The Egyptian Cabinet
Information and Decision Support Center

CLIMATE PROSPECTS JOURNAL

CLIMATE COOPERATION FOR BETTER TOMORROW

NOVEMBER 2023 FIFTH ISSUE

QUARTERLY JOURNAL ISSUED BY THE EGYPTIAN CABINET'S
INFORMATION AND DECISION SUPPORT CENTER

A SPIRITED PLATFORM TO ACCELERATE CLIMATE ACTION

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About IDSC

Since its establishment in 1985, IDSC has undergone many facelifts to cope with the changes in Egyptian society. In its first phase (1985- 1999), IDSC dedicated its efforts towards the development of Egypt's information infrastructure. The establishment of the Ministry of Communications and Information Technology in 1999 was a turning point that marked IDSC's role as a think tank that supports the decision-making process in various development domains. Later, the Prime Minister's Decree No. 2085 of 2023 stipulated restructuring IDSC as a public service agency –with a legal personality– affiliated to the Prime Minister. Such decision was a culmination of IDSC's efforts as an outstanding government think tank supporting decision-makers locally.

IDSC has long adopted a vision implying that it should be distinguished in the field of decision support in various comprehensive development issues, conduct a constructive social dialogue, and enhance communication with Egyptian citizens, who are the ultimate goal of development. This qualifies IDSC to play a bigger role in public policy making process, reinforce the efficiency and effectiveness of development efforts, and entrench a knowledge-based community.

In order to support every decision-maker, IDSC is continuously striving to become one of the best think tanks at the local, regional, and international levels. This was accompanied by a regional and international acknowledgment of IDSC's critical role as a think tank. The results of the Think Tanks and Civil Societies Program (TTCSP) of the University of Pennsylvania announced in February 2021 were substantial evidence. They revealed that IDSC was chosen among the best 20 think tanks in the world responding to COVID-19 pandemic in 2020 (No specific ranking for the list is mentioned), ranked 21st out of 64 think tanks globally as the owner of the best new idea or paradigm developed in 2020, taking into consideration that no other Egyptian think tank was classified in this criterion, and ranked 14th out of 101 think tanks in Africa and the Middle East for 2020. Moreover, IDSC won one gold award and four bronze awards in the Stevie Awards, announced in April 2022, out of over 700 competing teams from 17 countries in the Middle East and North Africa (MENA). It also won the American Special Achievement in GIS (SAG) Award in June 2022 for the digital publication of "Egypt's Description by Information" among nearly 100,000 international institutions.

Climate Prospects Journal

Climate Prospects Journal is one of the peer-reviewed scientific and applied publications issued quarterly by the Egyptian Cabinet's Information and Decision Support Center (IDSC). It is especially important due to the urgent priority attached to climate action on the national and international development agendas to safeguard human existence and safety against the repercussions of climate change and extreme weather phenomena.

The first issue was launched in November 2022 on the sidelines of Egypt's hosting of the 27th Conference of the Parties (COP27) of the United Nations Framework Convention on Climate Change (UNFCCC) from November 6 to 18 in Sharm El-Sheikh. It emphasizes the keenness of IDSC -the government think tank of the Egyptian Cabinet- on adhering to its role of supporting all decision-makers.

Climate issues are multidimensional and global, imposing their direct and indirect impacts on all aspects of development. In an attempt to shape the present and future changes and explore their implications on opportunities and challenges, Climate Prospects is introduced to be a new platform for analytical insights, ideas, and initiatives. It analyzes experiences to enrich national, regional, and international climate action.

The Journal addresses every decision-maker, including the public-policy maker and the executive teams, public and private institutions, and the citizen who wants to obtain trusted information. Hence, the community's visions and knowledge will be promoted along with a change in behaviors for a proper climate action.

CLIMATE PROSPECTS

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THE ECONOMIC STATUS NECESSITATES ENCOURAGING

THE PRIVATE SECTOR TO PLAY A GREATER ROLE IN:

PROVIDING THE NEEDED FUNDING FOR ECO-FRIENDLY PROJECTS, PROMOTING THE USE OF CLEAN ENERGY SOURCES, AND ADOPTING THE REQUIRED POLICIES AND MEASURES.

EGYPTIAN PRESIDENT

ABDEL FATTAH EL-SISI

Source: State Information Service (SIS), "President Sisi Opens The Annual Meetings Of The African Development Bank Group In Sharm El-Sheikh.", May 23, 2023.

CLIMATE CHANGE IS ONE OF THE MOST VITAL ISSUES ON OUR GLOBAL AGENDA. IT IS ALSO PIVOTAL FOR OUR AFRICAN CONTINENT, IN LIGHT OF ITS INTERRELATED NATURE, BOTH IN TERMS OF ITS IMPACT ON THE DEVELOPMENT AND LIVELIHOODS OF OUR COUNTRIES AND IN TERMS OF ITS DIRECT IMPACT ON OUR ABILITY TO PROMOTE MUCH-NEEDED DEVELOPMENT FOR OUR COUNTRIES AND PEOPLES. THIS ASSESSMENT OF THE NATURE OF THE PROBLEM WAS THE DRIVING FORCE BEHIND DRAFTING THE VISION AND PRIORITIES OF COP27, WHICH WAS HELD IN SHARM EL-SHEIKH IN NOVEMBER 2022.

PRIME MINISTER OF EGYPT

DR. MOSTAFA MADBOULY

Source: Egyptian Cabinet, Prime Minister's Speech at African Climate Summit Preparatory Meeting in Kenya, July 12, 2023.

CLIMATE PROSPECTS

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Acknowledgement

The Editor-in-Chief voices her special thanks to all the authors for their valuable contributions, the experts who refereed the research papers, and the Journal's work team. Thanks go to Chairman of the Suez Canal Authority (SCA), Admiral/ Osama Rabie, and his team for their efforts in drafting the Issue's Theme section. She also expresses her gratitude towards Head of Quality Department at IDSC, Ms. Heba Abo El-Wafa, and Executive Director of Quality Department, Mr. Hesham Aly.

Commentary of Editor-in-Chief

An opinion piece published in The Guardian on October 9, 2023, shed light on the dreadful cost of extreme climate events afflicting the world. Statistics indicate that an average of USD 16 million were lost per hour over the last twenty years. More clearly, the costs incurred due to the damage caused by climate incidents amounted to USD 2.8 trillion from 2000 to 2019, equivalent to USD 140.2 billion yearly on average.

Expectedly, the cost incurred by humanity escalates yearly with the increasing severity of harsh weather, which is no longer a secret. In 2022, it reached USD 280 billion, which equals double the annual cost incurred in the last twenty years on average.

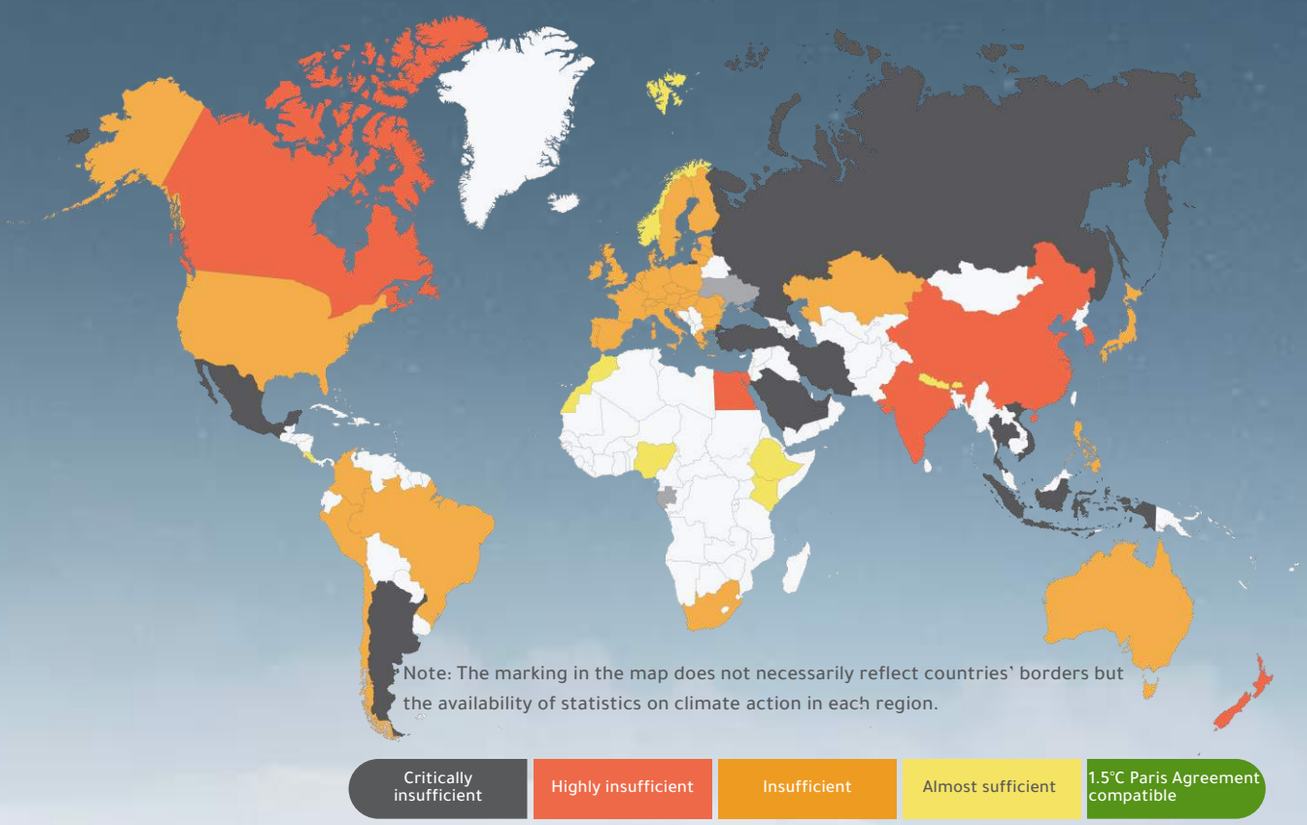
The absolute value of the lost sums due to climate change is profoundly significant. It also coincided with the erosion of global human and social capital. When compared to other affairs, the actuality of that cost becomes clearer. For instance, the climate events cost in 2022 equaled:

- 700% of the total value of the annual financing package set by the World Bank to aid developing countries in facing extreme weather events in FY 2024/2025, equivalent to USD 40 billion. It is going to be injected into projects that can help boost adaptation and resilience capabilities and preserve the ecosystems and environmental diversity.
- 117% of total direct investments targeted to be injected in 680 green hydrogen megaprojects proposals until 2030. This percentage was announced in 2022 at the international level, according to a report issued in September 2022 by the Hydrogen Council and McKinsey & Company. However, the actual implementation of these projects is slow as the final investment decision settled on 10% of the said (valued at USD 22 billion).
- 56% of the total value of green bonds issued globally in 2022, estimated at USD 500 billion. Notably, the cost of climate damage in that year is equal to the value of green bonds issued by the top 6 issuance countries: China (USD 85.4 billion), USA (USD 64.4 billion), Germany (USD 61.2 billion), the Netherlands (USD 26.7 billion), France (USD 24.8 billion), and the UK (USD 18.4 billion).
- 34% of the total value of the 2022 global cross-border mergers and acquisitions, estimated at roughly USD 832 billion, according to the data of S&P Global Market Intelligence.
- 22% of the total global foreign direct investment flow in 2022, registering USD 1.3 trillion, according to the statistics of the United Nations Conference on Trade and Development (UNCTAD).
- 9% of African countries' GDP combined in 2022, accounting for USD 3.0 trillion, according to the International Monetary Fund (IMF).

In light of numerous pieces of evidence and proof, it is safe to say that the continued failure to advance climate action considerably in all aspects of life will inevitably cost humanity a fortune, with no exceptions. The Climate Action Tracker (CAT) points out that climate action performance in all countries ranges from almost sufficient, insufficient, highly insufficient, and critically insufficient. The list is devoid of any country compatible with the Paris Agreement goal (1.5°C).

Figure 1

Climate Action Tracker, the world's state in November 2023



Source: Climate Action Tracker, November 2023.

Convening in Dubai, UAE, will the world rise to the occasion in COP28? Will it progress rapidly to promote climate prosperity? Will it finally break free from its comfort zone, overshadowed by climate action stagnation? The upcoming days and months will tell.

BY. EDITOR-IN-CHIEF
DR. RASHA MOUSTAFA AWAD

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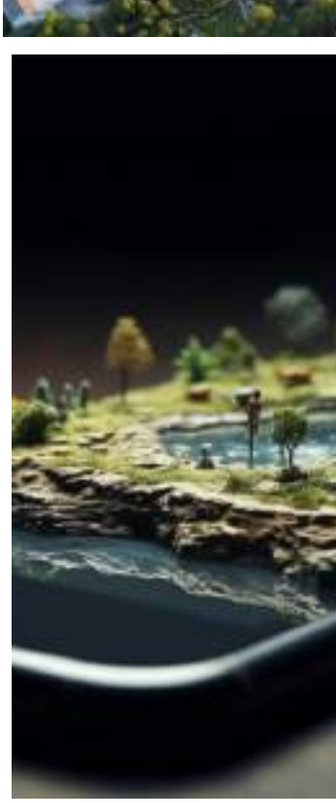

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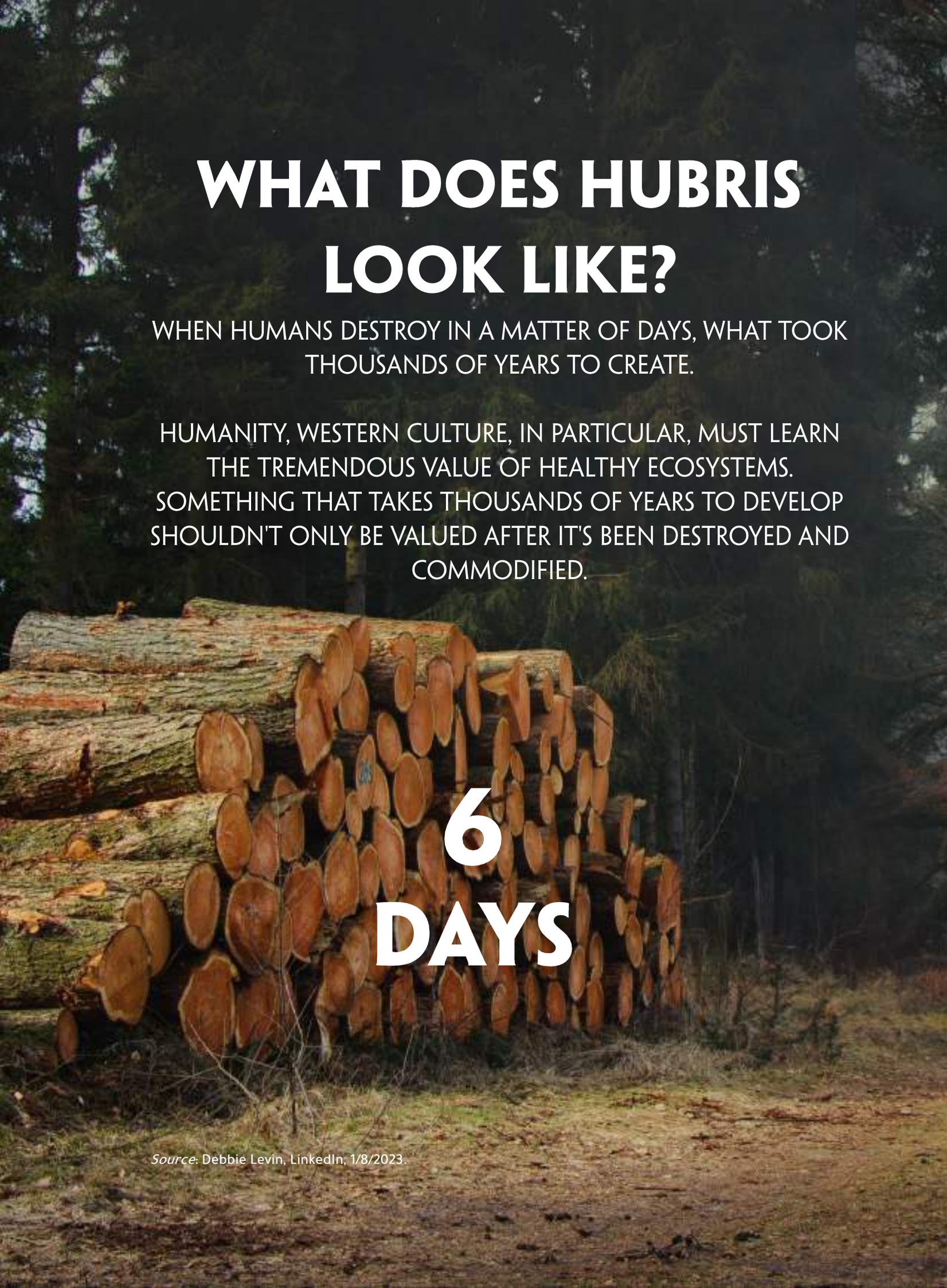

WHAT DOES HUBRIS LOOK LIKE?

WHEN HUMANS DESTROY IN A MATTER OF DAYS, WHAT TOOK THOUSANDS OF YEARS TO CREATE.

HUMANITY, WESTERN CULTURE, IN PARTICULAR, MUST LEARN THE TREMENDOUS VALUE OF HEALTHY ECOSYSTEMS. SOMETHING THAT TAKES THOUSANDS OF YEARS TO DEVELOP SHOULDN'T ONLY BE VALUED AFTER IT'S BEEN DESTROYED AND COMMODIFIED.

6 DAYS

Source: Debbie Levin, LinkedIn, 1/8/2023.

1,000 YEARS

Debbie Levin

CEO at the Environmental Media Association, She is considered one of the most influential people in the environmental movement and entertainment industry.

GIS For Climate Action

Esri is one of the leading companies according to the Forrester New Wave: Climate Risk Analytics

Mr. Sohail Elabd

Director of International Strategies at Esri

Mr. Elabd is an expert in geospatial technology. Elabd brings over 28 years of experience in driving national government GIS strategies, partnerships & alliances, and business development across emerging markets in the Middle East & Africa.

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Amidst the escalating concerns of global climate change, GIS emerges as an indispensable tool in the scientific community's arsenal. Through GIS, researchers are able to visualize and analyze the impacts of rising temperatures, changing precipitation patterns, and other climate-induced shifts on ecosystems and human societies.

Summary

Esri technology is playing a vital role in studying the environmental impacts of climate change. GIS, remote sensing, modeling, AI, and GeoAI are all powerful tools that can be used to better understand and address the climate crisis.

We all have a role to play in building a more sustainable future. By building green smart cities, investing in green transportation and infrastructure, and making small changes in our own lives, we can make a difference at global, regional and local levels.

Our commitment extends to future generations. We need to educate them about the climate crisis and the role of GIS in understanding its environmental impacts and helping them take action.

GIS for Climate Action

Forrester New Wave Report: Climate Risk Analytics

Esri is the global market leader in Geographic Information Systems (GIS) and Location Intelligence. The company's innovations support 350,000 organizations and empower more than 1 million users worldwide. Director of International Strategy, Mr. Sohail Elabd, explains how location intelligence help global leaders to understand climate change, realize the impact on many walks of life, and plan preventive actions. He shares global examples as well cases from Africa and Egypt.

GIS: The Advanced Lens of Environmental Study

Today, equipped with Esri's Geographic Information System (GIS) technology and the emerging realm of AI and GeoAI, geography is not just about understanding our planet, but also about proactive conservation.

The advent of GIS has revolutionized spatial analysis. Imagine a platform that can collate, manage, and analyze massive datasets, weaving them into comprehensible visual narratives. With Esri's technology, experts worldwide are utilizing GIS capabilities to study complex climatic interactions and their repercussions.

Remote sensing, a critical component of GIS, enables scientists to monitor and record changes in the environment. By capturing data from satellites, aircraft, or drones, remote sensing creates a continual stream of information. This continuous flow allows for the monitoring of deforestation, glacier retreat, and the health of marine ecosystems, among other critical environmental indicators.

The coupling of modeling with GIS opens a realm of possibilities. Predictive models, based on current and historical data, can project future climatic events. These forecasts provide insights into events such as potential droughts, flood-prone areas, or even shifts in animal migration patterns.

Esri GIS: An Essential Tool in the Study of Climate Change

Amidst the escalating concerns of global climate change, GIS emerges as an indispensable tool in the scientific community's arsenal. Through GIS, researchers are able to visualize and analyze the impacts of rising temperatures, changing precipitation patterns, and other climate-induced shifts on ecosystems and human societies. By aggregating data from varied sources, GIS paints a detailed picture of how climate change is affecting biodiversity, water resources, and agricultural yields. This technology also aids in understanding the socioeconomic implications, such as migration due to sea-level rise or altered farming practices in response to shifting climate zones. Essentially, GIS bridges the gap between raw climate data and actionable insights, providing a platform for conducting holistic studies and strategies. Its role in deciphering the multifaceted dynamics of climate change is irrefutable, making GIS not just a technological marvel, but a beacon of hope in addressing one of the most pressing challenges of our time.

The insights derived from GIS enable policymakers to set forth directives that are not just reactive but proactive. Monitoring is equally crucial. Setting policies without a framework to track their impact is akin to shooting arrows in the dark. Esri's GIS technology ensures that these arrows hit the mark. By continually updating its data pools and refining its visual outputs, GIS provides a mechanism to gauge the effectiveness of environmental policies and initiatives.

One of the most groundbreaking aspects of modern GIS is its predictive modeling capabilities. By analyzing current and historical data, GIS can forecast future environmental scenarios. This goes beyond just predicting natural disasters. It can project patterns like declining biodiversity, potential droughts, or even the spread of infectious diseases in certain conditions.

Artificial Intelligence (AI) and geospatial artificial intelligence (GeoAI) are rapidly emerging technologies with the potential to revolutionize the study of climate change. AI and GeoAI can be used to automate tasks such as image classification and data analysis and develop new insights from geospatial data.

For example, AI can be used to identify and track changes in sea ice extent over time. This information can be used to improve our understanding of how climate change impacts the Arctic ecosystem. GeoAI can be used to develop new models of climate change impacts. For example, GeoAI can be used to predict how sea level rise will inundate coastal communities in the coming decades.

Building Green Smart Cities

Green smart cities are designed to be environmentally friendly and sustainable. They use technology to improve energy efficiency, reduce waste, and promote sustainable transportation. Esri worked with 4 successful green smart cities around the world, namely Norfolk-Virginia in the USA, Sydney in Australia, London in England, and Kitakyushu in Japan.

GIS is a powerful tool for planning and managing green smart cities. For example, GIS can be used to identify the best locations for renewable energy projects, such as solar panels and wind turbines. GIS can help design sustainable transportation systems, such as bike lanes and public transit networks.

Green transportation and infrastructure are essential for building a more sustainable future. We need to invest in public transportation, electric vehicles (EVs), and other forms of low-carbon transportation. We also need to build green infrastructure, such as rainwater harvesting systems and green roofs.

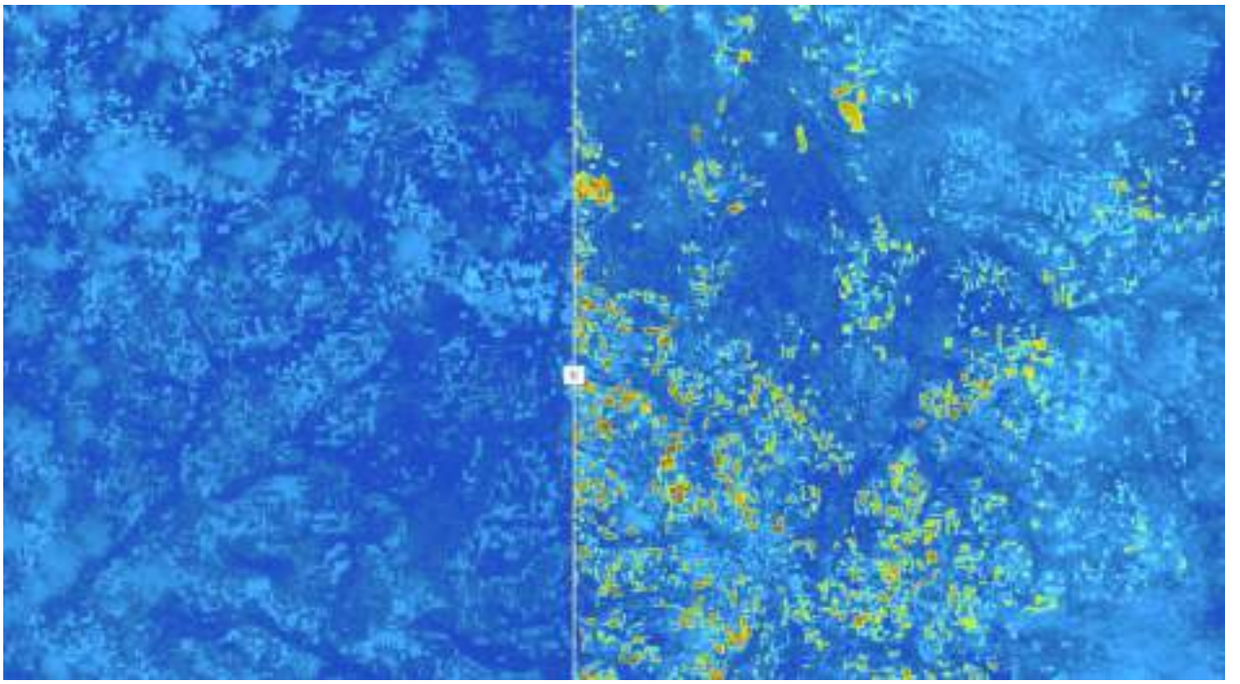
GIS can be used to plan and design green transportation and infrastructure projects. For example, GIS can identify the best routes for bike lanes and public transit lines and identify suitable locations for renewable energy projects and green infrastructure.

Geospatial Program for Agriculture in Africa

Africa, already struggling with low agricultural production and heavily degraded soils, is disproportionally affected by climate change including flooding, sea level rises, rising temperature, changes in rainfall patterns, which directly affect the agricultural landscape.

Through the Geospatial Program for Agriculture in Africa, Esri is enabling government agencies in the continent to implement a geospatial foundation for increased monitoring and understanding of the changing local conditions in relation to weather and land use patterns, land degradation, water allocation, yield and spread of pests and diseases compounded by climate change.

Using a combination of ready-to-use capabilities for extracting water balance and vegetation health indicators from imagery together with streamlined workflows for collecting (ground truth) data in the field or through IoT (Internet of Things) devices allows for near-realtime monitoring of water, soil, and crop conditions throughout the growing season. Having this data in the hands of decision makers in a timely fashion is crucial for quick decision support and intervention.



Moreover, using a combination of historic, current, and forecasted data, governments now can run multi-variable suitability and machine learning models to predict changes in crop suitability across the region and plan for the agricultural landscape of the future. Enabling forecasting and having access to predictive models are critical to ensure sustainable agricultural development and improve food security worldwide.

Protecting and Managing Biodiversity in Egyptian Nature Reserves

The Egyptian Environmental Affairs Agency (EEAA) has a responsibility for conserving and securing natural reserves which secure the ecosystem of our planet and play a key role in maintaining its balance, preserving important habitats, building resilience to climate change, ensuring global food security, maintaining water quality, and conserving natural resources.

EEAA used Esri technology in GIS and remote sensing to provide a quick, efficient, and reliable solution for understanding as well as monitoring the effects of the environmental hazards and climate change on natural reserves' biodiversity.

The project started with automating the daily monitoring activities of the natural reserves team. Interactive Dashboard was then used to enable a complete and instant view of the status, species frequency, and density cover of small mammals, big mammals, birds and vegetation. Finally, image analysis was used for studying the potential geo-environmental hazards related to climate change. This was achieved by generating a drainage network and watersheds for each natural reserve using a special precast watershed model and followed by morphometric analysis for these outputs to assess and spot the streams and watersheds that most likely represent a danger.

Egypt's Investment in GIS Education

Countries are investing in GIS education to ensure that future leaders have the skills and knowledge they need to address the climate crisis. Within context, Egypt recently signed an agreement with Esri to improve and promote GIS education in the country. Accordingly, all public universities in Egypt will receive a donation from Esri including the latest GIS technology, as well as training and knowledge transfer. This investment in GIS education will help Egypt develop a new generation of GIS professionals, who can play a leading role in addressing the climate crisis.

Esri GIS is an essential tool in the study of climate change - It keeps policy-makers informed with proactive monitoring and empowered with predictive modeling to improve the future of environmental conservation.

Small acts count - Every little bit helps when it comes to sustainability. Even small act –such as recycling, reduction of energy consumption, and composting– can make a big difference.

Egypt's investment in GIS education - Egypt recently signed an agreement with Esri to improve and promote GIS education in the country.

SUEZ Canal

A new strategy for a more eco-friendly maritime transport*

The Suez Canal Authority has adopted a new strategy for a more eco-friendly maritime transport. It is the "Green Canal" strategy, which puts the environmental dimension at the forefront of priorities. The strategy's goal is to achieve sustainable development through a clean, eco-friendly economy. It also supports the efforts of the International Maritime Organization (IMO) to reduce emissions resulting from the maritime shipping sector and promoting the trend of using clean, carbon-neutral fuels instead of fossil fuels. This strategy includes a group of initiatives and projects that cover various aspects of the navigation process in the Suez Canal, such as opting for eco-friendly fuel in operating its marine and land fleets, developing projects to generate electricity from renewable sources, establishing a new eco-friendly marina, and implementing measures to combat pollution and oil spills. An initiative was also launched to plant a tree for every vessel crossing the Canal, equivalent to planting 23,000 trees annually, which contributes to absorbing part of the harmful emissions released by vessels crossing the Canal.

* This file was prepared in cooperation with the Suez Canal Authority (SCA) of the Arab Republic of Egypt and other parties concerned. In this context, the Journal's editorial board extends its sincere thanks to the SCA's work team that drafted this file under the supervision of SCA Chairman, Admiral Osama Rabie.

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Suez Canal: Green Canal by 2030

Admiral/ Osama Rabie
Chairman of the Suez Canal Authority (SCA)

Admiral Rabie is SCA Chairman & Managing Director. He assumed the position of the Commander of the Egyptian Navy in 2015. He was also granted an MA in military science and naval studies.

A long time ago, Egypt took effective steps to reach a sustainable development model consistent with environmental conservation and climate change efforts. It, along with its political leadership, did not only believe in the right of its citizens and future generations to a better future, but it also recognized the golden opportunity offered in the green transition that would enable it to economically develop across various vital sectors.

The green economy may have become a pivotal issue for the economies of most countries because it targets improving citizen well-being, ensuring social justice, and reducing environmental risks.

As the Suez Canal Authority (SCA) is keen on effective participation in the country's development plans, it launched an ambitious strategy to transform into a green canal by 2030. The strategy aims at safeguarding the stability of global supply chains and maritime trade amidst environmental and climate challenges. It also targets committing to the standards of the International Maritime Organization (IMO) to reduce emissions generated by the maritime shipping industry in addition to encouraging the usage of carbon-neutral and clean fuel. Therefore, the efficiency and quality of the Suez Canal's services would be enhanced, enabling it to attract more clients. The Canal's role as a pivotal waterway for global trade and a principal partner in achieving climate change goals would also be consolidated.

SCA's strategy for the transition to a green economy relies on several initiatives and projects covering the different practical aspects of navigation in the Suez Canal. For instance, it will work on operating the 16 pilotage stations with renewable energy and running the engines of the affiliated marine units on natural gas. In addition, it shall enter into a contract with a Korean company to build 6 tugs and transform two ferries to run on liquefied natural gas (LNG) instead of fossil fuel. The ground transportation fleet shall operate with eco-friendly energy; moreover, vessels using clean energy and carbon-neutral fuel, such as green hydrogen, natural gas, methanol, and ammonia, shall be granted incentives.

Indeed, SCA is eager to promote its role in maintaining the Suez Canal as a safe zone against the risks of pollution and possible oil spill incidents. It has always complied with the marine safety procedures; its potential can satisfy all the prime requirements for addressing marine pollution whether at the human or technical levels, especially regarding its state-of-the-art pollution control skimmers. It has also acquired a holistic simulation system to train in controlling pollution.

Furthermore, SCA launched an initiative to plant a tree on every vessel crossing the Canal, which would amount to 23,000 trees annually. They should contribute to absorbing a portion of the harmful emissions of the vessels crossing the Canal. It also concluded an agreement with an international company specialized in collecting and recycling solid and liquid waste from crossing vessels. Lastly, it will establish the first eco-friendly marina in the Middle East.

Regarding the green economy, SCA participated in the events of COP27 through an important panel discussion titled "The Leading Role of the Suez Canal Authority in Maintaining Sustainable Green Supply Chains". It tackled several key topics by determining the environmental challenges facing the maritime transport industry and introducing diverse visions on means to benefit from the technological advancements in vessel construction. It discussed building a new generation of vessels that comply with the proper environmental standards.

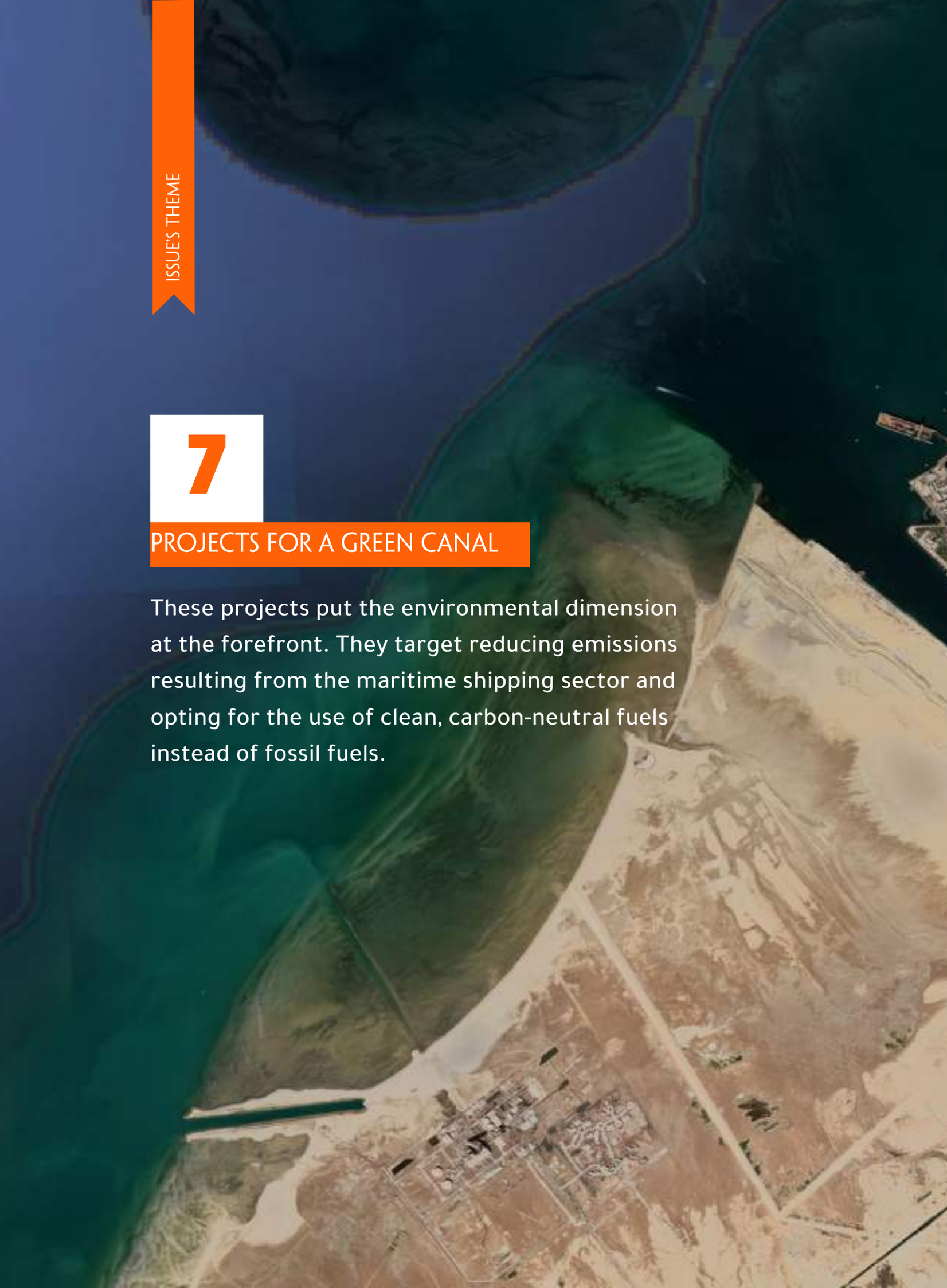
In conclusion, the Suez Canal has long reigned at the top of global navigational waterways and canals for over a century and a half. After adopting an ambitious strategy for the transition to a green economy, it has proven its entitlement to an absolute leadership. Its strategy aligns entirely with Egypt's public policy, calling for green policies in all fields, specifically the maritime field.

ISSUE'S THEME

7

PROJECTS FOR A GREEN CANAL

These projects put the environmental dimension at the forefront. They target reducing emissions resulting from the maritime shipping sector and opting for the use of clean, carbon-neutral fuels instead of fossil fuels.



1

The Suez Canal Economic Zone

The Project of Transforming the Suez Canal's Naval Fleet to an Eco-friendly Fleet

Project Summary

The Suez Canal is targeted to be green in line with the strategy adopted by the Suez Canal Authority (SCA) to prioritize the environmental aspect. It launched a prominent project to operate its tugs and ferries with natural gas, given that it is a clean fuel. The project truly implements Egypt's directives to achieve sustainable development through a clean and eco-friendly economy.

Goals:

- **Preserving the Canal's global standing by developing the naval fleet to cope with global advancements in transport: The Canal considers the necessity of environmental conservation and carbon emission reduction to curb climate change.**
- **Limiting the shipping industry's emissions and encouraging operating with clean and carbon-free fuel instead of fossil fuels: The project is expected to reduce CO_2 emissions by roughly 30%, remove 100% of the emissions of NOx and SOx, and completely prevent particle emissions.**
- **Rationalizing energy usage: The project shall reduce energy consumption by nearly 20% and enhance the security and services offered to vessels crossing the Canal.**

Executive Steps:

- Six new tugs running on dual-fuel engines (diesel and natural gas) are being manufactured, and 2 old ferries are being upgraded to run on natural gas instead of diesel.
- The naval staff training center is witnessing enhancements to qualify to train staff in building, maintaining, and operating naval units running on natural gas, ensuring their ability to work with the necessary technologies for the units' management and maintenance, according to the highest international safety and quality standards.
- A liquefaction unit was established at the northern entry point of the Suez Canal to provide liquefied natural gas (LNG).
- The prominent Korean expertise in this field was utilized. SCA has already been awarded a grant to conduct a feasibility study for the initiative, which will be finished soon. The project's technical studies will be finished by the end of 2024. The first tug is going to be received and operated by the end of 2025.

- Cooperation has been promoted between SCA and different bodies concerned to provide the necessary funds, including the Ministry of International Cooperation and the Ministry of Planning and Economic Development. The Ministry of Petroleum and Mineral Resources, a key element for the project's success, will provide compressed natural gas (CNG) to be converted into LNG through the unit to be built.

- The project's investment cost is roughly USD 150 million for the foreign components and EGP 450 million for the local components. The project's payback period (PBP) for the investment sum in case of operating the units using natural gas is after nearly 7 years of operation.

Expected Achievements:

- Egypt's efforts in sustainable development shall be boosted by integrating the environmental aspect in various local development fields, especially maritime transport. The project focuses on using natural gas as a clean and effective fuel in operating the naval units, compared to petroleum products, such as diesel that highly impact the environment.

- The project is expected to reduce carbon emissions due to LNG usage. Its impact would be greater if the project's scope were expanded to include fueling vessels with gas.

- The construction of naval units specialized in LNG shall be localized. SCA's shipyards offer strategic locations for establishing a prominent center at the level of Africa.

- The revenues will be substantial; the project will contribute to the optimal utilization of Egypt's natural gas and limit reliance on mostly imported fossil fuels. The project's net cash flow will reach roughly USD 773.4 million during the units' lifespan, which is estimated to be 25 years.

- Egypt's role as a significant regional gas trade hub shall be promoted. The project plans to establish a liquefaction unit at the northern entry point of the Suez Canal to provide LNG. As a result, new horizons would open up for service provision, such as fueling vessels crossing the Canal with gas, in addition to expanding endeavors to fuel the navy's fleet and any other Egyptian or foreign vessels with LNG, which was not available in Egypt before.

2

The Suez Canal Economic Zone

Ship Waste Collection and Recycling Project

Project Summary

A new service is going to be offered by Antipollution Egypt to vessels crossing the Suez Canal. Antipollution Egypt is a new joint stock company specializing in collecting solid and liquid waste, with investments amounting to USD 150 million. The service will be provided per European standards, using cutting-edge technologies and aligning with international regulations and Egyptian laws.

Goals:

- **Establishing an Egyptian joint stock company in partnership between SCA, represented by each of the Canal Rope Company and the Suez Shipyard Company, and the Greek company Antipollution.**
- **Collecting solid and liquid waste from vessels crossing the Suez Canal and constructing a waste recycling plant and another plant to generate electricity and produce green hydrogen.**
- **Recycling marine waste according to global standards and specifications and the environmental quality and safety conditions.**
- **Transforming the Suez Canal into a green canal in line with SCA's 2030 Strategy.**
- **Offering liquid and solid waste collection and recycling services will promote efforts to localize eco-friendly industries and activities to achieve the Sustainable Development Goals (SDGs); these services result from the strategy adopted by the Government to develop the concept of the Blue Economy.**
- **Stressing the importance of localizing modern waste recycling technologies: Waste is going to be transformed in the final phase to generate electricity and produce green hydrogen. Antipollution Egypt's waste collection and recycling system will be the latest worldwide.**
- **Optimally utilizing the Suez Canal and its surrounding area.**
- **Attracting more foreign investments and creating approximately 300 new job opportunities.**
- **Supporting the Suez Canal's efforts in implementing an ambitious strategy to diversify income sources and tap its assets and affiliated companies: It shall opt to introduce new activities and forge partnerships to exchange experience and share advanced technology. It also seeks to cope with the market requirements and development needs.**

- **Consolidating SCA's green transition efforts in preparation for announcing the Suez Canal as a green canal by 2030: The company's services include providing a range of eco-friendly logistical services like collecting solid and liquid waste from the vessels crossing the Canal. A waste recycling plant and another plant are going to be established to generate electricity and produce green hydrogen.**
- **Playing an important role in the Suez Canal area to embody a partnership not only at the level of companies or institutions, but rather a constructive partnership between Greece and Egypt: This cooperation will result in creating an added value through launching the solid and liquid waste collection service for the first time in the Suez Canal.**
- **Starting a new era in the history of international relations in a new field related to achieving environmental sustainability; investing this cooperation in maintaining the leading position of the Suez Canal in the field of maritime industry; achieving carbon neutrality; and ensuring the safe disposal of waste.**

Executive Steps:

- The project consists of several phases, starting from collecting waste from vessels in the Suez Canal to constructing a factory for generating electricity and producing green hydrogen.
- Necessary licenses for commencement are currently being obtained.
- Social contribution is an essential part of the project. Sessions are going to be held to raise awareness among the students and citizens of the Suez Canal's cities of environmental conservation. An educational platform will also be established in cooperation with the European academia and industrial sectors, qualifying graduates to work in the naval field.

Expected Achievements:

- The project is expected to attract investments exceeding USD 150 million over the next 10 years. Facilities shall be constructed to receive vessels carrying hazardous or non-hazardous waste and transform waste into energy.

3

The Suez Canal Economic Zone

Pollution Control Centers Development Project

Project Summary

SCA's pollution control centers are going to be developed, given SCA's environmental commitments to preserving the marine environment. It also plays a critical role, as stipulated in the national pollution control plan formed in cooperation with the Ministry of Environment.

Goals:

- **Providing SCA's pollution control centers with the latest equipment and simulation systems specialized in managing oil spill incidents.**
- **Coping with the growing needs of the Canal's ports that suffer from oil spill incidents of unknown origin and need a quick response to conserve the environment.**
- **Reducing vessel waiting time at ports, which may be affected by the duration specified for cleaning up.**
- **Maintaining the safety of the Suez Canal and its surrounding area against the potential risks of pollution and oil spills, along with complying with marine safety procedures.**
- **Setting groundwork for addressing oil spill incidents in the draft of Port Said and Port Tawfik.**

Executive Steps:

- Three MultiCleaner 128 pollution control units were handed over at the workshop of the Transit Department in Port Said after they had been manufactured at the French EFINOR, which is considered the biggest shipyard in the world specialized in manufacturing pollution control units.
- The new units are operating in the main pollution control centers affiliated with SCA's Transit Departments in three cities bordering the Canal. They are equipped with the latest navigation and radar systems to be able to navigate the Canal at all times, day or night.
- The water surface was cleaned up through collecting solid waste during absorbing the spill from water. Equipment was washed after spill absorption or in-situ burning using pumps with a capacity of 46 m^3/hour.
- A full-featured simulation is available to train on pollution control.

- An emergency oil pollution control plan was developed at SCA in line with its role in the national emergency plan for facing marine oil pollution accidents. Spots vulnerable to pollution risks were identified; in addition, a regulatory structure was formed for the control measures and management.

- Control measures have been executed at sites. Equipment was distributed among boats carrying oil skimmers and rubber booms at the three main centers and the 6 sub-centers in the pilotage stations to fully secure the waterway and the draft of Port Said and Port Tawfik.

Expected Achievements:

- New aluminum-based oil pollution control units (Skimmer 1, Skimmer 2, and Skimmer 3) will be the first of their kind in Egypt and the Middle East. They are designed according to the world's highest approved standards of oil pollution control units.

- The new units are going to be equipped with state-of-the-art oil spill control technology that allows them to automatically deal with oil spots easily, accurately, and quickly, opposing the traditional technologies used in the units of the main pollution control centers. They use skimmers to absorb oil according to the density, which requires certain accessories and surrounding the site with rubber booms.

- The new units will rely on front arms steered hydraulically to gather the oil at the unit's front and then absorb it using modern technologies that allow for separating oil and water. The skimmed oil is then stored in tanks with a capacity of 8 m^3, awaiting disposal in areas designated for receiving oils or floating tanks during sailing.

- SCA's readiness to immediately deal with any oil spill incident promptly and accurately at a high level of professionalism shall be promoted. For example, SCA could address some oil spill incidents, such as Al Samidoon (2004) and Philadelphia (2010).

4

The Suez Canal Economic Zone

SCZONE's Green Energy Industrial Park Project

Project Summary

The project culminates the State's strenuous efforts to transform the Suez Canal into a green canal. It aligns with the endeavors of the Suez Canal Economic Zone (SCZONE) in establishing a green economy and Egypt's vision on energy. The project entails establishing a modern industrial park for clean technology within the SCZONE.

Goals:

- **Establishing and operating an integrated industrial park for green energy, spanning an area of 2 million m^2 within the SCZONE within the framework of industrial development.**
- **Contributing to making the Suez Canal a catalyst for Egypt's future economic development endeavors: The project encompasses numerous agreements and promising logistical and industrial projects that can boost the Suez Canal's position, rendering it capable of competing with similar zones.**

Executive Steps:

- The financial and technical feasibility studies are going to be completed in 2024. The signing of the framework agreement took place inside SCZONE's pavilion in the Green Zone.
- An agreement for the electricity supply generated from solar energy sources with a capacity of 7 MW was signed with Jushi Company. Under the agreement, Jushi will assign its solar photovoltaic plant project to a consortium of Engazaat and CHINT Global.
- A contract was signed between ElSewedy Industrial Development Company and China's giant fiberglass corporation Jushi on the allocation of industrial land for an extension of Jushi's existing factory for sustainable fiberglass products within the Industrial (Industria) Sokhna project. The industrial complex spans an area of 60,000 m^2 and is an extension of Jushi's existing factory for eco-friendly, sustainable products. The facility shall consist of 4 production lines, with investments worth USD 920 million and a production capacity of 350,000 tons per year. Jushi will invest about USD 8 million, benefiting from the incentives provided by SCZONE.
- A contract was signed between ElSewedy Industrial Development Company, a subsidiary of ElSewedy Electric, and Futurefert, owned by the Emirati Sharqia Holding Limited, to allocate an industrial plot of land spanning an area of 127,000 m^2 within the Sokhna 360 project to establish a factory for sustainable agri-nutrients.

- The cooperation between both parties targets increasing Futurefert's investments in Egypt with about USD 50 million for the first and second phases. In the first phase, agri-nutrients will be produced, with a capacity of 300,000 tons.

Expected Achievements:

- The project targets the establishment of an industrial park specializing in green energy within SCZONE.
- Foreign investments in Egypt, especially in green energy, shall be boosted. The project entails cooperation with several foreign companies specialized in clean energy, such as Jushi, CHINT Global, and Futurefert, owned by Emirati Sharqia Holding Limited.
- Egypt's efforts in sustainable development will be promoted through the production of green energy in SCZONE. Cooperation between Egypt and the world in green energy and green technology will be enhanced, which would introduce Egypt to the international arena as one of the pioneering countries in the fight against climate change.
- The project is a genuine reflection of the Suez Canal's strategy that prioritizes the environmental aspect. It follows Egypt's directives to achieve sustainable development through an eco-friendly, clean economy and the efforts of the International Maritime Organization (IMO) to reduce emissions caused by the maritime shipping industry.
- The Suez Canal is targeted to be the next clean maritime transport hub. This initiative, in addition to others, is a key step to accomplishing the aspired goals for a better future and promoting eco-friendly, sustainable policies.
- The Suez Canal's commitment to transitioning to a green canal will positively affect maritime transport and all the international shipping lines, given its call for the transition to green energy.

5
The Suez Canal Economic Zone

The Project of Operating Pilotage Stations with Renewable Energy

Project Summary

Currently, the world is facing serious challenges like climate change and high energy costs; thus, SCA seeks to find innovative, sustainable solutions to enhance its services and conserve the environment. Among these solutions is an ambitious project to operate 16 pilotage stations with renewable energy at the Suez Canal.

Goals:

- **Improving the work of the Suez Canal pilotage stations that offer multiple services to vessels, such as directions, signaling, and communications: The project targets ensuring the safety and efficiency of the navigation flow for the vessels crossing the Canal and improving the stations' ability to evade collision, stranding, or damage incidents.**
- **Developing a ship steering system using satellites instead of tugs to declare the Suez Canal a green canal by 2030: There are 15 pilotage stations along the western bank of the Canal separated by approximately equal distance (roughly 10 km) and connected to the transit offices in Port Said, Suez, and Ismailia. Along the Canal's banks, buoys (guiding signals) are located to guide the vessels at night.**
- **Operating stations with renewable energy, instead of traditional energy sources to overcome the problems of high electric energy costs and power outage in some areas in addition to reducing CO_2 emissions affecting the environment.**
- **Generating electricity through solar panels and wind turbines to operate stations without the need for external electricity grids: The project is expected to save roughly 40% of the energy consumption rate and reduce CO_2 emissions by nearly 20%. The vessels' safety and service levels along the Canal will be enhanced.**

Executive Steps:

- A technical, environmental, and economic feasibility study was conducted. Solar and wind systems were developed, supplied, installed, run, maintained, and connected to pilotage stations. Performance and results have been monitored and assessed.

Expected Achievements:

- The project should achieve its goals and promote the Suez Canal's role as a green waterway that safeguards the environment and saves energy. This project reflects SCA's innovation and development endeavors, qualifying it to lead the maritime navigation field.

6
The Suez Canal Economic Zone

Green Ammonia Production Project

Project Summary

The project is a part of Egypt's green hydrogen project. The production of green ammonia involves using electricity to split water molecules into hydrogen and oxygen, known as electrolysis.

Goals:

- **The project is to be established under the framework of SCZONE's vision for the transition to a green economy.**
- **It is part of Egypt's plan to implement megaprojects to localize green fuel production along with its feeding and complementing industries.**
- **Green ammonia contributes effectively to reducing greenhouse gases as it produces hydrogen using renewable energy sources instead of natural gas or coal.**

Executive Steps:

- A framework agreement was signed among ACWA Power, a leading company in energy transition, the biggest private company operating in water desalination, and a pioneer in green hydrogen; the Sovereign Fund of Egypt (TSFE); SCZONE; the Egyptian Electricity Transmission Company (EETC); and the New and Renewable Energy Authority (NREA).
- Per the agreement, ACWA Power shall establish an action plan for the first phase with a production capacity of 600,000 tons of green ammonia annually, while expansion shall take place in the second phase with a production capacity of 2 million tons annually. Investments shall exceed USD 4 billion.
- SCZONE signed a memorandum of understanding with Energy China on the establishment of a green hydrogen industrial park to produce 1.2 million tons of green ammonia.
- As part of the project, some incentives shall be announced, such as land valuation, in addition to tax and financial incentives. The State's support aims at enhancing the business environment and offering incentives that can attract investments in this sector.

Expected Achievements:

- Egypt has already topped the Arab countries in terms of green ammonia export projects (12 projects).
- Egypt shall be one of the strategic sites for green ammonia usage as fuel for vessels.

7

The Suez Canal Economic Zone

The Project of Producing Green Methanol and Its Derivatives at the Suez Canal Economic Zone in Ain Sokhna

Project Summary

The project aims at promoting green transition of the Suez Canal Economic Zone through achieving leadership in producing green methanol and its derivatives. It shall enable the Zone to serve the sector of fueling ships with green fuel, eventually contributing to achieving the Egyptian State's goals of reducing pollution rates within marine shipping and reaching net zero carbon emission.

Goals:

- **Promoting the Egyptian State's goals represented in expanding projects of producing and using clean energy, such as green methanol and green ammonia, as well as achieving leadership in this sector.**
- **Improving Egypt's position as a main exporter of green fuel to European markets.**
- **Serving the sector of fueling ships with clean green fuel produced and made available by the Suez Canal Economic Zone.**
- **Tapping the considerable natural potential of Egypt, which allows carrying out world-class green methanol projects, such as reaching top-quality renewable energy sources, in light of the Suez Canal as the world's most significant trade route.**
- **Fostering the Suez Canal Economic Zone's transition to a green economy and its various industrial applications, including the green hydrogen industry as an important clean energy source globally.**
- **Tapping the great potential of the Suez Canal Economic Zone, represented in the integration between its ports and the industrial zones affiliated to it, in addition to the robust infrastructure of green hydrogen.**

- **Improving the status of the Suez Canal Economic Zone as a significant site along the Green Shipping Corridor.**

Executive Steps:

- A framework agreement among the General Authority for the Suez Canal Economic Zone, the Sovereign Fund of Egypt (TSFE), the New and Renewable Energy Authority (NREA), Egyptian Electricity Holding Company, C2X company –a subsidiary of multinational A.P. Moller Maersk– to implement a project for producing green methanol and its derivatives at the Suez Canal Economic Zone in Ain Sokhna.
- This framework agreement is the tenth one as part of the memoranda of understanding (MoUs) previously signed by the Suez Canal Economic Zone. An MoU was signed with Maersk in March 2023 to promote the green fuel industry in the Suez Canal Economic Zone.
- The investments in the first phase of the project amount to USD 3 billion.
- Work is afoot to supplement the current efforts of the Suez Canal Economic Zone represented in implementing the utility corridor, a route for supplying green fuel, after completing its manufacturing phases inside the industrial facility and storage processes to be transported and exported to the port to end up in all European markets.

Expected Achievements:

- The first phase of the project targets producing roughly 300,00 tons of green methanol annually and reaching one million tons annually once all phases are completed. This is attributed to the considerable potential of the project's location.
- It also aims at promoting the supply of green fuel to ships, which contributes to limiting pollution and reaching net zero carbon emissions.

Source: Wright. R, “The greatest threat to our planet is the belief that someone else will save it”, mood indigo living, April 19, 2023.

POLICY-ORIENTED PAPERS

Geography Matters: Coastal Green Hydrogen Hub as Key to Building Hydrogen Economy

This paper explains how a coastal GH_2 hub can catalyze an accelerating H_2 economy. This concept is envisioned to extend US decarbonization strategies to achieve net-zero GHG emissions by 2050.

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Hydrogen: Hype or Hope?

Hydrogen (H_2) presents a significant opportunity for modern energy systems. These systems are in the midst of the decarbonization transition due to public concerns about greenhouse gas (GHG) emissions, rapid technical innovation, the availability of specific energy resources, and the growing population from developing nations being lifted out of energy poverty[1]. High-carbon energy sources and carriers need to be replaced by low-carbon ones to handle the growing energy demand during the current energy transition[2]. While H_2 is not a panacea for this transition, it "uniquely complements and enables other decarbonization pathways such as direct electrification, energy efficiency measures, and biomass-based fuels"[3]. In other words, H_2 may assist other low-carbon technologies and energy efficiency improvements to achieve favorable decarbonization outcomes.

H_2 is the most abundant element available in the universe. On Earth, H_2 occurs naturally only in compound form with other elements in liquids, gases, or solids[4]. H_2 possesses many appealing physical properties. For example, it has a high energy density by mass. 1kg of H_2 (33.3kWh) stores about three times the energy content of 1kg of gasoline (12.2 kWh).

Tesla's 4680 lithium-ion batteries may reach 300Wh/kg. A few solid-state batteries may achieve less than 1kWh/kg, a fraction of H_2's density by mass[5]. H_2 also has environmental and health benefits since it does not generate carbon monoxide or sulfates when burnt in the air. Additionally, when H_2 is used in a fuel cell, it emits nothing but water (A fuel cell is a device that uses the chemical reaction between oxygen and hydrogen to produce electricity without combustion)[6]. H_2 is also used mainly as 1) a chemical feedstock and catalyst, 2) a chemical in ammonia production, 3) a hydrogenating agent in drug and food production, and 4) a chemical in petrochemical and refinery processing. Like electricity, H_2 may be utilized as an energy carrier to deliver, move, and store energy from other sources[7].

Nevertheless, H_2 production is costly and energy-intensive due to its separation from the hydrogen-containing feedstock with an energy source[8]. Standard large-scale production methods include natural gas steam methane reforming (SMR), nuclear high-temperature electrolysis, low-temperature electrolysis, biomass gasification, and coal gasification[9]. Electrolysis, a water-splitting H_2 production technology, is a "promising option for carbon-free hydrogen production from renewable and nuclear resources"[10]. Based on various technological methods and resources, H_2 can be described as black (coal), gray (natural gas), blue (coal/gas with carbon capture and sequestration), pink (electrolyzers with nuclear power), turquoise (pyrolysis through methane heating), and green or GH_2 (electrolyzers with renewable energy)[11]. This study, thus, focuses on GH_2 as a potential game changer for modern energy systems.

The enthusiasm surrounding H_2 as a low-carbon energy carrier is not new. For instance, in the 1970s, interest in H_2 was due to oil price shocks, gasoline shortages, acid rain, and air pollution. US federal government introduced the term hydrogen economy to define an industrial system running on nuclear and solar-generated H_2 [12.] The subsequent moderation in oil prices, public resistance against nuclear power, and air-pollution control measures lessened the H_2 excitement. In the 1980s, the rise in concern about climate change renewed the interest in H_2, with a focus on carbon capture technology, transportation, and renewable energy.

However, global oil prices remained low, lessening support for H_2 usage. In the early 2000s, climate change concerns led to renewed policy action, concentrating on peak-oil matters and the transportation sector. By 2010, the H_2 momentum diminished due to the peak oil concern's retreat, uncertainty about climate policy developments, and the rapid progress with battery electric vehicles. None of the waves of interest resulted in sustainable investment in the technology[13]. As a result, H_2 accounts for less than 1% of the current energy mix. It is mainly produced from unabated fossil fuels and is used on-site where it is obtained[14]. In essence, the lack of success in the previous H_2 scale-up was due to the dependence on high/rising oil and gas prices and the focus on one sector: transportation.

Although H_2 has not lived up to the hype for decades, there is hope that its time as a clean energy solution has finally come. Despite skeptics like Canadian businessman and investor Elon Musk, big investors such as Bill Gates and Andrew Forrest firmly believe in the GH_2 benefits[15]. In addition, H_2 supporters include the governments of the major economies, automakers, oil and gas companies, industrial gas producers, renewable electricity suppliers, gas/electric utilities, and engineering firms[16]. In fact, H_2 is hoped to regain momentum in the current energy transition thanks to four reasons. First, H_2 can deliver deep emissions reductions, especially in the hard-to-abate sectors: shipping, aviation, heavy-duty and long-distance road transport, steel and iron production, chemicals, high-temperature heating in industry, and building heating system. Second, H_2 can ensure the continuation of renewable electricity's growth. Third, technical innovation in other clean energy solutions can also benefit H_2 innovation. Fourth, H_2 can contribute to many policy objectives: economic development, energy access, local air pollution, and energy security[17].

Presently, energy security is at the forefront due to the Russia-Ukraine conflict. Europe's push to decrease its dependence on Russian gas is spearheading the push for GH_2. In July 2022, GH_2 cost less than natural gas in 8 European countries[18]. A nearly 450% jump in European gas prices over the past year has made the green fuel of the future cost-competitive about a decade ahead of schedule[19]. Thus, although gas prices may decline, this conflict solidified the political support and investor interest in scaling up the H_2 economy.

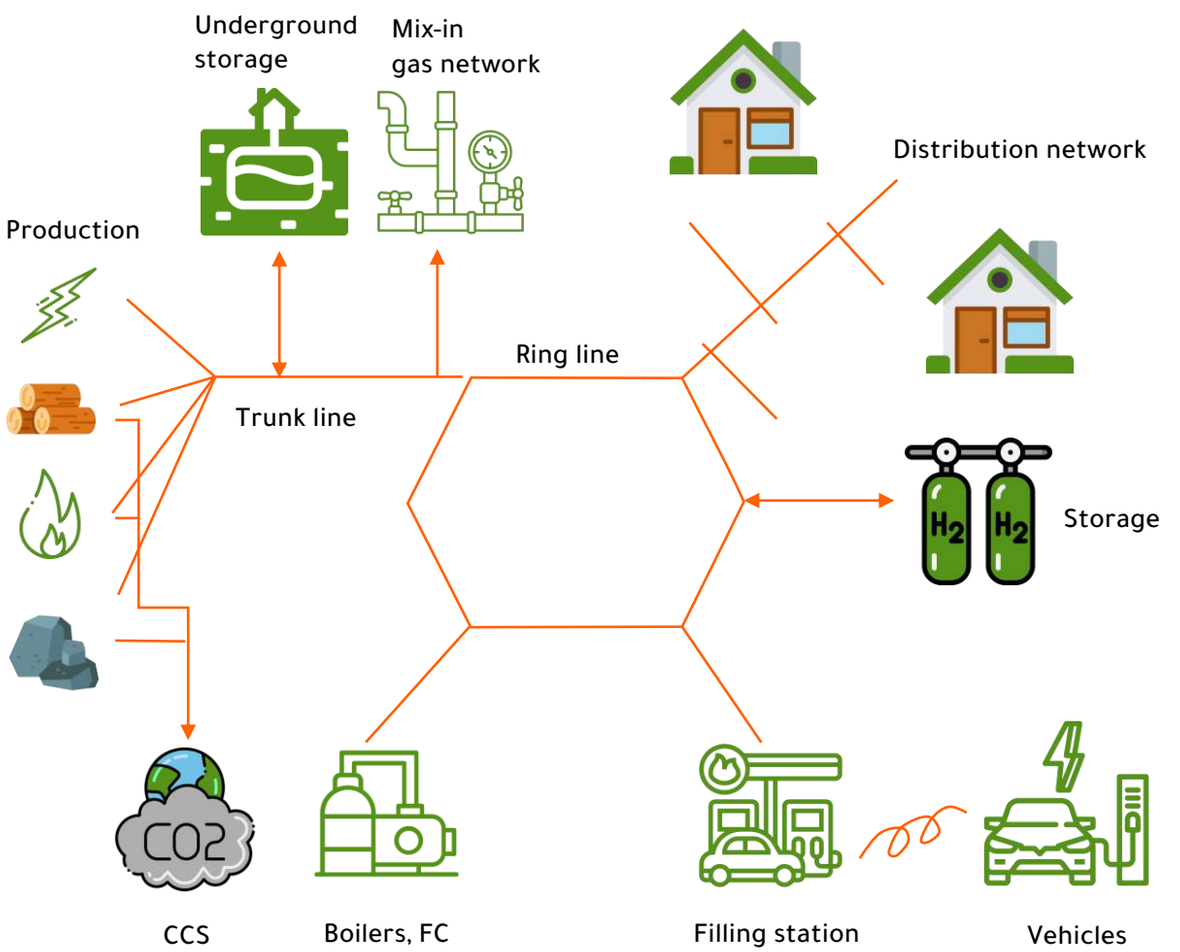
Hydrogen Infrastructure

H_2 infrastructure comprises production, storage, transmission, and distribution[20], as shown in Figure 1.

H_2 producers **can** use different technologies and energy input sources. An H_2 network is as follows: a trunk line feeds in a ring line around large demand centers (major cities), which, in turn, disperses in medium (industry, transport filling) and low-pressure distribution lines (households, service buildings) to end-users. Hydrogen can be consumed as such in boilers or fuel cells (stationary and mobile) or mixed in the natural gas grid. Several storage options can improve the flexibility of the H_2 line, such as sizeable underground storage on the trunk line level and local/regional storage on the ring line level[21].

Figure 1

Hydrogen (H_2) infrastructure



Source: Exploring the role of power-to-gas in the future Dutch energy system (p. 24) by Joode et al., 2014.[22]

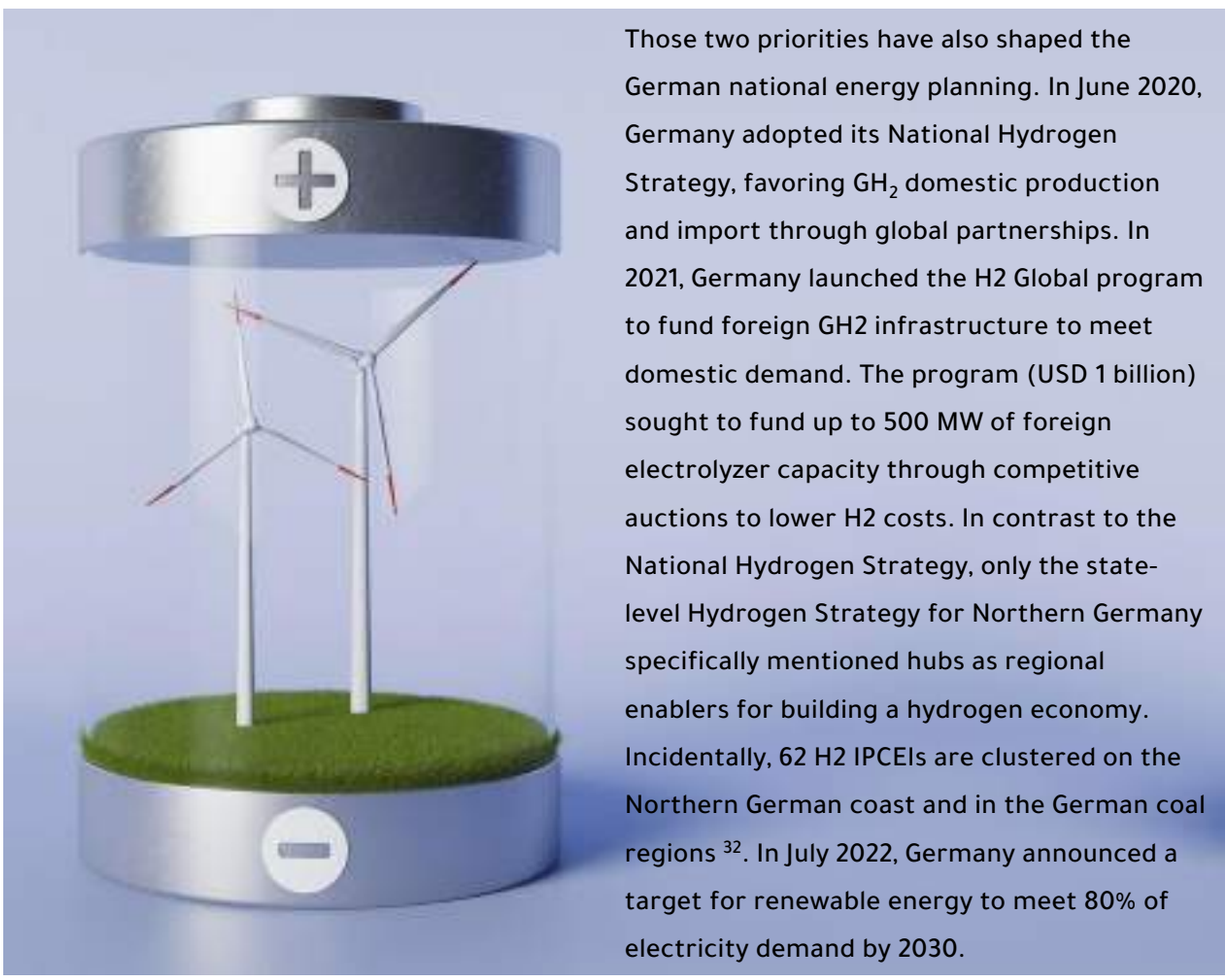
H_2 transportation, storage, and distribution represent the main challenges in integrating H_2 into the energy system[23]. H_2 transportation and storage are difficult due to H_2 's low-volumetric density at room temperature and capability to permeate metal-based materials. There are four main methods for H_2 transportation: tube trailers, pipelines, liquid tankers, and chemical hydrogen carriers. H_2 storage options are either physical-based (compressed gas, cold/cryo-compressed, liquid, and geological) or material-based (metal hydrides, absorbents, and chemical hydrogen carriers). No material-based storage options are ready for widespread commercialization[24]. H_2 distribution (dispensing and fueling) is the last vital part of H_2 infrastructure. Once the H_2 reaches a transmission hub or the import terminal, local distribution is necessary to deliver it to final users. Similar to transportation, the main options for H_2 distribution depend on volume, distance, and end-user needs. For example, the absence of H_2 fueling network in the transportation sector represents the main obstacle to fuel cell electric vehicle (FCEV) adoption since consumers would only purchase a FCEV if the stations existed to refuel it[25].

This paper would, therefore, highlight the significance of geography in creating an H_2 economy. It is organized into four main sections. After the Introduction, Section 1 describes the position and concept of the paper. Section 2 explains the opportunities and challenges for the concept expansion in the US. Section 3 delineates an analysis of the idea through case studies on the US Western and Gulf coasts. Section 4 discusses the recommendations for the concept expansion in the US. The paper concludes with a call for concept deployment. The following section describes the position and concept of this research paper.

Section 1: Position and Concept

The European Union (EU) field visits to the German Competence Center for Renewable Energies and Energy Efficiency in Hamburg University of Applied Sciences (CC4E/HAW Hamburg) and the Danish power company outlined the concept of this paper: a coastal GH_2 hub is a key to creating a hydrogen economy. A GH_2 hub is a regional network consisting of the production, end-use, and connective infrastructure needed to produce, transport, store, and use clean hydrogen in a functional regional market[26] First, Beba[27] introduced the Norddeutsches Reallabor project, a consortium of 53 Northern German partners from the business and science sectors as well as the government, attempting the holistic system integration through sector coupling with GH_2. Coastal states generate vast amounts of offshore/onshore renewable energy with additional potential for GH_2 production. Industrial clusters with gas/electricity grids are the backbone of this project, bundled into 4 coastal H_2 hubs around urban centers. Second, Ørsted's[28] whitepaper also provided the framework for GH_2 scale-up: 1) Accelerating renewable energy build-out, 2) supporting supply-side push through investment and operational support, 3) delivering demand-side pull through carbon pricing and quotas, 4) creating H_2 hubs, and 5) establishing standards and definitions for GH_2.

The study also conducted a literature review, which utilized various qualitative and quantitative sources to confirm the concept and perform the analysis. As mentioned in the introduction, energy security and climate change represent top priorities for EU policymakers. H_2 constitutes less than 2% of Europe's industrial energy consumption, and 96% of that H_2 is gray, derived from natural gas. In 2020, the EU launched its H_2 strategy and the European Clean Hydrogen Alliance, exploring how GH_2 may help decarbonize its economy cost-effectively, in line with the European Green Deal. Per the European Green Deal, the EU block pledged to lower emissions by at least 55% by 2030 (compared to 1990) and strive for the continent's climate neutrality by 2050. In May 2022, the EU announced the REPowerEU plan, which outlined a green hydrogen accelerator concept[29]. The plan targets 10 million tons of domestic renewable hydrogen production and 10 million tons of imports to the EU by 2030. The combined tonnage would need ~ 600GW of new solar/wind power and 200 GW of electrolyzers[30]. GH_2-hub-related initiatives are 1) H_2 infrastructure and investment scale-up, 2) proposal for a global European H_2 facility to foster business/investment opportunities in H_2 production, 3) Important Projects of Common European Interest (IPCEIs) to support innovation in the H_2 value chain, and 4) H_2 partnerships to facilitate the GH_2 import from third countries[31].



Those two priorities have also shaped the German national energy planning. In June 2020, Germany adopted its National Hydrogen Strategy, favoring GH_2 domestic production and import through global partnerships. In 2021, Germany launched the H2 Global program to fund foreign GH2 infrastructure to meet domestic demand. The program (USD 1 billion) sought to fund up to 500 MW of foreign electrolyzer capacity through competitive auctions to lower H2 costs. In contrast to the National Hydrogen Strategy, only the state-level Hydrogen Strategy for Northern Germany specifically mentioned hubs as regional enablers for building a hydrogen economy. Incidentally, 62 H2 IPCEIs are clustered on the Northern German coast and in the German coal regions [32]. In July 2022, Germany announced a target for renewable energy to meet 80% of electricity demand by 2030.

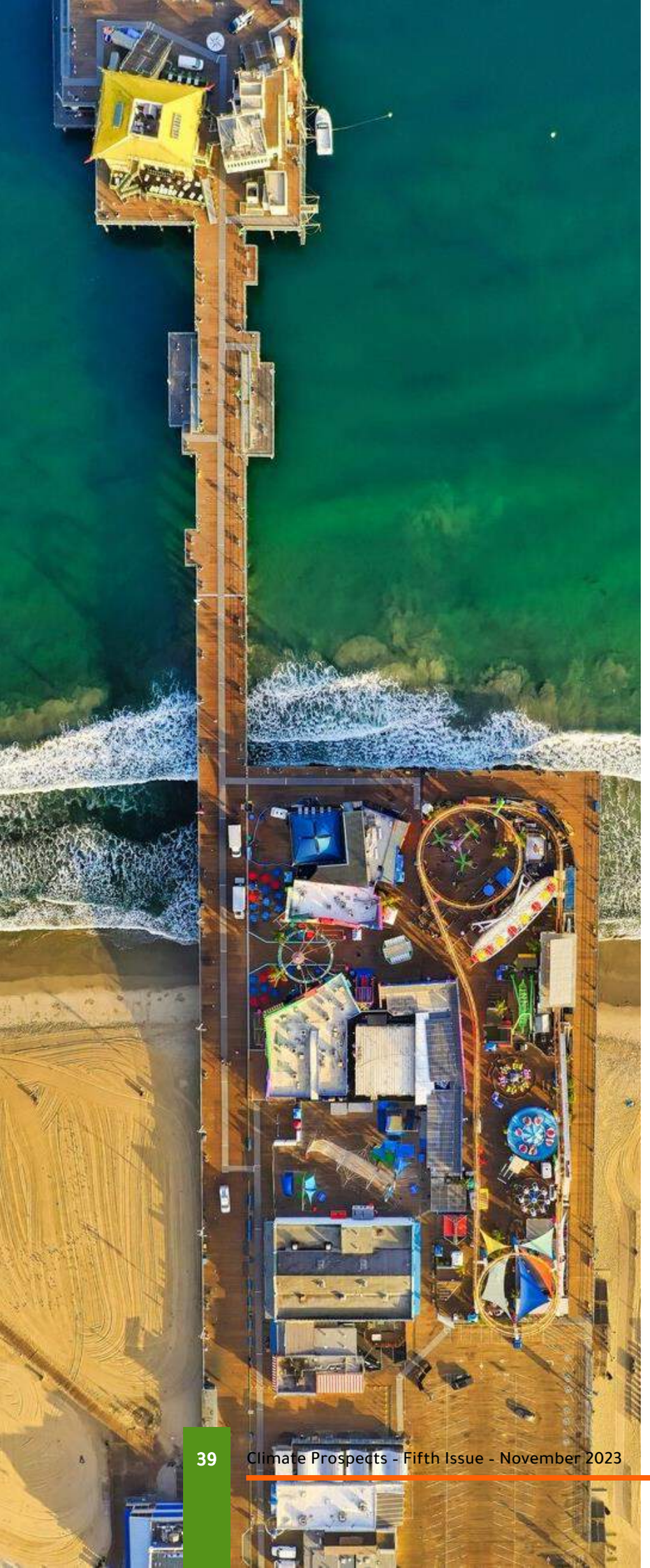
Northern Germany attempts to build a hydrogen economy by 2035. The selected unique regional opportunities for establishing the GH_2 infrastructure include: 1) Reliable offshore wind power with expansion potential that can be combined with coastal solar power for H_2 production, 2) seaports as locations for GH_2 import and export of H_2-related technologies/components, 3) underground storage formations (caverns) for H_2 storage, 4) industrial clusters with high-skilled workforce already using H_2 technology and infrastructure, 5) growing number of potential buyers from various sectors interested in GH_2, 6) H_2 pipelines and natural gas infrastructure for H_2 transport, 7) six government-supported projects testing H_2 infrastructure and additional research facilities, and 8) political will to support H_2 technology. However, the challenges are: 1) The lack of economically-viable business models for H_2 generation and usage, 2) the lack of compatibility or flexibility in the existing funding landscape with H_2 projects, 3) the capped expansion of renewable energy capacity due to strain on current German power transmission abilities, and 4) existing technical rules for H_2 blending in the gas infrastructure need to be adjusted[33].

Lastly, additional literature confirms the viability of the coastal GH_2 hub concept as a solution for creating a GH_2 economy. For instance, IEA[34] believes that coastal industrial clusters can serve as gateways to building clean hydrogen hubs, as shown in Figure 2.

Figure 2

Potential locations for coastal green hydrogen (GH_2) hubs

Source: The Future of Hydrogen (p. 178) by IEA (2019).[35]



Corbeau et al.[36] proclaim that "hubs at ports and industrial clusters will represent the first demand hydrogen centers, offering producers an area on which they can concentrate". Alicia Eastman, InterContinental Energy President, believes that coastal sites are keys to GH_2 production[37].

Based on the field-trip materials and literature review, the position and concept of this study are warranted concerning energy and the environment in the visited sites: a coastal GH_2. **A coastal GH_2 hub represents a solution for building a hydrogen economy**, especially in its early stages. An ideal coastal GH_2 hub, which promotes an effective holistic system integration, has the following characteristics: 1) A geographic cluster of facilities for renewable electricity generation with an additional capacity for GH_2 production, 2) sea/ocean ports as business and logistics hubs for the GH_2 import/export, 3) proximity to H_2 storage resources, 4) industrial clusters with a high-skilled workforce already using H_2 technology and infrastructure, 5) a large number of potential GH_2 off-takers from various sectors, and 6) H_2 pipelines, natural gas infrastructure, and other transportation modes for GH_2 transport. A supportive political environment is crucial for building a successful GH_2 economy. The following section outlines how this concept may be expanded in the US.

Section 2: Expandable Concept for the US?

The study's concept can be expanded in the US at possible locations with suitable components for an ideal coastal GH_2 hub. H_2 deployment is crucial for the US. Since the US has the world's largest economy, its decarbonization is essential for obtaining global GHG emissions reductions of the magnitude required to fight climate change. This section highlights opportunities and challenges for expanding this concept in the US.

Opportunities

Supportive Political Environment

In recent years, the US has started to create the solid groundwork for national H_2 solutions, despite an absence of an official H_2 strategy. In 2020, the US Department of Energy (DOE) published the Hydrogen Strategy and the Hydrogen Program Plan, outlining the strategic framework for nationwide H_2 deployment, as part of the H_2@Scale[38]program. In 2021, DOE launched the Hydrogen Energy Earthshot initiative to reduce clean H_2 costs by 80% to reach USD 1/kg by 2031[39]. In 2022, the US announced providing USD 9.5 billion in clean H_2 funding as part of the US Infrastructure Investment and Jobs Act (IIJA)[40] and granting DOE access to the USD 545 million Defense Production Act's emergency fund, which will also support domestic electrolyzer manufacturing[41]. The proposed Inflation Reduction Act (IRA-2022) is also poised to make US GH_2 the world's cheapest form of GH_2 under the tax-credit plan[48].

The H_2 hub concept is already well-recognized in the US since USD 8 billion of IIJA's federal investment has been allocated to the Regional Clean Hydrogen Hubs program (H_2Hubs). On June 6, 2022, DOE released a Notice of Intent to fund the program, whose eligible applicants include technology developers, state/local/tribal governments, industrial sector, utility commissions, etc. In addition, DOE's H_2-Matchmaker program sought to connect H_2 consumers, producers, and other stakeholders. In the early fall of 2022, DOE planned to publish the H_2Hubs funding announcement. Presently, DOE anticipates awarding funding to 6 to 10 H_2 hubs across the country, which are expected to be carried out over 8-12 years. DOE's program hopes to provide an award with a minimum range of USD 0.4-0.5 billion, and a maximum range of USD 1-1.25 billion, with a 50% minimum non-federal cost share. In choosing the projects, DOE will look for projects with geographic, feedstock, and end-use diversity. Further, DOE will prioritize projects that create employment opportunities and focus on environmental and energy justice, consent-based siting, labor and community engagement, and workforce development[43]. H_2 supporters view DOE funding for hubs as "deposits" that will fuel H_2 innovation and boost private investment[44].

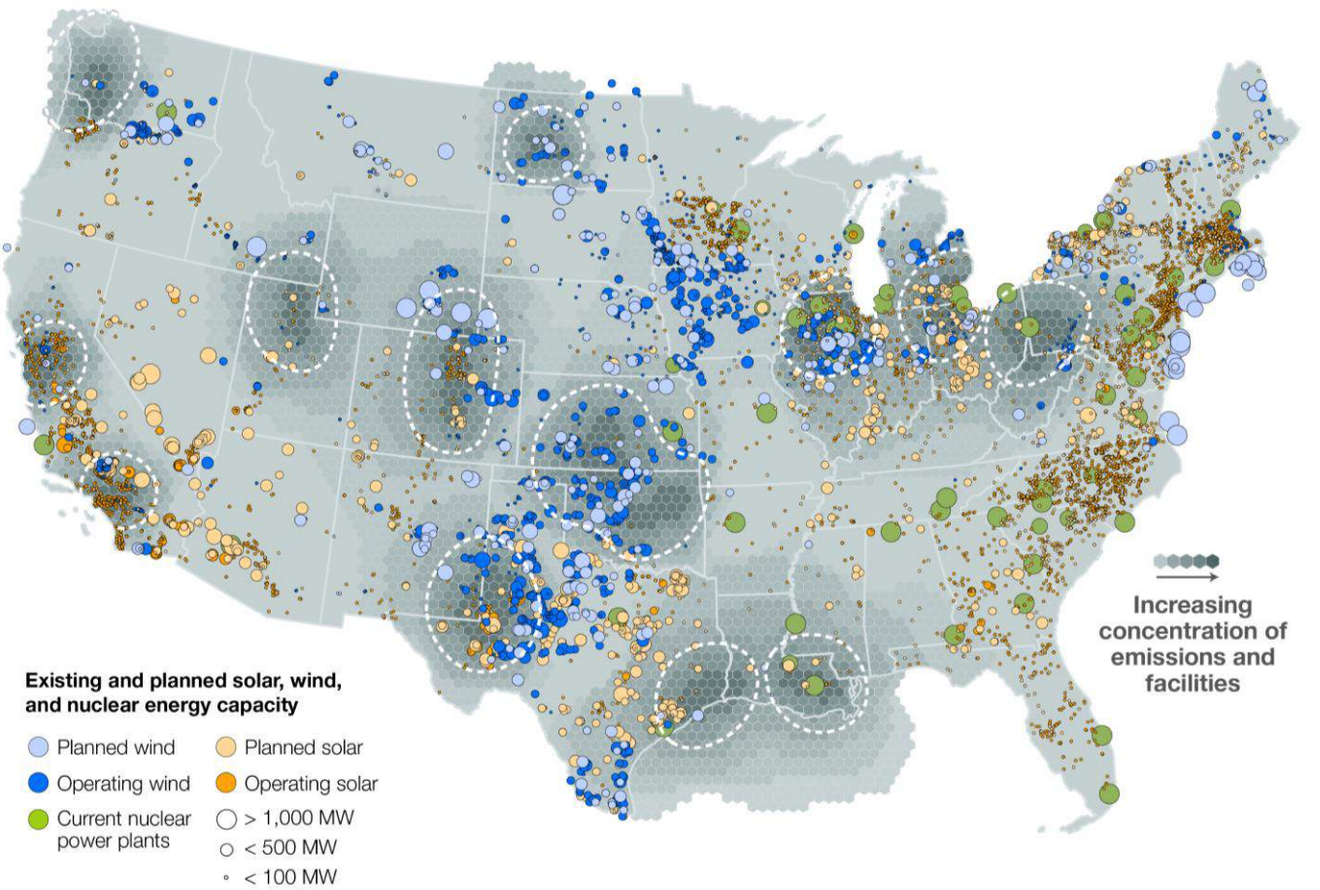
Possibilities for Coastal GH_2 hubs

The US has suitable locations with six components for an ideal coastal GH_2 hub, allowing the deployment of large-scale decarbonization solutions.

First, the country holds abundant renewable electricity sources (existing and planned) required for GH2 production, as shown in Figure 3 [45]. Given the electric intensity of water electrolysis, the capacity of electric generation dispatch markets and regional balancing authorities to take on additional load must be considered[46].

Figure 3

Renewable and zero-carbon electricity availability for hydrogen production and carbon removal

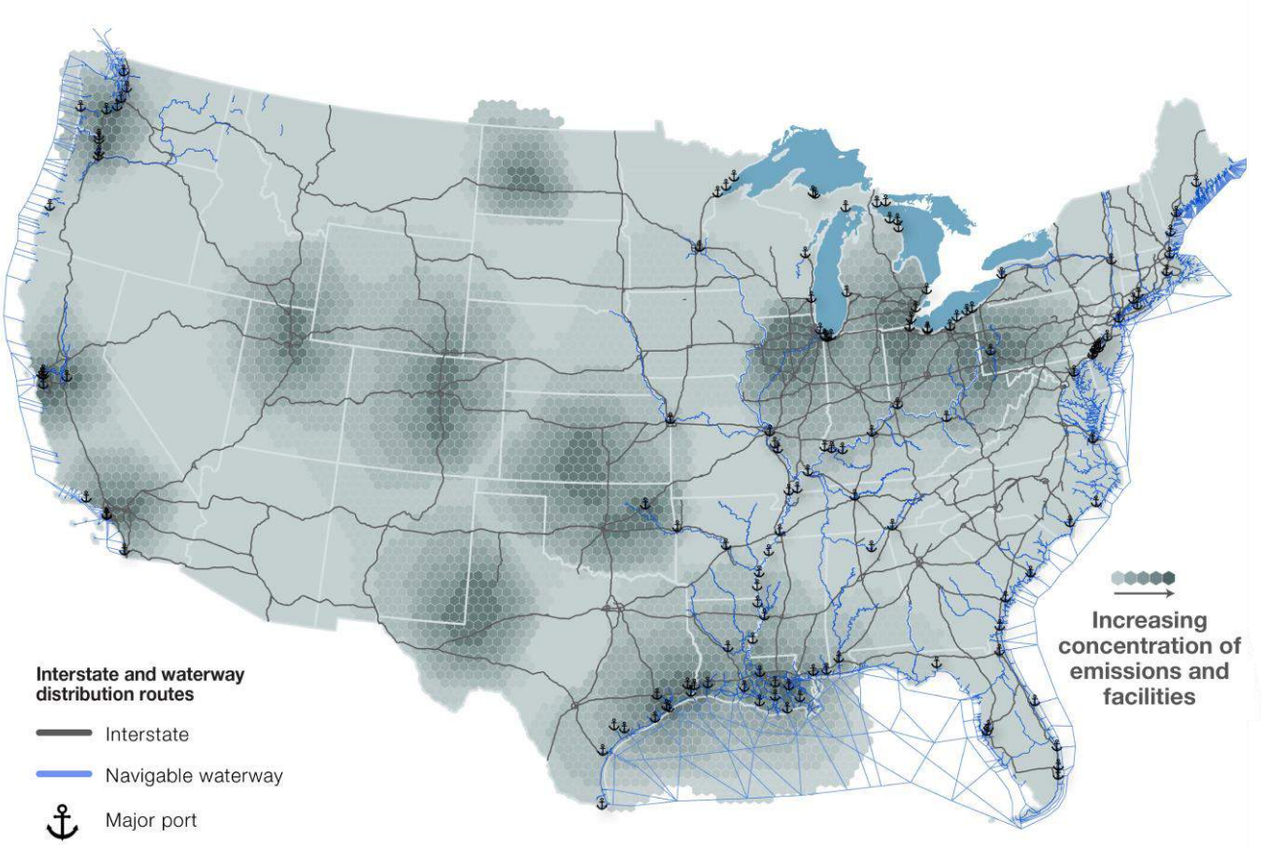


Source: An Atlas of Carbon and Hydrogen Hubs for United States Decarbonization (p. 21) by GPI (2022) [47].

Second, the country has large ports, similar to the ones in Northern Germany. Such ports are on the Pacific, Atlantic, and the Gulf of Mexico coasts, as shown in Figure 4.[48]

Figure 4

Transport infrastructure: major ports, barges, waterways & freight highways



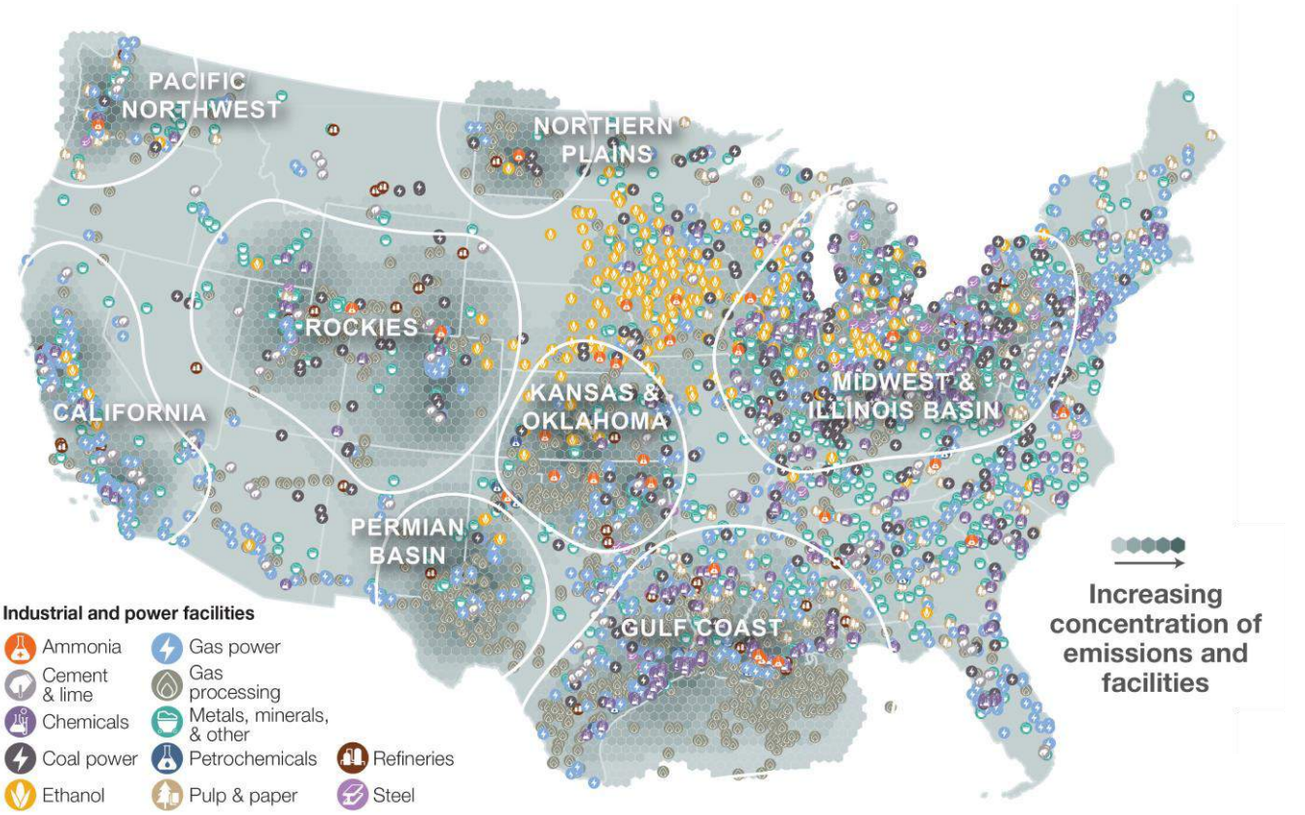
Source **:** An Atlas of Carbon and Hydrogen Hubs for United States Decarbonization (p. 25) by GPI.[49]

The ports hold potential for two purposes: 1) H2 usage as truck/fleet vehicles and inland/marine shipping fuel, and 2) international H_2 trade by ship[50]. For example, IRENA (2022) estimates that by 2050, in an optimistic scenario, the US and Saudi Arabia would be able to achieve levelized costs of about USD 0.75-0.80/kg. China will be the cheapest place for GH_2 production, followed by Chile, Morocco, Colombia, and Australia[51]. As soon as infrastructure, technology, and economies can support H2 trade through shipping, the H2 market might resemble the liquified natural gas (LNG) market from the early 2000s, such as point-to-point shipments based on long-term contracts. However, in contrast to the LNG, the H_2 market will not be unified since it will be traded in many forms, such as liquified hydrogen, ammonia, organic hydrogen carriers, etc[52].

Third, in terms of H_2 storage, the US possesses three caverns, which can be used to store H_2 on a massive scale[53]. In June 2020, DOE closed a USD 504.4 million loan to Advanced Clean Energy Storage hub. During its first phase, the hub is expected to produce up to 100 GH_2 tons/day stored in two salt caverns (each with 150 GWh capacity), resulting in the global single largest H_2 storage site[54].

Fourth, the US coastal industrial clusters that possess a high-skilled workforce are already using H_2 technology and infrastructure, as shown in Figure 5[55].

Figure 5
US industrial clusters



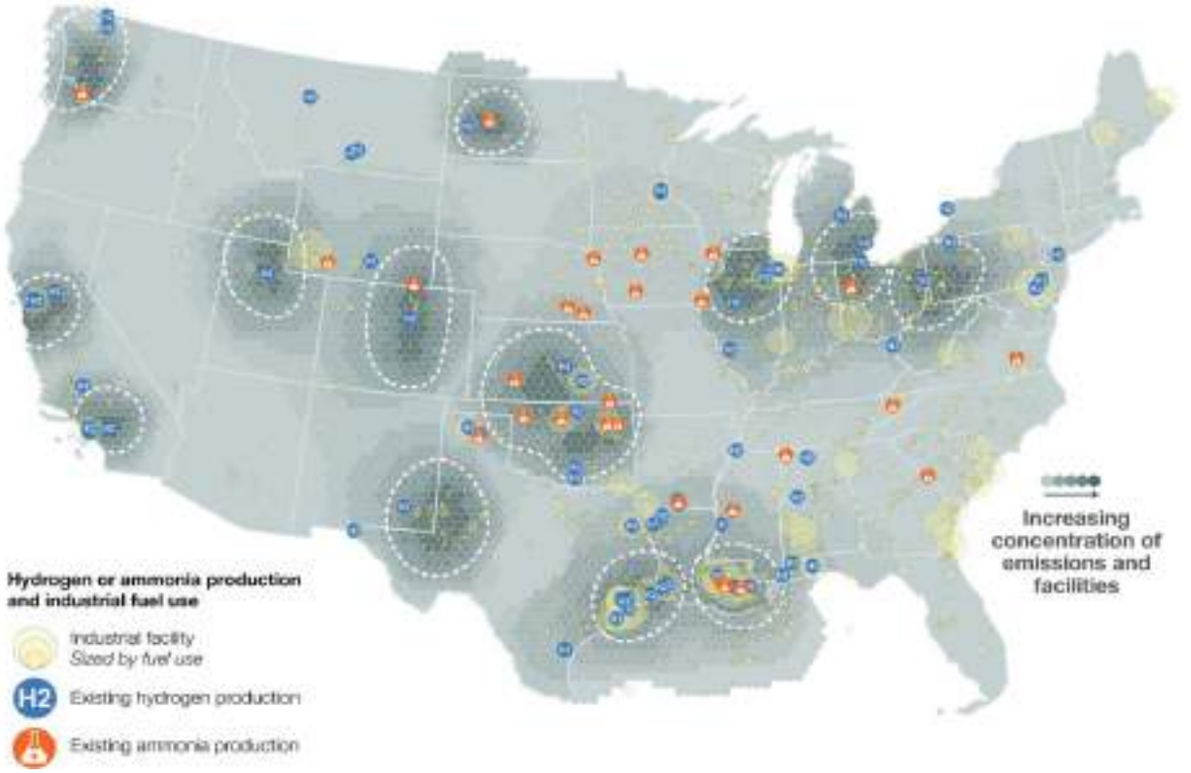
Source : An Atlas of Carbon and Hydrogen Hubs for United States Decarbonization (p. 28) by GPI.[56]

Such clusters provide an essential opportunity for scaling up H2 demand and supply. Since the GH_2 demand and supply can be co-located, they reduce the need for significant investment in transmission and distribution infrastructure. The US industrial clusters already have large established H_2 users for chemicals, ammonia, methanol, and steelmaking, offering an extensive and rising volume of GH_2 demand[57].

Fifth, the US coastal industrial clusters represent promising locations for expanding H_2 use in other sectors, as shown in Figure 6[58].

Figure 6

Hydrogen as a US decarbonization solution



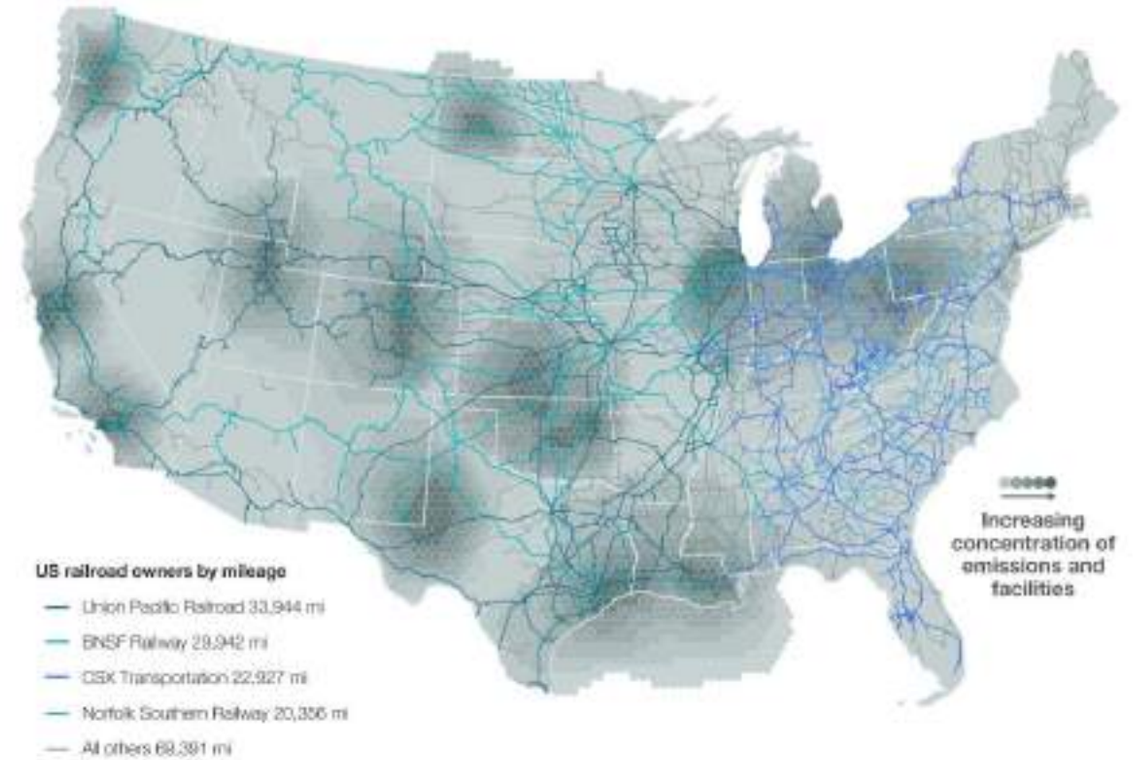
Source : An Atlas of Carbon and Hydrogen Hubs for United States Decarbonization (p. 18) by GPI[59].

Besides heavy industries, an effective coastal GH_2 hub needs to have many off-takers from other vital end-use sectors, which require H_2 as a decarbonization solution. Such sectors include long-haul, heavy-duty trucking, marine shipping, aviation, dispatchable power generation, and residential heating. The potential sources of H_2 demand co-located with industrial clusters may offer potential synergies. For example, a 500MW power plant might generate H_2 demand equal to 650,000 FCVs or heat demand from 2 million residential facilities[60].

Sixth, similar to Northern Germany, the US extensive transportation network can be used for H_2 transport. The country already possesses more than 1600 miles of H_2 pipelines[61]. Additionally, the country has railroads, barges, waterways, and freight highways that can transport GH_2 to places of utilization or storage, as shown in Figure 4 and Figure 7[62]. The US also has a well-developed natural gas infrastructure, allowing H_2 transport, as shown in Figure 8[63]. Using existing natural gas pipeline networks in H_2 transmission may benefit hydrogen supply technologies without incurring the significant investment costs and risks of developing a new H_2 transmission and distribution infrastructure[64]. Thus, the presented data and analysis prove that the has the political will and all components for ideal coastal GH_2 hubs. The following section addresses the challenges of the concept expansion in US.

Figure 7

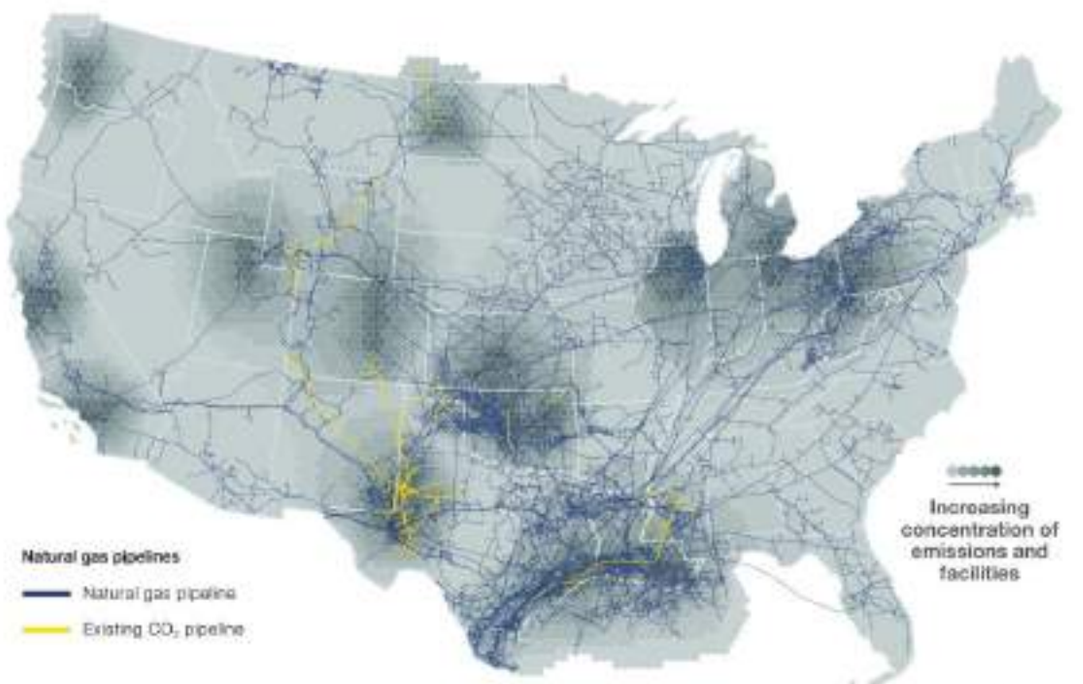
Transport infrastructure: railroads



Source : An Atlas of Carbon and Hydrogen Hubs for United States Decarbonization (p. 24) by GPI[65].

Figure 8

Transport infrastructure: natural gas pipelines



Source : An Atlas of Carbon and Hydrogen Hubs for United States Decarbonization (p. 26) by GPI[66].

Challenges

There are two significant challenges to successfully expanding the US coastal GH_2 hub's concept: 1) The costs of electrolyzers and H_2 infrastructure, and 2) competition with electrification in end-use sectors due to technology-neutral policies.

The Economic Impact: Technology and Infrastructure Costs

The economic issue with this study's concept expansion is connected to the costs of electrolyzers and H_2 infrastructure. Annually, the US produces ~10 MMT of H_2 from fossil fuels: (99%), SMR (95%), and coal gasification (4%). The US uses electrolysis only in 1% of its H_2 production. The current US H_2 costs are divided among GH_2 (USD 10-15/kg), gray H_2 (USD 2/kg), and blue H_2 (USD 5-7/kg)[67].

First, the competitive GH_2 levelized cost mainly depends on the cost of electrolyzers since renewable energy prices for solar/wind energy have decreased and become cost-competitive with natural gas[86]. The capacity of the largest electrolyzers proposed today is around 100MW, equal to only 10% of a steel plant's H_2 demand[69]. The current electrolysis technology is expensive, with approximately USD 1000/kW capacity and a conversion efficiency loss of about 10-30%[70]. Raw materials used in electrolyzer manufacturing will also be in tight supply near-term[71]. In 2020, the DOE analyzed that the US can generate GH_2 from polymer electrolyte membranes (PEM) at nearly USD 5-6/kg. This calculation assumes that existing technologies and electrolyzers cost USD 1500/kW and grid electricity prices amount to USD 0.05-0.07/kWh[72]. However, significant H_2 off-takers would consider H_2 economically viable only if it is made at USD 1/kg in the US and at USD 2/kg in the EU[73]. Therefore, building a GH_2 economy through coastal GH_2 hubs requires a drastic reduction in the cost of electrolyzers.

Fortunately, according to IRENA's World Energy Transitions Outlook 2022, the cost of H_2 electrolyzers will decline at comparable rates to the solar PV and onshore wind's cost decrease in the past decade[74]. Such reduction will be realized by scaling up manufacturing processes, utilizing learning-by-doing effects in electrolyzer utilization, and advancing system materials and design[75]. For example, Hysata, an Australian start-up, has recently developed a capillary-fed electrolyzer for alkaline electrolysis, representing a drastic improvement over the existing designs. The company claims its electrolyzer requires only 41.5 KWh/ $kgGH_2$, whereas the industry efficiency benchmark is 50kWh/ $kgGH_2$. The electrolyzer's high efficiency, low supply chain risks, and straightforward approach to mass manufacturing - all help position Hysata as a valuable player in delivering the world's cheapest GH_2[76]. Thus, such promising global developments indicate that the electrolyzer costs will eventually not challenge US coastal GH_2 hub expansion.

Second, the cost of building the H_2 infrastructure for its end-use sectors, such as transportation, might be prohibitive. In 2019, the US transportation sector was responsible for the most significant source of US emissions (28%), when compared to the power sector (25% of US emissions)[77]. Emissions reduction from the US transportation sector, with potential GH_2 assistance, is vital to meeting IPCC reduction mandates[78]. However, the costs of presently available H_2-fueling stations are higher than those of traditional gas stations. Such costs include on-site natural gas re-formers and more stringent compliance costs connected to federal, state, and local regulations[79]. Thus, the delay in building the H_2 transportation infrastructure might hurt the generation of customer demand to buy GH_2 at a price needed to cover production costs and generate a profit, regardless of potential subsidies provided by the US H_2Hubs program.

Opportunely, the provisions under the recently introduced Inflation Reduction Act of 2022 might help solve the challenge of the cost of H_2 infrastructure:

- The reinstatement of the Alternative Fuel Vehicle Refueling Property Credit for 10 years and raising of the cap for H_2-fueling stations to USD 100,000, with an allowance for the credit to be applied to any single refueling property instead of being based on the facility location.

- The provision of an extension of the Section 48 Investment Tax Credit for fuel cells and an addition of H_2 storage to the Investment Tax Credit.

- The creation of a novel Clean Vehicle Tax Credit, including FCVs, while providing USD 7,500 in credits for new purchases and up to USD 4,000 for used vehicles.

- The formation of a new Commercial Clean Vehicle Credit for fleet operators, providing them with up to USD 40,000, that may be applied to fuel cell electric buses and electric trucks (tested and deployed in the US)[80].

Therefore, the new US historical policy supporting the H_2 industry would simplify the challenge of the cost of H_2 infrastructure for its coastal GH_2 hub deployment. The following section discusses the competition with electrification in end-use sectors as another obstacle for US GH_2 hub developers.

Competition with Electrification in End-Use Sectors

The competition with electrification in coastal GH_2 hub's end-use sectors (i.e., transportation) due to technology-neutral policies is another challenge for expanding the study's concept in the US. Papadis and Tsatsoronis[81] believe that the electrification of cars and trucks may serve as the best approach for the transportation sector. However, applying electrification to the entire transportation sector may be problematic[82]. Therefore, as mentioned in the introduction, H_2 deployment can complement electrification in the transportation sector during the US energy transition. Recently, the US has adopted technology-neutral policies for its transportation sector. For instance, 50% of all new light trucks and passenger cars to be sold in 2030 need to be zero-emission vehicles, including electric, plug-in hybrid electric, or FCVs[83]. Although the country has set ambitious decarbonization targets, technology winners might not be discovered accurately and rapidly enough to justify H2 infrastructure build-out.

Gross[84] claims that technology-neutral policies can boost infrastructure development and vehicle uptake but hinder fair technological competition. In other words, the technology-unclear policies that encourage the turn to a low-carbon vehicle fleet may prevent establishing an accurate technology winner for the transportation segments. For example, in June 2020, the California Air Resources Board (CARB) passed a ruling that requires the broad adoption of zero-emission trucks from 2024, with all zero-emission heavy-duty vehicle sales by 2045. Although the CARB policy is technology-neutral, this ruling will significantly benefit California's electric trucks that are currently ahead of H_2 in research and development efforts[85]. Thus, such policies may encourage the electrification of medium-heavy-duty trucks, which are more suited for decarbonization through the deployment of GH_2 technology. Consequently, the policies might leave the deployment of H_2 infrastructure and FCVs significantly behind, reducing the GH_2 demand needed for the success of a US coastal GH_2 hub.

As discussed in the previous section, the newly introduced Inflation Reduction Act of 2022 might establish a level-playing field for the potential US coastal GH_2 hub developers. Besides the vast support for H_2 infrastructure, this monumental policy introduces the Clean Hydrogen Production Tax Credit, offering nearly USD 13 billion in value across the H_2 industry during the next 10 years. This credit provides up to USD 3/kg H2, depending on the carbon intensity of H_2 production, or a comparatively scaled up investment tax credit for up to 30% for new facilities. Based on this policy, the GH_2 producers might emerge as the main winners in the new hydrogen economy. Thus, the federal subsidies provided for H_2 infrastructure and production might lessen the severity of the competition with electrification in end-use sectors, where GH_2 is more beneficial for US decarbonization.

Regardless of the current challenges, the study's concept extension opportunities are more compelling in building the US hydrogen economy. The following section offers examples of the concept's upcoming use.

Section 3: Examples of Upcoming Use

Based on the previous map and concept expansion analyses, the US Western and Gulf of Mexico coasts are suitable locations for coastal GH_2 hubs, similar to ones in Northern Germany. Great Plains Institute (GPI)[86] also pinpoints such sites among 14 identified candidates for potential US H_2 hubs, as shown in Figure 9.

Figure 9

Potential hydrogen (H_2) hubs

Source: An Atlas of Carbon and Hydrogen Hubs for United States Decarbonization (p. 5) by GPI[87].

The following case studies describe potential coastal GH_2 hubs in Southern California and Texas, capable of holistic system integration through sector coupling with GH_2.

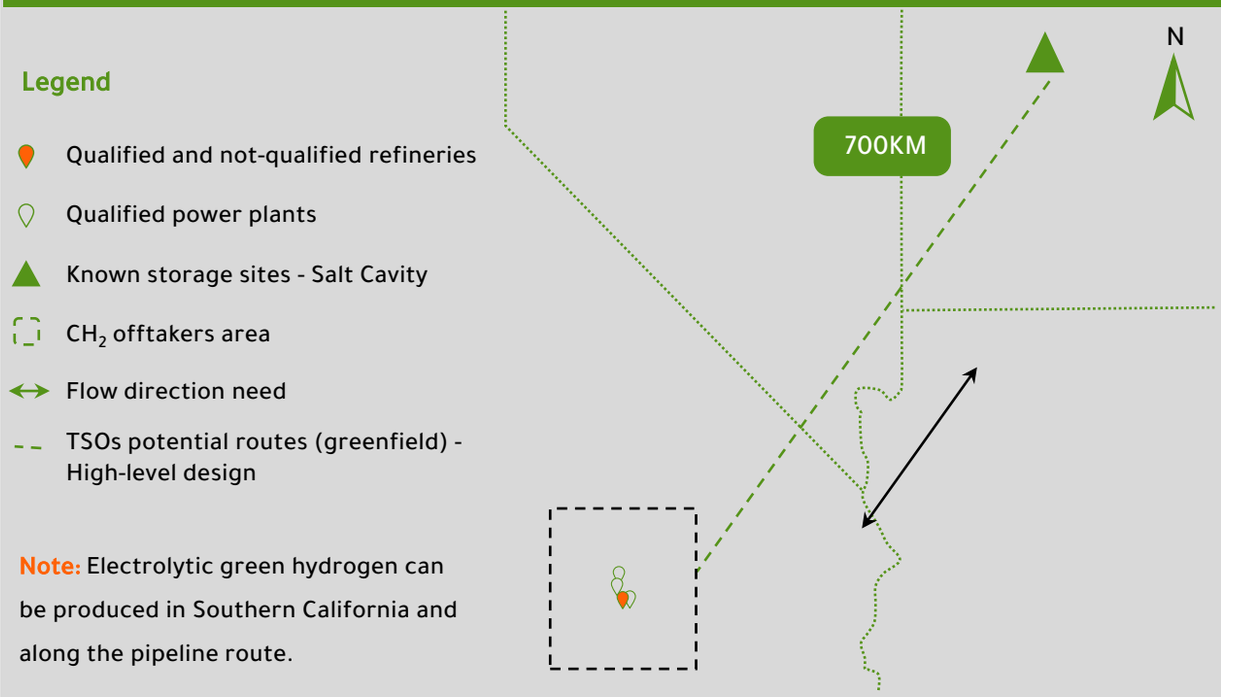
HyDeal LA (California) - Case Study

HyDeal Los Angeles (HyDeal LA), located on the US Western coast, is an initiative that seeks to position Los Angeles as the first US GH_2 hub. This utility-scale project aims at delivering GH_2 at ~USD 1.50/kg in concert with the USD 1/kg DOE Hydrogen Earthshot goal. It is estimated that the GH_2 hub will cost nearly USD 27 billion over ten years. This amount represents about 25% of the existing plan for the Southern California infrastructure spending by electric and gas utilities over the same period. HyDeal LA, currently in Phase 2, seeks to bring together the entire value chain across the LA Basin, including production, transport, storage, and multisectoral aggregated offtake[88].

As shown in Figure 10, this project meets all six prerequisites of an ideal coastal GH_2 hub.

Figure 10
HyDeal LA

The HyDeal LA hub connects multisectoral offtakers and low-cost renewable electrolytic production and storage, spanning four US states



Source : HyDeal Los Angeles (p. 2) by Green Hydrogen Coalition[89].

First, according to Figure 3, Los Angeles is surrounded by a cluster of facilities for renewable electricity (additional to planned and operating) generation from solar/wind energy for GH2 production. The hub developers anticipate using in the near term the existing electric infrastructure within the LA Basin for electrolysis[90].

Second, per Figure 4, the Port of Los Angeles and Long Beach, the two biggest US ports combined, can serve as business and logistics hubs for GH_2 import/export. The proximity to the Asia-Pacific region with large potential GH_2 consumers, especially, is attractive for this GH_2 hub[91].

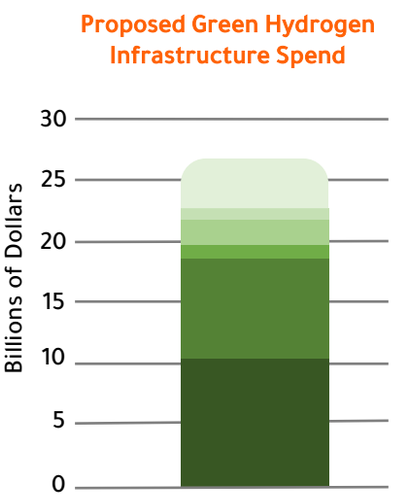
Third, per Figure 10, HyDeal LA is relatively close (700 km) to underground geological storage (salt domes) in Central Utah. GH2 storage can shift excess energy from periods of oversupply, like California in the spring, to periods of undersupply, like California in late summer[92]. During Phase 1, the hub developers analyzed potential key connection routes for GH_2 infrastructure[93].

Fourth, per Figure 5, HyDeal LA has industrial clusters with highly skilled workers already using H_2 technology and infrastructure. Southern California possesses a large concentration of heavy industries, including natural gas processing, petroleum refining, and steel and cement manufacturing. As shown in Figure 6, there are already 9 H_2-producing facilities, which are already co-located with the main corridor of fossil fuel use and industrial activity. GH_2 can potentially be a zero-carbon alternative to fossil fuels at these industrial facilities. HyDeal LA is focused explicitly on the GH_2 scale-up and use by displacing natural gas in the 4 power plants near Los Angeles and Long Beach ports. This project partners with the Los Angeles Department of Water and Power[94].

Fifth, HyDeal LA has many potential GH_2 offtakers from various sectors. During Phase 1, the hub developers identified 13 million metric tons of GH_2 likely to equal the total demand in the LA basin, focusing on applications in heavy-duty trucking in addition to previously mentioned industrial and power applications[95].

Sixth, HyDeal LA plans to build 100% dedicated GH_2 pipelines that connect Los Angeles with Central Utah. New GH_2 pipelines may follow existing right-of-way 1,596 miles of oil pipelines to reach effective build-out. HyDeal LA may also use 750 miles of natural gas pipelines, railroads, barges, waterways, and freight highways, as shown in Figures 4, 7, and 8. HyDeal LA developers plan to spend USD 4 billion on utility infrastructure, particularly building 2000-km greenfield pipelines, as reflected in Figure 11[96].

Figure 11
The HyDeal LA - Proposed GH_2 infrastructure spend



Category	Proposed Spend	Infrastructure Needed
Transport	USD 4B Utility infrastructure	2000 km greenfield pipelines
Storage	USD 1B Private sector	13 million m² Storage cumulated capacities
H_2 Compression ad hoc	USD 2B Utility infrastructure	570 MW
H_2 Compression	USD 1B Utility infrastructure	290 MW Compression cumulated capacities
H_2 Production	USD 8B Private sector	20 GW Electrolysis capacity 1.3 Mt Produced H_2
PV	USD 10B Private sector	26 GW Solar capacity 69 TWh Solar output

Source : HyDeal Los Angeles (p. 3) by Green Hydrogen Coalition [97].

Lastly, California has a supportive political environment. Los Angeles is set to become 100% renewable by 2035, and the state has a low-carbon fuel standard (LCFS). As a state with a significant refinery industry, California may use GH_2 production to generate LCFS credits[98]. California is also home to many clean energy research initiatives, namely Stanford University Hydrogen Initiative, which launched in May 2022[99].

Houston (Texas) - Case Study

According to GPI[100], Houston, Texas, is the best candidate for an initial US H_2 hub on the Gulf Coast, as shown in Figure 9. The Center for Houston's Future proclaims that a Houston-led clean hydrogen hub could have a sizable and lasting impact on the region[101]. This proposed coastal GH_2 hub also seeks to deliver GH_2 to meet the USD 1/kg DOE Hydrogen Earthshot goal. For example, Houston[102] estimates that average wind LCOE without Texas' Production Tax Credit may drop from USD 28/MWh in 2020 to USD 21/MWh in 2030, with a continuous decline in wind capital expenditures. The such estimation includes a capacity factor of 46% in 2020 and 51% in 2030, along with the growing electrolyzer system of ~ 2MW in 2020, ~ 20MW in 2025, and ~85MW from 2030 to 2050.

This LCOE also includes the top quartile of Texas' wind speed. Based on the assumptions above, GH_2 costs in Texas could be approximately USD 3.2/kg in 2020, USD 1.5/kg in 2030, and USD 1/kg in 2050.

A Houston-led proposed project (Houston) has all six components of an ideal coastal GH_2 hub.

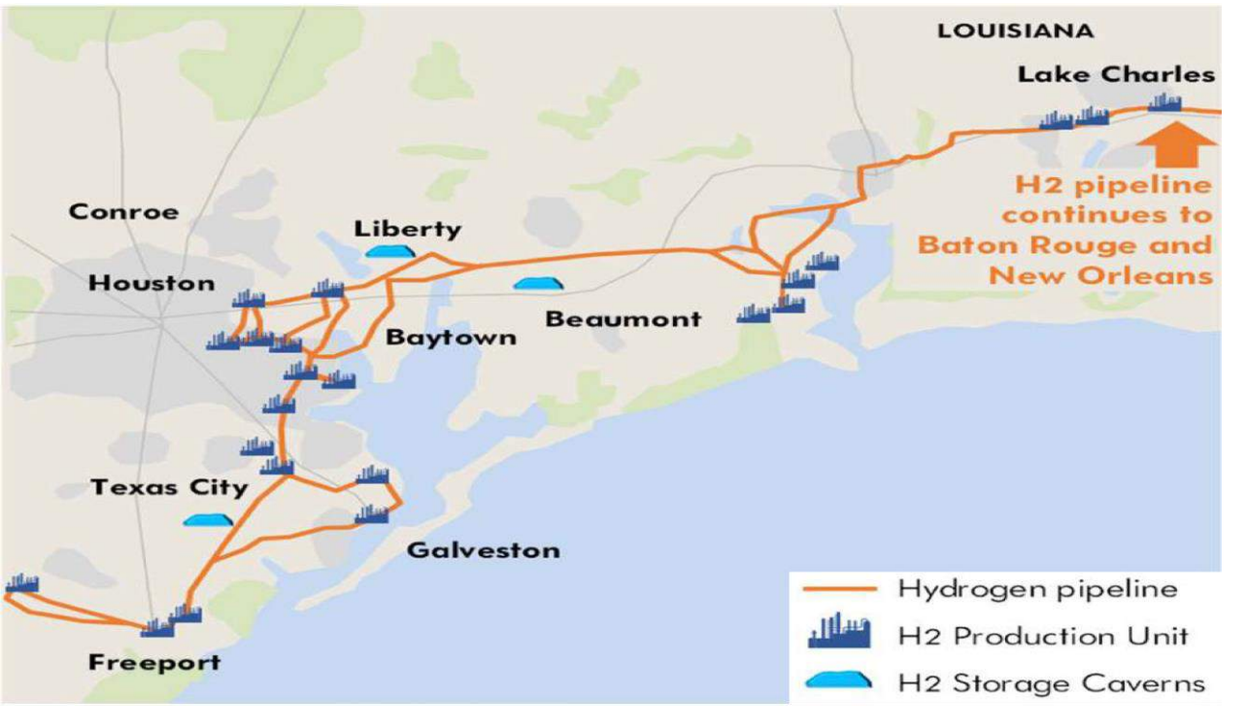
First, according to Figure 3, Houston is surrounded by a cluster of facilities for renewable electricity (additional to planned and operating) generation from solar/wind energy for GH2 production. Further, Texas can have a vital advantage in GH_2 output since it produces the most wind-powered generation in the US[103].

Second, per Figure 4, the Port of Houston can serve as a business and logistics hub for GH_2 import/export. Houston[104] believes that the US Gulf Coast can compete with the foreign exporters (Saudi Arabia, Australia, and Chile) on the GH_2 delivered cost by leveraging the port infrastructure, strategic considerations, and cost advantages. Texas GH_2 demand can reach 21MT in 2050 compared to 3.6MT in 2021, comprising 11 MT for local GH_2 demand and 10 MT for export.

Third, Houston has proximity to potential ample H_2 storage resources, as shown in Figure 12. Texas Gulf Coast has three out of four global salt caverns currently used for H_2 storage[105].

Figure 12

Current hydrogen system in the Gulf coast area



Source : Houston as the epicenter of a global clean hydrogen area (p. 6) by Houston[106].

Fourth, per Figure 5, Houston has industrial clusters with highly skilled workers already using H_2 technology and infrastructure. These clusters comprise petroleum refining, chemicals and petrochemicals production, and natural gas processing. As shown in Figure 6, there are already 14 H_2-producing facilities positioned next to the industrial clusters[107]. GH_2 can also be potentially utilized as a zero-carbon alternative to fossil fuels at these industrial facilities. After GH_2 export as the most significant driver of GH_2 demand, industrial applications are the second most significant GH_2 driver, accounting for ~6MT of GH_2 demand[108].

Fifth, Houston has many potential GH_2 off-takers from various sectors. In addition to the export of GH_2 and H_2-based fuels and industrial applications, mobility and utility are the other drivers of Texas GH_2 demand. Ground transportation mobility accounts for ~ 2.3 MT of GH_2 demand, and marine/aviation transportation accounts for ~1.5 MT of GH_2 demand[109].

Sixth, the Texas Gulf coast possesses 900 miles of H_2 pipelines, which account for more than half of all US H_2 pipelines and third of the world's total. Houston can also build new H_2 pipelines to follow existing right-of-way 11,494 miles of oil pipelines to reach effective build-out. Houston may also use existing 7,892 miles of natural gas pipelines, barges, waterways, and freight highways, as shown in Figures 4, 7, and 8[110].

Lastly, Houston has a supportive political environment in principle, given that it adopted a climate action plan of net zero carbon emissions by 2050. However, in contrast to Southern California, Texas still needs to take more ambitious actions to achieve GHG reductions[111] with additional supportive GH_2 policy frameworks. Due to the substantial oil and gas industrial presence, Texas coastal GH_2 hub developers might face stiff competition from their emerging blue H_2 counterparts[112]. For example, ExxonMobil plans to produce blue H_2 at its integrated petrochemical and refining facility close to Houston in Baytown, Texas[113]. The following section discusses suggestions for the US concept expansion.

Section 4: Discussion

This section outlines the highly optimistic vision for expanding the concept of coastal GH_2 hubs in the US. It includes guiding principles that shape the vision and recommendations for the concept expansion. EU field visit to the Dutch Research Institute for Transitions (DRIFT) in Rotterdam, Netherlands; van den Bergh's theoretical perspective on sustainable development; and "The Energy Imperative"[114] informed the vision.

First, Loorbach[115] described the model for transition governance, providing the vision's leading principles. Transition is a process of structural, non-linear systemic change in dominant regime that takes place over decades[116]. The regime is characterized by prevalent and familiar ways of thinking, organizing, and doing in a societal (sub)system[117].

Second, van den Bergh's evolutionary-technical theoretical perspective complements DRIFT's model since it focuses on maintaining co-evolutionary adaptive capacity in terms of knowledge and technology to react to uncertainties and fostering economic diversity of actors, sectors, and technologies[118]. Co-evolution is the proper perspective for thinking about governance for sustainable development[119].

Third, due to current energy security concerns about Russian natural gas, the vision does not incorporate Loorbach's[120]recommendation of "investing in blue hydrogen as a prelude to green hydrogen". Instead, the vision relies on Scheer's[137] avoidance of the traditional power industry's alternatives as bridges to renewable energy. Therefore, the vision and recommendations for the study's concept represent the slightly modified version of DRIFT's model. The study's author[122] introduces a new concept describing this type of transition governance model toward the H_2 economy: a quasi-revolutionary transition.

Guiding Principles and Recommendations

The main idea of the transition governance model is radical in the long-term, and diplomatic in the short-term[123]. Its five components anchor the vision and recommendations for developing US coastal GH_2 hubs. The suggestions for the study's concept expansion are based on the mix of strategies offered for HyDeal LA and Houston's coastal GH_2 hubs[124] and additional recommendations. The suggested principles are:

1. Systematicness: Engaging with emerging dynamics across societal levels

The current concerns about climate change and energy security dominate dynamics across societal levels. Therefore, coastal GH_2 hubs developers and proponents need to capitalize on such dynamics by creating momentum and gaining support throughout the industry and the government on all levels to focus on transition without bridge technologies, such as blue H_2. Like playing a symphony, an ensemble is stronger when everyone participates.

Scheer[125] advises two principles for mobilizing renewable energy 1) look beyond the current traditional costs of renewable energy and conventional technologies by incorporating the climate, health, and other costs, and 2) establish the priority of renewable energy as the systemic energy transition takes place. The adherence to such principles is vital since the growth of renewable energy is tied to the success of coastal GH_2 hubs, which have never before been created in the US. Additionally, HyDeal LA developers recommend executing an authentic stakeholder engagement about the GH_2 cost, uses, and benefits, especially for Communities of Concern, for a just and clean energy transition[126]. In sum, since the dominant regime is based on the traditional energy systems, the deep decarbonization transition will be a non-linear, systemic, and structural change throughout the decades.

2. Backcasting: Taking the desired transition as a starting point

The creation of a sustainable H_2 economy represents the starting point of the study's desired concept expansion. While assisting the growth of the hydrogen economy, a coastal GH_2 hub must achieve and then exceed the DOE's goals of USD 1/ kg H_2 and 2 kg CO_2/ kg H_2[127]. In addition, coastal GH_2 developers must align their objectives with the US, striving to reach net-zero emissions goals by 2050. The US can only achieve this target based on coordinated action, founded on four strategic pillars: federal leadership, non-federal leadership, innovation, and a broad society action[128].

HyDeal LA developers also recommend the following initiatives, which can help coastal GH_2 hub developers in the creation of a hydrogen economy: 1) Acceleration of electrolytic electric tariff design; 2) development of US framework and strategy for establishing GH_2 environmental attributes, and 3) clarification of jurisdictional authority for interstate H_2 pipelines[129].

3. Selectiveness: Focusing on a transformative agency already engaging with the transition

Based on DRIFT's model, the US coastal GH_2 developers need to focus on DOE, state, and local governments, as transformative agencies engaged in building the US H_2 economy. Despite the government's current attention on H_2, the playing field for GH_2 still needs to be developed to encourage the expansion of coastal GH_2 hubs. Cordeau et al.[130] state that the present state of H_2 can be compared to renewables a decade ago when government support was vital for these technologies' acceleration and cost reduction. Close government coordination is also essential for winning government funding and solving challenges associated with the development of US coastal GH_2 hubs. Lastly, the hub developers will benefit from establishing relationships with their counterparts abroad, such as Norddeutsches Reallabor and others in the Asia-Pacific.

4. Adaptation: Experimenting toward multiple goals and transition pathways

The application of van den Bergh's evolutionary-technical perspective to the study's concept expansion might prove helpful for coastal US GH_2 developers who research the tradeoffs of multiple transition pathways and goals to react to uncertainties. For example, HyDeal LA developers plan to explore municipal waste to clean/green H_2 for LA basin GH_2 production. They also plan to investigate GH_2 and its derivatives for aviation/maritime fuel and fertilizer[131]. Van den Bergh's theoretical perspective also stresses encouraging the economic diversity of sectors, actors, and technologies. Houston[132], for instance, endorses the creation of a broad-based regional ecosystem, which involves a variety of GH_2 sources, demand enablers, and coordinated storage and transport infrastructure. In so doing, sustainable development based on Houston's coastal GH_2 hub becomes an essential factor for the entire regional and social development.

5. Learning-by-doing and doing-by-learning: Ensuring monitoring and reflexivity

For the coastal US GH_2 hub to deliver on its promise to become a key to creating a hydrogen economy, it must address any associated challenges swiftly. It is easier and cheaper to develop such a hub right the first time than to fix it later. Kemp et al.[133] explain that transition management can help shape co-evolutionary processes by utilizing specific visions, transition trials, and cycles of learning and adaptation. For example, HyDeal LA hub developers divided their projects into multiple phases to guarantee reflexivity and monitoring of their efforts. After identifying GH_2 demand in Phase 1, HyDeal LA is "building on [the] previous work to co-create the path forward on a foundation of environmental justice"[134]. In doing so, Phase 2 reflexive and monitoring engagements would occur as bimonthly plenary meetings, monthly working groups, and mini-groups to speed up the hub development process[135].

US H_2@Scale program is also crucial in implementing the large US GH_2 infrastructure initiatives[136]. For instance, in collaboration with Frontier Energy and other stakeholders, H_2@Scale-Texas project demonstrates the learning-by-doing and doing-by-learning approach through two related initiatives. This three-year project started on July 1, 2020. First, the University of Texas-Austin hosts the novel integration of commercial H_2 production, distribution, and storage. Zero-carbon hydrogen is generated through electrolysis (wind and solar power) and SMR (renewable natural gas from a Texas landfill). The H_2 is used as a power source for the Texas Advanced Computing Center and GH_2 as a fuel for a fleet of Toyota Mirai's FCVs. Second, the project team conducts a feasibility study for H_2 production and scale-up at the Port of Houston, assessing the political, technological, and economic factors necessary for building a hydrogen economy[137]. Thus, the initiatives, implemented by HyDeal LA and H_2@Scale, guarantee the monitoring and reflexivity needed for effective deployment of the US coastal GH_2 hubs.

Conclusion

This paper explains how a coastal GH_2 hub can catalyze an accelerating hydrogen economy. This concept is envisioned to extend US decarbonization strategies to achieve net-zero GHG emissions by 2050. The analysis in this paper draws on materials from EU field-trip visits, domestic/international case studies, map analyses, and quantitative indicators to describe the concept derivation and possibilities for its expansion in the US. The study's author also extends the current sustainability literature by inventing a theoretical concept of quasi-revolutionary transition regarding the new transition governance model toward the hydrogen economy.

As with every research study, this study is not without limitations. Section 2 can benefit from an additional discussion about the impact of the GH_2 economy on the water problem. Some critics believe in the water insufficiency to support the hydrogen economy. However, others, based on their calculations of water requirement for electrolysis and beliefs in the saltwater desalination technology, confirm that the water supply will not be a limiting factor for electrolyzers[138]. This supplemental discussion may have been helpful to the discussion about challenges for US coastal GH_2 hubs.

The proposed vision in Section 4 has limitations as well. As acknowledged earlier, the vision and recommendations represent the highly optimistic pathway for the US H_2 economy build-up. Undoubtedly, it would be challenging to quickly increase GH_2 supply and demand in the near term.

Additionally, it might be challenging to ensure broad support for the coastal GH_2 concept due to potential pushback by the US natural gas/oil companies seeking to build coastal blue H_2 hubs. Further partisan divisions might also unnerve coastal US GH_2 proponents.

Regardless of these limitations, the study underscores the hope for GH_2 by presenting a specific concept and vision for building a sustainable hydrogen economy in the current geopolitical conditions. The Russia-Ukraine conflict drastically changed the global landscape regarding decarbonization and energy security. Such change can be viewed as the Overton Window, which can move sometimes dramatically, allowing acceptance of ideas that might have previously seemed outlandish[139].

Lastly, the European field-trip experience exposed the extent of the European and global response to such change by investing in the groundwork for a hydrogen economy. This study calls on the US to reinforce and solidify its global H_2 position.

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Climate-Centered ESG Framework: Business Practices Towards Sustainable Future

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Adopting an environmental, social, and governance (ESG) framework supported by climate action is no longer the sole responsibility of businesses. It became an opportunity for them to get into an extremely changing world.

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Abstract

Based on the philosophy that the real performance of businesses is reflected not only in their financial standards, but also in their commitment to promoting environmental sustainability, corporate social responsibility, and strong governance practices that integrate climate action into all their aspects. The researcher investigated the transformative dynamics of environmental, social, and governance practices that support climate action within businesses' strategic courses. In contrast to the traditional perspective that says that environmental, social, and governance considerations constitute restrictions that dampen businesses and reduce their financial performance, this policy paper emphasizes the pivotal role of these practices as stimuli for innovation and sustainable growth as they focus on climate.

In light of the rapidly changing global landscape, burdened by the climate recession risks, the researcher proved the possibility of integrating climate considerations within a climate-centered ESG framework. Meanwhile, the researcher upholds the logic that their practices do not only aim at achieving regulatory compliance, but they provide good opportunities for business to flourish, given their positive impact on several issues, foremost of which are market differentiation, stakeholder trust, and brand uniqueness.

Notably, many analyses concluded that businesses that adopt the environmental, social, and governance factors become more adaptable in the face of evolving regulatory risks.

The research emphasized the possibility of establishing a framework of environmental, social, and governance practices supported by climate action, regardless of the size and economic activity of the business institution, as an ethical responsibility and a strategic necessity for business continuity. However, this depends on a collective commitment under the leadership of its board of directors, a work environment that drives innovation and development, permanent and creative cooperation with all stakeholders, diligent joint work, and permanent coordination with peers from governmental and non-governmental institutions.

This policy paper seeks to formulate this strategic direction. It is divided into four main sections after the introduction: The first three sections highlight some environmental, social, and governance practices - respectively - that enhance climate action. Finally, the fourth section presented the most important concluding recommendations. The research methodology was based on qualitative analysis, focusing on inspiring measures and practices for international business institutions, which can be adopted, guided, and built upon.

Keywords: *Environmental, Social, and Governance Factors - Climate change - Climate-Centered ESG - Climate Action - Carbon Neutrality - Climate Governance.*

ESG is the compass guiding businesses toward a future where profitability is intertwined with social justice and environmental stewardship, ensuring a sustainable and just economy for all.

Sharan Burrow

A global advocate for human rights, climate action, and just transition. She is the former General Secretary of the International Trade Union Confederation and the president of the Australian Council of Trade Unions.

Introduction:

One of my friends told me how she got her current job, which she has always bragged about being the best throughout her career over more than twenty years. She saw the job opportunity advertisement, which included its details without mentioning the location. Then, she submitted her CV, and after a short time, she was invited to hold a personal interview. When she arrived before the scheduled time for the company headquarters, she had to walk into its garden, and she found an open faucet with water flowing from every corner. It even flooded a large area of the road, so she closed it without hesitation, then she searched for an official to inform him of what happened, but she did not find. She continued on her way.

When she entered the building's hall, she told the receptionist about her interview and informed him of the water tap incident so that he could take appropriate action. After he thanked her for her concern, she went to the elevator that would take her to the interview location. While she was waiting, she found several unutilized open electric switches. She turned them off and continued her way. After the hiring committee received her, she presented her experiences and qualifications. One of the committee members asked her if she had faced any difficulties or situations on her way to them, and she referred to the water tap incident in the garden.

To my friend's surprise, one of them continued her story and told her about turning off the electric switches. Furthermore, he announced that the water tap and electric switch accidents were intended so that the company could find out how job applicants would react to them because these responsible behaviors are an integral part of the selection criteria. From all applicants, her actions enabled her to get the job opportunity in the company. My friend later learned that her company is always looking for professionally distinguished people and investigates the compatibility of their behaviors and habits with its activities. It promotes working perfectly with fewer resources and without irresponsible exploitation of the planet's capabilities.

It adopts the environmental, social, and governance (ESG) approach, a term coined by James Gifford twenty years ago and formalized by the United Nations Global Compact when it was introduced in his 2004 report, "Who Cares Wins", prepared in cooperation with 20 financial institutions.

The main objective of this report was to demonstrate the inevitable necessity of integrating the environmental, social, and governance factors better into the financial analysis frameworks, asset management, and administrative practices. The report's designers noted that in light of the growing global competition, the companies that adopt this approach achieve greater success and add more value to their shareholders compared to the companies that do not pay attention to these factors. Accordingly, the report highlighted several main benefits of this integration, the most important of which are[1]:

Establishing more flexible and resilient financial markets	**Promoting the pace of sustainable development**	**Strengthening the understanding of stakeholders**	**Improving trust in financial institutions**

Thus, the framework of the environmental, social, and governance factors moved from the financial sector to various economic activities to reflect the non-financial factors included in the institutions' daily activities that may affect their current and future performance[2], including the perceived opportunities and risks. As summarized in Figure 1, this framework includes the following issues[3]:

Environmental Issues: They include changes in biodiversity and forests, overfishing, energy sources and the efficiency of their use, and preparedness to confront events resulting from changing weather patterns such as hurricanes, floods, and snow storms.

Social Issues: Occupational health and safety systems for the organization's employees, work conditions, child labor, and human rights.

Governance Issues: They include ethical standards and corporate behaviors, including combating corruption, promoting market competition and shareholder rights, and integrating stakeholders to improve transparency and accountability.

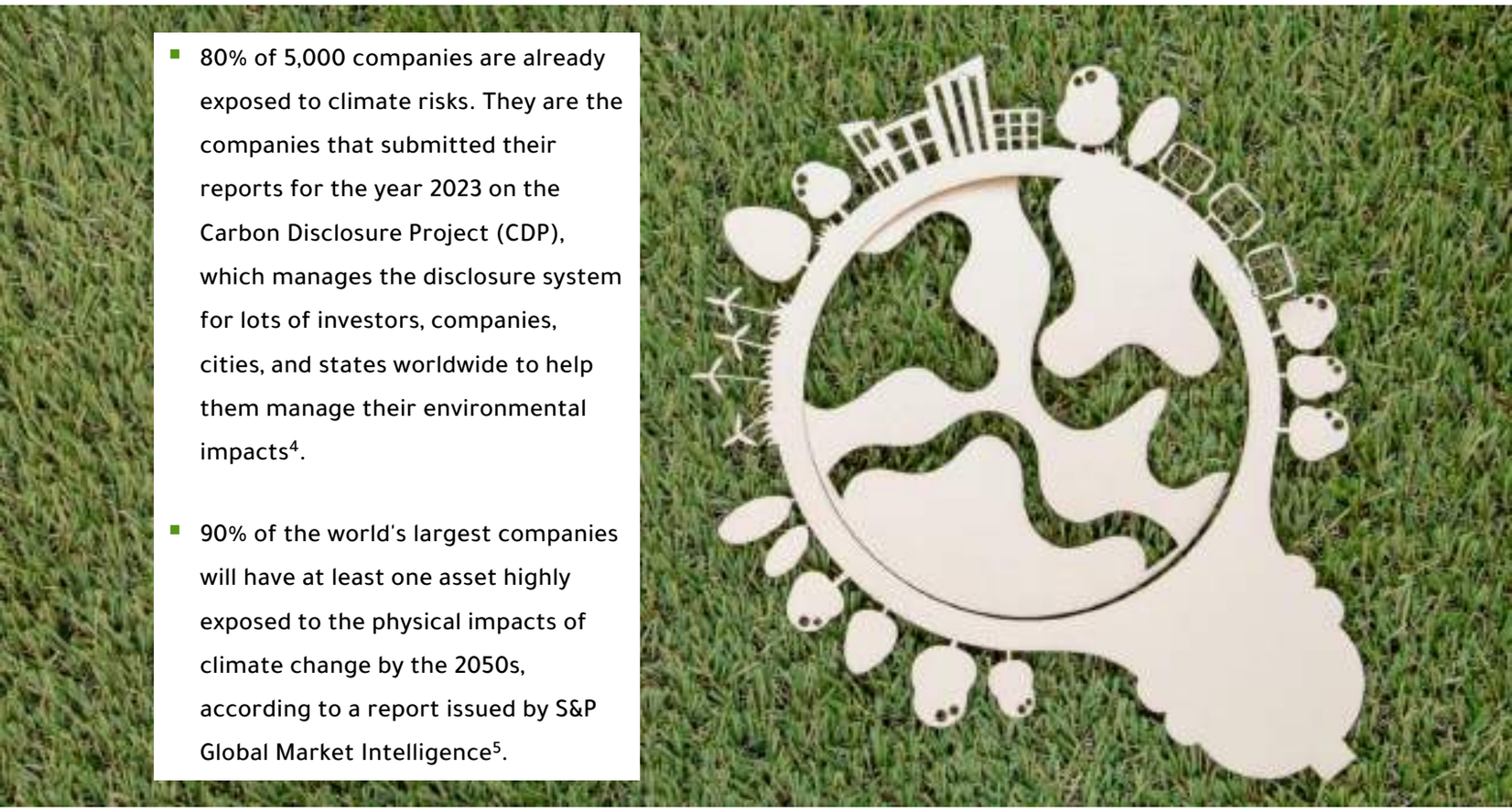
Figure 1

The environmental, social, and governance factors: general framework

Environmental Practices	Social Practices	Governance Practices
Renewable energy sources	Health and Safety	Ethical standards
Greenhouse gas emissions	Work conditions	Board diversity and governance
Energy efficiency	Employee benefits	Stakeholder engagement
Climate risks	Diversity and inclusion	Shareholder rights
Waste management	Human rights	Pay for performance
Recycling processes	Impact on local communities	
Emergency preparedness		

Source: Judith Rodin and Saadia Madsbjerg, ESG is missing a metric: R for resilience, World Economic Forum, Jun 7, 2021, accessed October 23, 2023, https://www.weforum.org/agenda/2021/06/esg-resilience-investment-environment-social-governance/

Strikingly, climate change has become at the forefront of the perceived risks that the framework of environmental, social, and governance factors must deal with more than ever before, where:



- 80% of 5,000 companies are already exposed to climate risks. They are the companies that submitted their reports for the year 2023 on the Carbon Disclosure Project (CDP), which manages the disclosure system for lots of investors, companies, cities, and states worldwide to help them manage their environmental impacts[4].

- 90% of the world's largest companies will have at least one asset highly exposed to the physical impacts of climate change by the 2050s, according to a report issued by S&P Global Market Intelligence[5].

If this is the case with major global companies, what about other businesses, especially small and very small ones? How can environmental, social, and governance practices be used in business institutions and governmental and non-governmental agencies, according to a broader approach to include climate action, in the face of the dangers of climate change? This is the issue that the researcher seeks to raise in this policy paper. The aim is to explore an aspect of these practices according to an applied approach and supported by the distinguished experiences that global business institutions adopt.

This paper is based on the qualitative analysis approach and secondary sources of information, with a special focus on measures and the processes that can be adopted within the framework of the environmental, social, and governance factors to enhance climate action. The paper is divided into four main sections, other than the introduction. The first three sections focused on the environmental, social, and governance practices - respectively - that enhance climate action. Finally, the fourth section presented the researcher's most important concluding recommendations.

How can environmental practices drive climate action?

Certainly, the era of extreme climate change requires fundamental changes in the philosophy of businesses and their business models to ensure enhancing their sustainability, especially since the economic activities of most of them are a major cause of the growing phenomenon of global warming. This prompted Mr. Brian Moynihan, the Chairman and CEO of Bank of America, to say that the environmental, social, and governance practices are not just hype but have become a strategic necessity. Hence, companies that integrate these practices into their identity become more able to confront global challenges and contribute to engineering a more sustainable future.

Brian Moynihan.

The Chairman and CEO of Bank of America.

Unsurprisingly, environmental practices come at the core of this strategic transformation. They involve a diverse and sophisticated package of policies, strategies, and initiatives that aim at reducing the environmental impacts of businesses and their carbon footprint, reducing greenhouse gas emissions, and compensating for remaining emissions that they could not get rid of. Inevitably, this falls within the climate action. At the forefront of these efforts are carbon neutrality commitments, achieving a net zero of carbon emissions, and presenting a positive model crucial to encourage others to adopt similar goals, which contributes to the comprehensive efforts to reduce emissions.

In this context, Shopify comes at the forefront of the shining models that can be followed. It is a Canadian company in the field of e-commerce. It provides a platform for companies to create and manage their stores online. In 2018, the company announced its endeavor to practically achieve the goal of carbon neutrality for its operational processes by 2030. Interestingly, this company achieved its goal in 2021, nine years before the planned date, mainly because it relied on several initiatives that complement each other to enhance sustainability, **the most important of which are[6]:**

- **Renewable energy localization:** The company has committed to using 100% renewable energy in its operations. It has invested in many renewable energy projects, including wind and solar energy generation projects. It has also installed solar panels on the roofs of its buildings.
- **Energy efficiency enhancement:** It has implemented energy efficiency practices, including the use of energy-saving equipment and reliance on modern systems to manage its facilities. The aim is to ensure continuous monitoring of energy use rates, take the necessary measures, and launch initiatives to improve its performance.
- **Waste reduction:** It has adopted initiatives to reduce waste resulting from its activities daily, including reducing single-use plastics and turning food waste into fertilizers.
- **Remote work:** The company considered this an effective mechanism to reduce the need for employees to attend and leave the workplace daily, which contributes to reducing carbon emissions.

Accordingly, business institutions play an essential role in climate action by contributing to the **eco-friendly and sustainability-promoting activities of technical innovation and research**, called green technologies. This contributes to developing climate-friendly products that reduce energy consumption, and/or use recycled materials, and/or increase their economic life. Among the distinguished models also is Interface[7], which specializes in producing raw materials for building floors, and the winner of the UN Global Climate Action Award for the year 2020.

Interface began its journey - in partnership with workers and suppliers - in 1994 to convert its operational activities to eco-friendly ones. It aimed at eliminating any negative impact it had on Earth by 2020. This journey was called "**Mission Zero**" over twenty-five years. By focusing on three main areas - supply chains, factories, and products - the company was able to achieve carbon neutrality throughout the entire life cycle of all its products. Among the main strategic paths it adopted to achieve this was the establishment of a production line that focused on sustainability and was called "**Net-Works**." It was based mainly on using recycled materials and supporting local communities.

Notably, Interface has achieved a success story beyond achieving the goal of carbon neutrality by creating negative carbon products to help restore the planet's health. It created a type of carpet, the first of its kind in the world, as it relies on a carbon-neutral production line. In addition, this kind of carpet stores the carbon emissions surrounding it during the production stages to prevent its release into the atmosphere, qualifying it to bear the negative carbon footprint. In other words, this product stores a larger amount of carbon than the amount it emits during the production stages through three main basics, as shown in Figure 2: adopting carbon sequestration technology, localizing the closed-loop manufacturing approach, and following the logic of the circular economy.

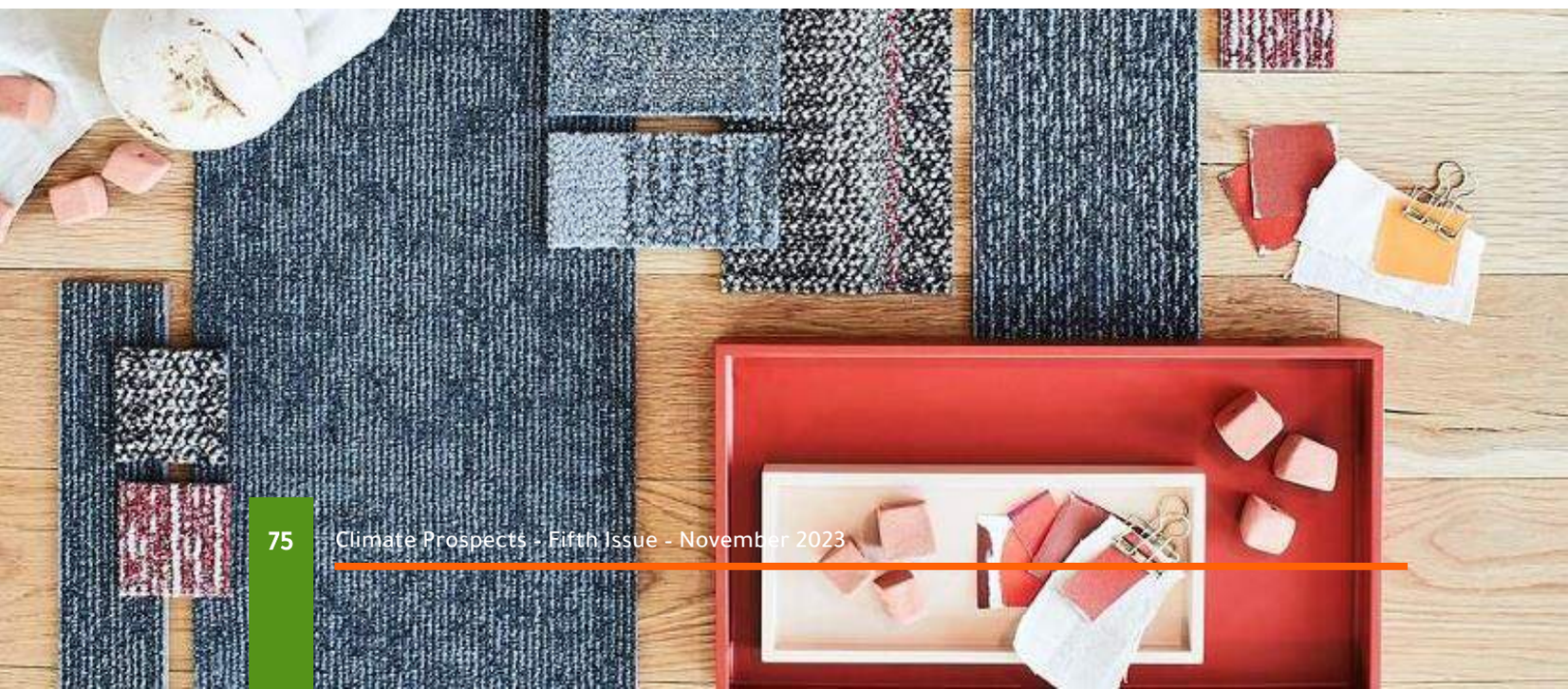


Figure 2

Interface: The basics of producing negative carbon products

(Carbon Sequestration)

A method of carbon capture and the long-term storage of atmospheric carbon dioxide. This prevents it from being released into the atmosphere and contributing to global warming.

(Closed Loop Manufacturing)

Recycling manufacturing waste and used flooring back into new flooring, conserving natural resources, diverting waste from landfills, and reducing the carbon released into the atmosphere.

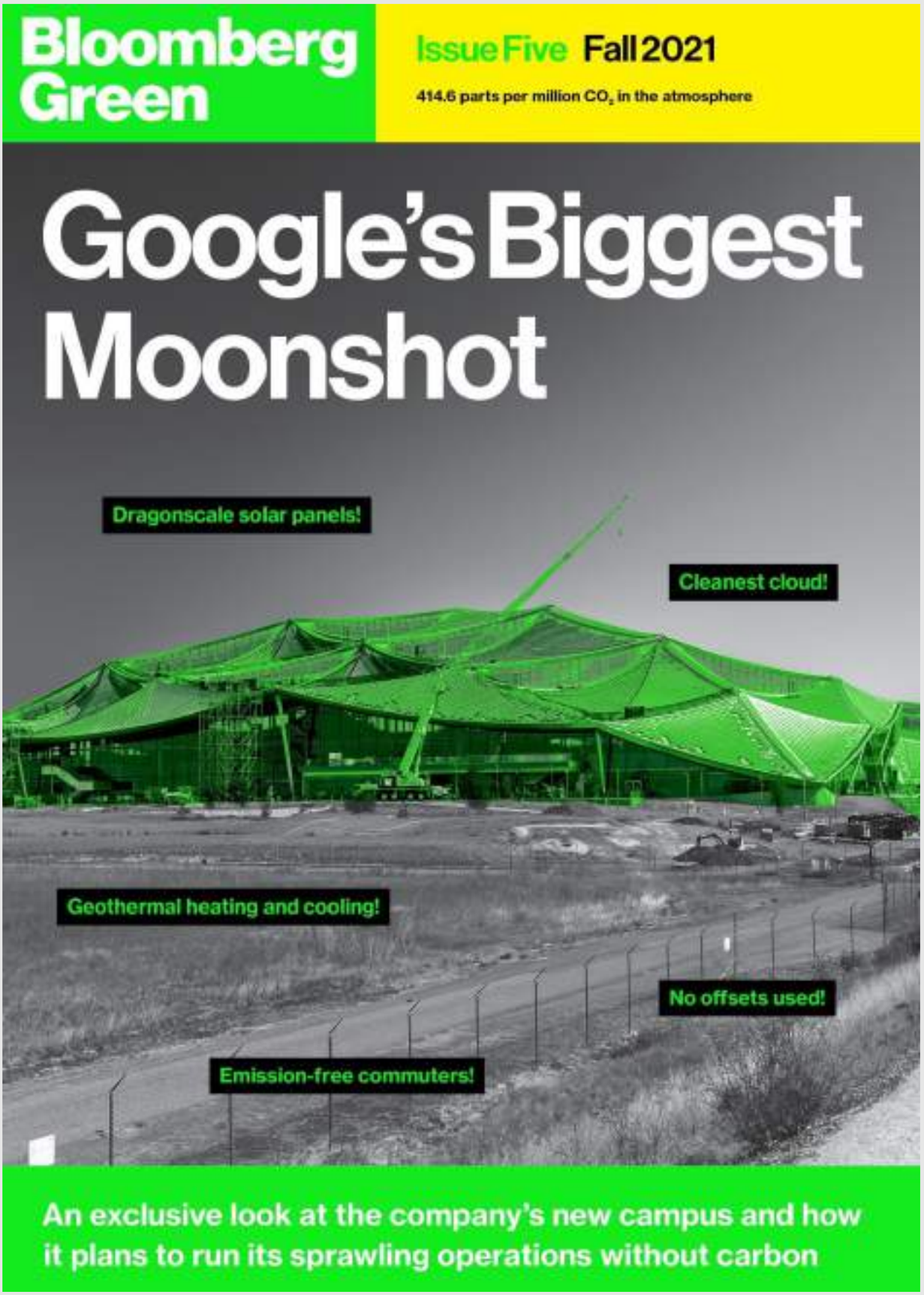
(Circular Economy)

Keeping resources in use for as long as possible, extracting the maximum value from products in use, then recovering and regenerating products and materials at the end of life.

Source: Interface, What Makes a Product Carbon Negative?, accessed October 31, 2023, https://www.interface.com/US/en-US/sustainability/carbon-negative.html

Moreover, the environmental practices that support climate action include **constructing green buildings and infrastructure**, which pave the way to more sustainable urban planning and energy and water consumption efficiency. The World Green Building Council (WorldGBC) is one of the largest networks that lead the transition to sustainable and carbon-free environments worldwide to achieve the ambitions of the 2015 Paris Climate Agreement and UN Sustainable Development Goals 2030. This could be achieved through many initiatives to combat carbon emissions from existing and new buildings and ensure a renewed infrastructure efficient in its use of resources and free of wastes[8].

Google is one of the examples that can be referred to in this context. Its CEO, Sundar Pichai, seeks to head the first giant company that operates without emissions around the clock, searching for a carbon-free future. Bloomberg considers this the company's greatest achievement. In 2020, Google announced its plan to operate its offices and data centers with electricity generated from clean sources by 2030, a project that it called "Moonshot", often used in the corporate world to denote bold projects[9].



Source: Mark Bergen, Google's Biggest Moonshot Is Its Search for a Carbon-Free Future, Bloomberg, October 17, 2021, accessed October 30, 2023, http://tinyurl.com/362uujbt

It is worth noting that achieving this dream requires adopting innovative and unconventional approaches, including unusual purchase contracts adopted by Google, and introducing a group of modern technologies, such as storing Lithium-Ion Battery, activating algorithms that predict wind patterns, and geothermal wells that were dug under the earth surface. In 2022, the company inaugurated a construction project for its new headquarters, Bay-View, in East Charleston. It is run on electricity entirely produced from the largest geothermal facility in North America[10].

In addition, **biodiversity conservation** is one of the fundamental environmental practices that businesses should undertake to combat the effects of climate change. The severe changes in temperature and storms, heavy rains, frost waves, and other severe weather events lead to the disruption of all types of life on Earth, including genes, bacteria, forests, coral reefs, and sustainable land use. The degradation of environmental systems leads to a series of negative economic repercussions, estimated at a decrease in GDP by about USD 2.7 trillion by 2030[11].

Since biodiversity conservation has become as important as reducing carbon emissions to enhance environmental sustainability, many business institutions are moving towards adopting the logic of **Nature-Based Solutions (NBS)**. This indicates that they can carry out their activities while restoring and preserving nature, mitigating and adapting to the effects of climate change, and supporting different lifestyles. Among the models that seek to achieve this is Nestlé Company, whose efforts to enhance sustainability include environment conservation to help restore and replenish the resources on which the humanity depends.

Source: Nestle, Sustainability: Protecting Nature, https://www.nestle.com/sustainability/nature-environment

In this context, the Swedish company IKEA adopts the **climate-oriented forest management** approach as a data-backed, strategic, and scientific approach to improve forest management practices, reforest degraded lands, and end deforestation. The aim is to mitigate the effects of climate change and build forest resilience. In 2020, the company has decided to invest EUR 100 million to implement reforestation projects, restore degraded forests, and improve forest management practices.

IKEA also seeks to develop long-lasting wooden products that can be renewed, reused, and then recycled, ensuring the long life of the product[12]. In addition, it opened a second market for its used furniture. It allows its customers - according to specific terms and conditions - to return it in exchange for a sum of money the company pays to them for repurchasing its furniture. This process contributes to extending the life of its products and promoting the use of previously used furniture while reducing waste and enhancing the circular economy practices it adopts[13]. Such practices contribute **to waste reduction and recycling**, a key path to improving climate action.

In addition, many business institutions launch **environmental education initiatives** and direct them to their employees and/or customers. The aim is to enhance their understanding of environmental challenges and mechanisms for addressing them while announcing their efforts and performance indicators. A shining example in this context is the American fashion company Patagonia, founded in 1973. It launched a media campaign under the slogan "Don't Buy These Jackets" to raise awareness about the environmental impact of consumerism and encourage customers to consider the environmental consequences of their purchases.

The main goal of this campaign was to encourage individuals to consider the impact of consumerism on the environment and to buy only what they need. Although this approach is risky and does not seem familiar, European Marketing Director for Patagonia, Jonathan Petty, points out that these initiatives contribute to establishing a strong community of people who appreciate the value of the brand and its products and help them change their consumer behavior for the better by making more rational purchases[14].

Notably, Patagonia has pledged since 1985 to allocate 1% of its sales to preserving and restoring the natural environment, drawing attention to the fact that in doing so, it imposes a self-tax on itself. Since then, the company has contributed more than USD 140 million in cash and in-kind donations to local and international environmental groups interested in the environment[15]. Moreover, it has set ambitious climate goals for itself and its partners along its supply chains, in line with the standards of the Science-Based Target Initiative (SBTi), which sets climate goals and verifies their achievement according to a strict approach to ensure compliance with the goals of the 2015 Paris Climate Agreement[16].

Furthermore, there are still many approaches adopted by business institutions to enhance the environmental practices within the environmental, social, and governance system, which has a positive impact on climate action. One of these approaches is adopting **Sustainable Commuting (SC)** programs, which motivate employees to use eco-friendly means of transportation. It is also called green commuting to reduce carbon emissions, taking into account that the transportation sector produces about 30% of carbon emissions.

These programs encourage employees to use public transportation, such as buses, tramlines, underground metro, and light rail, walk, use bicycles, or share private cars (Carpooling). For example, Adobe[17] adopts Adobe's Commute Program to encourage employees to explore alternative and comfortable means of affordable and sustainable transportation to reduce the number of vehicles on the roads. For this purpose, the company provides incentives and benefits to employees who choose eco-friendly transportation options, which contributes to reducing carbon emissions.

Last but not least, business institutions turned to form what they called the **"Green Team"**, emphasizing everyone's responsibility towards the environment. Cisco promoted this principle within its business approach, guided by the logic of the Canadian philosopher Marshall McLuhan - announced on its website - saying, "There are no passengers on spaceship Earth. We are all crew". This team includes many volunteering employees who work on projects such as energy conservation, waste reduction, and sustainability practices in the company[18].

Members of the Cisco Colorado Green Team.

The Role of Social Practices in Driving Climate Action

When world leaders promoted climate action by launching the Paris Agreement In 2015, a different view of corporate social responsibility practices began to take shape. It reflects the views, behaviors, and ethical practices adopted by an organization, including work values and ethics and the voluntary work directed to communities for their advancement. Social responsibility has become an urgent necessity and not a voluntary luxury, with the increasing need to focus efforts on supporting individuals and communities in the face of climate threats and helping the victims.

The reason behind this is the current, short-, medium- and long-term negative impacts of climate change on individuals and communities that limit their level of wellbeing, especially those who live in geographical areas suffering from extreme weather events, such as drought, desertification, stormy weather, floods …. etc. Certainly, this enhances the growing role of social practices within the business institutions' system of environmental, social, and governance practices, in cooperation with various stakeholder groups, including governments, local communities, NGOs, supply chains, and employees.

> **"The era of shareholder value alone is over. ESG is the new compass guiding corporations to be purpose-driven, responsible stewards of the planet, and contributors to the well-being of society.**

Paul Polman

The former CEO of Unilever International.

Perhaps Mr. Paul Polman, former CEO of Unilever International, was right when he concluded that the era of business institutions focusing on achieving profitability only to enhance the value provided to their shareholders has ended. They must all promote environmental, social, and governance practices as the new compass for what business institutions aspire to.

They must move towards a higher purpose, which is to preserve the Earth and contribute to enhancing the society's wellbeing. To achieve this, many social practices must be taken into account, including:

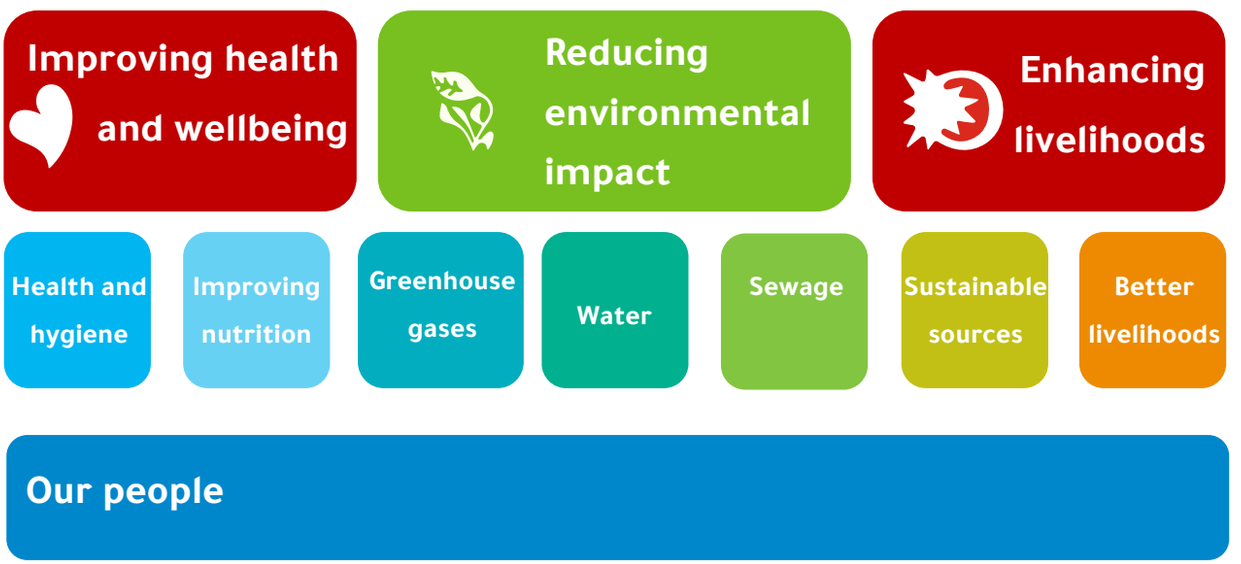
To begin with, corporate social practices can promote responsible investment and initiatives directed to protect marginalized groups, such as low-income populations, and emphasize **social justice**, decreased by climate change that disproportionately affects communities. Vulnerable and marginalized groups often bear the brunt of its cost. It is worth noting that the cost of climate losses and damages is estimated to range between USD 290 - 580 billion annually by 2030, most of which will fall on developing and least developed countries[19].

In other words, climate crises exacerbate social inequalities due to their social, economic, and health impacts, leading some to argue that climate justice and social justice are two sides of the same coin. Both are vital and essential to providing a sustainable future for all. One of the initiatives launched in this context is an initiative titled "Our Race to Health Equity"[20], which comes within Johnson & Johnson's strategy for environmental, social, and governance practices to improve access to quality health care.

On the other hand, strong social practices contribute to raising the level of **communities' participation and building their resilience** to combat climate change, especially those suffering from growing risks of severe weather events, rising sea levels, desertification, and other undesirable environmental changes, which contributes to preserving the communities' wellbeing. Unilever, which launched the Sustainable Living Plan in 2010-2020, is one of the shining models in this context. Figure 3 summarizes the pillars of this plan, which includes initiatives to improve the health and wellbeing of communities and reduce the environmental impact on them. It was implemented in partnership with several entities.

Figure 3

Unilever: The main pillars of the Sustainable Living Plan 2010-2020



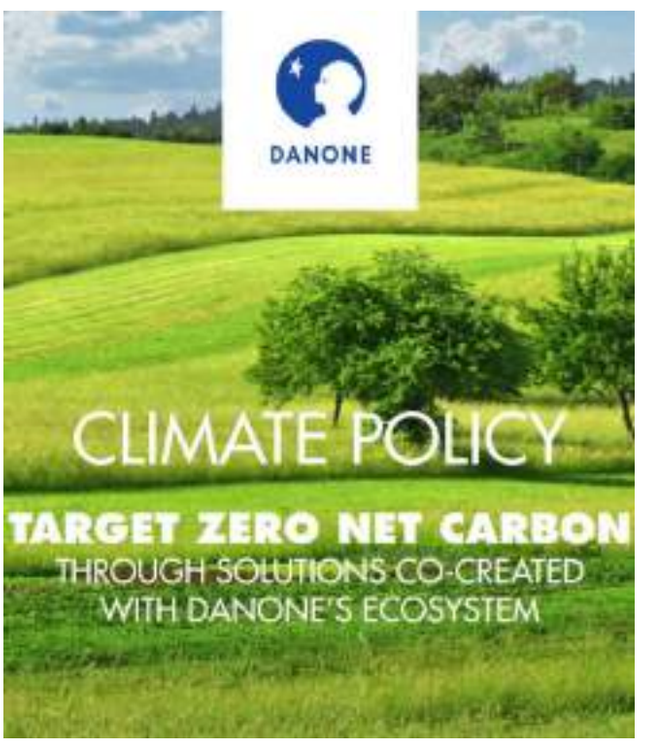
Source: University of British Columbia, Transformative Collaboration: Unilever's Sustainable Living Plan, UBC Blogs Site, December 2017, https://blogs.ubc.ca/sustainabilitystevensy/2017/12/

Furthermore, businesses can promote social practices under the environmental, social, and governance (ESG) framework. They could **cooperate and partner with local communities** and NGOs to implement initiatives and projects related to climate action, such as climate observing systems and early warning systems development. For instance, IBM and The Weather Company - its subsidiary - launched the Weather Signals[21] Project in 2019. IBM Weather Signals is an AI-based tool designed to help companies predict how fluctuations in weather can impact business performance, enabling them to proactively manage their supply chains.

Social practices imply, as well, safeguarding the internationally guaranteed **human rights** most vulnerable to climate change, for example, the right to food, clothing, adequate housing, health, and essential social services. Subsequently, the key messages circulated by the Office of the High Commissioner for Human Rights (OHCHR) highlight the essential obligations and responsibilities of States and other duty-bearers (including businesses). It is vital to adopt adequate and non-discriminatory policies, measures, and interventions to mitigate the direct and indirect impacts of climate change on human rights obligations[22].

Climate change can adversely impact and disrupt **supply chains**, affecting the performance of companies and the wellbeing of individuals and communities relying on them. Businesses good social practices necessitate consolidating suppliers' resilience against climate change impacts, addressing consequent social effects, and rendering the relevant companies' practices socially and environmentally responsible. In other words, sustainable supply chains would be established.

For instance, Danone (a food company) believes that food is health's most significant partner. Everything humans eat depends on the earth. Thus, its resources must be managed responsibly and sustainably through several initiatives targeting promoting social equity to enhance inclusive business practices and supporting local communities, especially the most vulnerable to climate challenges. Danone's adopted supply chain aims for these targets, covering farmers, the packaging process, logistics, retail sellers, and consumers. Each category bears specific pertaining responsibilities that complement each other to reduce the carbon print of the final product[23].

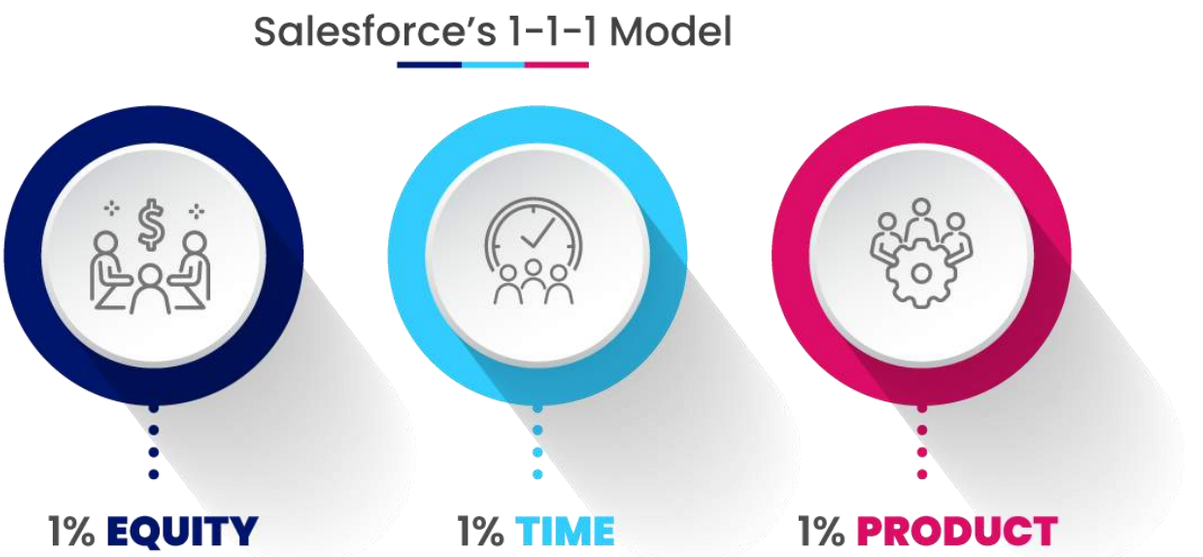


In addition, Starbucks adopts an ethical approach in its supply chains, which involve over 400,000 farmers in more than 30 countries worldwide, named Coffee and Farmer Equity (C.A.F.E.)[24]. Launched in 2004, this approach was considered the first of its kind in the coffee industry. C.A.F.E. Practices is a verification program that measures farms - belonging to its supply chain - against economic, social, and environmental criteria, all designed to promote transparent, profitable, and sustainable coffee growing practices while also protecting the wellbeing of coffee farmers and workers, their families, and their communities.

Businesses can also follow social practices that can enhance their **employees' wellbeing**. They could include occupational safety, security, and health to protect the employees against climate risks, especially in economic activities prone to climate risks. De facto, some companies - and countries - have adopted policies to protect the employees working outdoors against the high temperature. Given the importance of such aspects, occupational safety and health authorities in several countries opted to integrate climate risks into their occupational safety and health frameworks, ensuring all operating institutions' compliance.

The European Union has also adopted numerous pertaining legislative and non-legislative measures. The central piece of legislation is Directive 89/391/EEC, which establishes minimum occupational safety and health requirements for member states to adopt. It is considered a response to the risks emerging directly from climate change. It specifically states that the employer shall ensure the safety and health of workers in every aspect related to work and that the employer has the obligation to assess all risks to the health and safety of workers and implement the outcomes of this assessment. This also includes risks related to climate change and heat stress[25].

As part of their social practices, businesses encourage **volunteering among their employees**. They are motivated to engage in sustainability initiatives and climate action. Businesses also call for eco-friendly practices at the workplace and hold workshops, training sessions, and awareness programs to educate employees on climate change and relevant strategies. One of the good models in this field is Salesforce[26]: It was established in 1999 based on a vision of profitability and philanthropy as core pillars of the company. That took shape as the 1-1-1 model, which dedicated 1% of the company's equity, 1% of its product, and 1% of employees' time back to the community, for example, cultivating trees to face climate change.



Source: Salesforce, Salesforce Philanthropy Cloud: Putting Generosity into Action, April 1, 2022, https://www.theskyplanner.com/salesforce-philanthropy-cloud/

Lastly, **the call for climate policies** is a key social practice that can be a foundation for businesses. The Swedish Ikea[27] has announced that reducing greenhouse gas emissions across its value chain will be its main priority. Climate action advocacy groups have been calling for the same to accelerate the transition into a low-carbon economy.

Governance Practices Promotion to Accelerate Climate Action

Undoubtedly, there is a crucial correlation between business governance and climate change. On the one hand, governance, under the ESG framework, consolidates the rules according to which a business is steered and strategic orientations are formed. It influences the mechanisms of regulating the diverse relations among the board of directors, CEO, shareholders, employees, and stakeholders to institutionalize the decision-making process and introduce transparency and credibility to their financial and developmental outcomes. On the other hand, several businesses follow environmental and social practices to seize opportunities and address climate change risks, whose impacts should be governed to ensure performance safety and business model sustainability.

Climate action planning and implementation are highly complicated and intertwined because they are related to all business levels, the Sustainable Development Goals (SDGs) of a country, and the wellbeing of humans and nature. Therefore, **climate governance (CG)** has become the responsibility of businesses. In return, they enjoy numerous benefits, summarized in Box 1. The most important of these are mitigating climate risks and improving responses, enhancing regulatory compliance under relevant legal and legislative frameworks, and boosting trust in the climate actions of businesses.

Box 1

Climate Governance: Key benefits offered to businesses

- **Mitigating risks**: CG helps businesses to identify climate change risks that may affect it, such as extreme weather and disrupted supply chains. Hence, they will be preemptively ready to manage and limit the impacts, positively reflected in protecting their assets and ensuring sustainability.
- **Enhancing regulatory compliance**: Whereas many countries around the world adopt national strategies, by-laws, and standards to address climate change, CG ensures coherence between business practices and national directions and policies. It guarantees regulatory compliance, which would control relevant organizational risks and legal troubles.
- **Engaging stakeholders**: CG in businesses contributes to increasing cooperation opportunities; in addition, all stakeholders across all governance activities would work under an accountable participatory approach. It involves setting goals, forming policies and practices, monitoring and assessing performance, and suggesting improvement and development initiatives.
- **Endorsing research, development, and innovation**: Businesses have significantly realized their need to promote climate entrepreneurship, education, and investment. They seek to reengineer their operations and offer more sustainable and climate-friendly products and services. Thus, their climate footprint will be curbed; new markets will be opened; and their competitiveness will be boosted.
- **Enhancing the trademark's value**: CG definitely impacts trademarks. When businesses declare their outcomes backed with performance indicators, they evade being a suspect of greenwashing. Their mental image supporting environmental and social sustainability and accountable trade practices would be boosted, highlighting their positive role in protecting the planet.
- **Improving continuously**: Thanks to effective CG, businesses' boards, directors, and employees are always in anticipation of what the performance outcomes will be. They eagerly search for improvement opportunities by assessing the points of strength, seizing available opportunities, investigating risks, and addressing the points of weakness. They also seek to utilize the gained experiences and lessons inside and outside their business, taking into consideration customers' expectations and changing needs.

Source: Made by the author.

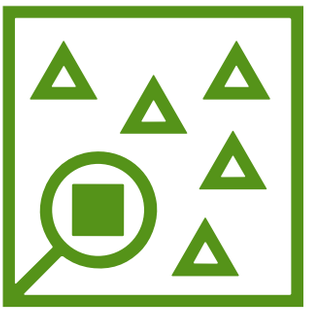
PWC's[28] model can be instructive in establishing an effective CG framework under ESG in business. It involves three phases, as illustrated in Figure 4. It also is based on the eight principles of climate governance stated by the World Economic Forum (WEF)[29] in 2019, as shown in Box 2. The principles cover climate accountability on boards, command of the climate subject, board structure, and material risk and opportunity assessment.

Figure 4

Climate governance phases

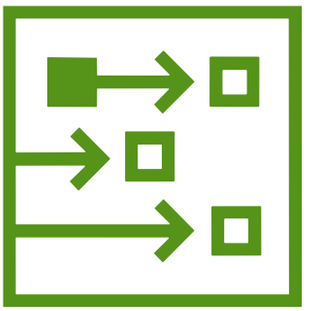
First phase:
Guiding principles

The framework begins with the eight CG principles and associated guiding questions previously published by the WEF.



Second phase:
Maturity assessment

This phase targets assessing business maturity regarding identifying, managing, and mitigating climate change risks to determine the targeted expectations, guided by the guiding questions of the 8 principles.



Third phase:
Outcomes

Based on the outcomes of the previous phases, targeted outcomes of climate action are determined against the results of the maturity assessment. Later, their results are monitored, followed up on, assessed, and reported. Key lessons should be drawn to improve performance.

Source: PWC, Climate Governance: A Framework, undated, October 20, 2023, https://www.pwc.co.uk/issues/esg/climate-governanance-a-framework.html

Box 2

WEF guiding principles for effective climate governance

Principle 1: Climate Accountability

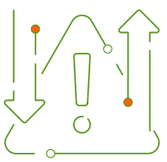
The board is ultimately accountable to shareholders for the long-term stewardship of the company. Accordingly, the board should be accountable for the company's long-term resilience with respect to potential shifts in the business landscape that may result from climate change. Failure to do so may constitute a breach of directors' duties.

Principle 2: Command of the Climate Subject

The board should ensure that its composition is sufficiently diverse in knowledge, skills, experience, and background to effectively debate and make decisions informed by an awareness and understanding of climate-related threats and opportunities.

Principle 3: Board Structure

As the stewards for long-term performance and resilience, the board should determine the most effective way to integrate climate considerations into its structure and committees.



Principle 4: Material Risk and Opportunity Assessment

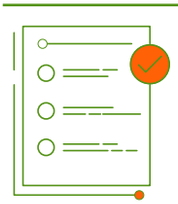
The board should ensure that management assesses the short-, medium-, and long-term materiality of climate-related risks and opportunities for the company on an ongoing basis. The board should further ensure that the organization's actions and responses to climate are proportionate to the materiality of climate to the company.

Principle 5: Strategic and Organizational Integration

The board should ensure that climate systemically informs strategic investment planning and decision-making processes and is embedded into the management of risk and opportunities across the organization.

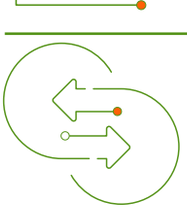
Principle 6: Incentivization

The board should ensure that executive incentives are aligned to promote the long-term prosperity of the company. The board may want to consider including climate-related targets and indicators in their executive incentive schemes. Variable incentives can also be extended to non-executive directors based on climate performance.



Principle 7: Reporting and Disclosure

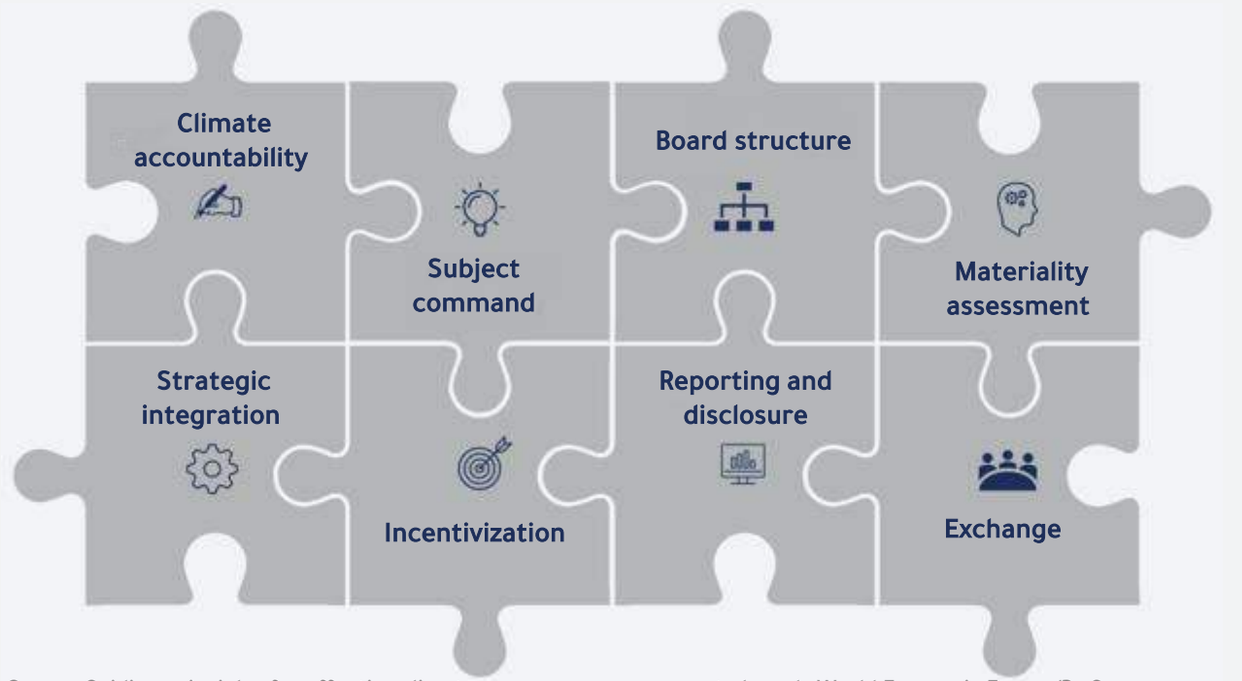
The board should ensure that material climate-related risks, opportunities, and strategic decisions are consistently and transparently disclosed to all stakeholders - particularly to investors and regulators. Such disclosures should be made in financial filings, such as annual reports and accounts, and be subject to the same disclosure governance as financial reporting.



Principle 8: Exchange

The board should maintain regular exchanges and dialogues with peers, policy-makers, investors, and other stakeholders on the latest climate-relevant risks, regulatory requirements, etc.

Source: World Economic Forum, How to set up effective climate governance on corporate board: Guiding principles and questions, in collaboration with PwC, January 2019, accessed October 30, 2023, https://www3.weforum.org/docs/WEF_Creating_effective_climate_governance_on_corporate_boards.pdf



Source: Guiding principles for effective climate governance on corporate boards World Economic Forum/PwC https://www.weforum.org/agenda/2019/09/the-need-for-corporate-climate-governance/

In a related context, some international frameworks can be used as guides to support CG efforts and relevant reporting processes. **The most prominent are**:

- The framework of the Task Force on Climate-related Financial Disclosures (TCFD)[30] was created by the Financial Stability Board to offer recommendations to companies on the disclosure of climate-related information in their financial filings. It covers governance, strategy, risk management, and performance indicators.

- The Climate Disclosure Project (CDP)[31] completely aligns with the TCFD.

- The Climate Disclosure Standards Board (CDSB)[32] offers a framework to disclose climate change and environment information in the businesses' financial filings, such as the annual budget.

- The Climate Resilience Principles (CRP) were formed by the Climate Bond Initiative to provide investors and stakeholders with guiding principles, enabling them to assess and report their adaptation ability.

- The Greenhouse Gas Protocol was issued by the World Resources Institute (WRI) and the World Business Council for Sustainable Development (WBCSD) to provide accountability and reporting standards relating to the greenhouse gas emissions of each product and the life cycle of businesses.

It is clear that governance practices and climate actions are complementary given the key issues included in ESG: the board's responsibility for climate action, climate goals, climate risk management, stakeholder engagement, disclosure, and reporting, and the correlation between the financial compensations to the management and sustainability and climate action. There is also a correlation between the **climate action ethical standards** that imply combating climate corruption.

Climate corruption often refers to deception and lack of integrity in implementing policies and interventions concerned with combating climate change, constituting a serious threat to the efficiency and effectiveness of climate action. The following demonstrate some climate corruption practices that must be included in ESG:

- **Corruption in climate finance:** Funds specified for climate-related projects or investments are misused, misallocated, or injected into high-emission projects or activities under the guise of green initiatives.

- **Corruption in formulating and implementing climate policies and practices:** Decision-making, whether at the governmental or private level, can be negatively influenced to achieve personal gains, undermining the effectiveness of measures made to address global warming.

- **Greenwashing:** Stakeholders and the public are misled regarding the impacts of businesses' activities on climate performance. Greenwashing involves disseminating false and misleading information or slogans to create a fake mental image of businesses and falsely promote their contributions to climate actions.

The proposals put forward by the Anticorruption for Development Global Forum, held in June 2023, can be used to address climate corruption under the ESG framework. **They are[33]:**

- **Assessing risks and taking the necessary actions:** It is recommended to consider the risks related to climate action, take the necessary actions at risk mitigation, and keep learning and adjusting actions based on effectiveness.

- **Creating and promoting transparency standards:** This applies to expected and achieved results, as well as to transparency of funding flows and disclosure.

- **Opting for comprehensive accountability:** Accountability should be comprehensive rather than just focused on financial aspects. The performance and fairness of investments made are even more important than accounting for spending sums.

- **Managing corruption risks effectively:** It is recommended to effectively manage corruption risks without posing an undue hurdle to business.

- **Using technology in accountability:** It is preferable to use technology to keep accountability efforts efficient. This does not mean having blind faith in technology since human assessment and analysis, as well as physical checks, are all important.

- **Engaging local stakeholders:** Civil society and private sector representatives can play important roles - albeit varying by context - to monitor climate actions and govern investments related to climate change.

- **Talking to investors:** It is advised to dialogue with both international and local investors, focusing on private sector investments. Talking to investors is the best way to know the needs for scaling up investments, as well as the potential corruption risks.

Concluding Recommendations

Managing Director of the International Monetary Fund (IMF), Ms. Kristalina Georgieva, mentions that environmental, social, and governance (ESG) do not represent restrictions against companies' performance. However, they stimulate innovation, resilience, and sustainable growth within a fast-changing global context. This increases the positive value such practices have on institutions' performance and ability to be resilient and face climate change in the long run.

Kristalina Georgieva
Managing Director of the
International Monetary Fund (IMF)

On the one hand, while facing environmental deterioration and social inequality resulting from climate change, ESG promotes activities of **research and development (R&D)**, as well as innovation inside businesses. The objective is to explore innovative solutions to deal with such issues. Moreover, ESG contributes to developing new, innovative products and services in line with the values of responsible consumers. They aim at achieving climate neutrality and –perhaps– transcend to innovate negative-emissions products.

On the other hand, climate change imposes several risks to businesses –according to the nature of the economic activity– including physical risks pertaining to extreme weather events and transitional risks related to changes in the market and public policy. Hence, integrating climate action into the entire system of ESG contributes to promoting businesses' ability to **face and adapt** to climate change impacts, ensuring their ability to flourish within an ever-changing business environment.

Furthermore, **sustainable growth**, a main goal for all profit and non-profit institutions, is closely linked to the effective integration of ESG, on which businesses are established, including climate change practices. This is attributed to many factors. Most importantly, this approach aligns with the preferences of responsible consumers and social expectations, promotes trust and loyalty to trademarks, and increases the value of sustainable and responsible businesses.

In light of a fast-changing global scene abounding with climate change issues, social inequality, and lack of governance transparency and accountability, dealing with ESG is **pivotal and crucial**. It contributes to adopting more effective market dynamics and promoting regulatory compliance with national and international frameworks, especially when climate goals that align with the strategic orientation of businesses are clearly determined and integrated into business strategies and operational processes.

In order to localize a framework for ESG supplemented with climate change, there has been an urgent need for businesses –with their various activities and sizes– to consider the following:

- Achieving a comprehensive integration into climate practices as part of the framework of ESG: Along with direct and indirect co-relations among the three basic pillars, climate change considerations should be integrated into the entire framework. This is verifiable after checking several guiding experiences within this paper.

- Benefitting from good experiences and practices to develop an integrated framework: The national and international arenas abound with a considerable number of practices for businesses that have already adopted effective climate interventions within ESG.

- Promoting internal entrepreneurship inside businesses: They mainly focus on climate-friendly technologies and practices while incubating major orientations and emerging technologies that ensure environmental sustainability and business growth.

- Providing activities to build capacities of employees at businesses: This is according to a detailed framework for the competencies and skills necessary to promote climate action, ensuring the launch of internal capabilities and involvement of everyone in climate action.

- Opening cooperation horizons and joint action with industry peers and civil society organizations (CSOs) to ensure knowledge exchange and adoption of a collective approach to face the global challenge of climate.

In conclusion, one can say that adopting an ESG framework supplemented with climate change is no longer a mere responsibility of businesses but also an opportunity to delve into a fast-changing world, taking into account that the journey of achieving sustainability of businesses requires a collective commitment, cooperation, and joint action aiming at reaping sustainable fruits at the institutional, national, and international levels.

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Transition to Green Economy and Sustainable Development Bets in Morocco

Thanks to the concerted efforts of variant actors, Morocco witnessed important structural transformations in terms of their frequency and type, enabling it to reach a new growth threshold. The transformations' features were evident in the accelerating demographic growth rate, urbanization, and life span extension.

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Abstract

The research paper reviews the New Development Model (NDM) 2035 report that targets unleashing potential and building trust to fast-track progress and prosperity for all in Morocco. It addresses a plethora of political, economic, social, environmental, and cultural issues; moreover, it proposes numerous public policies, regulatory mechanisms, and executive measures to achieve the established goals for relevant fields. Considering the cruciality of concentration in this research paper, the analytical approach to this report will be limited to the environmental aspect, for it is key to every development project, without disregarding the fact that development must be inclusive and relative to the economic and social aspects. The report concludes that Morocco is keen on preserving natural resources: Their sustainability and biodiversity conservation are required to address challenges and threats related to climate change and human activity. Morocco is highly exposed to these threats and their impacts, for example, exhaustion of water resources and disturbance of the production foundations of agriculture and ecosystems. According to the sustainability bet, the collective responsibility should be devoted to the natural capital and climate in the interest of all and to the upcoming generations.

Keywords: **New Development Model - Sustainable Development - Green Economy - Climate Change - the Kingdom of Morocco.**

Introduction

For many years, Morocco has been committed to sustainable development at the directives of its highest authority, especially in regard to natural resources governance, biodiversity conservation, and the fight against climate change. The environmental issue, situated at the heart of public policies, has emerged once again at the forefront of public discussions thanks to the report issued by the Special Commission on the Development Model (SCDM). It was established by His Majesty the King in November 2019 to launch an unprecedented project targeting building a prosperous, open society whose strength lies in pluralism, development, and territorial collectivities that have stood strong in the face of present and future challenges. Focusing on sustainability as a key to development aligns with the necessity of valuing natural capital and ensuring its preservation for current and upcoming generations. The report confirms said argument, calling for governing natural resources and transitioning to a green economy as a basis for achieving sustainable development in Morocco.

Thanks to the concerted efforts of variant actors, Morocco witnessed important structural transformations in terms of their frequency and type, enabling it to reach a new growth threshold. The transformations' features were evident in the accelerating demographic growth rate, urbanization, and life span extension. Concerning sustainability, the Kingdom of Morocco established a modern legislative framework on environmental protection and sustainable development; it provided for the right of all citizens to live in a peaceful environment in the 2011 constitution. It also passed numerous laws and strategies related to water, energy, combating climate change, forests, nature reserves, air quality, solid waste, coast protection, etc. In the past, Morocco also adopted an energy transition policy, targeting scaling up its electricity generation capacity from renewable sources to 42% out of total capacity in 2020 and 52% in 2030. Moreover, the National Energy Strategy, put in place by Morocco in 2009, has paved the way for the development of countless energy projects, especially in the fields of solar energy, wind energy, and hydropower. Consequently, Morocco has gained real-life experience in this field. Thanks to said reforms, it has progressed at the levels of social and economic stability and development.

First: The Research Problem

Based on the abovementioned, this analytical-qualitative research paper is based on a key problem: How does the New Development Model contribute to winning Morocco's sustainable development bets?

This pivotal problem encompasses sub-questions:

- What is the current environmental status in Morocco?
- What are the most significant environmental dilemmas included in the SCDM report?
- What are the opportunities highlighted by the report as keys to green transition?

Second: The Research Objectives

The research paper targets presenting NDM's key outcomes and SCDM's recommendations. The studied report is titled The New Development Model: Releasing Energies and Regaining Trust to Accelerate the March of Progress and Prosperity for All. A qualitative analysis is to be conducted on its three sections. Notably, NDM's first section tackles Morocco's status and the future. The second section presents the new model suggested by SCDM, and the third section puts forward change pillars to accomplish the aspired model. This paper focuses on the points related to natural resources and green transition. It aims at showcasing a bundle of mechanisms and programs that should be adopted to achieve the desired development by 2035 amidst bottlenecks concerned with climate change and natural resource depletion.

Third: The Research Significance

The environment and sustainable development issues, situated at the heart of Morocco's public policies, have emerged once again at the forefront of public discussions thanks to the SCDM report. It was established to launch an unprecedented project targeting building a prosperous, open society whose strength lies in pluralism, development, and territorial collectivities that have stood strong in the face of present and future challenges. Focusing on sustainability as a key to development aligns with the necessity of valuing natural capital and ensuring its preservation for current and upcoming generations. Thus, SCDM, which devoted sleepless nights to the NDM, has called for the promotion of natural resources governance. In this paper, an analytical-qualitative approach is adopted, relying on the NDM report as its main reference in addition to other official reports related to the subject matter of the analytical study.

The paper, through NDM, encourages fostering a strategy oriented toward the green economy and its application at the territorial collective level, with a focus on a hub economy that integrates local features and capabilities. Therefore, special attention should be paid to developing green industries in the fields of solar and wind energy, liquid sanitation, and waste management. Given that the environment is connected to NDM, the latter stressed the necessity of considering the climate change aspects through establishing production patterns and social structures that rely on sustainable development principles, guarantee the interests of upcoming generations, and ensure the sustainability of the natural ecosystem, the conservation of biodiversity, and the protection of the fauna and flora across various regions in terms of growth nature and pattern.

Fourth: Environment and Sustainable Development in Morocco - Bets and Challenges

In the midst of the social and demographic shifts happening in the Middle East and North Africa (MENA), Morocco unleashed a series of profound political, economic, and social reforms many years ago under the leadership of King Mohammed VI. In 2011, the new constitution culminated the Kingdom of Morocco's efforts. It stipulated for strengthening and promoting the united Moroccan society's values, a society that guarantees its citizens security, freedom, equal opportunities, respect for dignity, social justice, and the right to a clean environment. Furthermore, the National Charter for Environment and Sustainable Development was established and activated through sectoral programs and important fund allocation. In 2012, the Charter was converted into a framework law, implying an official integration of the environmental dimension into all the national economic, social, and cultural policies in Morocco.

The dynamism of the environment issue was evident throughout the past 10 years in variant economic sectors because of the National Charter for Environment and Sustainable Development, the strategy of water resource mobilization and water rationalization in agriculture, forests and biodiversity conservation, renewable energy development and energy efficiency plans, wastewater treatment improvements, better solid waste management, and programs for the sustainable development of agriculture, tourism, and fishing. As a result, the dynamism has contributed to providing a favorable atmosphere for the national transition to the green economy[1]. Morocco has, hence, commenced to reduce its dependence on its fossil fuel imports. It had pinpointed an ambitious goal to render renewable energy a source for saving 42% of the generated energy in the country by 2020 and diminish energy demand by 15% through adopted energy rationalization measures. Recently, the government has started decreasing its subsidy on diesel, petrol, and heavy fuel to boost rationalization efforts in energy consumption and combat pollution. Additionally, the Green Morocco Plan, a national agricultural strategy, targets growth, climate adaptation, and climate mitigation. It requires investments to promote agricultural productivity and measures to enhance water resources management and lessen fossil fuel consumption. New technologies in soil carbon management, such as direct seed dispersal, were also introduced. Morocco also presented the main pillars of its strategy for green growth before global private actors during the World Economic Forum in Davos. Although environmental sustainability necessitates trade-offs, Morocco bases its plans on a long-term perspective. De facto, climate change is a main factor in drafting the key decisions related to policies and investments. Morocco well acknowledges that its path to development is at a critical juncture. The World Bank estimates that nearly 7% of the country's wealth is attributable to the swiftly depleting natural resources. In 2004, the World Bank reckoned the cost of environmental degradation at 3.7% of the GDP[2].

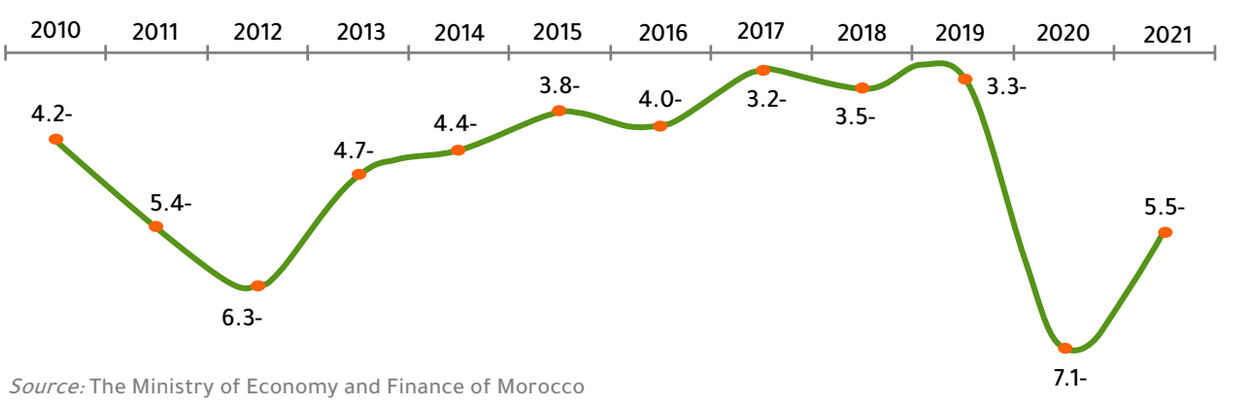
The shift in the national sustainable development dynamics requires its application through a new economic model that maintains the natural capital and ensures the highest level of social harmony. To this end, NDM 2035 was prepared with the help of practical actions to seek a green economy for Morocco. The SCDM report is, indeed, the result of numerous months of brainstorming, discussions, and interactions with various political and economic actors in addition to the civil society at the national, regional, and local levels[3]. The report pinpoints specific, real, and achievable goals; they are precise indicators to monitor accomplishments regularly. Different sectors can identify specifications to be met and challenges to be overcome for interim accomplishments in order not to run off the right track. The report also highlights strategic bets for the "Future Morocco". It focuses on parallel research for the practical intervention at the territorial level, energy and carbon emission reduction, digital platforms, funding resources diversification, and the consolidation of the "Made in Morocco" trademark. They represent the interests of environmental and sustainable development activists in recent years.

Fifth: Environmental Degradation and the 2030 Agenda for Sustainable Development

In the last decades, Morocco witnessed a critical economic boom due to the development of a group of vital socio-economic sectors, such as agriculture, industry, fishing, urban development, tourism, and infrastructure. Its resurgence was not void of some negative impacts on the environment. In the last 20 years, Morocco has made great strides across all fields. Having had changes in the treasury's revenues and expenses, the overall budget deficit skyrocketed, leading to the deterioration of the budget in 2020 to reach 7.1% of the GDP, compared to 3.3% of the GDP in 2019. In 2021, the budget deficit recovered by 1.6 percentage points of the GDP to reach 5.5% (Figure 1).

Figure 1

Budget balance as a percentage of the GDP in Morocco (Ministry of Economy and Finance, the Kingdom of Morocco, 2023) (%)



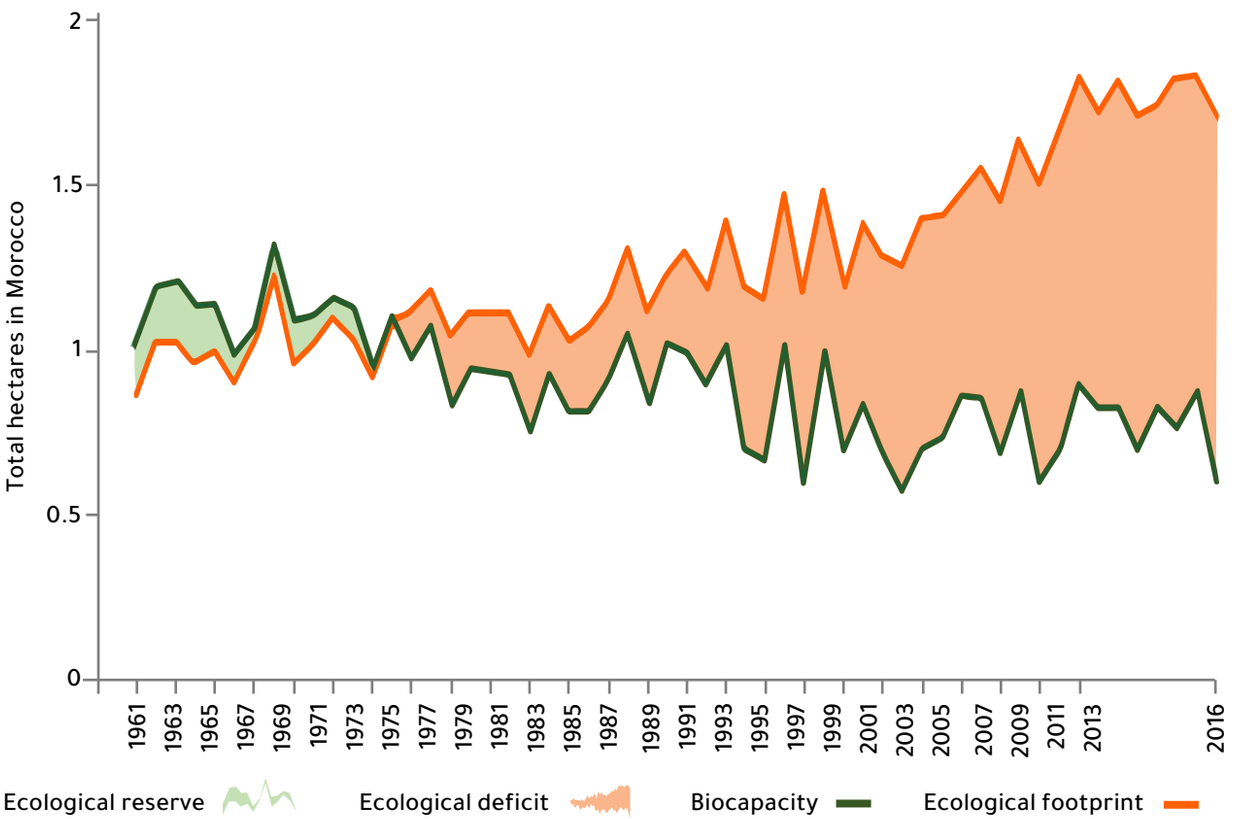
Source: The Ministry of Economy and Finance of Morocco

The Kingdom of Morocco was able to achieve economic growth, equal in average to 4%, over the last two decades and conducted numerous projects; consequently, it could set foot on an upward development trajectory and rendered its demographic shifts a catalyst for economic development. In Morocco, environmental degradation exceeded double the recorded cost at the global level. In 2014, said cost was estimated at roughly MAD 5.32 billion, equivalent to 52.3% of the GDP (MAD 960 per capita yearly). The Report on the State of the Environment in Morocco, made in 2020, assessed the environment's state and tendencies in Morocco, delved into the reasons and consequences of change, and pointed out some emerging issues and environmental challenges to face the country in the future. Seven environmental fields have been determined to be the subject of a holistic analysis: water, air, the continental ecosystem, the sea and coasts, the land, climate change, and circular economy[4].

Environmental degradation has afflicted the country with an ecological deficit for nearly half a century. It has resulted in a growing gap between the biocapacity of the national land and the ecological footprint of activities. The deficit reached roughly a hectare per person in 2016/2017 (Figure 2), i.e., three times less than the global average.

Figure 2

Evolution of the biocapacity and the ecological footprint in Morocco (The Global Footprint Network, 2019)



Source: Global Footprint Network. (2021). National Footprint Accounts.

The NDM report assesses the environmental state in Morocco as well. It indicates that the environment, natural resources, and biodiversity receive great hits due to climate change impacts while being under the effect of public policies and sectoral strategies that adequately consider the necessity of resource sustainability and environmental balance. The poor integration of environmental challenges and problems into projects and public policies has resulted in drastic adverse effects, the cost of which has amounted, per several national and international studies, to roughly 3% of the GDP. The report also highlights that the water status in Morocco is particularly alarming, reflecting Morocco's high vulnerability in the face of climate change. Due to the patterns of water consumption that do not consider its scarcity, the price of water used for drinking, industrial purposes, or irrigation does neither reflect the true cost of that resource nor encourages resorting to alternative resources.

The Moroccan coast, abundant with most of the country's economic activities, is also facing extreme weather phenomena. Despite the bets and challenges, Morocco's initiatives to adapt to the situation are limited. The delayed integration of environmental impacts into projects and public programs or the slow development of circular economy activities are evident proofs. Therefore, concerted efforts are required to face the major environmental challenges and dilemmas. In other words, meeting Morocco's commitments to the UN timeline concerned with the 2030 Agenda for Sustainable Development will be challenging due to the lack of a genuine shift in the development pathway[5]. The current pace of implementing the SDGs makes it difficult to achieve some SDGs. The challenges can be summarized as reducing social and gender disparities, reviving economic growth, creating adequate job opportunities - especially for the youth and women, protecting biodiversity, and addressing climate change impacts.

Sixth: Environment, Migration, and Climate Action

Climate change is one of the key factors of internal migration driven by the loss of livelihood in local communities and the general environmental degradation, which affects the collective health of the population and the quality of children's education. Statistics have shown that Africa's Sahara is the first region expected to face large-scale migration, estimated - by experts - at 86 million persons, followed by West Asia at nearly 49 million, South Asia at 40 million, North Africa at 19 million, and Latin America at 15 million. Subsequently, climate migration will negatively impact these countries' economies, rendering them more fragile. Thus, they must swiftly formulate policies to confront the situation before it is too late, taking into consideration the social segments that will be affected by climate change, such as small-scale farmers. Hence, Morocco's NDM has focused, in the field of the environment, on the fact that the escalation of climate change impacts will result in increasing pressures on national biodiversity and natural resources. De facto, Morocco may suffer from water scarcity by 2030[*]. Additionally, climate change could lead to an increase in the forced displacement of people from arid village areas towards urban areas, particularly the coastal area.

Demographically, the report expects that the world will encounter a notable increase in populations caused by the countries of the South, especially Africa, as opposed to an elevation in population aging in the developed countries, particularly Europe. These developments will expose Morocco to two phenomena: the increase of immigration from Sub-Saharan Africa due to climate change and the weak mobilization of growth qualifications and employment opportunities in these countries and the growing flow of Moroccans emigration to developed countries given the huge demand for qualified skills to compensate the deficit in their active population. More clearly, Morocco is exposed to real threats when facing two major challenges: managing the migration flows and motivating national skills and talents to work in Morocco.

According to the report, the international community has become more aware of the negative impacts of climate change on the overall ecological balance. Therefore, the environmental and ecological standards have been positioned at the center of the production system and the international exchanges. Morocco is obliged to reduce its carbon emission rate in order not to affect its exports in the future with any constraints. Investments must be injected into a production system that takes into consideration these standards and turns them into a significant competitive advantage.

In addition, the global energy arena, in relevance to the awareness of climate challenges, is witnessing a thorough reform process given the significant growth of the green energy sector and the launch of huge renewable energy programs, especially in Europe through the Green Deal[**].

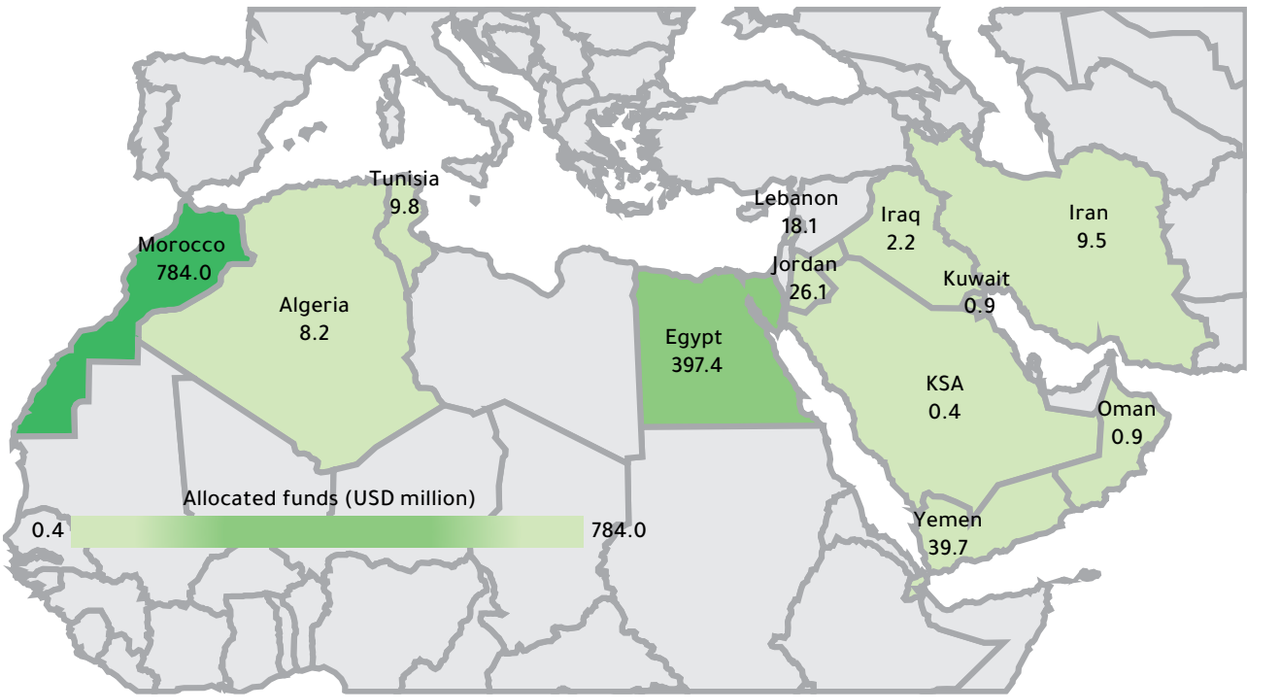
[*]The risk is transitioning into water scarcity by 2030 (500 m^3/hour/year). See the Economic, Social and Environmental Council, 2020.

[**]The Green Deal, launched by the European Commission in December 2019, targets making Europe a climate-neutral continent by 2050 through a new economic growth strategy.

This trend promotes Morocco's priorities in this field and calls for increasing the bet on renewable energy through investing in suitable projects and technological options with a strong impact on competitiveness.

Figure 3

Public sums allocated to climate finance in MENA countries



Source: Climate Funds Update

At the MENA level, Morocco has acquired a prominent position regarding public finance: the global investment value is USD 784 million. The map (Figure 3) clearly illustrates the scale of climate finance in different MENA countries[6].

Seventh: Aspirations for Morocco 2035

Morocco aspires to achieve the five development goals stipulated in the NDM. It seeks welfare, empowerment, inclusion, sustainability, and regional leadership in specific fields while placing bold bets for the future. The fourth goal, represented in a sustainable Morocco keen on preserving resources nationwide, shall be summarized in the following lines. Nowadays, resource sustainability and biodiversity conservation are required to address challenges and threats related to climate change and human activity.

Morocco is highly exposed to these threats and their impacts, for example, exhaustion of water resources and disturbance of the production foundations of agriculture and ecosystems. According to the sustainability bet, the collective responsibility should be devoted to the natural capital and climate in the interest of all and the upcoming generations[7].

Eighth: New Reference for Development Actions to Achieve Sustainability and Efficacy

This approach needs new work principles for all parties concerned. These principles should act as a guarantee for an actual and systematic application of the proposed approach to advance toward the development goals.

Said development will specify means to apply the NDM. In fact, development actions ought to be based on the impact on citizens, engagements amid a systemic and participatory atmosphere, and the development of actors' capacities. Subsidiarity, along with ecological and financial sustainability, should top the priorities.

The fifth principle - Sustainability and Efficacy - is the systematic inclusion of resource sustainability and efficacy of development options in the actors' interventions. The continuous aggravation of resource exhaustion poses the necessity of considering the requirements of environmental and financial sustainability in public performance; resources - natural or financial - must be reasonably utilized, valued, and preserved for the current and future generations. Hence, the report stresses the imperative of making wise, efficient decisions in resource usage, which should be based on regular analysis of costs and revenues. As for environmental sustainability, any project's external impact on the environment must be reviewed regularly. Moreover, the preservation of resources should tip the balance in case of strong adverse effects. To sum up, the efficacy of public spending should be continuously assessed[8].

A proposed tool is a network to ensure harmony with NDM. It could be a list of simple standards enabling actors to monitor the integration of recommended work principles into their initiatives.

8.1. Transition Strategic Pillars

NDM is based upon four key pillars for transition to achieve its aspirations and goals. These pillars need to be met according to the principles and approaches set in the development agenda. The fourth strategic pillar focuses on territories and the enhancement of their position in the development process. This trend requires transforming territories from a mere final step in the public centralized policymaking process to a key factor in forming, establishing, and applying public policies.

The report confirms that the said would be a catalyst for fair access to public services and a proper, suitable atmosphere for living. Resources would be preserved; the national identity would be esteemed; and the dignity of Moroccans would be safeguarded everywhere.

8.2. Strategic Options for Transition

The fourth pillar - Territories and Sustainability - identifies five strategic options as follows:

- Advocating for a prosperous and dynamic "Morocco of Regions".
- Bringing about an innovative territorial reorganization.
- Encouraging integrated territorial planning, focused on improving the living conditions (housing, connectivity, and mobility).
- Conserving natural resources and enhancing territorial resilience to climate change.
- Preserving water resources by optimizing usage and managing more strictly due to scarcity.

8.3. Advanced Agriculture under Environmental and Social Responsibility Standards

Agriculture tops the priorities of the Moroccan economy, given its correlation to economic, social, and environmental stakes. It is considered one of the most important sectors of Moroccan domestic products. Nevertheless, it has witnessed a slowdown in recent years due to climate fluctuations and late precipitation. According to the official figures, it contributes nearly 14% to the GDP and is a key employment source for roughly 75% of villagers. So, it is necessary to invest in non-agricultural sectors, for example, industry, services, and trade, in addition to paying more attention to scientific research and technology.

Furthermore, climate challenges have always imposed a serious threat and permanent obstacle to Morocco's agricultural sector. The Moroccan climate is characterized by irregular precipitation, whether in terms of location or timing and year-on-year rising temperature rate; as a consequence, periods of drought occur more often with varying intensity yet on a regular basis. Climate projections, concerned with precipitation and annual temperature rate conducted by the Intergovernmental Panel on Climate Change (IPCC) for 2050 compared to 2010, state that drought will increase gradually in Morocco as precipitation will fall by 11% and temperature will spike by 3.1°C. These changes will have negative impacts on agriculture as follows: 1) Reduced availability of irrigation water that can reach over 25% in tanks, 2) less revenues generated by rainfed agriculture that can reach 10% in some regions, 3) lost soil fertility due to water and wind erosion and its weak organic matter, 4) declined animal production as a result of the negative impacts on plant production, and 5) diminished water resources.

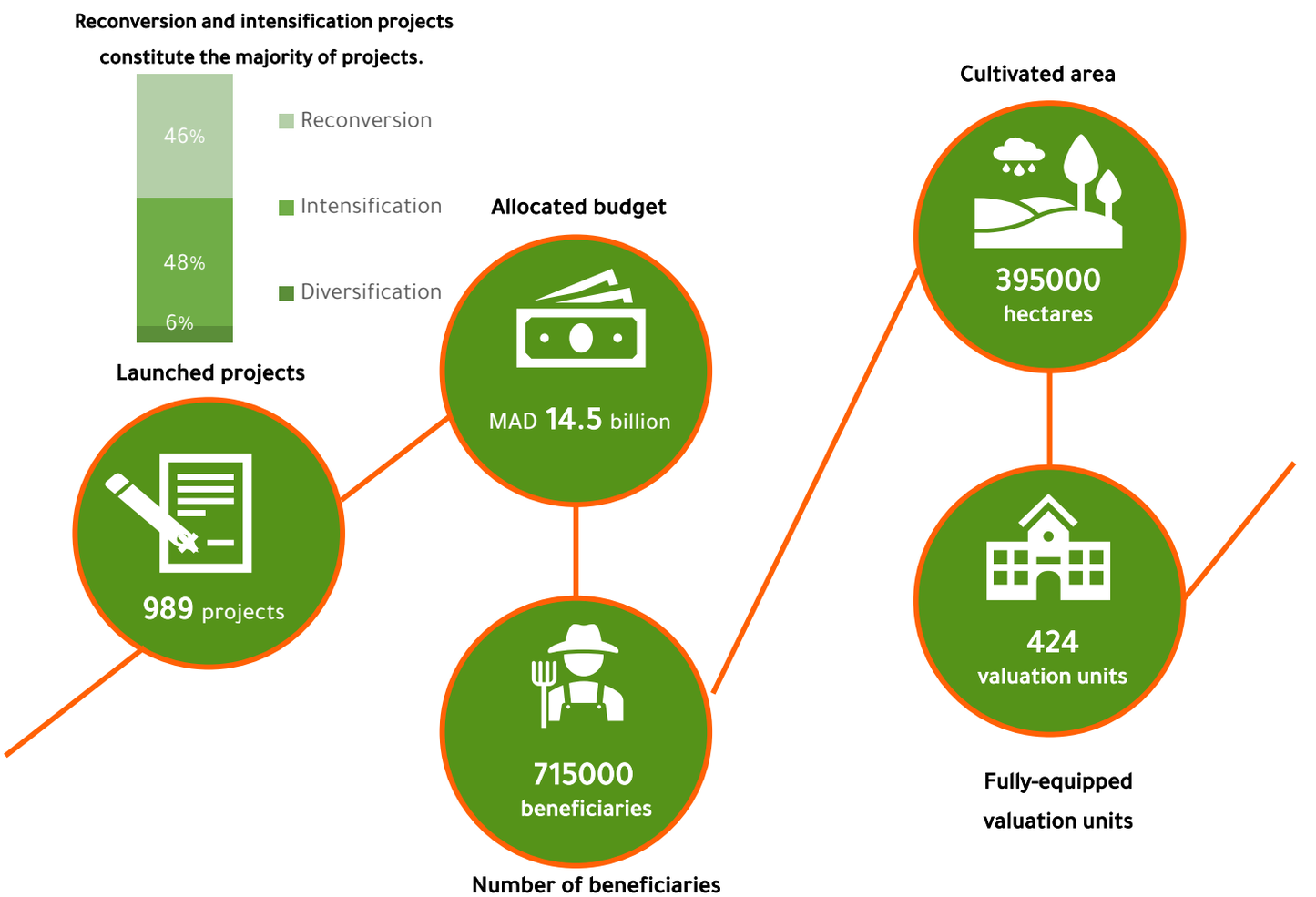
In addition, Morocco seeks a modern agricultural system that is socially and ecologically responsible and the utilization of technology in sustainability-oriented efforts for an established food sovereignty based on a modern, value-added, inclusive, and responsible agriculture. Hence, NDM calls for making further efforts for the sake of modern agriculture that is equally committed to environmental and social responsibility and contributes to achieving the food sovereignty goals. It also calls for including sustainability requirements and strengthening the ability to address climate change. Harmony can be orchestrated between productivity and sustainability via the following:

1. Expanding access to innovative production methods to enhance crops using precision farming.
2. Rationalizing water consumption in agriculture while considering its scarcity: Focus should be given to key sectors of food sovereignty, and advanced technologies shall be tapped to enhance the adaptation ability and preserve water. The true cost of water should also be characterized by transparency and competitiveness to facilitate the regulation process.
3. Supporting the development of family agriculture and rainfed agriculture along with introducing brief valuation procedures to the livestock sector that relies on grazing.
4. Promoting local production and boosting access to the proper agricultural inputs (Seeds capable of adapting to climate change, smart fertilization, local varieties preservation, and plant health control).
5. Fostering the proper and accessible financing methods for the ecological and agricultural systems.

The second pillar (Figure 4) seeks to empower 80% of villagers residing in fragile areas (Mountainous terrains, oases, and arid and semi-arid areas) to enhance their incomes and living standards sustainably. Consequently, they will be able to abandon subsistence agriculture and dive into promising beneficial production chains connected to the market. Food security will thus be guaranteed. This vision would enhance the public policy targets. The country particularly concentrates on integrating small-scale farmers because they lack the capital or the financing resources to invest, enhance income, and overcome fragility. The Green Morocco Plan was also updated to include programs based on an applicable approach targeting investments coupled with a strong country contribution. The second pillar mainly targets 3 categories of projects. The first is reconversion projects, which imply the substitution of cereals in fragile areas by higher value-added crops. The second is intensification projects; they involve the improvement of productivity and valuation of productions. The third is diversification projects, denoting the creation of additional farm income through additional productions (saffron, honey, medicinal plants, etc.)[9].

Figure 4

Second pillar (New approach to solidarity agriculture)



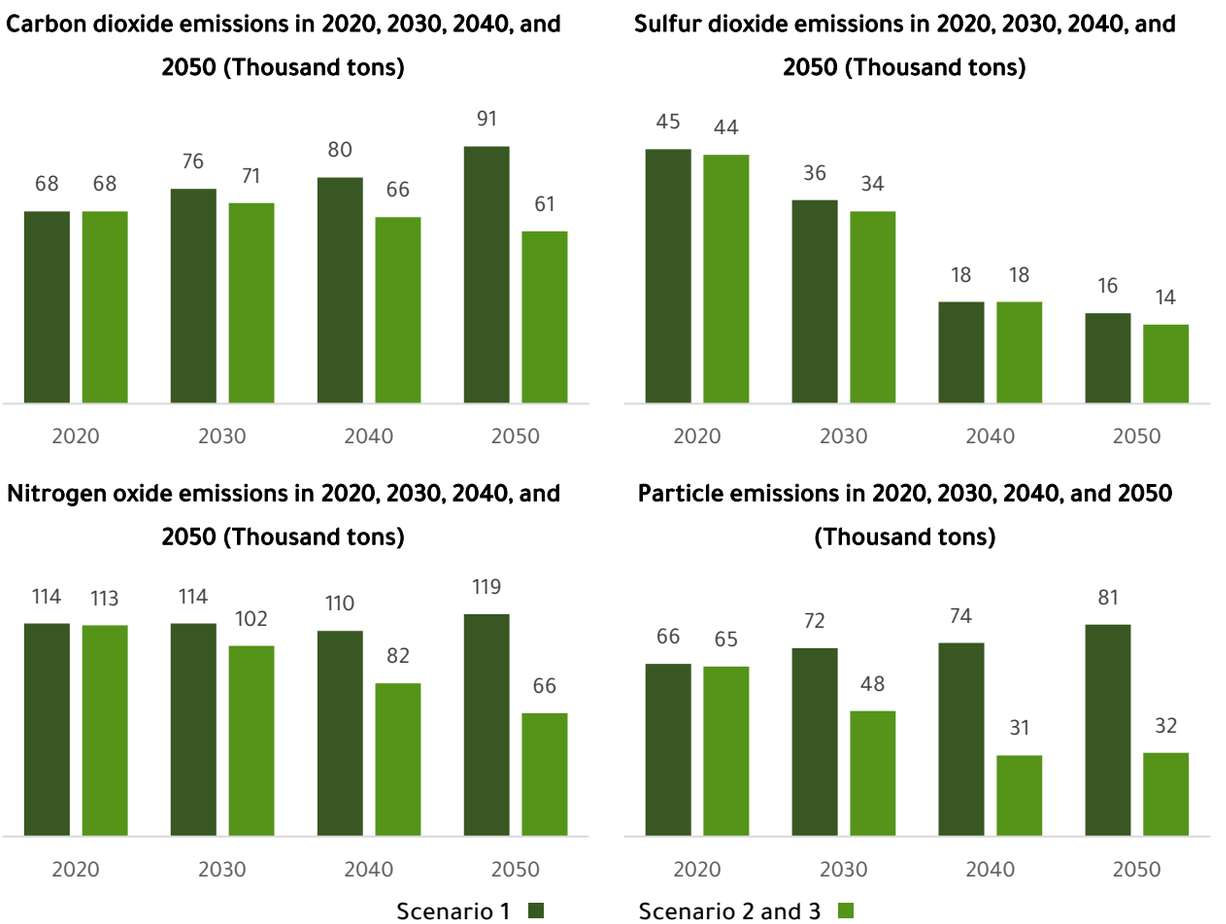
Source:مخطـط المغرب الأخضر الحصيلـة والآثار 2008 - 2018 (وزارة الفلاحة والصيد البحري والتنمية القروية والمياه والغابات)

Ninth: Low Carbon Renewable Energy and Green Economy

Morocco is accelerating its steps to increase energy generation from renewable resources. It targets achieving the goals of climate change and carbon neutrality by 2050 and establishing sovereignty in this sector. The Kingdom is also working on reducing greenhouse gas emissions by 45% by 2030 and planting 500,000 palms annually under the framework of the new agriculture strategy (Green Morocco Plan). It has embarked on a fast-paced journey to address climate change and meet the green economy requirements, such as the qualification of human resources to assume green jobs. Renewable resources will reduce greenhouse gas emissions by 30% and particle emissions by 50%; subsequently, population health will be enhanced, and climate change impacts will be mitigated[10]. The following data shows the evolution of greenhouse gas emissions after the integration of renewable energy in the energy mix (Figure 5).

Figure 5

The evolution of greenhouse gas emissions after the integration of renewable energy in the energy mix (The Economic, Social and Environmental Council model, 2020)



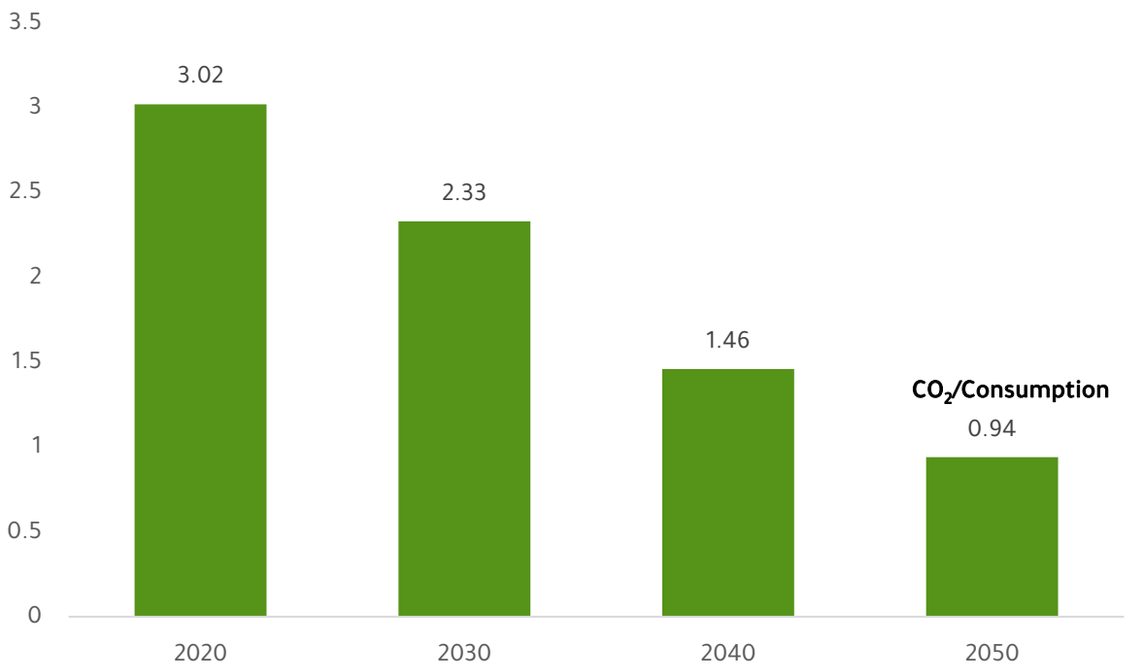
Source: تسريع الانتقال الطاقي لوضع المغرب على مسار النمو الأخضر. المجلس الاقتصادي والاجتماعي والبيئي (إحالة ذاتية رقم 45/2020). المملكة المغربية. 2020.

One of NDM's bets is turning Morocco into a leader in competitive and green energy (Figure 5). Its energy supply is targeted to be an important economic attractive factor by offering competitive energy mainly generated from renewable sources[11]. Expediting the transformation of Morocco into an economy characterized by low carbon emissions, competitiveness, and industry attractiveness will qualify it to be a reference for production methods free of carbon emissions and known for reliability and sustainability. Thus, the Moroccan export supply will be able to access promising markets. Foreign investors seeking investment opportunities in the green economy will also be attracted to the country.

The electrification of the transport sector will also enhance the carbon dioxide emission rates despite the spiking energy consumption rates. In scenario 3, 3.02 tons of carbon dioxide per each ton of oil equivalent shall be 0.94 tons of carbon dioxide per each ton of oil equivalent by 2050 (Figure 6).

Figure 6

Carbon dioxide emission rates caused by the primary energy consumption (ton per each ton of oil equivalent) (The Economic, Social and Environmental Council model, 2020)



Source: تسريع الانتقال الطاقي لوضع المغرب على مسار النمو الأخضر. المجلس الاقتصادي والاجتماعي والبيئي (إحالة ذاتية رقم 45/2020). المملكة المغربية. 2020.

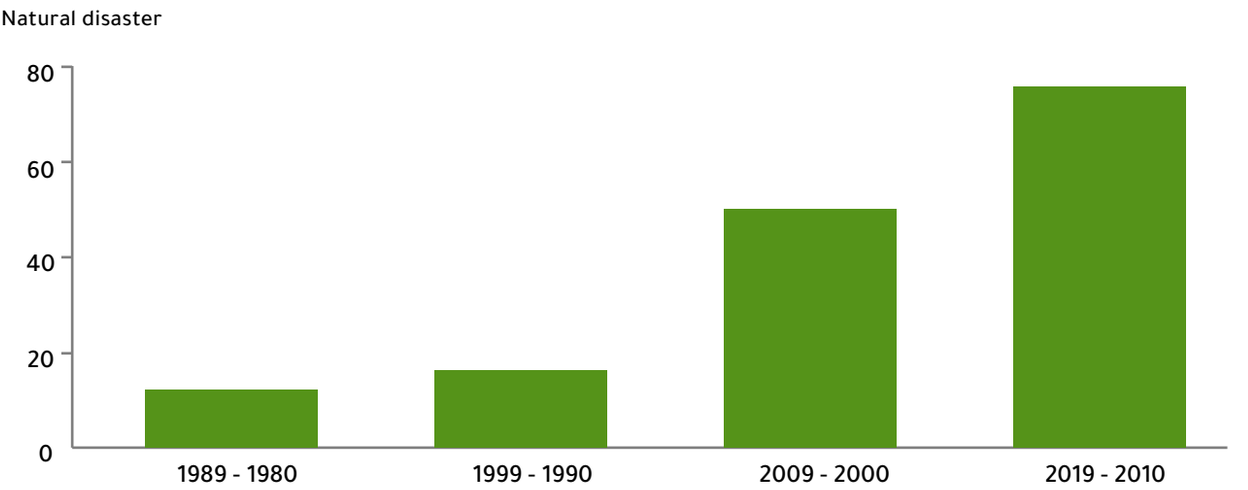
> Deeply reforming the energy sector has become vital to benefit from the current technological advancements in the renewable energy field and develop an open market for national and foreign investment.

Tenth: Natural Resources Conservation and Resilience against Climate Change

Territories, especially regionally, are the key to preserving natural and local resources. Hence, sustainability has gained considerable attention for being the basis of development. In parallel, the natural capital must be valued and preserved for the current and upcoming generations. On a separate note, climate change is known for the increase in the frequency and magnitude of some extreme weather events, for instance, destructive floods, long periods of drought, soil erosion, rising temperature, etc. While the population density is growing in coastal cities, the economic consequences, let alone the human loss caused by these events, may be tremendous (Figure 7).

Figure 7

Evolution of natural disasters in Morocco between 1980 and 2019



Source: Directorate of Civil Protection, 2020

Notably, NDM considers enhancing natural resources governance essential. Different actions must be in harmony during the practical implementation of the National Sustainable Development Strategy. The environmental impacts of investment programs ought to be assessed; such assessments shall be considered a benchmark for settling on programs[12]. The public sector must be entirely engaged in the governance process, according to the Exemplary Administration Pact concerned with sustainability adopted in 2019.

SCDM also calls for enhancing efforts targeting the development of agriculture through including sustainability commitments. It is necessary that Morocco resorts to high-value-added crops capable of withstanding climate change. SCDM also stresses the importance of radical solutions to the obstacles hindering Moroccan agriculture. Sustainability and valuation must be placed at the core of the agriculture strategy through:

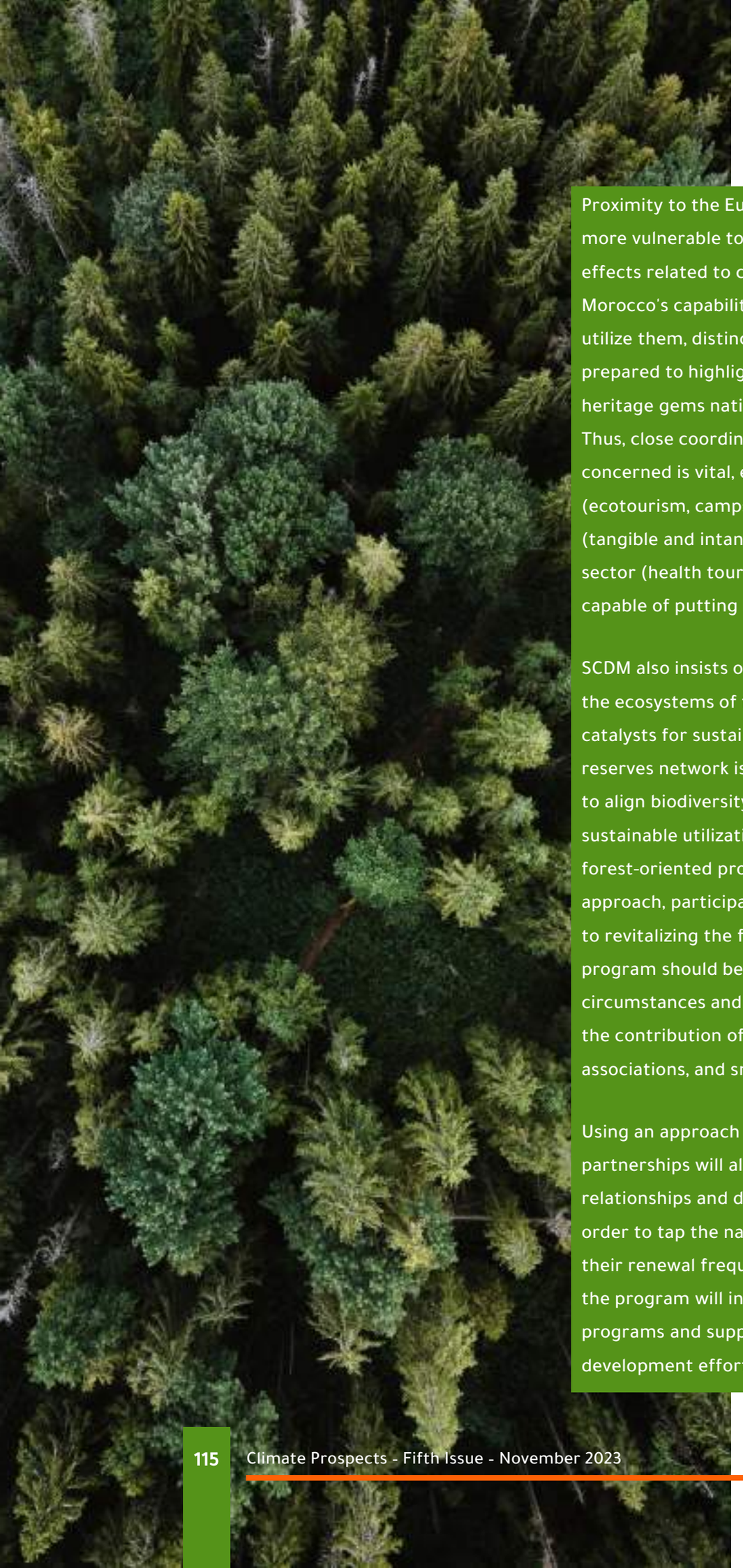
- The optimal utilization of water resources: Irrigated areas for crops that guarantee food security should be increased; moreover, the export crops sector should value water accurately, taking into consideration its direct and indirect cost to the country and society.

- Energy rationalization in agricultural consumption: Renewable energy should be extensively used in agriculture through tapping solar energy in pumping water[13].

Furthermore, SCDM suggests the optimal utilization of the available green and blue economies potential. They can create an added value at the territorial level. It also urges the adoption of a green economy strategy applied nationwide by opting for the circular economy concept that considers local potential and specificities. Developing green industry chains is specifically recommended in the fields of solar and wind energy, liquid sanitation, and waste management. Realizing the future needs of competent green sectors, SCDM suggests enhancing the training programs on green jobs via the appropriate stimulus measures. Actors can offer research, development, and innovation initiatives across the academic, industrial, and financial fields in addition to introducing the cultivation of other crops, already existing in some areas, to the green economy framework. It suggests establishing a legal framework for these crops and developing a valuation system subject to monitoring[14].

Regarding the blue economy, SCDM stresses the necessity of tapping Morocco's potential, for it is considered a maritime nation that owns an abundance of ports and maritime resources. While the planned measures should include traditional economic sectors like fishing, tourism, and port operations, they should equally focus on new highly qualified sectors (e.g., aquaculture, algaculture, marine bioproducts, shipbuilding, and renewable marine energy).

It is worth mentioning that Morocco's natural and cultural capital can considerably boost domestic and international tourism, specifically cultural tourism, recreational tourism, sports tourism, and ecotourism. Its diverse natural capital, historical and cultural heritage, hospitality, cuisine, and safe environment qualify it to be an attractive travel destination.



Proximity to the European market, which will be more vulnerable to low-impact environmental effects related to carbon emissions, will strengthen Morocco's capabilities in this field. To optimally utilize them, distinct tourism programs should be prepared to highlight Morocco's cultural and heritage gems nationwide and stimulate tourism. Thus, close coordination among all sectors concerned is vital, especially the agricultural sector (ecotourism, camps, and parks), the cultural sector (tangible and intangible heritage), the health sector (health tourism), and sports events highly capable of putting Morocco on the map.

SCDM also insists on conserving biodiversity and the ecosystems of forests as they are considered catalysts for sustainability. The national nature reserves network is recommended to be expanded to align biodiversity conservation with the sustainable utilization of forests; in addition, a forest-oriented program based on a territorial approach, participation, and partnerships is critical to revitalizing the forest ecosystems[15]. This program should be designed based on real circumstances and a participatory approach, with the contribution of pastoral societies, forest associations, and small-scale farmers.

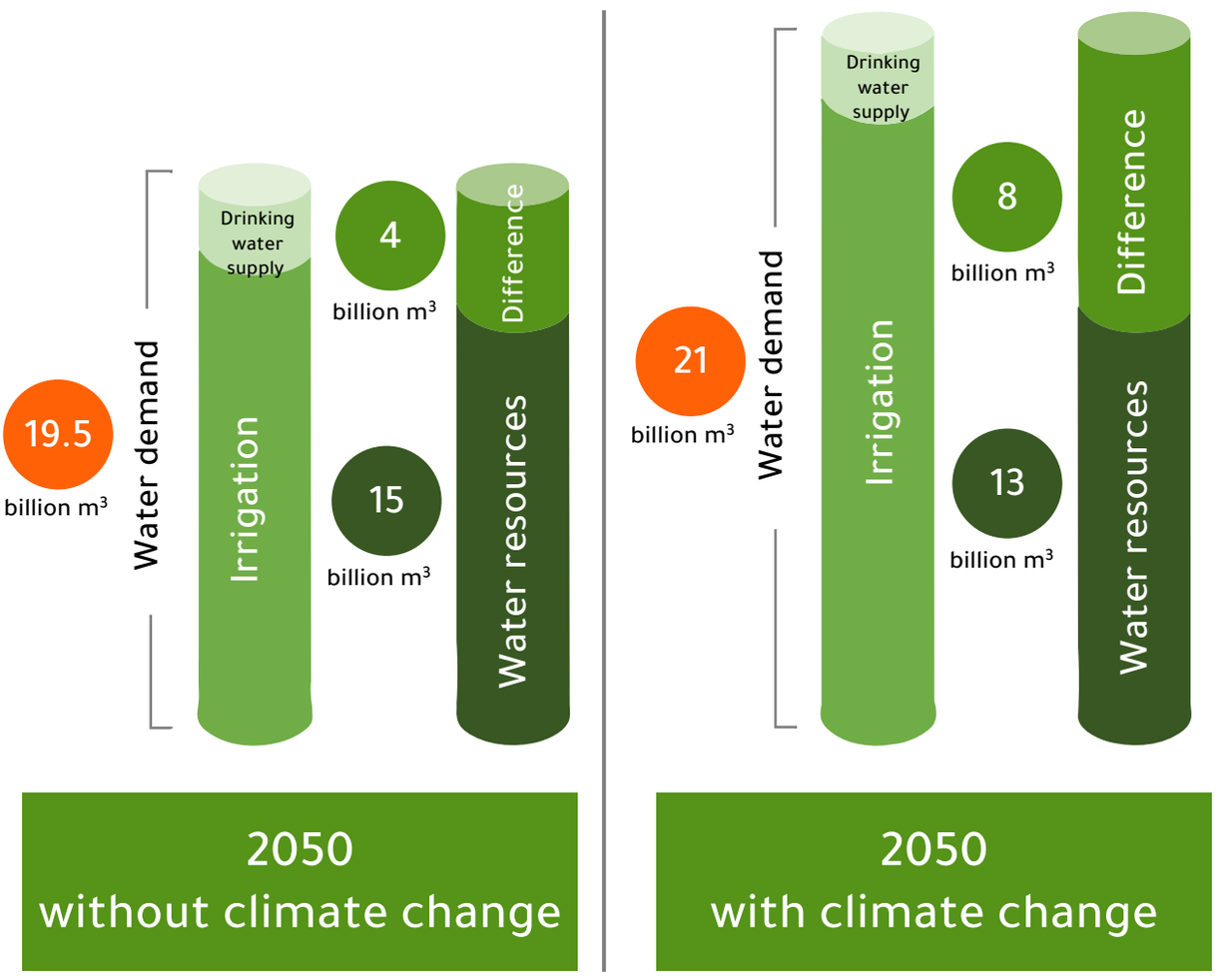
Using an approach based on the concept of partnerships will allow identifying the contractual relationships and delegating responsibilities in order to tap the natural resources according to their renewal frequency. Lastly, SCDM is keen that the program will include adequate training programs and support the research and development efforts in said field.

Eleventh: Water Conservation

Morocco suffers from an acute shortage of water resources that continues to aggravate. Water scarcity constitutes a direct threat to Morocco's economic, environmental, and social balance. It jeopardizes arid and semi-arid areas and regions where residents rely heavily on water resources[16].

In other words, the water issue requires an urgent solution. An approach that considers water scarcity systematically and prioritizes its conservation for current and future generations should be adopted. The different measures proposed by the National Water Plan represent a serious rescue plan that deserves to be provided with all requirements for success. Otherwise, shortage in water may range between 4 billion m^3 and 8 billion m^3 annually (Figure 8).

Figure 8
Water resources evolution by 2050



Source: Directorate of Water Research and Planning, 2019.

As a solution to the water crisis, SCDM puts forward four suggestions. Firstly, the sector must be reformed by promoting transparency on water resources cost across all phases (collection to distribution) through the following:

- Breaking the financial linkages between energy and water: The National Office of Electricity and Potable Water should be profoundly reformed to render water and electricity departments financially separate. The implicit formula of the tariff on water and energy would be annulled for a more transparent financial model.

- Integrating the cost of infrastructure concerned with water into this resource's cost: This shall be a prerequisite to control the current status that implies a free-of-charge dam and irrigation services, causing a low estimation of the water's cost. Opting for the best investments constitutes an imbalanced process as well.

This suggestion calls for making provided services related to the infrastructure paid, such as storing water, reducing surface runoff caused by floods, and offering hydropower. Thus, entities responsible for managing this utility will be able to generate revenues that can be directed to maintenance and necessary investments.

Secondly, SDCM recommends introducing a tariff that reflects the true value of water to rationalize its usage and better address its scarcity. The tariff review is necessary to obtain the permanent resources that would enable investments to mobilize new resources and preserve the available ones. Water loss (leakage and evaporation) should also be addressed along with rationalizing water usage through the following:

- Gradually increasing the water tariff applied to all consumers, households, and farmers: It is to ensure that they would be able to pay for the water services. The country will bear the responsibility of subsidizing the consumption of low-income households.

- As for agriculture, mechanisms should be put in to encourage water usage rationalization. Irrigation shares could be identified to suit the cultivated areas.

Thirdly, a national agency for water management should be established. It will compensate for the work of the ministerial committee for water. It will align public and sectoral policies in order to be applied suitably for each water basin. It will also be assigned to addressing the water crisis, using a holistic approach from the beginning to the end. The agency shall determine means for water resources distribution according to the instructions of the Supreme Council for Water and Climate; in addition, it will prepare and verify the tariff of different infrastructure services directed to storing, producing, and transporting water. It shall encourage relying on and using the standards of storing and collecting raw or treated water to preserve it in the long run, especially in the sectors most consuming of water, like agriculture and tourism in some areas.

Lastly, meeting future water needs would be impossible unless non-traditional resources are mobilized and underground services are preserved. It will be necessary to rationalize the use of groundwater by adopting patterns of exploitation that consider the capacity of replenishing groundwater. In addition, it will be appropriate to resort to seawater desalination to provide a supplementary and guaranteed source of water supply in the coastal cities, provide additional water resources for irrigated areas, and significantly control water loss[17]. Controlling the cost of energy and working with an adequate tariff considering the best value of the water resource can make this sector attractive to private investments and partnerships between the public and private sectors. Wastewater and rainwater should also be regularly treated and reused to meet the needs of the irrigated areas and reduce pressure on the dams. Hence, an organizational framework should be formulated, allowing the effective integration of treated water into water planning, identification of responsibilities related to treatment, and the determination of the follow-up cost of the treated water quality. Specifications should also be introduced concerning the safe and healthy reuse of treated water per the standards of the World Health Organization[18].

Conclusion and Recommendations

The NDM - its environmental dimension - confirms the necessity of considering climate-related aspects. It recommends introducing production patterns and social regulations stemming from the sustainable development principles that take into consideration the interests of upcoming generations. They should also ensure the natural ecosystems sustainability, biodiversity conservation, and fauna and flora preservation across regions.

Undoubtedly, the NDM, suggested by the SCDM, highlights numerous dilemmas closely related to the sustainable development bets in Morocco, including but not limited to the necessity of sustainable natural capital protection and valuation to achieve steady growth, green growth, the prioritization of the energy and water sectors, the environmental factor, the transition to the circular economy, and the fulfillment of Morocco's international commitments to address climate change impacts. These positive priority aspects require constantly implementing the necessary reforms for the current phase, especially since the world is becoming more complicated and volatile and its society is known for pluralism, maturity, and active citizenship. Therefore, Morocco's collective actions must be adjusted to be able to defeat the sustainable development challenges and boost the country's potential. We call for translating NDM's strategic pillars into a "national strategy for development", worthy of being adopted and implemented in a constructive and consensual manner and high sense of responsibility toward the public interest; it should be a common reference to all parties.

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Climate Intelligence: Climate Change Impact on Political Stability

Climate change impacts clearly have catastrophic repercussions on human security generally and on the national security of countries from multiple aspects. Global warming, for example, plays a major role in the existing and possible water conflicts in MENA, as well as other various and growing impacts of climate change.

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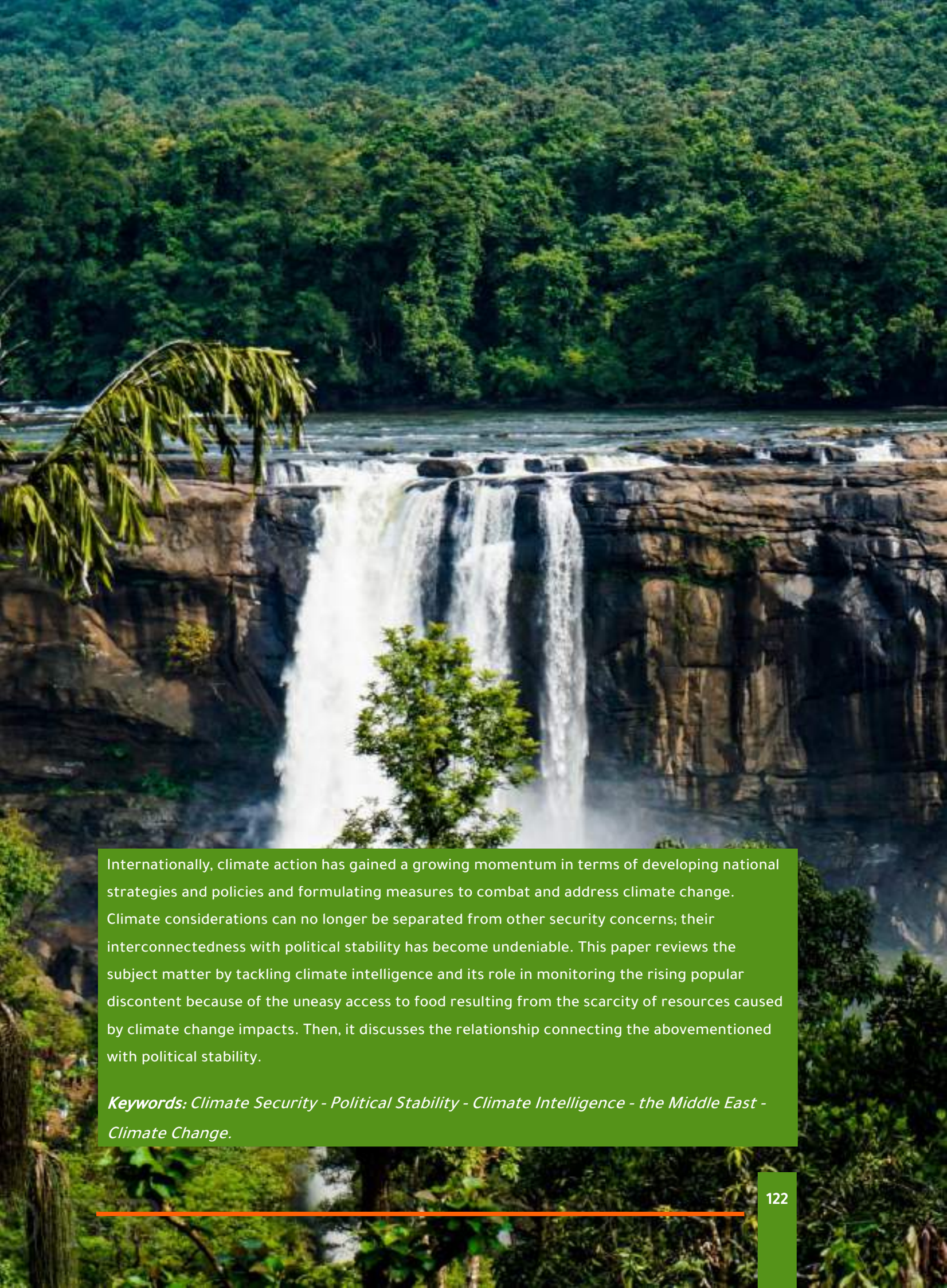
Abstract

The Middle East and North Africa (MENA) region is one of the most vulnerable regions to the impacts of climate change. The last years demonstrated the impact of environmental degradation on political and social instability. For instance, severe drought has frequently led to the loss of livelihoods, internal displacement, and the lack of food security. The annual temperature also increased by roughly 1°C in the last three decades. Several MENA countries, such as Algeria, Libya, Egypt, KSA, and Iraq, may witness the greatest rise in temperature.

Among the climate change impacts that afflicted the MENA countries is the change in the precipitation pattern, direction, and rate; in addition, their communities have suffered from a shortage in water supply due to climate change impacts.

Additionally, the climate has evidently become an integral factor in security thinking. Therefore, the US Department of Defense issued a report titled Climate Risk Analysis. It tackled the mechanisms with which the American military institution could integrate climate issues into its security strategy. It proved that governments realize that climate change jeopardizes human security and countries' national security.



Internationally, climate action has gained a growing momentum in terms of developing national strategies and policies and formulating measures to combat and address climate change. Climate considerations can no longer be separated from other security concerns; their interconnectedness with political stability has become undeniable. This paper reviews the subject matter by tackling climate intelligence and its role in monitoring the rising popular discontent because of the uneasy access to food resulting from the scarcity of resources caused by climate change impacts. Then, it discusses the relationship connecting the abovementioned with political stability.

Keywords: *Climate Security - Political Stability - Climate Intelligence - the Middle East - Climate Change.*

Introduction

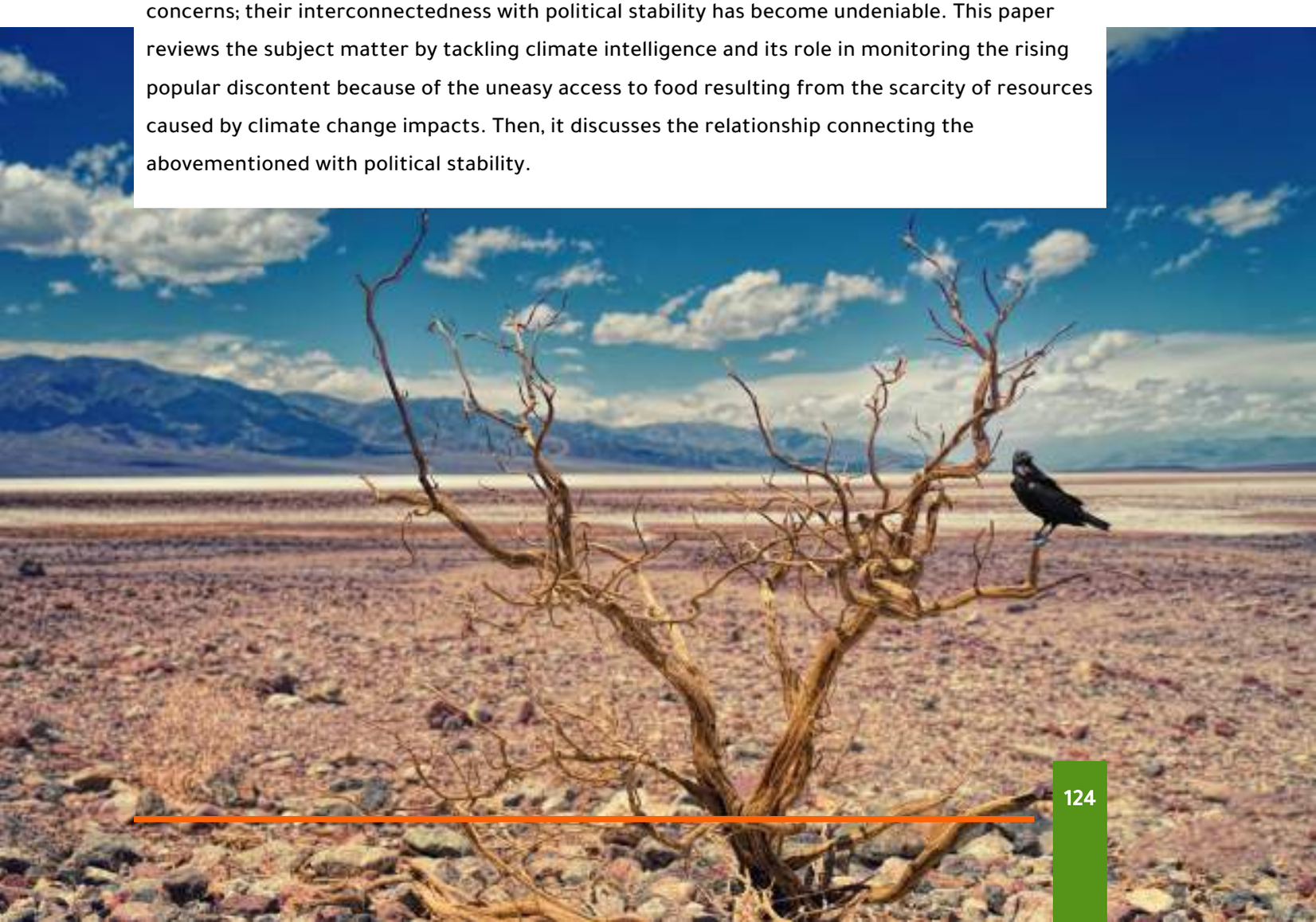
Climate change is considered a prominent challenge overshadowing the international arena in the 21st century. It is an existential threat to the Earth, even if its impacts differ among countries. According to the report issued last March by the Intergovernmental Panel on Climate Change (IPCC), temperature has risen by 1.1°C above the pre-industrial levels due to the repercussions of unbalanced or unsustainable energy use and land use for over a century and fossil fuel combustion. As a result, weather phenomena rates escalated, adversely affecting nature and humans worldwide. The report's suggested solution is the climate-resilient development pathway, which is based on combining adaptation measures with actions focused on reducing/evading greenhouse gas (GHG) emissions per useful methods[1]. Global warming is evident and unquestionable; global temperature is steadily rising at a pace difficult to contain under the 1.5°C threshold. Estimates indicate that the activities of the major industrialized countries are the main reason behind global warming. There is a cause-and-effect relationship between those countries' activities and most climate disasters worldwide. Considering the countries' lack of commitment toward the Paris Agreement goals, the repercussions and aftermath of climate change will aggravate[2], affecting all economic, political, social, and security aspects.

The Middle East and North Africa (MENA) region is one of the most vulnerable regions to the impacts of climate change. The last years demonstrated the impact of environmental degradation on political and social instability. For instance, severe drought has frequently led to the loss of livelihoods, internal displacement, and the lack of food security. The annual temperature also increased by roughly 1°C in the last three decades. Several MENA countries, such as Algeria, Libya, Egypt, KSA, and Iraq, may witness the greatest rise in temperature. Among the climate change impacts that afflicted the MENA countries is the change in the precipitation pattern, direction, and rate; in addition, their communities have suffered from a shortage in water supply due to climate change impacts.

Notably, the rise in temperature, precipitation pattern change, and water stress have adversely affected strategic economic sectors of high added value, like agriculture, with negative repercussions on the food security of most MENA countries. Indeed, climate change and its associated phenomena affect the region's future in terms of political instability and social conflicts. Therefore, a different approach is required to address these impacts from the root by using what has become known as "Climate Intelligence". The growing impacts of climate change have pushed most countries toward sharpening their focus on climate change intelligence and its impact on the global decision-making process.

In this context, the US Central Intelligence Agency (CIA) issued a first-of-its-kind report on the nexus between climate change and US national security, titled Climate Change and International Responses Increasing Challenges to US National Security Through 2040. It warns that climate change will intensify international tensions[3]. Given the role of climate change in international peace security, the Security Council also held a meeting on climate change, peace, and security on June 13, 2023. It tackled climate change as the defining challenge of the modern era. Its interconnected consequences - intensified extreme weather, rising sea levels, food and water insecurity, biodiversity loss, and heightened health risks - jeopardize human life, livelihoods, and ecosystems and have an adverse impact on national, regional, and global stability[4].

The climate has evidently become an integral factor in security thinking. Thus, the US Department of Defense issued a report titled Climate Risk Analysis. It tackled the mechanisms with which the American military institution could integrate climate issues into its security strategy. It proved that governments realize that climate change jeopardizes human security and countries' national security. Internationally, climate action has gained a growing momentum in terms of developing national strategies and policies and formulating measures to combat and address climate change[5]. Climate considerations can no longer be separated from other security concerns; their interconnectedness with political stability has become undeniable. This paper reviews the subject matter by tackling climate intelligence and its role in monitoring the rising popular discontent because of the uneasy access to food resulting from the scarcity of resources caused by climate change impacts. Then, it discusses the relationship connecting the abovementioned with political stability.



In this paper, the researcher discusses a key dilemma: How can the possible repercussions of climate change on MENA's political stability be overturned? What are the necessary policies and decisions to address the issue? The researcher invokes the index developed by the European Union Institute for Security Studies (EUISS) that assesses climate risks in the region to underline vulnerability, readiness, and mitigation efforts in various MENA countries.

There are serious connections between climate change and conflicts; therefore, the MENA countries have to advance climate forecasting because it can help in addressing environmental threats and their geopolitical, security, and economic impacts. They need to opt for climate intelligence. It comprises a bundle of intelligence mechanisms that study and monitor the impact of climate change on aggravating desertification and the population's gradual displacement within the country or across the MENA countries and digs into the relationship of the latter with food security and political stability.

Given that climate change impacts are multi-dimensional, complex, and transboundary, with great association with future state sovereignty dilemmas, the researcher uses the qualitative analysis approach regarding proposals and literature related to the policy paper. The paper is divided into 5 sections, as follows:

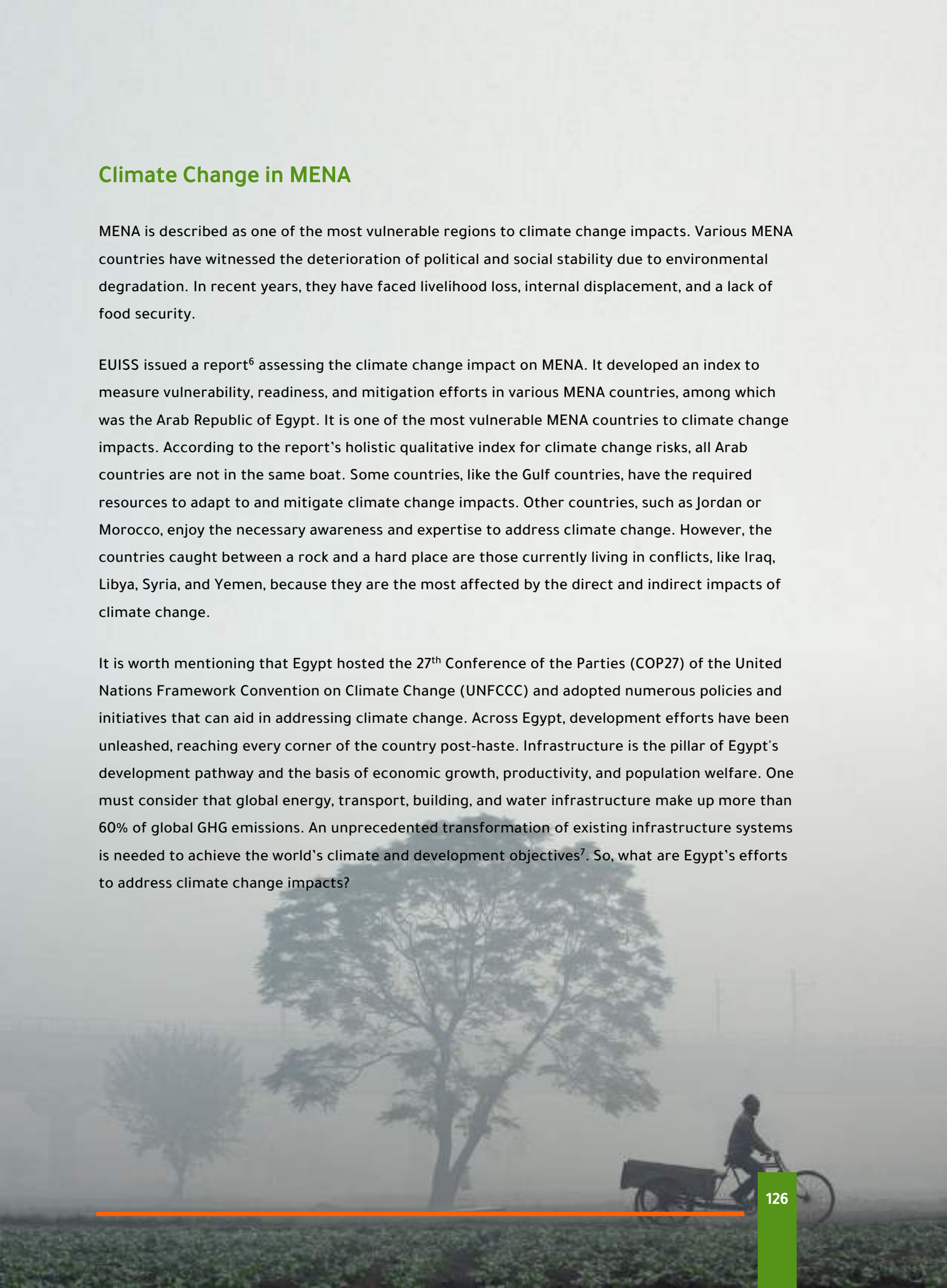
1. Climate change in MENA.
2. Climate change and political stability.
3. Climate security: It refers to the repercussions of climate change impacts and responses on the social, economic, and geopolitical systems, which affect in return peace and security. The growing widespread climate change impacts can contribute to the outbreak of conflicts, instability prevalence, and displacement waves rise, especially in regions suffering from vulnerability, poverty, and fragility that applies to MENA.
4. Climate security mechanisms (Climate Intelligence): The possible role of climate intelligence in mitigating/curbing the risks of conflicts and instability, which would consolidate regional and international peace and security, would be put under the microscope.
5. Final recommendations.

Climate Change in MENA

MENA is described as one of the most vulnerable regions to climate change impacts. Various MENA countries have witnessed the deterioration of political and social stability due to environmental degradation. In recent years, they have faced livelihood loss, internal displacement, and a lack of food security.

EUISS issued a report[6] assessing the climate change impact on MENA. It developed an index to measure vulnerability, readiness, and mitigation efforts in various MENA countries, among which was the Arab Republic of Egypt. It is one of the most vulnerable MENA countries to climate change impacts. According to the report's holistic qualitative index for climate change risks, all Arab countries are not in the same boat. Some countries, like the Gulf countries, have the required resources to adapt to and mitigate climate change impacts. Other countries, such as Jordan or Morocco, enjoy the necessary awareness and expertise to address climate change. However, the countries caught between a rock and a hard place are those currently living in conflicts, like Iraq, Libya, Syria, and Yemen, because they are the most affected by the direct and indirect impacts of climate change.

It is worth mentioning that Egypt hosted the 27th Conference of the Parties (COP27) of the United Nations Framework Convention on Climate Change (UNFCCC) and adopted numerous policies and initiatives that can aid in addressing climate change. Across Egypt, development efforts have been unleashed, reaching every corner of the country post-haste. Infrastructure is the pillar of Egypt's development pathway and the basis of economic growth, productivity, and population welfare. One must consider that global energy, transport, building, and water infrastructure make up more than 60% of global GHG emissions. An unprecedented transformation of existing infrastructure systems is needed to achieve the world's climate and development objectives[7]. So, what are Egypt's efforts to address climate change impacts?



Although Egypt's GHG emissions contribution to the global emissions does not exceed 0.6% as it is considered among the least countries contributing to global emissions, it is one of the most threatened countries by the adverse impacts of climate change in all categories. It faces rising sea level, saltwater intrusion, fertile land loss, and extreme weather events. Its agricultural productivity, crop structure, and the Nile flow are affected that in addition to the health impacts. Therefore, the Egyptian Government is paying utmost attention to addressing climate change impacts through an integrated and sustainable environmental system, targeting bolstering resilience and boosting the ability to face risks and rise to challenges.

Egypt took many actions; for instance, it was on the frontline of countries signing the UNFCCC, Kyoto Protocol, and the Paris Agreement. At the institutional level, the National Council for Climate Change (NCCC) was restructured in 2019 to be presided over by the Prime Minister. It is mandated with developing the country's public policies concerning climate change and formulating and updating climate-oriented strategies and sectoral plans. It also develops a comprehensive national climate change strategy and seeks to integrate climate change policies into the Sustainable Development Strategy (SDS)[8].

On May 19, 2022, Egypt launched the National Climate Change Strategy 2050 (NCCS) based on a broad vision targeting effectively addressing climate change impacts and repercussions. NCCS aims at enhancing the citizen's life and welfare, achieving sustainable economic growth, preserving natural resources, and advancing Egypt's leadership in the climate change field worldwide[9]. In conjunction with hosting COP27 in Sharm El-Sheikh in November 2022, Egypt was the first to issue green bonds in MENA. It additionally updated its goals to limit emissions by 2030. On July 7, 2022, Egypt launched the Country Platform for the Nexus of Water, Food, and Energy (NWFE) for climate finance and investment.

In 2022, Egypt devised the National Hydrogen Strategy to explore the production, utilization, and transport of hydrogen, especially green and blue hydrogen, as an energy source. The Government has been extensively relying on natural gas as an energy source in means of transport in parallel with encouraging the usage of electric vehicles.

Climate Change and Political Stability

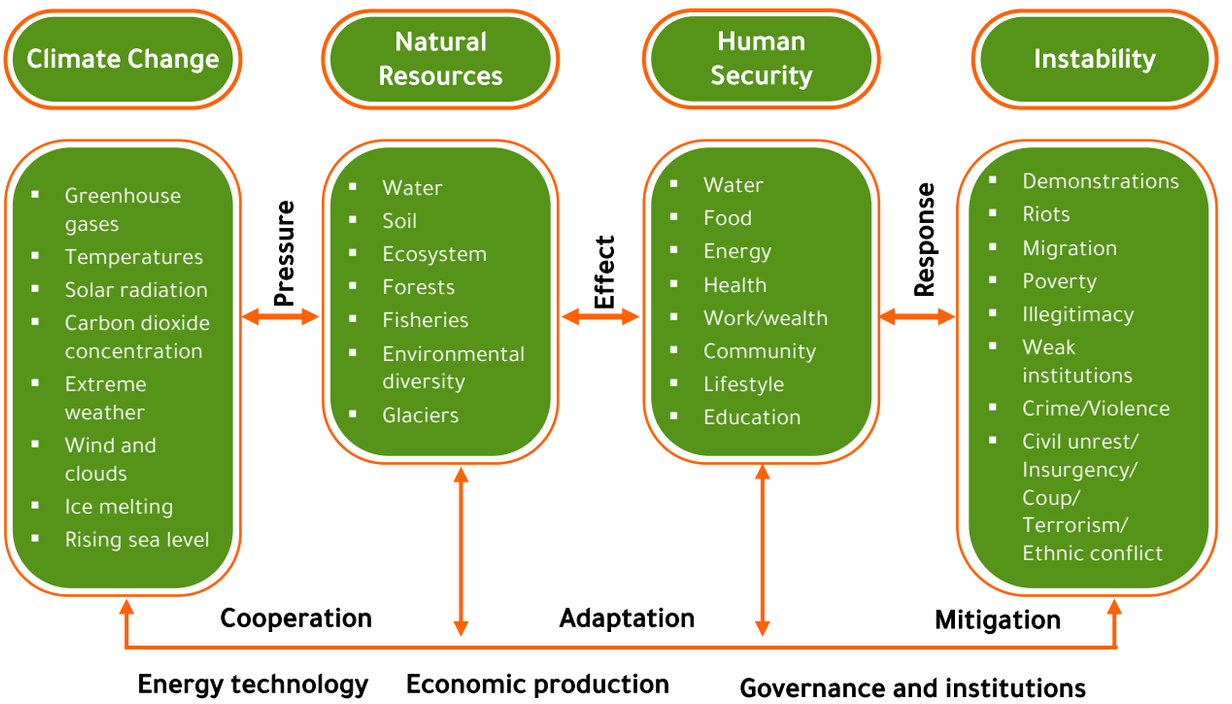
Climate change is closely linked to the risks of environmental degradation. However, it requires political treatment and scientific solutions, given that climate change has political, economic, security, and social impacts. It is also considered a catalyst for scarcity. In fact, pressures on the ecosystem change the rates of rainfall and temperatures, casting a shadow on the food production map and exacerbating food insecurity, water scarcity, and energy crises in various regions of the world. The result will be a random and unregulated displacement, whether internally or across national borders, which affects the adaptive capacity of communities, destabilizes them by threatening the identity of human groups, and creates a fertile ground for extremism and conflict.

Here, we address the correlation between climate change and the growing potential for conflict and political instability based on the fact that climate change increases the risk of international conflicts and civil wars. In addition, the catastrophic repercussions of climate change affect how conflicts are waged and their duration. Most importantly, climate change can alter these two characteristics, even for conflicts that it did not cause directly. It may have contributed to the conflicts in Syria and Darfur because it reduces the available necessary resources required to sustain some of the region's residents to less than the minimum. As a result, civilians become more vulnerable to being targeted as weapons spread, military forces grow, and militias increase. Although not all conflicts have these characteristics, climate change may increase the possibility of their outbreak. When fighting breaks out in such circumstances, achieving a purely political victory, such as one party's surrender, will not be enough because it will not address the fundamental imbalance between population and resources. This problem has two possible solutions. The first is to search for additional resources from other regions, especially humanitarian aid, which mostly flows in humanitarian emergencies and may incentivize fighters to target civilians. The second solution is to reduce the region's population through forced displacement/flight, preventing peace and stability, especially since climate change and its effects, in this case, weaken some governments, undermining their attitude towards violence. In such cases, people look to other groups, such as ethnic militias or other types of paramilitary organizations, to ensure their safety. Likewise, climate change may help perpetuate conflicts because drought and food insecurity hamper peace efforts in Syria, Sudan, and Somalia. Thus, climate change may be a "peace inhibitor" as well as a "threat multiplier"[10].

In this context, the German Advisory Council on Global Change identified four possible tracks linking climate change and conflicts[11]: the deterioration of freshwater resources, food insecurity, increased frequency and severity of natural disasters, and increasing or changing migration patterns. Accordingly, Scheffran developed a model to understand the causal relationship between climate change and its impact on natural resources, national security, and societal and political implications. This relationship can be shown as follows[12]:

Figure 1

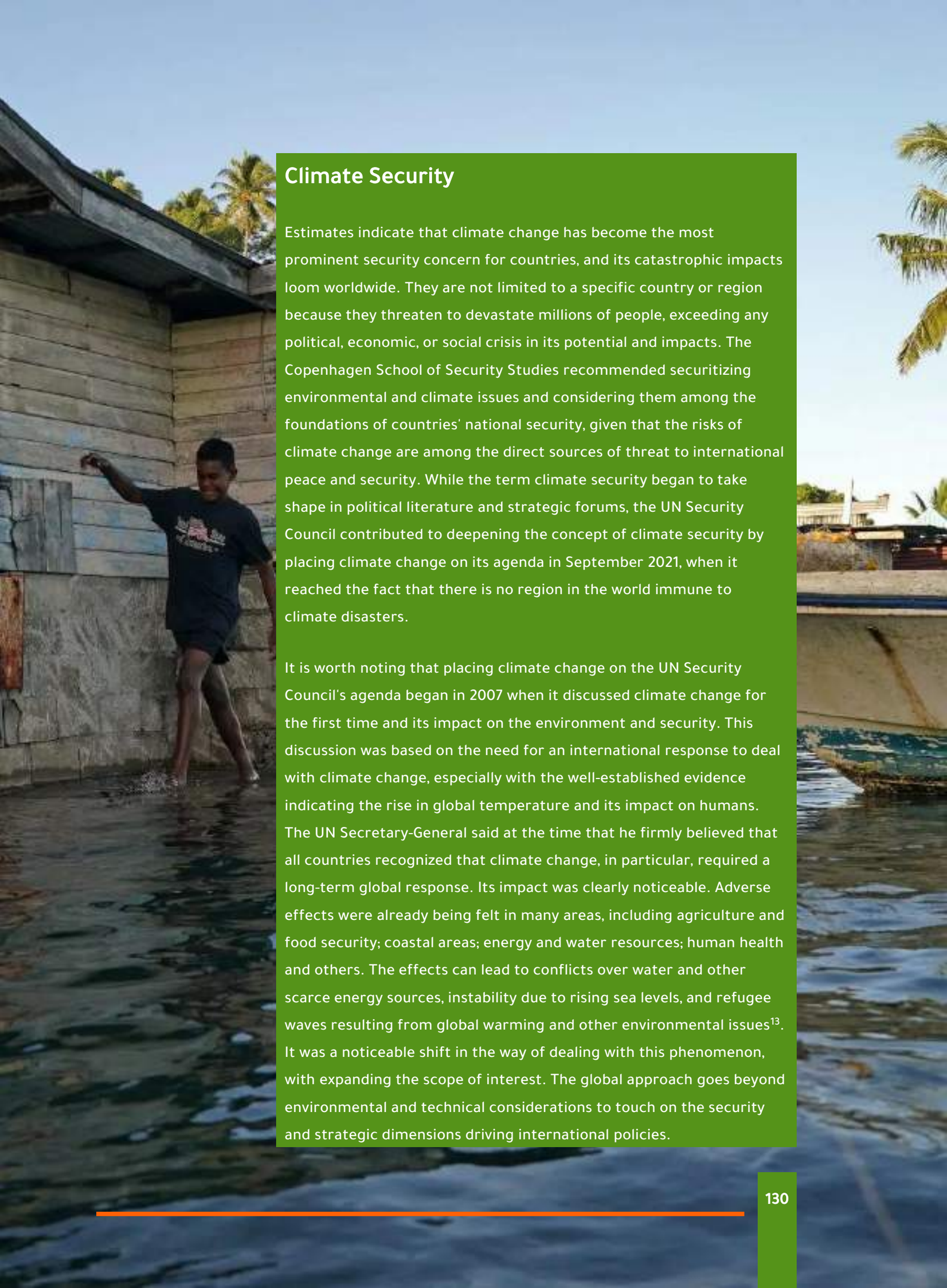
The relation between climate change and political stability



Source: Made by the author

The above figure indicates that climate change leads to pressure on natural resources, such as water, soil, and ecosystems, which affects the requirements for achieving human security and providing human needs. The result will be political and social instability due to complex interactions. Changes in natural resources negatively impact humanity, provoking reactions that affect social systems and increase tensions with their various social, economic, and political dimensions.

However, the feedback loop may allow humans and societies to adapt to climate change through strategies, institutions, and governance mechanisms that may be applied through technology or human and social capital. The aim is to adjust the economy and energy system to changing environmental conditions, provided that mechanisms for monitoring and predicting climate change and its catastrophic repercussions are available. Such mechanisms provide the opportunity to develop scenarios and operational plans to deal with the situation and its developments.



Climate Security

Estimates indicate that climate change has become the most prominent security concern for countries, and its catastrophic impacts loom worldwide. They are not limited to a specific country or region because they threaten to devastate millions of people, exceeding any political, economic, or social crisis in its potential and impacts. The Copenhagen School of Security Studies recommended securitizing environmental and climate issues and considering them among the foundations of countries' national security, given that the risks of climate change are among the direct sources of threat to international peace and security. While the term climate security began to take shape in political literature and strategic forums, the UN Security Council contributed to deepening the concept of climate security by placing climate change on its agenda in September 2021, when it reached the fact that there is no region in the world immune to climate disasters.

It is worth noting that placing climate change on the UN Security Council's agenda began in 2007 when it discussed climate change for the first time and its impact on the environment and security. This discussion was based on the need for an international response to deal with climate change, especially with the well-established evidence indicating the rise in global temperature and its impact on humans. The UN Secretary-General said at the time that he firmly believed that all countries recognized that climate change, in particular, required a long-term global response. Its impact was clearly noticeable. Adverse effects were already being felt in many areas, including agriculture and food security; coastal areas; energy and water resources; human health and others. The effects can lead to conflicts over water and other scarce energy sources, instability due to rising sea levels, and refugee waves resulting from global warming and other environmental issues[13]. It was a noticeable shift in the way of dealing with this phenomenon, with expanding the scope of interest. The global approach goes beyond environmental and technical considerations to touch on the security and strategic dimensions driving international policies.

Given the climate change impacts on national and global security due to the rise of extremist groups and violence as a result of conflict between citizens and states, political instability is expected to hit countries around the world. The reason is the fragility and weakness of political systems and the increasing possibility of conflicts between countries competing to secure resources for their citizens, which contributes to destabilization, strains the military readiness of the national state, and threatens the survival of its institutions.

Accordingly, the role of climate security is highlighted as the cornerstone for understanding the direct or indirect security risks of climate change. The Copenhagen School of Security Studies believes it is inevitable to securitize environmental issues in terms of dealing with environmental issues and problems as a threat to human security and the implications of this on national and global security. Since climate security falls within environmental security, climate change can be securitized because climate change is one of the main causes of environmental degradation. This means giving a security nature to climate change and making it a top national security priority for countries. Then, national governments can enact laws and impose exceptional procedures concerning the best way to deal with the negative effects of climate change. Moreover, they can develop new mechanisms to monitor and follow up on this change and predict the possibilities of its multiple impacts.

Climate Security Mechanisms (Climate Intelligence)

Mechanisms of addressing climate security require a perfect understanding of best practices and policies related to the challenges of climate change, conflicts, and human security. Hence, the interrelationship between climate change and conflicts must be considered to reduce the risks of conflicts and instability and enhance international peace and security. Climate change is a strategic dilemma requiring political rapprochement to address it. It also requires intelligence systems and mechanisms to monitor and predict it without being limited to scientific initiatives because the climate crisis has become a geopolitical factor in global conflicts. The countries' geostrategic power centers change when new trade routes are found, for example, due to the melting of glaciers. The need for raw materials also changes due to the global energy transition. Additionally, climate change plays a role in exacerbating conflicts related to food security.

A study issued in 2019 highlighted the devastating effects of rising global temperatures, especially in fragile and conflict-affected areas because the climate was affected by 3%- 20% of the risks of armed conflicts in the past century. This effect is expected to increase significantly in the coming years, especially since conflict-affected areas are exceptionally vulnerable to climate change because they are less able to develop adaptation mechanisms[14].

According to the United Nations Peacebuilding Fund (PBF)[15], about 70% of the countries most affected by climate change are also among the most fragile and conflict-hit countries due to the limited adaptive capacity of people, systems, and institutions dealing with the consequences of conflicts.

Given the growing conflict catalysts, increasing wars and armed conflicts, and the spread of militias and armed groups, we need to focus on what is known as "Climate Intelligence". In February 2023, The Washington Post warned against one of the proposed solutions for combating climate change and mitigating the severity of air temperature, known as solar geoengineering, because it has raised concern within the intelligence agencies. It may cause the outbreak of crises and wars since it proposes that countries suffering from high temperatures send a fleet of airplanes to spread fog that obscures the sun in the Earth's atmosphere, leading to lower temperatures. However, some countries believe that this solution may threaten their citizens to the extent that prompts them to respond militarily, urging American intelligence services to develop mechanisms to avoid wars that this type of climate engineering may provoke. This technology affects the sun's intensity in many parts of the world. Any decision taken by a country will affect the fate of the rest of the countries and all humanity[16].

Estimates indicate that rising temperatures on the planet or catastrophic climate events could change the situation unexpectedly. The Intergovernmental Panel on Climate Change (IPCC) says in its Fifth Assessment Report that there is "a well-established common concern" that climate change will increase the risk of armed conflict in some cases, even "if the impact strength is uncertain"[17]. Given the decrease/scarcity of vital resources, such as water, and countries' efforts to discover new opportunities for development in areas that were covered by ice, such as the Arctic, the chances of escalating international tensions and conflicts are increasing, especially with the ongoing competition between the great powers internationally.

The US intelligence community warns that "The fact that many of the river basins in the most affected water-stressed areas are shared means that interstate conflict cannot be ruled out - especially in light of the other tensions ongoing between many of these countries". Those areas with the most water stress - MENA - will also see the greatest population growth, creating even more stress on resources[18].

The United Nations report, titled "Climate Change, Water Conflicts, and Human Security", confirmed the seriousness of the region's climate change situation. It examined the intersection linking climate, water, conflict, and security in 11 cases in the Mediterranean, the Middle East, and the Sahel region. It concluded that climate change was an important source of violence and insecurity between or within those countries. The report indicated that the outbreak and escalation of conflict depended on countries' responses to climate change and that violence made people more vulnerable to climate risks[19].

Accordingly, it is important to increase the interest in climate intelligence in terms of obtaining information to study climate change's impacts on political and societal stability in countries of the region. It is possible to develop the Imagery Intelligence (IMINT) tools to be a system for collecting information through photography and aerial satellites. It is a means of collecting intelligence information and a method for precise information technology, being a subset of intelligence collection management, which in turn is a subset of the intelligence cycle management. IMINT is supplemented by MASINT non-photographic photovoltaic and radar sensors. Images are analyzed, and training is carried out on remote sensing. In addition, it is important to utilize the images, using ArcGIC and image interpretation techniques, and analyze the images of strategic infrastructure and military forces. The aim is to support political and military decision-makers at the operational and strategic levels[20].

IMINT plays a role in defense and security, where images are used to assess and report on the composition and capacity of strategic infrastructure. Hence, IMINT can be used to study and monitor the impacts of climate change on increasing desertification, drought, displacement, and the deterioration of the cultivated land area. This process allows us to predict popular resentment due to difficult access to food supplies and the deterioration of the basics of food security, leading to tensions, rebellion, and violence.

Final Recommendations

Climate change risks have represented an ongoing threat for years and continued to top the list of risks monitored by the Global Risks Report. The 18th edition of the report issued by the World Economic Forum in 2023 indicated that extreme weather and failure to mitigate and adapt to climate change came at the forefront of global risks and threats for the following ten years[21]. Concerning the Egyptian State's efforts to confront climate change, despite the existing plans for achieving a global goal related to climate change adaptation, progress in providing the required support to the population and infrastructure already affected by the climate change repercussions is limited. Funding the climate change adaptation activities is also insufficient. Funds allocated to address the food security crisis are still far below the required levels despite international commitments. Therefore, there is an urgent need for concerted global efforts to address the challenges of climate change through international strategies based on mitigation and adaptation under international agreements such as the Paris Agreement.

Concerning the Egyptian State, the World Bank Group Egypt's Country Climate and Development Report, issued on November 8, 2022, indicated that moving towards a low-emissions development path could help Egypt build the economy's ability to withstand shocks and enhance its competitiveness. Although Egypt's contribution to global GHG emissions remains low at 0.6%, emissions and economic growth remain closely linked, especially in the energy, transportation, and industrial sectors, which release about 80% of the country's GHG emissions[22].

Furthermore, I would like to highlight the catastrophic repercussions of the climate crisis on children and youth, especially regarding education. Climate change is linked to difficulties securing livelihoods and income, health risks, and human losses, which require ways to develop a smart educational system in Egypt. The goal is to ensure continuing education in a changing climate by implementing projects to provide educational spaces and structures designed to temporarily replace schools affected by natural disasters. In addition, scenarios must be developed to deal with the long-term impacts of climate change in education, such as affecting students' educational performance, food security, livelihood and income, political socialization of students and youth, and its implications on awareness.

In conclusion, climate change impacts clearly have catastrophic repercussions on human security generally and on the national security of countries from multiple aspects. Global warming, for example, plays a major role in the existing and possible water conflicts in MENA, as well as other various and growing impacts of climate change.

Governments around the world need to declare a state of climate emergency to limit such repercussions and develop future scenarios for dealing with what may be called climate refugees, especially from MENA, by establishing special climate intelligence units in all agencies and institutions concerned with early warning and developing future scenarios.

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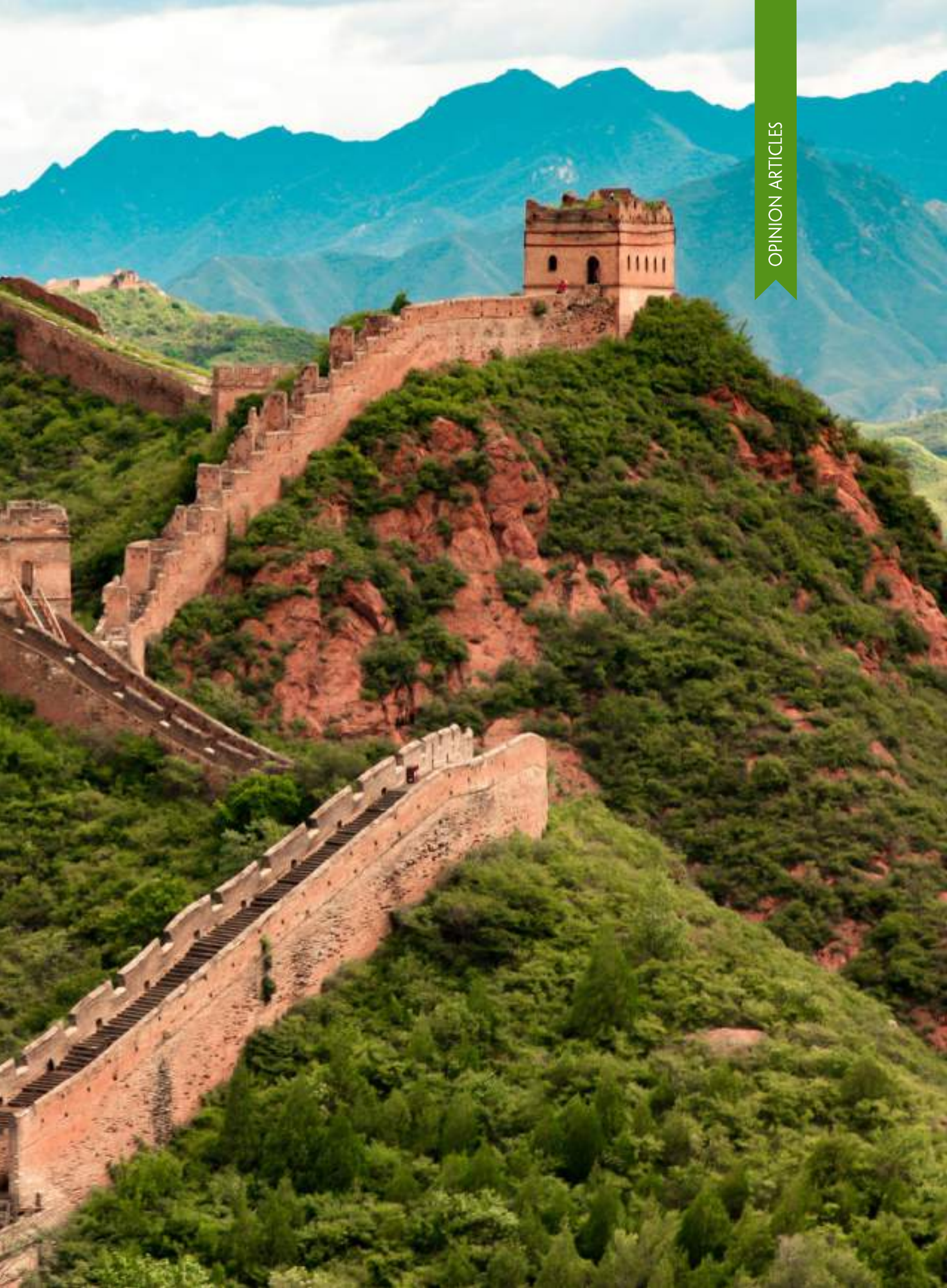
“CHINA'S GETTING A NEW GREAT WALL

CHINA’S 14TH FIVE-YEAR PLAN FOR THE PROTECTION AND DEVELOPMENT OF FORESTS AND GRASSLANDS STATES THAT BY 2025, CHINA WILL COMPLETE THE GOAL OF GREENING APPROXIMATELY 33.3 MILLION HA OF LAND AREA, THEREBY INCREASING THE COUNTRY’S FOREST COVERAGE RATE TO 24.1%.

Source: “China will aim to grow and conserve 70 billion trees by 2030 as part of the global tree movement”, 1t.org.



Dr. Samir Tantawi
Senior consultant and international expert in climate change with UNFCCC.

Early Warning Systems: A Vital Shield Against Climate Change Impacts

Early Warning Systems (EWS) stand as the watchful guardians in our battle against the relentless impacts of climate change. In an era of increasing climate unpredictability, they are the steadfast sentinels that offer us critical insights, precious minutes, and the opportunity to respond effectively to the looming threats.

Dr. Tantawi is Africa member to the IPCC with over 27 years of professional experience in climate change planning and strategies. He has obtained a Ph.D., Master, and Diploma in climate change and a B.Sc. degree in Mathematics.

Introduction

Climate change is one of the most pressing global challenges of our time. The Earth's climate is rapidly changing due to the increased emission of greenhouse gases, primarily from human activities such as burning fossil fuels and deforestation. These changes are causing a cascade of environmental disruptions, including rising temperatures, melting ice caps, more frequent and severe weather events, and shifting climate patterns. The consequences of climate change are not just theoretical; they are manifesting in real and often devastating ways, impacting ecosystems, economies, and human lives.

In the face of these mounting challenges, our ability to adapt and respond effectively has become paramount. Early Warning Systems (EWS) represent a critical pillar of our strategy to combat the impacts of climate change. These systems are designed to provide advance notice of impending climate-related disasters, giving us the precious gift of time to prepare and mitigate the devastating effects. They are the vanguard of resilience, enabling communities and nations to safeguard lives, property, and ecosystems in the era of climate uncertainty.

As we delve deeper into the role of Early Warning Systems in combating climate change, it becomes evident that these systems are not just a response to disaster; they are a proactive step towards building a sustainable future. In this article, we will explore the components of EWS, their crucial role in disaster risk reduction, and the ways in which they contribute to adaptive planning in a changing climate. Through examples of successful EWS and an examination of challenges and future directions, we will highlight the indispensable role these systems play in our collective efforts to address one of the most formidable challenges of our time.

What Are Early Warning Systems?

Early Warning Systems (EWS) are sophisticated tools and comprehensive processes strategically designed to detect, predict, and disseminate information about impending climate-related disasters and hazards. These systems are engineered to serve as the first line of defense against a wide array of climate-related threats, including hurricanes, floods, droughts, heatwaves, wildfires, landslides, and more. They are founded on the principle that knowledge is power, and timely, accurate information can save lives and minimize the devastating impact of disasters.

The components of Early Warning Systems encompass a multifaceted approach:

Monitoring and Data Collection: At the heart of every EWS lies a network of advanced technology. This network continuously monitors various environmental parameters critical for disaster detection and prediction. It includes an array of instruments such as weather stations, satellites, ocean buoys, seismic sensors, and environmental sensors placed in vulnerable areas. These instruments collect real-time data on weather patterns, sea levels, temperature, precipitation, seismic activity, and other crucial metrics.

Data Analysis and Forecasting: The collected data serve as the foundation for in-depth analysis and sophisticated forecasting models. Expert meteorologists, climate scientists, and computer algorithms process this data to create precise and reliable forecasts. These models predict the timing, intensity, and potential impact of impending climate-related events, allowing authorities and communities to prepare accordingly.

Alerts and Communication: Perhaps the most critical component of EWS is the effective communication of warnings and alerts. When a potential disaster is detected or forecasted, EWS instantly issue warnings to relevant authorities, communities, and the public. These warnings are disseminated through a variety of communication channels, including text messages, sirens, radio broadcasts, social media, television, and mobile apps. The rapid dissemination of alerts ensures that individuals and communities have the information they need to take immediate action.

Response Plans and Preparedness: Armed with early warnings, communities and governments develop comprehensive response plans and preparedness measures. These plans include evacuation procedures, the stockpiling of disaster relief supplies, coordination of emergency services, and the establishment of safe shelters. By preparing in advance, communities can substantially reduce the risk of harm and damage when disaster strikes.

The synergy of these components makes Early Warning Systems an invaluable tool in the fight against climate change. They empower individuals, communities, and governments to make informed decisions, take proactive measures, and adapt to the changing climate landscape. Moreover, EWS are not limited to predicting disasters; they are also integral to long-term climate resilience and adaptive planning, which are crucial aspects of combating climate change and ensuring a sustainable future.

The Role of Early Warning Systems in Combating Climate Change:

Early Warning Systems are not merely tools for disaster response; they are a cornerstone of climate change adaptation and mitigation. By saving lives, reducing property damage, enhancing resilience, and fostering sustainable development, EWS are pivotal in our collective efforts to combat the multifaceted challenges posed by climate change. As climate-related risks continue to intensify, the development and strengthening of Early Warning Systems remain an imperative aspect of securing a safer and more sustainable future for all.

Reducing Loss of Life: Early Warning Systems serve as a lifeline in the face of climate-related disasters, offering a critical window of opportunity for individuals and communities to take life-saving actions. By providing advance notice of impending events such as hurricanes, floods, and wildfires, EWS enable timely evacuations and sheltering, significantly reducing the risk of casualties. In densely populated areas vulnerable to storms or rising seas, these systems are often the difference between life and death.

Minimizing Property Damage: Beyond saving lives, EWS plays a pivotal role in mitigating property damage. With advance warnings, individuals and businesses can protect their homes, infrastructure, and assets. They can secure valuable belongings, reinforce buildings, and undertake flood-proofing measures. This proactive approach not only preserves livelihoods but also reduces the financial burden on governments and insurance agencies.

Economic Benefits: The economic benefits of EWS are substantial. The upfront investments in developing and maintaining these systems are far outweighed by the cost savings associated with disaster risk reduction. Preparedness measures, triggered by early warnings, are often more cost-effective than dealing with the aftermath of a disaster. EWS contribute to a stable economy by minimizing disruptions and preserving critical infrastructure.

Adaptive Planning: Climate change necessitates adaptive planning, and EWS are integral to this process. They provide critical data that informs decisions about land use, infrastructure development, and disaster risk reduction strategies. By incorporating EWS data into long-term planning, governments and communities can make informed choices that reduce vulnerability to climate-related risks and ensure sustainable growth.

Enhancing Resilience: Early Warning Systems are instrumental in building community resilience to climate change. Communities that receive timely warnings and have well-defined response plans in place can bounce back more rapidly from climate-related disasters. Moreover, EWS help foster a culture of preparedness, encouraging individuals and communities to take an active role in safeguarding their own well-being

Climate-Resilient Agriculture: Agriculture is particularly susceptible to climate change impacts. EWS provide valuable information to farmers, enabling them to adjust planting and harvesting schedules, implement drought-resistant crop varieties, and employ water-saving techniques. This enhances food security and helps mitigate the agricultural consequences of climate change.

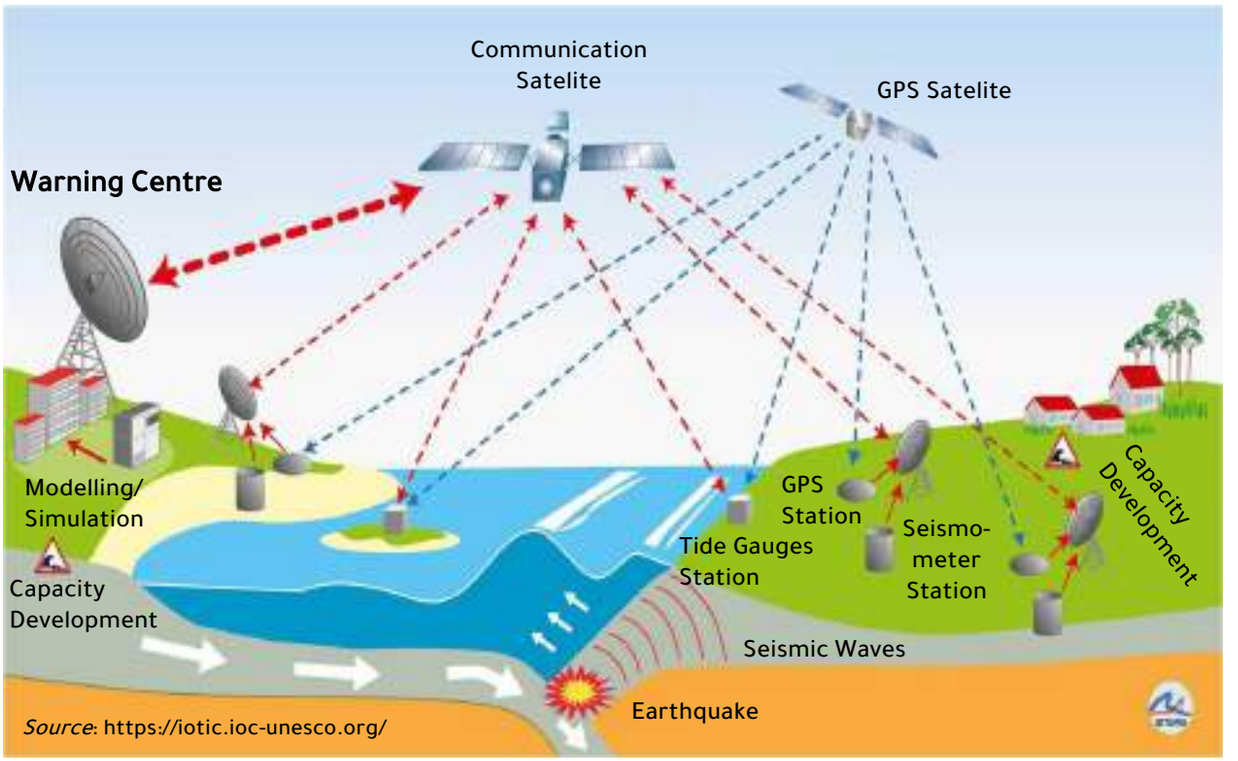
Biodiversity Conservation: EWS also plays a role in preserving biodiversity. They offer early warnings of habitat-threatening events like wildfires, allowing conservationists to take preventive action. This is critical for protecting endangered species and fragile ecosystems that are vulnerable to climate change.

Global Collaboration: Early Warning Systems often operate on regional, national, or international scales. Collaborative efforts, such as the sharing of data and expertise between countries, enhance the effectiveness of these systems. In a world interconnected by climate change impacts, global collaboration is vital to address transboundary threats.

Examples of Successful Early Warning Systems:

The following examples demonstrate the effectiveness and diversity of Early Warning Systems in addressing climate-related hazards. They underscore the importance of international cooperation, technological innovation, and proactive disaster risk reduction efforts in safeguarding communities and ecosystems against the impacts of climate change.

Indian Ocean Tsunami Warning System (IOTWS): The Indian Ocean Tsunami Warning System is a standout example of a regionally coordinated EWS. Established after the devastating 2004 Indian Ocean tsunami, this system involves numerous countries bordering the Indian Ocean. It employs a network of seismographic and oceanographic sensors to detect potential tsunami-triggering events and quickly disseminates warnings to coastal communities. Through international collaboration, the IOTWS has significantly improved the region's ability to mitigate the impact of tsunamis.



National Hurricane Center (NHC) - United States: The NHC is a leading authority in hurricane tracking and alerts. It provides timely and accurate information on the development and movement of hurricanes in the Atlantic Basin. Through advanced meteorological models and satellite technology, the NHC issues hurricane watches and warnings, giving residents along the U.S. Atlantic and Gulf coasts vital information to prepare and evacuate when necessary.

European Coastal Flood Awareness System (ECFAS): ECFAS is an initiative by the European Commission that aims to improve flood risk management across Europe. It integrates data from various sources, including weather forecasts, river discharge measurements, and snowmelt information, to provide early warnings of potential flooding events. EFAS helps European nations coordinate responses to flood threats and reduce the impacts of flooding on communities and infrastructure.

ECFAS

European Coastal Flood Awareness System

WHAT?

Copernicus Emergency Management Service (CEMS) provides support for natural or man-made disasters anywhere in the world.

ECFAS will develop a European Coastal Flood Awareness System, in the first instance as a proof-of-concept, with the aim of becoming one of Copernicus' core Emergency Management Services.

This project evaluates coastal flood risk contributing to a fully integrated risk cycle monitoring service. It will implement an awareness system for coastal areas (preparedness phase) and impact assessment products (response phase), fundamental for effective recovery and prevention.

Marine forcing forecasts will be improved through the integration of available models to reduce uncertainties and provide reliable coastal flood maps.

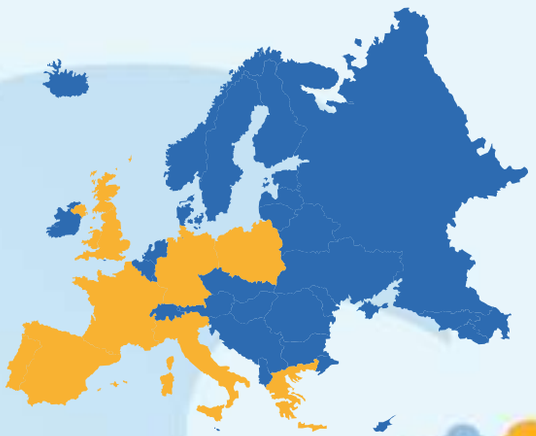
Hazard and impact assessments will be carried out considering the existing CEMS framework and adding impact on low-lying coastal areas, which represents a set of added value mapping products.

The technical operational feasibility of the products will be demonstrated through a performance assessment of the service in selected test cases for past-events, as well as in forecasting mode.

WHERE?

ECFAS is built on experience from test cases. The test cases are areas that have been severely affected by past coastal flooding. They will be used for calibration and validation of flood risk models.

The eventual ECFAS system will be applicable accross Europe, beyond these initial test cases.



The ECFAS Proof-of-Concept is built on

26 TEST CASES FROM AROUND EUROPE

European coastal regions account for

43% OF THE TOTAL EU-22

area and population

In Europe alone,

more than

50 MILLION PEOPLE

live in coastal and infrastructures. Through them zones of low elevation

Over

30 MILLION PEOPLE

Live in the **100-YR** event coastal flood plain

Population density in coastal regions is

3 TIMES HIGHER

than the global average

WHY?

Coastal areas are dynamic environments and low-lying coastal areas, are threatened by hazards that include overexploitation of marine resources, human pressure on ecosystems, water quality degradation and coastal flooding. Coastal flooding poses a major threat to coastal communities all over the world. Extreme storms are becoming more frequent and more severe. The Copernicus European Flood Awareness System (EFAS) provides solutions for inland flooding in Europe, but there is still no service for marine flooding in coastal areas. ECFAS will bring a new dimension to CEMS by complementing what exists today for river and runoff flooding with tools for coastal marine flooding.

HOW?

ECFAS has three maincomponents:

Warning is an early warning system providing forecasts based on ocean and wave models, including storm hazard predictions, tide and wave information, and mean sea level from historicial records.

Rapid Mapping will allow for assessment of a storm event during or immediately following impact, in support of immediate response. Rapid Mapping compares pre- and post-event images and analyses the extent and intensity of storm impacts.

Risk and Recovery Mapping supports longer-term risk management in view of prevention, preparedness, disaster risk reduction and recovery phases. It also allows for pre- and post-event evaluation of factors such as exposure, vulnerability, and resilience.

ECFAS draws on Earth Observation and other data (e.g. geomorphology, hydrology), as well numerical models (flood models and forecasts of water level) and on Copernicus core services products in building the European Coastal Flood Awareness System.

WHEN?

Jan 2021

ECFAS DEVELOPMENT BEGAN

DEC 2022

EXPECTED TO BE COMPLETE

SERVICE END USERS

ECFAS is tailor-made to its users, and involves them in the conception, design and evaluation of the new candidate Copernicus product. Its service is designed to support civil protection authorities, local and regional authorities, business owners, and communities, to be better prepared for and resilient to coastal storm threats.

ECFAS developments rely on contributions from Copernicus, its missions (Sentinel 1 and 2) and Core Services. Copernicus Entrusted Entities contribute to ECFAS Core Services Exploitation Team (CSET) and members of Copernicus User Forum contribute to ECFAS' Users Board (USB) to co-design and co-develop its service.

Atmosphere | Marine | Land | Climate Change | Security | Emergency

The majority of the world's megacities with a population of over

5 MILLION INHABITANTS are located within **100KM** of the coast

The population exposed to coastal flooding is predicted to increase to up to

1.52-3.65 MILLION by the end of the century

The present expected annual damage of

1.25 BILLION EURO is projected to increase ranging between **93 AND 961 BILLION EURO** by the end of the century

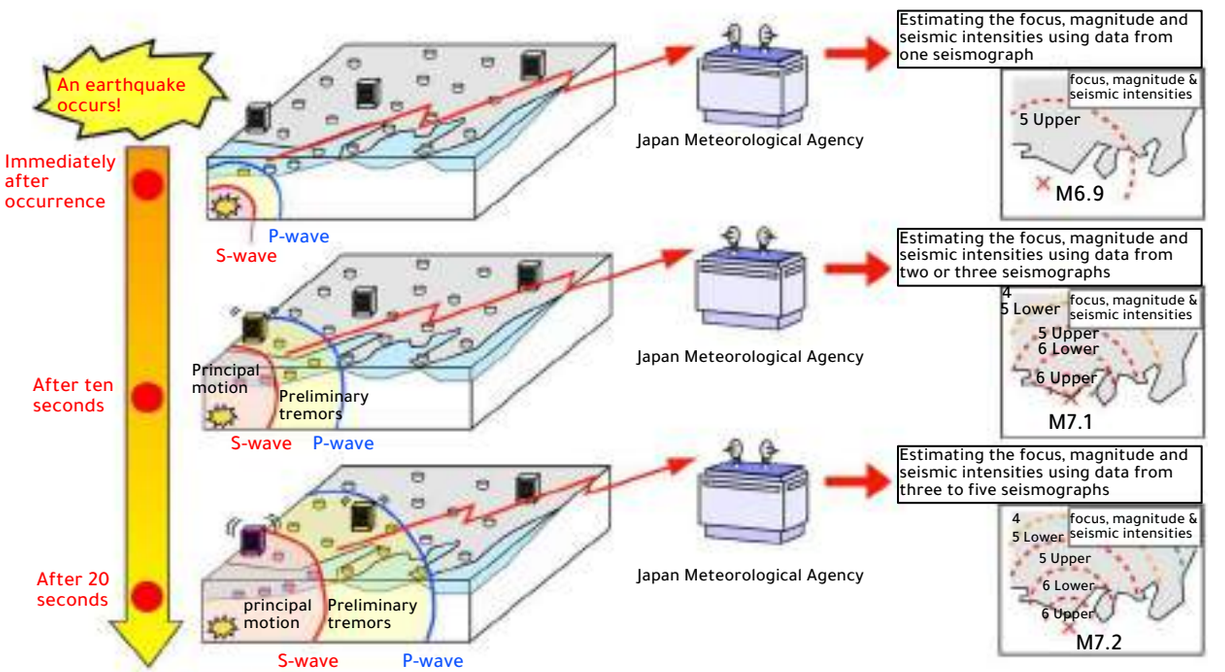
Seaports are critical to socioeconomic activities and infrastructures. Through them

80% IN TERMS OF VOLUME

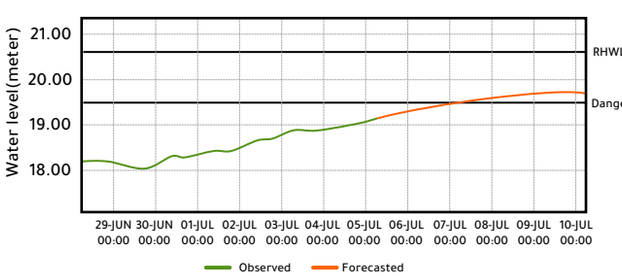
70% IN TERMS OF VALUE

of the internationally traded goods are transported

Japan Meteorological Agency (JMA) - Earthquake Early Warning System: Japan is prone to seismic activity. This System is renowned for its ability to issue alerts seconds to minutes before the arrival of strong ground shaking. These alerts provide valuable time for people to take cover and for automated systems to shut down critical infrastructure, minimizing casualties and damage.

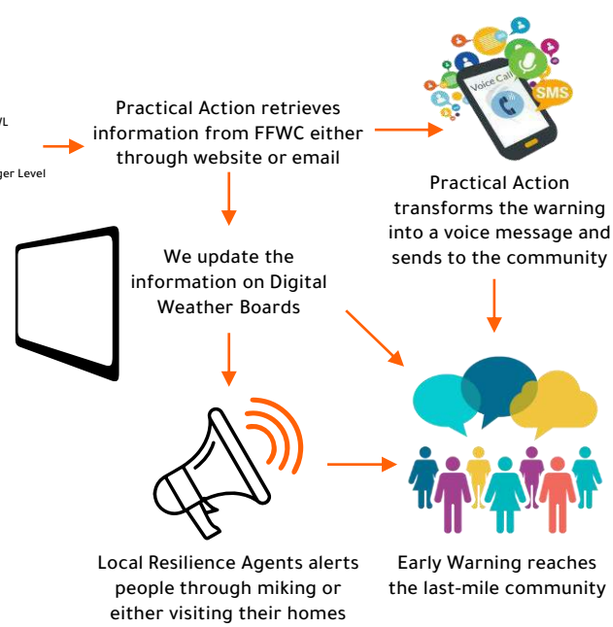


Flood Early Warning System in Bangladesh: Bangladesh is prone to monsoon flooding due to its geography and climate. The country has established an extensive flood early warning system, which includes river-level monitoring stations and meteorological data. These systems issue alerts to communities at risk, enabling timely evacuation and preparedness measures, and have played a crucial role in reducing flood-related fatalities.



Flood Forecasting and Warning Center (FFWC) generates early warning based on real time data

- Early warning of flood is generated and provided by Flood Forecasting and Warning Center (FFWC), Bangladesh Water Development Board (BWDB), Ministry of Water Resources (MOWR).
- Department of Disaster Management (DDM), Ministry of Disaster Management and Relief (MoDMR) share the warning issued by the (FFWC).



Source: www.floodresilience.net.bd

NOAA Weather Radio - United States: The National Oceanic and Atmospheric Administration (NOAA) Weather Radio is a comprehensive network of radio stations that broadcasts continuous weather information and alerts throughout the United States. It provides warnings for severe weather events, including tornadoes, hurricanes, and flash floods, allowing individuals to stay informed and take action to protect themselves and their property.

Pacific Tsunami Warning Center (PTWC): PTWC is responsible for providing tsunami warnings and information for the Pacific Ocean region. It monitors seismic activity and sea level data to detect potential tsunami threats. Through rapid dissemination of alerts, PTWC helps coastal communities in the Pacific prepare for and respond to tsunamis, mitigating the risk of loss of life and property.

Challenges and Future Directions:

While Early Warning Systems have made significant strides in safeguarding communities from climate-related disasters, they face ongoing challenges due to the complexity of climate change and the need for continuous innovation. Addressing these challenges requires sustained investments, international collaboration, and adaptive strategies that prioritize inclusivity and community engagement. As the world continues to grapple with the impacts of climate change, the evolution and enhancement of Early Warning Systems remain critical for reducing vulnerability and building resilience.

Data Accuracy and Availability: The reliability of Early Warning Systems heavily relies on accurate and up-to-date data. However, in some regions, data collection infrastructure may be lacking or prone to errors. Ensuring data accuracy, availability, and sharing across borders is essential for comprehensive and effective early warning.

Funding Constraints: Developing, maintaining, and upgrading Early Warning Systems can be expensive. Many nations, particularly in the Global South, face funding constraints that limit their ability to establish and sustain robust EWS. Securing consistent financial support, both domestically and through international assistance, is a challenge that must be addressed to ensure the effectiveness and accessibility of these systems worldwide.

Last-Mile Connectivity: Effective early warning depends on the ability to reach vulnerable communities, including those in remote or underserved areas. Last-mile connectivity, involving communication infrastructure and community education, is often a challenge. Efforts must focus on ensuring that warnings reach every corner of a country, including marginalized and remote populations.

Climate Change Complexity: Climate change is amplifying the complexity of disaster events. Events that were once considered rare are becoming more common. Developing predictive models that account for changing climate patterns and their impacts on various hazards is an ongoing challenge. Continuous research and adaptation of EWS to changing climate dynamics are crucial.

Cross-Border Coordination: Climate-related disasters frequently cross international boundaries. Effective early warning often requires international cooperation and information sharing. Enhancing cross-border coordination and collaboration is essential for addressing transboundary hazards such as cyclones, floods, and tsunamis.

Technological Advancements: Rapid advancements in technology offer opportunities for improving EWS, but they also present challenges. Early Warning Systems must continually adapt to harness the latest innovations in data collection, modeling, and communication. This requires significant investments in research and development.

Human Behavior and Response: Even with accurate warnings, human behavior can be unpredictable. People may underestimate the severity of a threat, delay evacuation, or ignore warnings altogether. Public education and community engagement are essential components of EWS to encourage timely and appropriate responses.

EWS for Emerging Risks: As climate change introduces new risks, such as heatwaves, urban flooding, and vector-borne diseases, Early Warning Systems must evolve to address these emerging challenges. Developing early warning capabilities for these novel risks is a priority.

Inclusive Design: Ensuring that Early Warning Systems are accessible to all, including people with disabilities, the elderly, and those with limited access to technology, is a crucial consideration. Inclusive design and outreach strategies must be integrated into EWS planning and implementation.

Adaptive Strategies

AI and Machine Learning: Leveraging artificial intelligence (AI) and machine learning algorithms can enhance the accuracy of early warnings. These technologies can process vast datasets and provide more precise predictions of climate-related hazards.

Community Engagement: Strengthening community engagement and education is vital. Communities should be involved in the design and implementation of EWS to ensure local knowledge and needs are considered. Education campaigns can improve public awareness and response.

Climate-Resilient Infrastructure: Investing in climate-resilient infrastructure, such as flood barriers and drought-resistant agriculture, can complement early warnings by reducing vulnerability to climate-related disasters.

Public-Private Partnerships: Collaboration between governments, the private sector, and NGOs can help bridge funding gaps and improve the effectiveness of EWS. Public-private partnerships can lead to the development of innovative technologies and solutions.

International Cooperation: Strengthening international agreements and cooperation frameworks for sharing data, technology, and expertise is essential for addressing global climate risks. The Sendai Framework for Disaster Risk Reduction and the Paris Agreement on climate change provide foundations for such collaboration.

Conclusion:

Early Warning Systems (EWS) stand as the watchful guardians in our battle against the relentless impacts of climate change. In an era of increasing climate unpredictability, they are the steadfast sentinels that offer us critical insights, precious minutes, and the opportunity to respond effectively to the looming threats.

As the Earth's climate continues to evolve, EWS are not merely tools; they are lifelines. They are the difference between lives saved and lost, between communities preserved and devastated, between a sustainable future and a world teetering on the brink of disaster.

Through the intricacies of meteorological models, the relentless collection of data, and the tireless dedication of scientists and professionals, EWS provides us with the power of foresight. They allow us to predict and prepare for climate-related disasters that can otherwise wreak havoc on our societies, economies, and ecosystems.

Yet, as this article has detailed, the path ahead for Early Warning Systems is not without its challenges. Funding constraints, data accuracy, inclusive design, and the relentless march of technological advancement all demand our attention and action.

In the face of these challenges, we must stand resolutely. Investments in EWS are investments in resilience. They are investments in the safety and well-being of our communities, in the protection of our natural heritage, and in the preservation of our economic stability.

As climate change intensifies, so too must our commitment to enhancing and expanding Early Warning Systems. International cooperation, the embrace of cutting-edge technology, and a dedication to inclusive and community-driven design are the beacons that will light our way forward.

In the grand tapestry of our response to climate change, Early Warning Systems are not merely threads; they are the warp and weft that hold it all together. They are our first line of defense, our proactive shield against the relentless storms of a changing climate.

In the end, the value of Early Warning Systems is not just measured in data and technology; it is measured in lives saved, in communities preserved, in economies sustained, and in a planet that continues to thrive despite the challenges it faces. Let us stand firm in our commitment to these indispensable systems as we navigate the uncertain waters of our changing world, forging a path toward a safer, more resilient, and more sustainable future for all.

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Towards Net Zero Emission: Circular Economy Path in MENA

Integrating the principles of circular economy unveils new sources of income and job opportunities. Establishing circular economy cycles does not only help the region overcome the challenge of waste reduction but also provides opportunities for investment.

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Amid the quicksand in the Middle East and North Africa (MENA), a technological transformation is afoot, fueled by the urgent global need to achieve net zero emissions. While spotlights are directed at the United Nations Climate Change Conference (COP28), countries from all over the globe are meeting to access and accelerate their commitments related to climate action. In fact, the MENA region is at the forefront of this global strife, as it utilizes climate technology and circular economy innovations to draw up a path towards a sustainable net zero future.

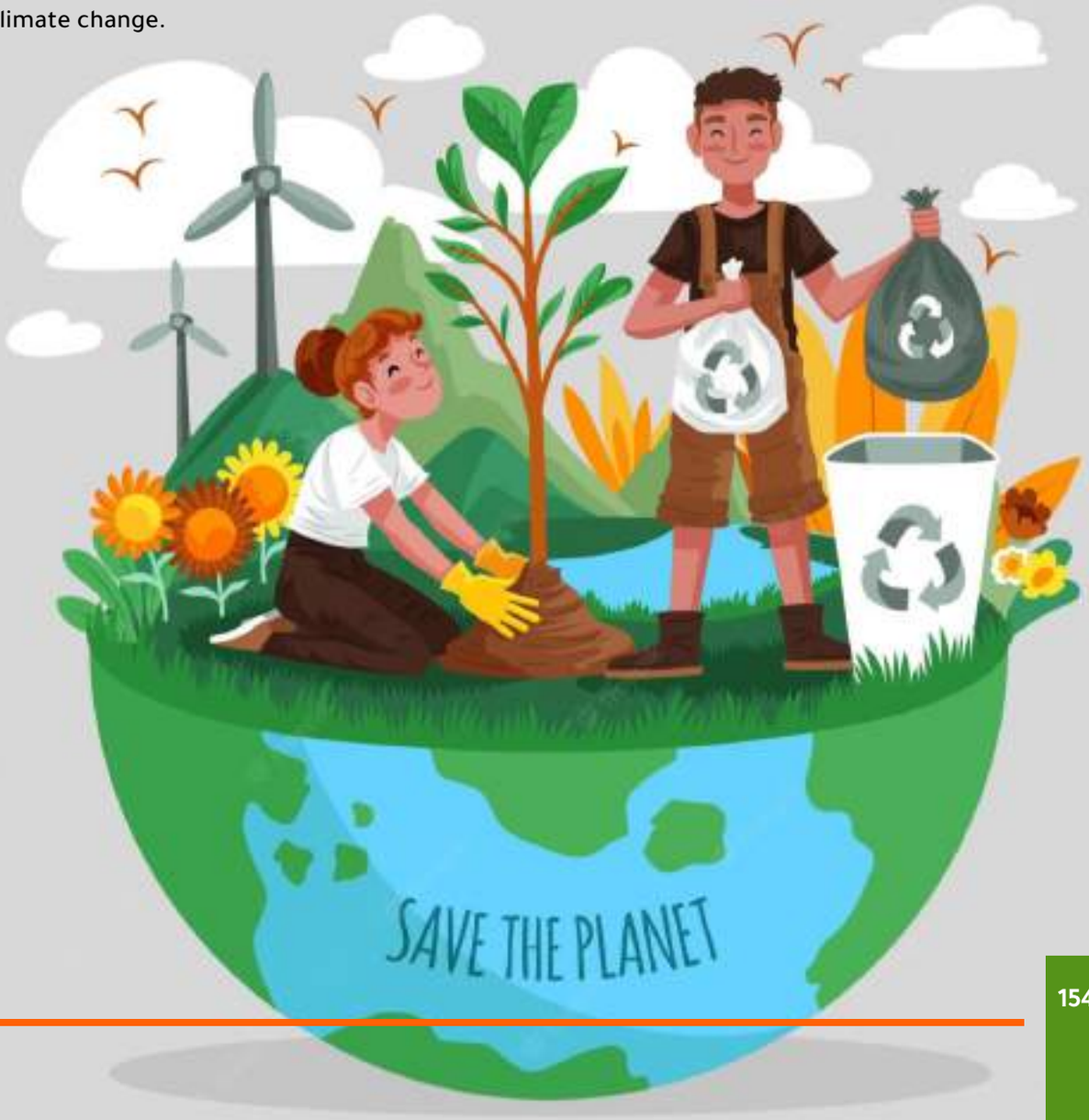
Tremendous Opportunities: Circular Economy and Net Zero Emissions

Circular economy refers to a system aiming at reducing waste and maximizing resources use through reusing products and recycling materials. This concept relies on three main steps: reduction, reuse, and recycling; thus, it establishes a closed-circle system allowing an efficient use of resources and waste reduction.

De facto, adopting a circular economy unleashes considerable horizons for the MENA region. Establishing circular economy cycles, especially in waste-generating sectors, will help the region reap countless fruits. According to a report issued by the World Economic Forum (WEF), the circular economy in the region can create substantial economic gains of up to USD 70 billion by 2030.

In 2019, a study –conducted by Strategy& Company for consulting– estimated that countries of the Gulf Cooperation Council (GCC) alone can provide nearly USD 138 billion by 2030 and reduce CO_2 emissions by 150 million tons thanks to the circular approach of economies. These figures highlight the double opportunity for applying circularity in the region: an opportunity to achieve financial gains in addition to another to reduce the environmental footprint, both of utmost importance nowadays.

It is possible for transition to the circular approach to reduce CO_2 emissions significantly. In fact, generating waste and how it is managed are major contributors to the aggregated carbon footprint of the economy, and this is the side on which countries increasingly focus to mitigate climate change.



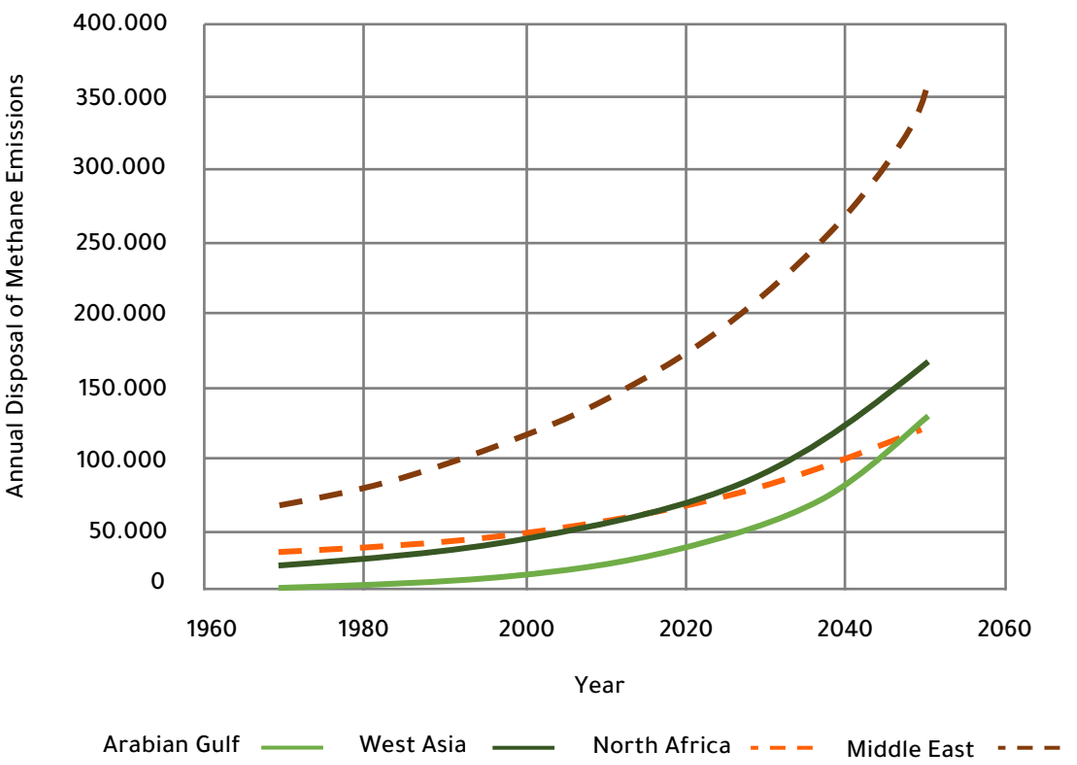
Biowaste, such as food waste, paper, and carton, emit methane, a strong gas part of the greenhouse gases (GHG). Hence, proper management of biowaste can mitigate the generation of methane; in addition, reusing and recycling waste help prevent any additional emissions resulting from raw materials sources, their manufacture, and conversion into new products. A circular economy offers new sources of income and creates job opportunities as well, promoting the social and economic fabric of the region.

Recent studies show that methane emissions resulting from waste in the MENA region are expected to exceed 350,000 Gg of CO_2e by 2050. This indicates how the negative effects of waste mismanagement and materials misuse impact lost economic opportunities and health repercussions on local communities and hinder combatting climate change.

To overcome this, the road to net zero emissions in the MENA region may be summed to a mix of technological innovation, policy frameworks, and cooperation among various stakeholders. Through adopting circular economy and utilizing advanced climate technologies, the region does not only respond to global climate crisis but also actively work on drawing a sustainable, net-zero path.

Figure 1

Unmitigated methane emissions resulting from solid municipal waste in MENA region and subregions



Source: Circular Economy in Cities of the MENA Region: Prospects and Challenges for Material Circularity, December 2021.

Underlining the Reality and Efforts of Transition to a Circular Economy in the Region

The MENA region can be divided into three subregions: the Levant (Iraq, Jordan, Lebanon, Syria, Palestine "West Bank and Gaza", and Israel), North Africa (Egypt, Morocco, Algeria, Libya, and Tunisia), Gulf Cooperation Council (GCC) countries (KSA, the UAE, Qatar, Oman, Kuwait, and Bahrain), and Sudan and Yemen. The region is usually categorized as one of the least-developing regions.

Through studying the status of waste management in these three subregions, a clear distinction between GCC countries on the one hand, and the Levant and North Africa countries on the other can be found. This distinction is evident upon comparing solid waste generation per capita all over the region. GCC countries have an average of 1.5 kg of solid waste per capita per day; this average exceeds the double of waste generation of the Levant and North Africa: 0.7 kg. The only exception of this stark distinction is Israel, with a solid waste per capita of 1.77 kg per day, which is closer to GCC countries than the Levant.

In fact, circular economy or recovering recyclable solid waste in the MENA region is still limited. Total recycling rates are estimated at an average of 9% all over the region. Looking at the countries separately, Israel has the highest recycling rate with 25%, followed by the UAE with 20%. This low recycling rate is mostly attributed to the lack of a compulsory segregation of waste and the ability to bear the costs of collecting and managing waste.

In response, continuous efforts to recover waste are afoot, with a focus on waste recovery and conversion into energy. Noticeable initiatives of circular economy were launched were implemented. Among such efforts, Qatar established Mesaieed Waste-to-Energy Plant to convert waste into energy in 2014, with a capacity for processing 2300-2500 tons per day and generating 42 MW.

Recently, the **UAE** announced the establishment of several waste-to-energy treatment plants in Umm Al Quwain, Sharjah, and Dubai. There are other plans for Abu Dhabi to establish its own waste-to-energy plant; other countries, namely Egypt, KSA, and Jordan, explore conversion of waste to energy.

Within context, Saudi Arabia has made strenuous efforts that reflected the practical application of several principles of circular economy. For instance, a leading company in recycling based in Riyadh, the first and largest in the MENA region, recycles 3 million tons of waste annually.

The Circular Carbon Economy (CCE) Initiative, envisaging a new era of sustainability in Saudi Arabia, was launched. It aimed at limiting carbon emissions while promoting economic growth, which affirms investments in clean energy projects and carbon capture and storage (CCS) technologies. These endeavors are concluded in developing circular business models that promote resource use efficiency and carbon management, establishing a sound basis to reach net zero emissions.

Moreover, the region launched green Sukuk to stimulate green finance and sustainable credits, such as the USD-1.2-billion Sukuk issued by Majid Al Futtaim (MAF) Company and the USD-1.3-billion Sukuk issued by Saudi Electricity Company (SEC).

Saudi Arabia targets converting all municipal waste in all waste dumps by 2035, recycling most of them, and using the remaining amounts to generate energy. The establishment of the Saudi Investment Recycling Company (SIRC) by the Public Investment Fund (PIF) in 2017 is considered a testimony to such efforts. Furthermore, Saudi Arabia set an ambitious goal to reach net zero carbon emissions by 2060; this commitment was announced during the Saudi Green Initiative Forum in light of a global call for climate action.

On a side note, a growing, noticeable interest in the Extended Producer Responsibility (EPR) legislations is evident. This interest mainly targets waste from electrical and electronic equipment (WEEE) and has been manifested in volunteering plans in countries like Jordan and Egypt. In Jordan, a new law was recently issued, embodying that interest.

Plastic waste is another aspect of waste management, in which the region is interested. In 2015, **Morocco** imposed a ban on plastic bags, and it currently drafts a policy on (EPR) covering plastic bags. Also, the **UAE** announced plans to construct a facility for recycling Polyethylene Terephthalate (PET) plastic, while **Saudi Arabia, Bahrain**, and **Tunisia** attempt to regulate the use of single-use plastic bags and enforce the use of eco-friendly alternatives.

In **Egypt**, the Government affirmed its commitment to promoting circular economy principles through various policies and initiatives aiming at reducing waste, increasing resource efficiency, and promoting sustainable consumption and production. The Government enforced a ban on single-use plastic bags, a significant step towards reducing plastic waste and promoting more sustainable practices.

In 2020, the Egyptian Waste Management Law introduced the legal basis to approve regulatory measures to limit single-use plastic bags in Egypt. The Law also established different technical standards for manufacturing, importing, or exporting plastic bags, as well as other standards for selling, exchanging, storing, distributing for free, or disposing. In addition, the Law specified the financial incentives and other forms of economic incentives to encourage innovation in order to find safe, eco-friendly alternatives for single-use plastic bags.

In November 2022, the first ban on plastic bags was imposed by the local authorities, especially in Sharm El-Sheikh in the context of hosting COP27.

Moreover, waste management and water resources efficiency are among the priority sectors that have long grown in Egypt, such as waste recycling, waster reuse, and waster desalination.

Citizenship education initiatives have emerged in other economic sectors, such as using recycled water in producing textiles or the construction sector.

In **Algeria**, waste management –while specially focusing on household waste– and renewable energy solutions are two major fields of circular economy fields in the country with a fewer number of empowering activities in sustainable textiles, organic cosmetic products, resource efficiency, sustainable tourism, and agriculture. However, enforcing laws and regulations poses a challenge despite the Algerian Government's efforts to ensure the applicability of said concepts and the political importance of processing urban waste.

As for **Tunisia**, they established a comprehensive regulatory framework and allocated a government agency to promote transition to circular economy. Noticeably, implementing national strategies and regulations in Tunisia is relatively slow, and there is a need for a more powerful political will and coordination among government agencies.

The most prominent economic sectors for developing circular economy in Tunisia include waste management, agriculture, tourism, textiles, and construction. These sectors witnessed some progress, but there is still a vast space for development.

Circular Economy Challenges in MENA

In spite of the continuous efforts for transition to circular economy, there are several challenges in Arab countries, including cultural, legislative, and technological barriers. Integrating principles of circular economy throughout the product life cycle is a work in progress. Moreover, the absence of public awareness and legal frameworks aggravates the complexity of approving circular economy practices. Generally speaking, some of such challenges can be highlighted as follows:

High Cost: Access to finance still poses a significant challenge facing circular economy initiatives. There is a shortage of investment capital and financing mechanisms that promote circular business models, especially from local sources. In fact, governments in most countries of the region bear most costs of collecting and managing waste, with a few exceptions in Algeria, Egypt, Jordan, Syria, Palestine, and Morocco. These governments attempted to reclaim costs of collecting and managing waste through municipal fees. While most countries in the region have specific government agencies responsible for enforcing waste regulations, they are still limited in terms of requirements of segregation, recycling, and reduction of waste.

Infrastructure: The quality of infrastructure still poses a major regional threat. Nearly 53% of total waste is disposed in open dumps, 25% sent to subject-to-monitoring or sanitary landfills, and only 9% are recycled. Although organic waste represents over half of the total solid waste, only 4% of the total solid municipal waste all over the region is composted into fertilizers.

This leads to environmental and health risks, with potential long-term repercussions on vulnerable communities if not managed. For example, out of 459 tons of waste daily disposed into open dumps in Lebanon in 2014, estimates show that 290 tons were burned in the open air, while 169 tons were disposed into current dumps.

Legislations and Laws: Transition to circular economy and biocycle requires changes in legislations and practices at the sectoral level and –sometimes– in terms of activities. For the transition in the Middle East and North Africa, it has to include several steps, namely determining the required change, developing a business case for this change, designing the change whether through the policy or amendments to processes and materials, and lastly implementing. The sectors that need the region's focus are construction, foods and beverages, trade, electric and electronic equipment, and textiles.

Need for Integrating Circular Economy Principles into Climate Technology: Integrating circular economy principles into climate technology is among the central points in the transition to circular economy. The fourth industrial revolution (4IR) – artificial intelligence (AI), 3D printing, big data, and the Internet of Things (IoT)– is critical to transition to circular economy. Such technologies promote the efficiency of production cycle and facilitating sustainable production and consumption processes in line with circular economy mechanisms.

Cooperation between AI platforms and circular economy institutions currently achieves tangible benefits in water conservation, which is a highly important resource in arid areas in the MENA region. Blockchain is the other cornerstone in this transition, as it enables tracking the products' environmental footprint in a transparent and anti-manipulation manner. Worthy to note, there is an interest in this path, where companies across the Middle East and North Africa (MENA) region utilize blockchain to track the sustainability of raw materials sources, improve trust with consumers, and promote the credibility of sustainability reports.

Even though it is less popular, mathematical modelling plays a vital role in directing waste management strategies. Dynamic models of the system are useful in predicting the volume of waste and segregation into basic components. In light of supporting circular economy institutions, these models help improve methods of collecting waste, thus reducing fuel consumption and emissions.

Lastly, integrating the principles of circular economy unveils new sources of income and job opportunities. Establishing circular economy cycles does not only help the region overcome the challenge of waste reduction but also provides opportunities for investment. Although this transition is useful, it requires a cooperative approach involving governments, private institutions, and investors in the MENA region to tap the full potential of circular economy.

Dialogues during COP28 shall affirm the necessity of climate action and indispensable role of technology in reaching net zero emissions goals. While countries reveal the progress they made and challenges they face in the global arena, the MENA region is getting ready to review its steps to integrate climate technology and circular economy innovation for a sustainable future.

Ms. Rozina Kanchwala
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Solar Panels Can't Withstand Bombs: A Call for Environmentalists to Speak Up on Gaza

This article is supported by Natasha Jamal, Kate Petriw, Ranjani Prabhakar, and Naomi Tyler

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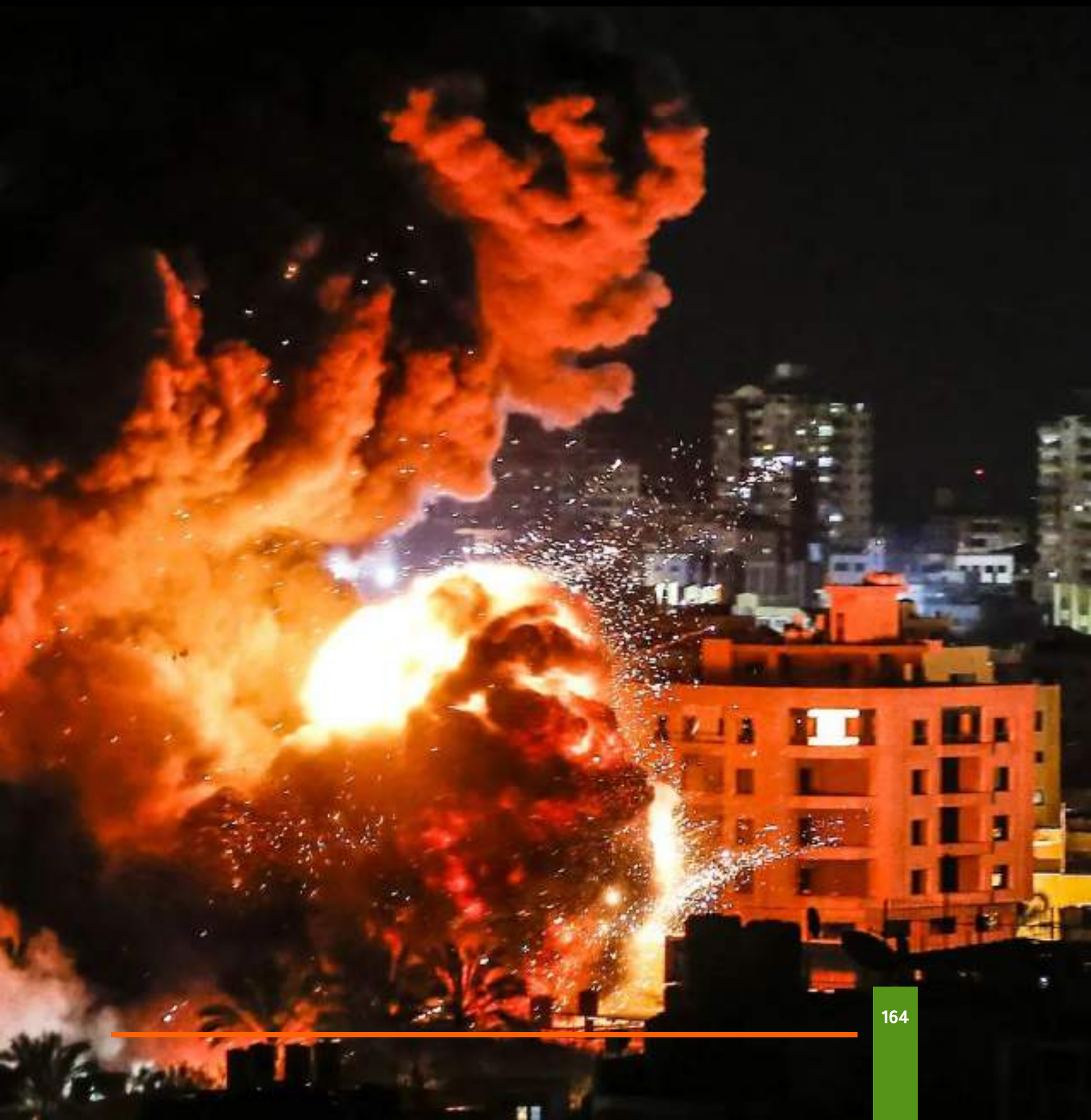
Why does not Gaza have electricity? This seemingly innocent question opens the door to an important discussion within the environmental movement, where people are working towards a clean energy and low carbon future.

Palestine is undoubtedly an intersectional issue encompassing racial, economic, health, gender, and carceral dimensions. At the nexus of these compounding issues is the environmental concern. In Gaza, access to food, land, water, and electricity are not just matters of infrastructure but pressing environmental concerns that intersect with larger social justice issues.

The label 'intersectional environmentalist' gained popularity during the Black Lives Matter movement in 2020, urging people to recognize the interconnectedness of social and environmental issues. For those environmentalists who spoke up in 2020 but have remained silent right now, it is time to extend this intersectional lens to the dire situation in Gaza, as some intersectional environmentalists are already courageously doing.

As the environmental community rightly celebrates the global growth of renewable energy as a means to combat climate change, we cannot ignore what is unfolding in Palestine. The carbon footprint of the bombs being dropped on Gaza is tremendous, undoing the collective efforts to remove carbon from the atmosphere and reduce carbon emissions worldwide. But outside of this recent escalation of violence, the ongoing realities of Palestinians living in Gaza and other Palestinian territories should also be seen as environmental justice travesties.



Energy Under Occupation

The recent power outages in Gaza have brought into sharp focus the region's crippling energy crisis. Fuel, essential for day-to-day functioning, is the lifeblood of any society. In Gaza, this vital resource flows through Israel, making the availability of electricity to Palestinians precarious. Gaza has one power plant, which became operational in 2002 with a capacity of 140 MW when it was built. Studies estimate that the actual power needs of Gaza are in fact closer to 400-500 MW, meaning that Gazans are frequently facing power shortages and outages. Under "normal" circumstances, this electricity shortage means hospitals in Gaza postpone surgeries, teachers teach by candlelight, and sewage water, unable to be fully treated by waste management, ends up dumped in the Mediterranean Sea, threatening marine life and the fishing industry in Gaza.

It is essential to underscore that Gaza's access to fuel is tightly controlled by Israel, and the Palestinians lack the capacity to produce their own fuel, perpetuating their reliance on external sources for this vital resource.

When a complete blockade occurs, as we witnessed in the past duration, Gazans are left quite literally in the dark, unable to access electricity - a critical need for daily life. Under the current bombing, the lack of electricity means hundreds of newborn babies reliant on incubators are at risk of dying, and rescue efforts are made more difficult as it is harder to search for people trapped under the rubble of their destroyed homes in the dark.

Energy democracy, a call within the environmental justice movement, recognizes that shifting from corporate, centralized control of energy to a system that is democratic and supports local economies – while committed to the principles of workers, nature, and future generations –would make perfect sense for Gaza "in theory".

In Gaza, an occupied territory that is reliant on its occupier to provide fuel, distributed energy resources –particularly solar panels and energy storage –may seem like a viable solution. Already, 13% of Gaza's electricity sources are renewable energy, including solar, wood, charcoal, and olive cake, but this does not suffice to fulfill energy needs. We know off-grid solar systems have the potential to provide reliable and sustainable energy, build resilience against conflicts, reduce dependence on fossil fuels (particularly from occupying entities), and mitigate the environmental impact of energy production. This limitation is not solely a matter of access and affordability; it is the stark reality of living under energy apartheid, where true energy independence remains an elusive aspiration for the people of Gaza. Even if this technology were to become available in Gaza (and other Palestinian territories), there is a significant, unignorable obstacle: solar panels cannot withstand bombs.

One might argue that the recent bombings are isolated incidents, but that is not the case. The Israeli army frequently bombs the Palestinian territories. In fact, Gaza's sole power plant was bombed by Israel in 2006, destroying six of its transformers and its fuel reservoir. After repairs, the plant today is capable of producing only around 110 MW, but because of fuel shortages, it often only produces around 60 MW, far lower than the actual needs of Gaza. Moreover, between 2008 and 2021, Israel launched military assaults on Gaza, lasting a total of 92 days - roughly 3 months of bombing in one of the most densely populated areas of the world (see next figure). So, even if Palestinians managed to transition off the grid and reduce their reliance on fossil fuel energy, it is impossible they would withstand the frequent bombing.

The bombs being dropped on Gaza have a massive carbon footprint. To provide context, one leg of a trans-Atlantic flight emits about one ton of carbon dioxide plus a number of other heat-trapping greenhouse gasses per passenger. In comparison, rocket launches generate between 50-75 tons of carbon dioxide per passenger. Israel boasted of dropping 6,000 bombs on Gaza in just six days (and more since then), resulting in (conservatively) 300,000 tons of carbon dioxide in the first six days of aggressive bombing. Beyond being a humanitarian crisis, Israel is catapulting us towards a climate disaster. Did you know that the Israel Defense Forces (IDF) is exempt from environmental laws, contributing to this environmental crisis with impunity?

The United States and other countries cannot be serious about addressing climate change if they continue to fund military activity because not only are those dollars being diverted from climate action, military activity accelerates our already tight timeline to actually address the climate crisis. The wealthiest countries that are funding Israel's military campaign were not even able to deliver the USD 100 billion in climate finance that they promised to the world's most climate-vulnerable countries nine years ago.

PALESTINE /ISRAEL

Gaza: 15 years of living under blockade

Israel's land, air, and sea blockade has trapped more than two million people inside the Gaza Strip since 2007. No portion of Gaza's society or economy has been left untouched.

Population
2.1m
One of the most densely populated areas in the world

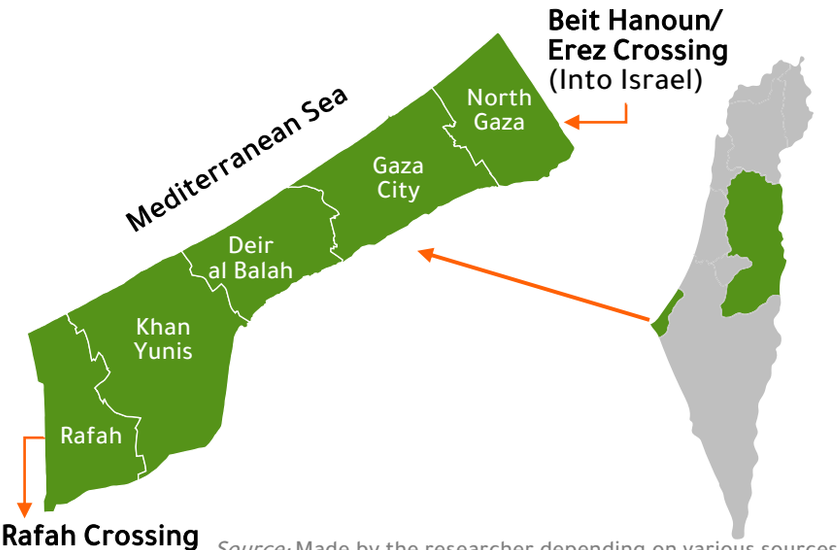
Area
365 km²

Unemployment rate
45%
Among the highest in the world

Food Insecure Households
64%
Especially impacting rural households

Israel launched four military assaults on Gaza:

1. **2008-9** Lasted 23 days
2. **2012** Lasted 8 days
3. **2014** Lasted 50 days
4. **2021** Lasted 11 days



Source: Made by the researcher depending on various sources

Water Under Occupation

Water, an essential human necessity, is a basic right that is consistently denied to Palestinians. Israel, as the occupying force, exercises complete control over the water supply. In fact, Israel has had complete control over the water supply for the last 56 years. Since 1967, Israeli military authorities have been dominion over all water resources and water-related infrastructure in the Occupied Palestinian Territories, leaving Palestinians at the mercy of their occupying power for access to this fundamental resource.

Moreover, Israel signed a Military Order in 1967, which requires Palestinians to seek approval from the Israeli army for any construction of new water installations. This restriction further exacerbates the water crisis, as Palestinians are effectively barred from building essential water infrastructure, leaving them utterly dependent on Israeli authorities for their basic water needs.

A 2017 Amnesty International report starkly illustrates the dire situation: approximately 180 Palestinian communities in rural areas in the occupied West Bank have no access to running water. In the same report, we learn a staggering 90-95% of the water supply in Gaza is contaminated and unfit for human consumption.

In Russia, targeted attacks on civilian infrastructure in Ukraine are rightfully deemed war crimes, according to the International Order. The daily realities of Gazans under occupation, even before October 7, are and should be called war crimes as well.

With these facts in mind, imagine how dangerous it is for prominent American celebrities, such as actor and comedian Sarah Silverman, to post such misinformed statement (see next image) to 2 million Instagram followers in support of Israel cutting off water to Gaza. Underlying her post is the inhumane and xenophobic belief that Palestinian civilians do not deserve water - a basic human right and a necessity for mere survival. Palestinians are systemically prevented from building their own infrastructure by Israel. Silverman's post is not only callous but also completely erroneous.

Any environmentalist who stands for social justice should be appalled that water is arbitrarily and categorically denied to Palestinians daily. With the mass media and influencers with large platforms questioning whether or not Palestinians even deserve water, this crisis must be seen as an environmental justice issue of mass proportions. From Flint to Standing Rock to Gaza - water is life.

Land Under Occupation

As environmentalists, we hold deep respect for Indigenous people as some of the world's greatest conservationists. Indigenous people represent 6% of the global population yet have stewarded 80% of the world's terrestrial biodiversity. We often begin our meetings with a land acknowledgment to recognize the original stewards of the land we are on, and we vow to use those words towards action. However, right now, a forced displacement and mass murder of Indigenous people is taking place in Gaza (and more broadly in Palestine since 1948), and the question we must ask is: why are we silent now?

The over 9 million olive trees in Palestine are a result of Indigenous Palestinians' land stewardship. We all know native trees are some of the most valuable resources for the planet and our fight against climate change. A lesser-known fact is that since 1967, the Israeli authority has uprooted or burned almost 1 million olive trees largely to displace Palestinians from their land to make way for settlements, actions deemed illegal by the international community. Removing these trees is both an ecological tragedy and an economic one, as the Palestinian economy is largely agriculture-based.

Olive trees hold special significance in the Middle East, representing resilience and endurance, and many of these drought-resistant trees have thrived in Palestine long before the Israeli occupation. Additionally, we all know that trees play a pivotal role in mitigating climate change by absorbing carbon, preventing soil erosion, and supplying oxygen. Despite our collective awareness and appreciation for trees, the destruction continues unabated. Where is the outrage of the environmental community?

While there are groups planting trees in Israel, namely the Jewish National Fund (JNF), the trees they plant are often non-native invasive that inhibit biodiversity. In the Negev desert, there is an aggressive tree planting campaign, which threatens endangered species, including ground-nesting birds like the spectacled warbler or raptors which need open landscapes to dive on prey. The Society for the Protection of Nature in Israel (SPNI) actually opposes further planting of trees in naturally unforested open spaces such as grasslands and shrublands, claiming that afforestation in sensitive ecosystems had a destructive impact on Israel's unique biodiversity. Furthermore, there is a human cost to the JNF's forestation of the desert efforts. In 2015, Israel's Supreme Court authorized the eviction of 1,000 Indigenous Arab Bedouin residents of two Negev villages to build the new town of Hiran and expand the Yatir Forest.

What is clear is that Indigenous ways of stewarding the land are being destroyed by both uprooting native trees and planting non-native ones.

The ecological damage extends beyond the uprooted trees. Much of Palestinian agricultural land, especially in Gaza, is tainted with heavy metals, as a result of repeated airstrikes and shelling. These toxic residues pose a significant threat to the environment, affecting not only the soil but also the health of the people who depend on these lands for their livelihoods.

While we are seeing claims of indigeneity to what is now Israel, it is important to understand that our modern understanding of indigenous refers to people who lived in a region consistently for thousands of years and have ties to the land. The Indigenous people of Palestine have been forcibly displaced since 1948 in what was called the "Nakba" (Catastrophe) and continue to be displaced and ethnically cleansed. Will we only acknowledge the land's original stewards a hundred years from now, when we can excuse ourselves by saying, "I wasn't alive when the forced displacement of people was happening"? As environmentalists, we have an ethical duty to speak out against such injustices and advocate for a more just and sustainable world, which begins by acknowledging the present crises and taking action to address them.

Environmental Justice Requires Taking a Stand Against Genocide

It is imperative for environmentalists to pay attention to what is happening in Palestine at this moment and the ongoing devastation that has persisted for decades. Of course, we condemn the terrorizing activities, which are responsible for violence and crime. However, to be true intersectional environmentalists, we must break our silence and confront the consequences of violent settler colonial oppression.

As a community committed to preserving and protecting our planet, we have a moral obligation to take a stance against genocide. The people of Gaza are showing us their horrific realities, and it is incumbent upon us to listen, act, and stand in solidarity for their sake and for the future of the planet.

We all want peace and a de-escalation of violence; we must also recognize that peace does not mean a return to the status quo. It must be rooted in the principles of freedom from occupation, land sovereignty, and the right to self-determination for the Palestinian people. If these ideas seem complicated, take comfort in knowing that many of the social justice leaders we all look up to, from Angela Davis and bell hooks to Nelson Mandela and Malcolm X, firmly stood on the side of Palestinian sovereignty. Our modern-day environmental hero, Greta Thunberg, also posted that she stands with Gaza. They all recognize that the struggles against all forms of injustice are intricately intertwined. As anti-apartheid South African leader Nelson Mandela stated, "But we know too well that our freedom is incomplete without the freedom of the Palestinians". So, let this be a resounding call to action for all of us, for we understand that a path to a more secure, livable planet cannot be paved through genocide or occupying a people. It is only through solidarity and justice, across all boundaries, that we may find the way forward to a better world.

AI's Eco-Warrior Shaping Sustainable Future

Ms.Yasmin Shokri
CEO of ESG&

AI is not only vital but indispensable in our quest for a sustainable world. The urgency of environmental challenges necessitates precision and innovation, and AI excels on both fronts.

Ms. Shokri has proven her steadfast dedication to bringing about lasting change in businesses through her current role as CEO of ESG&, a business devoted to offering ESG solutions. She has a strong background in ESG practices and a profound awareness of the potential and difficulties related to sustainability.

In the quest for a sustainable world, the integration of artificial intelligence (AI) is not an option—it is a necessity. As we face pressing environmental challenges, like climate change and biodiversity loss, AI emerges as a powerful ally in reshaping our approach to sustainability. In this article, we will explore the profound impact of AI on our way toward a more sustainable future.

The Urgent Need for Sustainability

Before delving into the role of AI, let us acknowledge the pressing need for sustainable practices. Our planet is facing environmental crises at an unprecedented scale. According to the Intergovernmental Panel on Climate Change (IPCC), global temperatures are rising at an alarming rate, leading to more frequent and severe weather events.

The Middle East and North Africa (MENA) stand prominently among the region's most vulnerable to climate risk. Studies have unequivocally demonstrated that, unless substantial changes are implemented, the MENA region is heading toward becoming uninhabitable by 2050. Startling statistics further underscore this grim reality.

The MENA region is experiencing a warming trend that outpaces the global average, with temperatures rising twice as quickly.

What is even more disconcerting is that it is the only region where emissions are escalating faster than the economic output, presenting a grave threat to both the environment and human well-being. Furthermore, water-related crises, such as droughts and scarcity, are anticipated to slash the region's GDP by a staggering 14% by 2050.

These challenges demand immediate action, and the business-as-usual approach is no longer an option. Here is where AI comes into play.

AI: A Solution to Environmental Challenges

Environmental Assessment Precision

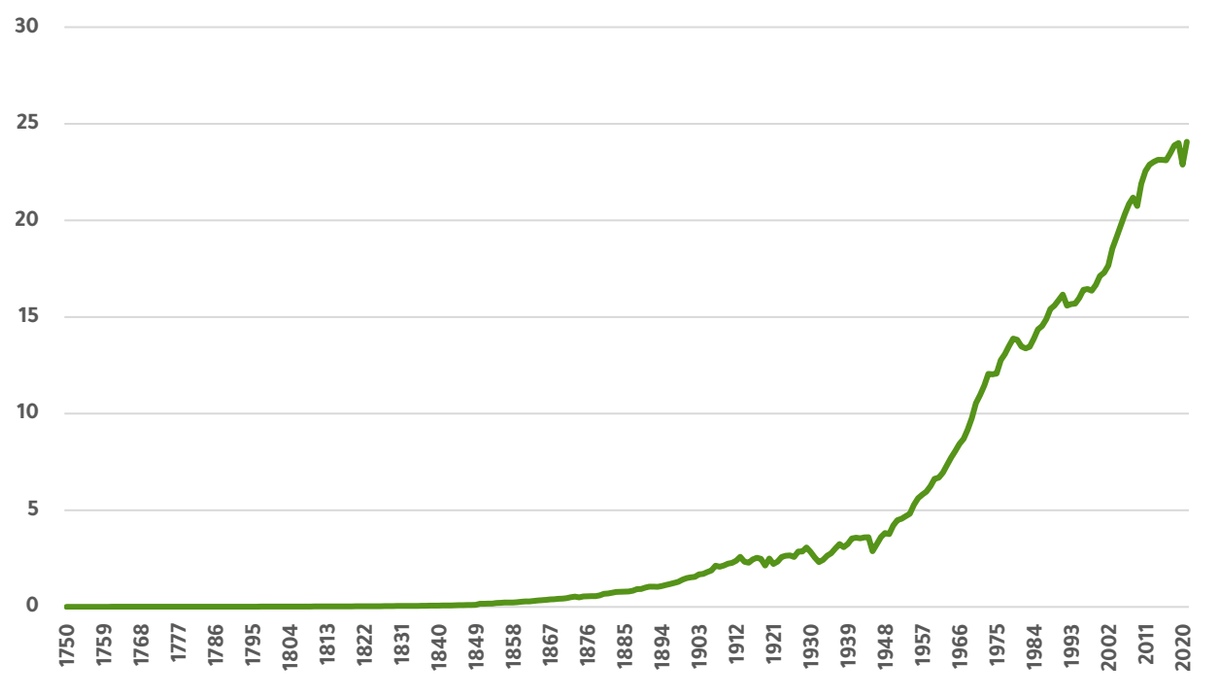
Traditional methods of environmental assessment often fall short of accurate and timely data. AI, however, excels in processing vast datasets and making precise predictions. For instance, AI-driven models can forecast the impact of climate change on specific regions, enabling policymakers to plan and allocate resources more effectively.

According to a report by McKinsey & Company, AI can improve the accuracy of climate change impact assessments by up to 30%. This precision is critical for developing targeted strategies to combat environmental threats.

The imminent threat of climate change is intensifying, and time is rapidly diminishing. Presently, global greenhouse gas (GHG) emissions stand at more than twenty billion metric tons of carbon dioxide (CO_2), and fifty billion metric tons of CO_2 and its equivalents (CO_2e). To align with the imperative goal of constraining the rise in average global temperatures to a mere 1.5°C, as outlined in the 2015 Paris Agreement, a formidable reduction of 50% in these emissions must be realized by the close of this decade, as stipulated in the Science Based Targets Initiative.

Figure 1

Total global emissions (billion metric tons)



Source: CO_2 and Greenhouse Gas Emissions - Our World in Data

Protecting Biodiversity

Preserving biodiversity and protecting natural habitats are vital components of ESG goals. AI with remote sensing technologies offers a new understanding of monitoring and safeguarding ecosystems.

The World Economic Forum reports that AI-driven solutions have contributed to a 30% reduction in illegal poaching activities in some regions, demonstrating AI's potential to safeguard endangered species and preserve biodiversity.

AI-powered systems can process vast amounts of satellite and drone imagery to track changes in land use, deforestation rates, and habitat fragmentation. This data can reveal how human activities impact local flora and fauna.

Moreover, AI can analyze acoustic data to track animal behavior and population trends. In marine environments, for instance, AI-powered hydrophones can detect and identify the vocalizations of marine species, helping researchers monitor and protect endangered marine life.

By tracking real-time biodiversity changes and habitat preservation efforts, companies can make informed decisions to mitigate their ecological impact and contribute to broader conservation objectives.

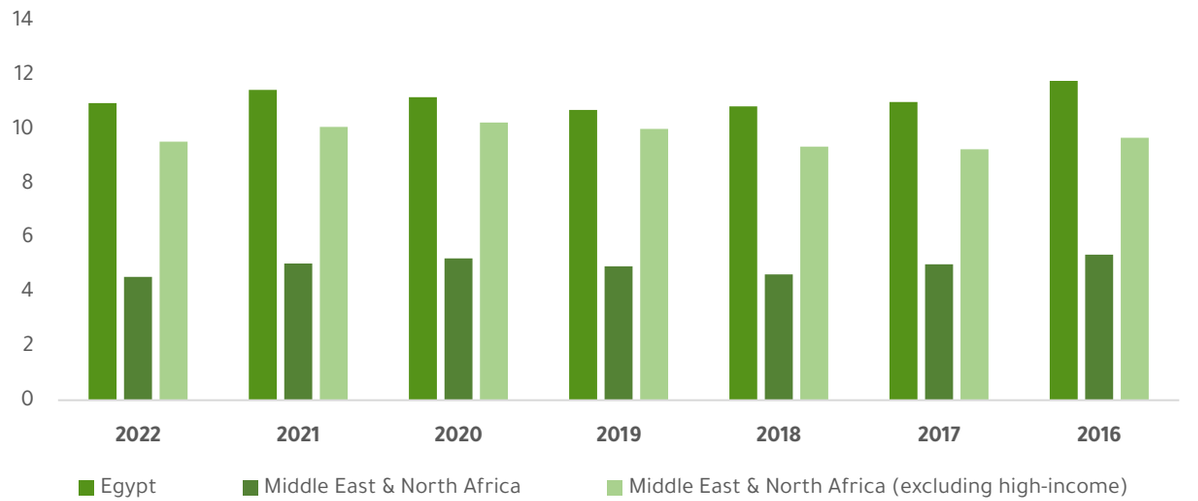
AI in Sustainable Agriculture

In the MENA region, where agriculture represents around 9% of the region's GDP,** over two-thirds of countries struggle with limited arable land and severe water stress due to unsustainable groundwater use. Notably, agriculture consumes 85% of available water resources.

*Reduce Carbon and Costs with the Power of AI | BCG
**Excluding high-income countries.

Figure 2

Agriculture, forestry, and fishing, % of GDP



Source: Agriculture, forestry, and fishing, value added (% of GDP) | Data (worldbank.org)

Smallholder farmers, who are essential for food security, are increasingly vulnerable to climate change, rendering efficient management of the water-food-energy nexus crucial for sustainable development. AI-driven solutions in the agricultural supply chain also play a vital role in conserving water and energy.

AI-driven water and resource management is pivotal in sustainable agriculture. By leveraging AI's capacity to analyze soil moisture, weather forecasts, and crop health data, precision in farming becomes achievable. This transformative approach empowers farmers to optimize irrigation with unparalleled precision, resulting in significant reductions in water wastage, increased crop yields, and a reduced environmental footprint.

Statistics underline the substantial impact of AI-driven resource management in agriculture. It can reduce water consumption while maintaining or increasing crop yields, a crucial achievement in arid regions like MENA. Moreover, smart farming practices can boost crop yields, leading to improved livelihoods for farmers and contributing to broader economic development in the region. These practices also have notable environmental benefits, as they decrease nutrient runoff, promote healthier soil, and lower GHG emissions, aligning with MENA's commitment to sustainability. In the face of climate change-related challenges, AI-equipped farming provides resilience by offering real-time weather and soil data for informed decision-making. In a region susceptible to extreme weather events, this resilience is of paramount importance. Embracing AI technologies can promote MENA's innovative and resilient agriculture to be at the forefront of countries, ensuring a prosperous future for the region.

Ethical Considerations

As we embrace AI in environmental assessment, it is crucial to address ethical concerns. Responsible AI use, transparency, fairness, and ethical considerations must be prioritized.

To ensure the responsible use of AI, organizations must be keen on safeguarding data privacy and security. A survey conducted by Deloitte reveals that 79% of consumers have concerns regarding how AI systems utilize their data. Thus, it is imperative to institute robust data protection measures and procure informed consent from individuals to mitigate these concerns. The said constitutes essential steps in this ethical journey.

The prevalent issue of bias in AI and machine learning systems cannot be overlooked. According to the AI Now Institute, a staggering 60% of such systems produce outcomes that are tainted by bias. This challenge of bias in AI originates from multiple sources, encompassing skewed training data, biased algorithms, and decision-making processes influenced by prejudice. Consequently, it requires a holistic approach, the engagement of diverse teams, inclusive data collection, rigorous testing, and continual monitoring. In the quest for responsible AI development, organizations and policymakers alike place growing emphasis on transparency, accountability, and the formulation of ethical guidelines. The overarching objective is to achieve fairness, equity, and inclusivity within AI systems. Addressing bias stands as an imperative task, essential for the creation of AI technologies that bestow benefits upon all individuals and communities while upholding ethical standards.

While the potential of AI is boundless, we have to walk the path of technological progress with a keen awareness of social and environmental ethics. The potential consequences of automation on employment must be confronted; furthermore, concerted efforts must be made to reduce the carbon footprint of AI. In doing so, we can ensure that our pursuit of AI is in harmony with our ethical obligations to both society and the environment.

The Prospects of AI in Advancing Sustainability

The outlook for AI in the realm of sustainability is exceptionally promising, with emerging technologies poised to elevate its capabilities significantly. For example, quantum computing holds the potential to revolutionize environmental simulations, while edge AI enables real-time data analysis. AI-driven solutions for a circular economy are capable of driving resource optimization, and the role of AI in climate resilience strategies will become increasingly indispensable.

Quantum Computing

Quantum computing, often seen as the next frontier in computational power, offers immense promise for advancing sustainability endeavors. On the one hand, traditional computers often grapple with the complexities of simulating climate patterns, biodiversity dynamics, and resource optimization. On the other hand, quantum computers can manage these tasks exponentially faster. Research conducted by IBM suggests that quantum computing could simulate atmospheric molecule behavior with unprecedented accuracy, thereby significantly advancing climate modeling and bolstering our capacity to predict and mitigate the effects of climate change.

Edge AI

Edge AI is revolutionizing real-time data analysis by processing data locally on IoT devices situated at the network's edge. This technology has been proven particularly invaluable in promptly monitoring and responding to environmental changes. Within the context of climate change, Edge AI assumes a pivotal role in enhancing sustainability across critical industries. In the energy sector, where irregular energy supply can adversely impact the environment and public welfare, Edge AI's intelligent forecasting is instrumental. Edge AI's models use historical data, weather patterns, grid health information, and more to create intricate simulations that optimize energy generation, distribution, and management, thereby reducing waste and GHG emissions. Additionally, Edge AI's predictive maintenance capabilities offer benefits in the manufacturing sector, which is also closely tied to climate change. It detects anomalies through sensor data, predicts machine failures, and facilitates timely repairs, ultimately averting costly downtime and reducing resource-intensive manufacturing processes. It contributes to lower energy consumption, decreased waste, and a more sustainable manufacturing ecosystem in line with climate change mitigation efforts.

AI in the Circular Economy

The circular economy model, which seeks to minimize waste and extend the lifespan of products and materials, is vital to sustainability. AI can play an instrumental role in optimizing resource utilization within this framework. AI algorithms can meticulously track the lifecycles of products, ensuring efficient recycling or repurposing. Research by the Ellen MacArthur Foundation estimates that incorporating circular economy principles within AI support could result in annual savings of USD 700 billion in the consumer electronics sector alone.

AI in Climate Resilience

As climate change accelerates, the development of climate-resilient infrastructure and strategies becomes imperative. AI can assist in this endeavor by powering predictive models that help communities anticipate and mitigate the impact of extreme weather events. The National Institute of Standards and Technology (NIST) reports that AI-driven flood prediction models have the potential to enhance flood forecasting accuracy by up to 30%. Such precision could save lives and reduce the economic damage resulting from flooding.

In conclusion, AI is not only vital but indispensable in our quest for a sustainable world. The urgency of environmental challenges necessitates precision and innovation, and AI excels on both fronts. The data and statistics we have explored in this article underscore the profound impact that AI can have on environmental assessment, carbon reduction, biodiversity conservation, and more.

Nevertheless, the integration of AI into sustainability must be accompanied by a steadfast commitment to ethical use, transparency, and equity. Responsible AI ensures that our pursuit of sustainability is equitable and just and benefits all stakeholders.

As we peer into the future, emerging technologies will only amplify AI's role as a champion for ecological causes. A path will be drawn toward a world where technology and ethics coexist harmoniously, paving the way for a more sustainable and equitable future for all. In this journey, AI will transcend the status of a mere tool; it will become the catalyst for transformative change, guiding us toward a world that is not merely sustainable but thriving.

With AI as our ally, we possess the potential to turn the tide on environmental challenges and create a future that is not just sustainable but also prosperous and equitable. It is a future where we can proudly declare that we have taken the necessary steps to safeguard our planet for generations to come. The era of AI-powered sustainability is upon us, and the path ahead is unmistakably clear.

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Food Security Challenges Amid Climate Change: A Personal Exploration

Mr. Karim Asaad
CEO & Founder, Brooks & Kempton Ltd

Food security in the face of climate change is a global challenge, one that directly affects us here in Egypt. Our daily meals, cultural traditions, and economic stability are intertwined with these issues.

Mr. Asaad was invited to participate in a panel at the SIAM Exhibition in Morocco, highlighting the importance of promoting UK exports, especially in the agricultural sector.
At Brooks & Kempton, they take great pride in serving as a one-stop-shop for all agricultural commodities.

Food security is something we all depend on, yet we often take it for granted. We fill our grocery carts without much thought, expecting our favorite foods to be available year-round. But behind this apparent abundance lies a complex web of factors, one of the most significant being climate change.

In this article, we'll delve into the intricacies of food security in a changing climate, examining both global challenges and Egypt's unique position in this global predicament. So, let's embark on this journey together to understand the food on our plates and the forces shaping its availability.

Climate Change Global Impact on Food Security

First things first, climate change is not just an environmental issue; it is a matter of food security for us all. You see, the changing climate disrupts the delicate balance of our global food systems. Extreme weather events like droughts, floods, and heatwaves are becoming more frequent, affecting crop yields and food distribution.

Recent statistics are sobering, showing a rise in such extreme weather events. In the last decade alone, the world experienced a 35% increase in droughts and a 46% increase in floods, impacting food production and access for millions.

Key Global Crops at Risk

To grasp the scale of the issue, we need to talk about the crops we rely on daily: wheat, rice, faba beans, lentils, and edible oils. These are dietary staples for billions. Yet, they're not immune to climate change impact.

Consider these figures: In 2020, wheat production worldwide dropped by 3.2%, primarily due to extreme weather events. In the same year, rice production saw a 1.3% decline. These may seem like small percentages, but they translate to millions of tons of lost food.

Now, let's bring this closer to home—Egypt. This ancient land faces specific vulnerabilities due to climate change. Water scarcity and desertification are pressing concerns. It is essential to understand how these factors shape the Egyptian food landscape.

For instance, Egypt imports approximately 50-60% of its wheat, making it particularly sensitive to global price fluctuations. In 2020, global wheat prices rose by 20%, affecting the cost of bread, a staple for Egyptians.

Impact on Wheat Production

Wheat, often called the "staff of life," holds a special place in Egypt's heart. It is the foundation of our daily bread, quite literally. But climate change throws a curveball into the wheat fields.

Egypt faces challenges in wheat production, from shifting weather patterns to water scarcity. In 2021, Egypt produced 8.6 million metric tons of wheat, but this still fell short of domestic consumption, resulting in imports to meet the demand.

Think about your family gatherings or favorite restaurant dishes. Rice, faba beans, and lentils are likely present. They are part of our cherished culinary traditions, and they are global stars too.

Climate change poses challenges to these crops worldwide, impacting supply chains and prices. However, in Egypt, there is a commendable effort to bolster their resilience through innovative farming practices. The Egypt Rice Market size is estimated at USD 1.95 billion in 2024, and is expected to reach USD 2.71 billion by 2029, growing at a CAGR of 6.88% during the forecast period (2024-2029).

Edible Oils and Egypt's Dependency

Now, shift your focus to your kitchen. Edible oils are cooking essentials, integral to Egyptian cuisine. But climate-related challenges in oil production and importation can affect the prices of these kitchen staples, influencing what we cook and how we cook it.

In 2020, Egypt imported over 1.4 million metric tons of edible oils, underscoring our reliance on global markets for this essential ingredient.

Adaptation Strategies in Egypt

The good news is that Egypt is not sitting idly by. there is a proactive approach to adapting to climate change in agriculture. Sustainable farming practices and water management strategies are being embraced.

Statistics show that by 2020, approximately 11% of Egypt's arable land was under improved irrigation, contributing to water conservation and crop resilience.

International Collaborations and Support

Our journey would not be complete without discussing international collaborations. Egypt isn't facing these challenges alone. There are partnerships with global organizations and allies to address food security challenges.

> In 2020, international donors provided Egypt with USD 10.8 million in funding for agricultural development projects, highlighting the collective effort to secure our food future.

The Role of Technology and Innovation

As we look to the future, technology and innovation play a pivotal role in mitigating climate change's impact on food security. From precision agriculture to drought-resistant crops, these advancements offer hope.

By 2021, over 30% of Egyptian farmers had adopted precision agriculture techniques, enhancing crop yields and reducing resource use.

Egypt's Unique Food Security Challenges

Climate change is an existential threat that transcends the boundaries of geography and affects us all. Its impact on food security is a cause for serious concern on a global scale. To fully appreciate the gravity of this issue, it is essential to explore how various climate-related factors are influencing our food systems.

Let's continue to expand on the article, specifically focusing on Egypt's unique food security challenges in the context of climate change:

While climate change is a global concern, its impacts are felt differently in various regions, and Egypt is no exception. This ancient land faces a set of unique vulnerabilities and complexities when it comes to ensuring food security in the face of a changing climate.

1. Water Scarcity and Desertification

Egypt's geography, dominated by vast stretches of desert, has always presented challenges for agriculture. However, climate change has exacerbated these challenges by intensifying water scarcity and desertification. Here's a closer look:

- Water scarcity remains a pressing concern in Egypt, where the Nile River is the primary source of freshwater. Changes in precipitation patterns and increased evaporation due to rising temperatures have placed added stress on this critical resource.

- Desertification, the spread of desert conditions into arable land, threatens agricultural productivity. As desertification encroaches on fertile areas, it reduces the available land for cultivation.

2. Wheat Dependency and Global Price Fluctuations

Egypt's dependence on wheat imports is a defining characteristic of its food security landscape. A vast majority, approximately 70%, of Egypt's wheat is imported, making the country particularly sensitive to global price fluctuations. Here's how this plays out:

- In 2020, global wheat prices surged by 20%. This rapid increase had a direct impact on the cost of bread, a dietary staple for Egyptians. Such price spikes can lead to economic strain and food insecurity for vulnerable populations.

- Egypt's reliance on wheat imports underscores the importance of international trade partnerships and the need to diversify food sources in order to mitigate price shocks.

3. Impact on Wheat Production

Wheat holds a special place in Egyptian culture, serving as the foundation of daily sustenance in the form of bread. However, climate change introduces a host of challenges to wheat production in Egypt:

- Shifting weather patterns and reduced water availability pose significant hurdles for wheat farmers. These climate-related challenges can result in fluctuating wheat yields.

- In 2021, Egypt produced 8.6 million metric tons of wheat, which is substantial but still fell short of domestic consumption. This shortfall necessitates imports to meet the nation's demand for this essential staple.

4. Rice, Faba Beans, and Lentils: Challenges and Solutions

Beyond wheat, other crops like rice, faba beans, and lentils are also integral to Egyptian cuisine and food security. Climate change affects these crops as well, prompting innovative solutions as Egypt is importing hindered thousands of Metric Tons of these commodities to cover local annual consumption.

- Climate change poses challenges to these crops globally, affecting supply chains and prices. However, in Egypt, there's a concerted effort to enhance their resilience through innovative farming practices.

- In 2021, Egypt's rice production reached 4.2 million metric tons, showcasing the progress made in bolstering the resilience of these essential crops.

5. The High Waste Rate of Edible Oils

One of the Challenges related to edible oils is the problem of waste because of the multiplicity of the stages of their manufacturing. The oil industry goes through several stages which include the seed preparation stage, the cooking stage, the extraction stage, and the refining stage. All these stages lead to a high rate of waste, something that requires modern quality systems including well-equipped factories, trained labor, high quality, and maintenance of equipment as well as measurement and calibration devices.

- As climate change impacts oil-producing regions, it is crucial for Egypt to diversify its sources of edible oils and invest in domestic production to ensure a stable supply.

In the face of these challenges, Egypt is actively pursuing adaptation strategies and international collaborations to bolster its food security efforts. However, there are some additional impediments:

1. Extreme Weather Events

Extreme weather events are becoming increasingly common as a result of climate change. Droughts, floods, and heatwaves are wreaking havoc on agricultural production worldwide. To put this into perspective, let's examine some data from recent years:

- In the last decade, the world witnessed a 35% increase in the frequency and severity of droughts. These prolonged periods of water scarcity devastate crop yields, leaving millions without reliable access to food.

- Likewise, floods surged by 46% in the same timeframe. These inundations not only destroy crops in their wake but also disrupt supply chains, making it challenging to transport food from farms to consumers.

2. Crop Vulnerabilities

Our global food supply heavily relies on a handful of key crops, including wheat, rice, faba beans, lentils, and edible oils. These crops are the foundation of diets for billions of people, making them critical to food security. However, these crops are far from immune to the effects of climate change:

- In 2020, the world witnessed a 3.2% reduction in wheat production due to extreme weather events. This seemingly small percentage translates to millions of tons of lost wheat, leading to higher prices and reduced availability.

- A 1.3% decline in rice production in the same year is another alarming statistic. Rice, a staple for much of the world's population, became scarcer and more expensive, affecting the diets of countless individuals.

3. Vulnerabilities in Food Distribution

Climate change does not just affect crop production; it also disrupts the distribution of food. With the increasing frequency of extreme weather events, transportation networks and infrastructure face greater challenges in delivering food to where it's needed. Here are some insights:

- Rising temperatures can affect the shelf life of perishable goods, making it more difficult to store and transport food safely.

The interplay of these factors creates a complex web of challenges that extend beyond national borders. It underscores the urgency of addressing climate change as a core component of global food security efforts.

Conclusion

In conclusion, food security in the face of climate change is a global challenge, one that directly affects us here in Egypt. Our daily meals, cultural traditions, and economic stability are intertwined with these issues.

The urgency of global cooperation cannot be overstated. We all have a role to play in making sustainable food choices, supporting local agriculture, and advocating for policies that promote resilience.

Let's keep our plates full, not just for ourselves but for the generations that will follow. The path to food security amid climate change is one we must tread together.

“

WEST ANTARCTIC ICE SHEET FACES 'UNAVOIDABLE' MELTING, **A WARNING FOR SEA LEVEL RISE.**

REGARDLESS OF HOW AGGRESSIVELY HUMANS ACT TO REDUCE FOSSIL FUEL EMISSIONS, WATERS AROUND SOME OF ANTARCTICA'S GLACIERS ARE FORECAST TO WARM AT A PACE THREE TIMES FASTER THAN THEY HAVE IN THE PAST.

Scott Dance & Chris Mooney
TWO REPORTERS AT THE WASHINGTON POST

Source: Dance. S, and C .Mooney, "West Antarctic ice sheet faces ‘unavoidable’ melting, a warning for sea level rise", Washington Post, October 23, 2023.

CLIMATE NARRATIVES

Dr. Rabab Mahrous

Expert at the Egyptian Cabinet's Information and Decision Support Center (IDSC)

Sophia Kianni: Climate Activist Aiming at Bridging Global Climate Awareness Gap

Translating climate information and bridging the knowledge gap play a vital role in promoting awareness of such a global challenge. The translation of research papers and information related to climate change has become a global priority, paving the way for bringing new ideas to the table, building bridges between communities, and engaging more people worldwide in solving climate change issues.

"Our mission is to make climate education more accessible to non-English speakers,"

Said Sophia Kianni, climate activist and founder of the Climate Cardinals organization, which aims at spreading knowledge of climate change in various languages around the globe. Although she is only 19 years old, she strives to spread societal awareness of climate change.

When the UN publishes some of the most up-to-date and promising data on the climate crisis, it only does so in six languages. But there are at least thousands of spoken languages, which means millions of people do not have access to this information.

Thus, Sophia Kianni, who is a student at Stanford University and the youngest member of the UN Youth Advisory Group on Climate Change, has set her mind to rectifying and bridging part of the huge gap in accessing climate change information through establishing Climate Cardinals.[1] This non-profit organization has nearly 10,000 volunteers, reaching millions of people in over 41 countries around the globe. It translates research papers on climate into 100 languages in order for everyone everywhere to acquire appropriate climate awareness.[2]

Who is Sophia Kianni?

Sophia Kianni is an Iranian-American social entrepreneur and activist. She studied at Stanford University and is the founder of Climate Cardinals, a youth-led climate nonprofit. She is the youngest United Nations advisor in US history.

Sophia has amassed a following of over 300,000 across social media platforms, and her work has been featured on The New York Times, CNN, Vogue, Business Insider, BBC, NPR, ELLE, The Guardian, and NBC. She has written for news outlets such as TIME Magazine, The Washington Post, MTV News, Cosmopolitan, and Teen Vogue.

Sophia is a prolific storyteller and has spoken at universities across the world, including Harvard, Stanford, Columbia, Yale, Oxford, Cambridge, and Princeton. She won the TED Global Idea competition, and her debut TED Talk has over 2 million views.

She has been named VICE Media's youngest Human of the Year, a National Geographic Young Explorer, and Forbes' 30 under 30.[3]

How Did Kianni's Passion for Climate Change Start?

Translation plays a vital role in the global climate change debate. Organizations like the United Nations or the European Parliament, together with global NGOs, rely on translation to analyze the results of academic research and make decisions.[4]

Many international organizations have decided to make climate change a top priority of the next decade. It's time to talk about how the translation industry can contribute to making our planet healthier. Translating climate change research and information can increase awareness about this global challenge, even bring new ideas to the table, build a bridge between communities, and engage more people around the world in solving climate change issues.

Worthy of mention, most scientific research papers and studies published on climate change issues are limited to English, which hurdles access to information for the highest number of people around the world.[5]

Hence, Kianni's passion for climate action, especially reducing the knowledge gap of climate change, started when she visited her home country of Iran. During her stay, she was struck by the fact that the air pollution in Iran was so bad that she could not see the stars at night due to smoke. Therefore, Kianni started reading about climate change in the Middle East. She was directed at the fact temperatures there are rising more than twice the global average. In addition, Kianni approached my relatives with these concerns, and she was struck by the fact that they told me that they had never heard about climate change or global warming.

Kianni decided to educate her relatives. She translated climate change information to Farsi after she realized that there was very little information in languages other than English. Hence, Kianni's relatives acquired the appropriate scientific background on climate change issues through reading her translations.

Breaking Down Barriers: What are Kianni's Efforts in Spreading Knowledge on Climate Change Issues Globally?

The matter was limited to spreading knowledge on climate change within Sophia's family only. The university student sought to spread such knowledge and social awareness of this field globally; thus, the idea of establishing Climate Cardinals, a non-profit organization based on volunteers globally translating climate sciences and research papers to break down the language barrier.

Kianni mentioned that a Google Scholar search of "climate change" publications will yield 3,700,000 research papers in English. Among the top ten countries most vulnerable to climate change, only one is majority English-speaking (Canada). Languages remain a significant barrier to the global transfer of scientific knowledge.

Kianni mentioned people who are unable to access enough research papers and information related to climate change are the most vulnerable to its impacts. As a result, these communities are not heard; they usually lack the possibility of access to the information they need to mitigate the impacts and prevent climate change.

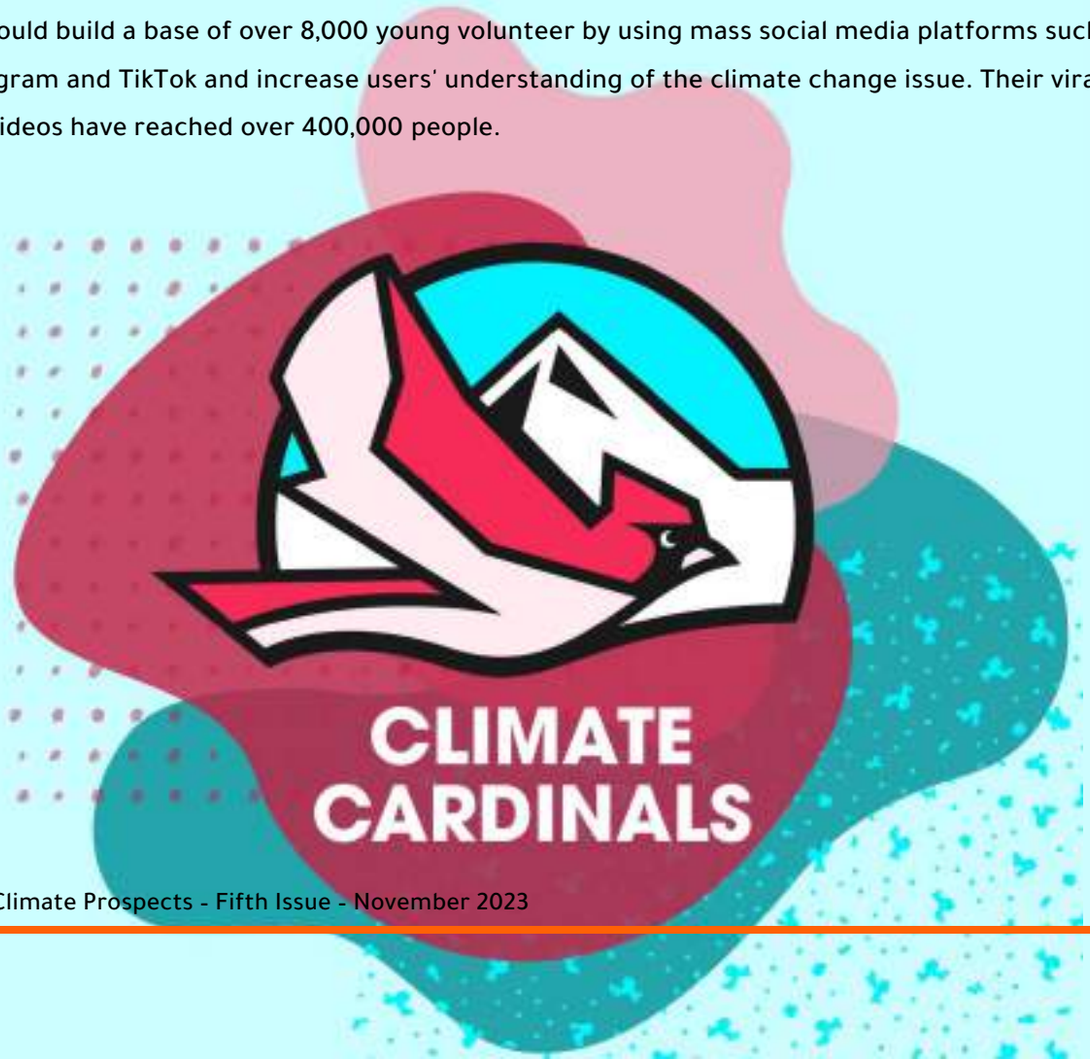
According to Kianni, it is so important to translate climate information so that the people who are being worst affected by climate change have information so that they can learn about what's happening to them and they can learn about how we can combat this issue.[6] Accordingly, Climate Cardinals seeks to make research papers, reports, and data related to climate change accessible to non-English speakers by translating climate sciences and research papers to over 100 languages.

> **I hope that other organizations work on translating its resources to more languages to ensure everyone everywhere has access to basic climate education.**

In fact, Sophia could broaden the scope of Climate Cardinals by using social media as a tool for promoting climate awareness and news outlets to disperse her platform, construct a compelling image for the organization, and attract volunteers to join the effort, driving over 100,000 people to visit our website to access climate resources.

With the spread of COVID-19 in 2020, the idea of establishing Climate Cardinals emerged. While the world was shut down, Kianni's momentum increased when she dedicated her additional free time at home to the idea she has been passionate about since she was twelve years old during her visit to Iran.

Kianni could build a base of over 8,000 young volunteer by using mass social media platforms such as Instagram and TikTok and increase users' understanding of the climate change issue. Their viral TikTok videos have reached over 400,000 people.



Global Impact: Kianni's Voice Echoing Inside UN Halls

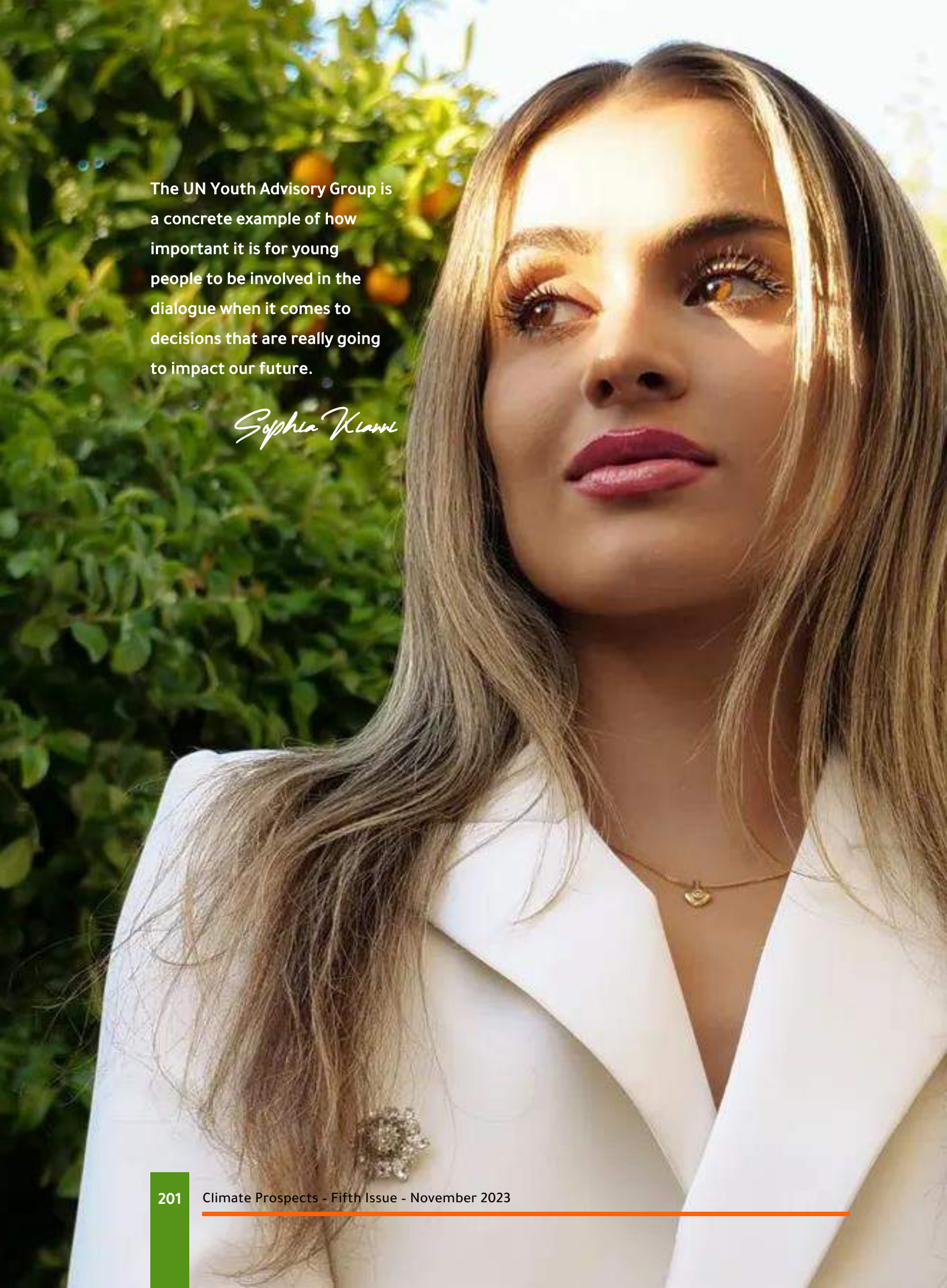
In light of her achievements in bridging the knowledge gap of climate change, which has been nothing short of incredible, the United Nations (UN) noticed such an impact. In 2021, the international organization invited Kianni to join its Secretary-General's Youth Advisory Group on Climate Change. She gave him advice on his climate strategy for 2020-2021. Additionally, she most recently organized a global youth consultation with young people from over 20 countries and published a report outlining six key climate actions that young people want world leaders to take.

The Youth Advisory Group consists of enthusiastic young people from all over the globe who preemptively participate in increasing awareness of climate change hazards. The Group works to provide the Secretary-General with practical and outcome-focused advice, diverse youth perspectives, and concrete recommendations. It also has a clear focus on accelerating the implementation of the Secretary-General's climate action agenda.

It led to Kianni's involvement in the UN's climate change conferences, COP26 and COP27, and several other major global events, which provided her with invaluable experience, expanded her social network with other prominent youth leaders in the field, and further increased her impact.

Worthy to mention, Kianni is also a member of Ashoka, a not-for-profit organization that promotes social entrepreneurship by connecting and supporting individual social entrepreneurs.

In addition, she is one of four Ashoka Young Changemakers involved in the INKEY Impact Fund, which works to identify, encourage, and enable other young, emerging changemakers who are making a positive change in the world to continue their incredible work.


The UN Youth Advisory Group is a concrete example of how important it is for young people to be involved in the dialogue when it comes to decisions that are really going to impact our future.
Sophia Kianni

In conclusion, Kianni is currently juggling her climate change advocacy work with full-time study at California's Stanford University and says she's also in the process of co-developing an online sustainable fashion initiative.[7]

Additional Messages:

- "Between classes, we'd work to get as many people as possible to pay attention to climate change".
- "I dedicated a lot of my free time to helping to organize different initiatives like strikes and reaching out to press to get them to cover the work that we were doing".
- "I work with some of the smartest people, much smarter than I am, so while I obviously have my own ideas and vision for Climate Cardinals and for the work we're doing, I would never treat that as the final way, we need to do things".

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Subsidization and Environmental Quality in Germany

Ms. Yasmine Hisham
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Subsidization may degrade the environment due to its consumption and production expansion consequences that stimulate pollution, waste, and resource consumption. Moreover, subsidization stimulates carbon dioxide and nitrous oxide emissions in Germany, which result in lower air quality.

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This article aims at addressing the impact of implicit and explicit subsidies on environmental quality by highlighting different arguments through which subsidies could adversely affect the environment. This relationship is examined mainly in Germany by focusing on its subsidies' reforms since 1990s and their environmental impacts. The article includes different linkages and effects that describe subsidization-environment relationship like overconsumption and overcapitalization effects. It also includes empirical reviews of studies done to investigate this relationship. It concludes that subsidization may degrade the environment due to its consequences of consumption and production expansion that stimulate pollution, wastes, and resources consumption. Moreover, it concludes that subsidization stimulates carbon dioxide and nitrous oxide emissions in Germany, which result in lower air quality.

Introduction:

The subsidy is a type of government intervention that makes consumers and producers better-off by allowing consumers to buy goods and services at prices below the perfectly competitive market-offered prices and raising the income of producers beyond their pre-subsidy earned income.

When Pareto optimality holds in a perfectly competitive market, the main purpose of subsidies is the re-distribution of income. However, when there is a market failure like market power, externalities, and lack of information and competition, subsidies are used to adjust these failures and re-distribute income. Subsidies are mainly used to adjust for positive externalities. Externalities are benefits and costs of consuming or producing a certain good or service that are not reflected through market prices, like research and development. On the contrary, negative externalities like pollution, which is usually the case in environmental economics, are efficiently corrected through externality taxes that are equal to the externality marginal cost. However, some subsidies result in an expansion of production or consumption with adverse environmental effects, which are called Environmental Harmful Subsidies (EHS). These subsidies could delay the movement towards a less carbonized global economy. Furthermore, they burden public budgets and deteriorate relative competitiveness in the economy. Also, sometimes, subsidization harms both the environment and the economy, which is called perverse subsidization. Subsidization can be either on-budget or off-budget. The first is directly financed by the government, and its removal has an immediate impact on the budget, like payments and grants to consumers and producers, The second is supported through preferential loans, price regulation, tax policies, etc. Subsidization may also be either direct or indirect, which means either directly imposed on certain recipients or reaching other participants in the economy through market transactions occurred by direct subsidies. This article addresses the relationship between subsidization and environmental quality, and it is divided into six sections, which are theoretical and empirical reviews, Germany: A case study, conclusion, appendix, and bibliography respectively.

Theoretical Reviews:

Several theoretical backgrounds describe the subsidies-environment relationship. In this instance, subsidies can be categorized into two categories. The first is the traditional subsidies to achieve economic and social positive outcomes. These subsidies might raise activities that degrade the environment. The second category is the subsidies with the purpose of environmental preservation, which may affect the economy through its environmental impacts.

Therefore, the relationship between subsidies and environmental quality can be explained by three main links. The first refers to variation in different activities or production's volume and composition. Production consists of consumer goods and intermediary goods, which serve as inputs in production. These activities' volume and composition depend on subsidy conditionality, usually conditional on income, profits, output, and input. The second link refers to the consequences of changes in activities' volume on the environment, like pollution level and resource usage. Thus, the environmental changes depend mainly on how much is filtered through government regulations, which means that the stricter the environmental policy, the lower the severity of pollution levels. Finally, the third link is related to the impacts of changes in waste and pollution levels on environmental damage, which depend on the environment's assimilative capacity.

Subsidization may take various forms. For instance, resource rent, a concept related to natural resources and externalities, is usually considered a subsidy because it is defined as the price producers should pay for renting a certain resource in case property rights are not clearly defined. Therefore, this concept can be applied to public resources as the resources' users pay no rent unless the government taxes these resources.

So, this rent can reflect the social costs of resource management.

Furthermore, from a welfare economics perspective, a negative externality may be considered a subsidy if it is not internalized in the market, which is called an implicit subsidy. For example, the existence of a polluting industry like the production of coal-based electricity results in additional costs faced by producers called external costs like emissions. In this instance, non-internalizing this externality through taxation equal to marginal environmental costs will result in actual production higher than optimal production. Thus, there will be an efficiency loss in the market. However, considering this case as a subsidy requires a valuation of external effects in monetary terms to evaluate the subsidy's size. This valuation is complex and requires wide uncertainty margins. Also, not all externalities are unacceptable from society's point of view, as social costs due to taxation may outweigh its social gains. Producer and consumer subsidies are mostly imposed in developed and developing countries, respectively. However, both are generally analogous to each other. Producer subsidy imposed through reducing inputs' prices results in the reduction of production costs.

However, the demand and supply relative elasticity of these inputs will determine the subsidy amount that will either be leaked to the producer or input supplier. If producers' demand elasticity is low, they will not change the level of their used inputs in production. Thus, input suppliers will increase their prices and capture a higher amount of this subsidy. In this instance, the higher the elasticity of the input's supply and demand, the higher the environmental degradation level. However, the subsidy amount leaked to the producers will enable them to reduce production costs and, thereby, their prices, stimulating demand and, consequently, environmental degradation. Similarly, subsidization that increases producer's revenues through market price support, which puts a minimum price level higher than the market price for producers, may adversely affect on the environment due to production expansion. However, there will be a relatively lower consumption level. Moreover, imposing input subsidies on certain activities in open economies gives them a competitive advantage in domestic and foreign markets. However, there will be comparative advantage distortion globally and, thereby, global waste of resources and disincentives to either new technologies' usage or energy inputs' reduction. Furthermore, consumer subsidies on goods, like energy products, will stimulate their consumption and, thereby, environmental damage, as subsidies change optimal market prices and quantities demanded into sub-optimal quantities and prices that stimulate emissions, wastes, resource consumption.

Consequently, producer and consumer subsidies could have far-reaching effects on consumption and investment patterns, stimulating environmental damage. This happens through various intermediary effects. For instance, subsidies attract more investments into an industry, and the net result of attracting capital to the industry by government interventions' price-distorting is the loss of biodiversity and ecosystem functions, which is called the "overcapitalization effect". Another investment-related effect is the "technology effect", as subsidies discourage the replacement of used harmful technology, which has a competitive advantage with a new environmentally friendly technology, also known as the "Lock-in effect".

In addition, subsidies result in the "inefficiency of resources effect" as they encourage inefficient resource usages either by industries that use resources as inputs or by consumers, which raises the environmental degradation level. Moreover, subsidies have an "overconsumption effect". For instance, subsidizing natural resources leads to overconsumption of goods, which degrades the environment through higher emissions levels. Finally, subsidies may result in a "public resource deprivation effect", as subsidies that include resources' sale at lower prices from the public domain may deprive financial resources, which could be used to enforce regulations that protect resources' sustainable management.

On the contrary, according to (OECD, 1998a), subsidization through direct income or lump sum support does not cause significant environmental damages as they do not directly expand consumption or production, but (Pearce, 2003), argued that these subsidies might lead to continuity in production due to profits' expansion when the optimal decision is ceasing it.

Furthermore, subsidization of the demand or supply side of clean technologies as an incentive will lead to expansion in the economy's total demand or supply beyond the optimal level. However, environmental impact is complex as it depends on the reduction rate of existing polluting technologies. Moreover, there will be an efficiency loss that could be turned into gains if the government taxed polluting technologies. The next section addresses empirical reviews on this topic.

Empirical Reviews:

Many studies investigated the subsidies-environment relationship. For instance, Clarke and Edwards (1997) developed a static general equilibrium model to investigate the impact of production subsidies in 12 sectors on carbon dioxide, sulphur dioxide, and nitrogen dioxide, and particulate emissions in West and East Germany during 1990. The results showed that removing all subsidies reduces total emissions in Germany, especially particulate emissions. Moreover, the benefits of reducing environmental damage represent 0.2% of Gross Domestic Product (GDP).

Furthermore, Welsch (1998) developed a dynamic general equilibrium model to examine the relationship between subsidies and carbon dioxide emissions in west Germany from 1995-2020 by focusing on the energy sector. The results showed that large reduction of subsidies leads to lower emission levels by about 0.4%, especially in coal production. Mukherjee and Chakraborty (2014) also investigated the relationship between government subsidies and carbon dioxide emissions in 131 countries from the period 1990-2010. The results showed that higher subsidies lead to higher emissions, especially in countries characterized by high urbanization levels and high GDP per capita and manufacturing sector's share of GDP. They concluded that there should be subsidization limits in both developed and developing countries.

Moreover, Akinyemi et al (2014) examined the relationship between fuel subsidy and environmental quality in Nigeria from 1970-2012. They applied Johannsen and Engel-Granger integration approaches. The results showed that subsidy and no subsidy payments have no impact on Nigeria's environmental quality. However, payment of effective subsidies has significant impacts on environmental quality. The next section introduces Germany as a case study.

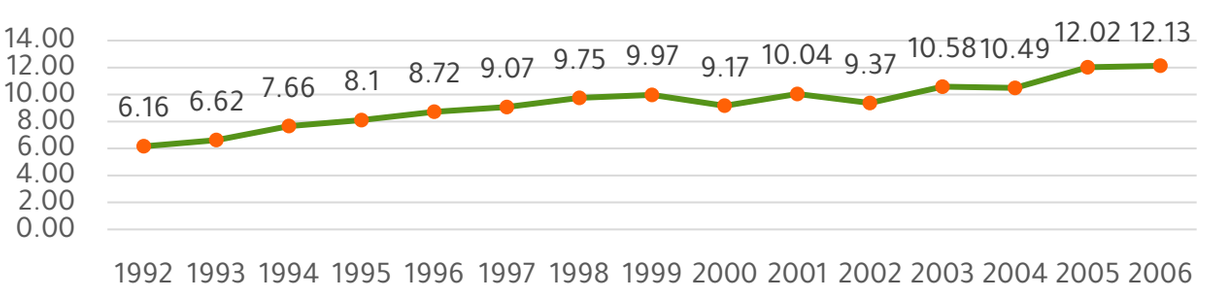
Germany: A Case Study:

Germany had faced several reforms in terms of subsidisation. Federal subsidies' volume in Germany had been tripled during the period of mid-1970s till mid-1990s. After that, subsidies became relatively stable for example they increased from 56€ bn in 2001 to 60€ bn in 2003. Energy subsidies in particular had faced significant increases over time. For example, in 2003, oil, hard coal, natural gas, nuclear energy and renewables subsidies increased significantly to be 54.726€ Mn, 22.189€ Mn, 19.694€ Mn, 17.555€ Mn and 2.161€ Mn respectively which indicates that subsidies on renewables like solar, wind and biomass are the lowest relative to other energy subsidies. Accordingly, fossil fuel represented 83.18% of total energy use in 2003 while alternatives and nuclear energy represented only 13.95%.

Furthermore, Germany imposed biofuel tax exemption for almost six years starting from 2004 as an off-budget support that offers preferential tax treatment to biofuel producers relative to other producers. The aim is to promote renewable fuels' usage and production, thereby reducing environmental degradation. Consequently, fossil fuel consumption decreased slightly from 82.57% in 2004 to 81.27% in 2006, and that of renewables increased slightly from 14.20% to 14.30%. These small changes indicate that the impact of biofuel tax exemption on the environment is ambiguous. Moreover, figures 1 and 2 show the changes in Germany's electricity production from natural gas and renewable sources from 1992-2006, which includes both effects of high energy subsidies imposition and biofuel tax exemption. The figures show relatively upward trends in both, but the gap between them in terms of values is large. However, this gap started to decline relatively since 2004, the tax exemption date. By focusing on the environmental impacts, figure 3 illustrates that carbon dioxide emissions released from natural gas increased significantly from 1992-2006, which is consistent with the rise of electricity production based on natural gas.

Figure 1

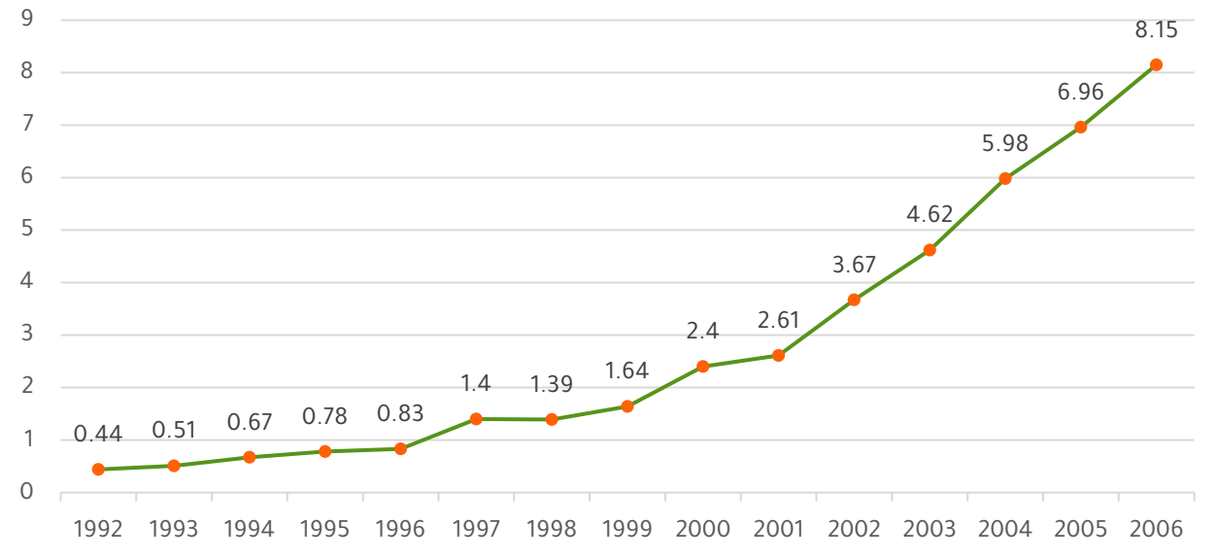
Electricity production from natural gas sources (% of total)



Source: World Bank, 2019.

Figure 2

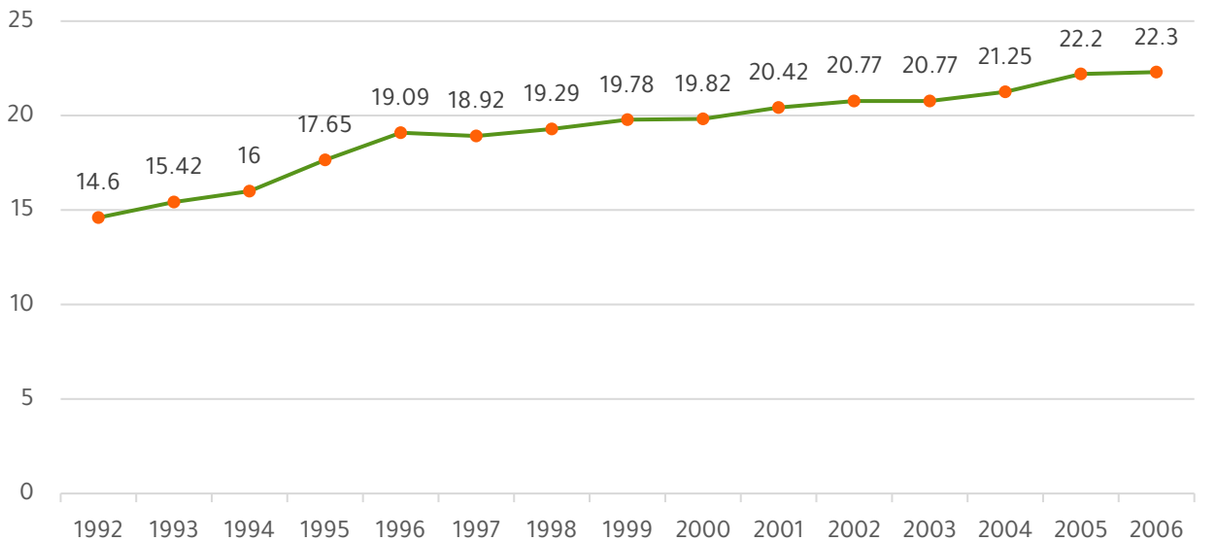
Electricity production from renewable sources (% of total)



Source: World Bank, 2019.

Figure 3

CO_2 emissions from natural gas consumption (% of total)

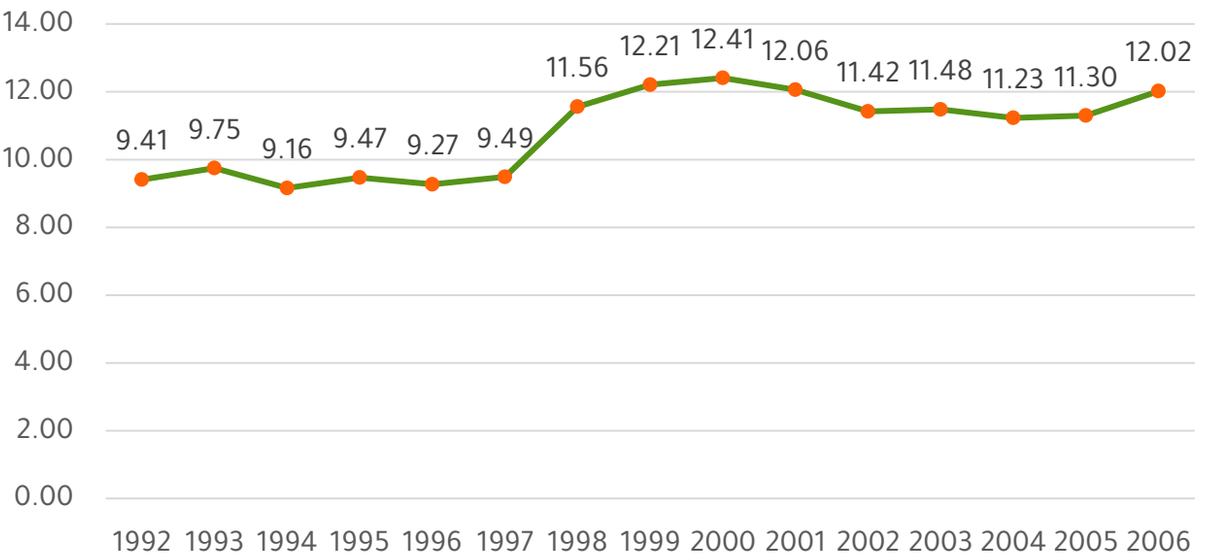


Source: World Bank, 2019.

Moreover, figure 4 shows that nitrous oxide, which is released mainly from the combustion of biofuels and fossil fuels, was relatively constant at 9.5% until 1997. Still, it started to increase after this year due to the increase in fossil fuels and biofuel subsidization. Both emissions have severe negative impacts on the environment, especially air quality.

Figure 4

Nitrous oxide emissions in energy sector (% of total)



Source: World Bank, 2019.

Conclusion:

To conclude, after reviewing different theoretical and empirical arguments on the relationship between either explicit or implicit subsidization and environmental quality and by descriptively analyzing the impacts of Germany's reforms in terms of subsidization on environmental quality, It is concluded that subsidization mostly leads to higher environmental degradation because it may result in the expansion of producing or consuming certain activities or products that degrade the environment. In Germany, both subsidization of non-renewables like coal and natural gas and implicit subsidization of renewables like biofuels lead to higher levels of carbon dioxide and nitrous oxide emissions, degrading the environmental quality. Removing EHS could have larger effects on the environment if they are imposed for a long time on environmentally appropriate variable costs. Moreover, they have to be applied to the existing production capacity, not a new market addition. They have upstream effects on the polluting or resource- intensive industries in the economy. In this context, several policies could be developed to enhance the environmental quality, such as encouraging and supporting the improvement of second-generation biofuel, taxation of the polluting energy sources to internalize their negative externalities in the market, taxation related to fuel's carbon content, involving biofuels, imposing strict environmental laws to limit subsidies' environmental damages, and raising public awareness of the eco-friendly techniques to preserve the environment.

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How Can Negative Impacts of Climate Change Be Reduced? Agrivoltaics As Model

Agrivoltaics is a smart type of agriculture that relies on technology and renewable energies. Thanks to computers, technology contributes to controlling the environmental and climatic characteristics of the air, including temperature and humidity, to provide the plants' needs.

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Over the past years, the agricultural sector has faced various challenges, from extreme climate conditions, conflicts, and wars to shortages of inputs and labor. Consequently, global food security is vulnerable to major risks and challenges that are becoming more serious with every passing day.

Despite this bleak picture, there are many practices through which some of these challenges can be confronted, at the top of which is agrivoltaics. It involves growing crops under solar panels and using the land simultaneously to produce food and energy, which increases land use efficiency and allows agricultural lands and solar farms to share land instead of competing for it.

Based on this vital and dual role of agrivoltaics, in the academic year 2022-2023, the Jamal Al-Din Al-Afghani School in Kenitra, Morocco, launched an initiative to introduce students to agrivoltaics. The initiative included applied models and experiments to raise awareness of the importance of this type of agriculture in ensuring food security and confronting climate change.

Agrivoltaics: A Moroccan Initiative to Reduce Climate Change Impacts on Agriculture

The idea of this initiative came out of a creative workshop that benefited 20 students at Jamal Al-Din Al-Afghani School in Kenitra. It emphasized the urgent need for smart farms by using new technologies to provide clean energy and reduce pollution, water use, and evaporation.

Today, agriculture uses a lot of resources, which requires a huge amount of water and energy. More than 85% of global water consumption is used for irrigation and watering purposes for food. Moreover, agriculture produces more than a third of the total greenhouse gases that cause global warming, leading to climate change.

Pictures of the workshop that defines the components of the agrivoltaics initiative and its design.

Meanwhile, the demand for food is growing. The world population, which now stands at more than 8 billion people, is expected to reach about 9.8 billion people by 2050, underscoring the need to nearly double current food production to meet this demand. If this situation remains unchanged, there will likely be significant food shortages, which may cause social unrest and possible economic collapse, causing conflicts and wars.

Therefore, envisaging new methods and innovations compatible with the negative impacts of climate change is required. **Agrivoltaics** is considered one of the technologies that can be used to confront and reduce these repercussions on food security, since it blocks the sun's rays, exploits its energy, and contributes to saving water.

Agrivoltaics is establishing a photovoltaic solar system over productive crops to optimally use the available space. Thus, it is a smart type of agriculture that relies on technology and renewable energies. Thanks to computers, technology contributes to controlling the environmental and climatic characteristics of the air, including temperature and humidity, to provide the plants' needs. In contrast, renewable energies contribute to reducing climate change and generating clean energy. The solar panels that cover plants contribute to reducing the transpiration of plants, thus reducing the loss of a large amount of water by plants.

In general, agrivoltaics is an outstanding means of achieving modern agricultural development, developing the rural economy, improving the farmers' lives, and developing agricultural production. Developing the idea of agrophotovoltaics is necessary for preserving and benefiting from agricultural lands in the field of solar energy. In addition, agriculture through installing solar panels on agricultural lands is one of the criteria to make the sector, which does not want to be left behind in fighting climate change, more sustainable.

As per a study published by Nature, if only 1% of arable land was devoted to solar energy production, it would be possible to offset global energy demand. The main benefit of agricultural PV is that it reduces greenhouse gas emissions from the agricultural sector. Furthermore, the dual use of land for agriculture and energy reduces pressure on ecosystems and biodiversity, which are affected by expanding agricultural areas.[1]

Agrivoltaics involves solar energy panels that are installed over crops to shade them, on the one hand, and generate energy to meet the needs of the farm itself, on the other hand. Moreover, the energy that exceeds the needs of the farm can be used to feed the local electricity networks. Estimates indicate that it could contribute to reducing climate change for all countries of the world through clean energy by 2025.

Several studies revealed increased crop yields when solar panels partially shade crops. Indeed, many countries in Europe, Asia, and the United States have sought to develop farms that rely on agrivoltaics. **In Europe**, for example, solar panels are placed over various types of crops, including fruit trees.[2] **In China**, agrivoltaics is used to combat desertification and for desert greening. Likewise, solar farms generate good profits for farmers in **the United States**. Estimates reveal that Texas farmers can get USD 500 per feddan annually from solar energy leasing, which increases to USD 1000 per feddan in the Central Valley in California. In the United States, the focus is also on crops that are harvested manually. In Arizona, researchers found that tomato production doubled under solar panels and was 65% more efficient in terms of water use.

Influenced by Countries Worldwide, What Are the Moroccan Initiative's Goals?

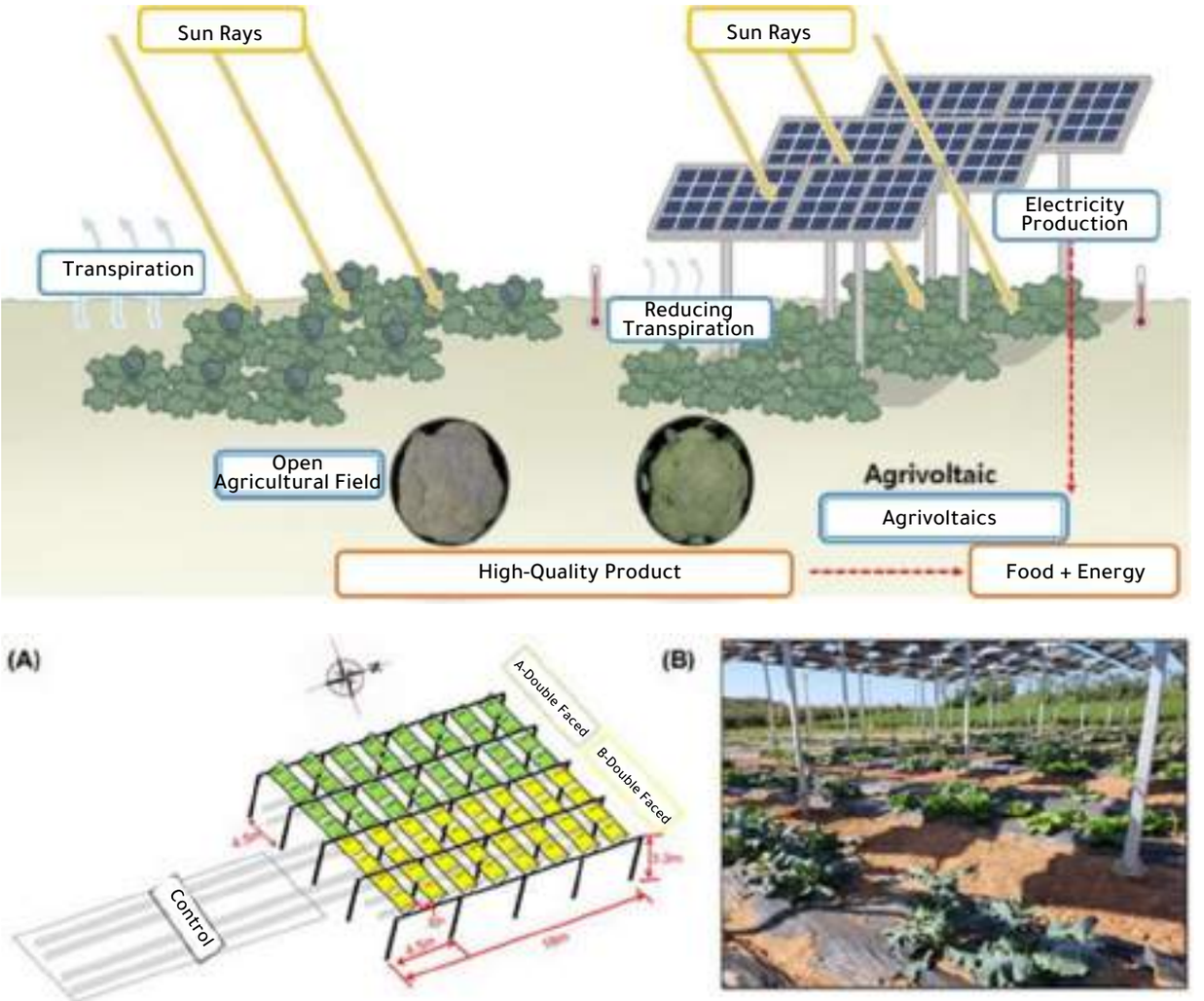
Given the returns of agrivoltaics in many countries, the Jamal Al-Din Al-Afghani School launched a Moroccan initiative to learn more about this eco-friendly agriculture that contributes to achieving food security through several applied models and experiments seen by students.

Initially, agrivoltaics was defined through the global experiences of the United States, China, Europe, and Germany, as a practice of cultivating crops under solar panels. Scientific studies show that some crops, grown this way, flourish and develop quickly with good yields.[3]

> "Doubling the land used for this type of agriculture enables us to feed the growing world population while providing them with sustainable energy at competitive prices. Additionally, there will be no need to increase resilience to climate change and to think about confronting the increasing rates of hunger and malnutrition.

According to several recent studies[4], this technology will achieve land use efficiency because it allows solar farms and agriculture to share land instead of competing against each other. It will also enable crops to flourish when grown in such environments.

Solar panels are installed high or suspended to allow plants to grow under them. They can also be placed on the roofs of greenhouses, allowing enough light and rainwater to reach crops while providing an access to agricultural machinery. The panels are installed at a height of 2-3 meters from the ground and with an angle of 30 degrees, providing shade and protection for crops from very hot or cold weather.



Pictures of the scientific design of agrivoltaics of green cauliflower according to Seung Hoon Chae's model[5].

Fruitful Results: How Did the Initiative Achieve Its Goals?

In this initiative, students were able to learn that each plant has a specific degree of tolerance to sun rays that it can actually use, which is called the light saturation point. Once reached, any light beyond this point does not increase photosynthesis or help the plant grow; it only increases its demand for water. It simply causes plant transpiration, wilting, and consequent crop yield loss.

Moreover, they learned that installing suspended solar panels enables plants to obtain the appropriate amount of sunlight, and excess sunlight can be used to generate electricity. They also learned that there is a mutual relationship between plants and solar panels, as plants help keep the solar panels cool, making them more productive, and panels placed over plants can produce up to a 10% increase in electricity[6]. Therefore, the students concluded that there is a symbiotic relationship in which both solar panels and crops benefit because they help each other perform better.

Renewable electrical energy produced sustainably on the farm can be used to operate electrical equipment and the precision agricultural technology that helps reduce water use. Excess energy can also be stored in batteries or sent to the grid for consumer use.

It was also emphasized that there is a profitable relationship between the three basic elements of modern life: food, water, and energy. One of the fruitful results of the initiative was to highlight the role of agricultural energy in using the same area of land to produce more food while introducing more renewable energy sources, given the increasing ability of solar energy to be a solution to the equation of sustainability of natural and energy resources and the dispensation of fossil sources energies.

Solar energy could also be a solution for countries that lack land, such as South Korea, Singapore, and others. Thus, agrivoltaics could be a game-changing solution because it works on renewable resources and can produce food to feed us sustainably in the future.

In general, the most prominent results of the agrivoltaics initiative are acquiring the basic knowledge concerning renewable energies and their role in developing agrivoltaics, enhancing capabilities of using water and preserving groundwater, learning about the new technical skills used in agrivoltaics, and recognizing the importance of creativity and modern technology in developing a type of agriculture adapted to the natural and climatic characteristics of the territories.

Noteworthy, the agrivoltaics initiative of the Jamal Al-Din Al-Afghani School won first place regionally for the second time in a row at the 16th edition of the Science Fair held in Rabat in May 2023.

Finally, this initiative is an attempt to raise awareness among students about the importance of agrivoltaics in reducing the repercussions of climate change or ensuring global food security. However, more efforts are needed at the local and international levels, and more research and studies are required in this field, given the multiple advantages and returns of this type of agriculture.

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The International Union for Conservation of Nature

AN AMBITIOUS PLAN TO SAVE THE WORLD'S OCEANS: **WHAT HAPPENED AT THE IUCN NATURE CONFERENCE?**

Source: Ann Hughes. R, "An ambitious plan to save the world's oceans: What happened at the IUCN nature conference", euronews October 25, 2023.,

5 TURNING POINTS

OF THE PLAN FOCUS ON MARINE CONSERVATION, OCEAN RENEWABLE ENERGY, SHIPPING, AQUATIC FOOD, AND COASTAL TOURISM.

- THE PROJECT WHICH FOCUSES ON MARINE CONSERVATION, OCEAN RENEWABLE ENERGY, SHIPPING, AQUATIC FOOD, AND COASTAL TOURISM.
- THE PROJECT IS THE JOINT EFFORT OF THE OCEAN & COASTAL ZONES COMMUNITY UNDER THE MARRAKECH PARTNERSHIP FOR GLOBAL CLIMATE ACTION, WHICH ENABLES COLLABORATION BETWEEN GOVERNMENTS AND KEY STAKEHOLDERS TO LOWER EMISSIONS AND INCREASE RESILIENCE AGAINST CLIMATE IMPACTS.
- BY 2030, THE PROJECT WILL SECURE INVESTMENTS OF AT LEAST EUR 68 BILLION TO SECURE THE INTEGRITY OF OCEAN ECOSYSTEMS.
- BY 2030, THE PROJECT PROVIDE AT LEAST EUR 3.8 BILLION TO SUPPORT RESILIENT AQUATIC FOOD SYSTEMS.
- IT ALSO AIMS TO INSTALL AT LEAST 380 GW OF OCEAN RENEWABLE ENERGY AND ENSURE ZERO EMISSION FUELS MAKE UP 5% OF INTERNATIONAL SHIPPING'S ENERGY DEMAND.

Ms. Howaida Mohamed

Political researcher at the Egyptian Cabinet's Information and Decision Support Center (IDSC).

State and Trends of Carbon Pricing 2023*

Introducing a price signal for climate change mitigation is critical to driving investment and behavior change to lower greenhouse gas emissions.

Carbon markets and mechanisms have steadily evolved since the first State and Trends of Carbon Pricing report was published 10 years ago in 2014. The share of global emissions covered by carbon taxes and emissions trading systems (ETSs) has grown from 7% to around 23%. Moreover, government revenues from carbon taxes and ETSs have grown nearly fivefold as policies have evolved and diversified to reflect increased ambition. Voluntary action around carbon markets has proliferated as corporations have become the biggest source of demand for carbon credits.

Carbon pricing must continue to grow, both in terms of coverage and price, to drive the transformational change needed to meet the Paris temperature goals. However, the global energy crisis posed significant challenges for energy markets and the world economy in 2022.

Governments have responded with measures to shield consumers from price hikes, adding to fiscal pressures accumulated during the COVID-19 pandemic. Thus, implementing direct carbon pricing policies has become more complex. The increasing urgency of addressing the climate crisis, the benefits of diversifying energy supplies, and the need to shore up government revenues have provided an even stronger rationale for introducing new and strengthening existing carbon pricing policies.

*The World Bank Group, "State and Trends of Carbon Pricing 2023", May 2023, (Accessed October 10, 2023), https://bitly.ws/WVoE.

Direct carbon pricing policies are touted as an efficient and effective climate mitigation policy. Carbon price provides an economic signal, allowing markets to determine where emissions can be reduced for the lowest cost. Governments weigh the implications of the different options, in particular, how they will affect consumers (particularly through energy prices), how they will affect government revenue, and the urgency of reducing emissions.

The year 2022 was marked by a global energy crisis that contributed to high inflation and a cost-of-living crisis in many parts of the world. The economic turmoil in 2022 and the COVID-19 pandemic hangover has left many governments facing fiscal pressures. According to the IEA, fossil fuel subsidies hit an all-time high in 2022.

Meanwhile, the urgency of tackling the climate crisis is as strong as ever. Extreme weather events hit most regions of the world in 2022. Many nations forged ahead with climate action, set new climate targets, or progressed concrete policies to reduce emissions in 2022. Despite encouraging signs, the overall ambition of climate policies still falls severely short of what is required, increasing the momentum for direct carbon pricing and making it a central element for many countries' plans to deliver on the Paris Agreement goals.

This important report provides an update on the developments of existing and planned direct carbon pricing policies, focusing on developing **emissions trading systems (ETSs) and carbon taxes**. It also analyzes key developments and trends in **carbon crediting mechanisms and carbon pricing** globally in 2022 until 2023.

First: Carbon Taxes and Emissions Trading Systems

The developments proved the governments' tendency to prioritize direct carbon pricing policies to reduce emissions even in difficult economic times. Economic turmoil and geopolitical instability in 2022 threatened to shift attention away from the urgent need for climate action. Despite these pressures, emissions trading systems and carbon taxes have proven resilient. While some countries directly intervened to keep carbon tax or ETS prices low, most prices remained relatively stable, **as shown below:**

Growth in Prices of ETSs and Carbon Taxes Slowed

Overall, ETSs and carbon taxes have weathered the 2022 global energy crisis relatively well. Half of these instruments saw prices increase, while around a third (those with fixed prices) saw prices unchanged. Fewer than 15% of instruments saw prices decrease[**]. The European Union Emissions Trading System (EU ETS) saw the biggest increases. Only a few countries responded to the political pressures from high energy prices by deliberately lowering carbon tax rates or postponing scheduled increases. Among these countries, Germany postponed the planned price increase until the end of 2023. Sweden has also postponed planned price increases.

By contrast, most jurisdictions did not tone down the ambition of their carbon taxes or ETSs. In some other jurisdictions, prices increased far more than inflation, and national carbon taxes increased in Ireland, Luxemburg, the Netherlands, and Norway.

Several jurisdictions decided to further strengthen existing carbon taxes or ETSs in the coming years. In November 2022, Singapore amended its carbon pricing bill. This will increase the country's carbon tax from its current rate of USD 4-19, starting in 2024. In addition, South Africa has proposed a rising trajectory for its national carbon tax, set to reach at least USD 30 in 2030.

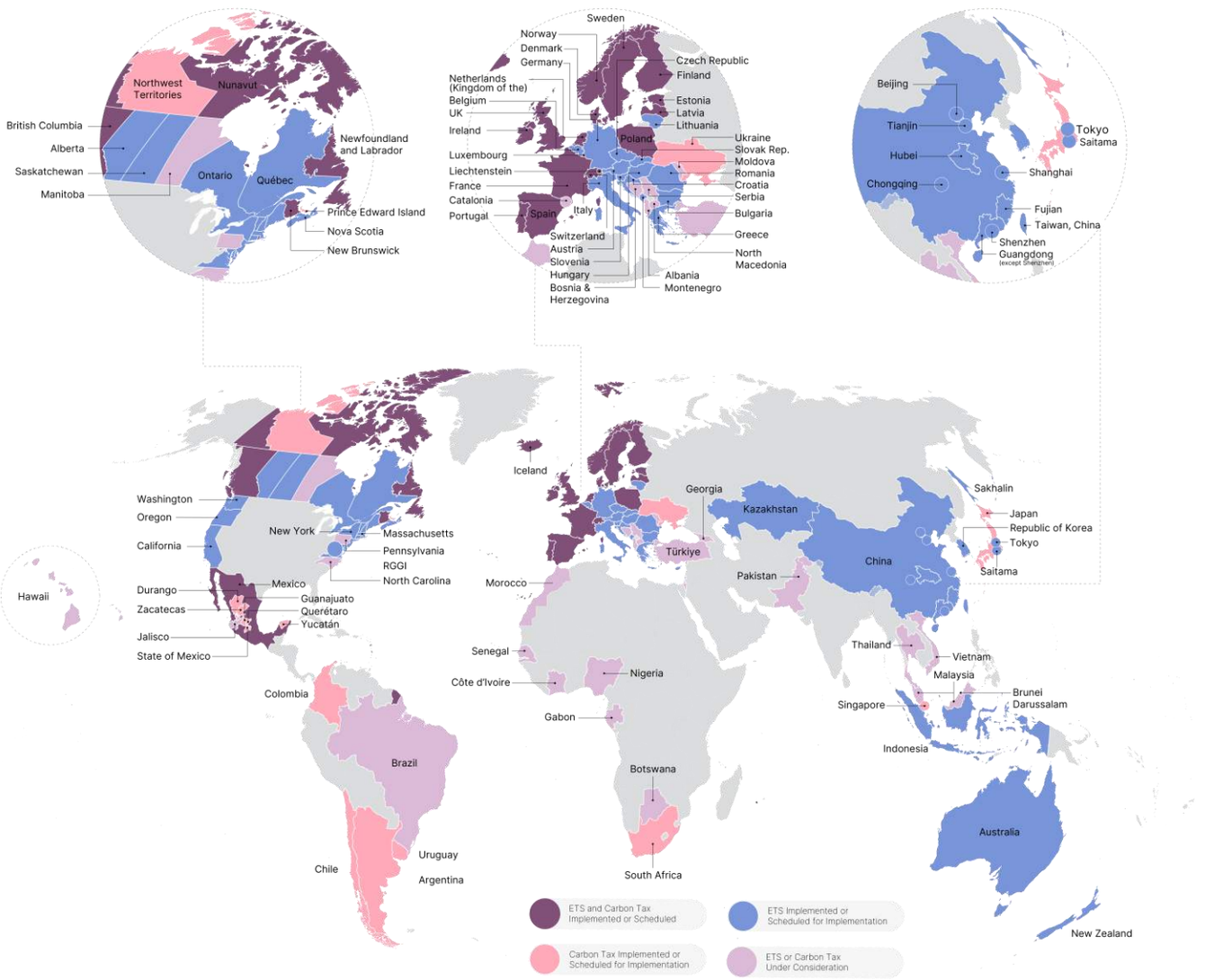
[**]The carbon price level represents the signal power to avoid or eliminate emissions. Higher prices give a greater incentive to further reduce emissions, while lower prices represent less incentive.

Uptake of ETSs and Carbon Taxes Grew Slightly

Notably, there is a growing trend of implementing emissions trading systems and carbon taxes in countries that are already pricing carbon. As of April 2023, 73 carbon taxes or ETSs are in operation. Since April 2022, the net result of developments during 2022 is a minor increase in the share of global GHG emissions that are covered by carbon taxes or ETSs. ETSs and carbon taxes in operation cover around 23% of global GHG emissions, an increase of less than 1% compared with 12 months ago.

Figure 1

Map of Carbon Taxes and ETSs

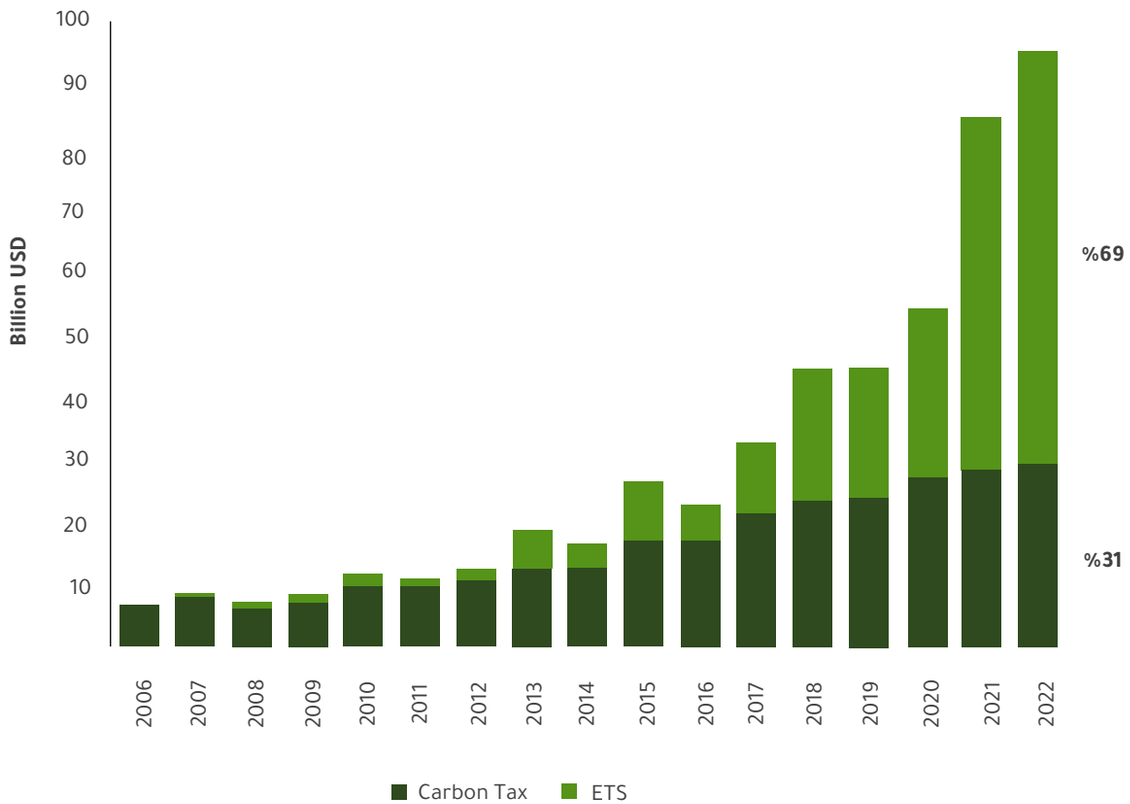


Source: The World Bank Group, "State and Trends of Carbon Pricing 2023", May 2023, (Accessed October 10, 2023), https://bitly.ws/WVoE.

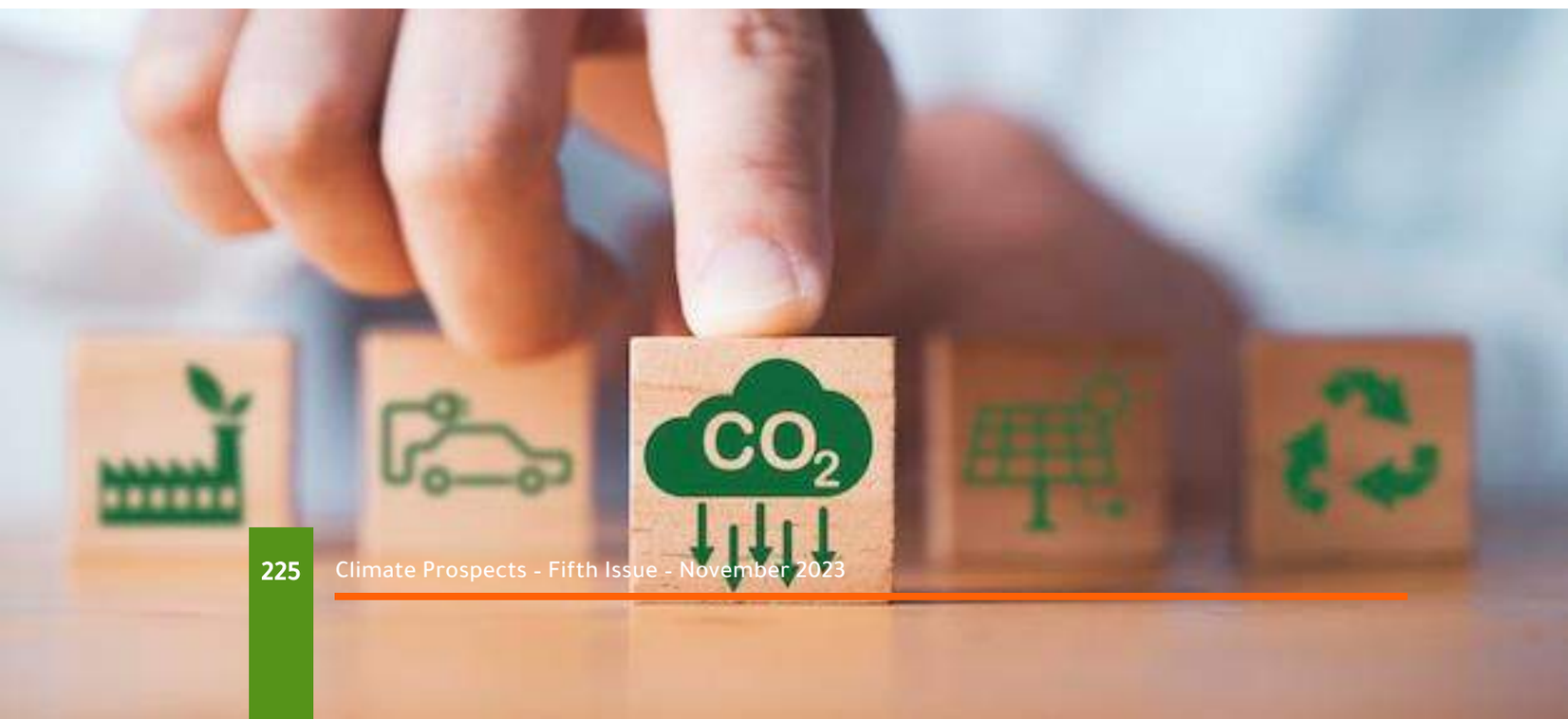
Until now, carbon taxes and ETSs have largely focused on energy and industrial emissions. Most carbon taxes apply to specific fossil fuels, while ETSs mostly focus on stationary energy and large industrial facilities. New Zealand is set to become the first country in the world to price agricultural emissions from 2025, extending carbon pricing beyond traditionally covered sectors.

Figure 2

Evolution of Global Revenues from Carbon Taxes and ETSs (2006-2022)



Source: The World Bank Group, "State and Trends of Carbon Pricing 2023", May 2023, (Accessed October 10, 2023), https://bitly.ws/WVoE.



Furthermore, revenues from carbon taxes and ETSs grew by over 10% in 2022, reaching almost USD 95 billion globally. The vast majority of carbon taxes and ETSs are located in high-income countries in Europe and North America. In 2022, ETSs accounted for 69% of global government revenues from direct carbon pricing, with the remaining 31% from carbon taxes. Although developing countries face particular social, economic, legal, and political barriers to implementing carbon taxes or ETSs, there is increasing interest in carbon pricing policies in these countries.

Figure 3

Map of Carbon Price Levels and Coverage of Implemented Carbon Taxes and ETSs

Source: The World Bank Group, "State and Trends of Carbon Pricing 2023", May 2023, (Accessed October 10, 2023), https://bitly.ws/WVoE.

Second: Carbon Crediting - Markets and Mechanisms

Carbon credit markets trade "carbon credits", which are units generated through voluntarily implemented emission reduction activities. Carbon credits can represent emission reductions achieved through either avoidance, for instance, by capturing methane from landfills or removal from the atmosphere, such as sequestering carbon through afforestation or directly capturing carbon from the air and storing it. Each carbon credit represents 1 metric ton of carbon dioxide equivalent (tCO_2e) reduced or removed. After two years of rapid growth, carbon credit markets slowed in 2022. Supply of new credits and demand from end users both fell slightly. Challenging macroeconomic conditions also impacted carbon credit markets. These headwinds were compounded by prominent public criticism of the integrity of some carbon credits and continued uncertainty around the best-practice use of carbon credits by companies for voluntary purposes. Despite these difficulties, carbon credit markets continue to evolve.

Supply of Carbon Credits Dropped Slightly

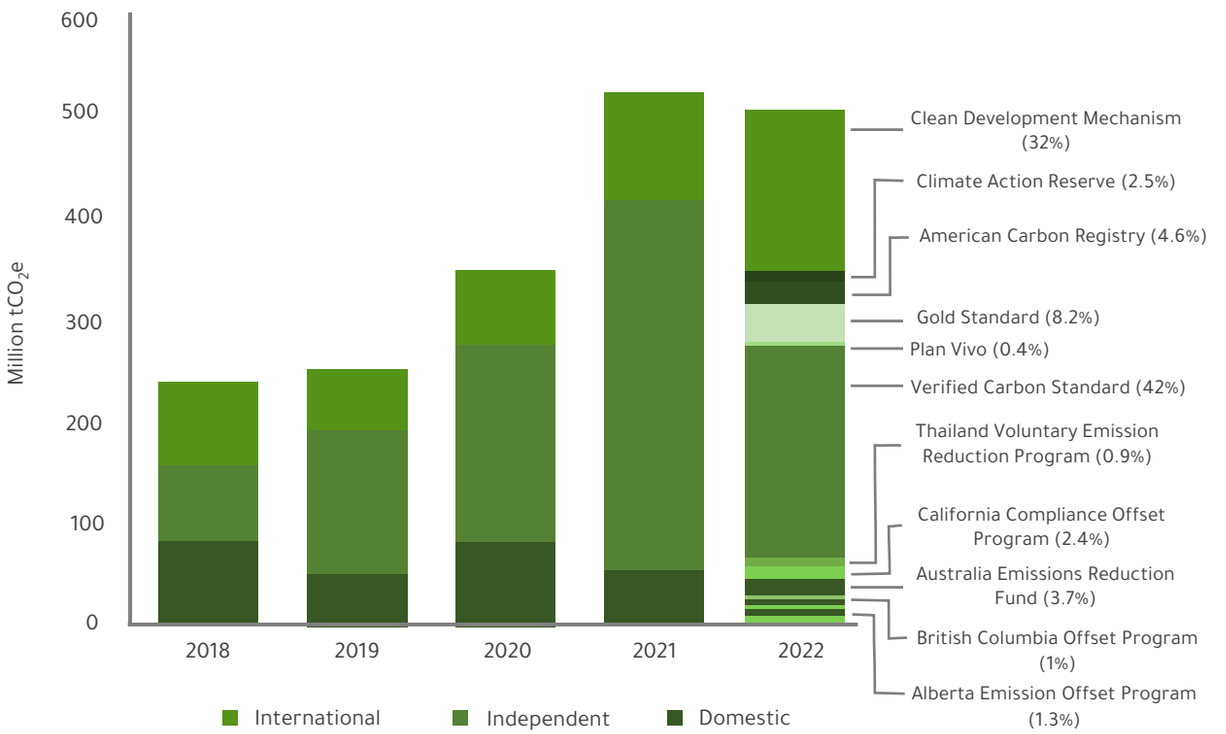
Carbon crediting mechanisms are divided into three types, namely, international crediting mechanisms, independent crediting mechanisms, and domestic crediting mechanisms. Independent crediting mechanisms issued the most carbon credits but saw volumes drop in 2022. Independent crediting mechanisms issued 275 million credits, which accounted for 58% of the 475 million credits issued in 2022. This represented a drop of 22% in credits issued compared with 2021.

However, the supply of credits from international crediting mechanisms grew in 2022, accounting for more than 30% of all credits issued. Domestic mechanisms represent a small portion of total issuances and remained fairly steady in 2022.

Multiple factors are driving the trend toward more domestic supply, including demand from national ETSs and carbon taxes and local voluntary demand for carbon credits or to generate credits under Article 6 of the Paris Agreement. The percentage of credit issuances from renewable energy activities has generally increased since 2018, reaching 55% of credits issued in 2022. The supply of credits from new large-scale renewable energy projects will likely reduce over time. There has been a growing focus on nature-based activities, covering emissions reductions from agriculture, forestry, and land use activities.

Figure 4

Global Volume of Issuances by Crediting Mechanism Type (2018–2022)



Source: The World Bank Group, "State and Trends of Carbon Pricing 2023", May 2023, (Accessed October 10, 2023), https://bitly.ws/WVoE.

Carbon credit markets have the potential to support the deployment and scaling up of technological removals, but only if credit prices increase significantly. Limiting global temperature increase to 2°C or less will require large-scale technological removal of carbon dioxide (CO_2) from the atmosphere. Many of these technologies are currently in the early stages of deployment and cost significantly more than prevailing market prices. Several voluntary corporate-led initiatives were launched in 2022, seeking to support the development of these technologies by making long-term purchase commitments for technological removals.

A survey of more than 500 medium and large businesses across the United States and Europe found that nearly 90% consider carbon credits important to compensate for unabated emissions that they cannot reduce, leading to forecast significant market growth driven by voluntary demand over the next decade.

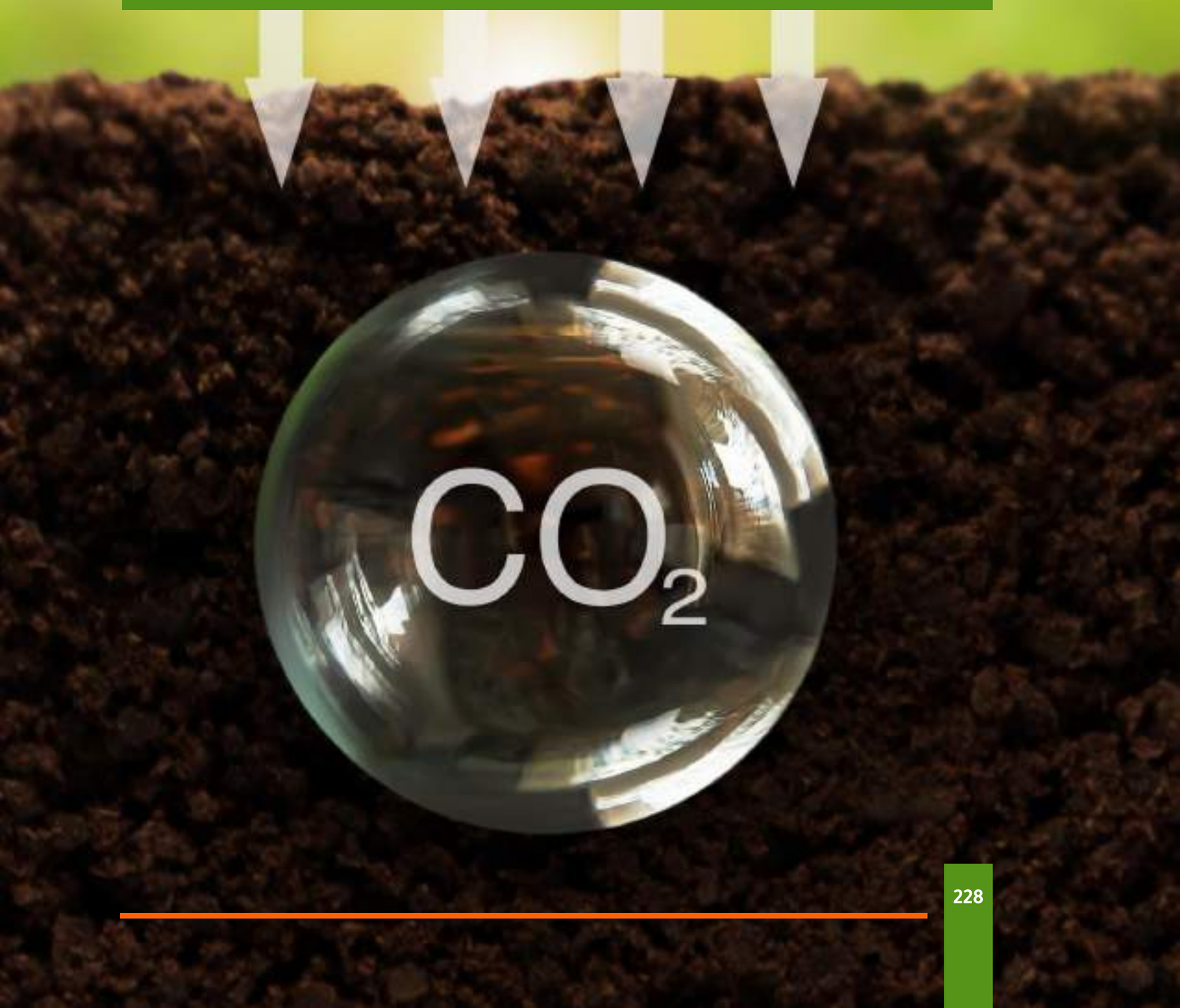
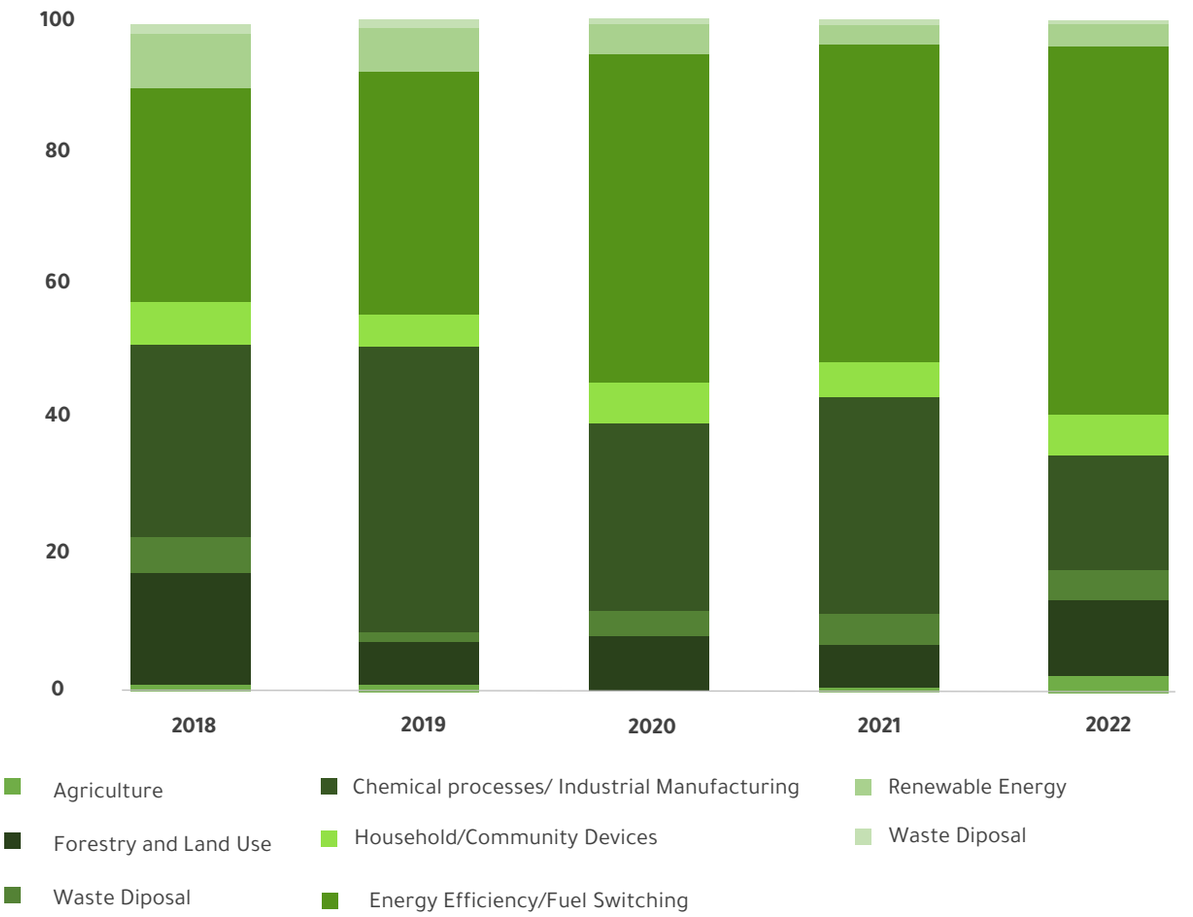


Figure 5

Percentage of Total Issuance by Project Category and Year (%)



Source: The World Bank Group, "State and Trends of Carbon Pricing 2023", May 2023, (Accessed October 10, 2023), https://bitly.ws/WVoE.

Conclusion

Carbon pricing is an important policy tool that can be part of a comprehensive policy package to decarbonize economies. Carbon pricing creates an economic incentive to support changes in investment, production, and consumption decisions. Notably, there is significant heterogeneity in carbon pricing policies in many countries.

Despite economic turmoil and energy price shocks, governments have generally maintained and, in some cases, advanced direct carbon pricing policies. Governments also continued to operate indirect carbon pricing in the form of fossil fuel excise taxes and subsidies worth over USD 1 trillion each year.

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Between Opportunities and Challenges: How Can Climate Science Be Key to SDGs?*

Weather-, climate-, and water-related sciences play a crucial role in achieving the SDGs.

We stand at the halfway mark for achieving the 2030 Agenda for Sustainable Development. With only 15% of the Sustainable Development Goals (SDGs) on track, we are far from meeting global climate goals. In addition, the chance of the mean temperature exceeding 1.5°C for at least one of the next five years is 66%. Urgent and ambitious mitigation and adaptation action is needed.

Worthy to mention, studies have shown that weather-, climate-, and water-related sciences play a crucial role in achieving the SDGs, given having undergone revolutionary advancements. Scientific advancements, satellites, and an increase in observational data have improved the ability to forecast hydrometeorological events with remarkable accuracy. New technologies are revolutionizing the way high-impact weather and water hazards are predicted.

Therefore, the annual report United in Science 2023 was issued to highlight the means to employ those sciences to achieve the SDGs. It also points out the challenges hindering their full and effective utilization. It provides a systematic assessment of the impacts of climate change on SDGs.

*Stuart. L and others. "United in Science 2023", United Nations Environment Programme. Sep 14,2023.

Warning Alarm: The World Urgently Needs to Reduce Emissions Promptly

Human activities associated with the emissions of greenhouse gases (GHG) have unequivocally caused global surface temperature in 2013-2022 to reach 1.15°C, of which 1.14°C can be attributed to human influence. GHG emissions have continued to increase, arising from the use of fossil fuels and the change in lifestyles and patterns of consumption and production across regions.

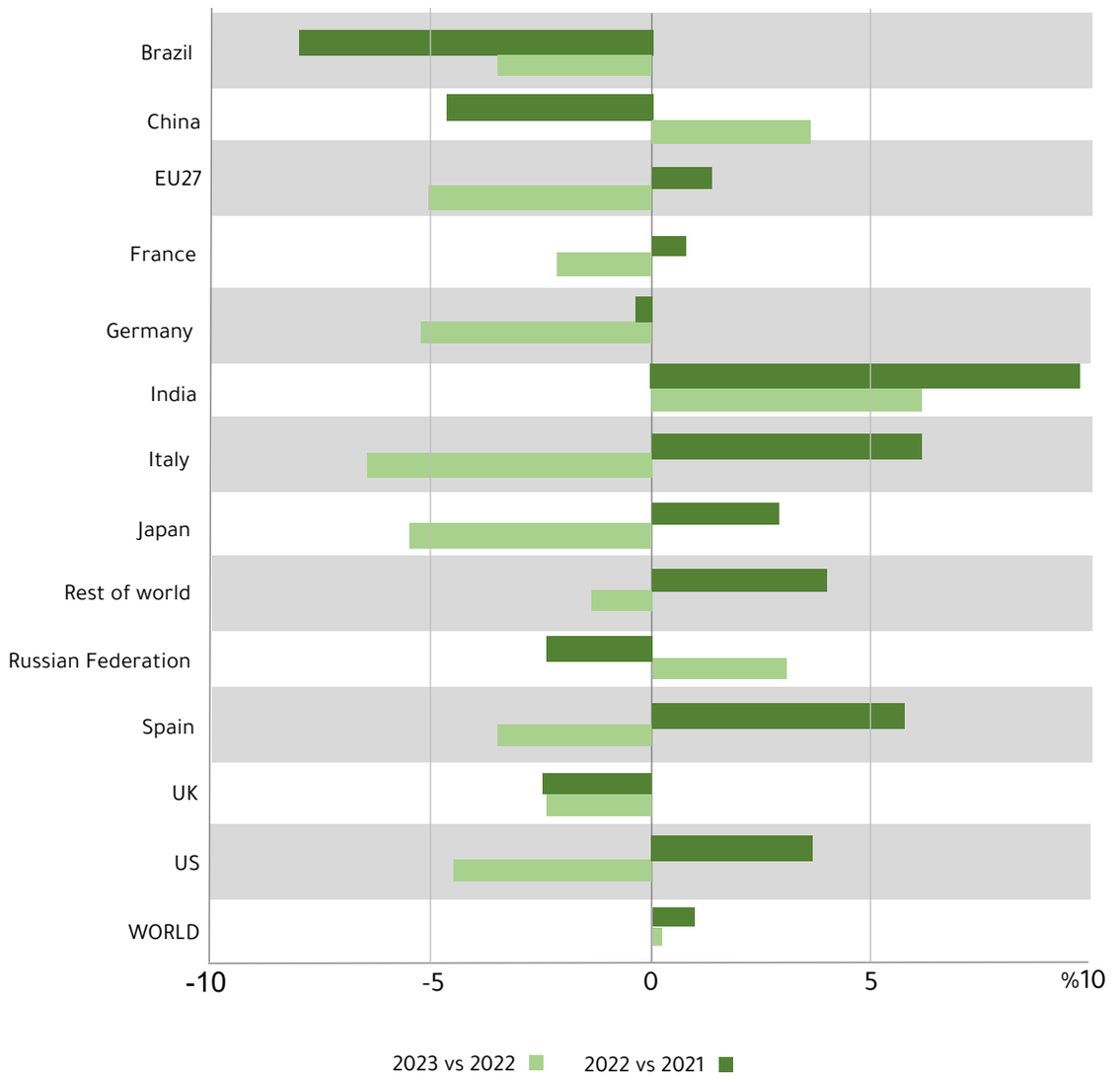
According to the Global Carbon Project, total CO_2 emissions from human activities remained high in 2022, with an estimated 40.6 billion tons of carbon dioxide ($GtCO_2$) emitted. Fossil CO_2 emissions are estimated to have risen 1% in 2022 relative to 2021, primarily driven by growth in oil use as the aviation sector rebounded following the COVID-19 pandemic. Coal emissions increased globally by about 1% in 2022.

The remaining carbon budget compatible with a 50% of chance of limiting global warming to 1.5°C continues to be depleted and has now been reduced to around 250 $GtCO_2$ based on a recent update of the Intergovernmental Panel on Climate Change (IPCC) estimate.

If total CO_2 emissions stay at current levels, this remaining budget would be exhausted before 2030, inexorably leading to an overshoot of 1.5°C global warming.

Figure 1

Preliminary estimates of the percentage change in fossil CO_2 emissions for January to June of 2023 compared with the same period for 2022 and the same comparison for 2022 versus 2021.



Source: Stuart. L and others. "United in Science 2023", United Nations Environment Programme. Sep 14,2023.

Preliminary estimates show that global fossil CO_2 emissions from January to June 2023 were 0.3% above the same period in 2022, as shown in Figure 1, with increased emissions from industry and all transport modes. In contrast, there has been very limited progress in reducing the emissions gap for 2030. It is estimated that current mitigation policies will lead to global warming of around 2.8°C over this century compared to pre-industrial levels. Immediate reductions in GHG emissions are needed urgently to achieve the goals of the Paris Agreement.

Climate Change and Zero Hunger: Negative Repercussions and Survival Opportunities

Climate change negative impacts and the rising GHG emissions will affect various SDGs. For instance, SDG 2 (Zero Hunger), concerned with ending hunger and achieving food security, has been adversely affected by climate change. Projections estimate that nearly 670 million people may still face hunger in 2030 due to more frequent and intense extreme weather events that are disrupting each pillar of food security (availability, access, utilization, and stability). Although overall agricultural productivity has increased, climate change has slowed this growth. Additionally, climate change poses an increasingly significant threat to rural small-scale producers, who are the backbone of global food security.

Additionally, heat and water stress conditions may result in food losses at the production stage, while excess rainfall may cause losses during the harvest and storage stages. Other hazards, such as landslides caused by heavy rainfall, may affect road infrastructure, hindering transportation and access to markets. As a result, food spoilage and waste may pose risks to food safety and consequently threaten food security.

Therefore, the achievement of SDG 2 is strongly connected to climate risk management, particularly along the agrifood value chain. Here comes the role of climate science in enabling farmers to make climate-informed decisions to improve food security.

For example, access to timely, reliable, and actionable data and information allows farmers to better manage agricultural inputs like fertilizer and pesticides, enhance productivity by optimizing crop variety selection and timing of planting, and reduce food losses related to the adverse effects of extreme weather and climate change. Therefore, climate science helps to significantly strengthen adaptive capacity and increase resilience in the agriculture sector, thereby improving food security.

Weather and climate services include relevant and timely information for agriculture. Weather-informed agricultural advisories help reduce the impacts of weather extremes during the agricultural season. Additionally, countries need adequate early warnings for food security to respond ahead of extreme weather events, such as floods and droughts, which disrupt and threaten food security.

For example, drought early warning systems can inform governments and humanitarian organizations of potential food security crises to support timely action before the situation develops into famine.

However, major challenges remain to ensure all countries and people have access to multi-hazard early warning systems. Challenges around data collection and exchange and monitoring of weather, climate, and agronomic information persist as well. Examples include insufficient weather and agrometeorological stations to collect ground data, interrupted monitoring, variable quality of data from agricultural fields, and insufficient long-term and high-quality climate forecasts for agricultural decision-making.

Moving forward, continued operational observations, particularly in lower-income countries, are urgently needed to improve weather forecasting and climate projections to support agricultural decision-making.

Good Life and Well-Being under the Microscope

SDG 3 seeks to ensure healthy lives and promote well-being for all. The pathway to achieving many of the SDG 3 targets is influenced by climatic conditions. Climate change and extreme events are projected to significantly increase ill health and premature deaths, as well as population exposure to heat waves and heat-related mortality.

Moreover, the global trend of rapid urbanization puts more people at risk of adverse health outcomes, as existing vulnerabilities to climate change may be aggravated in urban contexts. Climate change is also further threatening progress towards global universal health coverage (UHC) through healthcare system disruptions. Research and data that can help us to understand, monitor, and even predict health risks can be critical contributions to achieving SDG 3 targets through several mechanisms, such as the following.

The integration of health data with weather- and climate-related information: This mechanism can inform health policy to understand and monitor climate-sensitive communicable diseases and non-communicable diseases. Using seasonal climate outlooks, risk assessments can help to identify communities at greatest risk.

Heat health warning systems (HHWSs): They are an important climate service grounded in weather and climate science. An alarming number of preventable deaths and illnesses from extreme heat are occurring as global temperatures continue to rise. A recent epidemiological modeling study found that an additional 60,000 people died across Europe due to extreme heat during the summer of 2022.

HHWSs use weather and climate forecasts to provide public advisories and initiate public health interventions. These early warnings reduce health risks before, during, and after periods of extreme heat and contribute to achieving progress toward ensuring healthy lives and well-being for all.

Climate science and services: GHG emissions threaten health; hence, there is a clear need to systematically build resilience as well as to reduce GHG emissions across the health system. Climate science and services can provide evidence on past, present, and future climate risks and health vulnerabilities to identify the most effective options for transitions and investments in health systems capable of confronting climate change.

Although weather-, climate-, and water-related sciences play a crucial role in supporting good health and well-being, only 48% of National Meteorological and Hydrological Services provided tailored climate products and services to the health sector. To close this gap, enhancing collaboration between the weather, climate, water, and health science communities will be crucial to detect and monitor climate-related health risks. As a result, governments can devise policy options that minimize the effects of weather, climate, and water variability and change on public health, as well as implement effective mitigation strategies across the health sector.

Climate Science: Pathway to Universal Access to Drinking Water

SDG 6 encompasses targets such as achieving universal and equitable access to safe and affordable drinking water. Although water security is critical for meeting all SDGs, global warming will exacerbate water-related hazards. Floods can disrupt water supply systems and cause damage to sanitation infrastructure. In addition, more frequent droughts can lead to water scarcity, affecting water availability for people and ecosystems.

Climate science and services provide essential insights into hydrological conditions and inform decision-making processes to advance progress towards achieving SDG 6. Science allows us to collect and analyze data on various aspects of water resources, including rainfall patterns, river flow, groundwater levels, water quality, and aquatic ecosystems. Analyzing water samples can help identify pollutants, assess contamination levels, determine potential risks, and develop protective measures to safeguard water resources.

Scientific and technological advances, such as artificial intelligence (AI) and satellite technology, provide opportunities to enable the development of data-driven water management policies. Drones equipped with specialized sensors and cameras enable efficient environmental monitoring and infrastructure inspections. Additionally, satellite data support monitoring water consumption and identifying patterns and anomalies for informed decision-making.

Historical climate information is used to project future climate change. This information helps assess how these changes might affect water availability and increase the frequency of extreme hydrological events, such as floods and droughts. Decision-makers can use this information to implement climate change adaptation measures and develop water management strategies.

However, this requires bridging gaps on how to use such sciences in making informed decisions. For example, the lack of accessible and verified hydrological data is a significant challenge, with more than 60% of countries facing inadequate and declining hydrological monitoring capabilities. This lack of data results in knowledge gaps and ineffective policymaking and limits progress toward achieving SDG 6.

International Recommendations: How Can Other SDGs Be Achieved?

SDG 7 targets providing access to clean and affordable energy to all. SDG 7 is crucial for the achievement of many SDGs. Clean and affordable energy enables productive and sustainable agriculture and food production (SDG 2: Zero Hunger), provides electricity to social infrastructure such as healthcare, educational and water/sanitation facilities (SDG 3: Good Health and Well-being, SDG 4: Quality Education, SDG 6: Clean Water and Sanitation), and supports responsible industrial and service production (SDG 12: Responsible Consumption and Production).

SDG 7 also supports diverse economic activities, leading to economic growth, and provides decent jobs in the clean energy sector (SDG 8: Decent Work and Economic Growth). Additionally, sustainable industrialization requires reliable energy systems with limited environmental impacts (SDG 9: Industry, Innovation, and Infrastructure), and growing cities need large amounts of affordable and clean energy (SDG 11: Sustainable Cities and Communities).

Despite its importance and interconnection to other various SDGs, climate change-induced changes, including changes in wind speeds and patterns, impact energy generation by renewable resources.

Therefore, weather-, climate-, and water-related sciences are essential for supporting sustainable energy, including planning and development of renewable energy and operation and management of energy systems. Information on renewable energy resources, such as solar radiation, wind speed, and biofuel resources, can be built into nation al and international atlas tools and support investment decisions by identifying strategic locations for renewable power and grid development. Within context, information on renewable energy resources, such as solar radiation, wind speed, and biofuel resources, can be built into national and international atlas tools and support investment decisions by identifying strategic locations for renewable power and grid development. This contributes to improving decision-making for a low-carbon future.

Weather and climate also impact energy demand. Hot/humid climate and weather lead to summer energy peaks as demand for cooling increases, while dry and temperate/continental climates experience peak heating demand in winter. High-resolution weather and climate data and forecasts can help inform energy planning based on projected demand.

Precise supply-demand forecasts enhance the operations and management and increase the profitability of electricity supply businesses by reducing excess or shortage of supply, while contributing to grid stability by informing grid operators accurately about flexibility needs. However, challenges remain, particularly related to data quality, accessibility, and affordability.

For example, more granular geospatial and temporal data enable enhanced modeling and analysis for sustainable energy systems in low-income. Nevertheless, the availability of analytical tools, expertise, and large processing capabilities for generating and using this data remains a significant challenge. Access to data also remains a challenge, particularly in lower-income regions. Where open data sources do exist, they often lack higher resolutions.

In the backdrop of challenges facing the utilization of weather-, climate-, and water-related sciences in achieving the SDGs, the United Nations General Assembly introduced in August 2023 numerous recommendations to overcome such challenges:

- **Close the gaps in weather, climate, and hydrological observations and data:** Investing in systematic observations and promoting the free and unrestricted exchange of data is crucial to enhancing our understanding of the Earth system and strengthening weather-, climate-, and water-related sciences and services in support of achieving the SDGs.

- **Advance research and expand access to science, technology, and innovation:** Scaling up integrated weather-, climate-, and water-related research will close existing knowledge gaps and advance emerging technologies, such as high-resolution modeling, artificial intelligence, and nowcasting, that can support the SDGs when made accessible.

- **Strengthen scientific capacity and skills through education and training:** Enhancing scientific capacity, especially in lower-income countries, will support innovation and improve the use of climate science to ensure national sustainable development policies, plans, and actions are grounded in best-available science.

- **Embrace local, contextual, and Indigenous knowledge:** Enhancing participatory, user-driven approaches, such as citizen science and co-production, supports integration and legitimization of local, contextual, and Indigenous knowledge to translate climate science into on-the-ground impact for the SDGs.

- **Unite diverse stakeholders to boost the impact of science:** Mobilizing multidisciplinary collaboration with diverse stakeholders - including scientists, the private sector, civil society, youth, local communities, governments, and others - is essential to improve the effectiveness of weather-, climate-, and water-related science and accelerate progress towards achieving the SDGs.

In conclusion, unprecedented advances in weather-, climate-, and water-related sciences remain underutilized in support of sustainable development but must be accelerated and scaled up. The world has the solutions to achieve the SDGs - now is the time to mobilize the scientific community to supercharge SDG implementation.

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Global Trends in Climate Change Litigation: 2023 Snapshot

While much more work is needed to trace the full impacts of litigation over time, it is clear that it remains an important force in global and domestic climate governance.

At least 2,341 cases related to climate change have been captured in the climate litigation databases of the Sabin Center for Climate Change Law -affiliated to Columbia Law School- and Arnold & Porter. A total of 190 of which were filed from June 1, 2022, to May 31,2023. Around two-thirds of the total cases (1,157) have been filed since 2015, the year of the Paris Agreement. That year saw the start of a new wave of litigation characterized by increasing diversity in the range of legal arguments used and the geographical spread of the cases.

Data from the last few years suggests that growth of climate change litigation cases may be slowing. In the calendar year 2021, 266 new cases were filed, while this figure was 222 in 2022. This data was mentioned in the Global Trends in Climate Change Litigation: 2023 Snapshot* report issued by the Grantham Research Institute on Climate Change and the Environment and the Centre for Climate Change Economics and Policy. This report reviews key global developments in climate change litigation, with a focus on the period June 2022 to May 2023, highlighting the most important future trends in climate change litigation.

*Setzer, J. C. Higham, "Global Trends In Climate Change Litigation:2023 Snapshot." The Centre for Climate Change Economics and Policy & The Grantham Research Institute on Climate Change and the Environment, June 29, 2023.

Cases have been filed in at least 51 countries from across every region of the world. Cases have also been filed before international or regional bodies and courts. In the past year, cases from seven new jurisdictions were added to the global database: Bulgaria (first case filed in 2021), China (first case filed in 2016), Finland (first case filed in 2022), Romania (first case filed in 2023), Russia (first case filed in 2022), Thailand (first case filed in 2022), and Turkey (first case filed in 2021).

The United States remains the country with the highest number of documented climate cases, with 1,590 cases in total. Next is Australia, where 130 cases have been identified, and the United Kingdom, where 102 cases have been identified. A total of 67 cases have been filed before the Court of Justice of the European Union. Relatively high numbers of cases have also been documented in Germany (59), Brazil (40), and Canada (35).

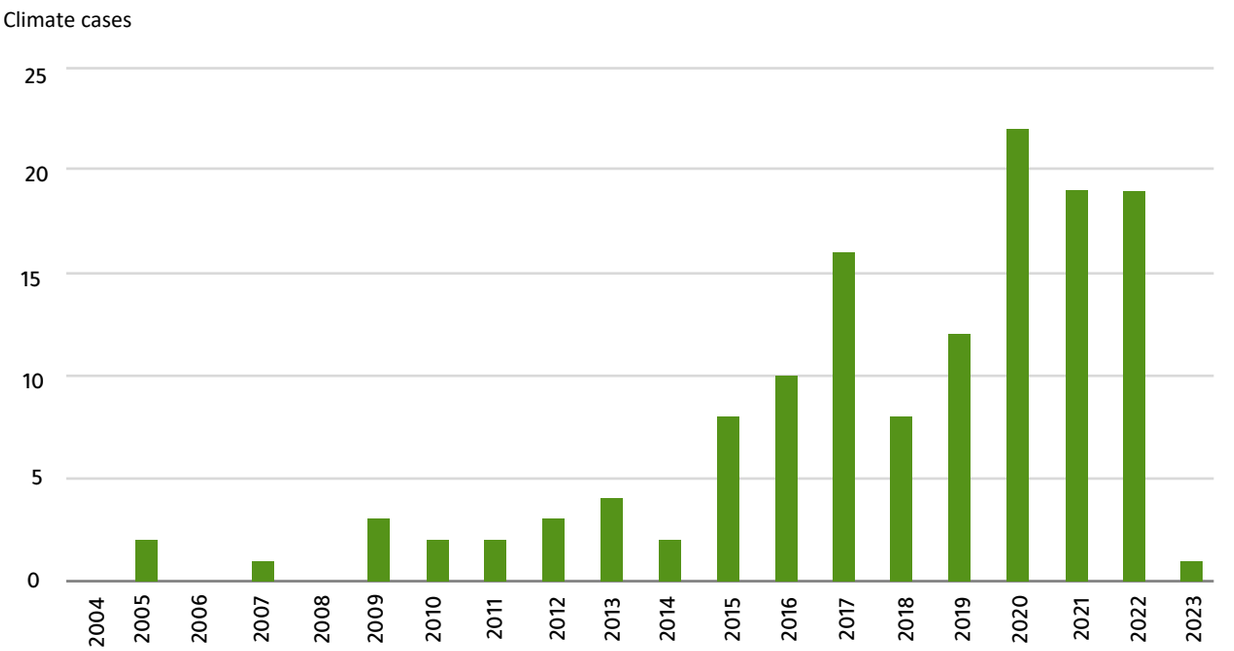
NGOs and Individuals: Key Actors in the Climate Change Litigation Rise

Historically, most climate cases have been filed in the Global North. However, recent years have seen a growth in cases filed before courts in the Global South. Overall, 135 cases from the Global South have now been captured in the database, with more than 50 of those filed since 2020, as shown in Figure 1. Among the most important trends specific to Global South climate litigation are the innovative use of human rights arguments, particularly arguments relying on the right to a healthy environment, and cases seeking to address gaps in the enforcement of pre-existing environmental legislation aimed at preventing environmental degradation. Such arguments have been most frequently used before Latin American courts but also in Africa and to a lesser extent in Asia.

Although the vast majority of climate cases are filed before domestic courts and the courts of the EU, there have been at least 50 cases or complaints filed before 11 international and regional courts and tribunals, UN Treaty Bodies, and others. Around 20 of these cases have been filed before human rights bodies, while 12 have been filed before Investor-State Dispute Settlement (ISDS) bodies under International Investment Agreements. Ten of the remaining cases were complaints under the noncompliance procedure of the Kyoto Protocol, filed between 2009 and 2018.

Figure 1

Number of climate litigation cases in the Global South over time (2004 up to May 31, 2023)



Source: Setzer, J. C. Higham, "Global Trends In Climate Change Litigation:2023 Snapshot." The Centre for Climate Change Economics and Policy & The Grantham Research Institute on Climate Change and the Environment, June 29, 2023.

> From June 2022 to May 2023, four new cases have been filed before international bodies. These include three requests for advisory opinions from international courts and one complaint requesting that prosecutors from the International Criminal Court investigate the Board of British Petroleum (BP) for its role in climate change.

Nearly 90% of the cases filed from June 2022 to May 2023 outside the US have been brought by non-governmental organizations (NGOs), individuals, or both acting together. In the US, the percentage remains lower, with just over 70% of cases brought by these actors and 13% of US cases filed in the last year brought by corporations and trade associations.

The increasing number of global cases filed by NGOs and individuals largely mirrors the increase in strategic and semi-strategic climate cases filed in recent years, showing that litigation continues to be used as a tool for groups that tend to be excluded or who are unsatisfied with climate governance decisions to try to get a seat at the negotiating table.

Strategic Litigation Standards and Its Increase against Companies

It is increasingly understood that climate change litigation is being used strategically as a tool to influence policy outcomes and/or to change corporate and societal behavior. Defining a case as strategic is subjective. This study considers the following key components when classifying a case as strategic. Where some but not all of these factors are present, cases are considered semi-strategic; however, the study counts semi-strategic and strategic cases as one group given that they share more similarities than differences. The key components are:

Identity of the plaintiffs: In strategic litigation, the plaintiffs are selected to communicate a carefully designed message. Most cases of strategic climate litigation are filed by an NGO, individual campaigner, a Member of Parliament, or political party. Some researchers have referred to litigation plus, an approach whereby the NGO and its lawyers work with communities to develop legal strategies around their concerns. Others use the term movement lawyering to emphasize the importance of co-creating strategic litigation with affected communities. Claimants are usually represented by an experienced legal team with a track record of bringing other strategic legal interventions.

Identity of the defendants: Strategic climate litigation has targeted actors that make the largest direct contribution to the problem (e.g. governments that can legislate and the largest emitters of CO_2). In addition to the obvious suspects, strategic litigation can be brought against actors that are not so visible but are crucial for the survivability of the value chain, such as the public authorities that grant the licenses and permits necessary for high emitters to carry out core activities and the financial institutions that provide the necessary capital for high emitters to develop their core activities.

Aim of the litigation: Strategic litigation sees advocates using climate litigation to drive ambition in climate action, taking a long view beyond the immediate success or failure of individual cases. Strategic cases seek remedies that extend beyond the situation of individual litigants and contribute to intended policy and regulatory impacts. Objectives for litigation might differ when comparing Global South jurisdictions with rich or developed countries, and in any one country, the strategies might change quite significantly depending on the directions established by national leaders.

If **the case is one piece of a larger puzzle:** Strategic litigation is part of a broader advocacy strategy of one or several organizations. Thus, it is possible to observe that the lawsuit complements or focuses on specific aspects of messages that will be raised by one or a group of organizations outside the courts. These efforts will be carried out by NGOs pressurizing legislators and policymakers or sending letters to targeted companies.

The climate litigation movement is also part of an emergent transnational climate litigation network that generates ideas and facilitates intellectual and financial resources to litigants. Media coverage and a communications campaign are often another part of this larger puzzle.

In addition, strategic litigation against companies is an area of increasing interest to many actors. The number of strategic cases challenging corporate action has started to diversify, with cases filed in new geographies and against companies in a wide range of sectors.

Cases are focused on companies, financial institutions, and trade associations in recognition of the fact that these organizations often have a significant influence on climate action, often to the serious detriment of citizens.

When analyzing all cases filed against companies between the start of 2015 and the end of 2022, we observe that 80% can be classed as strategic or semi-strategic. The year 2021 saw the highest number of corporate cases filed to date, with more than 30 cases so far identified. One of the reasons for this trend appears to be a significant increase in climate-washing cases - that is cases seeking to hold companies accountable for claims about the climate-friendliness of their operations or services.

Part of the shift may also be attributable to the identification of new pressure points within corporate value chains, particularly regarding the provision of finance for high-emitting activities. There is a growing effort to understand the unique aspects of climate litigation across the corporate world. For example, a new global initiative examining the unique aspects of climate litigation across the corporate world was launched in this last year.

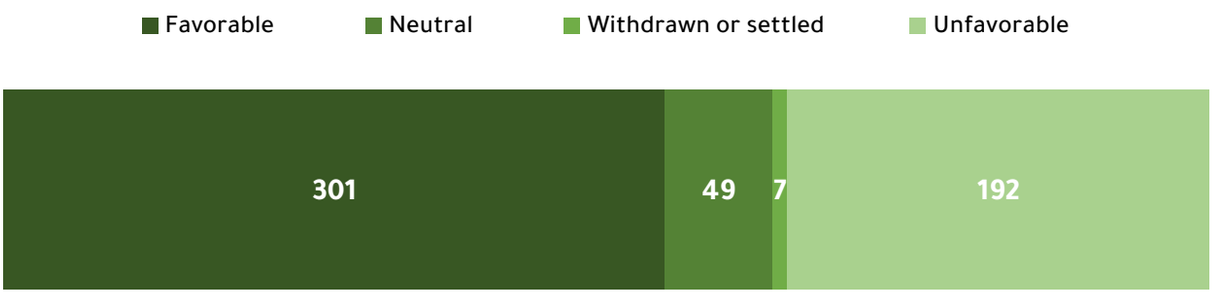
Direct and Indirect Impacts of Climate Litigation

Climate litigation may have direct impacts, where the result of the case results in a statement of law that requires a change in the behavior of the defendant and potentially similar actors of the same behavior. It can also have indirect impacts, where the case results in increasing costs and risks for actors, changes in public awareness, or changes in policy. Both impacts are represented by:

Direct Impacts

Judicial outcomes: Around 55% of the 549 cases in which either an interim or final decision has so far been rendered have had outcomes that are favorable to climate action, as shown in Figure 2. Cases are classified as neutral when it is not possible to assess whether the judgment would have a positive or negative impact on climate action. Cases may also be assessed as positive even where not all grounds argued by the claimants were successful.

Figure 2
Outcomes in global climate litigation



Source: Setzer, J. C. Higham, "Global Trends In Climate Change Litigation:2023 Snapshot." The Centre for Climate Change Economics and Policy & The Grantham Research Institute on Climate Change and the Environment, June 29, 2023.

Indirect Impacts

Amplifying climate risk: Finance is one sector that is starting to take considerable interest in the issue of climate change litigation. The increasing volume of evidence showed that actors external to the core community of climate litigation practitioners were starting to take the phenomenon of climate change litigation seriously. New stakeholders have been engaging with climate litigation from June 2022 to May 2023, including the Climate Financial Risk Forum (CFRF), a joint initiative by the Prudential Regulation Authority (PRA) and the Financial Conduct Authority (FCA) in the UK that brings together senior financial sector representatives to share their experiences in managing climate-related risks and opportunities.

Impacts on firm value: As the issue of climate change litigation becomes increasingly visible for investors, an important question is whether markets are systematically taking climate litigation risks into account. A recent interdisciplinary study has assessed whether climate litigation systematically causes defendant corporations' stock prices to fall and to what degree. It found that filing or an unfavorable court decision in a climate case reduces firm value by -0.41% on average, relative to expected values.

Shaping narratives: Much of the literature on the impacts of climate litigation has focused on the way that the existence of a climate case may influence decision-making processes, even if the case itself is unsuccessful in the face of procedural or doctrinal hurdles. These cases are described as "shaping narratives". From June 2022 to May 2023, new developments emerged that may be examples of this phenomenon in operation. In 2021, ClientEarth took the Belgian National Bank to court over its implementation of a European Central Bank (ECB) corporate bond purchase scheme. Many of the bonds purchased were effectively supporting the high emitting activities of some of Europe's most polluting companies. ClientEarth argued that this was inconsistent with Europe's climate objectives and the Paris Agreement.

The case was initially dismissed on procedural grounds. It was then appealed by ClientEarth but the NGO issued a press release in November 2022 noting it had withdrawn the case, after the ECB updated its policy to ensure that new bond purchases were tilted towards climate-friendly activities in a bid to align with the Paris Agreement. While the exact relationship between the case and the ECB's decision remains unclear, it provides another example of the way in which even unsuccessful cases can potentially have an influence on climate governance.

Climate Litigation Future Trends

Biodiversity-climate nexus and the importance of carbon sinks: Litigation seeking deforestation-free supply chains is likely to increase with legislative developments requiring corporate actors to carry out enhanced due diligence throughout their operations and value chains. On the biodiversity-climate nexus, litigation challenging carbon sinks is another area where we might see an increase in litigation. Arguments about the protection of carbon sinks under domestic climate legislation have started to emerge as a theme in countries including Sweden, Germany and Finland from June 2022 to May 2023.

Focus on the ocean: In addition to the focus on terrestrial carbon sinks, litigation may increasingly focus on the ocean, the world's largest carbon sink. Current estimates suggest that the ocean absorbs more than a quarter of human-caused greenhouse gas emissions and about 90% of the excess heat caused by greenhouse gas emissions already in the atmosphere. To date, climate litigation involving the oceans has tended to focus on two types of argument. Firstly, litigants have used arguments grounded in protections for ocean ecosystems and the communities that depend on them. Secondly, cases have emphasized the damage that changes to the ocean and its ecosystems caused by climate change are having on communities.

Extreme weather events - beyond climate litigation: As the impacts of climate change manifest in increasingly frequent and severe extreme weather events, the world is seeing growth in the number of claims arising in the wake of such events. There has also been a wave of further litigation in the wake of Winter Storm Uri in 2021, which although not directly focused on climate issues may have significant impacts on how the outcomes of climate-related disasters are understood.

Short-lived climate pollutants: Investigations and lawsuits could be brought against entities involved in the illegal trade in hydrofluorocarbons. Lawsuits might also be filed against government agencies or businesses with regard to black carbon soot or tropospheric ozone. Nuisance cases could also be potentially filed against farms that emit methane and ammonia. These lawsuits can be based on existing tort or human rights laws and regulations related to pollution and environmental protection as well as on specific environmental legislation that seeks to hold polluters accountable for the damage they cause to the climate.

Inter-state litigation: The analysis suggests that most climate cases before international courts to date consist of cases filed before human rights bodies or of investor-state arbitrations. While such disputes invoke international law, they are not typical international law disputes, as they are not concerned with the obligation that one state owes to another, but rather public and private law obligations that states owe to individuals or corporations. As momentum grows behind requests for advisory opinions from international and regional bodies, questions emerge on the possibility of inter-state cases with climate issues at their center being filed before international and regional bodies.

In conclusion, the analysis of trends in climate litigation from June 2022 to May 2023 confirms that the field of climate change litigation has continued to diversify, with an increasing number of strategic cases brought against corporate actors and financial institutions. The report also observes significant transnational exchange in this area of law, with both lawyers and judges looking beyond national borders for ideas.

Numerous new developments suggest that climate litigation is having an impact both within and beyond the courtroom. The overall body of direct outcomes in global climate cases tilted in favor of climate action and also new stakeholders engaging with the phenomenon of litigation. While much more work is needed to trace the full impacts of litigation over time, it is clear that it remains an important force in global and domestic climate governance.

Promoting Adaptation to Climate Change in Health Sector: China as a Model*

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Climate change affects population health through direct and indirect pathways. On the one hand, the rising global temperatures caused by climate change are resulting in longer and more frequent heatwaves, which can lead to heat exhaustion and dehydration. On the other hand, extreme weather events are causing mental health issues and physical injuries.

Climate change is one of the most pressing issues facing society worldwide. As documented by the State of the Global Climate 2022 report, the past eight years have seen the highest global mean temperature on record. Unprecedented levels of heat-trapping greenhouse gases (GHGs) are causing changes in the atmosphere and in the oceans. However, the impacts of climate change on health have not received enough attention in international literature or climate change adaptation policies. Nonetheless, climate change is predicted to lead to more than 250,000 deaths globally per year by 2050.

As one of the countries most impacted by climate change, China has experienced a significant increase in health challenges caused by climate change. In fact, extreme weather events and fluctuating temperatures led to the spread of infectious and non-communicable diseases and impacted the mental health of the Chinese population.

This report, issued by the World Economic Forum in collaboration with the Rockefeller Foundation, affirms the urgent need to tackle climate change's impacts on health and promote the health sector's ability to adapt to climate change.

*World Economic Forum, The Rockefeller Foundation, "Better Climate, Better Health: Using Precision Public Health Tools to Tackle Climate-Sensitive Diseases in China." September 2023.

In addition, the report sheds light on the health crises caused by extreme weather events in China and the most prominent efforts and successes made by the Chinese government in promoting climate change adaptation in the health sector.

Climate Change: Main Factor in Declined Public Health Levels

As shown in Figure (1), climate change affects population health through direct and indirect pathways. The rising global temperatures caused by climate change are resulting in longer and more frequent heatwaves, which can lead to heat exhaustion, dehydration, and even death. Higher temperatures also contribute to the spread of infectious diseases, such as malaria and dengue fever, as disease-carrying mosquitoes and ticks expand their geographic range. Climate change is also disrupting local ecosystems, leading to unpredictable changes in the distribution and availability of food, causing malnutrition and undernourishment.

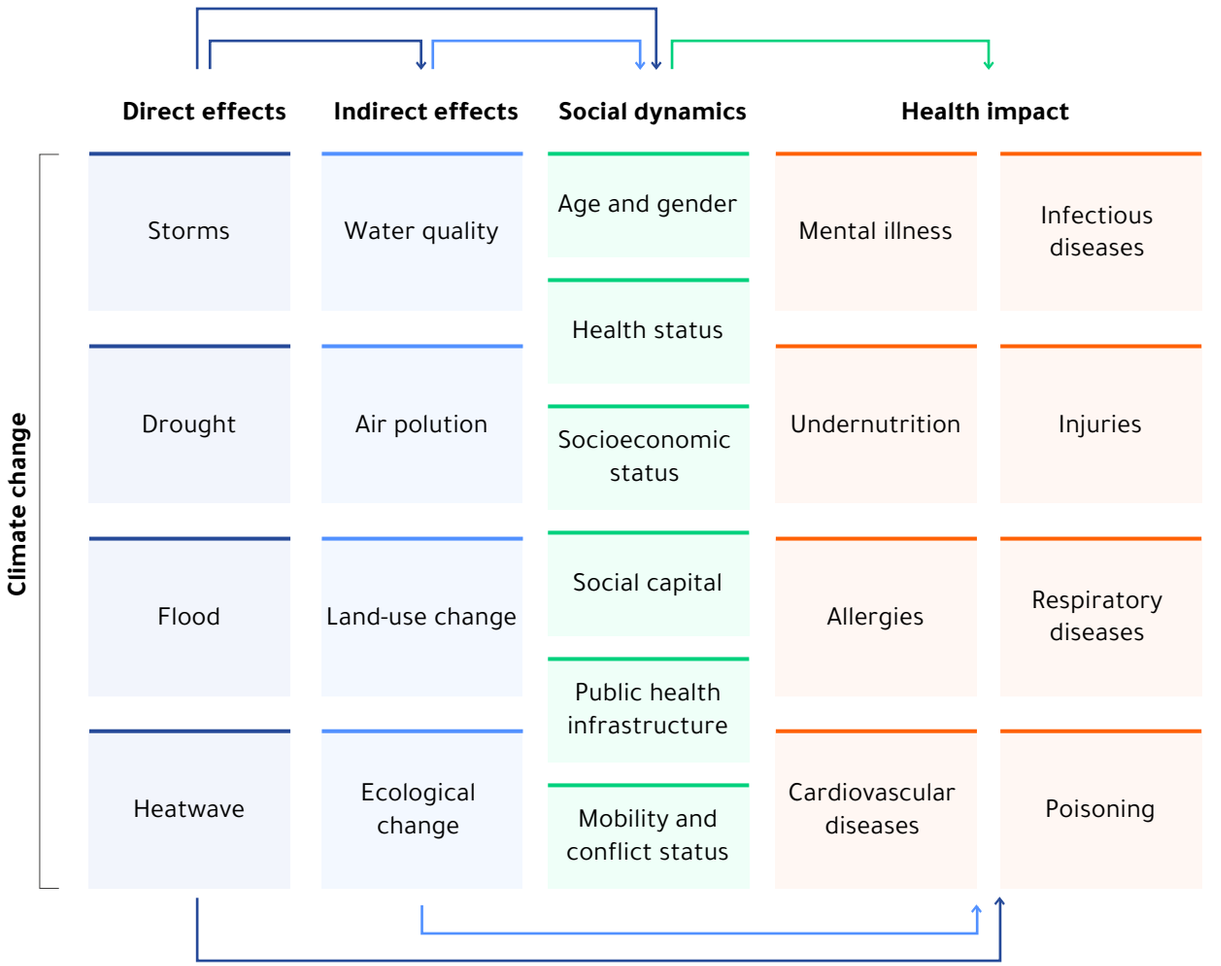
The indirect effects of climate change are particularly challenging to predict due to their lengthy causal chains. The ramifications can often last a lifetime. For example, extreme weather events are becoming more frequent and severe, causing physical injuries, mental health issues, and displacement of populations.

More importantly, the health impacts of climate change could be exacerbated by interactions with other non-climatic factors (e.g., socioeconomic status and gender). Vulnerable populations, such as elderly people, children, and low-income communities, are disproportionately affected by the health impacts of climate change because of heightened physiological sensitivities, greater exposure, or less capacity to take protective action.

Studies show that the worldwide burden of climate-sensitive diseases (CSD) in 2019 was 39.5 million fatalities (69.9% of all deaths in the year). Cardiovascular diseases (CVDs) made up the majority of these CSDs, accounting for 32.8% of mortalities. Following this are respiratory diseases, with chronic respiratory disease, respiratory infection, and tuberculosis contributing to 7% and 6.5% of deaths, respectively.

Figure 1

The direct and indirect effects of climate change on health and well-being



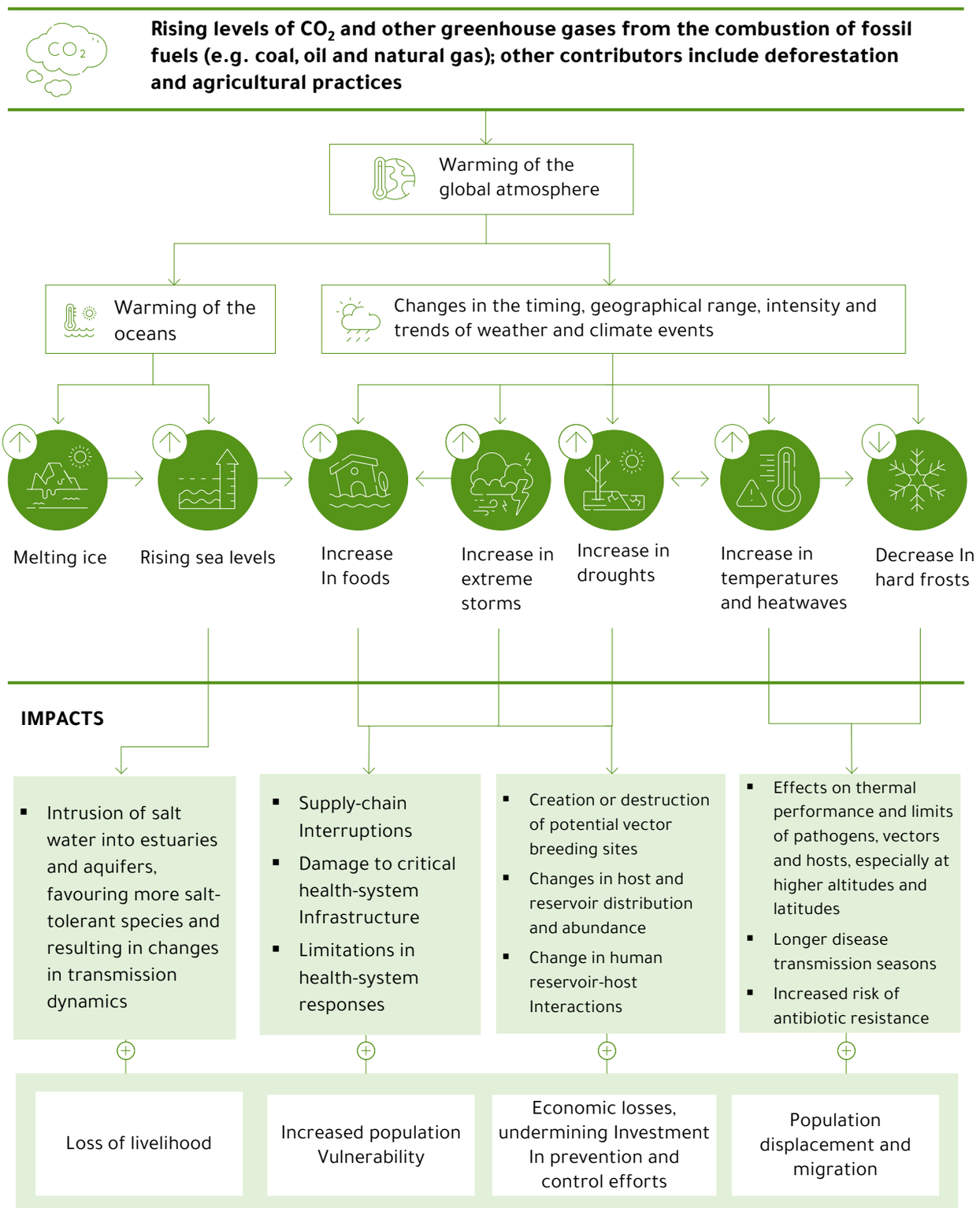
Source: World Economic Forum, The Rockefeller Foundation, "Better Climate, Better Health: Using Precision Public Health Tools to Tackle Climate-Sensitive Diseases in China." September 2023.

The linkage between CME factors and other infectious diseases has been well documented by numerous studies conducted in different regions of the world. For vector-borne diseases (VBD), the geographical distribution of vectors or reservoirs, changes in the survival, development, and reproduction rates of vectors, reservoirs, and pathogens, and an increase in vector biting and the prevalence of infection.

Another category of infectious diseases significantly affected by climate change is water-borne infectious diseases (WBD), particularly diarrhoeal diseases. Much of the population may be exposed to contaminated water during droughts because of inadequate sanitation. In the same way that drought can fuel outbreaks of WBDs, excessive rainfall, and floods can also impose great challenges in WBD control due to poor sanitation brought on by runoff from congested sewage systems or livestock contaminating water, as shown in Figure (2).

Figure 2

Pathways between fossil fuels and rising GHGs and VBDs



Source: World Economic Forum, The Rockefeller Foundation, "Better Climate, Better Health: Using Precision Public Health Tools to Tackle Climate-Sensitive Diseases in China." September 2023.

Grave Challenges Imposed by Climate Change on Health Sector in China

The frequency and intensity of extreme weather events have increased in many parts of China. In 2022, the country experienced a record frequency of extreme high-temperature events, with 366 national observatories breaking the historical extreme value of the highest temperature. Also, sea levels along China's coast have risen by around 3.3 millimetres per year since the 1980s, which is faster than the global average. Glacier retreat in China has accelerated in recent decades as well.

Amid rising patterns and severity of extreme weather events in the country, China has become one of the countries most vulnerable to the health impacts of climate change in the world, especially those related to temperatures. Both high and low temperatures can cause increases in residents' YLL. Overall, temperature was responsible for an average of 1.02 YLL per death in the study areas. Under the RCP 8.5 scenario, which is the worst scenarios of GHG gases concentration by 2100, the number of temperature change-related injury deaths in China is projected to increase by approximately 156,500 between the 2010s and the 2090s.

First: Relation between Climate Change and Infectious Diseases

Temperature probably helped spread insect-borne diseases (IBDs) in southern China while suppressing them in the northern area. Conversely, the impact of temperature change on rodent-borne disease cases is exactly the opposite of that of IBDs. The following part examines the impact of changing temperatures on the spread of specific infectious diseases:

Dengue: Between 2004 and 2020, the vectorial potential for dengue transmission increased significantly in 19 Chinese provinces as a result of changing climatic conditions. It was estimated that, by 2100, the number of dengue risk-free cities in China would reduce from 150 under RCP 2.6 to 55 under RCP 8.5.

Malaria: The monthly malaria cases in China may increase by 0.90% with each 1°C rise and by 3.99% with each 1% increase in relative humidity.

Hand, foot, and mouth disease (HFMD): Each 1°C rise could result in an increase of 1.8-5.9% in the number of weekly notified HFMD cases in west China. Other researchers found a significant correlation between temperature rise and an increased incidence of HFMD using meteorological and HFMD data from 2009 to 2014.

Second: Relation between Climate Change and Non-communicable Diseases

Using CVD and climate data from 15 Chinese megacities in 2007-2013, it was found that 17.1% of 330,352 deaths related to CVD were caused by ambient temperature.115 Projective studies conducted in Beijing predicted a 10.2-74% rise in the number of cardiovascular deaths attributable to temperature by 2050 or 2060.

As for mental health, a case-control study that engaged more than 430,000 individual deaths by suicide from all counties in mainland China a positive correlation was found between death risks and temperatures. Projections of mortality under various climate-change scenarios predicted rising trends in excess HRM for mental illnesses but declining trends in cold-related excess mortality.

Several studies indicated that environmental parameters were found to be significantly associated with childhood allergic diseases, particularly for temperature and air pressure. Similarly, hospital admissions due to respiratory and infectious diseases increased substantially during extreme heat and cold-weather events in Hong Kong.

China's Response to Climate-related Health Challenges

First: Local Governmental Actions

Since the launch of the National Climate Change Adaptation Strategy 2013 (NAS 2013), China has been interested in promoting monitoring and early warning systems for climate change. NAS 2013 outlined steps to integrate national and regional adaptation strategies, as well as high-priority tasks for seven sectors, including human health. To further strengthen adaptation actions and improve the climate resilience of natural ecosystems, as well as economic, health and social systems, 17 government ministries jointly issued the National Climate Change Adaptation Strategy 2035 (NAS 2035) in June 2022. The NAS 2035 envisages that by 2035, China will have established a nationwide climate impact and risk assessment system with improved early-warning capabilities.

Other than the regularly updated NAS, general rules and planned measures related to climate and health adaptation were dispersed across a number of policy documents produced by different government bodies in China. The most prominent of such documents is the Healthy China initiative in 2022, which aims at carrying out pilot projects to establish environmental health risk assessment systems, undertaking national monitoring of environmental health literacy among members of the public, and promoting health-related actions in response to climate change.

Second: Collaboration with Foreign Governments

In 2018, China and the Netherlands jointly initiated the establishment of the Global Commission on Adaptation. In 2019, the first regional office of the Global Center on Adaptation (GCA) was established in Beijing. As a key partner of the Chinese government, GCA China conducted an in-depth review of the NAS during its fine-tuning stage. Furthermore, the city of Beijing is collaborating with GCA China to design and launch its water ecorestoration plan, which has close ties with human health in the face of climate change.

Launched in 2020, Climate Risk and Resilience in China (CRR) is a public-private partnership project established by the German International Cooperation Agency (GIZ) and Swiss Re, commissioned by the German Federal Ministry for Economic Cooperation and Development. CCR aims to enhance the climate resilience of China's urban centres and their rural surroundings to reduce human and economic losses.

Third: Collaboration with International Organizations

In 2016, China and the WHO signed the China- WHO National Cooperation Strategy (2016- 2020), in which addressing "the impact of the environment and climate change on health" was outlined as one of the six strategic priorities. The Strategy was updated in 2018, and the climate-health-related priority was reframed to "promote the Healthy Cities movement and the attainment of health in all policies".

The National Health Commission (NHC), the MEE, and other government departments partnered in a series of environmental health projects at national and local levels between 2016 and 2020. Key outputs of the partnership included piloting gender-sensitive and climate-smart sanitation facilities for schools and health facilities in Qinghai. In addition, health education activities targeting school students and their parents were carried out in Jiangsu Province, focusing on the health impacts of climate change and self-protection in high temperatures and heatwaves.

In conclusion, the strenuous efforts made by the Chinese government could achieve significant progress in terms of climate change adaptation in the health sector all over the country, as follows:

- **Nationwide monitoring systems** were developed to provide technical support for climate change health risk assessment and the identification of climate-sensitive diseases and vulnerable populations. By the end of 2022, 167 monitoring points to measure the impact of air pollution on human health had been set up in 87 cities of 31 provinces.

- **As for promoting the country's ability to monitor vectors,** the National Vector Biological Surveillance System was developed, covering 91 localities in 31 provinces, and the National Important Vector Biological Resistance Surveillance System, covering 58 localities in 22 provinces.

- **Enhancing monitoring and prediction of extreme weather** events associated with climate change was targeted. For instance, in collaboration with research institutes and universities, the CMA has established a typhoon monitoring and forecasting system powered by AI.

- **Raised public awareness and understanding of the interlink between climate change and health was targeted**. In July 2020, the MEE compiled and published a brochure entitled Ecological Environment and Health Literacy of the Chinese Citizen, including principles, key terms, and recommendations for individual behaviour. In June 2023, China CDC released the first Guidelines for Public Health Protection in High Temperatures in China.

- **Data-sharing and the development of databases was another objective.** China has established multiple population health databases. Various types of data that are closely related to climate change can be found in the National/Local Statistical Yearbook, the Health Statistics Yearbook, population census data, the Notifiable Infectious Diseases Database, the National Disease Surveillance System's Causes of Death Monitoring Network Reporting Database and the Chinese Mental Health Database. This data is usually available for direct public access or is accessible on registration.

Global Hydrogen Review 2023

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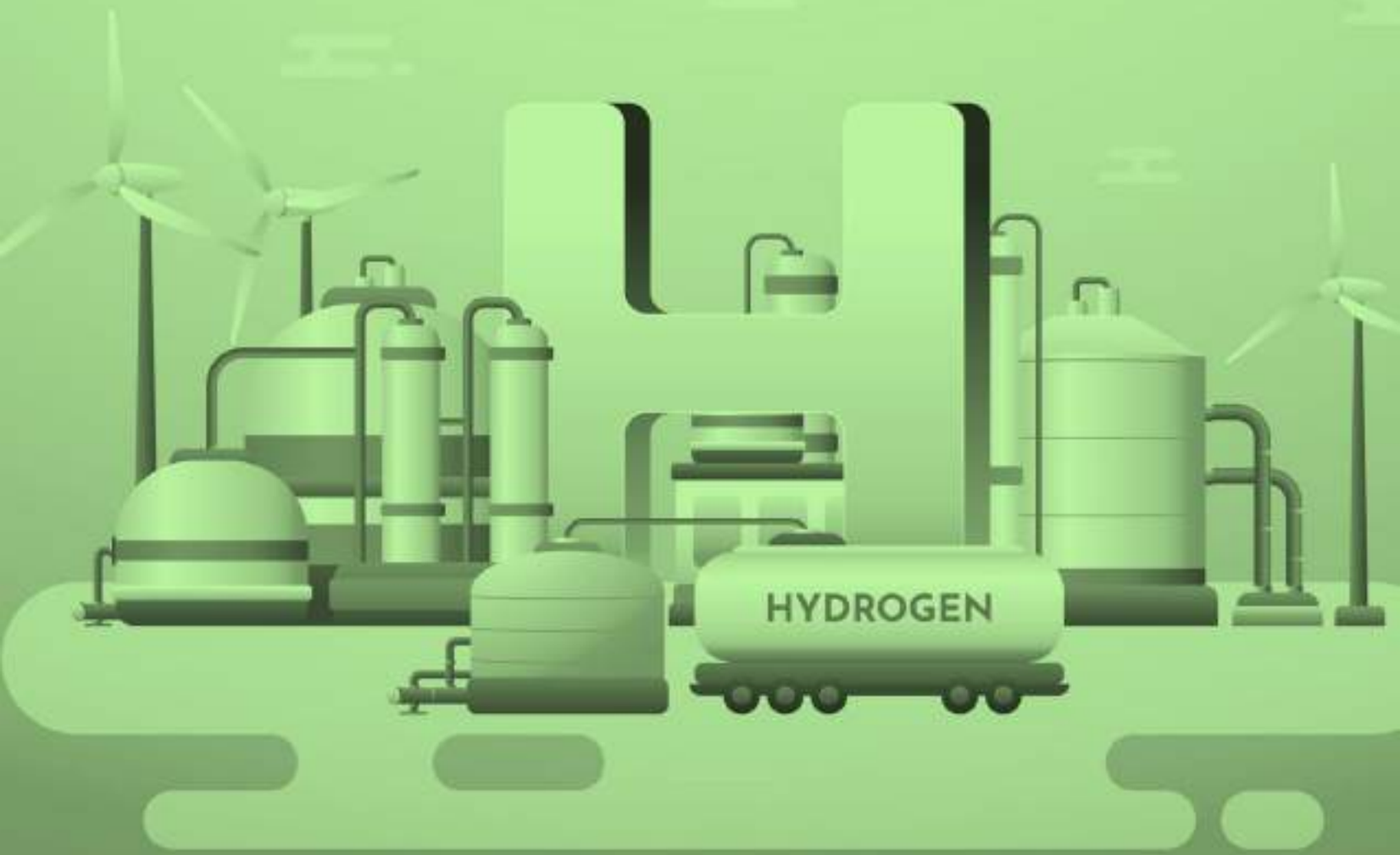
States need swift policy action on multiple fronts to tap into the low-emission hydrogen production. It can be an opportunity for countries to boost their economies for the future by creating industries along the supply chains of hydrogen technologies.

Hydrogen is one of the most abundant gases in nature, accounting for 75% of the universe's mass. It can be generated artificially through renewable or non-renewable resources. It is extracted from fossil fuels, which produce a lot of carbon dioxide emissions, while **low-emission hydrogen** is manufactured in a way that does not produce much greenhouse gas emissions. There are several ways to produce low-emission hydrogen, including electricity, water, or biomass.

The number of announced projects for low-emission hydrogen production is rapidly expanding. Annual production of low-emission hydrogen could reach 38 Mt in 2030 if all announced projects are realized, although 17 Mt comes from projects at the early stages of development. The potential production by 2030 from announced projects to date is 50% larger than it was at the time of the release of the International Energy Agency's Global Hydrogen Review 2022.

In this context, the **International Energy Agency (IEA)** has issued the Global Hydrogen Review 2023, an annual publication by the IEA since 2021. It tracks hydrogen production and demand worldwide, as well as progress in critical areas such as infrastructure development, trade, policy, regulation, investments, and innovation.



The report is an output of the Clean Energy Ministerial Hydrogen Initiative. It is intended to inform energy sector stakeholders on the status and future prospects of hydrogen, while also informing discussions at the Hydrogen Energy Ministerial Meeting organized by Japan. Focusing on hydrogen's potential major role in meeting international energy and climate goals, the review aims at helping decision-makers fine-tune strategies to attract investment and facilitate the deployment of hydrogen technologies at the same time as creating demand for hydrogen and hydrogen-based fuels. It compares real-world developments with the stated ambitions of government and industry.

The report depended on a detailed analysis of each region in the world, the number of their low-carbon hydrogen production projects, and a wide range of statistical sources. It aims at providing accurate estimates of the demand for energy and low-emission hydrogen in 2023.

The 2023 report includes a focus on demand creation for low-emission hydrogen. Global hydrogen use is increasing, but demand remains so far concentrated in traditional uses in refining and the chemical industry. To meet climate goals, there is an urgent need to switch hydrogen use to low-emission hydrogen and to expand use to new applications in heavy industry or transport.

Figure 1

Map of the locations of announced low-emission hydrogen production projects worldwide

Source: IEA Hydrogen Projects database

Note: The map includes announced projects starting after 2030.

China Has Succeeded in Electrolyzer Deployment and Use to Produce Low-emission Hydrogen

Hydrogen use has grown strongly in all major consuming regions except Europe. In Europe, hydrogen use suffered a big hit due to reduced activity - particularly in the chemical industry - as a consequence of the sharp increase in natural gas prices resulting from the Russia-Ukraine energy crisis. Several fertilizer plants reduced their production output or even stopped operations for prolonged periods of the year, reducing hydrogen use by nearly 6% in the region. In contrast, North America andthe Middle East observed strong growth (around 7% in both cases), which compensated for the drop in Europe.

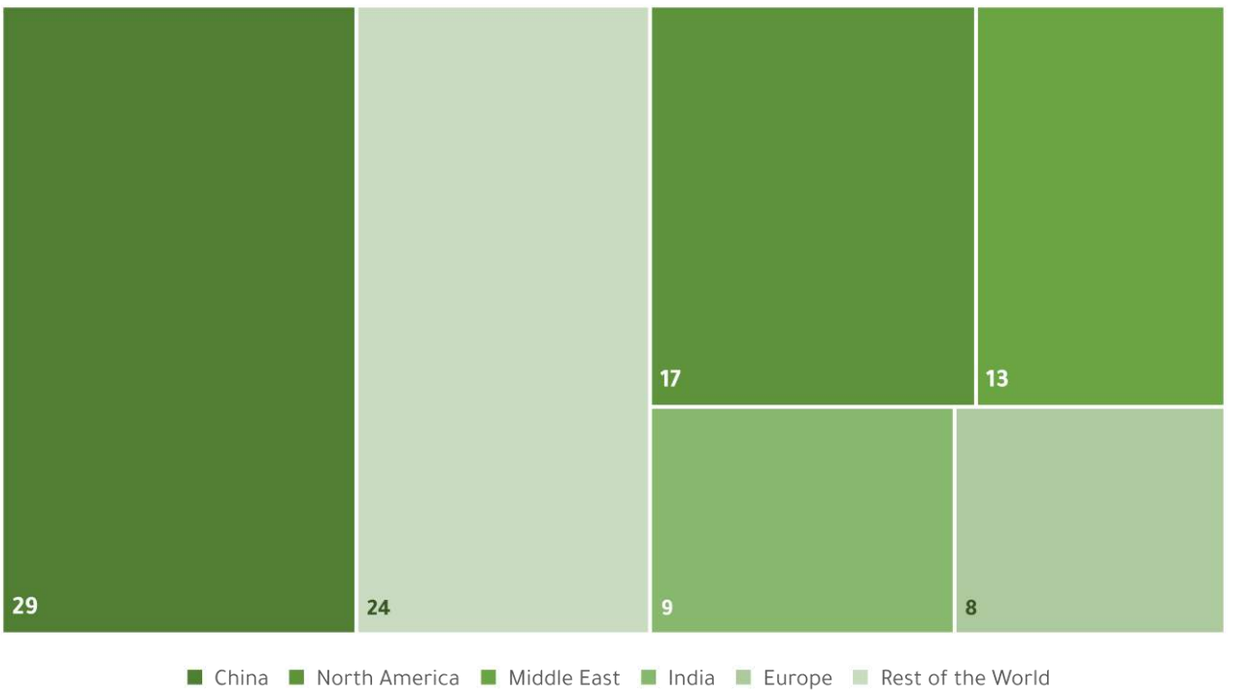
In 2020, China accounted for less than 10% of global electrolyzer capacity installed for dedicated hydrogen production, concentrated in small demonstration projects. However, in 2022, installed capacity in China grew to more than 200 MW, representing 30% of global capacity, more than double that of the second largest consumer, the United States, as shown in Figure 2.

> By the end of 2023, China's installed electrolyzer capacity is expected to reach 1.2 GW - 50% of global capacity - with another new world record-size electrolysis project (260 MW), which started operation this year.

In this context, China is poised to further cement its leading position in electrolyzer deployment: the country accounts for more than 40% of the electrolysis projects that have reached the final investment decision (FID) globally.

Figure 2

Hydrogen use by region in 2022 (%)



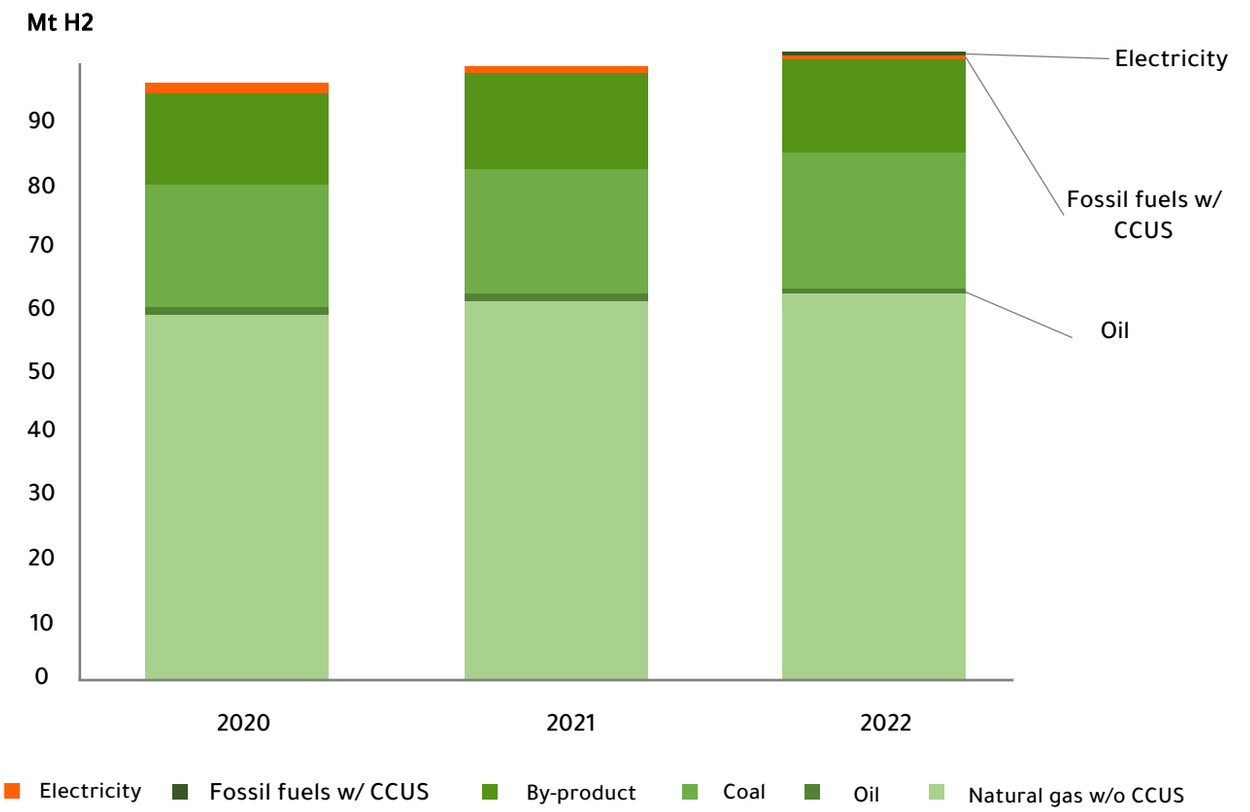
Source: global hydrogen Review 2023, International Energy Agency, September 2023. file:///C:/Users/pc/Downloads/GlobalHydrogenReview2023%20(1)%20(1).pdf

Low-emission Hydrogen Demand Is Lagging behind What Is Needed to Meet Climate Ambitions

In 2022, Hydrogen demand reached a historical high, but it remains concentrated in traditional applications. Global hydrogen use reached 95 Mt in 2022, a nearly 3% increase year-on-year.

Figure 3

Hydrogen production by technology (2020-2022)



Source: global hydrogen Review 2023, International Energy Agency, September 2023. file:///C:/Users/pc/Downloads/GlobalHydrogenReview2023%20(1)%20(1).pdf

Note: Global hydrogen production grew by 3% in 2022, but low-emission hydrogen production accounted for less than 1% of all production. It was produced through fossil fuels and Carbon Capture, Usage, and Storage (CCUS).

Demand remains concentrated in industry and refining, with less than 0.1% coming from new applications in heavy industry, transport, or power generation. Low-emission hydrogen is being taken up very slowly in existing applications, accounting for just 0.7% of total hydrogen demand, implying that hydrogen production and use in 2022 was linked to more than 900 Mt of CO_2 emissions.

In this context, the private sector has started moving to adopt low-emission hydrogen through off-take agreements, but efforts remain at a very small scale. Companies have signed off-take agreements for up to 2 Mt of low-emission hydrogen, although more than half are preliminary agreements with non-binding conditions. Notably, low-emission hydrogen use is still far from what is needed to meet climate goals.

Growing Global Trends to Increase Low-emission Hydrogen Production

Many countries seek to increase their low-emission hydrogen production. About 41 governments now have a hydrogen strategy in place and some of the early movers are updating their original strategies, raising ambitions. There is consensus that low-emission hydrogen is a key opportunity for decarbonizing sectors where emissions are hard to abate.

States need swift policy action on multiple fronts to tap into the low-emission hydrogen production. It can be an opportunity for countries to boost their economies for the future by creating industries along the supply chains of hydrogen technologies. Increasing efforts in line with the Net Zero Emissions (NZE) scenario could expand the market size up to USD 112 billion, roughly the size of the market for rooftop solar PV installations in the Asia Pacific region in 2022.

International Cooperation Initiatives to Stimulate Demand for Low-emission Hydrogen

States, international organizations, and multinational companies have launched a series of cooperation initiatives to foster the deployment of low-emission technologies, including hydrogen. Based on the commitments made by these initiatives, they could create 0.8-3 Mt of low-emission hydrogen demand by 2030. These initiatives predominantly target new applications of hydrogen, and there is no dedicated coalition targeting the chemical and refining sectors.

Scaling up low-emission hydrogen use is key to enabling the nascent hydrogen trade. International trade of hydrogen and hydrogen-based fuels are expected to be an important feature of a net zero future. In the NZE Scenario, more than 20% of the demand for merchant hydrogen and hydrogen-based fuels is internationally traded by 2030. Based on announced export-oriented projects, 16 Mt of hydrogen equivalent could be exported all around the world by 2030.

Accordingly, there have been announcements for around 50 terminals and port infrastructure for hydrogen and hydrogen-based fuels, and for up to 5 TWh of underground storage capacity aiming to be operative by 2030, but none of them has reached FID. Infrastructure projects typically have very long lead times, so it is critical to start developing them now to have a chance of them being available by 2030.

The report includes several recommendations to enhance low-emission hydrogen production and use.

Firstly: Implementing support schemes for low-emission hydrogen production and use

Some governments have announced numerous programs to support low-emission hydrogen production. However, in most cases, these programs are not yet implemented, or the funds have not yet been made available. This is hindering investment decisions for planned projects whose economic feasibility depends on public support, a situation that has worsened due to the impacts of inflation. Governments need to urgently implement these programs and make funding available to enable a scale-up compatible with their decarbonization ambitions.

Secondly: Taking bolder action to stimulate demand creation for low-emission hydrogen, particularly in existing hydrogen uses

States must take the lead and implement policies that encourage action in the private sector, combining support measures with regulations to require the adoption of low-emission hydrogen in existing applications. These measures can be complemented with technology-neutral regulations in priority sectors where alternative mitigation options exist such as steel, shipping, aviation, and long-distance road transport. The private sector can also contribute by establishing an international cooperation initiative focused on demand aggregation in chemicals or refining, which are best suited to scale up demand in the short term.

Thirdly: Fostering international cooperation to accelerate solutions for hydrogen certification and mutual recognition of certificates

Governments should keep moving forward with the implementation of clear regulations and associated certification schemes for hydrogen's environmental attributes. International cooperation needs to be reinforced to prevent a lack of alignment between these efforts, which could lead to market fragmentation. Referring to the emissions intensity of hydrogen production in regulations and certifications, based on a common methodology for determining the emissions, in line with the recommendations of the IEA's report for the 2023 G7 Climate, Energy and Environment Ministerial meeting, can facilitate the mutual recognition of certificates.

Fourthly: Addressing regulatory barriers, particularly for project licensing and permitting

The presence of a clear and stable regulatory framework must be balanced with a dynamic approach, calibrated to regular market monitoring, trying to make regulatory principles workable to not discourage investments. Governments should work to make licensing and permitting processes as efficient as possible and to improve coordination among different authorities involved in the process, particularly for certain infra structure developments, such as new pipelines and underground storage.

Fifthly: Supporting project developers during the inflationary period and extending regional reach

Governments can take action with interventions that respond to near-term financial risks including loan guarantees, export credit facilities, or public equity investment in projects, to help project developers that are struggling with increases in costs for equipment and capital. In addition, advanced economies need to raise concessional finance and boost cooperation to facilitate the development of first-of-a-kind projects in emerging markets and developing economies.

In conclusion, in light of the report, several challenges related to the production, use, and demand for low-emission hydrogen remain concentrated in traditional uses such as refining and chemicals. It is mainly produced from hydrogen-based fossil fuels. In this context, overcoming these challenges requires countries to take several international measures. Global demand for low-emission hydrogen should be increased, with adopting a comprehensive approach that combines incentives, regulations, and international cooperation. This requires governments and the private sector to take targeted and rapid measures to raise demand to a level consistent with the NZE scenario by 2050.

Author Guidelines

Governing Principles of the Journal's Works

The works of the Policy Paper Journal is governed by a number of principles that reflect IDSC's vision and strategic directions as follows:

Integrity: Researchers should adhere to the highest level of research ethics and meeting international standards in terms of good research such as upholding the value of knowledge and reliability, diligent research, accountability, credibility, innovative thinking, and dedication to work.

Value: Research contributions are essentially oriented towards public policies, usually starting with the introduction of the topic and its context, then a brief analysis of the issue in question supported by evidence, along with proposed policies and alternative options.

Quality: The research contribution is based on a well-known problem or issue, aims at answering specific questions, and adopts an appropriate research methodology for data collection and analysis while providing an informed analysis of the results in order to put forward visions and policy alternatives that benefit decision-makers.

Credibility: Highly credible and authentic official data and information sources should be used along with abiding by logic regarding ideas and insights and citing the results of supporting studies/experiences.

Excellence: The search for distinction and uniqueness from others is an objective of the Journal. All contributions made to the publication must be authentic; the researcher should not have published or submitted them to any other party. The rate of plagiarism should not exceed 10%.

Impartiality: Adherence to neutrality and rejection of all prejudices, whether political, religious, ethnic, ideological, or intellectual, is essential. This is without prejudice to different cultures or any reference to particular models or behaviors whose analysis is not based on a scientific approach.

Openness: Fair opportunities should be offered to all young researchers, practitioners, and experts –inside and outside Egypt– to participate in the Journal' works. This has a positive impact on its scientific composition, enriching the expertise and knowledge it provides.

Copyrights: IDSC reserves all copyrights for published contributions. Authors may not re-publish them in any scientific periodicals or publications until they have obtained a prior written consent from IDSC, provided that it was firstly published in the said Journal.

Contributions

A wide range of academics, experts, and practitioners in different disciplines are needed to analyze the repercussions of climate change and put forward courses of action to address them. Thus, the editorial board of "Climate Prospects" welcomes all valuable contributions made to relevant topics, covering the following categories:

Category I: Policy-oriented Research Papers

- Applied research, based on applied scientific analytical foundations and supported by domestic and international evidence, experience, and expertise to provide the decision-maker with applicable views, initiatives and measures. This enriches the State's efforts in various aspects of development.

- Such papers should focus on the decision-maker's agenda and present valuable results that contribute to policy development. It should begin with a problem and analyze its dimensions in order to introduce alternative initiatives and policies to address it for submission before the decision-maker to choose.

- All research papers are subject to scientific review by two specialized referees. They are determined according to the nature of the research subject matter. The personality of both the author(s) and the referee is obscured to preserve the principle of confidentiality and ensure impartiality.

- For guidance, content is usually segmented into 3 - 4 subsections, other than the introduction and summary section and the recommendations section:

  - ✓ The introduction contains a definition of the problem/issue of concern posed by the paper, presenting the main definitions used by the author briefly. They are followed by the structure of the paper/questions and the research methodology.

  - ✓ A section is to be allocated to analyzing the dimensions of the issue of concern based on quantitative or qualitative methods, corroborated by the most important evidence and data. Then, results are presented and interpreted. The results of comparative analyses can be utilized.

  - ✓ A bulk of the content is to be allocated to proposing policy alternatives/possible pathways to deal with the problem/issue of concern while starting a dialogue on them. The supporting grounds for both applied and research literature should be highlighted.

  - ✓ The paper concludes with a final section to review its main findings and recommendations.

- A separate section should not be devoted to the presentation of literature or details of definitions and terminology, but –instead– the said can be referred to –briefly– within the paper, provided that one provides a solid addition to the content.

- The research paper's range is 3500-5000 words without margins and references in either Arabic or English, taking into account proper linguistic norms, and that the content should be logical, clear and concise.

- Content could be reinforced with illustrative tools as an addition to its scientific value, including tables, charts, and effective illustrations, taking into account the guidelines to be outlined later.

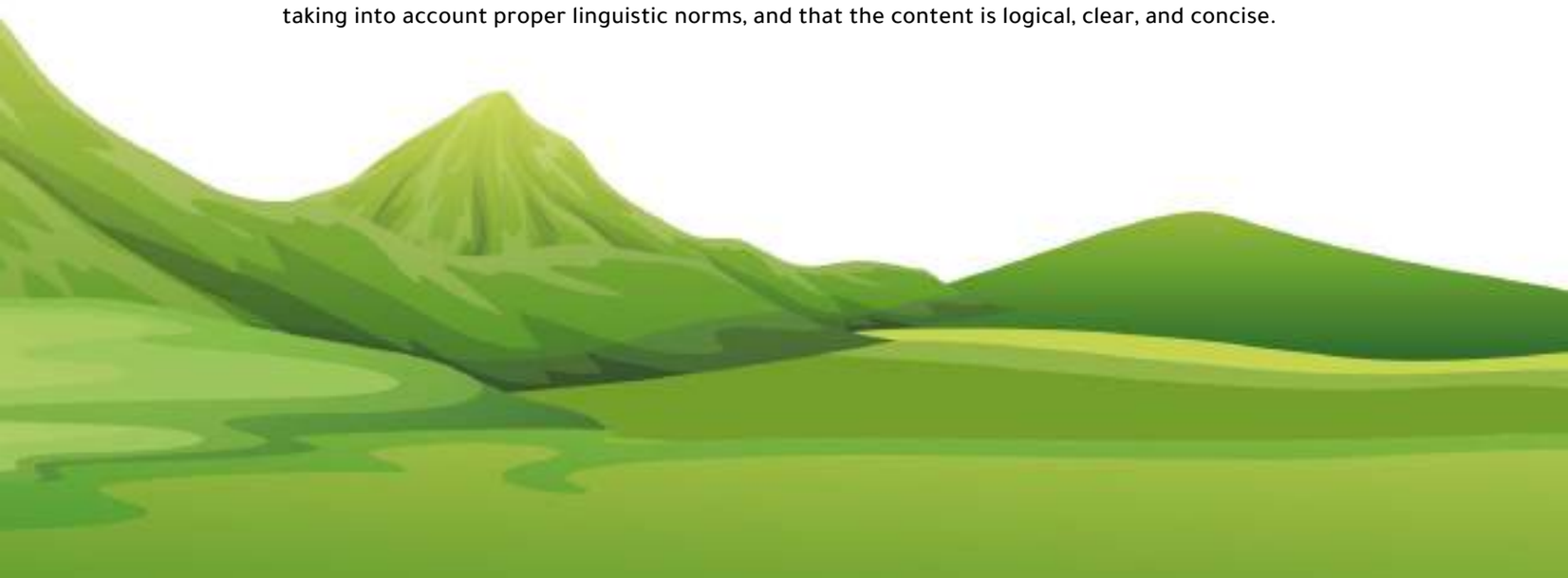
- In case of reliance on analytical models, emphasis is placed on their logic, findings, and significance, provided that the technical details of the model are mentioned in a technical appendix.
- The author(s) should take into account the attachment of an abstract in Arabic and English, each of which is 250 words.

Category II: Opinion Articles

- The opinion article presents an added value to the issue it addresses and a different view of what is known with informed ideas and visions that can be used by the decision-maker.
- It is of an applied research nature, focusing primarily on presenting a major problem, analyzing it according to the author's point of view while supporting it with evidence and information.
- It ranges between 1600-2000 words without the margins and references in either Arabic or English, taking into account proper linguistic norms and that the content is logical, clear, and concise.
- For guidance, content is usually divided into 3-4 subsections other than the introduction; their content must be balanced in a logical sequence, with the article ending with a concluding paragraph (In conclusion, ...).
- To attract the reader's attention, the article can start by a key question, a brief story, or a saying, provided that it is in harmony with the content.

Category III: Climate Narratives

- These narratives seek to present pioneering local, regional, and international experiences in climate action and coping with extreme weather phenomena to shed light on them and conclude lessons that inspire decision-makers.
- Climate narratives can cover the experiences of countries; regions; cities; governments; public or private institutions; or initiatives, programs, and projects. It can be formulated according to business narratives methodology.
- It should be an applied article, analyzing the experience according to the author's point of view. It should be supported with evidence and information.
- It ranges between 1600-2000 words without the margins and references, in either Arabic or English, taking into account proper linguistic norms, and that the content is logical, clear, and concise.



- For guidance, content is usually divided into 3-4 subsections other than the introduction; their content must be balanced in a logical sequence, with the article ending with a concluding paragraph (In conclusion, …).
- To attract the reader's attention, the article can start by a key question, a brief story, or a saying, provided that it is in harmony with the content.

Category IV: Report/Research Review

- It aims at utilizing the vast stock of knowledge available in all regions of the world in English, including studies, applied research, and international reports. It should offer an added value to the decision-maker.
- The review ranges between 1600-2000 words in Arabic, taking into account proper linguistic norms and that the content is logical, clear, and concise.
- For guidance, content is usually divided into 3-4 subsections other than the introduction; their content must be balanced in a logical sequence, with the article ending with a concluding paragraph (In conclusion, …).
- To attract the reader's attention, the article can start by a key question, a brief story, or a saying, provided it is in harmony with the content.

Methodology

- For all categories, the author(s) should send a proposal for the desired contribution to the Journal, within 250 words, with a brief biography to (CJ@idsc.net.eg). The nature and title of the research should be mentioned.
- The team examines the proposals made and expresses their opinion on them. The author(s) is addressed whether the proposed topic is acceptable, acceptable but needs modifications with clarification, or rejected.
- If the proposal is accepted, the author(s) will finalize the work and send via e-mail with an electronic copy of the sources on which it is based. This is in addition to completing the author's acknowledgement form that the content has never been published before and that it has not been submitted for publication at the present time.
- The team reviews the content sent and the rate of plagiarism is checked to ensure that it does not exceed 10%. The author is informed whether the content is definitively acceptable, acceptable but needs modifications with clarification, or rejected.

- After receiving the edited version of the content, the team will review and confirm its quality. In the case of applied research, the scientific review will be conducted until reaching the final edition.
- The Journal' team then proceeds with editing and graphic designing. The team reserves the right to edit the content provided according to the requirements of publication without prejudice to the text and the general idea.
- IDSC publishes and distributes the Journal' paper and electronic versions –according to internal working policies– through different channels and means it deems appropriate.

In any event, a number of objective criteria are relied upon in evaluating the contributions nominated for publication in the Journal, the foremost of which are:

- The importance of the topic for decision-makers, its added value, and the applicable knowledge, ideas, and measures that can be adopted to enhance development efforts.
- Adherence to the scientific methodology of academic writing in research and the scientific documentation of sources and references.
- Consistency and logic of used data, goals and hypotheses, accuracy and objectivity, and quality of content and ideas.
- The clarity, accuracy, and integrity of the language used in writing.
- Organization of the overall format of the paper's content and use of explicit tools (tables, graphs and illustrations).

General Rules of Writing

Basic Data: The title is mentioned on the first page with the full name of the author(s), job title, and the employer in Arabic and English, except for non-Arabic-speaking participants.

Dedication: If a person is thanked, it is mentioned in a margin on the first page, with triple name and job title, and the contribution to which he is thanked is briefly mentioned (no more than 40 words).

References: References are documented in the content without margins with all sources mentioned at the end of the research according to the Chicago Manual Style. They should be arranged alphabetically in Arabic first and then in English.

Terminology, Abbreviations and Symbols: When technical terms are first mentioned in the content in Arabic, the Arabic term is mentioned immediately followed by the term in English and its abbreviation in parentheses. The term is then used in Arabic only.

If the content is in English, the term is first given in full, followed by the abbreviation in parentheses, with the abbreviation later used.

Please avoid using terminology abbreviations in the heading or sub-headings with research inputs, as well as in table headings, graphic and illustrative formats.

Page Format:

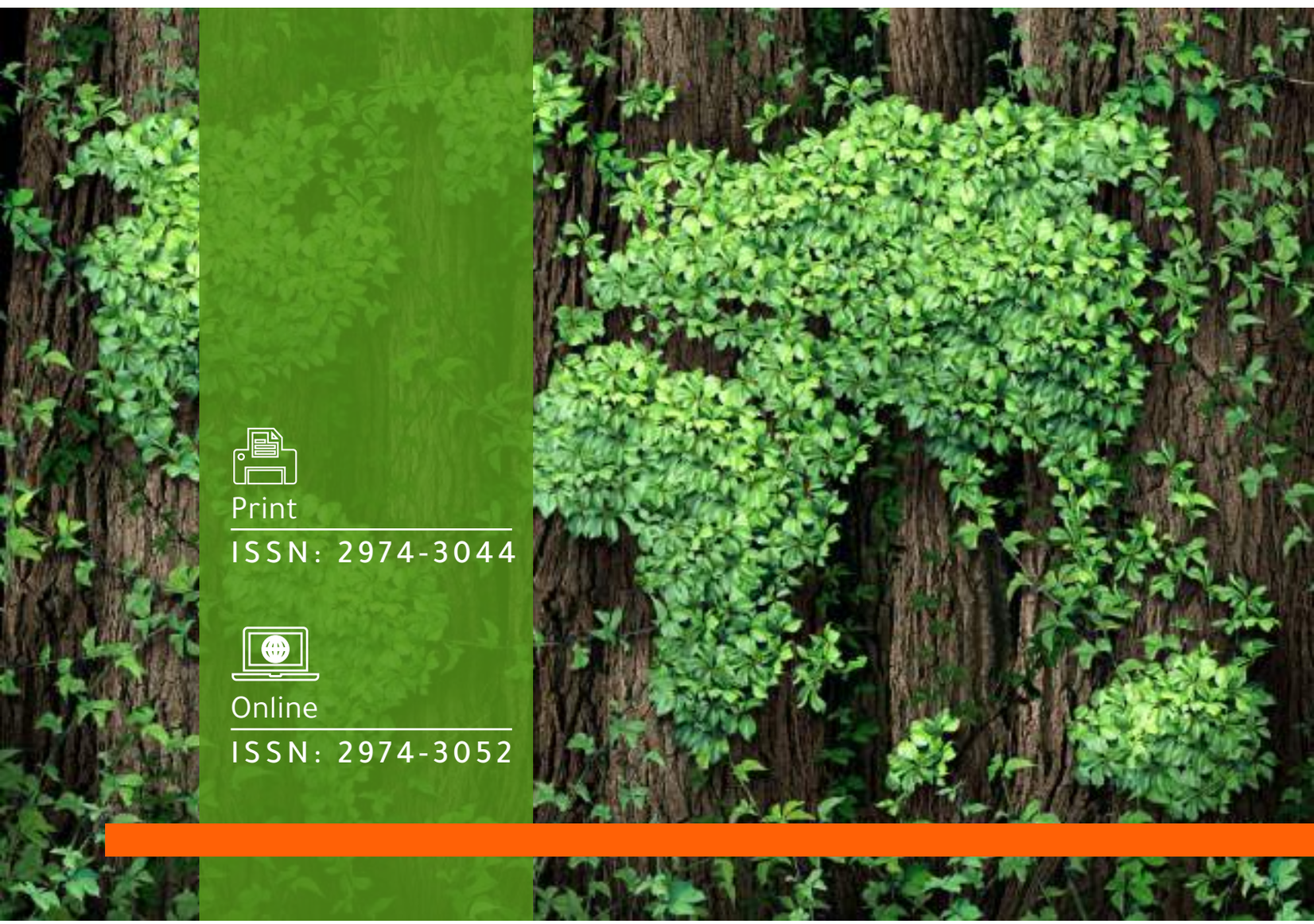
- Write in the MS Word file on the A4 page, with margins of 3 cm in all sides.
- Use size 16 Sakkal Magalla font for headings and subtitles, size 14 for metallic, with lines spacing 1.2 cm.
- Numbering starts from the title page.

Coordination of Graphic and Illustrative Formats:

- They are created within the content; they should not be imported from other programs such as PowerPoint or Excel and should not be added as a photo.
- All information should be mentioned on the graph or the illustrative form, including its number, the title at the top, the measurement unit, and any notes on the data and the source at the bottom in Sakkal Magalla font size 12.
- The graph or illustrative form is included after it is referred to in the content. No form may precede the pertaining content, and it shall be also numbered.
- In the charts, two-dimensional (2D) shapes are relied upon; three-dimensional (3D) shapes should be avoided. The type of chart should suit the target data displayed.

Table Coordination:

- They are created within the context and not added as a photo, bearing in mind that the number of their lines is suitable for presentation. In the case of long detailed tables, they can be mentioned in a statistical appendix.
- All the information about the table should be added including its number, its title at the top, the measurement unit, any notes on the data, and the source at the bottom, in a Sakkal Magalla font size 12.
- The table is included after being referred to in the context. No table may precede the pertaining content, and it should be also numbered.



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