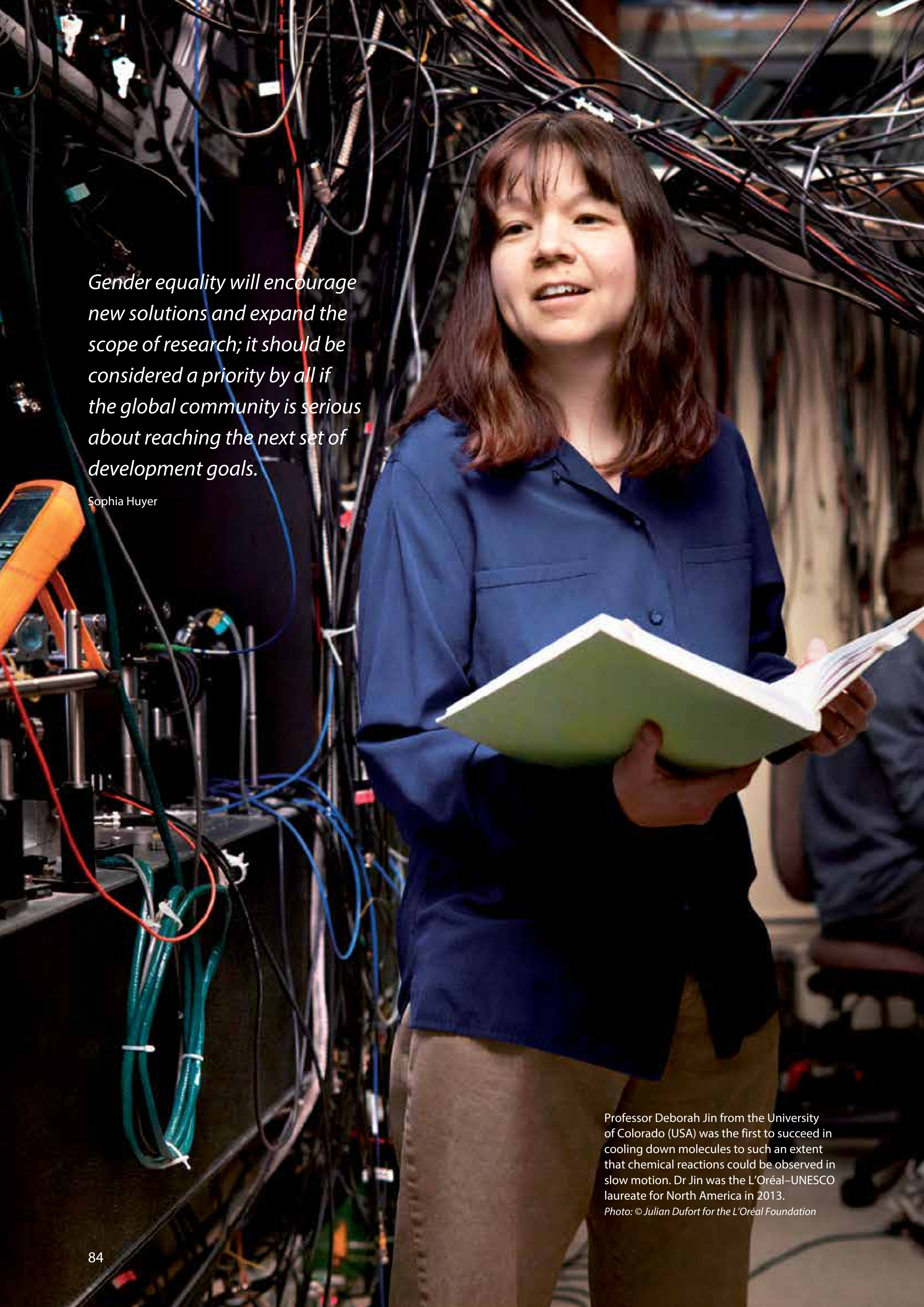


Gender equality will encourage new solutions and expand the scope of research; it should be considered a priority by all if the global community is serious about reaching the next set of development goals.

Sophia Huyer

Professor Deborah Jin from the University of Colorado (USA) was the first to succeed in cooling down molecules to such an extent that chemical reactions could be observed in slow motion. Dr Jin was the L'Oréal–UNESCO laureate for North America in 2013.
Photo: © Julian Dufort for the L'Oréal Foundation

3 · Is the gender gap narrowing in science and engineering?

Sophia Huyer

INTRODUCTION

Women underrepresented in decision-making on climate change

As the global community prepares to make the transition from the Millennium Development Goals to the Sustainable Development Goals in 2015, it is turning its attention from a focus on poverty reduction to a broader perspective combining socio-economic and environmental priorities. Over the next 15 years, scientific research will play a key role in monitoring relevant trends in such areas as food security, health, water and sanitation, energy, the management of ocean and terrestrial ecosystems and climate change. Women will play an essential role in implementing the Sustainable Development Goals, by helping to identify global problems and find solutions.

Since men tend to enjoy a higher socio-economic status, women are disproportionately affected by droughts, floods and other extreme weather events and marginalized when it comes to making decisions on recovery and adaptation (EIGE, 2012). Some economic sectors will be strongly affected by climate change but women and men will not necessarily be affected in the same way. In the tourism sector, for instance, women in developing countries tend to earn less than their male counterparts and occupy fewer managerial positions. They are also overrepresented in the non-agricultural informal sector: 84% in sub-Saharan Africa, 86% in Asia and 58% in Latin America (WTO and UN Women, 2011). There are, thus, clear gender differences in the ability to cope with climate-change-induced shocks.

Despite these gender differences, women are not represented equally in the key climate-change related sectors of science as skilled workers, professionals or decision-makers. Although they are fairly well represented in some related science disciplines – including health, agriculture and environmental management – they are very much a minority in other fields that will be vital for the transition to sustainable development, such as energy, engineering, transportation, information technology (IT) and computing – the latter being important for warning systems, information-sharing and environmental monitoring.

Even in those scientific fields where women are present, they are underrepresented in policy-making and programming. The Former Yugoslav Republic of Macedonia is a case in point. In this country, women are well-represented in governmental decision-making structures related to climate change, such as energy and transportation, environment and health services. They are also comparatively well-represented in related scientific disciplines. Many of them serve on the National Climate Change Committee. However, when it comes to designing and implementing plans, interpreting decisions and monitoring results, women are a rare commodity (Huyer, 2014).

TRENDS IN RESEARCH

Gender parity remains elusive among researchers

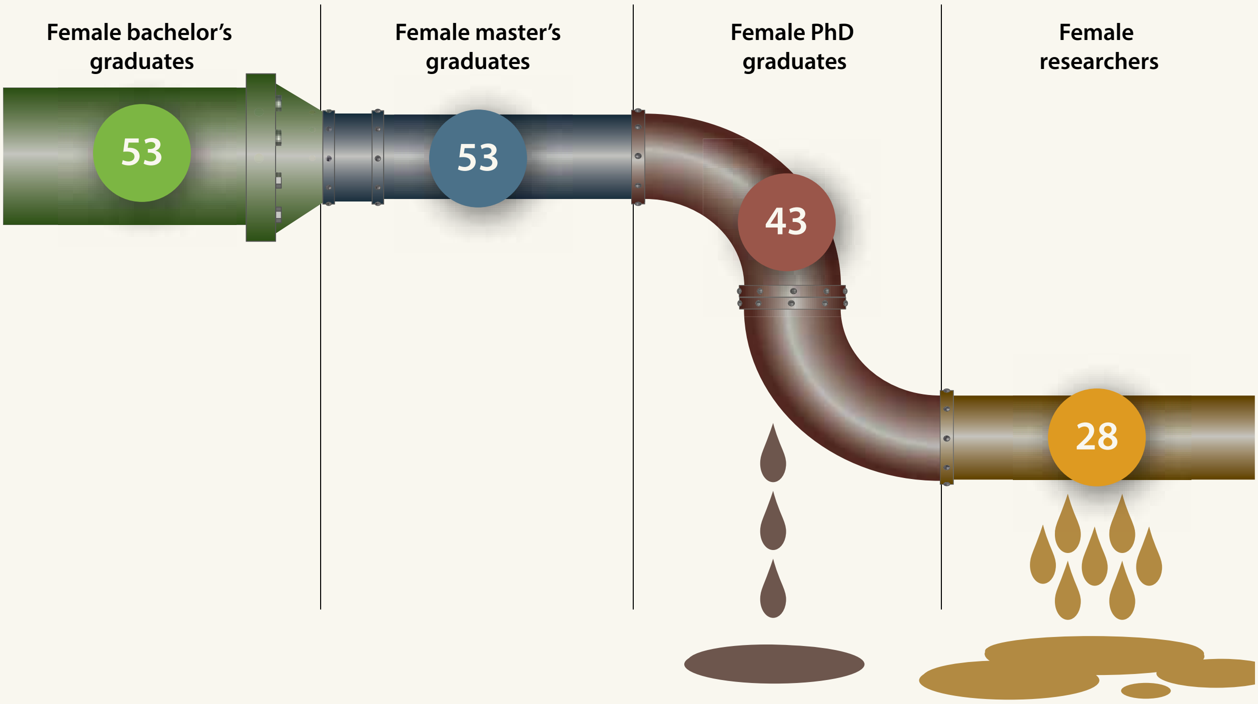
When it comes to women's participation in research overall, globally, we are seeing a leaky pipeline. Women are actively pursuing bachelor's and master's degrees and even outnumber men at these levels, since they represent 53% of graduates, but their numbers drop off abruptly at PhD level. Suddenly, male graduates (57%) overtake women (Figure 3.1). The discrepancy widens at the researcher level, with men now representing 72% of the global pool. The high proportion of women in tertiary education is, thus, not necessarily translating into a greater presence in research.

Although women account for just 28%[1] of global researchers, according to available data, this figure masks wide variations at both the national and regional levels (Figure 3.2). Women are highly represented in Southeast Europe (49%), for instance, and in the Caribbean, Central Asia and Latin America (44%). One in three researchers is a woman in the Arab States (37%), the European Union (33%) and the European Free Trade Association (34%), which are closely followed by sub-Saharan Africa (30%).

For many regions, gender parity (45–55% of researchers) is a legacy of the former Soviet bloc, which stretched across Central Asia, the Baltic States and Eastern Europe to Southeast Europe. One-third of the member states of the European Union (EU) today were once part of the Soviet bloc. Over the past decade, several Southeast European countries have managed to recover the gender parity in research that they had lost in the 1990s following the break-up of the former Yugoslavia: Croatia, FYR Macedonia, Montenegro and Serbia (see Table 10.4).

1. This estimate by the UNESCO Institute for Statistics for 137 countries excludes North America, owing to the international incomparability of these data. The global share of female researchers would not rise more than a few percentage points, however, even if the share of female researchers in the USA could be included in the calculation. Hypothetically, a 40% share of female researchers in the USA would push the global share up from 28.4% to 30.7%.

Figure 3.1: **The leaky pipeline: share of women in higher education and research, 2013 (%)**



Source: UNESCO Institute for Statistics estimates based on data from its database, July 2015

Countries in other regions have made great strides. In Asia, Malaysia, the Philippines and Thailand have all achieved gender parity (see Figure 27.6) and, in Africa, Namibia and South Africa are on the verge of joining this select club (see Figure 19.3). The countries with the highest proportion of female researchers are Bolivia (63%) and Venezuela (56%). Lesotho has slipped out of this category after experiencing a precipitous drop from 76% to 31% between 2002 and 2011.

Some high-income countries have a surprisingly low proportion of female researchers. Just one in four researchers is a woman in France, Germany and the Netherlands, for instance. Even lower proportions are to be found in the Republic of Korea (18%) and Japan (15%). Despite the government's efforts to improve this ratio (see Chapter 24), Japan still has the lowest proportion of female researchers of any member of the Organisation for Economic Co-operation and Development (OECD).

The lowest participation rate of all comes from Saudi Arabia: 1.4% (see Figure 17.7), down from 18.1% in 2000. However, this figure only covers the King Abdulaziz City for Science and Technology. Participation is also very low in Togo (10%) and Ethiopia (13%) and has almost halved in Nepal since 2002 from 15% to 8% (see Figure 21.7).

The glass ceiling still intact

Each step up the ladder of the scientific research system sees a drop in female participation until, at the highest echelons of scientific research and decision-making, there are very few women left. In 2015, the EU Commissioner for Research, Science and Innovation Carlos Moedas called attention to this phenomenon, adding that the majority of entrepreneurs in science and engineering tended to be men. In Germany, the coalition agreement signed in 2013 introduces a 30% quota for women on company boards of directors (see Chapter 9).

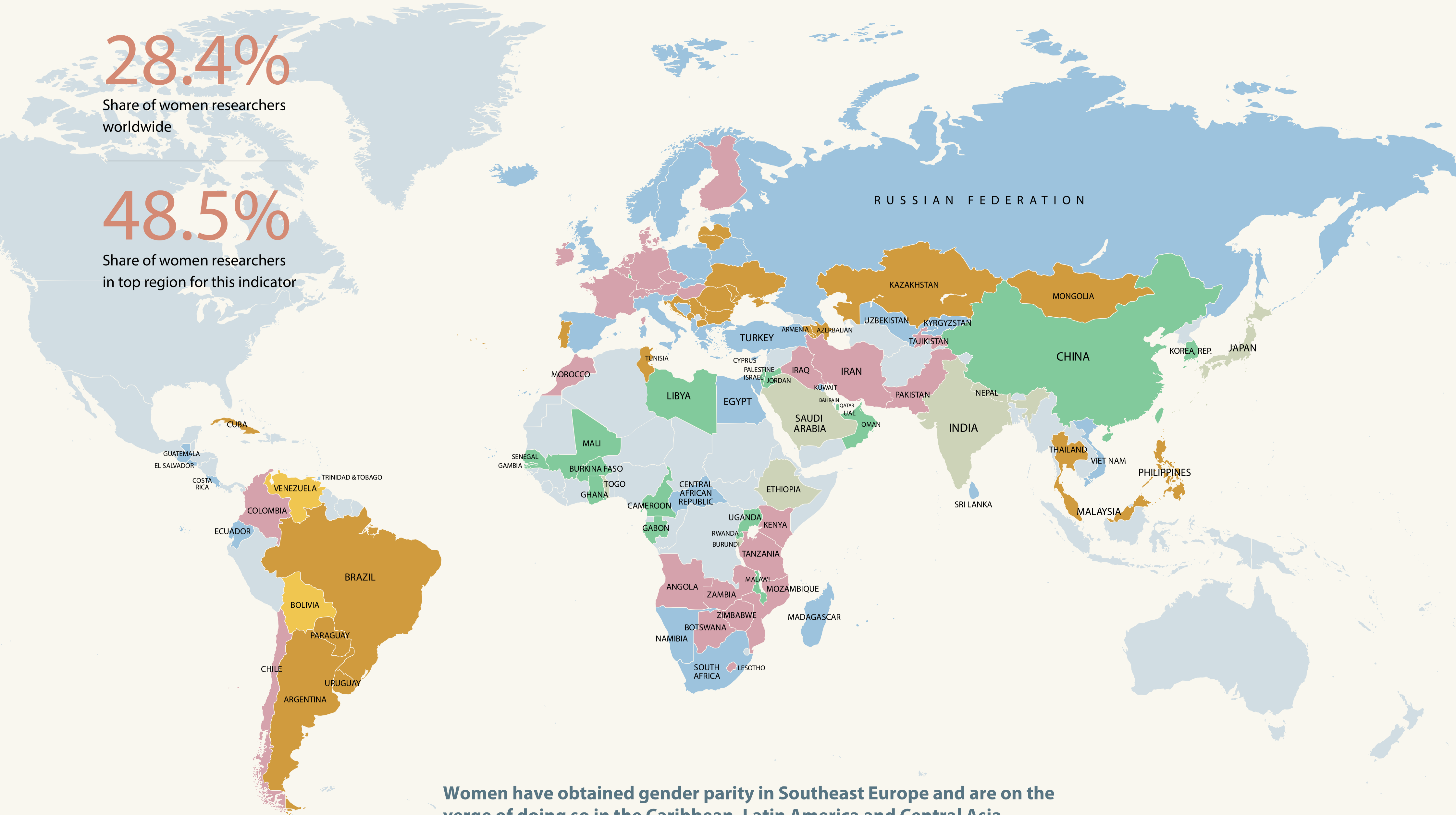
Although data for most countries are limited, we know that women made up 14% of university chancellors and vice-chancellors at Brazilian public universities in 2010 (Abreu, 2011) and 17% of those in South Africa in 2011 (Figure 3.3). In Argentina, women make up 16% of directors and vice-directors of national research centres (Bonder, 2015) and, in Mexico, 10% of directors of scientific research institutes at the National Autonomous University of Mexico. In the USA, numbers are slightly higher at 23% (Huyer and Hafkin, 2012). In the EU, less than 16% of tertiary institutions were headed by a woman in 2010 and just 10% of universities (EU, 2013). At the main tertiary institution for the English-speaking Caribbean, the University of the West Indies, women represented 51% of lecturers but only 32% of senior lecturers and 26% of full professors in 2011 (Figure 6.7). Two reviews of national academies of science produce similarly low numbers, with women accounting for more than 25% of members in only a handful of countries, including Cuba, Panama and South Africa. Indonesia deserves an honorary mention at 17% (Henry, 2015; Zubieta, 2015; Huyer and Hafkin, 2012).

Table 3.1: **Female researchers by field of science, 2013 or closest year (%)**

	Year	Natural sciences	Engineering and technology	Medical sciences	Agricultural sciences	Social sciences and humanities
Albania	2008	43.0	30.3	60.3	37.9	48.1
Angola	2011	35.0	9.1	51.1	22.4	26.8
Armenia	2013	46.4	33.5	61.7	66.7	56.3
Azerbaijan	2013	53.9	46.5	58.3	38.5	57.4
Bahrain	2013	40.5	32.1	45.9	–	43.0
Belarus	2013	50.6	31.5	64.6	60.1	59.5
Bosnia & Herzegovina	2013	43.7	29.6	58.1	42.7	47.0
Botswana	2012	27.8	7.9	43.6	18.1	37.5
Bulgaria	2012	51.0	32.4	58.8	55.6	55.8
Burkina Faso	2010	10.1	11.6	27.7	17.4	35.9
Cabo Verde	2011	35.0	19.6	60.0	100.0	54.5
Chile	2008	26.5	19.0	34.4	27.8	32.7
Colombia	2012	31.8	21.6	52.5	33.6	39.9
Costa Rica	2011	36.7	30.9	60.8	31.5	53.6
Croatia	2012	49.7	34.9	56.1	45.8	55.5
Cyprus	2012	38.7	25.4	46.3	22.8	43.6
Czech Rep.	2012	28.2	12.8	50.6	36.1	42.2
Egypt	2013	40.7	17.7	45.9	27.9	49.7
El Salvador	2013	35.4	17.7	65.0	35.5	46.4
Estonia	2012	38.2	32.0	65.0	49.7	61.8
Ethiopia	2013	12.2	7.1	26.1	7.6	13.3
Gabon	2009	31.4	20.0	58.3	30.2	17.0
Ghana	2010	16.9	6.6	20.8	15.5	22.3
Greece	2011	30.7	29.5	43.0	33.1	46.0
Guatemala	2012	44.1	43.5	60.6	17.2	53.6
Hungary	2012	24.0	20.0	48.1	37.8	44.8
Iran	2010	34.3	19.6	29.5	24.5	25.5
Iraq	2011	43.6	25.7	41.4	26.1	33.7
Japan	2013	12.6	5.3	30.8	21.5	31.9
Jordan	2008	25.7	18.4	44.1	18.7	31.7
Kazakhstan	2013	51.9	44.7	69.5	43.4	59.1
Kenya	2010	14.4	11.2	20.0	30.4	37.1
Korea, Rep.	2013	27.4	10.3	45.6	25.6	40.4
Kuwait	2013	41.8	29.9	44.9	43.8	34.7
Kyrgyzstan	2011	46.5	30.0	44.0	50.0	48.7
Latvia	2012	47.6	34.7	63.7	59.5	65.9
Lesotho	2009	42.0	16.7	–	40.0	75.0
Lithuania	2012	43.9	34.1	61.5	56.5	65.4
FYR Macedonia	2012	40.4	40.1	64.2	45.5	52.0
Madagascar	2011	34.6	18.7	33.8	24.9	44.8
Malawi	2010	22.2	6.5	17.5	12.5	32.8
Malaysia	2012	49.0	49.8	50.8	48.9	51.6
Mali	2006	7.2	15.1	14.9	25.9	12.2
Malta	2012	27.2	17.2	49.3	26.2	34.8
Mauritius	2012	36.4	19.4	41.7	45.4	51.9
Moldova	2013	45.7	29.0	52.5	45.4	61.0
Mongolia	2013	48.7	45.9	64.2	54.6	40.6
Montenegro	2011	56.7	37.0	58.5	54.5	49.0
Morocco	2011	31.5	26.3	44.1	20.5	27.1
Mozambique	2010	27.8	28.9	53.1	20.4	32.0
Netherlands	2012	23.3	14.9	42.8	31.9	40.8
Oman	2013	13.0	6.2	30.0	27.6	23.1
Pakistan	2013	33.8	15.4	37.0	11.0	39.9
Palestine	2007	21.2	9.6	25.5	11.8	27.9
Philippines	2007	59.5	39.9	70.2	51.3	63.2
Poland	2012	37.0	20.6	56.3	49.7	47.3
Portugal	2012	44.5	28.5	60.8	53.2	52.5
Qatar	2012	21.7	12.5	27.8	17.9	34.3
Romania	2012	46.8	39.0	59.1	51.0	49.8
Russian Fed.	2013	41.5	35.9	59.5	56.4	60.3
Saudi Arabia	2009	2.3	2.0	22.2	–	–
Senegal	2010	16.7	13.0	31.7	24.4	26.1
Serbia	2012	55.2	35.9	50.4	60.0	51.8
Slovakia	2013	44.3	25.8	58.5	45.5	52.1
Slovenia	2012	37.5	19.5	54.2	52.8	51.0
Sri Lanka	2010	40.0	27.0	46.4	38.2	29.8
Tajikistan	2013	30.3	18.0	67.6	23.5	29.3
Togo	2012	9.0	7.7	8.3	3.2	14.1
Trinidad & Tobago	2012	44.2	32.6	52.3	39.6	55.3
Turkey	2013	36.0	25.6	47.3	32.9	41.8
Uganda	2010	17.1	23.3	30.6	19.7	27.0
Ukraine	2013	44.5	37.2	65.0	55.0	63.4
Uzbekistan	2011	35.4	30.1	53.6	24.9	46.5
Venezuela	2009	35.1	40.4	64.9	47.6	62.8
Zimbabwe	2012	25.3	23.3	40.0	25.5	25.6

Source: UNESCO Institute for Statistics, August 2015

Figure 3.2: **Share of female researchers by country, 2013 or closest year (%)**



28.4%

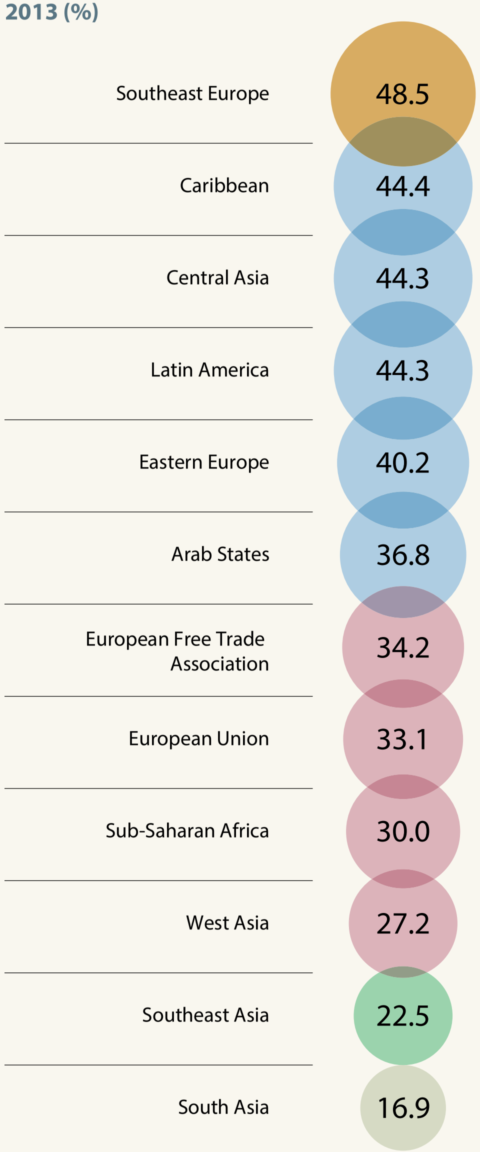
Share of women researchers worldwide

48.5%

Share of women researchers in top region for this indicator

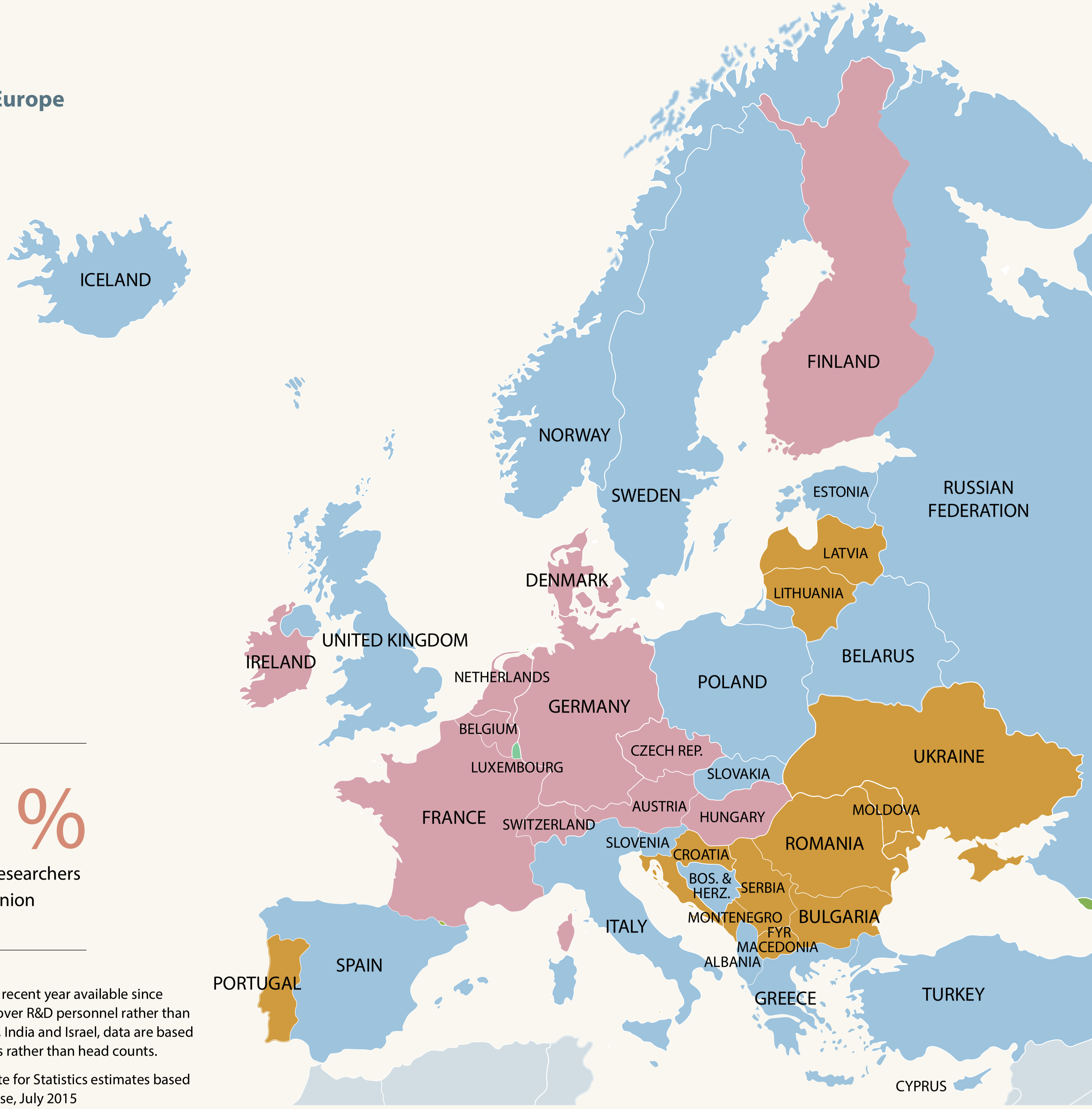
Women have obtained gender parity in Southeast Europe and are on the verge of doing so in the Caribbean, Latin America and Central Asia

Regional shares of female researchers, 2013 (%)



Note: Data are unavailable for North America. The regional averages are based on available data and are derived by using the nearest year's data, whenever data are missing for 2013.

Spotlight on Europe



- 0–14.9%
- 15–24.9%
- 25–34.9%
- 35–44.9%
- 45–54.9%
- 55% or more
- Data unavailable

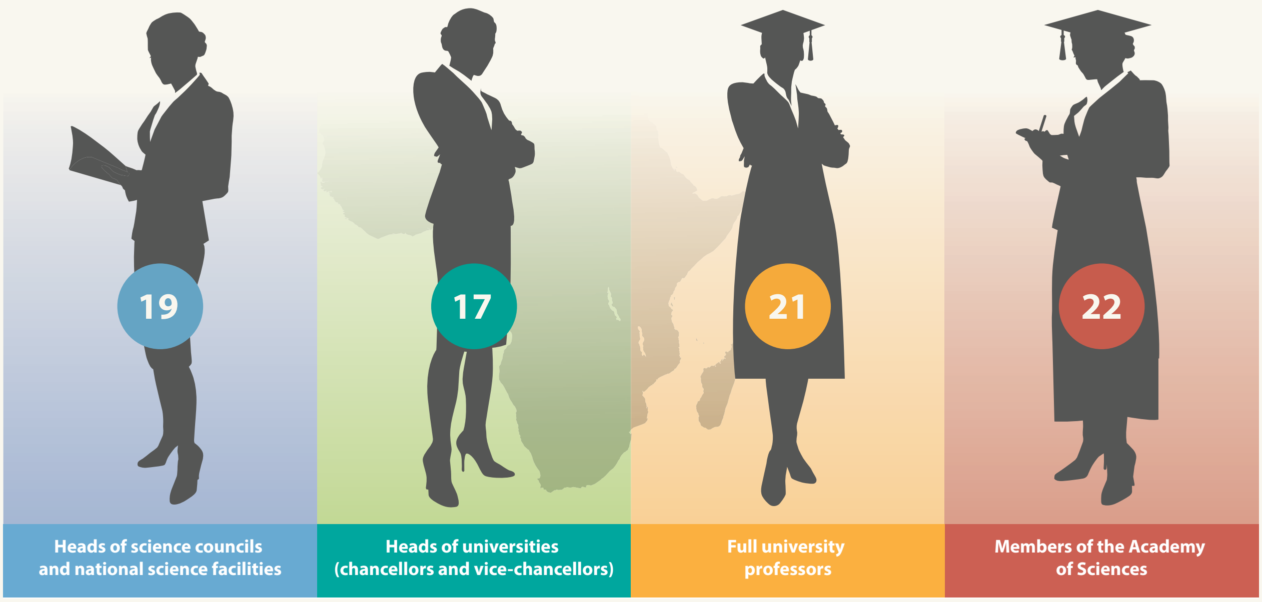
33.1%

Share of women researchers in the European Union

Note: Data for the most recent year available since 2007. For China, data cover R&D personnel rather than researchers. For Congo, India and Israel, data are based on full-time equivalents rather than head counts.

Source: UNESCO Institute for Statistics estimates based on data from its database, July 2015

Figure 3.3: **Share of women in selected South African institutions, 2011(%)**



Note: The data for the share of women among full university professors are for 2009.

Source: ASSAf (2011)

These trends are evident in other spheres of scientific decision-making, with women being underrepresented as peer reviewers, on editorial boards and research councils. A survey of 10 highly regarded journals in environmental biology, natural resource management and plant sciences reviewed the number of women on editorial boards and among editors from 1985 to 2013. The study found that women made up 16% of subject editors, 14% of associate editors and 12% of editors-in-chief (Cho *et al*., 2014).

TRENDS IN TERTIARY EDUCATION

The scales have tipped in favour of female students

The absence of women from the highest echelons of science and related decision-making is surprising, given the progress towards gender parity observed at all levels of education in recent decades. The pendulum has even swung the other way, with there now being a global gender imbalance in favour of female students, albeit not in all regions. Female university students dominate in North America (57%), Central and South America (49–67%) and even more so across the Caribbean[2] (57–85%). Europe and West Asia show a similar trend, with the notable exception of Turkey and Switzerland, where females make up around 40% of tertiary enrolment, and Liechtenstein (about 21%). In most Arab states, the same trend towards gender parity can be observed, the exceptions here being Iraq, Mauritania and Yemen, where figures for women drop to 20–30%. Data from Morocco show a cyclical pattern from 2000 but a general rise to 47% in 2010.

In sub-Saharan Africa, numbers are substantially lower, reflecting a gender imbalance in education at all levels (see Chapters 18–20). Shares of women graduates at the tertiary level range from the low teens to more than half, as in Namibia (58%) and South Africa (60%). Female representation has dropped substantially in Swaziland, from a high of 55% in 2005 to 39% in 2013. In South Asia, the participation of women in tertiary education remains low, with the notable exception of Sri Lanka at 61%.

Overall, women are more likely to pursue tertiary education in countries with relatively higher levels of national income. The lowest ratios of women to men tend to be found in low-income countries, most of which are situated in sub-Saharan Africa. Examples are Ethiopia (31%), Eritrea (33%), Guinea (30%) and Niger (28%). In Central African Republic and Chad, male tertiary students are 2.5 times more common than female ones (Table 19.4). Notable exceptions among the 31 low-income countries are Comoros (46%), Madagascar (49%) and Nepal (48%).

The same pattern can be found in countries with relatively low GDP per capita in other regions but there are signs that the trend is waning. In Asia, female students face considerable disparities in Afghanistan (share of women tertiary students: 24%), Tajikistan (38%), and Turkmenistan (39%) but the share has become much more favourable to women in recent years

2. Antigua and Barbuda, Barbados, Cuba, Dominican Republic and Jamaica in Cambodia (38% in 2011) and Bangladesh (41% in 2012). In the Arab States, the lowest participation rate concerns Yemeni women (30%). Djibouti and Morocco have each increased the share of female students to more than 40%.

A slight rise in national wealth may correlate to a drop in gender disparities. Sub-Saharan African countries with higher levels of wealth also report higher participation rates for women than men in tertiary education. For example, 59% of tertiary students are women in Cabo Verde and 54% in Namibia. However, there are notable exceptions among high-income[3] countries. Men continue to outnumber women in tertiary education in Liechtenstein, Japan and Turkey.

Empirical research and anecdotal observations highlight several reasons for the growing participation of women in higher education. Education is perceived as a means of moving up the social ladder (Mellström, 2009). Having a tertiary education brings individual returns in the form of higher income levels, even though women are obliged to have more years of education under their belt than men to secure jobs of comparable pay – a pattern found in countries of all income levels. Many countries are also anxious to expand their skilled labour force, in order to develop a knowledge economy and increase their global competitiveness, examples being Iran (see Chapter 15) and Malaysia (see Chapter 26). Another explanation lies in the active campaign for gender equality undertaken by numerous organizations in recent decades.

TRENDS IN TERTIARY SCIENCE EDUCATION

Women now dominate graduates in health

Although women tertiary graduates generally outnumber their male counterparts – with national and regional variations –, this is not necessarily the case when the data are broken down by field into science, engineering, agriculture and health.[4] The good news is that the share of female graduates in scientific fields is on the rise. This trend has been most marked since 2001 in all developing regions except Latin America and the Caribbean, where women's participation was already high.

The presence of women varies according to the field of study. Women now dominate the broad fields of health and welfare in most countries and regions but not the rest of the sciences; they are least likely to figure among engineering graduates, for instance. There are also exceptions to the rule. In Oman, for instance, women make up 53% of engineering graduates (Table 3.2). Women are a minority among health and welfare graduates in four sub-Saharan countries[5] and two Asian ones: Bangladesh (33%) and Viet Nam (42%).

The second-most popular field of science for women is science. While numbers are not as high as for health and welfare, the share of women studying science is on a par with that of men or slightly higher in many mainly Latin American and Arab countries. In the 10 countries reporting data from Latin America and the Caribbean, females make up 45% or more of tertiary graduates in science. They make up over half of graduates in Panama and Venezuela, the Dominican Republic and in Trinidad and Tobago (the latter having a very small graduate population). In Guatemala, as much as 75% of science graduates are female. Eleven out of 18 Arab States also have a majority of female science graduates.[6] The countries in South Asia reporting data – Bangladesh and Sri Lanka – reveal averages of 40–50%, whereas some east and southeast Asian countries show percentages of 52% or more: Brunei Darussalam (66%), Philippines (52%), Malaysia (62%) and Myanmar (65%). Japan and Cambodia have low shares of 26% and 11% respectively and the Republic of Korea a share of 39%.

Graduation rates for women in Europe and North America range from a high of 55% in Italy, Portugal and Romania to a low of 26% in the Netherlands. Next come Malta and Switzerland with 29% and 30% respectively. The majority of countries fall in the 30–46% range.

Within the broad field of science, some interesting trends can be observed. Women graduates are consistently highly represented in the life sciences, often at over 50%. However, their representation in the other fields is inconsistent. In North America and much of Europe, few women graduate in physics, mathematics and computer science but, in other regions, the proportion of women may be close to parity in physics or mathematics. This may explain the decrease in science students in some countries; often, an increase in agriculture or engineering occurs at the expense of science, suggesting a redistribution of female participation rather than an overall increase.

More women are graduating in agriculture

Trends in agricultural science tell an interesting story. Around the world, there has been a steady increase in female graduates since 2000. The reasons for this surge are unclear, although anecdotal evidence suggests that one explanation may lie in the growing emphasis on national food security and the food industry.

3. defined as countries with per capita GDP above PPP$ 10 000

4. 'Science' here is defined as encompassing life sciences, physical sciences, mathematics, statistics and computer sciences; 'engineering' includes manufacturing and processing, construction and architecture; 'agriculture' includes forestry, fisheries and veterinary science; 'health and welfare' includes medicine, nursing, dental studies, medical technology, therapy, pharmacy and social services.

5. Benin, Burundi, Eritrea and Ethiopia

6. Algeria, Bahrain, Jordan, Kuwait, Lebanon, Oman, Palestine, Qatar, Saudi Arabia, Tunisia and United Arab Emirates

Table 3.2: **Share of female tertiary graduates in four selected fields, 2013 or closest year (%)**

	Year	Science	Engineering	Agriculture	Health & welfare
Albania	2013	66.1	38.8	41.5	72.7
Algeria	2013	65.4	32.4	56.5	64.6
Angola	2013	36.2	19.3	21.7	63.3
Argentina	2012	45.1	31.0	43.9	73.8
Austria	2013	33.3	21.2	55.9	70.8
Bahrain	2014	66.3	27.6	a	76.8
Bangladesh	2012	44.4	16.6	31.1	33.3
Belarus	2013	54.4	30.0	29.2	83.8
Bhutan	2013	25.0	24.9	15.5	52.6
Bosnia & Herzegovina	2013	46.8	37.5	46.9	74.2
Brazil	2012	33.1	29.5	42.3	77.1
Brunei Darussalam	2013	65.8	41.8	a	85.7
Burkina Faso	2013	18.8	20.6	16.8	45.9
Colombia	2013	41.8	32.1	40.9	72.0
Costa Rica	2013	30.5	33.7	37.4	76.9
Cuba	2013	44.9	28.3	30.0	68.2
Denmark	2013	35.4	35.3	67.4	80.0
Egypt	2013	49.6	25.3	46.6	54.4
El Salvador	2013	59.0	26.6	24.6	78.0
Eritrea	2014	35.0	15.8	29.8	26.3
Finland	2013	42.5	21.7	57.6	85.1
France	2013	37.8	25.6	50.1	74.4
Georgia	2013	47.7	23.1	27.5	74.4
Ghana	2013	27.1	18.4	17.2	57.6
Honduras	2013	35.9	37.4	28.3	74.7
Iran	2013	66.2	24.7	41.1	65.1
Kazakhstan	2013	61.5	31.0	43.0	79.8
Kuwait	2013	72.2	25.0	a	44.5
Kyrgyzstan	2013	61.3	25.8	27.9	77.1
Lao PDR	2013	39.1	10.6	30.7	59.8
Latvia	2013	38.7	26.8	48.7	92.3
Lesotho	2013	54.5	27.5	45.7	78.8
Lithuania	2013	41.8	21.8	50.9	84.3
FYR Macedonia	2013	37.6	39.1	48.5	75.3
Madagascar	2013	32.1	24.2	51.9	74.1
Malaysia	2012	62.0	38.7	54.4	62.9
Mongolia	2013	46.6	37.9	63.0	83.9
Mozambique	2013	35.6	34.4	40.6	47.4
Myanmar	2012	64.9	64.6	51.5	80.7
Nepal	2013	28.4	14.0	33.3	57.0
Netherlands	2012	25.8	20.9	54.5	75.1
New Zealand	2012	39.1	27.4	69.3	78.1
Norway	2013	35.9	19.6	58.9	83.6
Oman	2013	75.1	52.7	6.0	37.8
Palestine	2013	58.5	31.3	37.1	56.7
Panama	2012	50.5	35.9	54.0	75.6
Philippines	2013	52.1	29.5	50.7	72.1
Poland	2012	46.1	36.1	56.4	71.5
Portugal	2013	55.7	32.5	59.9	78.9
Qatar	2013	64.7	27.4	a	72.9
Korea, Rep.	2013	39.0	24.0	41.1	71.4
Moldova	2013	48.9	30.5	28.3	77.6
Rwanda	2012	40.3	19.6	27.3	61.9
Saudi Arabia	2013	57.2	3.4	29.6	52.0
Serbia	2013	46.2	35.0	46.5	73.3
Slovakia	2013	45.6	30.9	50.9	81.9
Slovenia	2012	39.9	24.4	59.1	81.8
South Africa	2012	49.1	28.5	48.6	73.7
Spain	2012	38.4	26.8	45.4	75.0
Sri Lanka	2013	47.4	22.4	57.4	58.1
Sudan	2013	41.8	31.8	64.3	66.4
Swaziland	2013	31.6	15.2	42.8	60.4
Sweden	2012	40.6	28.9	63.1	82.0
Switzerland	2013	31.8	14.0	30.1	74.4
Syria	2013	50.9	36.0	45.0	49.5
Tunisia	2013	63.8	41.1	69.9	77.5
Turkey	2012	48.2	24.8	45.0	63.4
Ukraine	2013	49.6	26.2	34.1	80.6
United Arab Emirates	2013	60.2	31.1	54.1	84.6
UK	2013	45.7	22.2	64.1	77.3
USA	2012	40.1	18.5	48.3	81.5
Viet Nam	2013	a	31.0	36.7	42.3
Zimbabwe	2013	47.7	21.4	40.3	50.0

a = not applicable *Note:* Engineering includes manufacturing and construction. The oldest data are for 2012.

Source: UNESCO Institute for Statistics, August 2015

Another possible explanation is that women are highly represented in biotechnology. For example, in South Africa, women were underrepresented in engineering (16%) in 2004 and in 'natural scientific professions' (16%) in 2006 but made up 52% of employees working in biotechnology-related companies.

At the same time, women are poorly represented in agricultural extension services in the developing world. Better understanding of women's incursion into this sector, as well as their career paths, may shed some light on the barriers and opportunities for women in the other sciences.

Women least present in engineering

Women are consistently least represented in engineering, manufacturing and construction. In many cases, engineering has lost ground to other sciences, including agriculture. However, there are regional exceptions: the share of women graduating as engineers has risen in sub-Saharan Africa, the Arab States and parts of Asia. Of the 13 sub-Saharan countries reporting data, seven observe substantial increases (more than 5%) in women engineers since 2000.[7] However, less than 20% of women still graduate in engineering, with the notable exceptions of Liberia and Mozambique. Of the seven Arab countries reporting data, four observe a steady percentage or an increase;[8] the highest scores come from the United Arab Emirates and Palestine (31%), Algeria (31%) and Oman, with an astonishing 53%. Some Asian countries show similar rates: 31% in Viet Nam, 39% in Malaysia and 42% in Brunei Darussalam.

The numbers in Europe and North America are generally low: 19% in Canada, Germany and the USA and 22% in Finland, for example, but there are some bright spots: 50% of engineering graduates are women in Cyprus and 38% in Denmark.

Fewer female graduates in computer science

An analysis of computer science shows a steady decrease in female graduates since 2000 that is particularly marked in high-income countries. Exceptions in Europe include Denmark, where female graduates increased from 15% to 24% between 2000 and 2012, and Germany, which saw an increase from 10% to 17%. These are still very low levels. In Turkey, the proportion of women graduating in computer science rose from a relatively high 29% to 33%. Over the same period, the share of women graduates slipped in Australia, New Zealand, the Republic of Korea and USA. The situation in Latin America and the Caribbean is worrying: in all countries reporting data, the share of women graduates in computer science has dropped by between 2 and 13 percentage points.

This should be a wake-up call. Female participation is falling in a field that is expanding globally as its importance for national economies grows, penetrating every aspect of daily life. Could this be a symptom of the phenomenon by which 'women are the first hired and the first fired?' In other words, are they being pushed out once a company gains prestige and raises the remuneration of staff, or when companies run into financial difficulties?

Women engineers well-regarded in Malaysia and India

There are exceptions. The Malaysian information technology (IT) sector is made up equally of women and men, with large numbers of women employed as university professors and in the private sector. This is a product of two historical trends: the predominance of women in the Malay electronics industry, the precursor to the IT industry, and the national push to achieve a 'pan-Malayan' culture beyond the three ethnic groups of Indian, Chinese and Malay. Government support for the education of all three groups is available on a quota basis and, since few Malay men are interested in IT, this leaves more room for women. Additionally, families tend to be supportive of their daughters' entry into this prestigious and highly remunerated industry, in the interests of upward mobility (Mellström, 2009).

In India, the substantial increase in women undergraduates in engineering may be indicative of a change in the 'masculine' perception of engineering in the country. It is also a product of interest on the part of parents, since their daughters will be assured of employment as the field expands, as well as an advantageous marriage. Other factors include the 'friendly' image of engineering in India, compared to computer sciences, and the easy access to engineering education resulting from the increase in the number of women's engineering colleges[9] over the last two decades (Gupta, 2012).

TRENDS FROM A REGIONAL PERSPECTIVE

Latin America tops world for female participation

Latin America has some of the world's highest rates of women studying scientific fields; it also shares with the Caribbean one of the highest proportions of female researchers: 44%. Of the 12 countries reporting data for the years 2010–2013, seven have achieved gender parity, or even dominate research: Bolivia (63%), Venezuela (56%), Argentina (53%), Paraguay (52%), Uruguay (49%), Brazil (48%) and Guatemala (45%). Costa Rica is just a whisker behind, with 43%. Chile has the lowest score among countries for which there are recent data (31%). The Caribbean paints a similar picture, with Cuba having achieved gender parity (47%) and Trinidad and Tobago being on the cusp (44%).

7. Benin, Burundi, Eritrea, Ethiopia, Madagascar, Mozambique and Namibia

8. Morocco, Oman, Palestine and Saudi Arabia

9. Fifteen women's engineering colleges have been established in the country since 1991.

Factoring in specific scientific fields changes some of these dynamics. As in most other regions, the great majority of health graduates are women (60–85%). Women are also strongly represented in science. More than 40% of science graduates are women in each of Argentina, Colombia, Ecuador, El Salvador, Mexico, Panama and Uruguay. The Caribbean paints a similar picture, with women graduates in science being on a par with men or dominating this field in Barbados, Cuba, Dominican Republic and Trinidad and Tobago. In engineering, women make up over 30% of the graduate population in seven Latin American countries[10] and one Caribbean country – the Dominican Republic. Of note is the decrease in women engineering graduates in Argentina, Chile and Honduras.

The discouraging news is that the participation of women in science has consistently dropped over the past decade. This trend has been observed in all sectors of the larger economies: Argentina, Brazil, Chile and Colombia. Mexico is a notable exception, having recorded a slight increase. Some of the decrease may be attributed to women transferring to agricultural sciences in these countries.

Another negative trend is the drop in female doctoral students and in the labour force. Of those countries reporting data, the majority signal a significant drop of 10–20 percentage points in the transition from master's to doctoral graduates, a trend which augurs ill for employers.

Despite the substantial participation by women in the science and technology sector, attitudes and institutional practices persist in Latin America that devalue a women's ability. For example, a review of the software and information services industry in Latin America found that a glass ceiling persists, with substantial gender disparities in management positions and on boards of directors. National reviews of women's representation in science in the region refer to obstacles relating to the work–life balance and disadvantages to women in science and research who are expected to both manage the household and put in full-time and even overtime at the same rates as men (ECLAC, 2014; Bonder, 2015).

Gender parity in Eastern Europe and Central Asia

Most countries in Eastern Europe, West and Central Asia have attained gender parity in research (Armenia, Azerbaijan, Georgia, Kazakhstan, Mongolia and Ukraine) or are on the brink of doing so (Kyrgyzstan and Uzbekistan). This trend is reflected in tertiary education, with some exceptions in engineering and computer science. Although Belarus and the Russian Federation have seen a drop over the past decade, women still represented 41% of researchers in 2013.

One in three researchers is a woman in Turkey (36%) and Tajikistan (34%). Participation rates are lower in Iran (26%) and Israel (21%), although Israeli women represent 28% of senior academic staff. At university, Israeli women dominate medical sciences (63%) but only a minority study engineering (14%), physical sciences (11%), mathematics and computer science (10%) [see Chapter 16].

There has been an interesting evolution in Iran. Whereas the share of female PhD graduates in health remained stable at 38–39% between 2007 and 2012, it rose in all three other broad fields. Most spectacular was the leap in female PhD graduates in agricultural sciences from 4% to 33% but there was also a marked progression in science (from 28% to 39%) and engineering (from 8% to 16%) [see Figure 12.3].

Southeast Europe: a legacy of gender parity

With the exception of Greece, all the countries of Southeast Europe were once part of the Soviet bloc. Some 49% of researchers in these countries are women (compared to 37% in Greece in 2011). This high proportion is considered a legacy of the consistent investment in education by the Socialist governments in place until the early 1990s, including that of the former Yugoslavia. Moreover, the participation of female researchers is holding steady or increasing in much of the region, with representation broadly even across the four sectors of government, business, higher education and non-profit.

In most countries, women tend to be on a par with men among tertiary graduates in science. Between 70% and 85% of graduates are women in health, less than 40% in agriculture and between 20% and 30% in engineering. Albania has seen a considerable increase in the share of its women graduates in engineering and agriculture.

EU: female researcher pool growing fastest

Women make up 33% of researchers overall in the EU, slightly more than their representation in science (32%). Women constitute 40% of researchers in higher education, 40% in government and 19% in the private sector, with the number of female researchers increasing faster than that of male researchers. The proportion of female researchers has been increasing over the last decade, at a faster rate than men (5.1% annually over 2002–2009 compared with 3.3% for men), which is also true for their participation among scientists and engineers (up 5.4% annually between 2002 and 2010, compared with 3.1 % for men).

Despite these gains, women's academic careers in Europe remain characterized by strong vertical and horizontal segregation. In 2010, although female students (55%) and graduates (59%) outnumbered male students, men outnumbered women at the PhD and graduate levels (albeit by a small margin). Further along in the research career, women

10. Argentina, Colombia, Costa Rica, Honduras, Panama, Uruguay represented 44% of grade C academic staff, 37% of grade B academic staff and 20% of grade A academic staff.[11] These trends are intensified in science, with women making up 31% of the student population at the tertiary level to 38% of PhD students and 35% of PhD graduates. At the faculty level, they make up 32% of academic grade C personnel, 23 % of grade B and 11 % of grade A. The proportion of women among full professors is lowest in engineering and technology, at 7.9 %. With respect to representation in science decision-making, in 2010 15.5% of higher education institutions were headed by women and 10% of universities had a female rector. Membership on science boards remained predominantly male as well, with women making up 36% of board members.

The EU has engaged in a major effort to integrate female researchers and gender research into its research and innovation strategy since the mid-2000s. Increases in women's representation in all of the scientific fields overall indicates that this effort has met with some success; however, the continued lack of representation of women at the top level of faculties, management and science decision making indicate that more work needs to be done. The EU is addressing this through a gender equality strategy and cross-cutting mandate in Horizon 2020, its research and innovation funding programme for 2014–2020.

A lack of data for other high-income countries

In Australia, New Zealand and the USA, women make up the great majority of graduates in fields related to health. The same can be said of agriculture, in New Zealand's case. Both Australia and the USA have seen a modest progression in the share of female graduates in these two broad fields: 43–46% in agriculture and 76–77% in health for Australia and 47.5–48% in agriculture and 79–81% in health for the USA. Just one in five women graduate in engineering in these two countries, a situation that has not changed over the past decade. In New Zealand, women jumped from representing 39% to 70% of agricultural graduates between 2000 and 2012 but ceded ground in science (43–39%), engineering (33–27%) and health (80–78%). As for Canada, it has not reported sex-disaggregated data for women graduates in science and engineering. Moreover, none of the four countries listed here has reported recent data on the share of female researchers.

South Asia: the lowest shares of women

South Asia is the region where women make up the smallest proportion of researchers: 17%. This is 13 percentage points below sub-Saharan Africa. Of those countries in South Asia reporting data, Nepal has the lowest representation of all at 8% (2010), a substantial drop from 15% in 2002. Only 14% of researchers are women in the region's most populous country, India. The percentage of female researchers is highest in Sri Lanka but has receded somewhat to 37% (2010) from the 42% reported in 2006. Pakistan is gradually catching up (20% in 2013) [see Figure 21.7].

A breakdown of the research labour force reveals that South Asian women are most present in the private non-profit sector – they make up 60% of employees in Sri Lanka – followed by the academic sector: 30% of Pakistani and 42% of Sri Lankan female researchers. Women tend to be less present in the government sector and least likely to be employed in the business sector, accounting for 23% of employees in Sri Lanka and just 5% in Nepal (Figure 3.4).

Women have achieved parity in science in both Sri Lanka and Bangladesh but are less likely to undertake research in engineering. They represent 17% of the research pool in Bangladesh and 29% in Sri Lanka. Many Sri Lankan women have followed the global trend of opting for a career in agricultural sciences (54%) and they have also achieved parity in health and welfare. In Bangladesh, just over 30% choose agricultural sciences and health, which goes against the global trend. Although Bangladesh still has progress to make, the share of women in each scientific field has increased steadily over the past decade.

Southeast Asia: women often on a par with men

Southeast Asia presents a different picture entirely, with women basically on a par with men in some countries: they make up 52% of researchers in the Philippines and Thailand, for example. Other countries are close to parity, such as Malaysia and Viet Nam, whereas Indonesia and Singapore are still around the 30% mark. Cambodia trails its neighbours at 20%. Female researchers in the region are spread fairly equally across the sectors of participation, with the exception of the private sector, where they make up 30% or less of researchers in most countries.

The proportion of women tertiary graduates reflects these trends, with high percentages of women in science in Brunei Darussalam, Malaysia, Myanmar and the Philippines (around 60%) and a low of 10% in Cambodia. Women make up the majority of graduates in health sciences, from 60% in Laos to 81% in Myanmar – Viet Nam being an exception at 42%. Women graduates are on a par with men in agriculture but less present in engineering: Viet Nam (31%), the Philippines (30%) and Malaysia (39%); here, the exception is Myanmar, at 65%.

In the Republic of Korea, women make up about 40% of graduates in science and agriculture and 71% of graduates in health sciences but only 18% of female researchers overall. This represents a loss in the investment made in educating girls and women up through tertiary education, a result of traditional

11. Grade A is the highest grade/post at which research is normally conducted; grade B researchers occupy mid-level positions; grade C is the first grade/post to which a newly qualified PhD-holder would normally be recruited (European Commission, 2013).

Chapter 3

views of women's role in society and in the home. Kim and Moon (2011) remark on the tendency of Korean women to withdraw from the labour force to take care of children and assume family responsibilities, calling it a 'domestic brain drain'.

Women remain very much a minority in Japanese science (15% in 2013), although the situation has improved slightly (13% in 2008) since the government fixed a target in 2006 of raising the ratio of female researchers to 25% (see Chapter 24). Calculated on the basis of the current number of doctoral students, the government hopes to obtain a 20% share of women in science, 15% in engineering and 30% in agriculture and health by the time the current *Basic Plan for Science and Technology* ends in 2016. Today, Japanese female researchers are most common in the public sector in health and agriculture, where they represent 29% of academics and 20% of government researchers (see Figure 24.5). One of the main thrusts of Abenomics, Japan's current growth strategy, is to enhance the socio-economic role of women. Consequently, the selection criteria for most large university grants now take into account the proportion of women among teaching staff and researchers (Chapter 24).

Arab States: a high share of female students

At 37%, the share of female researchers in the Arab States compares well with other regions. The countries with the highest proportion of female researchers are Bahrain and Sudan, at around 40%. Jordan, Libya, Oman, Palestine and Qatar have percentage shares in the low twenties. The country with the lowest participation of female researchers is Saudi Arabia, even though they make up the majority of tertiary graduates, but the figure of 1.4% covers only the King Abdulaziz City for Science and Technology.

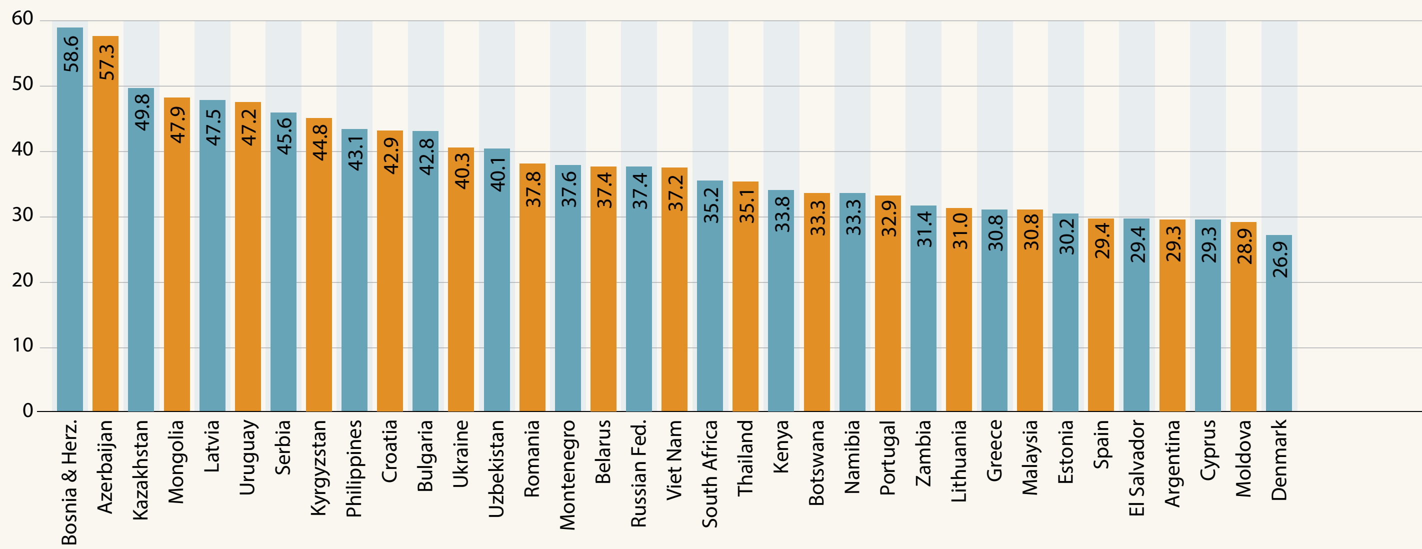
Female researchers in the region are primarily employed in government research institutes, with some countries also seeing a high participation of women in private non-profit organizations and universities. With the exception of Sudan (40%) and Palestine (35%), fewer than one in four researchers in the business enterprise sector is a woman; for half of the countries reporting data, there are barely any women at all employed in this sector.

Despite these variable numbers, the percentage of female tertiary-level graduates in science and engineering is very high across the region, which indicates that there is a substantial drop between graduation and employment and research. Women make up half or more than half of science graduates in all but Sudan and over 45% in agriculture in eight out of the 15 countries reporting data.[12] In engineering, women make up 53% of graduates in Oman, with rates of 25–38% in the majority of the other countries – which is high in comparison to other regions. Interestingly, the participation of women is somewhat lower in health than in other regions, possibly on account of cultural norms restricting interactions between males and females. Iraq and Oman have the lowest percentages (mid-30s), whereas Iran, Jordan, Kuwait, Palestine and Saudi Arabia are at gender parity in this field. The United Arab Emirates and Bahrain have the highest rates of all: 83% and 84%.

Why such a high proportion of female engineering students in the region? The case of the United Arab Emirates offers

12. Algeria, Egypt, Jordan, Lebanon, Sudan, Syria, Tunisia and UAE

Figure 3.4: **Share of women among researchers employed in the business enterprise sector, 2013 or closest year (%)**



Note: Data are in head counts. The oldest data are for the Philippines and Israel (2007), Iran, Lesotho and Zambia (2008) and Thailand (2009).

Source: UNESCO Institute for Statistics, August 2015 some insights. The government has made it a priority to develop a knowledge economy, having recognized the need for a strong human resource base in science, technology and engineering. With just 1% of the labour force being Emirati, it is also concerned about the low percentage of Emirati citizens employed in key industries (see Chapter 17). As a result, it has introduced policies promoting the training and employment of Emirati citizens, as well as a greater participation of Emirati women in the labour force. Emirati female engineering students have said that they are attracted to a career in engineering for reasons of financial independence, the high social status associated with this field, the opportunity to engage in creative and challenging projects and the wide range of career opportunities.

Once Arab women scientists and engineers graduate, they may come up against barriers to finding gainful employment. These include a misalignment between university programmes and labour market demand – a phenomenon which also affects men –, a lack of awareness about what a career in their chosen field entails, family bias against working in mixed-gender environments and a lack of female role models (Samulewicz *et al*, 2012; see also Chapter 17).

One of the countries with the smallest female labour force is developing technical and vocational education for girls as part of a wider scheme to reduce dependence on foreign labour. By 2017, the Technical and Vocational Training Corporation of Saudi Arabia is to have constructed 50 technical colleges, 50 girls' higher technical institutes and 180 industrial secondary institutes. The plan is to create training placements for about 500 000 students, half of them girls. Boys and girls will be trained in vocational professions that include information technology, medical equipment handling, plumbing, electricity and mechanics (see Chapter 17).

Sub-Saharan Africa: solid gains

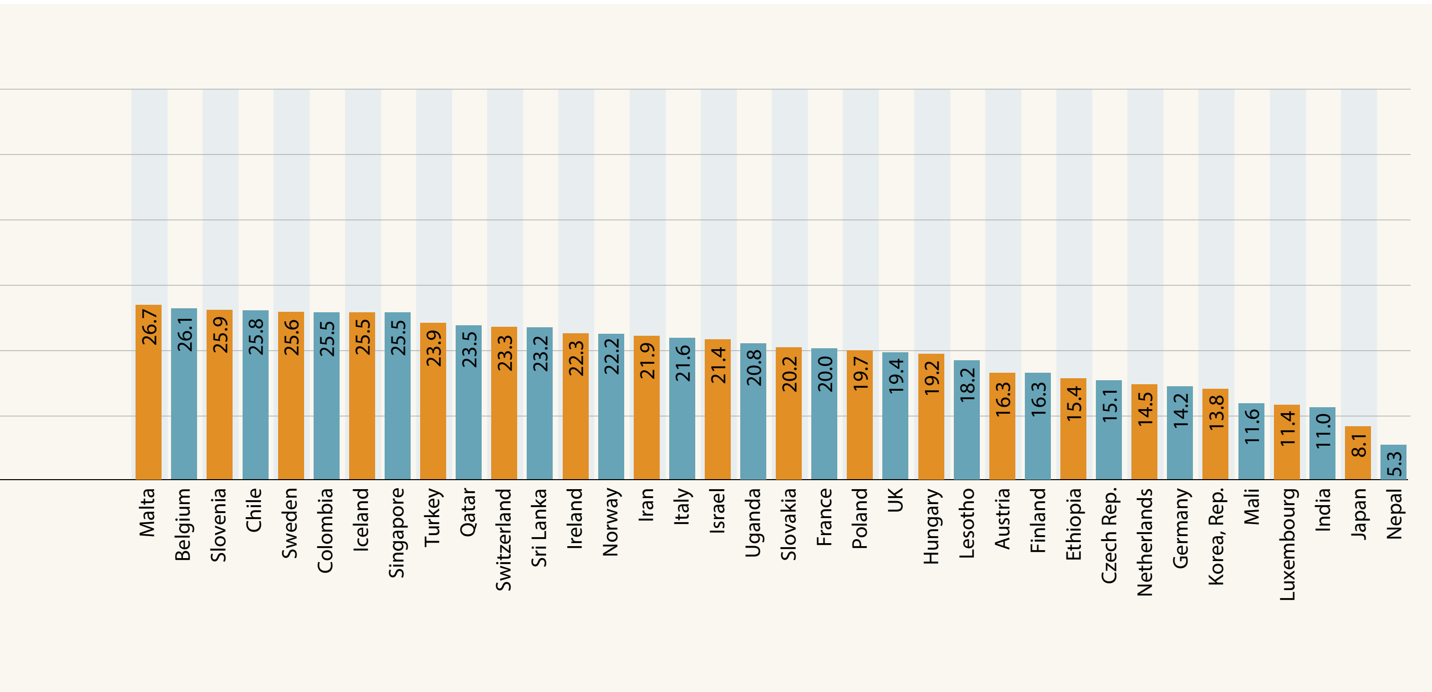
Just under one in three (30%) researchers in sub-Saharan Africa is a woman. Much of sub-Saharan Africa is seeing solid gains in the share of women among tertiary graduates in scientific fields. In two of the top four countries for women's representation in science, women graduates are part of very small cohorts: they make up 54% of Lesotho's 47 tertiary graduates in science and 60% of those in Namibia's graduating class of 149. South Africa and Zimbabwe, which have larger graduate populations in science, have achieved parity, with 49% and 47% respectively. The next grouping clusters seven countries poised at around 35–40%,[13] whereas the rest are grouped around 30% or below.[14] Burkina Faso ranks lowest, with women making up 18% of its science graduates.

Female representation in engineering is fairly high in sub-Saharan Africa in comparison with other regions. In Mozambique, Lesotho, Angola and South Africa, women make up between 28% (South Africa) and 34% (Mozambique) of science graduates. Numbers of female graduates in agricultural science have been increasing steadily across the continent, with eight countries reporting the share of women graduates of 40% or more.[15] In health, this rate ranges from 26% and 27% in Benin and Eritrea to 94% in Namibia.

13. Angola, Burundi, Eritrea, Liberia, Madagascar, Mozambique and Rwanda

14. Benin, Ethiopia, Ghana, Swaziland and Uganda

15. Lesotho, Madagascar, Mozambique, Namibia, Sierra Leone, South Africa, Swaziland and Zimbabwe



POLICY ISSUES

Progress but a persistent 'generation effect'

Concrete progress is being made in much of the world in increasing the share of women studying scientific disciplines. Moreover, female participation at tertiary level is expanding beyond life and health sciences. We are also seeing progress in the recognition of female scientists at national, regional and global levels. The African Union has instigated awards for women scientists, for instance (see Chapter 18). In the past five years, five Nobel prizes have been awarded to women for work in medicine, physiology and chemistry.[16] In 2014, the Iranian Maryam Mirzakhani became the first woman to receive the prestigious Fields Medal awarded by the International Mathematical Union.

However, the data also show that gender equality in science is not a natural result of these trends – it is not simply a matter of waiting for female tertiary graduates to make their way through the system. Gaps and barriers persist throughout the scientific research system. This has been systematically documented in Europe and the USA, where a decade or so of injecting policy, programming and funding into the system to promote gender equality in research have not produced as much progress as expected. Indeed, in the USA, numbers have remained stagnant and even decreased in some fields over the past decade, whereas there has been little change in the gender balance in the EU for positions of leadership and prestige (EU, 2013). Eurostat uses the term 'generation effect' to refer to a gender imbalance in the research population which increases with age rather than evening out. Despite increases in numbers of female students, the gender gap in scientific research in Europe is still disproportionately high, making it less likely women will automatically 'catch up' to men (EU, 2013).

Getting more women into science isn't working

A combination of factors reduces the proportion of women at each stage of a scientific career: the graduate-level environment; the maternal wall/glass ceiling; performance evaluation criteria; the lack of recognition; lack of support for leadership bids; and unconscious gender bias.

With regard to the graduate-level environment, a 2008 study of the career intentions of graduate students in chemistry in the UK found that 72% of women had planned to become a researcher at the start of their studies but, by the time they completed their PhD, only 37% still harboured this career goal. This was the result of a number of factors which 'discourage women more than men from planning a career in research, especially in academia'. Female students were more likely to encounter problems with their supervisor such as favouritism or victimization, or to feel that their supervisor was oblivious to their personal life, or to feel isolated from their research group. They were also more likely to be uncomfortable with the research culture of their group in terms of working patterns, work hours and competition among peers. As a result, female students viewed an academic career as offering a solitary existence; they felt intimidated by the competitive atmosphere and that an academic career demanded too much of a sacrifice from them concerning other aspects of their life. Many female students also spoke of having been advised against pursuing a scientific career, owing to the challenges they would face as a woman (Royal Society of Chemistry, 2008). In Japan, female engineering undergraduates complained of experiencing difficulties in approaching instructors with questions and had trouble engaging with learning both in and outside the classroom (Hosaka, 2013).

The 'maternal wall' results from expectations that a woman's job performance will be affected by her taking a leave of absence to have children, or by absences from work to take care of the family (Williams, 2004). In some countries, once women have embarked on a scientific career, their trajectories tend to be less stable than those of men and characterized by shorter term and temporary work, rather than full-time positions (Kim and Moon, 2011). Some of these challenges stem from a working and research environment where women are expected to fit in and 'become one of the boys' rather than one which encourages flexible working arrangements to accommodate the life situations of both women and men. In East Africa, barriers facing female researchers include difficulty in travelling to conferences or in participating in field work, on the assumption that they are the primary domestic caregiver at home (Campion and Shrum, 2004). The maternal wall is supplemented by the 'glass ceiling,' whereby a woman's performance tends to be more closely scrutinized than that of men, obliging women to work harder to prove themselves (Williams, 2004).

Women should not have to choose between two sacrifices

Women who do take leave for family reasons sacrifice progress in their careers, particularly in the research environment. When they return, they are either considered as having fallen behind in their career, compared to their peers, or in need of retraining in their field. Changing the current system of performance appraisal and reward to accommodate women's child-bearing years without obliging them to sacrifice their careers is the single most important step towards rectifying this imbalance.

In many countries, the work–life balance and family responsibilities are also emerging concerns for men (CMPWASE, 2007).

16. See: www.nobelprize.org/nobel_prizes/lists/women.html

Women have less access to research funding

Performance evaluation includes productivity measurements, such as the number of authored publications and patents, the citation rate of these papers and the amount of research funding obtained. In science, productivity is measured in terms of research, teaching and service (such as committee membership), with research tending to carry the most weight. Publication in high-prestige journals or conference proceedings ranks highest and teaching lowest. Studies in the USA indicate that female faculty tend to focus on teaching and service more than research, particularly in terms of the number of authored publications. At the same time, young researchers are expected to spend 80–120 hours per week in the laboratory, putting women with children at an immediate disadvantage (CMPWASE, 2007).

Universally, the publication rate of female researchers is lower than that for men, although there are data gaps. South African women authored 25% of published articles in 2005, Korean women 15% in 2009 (Kim and Moon, 2011) and Iranian women about 13%, with a focus on chemistry, medical and social sciences (see Chapter 15). Recent research suggests that the main explanation for this trend lies in women's limited access to funding and generally lower status: women are less represented than men at prestigious universities and among senior faculty, the very positions where researchers publish the most (Ceci and Williams, 2011). For example, in East Africa in 2004, the lack of equal access to funding and interaction with regional and international collaborators decreased the likelihood of female researchers being published in prestigious international journals (Campion and Shrum, 2004).

If women in all countries are penalized when it comes to research funding, the same goes for patents. 'In all countries, across all sectors and in all fields, the percentage of women obtaining patents is … less than their male counterparts' (Rosser, 2009). Globally, patenting rates by women are highest in pharmaceutical fields (24.1%), followed by basic chemicals (12.5%), machine tools (2.3%) and energy machinery (1.9 %). In Europe, the share of patent applications made by women was around 8% in 2008. About 94% of US patents are owned by men (Frietsch *et al.,* 2008; Rosser, 2009). Research on this topic suggests that ability is not an issue. Rather, women scientists tend not to understand or show interest in the patenting process, or to focus on research with a social impact rather than on technical processes that can be patented (Rosser, 2009).

A persistent bias that women cannot do as well as men

The number of women who have been recognized as leaders by high-prestige societies or through awards remains low, despite some high-profile exceptions. Lack of recognition of women's achievements contributes to the misconception that women cannot do science or, at least, not as well as men. This gender bias can be conscious or unconscious. In one study, all faculty, both male and female, rated a male applicant for a laboratory position significantly higher than a female applicant. The participants in the study also selected a higher starting salary and offered more career mentoring to the male (Moss-Racusina *et al.,* 2012).

Science remains one of the few sectors where gender bias is common and considered acceptable by some. In June 2015, 72 year-old Nobel laureate Sir Tim Hunt criticized the presence of women in his laboratories, explaining that he considered them a distraction and overly emotional. Weeks later, Matt Taylor from the European Space Agency wore a shirt with a garish pin-up girl pattern when making a major announcement about the Rosetta Project space probe. After people expressed indignation via social media, both men made public apologies.

Pragmatic reasons to hire a woman

Companies and institutions are increasingly aware that a diverse labour force will improve their performance and enable them to reach more segments of their target customer or client base or relevant stakeholders. Diversity in research also expands the pool of talented researchers, bringing in fresh perspectives, talent and creativity. Google recently recognized its own need for a more diverse labour force for the very reasons cited above. '[Google] is not where we want to be when it comes to diversity', according to Laszlo Bock, Google's senior vice president for people operations (Miller, 2014). Women make up just 17% of Google's technicians and one in four of its top executives. Ethnic diversity is also low, with 1% Afro-American, 2% Hispanic and 34% Asian employees in the USA.

Conversely, the attrition of talented women from the science system represents a serious loss in investment. Many governments are setting targets for raising the share of GDP spent on research and development (R&D), 60% of which goes on human resources. If governments are serious about reaching their targets, many more researchers will need to be hired. Widening the pool of talented researchers will increase the rate of progress towards reaching government targets and ensure that the money spent on educating half of these potential researchers does not go down the drain (Sheehan and Wyckoff, 2003). Many countries recognize that a greater gender balance and diversity in science and research would increase their competitiveness in a globalized economy. Malaysia and the United Arab Emirates have both instituted policies fostering greater diversity in the labour force, including women, and are seeing positive results. Science in both the public and private sectors in the Republic of Korea, on the other hand, is characterized by a strong, persistent gender imbalance in scientific research and industry.

The scientific endeavour itself suffers when women do not participate equally in research and industry (Figure 3.4). Feminist critiques of science have shown that the way in which experiments are set up, the way research questions are defined and the type of conclusions drawn from research findings are all influenced by gender (Rosser, 2009). How many inventions have never seen the light of day as a result of women's absence from research? What important considerations from a gender perspective are being overlooked? It was not until 1993 that aspirin was found to have a totally different effect on heart disease in men and women, reducing the chances of a heart attack in men but not of a stroke, while reducing the risk of a stroke in women but not of a heart attack (Kaiser, 2005).

Simply and perhaps most importantly, women should have the same opportunities as men to understand and benefit from the fruits of research, contribute to society, earn a living and choose a fulfilling profession. The United Nations has made a strong commitment to gender mainstreaming – be it in research, legislation, policy development or in activities on the ground – as part of its mandate to ensure that both women and men are in a position to influence, participate in and benefit from development efforts.[17] UNESCO has embraced this commitment by establishing gender equality as one of its two global priorities, along with Africa. UNESCO considers gender equality not only to be a fundamental human right but also a building block of sustainable, peaceful societies. This commitment includes promoting a greater participation by women in science, technology, innovation and research. This is why the UNESCO Institute of Statistics systematically collects gender-disaggregated data, which it then makes freely available to the public through interactive websites (Box 3.1).

Moving forward: policies for gender equality

Among industrialized countries, the EU and the USA have both adopted strong policies and funding incentives to foster the participation of women in science. Horizon 2020, the EU programme funding research and innovation from 2014 to 2020, treats gender as a cross-cutting issue; it implements a strategy to promote gender equality in research and innovation, including gender balance in research teams, gender balance on expert panels and advisory groups and the integration of gender aspects in the content of research and innovation projects to improve scientific quality and societal relevance.

In the USA, the Science and Engineering Equal Opportunity Act of 1980 mandates equal opportunities for men and women in education, training and employment in scientific and technical fields. As a result, the National Science Foundation supports and undertakes research, data collection and other activities to assess, measure and increase the participation of women in science, technology, engineering and mathematics. One of its programmes, ADVANCE, offers fellowships and awards for institutional transformation and leadership to increase the participation of women in research and reward excellence.[18]

A number of low- and middle-income countries have also developed policies in one or more areas to integrate women and gender issues more effectively into science. In 2003, the Department of Science and Technology of South Africa convened an advisory body to advise it on priorities, key directions and successful strategies for increasing the participation of women in science. This agenda is set in a national context of gender equality and driven by a national 'gender machinery' consisting of a group of co-ordinated structures within and beyond government: SET4W is part of the National Advisory Council on Innovation, a national body appointed by the Minister of Science and Technology to advise him or her, as well as the Department of Science and Technology and the National Research Foundation. Set4W provides advice on policy issues at the nexus of science, technology, innovation and gender (ASSAf, 2011).

The Brazilian approach combines policy with robust mechanisms for implementation. The high level of female representation in various sectors is a result of strong support for gender equality. Women's rights both inside and outside the home have been strengthened and the participation of women and girls in education and employment has been encouraged. This strategy has proven highly successful,

17. See: ww.un.org/womenwatch/osagi/gendermainstreaming.htm

18. www.nsf.gov/crssprgm/advance/

Box 3.1: Explore the data

Women in Science is an interactive data tool developed by the UNESCO Institute for Statistics. It lets you explore and visualize gender gaps in the pipeline leading to a research career: from the decision to enrol in a doctorate degree course to the scientific fields that women pursue and the sectors in which they work. By presenting both regional and country-level data, this product provides a global perspective on the gender gap in research, with an emphasis on science, technology, engineering and mathematics. Available in English, French and Spanish, it may be accessed at http://on.unesco.org/1n3pTcO.

In addition, the eAtlas of Research and Experimental Development lets you explore and export interactive maps, charts and ranking tables for more than 75 indicators on the human and financial resources devoted to R&D. Go to: http://on.unesco.org/RD-map.

Both products are automatically updated with the latest data. They can be easily embedded on websites, blogs and social media sites.

Source: UNESCO Institute for Statistics gender parity having been attained in the national labour force. The government has also increased investment in R&D and programmes fostering science and engineering education for all (see Chapter 7). The availability of scholarships, coupled with transparency in competitions at graduate levels, has encouraged many women to enter science (Abreu, 2011).

Systematic collection of gender-disaggregated data

To support policy implementation and research, both the EU and USA systematically collect gender-disaggregated data. In the USA, the National Science Foundation is also required to prepare and submit reports to the US Congress (parliament) on policy and programming to promote minority participation in these fields and to eliminate discrimination in science and engineering by sex, race, ethnic group or discipline. Since 2005, Eurostat has been given a mandate to collect gender-disaggregated data by qualification, sector, field of science, age, citizenship, economic activity and employment in the business enterprise sector. South Africa and Brazil also collect comprehensive gender-disaggregated data.

Creating a level playing field in the workplace

Extensive research has been undertaken in Europe and the USA to identify models which ensure that countries can benefit from the talent, creativity and accomplishments of both sexes when it comes to science and engineering. A number of approaches can be taken to promote an equitable and diverse workplace (CMPWASE, 2007; EU, 2013):

- Address unconscious bias in hiring and performance assessment;
- Implement sexual harassment training and policies and ensure redress for victims of harassment;
- Address the institutional culture and processes that penalize a woman's family life: performance evaluation in relation to hiring, tenure and promotion needs to accept flexible publication and research schedules to ensure that women (and men) who interrupt their career during their child-bearing years will not jeopardize their future career;
- Institutional gender policies need to be supported at the highest levels of governance;
- Decision-making and selection processes should be open, transparent and accountable. All professional, grant, selection and hiring committees should reflect a balance between male and female members;
- Modernize human resources management and the work environment;
- Eliminate the gender pay gap, including the gender research funding gap;
- Make resources available to parents for retraining or re-entering the labour force; and
- Ensure that women and men can take advantage of travel, conference and funding opportunities equally.

UN Women and the UN Global Compact have joined forces to produce the Women's Empowerment Principles, a set of guidelines for business on how to empower women in the workplace, marketplace and community. These guidelines are intended to promote best practice by outlining the gender dimensions of corporate responsibility and the role of business in sustainable development; the guidelines thus apply both to businesses and to governments in their interactions with the business world. Companies are asked to use a set of seven principles to assess company policies and programmes; develop an action plan for integrating gender considerations; communicate progress to stakeholders; use the Women's Empowerment Principles for guidance in reporting; raise awareness about the Women's Empowerment Principles and promote their implementation; and share good practices and lessons learned with others.

Box 3.2: **The CGIAR: advancing the careers of women in global research**

The Consultative Group on International Agricultural Research (CGIAR) established its Gender and Diversity programme in 1999 with a mandate to promote the recruitment, advancement and retention of women scientists and other professionals. A Gender Monitoring Framework was designed for the CGIAR in 2013 to monitor progress in addressing:

- what CGIAR has done in its own work place(s) to raise the share of women in senior positions and those seeking out CGIAR as an employer of choice; and
- progress in gender mainstreaming achieved throughout the CGIAR system, using such indicators as the number of male and female staff in key leadership positions, the integration of gender considerations into research priority-setting, implementation and evaluation and, lastly, the extent to which research budgets and expenditure are allocated with respect to gender.

In 2014, women made up 31% of the CGIAR leadership. The CGIAR Consortium has since hired a Senior Advisor on Gender and Research to advise centres on related issues in the workplace. Reports are also submitted to the CGIAR Fund Council every six months to monitor the performance of the Gender and Diversity programme.

Source: CGIAR (2015)

CONCLUSION

A need to 'fix the system'

Although more women are studying for degrees related to health, science and agriculture than before and there is even a gender imbalance in favour of women at the tertiary level overall, the sheer drop in female researchers to less than 30% globally indicates that serious barriers remain to the full participation of women in science and engineering. At the transition from master's to PhD level then, as they climb the rungs of the career ladder, a number of women are 'lost' to science.

Even women who embark on a career in science or engineering often leave their jobs for family reasons or change career paths more often than men. Recent research indicates that approaches to this problem need to change, an affirmation supported by the data. The approach of getting more women to study science and choose a scientific career needs replacing with an approach oriented towards 'fixing the system,' that is, addressing the points of attrition, barriers and culture that are causing women to abandon science.

The following steps, among others, can foster greater diversity in the scientific labour force:

Governments are encouraged to:

- collect data disaggregated by gender consistently in key sectors;
- implement policies that promote the participation of women in society and the labour force, as well as in science and innovation; and
- take steps to ensure that science and education systems are accessible, of a high quality and affordable.

Research, science and government institutions are encouraged to:

- commit to the equal representation of women in science, research and innovation management and decision-making;
- support a commitment to gender equality and diversity through funding, programming and the monitoring of progress; and
- introduce fellowships and grants to increase the representation of underrepresented groups.

Employers and governments are encouraged to:

- adopt open, transparent and competitive recruitment and advancement policies;
- adopt strategies to promote diversity in education and the workplace, including targets for the participation of different groups, financial support and access to employment opportunities; and
- ensure supplementary support for women in the form of training, access to finance and backing for entrepreneurship.

Gender equality is more than a question of justice or equity. Countries, businesses and institutions which create an enabling environment for women increase their innovative capacity and competitiveness. The scientific endeavour benefits from the creativity and vibrancy of the interaction of different perspectives and expertise. Gender equality will encourage new solutions and expand the scope of research. This should be considered a priority by all if the global community is serious about reaching the next set of development goals.

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