PATHWAYS TO SUCCESS: BRINGING A GENDER LENS TO THE SCIENTIFIC LEADERSHIP OF GLOBAL CHALLENGES

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FOREWORD

"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."

(Huyer 2015: 86)

This report explores the issue of women's leadership in science and brings to the discussion some related issues not usually taken into consideration. The initial motivation was to look at the career trajectories of women in positions of scientific leadership to show how power and knowledge can cohere in institutions to create and maintain dominant pathways. The report demonstrates the importance of having a gender perspective that would assure '*equal opportunity for entry and advancement into larger-scale science, technology, engineering, mathematics disciplines (STEM) and innovation systems*', one of the transformative actions so aptly described by the UN Commission on Science and Technology for Development (UNCSTD) Gender Advisory Board. Through interviews with women and men who lead international science and technology projects, the document highlights different pathways to success and how institutional change is so elusive and hard to achieve.

However, when the authors looked at respondents' individual pathways, they decided that, although it was important to demonstrate that alternative perspectives are possible, they would enlarge their perspective and look at other levels of analysis.

By highlighting alternative perspectives on how systems of scientific production operate, this report promotes alternative narratives and pathways in science. In these narratives, gender is recognised as an important factor in the career and leadership trajec-

tories of individual scientists and in how science for sustainable development is done. This has implications for the pathways pursued both by individual women scientists, and by organisations involved in science governance and practice at multiple levels. In this way, the pathways approach resonates with the overall GenderInSITE mission which aims to 'demonstrate how applying a gender lens to SITE can provide deeper insights, more effective programmes and more sustainable outcomes in the context of development'. GenderInSITE encourages the building of pathways that take into account the 'vision, concerns and abilities of both women and men' to ultimately 'make both scientists and science more effective'.

This report is, therefore, a contribution to the core aim and mission of GenderInSITE and to the discussion around the Sustainable Development Goals. None of the SDG targets will be achieved without science viewed through a gender lens.

Especially important is the focus on the context in which effective policies and actions at the gender/science interface have successfully emerged, tracing the role played by international science organisations (including intergovernmental organisations and non-governmental organisations) in building pathways to success. Looking at the different scientific aspects of their activities, 'including defining international policies, objectives and intergovernmental frameworks; developing scientific capacities at individual, institu-

tional and system-levels; and advocating for freedom and responsibilities in the conduct of science', the report shows their significant power in influencing all levels of the scientific system, and how there is still a long way to go to achieve real gender equity in many of their practices.

Looking at who and what have been the primary change agents and driving forces behind the pathways of success in scientific leadership, the report identifies different sets of actors within the scientific infrastructure as having promoted positive change. These include individual researchers themselves who, in their determination to use their science to change the world, have refused to accept society´s restraints on women´s roles. Also identified are independent advisory boards which helped develop gender champions and influenced the formation of far-reaching gender policy within different international structures, of which the EU is a shining example.

The report draws our attention to the complexity of science production and the multiple levels that comprise the global scientific system. It shows the progress of initiatives to promote women's leadership at the levels of regional, international and global collaboration and through the co-ordination of research funding. However, it also highlights the challenges that still remain to advance a gender lens both to research itself and to scientific leadership of global challenges. Because of the scope and reach of these organisations,

action here can lead to impacts at other levels. The report shows clearly that the central issue is the need to connect the different levels, addressing women scientists' challenges, amending organisations' policies, and ensuring a gender dimension in research as we consider today's global challenges.

This will involve a concerted programme of action to ensure that international science is able to play its role in meeting the global challenges of the 21st Century, but also in achieving the SDG's targets which will only be reached with 'women's full and effective participation and equal opportunities for leadership at all levels of decision-making in political, economic and public life'.

We would like to extend our gratitude to the Swedish International Development Cooperation Agency, Sida, for providing the funding to create this report, and for their longstanding support of GenderInSITE. We wish, finally, to thank the Institute of Development Studies team and all the authors for their effort and commitment, and for a contribution which we hope will help to ensure women researchers are represented and heard, and that a gender lens is applied at all levels of the international scientific system.

Trieste, November 2017

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CHAPTER 1

INTRODUCTION

Over the past 50 years, the organisation of science has been completely transformed by globalisation and digitisation. This is particularly relevant to those seeking to solve the pressing human and environmental challenges of our time. It is increasingly recognised that these complex global challenges can only be addressed through meaningful international collaboration and 'integrated science' which brings together scientists from different disciplines to co-construct knowledge. This is reflected in the growing influence of international scientific infrastructure, such as the relevant bodies of the EU and UN and in the high-profile merger between the International Council for Science (ICSU) and the International Social Science Council (ISSC). At the national level, the seven UK Research Councils have merged into one agency, UK Research and Innovation (UKRI).

This report draws attention to the importance of gender equality in scientific leadership. Ultimately, this has implications beyond science participation itself, to affect the very ways in which global challenges – including broader problems of gender inequality – are tackled.

The urgency of leveraging women's perspectives, talent and potential was recognised by the outcome document of the United Nations Conference on Sustainable Development, which recommended targeted measures to increase women's education, employment and leadership in science, technology, engineering and mathematics. Writing in 2014, the Executive Director of UN Women, Phumzile Mlambo-Ngcuka, acknowledged the dangers of failing to capitalise on women's knowledge and agency to 'improve resource productivity, enhance ecosystem conservation and sustainable use of natural resources, and to create more sustainable, low-carbon food, energy, water and health systems' (UN Women 2014: 7).

1.1 GENDER EQUALITY AND THE SUSTAINABLE DEVELOPMENT GOAL

Alongside these trends towards multi-disciplinarity and international scientific collaboration, there is a growing recognition of the necessity of gender equality both for achieving, and as an objective of, the Sustainable Development Goals (SDGs). Societal problems and concerns increasingly demonstrate the interrelated connections between humans and the environment.[1] Meanwhile, the inadequacy of 'business-as-usual' approaches to these problems has become increasingly clear. The SDGs propose that gender equality be recognised as a force for transformative change in the pursuit of sustainable social, environmental and economic development and specifically call for the promotion of 'women's voices, leadership and organisation' in science, recognising this as critical for tackling such global challenges (Seager *et al.* 2016: 209).

As stated in a recent Nature editorial: 'By almost any metric, women have made great gains in closing the scientific gender gap, but female scientists around the world continue to face major challenges' (Shen 2013: 22). As it currently stands there are few women in scientific leadership and agenda-setting roles; and data shows a broader gender imbalance in science, both in Europe and globally. Women are not only missing out on socioeconomic opportunities for professional and personal growth, but their perspectives are frequently absent or marginalised in the 'spaces' where scientific agendas and policies are shaped.

[1] Challenges include for instance, food production and food security; sustainable sanitation and wastewater management; energy production, supply and consumption; sustainable production and consumption of consumer goods; climate change; conflict and violence; and ecosystem conservation.

This report emerges out of consideration both of existing research which provides a quantitative picture on the persistence of gender inequality in science and leadership of major science projects (e.g. *She figures* series, SAGA project and monitoring data from *Horizon 2020*), and qualitative explanations detailing the numerous forms of structural discrimination that underlie this persistent inequality.

Underpinning this report is an important conceptual distinction. By *gender equality*, we refer to the equal access to and enjoyment of opportunities by women and men, whereas *gender equity* refers to the *process* of being fair to women and men in order to *achieve* gender equality (UNFPA 2005).[2] In this report, we highlight the evolution of policies for the enacting of gender equity (Chapter 3), and individual women's career pathways (Chapter 4) as scientific researchers.

[2] We acknowledge that gender identity extends beyond the binary concepts of women and men, and in our call for gender equality in science leadership, include the need to pay attention to the ways in which people claiming non-binary gender identities may also be systematically excluded from opportunities in science leadership, and how they may and can benefit from processes of gender equity. However, the report primarily refers to women and men as it is these categories upon which most prior research is based, and under which most people identify.

1.2

ADVANCING GENDER EQUALITY IN SCIENCE LEADERSHIP

The rapidly shifting landscape and rise of integrated science offers an opportunity to promote new forms of science to address complex global challenges. Addressing issues of gender, power and inequality is central to this challenge, as acknowledged by the SDGs, but is traditionally seen as the preserve of the social sciences. In this report, we turn our attention to ways forward, hoping to take advantage of this key moment to influence science policy and, through this, to advance women's equal representation in science through processes of equity – both in terms of *who* does and leads science, and *how* science is done.

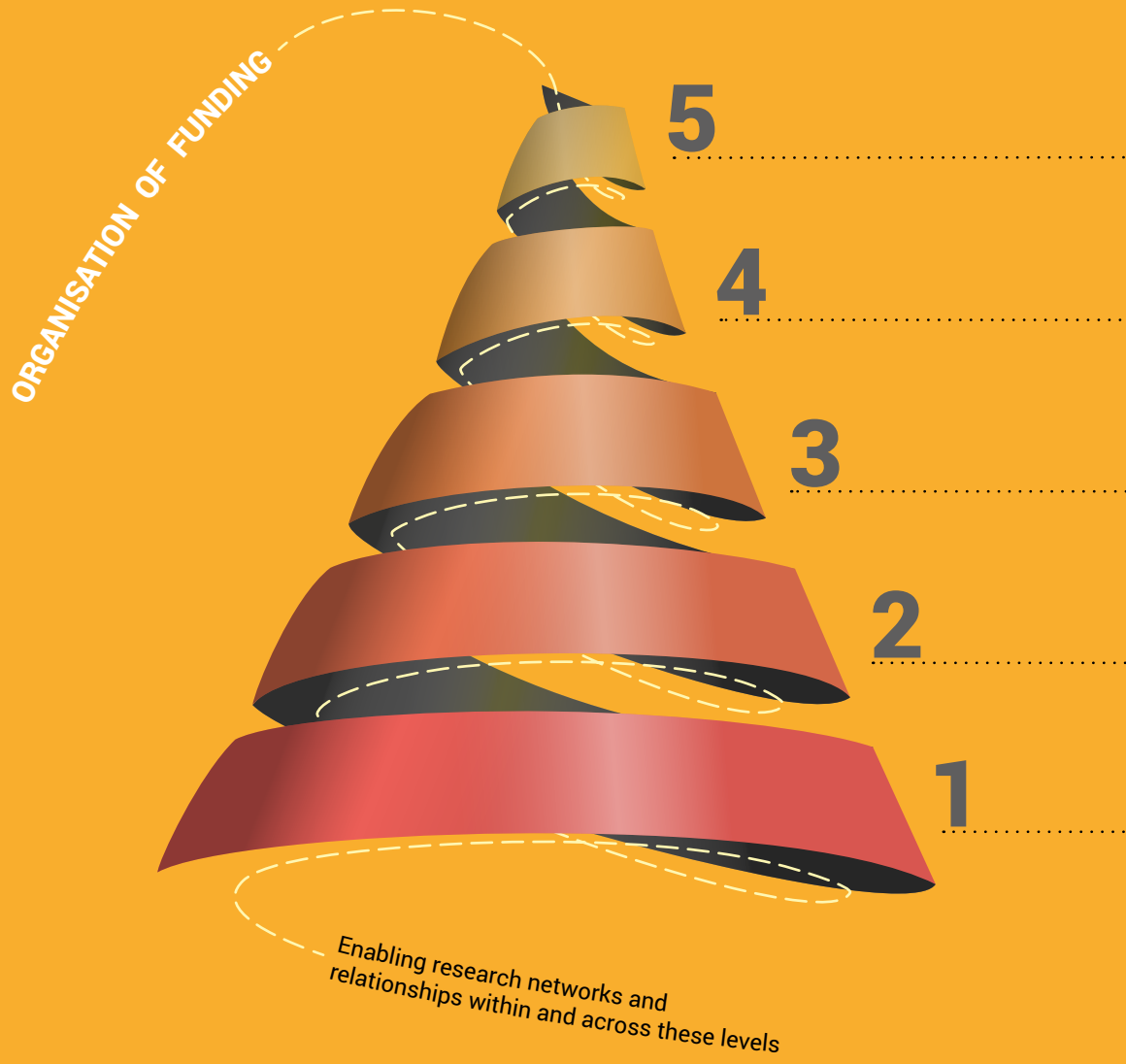
Using the idea of 'pathways' and through interviews with leading female scientists, we can see how policies promoting gender equity and science evolve and develop at five levels in the scientific system. Networks exist within and between these levels, allowing some individual scientists – on occasion – to span across the levels, but also limiting those scientists with weaker relationships. These levels shape individual women's pathways to scientific leadership and the influence they can exert in positions of leadership.

While there is recognition of the problem of unequal gender representation in science leadership across all levels, there is variable commitment to transformative change. This combination of promise and stagnation occurs within and across levels,

and varies in time. We do not address every level in depth, and instead, through case studies, focus on areas where encouraging change is taking place, and could be strengthened. We also highlight promising new policy pathways that have opened in EU science governance structures, and have begun to reinforce previously disjointed patchworks of policies and tools at the highest level. Furthermore, promising policies and initiatives targeted at the gender/science interface have evolved in the UN, and in the mid-levels of the scientific system, but in a rather ad hoc fashion. With regard to the day-to-day practice of science, we show through qualitative interviews with individual women scientists that, while there may be little formal policy support, there are a multitude of small and large actions which support women scientists in their pathways toward leadership, and which influence the policy pathways of science governance at higher levels of the scientific system.[3]

[3] While there may be different gendered patterns and dynamics at play in private sector science, citizen science, and indigenous science, this report limits its notion of the 'scientific system' to the formalised and not-for-profit structures, institutions and processes involved in the production of science for sustainable development.

PATHWAYS OF INFLUENCE AND SUPPORT FOR WOMEN SCIENTISTS



MULTILATERAL ORGANISATIONS

Science policy bodies of United Nations,
European Union and other regional organisations

GLOBAL SCIENCE CO-ORDINATION

International science organisations

PROFESSIONALISATION OF SCIENCE

National level co-ordination and policy

PRODUCTION OF SCIENCE

Research, universities, institutes, laboratories

INDIVIDUAL SCIENTISTS

Day-to-day work, activities and interactions

In this report, we ask:

— Where have progressive policies and practices on gender in science emerged, and where can they be strengthened?

— Who and what have been the primary change agents and driving forces behind these developments?

— What are the relationships between policy and behaviour change, and individual women scientists' pathways to leadership?

Policy pathways and individual women scientists' career pathways are intertwined across the levels of the scientific system. Progressive developments in policy at the highest levels seem to be furthered by individual women scientists and their coalitions, while their own pathways to leadership have in turn been influenced by particular policies and circumstances (both formal and informal) which they, as leaders, attempt to make available for others. In this report, by focusing primarily on positive examples of progress so far, we aim to present blueprints and/or starting points for others hoping to influence change at this moment of strategic opportunity.

1.3
METHODS

This report is written by women from a range of disciplinary and geographical backgrounds, and represents an example of collaborative 'integrated science' in action. The authors have first-hand experience of the changing global scientific environment, and of gender policy in science governance, reflected in Chapter 3. The eight women and three men interviewed for this report were identified in collaboration with GenderInSITE. These respondents represent natural and social sciences and come from diverse geographical backgrounds in both the global North and South. They hold (or held) high-profile leadership positions in international scientific organisations; are (or were) important nodes in multidisciplinary collaborations; and/or lead (or led) projects aiming to address global social and environmental challenges. We have anonymised all responses to protect their identities.

CHAPTER 2

THEORISING GENDER, LEADERSHIP AND SCIENCE

Worldwide, a gender imbalance exists in social science, natural science, technology and innovation (Howe-Walsh and Turnbull 2016; Sugimoto *et al*. 2013; Homma, Motohashi and Ohtsubo 2013). Women remain severely underrepresented in the areas of engineering, physics and computer science — less than 30% in most countries— and these figures are declining (WISAT 2012). Women in science leadership are scarcer still.

Economically speaking, leaving women out of the leadership equation results in massive losses to global GDP (Woetzel *et al*. 2015). But the problem goes beyond economic calculations. Gender equality, sustainability and development are highly interconnected and today's global challenges will not be addressed without taking women's perspectives, concerns and abilities into account (Leach, Mehta and Prabhakaran 2015). While important initiatives, such as the UN Women flagship programme 'Making Every Woman and Girl Count' promote the collection of quality gender statistics for development and give us a better idea of the state of women's equality and rights (UN Women 2016), addressing women's concerns goes beyond seeing them as 'subjects' of development. Women must be setting research agendas and provid-

ing leadership in scientific research. As long as they remain massively underrepresented in these positions, and especially in transnational and multidisciplinary projects, it is unlikely their concerns will be reflected in science, development policy or practice.

A wealth of research identifies the causal factors hindering women's ascent to top leadership roles (Fraser 2016). Many of these are captured as metaphors[4] such as: a lack of 'stretch assignments' for women (Fraser 2016); 'glass cliffs' (Haslam and Ryan 2008); 'sticky floors' (Caprile *et al*. 2015); 'polycarbonate ceilings' (Wren 2015); 'glass escalators' (Williams 1992); 'non-events' (Husu 2005); 'crystal' labyrinths (Eagly and Carli 2007); 'leaky pipelines' (Schiebinger 2002); and 'chilly climates' (Dugan *et.al.* 2013). Given all these barriers, how do women become leaders in science, and what pathways do they pursue to achieve seniority and recognition?

[4] See Appendix for more explanation of these metaphors. While metaphors are often evocative and capture some elements of the problem, there are many pitfalls in relying too heavily on them as accurate portrayals of a problem. Husu argues that these metaphors represent different aspects of the challenge, often in static ways which limit the scope for agency and change (2001). They also obscure power relations and underlying structural conditions.

2.1
A GENDER PATHWAYS APPROACH

The concept of a gendered pathways approach – used in this report to explore women's scientific leadership – draws on ideas from feminism, such as gendered subjectivities and embodiment; political ecology; and political economy (Cornwall and Sardenberg 2014; Leach *et al*. 2007; Leach *et al.* 2015) in relation to development, environmental sustainability and gender.

A pathways approach draws attention to the multiplicity of ways in which systems – such as systems of scientific production – and the processes, problems and issues embedded in them, are framed and understood. Arising out of diverse understandings are narratives, or stories about how these systems work. For instance, career progression

in mainstream science is widely understood as being solely based on a combination of scientific excellence and leadership skill and is supposedly gender neutral. This might be juxtaposed with an alternative narrative which emphasises how gendered socio-cultural notions of family and care have different implications for whether and how men and women progress towards scientific leadership. These narratives, which 'implicate and label gender and women' in different ways, do not however, carry equal weight (Leach, Mehta and Prabhakaran 2015: 8). While dominant narratives coexist with marginalised or alternative narratives, dominant narratives are reinforced by – and reinforce – powerful institutions and have material consequences that legitimise some approaches, policies, processes, styles and practices – or 'pathways' – while dismissing others. For instance, those excluding gender and power as a relevant factor in scientific leadership, reinforce processes of career advancement that favour men. It is these dominant narratives that frequently define the pathways reflected in policy, and which influence the career trajectories of both men and women scientists.

The strength of a pathways approach lies in showing how dominant pathways are not inevitable. By highlighting alternative perspectives on how systems of scientific production operate, this report promotes alternative narratives and pathways in science. In these narratives, gender is recognised as an important factor in the career and leadership trajectories of individual scientists and in how science for sustainable development is done. This has implications for the pathways pursued both by individual women scientists, and by organisations involved in science governance and practice at multiple levels. In this way, the pathways approach resonates with the overall GenderInSITE mission which aims to 'demonstrate how applying a gender lens to SITE can provide deeper insights, more effective programmes and more sustainable outcomes in the context of development'.[5] GenderInSITE encourages the building of pathways that take into account the 'vision, concerns and abilities of both women and men' to ultimately 'make both scientists and science more effective'.

[5] Applying a 'gender lens' is the act of acknowledging and making explicit the ways in which gender affects (and is affected by) issues, processes, institutions etc., and then using this understanding to improve policies, research and outcomes for women, men and others (UNCTAD 2011).

2.2

DOMINANT AND ALTERNATIVE NARRATIVES ABOUT GENDER IN SCIENCE

Embedded in the political and economic structures of late capitalism, science relies on, and reproduces, male hierarchies. Gaining access to, remaining in, and acquiring the experience and attributes necessary for leadership positions are profoundly gendered processes. Dominant narratives of scientific leadership explain the lack of women science leaders without reference to gender discrimination. One such narrative is that of a time lag: the relatively recent entry of women into science has not yet allowed enough time for a female labour force to develop. For example, in 1966, only 12% of all PhD researchers at the University of Berkeley in California were women, whereas, in 2002, it was 42% (Mason and Goulden 2002). Other narratives focus on women's socialisation and related traits and preferences, firstly suggesting that women are neither expected to, nor tend to, negotiate and assert themselves for better positions, titles, salaries, and promotions (McCullough 2011; Frehill *et al*. 2015), and secondly arguing that women tend to be seen, and see themselves as family nurturers rather than career professionals. This, the argument goes, results in their lack of interest in professional advancement (Mason and Goulden 2002) and/or their prioritisation of family needs at the expense of their own careers.

Persistently low numbers of women leaders in science, engineering and technology are also explained by the fact that the freedom of movement necessary

A 2016 Global Network of Science Academies report found that of 137 countries, only 32 (or 23%) had women making up 45% or more of scientists; 57 countries (or 42%) had scientific populations with between 31% and 44% of women researchers, while in a final 48 countries (or 35%), men made up more than 70% of researchers (ASSAf 2016). The Women in Science interactive tool, launched in 2014 suggests that globally, women make up only 30% of the world's scientists with no clear discrepancies between high-, middle-, and low-income countries. Rather, there are 'surprising exceptions': in Bolivia and Argentina for instance, women account for 63% and 52% of researchers respectively, compared to France with 26%, or Ethiopia at 8% (Wellcome Trust 2014). Women's representation in science also declines with seniority. In 2010 for example, 60% of the 1600 UK healthcare scientists were women, yet men held 66% of senior posts (Bevan and Learmonth 2013).

for research, and practicalities of field research, frequently do not fit with women's other domestic and caring roles (ICSU CFRS 2016).[6] Women scientists publish less than their male colleagues (Howe-Walsh and Turnbull 2016) and are less likely to be first or last authors, while women-authored publications receive fewer citations (Sugimoto *et al*. 2013). This has been shown to be influenced by: gender discrimination during peer review; professorial selection processes favouring men; fewer women role models; and women's self-perception as 'imposters' or inadequately qualified (Howe-Walsh and Turnbull 2016). Women scientists are also less frequently invited to give keynote presentations or to sit on prestigious committees; be nominated for prizes and have proposals funded (Urry 2015). They are also expected to do more mentoring despite having received far less mentoring than male colleagues (Javadi *et al*. 2016; Williams *et al*. 2014). Moreover, natural sciences, engineering, technology and mathematics are not typically portrayed as career-appropriate choices for women (Dugan *et al*. 2013).

Ultimately, 'the fact remains that women do not advance to the highest leadership positions in the same numbers, at the same rate, or through the same paths as male colleagues' (Dugan *et al.* 2013: 7). This is despite 50 years of concerted efforts to bring women into science through hiring and retention practices, initiatives such as Athena SWAN and ADVANCE[7],and increasingly visible discourse around inequities in the practice of science. As Urry argues, 'what is missing is not ways to do better — but the recognition that we must change' (2015: 472). This shows the value of looking critically at dominant and alternative understandings, narratives, and the pathways they legitimise. Dominant narratives reinforced by powerful institutions coexist with obscure, alternative ways of framing, understanding and organising the scientific system in gender-sensitive ways. Meaningful change requires exposure and promotion

[6] Women's caring responsibilities may restrict their ability to be away for extended time periods. Other factors which may discourage women from field research include difficultly in acquiring field-appropriate clothing and issues around safety, privacy and the possibility of gender-based harassment (ICSU CFRS, 2016).

[7] Athena SWAN Charter and the US National Science Foundation's ADVANCE programme) aim to advance the careers of women in science, technology, engineering, maths and medicine (STEMM) employment in higher education and research.

of these alternative narratives and pathways, but also recognition of and commitment to feminist-informed notions of empowerment. Through their gendered pathways approach, Cornwall and Sardenberg also remind us of the importance of linking the political with the personal, and that gender is deeply interwoven with other axes of difference including race, class, location, identity, ability, sexuality etc. which shape power relations in research processes.[8] And in seeking to challenge broader geo-political forms of dominance – which hold significant implications for science in the service of sustainable global development – they sought also to 'break with prevalent modes of north–south research relationships' in which the perspectives of southern researchers were marginalised (Cornwall and Sardenberg 2014: 73). New pathways towards gender equality in global scientific endeavours and leadership must also thus address unequal power relations on a number of social and political dimensions at multiple scales from the personal to the global.

[8] This complexity around identity, social markers and disadvantage is embodied by the feminist notion of intersectionality. While this report is primarily concerned with the collective concerns of 'women', it is important to reflect on the fact that there are divisions within this broad category which privilege some over others, and that interests are not universal. Similarly, men, also marked by different social identities, may face explicit or systemic discrimination in science.

2.3

DEFINING AND DECONSTRUCTING LEADERSHIP AND GENDER

Leadership is often characterised as a position of power, privilege and toughness and as something 'irredeemably masculine, heroic, individualist and normative in orientation and nature' (Grint 2011 cited in Sinclair 2014: 20). In the 1970s, these 'masculinist' practices were regarded as 'transactional', relying upon command and control techniques, rigid hierarchies and rewards-based systems (Elix and Lambert 2014). These were contrasted with more feminine, 'transformational' leadership styles used by women, who were believed to be more democratic, collaborative, and willing to share information and use promo-

tion of self-esteem to motivate people. Some would argue that these principles have now become more commonplace with leadership being increasingly seen as a 'purposeful, collaborative, values-based process that results in positive social change' (Komives, Wagner & Associates 2009 cited in Dugan *et al.* 2013: 8).

However, leadership is a socially constructed process (Sinclair 2014: 13) and different conceptualisations of leadership exist across contexts, involving gender, age, ancestry, wealth, political power or other factors. Multiple and conflicting understandings also exist in the same geographies or overlapping cultural spheres. Feminists have challenged dominant understandings of leadership, asking why women's contributions to public life are unrecognised, ignored, or labelled as 'community organising' rather than leadership.

Sinclair (2014) argues that a lack of women leaders will not be solved simply by encouraging women to become leaders, pointing to the need to draw on women's wisdom and experience of leadership and to acknowledge and address issues of power and gender. This involves reforming the ideal of leadership itself and changing the image of a great leader. There is a widespread assumption that women have a unique, distinctly 'feminine' leadership style. It is assumed that women *want* to lead with this more participatory, non-hierarchical style and yet, in reality, women themselves can and do adopt a wide range of leadership styles, including at times choosing to be dominant, assertive and hierarchical leaders. Assuming a dominant leadership style may backfire however, as women leaders are frowned upon for failing to act in accordance with gender norms (McCollough 2011). There is considerable diversity in both individual men's and women's leadership styles and, for this reason, it is important not to focus only on individuals and their personal pathways to success, but rather on what leadership involves, and on the power relations that determine what kinds of people are more likely to become leaders and what kinds of people are likely to be excluded from leadership opportunities.

Power relations are a critical, yet underexplored, component of leadership and, while attention remains focused on the individual and his or her agency, prowess and skill, it remains possible to ignore all the 'unpaid', 'unrecognised' contributions made to leadership by those surrounding the leader. It also remains possible to uphold an ethnocentric image of a white male leader. In contrast, Sinclair argues that leadership is 'often about proceeding in ambiguity, in circumstances of "not

knowing", and being open to diverse and shifting measures of success' (2014: 29).

The dangers of homogenisation and assumption are also important in relation to gender and science. Gender is particular to science in two ways: first, the *application of science is gendered*: it affects men and women differently and its outcomes are never universal solutions for all members of society when applied to development problems. It can result in positive outcomes or effects for women and negative ones for men; positive experiences for select women and not for others or, as is more commonly experienced, positive consequences for men. Second, the *doing of science is gendered* in ways which have operated to exclude women from scientific practice, and especially from its leadership.

All women and men in scientific contexts experience gender relations in the world of science. Like leadership, the concepts of 'science' and 'scientist' have implicit values and ideas built into them. The dominant 'vision of a scientist' has excluded women for many years, and rather stereotypically, has been of a slightly esoteric, quite possibly balding, white male professor. Furthermore, women of colour experience a 'double jeopardy' (Williams *et al*. 2014: 4) or 'double bind' (Malcom *et al.* 1978: 3) as they contend with both racial and gender exclusions. Yet even here, the picture is more nuanced. While Asian women scientists benefit from a stereotype that says they are 'good at science', black women scientists battle a far more negative stereotype and constantly have to prove their competence. Moreover, women interpret their experiences differently. Some attribute their lack of promotion to gender, some to racial basis or age discrimination (Williams *et al.* 2014) while yet others report never feeling gender, or any other forms of discrimination in the world of science. It is important to remember that men also report feeling unfairly disadvantaged, on the basis of age, interests, class, family etc. (see for example, Damaske *et al*. 2014). While there are patterns to be distilled in the way gender operates within the world of science and leadership; it is important not to homogenise all women and all men, nor to assume that all women are similarly affected by these patterns.

2.4

PATHWAYS TO EMPOWERMENT IN SCIENCE LEADERSHIP

Focusing on power as a means to understand women's underrepresentation in positions of science leadership is revealing. Women's lack of power is reflected in the glass ceiling, in their lower pay, slow salary progression and delayed tenure (Bevan and Learmonth 2012). Many initiatives are in place to encourage more women into science, to retain them as scholars and to address these overt issues through improved employment practices. Yet power differentials are also evident in a myriad of 'seemingly trivial incidents and transactions' (Bevan and Learmonth 2012: 137) or 'a thousand paper cuts… both small and large, that [keep] women in a subordinate position' (Mason and Goulden 2002: 23) and shape their identity, interactions and expectations in relation to scientific leadership. In keeping with the focus on power suggested by Sinclair (2014) and Damousi and Tomsic (2014), Bevan and Learmonth (2012) draw attention to the scientific norm, which supports male hierarchies, and to the ways in which women's opportunities in science and as leaders are subtly damaged. They suggest that scientists' opinions and appraisals are such that women scientists are undervalued and men scientists overvalued. The result is that 'women often are expected to work harder, contend with hostile or dismissive environments, accept unequal pay, and receive less developmental support and training, and they are frequently excluded from critical social networks (Dugan *et al*. 2013: 7).

Addressing power differentials goes beyond reforming hiring practices. It requires engaging in complex

and challenging aspects of social change. It forces us to recognise dominant narratives around science and leadership which uphold male hierarchies for what they are – the results of the coherence of power and knowledge – and to point out their shortcomings and blind spots, and to make the implications of these shortcomings widely recognised. It requires reflexivity on the part of all actors in the scientific system to evaluate their own complicity in upholding narrow ways of being and doing; to open up to alternative narratives and help construct new pathways, through formal policy, but also through nurturing the participation, voices, talents and contributions of not only women, but of scientists from across the spectrum of social difference. The women scientists we interviewed for this report are constructing their own pathways, cultivating collective senses of empowerment, and creating the types of social change – at both the grassroots and at higher levels of the scientific system – needed for science to engender a more equitable future.

CHAPTER 3

AN ENABLING ENVIRONMENT FOR SUCCESS?

This chapter explores the higher levels of the scientific system, namely multilateral organisations and global science coordination. It highlights policies and actions aimed at mainstreaming gender in international science activities, governance and operations; increasing women and girls' participation in scientific endeavours; and applying a gender lens to scientific practice. The chapter traces the role played at the gender/science interface by international science organisations – including intergovernmental organisations such as the UN and EU and non-governmental organisations – in building pathways to success. These organisations focus on different aspects of scientific practice, including defining international policies, objectives and intergovernmental frameworks; developing scientific capacities at individual, institutional and system-levels; and advocating for freedom and responsibilities in the conduct of science. Together, they reflect the changing ways of doing science globally, and wield significant power in influencing all levels of the scientific system, and the dynamics between them.

Two United Nations (UN) multilateral organisations have been especially important in discussions about gender and science over the last two decades. First, the United Nations Educational Scientific and Cultural Organization (UNESCO), the UN specialised agency with the mandate for science, and second, the UN Commission for Science and Technology for Development, created in 1993 within the UN Conference on Trade and Development (UNCTAD), the main organ of the UN General Assembly dealing with trade, investment and development issues. Both were instrumental in defining policies and related activities on gender/science. Other organisations which have not received the same level of analysis are the non-governmental international science organisations which bring together science institutions on a global scale; gather either national institutions such as academies of sciences or national and international disciplinary science bodies; and are extremely relevant in establishing blueprints and paradigms of good science practice. Examples include the InterAcademy Partnership (IAP), the International Council for Science (ICSU), the International Social Sciences Council (ISSC), the World Federation of Engineering Organizations (WFEO) and The World Academy of Science for the developing world (TWAS).[9] In this chapter we examine how these organisations have addressed gender issues in their work. Finally, the chapter looks in-depth at the European Union (EU) to provide a best practice example in the strong gender policies that have been embedded into *Horizon 2020*[10], the EU's largest ever Research and Innovation programme.

[9] Due to the limited amount of space in this report, we do not discuss all gender/science related activities of these organisations, nor do we have the ability to list all international science organisations engaged in gender/science activities. Rather, the research presented here is exploratory in nature, and designed to offer examples of where progress has been made, and to what extent.

[10] Designed as a seven-year program to run between 2014 and 2020 with a budget of 80 billion euros, *Horizon 2020*'s mission is to foster sustainable and inclusive growth and job creation, while ensuring Europe's continued competitiveness in the global economy, alongside the tackling of global challenges such as climate change. Removing barriers to research and innovation, and fostering international collaboration are the major avenues by which these objectives are pursued.

3.1 THE UNITED NATIONS AND UNESCO AT THE GENDER/SCIENCE INTERFACE

The recent negotiations and adoption of Agenda 2030, including the Sustainable Development Goals, have increased attention on the issue of gender equality and raised the visibility of a gender lens on sustainability issues. This higher profile has been evident both in recent literature on the subject (e.g. Hawley 2015), and also in the approval of an UN GA Resolution adopted in December 2015 which reaffirms 'that women have a vital role to play in achieving sustainable development', recognises 'that women and girls play a critical role in science and technology communities and that their participation should be strengthened' and proclaims the 11th of February as the International Day of Women and Girls in Science (UN General Assembly 2015). These activities exemplify the recent cross-fertilisation between gender advocacy and science advocacy within development policy frameworks and processes. This increased focus on issues of gender equity and science came about as a result of a dynamic landscape of activities and studies by UN organisations and functional commissions, and a deepening engagement of civil society organisations (UN n.d.-a) over the past 40 years.

UNESCO is the specialised agency of the United Nations with the mandate for science, and currently includes gender equality as one of its two Global Priorities (see UNESCO n.d.-a), which are to be applied to all its activities. However, this prioritisation of gender issues is not reflected in the organisation's statutory texts. For instance, the UNESCO Constitution (which came into force in 1946) retains dated masculine terms such as 'mankind', despite promoting scientific collaboration among nations without discriminating on the basis of economic or social factors such as sex, race, religion and language (see Article I). Nevertheless, UNESCO offers its Member States different strategies to address gender mainstreaming in Science-Technology-Innovation and Education systems, by providing individual and institutional capacity-developing

opportunities aimed at narrowing the gender gap in sciences towards achieving internationally agreed objectives including the Sustainable Development Goals (SDGs). This work is possible because of co-operation and joint initiatives between UNESCO and key non-governmental international sciences organisations such as ICSU, ISSC, IAP and WFEO.

UNESCO has also been heavily influenced by, and has strongly supported, the 1995 Beijing Platform for Action (BPfA) which mobilised high-level political support and international action for gender equality and the empowerment of women everywhere. This led to increased attention to gender issues within the organisation's activities. In 1999, for example, UNESCO organised, in collaboration with ICSU, The World Conference on Science, which sought to strengthen ties between science and society. The issue of gender was an important feature and was present in the many recommendations of the final proceedings (see UNESCO 2000).

Gender is a priority overseen by a dedicated Division in the Office of the Director-General and guided by the UNESCO Gender Priority Action Plan 2014–2021 which specifies gender mainstreaming and gender-specific programming in order to achieve gender equality and promote women's empowerment in UNESCO's five programmatic areas (Education; Natural Sciences; Social and Human Sciences; Culture; and Communication and Information). In this context, metrics on gender are collected; clarity is provided on terms such as 'men' and 'mankind' in the Basic Texts[11] and in website and communication material[12]; dedicated events are organised to discuss gender equality and women's empowerment (such as UNESCO's high-level conference 'Fostering Women's Empowerment and Leadership' organised in Paris in 2017); and senior UNESCO leadership positions, including that of Director-General, have been and are held by women.[13]

UNESCO also undertakes gender-specific programming and gender-mainstreaming activities within

[11] In UNESCO Basic Texts, a box states: *'All the terms used in this collection of texts to designate the person discharging duties or functions are to be interpreted as implying that men and women are equally eligible to fill any post or seat associated with the discharge of these duties and functions.'*
(see for instance, UNESCO Institute for Statistics 2011)

[12] The UNESCO "tag-line" – as can be seen in the UNESCO website's banner - emanates from the Constitution's preamble and has been reworded from the original *"… it is in the minds of men that the defences of peace must be constructed"* to *"Building peace in the minds of men and women"*
(see en.unesco.org)

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the context of its science activities (especially in the Natural Sciences Sector). 'Women, Science and Technology' was launched at the NGO Forum at Beijing in 1995 and concluded in 2002 having enabled several influential initiatives. These include the UNESCO Chairs on 'Women, Science and Technology' and the UNESCO/L'Oréal 'Women in Science' partnership and prizes which published the 'For Women in Science Manifesto' in 2016 (L'Oréal Foundation n.d.), and which will reach its 20th year of operation in 2018. The identification of women leaders among the laureates has raised awareness of women's roles in science, comprising as they do, a major award and the recognition of women experts from every region of the world. This process was also instrumental in identifying, and celebrating, the work of three women scientists who were subsequently awarded Nobel Prizes.

UNESCO has also examined the role of women in science and the gender dimension in science and technology. Since 2006, the UNESCO Institute for Statistics (UIS) has used an innovative methodology to study gender indicators in science, technology, engineering and mathematics (STEM). In 2007, the UIS together with UNESCO's Natural Sciences Sector published the first international report on science, technology and gender (UNESCO 2007). Many other UNESCO science reports have included a gender dimension and related data. Key among these are the UNESCO Science Report (UNESCO 2015) (the 2015 and 1996 editions include dedicated chapters); the 2010 report 'Engineering: Issues, Challenges and Opportunities for Development' published in partnership with WFEO and CAETS (UNESCO 2010); and the World Social Science Report (WSSR) series co-published with ISSC, among which is the noteworthy 2016 WSSR on 'Inequalities' (ISSC *et al*. 2016) and the 2013 WSSR on 'Global Environmental Change' (ISSC and UNESCO 2013). In 2014, UIS developed an interactive web-based 'Women in Science' tool, allowing for exploration of available data for countries worldwide (UNESCO 2017a).

A promising recent initiative, funded by the Swedish International Development Cooperation Agency (Sida), is the 'STEM and Gender Advancement' project (SAGA) that measures and assesses sex-disag-

gregated data in order to improve the situation of women and to reduce the gender gap in STEM fields in all countries at all levels of education and research (UNESCO 2017b). As it has established a comprehensive toolkit and helps countries embedded in the UNESCO network to implement this, this will enable Sida to effectively measure the participation of women in STEM in many countries where this data has previously not been available.

Another important UNESCO advocacy activity is the pilot country initiatives and outreach via the Global Observatory of Science Policy Information (GO-SPIN) which provides further information on SITE policies as well as related policy instruments, legal frameworks, studies and indicators, and strives towards developing national and regional strategies on issues such as gender equality and women's empowerment in these fields (UNESCO n.d.-b).

These activities, mostly spearheaded by UNESCO's Natural Sciences Sector, are linked to activities in other sectors, especially in Education and the Social and Human Sciences Sector. Activities in the Education Sector include fostering STEM education for girls – as demonstrated at the 2017 International Symposium and Policy Forum and in the resulting publication 'Cracking the code: Girls' and women's education in science, technology, engineering and mathematics' (UNESCO 2017c). Finally, activities of the Social and Human Sciences Sector address ethical issues relevant to gender/science as exemplified by the attention to gender in the 1974 Recommendations on the Status of Researchers, which were revised at the 39th session of the UNESCO General Conference in 2017 (UNESCO 2017d). These examples show the depth of work and multitude of initiatives which have existed, and which continue to exist, to support women researchers' active engagement in science. UNESCO has not been a lone voice in this area, and, as shown in the following section, the UN Commission for Science and Technology for Development has also made a significant impact in relation to gender and science.

3.2 BRINGING A GENDER LENS TO SCIENCE AND DEVELOPMENT: THE UN COMMISSION FOR SCIENCE AND TECHNOLOGY FOR DEVELOPMENT (UNCSTD)

The other multilateral UN organisation having an important role in the discussion of gender and science, and, indeed, for the conception of GenderInSITE, is the UN Commission on Science and Technology for Development (UNCSTD), a subsidiary body of the Economic and Social Council (ECOSOC). Established in 1992 as a result of the restructuring and revitalisation of the United Nations in economic, social and related areas, it has operated under UNCTAD, the UN Conference on Trade and Development in Geneva, Switzerland (UNCTAD n.d.).

The Commission was established to provide the General Assembly and ECOSOC with high-level advice on relevant issues through analysis and appropriate policy recommendations. Besides its mandate is to follow-up the World Summit on the Information Society (WSIS), the Commission acts as a forum for the examination of questions on science and technology and their implications for development; advancing the understanding of science and technology policies, particularly in respect to developing countries; and the formulation of recommendations and guidelines on science and technology matters within the United Nations system.

At its first session, the Commission chose to address the science and technology components of major United Nations Conferences, and given the then-forthcoming Fourth World Conference on Women and Development to be held in Beijing, China, the Commission chose 'Gender, Science, Technology and Sustainable Human Development' as one of three topics for its second session. A Gender Working Group (GWG) was appointed, eight men and eight women, who prepared a

substantive report later published as 'Missing Links' (UNCSTD 1995).[14] The mandate of the working group was defined by the area of overlap of three domains: science and technology; sustainable human development; and gender.

[14] UNCSTD (1995) *Missing Links: gender equity in science and technology for development*. Ottawa: ITDG Publishing, UNIFEM, IDRC (Gender Working Group)

The impressive work of the GWG, later confirmed as the still-active Gender Advisory Board (GAB) of the UNCSDT, had lasting results. Its findings brought the theme of science and technology to the Beijing Declaration and Platform for Action at the UN 4th World Conference on Women in 1995 and was instrumental in getting gender on the agenda at the 1999 World Conference of Science held in Budapest.[15] The Gender Advisory Board was one of the founding organisations of GenderInSITE in 2010.

[15] www.unesco.org/science/wcs/index.htm

At the core of the GWG recommendations were a list of eight transformative actions, both necessary and feasible which every country should invest in and for which the GWG report states the issue and outlines policy and program options for consideration by national governments, science and technology bodies and agencies. They remain, to this day, a comprehensive agenda on how to tackle the interrelated issues of gender, science and development and much progress has been made. This has resulted in an extensive body of research and analysis. This report is, however, one of the first to address the eighth transformative action, looking more deeply at issues of equal opportunity in large-scale science and innovation projects and systems.

In 2011, the UNCSTD contributed to the report prepared by UNCTAD, *Applying a Gender Lens to Science, Technology and Innovation* (UNCTAD 2011), at the request of the Economic and Social Council and as a contribution to the 55th session of the Commission on the Status of Women (CSW). In bringing together a series of good practice examples from around the world, this report demonstrates the need to go beyond isolated interventions. Rather, there needs to

be coherence across methodologies, regulations, policies, programmes, gender-sensitive monitoring, and evaluation. There is, in this report, recognition of the need for specific interventions to implement gender equality through programmes and support structures and of the need for capacity development, institution-building and partnerships to ensure that policy implementation takes place. It argues that, applying a gender lens to science, technology and innovation (STI) policy is not only important for promoting gender equality; it also makes economic sense, given the integral and critical role played by women in development. Such an approach requires the integration of a gender perspective throughout the policymaking process, from analyses and design to implementation and monitoring (UNCTAD 2011: Switzerland).

The issue of gender and science has, in recent years, gone beyond the still relevant matter of gender equity, and has recognised the economic importance of bringing a gender lens to science technology and innovation. This emphasis, on the importance of gender both in the scientific workforce and as core research content has also been promoted by international non-governmental science organisations.

THE EIGHT TRANSFORMATIVE ACTIONS OF THE GENDER ADVISORY BOARD (GAB)

1 - Gender equity in science and technology education
2 - Providing enabling measures for addressing gender inequalities in scientific and technological careers
3 - Making science responsive to the needs of society: the gender dimension
4 - Making the science and technology decision-making process more 'gender aware'
5 - Relating better with 'local knowledge systems'
6 - Addressing ethical issues in science and technology: the gender dimension
7 - Improving the collection of gender disaggregated data for policymakers
8 - Equal opportunity for entry and advancement into larger-scale science, technology, engineering, mathematics disciplines (STEM) and innovation systems.

3.3

GENDER PATHWAYS IN INTERNATIONAL NON-GOVERNMENTAL SCIENCE ORGANISATIONS

International non-governmental science organisations – the InterAcademy Partnership (IAP), the International Council for Science (ICSU), the International Social Science Council (ISSC), and the World Federation of Engineering Organizations (WFEO) – define the international landscape by convening national science bodies (e.g., academies of sciences), disciplinary bodies (e.g., scientific unions) and regional mechanisms/frameworks (e.g. regional networks) to mobilise international science to tackle global challenges. These organisations have significant upward influence over high-level policy frameworks, including within the UN as reflected for instance, in the ICSU-ISSC-WFEO co-organisation of the Scientific and Technological Community (STC) Major Group to the UN (UN n.d.-b). They also exert downward influence in shaping how gender is conceptualised in lower levels of the scientific system around the world.[16]

ICSU's attention to the gender/science nexus is well grounded in its Statutes, where reference to 'sex' and 'gender identity' is made within 'Statute 5: The Principle of Universality (freedom and responsibility) of Science'. This statute is safeguarded by the ICSU Committee on Freedom and Responsibility in the Conduct of Science (CFRS) which also developed *ad hoc* activities and an advisory note on gender issues

[16] ICSU and ISSC have started a process that will lead to their merging into one global organisation, known as the International Science Council, and bringing together the hard sciences and the social sciences, the International Science Council. The final merger is expected to take place in mid-2018. Hopefully this will bring a stronger focus on the issue of gender and science.

entitled 'Mobility and Field Research in the Sciences: Gender Equality and Prevention of Harassment' (ICSU CFRS 2016). However, most references to 'gender' in these statutory documents aimed to avoid bias rather than advocating for an overall transformation in gender relations and active narrowing of the gender gap in science. Moreover, gender was not systematically mainstreamed within these organisations. However, revised attention to gender and science has been triggered by the post-2015 sustainability debate, leading to new activities on the gender/science interface by these organisations, by their members and by regional networks and initiatives.

ICSU and other organising bodies have, over the past decade, invested in the professionalisation of science through initiatives and committees to advance gender in science. These include the International Mathematical Union (IMU) Committee for Women in Mathematics (CWM) established in 2015; the Australian Academy of Science's two-year pilot project Science in Australia Gender Equity (SAGE) launched in 2015; the International Union of Pure and Applied Chemistry's (IUPAC) Distinguished Women in Chemistry or Chemical Engineering Awards (IUPAC 2016) launched in 2011; the Human Sciences Research Council of South Africa's co-organisation of the Gender Summit 5 in 2015 and the Science Council of Japan's co-organisation of the Gender Summit 10 in 2017. The consortium of ICSU members also established the project 'A Global Approach to the Gender Gap in Mathematical and Natural Sciences: How to Measure It, How to Reduce It?' funded by the ICSU Grants Programme, which corroborates this interest at the professionalisation of science level and calls for further partnership in tackling the gender gap (ICSU n.d.). The IAP Regional Networks have actively explored the realities of women in science via Working Groups and publications. Successful outputs include: 'Women Scientists of the Americas: Their inspiring stories' (IANAS 2013); 'Young Women Scientists: A bright future for the Americas' (IANAS 2015); 'Women in Science and Technology in Asia' (AASSA 2015); 'Mainstreaming Gender in Science Education' (NASAC 2015); and the recent 'Women in Science: Inspiring stories from Africa' (NASAC 2017).

At the global science co-ordination level, *ad hoc* gender-focused initiatives and/or programmes have been launched such as the ISSC

co-sponsored 'Gender, Globalisation and Democratisation (GGD) Network'. This network provides robust knowledge that can be used to improve the social, economic, and political well-being of women within the context of globalisation. Other activities include the Women of the Antarctic WikiBomb celebrating female Antarctic researchers organised in 2016 by the ICSU Scientific Committee on Antarctic Research (Meet-up/SCAR 2016, 2018), and the International Network for the Availability of Scientific Publications or INASP's Gender Mainstreaming in Higher Education Toolkit (Bottomley 2017). Key publications and statements which demonstrate commitment include the 'Women for Science: Inclusion and Participation in Academies of Science' (ASSAf 2015) and the statement on SDG No. 5 by the STC Major Group – co-organised by ICSU, ISSC and WFEO – delivered at the 2017 Session of the High Level Political Forum (STC Major Group 2017).

These examples show the many stepping-stones provided by international non-governmental organisations across national, regional and global systems and across disciplines for promoting gender equality in the scientific enterprise via role-modelling, data collection, science education, science advice, and capacity development. However, there is no clear signposting to help individuals, institutions or countries at any level of the scientific system to facilitate the identification of pathways for girls and women in science and to reduce the gender gap.

Whilst there is a plethora of *ad hoc* activities monitoring gender gaps, promoting science education for girls, supporting girls and women in sciences, applying a gender lens to research and recognising excellent women scientists, there is no global map or portal to ongoing activities, nor coherent global policy or systemic approach to developing, implementing and linking up such activities.

The importance of developing a global gender policy for international science has been recognised within the context of the ICSU External Review Process (see report (ICSU ERP 2014) and response (ICSU 2016)). This report enables ICSU and ISSC to develop an evidence-based gender policy for the International Sci-

ence Council ensuing from the merger of ICSU and ISSC (ISC 2017). We believe that the merger between ICSU and ISSC represents an opportunity to develop an evidence-based gender policy for the resulting International Science Council (ISC), which might also play a leading global role in mapping the plethora of activities and initiatives into more coherent pathways rather than isolated stepping-stones.

Another important organisation to be considered in this context is TWAS - The World Academy of Sciences for the advancement of science in developing countries, a program unit within UNESCO and key player in building science capacity in the global South and in fostering inclusivity in science (TWAS n.d.). TWAS has increasingly emphasised gender equality in science, including by hosting the Organisation of Women in Science in Developing Countries (OWSD) and GenderInSITE since 1987 and 2012 respectively, and by the establishment of dedicated awards and prizes honouring women scientists in the global South (such as the OWSD-Elsevier Foundation Awards for Early-Career Women Scientists in the Developing World, TWAS-Abdool Karim Prize and TWAS-Fayzah M. Al-Kharafi Prize). It is important to highlight GenderInSITE's role – which is '*to inspire transformative actions and more effective development by understanding the impacts of SITE on women and men and how women and men can contribute to SITE*' (GenderInSITE, n.d.) – in bridging intergovernmental and non-governmental frameworks through co-operation with UN bodies (e.g., UNESCO, ECOSOC), with the media (e.g., with SciDevNet), and with non-governmental science organisations (e.g., ICSU, ISSC and IAP).

These partnerships and interventions between non-governmental international science organisations have been vitally important in promoting gender equality as a feature of the scientific workforce and as a core research component. However, as the following discussion demonstrates, ensuring that gender is addressed is not simply about introducing interventions. The chapter now turns to the European Union (EU) to explore the process of embedding gender policies into research, focusing both on how to keep gender on the political agenda and the challenges experienced in implementation.

3.4

LEARNING FROM SUCCESS: THE EVOLUTION OF GENDER POLICIES IN EUROPEAN SCIENCE FRAMEWORKS

Steps towards progressive gender and research policies in the EU began in the late 1990s, as gender disparities in EU science participation and the importance of considering the gendered implications of the content of science emerged. This echoes the processes experienced by intergovernmental and international non-governmental science organisations discussed in the previous sections. Increasing women's participation is a goal shared by many scientific institutions across Europe who broadly agree that the scarce presence of women in science and technology is a waste of resources that neither science nor the economy can afford. Women account for 60% of graduates from European universities, but despite excellent academic grades, many do not find places in the scientific system befitting their qualifications. Thanks to effective advocacy by feminists working within EU structures, far-reaching gender policies were embedded into *Horizon 2020,* the 8th iteration of the Research Framework Programs (FPs),[17] which runs from 2014 to 2020. This is the main policy instrument for the common European Research Area (ERA) whose purpose is to coordinate European research institutions and increase their capacity to collectively address the most important political, social and economic challenges facing the continent. [18]

[17] The European Research Framework Programs, including *Horizon 2020,* are managed by the European Commission – the executive body of the EU. However, they are designed, approved and adopted through consensus among the European Commission (through its Directorate-General of Research and Innovation), the Parliament (through its relevant committees), and Council of Competitiveness (in which member states are represented by their research and innovation related ministers).

[18] As the funding instrument of the ERA, Horizon 2020 is complemented by institutions such as the European Research Council and the European Institute of Innovation and Technology; policy documents and regulations; and numerous consultation processes. Specific programs for the coordination of research activities include the European Technology Platforms, through which industry and other stakeholders develop strategic research agendas, and the ERA-Net which supports national research programs. Horizon 2020 and the Research Framework Programs (FPs) are also key financial instruments for other European-wide initiatives – namely the Innovation Union and the Europe 2020 Strategy. See European Commission 2017; and European Commission n.d.

Through *Horizon 2020,* European policies aim to address the gender imbalance and increase the participation of women across the scientific system at all levels through institutional and structural change, while also encouraging the incorporation of the gender dimension into research and innovation to ensure wider applicability, validity and relevance.

These policy achievements are the result of 20 years of work in four critical areas, discussed below:

1. Gender-focused administrative and advisory structures
2. Production of data on women's participation in science in the EU and studies on gender in research policy
3. Policy documents and expert reports advocating for gender balance in science
4. Piloting of experimental gender-in-science policies and regulations

ADMINISTRATIVE AND ADVISORY STRUCTURES

As European Commission (EC) Commissioner for Research in the late 1990s, Édith Cresson (member of the French Socialist party and former Minister), created the basic policy structures to address the participation of women in European research. This happened in the aftermath of the adoption of the Treaty of Amsterdam in 1998 which followed recommendations stemming from the World Women's Beijing Conference of 1995. These advances were the result of the efforts of feminist women working within the structures of the EC (so called 'femocrats'), and of others working outside these structures in the feminist movement and academia.

In 1999, the EC created the Women and Science Unit within the Directorate-General of Research and the Helsinki Group on Women and Science, which housed a number of key women scientists, such as Mary Osborn, who actively promoted women's role in science.

The Women and Science Unit was the Commission's original, formal administrative structure, created specifically to establish policy to promote gender equality in research. In 2010, it underwent some reorganisation, becoming a small 'Gender Sector' under the new Science in Society Unit – later renamed the Science with and for Society Unit (SwafS).[19] The mandate of this structure is to design and implement policies and programs regarding the gender/science interface in research and innovation at the EC (its activities are described below). However, the current Gender Sector sits on a lower hierarchical level and is comparably smaller than its predecessor and, since its inception, has seen frequent changes and reductions in personnel. This instability has resulted in what might be perceived as waning influence.

The Helsinki Group on Women and Science (HG) in contrast, was created as an *informal* advisory body with the following main objectives: i) to advise the EC on the development of gender-relevant initiatives within different policy areas related to science, research and innovation; ii) to mobilise stakeholders; iii) to exchange best practices; iv) to support and advise the EC in the preparation of comparable European statistics and indicators on gender equality in research; v) and to create national-level awareness concerning European and national activities relating to gender equality in research.[20] The HG has been instrumental in advancing the gender agenda in research policy, including through data collection.

The HG has also played an influential role in shaping the priorities of the Commission. In 2009, to mark the Group's 10th year, the HG produced a landmark Position Paper, *Gender and Research Beyond 2010*. Its recommendations were adopted into an important 2010 Communication by the EC urging member states to approve structural changes to their research frameworks in order to support women in science.[21] More recently members of the HG group, through strategic

[19] The SwafS Unit mandate addresses a number of policy areas in addition to gender: open science, science education, ethical issues, and public engagement.

[20] The Helsinki Group is made up of two gender experts from each of the EU member states and associated countries: one representing the government and one representing the country's scientific institutions.

[21] A new Position Paper was in the process of being drafted in 2017.

efforts and informal collaboration, played a major role in the adoption of strong gender policies into *Horizon 2020.*

In 2013, the HG was given a slightly modified mandate which led to a more formal role for the Group (SwafS 2013). Of particular significance was the creation of a rotating co-Chair to be held by the Head of the SwafS Unit of the EC and by a governmental representative of the country holding the Presidency of the European Union.[22] Also of significance was a concurrent shift in the Group's status to a formal EC advisory committee, thus boosting its influence. In 2017, the Helsinki Group moved from being an advisory body of the EC to an advisory body to the European Council. The EC is no longer co-chairing the Group and the only Chair is now elected by its members instead of appointed via rotation.

[22] Thus the Commission, while moving to this role of co-Chair, would also keep the Secretariat of the HG. Other changes involved the formal creation of working groups, and a change in name, from the Helsinki Group on Women and Science, to the Helsinki Group on Gender in Research and Innovation.

DATA AND KNOWLEDGE

The creation of a substantial body of data and research has been an important dimension in the development of gender policies in the EU. Having considered the United States' decision to introduce a Science and Technology Equal Opportunities Act in 1980, which called for gender and race disaggregated data in scientific practice, the EU began to monitor, but not disaggregate, information on race and gender. The Women and Science Unit of the EC, through the European Technology Assessment Network (ETAN), published a report in 2001 entitled *Science Policies in the European Union: Promoting excellence through mainstreaming gender equality* under the leadership of Mary Osborn, an eminent cell biologist (ETAN 2000). The report established, for the first time, an overview of women in science in Europe. The EC has since funded a significant number of studies, building up a solid base of evidence and knowledge

which has profiled the gender imbalance in science at national and regional levels; provided a snapshot of even steeper gender imbalances in private sector research; focused on providing useful tips for action and lists of good practices to help reduce vertical segregation; and provided recommendations for improving transparency in assessment processes and research funding.[23]

Subsequent publications have also provided overviews and resources including a database of good practices in the 2009 report *Practising Gender Equality in Science* (*Dipartimento Per I Diritti E Le Opportunita*). Two landmark reports published in 2010, provided a complete synopsis of research on women and science in Europe.[24] *Genport,* launched in 2013, is an online repository of resources (Genport n.d.).

The triennial report *She Figures* has been published since 2003 and provides comparable statistics on the state of gender equality in research and innovation across Europe. *She Figures* highlights relevant factors, including the proportions of women and men among research staff and on research boards, while also keeping a measure of the degree of vertical segregation in academic research through the 'Glass Ceiling Index'. The report addresses working conditions for women and men researchers and, in the most recent edition, also assesses the degree of integration of the gender dimension in research and peer reviewed articles (ECD-GRI 2016).

The creation of this body of data on the gender imbalance in European research is deeply significant, providing as it does a rationale for the advancement of gender policies in research. It owes its existence to a network of feminists, scientists and allies embedded across EU structures and particularly in the EC's Women in Science Unit and the HG.

[23] Subsequent gender-based reports included: *Women in Industrial Research: A wake up call for European industry* (Rübsamen-Waigmann et al, 2003); *Waste of talents: turning private struggles into a public issue: Women and science in the ENWISE countries* (Blagojević et al, 2004); Mapping the maze: Getting more women to the top in research (European Commission 2008); and The gender challenge in research funding (European Commission 2009). These reports can be download at the European Commission website.

[24] *Meta-Analysis of Gender and Science Research* (Caprile *et al.* 2010); *Stocktaking 10 years of 'Women in Science'* (Marchetti and Raudma 2010).

POLICY DOCUMENTS AND EXPERT REPORTS

Policy documents and expert reports have been another important aspect of the evolution of gender policies in European research. A particularly transformative moment came in the form of an agreement adopted by the Competitiveness Council (comprising of European research and innovation ministers) in 2010 under the Spanish Presidency of the European Union to provide support for women in science and to promote structural change through the modernisation of scientific institutions across Europe. This agreement incorporated the recommendations of the Position Paper, entitled *Gender and Research Beyond 2009* by the Helsinki Group (Helsinki Group 2009), and – as suggested above – urged the EC to adopt a Communication on Structural Change (a specific recommendation for member states to follow).

The agreement explicitly recognises that gender stereotypes in work cultures pose barriers to women's participation in science and thus hinder the progress of science itself and stressed the importance of long-term strategies such as structural change programs and modernisation of universities and research institutions. In addition, it endorsed recommendations from the Helsinki Group's Position Paper on gender including the need to get top-level management on board for institutional change; the importance of supporting science education in schools; and greater recognition of the importance of work-life balance for both men and women.

The EC was receptive to this agreement and, in 2011, set up a Group of Experts on Structural Change to write a report that would become the basis of the future Communication on Gender and Research. This influential report, entitled *Structural Change of Research Institutions: Enhancing Excellence, Gender Equality and Efficiency in Research and Innovation*, fully acknowledged the structural roots of women's exclusion, shifting from a previous focus on women's individual actions towards an understanding that the position of women in science was a problem with systemic roots that required more systematic measures than those taken so far (Sánchez de Madariaga *et al*. 2011).

A crucial aspect of this report was its acknowledgement of gender bias as a key component of these structural inequalities, and an exploration of how this bias informs the very ways in which research institutions work, including important aspects of scientific endeavour such as

the evaluation of merit and how excellence is understood. The report pointed to three basic prerequisites necessary for change in any given organisation: establishment of understanding of the gendered character of the institution through gathering and publishing data and qualitative studies; the securing of top-level support, without which gender policies are very difficult to establish; and the generation of effective management practices to support and cultivate in-house gender expertise and train decision-makers and staff.

In addition to the above, the report's recommendations included: increasing transparency in decision-making; removing unconscious bias from institutional practices; promoting excellence through diversity; improving research by integrating a gender perspective; and modernising human resource management and the working environment. It also provided a selection of best practices from around the world and a guide for action with recommendations addressing different relevant stakeholders. [25]

The EC also set up an additional expert group – called Innovation Through Gender – whose aim was to craft recommendations for scientific communities, providing clear examples in different scientific domains of how to carry out gender analysis in research. This was in response to the implementation challenges of an earlier, cutting-edge policy instructing applicants applying for the large FP6 grants (2002-2006) to specify 'whether, and in what sense sex and gender are relevant in the objectives and the methodology of the project' in their research proposals (Schiebeinger 2011-2018a). Implementation of this requirement proved difficult, and the EC scaled it back under FP7 (2007-2013) as practical challenges in its management emerged given few researchers knew how to incorporate sex and gender analysis.

This expert group produced the *Gendered Innovations* website and a paper publication, both of which provided an array of relevant case studies in the fields of basic science, health and medicine, engineering, and environment (Schiebeinger 2011-2018b). They also

[25] These stakeholders included the EC itself, member states, research institutions and universities, gate-keepers of research excellence, and European-wide science organisations.

highlighted several methods researchers could use to integrate sex and/or gender dimensions into their research, providing tools for researchers to eliminate bias and enhance excellence by mainstreaming gender analysis into basic and applied research in fields beyond the social sciences and humanities.

The 2012 EC Communication on the ERA was influential in opening up and connecting EU research systems. It focused on five key priorities, among which, crucially, was gender equality and mainstreaming in research (European Commission 2012). [26] Echoing recommendations from the Structural Change Report (Sánchez de Madariaga *et al*. 2011), the Communication invited member states to:

— provide incentives and create legal/policy environments to remove barriers to women researchers, promote gender balance in decision-making, and strengthen gender dimensions in research;

— encourage efforts to foster cultural and institutional shifts on gender by partnering with research relevant organisations through charters, performance agreements and awards;

— and establish representation quotas of 40% for the under-represented sex on recruitment/career progression committees and research evaluation programs.

[26] The Communication, entitled *A reinforced European Research Area partnership for excellence and growth*, outlined five priorities: i) more effective national research systems; ii) optimal transnational co-operation and competition; iii) an open labour market for researchers; iv) gender equality and gender mainstreaming in research; v) optimal circulation, access to and transfer of scientific knowledge.

At the same time, research organisations were invited to:

— identify institutional gender bias in HR management, funding, decision-making, research programs and other procedures and practices and develop countering and monitoring strategies.

For its part, the EC committed to substantively integrate gender dimensions into *Horizon 2020* programs – from inception to evaluation – and to propose a member state recommendation in 2013 with guidance for institutional change leading to gender equal-

ity in universities and other research institutions.[27] These developments were not simply the result of formal processes; but of informal and semi-informal interventions and previous close relationships between individuals working at different institutions within the complex political landscape of European institutions.

[27] The European Commission under the mandate of Commissioner Geoghegan-Quinn in Research and Innovation did not follow up on this commitment to elaborate and propose a Recommendation to member states. As of 2017 with a new Commissioner in office this item is not on the agenda.

ENACTING GENDER PROVISIONS WITHIN EC REGULATIONS: EARLY MEASURES ADDRESSING GENDER IN FP6 AND FP7

The inclusion of robust gender measures in FP8 – *Horizon 2020* – was preceded by earlier policies embedded in the previous two Research Framework Programs, FP6 (2002-2006) and FP7 (2007-2013). These measures reflected the growing awareness around the importance of gendered dimensions in science and science production, to the credit of feminists and advocates embedded across EU structures, including for instance, the influential Helsinki Group.

These advocacy efforts resulted in the first iteration of gender policy in European research in FP6 which required that proposals 'indicate whether, and how, sex and gender are relevant variables in the objectives and methodology proposed'. However, it soon became apparent that – in the absence of additional measures to support both the administration and enforcement of the requirement on one hand, and the capacity of researchers applying for grants to follow through on the requirement on the other – the measure was largely ineffective.

While the requirement was removed from FP7, it led to a recognition of the need and efforts to provide resources that could empower researchers to integrate gendered perspectives into their work. These included a toolkit on how to incorporate gender in research – a forerunner of the *Gendered Innovations*

website earlier mentioned (Yellow Window 2018); and gender and science training programmes were offered throughout the continent. Additionally, FP7 included targets for the presence of women in research program committees, teams and calls for proposals. Finally, FP7 dedicated funding for gender equality plans in research institutions, and a small programme, continued under *Horizon 2020,* ensured that two or three gender-specific projects were funded per call for proposals. [28]

These early experiences, in combination with the policy documents and expert reports – such as the Helsinki Group Position Paper of 2009 (Helsinki Group), the Council Conclusions of 2010, the Structural Change Report of 2011 (Sánchez de Madariaga *et al*. 2011), the ERA Communication of 2012 (European Commission 2012), the *Gendered Innovations* website launched in 2012 (Schiebeinger *et al*. 2011-2018), the *She Figures* series, and the collection of studies funded by the EC – have been key inputs paving the way for the adoption of the 8th Framework Program *Horizon 2020* in 2014. These EC-supported activities facilitated the development of a strong European community of experts on gender in science, working mostly in academia, but also in the public sector and government. Some of these individuals were able to advance the gender agenda by strategic navigation of the complex policy processes both of the EU and of other European institutions – at national levels, within the Commission and the European Parliament, and through open consultations with stakeholders.

[28] This program was inspired by the ADVANCE program of the US National Science Foundation.

THE NEGOTIATED EMERGENCE OF GENDER POLICIES AND REGULATIONS IN *HORIZON 2020.*

Current European policies on gender in research materialise in the ongoing 8th Framework Program *Horizon 2020* (2014-2020). The multiple

processes which laid the foundations for the adoption of *Horizon 2020* have been described above, demonstrating the long-term nature of forging these new, alternative pathways to doing science. Yet, *despite* this long history of evidence building, advocacy and early measures, the current far-reaching policies were not inevitable. In fact, a combination of luck, and strategic and concerted efforts by feminists across EU structures converged to reshape narratives around gender/science and ensure the eventual successful integration of gender dimensions in *Horizon 2020's* final text.

As with all Framework Programs, the process of establishing *Horizon 2020* was initiated by the EC, whose services drafted a first text. Although the Commissioner at the time, Máire Geoghegan-Quinn, a former Irish politician, had always shown public support for gender equality policies in research, the text produced by the EC's Directorate-General Research made little reference to gender.

Two factors were key in reversing this situation and in ensuring that gender was incorporated into *Horizon 2020*. The first was the coincidental appointment as Rapporteur of *Horizon 2020* of the European Parliament, Teresa Riera, the President of the ITRE (Industry, Research and Energy) Committee, a Spanish professor and politician with a track record in the Spanish women's movement. This appointed Rapporteur is responsible for conducting the final rounds of FP negotiations, including the reception of amendments to the program, and to produce the final agreed text. Teresa Riera has been an open supporter of gender policies in research. Her appointment overlapped with the Presidency of FEMM, the Committee on Women and Gender Equality of the Parliament by her close friend Britta Thomsen, a Danish politician.

The second key factor was a proposal for amendments to one of *Horizon 2020's* final drafts, prepared by the Helsinki Group, which was strategically prepared by and at the initiative of the HG representatives of Spain, France and Denmark. [29] Indeed, in the years leading up to *Horizon 2020,* members of the HG collaborated with each other informally to develop many of the ideas and measures that would eventually make it into the above-mentioned amendment, and into the text of *Horizon 2020.* This informal collaboration involved representatives of those countries holding subsequent EU presidencies (Spain, Denmark, Cy-

[29] Inés Sánchez de Madariaga, Director of the Women and Science Unit at the Cabinet of the Minister of Research and Innovation of Spain, and Caroline Bélan Ménagier Senior Policy Officer at the MKIPADI of the French Minister for Higher Education and Research.

prus) and other members supporting these policies including France, Norway and the Czech Republic. The amendment text was sent within the allowable period of consultations to Rapporteur Teresa Riera of *Horizon 2020* who ensured that a very significant portion of the proposed amendments were accepted by the EU Parliament, integrated into the next draft, and kept in the text which was finally adopted.

GENDER IN *HORIZON 2020*

As a result of all the efforts described in previous sections, gender has become a key crosscutting issue in *Horizon 2020* and is enshrined into the program's core regulations and policies (Regulation (EU) No 1290/2013, 2013).

Horizon 2020 has three objectives regarding gender (see European Commission 2016a):

1. **Gender balance in decision-making:** A target of 40% is set for women's representation in expert groups and evaluation panels while advisory groups have a target of 50%. To facilitate the appointment of experts to the different groups and panels, the EC has reached out to potential candidates and actively encouraged women to apply (European Commission 2014). It has also added a number of 'gender' fields to the areas of expertise, which all candidates must complete when applying to be on the roster of EC experts. As a result, *Horizon 2020's* expert database is equally balanced between women and men and provides information allowing identification of gender experts in the different research areas and topics of *Horizon 2020.*
2. **Gender balance in research teams at all levels:** Funding applicants are encouraged to promote a gender balance at all levels of their teams. Gender

balance in teams is a ranking factor in the proposal evaluation process. By signing the grant agreement, beneficiaries commit to promoting equal opportunities between men and women. They also commit to aim, as far as possible, for gender balance at all levels of personnel, including at supervisory and managerial levels.

3. **Integrating the gender dimension in the content of research and innovation:** Integrating gender into research involves consideration of the biological characteristics and the evolving social/cultural features of both women and men. A compulsory question on how gender is relevant to funding proposals is included within the application process. This is evaluated as part of the excellence criteria, like any other relevant variable for the proposal. Additionally, gender is explicitly flagged in calls for proposals in many *Horizon 2020* programs, with evaluators paying particular attention to how gender is taken into account. [30] Another new aspect is that gender training can be considered among the eligible costs of a project, a measure designed to encourage researchers to further develop and share gender expertise in relation to funded projects.

[30] For example, the 2016-2017 Horizon 2020 work programme requires a gender component in 108 of the 568 topics.

In addition, a new Advisory Group on Gender has been set up in the Great Societal Challenges area of *Horizon 2020* to provide recommendations on: (1) the integration of gender dimensions in research and innovation as relevant; (2) possible interactions with other cross-cutting issues; (3) potential expert evaluators. Each thematic advisory committee for the Great Societal Challenges, whose mandate is to work on the individual great challenges, also includes a gender expert.

Important funding schemes which support gender equality in research and innovation policy have been preserved under *Horizon 2020.* This includes calls on gender topics integrated within the Science with and for Society (SwafS) Programme. These calls have become highly competitive and produce rich outputs in the form of toolkits, manuals, scientific articles, practical experiences and innovations. Through activities such as these, a very active community of experts on gender policies in research institutions has emerged across Europe.

Horizon 2020 also monitors the implementation of gender in research. To this purpose, the following indicators are used on an annual basis: the percentage of women participants in *Horizon 2020* projects, women project coordinators in *Horizon 2020*; women in advisory groups, expert groups, evaluation groups and panels; and the percentage of projects with gender integrated in the project design. Regarding the monitoring of the ERA generally, the percentage of women in Grade A positions – defined as the highest-ranking posts in research and/or academia (equivalent to full professor) is taken to measure advances across Europe.

MEASURES BEYOND *HORIZON 2020*

Beyond the direct impact that specific *Horizon 2020* measures are having on gender and research in Europe, a number of additional and complementary actions have also been taken by the EC, the Competitiveness Council, the European Parliament, and other actors such as the European Institute for Gender Equality (EIGE) which is part of the Directorate General for Justice at the EC. These actions, a few of which are highlighted below, form part of the implementation of the ERA, and are aimed at member states and scientific institutions across Europe.

To help research institutions, universities and other relevant stakeholders at lower levels of the scientific system to develop their own actions in support of gender equality, the EC, in collaboration with the EIGE, created an online toolkit: *Gender Equality in Academia and Research* (GEAR) (EIGE 2018). This collaboration appears to have introduced the term 'gender mainstreaming' which – although a key concept since the UN Beijing World Women's Conference of 1995 – had not been previously used in relation to European research institutions.

The Competitiveness Council, through its 2015 adoption of the '*Conclusions on advancing gender equality in the European Research Area*' (Council of the EU 2015) has called for cultural and institutional change to address gender imbalances in research institutions and in decision-making bodies through specific measures, plans and strategies. Member states are invited to set up guiding targets for full professors and for decision-making bodies, including scientific and administrative boards, recruitment and promotion committees as well as evaluation panels.

In 2015, the European Parliament adopted a '*Resolution on women's careers in science and universities, and glass ceilings encountered*' (European Parliament 2015). This called upon member states to create incentives for research centres and for universities to adopt and implement Gender Equality Plans; to integrate gender dimensions in their national research funding plans; to suppress legal and other barriers to the hiring, retention and promotion of women in research careers; and to implement global strategies for structural change. All these measures were aimed at reducing existing inequalities within institutions and research programs.

As reflected in the above examples, one important aspect of the gender priority of the ERA is that it aims to promote gender equality at multiple levels and across Europe. However, the ERA Progress Report of 2016 suggests only small advances at the national level:

> The analysis also shows that one of the main challenges the countries are facing remains the glass ceiling impeding women to reach higher positions. This is reflected in the fact that one third of researchers are women, while at higher-level positions the share of women drops below one quarter. Although data shows the situation is improving, the pace remains slow (European Commission 2016b).

In light of this, the ERA recognises the need to continue supporting the capacity of member states and individual institutions to enact the necessary structural changes through Gender Equality Plans and other measures.

CHALLENGES AND OPPORTUNITIES

As evidenced in *Horizon 2020,* the integration of gender dimensions into the main funding instrument of European research has been, for the most part, successful. This section explores the two main factors that contributed to this success, before going on to examine the challenges and difficulties of practical implementation.

The first factor, contributing to the successful integration of gender, was an approach which emphasised efficiency and excellence through a reliance on empirical data, the use of technical language and arguments, and the prioritisation of the business case over arguments couched in language around fairness, justice and equality. This technical approach meant that discussions and policy outputs on science and gender looked at this issue as a problem related to the efficient use of human resources and talent, quality and validity of results, and hence scientific excellence, rather than through the lens of feminist ideas of empowerment. This approach is exemplified by the *Gendered Innovations* website – the main tool developed for addressing gender in a research content. This website relies predominantly on quantitative methodologies and avoids the epistemological frameworks currently in use within feminist and gender studies. This approach, whether intentionally strategic, or the 'natural' approach of many actors within the process, has nonetheless proven very effective in reaching out to individuals and organisations which might otherwise not be receptive to gender issues on epistemological or political/policy grounds.

The second factor contributing to the gains achieved can be characterised as serendipity and opportunity. Embedding gender into *Horizon 2020* and EC research policy involved a combination of being in the right place at the right time, the political skills of certain individuals, and the seizing of key opportunities. As gender was a contested area within the ERA, certain people who occupied particular positions and maintained key relationships with other strategically situated individuals had greater capacity to act purposefully, and in collaborative ways at key points during the process. Such individuals were able to strategically lobby for the inclusion of gender or lobby against its exclusion at key moments. This resulted in substantial gains in getting gender onto the political and research agenda, despite often lacking significant support from the leadership of the institutions involved.

3.5 CONCLUSION

The implementation of the many gender requirements in *Horizon 2020* has been as difficult as the process leading up to their approval. The practicalities of ensuring that the many thousands of individuals – who participate in various capacities in the implementation of *Horizon 2020* – are familiar with gender issues are significant. Implementing *Horizon 2020* involves not only several hundred officers working at the EC, but also thousands of individuals who participate as evaluators, members of committees and other boards, and many thousands of researchers who submit proposals. Briefing all these people on the new gender requirements is proving difficult. Training researchers for whom gender/sex is a relevant dimension but who have not themselves been educated on this topic is even more challenging. For many, there is a tendency to simply 'add women', rather than to understand and theorise gender issues in meaningful ways.

The inclusion of gender issues in policy is equally challenging. *Horizon 2020* and the inclusion of gender into the political agenda of the EU was achieved through a combination of empirical data, technical language and rational arguments, as well as strategic and concerted efforts by feminist activists, and a certain amount of luck.

Outside EU structures however, other science organisations which make up the upper levels of the scientific system (such as UNESCO and international non-governmental science organisations such as ISSC, ICSU, WFEO and others) have not been able to achieve similar systemic change despite commitments to democratic science and to removing barriers to inclusion. While they have realised a number of achievements and ongoing activities, such as ensuring gender inclusivity in policy documents; developing a range of practical support mechanisms to support scientists' engagement with gender analysis; tracking metrics on women's inclusion; and creating opportunities for women scientists, what is less evident is a strong and organised feminist lobby, looking for opportunities to maximise and systematise gender gains across organisations, levels and disciplines. These organisations have succeeded in strengthening the importance of gender in science and have

done much to create stepping-stones at different levels and in different interdisciplinary domains, but have a long way to go before they can claim success in transformative, structural change to support women scientists' pathways to success. For this, organised, concerted efforts must be made to tie together isolated policies, initiatives and activities across the system, and gender and sex need to be mainstreamed across scientific disciplines, integrated into higher education curricula in systematic, normalised ways and, drawing on feminism and social science, properly theorised. This need to continue to work towards structural change – among all the organisations mentioned in this chapter (including among EU bodies), in addition to the many who are not – also means that concerted and steady streams of advocacy must continue to attempt to shape political agendas to ensure continued inclusion and recognition of gender in high-level science processes.

CHAPTER 4

LEADERSHIP PATHWAYS FOR INDIVIDUAL WOMEN SCIENTISTS

The previous chapter explored policy pathways with examples from the upper levels of the scientific system. In this chapter we focus on the first and second levels, namely individual scientists and the production of science, to explore the issue of gender, science and leadership through the experiences of highly successful women scientists. Our aim is to understand the pathways that these women have taken – both personal and professional – to achieve their current positions of leadership in, and influence over, the scientific system at multiple levels. Their pathways speak to their own personal convictions, drive and excellence in their work, to opportunities available to them, and to the important role that women leaders in science can and do play in redefining narratives and pathways.

Using these scientists' accounts of their career trajectories and their experiences of gender in science, we have attempted to distil intra-personal and organisational elements of social change. This approach differs from conventional analyses of women's leadership in science in that it does not focus on the barriers, or what is needed to remove gender differentials. Rather it asks: what routes have women taken to achieve their positions as successful leaders in science and gain

influence in the emerging international system of 'integrated science'? How have these pathways challenged dominant narratives relating to how scientists progress, and how have they leveraged their positions of leadership to shape pathways for other women leaders, or to affect how science is conducted?

While the previous chapter outlined emerging policy pathways at the upper levels of the scientific system, this exploration of individual women's careers reminds us of the importance of day-to-day interactions and leadership. The moves and choices women make – both small and big – impact their careers, and those of others around them, and also reverberate across the system, in direct, indirect, formal, and informal ways. It is a testament to the power and agency of women to successfully achieve scientific leadership, and to reshape broader narratives about how scientists become leaders, and how science itself is done.

We identified six key themes from the interviews, each of which is discussed in detail. They illuminate respondents' own pathways to leadership and success, how they have developed collaborative, flexible leadership styles, and how they have used their own pathways and positions to influence the scientific system:

1. The commitment to address a problem;
2. Refusing to back down: the belief that one can achieve anything;
3. Mentoring and role modelling;
4. Developing skills to exercise leadership;
5. Networks: building and harnessing connections for professional and scientific development;
6. Reshaping organisational cultures.

4.1
THE COMMITMENT TO ADDRESSING A PROBLEM

All of the senior scientists interviewed were committed to addressing particular societal challenges in their work, and it was this commitment – rather than a desire to be a leader – that propelled them to their positions of leadership. For the most part, these issues were global challenges with significant development implications, and the scientists situated their drive for excellence within broader debates about sustainable development and social justice. Their practice of science was not just a search for excellence, but a drive to use science in the service of humanity. For one of our interviewees, this drive was deeply personal, and reflective of her own life experiences:

> When you grow up on a continent where people are starving and you know your science can do something to help, then that's part of why you do it… Bringing change and sustainable livelihoods to people is very important for me, because at the end of the day, I am still the girl from that village.

This emphasis on scientific research as a means to bring about positive change and to help other people was a significant factor in these women's pathways to success. As Javadi and colleagues have argued, '(b)eing committed to the cause is a powerful motivator in overcoming barriers that exist in systems that

are not yet as easy for women to enter as they are for men' (2016: 236). As one scientist put it, 'I'm very passionate about [the work] – and that sustains me so that I can put up with all kinds of nonsense from people because I can see the endgame'. This drive was cited by many of our interviewees as something that outweighed the potential challenges associated with advancing as scientists in their respective fields. A couple of the interviewees saw this drive to 'make a difference' as something that women tend to 'seek out more', and thus for them, explained why fields such as public health, or some bioscience disciplines have become increasingly feminised.

These pathways – etched with passion, personal commitment and the drive to make a difference – also have potential to impact the world of international science. As leaders, the scientists reported efforts to influence research topics, the sorts of questions asked and, as one scientist put it, the *'values [which] play out in those questions'* – the very pathways of science itself. Many of them saw the issues that they were tackling as highly complex, and as requiring 'more holistic perspectives', and thus they were happy to take part in and advocate for collaborative 'integrated science' approaches. In particular, the social scientists among our interviewees reported advocating for scientific approaches 'open to and inclusive of social difference' and which are attentive to 'relations and power':

> **The fights that I'm fighting are quite often about social science in relation to the technical and about appreciating the voices of the really marginalised. I've spent quite a bit of my career arguing for the importance of indigenous knowledge, of citizen science, or listening to informal experiential expertise.**

By framing such efforts as a struggle, the scientist quoted above provides insight into the still widespread resistance of many non-social scientists to political and social considerations, including recognition of the importance of gender to sustainable development:

> I would like them [other scientists] to realise they cannot effectively do a project on say water resources, unless they understand the different roles that women and men and girls are playing in relation to the use and management of water.

For this scientist, driven by commitment to positive transformative change and sustainable development, these 'fights' are worth facing, as are the challenges of pursuing scientific careers as women ('putting up with all kinds of nonsense') to many of the other interviewees. Their deep personal commitments to solving complex global challenges, using their talents and abilities to rise to the tasks at hand, drove them to leadership where they have leveraged their positions to advocate and influence science for sustainable development at multiple levels, including in international scientific fora.

4.2

REFUSING TO BACK DOWN: THE BELIEF THAT ONE CAN ACHIEVE ANYTHING

Related to the deep personal commitments that these scientists brought to their work, several reported that being told that something was unattainable or impossible drove them to try harder. In some instances, this was related to dominant narratives about what women are or are not capable of. One of our older interviewees recalled being delighted to have been accepted to study at the University of Cambridge as her family had not believed she could nor that it was appropriate, while another recalled being told repeatedly in school 'that women can't do Maths, they don't think like that'. To such discouragements, these women reported developing defiant attitudes:

> But I'm a feminist, and so for me, if anything, that just sort of makes me more determined… Okay, you think I'm not gonna do it? I'm gonna do it.

This refusal to give up stood these women in good stead when tackling scientific challenges:

> I took a position which was considered very difficult and impossible to do, a new initiative. The company had four directors before me, all of them guys.… I saw this as an opportunity where if I work harder, and keep positive, it can be done, and actually it can be a very good stepping-stone for my career.

This demonstrates that the scientists did not experience seamless pathways to positions of leadership, and indeed found themselves being pushed in particular directions by dominant narratives. They chose however, not to interpret the conventional gender obstacles described in chapter 2 (Williams *et al*. 2014; Howe-Walsh and Turnbull 2014; Haslam and Ryan 2008) as barriers, but instead as spurs to greater effort and commitment. That formative experiences such as these shape women scientists and help them to achieve positions of leadership is also recognised by Javadi and colleagues in their exploration of the 'successes and challenges' experienced by women leaders in health. They argue that these experiences helped women leaders channel their 'tenacity and knowledge to challenge the status quo' (Javadi *et al.* 2016: 238), and to forge their own alternative narratives and pathways. The strikingly low numbers of women in many scientific disciplines, and especially in leadership positions, suggest however, that such discouragements and obstacles have led many women to 'self-select' out of scientific careers and leadership. This highlights the importance of supporting scientific leaders who can tackle the complex challenges of sustainable development and withstand discouraging messages and obstacles which are reinforced by dominant cultural narratives about gender in science. And while the experiences of the scientists we interviewed demonstrate the importance of persistence in the face of obstacles, it is important to reiterate that success does not result entirely on personal agency and doggedness, but also on resources and opportunities. The next section shows the importance of role models and mentorship which emerged as another crucial factor in the scientists' pathways to leadership.

4.3
MENTORING AND ROLE MODELLING

The idea that one has to '*see it to be it*' is frequently cited as a factor in women's underrepresentation in science and technology where they frequently 'find themselves working in a gendered institutional culture and with few female role models' (Howe and Turnbull 2016: 423). The lack of senior women scientists reinforces dominant narratives that sci-

entific careers and especially positions of scientific leadership are not appropriate choices for women. A related factor in encouraging women's participation in science and leadership is mentoring. Mentoring was first associated with the Greek Goddess Athena who 'descended to earth' to guide Telemachus, the son of Odysseus. She did so dressed as Telemachus' tutor, named Mentor, because at the time, mentoring was not seen as an appropriate task for women (Parikh and Redberg 2015). Mentors have played a key role in women's pathways to leadership. They recognise potential, help women develop personally and professionally, and provide them with examples of effective leadership (also see Javadi *et al.* 2016). And as scientific organisations do not necessarily work in gender-inclusive ways, they also provide entry into vitally important networks (IAC 2006). All of the scientists interviewed cited role models and/or mentors in their own pathways of professional development in science, and also reported playing these roles for others.

None of the scientists reported having admired particular women role models in science in a more removed way (as a young artist might admire a famous painter for instance), but rather, some cited personal or familial connections such as an aunt: *'She was sort of like a guru of everything academic in the family, I really looked up to her!'* This may be related to a lack of visibility of women scientists when many of our interviewees were themselves growing up and forging their own pathways in science. One scientist pointed out that she herself had no role models:

> **I came from a small village where women are married off at very young ages, and actually, you have no idea what women are capable of. I had no one that I could say when I grow up I want to be like this person.**

In recalling her own experience, she sees herself as having a personal responsibility to younger generations and never passes up invitations to speak to young audiences. Another scientist, who has become

deeply involved in building networks among and ensuring the visibility of women scientists in her field – including through such creative avenues as 'wikibombs' – noted how things had changed:

> It's amazing how different it looks for [young people] now. To be a graduate student… where they see all these amazing outstanding women in these huge leadership roles, and helping others, I don't know if I would have seen that 10 years ago.

Many of the scientists acknowledged that, as their careers had progressed and they achieved senior positions, they become aware of their own visibility, and of the effect this had on encouraging other women to pursue scientific careers, '*they see the possibilities that, well if she can do it, maybe I can do it. We did not know that this was possible. We can grow and lead an organisation'.* Simply by virtue of having reached positions of leadership and visibility in their own careers, and being successful in spite of the many gendered obstacles along with way, these women have begun to chip away at dominant cultural narratives about who does and leads science, in part paving the way for future generations of young scientists.

All of the scientists cited the importance of *mentors* to their careers – people who acted both as role models in a more intimate and interactive sense, and as providers of advice and encouragement. One scientist shared a story about how an academic supervisor had encouraged her enthusiasm, eventually making it possible for her to get out into the field:

> She shared her work with me on streams and rivers, and I had all these questions… then she said, do you want to go? I wanted to know the answers to these questions, so she sent me. And I was hooked.

And it was not just women who acted as effective mentors – men also played this role for our interviewees. Given that science leadership is largely dominated by men, their participation in mentoring of women scientists is essential for advancing women's careers – a point made by the male interviewees.

While the women acknowledged their own mentors, they shared far more about their own mentoring activities, which reflected their beliefs in the importance of supporting young scientists – both women and men – and also the open, flexible leadership styles they saw themselves as having adopted. Some described how their organisations supported mentoring in a formal sense, running top-down mentoring programmes, or engaging with broader national or regional systems to reach out to schools and universities, but these programmes seemed removed from their thoughts and were not what they were excited about sharing (one woman characterised formal one-on-one mentorship programmes as feeling like *'arranged marriages': 'sometimes it works and sometimes it doesn't'*). One interviewee described however, a formal organisation for early career researchers in her field (of which she was a founder), as being a space for skill development and peer mentorship which has had lasting effects on the broader culture of her particular scientific community. It offered for members a *'feeling of community and giving back that you don't get from just publishing papers'.*

Indeed, most of the scientists described mentoring as a rewarding process, and the examples they gave primarily referred to more informal, day-to-day instances of interacting with junior scientists. Such mentoring occurred on a personal basis and involved cultivating relationships of trust with junior scientists through which to '*inspire and encourage [what they] were good at and to show and give confidence that they can do it and succeed kind of on their own terms'*, but also to refer and connect them with others, and to advise them on a wide range of professional and personal matters.

While most reported playing a mentorship role with both men and women, some noted that while it 'hasn't felt as if it was about tackling gender inequalities', their closer relationships were with junior women scientists. Two interviewees reported specific instances during which they persuaded junior women not to quit: one because she had become convinced she was not as good as her male colleagues, and the other because she had become demoralised at the dramatic extent to which her field had changed during her maternity leave. Another comment-

ed that she often engaged in confidence-building with junior women, helping them to break habits of 'self-censorship' and to counter their fears of taking on challenging tasks – something she had observed as affecting women more than men.

Challenges around balancing work and personal life was another area brought up by one scientist who claimed she had 'never really drawn a boundary' around what was up for discussion. For her mentoring also involved:

> **Being understanding, sympathetic and flexible when people have found that life issues have gotten in the way, whether it's been around babies or caring responsibilities, or difficult marital situations and so on.**

Through mentoring, and serving as role models to junior scientists, the interviewees – who themselves benefited from mentors in their own pathways to leadership – demonstrate how women leaders, embedded in grassroots organisations can and do actively mitigate, in real time, some of the gendered barriers to advancement faced by women in science. By providing comfortable, informal spaces in which junior women and men can air their fears and concerns, receive encouragement and advice, have their accomplishments acknowledged, and gain access to crucial networks, women leaders lay foundations upon which junior scientists can build their own pathways to leadership. And while such examples as those given through these interviews are revealing of the crucial role played by women leaders in lifting up other women in science, one interviewee reflected on the risk that women like her, who have been fortunate enough to reach positions of leadership in progressive organisations, lose sight of *'the battles that still need to be won'.* She felt that she, and other successful women who have come to treat their mentoring roles as primarily informal and embedded in daily

professional activities, should be more explicit and purposeful in lifting others.

Having discussed how these women scientists help others, we explore their leadership styles in the following section, touching on how they learned to exercise leadership, what this looks like in terms of the daily management of their organisations, and the implications of these styles for international science in pluri-disciplinary spaces.

4.4
DEVELOPING SKILLS TO EXERCISE LEADERSHIP

Participation and leadership in spaces where international scientific agendas are set – such as those directed at global sustainable development (Chapter 1) – are beset with the same kinds of gendered obstacles described in Chapter 2. For our interviewees, becoming leaders in these spaces involved drawing on their excellence and drive, deep personal commitments, professional connections and networks (next section), and the belief that is was possible for them to be leaders in the first place.

Many of these women had been 'firsts' at one point or another in their careers – first woman head of department, head of faculty, organisation director – and, as such, had no female predecessors on which to model their own leadership styles and skills. Furthermore, in the 'earlier days', as described by an older interviewee, '*The culture was a bit different in that people weren't as supportive of training the next generation. I had to learn a lot on the fly*'. In some cases, the scientists also described having taken up their new positions while facing strong resistance to

their appointments, or environments in which all or most of their peers were men.

All the women we interviewed seemed to have developed their own, individualised leadership styles, without, it appears, feeling pressured to adopt traditionally masculinist approaches. There was an explicit rejection of *'combative'* and individualised notions of leadership about which one woman claimed *'I wouldn't want to compromise my values or my beliefs about ways of working… I want to be supporting people'.*

Notions of collaborative, participatory approaches, of shared vision, and of encouraging others to work towards collective success coloured the descriptions each interviewee gave of their own leadership styles:

> I've tried to adopt a style of leadership that's quite people-focused and relational and is facilitating and listening and that models by example.

> You can inspire, and provide good leadership, lead by example, but at the end of the day you are only as good as the team around you… We made things happen, we solved problems, we got the initiative running, and a few weeks later, it was considered one of the best science initiatives in Africa.

Offering a concrete example, one respondent shared an experience of trying to overcome a long-standing rift in departmental relationships. She, in a stroke of brilliance, tackled the problem by introducing a shared vision in the form of a research problem requiring the efforts of both departments to solve. In addition to this, she described instituting informal meetings and social gatherings through which to build trust, develop relationships and ensure inclusivity.

While most respondents described having to learn to lead on the job, one scientist explained how her attendance at a four-week women's leadership camp, shaped her commitment to diversity: *'you really need people that think about issues differently'*; and helped her embrace practices of delegation to develop the skills and talents of junior employees: '… if you kind of keep all that kind of work for yourself versus delegating it, then you limit the abilities of other people in your organisation'. Whether having had to learn to lead exclusively by doing, or having had opportunities for formal training, the interviewees all developed critical skills to navigate institutional and scientific challenges. The skills and techniques adopted by our respondents show the importance of collaborative endeavour, and of being attentive to the needs and dynamics of the team (*cf.* Vecchio 2002). Underlying this was an emphasis on creating partnerships that supported these leaders' desire to use science to bring about positive change, and an understanding that such complex problem-solving requires teamwork and diversity (Simard *et al.* 2008). In developing these styles and rejecting hierarchical notions of leadership, these scientists were redefining the very concept of leadership (Sinclair 2014), promoting alternative narratives of what it is to lead, and forging pathways which bring others along with them. And while a couple of respondents saw these styles as being more commonly appreciated and adopted by women, others were vehement in asserting that this was simply 'good leadership', no matter who is at the helm. Regardless, these types of leaderships are increasingly recognised as critical for international scientific endeavour. Collaborative partnerships that bring together a diverse range of contributions and perspectives are central to the complex problem-solving required for sustainable development. Related to this, and discussed in the next section, is the importance of networks.

4.5

NETWORKS: BUILDING AND HARNESSING CONNECTIONS FOR PROFESSIONAL AND SCIENTIFIC DEVELOPMENT

Most of our respondents acknowledged the role of networks in their own professional development as scientists, and pathways to leadership. One in particular credited her own professional growth, success and even her winning of several global scientific awards to her 'huge, huge network, on all continents'. She further explained:

> You have partners in international projects, partners where you work, you publish together, your name is with organisations, whether you raise funds with a group of international scientists… there is absolutely no way you can advance your career without these networks.

Formal events such as conferences, workshops, courses, trainings and awards – including nomination processes and awards ceremonies – and the establishment of databases of women scientists were forms of network building identified by the scientists, out of which more informal groups and connections developed. Networks were also seen as creating opportunities for mentoring and peer support, along with possibilities for career advancement and collaboration, scientific or otherwise. Respondents discussed and referenced broader networks encompassing both men and women, but primarily talked about purposeful, often women-centric networking.

However, many respondents observed that women network less than men. This reinforces conventional narratives characterising scientific culture as inherently masculine, and related networks such as 'boys'

clubs' from which women are typically excluded (Howe-Walsh and Turnbull 2016). One scientist, for example, noted how male networks had perpetuated male domination in her field, suggesting they *'select in their own image'* especially for high-stakes positions:

> They go for someone they can trust and generally, it's unlikely a woman. It's usually a male friend, you know they drink together, they build networks which are very close and that trust goes along with it.

Scholars have pointed to inhibitors of women's networking such as low numbers of women in particular scientific fields or organisations, career breaks, and women's domestic responsibilities which limit their ability to engage in the type of trust-building after-hours socialisation alluded to in the above quote (Sassler *et al*. 2016; IAC 2006; Howe-Walsh and Turnbull 2016).

One interviewee explained that the few women in her field were isolated from one another, preventing them from sharing experiences of the professional challenges they faced. Formal networking opportunities for women in science were described as being important for overcoming such isolation, and for building collective awareness around common challenges and barriers, and through this, to reframe these problems as systemic rather than '*something to do with them'.*

> They don't realise that it's a systemic issue. Time and time again when we have [sector specific] forums and conferences, the women come to me and say, 'this is an eye opener, we never realised this was going on.

Heightened consciousness of the systemic nature of their challenges also went beyond sectoral silos. Another scientist described becoming aware of how different the experiences of women in lab-based scientific fields were to her own in terms of flexibility. But it was not just opportunities for the development of collective awareness or individual advancement that the women saw as stemming from networking opportunities. Rather, they explained how this awareness led to a sense of

common cause and critical consciousness that galvanised them to work for change at both a grassroots level in their home organisations – the 'factory floors' of scientific production – and in personal spheres of influence, and collectively in broader policy environments and upper levels of the scientific system. They recognised the power of building on and mobilising the social capital that inheres in networks (Parker and Welch 2013) for concrete policy changes that would actively promote career pathways for other women scientists:

> Let's create this network where people can come together and discuss these issues and start making commitments in your organisations… if you're going to serve on a panel, or part of organising a conference, then just look for some gender balance on the panels your conference is responsible for.

> I felt immediately that something needs to be done, and we continued as a group to meet, and we formed a committee for women in engineering. […] But I think the more important level is to drive policy and make genuine change. We meet and we talk and that's all very nice, but we need to make things better.

Ultimately, the connections established through networks were seen as important for a number of reasons: to increase the visibility of women scientists and their achievements to each other; to form relationships of peer support and mentorship; to advance individual women's careers; to co-operate professionally; and perhaps most significantly, to provide foundations upon which collaboration for the promotion of gender-aware policy and organisational change could emerge. Networks were thus described as important sites where individual women's pathways intersect with policy pathways and social change at multiple levels to challenge dominant narratives and promote new ways of organising the production of science.

4.6
RESHAPING ORGANISATIONAL CULTURES

In this section, we turn our attention to the ways in which these women sought to shape formal policies and informal cultures in their organisations at multiple levels to 'lay down the ladder' for other scientists following in their footsteps, and to advocate for gender, and other lenses of social difference in spaces of international science production.

As discussed in Chapter 2 women's domestic responsibilities and the effect this has on their scientific careers is well-documented (Simard *et al*. 2008; Sassler *et al*. 2016; *Williams et al.* 2014; Mason and Goulden 2004), and the women were themselves highly aware of these challenges. Thus, many of their efforts revolved around institutionalising family-friendly work policies to accommodate women's (and men's) familial and domestic responsibilities while allowing them to continue their professional pursuits. These policies included flexible working hours, the ability to work remotely, reducing bureaucracy associated with leave, banning after-hours professional activities, and even setting up on-site crèches and allowing new parents to bring nursing infants to work. One scientist commented:

> Once I saw how productive women can be with access to flex hours, access to day-care, good maternity leave and so on, I really pushed to create a day-care centre there so that both women and men could bring their kids.

A number of respondents suggested that their own experiences – both positive and negative – had influenced their determination to create an accommodating workplace. One recalled being permitted to bring her own infants to work with her while another reflected that her achievements had been possible

because her partner had been *'quite happy to share all of the roles'* whereas others were not so lucky. In contrast, an older respondent explained that as a young woman, she had made a *'conscious decision not to have children'* in order to pursue her career, as her husband had made it clear he was unwilling to take on primary caring responsibilities. She claimed, *'I don't want to have any woman to have to make those sorts of decisions'.* Another interviewee lamented having had to pass up an opportunity due to having two small children and no family support at the time: *'I could have made such a contribution'.*

In addition to these personal experiences, two of the women also referenced the influence of external organisations whose missions were to support women in science. One respondent noted that such an organisation had helped and encouraged her own institution to *'look in a very granular way about how we're doing and where are the bottlenecks'.* As a result, her organisation has aimed to mitigate its 'glass cliff' to improve gender, and other types of representation.

Travel – essential for building a career in science, let alone collaborative international science and leadership – was another area the scientists highlighted as being tricky for women. While one respondent cited once losing a junior member of staff because her husband had not wanted her to travel internationally, most issues, again, centred on childcare. Nursing mothers in particular were unable to travel for any length of time without having their babies with them, while arranging for childcare presented obstacles for others with young children.

One woman, who has worked in her organisation for over twenty years and is now its director (she noted that she was initially one of only four women among some three-dozen researchers), described a situation in which she herself was instrumental in bringing about a particularly momentous policy development. Gender audits (also conducted with help from an external organisation) had revealed that women were failing to advance at the same rate as men because they were unable to keep up with the amount of international travel necessary for successful career progression when they began having children. She and others came up with a proposal to redirect excess funds to nursing mothers and parents with young children enabling them to travel with their child and a caregiver. While on maternity leave at the time, she brought her baby to the

meeting where the policy was to be discussed. Just as she was about to present the case in this forum which she described as '*really a rather patriarchal setup'*, her baby began to fuss:

> … so I stood there saying my thing with this baby breastfeeding and everybody said okay I think we should do this! It completely got the point across and brought home to everybody that if you're a nursing mother you have to take your baby with you and we have to be able to support that!… It's been one of our most progressive policies.

Today, this organisation has more than met gender parity. Women hold equal, if not more, senior positions than men. She notes however, that in contrast to this particularly memorable moment, most of this change has been through gradual and subtle shifts in organisational culture.

Indeed, many of the respondents spoke of their own efforts in terms of cultivating an informal atmosphere or 'culture' in which flexibility, work-life balance, and family-friendly understandings had '*become a normality and a set of cultural practices'*:

> We try to manage a culture which appreciates that people are people and they have personal lives, and health issues and family issues which kick in. […] It would be perfectly normal for somebody to say, sorry I've got to leave this meeting early because I've got to pick up my kid from school and nobody would go 'gasp'!

> If someone comes to me and says their kid is not feeling well, my answer is, what are you doing here? Go home and take care of your kid.

Many were also explicit in stating that such family-friendly cultures and policies operated to benefit everyone regardless of gender:

> … our executive officer is allowed to work at home on Mondays so he can be with his kids. So I don't think we have any policies that are specifically for women.

The broader significance and importance of this in challenging traditional dominant narratives that women are primarily responsible for childcare was appreciated by one social scientist in describing her organisation's parental leave policy:

> We take the full approach to parental leave – which applies to both men and women which is a really important move because assuming that parental leave is only for women plays into a gender imbalance in who's responsible for childcare.

While the majority of the women's comments centred around efforts to reshape cultures in their home organisations – primarily universities and research institutes – they also commented on their efforts to have an impact at higher levels of the scientific system. These spaces included international field-specific regulatory associations, national and regional level scientific bodies and committees, and multi-disciplinary international science projects in which these women (and men) held positions of leadership as directors, board members etc. Here, they reported, things were trickier. The stakes were higher, and they often faced, or at least sensed resistance to their advocacy for gender awareness. To get around this resistance, they developed strategies which included framing certain types of policies in gender-neutral ways. Referring to her efforts to implement a leave policy in her field's international regulatory and licensing organisation, one woman noted being careful to call it a '*career break'* while avoiding saying '*starting a family'*.

Explaining further:

> … and this is one of my strategies because an all-male board – I was the only woman – they don't want to hear about women's issues. So I just said, young people they want to be able to take a break, they want to climb a mountain! … And they still want to be scientists when they come back! And it passed. I had a hidden agenda but I didn't tell them.

A male respondent, who had sat on a national committee considering how to boost the capacity of scientists in the country, stressed the importance of having men also be champions of gender advocacy. He described a process through which – using evidence and data – he convinced the other members of the committee to focus on creating more hospitable environments for women scientists in the country.

While most of the interviewees focused on policies which would advance women's careers in science and perhaps tacitly assumed these would lead to gender being taken seriously as a factor in research itself, one woman, a social scientist, made explicit reference to advocating for this. In realising the value of having a man bring up gender in multi-disciplinary international scientific projects, she reported trying to convince men to make these points:

> Sometimes I say it, but if I can tactically persuade someone else to say it that's better, better if a man says it, and I always make sure I don't only say that. I don't want people to write me off and say well she's the woman and she's only going to say things about gender and nothing else important.

Another strategy that she employed was to couch gender in broader issues:

> Sometimes I would veil my approach into talking about gender by framing it around social differences of all kinds which is a way of bringing in a gender lens or a more kind of intersectional lens which says actually we need to be much more inclusive of diverse perspectives here amongst women as well as men, different ethnic backgrounds, different regional perspectives and so on.

This scientist's experience – of anticipating being dismissed on account of bringing up gender in these fora – along with other examples above, is revealing of how scientific narratives which exclude questions of gender from both the pathways along which scientists progress professionally, and from research questions around sustainable development themselves continue to persist. Challenging these narratives can, at times, require strategic interventions by those hoping to influence the policy pathways, and pathways of research itself. However, in this section, we have seen how women leaders, along with their teams, are making immense progress at the grassroots level. We have seen how their own pathways to leadership have shaped how they now work to facilitate pathways for other junior scientists in ways which are sensitive to the needs of both women and men. Related to the team-oriented supportive leadership styles reported by the women and discussed earlier in this chapter, the scientists overwhelmingly emphasised the cultivation of inclusive, family-friendly cultures which value work-life balance and flexibility and that challenge traditional gender stereotypes around care and responsibility which have for too long perpetuated the marginalisation of women in science and research. Their actions, sometimes formal, sometimes highly informal, sometimes strategic and sometimes not, are continuing to laying the groundwork not only for including women, but for opening up science more generally to recognise other under-represented constituents, to strive towards greater inclusion and diversity and to be more grounded in relation to all scientists' domestic and personal needs and constraints.

4.7

CONCLUSION

The scientists we interviewed had achieved leadership positions through professional excellence, passionate dedication to their work, and a resolution to persevere even when others did not believe in them. Forging their own pathways, the women progressed from junior researchers to become leaders of scientific organisations, including of international multi-disciplinary projects and initiatives aimed at tackling global challenges. These pathways were neither easy nor straightforward and required careful navigation around balancing family and career, and at times difficult decisions and sacrifices.

Their accounts suggest, however, that their stories were far from one-woman-shows. These women owed their success to mentors and role models, and to opportunities to participate in networks – both those geared primarily towards women and those of wider scientific communities. In reaching their positions of leadership they have themselves become role models, changing the landscape in which other women consider their career possibilities and ambitions, and influencing how leadership is now defined. Drawing on their own experiences and the experiences of other women, they have also worked to shape the institutional contexts in which scientific work takes place, at both the grassroots level, and at higher levels where scientific agendas are set and where scientific endeavour is itself increasingly taking place. They have worked, along with their teams, to reshape formal policies and cultivate informal cultures which value teamwork, collective success, flexibility and family-friendly environments, paving the way for both women and men scientists to follow in their footsteps to leadership. Their interventions, from the small but daily interactions in their home organisations, to the strategic moving and shaking they do in higher levels of the scientific system demonstrate the intersections of their own pathways as leaders, with the policy pathways in organisations at multiple levels of the scientific system which have the power to promote women scientists across disciplines and around the world.

These women scientists' accomplishments and the policy pathways in science signal that a broader shift is underway, with organisational cul-

tures looking to accommodate and support individuals across a range of social difference. Included in this broader shift is men's support for gender equality; their recognition of the benefits of greater diversity in science and a willingness to engage in discussions about exclusions and how to overcome them, advocating for better gender balances in science.

CHAPTER 5

RECOMMENDATIONS

As the Beijing Platform for Action recognised in 1995, equality between men and women is necessary to address the challenges faced in the 21st century (UN Women 1995). Women's full and successful participation in science is important, not just to women scientists, but also for the production of relevant science to meet these challenges, and thus for the whole of the scientific system. One interviewee illustrated this by comparing the landscape of scientific production to a biological ecosystem, which requires individual components to flourish so that the whole can thrive:

> When you think about a biological ecosystem, if some species or some component of that ecosystem is negatively impacted, by a chemical or constituent, or invasive species, then the whole ecosystem is negatively affected. Maybe not immediately, but down the road. So if we're going to use the word ecosystem for our organisations, or our communities, or our sectors, we start making a comparison to a true healthy biological ecosystem and that's where you want all the individual components to thrive because we are negatively affected when one of those components doesn't thrive and for me, in this gender ecosystem, that's exactly the way it is. Women need to thrive in this ecosystem, and if they don't, men will be negatively affected down the road as well.

This was echoed by other scientists, male and female, who stressed that the under-representation of women in positions of scientific leadership, and in science generally, has broader repercussions – that the whole of society misses out if women's potential and talents continue to be systematically excluded from scientific production. This also has implications for the ways in which collaboration and problem-solving happen. As Javadi and colleagues have argued in relation to women's leadership within the health workforce,

> Equity in leadership can help ensure that diverse perspectives are included in collective decisions; the interests of particular groups are protected; and a context can be created in which conflicting opinions and ideas can lead to change and more equitable distribution of resources (2016: 230).

This report explored three crucial questions in relation to women's leadership of international science and the establishment of pathways to success. First, it asked, *who and what have been the primary change agents and driving forces behind these developments?*

This report identifies three sets of actors within the scientific infrastruc-

ture as having promoted positive change. First, change has come about through individual researchers who, in their determination to use their science to change the world, refused to accept society's restraints on women's roles. Second, independent advisory boards have also done a lot to bring about change. And third, feminist networks within the scientific infrastructure have operated, often informally and below the radar, to develop gender champions, take advantage of opportunities presented within processes of policy formulation, and ultimately to ensure the inclusion of far-reaching gender policy within EU structures. Multiple, and disparate actions across different levels of the scientific system have thus brought about change, albeit in somewhat piecemeal ways.

This leads us to the following recommendations:

— **Recommendation 1**: Special efforts – including the development of a high profile portal or site, which details and links the many diverse gender/science initiatives and opportunities - are needed to redirect current training and leadership initiatives to enhance women's positions in international science.

— **Recommendation 2**: Targeting young scientists with a series of initiatives that can help build their success: including mentoring, role modelling, prizes, and targeted research calls.

Next, the report asked, *where have progressive policies and practices on gender in science emerged and where have they stalled?*

In answering this question, the report draws our attention to the complexity of science production and the multiple levels that comprise the global scientific system. At the levels of individual women scientists and where the production of science occurs, we see significant, if often informal advances. Today, in many science-production contexts there is an awareness of the importance of gender, and of women's leadership in science. Here, women have achieved positions of leadership, have made changes and have introduced ways of doing science that should make it easier for other women to emulate their leadership models. Such positive findings are reflected in other studies and recommendations, yet they remain individual, ad hoc, and dependent on the personalities of particular leaders, and cultures of particular organisations.

Initiatives and funding to promote women's leadership have also been taken at the professionalisation of science, global science co-ordination and multilateral organisations levels of influence and support. A lot of work has been done to build a strong institutional drive that embraces and promotes women's leadership of global science challenges, but it remains difficult to transfer this ambition to member states who are not motivated to promote gender equity in their countries' scientific institutions. There are still large gaps in relation to the promotion of women leaders in science. More work needs to be done to consolidate policy at these levels and new action is needed. Similarly, while some attention has been paid to the research focus and the need to ensure that scientific research pays attention to gender, more emphasis should guarantee that gender analysis of research content goes beyond lip service. At the level of regional, international and global collaboration and co-ordination, there is considerable scope to advance a gender lens both in research and in science leadership of global challenges. However, at present, action of this sort is insufficiently targeted and there is a lack of recognition of the potential to influence other levels in the system. For instance, action at the global science coordination and multilateral organisations level could address the structural aspects – such as the bias in the definition of scientific excellence – in ways that go beyond conventional gender policies. Moreover, because of the scope and reach of these organisations, action here can lead to a lot of action in the other levels.

The following steps are therefore necessary to ensure that progressive policies and practices on gender equality in international science leadership continue to flourish:

- **Recommendation 3**: More gender-related evidence is needed to inform international science, including open science and open data to support policy formulation and planning to promote women's leadership in science.
- **Recommendation 4**: Gender policies need to exist at all levels of international science, be actively promoted and be adhered to in all international science organisations.
- **Recommendation 5**: International science organisations should consistently advocate for gender equality in science and seek to support this with additional resources.

The final question posed in this research is, *what are the relationships between policy and behaviour change, and individual women scientists' pathways to leadership?*

Women scientists' pathways to leadership are shaped by the day-to-day work and policy processes that occur at every level. The women interviewed here have effected change at the level of individual scientists, introducing ways of working that benefitted them when they were young researchers and which now create opportunities for other women and men. In so doing, they are developing stepping-stones for other women who follow in their footsteps and are helping women scientists in general to navigate their ways though complex arrangements of international science. These women, by virtue of their positions as science leaders, also operate in, and interact with others at other levels including through initiatives specifically designed to bring women together. However, the activities of women scientists and the pathways to success that they have followed are conventional routes to empowerment and are not particularly new, ground-breaking or innovative. Moreover, many of the activities reported in this report are the result of individual expertise, opportunity, and ad hoc decisions rather than stemming from institutional support or the implementation of progressive policy. This suggests that, while lots of good work is being done by many different actors in the different levels of the scientific system, there is not enough connection between these actions and insufficient attention to how structures can 'bake in' inequalities. There is a need to build bridges which link these different opportunities into pathways. There are, at present, quite a lot of isolated activities, but not enough happening between the different levels of international science. Far more needs to be done to develop dialogue and co-operation within and between the levels:

— **Recommendation 6**: In order for international science organisations to move from being gender aware, to gender transformative, they need to design gender policies for international science, rather than focus on policies for individual organisations. Establishing independent gender working groups, which focus on getting gender onto international science agendas and working across science organisations, is one way of doing this.

— **Recommendation 7**: Internal organisational policy

must highlight gender, look for opportunities, and build gender awareness and gender-transformative processes through recognition of women scientists' needs at the level of individual scientists (including nomination processes; induction and training into gender issues for all staff; attention to where women are represented and where they are marginalised, equal opportunities at work, etc.); through enhanced recognition of power relations addressed through appropriate policies; and through a series of activities which build cross-institutional global commitments to enhance gender equality in international science.

The pathways approach shows the inadequacy of isolated initiatives.

It is not enough to address women scientists' challenges, or to amend organisations' policies, or to ensure a gender component of research into today's global challenges. Rather, it is about connecting these steps to create multiple, reinforcing pathways to success.

This involves a concerted programme of action to ensure that international science is able to play its role in meeting the global challenges of the 21st century, but also in achieving the SDGs, especially target 5.5 which calls for 'women's full and effective participation and equal opportunities for leadership at all levels of decision-making in political, economic and public life'.

BIBLIOGRAPHY

AASSA (2015) *Women in Science and Technology in Asia*, Gyeonggi-Do: Panmun Education Co., Ltd

ASSAf (2015) *Women for Science: Inclusion and Participation on Academies of Science. Academy of Science of South Africa*, Pretoria: Academy of Science of South Africa www.assaf.org.za/files/ASSAf%20news/ASSAF_IAP%20Report%20Final.pdf (accessed 5 July 2018)

Bevan, V. and Learmonth, M. (2012) '"I Wouldn't Say it's Sexism, Except That… It's All These Little Subtle Things": Healthcare Scientists' Accounts of Gender in Healthcare Science Laboratories', *Social Studies of Science* 43.1: 136-158, www.jstor.org/stable/43284174 (accessed 2 July 2018)

Blagojević, M.; Bundule, M.; Burkhardt, A.; Calloni,l M.; Ergma, E.; Glover, J.; Groó, D.; Havelková, H.; Mladanenič, D.; Olesky, E.; Sretenova, N.; Tripsa, M.F.; Velichová, D. and Zvinkliene, A. (2003) *Waste of talents: turning private struggles into a public issue: Women and science in the ENWISE countries*, Luxembourg: European Commission, ec.europa.eu/research/swafs/pdf/pub_gender_equality/enwise-report_en.pdf (accessed 6 July 2018)

Bottomley, R. (2017) *How INASP's 'Gender Mainstreaming in Higher Education' Toolkit is helping to shift mindsets*, INASP blog, 6 September, blog.inasp.info/inasps-gender-mainstreaming-higher-education-toolkit-helping-shift-mindsets/?utm_source=INASP&utm_campaign=ccd0d716d6- (accessed 5 July 2018)

Caprile, M.; Meulders, D., and O'Dorchai, S. (2015) *Gender and Science – Time for Action*, Synthesis Report, Cairo: Academy of Scientific Research and Technology, shemera.eu/sites/shemera/files/SR%20EN_0.pdf (accessed 12 July 2018)

Caprile, M. (coord.); Addis, E.; Castaño, C.; Klinge, I.; Larios, M.; Meulders, D.; Müller, J.; O'Dorchai, S.; Palasik, M.; Plasman, R.; Roivas, S.; Sagebiel, F.; Schiebinger, L.; Vallès, N. and Vázquez-Cupeiro, S. (eds) (2010) *Meta-Analysis of Gender and Science Research*, Luxembourg: European Office of the European Union, ec.europa.eu/research/swafs/pdf/pub_gender_equality/meta-analysis-of-gender-and-science-research-synthesis-report.pdf (accessed 6 July 2018)

Cornwall, A., and Sardenberg, C. (2014) 'Participatory Pathways: Researching Women's Empowerment in Salvador, Brazil', *Women's Studies International Forum* 45 (July): 72–80. doi.org/10.1016/j.wsif.2014.01.006 (accessed 18 July 2018)

Council of the European Union (General Secretariat) (2015) *Advancing gender equality in the European Research Area*, Council conclusions 1486/15, data.consilium.europa.eu/doc/document/ST-14846-2015-INIT/en/pdf (accessed 10 July 2018)

Damaske, S.; Ecklund, E. and Lincoln, A. (2014) 'Male Scientists' Competing De-

votions to Work and Family: Changing Norms in a Male-Dominated Profession', *Work and Occupations* 41.4: 477-507, doi.org/10.1177/0730888414539171 (accessed 17 July 2018)

Dipartimento Per I Diritti E Le Opportunita (2009) *Practising Gender Equality in Science*, cordis.europa.eu/result/rcn/45561_en.html (accessed 6 July 2018)

Dugan, J.P.; Fath, K.Q.; Howes, S.D.; Lavelle, K.R. and Polanin, J.R. (2013) 'Developing the Leadership Capacity and Leader Efficacy of College Women in Science, Technology, Engineering, and Math Fields', *Journal of Leadership Studies* 7.3: 6–23, doi.org/10.1002/jls.21292

Eagly and Carli (2007) in Frehill, L.M.; Abreu, A., and Zippel, K. (2015) 'Gender, Science and Occupational Sex Segregation' in W. Pearson Jr., L.M. Frehill, and C.L. McNeely (eds), *Advancing Women in Science. An International Perspective*, Basel: Springer International Publishing

Elix, J. and Lambert, J. (2014) 'Passionate Defenders, Accidental Leaders: Women in the Australian Environment Movement', in J. Damousi, K. Rubenstein and M. Tomsic (eds), *Diversity in Leadership: Australian women, past and present*, Canberra: The Australian National University Press

ECD-GRI (2016) *She Figures 2015*, Luxembourg: Publications Office of the European Union, ec.europa.eu/research/swafs/pdf/pub_gender_equality/she_figures_2015-final.pdf (accessed 10 July 2018)

EIGE (2018) *Gender Equality in Academic and Research – GEAR tool,* eige.europa.eu/gender-mainstreaming/toolkits/gear (accessed 10 July 2018)

ETAN (2000) *Science Policies in the European Union: Promoting excellence through mainstreaming gender equality,* Luxembourg: European Commission, ufm.dk/en/publications/2000/files-2000/promoting-excellence-through-mainstreaming-gender-equality.pdf (accessed 6 July 2018)

European Commission (n.d.) *Innovation Union*, ec.europa.eu/research/innovation-union/index_en.cfm?pg=home (accessed 14 July 2018)

European Commission (2008) *Mapping the maze: Getting more women to the top in research,* Luxembourg: Office for Official Publications of the European Communities, ec.europa.eu/research/science-society/document_library/pdf_06/mapping-the-maze-getting-more-women-to-the-top-in-research_en.pdf (accessed 6 July 2008)

European Commission (2009) *The gender challenge in research funding: Assessing the European national scenes*, Luxembourg: Office for Official Publications of the European Communities, ec.europa.eu/research/swafs/pdf/pub_gender_equality/gender-challenge-in-research-funding_en.pdf (accessed 6 July 2018)

European Commission (2012) *A Reinforced European Research Area Partnership for Excellence and Growth,* Brussels: Communication of the European Commission, ec.europa.eu/research/science-society/document_library/pdf_06/era-communication-partnership-excellence-growth_en.pdf (accessed 10 July 2018)

European Commission (2014) *Guidance for the selection of evaluators with gender expertise for proposals submitted under H2020 calls*, ec.europa.eu/transparency/regexpert/index.cfm?do=groupDetail.groupDetailDoc&id=16350&no=1 (accessed 11 July 2018)

European Commission (2016a) *Vademecum on Gender Equality in Horizon 2020*, ec.europa.eu/research/swafs/pdf/pub_gender_equality/2016-03-21-Vademecum_Gender%20in%20H2020-clean-rev.pdf (accessed 11 July 2018)

European Commission (2016b) *The European Research Area: Time for implementation and monitoring progress,* Luxembourg: Publications Office of the European Union, ec.europa.eu/research/era/pdf/era_progress_report2016/era_progress_report_2016_com.pdf (accessed 11 July 2018)

European Commission (2017) *European Research Area: An open space for research and growth*, ec.europa.eu/research/era/index_en.htm (accessed 14 July 2018)

European Parliament (2015) *Women's careers in science and university*, Texts adopted P8_TA (2015)0311, www.europarl.europa.eu/sides/getDoc.do?pubRef=-//EP//NONSGML+TA+P8-TA-2015-0311+0+DOC+PDF+V0//EN (accessed 11 July 2018)

Fraser, J. (2016) 'The Leadership Machine: All the Research about Women's Career Advancement Summed Up in One Usable Diagram' http://www.slideshare.net/clevergirl/full-text-version-the-leadership-machine-all-the-research-about-womens-career-advancement-summed-up-in-one-usable-diagram (accessed 12 July 2018)

Frehill, L.M.; Abreu, A., and Zippel, K. (2015) 'Gender, Science and Occupational Sex Segregation' in: Pearson, W. Jr., Frehill, L.M. and McNeely, C.L. (eds), *Advancing Women in Science. An International Perspective*, Springer International Publishing

GenderInSITE (n.d.) *Who we are*, https://genderinsite.net/about/who-we-are (accessed 5 July 2018)

GenPORT (n.d.) https://www.genderportal.eu/ (accessed 17 July 2018)

Haslam, A.S. and Ryan, M.K. (2008) 'The Road to the Glass Cliff: Differences in the Perceived Suitability of Men and Women for Leadership Positions in Succeeding and Failing Organizations', *The Leadership Quarterly* 19.5: 530–46, doi.org/10.1016/j.leaqua.2008.07.011

Hawley, J. (2015) *Why Women Will Save the Planet*, London: Zed Books Ltd.

Helsinki Group on Women and Science (2009) '*Gender and Research Beyond 2009', Changing research landscapes to make the most of human potential: 10 years of EU activities in Women and Science, and BEYOND*, Prague: 14-15 May, https://www.amit-es.org/sites/default/files/pdf/publicaciones/helsinki_group_2009.pdf (accessed 10 July 2018)

Homma, M.K.; Motohashi, R. and Ohtsubo, H. (2013) 'Maximizing the Potential of Scientists in Japan: Promoting Equal Participation for Women Scientists through Leadership Development', *Genes to Cells* 18.7: 529–32, doi.org/10.1111/gtc.12065

Howe-Walsh, L. and Turnbull, S. (2016) 'Barriers to Women Leaders in Academia: Tales from Science and Technology', *Studies in*

Higher Education, 41.3: 415–28, doi.org/10.1080/03075079.2014.929102

Husu, L. (2001) 'On metaphors on the position of women in academia and science', *NORA: Nordic Journal of Women's Studies* 9.3: 172-181, doi.org/10.1080/713801035

Husu, L. (2005) 'Women's Work-Related and Family-Related Discrimination and Support in Academia', in S.M. Texlar and V. Demos (eds), *Gender realities: Local and global,* Bingley: Emerald Group Publishing Limited

Huyer, S. (2015) 'Is the Gender Gap Narrowing in Science and Engineering', in *UNESCO Science Report: Towards 2030*, Paris: UNESCO, http://www.unesco.org/new/en/brussels/areas-of-action/natural-sciences/unesco-science-report-towards-2030/ (accessed 10 July 2018)

IAC (2006) *Women for Science: An Advisory Report*, InterAcademy Council

IANAS (2013) *Women Scientists of the Americas: Their inspiring stories,* Mexico: IANAS

IANAS (2015) Young Women Scientists: A bright future for the Americas, Mexico: IANAS

ICSU (n.d.) *Gender Gap in Science*, https://icsugendergapinscience.org/ (accessed 5 July 2018).

ICSU (2016) *Challenges and Opportunities for the International Council for Science A response to the 2014 External Review*, https://council.science/cms/2017/05/ICSU-response-to-2014-external-review.pdf (accessed 5 July 2018)

ICSU CFRS (2016) *Mobility and Field Research in the Sciences: Gender Equality and Prevention of Harassment*, https://council.science/cms/2017/04/CFRS_Advisory_note_Gender_Field_Research.pdf (accessed 5 July 2018)

ICSU ERP (2014) *Report of the External Review Panel of the International Council for Science*, https://council.science/publications/external-review-of-icsu (accessed 5 July 2018)

ISC (2017) *World's leading bodies of social and natural sciences to merge in 2018, becoming "International Science Council"*, press release, 26 October, https://council.science/current/press/worlds-leading-bodies-of-social-and-natural-sciences-to-merge-in-2018-becoming-international-science-council (accessed 5 July 2018)

ISSC, IDS and UNESCO (2016) *World Social Science Report 2016, Challenging Inequalities: Pathways to a Just World,* Paris: UNESCO Publishing, https://en.unesco.org/wssr2016 (accessed 4 July 2018)

ISSC and UNESCO (2013) *World Social Science Report 2013, Changing Global Environments*, Paris: OECD Publishing and UNESCO Publishing, http://www.worldsocialscience.org/activities/world-social-science-report/the-2013-report/read-changing-global-environments/ (accessed 4 July 2018)

IUPAC (2016) *IUPAC 2017 Distinguished Women in Chemistry or Chemical Engineering – call for nominations*, https://iupac.org/2017-women-in-chemistry/ (accessed 5 July 2018)

Javadi, D.; Vega, J.; Etienne, C.; Wandira, S.; Doyle, Y. and Nishtar, S. (2016) 'Women Who Lead: Successes and Challenges of Five Health Leaders', *Health Systems & Reform*

2.3: 229-240, doi.org/10.1080/23288604.2016.1225471

L'Oreal Foundation (n.d.) *For Women in Science Manifesto,* https://www.forwomeninscience.com/en/manifesto (accessed 4 July 2018)

Leach, M.; Scoones, I. and Stirling. A. (2007) *Pathways to Sustainability: An Overview of the STEPS Centre Approach*, STEPS Approach Paper, Brighton: STEPS Centre

Leach, M.; Mehta, L. and Prabhakaran. P. (2015) *Gender Equality and Sustainable Development,* London: Routledge

Malcom, S.M.; Hall, P.Q. and Brown, J.W. (1978) 'The Double Bind: The Price of Being a Minority Woman in Science', *Conference of Minority Women Scientists*, Virginia: December 1975,, AAAS Publication 76-R-3, https://www.aaas.org/sites/default/files/migrate/uploads/1975-Double-Bind.pdf (accessed 17 July 2018)

Marchetti, M. and Raudma, T. (eds) (2010) *Stocktaking 10 years of 'Women in Science'*, Luxembourg: Publications Office of the European Union, https://ec.europa.eu/research/swafs/pdf/pub_gender_equality/stocktaking-10-years-of-women-in-science-book_en.pdf (accessed 6 July 2018)

Mason, M.A. and Goulden, M. (2002) 'Do Babies Matter? The Effect of Family Formation on the Lifelong Careers of Academic Men and Women', *Academe* 88.6: 21-27, doi.org/10.2307/40252699

'Meetup/SCAR 2016' (2018) *Wikipedia*, https://en.wikipedia.org/wiki/Wikipedia:Meetup/SCAR_2016 (accessed 5 July 2018)

NASAC (2015) 'Mainstreaming Gender in Science Education', Workshop proceedings, Nairobi: 27-28 May 2015, http://www.interacademies.org/28504/Mainstreaming-Gender-in-Science-Education (accessed 5 July 2018)

NASAC (2017) *Women in Science*: *Inspiring Stories from Africa*, Nairobi: NASAC, http://nasaconline.org/wp-content/uploads/2017/08/Women-in-Science-Inspiring-Stories-from-Africa-2.pdf (accessed 5 July 2018)

Parikh, N.I. and Redberg, R. (2015) 'The Unique Strengths and Leadership of Women in Cardiology in the Context of Team-Centered Medical Care, Academic Medicine, and Biomedical Science', *Current Cardiovascular Risk Reports* 9.35, doi.org/10.1007/s12170-015-0460-7

Parker, M. and Welch, E.W. (2013) 'Professional networks, science ability, and gender determinants of three types of leadership in academic science and engineering', *The Leadership Quarterly* 24: 332–348, doi.org/10.1016/j.leaqua.2013.01.001

REGULATION (EU) No 1290/2013 OF THE EUROPEAN PARLIAMENT AND OF THE COUNCIL of 11 December 2013 laying down the rules for participation and dissemination in "Horizon 2020 - the Framework Programme for Research and Innovation (2014-2020)" (2013) *Official Journal of the European Union*, L 347.81, http://ec.europa.eu/research/participants/data/ref/h2020/legal_basis/rules_participation/h2020-rules-participation_en.pdf (accessed 10 July 2018)

Rübsamen-Waigmann, H.; Sohlberg, R.; Rees, T.; Berry, O.; Busmuth, P.; D'Antona, R.; De

Brabander, E.; Haemers, G.; Homes, J.; Jepsen, M.K.; Leclaire, J.; Mann, E.; Neumann, J.; Needham, R.; Nielsen, N.C.; Vela, C. and Winslow, D. (2003) *Women in Industrial Research: A wake up call for European industry*, European Commission, https://ec.europa.eu/research/swafs/pdf/pub_gender_equality/wir_final.pdf (accessed 6 July 2018)

Sánchez de Madariaga, I.; Raudma, T.; Rees, T.; Pollitzer, E.; Schraudman, M.; Eichemberger, T.; Sergent, S. and Hogan, A. (2011) *Structural Change of Research Institutions: Enhancing Excellence, Gender Equality and Efficiency in Research and Innovation*, Luxembourg: Publications Office of the European Union, https://ec.europa.eu/research/science-society/document_library/pdf_06/structural-changes-final-report_en.pdf (accessed 10 July 2018)

Sassler, S.; Glass, J.; Levitte, Y. and Michelmore, K.M. (2016) 'The missing women in STEM? Assessing gender differentials in the factors associated with transition to first jobs' *Social Science Research* 63: 192-208, doi.org/10.1016/j.ssresearch.2016.09.014

Schiebinger, L. (2002) 'European Women in Science', *Science in Context* 15.4: 437-481

Schiebeinger, L.; Klinge, I.; Sánchez de Madariaga, I.; Schraudner, M. and Stefanick, M. (eds) (2011-2018a) *Sex and Gender Analysis Policies of Major Granting Agencies*, http://genderedinnovations.stanford.edu/sex-and-gender-analysis-policies-major-granting-agencies.html (accessed 10 July 2018)

Schiebeinger, L.; Klinge, I.; Sánchez de Madariaga, I.; Schraudner, M., and Stefanick, M. (eds) (2011-2018b) *Gendered Innovations in Science, Health and Medicine, Engineering, and Environment,* http://genderedinnovations.stanford.edu (accessed 10 July 2018)

Seager, J.; Bechtel, J.; Bock, S. and Dankelman, I.E.M. (2016) *Global gender and environmental outlook*, Nairobi: United Nations Environment Programme (UNEP)

Shen, H. (2013) 'Inequality Quantified: Mind the Gender Gap', *Nature News* 495.7439: 22, doi.org/10.1038/495022a (accessed 17 July 2018)

Simard, C.; Henderson, A.D.; Gilmartin, S.K.; Schiebinger, L. and Whitney, T. (2008) *Climbing the Technical Ladder: obstacles and solutions for mid-level women in technology*, Michelle R. Clayman Institute for Gender Research and The Anita Borg Institute for Women and Technology Stanford University, http://www.gedcouncil.org/sites/default/files/Climbing_the_Technical_Ladder.pdf (accessed 17 July 2018)

Sinclair, A. (2014) 'A feminist case for leadership', in J. Damousi, K. Rubenstein and M. Tomsic (eds), *Diversity in Leadership: Australian women, past and present*, Canberra: The Australian National University Press

STC Major Group (2017) 'Statement by the Scientific and Technological Community (STC) Major Group on SDG 5', 12 July, https://sustainabledevelopment.un.org/content/documents/25230Sientific_Technologic_Community_MG_SESSION8_12july2017_web.pdf (accessed 5 July 2018)

Sugimoto, C.R.; Lariviere, V.; Ni, C.Q.; Gingras, Y. and Cronin, B. (2013) 'Bibliometrics: Global Gender Disparities in Science', *Nature* 504.7479: 211–213

SwafS (2013) *Mandate and Working Methods of the Helsinki Group on Gender in Research and Innovation*, http://ec.europa.eu/research/swafs/pdf/pub_gender_equality/new_mandate_helsinki_group_FIN_25%2004%202013.pdf#view=fit&pagemode=none (accessed 6 July 2018)

TWAS (n.d.) https://twas.org/ (accessed 5 July 2018)

UN (n.d.-a) *About Major Groups and other stakeholders*, https://sustainabledevelopment.un.org/majorgroups/about (accessed 4 July 2018)

UN (n.d.-b) *Scientific and Technological Community*, https://sustainabledevelopment.un.org/majorgroups/scitechcommunity (accessed 5 July 2018)

UNCSTD (1995) *Missing Links: gender equity in science and technology for development*, Ottawa: ITDG Publishing, UNIFEM, IDRC (Gender Working Group)

UNCTAD (n.d.) *Mandate and Institutional Background*, http://unctad.org/en/Pages/CSTD/CSTD-Mandate.aspx (accessed 4 July 2018)

UNCTAD (2011) *Applying a Gender Lens to Science, Technology and Innovation,* Switzerland: United Nations, http://unctad.org/en/docs/dtlstict2011d5_en.pdf (accessed 4 July 2018)

UNESCO (n.d.-a) *Priority Gender Equality*, https://en.unesco.org/genderequality (accessed 4 July 2018)

UNESCO (n.d.-b) *Global Observatory of Science, Technology and Innovation Policy Instruments (GO-SPIN)*, https://en.unesco.org/go-spin (accessed 4 July 2018)

UNESCO (2000) 'Science for the Twenty-First Century: A New Commitment', *World Conference on Science,* Budapest: UNESCO, 26 June - 1 July 1999, http://unesdoc.unesco.org/images/0012/001229/122938eo.pdf (accessed 4 July 2018)

UNESCO (2007) *Science, Technology and Gender*, Paris: UNESCO, http://unesdoc.unesco.org/images/0015/001540/154045e.pdf, (accessed 4 July 2018)

UNESCO (2010) *Engineering: Issues, Challenges and Opportunities for Development*, Paris: UNESCO, http://unesdoc.unesco.org/images/0018/001897/189753e.pdf (accessed 4 July 2018)

UNESCO (2015) *UNESCO Science Report: Towards 2030*, Paris: UNESCO, http://unesdoc.unesco.org/images/0023/002354/235407e.pdf (accessed 4 July 2018)

UNESCO (2017a) *Women in Science - Explore the Data,* http://www.unesco.org/new/en/natural-sciences/priority-areas/gender-and-science/improving-measurement-of-gender-equality-in-stem/women-in-science-explore-the-data/ (accessed 17 July 2018)

UNESCO (2017b) *Gender and Science: SAGA Project Implementation*, http://www.unesco.org/new/en/natural-sciences/priority-areas/gender-and-science/improving-measurement-of-gender-equality-in-stem/stem-and-gender-advancement-saga/saga-project-implementation/, (accessed 4 July 2018)

UNESCO (2017c) *Cracking the code: Girls' and women's education in science, technology, engineering and mathematics,* Paris: UNESCO

Publishing, http://unesdoc.unesco.org/images/0025/002534/253479E.pdf, (accessed 4 July 2018)

UNESCO (2017d) 'Proposal for revision of the UNESCO recommendation on the status of scientific researchers (1974)', 39th session Agenda item 7.4, http://unesdoc.unesco.org/images/0025/002541/254128e.pdf, (accessed 4 July 2018)

UNESCO Institute for Statistics (2011) *UNESCO Institute for Statistics Basic Texts*, Montreal: UNESCO Institute for Statistics, http://uis.unesco.org/sites/default/files/documents/uis-basic-texts-2000-en.pdf, (accessed 4 July 2018)

UNFPA (2005) *Frequently asked questions about gender equality*, https://www.unfpa.org/resources/frequently-asked-questions-about-gender-equality (accessed 4 July 2018)

UN General Assembly (2015) 'Resolution adopted by the General Assembly on 22 December 2015 (A/RES/70/212)', Seventieth session Agenda item 22(b), http://www.un-.org/en/ga/search/view_doc.asp?symbol=A/RES/70/212 (accessed 4 July 2018)

UN Women (1995) 'Beijing declaration and platform for action', *Fourth World Conference on Women*, Beijing: United Nations, 4-15 September, http://www.un.org/womenwatch/daw/beijing/pdf/Beijing%20full%20report%20E.pdf (accessed 11 July 2018)

UN Women (2014) *World Survey on the Role of Women in Development 2014: Gender Equality and Sustainable Development*, United Nations, http://reliefweb.int/report/world/world-survey-role-women-development-2014-gender-equality-and-sustainable-development (accessed 17 July 2018)

UN Women (2016) *Better Gender Statistics for SDGs Evidence-Based Localization*, http://www.unwomen.org/-/media/headquarters/attachments/sections/library/publications/2015/flagship-brief-statistics.pdf?vs=319 (accessed 17 July 2018)

Urry, M. (2015) 'Scientists Must Work Harder on Equality', Nature 528.7583: 471–73

Vecchio, R.P. (2002) 'Leadership and Gender Advantage', *The Leadership Quarterly* 13.6: 643–671, doi.org/10.1016/S1048-9843(02)00156-X

Wellcome Trust (2014) *Women in Science – Explore the Data for Countries Worldwide*, 6 March, https://blog.wellcome.ac.uk/2014/03/06/women-in-science-explore-the-data-for-countries-worldwide/ (accessed 31 March 2017)

Williams, C.L. (1992) 'The glass escalator: Hidden advantages for men in the "female" professions', *Social Problems* 39: 253–267, doi.org/10.2307/3096961 (accessed 17 July 2018)

Williams, J.C.; Phillips, K.W. and Hall, E.V. (2014) *Double Jeopardy? Gender Bias Against Women in Science*, UC Hastings College of the Law, https://toolsforchangeinstem.org/double-jeopardy-report-viewer/ (accessed 17 July 2018)

Woetzel, J.; Madgavkar, A.; Ellingrud, K.; Labaye, E.; Devillard, S.; Kutcher, E.; Manyika, J.; Dobbs, R. and Krishnan, M. (2015) *How Advancing Women's Equality Can Add $12 Trillion to Global Growth*, McKinsey Global Institute, http://www.mckinsey.com/glob-

al-themes/employment-and-growth/how-advancing-womens-equality-can-add-12-trillion-to-global-growth (accessed 17 July 2018

WISAT (2012) *National Assessments on Gender Equality in the Knowledge Society: Gender in science, technology and innovation,* http://wisat.org/wp-content/uploads/GEKS_Synthesis-Nov2012.pdf (accessed 17 July 2018)

Wren, K. (2015) 'Breaking through the Polycarbonate Ceiling', *Science* 348.6242: 1439, doi.org/10.1126/science.348.6242.1439

Yellow Window (2018) *Gender in research as a mark of excellence*, https://www.yellowwindow.com/genderinresearch (accessed 10 July 2018)

ACRONYMS

AASSA – Association of Academies and Societies of Sciences in Asia

ASSAf – Academy of Science of South Africa

BPFA – Beijing Platform for Action

CAETS -- International Council of Academies of Engineering and Technological Sciences

CWM – Committee for Women in Mathematics (of the IMU)

CSW – Commission on the Status of Women

EC – European Commission

ECD-GRI – European Commission Directorate-General for Research and Innovation

ECOSOC – Economic and Social Council

EIGE – European Institute for Gender Equality

EP – European Parliament

ETAN – European Technology Assessment Network

EU – European Union

ERA – European Research Area

FP – Framework Programme (for European Area research)

GAB – Gender Advisory Board (of the UNCSTD)

GDP – Gross Domestic Product

GEAR – Gender Equality in Academia and Research toolkit

GGD – Gender, Globalisation and Democratisation Network initiative

GO-SPIN – Global Observatory of Science Policy Information

GWG – Gender Working Group (of the UNCSTD)

HG – Helsinki Group

IAC – InterAcademy Council

IANAS – InterAmerican Network of Academies of Sciences

IAP – InterAcademy Partnership

ICSU – International Council for Scientific Unions (now merged with ISSC to form ISC)

ICSU CFRS – International Council for Scientific Unions Committee on Freedom and Responsibility in the conduct of Science

ICSU ERP – International Council for Scientific Unions External Review Panel

IDS – Institute of Development Studies

IMU – International Mathematical Union

INASP – International Network for the Availability of Scientific Publications

ISC – International Science Council

ISSC – International Social Science Council

ITRE – Industry, Research and Energy Committee

IUPAC – International Union of Pure and Applied Chemistry

NASAC – Network of African Science Academies

OWSD – Organisation of Women in Science in Developing Countries

SAGA – STEM and Gender Advancement (project funded by Sida)

SAGE – Science in Australia Gender Equity project (of the Australian Academy of Science)

SCAR – Scientific Committee on Antarctic Research

SDGs – Sustainable Development Goals

Sida – Swedish International Development Cooperation Agency

SITE – science, innovation, technology and engineering

STC Major Group – Scientific and Technological Community Major Group (to the UN)

STEM – science, technology, engineering and mathematics

STI – science, technology and innovation

SwafS – Science with and for Society

TWAS – The World Academy of Sciences

UN – United Nations

UNCTAD – United Nations Conference on Trade and Development

UNCSTD –United Nations Commission for Science and Technology for Development

UNEP – United Nations Environment Programme

UNESCO – United Nations Educational Scientific and Cultural Organisation

UNFPA – United Nations Population Fund

UIS – UNESCO Institute for Statistics

WFEO – World Federation of Engineering Organisation

WISAT – Women in Global Science and Technology

WSIS – World Summit on the Information Society

WSSR – World Social Science Report