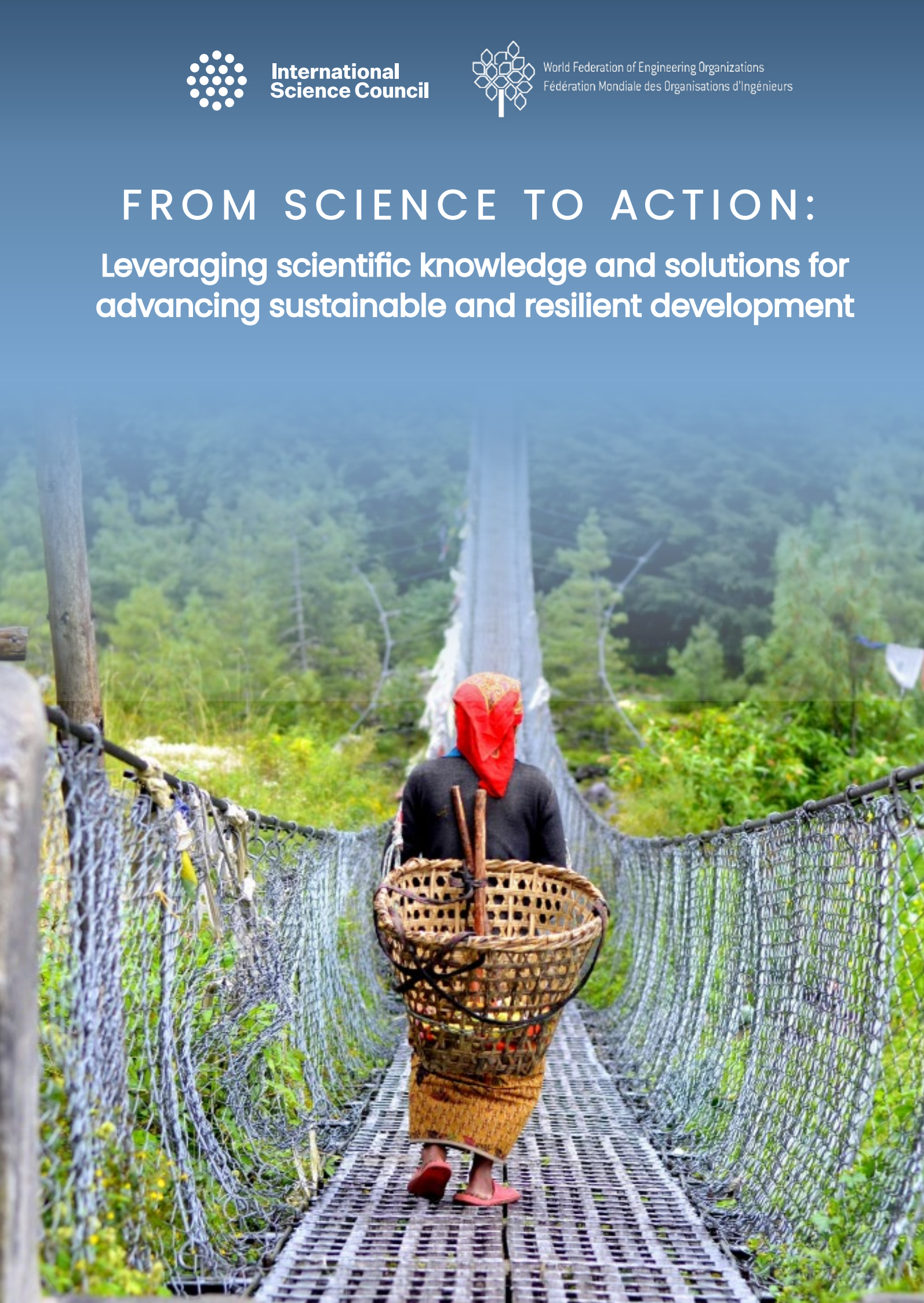
International Science Council

World Federation of Engineering Organizations
Fédération Mondiale des Organisations d'Ingénieurs

FROM SCIENCE TO ACTION:

Leveraging scientific knowledge and solutions for advancing sustainable and resilient development



This paper is published by the International Science Council (ISC) and the World Federation of Engineering Organizations (WFEO) as co-ordinators of the Scientific and Technological Community Major Group for the 2024 High-level Political Forum.

To cite this report:

Title: From science to action: Leveraging scientific knowledge and solutions for advancing sustainable and resilient development

URL: https://council.science/publications/from-science-to-action-hlpf2024/

Publisher: International Science Council

Publication date: July 2024

DOI: 10.24948/2024.09

Lead coordinator: Anda Popovici (ISC)

Authors: Mamoona Alam (Shaheed Benazir Bhutto Women University Peshawar and Organization for Women in Science for the Developing World); César Martín Agurto Castillo (Universidad Nacional de Piura); Rui Dang (Ala-Too International University and International Society for Ecological Economics); Sibel Eker (International Institute for Applied Systems Analysis); Kafayat Fakoya (Asian Fisheries Society and Organization for Women in Science for the Developing World); Alessia Falsarone (University of Chicago) Cynthia Ibeto (University of Nigeria Nsukka and Nigerian Young Academy); Michael Kuhn (International Institute for Applied Systems Analysis); Qi Liu (International Institute for Applied Systems Analysis); Susan Momanyi (Kisii University); Michelle Mycoo (The University of the West Indies); Claudia Reiter (International Institute for Applied Systems Analysis); Bukola Salami (University of Calgary and Social Sciences and Humanities Research Council of Canada); Yoko Shimpuku (Hiroshima University and Science Council of Japan); Luuk van Kempen (Radboud University); Fabian Wagner (International Institute for Applied Systems Analysis).

Contributors: Anne-Sophie Stevance (ISC), William Kelly and K. N. Gunalan (WFEO)

About the International Science Council

The International Science Council (ISC) works at the global level to catalyse and convene scientific expertise, advice and influence on issues of major concern to both science and society.

The ISC is a non-governmental organization with a unique global membership that brings together more than 250 international scientific unions and associations, national and regional scientific organizations including academies and research councils, international federations and societies, and young academies and associations.

About the World Federation of Engineering Organizations

The World Federation of Engineering Organizations (WFEO) is the international organization for the engineering profession. Founded in 1968, under the auspices of UNESCO, WFEO brings together national engineering institutions from some 100 nations and represents more than 30 million engineers.

Cover Image: Laurentiu Morariu on unsplash.com

Design: Sarah Clausen

Contents

Foreword

The International Science Council (ISC) and the World Federation of Engineering Organizations (WFEO) are co-organizing partners of the Scientific and Technological Community Major Group at the United Nations. In this role, we secure a mandate for science and technology at the UN and integrate these fields in major global policy processes, such as the implementation and monitoring of the 2030 Agenda.

During the High-Level Political Forums, the Major Group submits a statement on behalf of the S&T Community, consistently emphasizing that Member States underutilize the power of the scientific and engineering community as crucial and credible contributors in finding and implementing actionable pathways for realizing the Sustainable Development Goals (SDGs).

This year is different.

We see a step change in the way Member States are responding to our collective call for action on the SDGs with science- and technology-focused solutions. We are buoyed by the recent renewal of the UN Secretary General's Science Advisory Board and the exciting prospects the Group of Friends on Science for Action will bring to the global policy process.

But it's not enough.

In this paper, we outline once again, that the SDGs are off track with the goals of ending extreme poverty, ensuring food security, and addressing climate change and biodiversity loss remaining our biggest challenges. Without accelerated action, prolonged polycrises loom.

We address five key themes that detail policy interventions, transformative pathways and science- and technology-driven strategies to accelerate progress across multiple SDGs, supported by case studies demonstrating 'science and technology in action'.

These themes include:

- Integrating global agendas for a sustainable and resilient future
- Harnessing technology and innovation for equitable SDG implementation
- Leveraging science and technology for evidence-based tools for accelerated SDG progress
- Collaborative and interdisciplinary approaches for integrated SDG implementation
- Building capacity and mentorship for SDGs through science and innovation

Our case studies show that the scientific and technological community is ready to work with policy-makers, local communities, Indigenous peoples and other relevant stakeholders to co-design and co-implement context-specific solutions that take into account cultural values and local needs to step up SDG implementation. We are mobilizing to identify solutions with a sense of urgency, shifting the narrative from merely identifying problems to implementing action.

Through our case studies, we take you on an SDG acceleration journey, highlighting women in STEM initiatives in Pakistan, mentoring programs for Black youth in Canada to improve social and economic outcomes, digital innovations enhancing maternal health and childbirth outcomes in Tanzania, and circular economy strategies in the textile industry in Bangladesh. We explore the transformation of education through technology and its impact on equity and access in Perú, as well as how transdisciplinary science-based actions have strengthened the socio-economic resilience of communities in Kyrgyzstan.

This paper, submitted to the 2024 HLPF, continues previous appeals to policy-makers and global leaders to take urgent action by leveraging and integrating scientific knowledge, and rethinking and reorienting technology and innovation, in implementing and achieving the 2030 Sustainable Agenda. As always, the scientific and technological community stands ready to collaborate with Member States across all sectors and disciplines to accelerate progress on the SDGs.

We take this moment to acknowledge the many scientists, engineers, and citizens behind the case studies shared in this paper. They are exceptional people contributing to extraordinary outcomes in their communities. These success stories can, should, and must be scaled up to leverage scientific knowledge for sustainable and resilient development. They offer valuable lessons that can benefit others, and the HLPF should provide a platform to share and learn from these experiences. They represent hope and confidence that together we can make significant strides in achieving the SDGs.

Salvatore Aricò
Chief Executive Officer
International Science Council

Jacques De Mereuil
Executive Director
World Federation of Engineering Organizations

Introduction

The window for achieving the Sustainable Development Goals (SDGs) by 2030 is rapidly narrowing, revealing a concerning lack of progress on individual SDGs. A recent stocktaking report indicated that 88 percent of the 169 SDG targets are off track and 30 percent indicate a reversal in progress (United Nations, 2023) with targets aimed at ending extreme poverty, ensuring food security and addressing climate change deteriorating amid recent shocks from pandemics, conflicts and economic crises. Without a reversal of current trends and accelerated action, prolonged periods of crisis loom ahead.

Leveraging scientific insights, particularly through interdisciplinary and transdisciplinary approaches, is critical for addressing complex global challenges such as climate change, biodiversity loss and socio-economic inequalities. Better integrating science and technology into sustainable development strategies has the potential to enhance decision-making and drive innovative solutions, ensuring that progress towards the SDGs is both effective and equitable. This necessitates strengthening science–policy–society interfaces across all levels, enabling policy-makers and stakeholders to access and apply the latest scientific knowledge effectively. Governments must take concrete steps to enhance capacities in knowledge generation, synthesis, evidence collection and the translation of scientific findings into actionable policies and on-the-ground solutions. Establishing robust connections between science, policy communities and local communities through inclusive and deliberative engagement is crucial to fostering trust in scientific approaches.

Aligned with the focus of the 2024 High-Level Political Forum on Sustainable Development, this position paper brings together the latest scientific evidence and thinking from the scientific, engineering and technological community, highlighting policy-relevant and evidence-based insights to accelerate SDG progress. It provides concise, science-based key messages on SDG implementation, outlining policy interventions, transformation pathways and science-driven strategies to accelerate progress towards across several SDGs. The paper is structured in five key themes supported by case studies demonstrating ‘science in action’. They illustrate how scientific approaches inform decision-making and drive effective SDG implementation within diverse contexts, emphasizing synergies and trade-offs across multiple goals.

Key messages:

1 The SDGs are integral to other global agendas, including the Paris Agreement, the Kunming-Montreal Global Biodiversity Framework and the Sendai Framework for Disaster Risk Reduction. Integrated approaches to addressing climate change, biodiversity loss and achieving a sustainable, equitable future can create positive, synergistic impacts and avoid unintended negative consequences. Implementing these agendas requires sustainable investment and cohesive roadmaps through 2050 to scale up impactful interventions.

2 Rethinking and reorienting technology and innovation are crucial for effectively implementing the 2030 Agenda. Science plays a key role in assessing the ethical and societal implications of technologies, informing policies to reduce inequality and ensuring fair innovation and justice in achieving global development objectives.

3 Urgent action is needed to better leverage and integrate scientific knowledge from both natural and social sciences to guide key transformation pathways and measure progress for accelerated SDG achievement. Successful SDG implementation depends on evidence-based, context-specific prioritization that considers SDG synergies and trade-offs, including negative spillovers across countries, regions and sectors. Efforts should therefore equally focus on using scientific knowledge to develop tools and integrated solutions that address complex, interconnected challenges for accelerated SDG implementation.

4 Effective SDG implementation relies on sustained collaboration across disciplines, sectors and stakeholders to develop context-specific solutions for a safer, more just and sustainable future. Integrating insights from natural sciences, social sciences, humanities, engineering, Indigenous, local and practitioner knowledge is essential for addressing complex sustainability challenges. Participatory and multistakeholder approaches are crucial to ensure initiatives align with local needs and values, enhancing feasibility, equity and cultural acceptability, with broad positive impacts across various sectors and stakeholders.

5 Achieving SDGs and strategic transformations requires enhancing capacities at individual, institutional and network levels. This includes training scientists, promoting scientific literacy and improving science education. Global and national strategies for capacity building are essential to link science and technology with economic growth and human wellbeing, enhance decision-making, address the underrepresentation of women in science, technology, engineering and mathematics (STEM) fields to harness diverse talent to tackle global challenges.

Key theme 1:

Integrating global agendas for a sustainable and resilient future

The SDGs, as an indivisible agenda, are integral to other global agendas, including the Paris Agreement on Climate Change, the Kunming-Montreal Global Biodiversity Framework and the Sendai Framework for Disaster Risk Reduction, among others. Integrated and consistent approaches to deal with the challenges posed by climate change, biodiversity loss and achieving a sustainable, equitable and resilient future would facilitate positive and synergistic impacts, helping ensure that multiple objectives are achieved simultaneously, while avoiding unintended negative impacts. The implementation of these global agendas requires joined-up, sustainable investment and cohesive roadmaps on a longer time horizon, to 2050, to scale up impactful and synergistic interventions and achieve their collective ambitions.

Photo sourced via Canva

In a warming world characterized by polycrises and a more challenging risk landscape, achieving the SDGs requires taking into account multiple threats, vulnerabilities, complex risks and interactions to build more resilient societies and prevent the reversal of development trends and gains. In this context, national and local authorities need to adopt integrated and multi-hazard approaches to risk reduction, with the full support of scientific communities and other stakeholders. Science-based and community-centred approaches, as shown by the Naryn Urban Resilience Project in Kyrgyzstan (case study 1), can significantly enhance resilience and long-term sustainability in the face of climate change and socio-economic vulnerabilities.

1 Case study: Strengthening urban resilience in Naryn through science-driven sustainable development

Author: Rui Dang, Ala-Too International University and International Society for Ecological Economics

Geographical scope: Kyrgyzstan, Europe and Central Asia

The Naryn Urban Resilience Project (NURP) helps to enhance the resilience of Naryn, a city in Kyrgyzstan, through science-based actions targeting its environmental and socio-economic challenges. Located at an elevation of almost 2,000 m, within the Tien Shan Mountain range, Naryn is particularly susceptible to disasters such as landslides and floods, which are exacerbated by climate change. Additionally, socio-economic challenges, including limited access to resources and economic opportunities, further impede the city's ability to develop sustainably and respond effectively to crises.

Supported by the Swiss State Secretariat for Economic Affairs (SECO) and the Aga Khan Foundation, the NURP programme will run from 2022 to 2025. It aims to transform Naryn into a thriving and sustainable metropolitan region through a comprehensive planning process that integrates local capacity building, infrastructure improvement and community engagement to mitigate the impacts of climate change and enhance food security.

The NURP takes a science-based approach to tackle climate and socio-economic vulnerabilities in Naryn. It employs actions such as training for local authorities and stakeholders on sustainable development and resilience, empowering the community to effectively respond to and manage environmental and socio-economic challenges and ensuring culturally appropriate and supported local solutions. Partnering with Naryn State University and international organizations, NURP has developed programmes to enhance local governance in disaster risk management and urban planning. The project conducts comprehensive studies on local climate patterns, geological data and socio-economic conditions to inform the planning and development of resilient infrastructures and policies.

Key outcomes of the project include improved disaster response capabilities via geographic information systems (GIS) and improved infrastructure planning. The NURP project has strengthened local governance by providing extensive training in sustainable urban management and disaster risk management, contributing to robust community leadership and governance structures. Infrastructure improvements have been made to withstand adverse climate impacts, ensuring long-term sustainability and resilience. Moreover, NURP has prioritized community involvement. For instance, the Certificate Program in Urban Resilience of the University of Central Asia's Graduate School of Development was designed to comprehensively train government civil servants in Naryn and Khorog in economic, environmental, socio-economic, cultural and urban resilience, with the goals of enhancing their capacity to manage sustainable development projects and establishing a national centre of excellence in resilience.

NURP contributes to aligning resilience measures with local needs and fostering community ownership and participation. It supports progress towards SDG 2 (Zero hunger), SDG 11 (Sustainable cities and communities), SDG 13 (Climate action) and SDG 17 (Partnership for the goals).

Furthermore, empowering local communities through the integration of traditional ecological knowledge and scientific research is crucial for effective ecosystem restoration and conservation, climate adaptation and mitigation, and disaster risk reduction. This approach enhances resilience, supports sustainable livelihoods and advances multiple SDGs by addressing climate change, biodiversity loss and socio-economic challenges. For instance, in West Africa, women's ecological knowledge has been crucial for informing strategies and practices for the management and conservation of mangroves, and for contributing to the improved working conditions, financial security and empowerment of local women (case study 2). Similarly, in certain Small Island Developing States (SIDS), a strong nexus between modern science and Indigenous and local knowledge has been promoted to help SIDS enhance their resilience against threats such as climate change and advance SDG implementation (case study 3). Additionally, promoting nature-based solutions and their application by local communities, such as those in Owode, South West Nigeria, and Abatete in South East Nigeria, have had positive impacts by reducing several climate-induced hazards and risks, enhancing community resilience and improving livelihoods and food security (case study 4).

2 Case study: Low-hanging fruit: A women's knowledge-based approach to blue carbon restoration and conservation in West Africa

Author: Kafayat Fakoya, Gender in Aquaculture and Fisheries Section of the Asian Fisheries Society and Organization for Women in Science for the Developing World

Geographical scope: West Africa

Coastal habitats, including mangroves, provide a multitude of ecosystem services that help achieve the SDGs both directly and indirectly. Mangroves have historically given coastal communities access to productive fish and shellfish fishing grounds, supplying them with food and vital nutrients (SDG 2). Along with wood for building, they are also a source of wood for charcoal, firewood, honey, textiles, dyes, tannins and medicines (SDG 12). Beyond meeting basic needs, harvesting of natural resources ensures livelihoods and economic growth (SDG 8), as well as generating income and reducing poverty (SDG 1). Additionally, mangroves are essential wetlands that play a significant role in the cycling of nutrients and water (SDG 6), provide habitats for fish and marine organisms (SDG 14), and support high biodiversity, with numerous mammals, reptiles and birds, including threatened species (SDG 15).

Scientific research has underscored the critical role of mangroves in climate adaptation and mitigation. Mangroves are exceptional carbon sinks, storing four times more atmospheric carbon than mature tropical forests, making them essential in combating climate change. Recognizing their importance, 61 countries have included mangroves in their climate change mitigation and adaptation strategies.

Nevertheless, mangroves remain among the most endangered tropical ecosystems due to human activities, threatening local livelihoods and biodiversity, and exacerbating climate change. From 1996 to 2020, global mangrove loss totalled 5,245 km^2 (3.4 percent), with Africa losing 152.2 km^2 (2.15 percent) (Naidoo, 2023). In West Africa, the mutual dependence between shellfisheries, mangroves and the human component has frequently been overlooked. However, viewing mangroves as coupled natural–human systems has highlighted the importance of traditional ecological knowledge for conserving biodiversity and critical habitats linked to fisheries productivity.

Women-dominated mangrove shellfisheries offer a valuable link between local ecological knowledge and scientific efforts to address mangrove loss, sea level rise, ocean acidification and climate change. Women's ecological knowledge is crucial for informing the management and conservation of mangroves at both regional and global levels. Some examples of successful women-led, community-based conservation efforts are represented by the Try Oyster Women's Association and the Densu Oyster Pickers, which have developed oyster fishery management plans including community-managed, exclusive-use zones and seasonal closures for oyster harvesting. These actions are complemented by mangrove replanting efforts and oyster value chain development to enhance sustainability and economic benefits (Asare 2017: Development Action Association, 2018; Asare et 2019; Hayford et al. 2021; Su et al., 2021; Anokye and Potakye, 2023; Macfadyen et al., 2023; Roy et al. 2023). Other projects have also encouraged sustainable practices and conservation efforts (Wabnitz et al. 2023).

These initiatives demonstrate the effectiveness of integrating scientific research with local ecological knowledge to achieve sustainable mangrove management and conservation. Among the positive effects are reduced impacts on mangrove forests and increased harvest from implementing a closed season, along with improved working conditions, financial security and empowerment of local women through education and training.

3 Case study: Science in action in Small Island Developing States: Case study of Dominica

Author: Michelle Mycoo, The University of the West Indies

Geographical scope: Dominica and Small Island Developing States

Dominica faces severe climate change threats impacting its population, economy, ecosystems and culture. In 2017, it experienced two category 5 tropical cyclones, Irma and Maria, within two weeks, with Tropical Cyclone Maria destroying infrastructure and housing and causing losses of over 225 percent of the annual gross domestic product (GDP) (Eckstein et al., 2018). In response, the government adopted more resilient housing construction techniques and innovative approaches to capacity and resiliency building at the local community level to be implemented by 2030. These approaches are aligned with SDGs such as SDG 10 (Reduced inequalities), SDG 11 (Sustainable cities and communities) and SDG 13 (Climate action).

International funding was secured to rebuild safer housing, integrating science in resilient building practices and planning processes. Key components included maintaining a management information system to enhance the monitoring of building practices, land-use zoning and site selection. Another critical component was training government staff, local building contractors and artisans in the private sector in resilient reconstruction practices through government-operated technical assistance centres.

Within the context of the Climate Resilience and Recovery Plan, Dominica embarked on building resiliency at the community level by conducting vulnerability assessments.

- **Physical vulnerability** ranked highest due to climate change impacts on infrastructure, livelihoods and shelters.
- **Social vulnerability** affecting specific demographic groups such as single-parent households, elderly, children under 13 years of age and physically challenged persons, was ranked second.
- **Organizational vulnerability,** related to local governance and disaster planning capacity, was ranked third.

The assessments revealed varying levels of vulnerability across 67 communities.

The Community Emergency Readiness Initiative addressed capacity building for local governments and community organizations in 37 communities, focusing on enhancing community self-sufficiency after a major climatic event. The initiative developed Community Disaster Management Committees, Disaster Management Plans for communities and supplied essential resources such as equipment, food, water and back-up power generators to allow 15 days' autonomy and reduced dependence on government during a disaster.

The implementation of nature-based solutions has also been accelerated post-Tropical Cyclone Maria, when 10,000 landslides were recorded. This has been informed by the Indigenous knowledge of the Kalinago people and local knowledge among farmers. For decades, the use of vetiver for soil stabilization and landslide reduction has been a common practice. The use of nature-based solutions has strengthened community resilience to soil erosion, flooding and landslides, while safeguarding food and water security.

Dominica's case study highlights the successful integration of modern science with time-tested Indigenous and local knowledge to build resilience and achieve sustainable development in SIDS. This blended approach informs decision-making and action geared toward resiliency building and progress on the SDG agenda.

4 Case study: Utilizing local approaches to address the SDGs in Nigerian communities

Author: Cynthia Ibeto, University of Nigeria Nsukka and Nigerian Young Academy

Geographical scope: South West and South East Nigeria

Nigeria is highly vulnerable to climate change, despite accounting for the lowest amount of global greenhouse gas (GHG) emissions. Climate change threatens Nigeria's economic and social development, affecting forestry, agriculture and fisheries, and leading to food shortages. Climate change also fuels conflicts over dwindling resources, causing migration and ethnic clashes, such as the herder–farmer conflicts linked to Lake Chad's shrinkage. Furthermore, Nigerian communities are facing significant challenges related to energy poverty and environmental degradation, which they tackle through the application of nature-based solutions. The local strategies address some SDGs such as SDG 1 (No poverty), SDG 2 (Zero hunger), SDG 7 (Affordable and clean energy) and SDG 13 (Climate action), among others. These nature-based solutions are applications of basic scientific techniques implemented at the local level.

For instance, in Owode, Ogun State, South West Nigeria, female farmers at a cassava processing centre and other farm settlements have implemented various strategies and practices to reduce emissions from deforestation and biomass exploitation, and conserve the fast-depleting forest biomass.

These include:

Using various types of agricultural biomass and residues as substitutes for fuelwood.

- sun-dried seed or nut shells
- cassava peel
- forest litter

Using agricultural biomass as substitutes for fuelwood during the rainy season when demand is high.

- Palm kernel shells
- Palm oil fibre
- Palm oil bunches
- Other crop harvesting and processing waste

Using residue from biogas production as green manure to replenish soil nutrients and control soil erosion.

Additionally, in Abatete and other Anambra communities in South East Nigeria, land degradation is a major issue due to severe gully erosion. Although the large population is an identified cause of the problem, the erratic weather patterns have aggravated the situation. This problem has led to forced migration and livelihood and property loss, mainly affecting poor farmers and traders in those communities. In the Anambra communities, erosion control methods include planting erosion-resistant trees with deep roots to bind soil, placing sandbags at active erosion hotspots on farm roads and footpaths, and creating high ridges and raised beds around vegetable gardens to improve drainage and minimize waterlogging. Further, placing logs in shallow ditches helps to trap sediment and water to prevent gully erosion.

Photo sourced via Canva

Scientific research has played a key role in providing insights on the causes and consequences of climate change and risks, informing the adoption of nature-based solutions. Science has facilitated technological development and community education, enhancing problem-solving skills and living standards. It has also fostered trust in technologies and empowered collective action for the common good. Community actions have been based on existing evidence such as using vegetation to mitigate erosion, utilizing biomass for energy and hybridizing fish to boost their disease resilience.

These nature-based solutions have yielded significant positive outcomes. Communities have recognized nature-based solutions as important, profitable actions that have the capacity to sustainably restore the natural ecosystem of the community by reducing several climate-induced hazards and risks associated with unsustainable harvesting of forest resources.

These actions have improved the life and wellbeing of communities by reducing poverty and food insecurity and increasing livelihoods. For instance, adoption of biogas as an alternative to fuelwood has led to the establishment of several biogas stove fabrication centres resulting in enhanced food security and economic development. Minority groups, including people with disabilities, women and youths, have seen their livelihoods improved, thereby fostering social integration. Additionally, improved accessibility to farm roads has enhanced productivity and the shelf-life of fresh foods.

Key theme 2:

Harnessing technology and innovation for equitable SDG implementation

Rethinking and reorienting the role of technology and innovation is key to supporting the effective implementation of the 2030 Agenda. Science has a vital role to play in supporting the assessment of technologies, including their ethical dimensions and societal implications. It can, furthermore, inform policies to reduce inequality, aligning with SDGs and ensuring the widespread distribution of benefits through public institutions. This can foster fair innovation and support justice in achieving global development objectives. For instance, in Tanzania, equitable access to advanced medical technologies has led to improved distributive justice and maternal and newborn health outcomes advancing progress on key SDG 3 targets (case study 5).

Photo sourced via Unsplash

Similarly, a study on food rescue and food insecurity undertaken in Colombo, Sri Lanka, where more than half of households experience food insecurity, has recommended the use of web platforms and smartphone applications (apps) to improve coordination between food donors and front-line organizations, reducing food waste and elevating food security (case study 6).

Furthermore, through evidence-based approaches and technology and innovation integration in education, educational disparities in rural areas, exemplified in the Piura region of Peru, can be addressed effectively (case study 7).

5 Case study: Digital innovations to improve pregnancy and childbirth outcomes in the Pwani Region, Tanzania

Author: Yoko Shimpuku, Hiroshima University and Science Council of Japan

Geographical scope: Tanzania

In Tanzania, maternal health is a critical challenge, with only about half of pregnant women attending at least four antenatal care visits (Ministry of Health (Tanzania Mainland) et al., 2023). This low attendance rate increases the risk for late detection of pregnancy-related complications, contributing to the country's high maternal mortality rate and stillbirths. Tanzania's health system is constrained by a lack of medical resources such as medical devices, health personnel, hospital beds and non-obstetrician health facilities compromising perinatal safety. While in high-income countries, the use of cardiotocography is a standard practice to detect complications of pregnant women and foetuses, this is rare in Sub-Saharan Africa. The use of up-to-date medical devices with evidence-based assessment leads to a decrease of preventable deaths of pregnant women and foetuses. Addressing these issues aligns with key targets of SDG 3 (Good health and wellbeing).

Promoting the use of up-to-date medical devices in low resource settings is a challenge. Strong evidence is needed to convince the decision-makers to allocate budgets. In this context, scientific research has an essential role in assessing whether the application of advanced medical devices can benefit pregnant women and foetuses in Tanzania and in identifying any challenges to appropriately implementing these devices in resource-limited contexts. Such research contributes to achieving distributive justice and informs policy development for successful implementation.

One notable example in this area is the use of mobile cardiotocography (iCTG) that can measure foetal heart rate and uterine contractions. This technology has reduced the burden of hospital visits for pregnant women and ensured access to non-stress test examinations in remote areas with limited good-quality medical care. Additionally, another study conducted in Tanzania demonstrated that an educational smartphone app, used by midwives during antenatal care visits, significantly improved access to medical information for pregnant women (Shimpuku et al., 2023).

A collaboration study between Hiroshima University and Muhimbili University of Health and Allied Sciences in Tanzania with Melody International Ltd. and Castalia Co., Ltd. is being rolled out in phases.

Phase 1

Situational analysis through exploratory research to identify training needs

Phase 2

Develop the smartphone app and iCTG innovative systems.

Phase 3

Implement the mobile systems during pregnancy and labour, and evaluate the feasibility, usability and impacts on maternal and newborn health outcomes in Tanzania.

The study covers six villages in Kisarawe and four villages in Bagamoyo and district hospitals at each site. It will run until September 2024. As of 31 March 2024, 384 cases had been recruited from two health centres. Data have been collected, including on the outcomes of 185 cases.

The primary outcome measure was the percentage of pregnant women who received continuous care with at least four antenatal check-up visits.

Photo by World Bank (CC BY-NC-ND 2.0)

For women in labour, the key outcome was the percentage who underwent an emergency C-section based on iCTG testing results. Additional outcomes included detection of foetal heart rate abnormalities, referrals, preterm delivery, Apgar scores and perinatal mortality. This study represents a concrete first step toward achieving SDG 3 by providing robust scientific evidence to support policy recommendations and developments in Tanzania and around the world.

6 Case study: A circular economy approach to food security and poverty in Sri Lanka

Author: Susan Momanyi, Kisii University

Geographical scope: Asia

Colombo, the commercial capital of Sri Lanka, faces significant challenges of food insecurity and waste. Despite being an economic hub, nearly half of its 626,000 residents live in slums with inadequate facilities, and 59 percent of households experience food insecurity. Paradoxically, Colombo generates a large amount of food waste, with the Western Province accounting for 33 percent of Sri Lanka's total solid waste. In 2017, Colombo produced 353 tonnes of food waste daily, primarily from households, food services and markets.

Food rescue, also known as food recovery or redistribution, is a key strategy to address food insecurity and reduce food waste (Aloysius and Ananda, 2023; Onyeaka et al., 2023). For example, in Jordan, a possible cause of food insecurity is food waste, where at least 50 percent of the food is disposed of (Mousa, 2020). Food rescue involves collecting surplus edible food and distributing it to food-insecure individuals. There are more than 15 active policies and legislations in Sri Lanka addressing different stages of waste management; however, none include food rescue operations in their policy statements and goals, as a strategy to manage food wastage or to elevate food security.

In Colombo, Aloysius and Ananda (2023) conducted in-depth interviews with food donors and redistributors to analyse the existing food rescue system and inform policies to enhance food security. The study revealed significant gaps in the food rescue system, including the absence of facilitator and back-line organizations, which hinders effective coordination between food donors and redistributors, resulting in significant food wastage.

Photo sourced via Canva

To address these issues, the study recommends using web platforms and smartphone apps to better match food donors with front-line organizations, thereby improving coordination and reducing food spoilage. Establishing food banks with state-of-the-art storage and transport facilities was also suggested to support front-line organizations in managing perishable food donations (Aloysius and Ananda, 2023; Onyeaka et al., 2023). For example, artificial intelligence technologies can be used to monitor and optimize food production and supply chains, redistribute excess food to those in need and support circular economy initiatives (Onyeaka et al., 2023).

Taking China as an example, developing countries can improve food waste policies by improving legislation, guiding the development of food banks, promoting social governance and strengthening scientific research projects (Shen et al., 2024). Developing partnerships between government authorities, such as the Ministry of Agriculture and the Ministry of Urban Development, and supermarket chains is recommended to extend food rescue operations beyond Colombo, promoting a circular economy approach.

Formal agreements between food donors and rescue organizations are crucial for sustainable food redistribution. Currently, there are no formal agreements in Colombo, leading to irregular food donations and collection schedules. Policy-makers should facilitate the establishment of these agreements and develop health and safety guidelines on hygiene, food safety and minimum quality standards for surplus food redistribution. Raising awareness through government-led programmes about existing food redistribution activities and the benefits of food rescue can encourage more participation from retailers, suppliers and the general public.

Strengthening the food rescue system in Colombo could significantly reduce food insecurity in marginalized communities and contribute to sustainable urban development, addressing several interrelated SDGs such as SDG 2, aimed at ensuring access to safe, nutritious and sufficient food throughout the year by all people, including infants, by 2030, and SDG 12, which calls for halving the global food waste at the retail and consumer levels and the reduction of food losses along production and supply chains, including post-harvest losses by 2030.

7 Case study: Transformation of education through technology: impact on equity and access to education

Author: César Martín Agurto Castillo, Universidad Nacional de Piura

Geographical scope: Piura, Peru

The Piura region of Peru faces significant educational disparities between urban and rural areas, with many rural schools lacking basic infrastructure and access to modern resources. In response, efforts have been made to integrate information and communication technologies (ICT) into the educational system. The transformation of education through technology in the Piura region has been crucial to improving equity and access to education, directly contributing to SDG 4 (Quality education) and SDG 10 (Reduced inequalities).

Science has informed the application of innovative educational research and technologies to overcome the geographic and socio-economic barriers affecting the education system in rural areas. Science provides the tools and methodologies to design and implement effective solutions, such as the use of digital classrooms, online learning platforms and specialized teacher training programmes in educational technology. By applying evidence-based scientific approaches, the specific needs of the educational community in Piura have been identified, leading to the adaptation of technological interventions to those needs, and the continuous monitoring of the impacts on learning and educational equity.

The Peruvian government, together with international organizations, has implemented several programmes such as 'One Laptop per Child' and the installation of digital classrooms. These initiatives seek to equip schools with technological devices and improve Internet connectivity. Other actions implemented include teacher training in the effective use of educational technologies. These included the creation of digital content adapted to local needs and the integration of interactive tools in the teaching process; and the development of online learning platforms that allow students to access quality educational resources from their homes, overcoming geographic barriers and promoting educational continuity.

The introduction of various technological initiatives has significantly transformed the educational landscape, improving access to education, quality of learning and educational equity. Programmes such as 'One Laptop per Child', implemented by the Ministry of Education, distributed laptops to thousands of students, increasing access to digital resources.

- Students with regular access to technology showed a 20 percent improvement in maths and science grades (University of Piura, 2022).
- Teacher training programmes boosted digital competencies, with 85 percent of teachers feeling more prepared to use ICT in lessons.
- The 'Teacher Training Program in the Use of Portable Electronic Devices' enabled teachers to support students in using over 20 applications for various educational activities.
- Technological interventions significantly reduced the urban–rural academic achievement gap, with a 30 percent reduction in the difference in secondary education completion rate (World Bank, 2023).
- ICT also facilitated the inclusion of students with disabilities through adaptive tools supporting diverse learning needs.

While the integration of educational technologies has improved access and quality of education in Piura, challenges remain, such as the need for continuous maintenance of technological infrastructure and the updating of teacher training programmes. Future efforts should focus on the sustainability of these advances and expanding connectivity to reach more rural communities.

Key theme 3:

Leveraging science and evidence-based tools for accelerated SDG progress

Urgent action requires better leverage and integration of available scientific knowledge across both natural and social sciences to inform action on key transformation pathways and measure progress against desired outcomes for accelerated SDG progress.

Successful SDG implementation hinges on evidence-based, context-specific prioritization that accounts for SDG synergies and trade-offs across different contexts, including negative environmental and social spillovers between countries, regions, and sectors. Efforts must furthermore focus on identifying and overcoming systemic barriers to SDG implementation.

Photo by IWMI (CC BY-NC-ND 2.0)

Employing existing scientific knowledge to inform the development of tools and integrated solutions can support effective and urgent SDG implementation by addressing complex, interconnected challenges that negatively impact a wide range of SDGs. These tools can facilitate policy decisions and cooperative action among various stakeholders. For instance, the Greenhouse Gas and Air Pollution Interactions and Synergies (GAINS) model, a transparent, integrated science-based assessment tool, has proven invaluable in supporting evidence-based decision-making and maximizing synergies among various SDGs, leading to positive outcomes in different policy contexts (case study 8).

8 Case study: Integrated assessment for cooperative action on air pollution

Author: Fabian Wagner, International Institute for Applied Systems Analysis

Geographical scope: Europe and Asia

Clean air is crucial for public health and wellbeing, yet millions worldwide suffer from air pollution, one of the leading causes of death globally. Addressing air pollution is a complex, transboundary issue as many pollution sources are also significant GHG emitters. These emissions are tied to economic activity and comfort, presenting numerous barriers to effective mitigation. Scientific evidence indicates that reducing pollution aligns with SDG 3 (Good health and wellbeing) but requires a cooperative framework that allows stakeholders to jointly maximize synergies with other SDGs, such as SDG 7 (Affordable and clean energy), SDG 11 (Sustainable cities and communities), and SDG 13 (Climate action).

In this regard, the science-based integrated assessment model, Greenhouse Gas and Air Pollution Interactions and Synergies (GAINS), developed at the International Institute for Applied Systems Analysis (IIASA), has proven to be a useful tool to support evidence-based decision-making by identifying detailed cost-effective emission control strategies tailored to specific capabilities, existing technological solutions, weather and atmospheric patterns, vulnerabilities and potentials for co-benefits.

Photo by Wirestock on Freepik

The GAINS model is a transparent, science-based assessment tool that is freely available online covering both scientific and socio-economic aspects of air quality management and GHG mitigation.

It can be supplemented with publicly available information and scenarios from international sources, such as the International Energy Agency's World Energy Outlook, or with national scenarios developed by local experts. The GAINS model facilitates a common evidence-based language and understanding by various stakeholders describing the causes and implications of, and solutions to air pollution, which can be applied at different spatial scales, ranging from the megacity level to continental scales. The modelling framework can be used to analyse options for action and their implications, without being policy prescriptive.

The GAINS tool has supported several national and international policy processes that in turn have resulted in smart and effective environmental policies. For instance, the tool has been instrumental in supporting the European Commission's design of the National Emission Ceilings Directive and their Ambient Air Quality Directive, leading to specific European Union regulations for controlling the emissions of criteria pollutants, thereby saving thousands of lives. It has also supported the United Nations Economic Commission for Europe in revising the Gothenburg Protocol, one of the most successful international environmental collaborative actions. Recently, with support from the World Bank, the tool has also been used to support decision-makers in China, India, Pakistan and Nepal to design cost-effective strategies that also reflect equity considerations (SDG 10). Furthermore, by being easily accessible and transparent, the GAINS model also helps to foster trust in science and evidence-based decision-making, thereby contributing to SDG 16 by strengthening institutions and social capital.

Additionally, science can provide the evidence, tools and methodologies needed to develop thorough metrics, such as the Years of Good Life (YoGL) indicator, which integrates multiple dimensions of human wellbeing. These metrics enable a thorough comparison of sustainability actions to improve wellbeing and facilitate empirical analysis to project future scenarios, considering feedback mechanisms between economic, demographic and biophysical systems (Case study 9).

9 Case study: Future human wellbeing

Author: Sibel Eker, Michael Kuhn, Claudia Reiter and Qi Liu, International Institute for Applied Systems Analysis (IIASA)

Geographical scope: Global

Human wellbeing is the ultimate goal of sustainable development, explicitly covered by SDG 3 (Good health and wellbeing). However, wellbeing is a multifaceted concept that encompasses interconnected material, social and ecological dimensions. Traditional metrics, such as GDP per capita, are highly limited and do not capture the full breadth of human wellbeing. Climate change, meanwhile, poses substantial threats to wellbeing through its impacts on health, economic output and social systems. The challenge lies in overcoming the lack of comprehensive analysis that integrates the combined effects of climate change and sustainable development on long-term future wellbeing. Previous studies have often focused on specific aspects of climate impact, such as economic damage and health impacts, without considering their interconnectedness and feedback loops.

To address this gap, the study by Kuhn et al. (2023) employs a dynamic systems model to project future wellbeing under various socio-economic and climate scenarios. This study utilizes the YoGL indicator (Lutz et al., 2021), which integrates multiple dimensions of human wellbeing, including longevity, cognitive ability, poverty, health and subjective life satisfaction. Science plays a critical role by providing the tools and methodologies needed to develop comprehensive wellbeing metrics like YoGL. These metrics enable a thorough comparison of sustainability actions to improve wellbeing and facilitate empirical analysis to project future scenarios, considering feedback mechanisms between economic, demographic and biophysical systems. The study employed an ex-ante analysis of science-based sustainability actions, and showed that tackling climate change has tremendous positive effects on human wellbeing. While the short-term benefits of inaction on human wellbeing are negated by climate impacts on longevity and the economy, comprehensive climate action leads to sustained wellbeing improvements. Moreover, the study highlights the significant role of female empowerment through education and labour participation, enhancing wellbeing under different climate scenarios.

The study was part of the IIASA Flagship Report launched in September 2023 at the 78th Session of the UN General Assembly and at a European Union Commission Library Talk, creating widespread awareness about the necessity of a systems analysis approach for sustainability policy-making at all levels to ensure broader, longer-term considerations. There was widespread agreement among participating stakeholders about the importance of this approach for the future assessment of policies.

Integrating an empirically operationalizable wellbeing measure into a dynamic systems model opens the potential for widespread applications. This includes assessing the wellbeing cost of carbon emissions (beyond the social cost of carbon) and evaluating progress against specific SDGs in wellbeing terms. This approach provides a rigorous account of systemic impacts and helps explain how improvements in SDGs contribute to a unified wellbeing metric.

The study employed an ex-ante analysis of science-based sustainability actions, and showed that tackling climate change has tremendous positive effects on human wellbeing. While the short-term benefits of inaction on human wellbeing are negated by climate impacts on longevity and the economy, comprehensive climate action leads to sustained wellbeing improvements. Moreover, the study highlights the significant role of female empowerment through education and labour participation, enhancing wellbeing under different climate scenarios.

The study was part of the IIASA Flagship Report launched in September 2023 at the 78th Session of the UN General Assembly and at a European Union Commission Library Talk, creating widespread awareness about the necessity of a systems analysis approach for sustainability policy-making at all levels to ensure broader, longer-term considerations. There was widespread agreement among participating stakeholders about the importance of this approach for the future assessment of policies.

Science can, furthermore, support integrated solutions and foster policy coherence in addressing complex SDGs trade-offs and advancing sustainable development. The case study in Rwanda presents a nuanced challenge intersecting food security (SDG 2) and public health (SDG 3). Through interdisciplinary collaboration and innovative scientific approaches, researchers effectively dismantled policy silos, challenging prevailing beliefs, leading to positive impacts for local populations (case study 10).

10 Case study: Exploring avenues for malaria-free rice cultivation through local resource mobilization

Author: Luuk van Kempen, Radboud University

Geographical scope: Rwanda

To boost local food supply and farmer incomes, the Rwandan government initiated a set of actions to convert wetlands into rice fields. However, this expansion of rice cultivation has inadvertently created fertile breeding grounds for mosquitoes that carry malaria, causing malaria to rebound strongly from earlier success in eradication efforts. This particularly affects rice-farming families and residents living in proximity to rice cultivation areas.

As part of an interdisciplinary collaborative effort, a significant trade-off between SDG 2 (Food security and smallholder incomes) and SDG 3 (Public health and communicable diseases) has been identified and mapped utilizing the analytical framework from the ISC Guide to SDG Interactions: From Science to Implementation. These findings furthermore overturn the prevailing 'paddy paradox', a belief that increased income from rice production in Sub-Saharan Africa would offset the malaria risk due to better protection measures.

Specifically, in the Rwandan case, different types of data have been combined in an interdisciplinary manner to link rice cultivation to intensified malaria transmission. Social scientists have gathered community insights on changes in malaria infection rates, complemented by data from malariometric surveys, rapid diagnostic tests for malaria infections and mosquito surveillance in and around rice fields undertaken by medical and entomological teams.

Once the trade-off between SDG targets 2.3 and 3.3 had been established, scientific solutions were sought, focusing on bio-larvicides to control mosquito populations. Bio-larviciding campaigns were piloted in close collaboration with rice farmers' cooperatives and proved to be an effective solution, without any harm to rice plants, the wider environment or humans. Both mosquito monitoring data and farmers' own perceptions concurred that bio-larviciding reduced the malaria case rate. The pilot also demonstrated that rice-farming communities were successful in self-organizing the bio-larviciding campaign, performing on par with communities where experts lead.

However, turning bio-larvicide spraying into a routine activity has proven financially challenging. To explore local resource mobilization, researchers conducted bidding game experiments, assessing farmers' willingness to contribute financially and local consumers' willingness to pay a premium for 'malaria-free' rice. While the results showed notable contributions, they were insufficient to cover the full cost, requiring government and international donor support. These entities could also help establish a credible certification system for 'malaria-free' rice.

The research findings led to breaking the policy silos around SDG 2 and SDG 3. This is witnessed by the recent integration of bio-larviciding campaigns into Rwanda's official malaria strategy, targeting rice-growing regions with large-scale spraying using drone technology. Additionally, malaria risk is increasingly considered in agricultural projects, such as those advised by the International Fund for Agricultural Development, which now include environmental risk assessments to mitigate the spread of infectious diseases.

Key theme 4:

Collaborative and interdisciplinary approaches for integrated SDG implementation

Sustained collaboration across disciplines, sectors and stakeholders is key for SDG implementation, enabling the development of context-specific solutions and pathways towards a safer, more just and sustainable future.

Photo : USAID Urban (CC BY-NC-SA 2.0)

The interconnected and complex nature of sustainability challenges requires a multistakeholder approach to facilitate systematic change and streamline efforts towards sustainability. Integrating interdisciplinary and transdisciplinary insights – from natural sciences, social sciences, humanities and engineering, alongside Indigenous, local and practitioner knowledge – is essential for identifying effective solutions. Participatory approaches involving policy-makers and community support help to ensure that initiatives align with the unique needs and values of local populations, enhancing the feasibility, sustainability, equity and cultural acceptability of solutions.

These collaborative efforts hold the potential to positively impact a wide array of sectors and stakeholders, yielding beneficial outcomes for a set of SDG targets. For example, endeavours to introduce circular economy strategies in Bangladesh's textile industry, underpinned by scientific research and involving diverse relevant stakeholders, have resulted in reductions in waste and pollution, efficient resource management and the creation of new business opportunities, contributing to progress on various SDG targets (case study 11).

11 Case study: Circular economy strategies in the textile industry: A science-driven approach to reducing waste and pollution in Bangladesh

Author: Alessia Falsarone, University of Chicago

Geographical scope: Bangladesh and South East Asia

The textile industry in Bangladesh, a key economic contributor, generates significant challenges due to its substantial waste generation and pollutant emissions, which adversely affect human health and the environment. The adoption of circular economy strategies has led to waste reduction, diminished use of virgin resources and lowered environmental impacts, while also creating new business opportunities (Khajuria et al., 2022). These efforts support SDG 9 (Industry, innovation and infrastructure), SDG 12 (Responsible consumption and production) and SDG 6 (Clean water and sanitation) by promoting sustainable industrialization, reducing waste and pollution, and conserving water resources.

Photo by Vershinin on istock

Scientific research has played a pivotal role in tackling these challenges. Researchers have collaborated with textile companies, policy-makers and nongovernmental organizations to conduct life cycle assessments and material flow analyses, quantifying the environmental impacts of the textile industry at every stage, identifying critical hotspots and prioritizing areas for intervention.

Key science-based actions include developing circular business models, such as designing garments for longevity and recyclability, establishing closed-loop production systems, and introducing leasing or sharing models. These initiatives not only lead to an extended lifespan of textiles but also facilitate recycling and resource conservation (Ellen MacArthur Foundation, 2017). Additionally, researchers have identified and helped implement cleaner production technologies to treat wastewater and reduce the use of hazardous chemicals, significantly improving the overall sustainability of textile production processes (Sandin et al., 2017).

Policy and capacity building have also been integral to this effort. Scientists have worked with policy-makers to create incentives that promote the adoption of circular economy practices and have provided training for industry stakeholders on circular business strategies and technologies. The Government of Bangladesh has recognized the potential of the circular economy to support sustainable development, poverty reduction and environmental protection, enhancing the competitiveness of key export industries like ready-made garments, which contribute over 10 percent to the country's GDP. In 2023, the government passed the Plastic Industry Development Policy, ensuring the circularity of resources in the plastic industry, and included circular economy principles in its National Industrial Policies.

This case study demonstrates how scientific research can inform the transition to circular economy approaches in polluting industries, contributing to multiple SDG targets. Outcomes include reduced waste and pollution, decreased emissions of pollutants into waterways and reduced demand for virgin raw materials. These approaches have created new revenue streams, enhanced the competitiveness of participating companies and contributed to improved brand reputation, leading to new economic benefits while reducing the environmental impacts.

Key theme 5:

Building capacity and mentorship for SDGs through science and innovation

Meeting societal goals for sustainable development and strategic transformations for the SDGs requires substantial capacities and skills at individual institutional and network levels (IGS, 2023) and strengthen national science, technology and innovation systems. This involves training the next generation of scientists and engineers, building scientifically literate publics and improving science education at all levels.

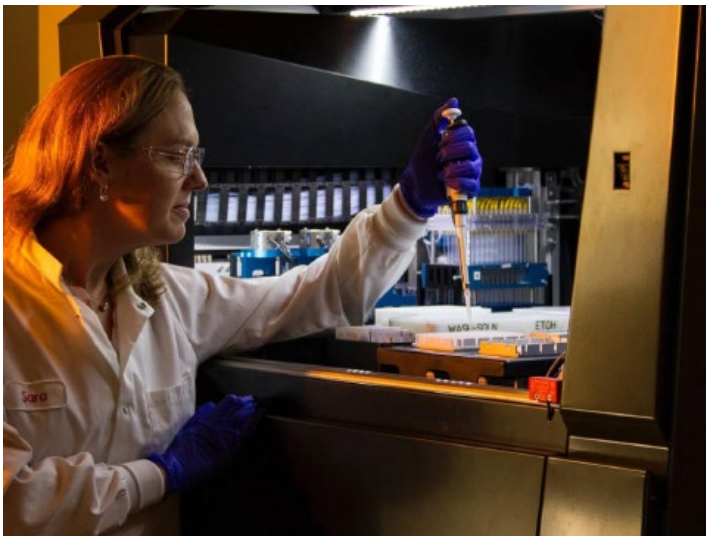


Photo sourced via Unsplash

Addressing issues such as mobility and brain drain, encouraging the participation of women in science and engineering, and assessing the effectiveness of various interventions are crucial. Clear global and national strategies and initiatives for capacity building are necessary to link science and technology with economic growth and human wellbeing, improve science-based decision-making and build future workforces capable of leveraging scientific and technological advances.

Additionally, the underrepresentation of women in STEM fields needs to be addressed to harness diverse talent to deal with pressing global challenges, including health care and climate change. In this regard, the establishment of a Centre for Women in STEM (CWS) in Pakistan is an illustration of how a centralized support system can help women's professional growth and wellbeing, assisting them in overcoming domestic barriers, career obstacles and mental health concerns (case study 12).

12 Case study: Women in STEM in Pakistan

Author: Mamoona Alam, Shaheed Benazir Bhutto Women University Peshawar and Organization for Women in Science for the Developing World

Geographical scope: Pakistan, particularly Khyber Pakhtunkhwa

In Pakistan, women in STEM face a lack of dedicated support and resources specifically designed to address the usual challenges encountered by women, such as domestic barriers, career obstacles and mental health concerns. These issues directly hinder women's professional growth and personal wellbeing, and are exacerbated by the lack of a centralized support system. This makes it difficult for women to access necessary resources and guidance.

Shaheed Benazir Bhutto Women University Peshawar is the first women-only university in Khyber Pakhtunkhwa. It provides the largest female education platform in the region. Although recent efforts have increased female representation in STEM jobs to 50 percent in 2019, women remain underrepresented in key areas such as physical sciences, computing and engineering. To support women in STEM, the University established the Centre for Women in STEM (CWS), which focuses on the women and young girls of Khyber Pakhtunkhwa.

The CWS is a safe and inclusive platform where women can receive tailored support, including career counselling services, post-graduation guidance and advice on international and national scholarships for women in STEM, enabling them to overcome challenges and thrive in their careers.

The establishment of the CWS aligns with several SDGs and Pakistan's Vision 2047. It directly relates to SDG 5 (Gender equality) by empowering women, eliminating discrimination, and ensuring equal rights for all. By providing counselling services and promoting women's rights, the initiative contributes to SDG 4 (Quality education), SDG 9 (Industry innovation and infrastructure) as well as SDG 10 (Reduced inequalities). Additionally, it contributes to SDG 8 (Decent work and economic growth) by supporting women in their career development and promoting their economic empowerment. By connecting this initiative to the SDGs, the global importance of supporting women in STEM is emphasized and better understood.

The CWS offers a range of career counselling services, including:

Individual counselling sessions.	Group internships in STEM-related areas.	International student exchange programmes in STEM.

Mathematics mock exercises are offered to prepare women students for international exams, as well as guidance on navigating the STEM system and accessing protective measures. Collaboration with international and national bodies and local authorities is pursued to ensure effective representation and support. The CWS conducts workshops and training sessions on STEM careers, gender equality and leadership, as well as entrepreneurship and vocational skills development programmes, to encourage career growth and economic empowerment.

Support services offered:

- Mathematics mock exercises
- CWS provided workshops and training sessions
- Collaboration with international and national bodies and local authorities
- Research Support
- Community Services
- Mentorship Programmes

For research support, the CWS assists with paper publications and facilitates lab connections throughout Pakistan to foster research collaboration. It has also developed labs at Shaheed Benazir Bhutto Women University Peshawar by securing national and international funding and provides scholarships for women in STEM to support advanced education. Additionally, the CWS offers community services for women graduate colleges in Khyber Pakhtunkhwa (KPK) and connects high school girls to STEM to inspire and support future generations.

Mentorship programmes can furthermore foster inclusive growth and development, bridging gaps in education, employment and social inclusion, particularly for marginalized groups, by providing guidance, support and opportunities for skills development. The Black Youth Mentorship and Leadership Program in Canada illustrates the impact of such initiatives. By empowering Black youth with leadership skills, educational support and community engagement opportunities, the programme addresses social and economic disparities, contributing to increased career aspirations, self-esteem, confidence and educational goals for Black youth (case study 13).

13 Case study: Mentorship programme to improve social and economic outcomes of Black youth in North America: A case study of Black youth

Author: Bukola Salami, University of Calgary and Social Sciences and Humanities Research Council of Canada

Geographical scope: North America

The Black population in Canada has grown significantly, reaching 1.5 million people in 2021, an increase of 349,000 from 2016 to 2021 (Statistics Canada, 2023). This community currently constitutes 4.3 percent of the total population and 16.1 percent of the racialized population. The Black population is notably young, with a median age of 30.2 years compared to 41.2 years for the overall Canadian population, and has a higher proportion of children under 15 years old (26.1 percent compared to 16.5 percent).

Despite demographic growth, Black Canadians face significant social, economic and health disparities (United Nations Human Rights Council, 2017).

- **In 2021, the 1.5 million Black Canadians had lower employment rates and incomes than the general population (Turcotte, 2020).**
- **Nearly one-third of Black children lived in low-income households.**
- **Educational outcomes also lag, with only half of Black boys aged 13 to 17 in 2006 achieving post-secondary qualifications by 2016, compared to 62 percent of other boys.**

Factors contributing to these disparities include negative teacher attitudes, systemic racism, limited mentorship, resulting in poorer educational and economic outcomes (Codjoe, 2001; James and Turner, 2017).

Scientific findings indicate that Black-focused education is effective in enhancing the academic success of Black youth (Dubois et al., 2011; Myers and Grosvenor, 2011; Maylor, 2013). Studying Black history has been shown to boost learning motivation and elevate achievement by addressing low self-esteem issues (Irving, 2000; Kempf and Dei, 2020). Furthermore, research highlights that having Black teachers can reduce alienation and expulsion rates among Black students, while increasing their self-esteem and university attendance rates (Egalite et al., 2015; Lindsay and Hart, 2017; Gershenson et al., 2018).

Recognizing this, the Black Youth Mentorship and Leadership Program was established in 2019–2020, funded by the Government of Canada. This programme aims to empower Black youth in grades 10 (15–16 years old) and 11 (16–17 years old) through leadership skills development, post-secondary education support and community engagement. It includes workshops, career development panels, research practice, mentorship and professional shadowing (University of Calgary, 2024).

The programme's design is based on participatory action research conducted by the University of Alberta, involving over 200 Black parents, community leaders and service providers. This research identified barriers such as racism, lack of Black mentors, and systemic educational biases (Alaazi

Photo by The University of Calgary

et al., 2017). Upon completion of the research project, a stakeholder engagement day (Yohani et al., 2017) was organized, which emphasized the need to create mentorship for both parents and youths and to capitalize on the resources within the community.

Over the past five years, the programme has positively impacted around 150 Black youth, leading to its expansion to the undergraduate level. Programme participants have engaged in initiatives like a COVID-19 vaccine hesitancy campaign, proposals for designing a Black youth hub, and creating resource booklets for Black parents and individuals in Alberta. They have also published opinion editorials on topics such as Black youth experiences in the educational system and mental health.

Programme participants have reported increased career aspirations, self-esteem, and confidence. Quantitative surveys showed a significant increase in confidence about completing university and aspirations to become leaders in their fields. For example, pre- and post-programme surveys indicated a 23 percent increase in confidence about university completion in 2020 and 2022, and an 18 percent increase in 2023. Additionally, participants reported feeling better about themselves and being a Black youth.

This initiative demonstrates the power of targeted mentorship and education programmes in reducing disparities and promoting equity within the Black community in Canada, enhancing the social, educational and economic outcomes for Black youth, and addressing SDG 1 (No poverty), SDG 2 (Zero hunger), and SDG 10 (Reduced inequalities).

Bibliography

Independent Group of Scientists (IGS) appointed by the Secretary-General. 2023. Global Sustainable Development Report 2023. Times of Crisis, Times of Change: Science for Accelerating Transformations to Sustainable Development. New York, United Nations.

United Nations. 2023. The Sustainable Development Goals Report. Special Edition. New York, United Nations. https://unstats.un.org/sdgs/report/2023/The-Sustainable-Development-Goals-Report-2023.pdf

Case study 1

Embassy of Switzerland. 2024. *Naryn Urban Resilience*. Bishkek, Kyrgyzstan, Embassy of Switzerland. https://www.eda.admin.ch/deza/en/home/themes-sdc/health-development/health-systems-sanitation.html/content/dezaprojects/SECO/en/2022/UR01373/phase1

Kabar News Agency. 2022. AKDN L*aunches Innovative Five-year Initiative to Strengthen Resilience of Naryn Town.* Bishkek, Kyrgyzstan, Kabar News Agency. https://en.kabar.kg/news/akdn-launches-innovative-five-year-initiative-to-strengthen-resilience-of-naryn-town/

University of Central Asia. 2024. *Certificate Programme in Urban Resilience.* Naryn, University of Central Asia. https://ucentralasia.org/schools/graduate-school-of-development/executive-education/certificate-programme-in-urban-resilience

University of Central Asia. 2024. *Naryn Urban Resilience Program (NURP) Program Overview.* Naryn, University of Central Asia. https://ucentralasia.org/schools/graduate-school-of-development/naryn-urban-resilience-program

University of Central Asia. 2024. *University of Central Asia signs MoU with Naryn State University to Promote Sustainable Development of Naryn.* Naryn, University of Central Asia. https://ucentralasia.org/news/2023/december/university-of-central-asia-signs-mou-with-naryn-state-university-to-promote-sustainable-development

Case study 2

Anokye, N. A. and Potakey, H. M. D. 2023. *Understanding the Nexus of Mangroves and Women in Ghana. Technical Report.* Washington, D. C., The World Bank. https://www.wacaprogram.org/sites/waca/files/knowdoc/Mangroves%20and%20Women_Ghana.pdf

Asare, A. 2017. *Profiling of Oyster Fisheries Report. The USAID/Ghana Sustainable Fisheries Management Project (SFMP).* Narragansett, RI, Coastal Resources Center, University of Rhode Island. https://pdf.usaid.gov/pdf_docs/PA00T4GH.pdf

Asare, B., Obodai, E. A. and Acheampong, E. 2019. *'Mangrove oyster farming: Prospects as supplementary livelihood for a Ghanaian fishing community.'* Journal of Fisheries and Coastal Management, Vol. 1, pp. 7–14.

Development Action Association. 2018. *Mangrove replanting at Densu estuary. The USAID/Ghana Sustainable Fisheries Management Project (SFMP).* Narragansett, RI: Coastal Resources Center, University of Rhode Island and Densu Oyster Pickers Association.

Global Mangrove Alliance 2023. *Mangrove Law and Policy. Global Mangrove Alliance.* https://www.mangrovealliance.org/wp-content/uploads/2023/12/GMA-Policy-Brief_V6.pdf

Hayford, A., Effah, J. E., Fuseina, I., Abednego, P. and Richard Y. 2021. 'Women in West African mangrove oyster (Crassostrea tulipa) harvesting, contribution to food security and nutrition in Ghana.' *Oceanography and Fisheries*, Vol. 14, No. 1, p. 555878.

Macfadyen, G., Vilela López, B., Thiao, D. and Ward, A., 2023. T*he Mangrove Oyster Value Chain in the Gambia: Summary Analysis and Design Report.* Rome, FAO.

Naidoo G. 2023. 'The mangroves of Africa: A review.' *Marine Pollution Bulletin*, Vol. 190, p. 114859. https://doi.org/10.1016/j.marpolbul.2023.114859

Roy, S., Dasgupta, S. and Miranda, J. J. 2023. *Benefits of Mangrove Afforestation and Restoration Programs in Ghana.* Technical Report. Washington, D. C., West Africa Coastal Areas High-Level Platform, The World Bank. https://www.wacaprogram.org/sites/waca/files/knowdoc/Mangroves%20Afforestation%20and%20Restoration_Ghana.pdf

Su, J., Friess, D. A. and Gasparatos, A. 2021. 'A meta-analysis of the ecological and economic outcomes of mangrove restoration.' *Nature Communications,* Vol. 12, Art. No. 5050. https://doi.org/10.1038/s41467-021-25349-1

United Nations Regional Information Centre. 2022. *Mangroves for Sustainable Development.* Brussels, Belgium, UN Regional Information Centre. https://unric.org/en/mangroves-for-sustainable-development/

Wabnitz, C. C. C., Cutting, A., Harper S. J. M., et al. 2023. Gender and Fisheries – The Republic of The Gambia. Country Fact Sheet. Ocean Risk and Resilience Action Alliance (ORRAA).

Case study 3

Eckstein, D., Künzel, V. and Schäfer, L. 2017. *Global Climate Risk Index 2018*. Bonn, Germanwatch. www.germanwatch.org/de/14638

Case study 4

Ataguba, A. G. and Angela, A. 2024. 'Hybridization and growth performance of progeny from crosses between *Clarias gariepinus and Heterobranchus sp.' Aquaculture Studies*, Vol. 24, No. 1, AQUAST1154.

Dahanayake, A. C., Webb, J. A., Greet, J. and Brookes, J. D. 2024. 'How do plants reduce erosion? An Eco Evidence assessment.' *Plant Ecology.* https://doi.org/10.1007/s11258-024-01414-9.

Fowdur, T. P. Rosunee, S., Ah King, R. T. F., Jeetah, P. and Gooroochurn, M. 2024. *Artificial Intelligence, Engineering Systems and Sustainable Development: Driving the UN SDGs.* Leeds, UK, Emerald Group Publishing.

Haider, H. 2019. *Climate Change in Nigeria: Impacts and Responses.* K4D Helpdesk Report 675. Brighton, UK, Institute of Development Studies.

Obada, D. O., Muhammad, M., Tajiri, S. B., Kekung, M. O., Abolade, S. A., Akinpelu, S. B. and Akande, A. 2024. 'A review of renewable energy resources in Nigeria for climate change mitigation.' Case Studies in Chemical and Environmental Engineering, Vol. 9, p. 100669.

Okeke, C. U., Ogunji, C. V. and Anieze, E. E. 2023. *Unlocking Adaptation Potential: Insights into Nigeria's Climate Change Policies, Initiatives and Local Actions.* Berlin, Africa Policy Research Institute.

Okon, U. A., Usman, R., Katchy, U. I. and Salam, S. 2022. 'Community perception and adaptation to climate change in Benue State, Nigeria, 2021.' *PAMJ One Health*, Vol. 7, p. 37.

Saleem, M. 2022. 'Possibility of utilizing agriculture biomass as a renewable and sustainable future energy source.' *Heliyon*, Vol. 8, No. 2, p. e08905.

Tajudeen, T. T., Omotayo, A., Ogundele, F. O. and Rathbun, L. C. 2022. 'the effect of climate change on food crop production in Lagos State.' *Foods*, Vol. 11, No. 24, p. 3987.

USAID. 2023. *Nigeria Climate Change Country Profile. Fact Sheet* – November 29. Washington, D. C., USAID. https://www.usaid.gov/climate/country-profiles/nigeria

Case study 5

Ministry of Health (Tanzania Mainland), Ministry of Health (Zanzibar), National Bureau of Statistics, Office of the Chief Government Statistician (OCGS) and ICF. 2023. *Tanzania Demographic and Health Survey and Malaria Indicator Survey 2022 Key Indicators Report.* Dodoma, Tanzania, and Rockville, MD, Ministry of Health (Tanzania Mainland), Ministry of Health (Zanzibar), National Bureau of Statistics, Office of the Chief Government Statistician (OCGS) and ICF.

Shimpuku, Y., Mwilike, B., Mwakawanga, D. L., Ito, K., Hirose, N. and Kubota, K. 2023. 'Development and pilot test of a smartphone app for midwifery care in Tanzania: A comparative cross-sectional study.' *PLoS One*, Vol. 18, pp. 1–19. https://doi.org/10.1371/journal.pone.0283808

Case study 6

Aloysius, N. and Ananda, J. 2023. 'A circular economy approach to food security and poverty: A case study in food rescue in Sri Lanka.' *Circular Economy and Sustainability*, Vol. 3, pp. 1–22.

Mousa, T. 2020. 'Food Security, Food Waste, and Food Donation and Redistribution in Jordan.' *Austin Journal of Nutrition and Food Science*, Vol. 8, No. 3, p. 1145.

Onyeaka, H., Tamasiga, P., Nwauzoma, U. M., Miri, T., Juliet, U. C., Nwaiwu, O., and Akinsemolu, A. A. 2023. 'Using artificial intelligence to tackle food waste and enhance the circular economy: Maximising resource efficiency and minimising environmental impact. A review.' *Sustainability*, Vol. 15, No. 13, pp. 10482.

Shen, G., Li, Z., Hong, T., Ru, X., Wang, K., Gu, Y., Han, J., and Guo, Y. (2024). 'The status of the global food waste mitigation policies: Experience and inspiration for China.' *Environment, Development and Sustainability*, Vol. 26, No. 4, pp. 8329–8357.

Case study 7

Cuenca, R. 2020. 'Inequalities in access to education in Peru.' Journal of Education, 3(2), 45-56.

Díaz, J. 2019. *Rural Education in Piura: Challenges and Perspectives.* Lima, Peru, Institute of Peruvian Studies.

Flores, M. 2022. *Impact of ICT on rural education in Piura.* Lima, Peru, University of Piura.

Gómez, P. 2021. 'Technology and education: Experiences in Piura.' *Latin American Journal of Education*, Vol. 10, No. 3, pp. 112–129.

Hernandez, L. 2023. *Digital Divide in the Peruvian Educational System.* Lima, Peru, Institute of Peruvian Studies.

Ministry of Education of Peru. 2021. *Access to Technology in Education: Piura Report.* Lima, Peru, Ministry of Education.

Ministry of Education of Peru. 2021. *One Laptop per Child: Impact Report.* Lima, Peru, Ministry of Education.

National Institute of Statistics and Informatics (INEI). 2022. *National Teacher Survey 2022.* Lima, Peru, INEI.

United Nations. 2015. *Transforming Our World: The 2030 Agenda for Sustainable Development.* Geneva, United Nations.

UNESCO. 2021. *Sustainable Development Goal 4: Quality Education.* Paris, UNESCO.

University of Piura. 2022. *Impact of ICT on Academic Performance: Case Study in Piura.* Piura, Peru, University of Piura.

World Bank. 2023. *Education in Peru: Annual Report.* Washington, D. C., World Bank.

Case study 8

Amann, M., Bertok, I., Borken-Kleefeld, J., Cofala, J., Heyes, C., Höglund-Isaksson, L., Klimont, Z., Nguyen, B., Posch, M., Rafaj, P., Sandler, R., Schöpp, W., Wagner, F., Winiwarter, W. 2011. 'Cost-effective control of air quality and greenhouse gases in Europe: Modeling and policy applications.' *Environmental Modelling & Software*, Vol. 26, pp. 1489–1501. https://doi.org/10.1016/j.envsoft.2011.07.012

Klimont, Z. 2021. *Greenhouse Gas and Air Pollution Interactions and Synergies (GAINS).* Laxenburg, Austria, IIASA. http://gains.iiasa.ac.at

UNECE. 2024. *Air Quality Modelling Advances to Support Revision of the Gothenburg Protocol.* Geneva, UNECE. https://unece.org/environment/news/air-quality-modelling-advances-support-revision-gothenburg-protocol

World Bank. 2023. *Striving for Clean Air: Air Pollution and Public Health in South Asia.* New York, The World Bank. https://doi.org/10.1596/978-1-4648-1831-8

Case study 9

Kuhn, M., Eker, S., Reiter, C., and Liu, Q. 2023. *'Global systems analysis for understanding the drivers of sustainable wellbeing.'* W. Lutz and S. Pachauri (eds.), *Systems Analysis for Sustainable Wellbeing.* Laxenburg, Austria, IIASA, pp. 61–76.

Lutz, W., Striessnig, E., Dimitrova, A., Ghislandi, S., Lijadi, A., Reiter, C., Spitzer, S., Yildiz, D. 2021. *'Years of good life is a well-being indicator designed to serve research on sustainability.' Proceedings of the National Academy of Sciences*, Vol. 118, No. 12, p. e1907351118. https://doi.org/10.1073/pnas.1907351118

Case study 10

Hakizimana, E., Ingabire, M. C., Rulisa, A., Kateera, F., Van den Borne, B., Muvunyi, C. M., Van Vugt, M., Mutesa, L., Bron, G.M., Takken, W. and Koenraadt, C. J. M. 2022. *'Community-based control of malaria vectors using Bacillus thuringiensis var. israelensis (Bti) in Rwanda.' International Journal of Environmental Research and Public Health,* Vol. 19, No. 11, pp. 6699. https://doi.org/10.3390/ijerph19116699

Ingabire, C. M., Hakizimana, E., Rulisa, A., Kateera, F., Van den Borne, B., Muvunyi, C. M., Mutesa, L., Van Vugt, M., Koenraadt, C.J.M., Takken, W. and Alaii, J. 2017. Community-based biological control of malaria mosquitoes using *Bacillus thuringiensis var. israelensis (Bti)* in Rwanda: community awareness, acceptance and participation.' *Malaria Journal,* Vol. 16, pp. 399. https://doi.org/10.1186/s12936-017-2046-y

Kateera, F., Mens, P. F., Hakizimana, E., Ingabire, C. M., Muragijemariya, L., Karinda, P., Grobusch, M. P., Mutesa, L. and Van Vugt, M. (2015). 'Malaria parasite carriage and risk determinants in a rural population: a malariometric survey in Rwanda. *Malaria Journal,* Vol. 14, p. 16. https://doi.org/10.1186/s12936-014-0534-x

Rulisa, A., van Kempen, L. and Koch, D.-J. 2022. 'When local trade-offs between SDGs turn out to be wealth-dependent: Interaction between expanding rice cultivation and eradicating malaria in Rwanda. *Sustainability*, Vol. 14, No. 4, pp. 2100. https://doi.org/10.3390/su14042100

Rulisa, Alexis and van Kempen, Luuk and Hakizimana, Emmanuel and Koenraadt, Constantianus. 2023. Local resource mobilization for malaria vector control among Rwandan rice farmers: A pilot study into the role of community ownership.' *Journal of Health, Population and Nutrition*, Vol. 42, https://doi.org/10.1186/s41043-023-00345-x

Rulisa, A., van Kempen, L., Mutesa, L., Hakizimana, E., Ingabire, C. M., Kateera, F., Koenraadt, C. J. M., van Vugt, M., van den Borne, B. 2021. 'Willingness to contribute to bio-larviciding in the fight against malaria: A contingent valuation study among rice Farmers in Rwanda.' *International Journal of Environmental Research and Public Health*, Vol. 18, No. 21, pp. 11575. https://doi.org/10.3390/ijerph182111575

Rulisa, A., van Kempen, L. and Koch, D. J. 2023. 'Exploring willingness-to-pay for "malaria-free" rice among rural consumers in Rwanda: Examining the potential for a local voluntary standard.' *Agricultural and Food Economics*, Vol. 11, pp. 30. https://doi.org/10.1186/s40100-023-00271-w

Case study 11

Ellen MacArthur Foundation. 2017. A New Textiles Economy: *Redesigning Fashion's Future.* Isle of Wight, UK, Ellen MacArthur Foundation. https://www.ellenmacarthurfoundation.org/a-new-textiles-economy

Khajuria, A., Atienza V. A., Chavanich, S., Henning, W., Islam, I., Kral, U., Liu, M., Liu, X., Murthy, I. K., Oyedotun, T. D. M., Verma, P., Xu, G., Zeng, X. and Li, J. 2022. 'Accelerating circular economy solutions to achieve the 2030 agenda for sustainable development goals.' *Circular Economy*, Vol. 1, No. 1, p. 100001.

Sandin, G. and Hasselqvist, A. 2017. 'A framework for analysis of environmental impacts of textile fibers.' *Resources, Conservation and Recycling*, Vol. 125, pp. 242–254.

Case study 12

Hack, K. 2017. *Needs Analysis for STEM Higher Education in Pakistan.* London: British Council. https://www.britishcouncil.pk/about/research-reports/needs-analysis-stem-higher-education-pakistan

Pakistan Science Foundation. 2022. *STEM*. Islamabad, Pakistan, Pakistan Science Foundation. https://psf.gov.pk/stem.aspx

STEAM Pakistan. 2024. *STEAM Club*. Islamabad, Pakistan, STEAM. *https://www.steampakistan.com/*

STEM. 2023. *STEM Online Resources*. STEM. *https://stem.org.pk/*

STEM. 2024. *STEM Careers Programme*. Islamabad, Pakistan, STEM. https://stem.edu.pk/

STEM Visions. 2024. Website. Faisalabad, Pakistan, STEM Visions. http://www.stemvisions.pk/

Case study 13

Alaazi, D., Vallianatos, H., Yohani, S., Okeke-Ohejirika, P., Ayalew, T., Salami, B., Nsaliwa, C. 2017. *Parenting and Mental Health Promotion Practices of African Immigrants in Alberta*. University of Alberta, Canada. https://era.library.ualberta.ca/items/b61ad64a-92cc-4e41-9512-7e8c8a095548

Codjoe, H. M. 2001. 'Fighting a "public enemy" of Black academic achievement: The persistence of racism and the schooling experiences of Black students in Canada.' *Race, Ethnicity and Education,* Vol. 4, No. 4, pp. 343–375. https://doi.org/10.1080/13613320120096652

Codjoe, H.2006. The role of an affirmed Black cultural identity and heritage in the academic achievement of African-Canadian students. Intercultural Education, 17(1), 33–54. https://doi.org/10.1080/14675980500502271

DuBois, D. L., Portillo, N., Rhodes, J. E., Silverthorn, N., Valentine, J. C. 2011. 'How effective are mentoring programs for youth? A systematic assessment of the evidence.' *Psychological Science in the Public Interest*, Vol 12, No.2, pp. 57–91. https://doi.org/10.1177/1529100611414806

Egalite, A. J., Kisida, B. and Winters, M. A. 2015. Representation in the classroom: The effect of own-race teachers on student achievement. *Economics of Education Review*, Vol. 45, pp. 44–52.

Gershenson, S., Hart, C., Hyman, J., Lindsay, C. and Papageorge, N. W. 2018. *The Long-run Impacts of Same-race Teachers*. Working Paper No. w25254. Cambridge, MA, National Bureau of Economic Research.

Irvine, J. J. 2000. Afrocentric education: Critical questions for further considerations. D. S. Pollard and C. S. Ajirotutu (eds.), *African-centered Schooling in Theory and Practice*. Westport, CT, Bergin & Garvey, pp. 199-210.

Kempf, A. and Dei, G. J. S. 2020. 'Afrocentric education in North America: An introduction.' J. M. Abidogun and T. Falola (eds). *The Palgrave Handbook of African Education and Indigenous Knowledge.* Cham, Palgrave Macmillan, pp. 787–801.

Lindsay, C. A. and Hart, C. M. 2017. 'Exposure to same-race teachers and student disciplinary outcomes for Black students in North Carolina.' *Educational Evaluation and Policy Analysis*, Vol. 39, No. 3, pp. 485–510.

James, C. E. and Turner, T. 2017. *Towards Race Equity in Education:* The Schooling of Black Students in the Greater Toronto Area. Toronto, The Jean Augustine Chair in Education, Community and Diaspora, York University.

Maylor, U., Rose, A., Minty, S., Ross, A., Issa, T. and Kuyok, K. A. 2013. 'Exploring the impact of supplementary schools on Black and Minority Ethnic pupils' mainstream attainment.' *British Educational Research Journal*, Vol. 39, No. 1, pp. 107–125.

Myers, K. and Grosvenor, I. 2011. 'Exploring supplementary education: Margins, theories and methods.' *History of Education,* Vol. 40, No. 4, pp. 501–520.

Myers, K. and Grosvenor, I. 2011. 'Birmingham stories: Local histories of migration and settlement and the practice of history.' *Midland History*, Vol. 36, No. 2, pp. 149–162. https://doi.org/10.1179/004772911X13074595848915

Yohani, S., Salami, B., Mohamud, H., Alaazi, D., Ayalew, T., Vallianatos, H., Nsaliwa, C., Okeke-Ihejirika, P. 2017. *African Immigrant Child and Family Well-being in Alberta. First Stakeholders Meeting Proceedings.* University of Alberta, Canada. https://doi.org/10.7939/R3F766N12

Statistics Canada. 2023. *Black History Month 2023… by the numbers.* Ottawa, Statistics Canada. https://www.statcan.gc.ca/en/dai/smr08/2023/smr08_270

Turcotte, M. 2020. Results from the 2016 Census: Education and Labour Market Integration of Black Youth in Canada. Insights on Canadian Society. Ottawa, Statistics, Canada. https://publications.gc.ca/collections/collection_2020/statcan/75-006-x/75-006-2020-2-eng.pdf

United Nations Human Rights Council. 2017. *Report of the Working Group of Experts on People of African Descent on its Mission to Canada.* Geneva, Switzerland, UNHCR. https://www.refworld.org/reference/mission/unhrc/2017/en/118673

University of Calgary. 2024. *Black Youth Mentorship Program.* Calgary, University of Calgary. https://cumming.ucalgary.ca/research/bare/research/black-youth-mentorship-and-leadership-program

Follow us at x.com/ScienceTechUN

International Science Council

World Federation of Engineering Organizations
Fédération Mondiale des Organisations d'Ingénieurs