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Addressing the Digital Gender Gap in Empowering Women for Climate Resilience in Africa

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Abstract

Africa confronts a double jeopardy: it endures significant climate change impacts and suffers from one of the world's widest digital gender gaps. This article argues that closing the digital gender gap is not merely an aspiration but a prerequisite for effective women-led climate resilience across Africa. By analysing case studies from Kenya, Uganda, Rwanda, Ethiopia, and Mozambique, the paper reveals that limited digital access restricts women's involvement in climate decision-making, undermines agricultural adaptation, and limits access to early warning systems and financial resources. It further examines key legal frameworks, including CEDAW, the Maputo Protocol, and the Sustainable Development Goals, which mandate that states and stakeholders promote digital inclusion. Methodologically, this article adopts a doctrinal legal analysis of the international, regional, and domestic instruments bearing on the digital gender gap, combined with a qualitative synthesis of secondary case-study literature, policy reports, and empirical studies drawn from the 5 focus countries. The paper concludes with innovative recommendations for policymakers and the private sector, focusing on leveraging technology to enhance women's digital literacy, creating inclusive digital platforms for climate adaptation, and fostering public-private partnerships to ensure sustainable funding. These strategies aim to integrate digital access into climate-resilience frameworks in a transformative manner, ultimately empowering women as key agents in addressing climate change.

Keywords

Digital gender gap; Climate resilience; Women's empowerment; Africa; ICT; Human rights; SDGs

Introduction

Africa is currently grappling with the unprecedented challenges of climate change, which disproportionately affects vulnerable populations, particularly women (Aguilar, 2008; Osman-Elasha, n.d.). As crucial agents of change, women play a vital role in

addressing climate-related issues, yet they face significant barriers that hinder their full participation in climate decision-making and adaptation efforts (Gender Action, 2008; IUCN, 2004b, 2007; Osman-Elasha, 2008; Third Global Congress of Women in Politics and Governance, 2008). One such barrier is the persistent digital gender gap, which limits women's access to digital technologies, critical information, and climate support networks (IPCC, 2001; IUCN, 2004a), including early warning systems (UN Women, 2023). This gap not only exacerbates existing gender inequalities but also limits women's capacity to build resilience against climate change, participate in climate decision-making processes, and connect with climate support networks and resources (UN Women, 2022).

As the world strives to achieve gender equality and mitigate the impacts of climate change, addressing the digital gender gap in Africa is crucial. Also, technology/ICT use is at the heart of the 17 SDGs, as research has shown that information and communication technology (ICT) could be used to improve food security, promote agricultural sustainability, end poverty and promote inclusive and sustainable economic growth, build resilient infrastructure and foster innovation, etc. (Bogdan-Martin, 2017). The paper argues that bridging the digital gender gap in Africa can unlock women's potential to drive climate resilience and sustainable development. To explore the themes, the paper aims to answer two questions: How does the digital gender gap perpetuate existing gender disparity, and how can gender-inclusive laws and policies bridge this gap in climate resilience approaches/frameworks?

Kenya, Uganda, Rwanda, Ethiopia, and Mozambique were selected as case studies because, together, they illustrate the principal dimensions of the digital gender gap's relationship to climate resilience across the region: established mobile-money-based financial inclusion (Kenya), SMS/IVR-based agricultural extension (Uganda and Ethiopia), sustained state investment in digital infrastructure and STEM education (Rwanda), and community-based digital early warning systems in a high climate-risk setting (Mozambique). This purposive, illustrative sampling, rather than random or representative sampling, allows the analysis to draw out common conditions for success and failure across varied institutional and infrastructural contexts. To answer the above questions, the paper explores the intersection of gender, technology and climate resilience, highlighting the need to empower women through digital inclusion and gender-sensitive initiatives.

This paper treats women as a broad analytical category for reasons of scope; it does not fully disaggregate the digital gender gap by disability, age, rural or urban location, or indigenous status. These intersecting factors materially shape digital access and are acknowledged here as a scope limitation warranting dedicated future research.

The paper is divided into seven parts. The first part introduces the paper by providing an overview of climate change impacts, describing the digital gender gap, and emphasising the importance of addressing both issues concurrently. The second part discusses the digital gender gap, its scope, and disparities in access to digital technologies and explains how it perpetuates existing gender inequalities. The third part discusses the potential of digital technologies to enhance women's climate resilience by leveraging digital access and literacy to increase women's participation in climate decision-making and

adaptation efforts. The fourth part discusses the human rights implications and framework for the gender data gap. The fifth part discusses strategies, legal reforms, and solutions to addressing the digital gender gap. The sixth part discusses successful initiatives to address the digital gender gap and women's climate resilience, as well as their impacts and outcomes. The final section concludes the paper by providing specific recommendations for policymakers, development practitioners, and private-sector actors to address the digital gender gap and empower women to achieve climate resilience.

Methodology

To ensure methodological transparency and rigour, this article employed a systematic literature search and thematic synthesis to examine the intersections of the digital gender gap, climate resilience, and women's empowerment within African contexts. The search strategy utilized targeted keyword combinations including digital gender gap, climate resilience, women's empowerment, Africa, and ICT, across multiple academic databases (Google Scholar, JSTOR, and PubMed), institutional repositories, and organizational reports from entities such as UN Women, the World Bank, and the International Telecommunication Union. Studies were included if they were peer-reviewed, published between 2013 and 2026, geographically focused on Africa, and empirically engaged with the nexus of digital access, climate adaptation, and gendered empowerment; non-peer-reviewed works, studies from non-African settings, and those lacking empirical data were excluded. Following an initial screening of titles and abstracts, selected full texts were reviewed against the inclusion criteria, and a thematic synthesis was subsequently conducted to identify, categorize, and interpret recurrent patterns including legal frameworks, technological interventions, and contextual case studies, thereby illuminating both persistent barriers and strategic opportunities for policy and practice aimed at reducing digital disparities and strengthening women's agency in climate adaptation efforts. This rigorous and transparent methodological framework underpins the study's findings, anchoring them in a robust evidence base.

Digital Gender Gap: A Barrier to Women's Empowerment

This section situates the digital gender gap within its climate-resilience stakes. As the sections that follow show, disparities in digital access directly constrain women's ability to receive climate information, participate in adaptation planning, and access the financial and agricultural tools needed to withstand climate shocks. The barriers mapped below are therefore not merely a general equality concern but a specific constraint on women-led climate resilience.

According to the 2005 UN Women report, the digital gender gap refers to gender differences or disparities in the resources and capabilities needed to access and effectively utilise ICTs within and between countries, regions, sectors, and socio-economic groups (UN Women, 2005). It also refers to the disparity between men and women regarding access to and use of digital technologies such as the Internet, mobile phones, and other digital tools (OECD, 2018). This gap limits women's access to information and opportunities and hinders their empowerment (OECD, 2018). It has also been known to manifest in various ways, such as in terms of access to technology, digital skills, online participation, and representation in tech-related fields (UNESCO Institute

for Statistics, 2023). In quantitative terms, the gap is stark. According to a 2023 World Bank blog, Sub-Saharan Africa has one of the widest gender gaps in mobile internet use globally, with over 190 million women not using mobile internet services, representing a 37% gender gap (GSMA, 2023; Kwakwa, 2023). A survey conducted across 16 countries in Eastern and Southern Africa found equally low levels of internet access via mobile phones by female (48%) and male (50%) respondents. In Kenya, only 10% of women used a mobile phone to get information on products and services compared to 22% of men. In Uganda, only 13% of women use the internet compared to 24% of men (Kwakwa, 2023). UNESCO data further confirm that gender imbalances remain profound in digital skills and STEM careers across the continent (UNESCO Institute for Statistics, 2023).

The consequences of this gap extend well beyond technology itself. Digital technology has fundamentally reshaped how people communicate, inform themselves and relate to each other (Turkle, 2011). It has shaped people's experiences of time (Wajcman, 2015), expanded existing and new forms of political activism (Friedman, 2016), affected governance systems, including how public services are delivered (Eubanks, 2018), and altered production and consumption patterns with far-reaching implications for the world (ILO, 2019). Therefore, women who lack access to digital technologies are disadvantaged across all of these dimensions simultaneously, and that disadvantage is compounded in the context of climate change, where timely information, coordination, and market access can be life-altering.

While it has been noted that women are increasingly seen as more vulnerable than men to the impacts of climate change, mainly because they represent the majority of the world's poor and are proportionally more dependent on natural resources, land and rain-fed agriculture, unequal access to technology has further exacerbated this vulnerability (Kwakwa, 2023). The digital gender gap amplifies this vulnerability by denying women the information tools needed to anticipate, respond to, and recover from climate-related shocks. Addressing this gap, answering the first research question therefore means confronting the structural conditions that produce it: poverty, discriminatory social norms, restricted mobility, lower levels of formal education, and the absence of women in technology design and governance spaces.

Another critical impact of the digital gender gap with regard to climate resilience is climate justice. Climate-resilient projects or infrastructures adopted or provided by a nation should focus on vulnerable populations and bring about equitable solutions; that is, they should bring more benefit than burden to the vulnerable population. For instance, wind, solar, and other clean energy projects must prioritise their benefits to women and children. Similarly, Goal 9 of the Sustainable Development Goals emphasises the need to build resilient infrastructure, promote sustainable industrialisation, and foster innovation. In summary, the digital gender gap is both a symptom and a driver of broader gender inequality. It limits women's access to information and opportunities, hinders their empowerment, and, critically for the purposes of this article, reduces their capacity to build resilience to climate change. The statistics above reveal a stark reality: as women's access to digital technologies remains limited, their ability to contribute to climate resilience is severely undermined. Understanding this connection is essential as

this article explores the potential of digital technologies to empower women in climate adaptation efforts.

Leveraging Digital Technologies for Women's Climate Resilience

This section explains how digital literacy and access can enhance women's participation in climate decision-making and adaptations. It also highlights the importance of gender-sensitive digital literacy programmes and explains the need for inclusive digital infrastructure and access to affordable digital technologies.

Building on the understanding of the digital gender gap, it is evident that enhancing digital literacy among women is pivotal. By equipping women with the necessary skills, their engagement in climate resilience initiatives can be transformed. The COVID-19 pandemic demonstrated the vital need for digital technology in education, businesses, activities, and services. Recent studies have also shown that the digital revolution can bring immense potential to improve social and economic outcomes for women, but, more often than not, women are left behind due to the persistent gap in access to digital technologies between women and men in Africa (Haleem *et al*., 2022). Despite the range of initiatives that have been implemented since the adoption of the Beijing Declaration and Platform for Action and the different constitutional provisions in African countries' constitutions, there remains a lack of coherent policy on promoting the participation of women in the digital revolution (ITU, 2023a).

This optimism, however, requires qualification. Increased digital access also creates new risks for women: gender-based cyberviolence, online harassment, and surveillance are well-documented barriers to women's continued engagement online and can deter participation even after initial access is achieved. Reliance on foreign-owned digital platforms and infrastructure further raises 'digital colonialism' concerns, in which the terms of access, data governance, and platform design are set by external actors rather than the women and communities who use them. A gender-responsive digital inclusion strategy must therefore pair expanded access with online safety protections and support for locally governed digital infrastructure, as discussed further below

Access to Climate Information and Early Warning Systems

In Africa, women face significant challenges in accessing and utilising digital tools to enhance their participation in climate resilience efforts. The digital gender gap exacerbates existing disparities by limiting women's ability to access crucial information and data on climate change, weather patterns, agricultural practices, and disaster preparedness, thereby limiting their capacity to make informed decisions to mitigate the impact of climate- related events (Raj *et al*., n.d.). Weather forecasting and early warning systems are particularly significant: they enable women to prepare for extreme weather events such as floods, droughts, and storms, reducing loss of life, property, and livelihoods (Pham, Thieken and Bubeck, 2024).

Furthermore, the collection, analysis, and dissemination of data related to climate change and its impacts can help researchers, policymakers, and communities make more informed decisions about climate adaptation and mitigation strategies. Citizen-generated

data can complement official data sources and provide valuable insights into local climate impacts and adaptation needs (Bryan *et al*., 2024).

Digital Agriculture Support

In a 2023 International Women's Day statement, the World Food Programme emphasised that bridging the digital gender divide is essential for unleashing women's potential in rural areas (WFP, 2023) and also helping reduce losses in agriculture and livelihoods (FAO, 2001). Although most low-income women in developing countries are primarily employed in agriculture (Mehra and Rojas, 2008), a substantial body of literature demonstrates that men have been the primary adopters and shapers of agricultural technologies, and that agricultural innovations have historically been designed for men's use (Gebre *et al*., 2019). According to the African Development Bank, African women account for up to 52 per cent of the agricultural workforce in Sub-Saharan Africa and perform approximately 50 per cent of farm labour (AfDB, 2015).

This creates a need for digital agricultural support tools such as mobile apps, drones and sensors to provide real-time data on soil quality, crop health and weather conditions to help women farmers make more informed decisions about planting, irrigation and pest control and increase agricultural resilience (AfDB, 2015). Digital technology can potentially improve agricultural resilience by providing access to markets for rural women, aiding financial inclusion and facilitating networking and knowledge sharing (Choruma *et al*., 2024; Kessy, Kampire and Gerald, 2023). Access to information is critical for women to adopt climate-smart agricultural practices. Digital platforms have the potential to connect women farmers to markets, allowing them to sell their produce at a competitive price and access a broader customer base (Vermeltfoort, 2018). This can improve their economic resilience and reduce dependency on local markets. They can also facilitate networking, crowdsourcing and knowledge sharing among women in rural communities, enabling them to learn from each other's experiences, share best practices and collaborate on climate resilience initiatives (Vermeltfoort, 2018).

Financial Inclusion

The digital gender gap hinders women's empowerment, economic opportunities and decision-making power in climate-related activities, ultimately impeding sustainable development and resilience in the face of environmental challenges (G20 GPFI, 2020). Therefore, addressing this gap can enable women to access financial services, savings products, credit, and insurance, all of which help them recover from climate-related shocks and invest in climate-resilient agricultural practices (G20 GPFI, 2020). According to the World Food Programme, bridging the digital gender divide is essential for unleashing women's productive potential in rural areas and reducing losses in agriculture and livelihoods (WFP, 2023).

Data Research and Smart Infrastructure

Beyond immediate household-level benefits, digital technologies enable the collection, analysis, and dissemination of climate data that can help researchers, policymakers, and communities make more informed decisions about climate adaptation and mitigation.

Citizen-generated data can complement official data sources and provide valuable insights into local climate impacts and adaptation needs. There is also emerging evidence that Internet of Things (IoT) devices and smart sensors can be integrated into infrastructure systems to improve their resilience to climate-related hazards: for example, smart grids that optimise energy distribution during extreme weather. Although digital technologies can provide new opportunities for women's empowerment, technology alone cannot address the systemic problems driving the digital gender divide (ICRW, 2010). Policy must prioritise concrete policy actions fostering women and girls' full participation and inclusion in the digital revolution while at the same time addressing ingrained stereotypes, practices and norms that lead to discrimination and even violence against women (Hilbert, 2011). There is no one solution to closing the gender digital divide. Gender inequality stems from multiple intersecting economic, social, political and cultural barriers, and remedies must be grounded in evidence about which barriers exist across different contexts. Therefore, national digital strategies must actively aim to close the gender digital access, adoption and usage gaps and improve the affordability of digital technologies while enhancing online safety. The national digital strategies should include targets (both numbers and dates) for closing the digital gender divide across at least four dimensions, namely, extend networks and digital access (e.g. through satellite) to rural areas to promote access to and affordability and use of connected digital devices (e.g. smartphones, tablets, laptops), especially for low-income individuals and increase online safety (Squicciarini, 2018).

In summary, bridging the digital gender gap is essential for empowering women for climate resilience in Africa by improving access to information, building capacity, fostering networking and collaboration, creating economic opportunities, and enhancing advocacy and policy influence. By investing in digital skills and connectivity for women, stakeholders can support their active participation in climate resilience efforts and contribute to more sustainable and inclusive development in the region.

Human Rights Implications of the Digital Gender Gap and Legal Framework

The digital gender gap in Africa poses significant human rights challenges, affecting various aspects of women's social, economic, and political lives (UN Women, 2023). Addressing it is not merely a policy choice but a legal obligation arising from a robust architecture of international, regional, and national instruments.

International Instrument

The Universal Declaration of Human Rights (UDHR) of 1948 establishes equality and non-discrimination as foundational principles (Articles 1 and 2), while Article 19 guarantees the right to freedom of expression, which encompasses the right to seek, receive, and impart information, which is a right increasingly exercised through digital platforms (UN General Assembly, 1948). The Convention on the Elimination of All Forms of Discrimination Against Women (CEDAW) requires State Parties to eliminate discrimination against women in all areas, including education and access to information (Articles 1 and 2). Similarly, the CEDAW Committee has specifically recognised the importance of technology for women's empowerment, and the CSW67 Agreed

Conclusions of March 2023 call on states to promote gender-responsive digital policies (CEDAW, 1979; CSW67, 2023).

The International Covenant on Civil and Political Rights (ICCPR) ensures the equal right of men and women to enjoy civil and political rights (Article 3) and protects freedom of expression, including digital communication (Article 19). The International Covenant on Economic, Social and Cultural Rights (ICESCR) mandates that states ensure the rights in the Covenant are exercised without discrimination (Article 2(2)) and recognises the right to participate in cultural life, which is increasingly digital in character (Article 15) (ICCPR, 1966; ICESCR, 1966).

Regional Instruments

At the regional level, Article 18 of the African Charter on Human and Peoples' Rights emphasises the need to eliminate discrimination against women and promote their rights. The African Union's Agenda 2063 includes goals for gender equality and women's empowerment, explicitly recognising the importance of technology as an enabler of development. Most specifically, Article 12 of the Maputo Protocol emphasises women's rights of access to training and resources, particularly in science and technology (Maputo Protocol, 2003). This provision underscores the necessity of addressing barriers that women face in accessing digital education and resources. By promoting education in science and technology and integrating gender sensitization into curricula, this framework directly targets the systemic issues contributing to the digital gender gap, advocating for equal opportunities that empower women to participate fully in the digital economy.

Development Goals and Commission Targets

Sustainable Development Goal (SDG) 5 mandates gender equality and the empowerment of all women and girls, including through the enhancement of the use of enabling technology. SDG 9 calls for inclusive and sustainable industrialisation and innovation, with gender considerations embedded across its targets. UN Women and the Broadband Commission for Sustainable Development's Target 7 aims to achieve gender equality across all broadband targets by 2025, including eliminating gender disparities in broadband policy, affordability, and online access (Broadband Commission for Sustainable Development, 2018, 2023).

It is important to distinguish the binding force of these instruments. CEDAW, the ICCPR, and the ICESCR are binding treaty law for ratifying states, whereas the SDGs and the African Union's Agenda 2063 are soft-law, political commitments that create no directly enforceable obligation. The binding force of CEDAW and the Maputo Protocol is, moreover, qualified in practice: not all African states have ratified the Maputo Protocol, and a number of CEDAW ratifications carry reservations that limit the Convention's domestic effect. Enforcement also varies: CEDAW obligations are principally operationalised through periodic state reporting to the CEDAW Committee, while Maputo Protocol violations may be raised through the African Commission on Human and Peoples' Rights' complaints procedure, both of which depend on state cooperation and civil-society monitoring for real-world effect.

Taken together, these frameworks establish clear legal obligations. States must take active steps through legislation, regulation, investment, and programming to close the digital gender gap. The urgency cannot be overstated: the gap is simultaneously an obstacle to the realisation of existing human rights and a barrier to achieving the SDGs. Failure to act perpetuates cycles of poverty and inequality, reinforces discriminatory gender roles, restricts economic agency, and limits women's ability to engage fully in the public and political life guaranteed to them under international law. Increasing evidence demonstrates that the gap in digital access impedes women's educational opportunities and perpetuates cycles of poverty and inequality, reinforces traditional gender roles and stereotypes, limits women's agency and perpetuates systemic discrimination, which is contrary to principles of equality and non-discrimination. Also, it hinders their ability to participate fully in society and restricts their ability to engage in e-commerce and online entrepreneurship, thereby infringing on their economic rights and potential for financial independence. Therefore, the urgency in addressing the digital gender gap cannot be overemphasised, as it is an enabler for the Sustainable Development Goals.

Strategies and Legal Reforms for Closing the Digital Gender Gap

Recognising the human rights implications of the digital gender gap underscores the urgency of addressing this issue. Therefore, the following strategies are essential for promoting gender-responsive digital inclusion and ensuring women's full participation in climate resilience. There is no single solution to closing the digital gender gap. Gender inequality stems from multiple intersecting economic, social, political, and cultural barriers, and remedies must be grounded in context-sensitive evidence. The following strategies represent an integrated set of interventions that, taken together, can materially advance women's digital inclusion and thus their climate resilience.

Gender-Responsive National Digital Strategies

Governments across Africa must design and implement national digital strategies that actively target the gender gap. Such strategies should include time-bound, measurable targets for closing disparities in digital access, adoption, and use across at least four dimensions (Squicciarini, 2018). First, networks and digital infrastructure should be extended, including through satellite and community networks to rural areas where women are most concentrated and most underserved (A4AI, 2020). Second, the affordability and availability of digital devices (smartphones, tablets, laptops) must be improved, particularly for low-income individuals and households headed by women (UNCTAD, 2021). Third, mobile money and e-banking services should be expanded and promoted specifically to women and other disadvantaged groups as a gateway to financial inclusion (G20 GPFI, 2020). Fourth, online safety frameworks, including legal protections against gender-based cyberviolence, data privacy rights, and digital literacy on safe use, must be strengthened (ITU, 2023a).

Gender-Sensitive Digital Literacy Programmes

Improving digital access without simultaneously building digital literacy will not achieve meaningful inclusion. Gender-sensitive digital literacy programmes should be

integrated into national education curricula at primary and secondary levels, and delivered through non-formal channels — community centres, agricultural extension services, health clinics — for adult women who have not had the benefit of formal schooling (UNESCO, 2017). Programmes should go beyond basic computing skills to encompass climate-relevant applications: how to access and interpret weather data, how to use agricultural market platforms, and how to utilise digital financial services. Rwanda's experience of investing in girls' STEM education and establishing ICT integration across the school system provides a replicable model for other African states (Witaba, 2022).

Integrating Gender into National Climate Frameworks

Climate policy frameworks, including Nationally Determined Contributions (NDCs) under the Paris Agreement, should explicitly integrate digital access as a gender-responsive climate adaptation strategy (Paris Agreement, 2015). The Intergovernmental Panel on Climate Change's Sixth Assessment Report confirms that gender-responsive adaptation is among the most effective levers for building resilient food systems and communities (IPCC, 2022). National Adaptation Plans (NAPs) should incorporate digital literacy and connectivity targets for women, with dedicated budget lines and implementation monitoring (UNFCCC, 2012). The NDC Partnership provides practical guidance for integrating gender into NDC design, which States can adapt to include digital inclusion commitments (NDC Partnership, 2021).

Private Sector Engagement

Private-sector actors, including telecommunications companies, device manufacturers, financial service providers, and digital platform operators, have both a commercial interest and a responsibility to close the gender gap. Companies operating in Africa should be encouraged, through regulatory incentives and voluntary commitments such as the UN Women's Empowerment Principles, to offer gender-disaggregated products and pricing, invest in last-mile infrastructure, and design services that meet the specific needs of women in rural and peri-urban areas (ITU, 2022; UN Women and UN Global Compact, 2010).

Case Studies/Findings: Initiatives Addressing the Digital Gender Gap and Women's Climate Resilience

The following case studies illustrate how digital interventions, when designed with gender intentionality, can materially advance women's climate resilience. They also reveal the conditions under which such programmes succeed or fall short. As noted in the Introduction, these five cases were selected for the range of digital interventions they illustrate, such as financial inclusion, agricultural extension, STEM and digital-literacy investment, early warning systems, and market platforms, rather than as a statistically representative sample of African digital-inclusion initiatives; they are illustrative rather than exhaustive.

Kenya: M-Pesa and Women Smallholder Farmers

Kenya's M-Pesa mobile money platform, launched in 2007, has become one of the most studied examples of digital financial inclusion in the Global South. For women smallholder farmers, M-Pesa has transformed access to input finance, insurance, and market payments (Kannan, 2024). Digital weather-indexed crop insurance products linked to mobile money accounts have enabled women farmers in drought-prone counties to purchase insurance that pays out automatically when rainfall falls below a threshold, reducing their vulnerability to climate-related production shocks (Muhammad, 2024). The key success factor was interoperability: because M-Pesa operated across networks and required only a basic mobile phone, it was accessible to women who could not afford smartphones. The lesson for climate resilience programming is that digital financial inclusion initiatives must prioritise accessibility over sophistication.

Uganda and Ethiopia: Digital Agricultural Extension Services

Across Uganda and Ethiopia, FAO and partner organisations have piloted digital agricultural extension services that deliver climate-smart farming advice directly to women farmers via SMS and interactive voice response (IVR) in local languages. Because women in rural Uganda and Ethiopia often have lower literacy rates than men, voice-based delivery is particularly important (FAO, 2022). Platforms such as Esoko (operational in multiple African countries) aggregate market price data, weather forecasts, and agronomic advice, enabling women to make informed decisions about planting, pest management, and when and where to sell their produce (Tsan *et al*., 2019).

Rwanda: Digital Inclusion and Gender-Responsive STEM

Rwanda's sustained investment in ICT infrastructure, combined with targeted programmes to increase girls' participation in STEM education, has produced measurable results. The government's Smart Rwanda Master Plan and associated digital economy strategy established national ICT hubs, reduced the cost of broadband access, and introduced computer literacy as a compulsory subject. Dedicated programmes to mentor girls in technology, including partnerships with the private sector, have increased the share of women in Rwanda's growing tech sector (Witaba, 2022). In the climate context, Rwandan women farmers with greater digital literacy have shown higher rates of adoption of digital advisory services for climate-smart agriculture, illustrating the compounding benefits of long-term investment in women's digital capabilities.

Mozambique: Digital Early Warning Systems and Cyclone Preparedness

Mozambique is among the African countries most severely affected by cyclones and floods. Following Cyclone Idai in 2019, INGC (the national disaster management agency) and UNDP piloted community-based early warning systems that used SMS alerts, radio, and a community volunteer network to disseminate weather warnings to remote villages. The INGC/UNDP post-pilot programme review found that women who received timely digital alerts were significantly more likely to evacuate early and to organise their families and neighbours to do so (INGC Mozambique and UNDP, 2020).

However, the initiative also revealed a critical gap: women with feature phones received alerts, but women without any phone, disproportionately the poorest and most isolated, did not. This underscores the imperative of universal connectivity as the foundation of climate resilience (UNDRR, 2021).

Sub-Saharan Africa: Digital Market Platforms and Women's Economic Resilience

Across sub-Saharan Africa, digital marketplace platforms, linking producers directly to urban buyers and export markets, have shown particular promise for women traders and farmers. Platforms designed specifically for smallholder farmers, operating in local languages and requiring only feature phones, have enabled women to diversify their markets, secure better prices, and reduce dependence on male intermediaries (Simons, 2021). Economic resilience is climate resilience: women who have diversified income streams and savings are better able to absorb the losses caused by droughts, floods, or pest infestations without making distress sales or withdrawing children from school (G20 GPFI, 2020).

Taken together, these case studies support three cross-cutting conclusions. First, digital interventions are most effective when designed with the participation of the women they aim to serve, and when they take into account literacy levels, language, and device access. Second, digital inclusion and climate resilience are mutually reinforcing: investments in women's digital access produce dividends across agricultural productivity, financial security, and disaster preparedness. Third, no single intervention is sufficient; effective programming requires a combination of infrastructure, literacy, content, safety, and financial inclusion components working together. The insights gained from these case studies not only highlight successful interventions but also illustrate the broader implications for policy and practice. These examples demonstrate that closing the digital gender gap is crucial for empowering women in climate resilience efforts.

Conclusion and Recommendations

This article does not suggest that closing the digital gender gap is universally sufficient, but rather that the evidence reviewed indicates it may be a necessary precondition more than a mere aspiration for advancing women-led climate resilience in the African settings under consideration. The digital gender gap perpetuates existing gender disparities, the answer to the first research question, by denying women timely climate information, agricultural market access, financial services, and the ability to participate in climate decision-making processes. Gender-inclusive laws and policies can bridge this gap by embedding digital access and literacy commitments into NDCs, national digital strategies, development plans, and the legal frameworks governing telecommunications, land rights, and financial services (UN Secretary-General, 2021).

The human rights architecture reviewed in Section 4 leaves no doubt that States bear binding obligations to act. CEDAW, the Maputo Protocol, the SDGs, and the African Union's Agenda 2063 collectively demand gender-responsive digital policies with measurable outcomes. The case studies in Section 6 confirm that, when digital interventions are designed with intentionality and implemented at scale, they deliver real

benefits for women's climate resilience. The task now is to move from isolated pilots to systemic change.

Recommendations for Policymakers

Governments should enact national digital strategies with explicit, time-bound gender equity targets, aligned with their NDC commitments and NAPs, specifying how digital access will be extended to women in rural and peri-urban areas (UNFCCC, 2012). This recommendation responds directly to a gap identified in Section 6.4: Mozambique's post-Cyclone Idai early warning pilot reached women who owned even a basic feature phone, but not the poorest and most isolated women who owned no phone at all. National digital strategies should therefore treat universal device access, not merely network coverage, as a distinct, measurable target, since network extension alone does not reach women without a device to receive such services. Legal and regulatory frameworks should be reformed to eliminate discriminatory provisions, including those on property ownership, financial account access, and identification, that prevent women from accessing digital devices and services.

Gender-disaggregated data on digital access and use should be collected, published, and used to track progress. Without data, accountability is impossible (ITU, 2023b). Digital literacy for climate resilience should be integrated into agricultural extension services, health systems, and community programmes, ensuring that delivery mechanisms are accessible to women with low literacy and no prior technology experience.

Recommendations for Development Organizations

Development practitioners should require gender-responsive digital design as a standard component of all climate-resilience programming, including minimum criteria for women's participation in programme design, gender-disaggregated monitoring, and investment in women's digital literacy alongside technology deployment. Funding should be directed to close the "last-mile" connectivity gap, prioritising community-level infrastructure in rural areas and ensuring that funding structures incentivise the inclusion of the most marginalised women, those without any phone or without reliable electricity (GSMA, 2020). The evidence base should be strengthened through investment in longitudinal research on the relationship between women's digital access and climate adaptation outcomes, filling critical knowledge gaps that currently limit programme design.

Recommendations for the Private Sector

Telecommunications companies should commit to gender parity targets in mobile internet access and develop affordable data packages, device payment schemes, and locally relevant content designed to serve women users (UN Women and UN Global Compact, 2010). Technology and platform companies should invest in locally-owned and locally-operated digital solutions developed in African languages, adapted to low-bandwidth environments and designed to address the specific climate resilience needs of women farmers, traders, and community leaders.

Financial service providers should expand women's access to digital financial products including weather-indexed insurance, mobile savings, and credit that build economic resilience to climate shocks and reduce vulnerability in the aftermath of disasters. The digital revolution and the climate crisis are the defining challenges of the twenty-first century. African women stand at their intersection, bearing disproportionate burdens from both. Closing the digital gender gap will not solve climate change, but it is a necessary condition for empowering the women who have the knowledge, the will, and the right to lead Africa's climate resilience efforts. The legal frameworks, development evidence, and practical models are all available. What is required now is political will, sustained investment, and gender-transformative design.

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