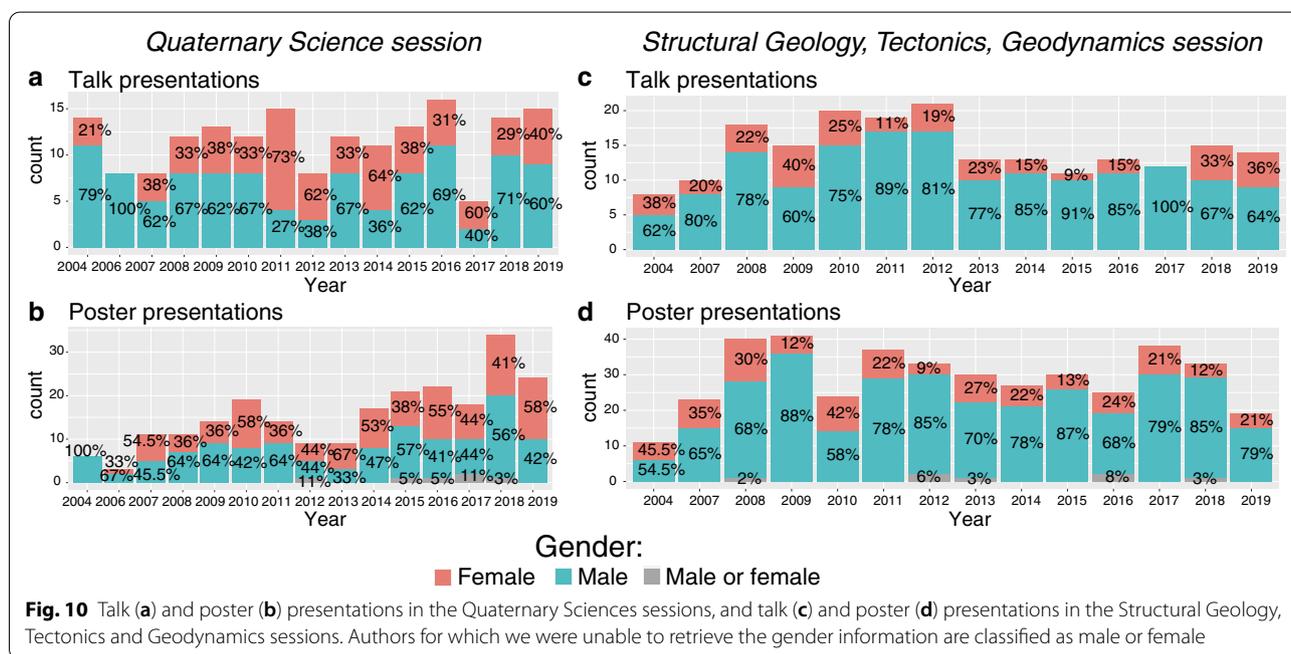
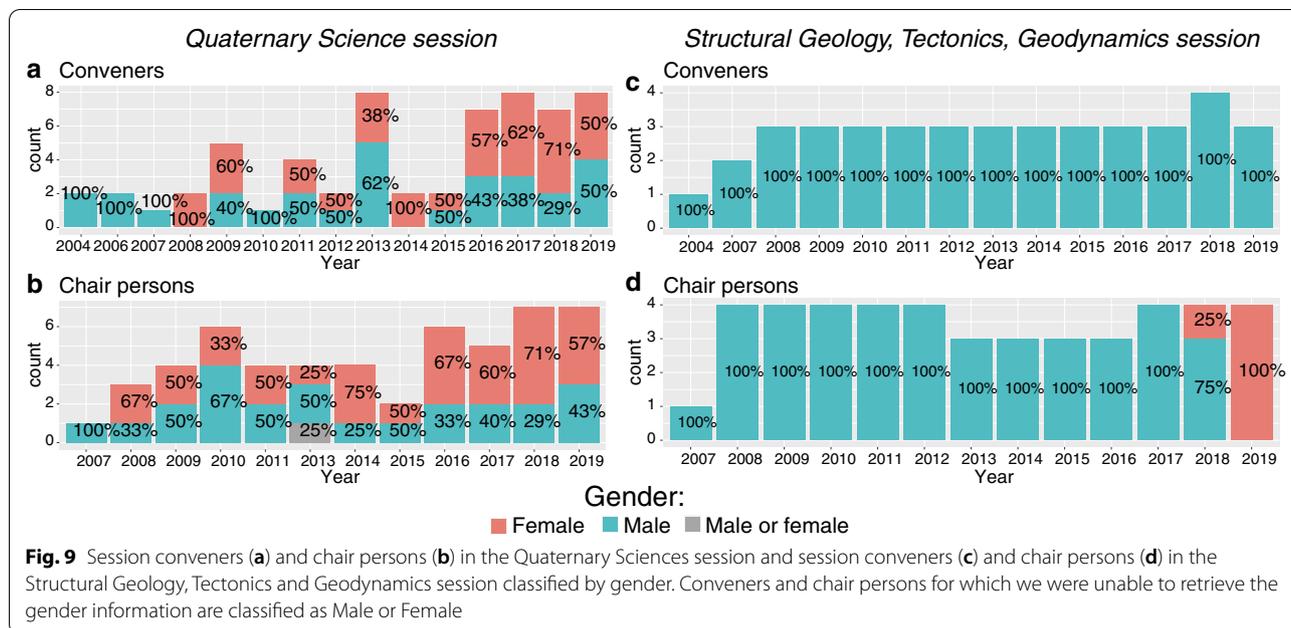


Fig. 8 Plenary lecture speakers (**a**) and plenary chair persons (**b**) classified by gender

and CHGEOL awards example, can encourage the community to pursue a progressive amelioration towards a more equal and inclusive gender distribution. A significant step forward is expected in the next years, after the

introduction by the SCNAT of new guidelines for the SGM (adopted by the SGM program committee on 13th March 2020) that explicitly recommends that diversity and gender balance should be considered when selecting



keynote speaker and member of the local organization committee.

Nevertheless, data also show that strong disparity between men and women still exists in the advanced career positions and in the representation in prominent roles in public events (e.g., plenary speakers). In particular the organizational and conference leading positions are firmly dominated by male scientists. Moreover, a

large fraction of female participants are students or PhD students, confirming the important drop out of female scientists in academia after the PhD. This suggests that particular attention has to be focused on the early stages of women academic and scientific careers.

Another important finding is the prominent horizontal segregation observed among geoscience disciplines (e.g., Quaternary Sciences vs. Structural Geology). This

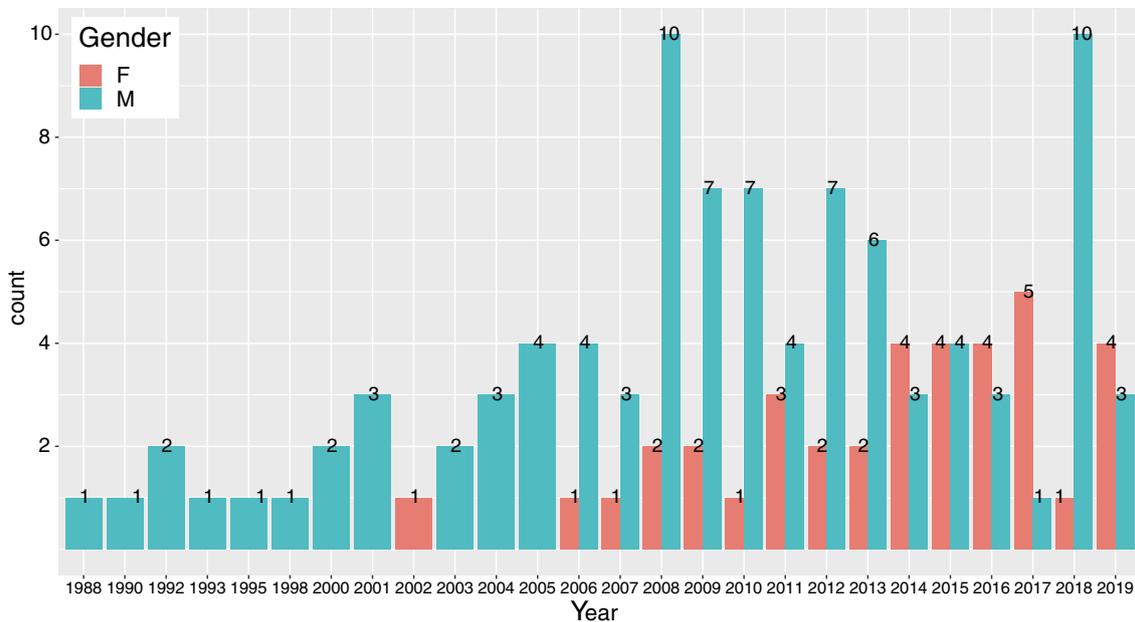


Fig. 11 Total appointed prizes per year, classified by gender

observation reveals that looking only at the total number of students and/or participants might lead to significant bias and horizontal gender segregation issues would be overlooked. The reasons why certain fields are

more capable to attract and retain female scientists are yet to be understood, and further investigations at each geosciences department would be advisable (i.e., internal survey of student gender distribution among different study fields). However, considering the large student participation at the SGM, it is reasonable to think that diversifying session conveners and chair persons might be helpful to make female students feel more welcome, empowered, and overcome possible drop out.

Finally, we wish that this report raises awareness in the Swiss geosciences community and stimulates inter-gender cooperation and an open dialogue aimed at reaching the common goal of more balanced participation, responsibilities and credit recognition. We hope that this report will encourage other academic communities, notably in the STEM disciplines, to collect and publish similar data.

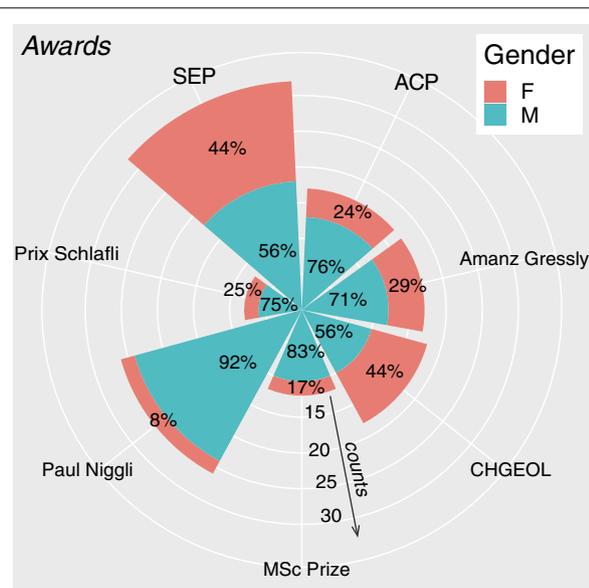


Fig. 12 Gender distribution for different prizes. Paul Niggli medal, Prix Schäfli (only for prizes appointed to a PhD in geosciences), Schnee-Eis-Permafrost (SEP) award, Atmospheric Chemistry and Physics (ACP) award, and best MSc thesis award (MSc Prize), Amanz Gressly prize (for major contribution in the field of paleontology), Swiss Geologist association (CHGEOL). White lines correspond to counts with five counts interval

8 Perspectives

Although improvements are observed over the last 17 years, a series of actions are required to make a significant step forward to a better gender integration. Here we provide a series of suggestions based on the current available data.

- Guidelines: the SGM organizing committee and SCNAT should clearly communicate and make accessible the new guidelines to the local organizing

committee and all session conveners, and encourage their application.

- Session conveners and chair persons: a healthy turnover of session conveners and chair persons is advisable in order to include young scientists and foster networking among the Swiss academic community. In addition, this will allow presenting a range of diverse role models to student participants and, potentially, overcome horizontal gender segregation.
- Prizes: award committee members should encourage student supervisors to consider gender balance when nominating their students and/or alternative nomination procedures should be considered (e.g., open nomination, self-nomination).
- Childcare facilities: wherever possible, childcare facilities should be organized by the local committee and promptly advertised before abstract submission, in order to foster the participation of scientists with family responsibilities.
- Future data collection: monitoring future progress in diversity, equality and inclusion requires collection of data. This could be done upon registration, where authors are given the possibility to provide anonymously the information about presentation type (talk or poster), gender and career stage (e.g., years after PhD and/or position). The SCNAT should discuss policies regarding collection, organization and storage of such a dataset.

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Authors' contributions

This work resulted from the data collection and analysis conducted by FP and GG. Both FP and GG wrote the report. Both authors read and approved the final manuscript.

Authors' information



Francesca is a post-doctoral researcher at the University of Bern working on metamorphic petrology with a focus on the role of fluids in metamorphic reactions and mass transfer during subduction. She received her BSc. in Geology from the University of Milano Statale before moving to Paris for a MSc. in Geology at the University of Paris VI. In 2017, she completed her PhD on

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Giulia is a geologist with focus on Quaternary glacial geology and geochronology. She obtained her BSc and MSc degree from the University of Rome Sapienza and later moved to Pisa, where she completed a PhD in Earth Sciences in 2016. During her PhD, aimed at reconstructing the evolution of glaciers in the Northern Apennines (Italy) since the Last Glacial Maximum, she started collaborating with the Laboratory of Ion Beam Physics at ETH Zürich. Since 2017, she is involved in different projects related to radiocarbon dating, with main applications to dendrochronology (WSL Birmensdorf), archeology and paleoanthropology (University of Geneva). Currently she works at the 14C facility of the Laboratory of Ion Beam Physics ETH Zürich.

Availability of data and materials

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Competing interests

The authors declare that there are no competing interests.

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