



NHSMUN

UNEA

BACKGROUND GUIDE

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Dear Delegates,

Welcome to the United Nations Environment Assembly (UNEA) in this edition of NHSMUN 2025! My name is Ana Paula Coloma, and I am beyond excited to be your Director for Session I!

I am in my fourth year of university, studying Business Administration at Universidad del Pacífico in Lima, Peru. Alongside my studies, I am an intern at Banco de Crédito del Perú, where I work in the corporate and business credit products division. There, I assist clients with their needs and help ensure the smooth operations of our digital services. In my free time, I enjoy painting, spending time with friends, staying active by playing sports, and having fun singing Karaoke!

My experience with Model United Nations began in 2018 as part of my school's debate team, and since then, it has been a transformative experience for me. Over the years, MUN has given me countless opportunities to develop my public speaking, negotiation, and leadership skills. It has also taught me to work with people from all over the world. But more than anything, it has been about the friendships I have made along the way with others who share my passion for debate and diplomacy. MUN has truly shaped who I am today, deeply impacting my professional and personal growth. I first attended NHSMUN as a delegate in 2021, and now I am thrilled to continue my journey as part of the NHSMUN staff for another year. Last year, I was the Director of SOCHUM for Session I and had a great time meeting all the delegates. It was such a fantastic experience that I had to come back again as a Director for this NHSMUN 51st conference!

Joelle and I have carefully selected the debate topics "Sustainable Urban Development in Megacities" and "Mitigating the Impacts of the Oil Industry on Biodiversity," both of which have significant global impacts. This background guide will help you research the topics with a focus on your country's context. Choose your information carefully and consider how your proposals can be practically implemented. Both topics are complex and influenced by cultural and environmental factors, so I encourage you to approach them creatively and suggest innovative solutions. I also expect a commitment to diplomatic negotiation and dialogue, a genuine passion for the topics, and an open mind to diverse viewpoints. Most importantly, let's create a positive and enjoyable environment where we can all have helpful discussions and show good leadership.

I cannot wait to see you all on the committee and have a great time together. If you have questions regarding the conference, the information on this guide, NHSMUN policy, or MUN in general, feel free to reach out to Joelle or me. Best of luck, everyone!

See you in March!

Ana Paula Coloma

Director of United Nations Environment Assembly (UNEA)

Session I

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Dear Delegates,

Welcome to NHSMUN 2025! My name is Joelle Boilard, and I am the session II director for the United Nations Environment Assembly (UNEA). I am super excited to be a part of NHSMUN's 51st annual conference! This is my second year on NHSMUN staff and my fourth NHSMUN overall. Last year, I was an assistant director for CSTD. As a delegate, I participated in both UN-HABITAT and UNEA. Reflecting on my time as a delegate, I reflect fondly on my dais's ability to be fun, yet their expertise truly inspired fair leaders and me. My goal is to replicate this for you all this year!

Currently, I am attending the University of Alberta in Edmonton, Canada. I am majoring in Integrative Physiology and minoring in French language & literature. This allows me to combine my interest in the sciences with my love for languages and exploring other cultures. Outside of school and MUN, I love to read, bake, hike, and go to the gym. I am also a big fan of bad jokes and good music! Before starting university, I took a gap year to live and work in Barbados- one of the most amazing decisions of my life! I grew up moving frequently, even attending and completing high school in Trinidad & Tobago, so I was excited to stay in the Caribbean. It was through living overseas that I also discovered my passion for international affairs and the world of MUN. During my time abroad, I got to work at different diplomatic missions and meet people from around the world. I have witnessed how many issues, including those discussed in this background guide, impact different parts of the world.

Something I especially love about UNEA is that everyone is affected in some way by environmental issues, no matter who you are or where you live. I suggest letting your own experiences fuel your interest when doing research- but challenging yourself to understand and defend views and needs that are different from your own. In this background guide, my co-director and I have prepared some of the most current and relevant information on the topics named for debate. I suggest reading the guide carefully and using the information highlighted in guiding your research as you prepare for March. These topics are constantly evolving, so please continue researching developments as they happen!

I truly look forward to the conference in March, and to witnessing how debate unfolds. Until then, please feel free to reach out with any questions or concerns you may have. I can't wait to see you all, best of luck in your preparations!

Cheers!

Joelle Boilard

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Session II

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A Note on the NHSMUN Difference

Esteemed Faculty and Delegates,

Welcome to NHSMUN 2025! We are Terry Wang and Jordan Baker, and we are this year's Secretary-General and Director-General. Thank you for choosing to attend NHSMUN, the world's largest and most diverse Model United Nations conference for secondary school students. We are thrilled to welcome you to New York City in March.

As a space for collaboration, consensus, and compromise, NHSMUN strives to transform today's brightest thinkers, speakers, and collaborators into tomorrow's leaders. Our organization provides a uniquely tailored experience for all through innovative and accessible programming. We believe that an emphasis on education through simulation is paramount to the Model UN experience, and this idea permeates throughout numerous aspects of the conference:

Realism and accuracy: Although a perfect simulation of the UN is never possible, we believe that one of the core educational responsibilities of MUN conferences is to educate students about how the UN System works. Each NHSMUN committee is a simulation of a real deliberative body so that delegates can research what their country has said in the committee. Our topics are chosen from the issues currently on the agenda of that committee (except historical committees, which take topics from the appropriate time period). We also strive to invite real UN, NGO, and field experts into each committee through our committee speakers program. Moreover, we arrange meetings between students and the actual UN Permanent Mission of the country they are representing. Our delegates have the incredible opportunity to conduct first-hand research, asking thought-provoking questions to current UN representatives and experts in their respective fields of study. These exclusive resources are only available due to IMUNA's formal association with the United Nations Department of Global Communications and consultative status with the Economic and Social Council. No other conference goes so far to deeply immerse students into the UN System.

Educational emphasis, even for awards: At the heart of NHSMUN lies education and compromise. Part of what makes NHSMUN so special is its diverse delegate base. As such, when NHSMUN distributes awards, we strongly de-emphasize their importance in comparison to the educational value of Model UN as an activity. NHSMUN seeks to reward students who excel in the arts of compromise and diplomacy. More importantly, we seek to develop an environment in which delegates can employ their critical thought processes and share ideas with their counterparts from around the world. Given our delegates' plurality of perspectives and experiences, we center our programming around the values of diplomacy and teamwork. In particular, our daises look for and promote constructive leadership that strives towards consensus, as real ambassadors do in the United Nations.

Debate founded on strong knowledge and accessibility: With knowledgeable staff members and delegates from over 70 countries, NHSMUN can facilitate an enriching experience reliant on substantively rigorous debate. To ensure this high quality of debate, our staff members produce detailed, accessible, and comprehensive topic guides (like the one below) to prepare delegates for the nuances inherent in each global issue. This process takes over six months, during which the Directors who lead our committees develop their topics with the valuable input of expert contributors. Because these topics are always changing and evolving, NHSMUN also produces update papers intended to bridge the gap of time between when the background guides are published and when committee starts in March. As such, this guide is designed to be a launching point from which delegates should delve further into their topics. The detailed knowledge that our Directors provide in this background guide through diligent research aims to increase critical thinking within delegates at NHSMUN.

Extremely engaged staff: At NHSMUN, our staffers care deeply about delegates' experiences and what they take away from their time at NHSMUN. Before the conference, our Directors and Assistant Directors are trained rigorously through hours of workshops and exercises both virtual and in-person to provide the best conference experience possible. At the conference,

delegates will have the opportunity to meet their dais members prior to the first committee session, where they may engage one-on-one to discuss their committees and topics. Our Directors and Assistant Directors are trained and empowered to be experts on their topics and they are always available to rapidly answer any questions delegates may have prior to the conference. Our Directors and Assistant Directors read every position paper submitted to NHSMUN and provide thoughtful comments on those submitted by the feedback deadline. Our staff aims not only to tailor the committee experience to delegates' reflections and research but also to facilitate an environment where all delegates' thoughts can be heard.

Empowering participation: The UN relies on the voices of all of its member states to create resolutions most likely to make a meaningful impact on the world. That is our philosophy at NHSMUN too. We believe that to properly delve into an issue and produce fruitful debate, it is crucial to focus the entire energy and attention of the room on the topic at hand. Our Rules of Procedure and our staff focus on making every voice in the committee heard, regardless of each delegate's country assignment or skill level. Additionally, unlike many other conferences, we also emphasize delegate participation after the conference. MUN delegates are well researched and aware of the UN's priorities, and they can serve as the vanguard for action on the Sustainable Development Goals (SDGs). Therefore, we are proud to connect students with other action-oriented organizations to encourage further work on the topics.

Focused committee time: We feel strongly that face-to-face interpersonal connections during debate are critical to producing superior committee experiences and allow for the free flow of ideas. Ensuring policies based on equality and inclusion is one way in which NHSMUN guarantees that every delegate has an equal opportunity to succeed in committee. In order to allow communication and collaboration to be maximized during committee, we have a very dedicated administrative team who work throughout the conference to type up, format, and print draft resolutions and working papers.

As always, we welcome any questions or concerns about the substantive program at NHSMUN 2025 and would be happy to discuss NHSMUN pedagogy with faculty or delegates.

Delegates, it is our sincerest hope that your time at NHSMUN will be thought-provoking and stimulating. NHSMUN is an incredible time to learn, grow, and embrace new opportunities. We look forward to seeing you work both as students and global citizens at the conference.

Best,

Terry Wang
Secretary-General

Jordan Baker
Director-General

A Note on Research and Preparation

Delegate research and preparation is a critical element of attending NHSMUN and enjoying the debate experience. We have provided this Background Guide to introduce the topics that will be discussed in your committee. We encourage and expect each of you to critically explore the selected topics and be able to identify and analyze their intricacies upon arrival to NHSMUN in March.

The task of preparing for the conference can be challenging, but to assist delegates, we have updated our [Beginner Delegate Guide](#) and [Advanced Delegate Guide](#). In particular, these guides contain more detailed instructions on how to prepare a position paper and excellent sources that delegates can use for research. Use these resources to your advantage. They can help transform a sometimes overwhelming task into what it should be: an engaging, interesting, and rewarding experience.

To accurately represent a country, delegates must be able to articulate its policies. Accordingly, NHSMUN requires each delegation (the one or two delegates representing a country in a committee) to write a position paper for each topic on the committee's agenda. In delegations with two students, we strongly encourage each student to research each topic to ensure that they are prepared to debate no matter which topic is selected first. More information about how to write and format position papers can be found in the NHSMUN Research Guide. To summarize, position papers should be structured into three sections:

I: Topic Background – This section should describe the history of the topic as it would be described by the delegate's country. Delegates do not need to give an exhaustive account of the topic, but rather focus on the details that are most important to the delegation's policy and proposed solutions.

II: Country Policy – This section should discuss the delegation's policy regarding the topic. Each paper should state the policy in plain terms and include the relevant statements, statistics, and research that support the effectiveness of the policy. Comparisons with other global issues are also appropriate here.

III. Proposed Solutions – This section should detail the delegation's proposed solutions to address the topic. Descriptions of each solution should be thorough. Each idea should clearly connect to the specific problem it aims to solve and identify potential obstacles to implementation and how they can be avoided. The solution should be a natural extension of the country's policy.

Each topic's position paper should be **no more than 10 pages** long double-spaced with standard margins and font size. **We recommend 3–5 pages per topic as a suitable length.** The paper must be written from the perspective of your assigned country and should articulate the policies you will espouse at the conference.

Each delegation is responsible for sending a copy of its papers to their committee Directors via [myDais](#) on or before **February 21, 2025**. If a delegate wishes to receive detailed feedback from the committee's dais, a position must be submitted on or before **January 31, 2025**. The papers received by this earlier deadline will be reviewed by the dais of each committee and returned prior to your arrival at the conference.

Complete instructions for how to submit position papers will be sent to faculty advisers via email. If delegations are unable to submit their position papers on time, please contact us at info@imuna.org.

Delegations that do not submit position papers will be ineligible for awards.

Committee History

The United Nations Environment Assembly (UNEA) was created in 2012 due to the UN Conference of Sustainable Development held in Rio de Janeiro, Brazil. It serves as the world's highest decision-making body for environmental matters. Most of these matters are at the core of the 2030 Sustainable Development Agenda.¹ Since its establishment, environmental issues have been given the same level of importance as global concerns such as peace, security, and health.² It's mandated to ensure the active participation of the stakeholders in the governance of the United Nations Environment Programme (UNEP) and to promote a strong science-policy interface. Creating worldwide environmental legislation and policies are also some focuses of this body.³

UNEA has a universal membership. All 193 country members of the United Nations can participate and vote on decisions regarding the conference topics.⁴ It is the governing body of the United Nations Environment Programme (UNEP).⁵ Sessions take place once every two years in the official UNEP headquarters in Nairobi, Kenya, being one of only two countries with offices in the developing world.⁶ Additionally, they have regional offices in Africa, Europe, North America, West Asia, Latin America, the Caribbean, Asia, and the Pacific. They also have 12 sub-regional programs and offices.⁷ At the sub-regional level, UNEP works to forge strong partnerships for collaborative and effective environmental management. It works with intergovernmental bodies, environment ministries, research organizations, international bodies, and UN agencies to identify and address common and global issues.⁸ The six UNEP regions include Africa, Asia and the Pacific, Europe, Latin America and the Caribbean, North America, and West Asia. Given their work at the national and regional levels, Major Groups and Stakeholders are well placed to participate in the implementation of UNEP's work through cooperation with the regional offices.⁹

UNEA's largest achievements involve the advancement of environmental governance through the creation of important resolutions and treaties, such as the Nairobi Declaration of 2017 and the Cartagena Protocol on Biosafety.¹⁰ Furthermore, the Assembly has supported resolutions on matters such as the trafficking of illicit wildlife, waste, chemical management, and the application of natural solutions for sustainable development.¹¹ UNEA, however, has faced restrictions and difficulties. Its decision-making procedure may slow Action on critical issues, frequently calling for agreement from all 193 member nations. Furthermore, the resolutions of the Assembly are not legally binding, meaning that they are not enforceable by law; each nation's ability and political desire to carry them out will determine how they are implemented.¹² Financial constraints and the intricate nature of global environmental issues, including the triple planetary crisis of pollution, biodiversity loss, and climate change, challenge the UNEA's ability to fulfill its mission fully. However, these obstacles highlight the need for innovative solutions and greater collaboration to drive progress worldwide.¹³

1 "What is the UN Environment Assembly and why does it matter?" UN News, February 25, 2024, <https://news.un.org/en/story/2024/02/1146932>.

2 "About the United Nations Environment Assembly," UN Environment Programme, 2024, <https://www.unep.org/environmentassembly/about-united-nations-environment-assembly>

3 "UN Environment Assembly 5 Resolutions," UN Environment Programme, March 2, 2022, <https://www.unep.org/resources/resolutions-treaties-and-decisions/UN-Environment-Assembly-5-2>

4 "About the United Nations Environment Assembly," UN Environment Programme, 2024.

5 "About the United Nations Environment Assembly," UN Environment Programme, 2024.

6 Rules of Procedure of the United Nations Environment Assembly of the United Nations Environment Programme, United Nations General Assembly, K1610826, 5. May, 2016. <https://wedocs.unep.org/bitstream/handle/20.500.11822/14367/K1610826%20%281%29.pdf?sequence=1&isAllowed=y>

7 "Where We Work", United Nations Environment Programme Global Environment Facility, <https://www.unep.org/gef/about-us/where-we-work>

8 "Regional Initiatives", UN Environment Programme, 2024, <https://www.unep.org/regions/asia-and-pacific/regional-initiatives>

9 "Engaging in the Regions", UN Environment Programme, 2024, <https://www.unep.org/civil-society-engagement/participation-and-engagement/engaging-regions>

10 "Multilateral actions to safeguard the environment: A timeline", UN Environment Programme, 2024, <https://www.unep.org/multilateral-actions-safeguard-environment-timeline>

11 "What you need to know about the UN Environment Assembly", UN Environment Programme, February 18, 2022. <https://www.unep.org/news-and-stories/story/what-you-need-know-about-un-environment-assembly>

12 "What you need to know about the UN Environment Assembly", UN Environment Programme, February 18, 2022.

13 UN News, "What is the UN Environment Assembly and why does it matter?"



UNEA

NHSMUN 2025

TOPIC A: SUSTAINABLE URBAN DEVELOPMENT IN MEGACITIES

Photo Credit: Ming Chen

Introduction

Megacities, as defined by the United Nations, are cities with more than 10 million people living in urban areas.¹ This includes not only the city center but also the nearby regions.² Megacities show rapid growth, high population density, and significant economic, social, and environmental challenges. These cities act as global economic centers, attracting people for job opportunities, education, and services.³ Due to its influential position, they earn the title of “Global Cities.”⁴ China leads the list with several megacities, such as Chongqing, Shanghai, and Beijing, reflecting its rapid economic growth and urban expansion.⁵

Sustainable megacities use technologies and planning to make urban life greener and more comfortable.⁶ They include green roofs to filter CO₂, put solar panels on buildings for clean energy, and set up vertical farms to save space and resources.⁷ Other measures are promoting electric vehicles and rental bicycles, improving waste management, and use sensors to monitor congestion. These efforts help to reduce environmental damage while improving urban living conditions.

Over the years, the number of megacities has grown significantly. Today, there are 44. By 2030, this number is expected to rise to 56, and by 2050 it could reach 67.⁸ This expansion reflects the significant importance of global urban dynamics. The population in these megacities is expected to grow by 266 million, which is around half of the total population growth across all major cities.⁹ The fastest growth is likely in African megacities due to high birth rates and a younger population. Other cities like Paris and Tokyo will grow through net migration as their birth rates decrease.¹⁰ In addition, emerging megacities in the Asia Pacific region are

expected to remain the largest. Delhi is predicted to become the largest megacity in the world by 2050, with nearly 47 million inhabitants.¹¹

Urbanization is a global phenomenon that has a social and economic impact. Over half of the world’s population lives in urban areas, and this number keeps growing.¹² The 21st century is often called the “century of the city” because of the rapid urban expansion.¹³ Sustainable development aims to balance economic growth with environmental conservation. Megacities mean achieving urban life without compromising the well-being of people, living standards, and environmental health.¹⁴ Cities account for 80 percent of greenhouse gas emissions and 75 percent of resource consumption.¹⁵ Despite this, they remain essential for providing necessary services such as energy, healthcare, and employment to those in need.¹⁶ Cities must address these needs while adopting more sustainable practices. This includes increasing green spaces such as parks and green roofs and implementing green streets to cool urban areas naturally and reduce dependence on energy-draining

1 “Megacities,” World Data Info, last modified February 2024, <https://www.worlddata.info/megacities.php>.

2 “Understanding Megacities: Dynamics and Realities of Urban Centers Worldwide,” Wilo, last modified March 13, 2024, https://wilo.com/en/Pioneering/Stories/Understanding-Megacities-Dynamics-and-Realities-of-Urban-Centers-Worldwide_40512.html.

3 World Data Info, “Megacities.”

4 World Data Info, “Megacities.”

5 World Data Info, “Megacities.”

6 Wilo, “Understanding Megacities: Dynamics and Realities of Urban Centers Worldwide.”

7 Wilo, “Understanding Megacities: Dynamics and Realities of Urban Centers Worldwide.”

8 “Rise of new megacities will drive global urban growth,” Oxford Economics, last modified January 26, 2024, <https://www.oxfordeconomics.com/resource/rise-of-new-megacities-will-drive-global-urban-growth>

9 Oxford Economics, “Rise of new megacities will drive global urban growth.”

10 Oxford Economics, “Rise of new megacities will drive global urban growth.”

11 Oxford Economics, “Rise of new megacities will drive global urban growth.”

12 Deren Li, Jun Ma, Tao Cheng, John L. van Genderen, and Zhenfeng Shao, “Challenges and opportunities for the development of MEGACITIES,” *International Journal of Digital Earth* 12 (August 2018): 1382-1387, <https://doi.org/10.1080/17538947.2018.1512662>.

13 Li, Ma, Cheng, van Genderen and Shao, “Challenges and opportunities for the development of MEGACITIES,” 1382-1387.

14 Tim Heinrich Son, Zack Weedon, Tan Yigitcanlar, Thomas Sanchez, Juan M. Corchado, Rashid Mehmood, “Algorithmic urban planning for smart and sustainable development: Systematic review of the literature,” *Sustainable Cities and Society* 94 (July 2023):104562, <https://www.sciencedirect.com/science/article/pii/S2210670723001737>.

15 Inger Andersen, “Nature in our cities,” UNEP, last modified June 30, 2021, <https://www.unep.org/news-and-stories/speech/nature-our-cities>

16 Andersen, “Nature in our cities.”

air conditioning.¹⁷ Delegates must address the challenge of aligning their city's activities with surrounding areas. Given the high energy and resource consumption, coordinating effectively with neighboring regions to promote sustainability is crucial. Ensuring that this consumption remains sustainable is critical since about 75 percent of the infrastructure in 2050 is yet to be built.¹⁸ Lastly, cities are making progress, but national governments still need support. Developing effective business models is also important for nature-based solutions, which is why UNEA is working on guidelines to help find ways to generate revenue from these solutions.¹⁹

Megacities face significant challenges like fast population growth, high resource use, and environmental issues.²⁰ High-density buildings and limited green spaces make urban conditions worse, causing pollution, heat island effects, and waterlogging.²¹ Traffic congestion and poor disaster planning also impact social and economic development. Land collapse, where the ground sinks and threatens infrastructure, affects over 150 major cities.²² Also, pollution and waste management issues are common in megacities.²³ The large amounts of waste overwhelm current management systems and harm health.²⁴ Additionally, overpopulation and lack of housing in megacities can cause homelessness and the development of slums.²⁵ This is because affordable housing is hard to find in the city center and surrounding areas due to high living costs.²⁶ Traffic congestion makes parking, public transport, and traffic management difficult.²⁷ Finally, energy use is often not sustainable and inefficient, making it hard to manage resources effectively.²⁸ Focusing on sustainable urban development is

critical to finding ways to help megacities grow responsibly while protecting the environment for future generations.

History and Description of the Issue

Rise of Megacities

Cities have played a crucial role in human civilization for thousands of years, evolving from early settlements into complex urban centers we know today. Earliest cities, such as Mesopotamia, Egypt, and the Indus Valley, emerged around river valleys where water was readily available for drinking, agriculture, and transportation.²⁹ These cities became centers of trade, governance, and culture, therefore attracting people from surrounding areas.³⁰ As societies advanced, so did their cities. For example, Ancient Rome grew into a metropolis with sophisticated infrastructure, including roads, aqueducts, and public buildings. This facilitated urban life and economic activity.³¹ These cities were cultural, political, and economic hubs that influenced vast regions.³² Until the early 19th century, no city in the world had more than one million inhabitants.³³ Historically, the world's largest cities were often the capitals of vast empires. Cities like Rome, Chang'an, and Beijing were among the first to reach one million population.³⁴ They also played a significant role in their countries' economies through diverse employment opportunities across different sectors since their concentrated talent and resources led to better city advancements. They also became central hubs for finance and commerce, attracting business and investments, which

17 Andersen, "Nature in our cities."

18 Andersen, "Nature in our cities."

19 Andersen, "Nature in our cities."

20 Li, Ma, Cheng, van Genderen and Shao, "Challenges and opportunities for the development of MEGACITIES," 1382-1387.

21 Li, Ma, Cheng, van Genderen and Shao, "Challenges and opportunities for the development of MEGACITIES," 1382-1387.

22 Li, Ma, Cheng, van Genderen and Shao, "Challenges and opportunities for the development of MEGACITIES," 1382-1387.

23 Li, Ma, Cheng, van Genderen and Shao, "Challenges and opportunities for the development of MEGACITIES," 1382-1387.

24 Wilo, "Understanding Megacities: Dynamics and Realities of Urban Centers Worldwide."

25 Wilo, "Understanding Megacities: Dynamics and Realities of Urban Centers Worldwide."

26 Wilo, "Understanding Megacities: Dynamics and Realities of Urban Centers Worldwide."

27 Li, Ma, Cheng, van Genderen and Shao, "Challenges and opportunities for the development of MEGACITIES," 1382-1387.

28 Li, Ma, Cheng, van Genderen and Shao, "Challenges and opportunities for the development of MEGACITIES," 1382-1387.

29 "The History of Cities," National Geographic Education, accessed June 30, 2024, <https://education.nationalgeographic.org/resource/history-cities/>.

30 National Geographic Education, "The History of Cities."

31 National Geographic Education, "The History of Cities."

32 "Urbanization and the Megacity," World Population History, accessed June 30, 2024, <https://worldpopulationhistory.org/urbanization-and-the-megacity/>.

33 Jerzy Kleer, and Katarzyna Anna Nawrot. "Rise Of Megacities, The: Challenges, Opportunities And Unique Characteristics," *World Scientific* (April 2018): <https://doi.org/10.1142/q0125>.

34 Kleer, and Nawrot, "Rise Of Megacities, The: Challenges, Opportunities And Unique Characteristics."

enhanced global trade through their international gateways.³⁵ Due to these, megacities sometimes contribute more than one-third of their GDP.³⁶

Since 1950, the world population has increased dramatically, from 2.5 billion to 7.3 billion in 2015 due to urbanization.³⁷ According to the UN predictions, the world population is expected to reach 11.2 billion by 2100.³⁸ The biggest increase in population was observed in Asia, accounting for 62 percent of the total world population growth.³⁹ As a result, significant changes have ensued in the structure of the world population. In 2015, 59,8 percent of the world population lived in Asia (4.4 billion), 16.1 percent in Africa (1.2 billion), 10 percent in Europe (738.4 million), 8.6 percent in Latin America and the Caribbean (634.4 million), 4.9 percent in North America (357.8 million), and 0.5 percent in Oceania (39.3 million).⁴⁰

One of the main characteristics of these demographic changes has been urbanization. In 1980, the global urbanization rate was 39.35 percent, a modest increase from previous decades. However, this rate escalated significantly, reaching 46.69 percent by 2000 and 55.72 percent by 2019.⁴¹ Before 1980, there were six megacities located in five countries. They were Indonesia, Brazil, Mexico, Japan (having two megacities), and the United States.⁴² This rapid urban growth, particularly in the rise of megacities, has transformed the global urban landscape. During this period, megacities increased from six to 35 in 2020. These types of cities were originally spread across both developed and developing countries, but by 2020, a significant concentration was found in developing countries.⁴³ Even though the divergent growth pattern of the city system is not associated with the economic development status or the

country size, it is relatively prevailing in developing countries such as Egypt, Russia, and Colombia.⁴⁴ Also, the average population of megacities grew from 16.4 to 25.8 million, highlighting the urban expansion.⁴⁵

The urban population has been constantly growing, but only in the early 21st century did it reach the rural population. Nearly two-thirds of the global population growth between 1950 and 2015 occurred in urban areas.⁴⁶ Also, future population growth is expected to be focused predominantly in urban areas. While urbanization brings numerous benefits, such as economic growth, cultural exchange, and innovation, it also brings significant risks.⁴⁷ Rapidly expanding megacities can experience severe strain on their infrastructure. Housing shortages can lead to the proliferation of informal settlements, where living conditions are often poor.⁴⁸ Some of the challenges these megacities face are high crime rates, often caused by significant social inequalities. Environmental pollution and contamination are two additional significant issues leading to disease spread due to poor hygiene conditions. Overpopulation and a lack of living space can also lead to increased homelessness as a result of inadequate public infrastructure.⁴⁹

The Industrial Revolution in the late 18th and early 19th centuries significantly transformed urban development.⁵⁰ Industrialization led to the creation of factories and mass production, which are urban areas with over 10 million people. Cities like Tokyo, Delhi, and Sao Paulo emerged as symbols of modern urban life, offering diverse economic opportunities, cultural experiences, and improving living standards. The 20th century saw even greater urbanization, driven by economic opportunities and advancements in

35 Kleer, and Nawrot, "Rise Of Megacities, The: Challenges, Opportunities And Unique Characteristics."

36 Kleer, and Nawrot, "Rise Of Megacities, The: Challenges, Opportunities And Unique Characteristics."

37 Kleer, and Nawrot, "Rise Of Megacities, The: Challenges, Opportunities And Unique Characteristics."

38 Kleer, and Nawrot, "Rise Of Megacities, The: Challenges, Opportunities And Unique Characteristics."

39 Kleer, and Nawrot, "Rise Of Megacities, The: Challenges, Opportunities And Unique Characteristics."

40 Kleer, and Nawrot, "Rise Of Megacities, The: Challenges, Opportunities And Unique Characteristics."

41 Ding Chengri, He Xiao, and Zhu Yongming, "Megacity Growth, City System and Urban Strategy," *Chinese Journal of Urban and Environmental Studies* 10, no. 1(2022): 2250005, <https://www.worldscientific.com/doi/pdf/10.1142/S2345748122500051>

42 Ding, Xiao, and Yongming, "Megacity Growth, City System and Urban Strategy," 2250005.

43 Ding, Xiao, and Yongming, "Megacity Growth, City System and Urban Strategy," 2250005.

44 Ding, Xiao, and Yongming, "Megacity Growth, City System and Urban Strategy," 2250005.

45 Ding, Xiao, and Yongming, "Megacity Growth, City System and Urban Strategy," 2250005.

46 Kleer, and Nawrot, "Rise Of Megacities, The: Challenges, Opportunities And Unique Characteristics."

47 "Megacities: Dynamics, Realities & Sustainable Future," Wilo, n.d.,

48 "Megacities: Dynamics, Realities & Sustainable Future," Wilo, n.d.,

49 "Megacities: Dynamics, Realities & Sustainable Future," Wilo, n.d.,

50 Mateusz Grabowski, "The 18th and 19th Century Industrialization Process as the Main Aspect of City Creation and Its Impact on Contemporary City Structures: The Case of Lodz," IOP Conference Series Materials Science and Engineering 471 (February 23, 2019): 082046, <https://doi.org/10.1088/1757-899x/471/8/082046>.



Construction of city in Lima, Peru
 Credit: Elvis Cortez

transportation and communication technologies.⁵¹ Cities began to expand both vertically and horizontally with the construction of skyscrapers and the development of suburbs.⁵² This period also saw the rise of megacities.

When a city grows at a manageable rate, often considered one percent annually, its infrastructure can keep pace with the increasing population and demands.⁵³ That means there's time to plan and build any necessities such as roads, public transportation, clinics, water treatment facilities, and housing alongside the increase in human numbers.⁵⁴ The risk of rapid urban growth is that infrastructure often can't develop quickly enough to meet the needs of the people. Without adequate infrastructure, residents may be forced to create their solutions with whatever resources are available.⁵⁵ Megacities offer valuable lessons for governance. They face unique challenges that can inform how other cities manage their growth and development.⁵⁶ Learning from these experiences can help countries anticipate future issues and find innovative solutions.

Globalization further accelerated the growth and interconnection of cities, transforming them into "world cities" that exerted significant influence on global affairs.⁵⁷ A world city is a control center of the global economy. These cities are preeminent sites for investment. Cities have become central to trading, finance, and communication. Examples are London, Tokyo, and Hong Kong, which facilitate the movement of goods, capital, and ideas across borders. Nevertheless, this process of globalization has accelerated urbanization, with people moving to cities in search of economic opportunities and a better quality of life.⁵⁸ As cities attract more businesses and talent, they grow in size and complexity, often transforming into megacities, especially in developing regions where rapid expansion is fueled by both natural population growth and migration from rural areas. The urbanization process generally occurs due to one or more of the following processes: natural population growth, net migration from rural to urban areas, the progressive extension of urban boundaries, or new urban

51 Grabowski, "The 18th and 19th Century Industrialization Process as the Main Aspect of City Creation and Its Impact on Contemporary City Structures: The Case of Lodz."

52 Sunny Kulkarni, "City Expansions and the Vertical Urbanization Approach," Medium, May 1, 2018, <https://medium.com/@SunnyKulkarni/city-expansions-and-the-vertical-urbanization-approach-10280a05a01>.

53 World Population History, "Urbanization and the Megacity."

54 World Population History, "Urbanization and the Megacity."

55 World Population History, "Urbanization and the Megacity."

56 Li, Deren, Jun Ma, Tao Cheng, John L. van Genderen, and Zhenfeng Shao. "Challenges and opportunities for the development of MEGACITIES." *International Journal of Digital Earth* 12, no. 12

57 Peter Hall, "Globalization and the world cities," *Globalization and the world of large cities* (1998): 17-36. <https://citeseerx.ist.psu.edu/document?repid=rep1&type=pdf&doi=8a32924c77913c0f94b8157697c131cade4e25e4#page=34>

58 Peter Hall, "Globalization and the world cities," *Globalization and the world of large cities* (1998): 17-36.

centers. Economic advantage is one of the main reasons for migration from rural locations, and it is linked to sustained economic growth.⁵⁹

However, globalization also brings significant challenges. The rapid growth of these cities often leads to wealth and resource disparities. Overcrowding can strain infrastructure, housing, and public services, causing congestion, pollution, and social inequality. Additionally, the dominance of world cities in the global economy can marginalize smaller cities and rural areas, increasing regional inequalities.⁶⁰ Only in the early 19th century, no city had more than one million people. Now, there are over 20 cities with populations exceeding ten million.⁶¹

Migration also plays a fundamental role in shaping cities around the world. People migrate from rural to urban areas or across borders in search of better opportunities, safety, or a new life.⁶² As migrants settle in cities, they bring diverse cultures, languages, and traditions, enriching the social network and interactions of people in the urban communities. The presence of migrants transforms cities into transient spaces characterized by fluidity and adaptation, becoming centers of cultural exchange and social interaction.⁶³

The migration of people represents one of the most important social phenomena of the late 20th and early 21st centuries.⁶⁴ It is interconnected with rapid urbanization, with a prediction of

a high increase in immigration from 12 percent in 2010 to 17-19 percent in 2050, driving the exponential growth of urban areas.⁶⁵ Migrants leave their rural lifestyles seeking better opportunities in cities, such as economic prospects and living conditions.⁶⁶ Migration evidences the economic disparities within regions and the increasing inequalities between societies. People in rural areas often have diminishing access to social services, including health facilities and educational programs, as higher-quality opportunities are increasingly only found in urban areas.⁶⁷ In most of these places, there is a badly planned infrastructure to serve their rapidly growing populations.⁶⁸ This lack of services pushes many rural inhabitants to migrate to cities for better living conditions. Urban areas offer more economic opportunities, better healthcare, and improved education facilities, making them attractive destinations for those seeking to improve their quality of life.⁶⁹ Urban areas are growing at an exponential pace. Urban areas can become overwhelmed by the rapid increase in population, leading to overburdened infrastructure, housing shortages, and strained public services.⁷⁰ Today, more than 55 percent of the world's population lives in urban areas. The number of cities with over ten million people is increasing, with at least 33 megacities today, mostly in the LIDCs and emerging and developing countries (EDCs) in Asia, Africa, and Latin America.⁷¹

Various factors drive rural-to-urban migration, each

59 International Organization for Migration, "World Migration Report 2015: Urbanization, rural.urban migration and urban poverty" IOM, (2015) https://www.iom.int/sites/g/files/tmzbd1486/files/our_work/ICP/MPR/WMR-2015-Background-Paper-CTacoli-GMcGranahan-DSatterthwaite.pdf

60 International Organization for Migration, "World Migration Report 2015: Urbanization, rural.urban migration and urban poverty" IOM, (2015)

61 International Organization for Migration, "World Migration Report 2015: Urbanization, rural.urban migration and urban poverty" IOM, (2015)

62 Dr. Benjamin Etzold, "Migrants Turn Cities at the Crossroads into Transient Urban Spaces," *Transient Spaces* (November, 2019), <https://doi.org/10.34834/2019.0005>.

63 Dr. Benjamin Etzold, "Migrants Turn Cities at the Crossroads into Transient Urban Spaces," *Transient Spaces* (November, 2019),

64 Thu Hien Dao et al., «Global Migration in the 20th and 21st Centuries: The Unstoppable Force of Demography», Fondation Pour Les Études Et Recherches Sur Le Développement International, 2010, <https://ferdi.fr/dl/df-Zk26mfKfrFAbx6eLN4wnhGRa/ferdi-p223-global-migration-in-the-20th-and-21st-centuries-the-unstoppable.pdf>.

65 Thu Hien Dao et al., «Global Migration in the 20th and 21st Centuries: The Unstoppable Force of Demography», Fondation Pour Les Études Et Recherches Sur Le Développement International, 2010,

66 International Organization for Migration, "World Migration Report 2015: Urbanization, rural.urban migration and urban poverty" IOM, (2015)

67 Bahira Sherif Trask, «Migration, Urbanization, and the Family Dimension», Department Of Economic And Social Affairs (UNDESA) (Division for Inclusive Social Development (DISD), May 2022), <https://www.un.org/development/desa/family/wp-content/uploads/sites/23/2022/04/Migration-Urbanization-and-the-Family-Dimension-by-Bahira-Trask.pdf>.

68 Bahira Sherif Trask, «Migration, Urbanization, and the Family Dimension», Department Of Economic And Social Affairs (UNDESA) (Division for Inclusive Social Development (DISD), May 2022),

69 Bahira Sherif Trask, «Migration, Urbanization, and the Family Dimension», Department Of Economic And Social Affairs (UNDESA) (Division for Inclusive Social Development (DISD), May 2022)

70 Bahira Sherif Trask, «Migration, Urbanization, and the Family Dimension», Department Of Economic And Social Affairs (UNDESA) (Division for Inclusive Social Development (DISD), May 2022)

71 "Urban Growth - Urban Populations - OCR - GCSE Geography Revision - OCR - BBC Bitesize," BBC Bitesize, February 1, 2023, <https://www.bbc.co.uk/bitesize/guides/z24ksg8/revision/1>.

contributing to the movement of people from the countryside to cities. This happens because of push and pull factors, which are things that make people want to leave rural areas and things that attract people to the city.⁷² These push factors include unemployment, lower wages, poor living conditions, few facilities, natural disasters, and poor health and education services. The pull factors include more jobs, higher wages, better living conditions, education and health services, better facilities, and fewer natural disasters. Rural areas often lack the diverse job markets in cities, leading individuals to migrate and find employment. Urban areas typically offer higher wages and a broader range of job opportunities in manufacturing, services, and technology sectors. This economic pull is a major reason people move to cities to improve their living standards.

Another cause is the disparity in access to education and healthcare. Rural regions frequently have limited educational facilities and healthcare services, which can significantly affect the inhabitants' quality of life. On the other hand, cities tend to provide better access to higher-quality education and comprehensive healthcare services. Families may choose to move to urban areas to ensure their children receive a good education and a healthier lifestyle.

As megacities continue to grow and face complex challenges, technology offers promising solutions worldwide to revolutionize urban living. The second generation of urban infrastructure development was the second industrial revolution, which laid the foundation for much of our current urban infrastructure and building systems.⁷³ Many of these technologies developed during that time, such as indoor plumbing, electricity, the telephone, and the internal combustion engine, formed the basis for modern cities. However, these were developed without considering

today's challenges of resource scarcity and the scale of urban environments., considering the high costs.⁷⁴ As populations increase, these urban landscapes face escalating demands on infrastructure, sustainability, and governance. That's why technologies like smart grids, satellite communication, and rooftop heating and cooling systems emerged as a response to optimize resource allocation, environmental resilience, and improving the quality of life of millions of inhabitants.

Environmental Consequences of Urbanization

As cities grow rapidly due to the intensification of urban growth, there are significant struggles for local governments in terms of public services, community relations, finance, and the environment. One of these threats is the struggle to provide the necessary services to all residents, such as clean water, sanitation, and health, which leads to an increase in poverty.⁷⁵ Consequently, this creates disparities among its inhabitants, which weakens the social aspect of the city. Moreover, the energy used results in greater air pollution, specially created by industrial activities, vehicles, and energy production. This has a huge impact on human health, causing respiratory issues, cardiovascular diseases, and other health problems.⁷⁶ In addition, vehicles contribute to elevated lead levels in urban air. Exposure to this chemical is particularly harmful to children, causing developmental issues, learning disabilities, and other health issues.⁷⁷ Furthermore, large volumes of uncollected waste in cities can spread diseases and contaminate water sources.⁷⁸ Additionally, urban development can increase the risk of environmental hazards such as flash flooding because the materials used prevent proper water drainage.⁷⁹ Pollution and physical barriers to root growth are also threats that can result in the loss of urban tree cover. Trees are crucial to maintaining air quality, providing shade,

72 "Urban populations-OCR", BBC, accessed June 30, 2024, <https://www.bbc.co.uk/bitesize/guides/z24ksg8/revision/1>.

73 Saeid Saidi et al., «Integrated Infrastructure systems—A Review», *Sustainable Cities And Society* 36 (1 de enero de 2018): 1-11, <https://doi.org/10.1016/j.scs.2017.09.022>.

74 "Megacities and Innovative Technologies," Mega-cities Project, accessed June 30, 2024, <https://megacitiesproject.org/projects/megacities-and-innovative-technologies/>.

75 National Geographic. "Urban Threats." *National Geographic*, accessed June 30, 2024. <https://www.nationalgeographic.com/environment/article/urban-threats#>

76 National Geographic. "Urban Threats." *National Geographic*, accessed June 30, 2024. <https://www.nationalgeographic.com/environment/article/urban-threats#>

77 National Geographic. "Urban Threats." *National Geographic*, accessed June 30, 2024. <https://www.nationalgeographic.com/environment/article/urban-threats#>

78 National Geographic. "Urban Threats." *National Geographic*, accessed June 30, 2024. <https://www.nationalgeographic.com/environment/article/urban-threats#>

79 National Geographic. "Urban Threats." *National Geographic*, accessed June 30, 2024. <https://www.nationalgeographic.com/environment/article/urban-threats#>



Air pollution in Hong Kong
Credit: Yym1997

and supporting urban biodiversity. This loss increases the heat island effect. Lastly, urbanization inhibits animal populations through exposure to toxic substances, collisions with vehicles, and the loss of habitat and food sources., which affects the ecological balance.

Urbanization has drastically changed where people live by concentrating over half of the global population in less than one percent of the Earth's surface area.⁸⁰ As a result, a significant water demand is increasingly challenging to meet. With this high population density, natural resources are running low, affecting ecosystem services, which can be defined as benefits that people obtain from ecosystems.⁸¹ Approximately three-quarters of terrestrial environments and around 66 percent of marine environments have been significantly modified by human activities.⁸² Agricultural and livestock production utilize more than one-third of the world's land surface and nearly 75 percent of freshwater resources.⁸³ A third of the fish we catch from the sea are taken too fast to

be sustainable. Every year, 60 billion tons of renewable and nonrenewable resources are extracted.⁸⁴ The main reason for these problems is humanity's increasing demands for food, energy, water, and other resources.

Water scarcity occurs when there's insufficient water for human needs and natural processes. Some factors that influenced it are the reduction of rainfall, how well the land and underground store water, and the amount of water used for various purposes. These factors interact to create water shortages in cities worldwide, highlighting the need to consider ecosystems in managing urban water crises. Water demand exceeds supply in 12 major cities like Cairo, Delhi, and Jakarta, affecting 178 million people. For instance, these cities face a deficit of 5.27 billion cubic meters annually, and by 2035, this could be better if there is better water management. Climate change further threatens these vulnerable water supplies.

Megacities also face significant population pressure, which

80 Rodrigues, Elaine Aparecida, Maurício Lamano Ferreira, Amanda Rodrigues de Carvalho, José Oscar William Vega Bustillos, Rodrigo Antonio Braga Moraes Victor, Marcelo Gomes Sodré, and Delvonei Alves de Andrade. "Land, water, and climate issues in large and megacities under the lens of nuclear science: An approach for achieving sustainable development goal (SDG11). *MDPI Sustainability* 14, no. 20 (October 2022): 13646. <https://doi.org/10.3390/su142013646>

81 Rodrigues, Elaine Aparecida, et. al, "Land, water, and climate issues in large and megacities under the lens of nuclear science: An approach for achieving sustainable development goal (SDG11). *MDPI Sustainability* 14, no. 20 (October 2022): 13646. <https://doi.org/10.3390/su142013646>

82 Rodrigues, Elaine Aparecida, et. al, "Land, water, and climate issues in large."

83 Rodrigues, Elaine Aparecida, et. al, "Land, water, and climate issues in large."

84 Rodrigues, Elaine Aparecida, et. al, "Land, water, and climate issues in large."

has led to overcrowding, inadequate infrastructure, housing shortages, and strain on urban services.⁸⁵ For example, in cities in India like Mumbai, Delhi, Kolkata, and Chennai, the growth of slums and informal settlements alongside urbanization exacerbates issues of poverty and social marginalization.⁸⁶ Regarding environmental implications, urbanization in India contributes to land conversion, deforestation, soil degradation, and fragmentation of natural habitats, which reduces biodiversity.⁸⁷ This process involves significant emissions of pollutants such as volatile organic compounds (VOCs), greenhouse gasses (GHGs), and particulate matter (PM), leading to poor air quality, smog formation, and health problems for urban residents. The use of materials like concrete and asphalt in urban areas leads to the “urban heat island effect,” where cities experience higher temperatures compared to nearby rural regions.⁸⁸ Urbanization and industrialization are the primary drivers of this effect. Many urban areas experience higher temperatures compared to their surroundings of rural areas, especially at night. It’s like cities are warmer islands with cooler landscapes around them.

Moreover, there are two types of Urban Heat Island: Surface and Atmospheric.⁸⁹ The first occurs when urban surfaces, roofs, and pavements absorb heat during the day. These types of surfaces get more sunlight compared to shaded rural areas, causing temperatures to rise, which is why this effect is strongest during the daytime. On the other hand, Atmospheric Urban Heat Island occurs when the air in urban areas becomes warmer than the air near rural areas. This is divided into Canopy Layer UHI and Boundary Layer UHI. The first extends from the

ground up to the top of the trees or rooftops, while the second starts from the top of roofs or tree canopies and goes up until the urban influence in the atmosphere diminishes.

Water Scarcity and Contamination

Water is a vital and limited resource that plays a crucial role in the global socio-economic prosperity of millions of people, particularly for those living in densely populated cities and urban areas.⁹⁰ As urbanization continues to accelerate, it is projected that by 2050 the urban population will increase by two to three billion people. Therefore, it is expected that urban land cover will expand to 1.2 million km².⁹¹ This urban growth has significantly impacted water management, decreasing infiltration, increasing groundwater extractions, and increasing the discharge of contaminants and industrial wastes into both surface and groundwater systems.⁹² Moreover, climatic factors like rising temperatures alter rainfall patterns, especially during extreme wet and dry spells. These climatic and land-use changes pose a serious threat to urban hydrology by altering natural watersheds.⁹³

Cities house around 57 percent of the global population and play a fundamental role in achieving the UN Sustainable Development Goals.⁹⁴ Of the 304 large cities, 90 percent faced water risks in 2015, which was about three times the number of cities facing scarcity risk, and nearly a quarter faced both scarcity and contamination risks.⁹⁵ There was a projection that from 2015 to 2050, 88.8 percent of cities will face increasing water risks, with one-third of these cities

85 Sandeep K. Tyagi, Vikas Kumar, Kuldeep Kumar, and Dharmendra Kumar, “Environmental health quality and the consequences of urbanization: a review,” *International Journal of Advances in Agricultural Science and Technology* 10, no. 5 (May 2023): 13-23, <https://www.researchgate.net/profile/Vikas-Kumar-79/publication/371139412>

86 Tyagi, Kumar, Kumar, and Kumar, “Environmental health quality and the consequences of urbanization: a review,” 13-23.

87 Tyagi, “Environmental health quality.”

88 Tyagi, “Environmental health quality.”

89 Bhargava, A., S. Lakmini, and S. Bhargava, “Urban heat island effect: It’s relevance in urban planning.” *J. Biodivers. Endanger. Species* 5, no. 187 (2017): 2020. <https://doi.org/10.4172/2332-2543.1000187>

90 Madhav, Sugghosh, Abhishek Kumar Bhardwaj, Eugenia Valsami-Jones, and Arun Lal Srivastav, eds. *Urban Water Crisis and Management: Strategies for Sustainable Development*. 1st edition, Elsevier, 2022. <https://books.google.com.pe/books?hl=en&lr=&id=xzJcEAAAQBAJ&oi=fnd&pg=PP1>

91 Sugghosh Madhav, Abhishek Kumar Bhardwaj, Eugenia Valsami-Jones, and Arun Lal Srivastav, eds. *Urban Water Crisis and Management: Strategies for Sustainable Development*.

92 Sugghosh Madhav, Abhishek Kumar Bhardwaj, Eugenia Valsami-Jones, and Arun Lal Srivastav, eds. *Urban Water Crisis and Management: Strategies for Sustainable Development*.

93 Sugghosh Madhav, Abhishek Kumar Bhardwaj, Eugenia Valsami-Jones, and Arun Lal Srivastav, eds. *Urban Water Crisis and Management: Strategies for Sustainable Development*.

94 Liu, Zhifeng, Jiahe Ying, Chunyang He, Dongjie Guan, Xinhao Pan, Yihua Dai, Binghua Gong et al. “Scarcity and quality risks for future global urban water supply.” *Landscape Ecology* 39, no. 2 (2024): 10 <https://doi.org/10.1007/s10980-024-01832-0>

95 Liu, Ying, He, Guan, Pan, Dai, Gong et al. “Scarcity and quality risks for future global urban water supply,” 10.

will face dual risks by 2050.⁹⁶ From 1950 to 2020, the global urban population living in cities increased to 44.4 billion and is projected to reach 6.7 billion by 2050.⁹⁷ Potential solutions to water scarcity, like groundwater exploitation, seawater desalination, increased water storage, improved water-use efficiency, and urban landscape management, depend on many factors, like the severity of water scarcity, urban and regional geography, socio-economic characteristics, and environmental carrying capacity.⁹⁸ This emphasizes the vital need for urban water management strategies to maintain sustainability and resilience.

Human activities and climate change are seriously impacting urban water supply quantity and quality of water availability in cities. When it comes to the quantity of water, the increasing urban population, economic growth, and rising demands from industries, agriculture, and households are some of the causes that are leading to the rise in water scarcity.⁹⁹ On the other hand, the quality of urban water is deteriorating because of pollutants like nutrients, chemicals, and sediments from activities such as urban expansion, manufacturing, heavy industry, agriculture, and mining that are reducing the availability of clean water.¹⁰⁰ Given these challenges, assessing the combined effects of human pressures and climate change on global urban water scarcity and quality risks is urgent. This integrated approach is essential to identify the effective measures to maintain the urban water security.¹⁰¹ Such assessment will help to formulate strategies to have a more effective management of water resources and support

the achievement of the UN Sustainable Development Goals, especially Goals 6, 14, and 15.¹⁰²

For example, 11 megacities, including Sao Paulo, Mumbai, and Dhaka, are facing very high water quality risks.¹⁰³ Meanwhile, five megacities, including Delhi, Beijing, Los Angeles, Moscow, and Bangalore, are experiencing very high water scarcity risks.¹⁰⁴ Bangalore, in particular, is confronting critical issues in both water scarcity and quality.¹⁰⁵ In contrast, water security risks were generally lower in high-income and upper-middle-income countries because they have more resources to invest in advanced water management technologies, infrastructure, and treatment facilities.¹⁰⁶ Additionally, these countries tend to benefit from more economic stability and greater access to financial resources.¹⁰⁷ Looking at the future, it is projected that 25 to 27 megacities will face rising risks to water security.¹⁰⁸ Of these, 70.4 percent to 85.2 percent will experience increasing risks to water quality, almost 70.4 percent to 100 percent will face rising scarcity risk, and 48.1 percent to 81.5 percent will face risks related to both water scarcity and quality.¹⁰⁹ Low-income and lower-middle-income countries face a more serious urban water security risk compared to high-income and upper-middle-income countries.¹¹⁰

Pollutants released from various sources can severely affect the physical, chemical, and biological quality of urban water.¹¹¹ Physical water pollution can be caused by temperature, color, turbidity, and suspended materials in the water.¹¹² A significant source of this form of pollution is the discharge from power

96 Liu, Ying, He, Guan, Pan, Dai, Gong et al. "Scarcity and quality risks for future global urban water supply," 10.

97 He, Chunyang, Zhifeng Liu, Jianguo Wu, Xinhao Pan, Zihang Fang, Jingwei Li, and Brett A. Bryan. "Future global urban water scarcity and potential solutions." *Nature Communications* 12, no. 1 (2021): 4667. <https://www.nature.com/articles/s41467-021-25026-3>

98 He, Chunyang, Zhifeng Liu, Jianguo Wu, Xinhao Pan, Zihang Fang, Jingwei Li, and Brett A. Bryan. "Future global urban water scarcity and potential solutions." *Nature Communications* 12, no. 1 (2021): 4667. <https://www.nature.com/articles/s41467-021-25026-3>

99 Liu, Ying, He, Guan, Pan, Dai, Gong et al. "Scarcity and quality risks for future global urban water supply," 10.

100 Liu, "Scarcity and quality risks for future global urban water supply."

101 Liu, "Scarcity and quality risks for future global urban water supply."

102 Liu, "Scarcity and quality risks for future global urban water supply."

103 Liu, "Scarcity and quality risks for future global urban water supply."

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107 Liu, "Scarcity and quality risks for future global urban water supply."

108 Liu, "Scarcity and quality risks for future global urban water supply."

109 Liu, "Scarcity and quality risks for future global urban water supply."

110 Liu, Ying, He, Guan, Pan, Dai, Gong et al. "Scarcity and quality risks for future global urban water supply," 10.

111 Sugghosh Madhav, Abhishek Kumar Bhardwaj, Eugenia Valsami-Jones, and Arun Lal Srivastav, eds. *Urban Water Crisis and Management: Strategies for Sustainable Development*.

112 Sugghosh Madhav, Abhishek Kumar Bhardwaj, Eugenia Valsami-Jones, and Arun Lal Srivastav, eds. *Urban Water Crisis and Management: Strategies for Sustainable Development*.

plants.¹¹³ Chemically, natural water contains both beneficial and harmful chemical compounds for human health; however, pollution introduces a wide range of toxins into surface and groundwater systems.¹¹⁴ Finally, biological pollution refers to pathogens such as bacteria, viruses, and parasites that can infiltrate urban water systems, primarily through stormwater and untreated wastewater.¹¹⁵

Urbanization significantly affects water resources by increasing contamination and scarcity. As cities expand, they release contaminants into surface water, which not only raises the volume of polluted runoff but also deteriorates water quality.¹¹⁶ As a consequence, this process leads to a dramatic drop in groundwater levels, intensified by the loss of permeable surfaces due to urban structures, roadways, and services.¹¹⁷ This loss reduces the water that seeps into the ground, increasing surface runoff and causing floods in urban areas.¹¹⁸ Additionally, the discharge of pollutants from vehicle emissions and unplanned disposal practices, such as pharmaceuticals, food additives, disinfectants, heavy metals, microplastics, and organic contaminants, hurt water supplies in megacities.¹¹⁹ Also, this waste ends up in groundwater, lakes, oceans, etc.¹²⁰ The growing population in megacities, which are driven by potential facilities such as modern water supplies and quicker servicing opportunities, which attract rural people to migrate to urban spaces, have an increasing demand for water every day.¹²¹ However, city infrastructures have needed help to keep up with this rapid growth. Resulting in inadequate access to potable water and proper sanitation.¹²²

This is particularly evident in various megacities in India, where severe water scarcity has worsened due to massive urbanization, city expansion, and high population densities.¹²³

The growing demand for water is expected to be the main cause of rising water scarcity risks for cities, with population growth being the main contributing factor.¹²⁴ Other factors include the expansion of cropland fertilization, urban areas, and pastureland.¹²⁵ Additionally, landscape sustainability is deeply impacted by these challenges. Green spaces and water bodies are crucial to providing ecosystem services and improving

human well-being in urban environments.¹²⁶ It is recommended that these areas be expanded to improve urban landscape sustainability. However, this approach can lead to higher water consumption and exacerbate urban water scarcity in arid regions.¹²⁷ Alterations in the landscape patterns of urban water sources can directly affect water-related ecosystem services, affecting both the quantity and quality of urban water supply.¹²⁸ As of 2015, nearly 90 percent of the world's largest cities in 2015 continued to face water quality risks due to degraded water source landscapes, underscoring the need for balanced and sustainable water management strategies.¹²⁹

Demographic and environmental challenges, such as urban and population growth, are the leading cause of vulnerability of water resources.¹³⁰ Rapid population growth often puts pressure on the oldest systems of the city center, testing the

113 Sughosh Madhav, Abhishek Kumar Bhardwaj, Eugenia Valsami-Jones, and Arun Lal Srivastav, eds. *Urban Water Crisis and Management: Strategies for Sustainable Development*.

114 Sughosh Madhav, Abhishek Kumar Bhardwaj, Eugenia Valsami-Jones, and Arun Lal Srivastav, eds. *Urban Water Crisis and Management: Strategies for Sustainable Development*.

115 Sughosh Madhav, Abhishek Kumar Bhardwaj, Eugenia Valsami-Jones, and Arun Lal Srivastav, eds. *Urban Water Crisis and Management: Strategies for Sustainable Development*.

116 Ghosh, Dipankar, Palash Ghorai, and Sudipta Dutta. "Comparative analysis of water supply systems in megacities in developed and developing countries." In *Current Directions in Water Scarcity Research*, vol. 6, pp. 65-83. Elsevier, 2022. <https://doi.org/10.1016/B978-0-323-91838-1.00007-5>

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123 Ghosh, "Comparative analysis of water supply systems."

124 Liu, Ying, He, Guan, Pan, Dai, Gong et al. "Scarcity and quality risks for future global urban water supply," 10.

125 Liu, Ying, He, Guan, Pan, Dai, Gong et al. "Scarcity and quality risks for future global urban water supply," 10.

126 Liu, Ying, He, Guan, Pan, Dai, Gong et al. "Scarcity and quality risks for future global urban water supply," 10.

127 Liu, Ying, He, Guan, Pan, Dai, Gong et al. "Scarcity and quality risks for future global urban water supply," 10.

128 Liu, Ying, He, Guan, Pan, Dai, Gong et al. "Scarcity and quality risks for future global urban water supply," 10.

129 Liu, Ying, He, Guan, Pan, Dai, Gong et al. "Scarcity and quality risks for future global urban water supply," 10.

130 UNESCO, "Water, megacities and global change: portraits of 15 emblematic cities of the world," <https://unesdoc.unesco.org/>

reliability of municipal services, including water delivery systems.¹³¹ Another challenge for megacities is the demand for drinking water.¹³² For example, in Mumbai, the water distribution system is nearly non-existent in slum areas, which house 56 percent of the city's population.¹³³ Similar happens in the city of Lagos, where the public operator, Lagos Water Corporation (LCW), produces only 349000 m³, which is below the daily demand of 2.9 million m³.¹³⁴ In response, over 200 shantytowns, which are home to two-thirds of the population, have developed their water systems or get water from private sources that operate boreholes and dug wells.¹³⁵ Consequently, there is an entirely disorganized system failing to meet the demands of the population.¹³⁶

To address water security challenges, states have committed to implement integrated water resources management (IWEM) systems in specific areas by 2030 as part of the Sustainable Development Goals.¹³⁷ IWRM is a comprehensive approach based on the four key principles of the 1992 Dublin Statement on Water and Sustainable Development.¹³⁸ This is recognized as the first base of fresh water, which is a limited and essential resource for life, development, and the environment. Therefore, managing and developing water resources should involve a collaborative approach, engaging users, planners, and policy-makers at all levels.¹³⁹ Additionally, women play a central role in providing, managing, and protecting water

resources. Lastly, water should be recognized as an economic good due to its importance across multiple uses.¹⁴⁰ Five factors should be taken into consideration to manage water resources effectively. The first one is socio-demographic, which ensures that everyone has access to water and sanitation.¹⁴¹ The second factor is economic, which deals with the water demands and how much money is spent on water services (budget).¹⁴² The third one is technological, which looks at whether the infrastructure for water supply and sanitation is good enough (WSS).¹⁴³ Fourth, environmental factors refer to issues such as climate change, how land is used, water pollution, and contamination.¹⁴⁴ Lastly, governance factors involve setting up institutional frameworks, plans or strategies and performance to make sure water management is done well.¹⁴⁵

Transportation and Mobility

The global transportation sector is facing critical issues that need immediate attention. Fossil fuel-powered vehicles are one of the main contributors to climate change. The combustion of fossil fuels generates gasoline and diesel, which releases carbon dioxide (CO₂) and other greenhouse gasses into the atmosphere.¹⁴⁶ This traps heat and raises global temperatures.¹⁴⁷ This raises the need for sustainable transportation, which includes modes of transport that are energy efficient, low or zero emission, and affordable.¹⁴⁸ The

ark:/48223/pf0000245419.

131 UNESCO, "Water, megacities and global change: portraits of 15 emblematic cities of the world," <https://unesdoc.unesco.org/ark:/48223/pf0000245419>.

132 UNESCO, "Water, megacities and global change: portraits of 15 emblematic cities of the world," <https://unesdoc.unesco.org/ark:/48223/pf0000245419>.

133 UNESCO, "Water, megacities and global change: portraits of 15 emblematic cities of the world," <https://unesdoc.unesco.org/ark:/48223/pf0000245419>.

134 UNESCO, "Water, megacities and global change: portraits of 15 emblematic cities of the world," <https://unesdoc.unesco.org/ark:/48223/pf0000245419>.

135 UNESCO, "Water, megacities and global change: portraits of 15 emblematic cities of the world," <https://unesdoc.unesco.org/ark:/48223/pf0000245419>.

136 UNESCO, "Water, megacities and global change: portraits of 15 emblematic cities of the world," <https://unesdoc.unesco.org/ark:/48223/pf0000245419>.

137 Edo, Elena, Goncha Sadayeva, Nesma Hassan, "MENA Megacities Approaching Day Zero," <https://ic-sd.org/wp-content/uploads/2020/11/Elena-Edo.pdf>.

138 Edo, "MENA Megacities Approaching Day Zero."

139 Edo, "MENA Megacities Approaching Day Zero."

140 Edo, "MENA Megacities Approaching Day Zero."

141 Edo, "MENA Megacities Approaching Day Zero."

142 Edo, "MENA Megacities Approaching Day Zero."

143 Edo, "MENA Megacities Approaching Day Zero."

144 Edo, "MENA Megacities Approaching Day Zero."

145 Edo, "MENA Megacities Approaching Day Zero."

146 Etukudoh, Emmanuel Augustine, Adedayo Adefemi, Valentine Ikenna Ilojiyana, Aniekian Akpan Umoh, Kenneth Ifeanyi Ibekwe, and Zamathula Queen Sikhakhane Nwokiedigwu, "A Review of sustainable transportation solutions: Innovations, challenges, and future directions," *World Journal of Advanced Research and Reviews* 21, no. 1 (2024): 1440-1452, <https://doi.org/10.30574/wjarr.2024.21.1.0173>.

147 Etukudoh, "A Review of sustainable transportation solutions."

148 Etukudoh, "A Review of sustainable transportation solutions."

goal is to minimize the negative impact on the environment while supporting mobility needs.¹⁴⁹ Sustainable transportation offers benefits like saving costs on fuel and vehicles, reducing greenhouse gas emissions, and improving air quality.¹⁵⁰ Therefore, governments and organizations, such as the United Nations Sustainable Transport Conference, are taking steps to promote sustainable transportation.¹⁵¹ Public transit, such as buses, trains, and other forms of public transit, is a crucial component of sustainable urban development because it offers alternatives to private vehicles, promotes efficiency, reduces traffic congestion, and cuts emissions.¹⁵²

While transport has brought many benefits and is needed in today's society, its development has also negatively impacted the environment. The growth of fuel consumption, traffic congestion, and the rising number of accidents are key issues.¹⁵³ Also, passenger traffic is expected to be 80000 billion passenger kilometers, highlighting the growing demand for mobility.¹⁵⁴ To address this, many actors have made voluntary financial and operational contributions to support sustainable mobility.¹⁵⁵ Transport is responsible for 23 percent of energy-related greenhouse gas emissions (GHG).¹⁵⁶ To tackle this, multilateral development banks have committed over USD 175 billion in loans and grants for transportation projects in developing countries over the next decade.¹⁵⁷ Additionally, the Lima-Paris-Agenda has initiated 15 transport projects aiming to reduce the carbon footprint by 2025.¹⁵⁸ Car emissions and weather conditions are the main factors that affect pollution

levels in urban areas.¹⁵⁹ Furthermore, urbanization has increased the need for mobility, expanded trade, and improved accessibility worldwide, leading to more transportation in urban areas.¹⁶⁰ By 2050, the number of vehicles on the road will double to one billion.¹⁶¹ As a result, cars and vehicles contribute to heat emissions, which worsen the "urban heat island" effect, where intense heat waves impact society.¹⁶² Consequently, This creates a great demand for summer cooling and air conditioning in buildings.¹⁶³ Ultimately, thermal loads could double due to this effect, and the efficiency of air conditioning systems could be reduced by 25 percent.¹⁶⁴

Megacities are the future of urbanization, as these areas are commonly connected by advanced transportation and information networks.¹⁶⁵ The formation of a megacity relies on developed and efficient urban transport infrastructure to build solid socio-economic connections between the central region and the outlying regions.¹⁶⁶ Central regions have good communication and high population density, leading to prosperity, while outlying regions have poor communications and sparse population.¹⁶⁷ In the case of Singapore, their efficient bus network has transformed the public transport system.¹⁶⁸ Their strategic route planning considers the needs of diverse communities, and the network is designed to cover key residential, commercial, and industrial areas, ensuring significant accessibility.¹⁶⁹ Consequently, this reduces the need for private vehicles, especially in urban areas where residents can rely on the bus network for their daily routine, cutting

149 Etukudoh, "A Review of sustainable transportation solutions."
 150 Etukudoh, "A Review of sustainable transportation solutions."
 151 Etukudoh, "A Review of sustainable transportation solutions."
 152 Etukudoh, "A Review of sustainable transportation solutions."
 153 Haddad Louiza, Aouachria Z roual, Haddad Djamel, "Impact of the Transport on the Urban Heat Island," *International Journal for Traffic and Transport Engineering* 5, no. 3 (February 2015): 252-259, [http://dx.doi.org/10.7708/ijtte.2015.5\(3\).03](http://dx.doi.org/10.7708/ijtte.2015.5(3).03)
 154 World Bank, *Sustainable Transport at the Heart of the Sustainable Development Goals* (Ashgabat, November, 2016), <https://sdgs.un.org/sites/default/files/documents/11686Thematic%2520discussion%25201%2520concept%2520note.pdf>.
 155 World Bank, *Sustainable Transport at the Heart of the Sustainable Development Goals*.
 156 World Bank, *Sustainable Transport at the Heart of the Sustainable Development Goals*.
 157 World Bank, *Sustainable Transport at the Heart of the Sustainable Development Goals*.
 158 World Bank, *Sustainable Transport at the Heart of the Sustainable Development Goals*.
 159 Louiza, Z roual, Djamel, "Impact of the Transport on the Urban Heat Island," 252-263.
 160 Louiza, Z roual, Djamel, "Impact of the Transport on the Urban Heat Island," 252-263.
 161 World Bank, *Sustainable Transport at the Heart of the Sustainable Development Goals*.
 162 Louiza, Z roual, Djamel, "Impact of the Transport on the Urban Heat Island," 252-263.
 163 Louiza, Z roual, Djamel, "Impact of the Transport on the Urban Heat Island," 252-263.
 164 Louiza, Z roual, Djamel, "Impact of the Transport on the Urban Heat Island," 252-263.
 165 Zhangyuan He, Qiyang Liu, and Pengjun Zhao, "Challenges of passenger and freight transportation in mega-city regions: A systematic literature review," *Transportation Research Interdisciplinary Perspectives* 16 (December, 2022): 100730, <https://doi.org/10.1016/j.trip.2022.100730>
 166 He, Liu, and Zhao, "Challenges of passenger and freight transportation in mega-city regions: A systematic literature review," 100730.
 167 He, Liu, and Zhao, "Challenges of passenger and freight transportation in mega-city regions: A systematic literature review," 100730.
 168 Etukudoh, "A Review of sustainable transportation solutions."
 169 Etukudoh, "A Review of sustainable transportation solutions."

down traffic congestion and lowering carbon emissions.¹⁷⁰

The electric vehicle (EV) revolution is transforming transportation with advantages in battery technology and infrastructure development, making it easier for more people to start using it.¹⁷¹ Cities around the world are increasingly embracing EVs over traditional vehicles, regarding their environmental benefits.¹⁷² This shift represents a move towards more sustainable and reliable transportation.¹⁷³ One example is Oslo, Norway, which has emerged as a leader in electric mobility, earning the title “Electric Vehicle Capital” due to its strategic incentives, extensive infrastructure development, and supportive policies.¹⁷⁴ These incentives, including access to bus lanes and a strong charging network, align with Oslo’s environmental goals and offer a model for the cities that are struggling with urban and environmental challenges.¹⁷⁵ Similarly, Amsterdam, Netherlands, is using electric boats on its canals, which run on clean energy, to reduce water pollution and improve the environment.¹⁷⁶ This shows that electric transportation is not just for cars but can be applied in different aspects of city life.¹⁷⁷

Urban Planning

Most cities commonly have different noises, from traffic to construction. It is estimated that new structures equivalent to the size of Paris are built every five days.¹⁷⁸ How we construct and operate buildings could be more sustainable. According to a recent report from the United Nations Environment

Programme (UNEP), in 2022, energy-related carbon dioxide emissions from building operations and construction reached ten gigatonnes, accounting for 37 percent of global carbon dioxide emissions.¹⁷⁹ The Acting Chief of Climate Mitigation at UNEP mentioned that “reducing the carbon footprint of our homes, offices and other buildings will be essential to meet the targets of the Paris Agreement and averting a climate catastrophe.”¹⁸⁰ It emphasizes that although people inhabit buildings, they are a main contributor to global carbon dioxide emissions, which trap heat and contribute to climate change.¹⁸¹ Therefore, making buildings more energy-efficient and sustainable is essential to reduce these emissions.

Urbanization has increased global wealth, with cities generating 80 percent of the world’s economy.¹⁸² However, poorly planned and managed urbanization has left a billion people living in slums with inadequate and often unstable living conditions.¹⁸³ If this is handled correctly, this process can help tackle major global challenges such as poverty, inequality, environmental degradation, climate change, fragility and conflict.¹⁸⁴ To ensure a positive impact, cities must understand their progress towards achieving the Sustainable Development Goals (SDGs), where they also need support in translating performance data into strategic plans.¹⁸⁵ This support includes developing, financing, and implementing targeted actions that can accelerate the achievement of SDGs and improve the well-being of all.¹⁸⁶

170 Etukudoh, “A Review of sustainable transportation solutions.”

171 Etukudoh, “A Review of sustainable transportation solutions.”

172 Etukudoh, “A Review of sustainable transportation solutions.”

173 Etukudoh, “A Review of sustainable transportation solutions.”

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175 Etukudoh, “A Review of sustainable transportation solutions.”

176 Etukudoh, “A Review of sustainable transportation solutions.”

177 Etukudoh, “A Review of sustainable transportation solutions.”

178 “Why Making Buildings Greener is Crucial for Countering Climate Change,” UNEP, last modified June 20, 2024, <https://www.unep.org/news-and-stories/story/why-making-buildings-greener-crucial-countering-climate-change>

179 UNEP, “Why Making Buildings Greener is Crucial for Countering Climate Change.”

180 UNEP, “Why Making Buildings Greener is Crucial for Countering Climate Change.”

181 UNEP, “Why Making Buildings Greener is Crucial for Countering Climate Change.”

182 UN-Habitat. “Sustainable Development Goals Cities.” Accessed June 30, 2024. <https://unhabitat.org/programme/sustainable-development-goals-cities>

183 UN-Habitat. “Sustainable Development Goals Cities.” Accessed June 30, 2024. <https://unhabitat.org/programme/sustainable-development-goals-cities>

184 UN-Habitat. “Sustainable Development Goals Cities.” Accessed June 30, 2024. <https://unhabitat.org/programme/sustainable-development-goals-cities>

185 UN-Habitat. “Sustainable Development Goals Cities.” Accessed June 30, 2024. <https://unhabitat.org/programme/sustainable-development-goals-cities>

186 UN-Habitat. “Sustainable Development Goals Cities.” Accessed June 30, 2024. <https://unhabitat.org/programme/sustainable-development-goals-cities>



Sustainable architecture in Bangladesh
 Credit: Shafiul Islam Shaikot

The main reasons for high emissions from buildings are operational and embodied carbon.¹⁸⁷ The first arises from the great energy used for heating, cooling, and lighting buildings. It is estimated that in 2022, this sector accounted for 34 percent of the world’s power consumption.¹⁸⁸ In many countries, energy is still generated from fossil fuels like coal and oil, which release carbon dioxide when burned.¹⁸⁹ The second one comes from the energy-intensive production of materials like steel, cement, aluminum, and glass, as well as the transportation and installation, generating more carbon dioxide emissions.¹⁹⁰ Despite the efforts to decarbonize, emissions are still rising, increasing by one percent between 2021 and 2022, equivalent to adding 10 million cars to the world’s roads.¹⁹¹ The sector remains off track to achieve decarbonization by 2050, with only six percent of the energy used in buildings coming from renewable sources in 2022.¹⁹² Given that half of the buildings that will exist by 2050 are not yet built, it is crucial to make near-zero-emission and resilient

buildings the standard practice by 2030 to avoid more extreme weather conditions.¹⁹³

To reduce operational carbon emissions, buildings must become more efficient by reducing the energy used for heating and cooling.¹⁹⁴ This can be done by using more efficient appliances, improving energy planning and system integration, and increasing the use of renewable energy.¹⁹⁵ More investments in making climate-friendly buildings must be made, even though the current spending on decarbonizing structures is at USD 285 billion, according to the Global Status Report for Buildings and Construction.¹⁹⁶ However, that number is already short for future targets between 2030 and 2050.¹⁹⁷

On the other hand, to tackle embodied emissions, there is a three-part approach: avoid, shift, and improve.¹⁹⁸ The first part, “Avoid,” involves using fewer materials, reusing building

187 UNEP, “Why Making Buildings Greener is Crucial for Countering Climate Change.”
 188 UNEP, “Why Making Buildings Greener is Crucial for Countering Climate Change.”
 189 UNEP, “Why Making Buildings Greener is Crucial for Countering Climate Change.”
 190 UNEP, “Why Making Buildings Greener is Crucial for Countering Climate Change.”
 191 UNEP, “Why Making Buildings Greener is Crucial for Countering Climate Change.”
 192 UNEP, “Why Making Buildings Greener is Crucial for Countering Climate Change,” *United Nations Environmental Programme*, June 20, 2024, <https://www.unep.org/news-and-stories/story/why-making-buildings-greener-crucial-countering-climate-change>
 193 UNEP, “Why Making Buildings Greener is Crucial.”
 194 UNEP, “Why Making Buildings Greener is Crucial.”
 195 UNEP, “Why Making Buildings Greener is Crucial.”
 196 UNEP, “Why Making Buildings Greener is Crucial.”
 197 UNEP, “Why Making Buildings Greener is Crucial.”
 198 UNEP, “Why Making Buildings Greener is Crucial.”

components, and repurposing existing buildings.¹⁹⁹ With this, the energy and emissions associated with producing and transporting the material are decreased, and the waste caused by new material is reduced, reducing construction's impact. The "Shift" refers to using more renewable, sustainably sourced materials like timber and bamboo.²⁰⁰ By shifting these greener materials, the construction sector can lower its reliance on fossil fuels and reduce greenhouse gas emissions. The "Improve" refers to reducing and improving the carbon footprint of traditional materials such as concrete, steel, and aluminum by using renewable energy in the manufacturing process.²⁰¹ Governments can develop and enforce climate action plans in building and construction to lower the carbon footprint they emit and also establish policies to minimize embodied carbon through sustainable practices and materials, especially since 161 nations haven't done it yet.²⁰²

To further enhance sustainability efforts, a 2022 survey on renewable energy systems revealed a strong agreement within the research community about the technical and economic viability of achieving 100 percent renewable energy.²⁰³ It also recognized that wind and solar power are crucial components of these future renewable energy systems.²⁰⁴ Despite the technical, economic, resource, environmental, and other challenges that remain, there is growing support for the feasibility of this concept.²⁰⁵ The urgency for this type of energy (RES) has intensified due to the growing demand and environmental issues linked to the consumption of fossil

fuels.²⁰⁶ For instance, the cost of energy production from solar resources has dropped significantly in recent years.²⁰⁷ Moreover, renewable alternatives such as biofuels and hydrogen fuel, when produced through renewable processes, offer viable replacements for fossil fuels.²⁰⁸ While both have gathered significant attention, biomass is limited and must be used appropriately, but electrofuels are unrestricted by the same limitations.²⁰⁹

To advance sustainable energy planning, there is a ten-step process planning guide that can serve as a comprehensive framework for local action. The first step is for cities to designate a lead office and identify a champion, someone with charisma and influence who will drive the project while involving all city departments.²¹⁰ The next step is to establish partnerships with organizations, NGOs, businesses, and utilities focused on energy efficiency and climate change programs.²¹¹ Following this, aligning the strategies with the city's vision, goals, and policies is crucial. Conducting an energy and greenhouse gas (GHG) audit will provide a clear understanding of the situation.²¹² Based on this information, the next step is to analyze it and develop a draft plan prioritizing the key issues and evaluation solutions according to their benefits.²¹³ Moreover, it will gain support from both the public and city staff to finalize the plan. When implementing and financing it, it is important to avoid short-term perspectives and aim for the greatest impact.²¹⁴ Additionally, to keep the plan on track, regular monitoring and evaluation should be applied

199 UNEP, "Why Making Buildings Greener is Crucial."

200 UNEP, "Why Making Buildings Greener is Crucial."

201 UNEP, "Why Making Buildings Greener is Crucial."

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203 Østergaard, Poul Alberg, Neven Duic, Younes Noorollahi, and Soteris Kalogirou. "Renewable energy for sustainable development." *Renewable energy* 199 (2022): 1145-1152.

204 Østergaard, Poul Alberg, Neven Duic, Younes Noorollahi, and Soteris Kalogirou. "Renewable energy for sustainable development." *Renewable energy* 199 (2022): 1145-1152.

205 Østergaard, Poul Alberg, Neven Duic, Younes Noorollahi, and Soteris Kalogirou. "Renewable energy for sustainable development." *Renewable energy* 199 (2022): 1145-1152.

206 Østergaard, Poul Alberg, Neven Duic, Younes Noorollahi, and Soteris Kalogirou. "Renewable energy for sustainable development." *Renewable energy* 199 (2022): 1145-1152.

207 Østergaard, Poul Alberg, Neven Duic, Younes Noorollahi, and Soteris Kalogirou. "Renewable energy for sustainable development." *Renewable energy* 199 (2022): 1145-1152.

208 Østergaard, Poul Alberg, Neven Duic, Younes Noorollahi, and Soteris Kalogirou. "Renewable energy for sustainable development." *Renewable energy* 199 (2022): 1145-1152.

209 Østergaard, Poul Alberg, Neven Duic, Younes Noorollahi, and Soteris Kalogirou. "Renewable energy for sustainable development." *Renewable energy* 199 (2022): 1145-1152.

210 United Nations Department of Economic and Social Affairs, "Sustainable Urban Energy Planning: A Handbook for Cities and Towns in Developing Countries," 2009, <https://sdgs.un.org/publications/sustainable-urban-energy-planning-handbook-cities-and-towns-developing-countries-17160>.

211 United Nations Department of Economic and Social Affairs, "Sustainable Urban Energy Planning."

212 United Nations Department of Economic and Social Affairs, "Sustainable Urban Energy Planning."

213 United Nations Department of Economic and Social Affairs, "Sustainable Urban Energy Planning."

214 United Nations Department of Economic and Social Affairs, "Sustainable Urban Energy Planning."

alongside effective communication.²¹⁵

Current Status

Smart Megacities Initiatives

Megacities have become centers of wealth creation in recent years, forming 85 percent of the world's GDP.²¹⁶ The effectiveness of planning and development of urban areas determines the well-being of megacities. This includes aspects such as infrastructure and sustainability. Megacities also face the challenge of meeting the needs of the growing populations. To achieve this, megacities need to go through a modernization process. In this process, it is essential to consider technological innovations and modern initiatives that could be useful in making cities smarter. While there are different definitions of smart megacities, one aspect they all have in common is the use of technology. Smart cities are urban areas with a high standard of living that consider data collection to improve the quality of life of their citizens and use technology to improve the efficiency of services.²¹⁷ Local governments in smart cities use new technologies to help with urban planning. Technologies used to collect data are essential to smart city initiatives. The data collected helps the local governments improve urban planning.²¹⁸ The data shows the social problems and, hence, the areas that require more work. Technology is also essential for implementing solutions based on the collected data. Most smart cities use information and communication technologies (ICT) and the Internet of Things (IoT).²¹⁹ ICTs are a set of technological tools used to transmit, store, or share information.²²⁰ Examples of ICTs are computers, phones, radios, and other common media

and daily communications technologies. Internet of Things are physical devices that can interact with little human intervention by connecting to the Internet or Internet through wireless networks.²²¹ IoTs include security cameras, smart watches, irrigation systems, and vehicles. IoTs and ICTs are used to create solutions to manage the assets and processes of a megacity.

Using technology like IoT and ICTs, we can implement smart infrastructure. Infrastructure refers to the basic systems and services used by a country to work effectively.²²² Infrastructure impacts sustainable development, quality of life, and economic growth in urban communities. The development of infrastructure is one of the most important factors in megacities. Good infrastructure can enhance a country's productivity and efficiency.²²³ Countries can analyze data to understand how infrastructure is used and its strains, considered smart infrastructure. Smart infrastructure is highly beneficial to megacities. It can be applied to infrastructure, mobility, and sustainability. Smart cities can also lead to economic growth. Better infrastructure and technological innovation can encourage job creation and business opportunities.²²⁴ Smart infrastructure can also be used to improve society's internal systems. This can lead to a smart society where digital technology improves people's well-being, economic power, and organization. The people in smart megacities need the skills to use the facilities and services. Quality education services are needed to master these skills. Hence, education, specifically digital education, is prioritized in smart cities. Smart infrastructure also promotes the use of smart governance. Governance refers to how countries are managed at the highest level.²²⁵ Smart governance means those

215 United Nations Department of Economic and Social Affairs, "Sustainable Urban Energy Planning."

216 Irina Vaslavskaya et al., "Achieving the principles of sustainable development: implementation of smart solutions in the infrastructure of modern megacities," *E3S Web Conferences* 449 (November 2023): 1-11, <https://doi.org/10.1051/e3sconf/202344905001>.

217 Alice Gomstyn and Alexandra Jonker, "What is a smart city?" November 22, 2023, <https://www.ibm.com/topics/smart-city> 2023.

218 Gomstyn and Jonker, "What is a smart city?"; Vaslavskaya et al., "Achieving the principles of sustainable development: implementation of smart solutions in the infrastructure of modern megacities."

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221 Samuel Greendar, "Internet of Things," last modified on August 10, 2024, <https://www.britannica.com/science/Internet-of-Things>.

222 "Infrastructure," Cambridge, accessed August 24, 2024., <https://dictionary.cambridge.org/dictionary/english/infrastructure>.

223 Vaslavskaya et al., "Achieving the principles of sustainable development: implementation of smart solutions in the infrastructure of modern megacities."

224 Gomstyn and Jonker, "What is a smart city?"

225 Chu Xiao Hui et al., "Greening smart cities: An investigation of the integration of urban natural resources and smart city technologies for promoting environmental sustainability," *Sustainable Cities and Society* 99 (December 2023), <https://doi.org/10.1016/j.scs.2023.104985>.

at the highest management level should apply the highest systems possible and focus on creating new forms of social organizations. This includes e-government, which focuses on increasing transparency by making data available to all.²²⁶

Smart megacities also focus on improving the sustainability of their operations. They have served as a solution for urban challenges and their environmental consequences. Smart cities can use collected data to optimize resource allocation and implement more efficient city services. As a result, smart cities can help cut carbon emissions and contribute to global efforts to address climate change.²²⁷ Smart megacities can reduce the negative impact of urbanization on the environment with innovative technologies and sustainable practices.²²⁸ For instance, megacities help promote green spaces. Green spaces are areas with natural vegetation, like grass and trees, available to the public.²²⁹ In urban areas, the implementation of green spaces promotes the use of natural resources. Green spaces help purify air and reduce the effects of climate change. Additionally, they are centers of social development.²³⁰ This is because they serve as citizens' gathering spaces and provide a space for sports and recreational activities. On the other hand, smart cities are a helpful tool to promote smart energy consumption. In the modern world, energy is the most important infrastructure.²³¹ However, most energy types harm the environment. Smart cities promote sustainable energy, which refers to using the energy of the wind, sun, tide, and geothermal energy. This type of energy is not only good for the

environment, but it also has a low economic cost.

Additionally, technology can be used to implement systems that optimize energy distribution. Another example is the use of smart power grids, which produce and consume electricity at the same time.²³² Implementing technology in megacities also promotes a smart use of water resources. With growing populations and the impact of climate change, water scarcity has been increasing.²³³ Water scarcity refers not only to water accessibility but also to its distribution and quality. Smart cities focus on improving the level of water quality. For example, Mumbai, India implemented smart water meters so that the water supply system can be restored remotely.²³⁴

Megacities can also help mitigate carbon emissions by advocating for eco-friendly transportation. They can use technology to help improve the efficiency of transportation and mobility. If used properly, technology can help reduce travel time in megacities by 20 percent.²³⁵ For example, smart transportation works to reduce traffic congestion. South Korea has a system of adaptive traffic signals called BlueSignal.²³⁶ Said system uses real-time traffic information and technology to predict the best traffic system to reduce traffic. Another example is intelligent public transportation. This refers to a platform to facilitate the use of electric vehicles, electronic payments, and smart parking.²³⁷ Artificial intelligence (AI) is increasingly recognized as a powerful tool for addressing the challenges faced by megacities. AI is set to become one of the principal means for local governments to achieve smart

226 Xiao Hui et al., Greening smart cities: An investigation of the integration of urban natural resources and smart city technologies for promoting environmental sustainability."

227 Gomstyn and Jonker, "What is a smart city?"

228 Xiao Hui et al., Greening smart cities: An investigation of the integration of urban natural resources and smart city technologies for promoting environmental sustainability."

229 "Green space & parks," County Health Rankings, accessed August 25, 2024, <https://www.countyhealthrankings.org/strategies-and-solutions/what-works-for-health/strategies/green-space-parks#>

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231 Amir Hoshang Fakhimi, Hossein Khani, and Javad Majrouhi Sardroud, "2-Smart-city infrastructure components," Solving Urban Infrastructure Problems Using Smart City Technologies (2021): 17-54, <https://doi.org/10.1016/B978-0-12-816816-5.00002-4>.

232 Vaslavskaya et al., "Achieving the principles of sustainable development: implementation of smart solutions in the infrastructure of modern megacities."

233 Hoshang Fakhimi, Hossein Khani, and Majrouhi Sardroud, "2-Smart-city infrastructure components."

234 Vaslavskaya et al., "Achieving the principles of sustainable development: implementation of smart solutions in the infrastructure of modern megacities."

235 Vaslavskaya et al., "Achieving the principles of sustainable development: implementation of smart solutions in the infrastructure of modern megacities."

236 "5 examples of smart city transportation solutions," NEC, accessed August 25, 2024, <https://www.nec.co.nz/market-leadership/publications-media/5-examples-of-smart-city-transportation-solutions/>.

237 Xiao Hui et al., Greening smart cities: An investigation of the integration of urban natural resources and smart city technologies for promoting environmental sustainability."



Train station in Tokyo, Japan
Credit: Syced

and sustainable development.²³⁸ Alongside urban design, it can make the urban planning process much more effective.²³⁹ Hence, AI can be a beneficial tool for smart megacities. Artificial intelligence can help generate new data by learning from historical data, promoting innovation.²⁴⁰ AI can also help predict movements, which can be extremely useful when implementing smart transportation. Besides, AI promotes data processing and data protection since it prevents data misuse.²⁴¹

Case Study: Tokyo as a Sustainable Megacity

A successful case of Sustainable Urban Development in megacities is Tokyo. Different historical, economic, and social factors caused Tokyo's rise to megacity status. The city's origins can be linked to the development of Edo, a small fishing village in the 17th century.²⁴² Edo had a rapid growth due to the political importance it took. The Meiji Restoration in the

late 19th century further accelerated Tokyo's development.²⁴³ The restoration shifted Japan from feudal society to a modern state with Edo, which was renamed Tokyo, as the capital.²⁴⁴ This brought significant modernization efforts, including the construction of infrastructure and the adoption of Western technologies. After World War II, the birth rate in Japan increased. Tokyo reached ten million inhabitants by the 1964 Olympics, the largest population in the world.²⁴⁵ Tokyo's social and cultural dynamics also played a role in its expansion. The city became a hub for modern Japanese culture, including the rise of anime, which gained international recognition during the 1960s.²⁴⁶ The 1960s and 1970s marked a period of economic growth in the state, known as the "Japanese Economic Miracle," that established Tokyo as an economic center.²⁴⁷ This turned Tokyo into one of the first megacities in the world, along with New York.²⁴⁸ By 2010, Tokyo reached

238 Heinrich Son, Weedon, Yigitcanlar, Sanchez, M. Corchado, Mehmood, "Algorithmic urban planning for smart and sustainable development: Systematic review of the literature."

239 <https://www.aiplusinfo.com/blog/artificial-intelligence-and-urban-design/>

240 Ibrar Yaqoob et al., "Metaverse applications in smart cities: Enabling technologies, opportunities, challenges, and future directions," *Internet of Things 23* (October 2023), <https://doi.org/10.1016/j.iot.2023.100884>.

241 Yaqoob et al., "Metaverse applications in smart cities: Enabling technologies, opportunities, challenges, and future directions."

242 Jed Baso, "Why is Tokyo So Big? | How Tokyo, Japan Became The World's Biggest City," Our Mammoth World, last modified March 22, 2024, <https://www.ourmammothworld.com/post/why-is-tokyo-so-big-the-real-origins-of-tokyo-and-why-it-s-a-megacity>.

243 Baso, "Why is Tokyo So Big? | How Tokyo, Japan Became The World's Biggest City."

244 Baso, "Why is Tokyo So Big? | How Tokyo, Japan Became The World's Biggest City."

245 Baso, "Why is Tokyo So Big? | How Tokyo, Japan Became The World's Biggest City."

246 Baso, "Why is Tokyo So Big? | How Tokyo, Japan Became The World's Biggest City."

247 "How Tokyo Became the Largest City in Japan," Japan Wonder Travel Blog, last modified 2022, <https://blog.japanwondertravel.com/how-tokyo-became-the-largest-city-in-japan-32406#toc3>.

248 "Tokyo megacity," Designing Buildings, last edited May, 2021 https://www.designingbuildings.co.uk/wiki/Tokyo_megacity.

13 million people.²⁴⁹ By 2020, the Greater Tokyo Area will remain the largest megacity in the world, with a population of 37.4 million in 2020.²⁵⁰ Tokyo's population is estimated to be one-third of Japan's total population.²⁵¹

The migration to cities has caused the decline of rural communities, causing the closure of different enterprises due to the lack of workers. To address this and the growing population in Tokyo, the Japanese government started a new program in April 2023. The government is offering families one million yen to move out of Tokyo and stay in rural areas for at least five years.²⁵² They aim to activate rural areas by bringing in new residents and boosting local economies.²⁵³ In addition, it also helps to reduce the population pressure in Tokyo to keep it sustainable and provide a good quality of life. Sustainable development refers to a lifestyle that meets today's present needs without compromising the chances and resources of future generations.²⁵⁴ It has three areas: economic

growth, environmental protection, and social equity.²⁵⁵ A sustainable megacity addresses these challenges with efficient urban planning. Economically, it promotes inclusive growth and job opportunities while managing resources efficiently. Environmentally, it aims to reduce carbon footprint. Socially, it aims to improve the quality of life of all residents by addressing inequalities and ensuring basic services.

Tokyo has embraced sustainability locally and nationally, which aligns with global goals.²⁵⁶ Japan has taken significant steps to implement the 2030 Agenda for Sustainable Development. This is reflected in the National Implementation Framework and the Implementation Guiding Principles (IMPs) in 2016. Japan has designed different mechanisms to incorporate the Sustainable Development Goals (SDGs) into local planning and policies.²⁵⁷ The Tokyo Metropolitan Government introduced the long-term plan "Future Tokyo: Tokyo's Long-Term Strategy" in March 2021.²⁵⁸ This plan outlines a vision

249 Baso, "Why is Tokyo So Big? | How Tokyo, Japan Became The World's Biggest City."

250 Designing Buildings, "Tokyo megacity."

251 Baso, "Why is Tokyo So Big? | How Tokyo, Japan Became The World's Biggest City."

252 Baso, "Why is Tokyo So Big? | How Tokyo, Japan Became The World's Biggest City."

253 Baso, "Why is Tokyo So Big? | How Tokyo, Japan Became The World's Biggest City."

254 "Fast Facts – What is Sustainable Development?" United Nations, August, 2023, <https://www.un.org/sustainabledevelopment/blog/2023/08/what-is-sustainable-development/>.

255 Tim Heinrich Son, Zack Weedon, Tan Yigitcanlar, Thomas Sanchez, Juan M. Corchado, Rashid Mehmood, "Algorithmic urban planning for smart and sustainable development: Systematic review of the literature," *Sustainable Cities and Society* 94 (July 2023):104562, <https://www.sciencedirect.com/science/article/pii/S2210670723001737>.

256 Hiromi Masuda, Mahesti Okitasari, Yatsuka Kataoka, "SDGs mainstreaming at the local level: case studies from Japan," *Sustainability Science* 16, (June 2021):1539–1562, <https://doi.org/10.1007/s11625-021-00977-0>.

257 Masuda, Okitasari, Kataoka, "SDGs mainstreaming at the local level: case studies from Japan."

258 *Tokyo Sustainability Action*, (Tokyo: Tokyo Metropolitan Government, 2021) <https://sdgs.un.org/sites/default/files/vlrs/2022-04/>



Sustainable Hospital in Tokyo

Credit: Kakidai

for the city in the 2040s and the steps it will take to get there by 2030. Tokyo is focused on creating a more inclusive and sustainable city, addressing the changes made by COVID-19.²⁵⁹

For example, in the environmental aspect, they are aiming to reform Tokyo's Bay Area into a space that combines nature and urbanization with high technology.²⁶⁰ This aligns with different SDGs and consolidates Tokyo as a leader in sustainability.²⁶¹ Additionally, the Tokyo eSG project will redevelop an unused 1000-hectare area in Tokyo Bay, previously used for the 2020 Olympics and waste disposal, into a vibrant, green community.²⁶² The city plans to meet its energy needs entirely through renewable energy sources. It is expected that by 2030, they will increase the use of renewable energy by 50 percent.²⁶³ Therefore, they are developing wind power and floating solar farms, all managed by advanced smart grids.²⁶⁴ In addition, for a future clean and sustainable city, the plan includes building a "sharing economy," where resources are shared to reduce waste.²⁶⁵ It also aims to attract ESG-focused investment with TMG's green finance scheme, offering subsidies to foreign companies focused on sustainability.²⁶⁶

Tokyo developed 2021 the "Sustainability Guidelines for Business Events in Tokyo." It looks to promote the best practices in organizing eco-friendly events.²⁶⁷ In 2023, they also introduced the "Carbon Footprint Calculator for Business Events in Tokyo." This helps organizers understand and mitigate the environmental impact of their events.²⁶⁸ They expect to cut greenhouse gas emissions by 50 percent.²⁶⁹

Furthermore, the Ministry of Land, Infrastructure, Transport and Tourism (MLIT) is developing the PLATEAU project.²⁷⁰ It offers a detailed 3D virtual model to track urban activity, improve disaster planning, and better planning in the future.²⁷¹ This project highlights Tokyo's use of digital tools to make city management more effective and sustainable. Likewise, Tokyo's commitment to sustainability is reflected in its pioneering efforts to reduce carbon emissions from buildings, which account for about 70 percent of the city's total emissions.²⁷² The city has launched the world's first emission reduction program for structures and is collaborating with Kuala Lumpur to exchange knowledge and strategies for improving energy efficiency.²⁷³

Sustainable Development Goals

In 2015, the United Nations adopted the 2030 Agenda for Sustainable Development to make the world more sustainable. It aims to eradicate poverty and promote prosperity, peace, and environmental protection. This plan includes 17 goals and 169 targets to support human rights and progress. By 2030, all countries will work together to ensure no one is left behind. One relevant SDG regarding Sustainable Urban development is SDG 6: Clean Water and Sanitation. This goal aims to provide the availability and sustainable management of water for all.²⁷⁴ The United Nations System-wide Strategy for Water and Sanitation (SWS) underscores the importance of SDG six by emphasizing the need for coordinated efforts to manage water resources effectively and improve sanitation

tokyo_sustainability_action.pdf.

259 *Tokyo Sustainability Action*.

260 Stefan Ellerbeck, "Tokyo wants to build a future-proof city. Here's how," World Economic Forum, last modified September, 2022, <https://www.weforum.org/agenda/2022/09/japan-tokyo-city-sustainable-future/>.

261 *Tokyo Sustainability Action*.

262 Ellerbeck, "Tokyo wants to build a future-proof city. Here's how."

263 "Sustainable Business Events in Tokyo," Business Events Tokyo, accessed August, 2024, https://businesseventstokyo.org/sustainable_business_events_in_tokyo/.

264 Ellerbeck, "Tokyo wants to build a future-proof city. Here's how."

265 Ellerbeck, "Tokyo wants to build a future-proof city. Here's how."

266 Ellerbeck, "Tokyo wants to build a future-proof city. Here's how."

267 Business Events Tokyo, "Sustainable Business Events in Tokyo."

268 Business Events Tokyo, "Sustainable Business Events in Tokyo."

269 Business Events Tokyo, "Sustainable Business Events in Tokyo."

270 Kasey Furutani, "This free virtual 3D model lets you explore Tokyo's 23 central wards," Time Out, last modified April, 2021, <https://www.timeout.com/tokyo/news/this-free-virtual-3d-model-lets-you-explore-tokyos-23-central-wards-040621>.

271 Furutani, "This free virtual 3D model lets you explore Tokyo's 23 central wards."

272 "Transforming Cities: The cities sharing big ideas," C40, last modified February 2023, <https://www.c40.org/case-studies/transforming-cities-tokyo-kuala-lumpur/>.

273 C40, "Transforming Cities: The cities sharing big ideas."

274 "Transforming Our World: The 2030 Agenda for Sustainable Development."

services.²⁷⁵ Despite some progress, billions of people still lack these basic services. Water scarcity is increasing due to conflicts and climate change, and water pollution is affecting human health and the environment.²⁷⁶

Another relevant SDG for this topic is SGD 7: Affordable and Clean Energy. This goal focuses on ensuring access to affordable, reliable, sustainable, and modern energy for all.²⁷⁷ It aims to increase the use of renewable energy, improve energy efficiency, and expand infrastructure to provide clean energy globally.²⁷⁸ By 2021, 675 million people, mainly living in Sub-Saharan Africa, were still lacking electricity.²⁷⁹ Also, if the slow transition to cleaner cooking methods continues, one in four people will still rely on unsafe and inefficient cooking systems by 2030.²⁸⁰ This includes open fires or traditional stoves.

Advancing industry and infrastructure is essential for improving sustainability in urban areas. SDG 9: Industry, Innovation, and Infrastructure aims to build resilient infrastructure, promote sustainable industrialization, and drive innovation.²⁸¹ This approach increases connectivity and economic opportunities and addresses energy access challenges, contributing to a more sustainable urban area.²⁸²

The most relevant SDG is SDG 11: Sustainable Cities and Communities. This goal aims to make cities inclusive, safe, resilient, and sustainable. It focuses on providing affordable housing and ensuring safe and accessible transport.²⁸³ The 2021 Transportation Report highlights the need for efficient,

accessible, and eco-friendly transportation systems to reduce urban congestion, lower emissions, and improve quality of life.²⁸⁴

SDG 13 is also crucial for sustainability in urban areas, as it tackles Climate Action. This goal aims to take immediate action to combat climate change and its impact by increasing global resilience to climate-related hazards.²⁸⁵ By 2030, a rapid, deep, and sustained GHG emission reduction by 43 percent is needed, and for 2050, it must be net zero.²⁸⁶

The last relevant SDG for this topic is SDG 15: Life on Land. This last goal focuses on protecting, restoring, and promoting the sustainable use of terrestrial ecosystems.²⁸⁷ It also focuses on saving forests, stopping land from becoming deserts, managing land responsibly, and protecting wildlife and natural spaces.²⁸⁸ The “Future We Want” document highlighted the severe global loss of biodiversity and ecosystem degradation, affecting food security, water access, and health.²⁸⁹

A few SDGs to remember as progress is made is to include sustainable transportation in any urban planning. Sustainable transport is vital to achieving several Sustainable Development Goals.²⁹⁰ For example, it supports SDG 1: No Poverty and SDG 2: Agricultural Productivity by improving road access so people can get to work and transport goods more efficiently. SDG 3: Health and Well-Being by reducing road accidents and pollution. SDG 7: Affordable and Clean Energy by integrating new technologies and fossil fuel-free modes of

275 “United Nations System-wide strategy for water and sanitation,” accessed October 12, 2024, https://sdgs.un.org/sites/default/files/2024-06/UN_System-wide_Strategy_for_Water_and_Sanitation_Advance_May2024_0.pdf.

276 “United Nations System-wide strategy for water and sanitation,” accessed October 12, 2024, https://sdgs.un.org/sites/default/files/2024-06/UN_System-wide_Strategy_for_Water_and_Sanitation_Advance_May2024_0.pdf.

277 “Transforming Our World: The 2030 Agenda for Sustainable Development.”

278 “Transforming Our World: The 2030 Agenda for Sustainable Development.”

279 “Transforming Our World: The 2030 Agenda for Sustainable Development.”

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281 “Transforming Our World: The 2030 Agenda for Sustainable Development.”

282 “Report of the Meeting: Expert Group Meeting on Sustainable Transport,” Department of Economic and Social Affairs, accessed October 12, 2024, <https://sdgs.un.org/documents/report-meeting-expert-group-meeting-sustainable-transport-54813>.

283 “Transforming Our World: The 2030 Agenda for Sustainable Development.”

284 “Report of the Meeting: Expert Group Meeting on Sustainable Transport,” Department of Economic and Social Affairs, accessed October 12, 2024, <https://sdgs.un.org/documents/report-meeting-expert-group-meeting-sustainable-transport-54813>.

285 “Transforming Our World: The 2030 Agenda for Sustainable Development,” department of economic and social affairs, accessed October 12, 2024, <https://sdgs.un.org/2030agenda>.

286 “Transforming Our World: The 2030 Agenda for Sustainable Development,” department of economic and social affairs, accessed October 12, 2024, <https://sdgs.un.org/2030agenda>.

287 “Transforming Our World: The 2030 Agenda for Sustainable Development,” department of economic and social affairs, accessed October 12, 2024, <https://sdgs.un.org/2030agenda>.

288 “Transforming Our World: The 2030 Agenda for Sustainable Development,” department of economic and social affairs, accessed October 12, 2024, <https://sdgs.un.org/2030agenda>.

289 “Biodiversity and Ecosystems,” Department of Economic and Social Affairs, accessed October 12, 2024, <https://sdgs.un.org/topics/biodiversity-and-ecosystems>.

290 World Bank, *Sustainable Transport at the Heart of the Sustainable Development Goals*.

transportation.²⁹¹ It also aims to achieve SDG 11: Sustainable Cities and Communities through sustainable urban public transport systems. It can also be related to SDG 12: Responsible Production and Consumption by reducing fuel subsidies.²⁹²

Bloc Analysis

Points of Division

The City Expansion Index analyzes the urban expansion of cities around the world with over one million of inhabitants.²⁹³ The dataset shows the urban growth between 2000 and 2014 in 377 cities around the world with a population of over one million residents.²⁹⁴ This index recognized two different types of expansion: upward and outward. The upward expansion refers to the city's and its buildings' vertical expansion. On the other hand, outward expansion refers to the horizontal expansion of the city and its constructions. Its purpose is to help governments manage urban expansion in an informed way, achieving socio-economic and environmental benefits to the cities.²⁹⁵ Using this information is essential to plan the solutions, as unmanaged urban expansion increases the costs and the gaps of social inequalities.²⁹⁶

This bloc division used the layer of outward and upward expansion index. In the database, the outward expansion is shown by the size of the circle, while the upward expansion index is indicated by the color of the circle.²⁹⁷ Nevertheless, the index also gives the cities two values from zero to 16, according to their outward and upward expansion. For this bloc division,

an assigned value over one will be considered a high expansion. It is essential to understand what expansion the cities and countries are experiencing since they face different challenges. Therefore, their solutions should address the specific issues. For example, fast outward expansion is associated with lower-income cities and broader social inequalities.²⁹⁸

High Horizontal Expansion - High Vertical Expansion

This set of countries includes those with a value over two for upward and outward expansion. Countries with cities in this bloc are facing high urbanization, mainly as a result of economic growth.²⁹⁹ Their status as an economic and financial center has given them the name of Global Giants.³⁰⁰ Urban development and growth can lead to rapid city infrastructure changes and environmental challenges. Countries in this bloc should focus on securing good urban services –housing, sanitation, transportation– to their increasing population while limiting their climatic effects. For example, China has many cities facing high expansion in both ways. Some of these cities are Shanghai, Changzhou, and Shenzhen. In 1950, only 13 percent of China's population lived in cities. However, it is expected to reach 60 percent by 2030.³⁰¹ 25 out of 100 world's largest cities are located in China.³⁰² Even when these large cities have implicated environmental issues, like pollution, China is also working on using population density to improve other environmental practices, such as energy usage.³⁰³ In addition, China is working on 80 programs that aim to reduce the carbon emissions in cities around the country.³⁰⁴

291 World Bank, *Sustainable Transport at the Heart of the Sustainable Development Goals*.

292 World Bank, *Sustainable Transport at the Heart of the Sustainable Development Goals*.

293 "City Expansion Index", World Resources Institute, Accessed August 21, 2024, <https://resourcewatch.org/data/explore/cit037-Upward-and-Outward-Expansion-Index?s>.

294 World Resources Institute, "City Expansion Index."

295 World Resources Institute, "City Expansion Index."

296 "Upward and Outward Growth: Managing Urban Expansion for More Equitable Cities in the Global South," World Resources Institute, last modified January, 2019, https://www.wri.org/research/upward-and-outward-growth-managing-urban-expansion-more-equitable-cities-global-south?ap3c=1GaoMtiacsnaNO4GAGaoMthvnsGFFc8-MXHtp3fYJwxQtX_vMQ.

297 World Resources Institute, "City Expansion Index."

298 World Resources Institute, "Upward and Outward Growth: Managing Urban Expansion for More Equitable Cities in the Global South."

299 "Challenges faced due to urbanization," European Commission, last modified July 3, 2020, https://knowledge4policy.ec.europa.eu/foresight/topic/continuing-urbanisation/challenges-faced-due-to-urbanisation_en.

300 Jeff Desjardins, "The Megacity Economy: How Seven Types of Global Cities Stack Up," Visual Capitalist, last modified February 7, 2017, <https://www.visualcapitalist.com/megacity-economy-7-types-global-cities/>.

301 "What Should We Understand about Urbanization in China?," Yale Insights, last modified November, 2013, <https://insights.som.yale.edu/insights/what-should-we-understand-about-urbanization-in-china>.

302 Yale Insights, "What Should We Understand about Urbanization in China?."

303 Yale Insights, "What Should We Understand about Urbanization in China?."

304 Yale Insights, "What Should We Understand about Urbanization in China?."

Other countries that might fall into this bloc are the United States, which has cities like Dallas and New York. Another example is Thailand with cities such as Bangkok, which has 80 percent of Thailand's urban area.³⁰⁵ Therefore, Thailand is working on Bangkok's urbanization under the standard of the New Urban Agenda. This project aims to create "livable cities and ensure equal opportunities and equal access to government services for all."³⁰⁶

High Horizontal Expansion - Low Vertical Expansion

This set of countries includes those with a value over two outward expansions but a low number for upward expansion. Countries with cities in this bloc usually do not have a planned urban development.³⁰⁷ Common factors among these cities include low land governance and still consolidating financial markets. The unmanaged and informal urban expansion has caused an increase in costs, deepened socio-economic gaps, and poor quality of services.³⁰⁸ The informal urban settlements are more affected by climate change and natural disasters due to their poor quality materials and high-density population.³⁰⁹ On the other hand, informal and unplanned settlements are also a cause of deforestation.

For example, Colombia's capital, Bogota, has experienced rapid demographic growth through waves of rural-to-urban migration due to the armed conflict.³¹⁰ This migration caused informal settlements in the marginalized areas of Bogota, which were facilitated by the lack of an Urban Master Plan for

the city for over a decade.³¹¹ Ciudad Bolívar is one of Bogota's neighborhoods formed by slums, even considered one of the world's largest mega-slums. It is estimated that 46 percent of the displaced population who migrated to the city are living in Ciudad Bolívar.³¹² Additionally, most of this neighborhood lacks public services such as water and electricity.³¹³ Nigeria can also be included in this bloc, with cities such as Port Harcourt. In 2022, over 600 people died in Nigeria because of the floods.³¹⁴ Most of them can be associated with informal settlements due to the precarious locations, often beside rivers, and poor quality materials.³¹⁵ In addition, these populations are most vulnerable to being displaced by these natural disasters.

High Vertical Expansion - Low Horizontal Expansion

In recent years, vertical urbanization has grown popular as it solves the problem of limited areas to build inside a city.³¹⁶ Therefore, countries and cities in this bloc have a value of over two for upward expansion but a low number for outward expansion. Vertical urbanization addresses the protection of agricultural areas that were being erased by traditional horizontal urbanization.³¹⁷ Vertical urbanization also aims to reduce energy usage and innovate in different ways to address the environmental effects of urbanization.³¹⁸ Countries and cities of this bloc usually invest in development and green infrastructure. It includes São Paulo, Brazil, and Las Vegas, USA.

305 "Thailand," UN-HABITAT, last modified 2019, <https://fukuoka.unhabitat.org/en/tag/thailand/>.

306 UN-HABITAT, "Thailand."

307 Anjali Mahendra and Karen C. Seto, *Towards a More Equal City, Upward and Outward Growth: Managing Urban Expansion for More Equitable Cities in the Global South* (Washington D.C: World Resource Institute, 2019), https://files.wri.org/d8/s3fs-public/upward-outward-growth_2.pdf

308 Mahendra and Seto, *Towards a More Equal City, Upward and Outward Growth: Managing Urban Expansion for More Equitable Cities in the Global South*.

309 Angela R. Pashayan, "Informal settlements and climate change in the 'last mile of urbanization'," Brookings, last modified February 29, 2024, <https://www.brookings.edu/articles/informal-settlements-and-climate-change-in-the-last-mile-of-urbanization/>.

310 Nicolás Rueda-García, *Urban Slums Reports: The case of Bogotá, Colombia* (Bogota: Universidad de los Andes, 2003), https://www.ucl.ac.uk/dpu-projects/Global_Report/pdfs/Bogota.pdf.

311 "Tras una década de espera, el nuevo Plan de Ordenamiento Territorial de Bogotá es una realidad," Secretaria de Planeación de Bogotá, last modified December 29, 2021, <https://www.sdp.gov.co/noticias/tras-decada-de-espera-nuevo-plan-de-ordenamiento-territorial-de-bogota-realidad>.

312 "Colombia - Bogotá," World Housing, accessed August, 2024, <https://worldhousing.org/communities/bogota-colombia/>.

313 World Housing, "Colombia - Bogotá."

314 Pashayan, "Informal settlements and climate change in the 'last mile of urbanization'."

315 Pashayan, "Informal settlements and climate change in the 'last mile of urbanization'."

316 "Areas Taking Advantage of Vertical Urbanisation," Boon Edam, accessed August 22, 2024, <https://www.boonedam.com/blog/vertical-urbanisation-and-areas-taking-advantage>.

317 "What is Vertical Urbanisation , and What Does it Mean for Our Cities?," Boon Edam, accessed August 22, 2024, <https://www.boonedam.com/blog/vertical-urbanisation>.

318 Boon Edam, "What is Vertical Urbanisation , and What Does it Mean for Our Cities?"

Low Horizontal Expansion - Low Vertical Expansion

Countries and cities in this bloc have a low upward and outward expansion value. Even if they have a growing population, it is at smaller rates, and they are future emerging megacities. Countries and cities in this bloc should focus on developing an urban master plan guided by the New Urban Agenda adopted in 2016. It is important to have an organized and controlled urban plan as it can ensure sustainable development and a future for its population.³¹⁹ Cities and countries in this bloc include Barranquilla, Colombia; Panama City, Panama; and Munich, Germany.

Committee Mission

The United Nations Environment Assembly (UNEA) is the main global organization for environmental governance.³²⁰ It guides international efforts to promote sustainable development and environmental protection.³²¹ UNEA's mission is to inspire, inform, and enable nations and peoples to work together to ensure better lives today while taking care of the planet for future generations.³²² The committee addresses many environmental problems, like climate change and loss of nature, and supports efforts to develop cities sustainably. Sustainable urban development in megacities has become increasingly urgent due to these urban areas' rapid growth and expansion. Megacities face unique challenges related to environmental sustainability, resource management, and equitable access to essential services.³²³ They often need help with problems such as inadequate infrastructure and overburdened resources. This can end up affecting vulnerable groups like low-income residents, migrants, and those facing socio-economic disadvantages.³²⁴ Sustainable urban development is crucial in addressing these challenges while promoting economic growth and ensuring environmental stewardship.

To address these challenges, UNEA provides a platform for member states to discuss and find solutions for sustainable urban development.³²⁵ Delegates should emphasize integrating environmental sustainability into urban planning and expansion strategies. This means promoting practices that reduce greenhouse gas emissions, improve resource efficiency, and ensure fair access to services and opportunities. Delegates can use the help of the United Nations Human Settlements Programme (UN-Habitat) and UNICEF to support their recommendations. UN-Habitat specializes in sustainable urban development and can offer guidance on effective planning and infrastructure solutions. They help cities manage their growth, handle challenges, and ensure development is fair for everyone. UNICEF's involvement is important for addressing the needs of vulnerable populations within urban areas. Their focus on child welfare and education can help ensure that urban development incorporates essential services and opportunities for all residents, particularly children and marginalized communities.

Delegates should focus on identifying and promoting innovative solutions that balance urban growth with sustainability. This includes encouraging actions that lower greenhouse gas emissions, use resources more efficiently, and provide equal access to services and opportunities for everyone.

319 "The New Urban Agenda," Housing III, accessed August, 2024, <https://habitat3.org/the-new-urban-agenda/>.

320 "What is the UN Environment Assembly and why does it matter?" UN News, February 25, 2024, <https://news.un.org/en/story/2024/02/1146932>.

321 "What is the UN Environment Assembly and why does it matter?"

322 "What is the UN Environment Assembly and why does it matter?"

323 "Transforming Our World: The 2030 Agenda for Sustainable Development."

324 "Transforming Our World: The 2030 Agenda for Sustainable Development."

325 "What is the UN Environment Assembly and why does it matter?"



UNEA

NHSMUN 2025



TOPIC B: MITIGATING THE IMPACTS OF THE OIL INDUSTRY ON BIODIVERSITY

Photo Credit: GuavaTrain

Introduction

Biodiversity comprises one-third of the environmental triple threat, alongside pollution and climate change.¹ Threats to biodiversity also threaten humankind. Today, the oil industry is among the top threats to the environment.² It affects all three elements of the triple threat. The processing and usage of oil is highly pollutant. Obtaining oil resources is a large threat to climate change as a whole.³ Emissions and spills are some of the larger risks of the industry. In 2023 alone, roughly 2,000 tons of oil spilled into the environment.⁴ The combination of spillage and emissions is severe. An annual average of roughly five billion tons of emissions are created from the production and transportation of oil alone.⁵ The impacts of the oil industry on the environment are severe, taking a large toll on biodiversity levels worldwide.

The oil industry impacts various species. Spilled oil spreads quickly, wiping away nearly all signs of life in affected areas.⁶ Over time, oil remnants continue to worsen impacts on local species. Spills are not the only harmful part of the oil industry. Drilling, processing, and using oil damage ecosystems, habitats, and animal lives. The oil industry alone makes up for around one-third of greenhouse gas (GHG) emissions caused by human activities.⁷ These impacts threaten many species around the world. These include coral, fish, trees, turtles, and birds. Harm from dropping biodiversity levels is not limited to plants and animals. These losses also threaten human industries and activities. Notably, tourism is known to be driven away by oil spills and infrastructure.⁸ This takes a toll on local businesses in surrounding areas. The impacts of the oil industry on biodiversity also deteriorate human access to clean water, air, and food resources.⁹ This threatens agriculture, fishing, and other food-based sectors. These impacts on ecosystems ultimately make their way to humans,

harming human health.¹⁰ This places stress on governments and health systems worldwide.

The loss of biodiversity has caught the attention of governments and organizations. The United Nations (UN) has added biodiversity to its frameworks. The Sustainable Development Goals (SDGs) include targets on biodiversity and the environment.¹¹ These goals are central to the work of the United Nations Environment Assembly (UNEA).¹² UNEA uses them to guide governments and make big decisions about the environment. Although some solutions are in place, they need to be improved. The oil industry continues to grow around the world every day. Its alternatives are also risky, posing environmental and human rights concerns.¹³ Delegates in UNEA are tasked with finding the balance between industry development and mitigating environmental concerns. Environmental concerns from the industry are continually developing, and because of this, frameworks and preparations are required. Delegates should prepare solutions

1 "About the United Nations Environment Programme," United Nations Environment Programme, accessed August 3, 2024, <https://www.unep.org/>.

2 International Energy Agency, *Emissions from Oil and Gas Operations in Net Zero Transitions*, (IEA:Paris, May 2023), <https://www.iea.org/reports/emissions-from-oil-and-gas-operations-in-net-zero-transitions>.

3 International Energy Agency, *Emissions from Oil and Gas Operations in Net Zero Transitions*.

4 "Oil Tanker Spill Statistics 2023," ITOPE, accessed August 3, 2024, <https://www.itopf.org/knowledge-resources/data-statistics/statistics/>.

5 International Energy Agency, *Emissions from Oil and Gas Operations in Net Zero Transitions*.

6 Sarah Holcomb, "Oil Kills," Oceana, October 31, 2023, <https://oceana.org/blog/oil-kills/>.

7 "Energy," United Nations Environment Programme, accessed July 3, 2024, <https://www.unep.org/topics/energy>.

8 "Oil Drilling Infrastructure Drives Away Tourism Dollars," Southern Environmental Law Center, accessed July 8, 2024, <https://www.southernenvironment.org/news/oil-drilling-infrastructure-drives-away-tourism-dollars/>.

9 Melese Muluneh, "Impact of Climate Change on Biodiversity and Food Security: a global perspective- A Review Article," *Agriculture and Food Security* 10, vol. 36, September 2021. <https://doi.org/10.1186/s40066-021-00318-5>.

10 Jena Webb, "What Do We Know About How Oil Spills Affect Human Health?," April 2018, <https://amazonfrontlines.org/chronicles/health-oil/?debug>.

11 "Sustainable Development Goals: 17 Goals to Transform our World," United Nations Exhibits, accessed July 28, 2024, <https://www.un.org/en/exhibits/page/sdgs-17-goals-transform-world>.

12 United Nations Environment Programme, "About the United Nations Environment Programme."

13 Chloe Brenner, "Green vs Green: Conflict Between Renewable Energy and Biodiversity Loss," Duke, Nicholas School of the Environment, April 16, 2024, <https://blogs.nicholas.duke.edu/env212/green-vs-green-conflict-between-renewable-energy-and-biodiversity-loss-chloe-brenner/>.

to combat this issue's nuances and fine details.

History and Description of the Issue

The Rise of the Modern Oil Industry

Oil and gas are the world's most valuable commodities. These are by-products of fossil fuels which have a great influence on the workforce. Oil and gas are responsible for three percent of global domestic product.¹⁴ Being of such high value, this industry also holds power over global development and plays a large role in many conflicts today. It is one of the world's most traded commodities and provides jobs for millions yearly. Because of this influence, the control over these natural resources is significant in the world's geopolitical and socio-economic landscapes, both historically and in modern times.¹⁵ Although petroleum products have been around for a long time, modern oil wells were created in the 1850s.¹⁶ Since then, the industry has served a major role in advancements of the industrial revolution. Transportation, construction, cooking, manufacturing, heating, and cooling have all made great strides thanks to using fossil fuels. Petroleum composes around 95 percent of the energy used in transportation.¹⁷ Many vehicles, including cars, trucks, airplanes, and boats, depend on this as their primary fuel source.

In comparison to bio-fuels and other alternatives, petroleum-based fuels are often less expensive and have a higher density of energy.¹⁸ Petroleum-based additives are often used to increase function and longevity in heating and cooling systems. They are used to lubricate and clean contaminants from these

systems.¹⁹ Air conditioning is a continually growing industry, with the number of installed units being expected to triple by 2050.²⁰ The use of these products benefits consumers and manufacturers around the world. These industrial benefits contribute to the vast importance of petroleum around the world. Today, 50 companies are responsible for approximately half of the world's oil production.²¹ Those dependent on oil view it as essential for economic growth and poverty eradication. Despite this use, oil's status as a non-renewable resource ultimately threatens long-term development. This cost impacts not only the environment but also economic and social development in the coming years.²²

Oil is considered a primary energy source, as it is derived from fossilized organic materials. It is found across the world, both above and below sea level. Geological formations containing oil for extraction are known as oil reserves. The raw material extracted from these reserves is crude oil. Crude oil is the natural oil state straight out of the ground. It is composed of hydrocarbons and organic materials. These are eventually processed into fuels and other petroleum products.²³ No matter the reserve's depth, oil extraction principles remain constant. These principles refer to the oil field's life cycle, which is divided into five stages. These are exploration, appraisal, development, production, and abandonment.²⁴ Exploration is best described as the discovery of a new reserve, with appraisal being the study of the reserve. This is followed by development, equipment installation, and production, which is the physical extraction of oil products. The cycle ends with abandonment, which is removing infrastructure and closing the well. Masses of equipment are required to carry

14 International Labour Organization, *The Future of Work in the Oil and Gas Industry*, (Geneva: Sectoral Policies Department, 2022) <https://www.ilo.org/media/369081/download>.

15 United Nations Environment Programme Finance Initiative, *Position on the Oil and Gas Industry*, (Geneva: March 2023), <https://www.unepfi.org/wordpress/wp-content/uploads/2023/03/NZAOA-Position-on-the-Oil-and-Gas-Sector.pdf/>.

16 International Labour Organization, *The Future of Work in the Oil and Gas Industry*,

17 Emil Frankel and Thomas Menzies, "Reducing Oil Use in Transportation," *Issues in Science and Technology*, 2012, <https://issues.org/frankel/>.

18 Frankel and Menzies, "Reducing Oil Use in Transportation."

19 "The Importance of Fuel Treatment for Optimal HVAC Performance," FPPF, accessed July 15, 2024, <https://fppf.com/the-importance-of-fuel-treatment-for-optimal-hvac-performance/>.

20 Jules Brion and Juliette Laffont, "The Paradox of Air Conditioning: A Life-Saver that Aggravates Global Warming," *Le Monde Environnement*, modified August 22, 2023, https://www.lemonde.fr/en/environment/article/2023/08/22/the-paradox-of-air-conditioning-a-life-saver-that-aggravates-global-warming_6102678_114.html.

21 Organization of the Petroleum Exporting Countries, *OPEC Statement to the UN Climate Change Conference*, Dubai: OPEC, December 2023, https://www.opec.org/opec_web/en/press_room/7269.htm.

22 United Nations Environment Programme Finance Initiative, *Position on the Oil and Gas Industry*,

23 Daniel Liberto, "What is Crude Oil and Why is it so Important?" Investopedia, updated July 17, 2024, <https://www.investopedia.com/terms/c/crude-oil.asp>.

24 Tatjana Paulauskiene, "Petroleum Extraction Engineering," *INTECH Open*, (February 2018), doi.org/10.5772/intechopen.70360.

out these processes, whether the reserve is on land or in the ocean. Trucks and other common infrastructure are used to drill straight into the ground on land. Off-shore, platforms and water vessels are used to allow drilling in reserves below sea level.²⁵ The end product of drilling is crude oil, which eventually separates into usable fuels and materials.

The use of crude oil products includes various fuels for transport and energy and some less obvious everyday products. Detergents, inks, tires, polishes, asphalt, and preservatives are all among the hundreds of hidden uses for oil.²⁶ These products are fairly cheap to produce and purchase and are often considered necessary in most societies. Additionally, oil products are essential in clothing, through polyester, weaponry, napalm, and manufacturing, and for cosmetics, through paraffin and naphtha.²⁷ When considering the oil industry, it is important to include these elements in a diverse debate approach. The world's dependence on oil led to the creation of international bodies for collaboration and policy in

this industry. One of the more notable organizations formed was the Organization of the Petroleum Exporting Countries (OPEC). OPEC was created in Baghdad, Iraq, in September of 1960.²⁸ Kuwait, Iran, Iraq, Saudi Arabia, and Venezuela were its first five members. They have since seen the joining and suspension of other member states, such as the United Arab Emirates, Qatar, Libya, and Ecuador. The main objectives of OPEC involve the coordination of petroleum policies, regulating prices, and ensuring efficiency in the industry.²⁹ Today, this body continues to dominate the political landscape of the oil sector and voices its importance internationally.

Despite fossil fuels making up most of the world's energy sector, the average growth rate has been slowly declining throughout the last decade.³⁰ Being a non-renewable source, production has become increasingly difficult. Environmental concerns are also pushing many away from the industry. Although energies drive innovations and economic growth, this sector accounts for 34 percent of GHG emissions that are

25 "Comparing Cost, Benefit and Challenge: Onshore vs Offshore Drilling," PetroSync, accessed July 15, 2024, <https://www.petrosync.com/blog/onshore-and-offshore-drilling>.

26 "Products Made From Petroleum," Ranken Energy Corporation, accessed July 2, 2024, <https://www.ranken-energy.com/index.php/products-made-from-petroleum/>.

27 "List of Petroleum Products and their uses," Bharat Petroleum, accessed July 2, 2024, <https://www.bharatpetroleum.in/blog/Blog-Detail.aspx?id=26>.

28 "Brief History," Organization of Petroleum Exporting Countries, accessed July 3, 2024, https://www.opec.org/opec_web/en/about_us/24.htm.

29 "Brief History," Organization of Petroleum Exporting Countries.

30 Paulauskiene, "Petroleum Extraction Engineering."



Modern oil rig rendering
 Credit: Salman Al-Mazini

caused by human activity.³¹ This adds up to approximately 20 Gigatons of emissions globally.³² This is equivalent to twenty billion metric tons- a figure that needs to be cut in half to match Paris Agreement targets.³³ These emissions are produced at every stage in the oil field's life cycle. From exploration to abandonment, GHG emissions are extreme.

One of the most harmful gases produced is methane. Methane is a heat-trapping gas that has doubled atmospheric concentration over the last 200 years. It is said to be responsible for 20-30 percent of global warming.³⁴ This has been ongoing throughout the industrial revolutions.³⁵ The industrial revolution, which is the transition from manual to automated labor, has been historically favored by the oil industry.³⁶ Methane has been a large by-product of these revolutions. Because of its climate-warming effects, various governmental and private bodies consistently track atmospheric methane concentration levels. This has led to the creation of international bodies, such as the United Nations Environment Programme's (UNEP's) International Methane Emissions Observatory (IMEO). IMEO works to create accessible data on methane emissions. The goal of IMEO is to encourage emission reduction. It is also a key player in the Global Methane Pledge. This pledge attempts to reduce global methane emissions by 30 percent over ten years, from 2020-2030.³⁷

Rising global temperatures, largely from this influx of GHGs, are increasingly damaging to global biodiversity levels. The warming of air and water makes many habitats grow unsustainable for life. Additionally, this causes an increase in natural disasters, such as hurricanes and floods.³⁸ Because

of global warming, the world is currently losing species approximately 1,000 times faster than any other recorded time.³⁹ Wasted land, from the abandonment phase of the oil field's life cycle, also poses a significant threat to biodiversity targets. In the United States alone, over 120,000 abandoned oil reserves have not been properly concealed.⁴⁰ This menaces wildlife, risking animal safety in and around these sites. A lack of proper cleanup processes causes masses of chemical pollution. This infiltrates water and soil, creating health hazards for humans and wildlife. The construction during the appraisal and development of oil reserves also contributes to this species loss, destroying pre-existing habitats. The equipment required for these processes, alongside exposed reserves, also worsens this risk. GHGs, such as methane, are quickly into the atmosphere.⁴¹ These processes continue the global warming cycle and exacerbate the danger of the oil industry.

Today, many countries are making efforts to reduce their fossil fuel consumption. Although the oil industry and its products have been proven essential to the development of various countries worldwide, its faults have become apparent. Research and discussions are continuous on the mitigation of the industry, as the efficient decrease of the oil industry has become a proven challenge. Zero-emission infrastructures and technologies are being developed simultaneously with fossil fuel technologies.⁴² Saudi Arabia, for example, is a global powerhouse in the oil industry. Thanks to oil and gas, the country has been able to develop so efficiently. The infrastructure created for and by this industry has helped to

31 "Energy," United Nations Environment Programme.

32 "Energy," United Nations Environment Programme.

33 "Energy," United Nations Environment Programme.

34 "Methane," National Aeronautics and Space Administration, accessed July 2, 2024, <https://climate.nasa.gov/vital-signs/methane/?intent=121>.

35 "Methane," National Aeronautics and Space Administration.

36 "Industrialization, Labor, and Life," National Geographic Education, accessed July 15, 2024, <https://education.nationalgeographic.org/resource/industrialization-labor-and-life/>.

37 "International Methane Emissions Observatory," United Nations Environment Programme, accessed July 2, 2024, <https://www.unep.org/topics/energy/methane/international-methane-emissions-observatory>.

38 Daniel Vernick, "Is Climate Change Increasing The Risk of Disasters?" World Wide Fund for Nature, April 2, 2024, <https://www.worldwildlife.org/stories/is-climate-change-increasing-the-risk-of-disasters>.

39 "Causes and Effects of Climate Change," United Nations Climate Action, accessed July 3, 2024, <https://www.un.org/en/climatechange/science/causes-effects-climate-change>.

40 "Oil and Gas Companies Will Have to Pay More to Drill on Public Land," EarthJustice, April 12, 2024, <https://earthjustice.org/brief/2024/oil-and-gas-companies-will-have-to-pay-more-to-drill-on-public-land>.

41 "The Environmental Impacts of Oil Rigs: How to Mitigate Using Simulation Technology," Esimtech, accessed July 3, 2024, <https://www.esimtech.com/the-environmental-impact-of-oil-rigs-how-to-mitigate-using-simulation-technology.html>.

42 United Nations Environment Programme Finance Initiative, *Position on the Oil and Gas Sector*.

advance the industrial revolution in Saudi Arabia and the rest of the world.⁴³ Being a founding member of OPEC, Saudi Arabia has historically had a presence in the international oil industry scene. However, their international presence goes deeper than that. Foreign companies or investments have built many of their historic oil reserves and infrastructures. For example, the Jeddah Refinery was built in 1967 by the Chiyoda Corporation from Japan. While this plant was running, it was infamous for its innovations in both electrical energy and gasoline production.⁴⁴ It now stands as a testament to the ongoing diversification of the Saudi Arabian economy and the continuation of technological advancements in the region. With the efforts to reduce fossil fuel consumption, many of these sites have become decommissioned and grown into heritage sites, honoring their role in the country's development. Other countries around the world have also made similar progress, such as China's Yumen Province Oilfield or Trinidad and Tobago's La Brea Pitch Lake.⁴⁵

The continuous modernization of the oil industry is critical across the world. While some countries have succeeded in reducing their dependence, others still rely on older models or oil processing methods. Many war-torn or lower-income countries rely on fossil fuels for over three percent of their gross domestic product (GDP).⁴⁶ This results in a gap between production and innovation, which must be highly considered when researching and discussing solutions for decarbonization.

Access to Clean Water & Air

The oil industry's impacts are significant outside of GHG emissions. It deteriorates global biodiversity levels in both plants and animals, above and below the water. This

ultimately worsens the quality of the air and water we breathe. The oil and gas industry is accountable for nearly 5.1 billion tonnes of GHG emissions in the atmosphere.⁴⁷ As previously mentioned, methane is one of the most significant contributing gasses to global warming. An estimated 60 percent of global methane emissions are the result of human activities, notably oil extraction and processing.⁴⁸ Despite the prominence and danger of methane, it is not the only toxic gas in the atmosphere. Carbon dioxide traps less heat than methane but remains in the atmosphere for hundreds of years longer.⁴⁹ Much of this is released into the atmosphere during the combustion and processing of oil. Transportation, production, and drilling emissions are all contributors to these emissions. Air pollution is also significant in the processing of oil. Flaring is a common practice done by many companies, by which excess natural gas is burnt in the open air.⁵⁰ These flames contribute to GHG emissions and increase the risks of local grass and forest fires.

These fossil fuels can partially be absorbed into land ecosystems, creating carbon sinks. A carbon sink is qualified as anything that absorbs more carbon dioxide than it emits.⁵¹ Plains, mountains, and forests are among those considered to be carbon sinks. Biodiversity is an important element of carbon sinks, as it adds to the high capacity of carbon absorption. Over the last ten years, land ecosystems have absorbed 30 percent of carbon emissions caused by human activity.⁵² This includes activities such as burning fossil fuels through transportation, construction, processing, and more. Land degradation is threatening biodiversity and its potential to absorb emissions. The destruction of habitats for plants and animals through deforestation and development takes

43 "The Oil Industrial Heritage in Saudi Arabia," United Nations Educational, Scientific, Cultural Organization, January 23, 2023, <https://whc.unesco.org/en/tentativelists/6639/>.

44 "The Oil Industrial Heritage in Saudi Arabia," United Nations Educational, Scientific, Cultural Organization.

45 "The Oil Industrial Heritage in Saudi Arabia," United Nations Educational, Scientific, Cultural Organization.

46 Lars Jensen, *Global Decarbonization in Fossil Fuel Export-Dependent Economies*, (New York: United Nations Development Programme, May 2023), <https://www.undp.org/sites/g/files/zskgke326/files/2023-05/Global%20Decarbonization%20in%20Fossil%20Fuel%20Export-Dependent%20Economies.pdf>.

47 International Energy Agency, *Emissions from Oil and Gas Operations in Net Zero Transitions*.

48 "Methane," National Aeronautics and Space Administration.

49 "Methane," National Aeronautics and Space Administration.

50 "Oil Extraction: The Impact of Oil Production in the Rainforest," World Rainforests, accessed July 13, 2024, <https://worldrainforests.com/0806.htm>.

51 "What is a Carbon Sink?" Client Earth, accessed July 13, 2024, <https://www.clientearth.org/latest/news/what-is-a-carbon-sink/>.

52 "Land- The Planet's Carbon Sink," United Nations Climate Action, accessed July 13, 2024, <https://www.un.org/en/climatechange/science/climate-issues/land>.



Workers cleaning coastal oil spill

Credit: Gore Lamar, U.S. Fish and Wildlife Service

away the planet's ability to produce clean water and air.⁵³ However, the intensity of today's climate crisis is taking a toll on the land's ability to absorb GHGs. Globally, 86 percent of land ecosystems are slowly declining in their ability to absorb carbon.⁵⁴ Although abundant levels of carbon dioxide are present in the atmosphere, the warming from methane slows this process.⁵⁵ The loss of biodiversity through land degradation also contributes to this, as clean water and fertile soil are less accessible to these plants.

Oil drilling and construction are extremely harmful to surrounding environments. Chemical pollution from oil spills is one of the most common forms of ecosystem damage from the oil industry. When oil becomes homogeneous with water sources, it becomes classified as chronic oil pollution. This can come from repeated small oil spills or leaks, which often go unnoticed. The continuation of these spills accumulates in large quantities in the water body. Oil spreads rapidly- only one liter of leaked oil is required to contaminate one million

liters of freshwater.⁵⁶ Additionally, chemicals released from the equipment, such as mercury and microplastics, are often highly present in these scenarios. The gradual accumulation of these causes injury or death to species of both plants and animals.⁵⁷ This pollution and buildup of dead and/or decaying species leads to high water contamination levels and, in some instances, pushes it beyond safe levels for irrigation.

The relationship between water, land, and biodiversity levels is strong. Unsustainable practices surrounding agriculture or water systems directly impact biodiversity, causing a loss of ecosystems. For example, large amounts of wastewater are created during crude oil processing. One of the major methods of disposal is through underground injection.⁵⁸ This ultimately fragments the water cycle, leaving polluted water stagnant or inaccessible.⁵⁹ This is especially harmful in regions that depend on well water or do not have access to adequate water treatment facilities. Additionally, chemical pollution from oil products, such as plastics and detergents, is often dumped in

⁵³ "Land- The Planet's Carbon Sink," United Nations Climate Action.

⁵⁴ Esprit Smith, "Land Ecosystems are Becoming Less Efficient at Absorbing Carbon Dioxide," National Aeronautics and Space Association, December 21, 2020, <https://climate.nasa.gov/news/3057/land-ecosystems-are-becoming-less-efficient-at-absorbing-carbon-dioxide/>.

⁵⁵ Esprit Smith, "Land Ecosystems are Becoming Less Efficient at Absorbing Carbon Dioxide."

⁵⁶ "The Impact of Oil Spills," Oil Care UK, accessed July 3, 2024, <http://oilcare.org.uk/what-we-do/impacts-of-oil/>.

⁵⁷ Harsh Patni and Balasubramanian Ragunathan, "Recycling and reusing of oilfield produced water- A review," *Materials Today* vol. 77, pp 307-313 (December 2022) <https://doi.org/10.1016/j.matpr.2022.11.372>.

⁵⁸ "Final Report: Oil and Gas Extraction Wastewater Management," United States Environmental Protection Agency, accessed July 22, 2024, <https://www.epa.gov/eg/final-report-oil-and-gas-extraction-wastewater-management>.

⁵⁹ Secretariat of the Convention on Biological Diversity, *Water and Biodiversity*, (Montreal: United Nations Environment Programme, 2015), <https://www.cbd.int/gbo4/gbo4-water-en.pdf>.

water sources. This ultimately infiltrates water systems and in some cases, is consumed by humans and animals. These risks are pertinent and urgent in various types of aquatic ecosystems and water sources, ranging from wetlands and groundwater sources to oceans.⁶⁰

This excess of air takes a toll on public health and is dangerous to cardiovascular and respiratory health. Challenges to human health, including childhood asthma and birth defects, can also be symptoms of elevated methane exposure.⁶¹ Carbon Dioxide exposure also correlates to elevated blood pressure, heart rate, dizziness, and confusion. Long-term exposure to these GHGs ultimately increases risks of cancers, as well as cardiac obstruction.⁶² The compilation of these risks adds pressure to global healthcare systems, especially those under-equipped or underfunded, to deal with increased numbers of patients. Adaptive solutions and plans are essential in preparing for this increasing health crisis.

Through the restoration of land ecosystems and biodiversity, the potential for economic benefit is large. These gains add up to an estimated 140 trillion US dollars per year.⁶³ Grasslands, savannahs, and rainforests all contribute to the carbon absorption and protection that lands provide.⁶⁴ At least half of the world's population struggles with access to safe water for at least one month every year.⁶⁵ This figure is only on track to worsen because of climate change. By 2025, at least 1.8 billion people worldwide are anticipated to face absolute water scarcity.⁶⁶ Global tensions over safe and reliable access to water exacerbate local and large-scale conflicts and

are expected to continue. Resource scarcity drives tension within communities. In conflict, cutting off access to water serves as a method of warfare.⁶⁷ Access to clean water directly impacts drinking water and agriculture systems, both of which are vital socio-economic drivers for millions of people worldwide.⁶⁸ This crisis is further aggravated by oil pollution and processing, alongside the rapid decrease in biodiversity around the globe. The impairment of freshwater ecosystems due to human pollution is widespread in the water crisis.

Human needs and pollution are constantly pressuring water resources. The average amount of water wasted by oil reserve systems ranges from 250-605 million barrels each day.⁶⁹ This water is contaminated with toxic materials and is extremely pollutant. The discarded contents contain high salts, hydrocarbons, and hydrogen sulfides. When this reaches water bodies, it kills fish and other aquatic species rapidly.⁷⁰ These toxic chemicals are tough to process and filter. As a result, only approximately one percent of this waste can be cleaned and recycled, with the remaining being discarded into the environment.⁷¹ Through the climate crisis, there are select plant and animal species that can slow global warming. Mangroves are a coastal tree species essential in water and air filtration. Prominent around the world, these are the only species that thrive in salty waters. These trees are essential to biodiversity targets, being home to over 1,500 species, 15 percent of which are threatened.⁷² These include marine and land animals, ranging from sloths and tigers to manatees and turtles.⁷³ They are home to over one thousand species of birds,

⁶⁰ Secretariat of the Convention on Biological Diversity, *Water and Biodiversity*.

⁶¹ Jillian Mckoy, "Air Pollution from Oil and Gas Production Contributes to Thousands of Early Deaths, Childhood Asthma Cases Nationwide," Boston University School of Public Health, May 8, 2023, <https://www.bu.edu/sph/news/articles/2023/air-pollution-from-oil-and-gas-production-contributes-to-thousands-of-early-deaths-childhood-asthma-cases-nationwide/>.

⁶² "Climate Impacts on Human Health," United States Environmental Protection Agency, accessed July 25, 2024, <https://climatechange.chicago.gov/climate-impacts/climate-impacts-human-health>.

⁶³ "Land- The Planet's Carbon Sink," United Nations Climate Action.

⁶⁴ "Land- The Planet's Carbon Sink," United Nations Climate Action.

⁶⁵ "Global Water Shortages Are Looming. Here's What Can be Done About Them," United Nations Environment Programme.

⁶⁶ "Global Water Shortages Are Looming. Here's What Can be Done About Them," United Nations Environment Programme, accessed July 3, 2024, <https://www.unep.org/news-and-stories/story/global-water-shortages-are-looming-here-what-can-be-done-about-them>.

⁶⁷ "Having access to water is increasingly a matter of survival in conflict zones," International Committee of the Red Cross, accessed July 20, 2024, <https://www.icrc.org/en/document/having-access-water-increasingly-matter-survival-conflict-zones>.

⁶⁸ United Nations Sustainable Development Goals, "Water Crises Threaten World Peace," press release, March 22, 2024, <https://www.un.org/sustainabledevelopment/blog/2024/03/un-world-water-development-report/>.

⁶⁹ Harsh Patni and Balasubrimanian Ragunathan, "Recycling and reusing of oilfield produced water- A review."

⁷⁰ Harsh Patni and Balasubrimanian Ragunathan, "Recycling and reusing of oilfield produced water- A review."

⁷¹ Harsh Patni and Balasubrimanian Ragunathan, "Recycling and reusing of oilfield produced water- A review."

⁷² "An Inside Look at the Beauty and Benefits of Mangroves," United Nations Environment Programme, accessed July 14, 2024, <https://www.unep.org/news-and-stories/story/inside-look-beauty-and-benefits-mangroves>.

⁷³ "Understanding How Mangrove Loss Threatens Biodiversity," United Nations Environment Programme, accessed July 14, 2024, <https://www.unep-wcmc.org/en/news/understanding-how-mangrove-loss-threatens-biodiversity>.

ranging from the Americas to Africa and South-East Asia.⁷⁴ Despite their recognized importance, one-fifth of global mangrove populations have been lost.⁷⁵ This loss is critical to the climate crisis because they absorb carbon emissions and filter marine environments. Mangroves contribute significantly to the world's access to clean air and water for human and animal species. They are considered heroes in climate change, absorbing 1000 tonnes of carbon per hectare in their direct ecosystems.⁷⁶ Because of this importance, it is essential to prioritize the restoration and conservation of global mangrove populations.

Salt and freshwater ecosystems are necessary to sustain nature on the planet. These are known as blue ecosystems, and they are vital in regulating temperatures, protecting against erosion, and generating oxygen. Blue ecosystems also carry a vast amount of the world's biodiversity.⁷⁷ Mangroves are a key element in these. Their role in water and air filtration, increasing biodiversity, and environmental resilience have dubbed them as the world's most important trees.⁷⁸ The UN highlights the importance of this species in its actions under the Decade of Ocean Science. The UN supports the Decade of Ocean Science initiative, highlighting seven goals under ten challenges to be completed between 2021 and 2030.⁷⁹ Mangroves are an essential species under the targets of the decade. They play an integral role in providing for human and animal resources worldwide and increasing resilience to climate change. It is through action surrounding essential species that pollution mitigation can be done.

Food Scarcity

The United Nations has projected that global food production will need to double by 2050 to keep up with the growing population.⁸⁰ This becomes difficult when considering the challenges to food production. The oil industry worsens climate change, water shortages, and biodiversity loss, further contributing to this issue. Oil exploration hurts the land, air, and marine environments where food is produced.⁸¹ Fish are among the most accessible sources of protein for many communities around the world. Marine fisheries feed more than half of the populations in lower-income countries.⁸² This oil industry disrupts this figure when spilled oil infiltrates marine species. In oil spills, marine creatures, including fish, shellfish, and seaweed, that are exposed to toxic chemicals perish almost instantly. This also impacts seafood or mariculture farms, often still exposed to open seas.

Creatures who are exposed often end up contaminated, ultimately causing concern for human health.⁸³ Studies by the University of Miami have shown that mahi-mahi exposed to even small quantities of oil face long-term impacts. Immediately, exposed fish become smothered in oil. It fills their gills, causing near-instant death. Fish not physically affected by oil contamination suffer delays in swimming and survival skills. This is because of cardiovascular and neurological impacts caused by even small doses of oil exposure. As a result, these fish are more vulnerable to predators and less likely to survive extreme weather systems.⁸⁴ Mahi-mahi is an important source of food for populations in warm environments. The demand for this fish is high, both locally and internationally.⁸⁵

74 "Understanding How Mangrove Loss Threatens Biodiversity," United Nations Environment Programme.

75 "An Inside Look at the Beauty and Benefits of Mangroves," United Nations Environment Programme.

76 "An Inside Look at the Beauty and Benefits of Mangroves," United Nations Environment Programme.

77 "Why Blue Ecosystems Matter," United Nations Environment Programme, accessed July 15, 2024, <https://www.unep.org/topics/ocean-seas-and-coasts/blue-ecosystems>.

78 "The Magic of Mangroves," The Ocean Agency, accessed July 13, 2024, <https://www.theoceanagency.org/toolkits/mangroves>.

79 "10 Challenges," United Nations Decade of Ocean Science for Sustainable Development, accessed July 15, 2024, <https://oceandecade.org/challenges/>.

80 "Water, Food, and Energy," United Nations Water, accessed July 4, 2024 <https://www.unwater.org/water-facts/water-food-and-energy>.

81 Precious Ehiomogbe, Akindele Alonge, Unwana Udoumoh, and Ubong Assian, "Effects of Crude Oil Spill on Global Food Security: A Review," *Fascicule 2*, May 2023, https://www.researchgate.net/publication/370602555_EFFECT_OF_CRUDE_OIL_EXPLORATION_ON_GLOBAL_FOOD_SECURITY_A_REVIEW.

82 "Goal 14: Conserve and Sustainably Use the Oceans, Sea, and Marine Resources," United Nations Sustainable Development Goals, accessed July 4, 2024, <https://www.un.org/sustainabledevelopment/es/oceans/>.

83 International Tanker Owners Pollution Federation, *Effects of Oil Pollution on Fisheries and Mariculture*, (London:ITOPF, 2011), https://www.itopf.org/fileadmin/uploads/itopf/data/Documents/TIPS_TAPS_new/TIP_11_Effects_of_Oil_Pollution_on_Fisheries_and_Mariculture.pdf.

84 Jones, Robert Jr., "Studying the impact of oil on mahi-mahi," University of Miami, news article, April 19, 2019, <https://features.miami.edu/2019/oil-spill/studying-the-impact-of-oil-on-mahi-mahi/index.html>.

85 "Road to sustainable growth of mahi-mahi production in the Dominican Republic," Food and Agriculture Organization, June 8,

A decrease in population ultimately contributes to global food scarcity rates. This impact goes beyond the direct hits from oil spills when oil contamination has such a far reach. It also impacts the livelihoods of fishermen, restaurants, and other businesses that use fishing to generate income. Many marine species are vulnerable to ocean warming due to high GHG emissions in the atmosphere. Warming climates disrupt critical life systems, such as metabolism and reproduction. It has been found that many fish populations are gradually shifting away from the equator or to deeper waters as they escape warming environments.⁸⁶ This impacts aquatic ecosystems and disrupts food systems. All twelve countries that rely the most on fish for nutritional value are located in warm environments.⁸⁷ When fish and marine species leave these regions, it takes away valuable resources for their populations.

Agriculture is another vital source of nutrition and income around the world. This industry is known to be threatened by oil-based pollution and climate change. The impacts of unhealthy agricultural systems impact individuals across society around the world. Despite growing needs, agricultural production in continental Africa is predicted to drop 30 percent by the year 2025.⁸⁸ This trend is consistent with figures around the world. Much of it is caused by oil pollution. Chemical pollution from oil spills makes soils infertile and unable to transfer nutrients. Seed growth and plant development risks being slowed or stopped completely from contact with oil. In developed crops, oil exposure prevents water uptake, causing dehydration. It also prevents growth and regeneration of damaged plant tissue.⁸⁹ These barriers to development deteriorate crop production both commercially and privately. The rise in extreme weather is detrimental to growth conditions.

Floods, droughts, wildfires, and other natural events caused by global warming severely impact global food production. These changes will likely continue, regardless of subtle changes in human behavior. This is caused by climate inertia, the delayed or continual response from past events or disasters.⁹⁰ Because of this, adaptation and preparation are key to finding solutions to global food scarcity.

For example, the Niger Delta, an area of a Nigerian river, has suffered the impacts of oil spills on its crops for nearly six decades. It is because of these hardships that the region has now been dubbed one of the most polluted places on earth.⁹¹ The Niger Delta is home to over 6.5 million people, 70 percent of which live in rural communities.⁹² Many of them depend on food for cultural and ceremonial practice. Soils were known to be fertile and rich before the oil industry settled in the area. However, over the past six decades, there have been an average of 150 oil spills annually. This adds up to over 23 thousand barrels bi-annually.⁹³ Policies and regulations regarding oil spills are in place. These consider both mitigation and cleanup. In reality, the response is often delayed by the companies at fault. The cleanup of these spills takes several weeks, giving oil time to seep into soil and groundwater, harming crops and other sources of nutrition. The impacts on crops and food production have increased the cost of groceries and decreased the quality of the available food. Many crops that are essential to Nigerian culture, such as plantain, cassava, and yam, are impacted by these spills and become unfit for consumption.⁹⁴ Foods considered 'staple' to local diets have become nearly inaccessible. With two-thirds of the population living below the poverty line, this increase in prices risks furthering the divide between the country's rich and poor communities.⁹⁵

2022, <https://www.fao.org/in-action/fish-4-acp/resource-detail/ru/c/1538755/>.

86 "Study: Most marine fish are responding to ocean warming by relocating toward the poles," Global Seafood Alliance, May 31, 2023, <https://www.globalseafood.org/advocate/study-most-marine-fish-are-responding-to-ocean-warming-by-relocating-toward-the-poles/>.

87 Marine Resources Assessment Group, *The Twelve Countries with the Highest Nutritional Dependency on Fish*, (MRAG:United Kingdom, 2005) https://mrag.co.uk/sites/default/files/fmspdocs/R4778J_FTR2.pdf.

88 Melese Muluneh, "Impact of Climate Change on Biodiversity and Food Security: a global perspective- A Review Article."

89 Precious Ehiomogue, Akindele Alonge, Unwana Udoumoh, and Ubong Assian. "Effects of Crude Oil Spill on Global Food Security: A Review,"

90 "Food Insecurity and Climate Change," United Kingdom Met Office, accessed July 4, 2024, <https://www.metoffice.gov.uk/research/climate/climate-impacts/food-security/food-insecurity>.

91 Arinze Chijoke, "Niger Delta oil spills bring poverty, low crop yields to farmers," Al Jazeera, September 9, 2022, <https://www.aljazeera.com/features/2022/9/9/niger-delta-oil-spills-bring-poverty-low-crop-yields-to-farmers>.

92 Abosede Babatunde, "How the oil industry is damaging food production in Nigeria's Niger Delta," LSE Business Review, January 12, 2024, <https://blogs.lse.ac.uk/businessreview/2024/01/12/how-the-oil-industry-is-damaging-food-production-in-nigerias-niger-delta/>.

93 Chijoke, "Niger Delta oil spills bring poverty, low crop yields to farmers,"

94 Chijoke, "Niger Delta oil spills bring poverty, low crop yields to farmers,"

95 "Population and the Government in Nigeria- Too big to go green?," Population Matters, accessed July 4, 2024, <https://populationmatters.org/news/2024/02/population-and-the-environment-in-nigeria-too-big-to-go-green/>.



Collective fishing in Bangladesh
Credit: Water Alternatives Photos

Before the discovery of oil, Nigeria’s food market was nearly self-sufficient. However, the country now relies on approximately 20 billion US dollars worth of food imports annually.⁹⁶ This is another downside of the oil industry’s impact on the country since its beginnings in the 1970s. The oil and gas industries have composed over 70 percent of Nigeria’s foreign revenue over this period.⁹⁷ Because of this fiscal importance, reducing the need for oil is extremely difficult. Being one of the fastest-growing populations and economies in the world, this industry continues to expand. Additionally, despite the prominence of third-party intervention in the region, there has been minimal curbing of the industry. It is nearly impossible for the country or local businesses to develop energy alternatives appropriate for the population. This struggle is not unique to Nigeria. Qatar, Saudi Arabia, and the United Arab Emirates all rely on food imports for 80 to 90 percent of demand.⁹⁸ These countries all dominate in global fossil fuel production. Due to the complexity of this new challenge, policymakers must plan proactively for future hurdles to gain longevity.

When discussing solutions, there are three principal dimensions to consider. It is the combination of availability,

utilization, and accessibility that increases food stability. Food availability, both in terms of production and importation, is the first determining factor. This requires a sufficient amount of quality food. The food must be diverse enough to meet a population’s nutritional needs in determining quality. With increasing amounts of genetic modification in crops, diversity is being lost. Because of this, quantity is often being met, but quality is falling short around the world.⁹⁹ As a whole, wild and domestic biodiversity are essential in availability. Pollinating species and fungi, for example, are wild species that contribute to domesticated species by providing nutrients. Genetic diversity is essential to availability in ensuring resilience and, therefore, longevity of crops in the instances of disease or pests. Resilience is also growing in importance with the increase in extreme weather caused by the climate crisis. This allows continuity of available food resources, even in unprecedented times.

The next dimension of food stability is utilization. This involves the development, processing, and combination of resources.¹⁰⁰ Food agencies must be able to use what is available, especially when availability is lacking. These may include periods of

⁹⁶ Abdullah Djella, Luiji Cemballo, Marilena Furno, and Francesca Caracciolo, “Is Oil Export a Curse in Developing Economies? Evidence of Paradox of Plenty on Food Dependency,” *New Medit*, no. 4, (2019) : 51-64 <http://doi.10.30682/nm1904d>.

⁹⁷ Chijoke, “Niger Delta oil spills bring poverty, low crop yields to farmers.”

⁹⁸ Djella, et al, “Is Oil Export a Curse in Developing Economies? Evidence of Paradox of Plenty on Food Dependency,” 51-64.

⁹⁹ Food and Agriculture Organization of the United Nations, *How the World’s Food Security Depends on Biodiversity*, (Rome: FAO, 2020) <https://openknowledge.fao.org/server/api/core/bitstreams/60c9896f-6ed9-4b0e-982a-3d001a1ef2a6/content>.

¹⁰⁰ Food and Agriculture Organization of the United Nations, *How the World’s Food Security Depends on Biodiversity*,

drought or flood. Proper usage minimizes waste and optimizes benefits. Biodiversity is highly important in the preservation and processing of foods. For example, the microorganisms involved in the production of bread or the processing of dairy products, such as cheese.¹⁰¹ Both of these are common staples around the world. Because of its importance, most countries can benefit from improved processing.

For availability and proper usage to make a difference, sustainably produced food must be accessible to the greater population. Across the world, over three billion people can not afford a healthy diet.¹⁰² For food to be stable, it must be accessible and affordable to rural and urban populations alike. All people need to be able to afford food or obtain the means to grow their own. Growing, hunting, or processing should be available where accessible food is not. Increasing biodiversity levels contribute to this significantly. More production increases affordability, and easier access allows for sustainable re-investment in food sources, which gives people selection and variety.¹⁰³ When considering long-term solutions, biodiversity allows future generations to continue the trends of food stability, thus increasing resilience and improving future lives. By 2050, demands in global food production are expected to increase significantly. Countries expected to see the highest increase in demand are also the most vulnerable to climate change and pollution.¹⁰⁴ These high populations, correlated with high levels of hunger, have the lowest ability to adapt to increasing challenges in food supply. The need for sustainable solutions to hunger is urgent and requires adaptable frameworks to increase food accessibility for all.

Impacts on Tourism

The environmental impacts of oil exploration also place stress on other industries. This biodiversity loss has impacted

tourism and recreation in various environments. Endangered species motivate reduced human activity. Site protection, such as hunting bans or the creation of reserves, are some causes of these reductions. Additionally, extinct or dead species take away the appeal for tourists. Likewise, chemical and air pollution caused by drilling and spills create a dangerous environment for visitors. The costs of cleanup and regeneration increase the difficulty of rebounding after these businesses are impacted. Around the world, 80 percent of tourism is concentrated in coastal regions.¹⁰⁵ The income these businesses bring generates opportunities for economic growth, especially in less-developed countries. This tourism employs up to a third of the population in many maritime countries, generating at least 134 billion US dollars annually around the world.¹⁰⁶ Because of this, it is important to ensure the prosperous continuation of tourism worldwide.

The presence of oil infrastructure has an observable impact on tourism levels. When drilling equipment is built in a community, the average decrease in tourism levels is by fifty percent.¹⁰⁷ These builds include pipelines, drills, offshore rigs, refineries, storage systems, and more. These construction projects are timely and costly, transforming the landscape of communities. In the long term, many tourists and residents consider these infrastructures displeasing. Aesthetics, sound pollution, and air pollution, as well as the risk of disaster, typically drive a change in population and business.¹⁰⁸ The impacts on plants, wildlife, and human health ultimately decrease the desire to visit oil-based communities. One of the most harsh ocean polluters is the occurrence of oil spills. These spills make their way into aquatic environments through vessel spills, leaks during consumption, or seeps during extraction.¹⁰⁹ This contamination kills marine plants and animals, such as corals and fish. Dead or bleached corals are nearly impossible

101 Food and Agriculture Organization of the United Nations, *How the World's Food Security Depends on Biodiversity*,

102 "A Wake-up Call to Fight Hunger," United Nations Food, accessed July 4, 2024, <https://www.un.org/en/global-issues/food>.

103 Food and Agriculture Organization of the United Nations, *How the World's Food Security Depends on Biodiversity*,

104 "Short Lived Climate Pollutants and Food Security," UNEP Clean Air & Climate Coalition, accessed July 8, 2024, <https://www.ccacoalition.org/content/short-lived-climate-pollutants-and-food-security>.

105 "Goal 14: Conserve and Sustainably use the oceans, seas, and marine reserves," United Nations Sustainable Development Goals, accessed July 6, 2024, <https://www.un.org/sustainabledevelopment/es/oceans/>.

106 "Goal 14: Conserve and Sustainably use the oceans, seas, and marine reserves," United Nations Sustainable Development Goals,

107 Southern Environmental Law Center, "Oil Drilling Infrastructure Drives Away Tourism Dollars."

108 Oceana, *Offshore Drilling Could Transform Beach Towns into Oil Towns*, (Washington: Oceana, 2020) https://usa.oceana.org/wp-content/uploads/sites/4/17335/infrastructure_fact_sheet_final_0.pdf.

109 Naomi Álvarez Waló, *Economic impacts of oil spills in island tourism destinations. An application to the Canary Islands*, (Spain: Universidad de la Laguna, July 2016) <https://riull.ull.es/xmlui/bitstream/915/2760/1/Economic+impacts+of+oil+spills+in+island+tourism+destinations.+An+application+to+the+Canary+Islands..pdf>.

to regrow, and their diverse populations leave with them. When highly desired or ‘iconic’ species are pushed out of an environment, human interest in exploring these environments decreases.¹¹⁰

A key example of an iconic species is the sea turtle. Turtle conservation tours are a common bucket list item for many. These tours, often led by volunteer conservationists, bring in finances for local businesses and for larger conservation projects.¹¹¹ When done properly, these tours can have a long-term positive impact on turtle populations, increasing human awareness of how to benefit them. Although they are fairly robust creatures with long lifespans, turtles are extremely vulnerable to the impacts of the oil industry. Contact with oil increases egg mortality, induces developmental issues, and harms the skin and internal organs of the turtles. Consumption of petroleum-based products, such as plastics and chemicals, also contributes to the decreasing populations of this species.¹¹² Lost turtle populations discourage thousands of people from participating in underwater or dry-land activities, causing significant losses to the tourism industry.

These disasters do not only affect marine life. Various land species are also impacted through direct contact and food contamination. Birds are frequent victims of oil smothering, which removes their ability to fly or swim. They often consume oil products, either to clean their feathers or through consuming contaminated organisms. Mammals, such as bears and otters, are highly vulnerable to the impacts of oil exposure. Direct exposure is toxic to their skin and organs and has a direct effect on the ability of fur and fat to moderate the animal’s warmth.¹¹³ These species also suffer a loss of habitat due to land exploitation. Oil exploration and infrastructure

developments deteriorate ecosystems, forcing animals to either migrate or perish from these locations. Roads, pipelines, and processing plants are all among the developments built by these companies. The further loss of habitat and animal life, as well as plants that are physically contaminated or removed, diminishes the tourist desire to visit a region. This contributes significantly to the loss of tourism-based income for vulnerable communities.

Organizations focused on scuba diving and snorkeling are especially vulnerable to the loss of business from the loss of marine life. With over 4200 recognized diving sites around the world and over 4,000 recognized dive shops around the world, there is a significant community impacted by these changes.¹¹⁴ To boost interest, there has been an insurgence of man-made shipwrecks that mocked coral reefs to restore habitats for fish populations. Private organizations, such as the Professional Association of Diving Instructors (PADI), have also begun launching initiatives to promote engagement in marine conservation. These include community grants, educational programs, and new policies for certification.¹¹⁵ Oil spills also deteriorate the quality of coastlines and beaches. Unrefined oil gathers overtime at the water’s surface, ultimately following tide patterns on coastlines. This infiltrates into the sand, as its degradation time ranges from multiple months to many years.¹¹⁶ During this lengthy process, oil contamination harms invertebrate communities along the way. Species displaying the highest mortality rates from oil contamination include crabs, mussels, clams, and urchins.¹¹⁷ The influx of polluted conditions, alongside human health impacts, lessens the human desire to visit beaches affected. Extreme weather events like hurricanes and floods erode sand structures and

110 “Getting Involved in Ocean Conservation & PADI’s Blueprint for Ocean Action,” Professional Association of Diving Instructors, accessed July 9, 2024, <https://blog.padi.com/blueprint-for-ocean-action/>.

111 Ashleigh Bandimere, “Sea Turtle Tourism Offers Opportunity to Observe and Interact While Having a Positive Impact,” Oceanic Society, April 24, 2024, <https://www.oceanicsociety.org/travel-ideas/sea-turtle-tourism-offers-opportunity-to-have-positive-impact/>.

112 Sarah Milton, Peter Lutz, and Gary Shigenaka, *Oil Toxicity and its Impacts on Sea Turtles*, (Florida : Reef Relief, 2022) <https://www.reefrelief.org/wp-content/uploads/oil-turtle1.pdf>.

113 EPA Office of Emergency and Remedial Response, “Wildlife and Oil Spills,” *Controlling Oil Spills and Oil Spill Response*, 5, July 8, 2024, https://dnr.maryland.gov/wildlife/Documents/OilSpills_Wildlife.pdf.

114 “Top Dive Sites Around the World,” Professional Association of Diving Instructors, accessed July 7, 2024, <https://www.padi.com/dive-sites/all>; Darcy Kieran, “The Size of the Scuba Diving Industry,” Medium, July 17, 2019, <https://medium.com/scubanomics/the-size-of-the-scuba-diving-industry-573b8ac44c7c>.

115 “PADI Environmental and Social Responsibility,” Professional Association of Diving Instructors, accessed July 8, 2024, <https://www.padi.com/csr>.

116 Markus Huettel, “Oil Pollution of Beaches,” *Current Opinions in Chemical Engineering*, vol. 36, (June 2022) <https://doi.org/10.1016/j.coche.2022.100803>.

117 Adriana Bejarano and Jacqueline Michel, “Oil spills and their impacts on sand beach invertebrate communities: A literature review” *Environmental Pollution*, vol. 219 (November 2016) <https://doi.org/10.1016/j.envpol.2016.07.065>.

beach infrastructure. This removes sales and business from hotels, shops, restaurants, and other coastal businesses. Additionally, repairing the damages caused by climate change to these regions is highly costly. The cost of repair for climate-change-induced damages averages 143 billion US dollars each year.¹¹⁸ This comes from private and public bodies, covering repairs and clean-ups caused by extreme weather and chemical pollution.

Oil spills are also precarious for human health. Oil-contaminated waters are toxic and sometimes fatal upon human exposure. Many of these health impacts are chronic, such as skin or nervous system damage. Oil exposure also harms the human reproductive and respiratory systems and damages internal organs, namely the liver. The high levels of toxins present in oil contamination are correlated with an increased risk of cancer and other severe illnesses.¹¹⁹ These health impacts force a decrease in tourism levels, as human exposure to these spills is hazardous. Since 2011, the Atlantic

Ocean has been seeing an influx of sargassum seaweed.¹²⁰ This is believed to be caused by warming waters, alongside an influx of chemical pollution in the water.¹²¹ Sargassum presents as large mats on the water's surface, washing up on beaches and coastlines. While in the ocean, these mats provide habitat and nutrition to various species. However, once they grow closer to land and reefs, the effects are deadly to human and animal life. High levels of trapped debris and bacteria cause physical harm and infection.¹²² Fish, crustaceans, seahorses, and coral reefs are among the species harmed by sargassum mats. Decreased oxygen concentrations in and around these mats also harm life nearby. The areas most affected by this phenomenon range from Western Africa to the Caribbean and South America, as well as Latin America and Mexico.¹²³ Many countries depend on tourism for income, but global influxes of sargassum concern businesses and tourists alike.

For most Small Island Developing States (SIDS), marine tourism constitutes the largest sector of the economy.¹²⁴

118 Paige Bennett, "Climate Change is Costing the World \$16 Million per Hour: study," World Economic Forum, October 12, 2023, <https://www.weforum.org/agenda/2023/10/climate-loss-and-damage-cost-16-million-per-hour/>.

119 Amazon Frontlines, Jena Webb, "What Do We Know About How Oil Spills Affect Human Health?"

120 Sarah Griffiths, "The Real Story Behind the Atlantic's Breaking Seaweed Blobs," *British Broadcasting Company*, June 28, 2023, <https://www.bbc.com/future/article/20230622-what-is-causing-the-atlantics-seaweed-blobs>.

121 Sarah Griffiths, "The Real Story Behind the Atlantic's Breaking Seaweed Blobs."

122 Sarah Griffiths, "The Real Story Behind the Atlantic's Breaking Seaweed Blobs."

123 Sarah Griffiths, "The Real Story Behind the Atlantic's Breaking Seaweed Blobs."

124 "Sustainable Coastal & Marine Tourism," High Level Panel for a Sustainable Ocean Economy, accessed July 6, 2024, <https://oceanpanel.org/opportunity/sustainable-coastal-marine-tourism/>.

Sea turtles, a commonly sought-after marine species in the tourism industry.

Credit: Anne Laudisoit



SIDs make up approximately one percent of the world's population.¹²⁵ They suffer uniquely from remote locations, lack resources, and have a high vulnerability to climate change.¹²⁶ Because of this, socio-economic and environmental challenges are persistent. The loss of biodiversity from climate change is amplified by the niche populations suited to their environments. As per the Fourth International Conference on SIDs, it should be prioritized to increase resilience and sustainability through tourism.¹²⁷ This includes respect towards biodiversity, wildlife, and ecosystems.¹²⁸ Notably, the outcomes also include the promotion of entrepreneurship and creative employment across the workforce.¹²⁹ The Caribbean alone hosts 10 percent of the world's coral reef population.¹³⁰ The northern Caribbean hosts the Andros Barrier Reef, one of the world's most extensive reefs. High levels of biodiversity on the islands are common, with the Maldives alone hosting over 1,100 marine species.¹³¹ SIDs also share high rates of endangered species. For example, the Pacific islands are home to 476 known threatened species.¹³²

Sustainable development for these countries is highly dependent on prosperous, responsible maintenance of tourism. Across SIDs, the GDP increase from tourism ranges from 0.7 to 15.2 percent.¹³³ This makes up a large portion of the country's income for both formal and informal workers. The informal sector is prominent in most SIDs, with a high reliance on

subsistence agriculture. In many, the formal industry is small and lacks proper education or training systems.¹³⁴ Labor laws are often limited, and discrimination is high in many work environments.¹³⁵ These challenges highlight the prominence of the informal sector, with many people depending on alternative sources of income. Inconsistencies in the workforce contribute to SID's high vulnerability to oil spills. In the 2024 Tobago oil spill, for example, officials were unable to track down the parent company of the sunken barge.¹³⁶ Information regarding the boat that had brought this barge into the waters of Trinidad & Tobago was minimal, including its owner and origins. This lack of information persists despite investigations performed by five Caribbean countries.¹³⁷ This oil spill ended up traveling as far as 144 kilometers, contaminating the waters and aquatic ecosystems as far as Grenada and Bonaire.¹³⁸ Mangroves were the main species of concern from this disaster, as they are a heavily preserved species in the region.¹³⁹

Another severe oil spill that impacted SIDs was the 2020 Wakashio oil spill in Mauritius.¹⁴⁰ This oil spill has become the worst environmental disaster in the East African country's history. The vessel leaked nearly 1,000 tons of fuel into a lagoon and coral reef, polluting the nation's coastline.¹⁴¹ This had toxic impacts on the region's people, plants, and animals. Many residents risked their health and safety to create makeshift cleaning and protective solutions. The vessel was

125 United Nations Office of the High Representative for the Least Developed Countries, Landlocked Developing Countries and Small Island Developing States, *Small Island Developing States in Numbers: Biodiversity & Oceans*, (Samoa: UN-OHRLLS, 2017) https://www.un.org/ohrrls/sites/www.un.org.ohrrls/files/sids_biodiversity_and_oceans_2017.pdf.

126 United Nations Office of the High Representative for the Least Developed Countries, Landlocked Developing Countries and Small Island Developing States, *Small Island Developing States in Numbers: Biodiversity & Oceans*.

127 United Nations General Assembly, Item 10, Fourth International Conference on Small Island Developing States, A/CONF.223/2024/4, (April 12, 2024,) <https://sdgs.un.org/sites/default/files/2024-05/n2409990.pdf>.

128 "Tourism in Small Island Developing States (SIDS)" United Nations Tourism, accessed July 15, 2024, <https://www.unwto.org/sustainable-development/small-islands-developing-states>.

129 "Tourism in Small Island Developing States (SIDS)" United Nations Tourism.

130 United Nations Office of the High Representative for the Least Developed Countries, Landlocked Developing Countries and Small Island Developing States, *Small Island Developing States in Numbers: Biodiversity & Oceans*.

131 United Nations Office of the High Representative for the Least Developed Countries, Landlocked Developing Countries and Small Island Developing States, *Small Island Developing States in Numbers: Biodiversity & Oceans*.

132 United Nations Office of the High Representative for the Least Developed Countries, Landlocked Developing Countries and Small Island Developing States, *Small Island Developing States in Numbers: Biodiversity & Oceans*.

133 "Tourism in Small Island Developing States (SIDS)" United Nations Tourism.

134 International Labor Organisation, *Decent Work and Social Justice for SIDS*, (New York: ILO, 2024) <https://www.ilo.org/media/450566/download>.

135 International Labor Organisation, *Decent Work and Social Justice for SIDS*.

136 Vanessa Buschschlüter, "Oil Spill Spreads Across Caribbean from Tobago to Bonaire," *British Broadcasting Company*, February 27, 2024, <https://www.bbc.com/news/world-latin-america-68413102>.

137 "Tobago Oil Spill Spreads to Grenada Waters and Could Affect Venezuela," *The Guardian*, accessed July 15, 2024, <https://www.theguardian.com/world/2024/feb/15/trinidad-tobago-oil-spill>.

138 "Tobago Oil Spill Spreads to Grenada Waters and Could Affect Venezuela," *The Guardian*.

139 Vanessa Buschschlüter, "Oil Spill Spreads Across Caribbean from Tobago to Bonaire."

140 Bruneau Laurette, Rama Valayden, Melita Steele, and Hisayo Takada, "Mauritius one year after oil disaster," *GreenPeace*, August 5, 2021, <https://www.greenpeace.org/international/story/49085/mauritius-worst-environmental-disaster-one-year-on/>.

141 Laurette, et al, Mauritius one year after oil disaster."

ultimately sunk on top of a whale nursery. Because of this, over fifty deceased whales and dolphins washed up on the island's shores in the months following the spill.¹⁴² Despite having some known information, the response on behalf of the government and company was minimal. Protests demanding action took place, but there were no concrete plans to avoid future incidents.¹⁴³ There was also minimal information released regarding the impacts on humans, ecosystems, or the cause of the vessel's sinking.¹⁴⁴ Mauritius is infamous for its marine diversity, which attracts a large tourist population. At the time of the incident, the country was already suffering from a loss of tourism due to the COVID-19 pandemic. This loss was only worsened by the contamination in its seas and surrounding waters.¹⁴⁵ In both cases, a heavy toll is taken on the tourism sector. In 2023 alone, SIDs welcomed 36 million international tourists.¹⁴⁶ Much of this tourist population is drawn by the islands' unique biological and cultural diversity. However, these tourists are pushed away when oil spills and natural disasters affect local ecosystems. In the navigation of these issues, tourism must support climate adaptation tactics.¹⁴⁷ Solutions for increasing sustainable tourism should support cultural and economic development and prioritize the environment.¹⁴⁸ This importance of tourism and development is universal. As the climate crisis continues, adaptive solutions are required in continuing to support this industry, especially in the pursuit of reaching Paris Agreement targets.¹⁴⁹ It is essential to consider short-term and long-term solutions,

considering the benefits and downfalls of each.

Case Study: Deepwater Horizon

The Deepwater Horizon has gone down as one of the largest oil spills in history.¹⁵⁰ This disaster occurred on April 20, 2010, in the Gulf of Mexico.¹⁵¹ In the 87 days following the spill, nearly 3.2 million barrels of oil were released into the ocean, taking a massive toll on human, animal, and plant life.¹⁵² This event was the result of various overlooked details in the planning and execution of the rig. Human and mechanical issues are to blame for the spillage from the well, over five kilometers deep.¹⁵³ The impacts of this oil spill are still prevalent today. The economic impacts, loss of biodiversity, and impacts on human health are all driving forces for modern oil spill frameworks and regulations. Deepwater Horizon is the name of the rig that exploded and ultimately sank in this incident. It was owned by British Petroleum (BP) and operated alongside Transocean, a Swiss company.¹⁵⁴ Before the spill, the rig operated successfully for seven years.¹⁵⁵ Only two days after the spill began, the rig sank entirely, and between 12 and 19 thousand barrels of oil spilled daily. These spills continued nonstop until July of 2010.¹⁵⁶ Investigations took place shortly after to determine the causes of this spill. All fault was ultimately directed towards the rig's owners and contracted companies. Seven violations of federal law were reported.¹⁵⁷ These included failure to conduct proper safety

142 Laurette, et al, Mauritius one year after oil disaster."

143 Shaama Sandooyea, Hisayo Takada and Melita Steele, "The Devastation of the Mauritius Oil Spill is still Unaddressed," Al Jazeera, February 6, 2021, <https://www.aljazeera.com/opinions/2021/2/6/we-must-make-sure-the-mauritius-oil-spill-does-not-repeat>.

144 Shaama Sandooyea, Hisayo Takada and Melita Steele, "The Devastation of the Mauritius Oil Spill is still Unaddressed."

145 Shaama Sandooyea, Hisayo Takada and Melita Steele, "The Devastation of the Mauritius Oil Spill is still Unaddressed."

146 "Tourism in Small Island Developing States (SIDS)" United Nations Tourism.

147 "Tourism in Small Island Developing States (SIDS)" United Nations Tourism.

148 "Tourism in Small Island Developing States (SIDS)" United Nations Tourism.

149 Matilda Bartley, "Tourism- the lifeblood of SIDS: UN High-level Thematic Event on Tourism," Alliance of Small Island States, April 16, 2024, <https://www.aosis.org/tourism-the-lifeblood-of-sids-un-high-level-thematic-event-on-tourism/>.

150 John Broder, "BP Shortcuts led to Gulf oil spill, report says," *New York Times*, September 14, 2011, https://www.nytimes.com/2011/09/15/science/earth/15spill.html?unlocked_article_code=1.8U0.QzMF.BWR84LJrEq8U&smid=url-share.

151 Zanager Artis, "Fourteen Years After Deepwater Horizon, Drilling is Still a Threat," NRDC, April 19, 2024, <https://www.nrdc.org/bio/zanager-artis/fourteen-years-after-deepwater-horizon-drilling-still-threat>.

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154 "British Petroleum Deepwater Horizon Oil Spill Case," International Rights of Nature Tribunal, accessed July 20, 2024, <https://www.rightsofnaturetribunal.org/cases/british-petroleum-deepwater-horizon-oil-spill-case/>.

155 James Meigs, "Blame BP for Deepwater Horizon. But Direct Your Outrage to the Actual Mistake," *Slate Technology*, September 30, 2016, <https://slate.com/technology/2016/09/bp-is-to-blame-for-deepwater-horizon-but-its-mistake-was-actually-years-of-small-mistakes.html>.

156 International Rights of Nature Tribunal, "British Petroleum Deepwater Horizon Oil Spill Case."

157 Broder, "BP Shortcuts led to Gulf oil spill, report says."



An oil containment boom deployed to New Harbor Island, La. to mitigate environmental damage from the Deepwater Horizon oil spill.

Credit: U.S. Navy

testing, both for environmental and human health.¹⁵⁸ At the time, BP was the sixth largest oil company in the world, reputed for advanced staff and technology.¹⁵⁹ On the scene, 11 workers lost their lives, and hundreds of nearby marine animals perished.¹⁶⁰ Only around 25 percent of the oil spilled was successfully recovered, leaving large amounts of oils and chemicals at sea.¹⁶¹

One of the most significant impacts of the Deepwater Horizon spill was the loss of biodiversity in the region. Marine mammals were some of the worst affected. For example, the Gulf of Mexico whale is a species native to the waters in which it occurred. In the immediate aftermath of this disaster, 17 percent of the Gulf whale population was killed.¹⁶² This is a substantial toll, especially considering the continued impacts on populations afterward. Long-term, the oil that was not cleaned up made its way into food systems and habitats. It has caused long-term health impacts for this species, such as reproductive failure. Today, fewer than 100

Gulf of Mexico whales are alive.¹⁶³ High rates of reproductive failure, cardiovascular disease, and impaired response times are common in many marine creatures native to the Gulf. Other species still being impacted by the disaster include various species of dolphins and whales living at various ocean depths. In bottlenose dolphins living in affected regions, reproductive issues are prominent. In populations exposed to oil pollution, only about 20 percent of pregnancies are successful.¹⁶⁴ This figure has remained stable since 2015 and displays a sharp distinction between those in contact with the oil.¹⁶⁵ In other unaffected regions, 83 percent of bottlenose dolphin pregnancies are successful.¹⁶⁶ Because of this gap, inequalities exist in biodiversity levels between polluted and less polluted regions. Sperm whales and pantropical spotted dolphins are also among the species that saw a declined presence in the spill area. This loss of presence is correlated to both impacts of contact with the oil and a change in migratory patterns as they move towards cleaner waters.¹⁶⁷ Lost populations are of

¹⁵⁸ Broder, "BP Shortcuts led to Gulf oil spill, report says."

¹⁵⁹ Meigs, "Blame BP for Deepwater Horizon. But Direct Your Outrage to the Actual Mistake."

¹⁶⁰ Artis, "Fourteen Years After Deepwater Horizon, Drilling is Still a Threat."

¹⁶¹ "A Deadly Toll," Center For Biological Diversity, accessed July 20, 2024, https://www.biologicaldiversity.org/programs/public_land/energy/dirty_energy_development/oil_and_gas/gulf_oil_spill/a_deadly_toll.html.

¹⁶² Artis, "Fourteen Years After Deepwater Horizon, Drilling is Still a Threat."

¹⁶³ Artis, "Fourteen Years After Deepwater Horizon, Drilling is Still a Threat."

¹⁶⁴ Joan Meiners, "Ten Years Later, BP Oil Spill Continues to Harm Wildlife- Especially Dolphins," National Geographic, April 17, 2020, <https://www.nationalgeographic.com/animals/article/how-is-wildlife-doing-now--ten-years-after-the-deepwater-horizon>.

¹⁶⁵ Meiners, "Ten Years Later, BP Oil Spill Continues to Harm Wildlife- Especially Dolphins."

¹⁶⁶ Meiners, "Ten Years Later, BP Oil Spill Continues to Harm Wildlife- Especially Dolphins."

¹⁶⁷ Meiners, "Ten Years Later, BP Oil Spill Continues to Harm Wildlife- Especially Dolphins."

concern, especially as warming waters and increased pollution limit the amount of new environments that are plausible for species that can migrate.

Sediments released by the explosion traveled as far as 150 kilometers away from the site.¹⁶⁸ Because of this, a vast range of life was affected beyond the visible losses of life. Habitats and sources of nutrition became a cause of concern. When these necessities are threatened, so is animal life. Low oxygen caused by oil smothering is a large concern for animals residing near algae or seaweed. Contact with oil can also cause algae blooms to sink, further dispersing oil into the ocean.¹⁶⁹ These small changes are vital for the survival of marine species. Microbial communities are especially vulnerable to even the smallest amounts of oil contamination.¹⁷⁰ Microbes and bacteria are the basis of ecosystems, and they correlate with nutrient levels in an environment. They form microbial communities through interactions in their environments. In oil spills, changing nutrient levels modify the microbial populations, therefore impacting the interactions occurring on the site.¹⁷¹ Collected oil at the water's surface impacts water temperatures alongside the amount of sunlight reaching marine species. With warming temperatures caused by emissions, microbes and other sensitive species were already at risk. The rapid changes from the massive oil spill only worsened conditions. Microbes and other small organisms are the bases of the food chain, affecting the quality of life for all those above it.¹⁷² The long-standing impacts are extremely difficult to mitigate and improve when such issues persist. The loss of food and nutrition affects nearly all species and ultimately risks human activities, including

fishing and tourism.

Deep-water coral reefs also face long-standing damage post-oil spills. Investigations on 300 coral reef sites located in the gulf have proven continuous stress and damage nearly 15 years later.¹⁷³ Reefs have shown delayed growth and discoloration. Fish and crustaceans depend on coral structures at depth for protection and life. However, some have become grounds for parasites, which take over the habitat of the diverse life in coral reefs.¹⁷⁴ Corals take hundreds of years to grow completely, and this trend is being followed in restoring the Gulf of Mexico. Projections suggest that any visible regrowth would take up to 27 years.¹⁷⁵ That being said, the complete restoration of these reefs is seeing further delays due to human activities. Fishing, mining, and oil drilling continue to impact damaged species. Deep-sea organisms are commonly slow to develop and have long lifespans. Because of this, their resilience and adaptability are inherently low.¹⁷⁶ In continued efforts, it is important to consider different species' unique strengths and weaknesses as they promote regional biodiversity. The loss of coral reefs ultimately impacts whole ecosystems and negatively impacts human activity.

The adverse impacts of the Deepwater Horizon oil spill also rippled into the quality of life for people living in the surrounding areas. Outside of the 11 workers who lost their lives on the scene, many continue to suffer long-term damages to their mental and physical health as a result of hydrocarbon exposure.¹⁷⁷ Heart disease and weakened lung capacity were the most commonly reported symptoms. These issues impact

168 Meiners, "Ten Years Later, BP Oil Spill Continues to Harm Wildlife- Especially Dolphins."

169 Sean Powers, Frank Hernandez, Robert Condon, Marcus Drymon, and Christopher Free, "Novel Pathways for Injury from Offshore Oil Spills: Direct, Sublethal, and Indirect Effects of the Deepwater Horizon Oil Spill on Pelagic Sargassum Communities," *PLOS ONE*, (September 2013) <https://doi.org/10.1371/journal.pone.0074802>.

170 Oliver Milman, "Deepwater Horizon Disaster Altered Building Blocks of Ocean Life," *The Guardian*, June 28, 2018, <https://www.theguardian.com/environment/2018/jun/28/bp-deepwater-horizon-oil-spill-report>.

171 Maryam Somee, Seyed Dhastgheib, Mahmoud Shavandi, Leila Ghanbari, Kaveh Kavousi, Mohammed Amoozegar, and Maliheh Mehrshad, "Distinct microbial community along the chronic oil pollution continuum of the Persian Gulf converge with oil spill accidents." *Scientific Reports*, no 11, (May 2021), <https://doi.org/10.1038/s41598-021-90735-0>.

172 Milman, "Deepwater Horizon Disaster Altered Building Blocks of Ocean Life."

173 "Oil and Coral Shouldn't Mix: Deepwater Horizon Still Affecting Deep Water Coral," Environment Texas, accessed July 20, 2024, <https://environmentamerica.org/texas/center/updates/oil-and-coral-shouldnt-mix-deepwater-horizon-still-affecting-deep-sea-coral/>.

174 Environment Texas, "Oil and Coral Shouldn't Mix: Deepwater Horizon Still Affecting Deep Water Coral."

175 Fanny Girard, Katriona Shea, and Charles Fisher, "Projecting the recovery of a long-lived deep sea coral after the Deepwater Horizon oil spill using state-structured models," *Journal of Applied Ecology*, vol 55 no. 4, (March 5, 2018), <https://doi.org/10.1111/1365-2664.13141>, 1812-1822.

176 Fanny Girard and Charles Fisher, "Long-Term impact of the Deepwater Horizon oil spill on deep sea coral detected after seven years of monitoring," *Biological Conservation*, vol 225, (September 2018), <https://doi.org/10.1016/j.biocon.2018.06.028>, 117-127.

177 Paul Sandifer, Alesia Ferguson, Melissa Finucane, Melissa Partyka, Helena Solo-Gabriele, Ann Walker, Kateryna Wowk, Rex Caffey, and David Yoskowitz, "Human Health and Socioeconomic Effects of the Deepwater Horizon Oil Spill in the Gulf of Mexico," *Oceanography*, vol 34, no.1, (June 2021) <https://doi.org/10.5670/oceanog.2021.125>, 174-191.

workers' ability to work in the heat or complete strenuous tasks. The risk of heart attack is also commonly associated with these symptoms. Exposure to dispersants and other cleaning chemicals in both workers and passers also led to severe neurological issues. These included memory delays, decreased brain function, and increased mental illness. In nearby communities, children exposed to the oil spill were double as likely to face future health problems in comparison to those not exposed.¹⁷⁸ Headache, blurred vision, confusion, and feelings of numbness were among the highest reported symptoms. Overexposure to toxic chemicals like such also increases risks of cancer and other fatal illnesses.¹⁷⁹ These impairments took away from people's ability to work efficiently, further delaying future cleanup processes. They also put strain on healthcare systems, which were not prepared for the influx of patients from chemical exposure.

Due to this disaster, the Gulf of Mexico also suffered from a loss of business, including tourism and fishing. In the American state of Louisiana, there was a total loss of 422 million US dollars in tourism profits in the immediate three years.¹⁸⁰ The region's seafood industry as a whole lost an estimated one billion US dollars in potential profits.¹⁸¹ This loss of funds impacted many vulnerable demographics, including resource-dependent communities and people suffering social disparities along the coasts. Minorities and low-income communities who lacked the opportunity to seek protection from the oil spill tended to have greater chances of health damages.¹⁸² The loss of biodiversity in the Gulf worsened these struggles as well. Over time, oil residue in marshes caused damage to 98 percent of commercially important species.¹⁸³ These include fish for nutrition and iconic species that boost tourism.

Today, this disaster stands as a testament to the dangers of oil drilling. It has inspired the development of oil protocols and served as a springboard for studying the dangers of oil spills. In the USA, this involved the formation of three bureaus: Ocean energy management, safety and environmental enforcement, and natural resources revenue. The health damages done to workers and fines given to oil producers have set a precedent for potential industry damage. Companies have been held accountable for disasters, and there has been an increase in offshore monitoring.¹⁸⁴ Despite these actions and known dangers, oil drilling continues to develop. As of April 2024, there were over 2,700 wells and 500 platforms belonging to the oil industry located in the Gulf of Mexico alone.¹⁸⁵ Oil spills continue to threaten coastal communities and biodiversity. In 2022, the Mare Doricum oil spill off the coast of Peru devastated the local coastline.¹⁸⁶ Over one thousand seabirds were left coated in oil, and over two thousand fishermen saw their business come to a halt.¹⁸⁷ The impacts of the Deepwater Horizon and similar spills continue to occur with minimal repercussions. The need for tightened regulations is urgent, especially in light of continued disasters. Preparation for and mitigation of disasters is only increasing in importance as the industry continues to grow.

Current Status

Case Study: Arctic Oil Drilling

The Arctic is a commonly overlooked region when discussing climate change and world issues. This lapse is severe and impacts the survival of Arctic species and the quality of life

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180 "Tourism and Oil Spills Don't Mix," Surfrider Foundation, accessed July 20, 2024, <https://www.surfrider.org/news/tourism-and-oil-spills-dont-mix>.

181 Andy Sharpless, "10 years later, Deepwater Horizon disaster is history we can't afford to repeat," Oceana, April 20, 2020, <https://oceana.org/blog/ceo-note-10-years-later-deepwater-horizon-disaster-history-we-cant-afford-repeat/>.

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183 Hannah Waters, "Breaking Down the Myths and Misconceptions about the Gulf Oil Spill," Smithsonian Ocean, April 2014, <https://ocean.si.edu/conservation/pollution/breaking-down-myths-and-misconceptions-about-gulf-oil-spill>.

184 Mckenzie Turner, "How the Deepwater Horizon Oil Spill Changed Regulations- Lessons for Workplace Safety," Brewer Science, November 15, 2021, <https://blog.brewerscience.com/how-the-deepwater-horizon-oil-spill-changed-regulations-lessons-for-workplace-safety>.

185 Artis, "Fourteen Years After Deepwater Horizon, Drilling is Still a Threat."

186 "Oil Spill at Sea: who will pay for Peru's worst environmental disaster?" The Guardian, accessed July 20, 2024, <https://www.theguardian.com/environment/2022/mar/07/oil-spill-at-sea-who-will-pay-peru-worst-environmental-disaster>.

187 The Guardian, "Oil Spill at Sea: who will pay for Peru's worst environmental disaster?"

for its four million inhabitants.¹⁸⁸ This region is extremely vulnerable to climate change. Its landscape, composed mostly of tundras and glaciers, causes unique challenges regarding the climate crisis. Any warming greater than the annual average is experienced two to three times higher in the Arctic, with global warming as a whole impacting the region four times faster than in the rest of the world.¹⁸⁹ These impacts, worsened by human activity such as oil drilling, threaten the biodiversity in the region.

Many iconic species call the Arctic home, including the Arctic fox, polar bears, and the narwhal. However, the diverse life in the region is much greater than this. There are 21,000 known species residing in the Arctic.¹⁹⁰ These species vary from highly adapted birds, mammals, fish, and invertebrates to plants, fungi, and bacteria. Human interactions with these species have historically been low, allowing them to thrive independently. Connections between indigenous populations and native species are sacred and important. However, this harmony has been increasingly disrupted in recent years. Warming temperatures and melting glaciers increase access to human activity in the region. This has created new, increasing challenges to Arctic ecosystems and biodiversity.¹⁹¹

Arctic communities are known to be highly adaptable and resilient. However, increasing economic and industrial development challenges this resilience.¹⁹² These developments challenge human health and access to cultural practices. They also threaten ocean health, and the unique marine and terrestrial life located in the region.¹⁹³ Despite the presence of six countries and two sovereign territories in the Arctic, there is minimal government-based urgent support for the

region.¹⁹⁴ Many restoration projects and policies are based on non-government organizations and are desperate for action in their call to protect the Arctic. Oil drilling and developments are an increasing threat to the Arctic environment. The region is known for its vastly untouched reserves. These have become more valuable in recent years, as oil production brings great regional income. Covered in ice, the Arctic's unique geological makeup has led seismic experts to estimate that the region holds 90 billion barrels of oil.¹⁹⁵ The United States Geological Survey has estimated that around 30 percent of the world's undiscovered oil resources are located in the Arctic region, 84 percent of which is located offshore.¹⁹⁶ Many of these resources are difficult to obtain, and they have high costs related to exploration. Transportation of equipment and workers to carry out the drilling process is difficult, making it a low investment for many companies.¹⁹⁷ However, with the recent impacts of global warming, obtaining oil resources is becoming increasingly easy. There are many companies active in the region, based around the world. Russian, Dutch, Norwegian, and Italian are among the nationalities benefiting from oil exploration in the Arctic.¹⁹⁸ Despite its economic benefit, this drilling is extremely harmful to the environment. Oil drilling, especially in cold climates, releases an excess of carbon dioxide and methane gasses into the atmosphere.¹⁹⁹ Alongside this, the thawing of permafrost releases further trapped gasses. Permafrost is the thick layer of ice that spreads underground. It can stretch up to 1,5 meters deep, and it traps fauna, flora, and greenhouse gasses, mainly methane.²⁰⁰ This also causes the land to soften, deteriorating existing habitats and developments in the Arctic.²⁰¹ These gasses contribute to global warming and glacier melting. This ultimately leads to

188 Marlene Almonte, "Vulnerability in the Arctic in the Context of Climate Change and Uncertainty," *The Arctic Institute*, May 2, 2023, <https://www.thearcticinstitute.org/vulnerability-arctic-context-climate-change-uncertainty/>.

189 Marlene Almonte, "Vulnerability in the Arctic in the Context of Climate Change and Uncertainty."

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191 "Safeguarding Arctic Biodiversity," Arctic Council, accessed July 17, 2024, <https://arctic-council.org/explore/topics/biodiversity/>.

192 "Protection of the Arctic Marine Environment," United Nations Environment Programme, accessed July 17, 2024, <https://www.unep.org/protection-arctic-marine-environment-pame>.

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194 Marlene Almonte, "Vulnerability in the Arctic in the Context of Climate Change and Uncertainty."

195 "Arctic Oil: Ownership, Drilling, and Environmental Risks," Just Energy, accessed July 17, 2024, <https://justenergy.com/blog/arctic-oil-ownership-drilling-environmental-risks/>.

196 "Protection of the Arctic Marine Environment," United Nations Environment Programme.

197 "Arctic Oil: Ownership, Drilling, and Environmental Risks," Just Energy.

198 "Arctic Oil: Ownership, Drilling, and Environmental Risks," Just Energy.

199 "The Threat," Protect The Arctic, accessed July 16, 2024, <https://www.protectthearctic.org/threat-of-drilling-in-the-arctic-national-wildlife-refuge>.

200 Adventure Canada, "Top of the World: Ten Facts about the Arctic," accessed July 25, 2024, <https://www.adventurecanada.com/canadian-high-arctic-and-greenland/top-of-the-world-ten-facts-about-the-arctic>.

201 Steven Jones, "5 Animals Threatened by Arctic Oil Drilling," *Medium*, October 10, 2017, <https://medium.com/center-for-biological->

further accessibility to the Arctic, worsening the cause.

These developments in oil have encouraged development in other industries. Arctic tourism, for example, has seen a significant increase. As the warming climate makes the region more accessible, passenger boats are increasingly gaining access. From 2013 to 2023, the number of passenger vessels in the Arctic rose by 37 percent.²⁰² This rise in human activity further contributes to environmental concerns in the region. As waters continue to open up, allowing this figure to continue growing. Three-quarters of these passenger ships use heavy fuel oil (HFO) to allow successful navigation of colder waters.²⁰³ HFO has some of the highest levels of emissions among marine fuels. It poses a large risk if spilled into waterways, which increases with the number of vessels in the area.²⁰⁴ This increase in business requires specific frameworks and guidelines to navigate the growth and risks safely. In 2020, the Senior Arctic Officials Marine Mechanism (SMM) initiative was launched.²⁰⁵ The SMM has brought together various stakeholders and experts from across the Arctic to raise cooperation on regional issues. Among these, there is participation from Arctic countries, Indigenous leaders, and the International Maritime Organization (IMO).²⁰⁶ This navigation of increased access to the region is a growing concern that requires similar collaboration to proceed.

The impending risk of oil spills threatens catastrophic results in the Arctic. The nature of HFO makes it difficult to clean up, as it forms a thicker layer larger than the original oil spill. Accessibility difficulties make cleanup procedures take longer. Low visibility from shorter days, cold temperatures, and other difficult conditions impact accessibility. This allows time for oil to freeze into ice masses, incorporating it into the ecosystem.

Responders and aid workers must travel long distances to reach remote locations of oil spills. Through the cycles of melting and refreezing, this oil continues to infiltrate water systems and ultimately makes its way through food chains and systems.²⁰⁷ This mixing increases the complexity and cost of cleanup, further delaying response times. Although Arctic oil spills are fairly rare, they are of severe concern. Most research done is based on spills elsewhere in the world. However, global warming is increasing the likelihood of disaster. A risk assessment performed in Nunavut, Canada, has determined that an oil-related catastrophe could cost 7.5 billion US dollars in repair and cleanup.²⁰⁸

The oil industry is extremely harmful to biodiversity levels in the Arctic. Drilling, processing, and spills are all dangerous for animal life. Over half of the Arctic bird species are at risk of extinction because of global warming's impacts on their habitats.²⁰⁹ The Spoon-billed Sandpiper, for example, has seen a 90 percent decline in population over the last 40 years.²¹⁰ Many Arctic bird species are migratory, with declining populations being indicative of the world's health.²¹¹ Climate changes impact migration patterns, habitats, and nutrition for these species. Direct exposure to oil is toxic for many Arctic species as well. In mammals, contact with fur limits the ability to regulate warmth. For birds, contact with feathers may limit flying capacities. Underwater, there is the risk of smothering or consumption of marine species.²¹²

Contact with oil and its impacts is severe for human and animal populations native to the Arctic. For belugas, human-created pollution destroys their health and habitats. Long-term exposure is a risk for these creatures, who tend to swim close to shore. Underwater drilling for natural gas is very

diversity/5-animals-threatened-by-arctic-oil-drilling-e8cc43829866.

202 "Protection of the Arctic Marine Environment," United Nations Environment Programme.

203 Antonia Sohns, "Heavy Fuel Oil Threatens Arctic Communities' Food Security and Environment," *Medium*, November 21, 2016, <https://medium.com/oceans-vessels/heavy-fuel-oil-threatens-arctic-communities-food-security-and-environment-c976a02b3608>.

204 Arctic Council, "Safeguarding Arctic Biodiversity."

205 Arctic Council, "Navigating the future of Arctic Shipping," accessed July 25, 2024, <https://arctic-council.org/news/navigating-the-future-of-arctic-shipping/>.

206 Arctic Council, "Navigating the future of Arctic Shipping."

207 Antonia Sohns, "Heavy Fuel Oil Threatens Arctic Communities' Food Security and Environment."

208 Karina Zapata, "Arctic Oil Spill Cleanup Costs Could Reach \$9.4B Over Five Years, says Risk Analyst," *Canadian Broadcasting Company*, July 15, 2021, <https://www.cbc.ca/news/canada/north/arctic-oil-spill-study-1.6103155>.

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210 Arctic Council, "The Arctic Migratory Birds Initiative," accessed July 25, 2024, <https://arctic-council.org/news/navigating-the-future-of-arctic-shipping/>.

211 Arctic Council, "The Arctic Migratory Birds Initiative."

212 "How would offshore oil and gas drilling in the Arctic impact wildlife?" World Wide Fund for Nature, accessed July 17, 2024, <https://www.worldwildlife.org/stories/how-would-offshore-oil-and-gas-drilling-in-the-arctic-impact-wildlife>.

harmful to belugas, as potentially exposed gasses stay trapped underwater.²¹³ Arctic seals are victims of food scarcity as oil enters the food chain. A decrease in snow and ice also prevents seals from building habitats and caves for their young, creating vulnerable populations.²¹⁴ Walruses, who depend on seawater and ice shelves for habitat and hunting, are also challenged by global warming and the increased risk of oil spills.²¹⁵ The loss of these species, among others, is also detrimental to Arctic indigenous populations. Many groups depend on fishing and hunting for cultural and nutritional needs. The risk of chemical consumption is also prevalent in these communities, creating risks for public health. Long-term ingestion of hydrocarbons has been associated with cancer and reproductive issues, among others.²¹⁶

Seismic surveying is another process in the industry that is harmful to biodiversity. This is a process of finding oil reserves by sending large vibrations through the ground. Surveying is performed on large equipment, requiring heavy trucks and lots

of energy for transport.²¹⁷ Notably, this process is dangerous for polar bear populations. Vehicles and transportation tend to scare bears and cubs out of their dens. The risk of total habitat destruction is also present. When habitat is lost, it puts young cubs at risk of freezing, as regulatory mechanisms are not yet developed.²¹⁸ The consequences of surveying have already been observed, with a recent decline in population by nearly 40 percent.²¹⁹ This figure will continue dropping as conditions worsen and development continues in the region.

To combat the risks associated with increased oil development in the Arctic, work is being done to implement and create policies for protecting the Arctic. The Arctic Council, for example, is composed of six working groups and representatives from the eight Arctic nations. These nations include Canada, Denmark, Finland, Iceland, Norway, Russia, Sweden, and the United States of America.²²⁰ Currently chaired by Norway, this group focuses on people, biodiversity, the climate, emergency preparedness, and more. They create policy

213 Jones, “5 Animals Threatened by Arctic Oil Drilling.”

214 Jones, “5 Animals Threatened by Arctic Oil Drilling.”

215 Jones, “5 Animals Threatened by Arctic Oil Drilling.”

216 Ekaterina Borshchevskaia, Valerie Gorokhovskaya, Maria Khludova, Erdni Mangutov and Anna Shapulenko, “Pollution in the Arctic: Oil and Gas Extraction on the Continental Shelf as a Major Contributor,” *The Arctic Institute*, June 28, 2022, <https://www.thearcticinstitute.org/pollution-arctic-oil-gas-extraction-continental-shelf-major-contributor/>.

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220 “Who We Are,” The Arctic Council, accessed July 18, 2024, <https://arctic-council.org/>.



U.S. Coast Guardsmen lower oil skimmer into the arctic
 Credit: Petty Officer 2nd Class Kelly Parker

regarding fuels, oils, and other climate-based challenges in the Arctic.²²¹ Despite the work done, the Arctic Council and similar organizations struggle to keep up with developments in the industry. Geopolitical and financial factors are also preventing many of their policy frameworks from being put into action, limiting the capacities of the Arctic Council.²²² The Willow Project, located in the United States of America, is a prime example of continued development despite known risks. Approved in 2023, the land of the project is predicted to hold 600 million barrels of oil.²²³ This large project was approved despite masses of protest and backlash, primarily due to environmental concerns.²²⁴ As the oil and gas industry continues to develop in the Arctic, it is essential to consider limitations and possibilities in regulating oil consumption and exploration.

Current Solutions and Their Barriers

This issue has been largely recognized around the world. However, gaps exist between the issue and the action. Many organizations are increasing their fossil fuel production despite having pledged net zero emissions in the coming decade.²²⁵ Although some have succeeded in reducing GHG emissions, many governments are still looking for ways to cease oil production. This has led to the Production Gap, which highlights the clashes between commitments and realities of the climate crisis. Fossil fuel dependency is creating a barrier to accomplishing climate targets. Governments are planning to produce around 110 percent more fossil fuels by 2030 than what is consistent with limiting global warming to

1.5°C.²²⁶ Many reasons exist for these gaps, including lack of accountability. Low accessibility is another key factor in these limitations. Continued development in the oil industry will only increase the toll on biodiversity and other environmental targets.

The countries that can produce environmentally efficient technologies need to do so. 151 countries have pledged net-zero climate emissions by 2030.²²⁷ However, many policies are blurred, both in governments and private companies. They often need more specific details or requirements. Corruption also allows specific companies to follow the rules less severely. This contributes to a lack of accountability. As a result, the fossil fuel industry continues developing.²²⁸ In many instances, recommendations are made instead of laws or goals. These recommendations allow flexibility and refrain from force companies to follow up on climate targets. Where goals are present, they often need to be higher to reach UN- mandated targets. Laws force accountability and action, stressing the urgency of the matter at hand.²²⁹

Climate funds need to be shared properly. These funds are meant to help countries and groups most at risk from climate disasters. But only 10 percent goes to the industries directly affected.²³⁰ This is a common issue in climate discussions. Indigenous people protect 80 percent of the world's biodiversity, but they get very little help.²³¹ They receive only one percent of global climate funds, showing a major gap in support. Indigenous communities were part of the World Economic Forum's Annual Meeting. Their knowledge is vital

221 "Who We Are," The Arctic Council.

222 Brett Simpson, "The Rise and Sudden Fall of the Arctic Council," *Foreign Policy Analysis*, May 31, 2023, <https://foreignpolicy.com/2023/05/31/arctic-council-russia-norway/>.

223 Ella Nilson, "The Willow Project has been approved- here's what to know about the controversial oil-drilling venture," *Cable News Network*, March 14, 2023, <https://edition.cnn.com/2023/03/14/politics/willow-project-oil-alaska-explained-climate/index.html>.

224 Nilson, "The Willow Project has been approved- here's what to know about the controversial oil-drilling venture."

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226 United Nations Environment Programme, "Production Gap Report 2023," accessed July 25, 2024, <https://www.unep.org/resources/production-gap-report-2023>.

227 United Nations Environment Programme, "Governments plan to double the fossil fuels in 2030 than the 1.5 warming limit allows," press release, November 8, 2023, <https://www.unep.org/news-and-stories/press-release/governments-plan-produce-double-fossil-fuels-2030-15degc-warming>.

228 Kathy Mulvey, "Climate Accountability," *Union of Concerned Scientists*, accessed July 25, 2024, <https://www.ucsusa.org/take-action/climate-accountability>.

229 Melisa Čavčić, "Eight countries take steps to erase fossil fuels from EU's power system as 'ground-breaking' new law comes to light," *Offshore Energy*, December 20, 2023, <https://www.offshore-energy.biz/eight-countries-take-steps-to-erase-fossil-fuels-from-eus-power-system-as-ground-breaking-new-law-comes-to-light/>.

230 Blaire Glencourse and Sanjeeta Plant, "How green accountability can create more equitable climate finance," World Economic Forum, June 21, 2023, <https://www.weforum.org/agenda/2023/06/green-accountability-equitable-climate-finance/>.

231 Glencourse and Plant, "How green accountability can create more equitable climate finance."

for protecting biodiversity. The forum highlighted the need to support these communities.²³² financially For example, Brazil has a system that pays communities for ecosystem services.²³³ Giving Indigenous people a voice in decision-making is key to protecting biodiversity.

Decision-makers in the private sector need to pay more attention to climate targets. In many cases, action is replaced by ‘greenwashing.’ Greenwashing involves rebranding or new marketing that alludes to environmental improvements despite minimal work being done.²³⁴ To prevent this, accountability must improve to sustain set targets. In addition, holding companies accountable is also important. Coca-Cola has been declared the worst plastic polluter in the world, producing over three million tons of plastic packaging a year.²³⁵ Coca-Cola is facing a lawsuit imposed by Earth Island Institute. The institute accused Coca-Cola of false commercial practices and failing to comply with their environmental and sustainability claims.²³⁶ Alternatives to fossil fuels are growing faster than ever. By 2030, these green technologies could be worth 9.5 trillion US dollars.²³⁷ This market is growing quickly to make products with low carbon footprints. Some alternatives include solar power, biofuels, electric cars, wind energy, biogas, and green hydrogen.²³⁸ Even though these options exist, the industry still has big inequalities. There are also environmental and humanitarian concerns around these new developments.

Sweden is marked as a leader in renewable energy sources

in the European Union. Hydropower, biofuels, and wind power are some of the innovations that make up two-thirds of the country’s energy consumption.²³⁹ This country has been steadily making improvements to its energy consumption. In the transportation sector, emissions are expected to drop by 70 percent between 2010 and 2030.²⁴⁰ Sweden has been proven accountable for its past targets. From 2000-2020, renewable energy consumption rose by 47 percent.²⁴¹ This demonstrates continuous, stable improvement in the country. Although some oil industries are still used in the country, Sweden is a global leader in decarbonization. Sweden’s policies demonstrate flexibility in meeting international targets.²⁴² Other countries following similar patterns include Finland, Latvia, and Estonia.²⁴³ This trend is prominent in the European Union, especially approaching 2050. This is because it aims to be the world’s first carbon-neutral continent, as stated in the ‘European Green Deal.’²⁴⁴ This deal was finalized in 2020, with the main goal of modernizing the European economy, making it more resource-efficient and competitive.²⁴⁵ It is through following similar, adaptable frameworks that this success can be recreated worldwide.

The shift to alternative energy faces many barriers worldwide. One of the biggest problems is money. Aroundonetrillion US dollars is needed for renewable energy investments to meet climate goals.²⁴⁶ This makes it harder to keep up with growing energy demand. In many countries, high costs make

232 Laura Beltran, “Lessons from Indigenous leaders to protect the Amazon rainforest,” World Economic Forum, January 30, 2024, <https://www.weforum.org/agenda/2024/01/lessons-from-indigenous-leaders-to-protect-the-amazon-rainforest/>.

233 Beltran, “Lessons from Indigenous leaders to protect the Amazon rainforest.”

234 Union of Concerned Scientists, “Fossil Fuel Accountability,” accessed July 25, 2024, <https://www.ucsusa.org/climate/accountability#toc-greenwashing>.

235 “Coca-Cola’s Plastic Pollution Problem,” Sierra’s Club, December 1, 2022, <https://www.sierraclub.org/michigan/blog/2022/12/coca-cola-s-plastic-pollution-problem>.

236 “Coca-Cola Must Face Greenwashing Lawsuit in D.C.,” Plastic Pollution Coalition, September 04, 2024, <https://www.plasticpollutioncoalition.org/blog/2024/9/4/coca-cola-must-face-greenwashing-lawsuit-in-dc>.

237 “Embrace green tech revolution or risk falling behind, new UN report warns,” United Nations Global Perspectives on Human Stories, last edited March, 2023, <https://news.un.org/en/story/2023/03/1134672>.

238 United Nations Conference on Trade and Development, *Technology and Innovation Report 2023*, (New York: February 2023), https://unctad.org/system/files/official-document/tir2023_en.pdf.

239 Ewan Thompson, “This Country is Leading the Charge for Renewable Energy Generation in the EU,” World Economic Forum, January 9, 2024, <https://www.weforum.org/agenda/2024/01/renewable-energy-transition-generation-eu/>.

240 “Sweden,” International Energy Agency, accessed August 1, 2024, <https://www.iea.org/countries/sweden>.

241 International Energy Agency, “Sweden.”

242 International Energy Agency, “Sweden.”

243 Thompson, “This Country is Leading the Charge for Renewable Energy Generation in the EU.”

244 Thompson, “This Country is Leading the Charge for Renewable Energy Generation in the EU.”

245 “The European Green Deal,” European Commission, accessed August 1, 2024, https://commission.europa.eu/strategy-and-policy/priorities-2019-2024/european-green-deal_en.

246 “Breaking Down Barriers to Clean Energy,” World Bank Group, accessed July 25, 2024, <https://www.worldbank.org/en/news/feature/2023/05/16/breaking-down-barriers-to-clean-energy-transition>.

it hard for local people to access renewable energy.²⁴⁷ A lack of support, like subsidies, makes it even less affordable.²⁴⁸ Poor planning and limited resources also reduce access to these technologies at a national level. Many less-developed countries are struggling to adopt new technologies. Countries in Latin America, the Caribbean, and sub-Saharan Africa are the most behind.²⁴⁹ They risk missing out on advancements and falling further behind. This gap in development is called the green technology gap. Most climate-safe technologies are owned by a few countries and traded privately.²⁵⁰ Financial problems and physical barriers make things worse for less-developed nations.²⁵¹ This widens the gap, making it harder for them to catch up with alternatives.

Access to alternative energy sources is not the perfect solution to this environmental crisis. Although it reduces emissions, the presence of renewables is often harmful to the world's biodiversity. Space occupied by these processes, such as solar panels, drives animals out of their habitats. The average solar farm requires up to 10 times the space as the average oil drilling site.²⁵² Powerful wind turbines tend to cause damage to birds and bats. Other forms of renewable energy damage habitats and animal lives. This comes because the construction of new green technologies also harms the environment. In total, nearly 5 thousand species are being threatened by mineral extraction.²⁵³ In mineral extraction, the physical process and the land clearing threaten biodiversity. This mineral processing is a necessary evil. It produces materials essential to GHG reduction, including lithium, limestone, and cobalt.²⁵⁴ These metals are important in constructing solar panels, electric cars, and wind turbines. Through their production, harm is done to the land and aquatic species. Mines directly impact hill and

mountain ecosystems, removing habitats and food sources. Water pollution caused by runoff and waste directly impacts nearby species. Recent turbine developments have threatened the North Atlantic Right Whale, among other endangered species. Marine species are at the highest risk from mining, with 2,053 species being harmed explicitly by mining.²⁵⁵ Through these losses, improvements are urgently needed to mitigate the biodiversity loss due to oil alternatives.

On top of environmental concerns, mining for energy alternatives also presents ethical issues. Although less pressing than fossil fuel shortages, these metals are also non-renewable. With a growing market for green technologies, this has become a growing concern. In the coming years, the demand for these 'sustainable' materials is projected to increase by 500 percent.²⁵⁶ Although this shows the potential for industrial development, it also pressures suppliers. Deposits of these metals are focused in a few countries, leaving room for corruption and exploitation in the industry. For example, the Democratic Republic of the Congo (DRC) produces over 60 percent of the world's cobalt.²⁵⁷ This large supply brings controversy to the industry. Political instability in the region and weak labor codes present ethical concerns regarding the supply. Notably, high volumes of child labor in these mines have raised concerns about these working conditions.²⁵⁸ However, collaboration through the private and public sectors can mitigate these growth trends. Environmental and social governance and enforcement are required to moderate this development.

Despite growth in alternative energy, the fossil fuel industry keeps expanding.²⁵⁹ It promises development and prosperity to those in need. Many countries are torn between the benefits of

247 World Bank Group, "Breaking Down Barriers to Clean Energy."

248 World Bank Group, "Breaking Down Barriers to Clean Energy."

249 United Nations Global Perspectives on Human Stories, "Embrace green tech revolution or risk falling behind, new UN report warns."

250 Vincente Yu, "Addressing the Climate Technology Gap in Developing Countries Through Effective Technology Transfer," *Tess*, December 13, 2023, <https://tessforum.org/latest/addressing-the-climate-technology-gap-in-developing-countries-through-effective-technology-transfer>.

251 Yu, "Addressing the Climate Technology Gap in Developing Countries Through Effective Technology Transfer."

252 Chloe Brenner, "Green vs Green: Conflict Between Renewable Energy and Biodiversity Loss."

253 University of Cambridge, "Thousands of birds and fish threatened by mining for clean energy transition, study finds," *Science Daily*, July 26, 2024, <https://www.sciencedaily.com/releases/2024/07/240726113419.htm>.

254 University of Cambridge, "Thousands of birds and fish threatened by mining for clean energy transition, study finds."

255 University of Cambridge, "Thousands of birds and fish threatened by mining for clean energy transition, study finds."

256 Richard Herrington, "Mining Our Green Future," *Nature Review materials*, no. 6, (2021), 456-458, <https://doi.org/10.1038/s41578-021-00325-9>.

257 Herrington, "Mining Our Green Future."

258 Herrington, "Mining Our Green Future."

259 Union of Concerned Scientists, "Fossil Fuel Accountability."

fossil fuels and the climate crisis. Guyana is a prime example, with over 30 offshore oil discoveries in recent years.²⁶⁰ By 2027, the country could produce more than 1.3 million barrels of oil per day.²⁶¹ Though Guyana once had strong environmental policies, it now heavily invests in oil. The goals are economic and social development.²⁶² The economy has already grown through new infrastructure and outside businesses moving in.²⁶³ But this growth brings serious risks to the environment. Biodiversity loss and other impacts are expected. Guyana's capital, Georgetown, is even projected to be underwater within the next decade.²⁶⁴ This problem will likely get worse with continued development. Many alternatives to fossil fuels are being developed, while the oil demand remains high. Sadly, both of these affect biodiversity and the environment. UNEA delegates are urged to find a balance between sustainable growth and protecting the environment in the oil industry.

Sustainable Development Goals

The UN's 17 Sustainable Development Goals (SDGs) are a call to action for stakeholders worldwide. They focus on improving quality of life through environmental protection, reduction of poverty, and peacebuilding initiatives.²⁶⁵ Participation in attaining these goals is urgent and encouraged among civil society, the private sector, UN systems, and governments. The UN enforces the SDGs, and they are regularly reviewed at the High-Level Political Forum (HLPF), as required.²⁶⁶ UNEA holds a strong relationship with the SDGs. This is highlighted by meetings and goals set within the assembly.²⁶⁷ These targets must be considered in debate, especially as they impact the topic. All goals should be considered, especially when creating

and debating resolutions for sustainable development.

The oil industry's impact on biodiversity connects to several goals. Goal seven focuses on affordable and clean energy for all. It highlights the need for reliable, accessible, and sustainable energy.²⁶⁸ This includes both fossil fuels and renewable sources. Finding better alternatives for oil is key. Goal 7.A stresses cooperation in education and technology. This includes using renewable energy, cleaner fossil fuels, and investing in infrastructure.²⁶⁹ Goal seven also focuses on making fossil fuels more sustainable, not completely removing the industry.

Goals 14 and 15 deal with biodiversity, through life above land and below water.²⁷⁰ These goals encompass the loss of biodiversity at hand. Preserving biodiversity is essential in the mitigation of the oil industry. Goal 14 explicitly addresses both aquatic biodiversity and the sustainable use of water systems.²⁷¹ The concepts and targets discussed in this goal can be translated into debate regarding the oil industry. Water pollution due to fossil fuel production and usage is a large concern. This is especially relevant as it impacts marine life, drinking water, and aquatic-based business. Target 14.1 highlights the importance of reducing marine debris and pollution.²⁷² This addresses the physical pollutants and debris caused by oil spills and drilling. Target 14.7 encourages the resilience of businesses, including fisheries and tourism, both of which struggle from the oil industry.²⁷³ The sustainable use and development of marine technologies are also highlighted. This is encompassed by target 14. A, which also connects ocean health and biodiversity targets alongside SDGs and other vulnerable countries.²⁷⁴ It is through the responsible use and protection of aquatic resources that biodiversity has the hope

260 "A timeline of Exxon's oil development projects in Guyana," Oil Now, accessed July 25, 2024, <https://oilnow.gy/news/a-timeline-of-exxonmobils-guyana-oil-development-projects>.

261 Oil Now, "A timeline of Exxon's oil development projects in Guyana."

262 Gaiutra Bahadur, "Is Guyana's Oil a Blessing or a Curse?" *New York Times*, March 30, 2024, <https://www.nytimes.com/2024/03/30/headway/is-guyanas-oil-a-blessing-or-a-curse.html>.

263 Bahadur, "Is Guyana's Oil a Blessing or a Curse?"

264 Bahadur, "Is Guyana's Oil a Blessing or a Curse?"

265 United Nations Exhibits, "Sustainable Development Goals: 17 Goals to Transform our World."

266 "High Level Political Forum," United Nations High Level Political Forum on Sustainable Development, accessed July 28, 2024, <https://hlpf.un.org/home>.

267 "About UNEA-5," United Nations Environment Programme, accessed July 28, 2024, <https://www.unep.org/environmentassembly/unea5/about-unea-5>.

268 "Goal 7," United Nations Department of Economic and Social Affairs, accessed July 28, 2024, <https://sdgs.un.org/goals/goal7>.

269 United Nations Department of Economic and Social Affairs, "Goal 7."

270 United Nations Exhibits, "Sustainable Development Goals: 17 Goals to Transform our World."

271 "Goal 14," United Nations Department of Economic and Social Affairs, accessed July 28, 2024, <https://sdgs.un.org/goals/goal14>.

272 United Nations Department of Economic and Social Affairs, "Goal 14."

273 United Nations Department of Economic and Social Affairs, "Goal 14."

274 United Nations Department of Economic and Social Affairs, "Goal 14."

to remain prosperous.

Goal 15 focuses on preserving biodiversity on land. Oil drilling, processing, and spills harm this directly. The goal promotes the sustainable use of land to prevent ecosystem damage.²⁷⁵ Both the oil industry and its alternatives can reduce their impact on nature. Target 15.5 calls for protecting endangered species to stop biodiversity loss.²⁷⁶ This is important because biodiversity loss affects many parts of society. Targets 15.A and 15.B stress the need to gather resources, including financial support, for conservation efforts.²⁷⁷ These resources are key to creating plans that improve biodiversity worldwide.

Goal 13 incorporates the goals of UNEA, focusing on climate action. It emphasizes the urgency of the climate crisis and the need to strengthen resilience in combating this issue.²⁷⁸ Many targets in this goal are closely aligned with those necessary for solving the topic at hand. Targets 13.1 and 13. B focuses on resilience and capacity building in the face of disaster.²⁷⁹ These are especially important in preparation for the continued developments of the oil industry and its dangerous impacts. These include the potential dangers of alternatives, as well as the direct effects of the industry. Target 13.A further mobilizes climate funding initiatives.²⁸⁰ This follows the lines of 15.A and 15. B, and should be considered when forming solutions for the task at hand.

In examining the nuances of biodiversity and the oil industry, many other goals are to be considered. These include hunger, water, poverty, and many other highlighted concerns. The impacts of the oil industry on biodiversity are vast, affecting various aspects of human and animal life. Goal nine's focus on infrastructure and goal 10's focus on reducing inequalities are essential in preparing for energy alternatives and other developments in the industry.²⁸¹ The SDGs must be considered

while mitigating the future of the environment. This includes its variations and niches as they follow the objectives of UNEA.

Bloc Analysis

Points of Division

The impacts of the oil industry on the environment are felt worldwide. The implications of these are significant. This ultimately impacts various sectors of the workforce and human livelihoods. In mitigating the impacts of the oil industry on biodiversity, it is important to take a multi-dimensional approach. Policies surrounding environmental protection and fossil fuel dependency can be compared in finding this approach. The Environmental Protection Index (EPI) is commonly used to determine a country's performance towards climate action.²⁸² It compares 58 indicators divided into 11 categories.²⁸³ These include environmental health, sustainability of food systems, air pollution, and waste management, among others.²⁸⁴ By using EPI scores, countries can identify strengths and weaknesses in their policy and actions. The EPI can be compared to oil usage to determine the best country stances surrounding this topic. This can most simply be quantified by percentages of primary energy consumption from oil.²⁸⁵ This index also compares the consumption of other fossil fuels, such as coal and gas. It is important to take all these into account as global fuel consumption has changed over the decades. For example, coal consumption has decreased, but gas and oil consumption has increased as they have consolidated in states' economies. A country's reliance on oil may also compare to environmental performance. Efforts to reduce oil consumption, production, and exportation are extremely important in drawing contrasts

²⁷⁵ "Goal 15," United Nations Department of Economic and Social Affairs, accessed July 28, 2024, <https://sdgs.un.org/goals/goal15>.

²⁷⁶ United Nations Department of Economic and Social Affairs, "Goal 15."

²⁷⁷ United Nations Department of Economic and Social Affairs, "Goal 15."

²⁷⁸ "Goal 13," United Nations Department of Economic and Social Affairs, accessed July 28, 2024, <https://sdgs.un.org/goals/goal13>.

²⁷⁹ United Nations Department of Economic and Social Affairs, "Goal 13."

²⁸⁰ United Nations Department of Economic and Social Affairs, "Goal 13."

²⁸¹ "The 17 Goals," United Nations Department of Economic and Social Affairs, accessed July 28, 2024, <https://sdgs.un.org/goals>.

²⁸² "Environmental Index by Country," World Population Review, accessed July 31, 2024, <https://worldpopulationreview.com/country-rankings/environmental-performance-index-by-country>.

²⁸³ "About the EPI," Environmental Performance Index, accessed July 31, 2024, <https://epi.yale.edu/about-epi>.

²⁸⁴ "2024 Environmental Performance Index," Environmental Performance Index, accessed July 31, 2024, <https://epi.yale.edu/measure/2024/EPI>.

²⁸⁵ Hannah Ritchie and Pablo Rosado, "Fossil Fuels," Our World in Data, January 2024, <https://ourworldindata.org/fossil-fuels>.

between policies.²⁸⁶ In comparing the EPI and oil dependency, clear divisions can be made.

High EPI (60+) - Low Oil Dependence (≤30 percent)

Countries within this range have shown success in their efforts towards protecting ecosystems and biodiversity. In terms of EPI scores, this high range signifies a continuous improvement in addressing the climate crisis.²⁸⁷ High amounts of funding, education, and other efforts are successfully implemented for their populations and environments.²⁸⁸ Heightened EPI scores often correlate with high GDP, positive labor laws, and societal stability.²⁸⁹ They are also common with low oil levels and other fossil fuel dependency. Within this range, oil makes up for under one-third of energy production. Countries within this low range tend to use their resources efficiently, in pushing alternative energy sources. Geothermal, wind, solar, and other energy sources are well-developed and properly financed.²⁹⁰ They often have economic stability sufficient to branch away from fossil fuels and provide affordable and sustainable alternatives for their populations. Countries in this bloc also invest in research and development of renewable energy.

For example, Iceland is the world's leader in renewable energy use and is ranked in the 10th place on the EPI index with a score of 62.80.²⁹¹ Nearly 70 percent of Iceland's energy comes from clean and renewable sources.²⁹² Iceland started the transition from coal to geothermal energy in 1950. Nevertheless, the government incentivized the transition in the late 60s by establishing a geothermal drilling mitigation fund. This fund

was important as it “accelerated the transition by decreasing municipalities’ risks in undertaking geothermal projects.”²⁹³ Other countries that fall into this category may include Sweden, the Netherlands, and Norway.²⁹⁴ The countries in this range are global leaders in this issue. Their efficient use of local, clean resources and smart economic practices have helped them mitigate and avoid the negative impacts of the oil industry on local and international biodiversity. Their policies should be adapted and recreated to boost efforts around the world.

Medium EPI (40-60) - Medium Oil dependence (30-50 percent)

Countries within these ranges tend to have some progress or effort towards environmental prosperity. Emissions in these countries are slowly decreasing. However, some barriers exist to successful change. Economic factors often tie into this, including job conditions and dependency. A lack of accountability surrounding climate policy is another large barrier.²⁹⁵ These factors impact EPI scores as well as oil dependency. Mid-ranged EPI scores are proof of improvement efforts. However, many 10-year improvement values are low.²⁹⁶ This further demonstrates a lack of accountability, with targets that remain unmet. Oil dependency levels are also in the medium range for these countries. In many, alternatives are accessible. Despite accessibility, many populations do not continue the development of alternative energy technologies.²⁹⁷ These delays in action ultimately make long-term changes more complicated and costly.²⁹⁸ These complications accumulate and increase the difficulty of catching up to climate targets.

286 Lars Jensen, *Global Decarbonization in Fossil Fuel Export-Dependent Economies*.

287 World Population Review, “Environmental Index by Country.”

288 World Population Review, “Environmental Index by Country.”

289 Nuno Silva, José Fuinhas, Matheus Koenkagan, and Emad Kazemzadeh, “What are the causal conditions that lead to high or low environmental performance? A worldwide assessment,” *Environmental Impact Assessment Review*, vol. 104, (January 2024), <https://doi.org/10.1016/j.eiar.2023.107342>.

290 “Countries Least Dependent on Fossil Fuels Sources for Energy Needs,” World Atlas, accessed July 31, 2024, <https://www.worldatlas.com/articles/countries-least-dependent-on-fossil-fuel-sources-for-energy-needs.html>.

291 “Iceland,” Environmental Performance Index, accessed August 31, 2024 <https://epi.yale.edu/epi-results/2022/country/isl>.

292 World Atlas, “Countries Least Dependent on Fossil Fuels Sources for Energy Needs.”

293 “Iceland’s Sustainable Energy Story: A Model for the World?,” United Nations, last modified December, 2015, <https://www.un.org/en/chronicle/article/icelands-sustainable-energy-story-model-world>.

294 Environmental Performance Index, “2024 Environmental Performance Index,”

295 Ed Finn, “Why is Canada far behind other countries in switching from fossil fuels to renewable energy sources?” The Independent, May 21, 2018, <https://theindependent.ca/commentary/the-nonagenarians-notebook/why-is-canada-far-behind-other-countries-in-switching-from-fossil-fuels-to-renewable-energy-sources/>.

296 Environmental Performance Index, “2024 Environmental Performance Index,”

297 Finn, “Why is Canada far behind other countries in switching from fossil fuels to renewable energy sources?”

298 “Climate accountability in practice,” Canadian Climate Institute, accessed August 2, 2024, <https://climateinstitute.ca/report-section/climate-accountability-in-practice/>.

Internal difficulties, such as corruption, contribute further to the delay.²⁹⁹

For example, Brazil has an EPI score of 43.60 and is still developing its national oil industry.³⁰⁰ Brazil's oil exploration has increased since 2007, when it gained independence from imports. Brazil is among the top 10 producers of oil in the world. Nevertheless, it is also the most biodiverse country.³⁰¹ Petrobras, Brazil's biggest state-owned oil company, launched the Petrobras Socio-Environmental Program in 2023. With this program, they aim to protect 70 species of endangered wildlife, mostly in oceans.³⁰² Other countries in this bloc include Croatia and Canada.³⁰³ Policies exist and are developing, but could use some fine-tuning to accelerate progress. In many, the health of ecosystems and biodiversity is being discussed, but it continues to be challenged.³⁰⁴ Continuous loss of natural areas and ecosystems due to natural or human-created factors is a large risk in these countries.³⁰⁵ Because of this, those in this bloc would benefit from improved financial allocation, education, and infrastructure development. Many would benefit from following other models and frameworks for climate-based policies. In following other frameworks, countries in this bloc can see a more formalized climate governance process.³⁰⁶ This may include setting pathways and clearly defined roles in working towards long-term solutions and goals. These improvements could help populations gain access to oil alternatives, ultimately reducing its impacts and risks.

Low EPI (≤ 40) - High Oil Dependence (50 percent +)

Countries within this block struggle to make improvements towards the climate crisis. Lack of resources creates a significant barrier to environmental resilience and decarbonization. Economic hardship, lack of space, and low levels of education also contribute to this.³⁰⁷ Often, high levels of corruption also serve as a barrier to environmental policy. Inequalities are often high, both internationally and within the countries.³⁰⁸ Many countries in this bloc fall on the lower end of the green technology gap.³⁰⁹ They are challenged with lower levels of development and scarce access to resources. Because of the need for more resources, they are often prone to the impacts of climate change and lost biodiversity.³¹⁰ This worsens their ability to improve climate-based regulations and targets. It also increases vulnerability to its impacts. These include those on public health and the quality of water and air. Political and economic instability paired with high dependence on oil also makes it much more difficult to switch to alternative sources.³¹¹ These barriers keep the divide clear between low and high-EPI-scoring countries.

Trinidad and Tobago, Morocco, and Guyana fall within these ranges of low EPI and high oil dependency.³¹² To increase capacity for climate improvements, these countries may benefit from international aid and efforts. Mitigation measures must be strong and equitable to reduce adverse effects on select populations and countries. International efforts to benefit these countries should focus on the promotion of resilience and adaptation in preparing for upcoming changes.³¹³ Some of

299 Silva et al, "What are the causal conditions that lead to high or low environmental performance? A worldwide assessment."

300 "Brazil," Environmental Performance Index, accessed August 31, 2024, <https://epi.yale.edu/epi-results/2022/country/bra>.

301 Luciana Braga, "Oil in Brazil: Evolution of exploration and production," Encyclopédie de l'énergie, last modified November 29 2018, <https://www.encyclopedie-energie.org/en/oil-in-brazil-evolution-of-exploration-production/>.

302 "Protecting and caring for our biodiversity is a commitment," Petrobras, accessed August 31, 2024, <https://petrobras.com.br/en/sustentabilidade/biodiversidade>.

303 Finn, "Why is Canada far behind other countries in switching from fossil fuels to renewable energy sources?"

304 Ulga Rukovets, "New Report Provides a Ranking of Sustainability Around the World," Earth Institute at Columbia University, June 5, 2024, <https://phys.org/news/2024-06-sustainability-world.html>.

305 Rukovets, "New Report Provides a Ranking of Sustainability Around the World."

306 Canadian Climate Institute, "Climate accountability in practice."

307 Rukovets, "New Report Provides a Ranking of Sustainability Around the World."

308 Céline Guivarch, Nicolas Taconet, and Aurélie Méjean, "Linking Climate and Inequality," International Monetary Fund, September 2021, <https://www.imf.org/en/Publications/fandd/issues/2021/09/climate-change-and-inequality-guivarch-mejean-taconet>.

309 United Nations Global Perspectives on Human Stories, "Embrace green tech revolution or risk falling behind, new UN report warns."

310 Ruma Bhargava and Megha Bhargava, "The climate crisis disproportionately hits the poor. How can we protect them?" World Economic Forum, January 13, 2023, <https://www.weforum.org/agenda/2023/01/climate-crisis-poor-davos2023/>.

311 Rukovets, "New Report Provides a Ranking of Sustainability Around the World."

312 Environmental Performance Index, "2024 Environmental Performance Index,"

313 Guivarch et al, "Linking Climate and Inequality."

these efforts may include financial aid and increased education measures. These countries can sustainably contribute to mitigation efforts through improved frameworks and aid.

mandate to research the various nuanced details regarding this topic. Holistic solutions are required, especially in fostering cooperation for sustainable conclusions for the oil industry, biodiversity, and their impacts on humanity.

Committee Mission

UNEA is the largest high-level body for decision-making regarding the environment.³¹⁴ It has universal membership. The assembly sets policy and responses for environmental challenges as they emerge. These challenges may include anything from climate change to food waste. It prioritizes the environmental triple-threat of climate change, biodiversity loss, and pollution.³¹⁵ Under its mandate, UNEA discusses all concerns related to the environment.³¹⁶ This includes collaboration between private and public sectors, which is necessary in solving the topic at hand. Delegates in UNEA are highly encouraged to consider this breadth of the mandate in preparation for debate. Other bodies and stakeholders also guide decisions and discussions. Namely, the SDGs are a guiding force in the Assembly. In fostering global sustainability, UNEA supports all 17 goals.³¹⁷ Delegates should also consider decisions other bodies make about the topic at hand. These include the UN Convention on Biodiversity, the United Nations Development Programme, and the United Nations Framework Convention on Climate Change (UNFCCC).

When focusing on the oil industry and its impacts on biodiversity, it is important to consider sustainability in all solutions. These should include the losses felt in clean water, human health, business, access to food, environmental health, and others. The environmental impacts felt by the oil industry are persistent and urgent. These should be especially considered when discussing the goal of resource efficiency.³¹⁸ Other climate goals can be achieved through the efficient use of resources, such as fossil fuels. Delegates must consider the sustainable use of resources, especially in the energy industry's future. While mitigating the impacts of the oil industry on biodiversity, delegates must engage all sides of this multifaceted issue. Delegates can use the breadth of UNEA's

³¹⁴ United Nations Environment Programme, "About the United Nations Environment Programme."

³¹⁵ United Nations Environment Programme, "About the United Nations Environment Programme."

³¹⁶ United Nations Environment Programme, "About the United Nations Environment Programme."

³¹⁷ United Nations Environment Programme, "About the United Nations Environment Programme."

³¹⁸ "Climate Action," United Nations Environment Programme, accessed August 2, 2024, <https://www.unep.org/topics/climate-action>.

Research and Preparation Questions

Your dais has prepared the following research and preparation questions as a means of providing guidance for your research process. These questions should be carefully considered, as they embody some of the main critical thought and learning objectives surrounding your topic.

Topic A

1. How does globalization influence sustainability efforts in megacities, and what strategies can countries adopt to minimize its negative impacts while maximizing its benefits?
2. How can the factors driving urbanization in your country contribute to the development of megacities, and what strategies can be implemented to ensure these cities balance rapid urbanization with sustainable practices while maintaining economic growth and social equity?
3. How does your country control its environmental footprint, considering its population growth rate, transportation needs, and urbanization process?
4. What changes are being implemented by your country to ensure sustainable megacities and urbanization compared to other cities worldwide?
5. How does migration affect the development of megacities? What benefits and challenges does migration bring to megacities' sustainability levels in terms of innovation and job opportunities?
6. What is the role of technology in the development of megacities, and how can it contribute to the sustainability levels in your country?

Topic B

1. To what extent do marginalized groups, such as indigenous communities, hold power in decision-making surrounding the oil industry in your country? What impacts are made by these groups?
2. What conservation efforts currently exist in your country? How are these enforced?
3. What are some of the key industries in your country's economy? How does biodiversity loss impact these?
4. How reliant is your country's economy on the oil industry?
5. How are alternative energy sources being developed in your country? How are these being made accessible?
6. What barriers does your country face in its transition away from fossil fuels?
7. How prominent are your country's standards surrounding oil production? How are these enforced and followed?

Important Documents

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