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EDITED BY
Monirul Mirza,
Environment and Climate Change Canada, Canada

REVIEWED BY
Susan Buckingham,
Independent Researcher, Cambridge, United Kingdom
Marielle Feenstra,
Delft University of Technology, Netherlands

*CORRESPONDENCE
Mathilde Rainard
✉ pt15mr@leeds.ac.uk

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Gender equality and climate change mitigation: Are women a secret weapon?

Mathilde Rainard[1]*, Christopher J. Smith[1,2] and Shonali Pachauri[2]

[1]School of Earth and Environment, University of Leeds, Leeds, United Kingdom, [2]Energy, Climate and Environment Program, International Institute for Applied Systems Analysis, Laxenburg, Austria

An orthodox assumption frames gender equality as a panacea to the climate crisis, whereby empowering women is assumed to have tremendous positive effects on countries' environmental performances. However, the gender-climate nexus literature often disregards feminist epistemology, detrimentally integrating harmful gendered assumptions within its analyses, and therefore policy recommendations. To remedy this, links between gender equality and climate change mitigation action were investigated, through a mixed-method approach, which includes feminist theories. Two metrics of gender equity, the Global Gender Gap Index and the Gender Inequality Index, and their correlations to a sustainability metric, the Environmental Performance Index, were analyzed. This quantitative analysis was enriched by 13 interviews with gender-climate experts. Results showed that, despite statistically significant correlations between both gender equality indices and the Environmental Performance Index, the positive relationship between gender equality and environmental performances is contextual and multi-faceted. Disregarding situated gender constructs, understanding gender as binary, and positing women as a homogeneous group, all mask multiple interactions between gender equality and climate change mitigation. Unveiling these interactions necessitates better integration of radical gender theories within climate change science through interdisciplinary research, permitting epistemological pluralism. To further this, a methodological framework is proposed, to help guide environmental researchers willing to consider gender in their work. Furthermore, the impact of gender mainstreaming within climate policies is explored, presenting subsequent policy recommendations. Finally, findings and the systemic transformation potential of gender equality, amongst other forms of equality, are discussed, reinforcing the idea that there is no climate justice without gender justice, and that justice and equality are cornerstones of sustainable societies.

KEYWORDS

climate change mitigation action, gender mainstreaming, equality, ecofeminism, Sustainable Development Goal (SDG) 13, gender equality

Highlights

- A mixed-methods approach is used to explore the role of gender in mitigation.
- Correlations between gender equity and sustainability were explored with 13 gender experts.
- Lack of feminist theories in climate science leads to maladaptive policies.
- Interdisciplinary research is needed to implement gender-transformative policies.
- A suggested project design framework is provided to support future research.

1. Introduction

Climate change is the biggest challenge faced by humanity (Anderson et al., 2014; Steffen et al., 2015; Pearse, 2017; MacGregor, 2021; IPCC, 2022). Climate change is commonly understood as a "wicked" problem meaning it defies conventional solutions and cannot be solved by the same means that helped create it (FitzGibbon and Mensah, 2012; Carter, 2018). Solutions to climate change are often categorized as either climate change adaptation or climate change mitigation (IPCC, 2022). The impacts of climate change are unequally distributed throughout the world, therefore, adaptation studies are most focused in developing countries (Pielke et al., 2007; Global Gender and Climate Alliance, 2016) whilst developed countries must urgently mitigate greenhouse gas (GHG) emissions through innovative policies and systemic changes (Anderson et al., 2014; Creutzig et al., 2018; IPCC, 2022). In this context, a growing body of literature centered upon the gender-climate nexus explores links between achieving gender equality and increasing individuals' resilience to a changing climate or enhancing climate change mitigation action (MacGregor, 2010; Global Gender and Climate Alliance, 2016; Andrijevic et al., 2020; McGee et al., 2020). The gender-climate nexus highlights how solutions and causes to climate change are not gender neutral (MacGregor, 2010, 2014; Nightingale, 2017; Pearse, 2017).

Gender has mainstreamed in climate change science, following the process of gender mainstreaming established by the 1995 Beijing Platform and Declaration, which highlighted 12 key socioeconomic areas needing urgent action to ensure equal opportunities between men and women (UNWOMEN, 2021). Gender mainstreaming is the process of incorporating a gender lens to any political response to limit perpetuation of gender inequalities through institutional means (Alston, 2014). Beneficial to a certain extent (Resurrección, 2013), gender mainstreaming has resulted in a dilution of radical gender and feminist theories explaining its marginal impact in practice (Prügl, 2010; Wittman, 2010). Moreover, the hegemonic positivist epistemology in climate change adaptation limits the integration of qualitative and feminist methods (Thompson-Hall et al., 2016; Lau et al., 2021). Thus, paradoxically, many researchers study gender without engaging with feminist epistemology resulting in the spread of harmful gendered assumptions in climate policy responses, like perceiving women as innately connected to nature or gender equality as solely a women's issue (Lau et al., 2021).

On the one hand, the climate adaptation literature increasingly explores gender through feminist lenses, utilizing qualitative methods and considering intersectionality (Crenshaw, 1989; Global Gender and Climate Alliance, 2016), particularly in vulnerability studies. Vulnerability in this context is the potential for an individual or a system to be adversely impacted by climate change (Füssel, 2007). Vulnerability researchers have highlighted the intersectional origins of inequalities to climatic impacts, identifying power dynamics' roles (O'Brien et al., 2004, 2007; Tschakert, 2007, 2012; Ford et al., 2010; Thomas et al., 2019; Barnett, 2020; Rahman and Hickey, 2020). This has subsequently challenged the "one size fits all" approach implied by gender mainstreaming (Alston, 2014). At the same time, a growing body of literature is advocating for "gender-transformative" responses to climate change adaptation, as opposed to gender-responsive or gender-sensitive policies (Global Gender and Climate Alliance, 2016; Resurrección et al., 2019; Table 1). Gender-responsive policies are right-based responses to gendered climatic impacts, while gender-sensitive policies disparately cater to males and females without addressing the causes behind differing gendered experiences (Resurrección et al., 2019). The gender-transformative approach is not solely aimed at women, rather the concept is holistic and intersectional (Resurrección et al., 2019). Generally, the notion of transformation arising from adaptation research transcends the climate change adaptation/mitigation dualism to tackle the climate crisis holistically (O'Brien, 2012; Resurrección et al., 2019). Nevertheless, progress is non-linear with mostly gender-sensitive approaches being used in practice (Bee et al., 2013; Resurrección et al., 2019).

On the other hand, within the climate change mitigation literature, transformation and gender have also garnered attention, notably amongst advocates of radical and systemic approaches to mitigate GHG emissions (Shove, 2010; Koch, 2013, 2020; Raworth, 2017). However, when links between gender equality and climate action are appraised, the concept of transformation is often absent, and feminist epistemology considered within adaptation is substituted by quantitative analysis of sex-disaggregated data through cross-country regression analysis, concluding gender equality would foster climate change mitigation action (see Ergas and York, 2012; Mavisakalyan and Tarverdi, 2019; McGee et al., 2020). The reality is more complex, as understanding women as a homogenous group masks the contextual implications of increased gender equality on climate change mitigation action (Knight and Givens, 2021; Lau et al., 2021).

We call for more research that integrates feminist epistemology into climate change mitigation. This paper contributes to this call by utilizing a pragmatic research paradigm and mixed-methods approach through a critical ecofeminist lens (Plumwood, 1997, 2002; Gaard, 2017). We define gender equality as equality of treatments and opportunities between individuals of different gender, where gender is considered as a social construct per Beauvoir (1949), recognizing that gender is not a binary construct (Butler, 1988). Critical ecofeminism was chosen for a framing because it goes beyond classic ecofeminist theories (Badoux, 1974; Merchant, 1980, 1981) and avoids essentializing women's relation to nature. It calls for the reconciliation of all agents of society within a holistic ecofeminist sustainable movement (Gaard, 2017), and aligns with the transformation literature (O'Brien, 2012; Dow et al., 2013; Pelling et al., 2015). The aims of this work are to explore the links between Sustainable Development Goal (SDG) 5 (gender equality) and SDG 13 (Climate Action) (UNSDG, 2015), whilst interrogating hegemonic methodologies and tools in the literature and to provide a methodological framework to engage with feminist theories within the gender-climate nexus research space.

In what follows, how gender equality relates to climate policy, climate action, and general mitigation efforts is investigated. The vast scope of this field is supported by the mixed-method global approach adopted for this research and detailed below (Section 2). Section 3 presents the results of the quantitative analysis undertaken. However, to untangle the links between gender equality and climate mitigation action further, more empirical research integrating feminist epistemology is needed. To help achieve this, Section 4.1 discusses methodological issues and suggests a methodological framework (Figure 5) to inform future researchers willing to integrate gender into their work. The framework takes the shape of a decision tree guiding project design, helping to guide the choices one can make at the early stages of a project's development, and to

TABLE 1 Gender-climate nexus key definitions.

Gender-climate related definitions	
Gender mainstreaming	The process of incorporating a gender lens within all political responses to ensure gender inequalities are not perpetuated through institutional means
Gender-sensitive policies	Policies that cater differently to males and females acknowledging gender inequalities embedded in climatic impacts but do not address the root causes of inequalities
Gender-responsive policies	Right-based policy responses to gendered climatic impacts to address part of the root causes behind gender inequalities
Gender-transformative policies	Policy responses that systematically address root causes of inequalities beyond just gender to consider multiple social factors at play in gendered climatic impacts

better integrate feminist epistemology when exploring the gender-climate nexus. It also provides practical recommendations to answer the points raised in that section. Section 4.2 discusses the policy implications of the research. Sections 4.3 and 4.4, respectively, present the recommendations derived from the quantitative and qualitative analyses and their integration. Finally, we discuss the contribution of this paper to the gender-climate nexus literature in Section 5, examining the place gender equality holds in transformation and the limitations of our research. Section 6 concludes.

2. Methodology

2.1. Operationalization

The mixed-methods approach adopted for this research is justified by three considerations. First, utilizing mixed methods aligns with the pragmatic research paradigm. Pragmatism considers that natural reality exists outside of humans' perceptions, but societies and social norms shape and co-create that reality, consciously and subconsciously (Rorty, 1982). Thus, pragmatism is the most relevant paradigm to foster the idea of interactions between technical and social solutions to climate change mitigation (Rayner, 2012; Mason, 2018; Westholm and Arora-Jonsson, 2018). Second, the mixed-methods approach reinforces the idea of complementarity between quantitative methods utilized in mainstream appraisals of links between SDG5 and SDG13, and the qualitative methods used by feminists and gender researchers. Finally, the mixed-methods approach is an attempt to avoid the pitfalls of both methods when used separately, notably, the lack of generalization attached to qualitative approaches, and the potentially misleading results fostered by quantitative approaches (Bryman, 2016; Mason, 2018; Tracy, 2019).

Two indices of gender equality, the Gender Inequality Index (GII) (UNDP, 2020a) and the Global Gender Gap Index (GGGI) (World Economic Forum, 2020a) are analyzed to highlight correlations with the Environmental Performance Index (EPI) (Wendling et al., 2020) in a cross-country regression analysis. To critically assess results of the quantitative analysis, 13 feminist and gender researchers, whose work focusses on the gender-climate nexus, were interviewed, and these interviews were used in coordination with the regression analysis to provide guidance for researchers willing to incorporate gender in their work, and inform the development of the decision tree presented in Section 4.1.

The pragmatic research paradigm and subsequent mixed methods approach called for an abductive analysis, where the quantitative and qualitative analyses informed each other iteratively. However, for clarity, both are presented separately below (Sections 2.2 and 2.3), despite them conjointly answering the project's aims: to assess links between gender equality and climate change mitigation action through a feminist lens whilst interrogating hegemonic methodologies and tools in the literature, and to provide a methodological framework to engage with feminist theories within the gender-climate nexus.

2.2. Country regression analyses

To appraise possible links between SDG5 and SDG13, the three indices and some of their selected indicators were analyzed. First, correlations between the aggregated scores of all indices were investigated. Second, dividing countries by income categories according to the World Bank classification (Supplementary material), the same correlations were run for 2020 and 2010 data series, highlighting the importance of national context. Third, correlations between the Climate Change component of the EPI (EPI-CC), composed of eight sub-indicators and the GGGI aggregated score were run. Then, correlations between two sub-indicators of the EPI-CC (the GHG emission per capita, EPI-GHG-PC and the GHG emissions intensity of GDP, EPI-GHG-GDP) and the aggregated score of the GGGI were run. The same analysis was undertaken with the aggregated score of the GII. Finally, correlations between two sub-components of the GGGI [the Women Economic Opportunities (GGGI Economic) composed of 5 indicators, and the Women Political Empowerment (GGGI Political) composed of 3 indicators] and the aggregated score of the EPI were investigated. All analyses run are summarized in Table 2. These were distilled into four hypotheses (H1–H4):

- Hypothesis 1: Increased gender equality relates to the environmental sustainability of countries (Ergas and York, 2012; Joireman and Liu, 2014).
- Hypothesis 2: The relationship between gender equality and environmental performances is contextual and influenced by countries' national affluence, rather than a universal truth (Chan et al., 2018; Knight, 2019; Knight and Givens, 2021). H2 was also tested on 2010 data series of the indices, to highlight evolution over time.
- Hypothesis 3: Gender equality influences the specific climate change indicators of GHG emissions per capita and GHG intensity of GDP (McGee et al., 2020; Ergas et al., 2021).
- Hypothesis 4: Women's political empowerment and economic opportunities make a difference on environmental

TABLE 2 Correlations performed in the quantitative analysis, and the hypothesis tested.

Indicators	GII score	GGGI score	GGGI economic	GGI political
EPI Score (aggregated)	H1	H1	H4	H4
EPI Score (aggregated) by national income category	H2	H2		
EPI climate change	H3	H3		
EPI GHG emissions	H3	H3		
EPI GHG intensity	H3	H3		

performances of countries (Joireman and Liu, 2014; Mavisakalyan and Tarverdi, 2019).

The regression analyses in Table 2 contribute to understanding whether the indices are appropriate tools to appraise links between SDG5 and SDG13. Correlation coefficients are expected to be negative for the GII in the case of a positive relationship between gender equality and sustainability, as the GII ranges from 1 to 0, where 0 is no disadvantage for women (UNDP, 2020a), whereas the GGGI is expected to show positive correlations, as the index ranges from 0 to 1, where 1 is perfect institutional equality between men and women (World Economic Forum, 2020a).

The use of mainstream indices (GGGI, GII, and EPI) rather than indices attentive to questions of non-binarity, happiness or wellbeing is justified by their prevalence in the literature and by their wide availability, noting both are linked. Subsequently, understanding their potential caveats and criticisms by gender experts have implications for further research and future data gathering efforts, while also informing the insights that may be gleaned from this analysis and that of aforementioned studies (Ergas and York, 2012; Mavisakalyan and Tarverdi, 2019; McGee et al., 2020). Furthermore, these indices consider a large sample of countries (142), beneficial in highlighting differences between groups of countries, and permitting for better contextualization of results. Moreover, comparing two indices of gender equality (GGGI and GII) highlighted differences in their respective definitions of gender equality and the implications of these definitions on results of correlation with the EPI. The GGGI understands gender equality as equal institutionalized opportunities between males and females (World Economic Forum, 2020a) and the GII is a measure of gender-based disadvantages (UNDP, 2020a). Finally, these indices were familiar to most experts interviewed, so also facilitated discussion (Section 2.3).

2.3. Interviews: Sampling, method, and analytical approach

A total of 13 gender experts were interviewed. All experts interviewed and willing to be named have been listed in the Acknowledgments, and provided informed consent. The procedures of the University of Leeds Ethics Committee were followed. The interviewees were selected by reviewing relevant literature, mixing purposive and snowball sampling. Experts were selected based upon their work, as well as on the countries and context in which they base their research, to foster a variety of perceptions and viewpoints. The interviews were semi-structured (Mason, 2018) and conducted in a collaborative style (Rapley, 2001, 2014), including self-disclosing introductory remarks to establish rapport, following feminist methods (Moser et al., 1981; Oakley, 2016). The experts were first presented with preliminary results and interpretations from the quantitative analysis, as well as a general script of talking points (Supplementary material). They were asked to comment on the document, discussing results and interpretations. Before proceeding with the interview script, they were probed to present their main research interests and to explain any ongoing projects related to gender-climate issues. The questions focused on the following key points:

- Perceptions of links between gender equality and climate change mitigation action.
- Methodologies used in the literature to uncover these links and how experts perceived potential methodological strengths and weaknesses.
- The way experts overcome methodological weaknesses in their work.
- Implications for policy of using these methods and experts' recommendations to policymakers.

Questions were catered to each interviewee, owing to the semi-structured approach and the variety of their contributions to the gender-climate nexus. Questions were open ended, to avoid steering interviewees answers (Bryman, 2016; Mason, 2018). However, sharing preliminary data interpretations and self-disclosing remarks may have influenced discussions (Rapley, 2001). To limit the intrusion of the interviewer's preconceptions in the results, self-reflexivity was maintained throughout the analysis (Bryman, 2016). Self-reflexivity is illustrated by the difference between the interpretation of data in the results compared to the interpretations in the document provided to experts before the interview (Supplementary material).

The content of interviews was analyzed using a thematic semantic approach (Mason, 2018), extracting explicit themes arising across interviews (Bryman, 2016; Mason, 2018), considering pre-defined categories, while allowing unforeseen themes to develop. Five out of 15 categories, resulting from the project's objectives, were pre-defined: methodological issues and recommendations, impacts on policy and recommendations, and gendered perspectives on mitigation (Supplementary material). First, nodes (categories) were created, then, interlinked nodes were reorganized according to the aims and hypotheses, and within the nodes, themes were extracted and structured during the interpretation of the results (Maguire and Delahunt, 2017). The experts' interviews enabled in-depth reinterpretation of quantitative results, including the definition of H4

and refinement of H3, to include the GHG intensity of GDP. Finally, the experts' remarks enabled consideration of the paper's implications for policy, discussed in Section 4.

2.4. Methodological framework: Aim and design for a useful tool

Following the quantitative and qualitative analyses, and guided by the literature reviewed to design this paper, a pattern emerged, showing what was missing from the available literature and data to deepen our understanding of the links between gender equality and climate change mitigation action. The mixed-methods results allowed for building a methodological framework, in the shape of a decision tree (Section 4.1, Figure 5), to inform the design of future environmental research projects willing to include gender.

The framework was built with the help of the experts interviewed, by analyzing their answers when discussing key points 2 and 3 ("Methodologies used in the literature to uncover these links and how experts perceived potential methodological strengths and weaknesses" and "The way experts overcome methodological weaknesses in their work."). The data analysis was useful too, by showing what was missing from the available data, and how indices' construction could lead to misleading interpretations of statistical analysis. In other words, the data showed gaps, and the expert interviews helped inform how to fill these gaps in future research.

The shape of the methodological framework was justified by the need to address the root of the most common methodological issues encountered in the literature discussed in Section 4.1. Indeed, the project design stages are fundamental to avoid perpetuating gender bias and harmful assumptions. Moreover, addressing issues arising at the project design stage allows a deeper integration of feminist epistemology. Finally, shaping the methodological framework as a decision tree renders it more accessible, making it a useful resource for first-time gender-climate nexus researchers.

3. Results

3.1. H1: Gender equality influences countries' environmental performances

H1 was confirmed by the quantitative analysis (Figure 1), with a stronger correlation between the GII and the EPI (Figure 1B), compared to the correlation between the GGGI and EPI (Figure 1A). In both cases, there is a statistically significant relationship between gender equality and countries' environmental performances. The difference between the strong correlation observed between GII and EPI and the weaker correlation between GGGI and EPI can be explained by the composition of the indices. The GII is intrinsically linked to the Human Development Index of the United Nations (UNDP, 2020a), highlighted as showing similar ranking of countries as the EPI (Wendling et al., 2020), whereas the GGGI data is mainly drawn from the World Economic Forum data sets (World Economic Forum, 2020a). Furthermore, the GGGI is a complex aggregation of indicators to measure women's political involvement (three sub-indicators) and women's economic opportunities (five sub-indicators) (World Economic Forum, 2020a). In comparison, the GII measures these political and economic aspects through three sub-indicators in total (UNDP, 2020a). Beyond these differences in strength of correlation, the composite nature of the indices' final scores questions the relevance of H1 statistical significance in revealing causality between gender equality and environmental performances, as highlighted by participant D: "*I do not put much weight or faith in this type of analysis*" and participant H: "*we do not have the data to fully understand this link.*" For participant G, looking at composite and aggregated data was: "*neglecting scale.*" Experts explained how overlooking the contextuality of gendered experiences was considering women as a homogenous group, an assumption neglecting the contextuality of gender norms' construction and intersections between gender, race, age, and class inequalities.

3.2. H2: Links between gender equality and environmental performance are contextual, influenced by countries' national affluence

Figure 2 illustrates the relationship between gender equality and climate change mitigation action contextually, with the importance of national influence (Knight and Givens, 2021) represented by countries' income, as per the World Bank's classification (World Economic Forum, 2020b). Hypothesis 2 is partially confirmed in the case of high income (higher gender equity) in both GGGI and GII indices. The lack of correlation for low-income countries is also partly explained by a lack of data. Middle-income countries reveal some interesting subtleties. The strong correlation between GII and EPI in lower-middle-income countries compared to upper-middle-income countries (Figure 2G) was intuitively justified by four participants as caused by gender mainstreaming within institutional funding bodies. As participant E explained: "*donors push for the implementation of gender,*" meaning lower-middle-income countries receiving international development aid are compelled to integrate gender issues in their development plans, that are considered as part of the EPI (Wendling et al., 2020). Gender mainstreaming within international politics and funding bodies highlighted by experts is illustrated by stronger correlations between GGGI and GII and EPI over time in higher-middle income countries as they continue to develop (Table 3).

However, the more comprehensive definition of gender equality built within the GGGI, and weaker correlations associated with this index show that the reality of women's integration in public and private sectors pushed by gender mainstreaming is to be nuanced. The experts agreed gender mainstreaming made gender a "*box to tick,*" as expressed by participant B, where underlying power dynamics creating gendered differences are ignored, never achieving true integration of women within decision-making. Furthermore, the slightly weaker correlations over time for higher-income countries question the strength of the relationship between gender equality and environmental performances. Subsequently, interviewees insisted on the contextuality of gendered experiences and norms. Participant B explained: "*[women] need to be integrated within the climate debates (. . .) they have a microcosmic understanding of what is happening to the climate (. . .) we neglect that information at our peril.*" As such, women's experiences, knowledge, and roles to overcome the climate crisis need to be contextualized and acknowledged, and women's absence needs to be recognized. This was investigated further by testing H3 and H4.

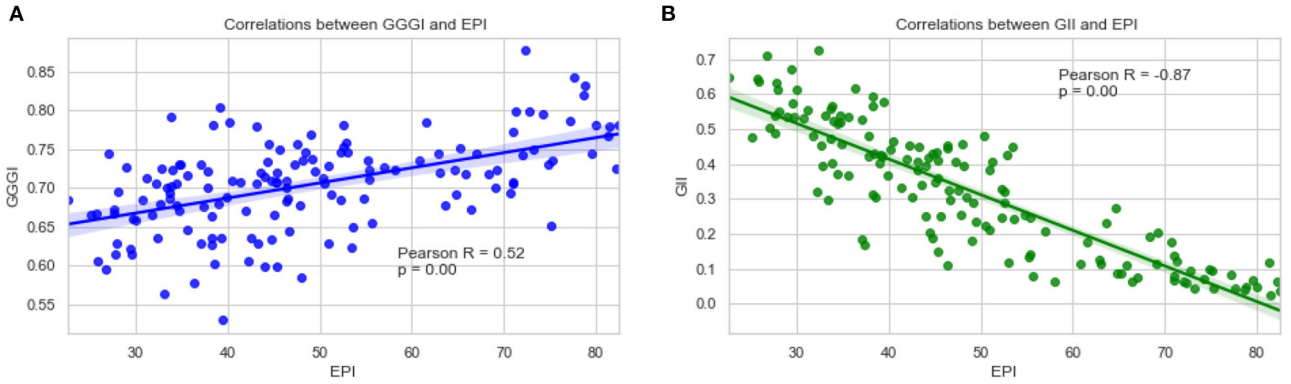

FIGURE 1
Correlation of **(A)** Global Gender Gap Index (GGGI) with Environmental Performance Index and **(B)** Gender Inequality Index (GII) with EPI. Correlations show composite indices for 2020.

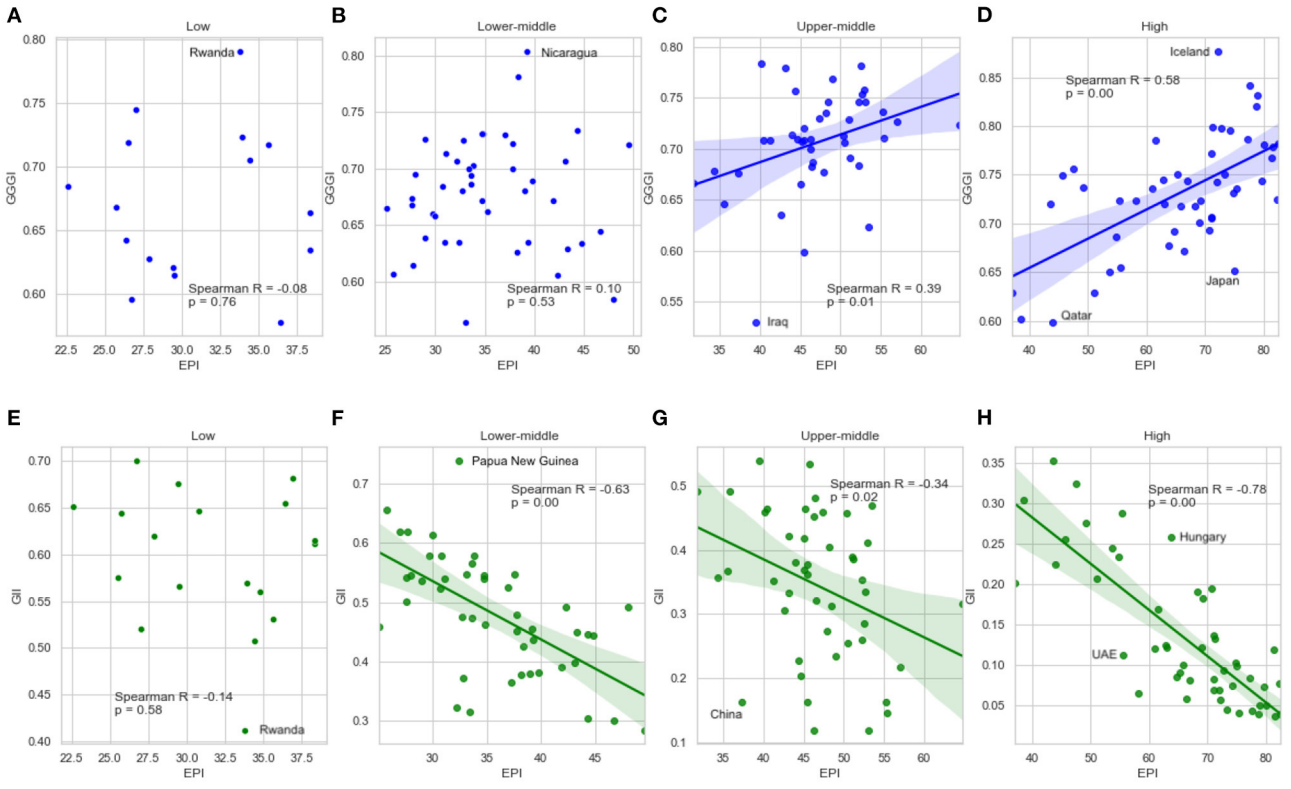

FIGURE 2
(A–D) Correlations between GGGI and EPI per income category: **(A)** low income, **(B)** lower-middle income, **(C)** higher-middle income, and **(D)** high income. **(E–H)** Correlations between GII and EPI per income category: **(E)** low income, **(F)** lower-middle income, **(G)** higher-middle income, and **(H)** high income. Regression lines are drawn in the cases of statistically significant correlations ($p < 0.05$).

3.3. H3: Gender equality influences climate change, GHG emissions per capita, and GHG intensity of GDP

Both indicators aligned when investigating H3, with expected stronger correlations between the GII and EPI sub-indicators compared to GGGI. Gender equality indicators are correlated to climate change (EPI-CC) and GHG emissions per capita indicators (EPI-GHG-PC) but are uncorrelated with GHG intensity of GDP (EPI-GHG-GDP). Participant G highlighted the possibility of reverse causality being revealed. Developed countries have institutionalized gender equality earlier in time, therefore, achieving better scores on gender equality indices due to historical and ongoing gender debates (Beer, 2009). They are also responsible for most GHG emissions and environmental degradation (Herzog, 2009) whereas low-income countries have historically contributed little to climate change (Sarkodie and Strezov, 2019), despite cases of high-income countries offshoring high-emitting sectors such as manufacturing to

TABLE 3 Correlation coefficients between GGGI and EPI and between GII and EPI for each income category, using EPI composite scores for 2010 and 2020.

Income	Low		Lower-middle		Higher-middle		High	
EPI year	2010	2020	2010	2020	2010	2020	2010	2020
GGGI vs. EPI	0.15	−0.08	0.25	0.14	0.21	**0.38**	**0.61**	**0.58**
GII vs. EPI	−0.2	−0.13	**−0.52**	**−0.63**	−0.06	**−0.34**	**−0.82**	**−0.78**

Statistically significant (at the 5% level) results are in bold.

developing countries to service their own consumption. As such, what can be highlighted from Figures 2, 3 is the link between economic growth and environmental harm, acknowledging that developed countries tend to have greater institutionalized gender equality, as gender equality benefits economic growth (Kabeer and Natali, 2013). Furthermore, absence of correlation between gender equality indices and the GHG intensity of GDP indicator is revealing of women's absence from decision making, which was discussed with all experts. This leaves women with little influence on economic or political decisions impacting the GHG intensity of GDP. However experts agreed that assuming increasing female presence in decision-making would result in decreasing the GHG intensity of GDP is misleading. Deconstructing the GGGI to understand the links between women's economic opportunities and political empowerment with environmental performances, showed that gender equality in these domains was weakly correlated to the EPI.

3.4. H4: Women's political empowerment and economic opportunities

Figure 4 shows correlations between the Economic Opportunities subcategory of the GGGI (GGGI Economic) and EPI (Figure 4A) and the Political Empowerment component of GGGI (GGGI Political) and EPI (Figure 4B). The weak correlations in Figure 4 are revealing of two dynamics according to experts. First, there is a long way to go before achieving equality in the economic and political domains. Second, women are not the expected panacea to solve the climate crisis. Participant C injuncted: "*They should not be! It's not up to women to clean everyone's mess,*" summarizing most interviewees' perspectives. This also follows from the fact that relationships between gender equality and environmental performances are more multifaceted than they appear in Figure 1. The dynamics revealed by the cross-country regression analysis are dependent upon indices' construction, value-laden, and subject to reverse causality (Rodriguez and Rodrik, 2001; Rayner, 2012).

Interviewees agreed that the little gender equality achieved globally, notably, in the political sphere, is symptomatic of unchanged systemic power dynamics influencing the state of the global climate. The Global South will suffer the most from the consequences of climate change, relying on the Global North's assistance to adapt to climatic impacts (IPCC, 2018). The dichotomy between adaptation and mitigation was challenged by all the experts. Participant A expressed: "*I feel adaptation is muddling through (…) there has to be some kind of transformation*". All interviewees mentioned achieving gender equality as participating in the necessary systemic transformation of neoliberal societies to overcome the climate crisis, discussing reproduction of inequalities embedded in neoliberal systems. The notion of transformation transcends the idea of gender equality to address inequalities holistically and requires to "*change the way we conceive our relationships*" said participant I, before explaining that systemic transformations required "*paradigm shifts*", in political, technical, and personal realms. Participant I also mentioned "*animals (…) and trees rights*" and emphasized the importance of "*indigenous knowledge,*" like most (9/13) experts, aligning with critical ecofeminist theories (Plumwood, 1997, 2002; Gaard, 2017). Furthermore, most interviewees (9/13) discussed individualism and hierarchical relationships between individuals imposed by neoliberal, patriarchal and neo-colonial systems' hegemony as influencing the solutions implemented to overcome the climate emergency, "*the elephant in the room,*" according to participant A. However, technical solutions still prevail within academia and the political sphere.

4. The gender-climate nexus methodologies, issues, progress and recommendations

4.1. Methodological issues and progress according to interviewees

Four themes arose from the analysis of the experts' interviews regarding methodological weaknesses: the impact of gender mainstreaming at the project design stage, the ambivalence of sex-disaggregated data, the difficult equilibrium between depth and breadth, and the problematic conceptualization of gender.

Gender mainstreaming's main positive impact was opening the discussion about gender; however, forcing a gender lens can be detrimental according to all the experts interviewed. Gender mainstreaming made gender an "*add-on*" according to participant E, reflecting most (10/13) experts' opinions. This translates into gender-climate nexus literature adding a gender section rather than integrating gender when designing research projects, the risk being to consider: "*gender is done*" as participant J put it, meaning the gender agenda would disappear despite little effective progress achieved.

All the participants agreed that most research: "*simplifies gender (…) [as] men vs. women (…) and we know gender is non-binary,*" summarized participant G. Thus, gender-climate focused research often disregards the fact that gender is not a binary construct, problematically ignoring contextual social constructs underlying gendered dynamics. This translates into the predominant use of sex-disaggregated data. Sex-disaggregated data is convenient, and experts agreed that striving for more quantitative analyses integrating sex-disaggregated information would be beneficial, if weaknesses of such data are acknowledged. Sex-disaggregated data is an entry point to study gender, but lacks the depth and breadth necessary

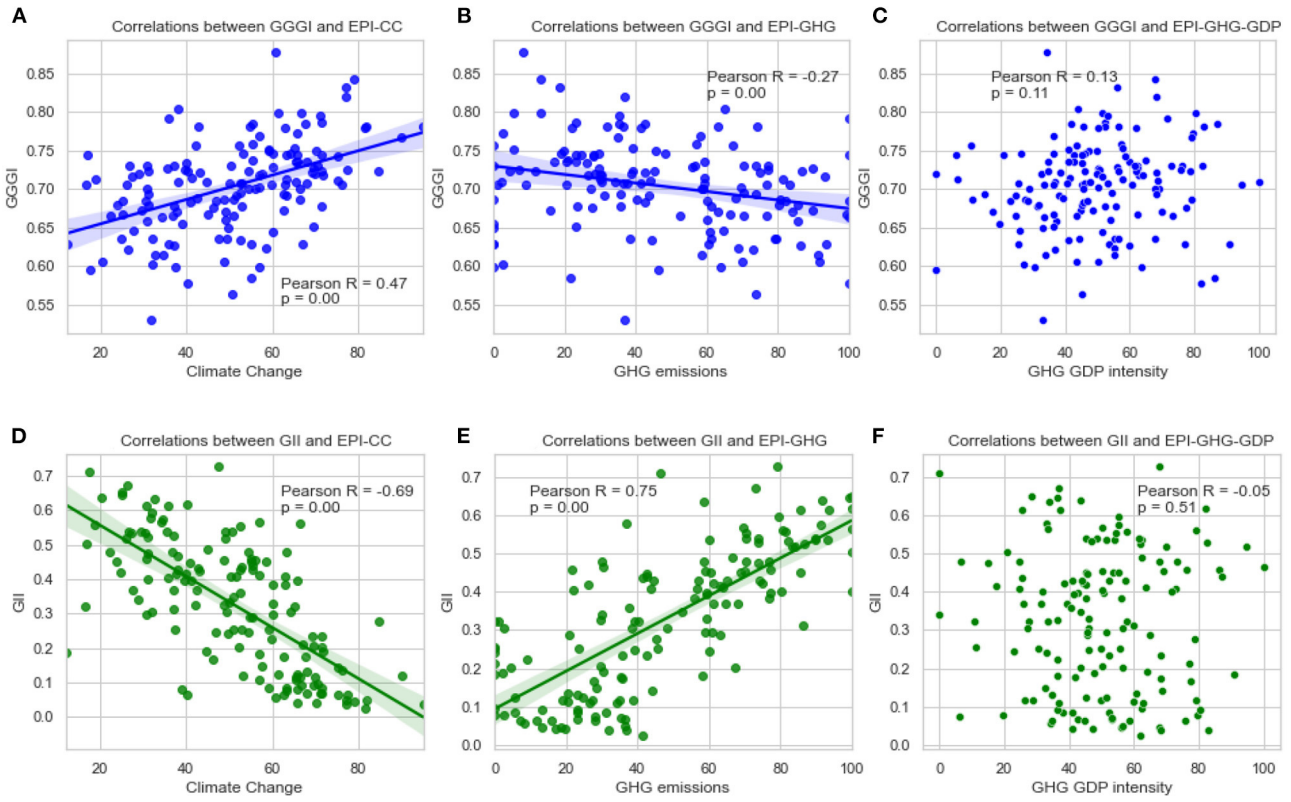

FIGURE 3
(A–C) GGGI (blue) and **(D–F)** GII (green) correlations with **(A, D)** EPI climate change indicator, **(B, E)** GHG emissions per capita, and **(C, F)** GHG GDP intensity sub-indicators.

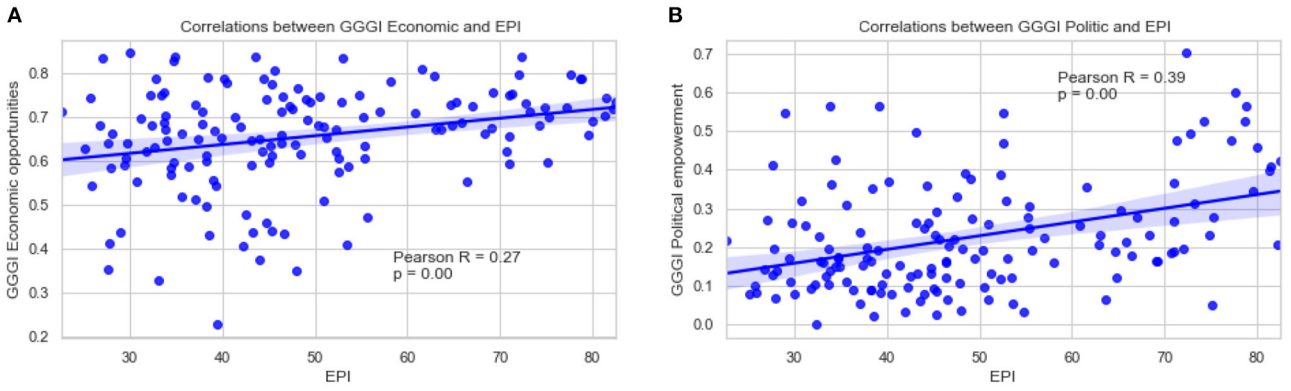

FIGURE 4
(A) Correlation between EPI and the economic opportunities sub-component of the GGGI. **(B)** Correlation between EPI and the political empowerment sub-component of the GGGI.

to understand constructed social phenomena. The generalization of sex-disaggregated data was also discussed by experts to highlight inequalities, deepening the understanding of the links between one's biological sex and position in society, but neglecting other forms of identity.

The difficult balance between breadth and depth when studying gender was also recognized by all interviewees. Producing broad knowledge regarding gender is fundamental to provide policy recommendations based on academic research but without an in-depth understanding of gendered social phenomena at the individual and household level, risks failing to solve the problems addressed. To find the right balance between depth and breadth, the gender component in academic literature needs to be conceptualized appropriately, defining gender and the issue to be addressed clearly. Therefore, the experts agreed that the right tools need to be deployed at the research project design stage.

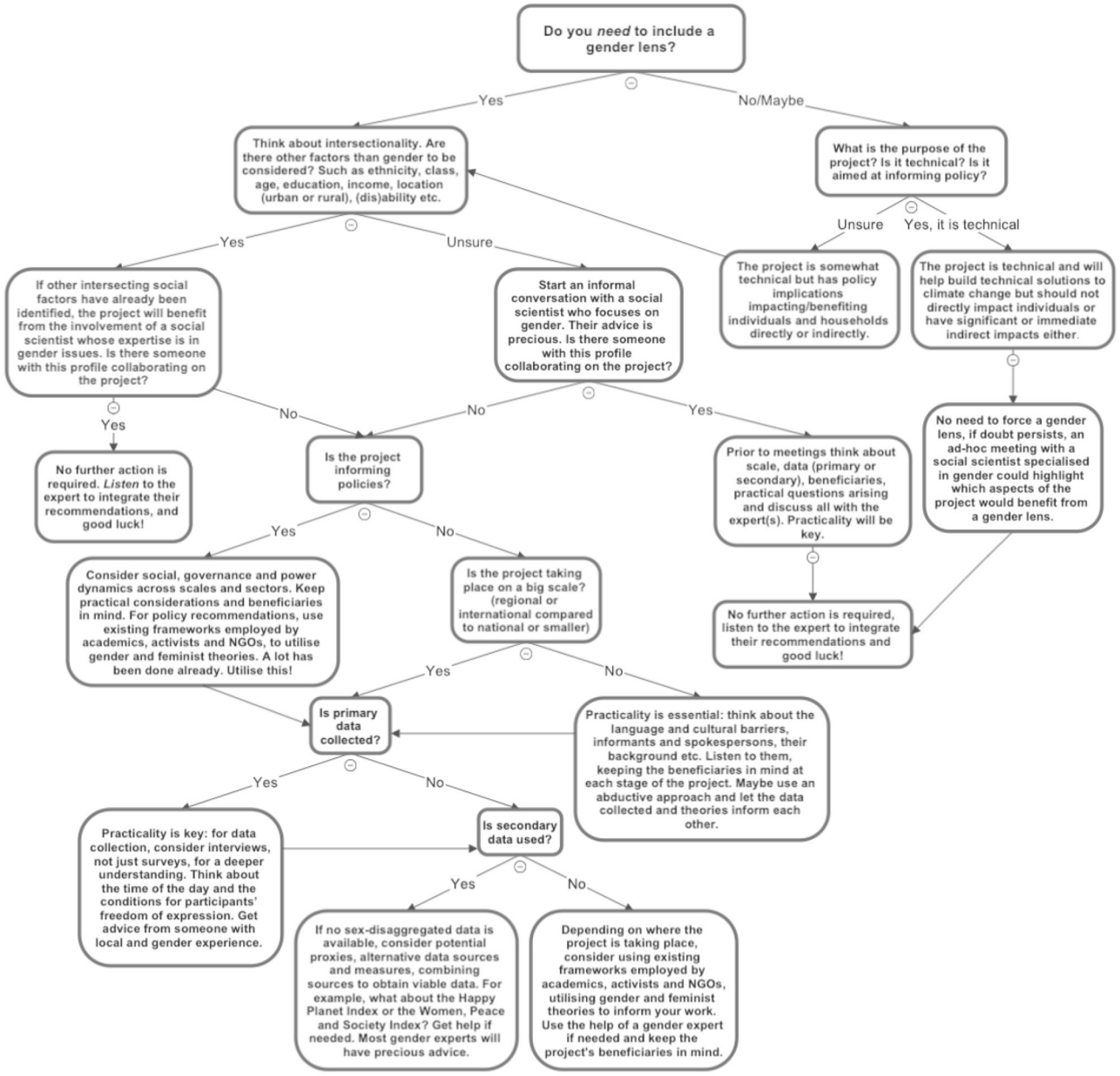

FIGURE 5
Decision tree to inform environmental projects' design seeking to integrate gender.

Finally, all interviewees highlighted that theoretical and practical reflections are central to conceptualization. For example, participants A and D suggested linking contextual research back to existing feminist frameworks to inform policy, for instance the four Rs (recognition, reduction, redistribution, responsibility) (Oxfam, 2008; Butt et al., 2020). Seven participants reflected upon past experiences sharing anecdotes of misaligned research projects' means and objectives. Participant H remembered:

"*I was brainstorming with (…) engineers, they were developing this hydrogen* [stove] *for use in developing countries (…) to reduce wood* [consumption and] *in-home pollution. (…) I said what do women want to cook on it? (…) They had* [not] *asked them! (…) They had a brilliant solution to a technical problem, but it wasn't necessarily the right problem.*"

Methodological issues highlighted by experts are easily overcome with theoretically sound and practical research project design, considering feminist epistemology and more radical gender theory, notably, understanding the intersectional and contextual nature of gender inequalities as well as the centrality of collecting appropriate data. However, as participant A put it: "*with gender (…) you need learning by doing*" and according to participants, since the Beijing platform instituted gender mainstreaming, progress has been made in this regard. Participants noted progress regarding the integration of more radical gender theories, to overcome the "radical potential paradox" (Wittman, 2010, p. 51) brought in by gender mainstreaming. Radical here was defined according to the Latin etymology meaning "roots" (Oxford English Dictionary, 1989), highlighting the necessity of grounding gendered research in gender

theories and feminist epistemology. According to participants, it implied developing interdisciplinary research, including gender at the research project design stage.

Beyond integrating gender for the sound conceptualization of research projects, experts highlighted how interdisciplinary research avoids siloed solutions to a "wicked" issue (Carter, 2018, p. 310) like climate change, allowing for more holistic approaches. Most experts (9/13) criticized Enlightenment thinking and its modern expressions, characterized by the object/subject and nature/culture dualisms fundamentally hierarchizing individuals and knowledge as well as emphasizing technical solutions to problems. Both Enlightenment thinking and its critiques are rooted in Western culture and as such should be recognized as situated, as per Haraway (2020), noting that the prevalence of such critiques here can be explained by the interviewees' knowledge situation. Thus, the promotion of interdisciplinary research is a natural first step, whereby differently situated pieces of knowledge (Haraway, 2020) can converse. Beyond the promotion of interdisciplinary research, acknowledging that available data is inadequate in describing social phenomena and developing alternative measures is another way to avoid reproducing neoliberal narratives inherited from the Enlightenment. This can open the way to integrate narratives other than the dominant western ones. Increasingly, these alternative measures, like the carbon intensity of wellbeing (Jorgenson, 2014; Gough, 2017; Ergas et al., 2021), the Happy Planet Index (2016), or measurements of the 12 social foundations depicted by Raworth (2017) in Doughnut Economics are considered, as they avoid purely economic representation of prosperity.

The recommendations of the experts are summarized in the decision tree in Figure 5, which aims to practically inform the design of environmental research projects seeking to consider gender.

4.2. Implications for policy according to interview analysis

Gender mainstreaming and the increasing interest in gender within climate change science has had policy impacts globally. In the following part we will consider the implications for policy of gender mainstreaming in environmental research through the analysis of experts' interviews. Five intertwined themes arose from the analysis of experts' interviews.

The first of these themes was regarding the deradicalization of gender theories, understood as inevitable by all experts for gender to mainstream. As participant L said: "*It is the way in international treaties,*" as for all countries to ratify a global agreement, what is deemed "extreme" by some is often diluted. Two participants highlighted that it was the case with the Paris Agreement too, during which a lot of debates surrounding women and their role for adaptation and mitigation ended up as: "*maybe one paragraph*" sighed participant H, before adding: "[they have] *taken all the teeth out of the tiger. It might lick you to death, but it's not going to savage you,*" reflecting upon the non-binding nature of international agreements. More recently, the final COP26 agreement in Glasgow disappointed many for similar reasons (UN NEWS, 2021).

The second theme relates to the constant dilution of gender theories within research, which translates into maladaptive policies (Lau et al., 2021). When gender theories are overlooked in research informing policies, assumptions such as women being a homogeneous group can be transcribed into policies, which ignores the role of other social factors, resulting in maladaptive policies that only address part of the issue. The third, Participant D explained, was conceiving gender equality as meaning: "*women's rights (…)* [excluding] *males and masculinities,*" which neglects the voices of others and consideration of gender as a non-binary construct. Women are burdened with even more responsibilities and men and their struggles are ignored.

The fourth theme, in most interviewees' perceptions (11/13), was how this dilution mechanism causing maladaptation triggers the exclusion of certain individuals. Notably, exclusion of poorer individuals' voices, indigenous knowledge, and social justice considerations from climate debates, thus depriving humanity of invaluable knowledge, creativity and understanding of natural dynamics, all necessary to answer the climate emergency. Subsequently, for all experts, the main link between gender equality and climate change mitigation action was how equality opens the way toward social justice, paramount to the organization of sustainable societies. Both participants B and K said: "*climate justice is social justice (…) and there is no social justice without gender justice.*"

Finally, for nearly all participants (11/13), the dilution-maladaptation-exclusion trilemma is an expression of established power dynamics. Paraphrasing Phillips (2017) book, participant H simply said: "*to those in power, equality is a threat.*" Nuancing their ideas, all experts appreciated that gender mainstreaming allowed pushing these issues in the public space: "*opening the way*" explained participant L. Furthermore, five interviewees talked about how the climate emergency was changing international power dynamics, whereby poorer or less developed countries are now the focus of efforts to protect biodiversity, which might illuminate a hopeful trend. However, all experts acknowledged there was still a long way to go, participant B noted: "*women remain the supplicants banging at the door,*" positing policy suggestions to remedy this.

4.3. Recommendations based on interview analysis

The ways forward suggested by experts can be grouped in four themes: listening, learning, radicalizing, and re-politicizing, which all rely on three underlying arguments: morality, practicality, and the logical argument, summarized in a famous quote attributed to Albert Einstein: "*No problem can be solved from the same level of consciousness that created it,*" paraphrased by two experts.

The morality argument relies on the idea that the climate crisis and its related inequalities should be solved simply because it would be immoral not to (Shove, 2010). The practicality argument can be summed by the idea that, because humanity is facing disastrous events, it cannot deprive itself of most of its creativity. Without necessarily mentioning critical ecofeminism, all interviewees implored decision-makers to "listen" (Gaard, 2017, p. xvi). This implied listening to multiple actors, including activists and academics but also citizens, without hierarchizing their contributions using neoliberal preconceptions, overvaluing the opinions of the Western Educated Industrialized Rich and Democratic (the WEIRDs, term used by three participants). However, beyond addressing

decision-makers, experts acknowledged how listening and creating the space for open discussions was a recommendation to be followed by all parties. Differences of opinion need to be overcome to foster creative solutions to the climate emergency. In other words, listening meant creating a space for collaborative and inclusive learning. According to experts, learning was not just increasing each other's knowledge, but also reconsidering situated norms and values by understanding their constructions and acknowledging their lack of universality, better enabling transformation. Listening, then learning could lead to the necessary radicalization and re-politicization of western societies in most (8/13) interviewees' perceptions.

The radicalization advocated by experts was justified by the need for transformational paradigm shifts already outlined by social theorists (Stern and Dietz, 2015; Urry, 2015) and echoed by environmentalists (Anderson and Bows, 2012; O'Brien, 2016; Eizenberg and Jabareen, 2017). Once again, radicalization does not mean extreme, rather it is a call toward integration of alternative societal theoretical conceptions, away from the models which created the current climatic situation, rooting back social norms to end "remoteness" (Plumwood, 2002, p. 73) between humans and nature. This radical movement is inseparable from a re-politicization of neoliberal societies, in which citizens' faith in democratic institutions is restored through the implementation of participatory and deliberative democratic tools to restructure power dynamics. This would foster equality without forcing it upon individuals by laying the ground for equalitarian participation and discussions, creating a virtuous cycle where individuals ultimately listen and learn from each other permanently. These suggestions intrinsically link back to the notion of transformation (O'Brien, 2012) and the need to transcend "*all the -isms*" as participant I put it.

4.4. Integration

To summarize, the links between gender equality and climate change mitigation action are multidimensional and integrated with other power dynamics underlying neoliberal societies. Women have not played the same role as men in creating carbon-intensive systems of production with women's voices only recently included in the debate. This does not mean women would have done differently than their male counterparts, and assuming this essentialises women's relationship to nature and the environment and fails to challenge constructed power dynamics underlying gender norms, ignoring gendered experiences' contextuality. If women had benefited from the same privileges as men, there is no way of knowing if societies would have developed the same carbon-intensive systems of production or not. Assuming they would not have done so is viewing women as inherently closer to nature and the environment, which is an assumption constructed by gendered modern and western worldviews. The ecofeminist literature (Plumwood, 2002; Gaard, 2017) emphasizes how equality is one tool in societies' belt alongside economic and environmental improvements to ensure the planet thrives.

Statistically significant relationships highlighted in the quantitative analysis are revealing of two trends according to experts. First, rather than gender equality positively impacting climate change mitigation action, it is understood that greater equality between a society's members is revealing of society striving for a fairer organization, which is paramount in achieving sustainable societies. Therefore, gender equality is inseparable from social and climate justice. In other words, climate justice depends on social justice and social justice cannot be achieved without bridging gender inequalities among other inequalities. Second, cross-country analysis of available data is subject to caveats and the links between gender equality and climate change mitigation action need to be investigated further through interdisciplinary research, considering radical gender theories, more comprehensive sex-disaggregated data and alternative measures of wealth, prosperity, and affluence, as the climate change emergency is shifting international dynamics.

Gender mainstreaming has exposed the gendered causes and impacts of climate change, but radicalization of the gender-climate nexus literature is needed to overcome the harmful assumptions perpetuated by the dilution of gender theories through mainstreaming. Furthermore, theories' dilution has led to maladaptation inseparable from the exclusion of certain individuals from climate change debates. Overcoming the dilution-maladaptation-exclusion trilemma necessitates emphasizing listening to all parties in policy making, learning from one another and accepting radicalization through societies' re-politicization thanks to inclusive and participatory democratic actions. This could lead to systemic transformations that holistically tackle climate change.

5. Discussion

5.1. Contribution and contextualization

The quantitative analysis undertaken in this study finds similar results to that found in the wider literature (Ergas and York, 2012; Mavisakalyan and Tarverdi, 2019; McGee et al., 2020). All these studies find a statistically significant link between composite indices of gender equality and environmental performances of countries. The similarity in results can be explained by the homogeneity of the data considered. Mavisakalyan and Tarverdi (2019) used the Climate Laws, Institutions and Measures Index, similar in its construction to the EPI, but simpler (Steves et al., 2011; Wendling et al., 2020). Ergas and York (2012) and McGee et al. (2020) used World Bank data sources to measure CO_2 emissions per capita (World Bank, 2010, 2017), which is also accounted for in the EPI (Wendling et al., 2020). Ergas and York (2012) used a women's political status index developed by Nugent and Shandra (2009) and based on the GII and GGGI. McGee et al. (2020) used the GII, and Mavisakalyan and Tarverdi (2019) used World Bank indicators of female seats in parliaments, a sub-indicator of the GGGI Political component.

In contrast to McGee et al. (2020) we find no statistically significant link between GHG intensity of GDP and gender equality. Their study suggested greater institutional gender equality was linked to decoupling CO_2 emissions from economic growth. This could be due to the addition of developing countries in our analysis. The importance of national affluence in the correlation between gender equality and climate action found in this study is comparable to that found by Knight (2019) and Knight and Givens (2021), underlining the contextuality of gendered phenomena (Schwartz and Rubel-Lifschitz, 2009; Chan et al., 2018). Furthermore, consideration of gender mainstreaming in the Paris Agreement, not considered by the aforementioned studies, was integrated in this work through the use of 2020 EPI data (Wendling et al., 2020), and could explain

differences in results. Nevertheless, the Paris Agreement's effects on environmental performances and integration of gender are relative, as pre-Glasgow NDC trajectories would require a further 80% decrease in emission rate to respect the 2°C limit determined by the agreement (Liu and Raftery, 2021). Furthermore, gender within NDCs is predominantly framed using gender-sensitive approaches (Remteng et al., 2021) rather than gender-responsive or gender-transformative approaches (Resurrección et al., 2019).

Enriching the quantitative analysis with evidence gathered through expert dialogue, allowed this research to consider different interpretations of the results. For example, Mavisakalyan and Tarverdi (2019) concluded female parliamentarians made a difference to climate mitigation action, like McGee et al. (2020) and other studies (see Lambrou and Piana, 2006; Cook et al., 2019). In this study, the relationship between women's political empowerment and environmental performances is understood as contextual and dependent upon culturally diverse gendered constructs similarly to Chan et al. (2018) and Knight and Givens (2021), so as to avoid essentializing women's relation to nature, also integrating Lau et al. (2021) findings. Female parliamentarians should not be expected to make a difference, rather political systems allowing gender diverse representation can be expected to support equalitarian social values that are paramount to achieving sustainable societies (Lee and Zusman, 2018). Furthermore, comparing two indices of gender equality, as done in this work, helped to exemplify the relativity of the link between female representation and environmental performances, such that the more complex indicators embedded in the GGGI were more weakly correlated with the EPI. Moreover, the mixed-method approach allowed us to draw upon the experts' methodological insights to create the decision tree (Figure 5) and highlighted the limits of employing positivist epistemological approaches to appraise links between gender equality and climate change mitigation action. The feminist perspective was fundamental in challenging harmful gendered assumptions still present in the literature, and filling a gap, where little consideration is given to feminist theories when studying the gender-climate nexus (Global Gender and Climate Alliance, 2016; Thompson-Hall et al., 2016; Lau et al., 2021).

Recognizing how knowledge is situated (Haraway, 2020) is primordial in environmental research, as different epistemological positions highlight differing solutions to the climate emergency (Rayner, 2012). Here, the feminist epistemology skewed results toward societal and systemic considerations. This paper does not intend to hierarchize and oppose technical or social solutions to the climate urgency, rather, by embracing pragmatism (Rorty, 1982), it is understood that all solutions are complementary and should be considered holistically. However, less attention has been given in the past to social considerations in environmental research (Rayner, 2012; Urry, 2015; O'Brien, 2016), whereas climate change is a "wicked issue" (Carter, 2018, p. 310) and requires drawing upon the expertise of several disciplines. To overcome this, interdisciplinary research that promotes epistemological pluralism was recommended (Miller et al., 2008; Rayner, 2012). Nevertheless, interdisciplinarity in research is subject to established power dynamics (Miller et al., 2008), and is gendered, appealing more to women (Rhoten and Pfirman, 2007). Subsequently, creating an equalitarian space is fundamental to ensure dialogue is maintained in interdisciplinary teams (Miller et al., 2008). Beyond academia, creating egalitarian spaces, where different voices can contribute to the climate debate, can enable systemic transformations (Dow et al., 2013; Pelling et al., 2015; O'Brien, 2016).

5.2. The place for gender equality in transformation

In the context of climate change, the transformation notion, arising from adaptation literature (Moser and Ekstrom, 2010; Dow et al., 2013; O'Brien and Sygna, 2013; O'Brien, 2016) considers rethinking human systems holistically, and challenging the current state of relationships between humans and nature (Pelling et al., 2015). Remarkably, it considers the multi-layered interactions between social and natural systems to offer policy responses that go beyond adapting systems to climatic impacts by transforming them, while at the same time increasing adaptive capacities, limiting future impacts, and enabling sustainable development (O'Brien, 2012; Pelling et al., 2015). Thus, transcending the adaptation/mitigation dualism.

Transformation is by essence radical (Dow et al., 2013; Pelling et al., 2015), addressing root causes of climate change by incrementing non-linear changes, i.e., paradigm shifts. As such, concepts underpinning transformation are shared by post-growth (Koch, 2013; Raworth, 2017), critical ecofeminism (Shiva, 2005; Gaard, 2017) and even quantum social change (O'Brien, 2016) thinkers alike. The common assumptions that encompass this thinking include recognition of neoliberal systems' failure to address climate change (Shiva, 2005; Dow et al., 2013; Gaard, 2017; Koch, 2020), overcoming social contracts inherited from the Enlightenment (Pelling, 2010; O'Brien, 2012; Gaard, 2017) and radicality (Pelling et al., 2015; Gaard, 2017; Raworth, 2017). Therefore, gender equality, as defined here, appears as one paradigm shift, and part of the equation to reshape relationships between humans, among addressing inequalities globally, and to alter existing social contracts (O'Brien et al., 2009). Despite a flourishing literature interested in various forms of transformation (Pelling, 2010; Dow et al., 2013; Harvey, 2013; Tschakert et al., 2013; Pelling et al., 2015; O'Brien, 2016), the concept's visibility in decision making is limited to isolated systems and is potentially undermined, as requiring power redistribution (Pelling et al., 2015).

During the interviews, the experts equally insisted on the transformational power of gender equality, and the lack of progress in this domain. In their recommendations to policymakers, the re-politicization of western societies held a central place in enabling gender equality and the power redistribution necessary to solve the climate emergency. It was understood that changes in the personal realm, through individuals' re-politicization, could enable shifts in power dynamics, and thus, transformation (Pelling et al., 2015; O'Brien, 2018). Over the past 5 years, neoliberal societies have witnessed an increase in demonstrations, illustrating new forms of citizens' political engagement, and a step toward re-politicization (Amnesty International, 2019). Whether within the Fridays4Future youth movement; the Extinction Rebellion actions; indigenous revendications in Brazil and Canada, equality holds a central place between individuals of different genders, ages, races or even across species (Amnesty International, 2019). The newly invented "ecocide" crime, referring to harmful actions toward ecosystems enacted by states or corporations is an illustration of environmental claims penetrating established systems (Siddique, 2021). Similarly, legal actions have been taking place across the globe to address governments' inaction in the face of climate change as "unlawful" (Schiermeier, 2021). Academics and citizens alike are forcing governments to acknowledge neoliberalism's weaknesses, with social and environmental calls converging (Worms and Butler, 2021).

However, despite the COVID-19 pandemic, acknowledged by scientists as caused by environmental harm (Daszak, 2020; Dobson et al., 2020), and numerous catastrophic climatic events riddling the global North (UNFCCC, 2021), NDCs and green-recovery pledges still fall short (Liu and Raftery, 2021; UNFCCC, 2021). Nonetheless, these events might be the necessary crises to disrupt social practices, change personal realms, and enable access to deep leverage points that empower systemic transformation (Meadows, 2008). Establishing these links further requires an in-depth investigation of complex concepts, and constitutes avenues for future research.

5.3. Limitations and future research implications

Firstly, we employed only 2020 index data for the EPI and GII, as these were only available for 2020 despite GGGI data available for 2021, though we did monitor changes over time using 2010 values of these indices. The COVID-19 pandemic and its effects on both gender equality and environmental performances are thus not fully accounted for in the quantitative analysis. The economic crisis that has resulted from the pandemic has had tremendous effects on the gender gap, as it will now take 135 years for women to reach equality compared to the 99 years predicted earlier in the WEF 2020 report (World Economic Forum, 2020a, 2021). Simultaneously, the pandemic has affected countries' environmental performances, with a 7–8% reduction of GHG emissions over 2020 due to global lockdowns and a slowdown of the global economy (Forster et al., 2020; Le Quéré et al., 2020; Liu et al., 2020). While emissions have since rebounded to pre pandemic levels (Davis et al., 2022), beyond the direct effect of lockdown restrictions on GHG emissions, the pandemic brought environmental considerations to the heart of the political debate (UNDP, 2020b). As such, using updated data accounting for COVID-19 effects is an avenue for future research, as is exploring the crisis's potential for enabling transformative changes.

Secondly, understanding the multi-layered relationship between gender equality and environmental performances at different scales necessitates the investigation of currently scattered or unavailable sex-disaggregated data. As recommended by experts, this is an opportunity for future interdisciplinary research. Moreover, it points to the need for new data collection efforts that consider gender as a non-binary construct and goes beyond mere sex-disaggregated data and indicators.

Thirdly, there are limitations associated with the interviews and subsequent findings. All interviews were conducted with English speakers and interviewees were mostly located in the Global North, potentially skewing results toward western viewpoints (Temple and Edwards, 2002; Mason, 2018), though interviewees' research primarily focused on the Global South. As such, future research could draw upon the present findings, enriching them through a larger number of more diverse interviewees. Alternatively, conducting interdisciplinary focus groups, exploring similar themes, would also benefit the gender-climate nexus literature, enabling epistemological pluralism (Miller et al., 2008).

Finally, this project touched upon the complex interactions between different epistemological and ontological perspectives. Exploring further the interactions between ecofeminism, post-growth, post-development, and quantum social changes could unveil synergistic potential in their common underpinning concepts. Furthermore, increasing the visibility of these discourses in the public sphere could enable their self-fulfilling potential, disseminating changes in the personal realm, and initiating transformative actions.

6. Conclusion

This paper presents a mixed-methods approach to assessing the drivers of gender equity and its relationship to environmental performance. The quantitative analysis carried out in this research analyzed country-level regressions between gender equity metrics (the GII and GGGI) and a measure of environmental sustainability, the EPI. The GGGI, composed of a more complex aggregation of indicators (Women's Economic Opportunities and Women Political Empowerment indicators) was found to be more weakly correlated with the EPI, as compared to the GII. This suggests that the relationship (though not necessarily causality) between gender equality and climate change mitigation action is multi-faceted and contextual. This is also reinforced by the income categories analysis, which underlines the role of countries' national affluence in moderating this relationship.

Understanding the links between gender equality and climate change mitigation requires the development of more comprehensive and detailed indices and better data collection efforts. These efforts could focus on the fact that gender is not a binary construct, the lack of sex-disaggregated data, and also recognize alternative measures of wealth and prosperity. Data collection efforts that recognize gender as a non-binary construct are in their infancy, but research on gender equality and climate change action can be informed by efforts in the health realm, where such data is collected and these differences have been analyzed (Cicero et al., 2020). Recognition and construction of alternative measures of wealth and wellbeing are also in their infancy, but include efforts such as those that define decent living standards and access to these across populations (Rao and Min, 2018).

The qualitative analysis carried out in this research revealed the contribution of gender equality toward climate and social justice, explaining how greater gender equality is revealing of fairer societies' organization, paramount to achieving sustainable futures. The critical ecofeminist lens, pragmatic paradigm and mixed-methods approach applied here challenged mainstreamed appraisals of the gender-climate nexus and allowed for deriving methodological recommendations regarding the integration of gender in environmental research projects whilst investigating the impact on policy.

Gender inequality, and other forms of inequalities, were highlighted as inherited from the Enlightenment, and as central issues to solve to overcome the climate crisis, by the qualitative interviews undertaken in this research. Not only are climatic impacts unequally felt, but voices carrying solutions to these impacts are unequally heard, in political debates, but also academia. Moreover, technical solutions still prevail despite recognition of their limitations in holistically tackling the crisis. Listening to these alternative voices is a cornerstone of critical ecofeminism, aligning with other emerging discourses considering transformation, like post-growth movements. Listening means creating egalitarian spaces in which all voices can be heard. In academia, this can be translated into the acceptance of epistemological pluralism embedded in interdisciplinary

research, which can inform policies accordingly. Beyond academia, re-politicization and radicalization of climate debates can enable paradigm shifts, in the political, technical, and personal realms. Therein lies the potential for systemic transformation. Transformation of current systems requires rethinking relationships beyond current hierarchies imposed by neoliberal pre-conceptions. As such, gender equality is no panacea to the climate crisis, as there is no simple remedy to this "wicked issue" (Carter, 2018, p. 310), but it can participate in reshaping relationships. Equality, between genders, but also between classes, ages, races, and species, is fundamental to alter established social contracts to overcome the climate crisis. Promoting equality challenges established power dynamics, and, therefore, can represent a difficult task. However, the pandemic and climate crisis could represent deep leverage points for empowering systemic transformation, but only time will tell.

Data availability statement

The datasets presented in this study can be found in online repositories. The names of the repository/repositories and accession number(s) can be found in the article/Supplementary material.

Ethics statement

Written informed consent was obtained from the individual(s) for the publication of any potentially identifiable images or data included in this article.

Author contributions

MR and CS conceived the work. MR, CS, and SP designed the project and carried out further critical revisions of the manuscript. MR undertook the data collection and analysis with advice from CS and SP. MR drafted the initial version of the manuscript. All authors contributed to the article and approved the submitted version.

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Conflict of interest

The authors declare that the research was conducted in the absence of any commercial or financial relationships that could be construed as a potential conflict of interest.

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Supplementary material

The Supplementary Material for this article can be found online at: https://www.frontiersin.org/articles/10.3389/fclim.2023.946712/full#supplementary-material

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