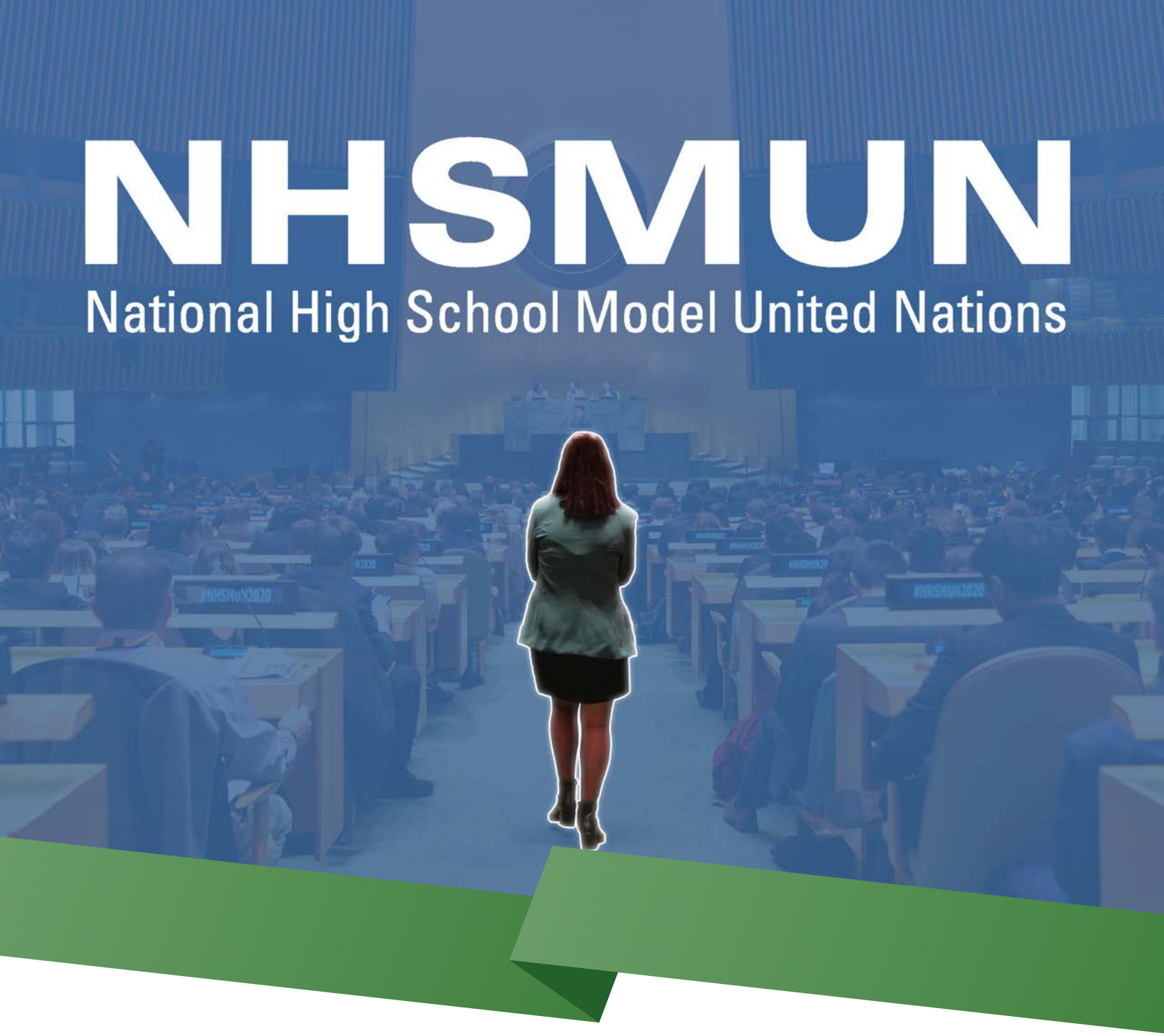
NHSMUN

National High School Model United Nations



BACKGROUND GUIDE

2021

UNEA

Topic A: Mitigating the Effects of Pollution on Marine Life

Topic B: The Effects of Hazardous Electronic Waste on the Environment

NHSMUN
National High School Model United Nations

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Dear Delegates,

I am incredibly excited to welcome you to the United Nations Environment Assembly at NHSMUN 2021! My name is Mitali, and I am thrilled to be your Session I Director for UNEA. I hope you find both of the topics interesting and look forward to the innovative solutions you propose!

This will be my sixth year participating in Model United Nations and my third year on staff at NHSMUN. During my senior year of high school, I attended NHSMUN 2018 as the delegate of Senegal in UNCTAD. The learning experience of interacting with delegates from all over the world and the advice the dais gave me motivated me to apply to staff NHSMUN the following year. At NHSMUN 2019, I served on the dais as the Assistant Director of UNHRC, and in 2020, I had the pleasure of being Director of UNHRC. I enjoyed topics discussed during committee sessions and was thoroughly impressed by the caliber and motivation of delegates that attended. Returning to staff as Director of UNEA this year, I cannot wait to meet you all and see the wonderful ideas you will put forth!

I'm going into my third year of studying biomedical health sciences at the University of Calgary in Canada. During the last two years, I learned to appreciate the interdisciplinary approach to health issues using a biomedical approach, using technology, and using a societal perspective by focusing on health policy. Outside of class, I work in a brain-computer interface lab to help stroke patients and volunteer with Bridging Research Innovation Globally in Health Technology (BRIGHT) to identify and mitigate gaps in health policy.

My co-Director, Kruttika Gopal, and I have worked hard over the past year to select and research engaging topics that we hope you find thought-provoking. Topic A, "Mitigating the Effects of Pollution on Marine Life," focuses on protecting marine life from water contamination and acidification due to run-off. The sources of this pollution, ranging from acid precipitation to improper sewage management, contribute to the decreasing biodiversity and degradation of marine ecosystems. Topic B, "The Effects of Hazardous Electronic Waste on the Environment," centers around mitigating the air, water, and soil pollution that results from mismanagement of electronic waste. Preventative policies focus on the importance of sustainable production and consumption, developing recycling infrastructure, and mitigating the illegal export of e-waste. Delegates are urged to think critically regarding the current policies for preventing environmental harm and then develop novel and feasible solutions to resolving the rising issue of electronic waste.

I am incredibly grateful for the fascinating discussions, endless learning opportunities, and the incredible friendships that Model United Nations has provided me with. While the Background Guide is a phenomenal resource to start with, Kruttika and I would also love to answer any questions or concerns. Feel free to contact us with anything, and we will be more than happy to help and even just get to know you! I hope you have an amazing experience at NHSMUN 2021!

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Dear Delegates,

Welcome to the United Nations Environment Assembly at NHSMUN 2021! My name is Kruttika Gopal, and I am the Director of the UNEA for Session II. After attending NHSMUN all four years of high school, I enjoyed the experience so much that I had to come back! The opportunity that NHSMUN grants for delegates to meet people from across the globe while also participating in a passionate debate is one-of-a-kind. NHSMUN holds a special place in my heart, as it brought me lifelong friendships, taught me essential leadership skills, and showed me the importance of collaboration to enact meaningful change. These factors and more inspired me to pursue an education that allows me to continue growing in these ways. I am so excited for all of you to experience it in just a few months!

I am originally from Milford, Connecticut, and I am currently a sophomore at American University in Washington, DC, studying communications, law, economics, and government (all one major) and minoring in environmental science. On campus, I am a member of the Honors and Leadership Programs, staff the Model G20 Summit, and am in a few political and environmental activism groups. Aside from academics, I love music and am the music director of my a cappella group. I also love hiking and exploring nature, so our Outdoors Club is a go-to for me. Above all, I am extremely passionate about the environment, and I hope to someday work in environmental law or policy. I believe that the environment should be at the forefront of everyone's minds when thinking about global issues in the modern world. Given this, I am super happy to be a part of this committee!

My co-Director, Mitali Pradhan, and I are thrilled to present your Background Guide, which we hope is valuable to your research for our debate. Since environmental issues are so pressing in every aspect of life, picking topics for this year's conference was not a simple process. We chose the two topics of "Mitigating the Effects of Pollution on Marine Life" and "The Effects of Hazardous Electronic Waste on the Environment" because they are complex issues that have ramifications impacting the entire global community. We hope that this guide will help you navigate your research and preparation for when our committee convenes in March. These topics are constantly evolving, so it is up to you to read what is covered in this guide and follow the new developments leading up to NHSMUN. Environmental issues affect the entire world greatly, so I hope you are just as eager as I am to tackle some pertinent global problems through innovative solutions.

If you have any questions, comments, or concerns, please don't hesitate to reach out to me! I would love to help you prepare for the committee. Best of luck, and I cannot wait to see you in March!

Best,

Kruttika Gopal
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United Nations Environment Assembly, Session II

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A Note on the NHSMUN Difference

Esteemed Faculty and Delegates,

Welcome to NHSMUN 2021! Our names are Rose Blackwell and JJ Packer, and we are this year's Directors-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 our conference in March!

As a space for collaboration, consensus, and compromise, NHSMUN strives to transform today's brightest thinkers into tomorrow's leaders. Our organization provides a uniquely tailored experience for all in attendance 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 NHSMUN.

Debate founded on strong knowledge: 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 extremely detailed and comprehensive topic overviews (like the one below) to prepare delegates for the complexities and nuances inherent in global issues. 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.

Extremely prepared and engaged staff: The detailed knowledge that our directors provide in this background guide through diligent research aims to spur critical thought within delegates at NHSMUN. Before the conference, our Directors and Assistant Directors are trained rigorously through copious hours of exercises and workshops to provide the best conference experience possible. Beyond this, our Directors and Assistant Directors read every position paper submitted to NHSMUN and provide thoughtful insight 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.

Emphasis on participation: The UN relies on the voices of all of its Member States to create resolutions most likely to make a dramatic 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. However, 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 also connect students with other action-oriented organizations to encourage further work on the topics.

Focused committee time: We feel strongly that 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. We staff a very dedicated team who type up and format draft resolutions and working papers so that committee time can be focused on communication and collaboration.

Educational emphasis, even for awards: At the heart of NHSMUN lies education and compromise. As such, when NHSMUN does distribute awards, we de-emphasize their importance in comparison to the educational value of Model UN as an activity.

NHSMUN seeks to reward schools whose students 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. We always prioritize teamwork and encourage our delegates to engage with others diplomatically and inclusively. In particular, our daises look for and promote constructive leadership that strives towards consensus, as delegates do in the United Nations.

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). This creates incredible opportunities for our delegates to do first-hand research by reading the actual statements their country has made and the resolutions they have supported. We also incorporate real UN and NGO experts into each committee through our committee speakers program and arrange for meetings between students and the actual UN Permanent Mission of the country they are representing. No other conference goes so far to deeply immerse students into the UN System.

As always, we welcome any questions or concerns about the substantive program at NHSMUN 2021 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,

Rose Blackwell and JJ Packer
Directors-General

A Note on Research and Preparation

Delegate research and preparation is a critical element of attending NHSMUN and enjoying the conference's intellectual and cosmopolitan perspective. We have provided this Background Guide to introduce the topics that will be discussed in your committee. This document is designed to give you a description of the committee's mandate and the topics on its agenda. We do not intend to represent exhaustive research on every facet of the topics. 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. Delegates must be prepared to intelligently utilize your knowledge and apply it to your country's unique policy.

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.

An essential part of representing a state in an international body is the ability to articulate a given state's views in writing. Accordingly, NHSMUN requires each delegation (the one or two delegates representing a country in a committee) to write a position paper for both topics on the committee's agenda. In delegations with two students, we strongly encourage each student to participate in the research for both topics, to ensure that both students are prepared to debate no matter what topic is selected first. More information about how to write and format positoin papers can be found in the NHSMUN Research Guide. To summarize, position papers should be structured into three sections, described below.

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 background, 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 for both topics combined double-spaced with standard margins and font size. **We recommend 2-4 pages per topic as a suitable length**. The paper must be written from the perspective of the country you are representing at NHSMUN 2021 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 **19 February 2021**. If a delegate wishes to receive detailed feedback from the committee's dais, a position must be submitted on or before **29 January 2021**. 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 the email submitted at registration. If delegations are unable to submit their position papers on time, they should contact us at info@imuna.org as soon as possible.

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

Committee History

Global initiatives to create an international body focused on protecting the environment began in 1972 with the establishment of the United Nations Environment Programme (UNEP) and the founding of its Governing Council under General Assembly Resolution 2997.[1] The United Nations Environment Association (UNEA) was then created in June 2012 when world leaders gathered for the United Nations Conference on Sustainable Development, also known as the RIO+20, and recognized the need for strengthening and extending the mandate and legitimacy of the United Nations Environment Programme in order to establish sustainability as a global priority.[2] Currently, the UNEA is the world's highest-level organ on environmental issues.

In 2013, under General Assembly Resolution 67/251, the roles of the UNEP Governing Council were transferred to the UNEA. This mandate enables the UNEA to promote international cooperation within the field of the environment and to provide the United Nations and other countries and international organizations with guidance on environmental matters through its resolutions and calls to action. The UNEA is also tasked with developing environmental policies and laws to confront and address threats to our planet's health. Some of the environmental issues that are discussed include pollution, climate change, protecting water-ecosystems, and sustainable development, along with a variety of others.[3] Although UNEA is bound to respect country sovereignty like all other UN bodies, there have been discussions about extending UNEA's mandate to include post-conflict environmental damage and even the creation of specific interventions in deeply affected regions.[4]

The UNEA acknowledges that there are significant obstacles to protecting our environment, but firmly believes that the world can accomplish the 2030 Agenda for Sustainable Development Goals through global and intergovernmental cooperation.[5] Unlike the UNEP, the UNEA is a decision-making body that develops resolutions to directly tackle environmental issues.[6] The UNEA holds one regular session every two years, and special sessions may take place upon the request of various UN bodies.[7]

The UNEA has universal membership, which means that all 193 UN member states are represented in the UNEA.[8] In addition to member states, a number of groups have been granted observer status to the UNEA from different regions, including the African Wildlife Foundation, Amnesty International, Caribbean Policy Development Center, Asian Environmental Society, Climate Action Network, and Greenpeace International.[9] Observer status enables these groups to attend and speak at most meetings of the UNEA, but does not allow them to vote on resolutions.[10]

The Fourth Session of the UNEA was held in March 2019 and adopted a wide range of resolutions. It was successful with the adoption of resolutions to ensure sustainability in multiple areas, including consumption and production, food waste practices,

1 A/RES/2997 (XXVII), "Institutional and Financial Arrangements for International Environmental Co-operation," 15 December 1972, accessed 22 September 2019, www.un.org/en/ga/search/view_doc.asp?symbol=a/res/2997(XXVII).
2 "UN Environment Assembly and Governing Council," *UN Environment*, accessed 21 September 2019, http://web.unep.org/environmentassembly/un-environment-assembly-and-governing-council; Joyeeta Gupta and Stephen Stec, "Strengthening UNEP's Legitimacy: Towards Greater Stakeholder Engagement," *UNEP Perspectives*, No. 11 (March 2014): pp. 1-11, http://wedocs.unep.org/bitstream/handle/20.500.11822/7461/-UNEP_Perspective_Series_–_Strengthening_UNEP's_Legitimacy_Towards_Greater_Stakeholder_Engagement-2014ENVIRONMENT_PAPERS_DISCUSSION_11.pdf.pdf?sequence=3&isAllowed=y.
3 "UN Environment Assembly and Governing Council"
4 Doug Weir, "In Search of Environmental Security at UNEA-4," *Toxic Remnants of War Network,* last modified 2 March 2019, https://www.trwn.org/in-search-of-environmental-security-at-unea-4/.
5 Doug Weir, "In Search of Environmental Security at UNEA-4."
6 "UN Environment Assembly and Governing Council."
7 UNEP/EA.3/3, "Rules of Procedure of the United Nations Environment Assembly of the United Nations Environment Programme," 16 January 2016, accessed 22 September 2019, www.wedocs.unep.org/bitstream/handle/20.500.11822/14367/K1610826%20%281%29.pdf?sequence=1&isAllowed=y.
8 "Delivering on the 2030 Agenda," *UNEA*, accessed 20 September 2019, https://sustainabledevelopment.un.org/partnerships/unea.
9 "List of Accredited Organizations," *UN Environment*, last modified 11 December 2018, https://www.unenvironment.org/civil-society-engagement/accreditation/list-accredited-organizations?field_major_group_target_id=All&field_associated_region_target_id=61&field_country_target_id=323.
10 Agence France-Presse, "United Nations Observer Status: Facts," *The National*, accessed 25 September 2019, https://www.thenational.ae/world/mena/united-nations-observer-status-facts-1.438482.

business practices, infrastructure, ocean management, chemical waste procedures, coral reef, peatland and nitrogen management, mineral resource governance, and the equality and empowerment of women in environmental governance.[11]

Within the United Nations, the UNEA is a deliberative body and is the highest-level international decision-making body on the environment.[12] The primary limitation of the UNEA results from the fact that its mandate is restricted to solely environmental issues. Some of the problems that the UNEA is tasked with solving are therefore difficult to address, because environmental issues are varied in origin. For example, when discussing post-conflict environmental damage at the second and third meetings of the UNEA, the committee was unable to regulate any of the wartime activities that began the environmental degradation.

As the UNEA receives 95% of its funding from flexible and earmarked voluntary contributions, it often implements programs in collaboration with funding partners. The flexible funds are placed into a large pool for broad investment decisions, whereas the earmarked funds are directed toward specific recipients such as a project, theme, or country. The majority of the UNEA's flexible funds come from the Environment Fund, and these funds are complemented by various earmarked funds for specific projects. Additionally, the UNEA participates in numerous partnerships with governments, the scientific community, and the private sector as well as many international and UN organizations.[13] Notably, it has collaborated with the World Health Organization (WHO) regarding environmental health risks.[14] Additionally, in January 2008, the UNEP entered into an agreement with the Joint Research Centre of the European Union's executive branch (the European Commission) that aimed to improve the understanding and resolving of issues concerning the global environment, particularly promoting the further development of international partnerships in the environmental information field.[15] Moreover, the UNEP partnered with the United Nations Industrial Development Organization (UNIDO) to create the Climate Technology Centre & Network, which facilitates the transfer of technologies for climate mitigation and adaptation, especially in developing countries.[16]

The UNEP significantly collaborated on The Montreal Protocol on Substances That Deplete the Ozone Layer in 1987, which reduced the emission of harmful gases that thin the ozone layer.[17] Also, since 2008, UNEP has been measuring its own greenhouse gas emissions through its inventory and making an effort to reduce them and offset emissions through strategic planning.[18] Moreover, UNEP implemented the Solar Loan Programme in India, which sponsored and enabled over 100,000 Indians to set up solar power systems.[19]

In August 2015, the UNEP signed its Environmental Policy and developed an Environmental Management System (EMS) to guide its operations. The EMS outlines actions to be taken to improve awareness and communication activities across all UNEP offices and staff. It defines the scope and boundaries of the organization and authorizes specific strategies to be used to reduce the UNEP's own footprint.[20] The creation of this policy was a notable advancement in defining UNEP's commitment to the environment by planning an established set of processes to be utilized in all UNEP offices.

11 "Proceedings, Report, Ministerial Declaration, Resolutions and Decisions," *UN Environment*, accessed September 21, 2019, https://web.unep.org/environmentassembly/proceedings-report-ministerial-declaration-resolutions-and-decisions.
12 "Delivering on the 2030 Agenda," *UNEA*.
13 "Funding partners," *UN Environment,* accessed 22 September 2019, http://www.unenvironment.org/about-un-environment/funding/funding-partners.
14 "UN Environment and WHO agree to major collaboration on environmental health risks,"*World Health Organization*, Jan 10, 2018, https://www.who.int/news-room/detail/10-01-2018-un-environment-and-who-agree-to-major-collaboration-on-environmental-health-risks.
15 "Collaboration with the United Nations Environment Programme," *European Commission*, 29 January 2008, https://ec.europa.eu/jrc/en/news/collaboration-united-nations-environment-programme-unep-7437.
16 "Delivering the Programme of Work through Partnerships," *UN Environment*, 22 October 2018, http://wedocs.unep.org/bitstream/handle/20.500.11822/26379/UN%20environment%20partnerships.pdf?sequence=21&isAllowed=y.
17 "The Montreal Protocol on Substances That Deplete the Ozone Layer," *U.S. Department of State,* Feb. 11, 2019, https://www.state.gov/key-topics-office-of-environmental-quality-and-transboundary-issues/the-montreal-protocol-on-substances-that-deplete-the-ozone-layer/.
18 "Achievements," *UNEP,* accessed 22 September 2019, https://www.unenvironment.org/about-un-environment/sustainability/achievements.
19 "UNEP's India Solar Loan Programme Wins Energy Globe," *Horizon International Solutions*, 13 April 2007, https://www.solutions-site.org/node/258.
20 "Achievements," *UNEP,* accessed 22 September 2019.

UNEA

NHSMUN 2021

TOPIC A:
MITIGATING THE EFFECTS OF POLLUTION ON MARINE LIFE

Photo Credit: adege

Introduction

Oceans occupy over 90 percent of the habitable space on the planet and house over a million different species, with new life being discovered every day.[1] From microscopic organisms like plankton to the blue whale, the largest animal on the planet, the ocean gives life to many life forms. However, with 60 percent of the world's major marine ecosystems currently being degraded or used unsustainably, the need to reevaluate the effects of human activity on oceans has never been more urgent.[2] Around 20 billion tonnes of waste ends up in the world's oceans every year, often without any treatment or processing.[3] As the world continues to become aware of the volume of ocean pollutants and their effects, the clearer it becomes how pressing the issue is. Marine pollutants are threatening the very survival of marine life. Pollution of our oceans has caused a decline in the biodiversity and resilience of the world's ecosystems.

The erroneous notion that the ocean has a limitless capability to dilute pollution is a deeply embedded myth in industrialized cultures.[4] This belief is the cornerstone of widespread ocean dumping and the legal systems that allow this deliberate discharge of waste directly into the sea. However, this concept is both unfounded and extremely harmful as research from various international conservation groups has repeatedly shown that ocean dumping has empirically negative effects on marine life. Runoff from industrial or agricultural sites can also react with other dumped waste creating unexpected toxic pollutants. Chemical intruders can include oil, pesticides, fertilizers, and toxic metals. As chemical production grows steadily by four percent every year, the variety of chemical pollutants entering the ecosystem rises as well as their quantity.[5] Plastic pollution is also pervasive, with an estimated 5.25 trillion pieces in our oceans.[6] Plastic waste kills approximately 100 million marine animals during the course of each year.[7] Another growing concern is small pieces of plastic called microplastics, which can serve as a vector for concentrating other chemical pollutants.

The worsening impacts of carbon emissions and climate change complicate the issue of ocean pollution. As oceans absorb carbon, they become more acidic through a process known as ocean acidification, which can break down the bodies of marine creatures and deoxygenate the water. Since the 1950s, areas of the ocean that are so acidified that no life exists called "dead zones" have quadrupled due to climate change, pollution, and warming waters."[8] Climate change also disrupts marine ecosystems by causing sea-level rise, melting ice caps that release contaminants into the ocean, and provoking violent storm patterns that can displace underwater species. The use of fuels by maritime transportation not only contributes to global greenhouse gas (GHG) emissions but also brings foreign contaminants into the water through leakages. While 90 percent of the planet's international trade is transported by ship, 50 percent of the world's ship cargo is considered dangerous to the environment.[9]

The United Nations Environment Assembly (UNEA) has taken actions to tackle marine pollution, such as the Basel Convention and two resolutions passed in 2019 at the assembly's

1 "International Day for Biological Diversity," *United Nations Educational, Scientific and Cultural Organization*, Accessed July 14, 2020, http://www.unesco.org/new/en/unesco/events/prizes-and-celebrations/celebrations/international-days/international-day-for-biological-diversity-2012/.
2 "International Day for Biological Diversity."
3 Joanna Immig and Mariann Lloyd-Smith, "Ocean Pollutants Guide: Toxic Threats to Human Health and Marine Life," *National Toxics Network,* Last modified October 2018, https://ipen.org/sites/default/files/documents/ipen-ocean-pollutants-v2_1-en-web.pdf.
4 Immig and Lloyd-Smith, "Ocean Pollutants Guide: Toxic Threats to Human Health and Marine Life."
5 Immig and Lloyd-Smith, "Ocean Pollutants Guide: Toxic Threats to Human Health and Marine Life."
6 "Marine and Ocean Pollution: Statistics and Facts 2020," *Condor Ferries*, accessed June 11, 2020, https://www.condorferries.co.uk/marine-ocean-pollution-statistics-facts.
7 "Microplastics, Microbeads and Single-use Plastics Poisoning Sea Life and Affecting Humans," *United Nations News*, November 4, 2019, https://news.un.org/en/story/2019/11/1050511.
8 Immig and Lloyd-Smith, "Ocean Pollutants Guide: Toxic Threats to Human Health and Marine Life."
9 "Marine and Ocean Pollution: Statistics and Facts 2020."

meeting in Nairobi, Kenya. UNEP/EA.4/Res.11 encourages policies that protect marine ecosystems from land-based activity-related threats, and UNEP/EA.4/Res.6 places a focus on reducing marine plastic litter and microplastics.[10] Despite these calls to action, a concrete framework that encompasses waste and resource management strategies, carbon emission reduction, and enforced implementation of international regulations is yet to be made. Whether it be through the 143.8 million tonnes per year of seafood consumed worldwide, the oxygen we breathe, or the weather we experience, the ocean and its life play an integral role in our survival.[11] To truly mitigate the effects of pollution on underwater ecosystems, significant changes to the way the world lives and consumes must be made. The world human population is projected to reach 9.7 billion by 2050, making it clear that current waste practices and resource consumption cannot be sustained.[12] The reduction of ocean pollution is a critical topic that needs to be addressed by the UNEA to ensure the preservation of marine life.

History and Description of the Issue

Ocean Dumping

The health and productivity of marine environments are threatened anytime waste or other matter is disposed of at sea. Ocean dumping occurs when wastes and materials are disposed of deliberately into the ocean using aircraft, boats, or platforms, having a detrimental and degrading effect on the aquatic environments.[13] Marine dumping has been ingrained into human activity since antiquity, as early civilizations like the ancient Romans and Mayans considered streams, lakes, and estuaries to be readily available containers for their waste.[14] Unaware of the unfavorable outcomes it would have for the environment, they discharged waste into these bodies. As civilizations moved closer to coastal regions and sea navigation intensified, the ocean was viewed as an even larger and more convenient repository for food waste, trash, mining waste, and human waste because rivers and estuaries began displaying the negative effects of dumping.[15] Following this, the Industrial Age brought with it the new problems of chemical and industrial waste. The disposal of waste into the water by humans continues to be universally practiced. Today, over 80 percent of pollution in our oceans comes from land-based sources.[16] An estimated 14 billion pounds of waste is dumped into the world's oceans every year, much of it untreated.[17] Although ocean dumping encompasses all waste that is purposefully discarded into the sea, the most commonly dumped waste includes dredged material, sewage sludge, and radioactive waste.[18]

Dredging is the act of excavating both naturally deposited, and man-made detritus and waste from the bottom of bodies of water."[19] This process benefits the shipping industry, as it clears up underwater surfaces for the maintenance of bottom clearance by marine vessels and smooth underwater transport.[20] It also aids in constructing projects such as bridges, dams, docks, and piers by performing the necessary underwater excavation work.[21] Although dredging is beneficial to human activity, it can be harmful to marine environments when the dredged waste is dumped back into the ocean.

Approximately 20 percent of the material dredged from rivers

10 UNEP/EA.4/Res.6, "Marine Plastic Litter and Microplastics," *United Nations Environment Assembly*, March 28, 2019, http://wedocs.unep.org/bitstream/handle/20.500.11822/28340/K1901091%20-%20UNEP-EA-4-Res-6%20-%20Advance.pdf?sequence=3&isAllowed=y.
11 Immig and Lloyd-Smith, "Ocean Pollutants Guide: Toxic Threats to Human Health and Marine Life."
12 Immig and Lloyd-Smith, "Ocean Pollutants Guide: Toxic Threats to Human Health and Marine Life."
13 "Marine Dumping," *Safe Drinking Water Foundation*, accessed June 11, 2020, https://www.safewater.org/fact-sheets-1/2017/1/23/marine-dumping.
14 Robert M. Engler, "Ocean Dumping," *Encyclopedia.com*, June 8, 2020, https://www.encyclopedia.com/environment/educational-magazines/ocean-dumping.
15 Engler, "Ocean Dumping."
16 Drew Brucker, "Ocean Pollution Facts, Stats, and Solutions," *Rubicon* (blog), October 9, 2017, https://www.rubicon.com/blog/ocean-pollution-facts/.
17 "Marine Debris and Plastics," *Seastewards* (blog), accessed July 3, 2020, http://seastewards.org/projects/healthy-oceans-initiative/marine-debris-and-plastics/.
18 "Marine Dumping."
19 Anish Wankhede, "What Is Dredging?," *Marine Insight*, February 5, 2020, https://www.marineinsight.com/guidelines/what-is-dredging/.
20 Wankhede, "What Is Dredging?"
21 "Dredging 101," *Geoform International*, last modified April 3, 2020, https://geoforminternational.com/sediment-removal-101/.

and harbors is dumped into the ocean.[22] About 10 percent of this material is polluted with heavy metals (including cadmium, mercury, and chromium), heavy oils, and chemicals from pesticides called organochlorines.[23] The sediment quickly absorbs these chemicals, especially heavy metals. These toxins have a deadly effect on marine organisms. On top of this, essential minerals get dredged out with the silt, leaving the resultant water and land lacking in nitrates and phosphates.[24] Nitrates are used by plants and animals to synthesize protein and phosphates. In plants, they convert sunlight into usable energy.[25] When such materials are removed from or deposited back into their source, it alters the mineral composition of the water, which extensively affects the life of flora and fauna prevalent in that area.[26]

Sewage sludge, the "solid, semisolid, or slurry residual material" that is a resulting byproduct of wastewater treatment, unlike dredged material, can be used positively. If not still chemically contaminated by oils, organic chemicals, and metals after treatment, it can be recycled as fertilizer for crops.[27] Regardless of if it is chemically contaminated or not, sludge still has a detrimental impact when introduced to marine environments. Unfortunately, treatment centers tend to go the cheaper route and dump sludge into the ocean.[28] In the Mediterranean Sea, 80 percent of sewage discharged into the water is untreated and contains hazardous chemicals.[29] Likewise, the perpetrators of this dumping are not limited to treatment facilities—cruise ships have also been found to illegally release large amounts of sewage into oceans. The United States Environmental Protection Agency has found that a "single 3,000-person cruise ship pumps 150,000 gallons of sewage—about 10 backyard swimming pools' worth—into the ocean per week."[30] When sewage enters the water, microorganisms like algae and bacteria feast on the excess nitrates, phosphates, and other organic matter found in human waste, causing algal blooms, where colonies of algae grow out of control.[31] This induces eutrophication, an excessive richness of nutrients that

Dredged material is dumped back into the water to fill in an inlet between two islands in the Gulf Islands National Seashore, along the Gulf of Mexico.

22 "Ocean Pollution," *MarineBio*, last modified February 16, 2019, https://marinebio.org/conservation/ocean-dumping/.
23 "Ocean Pollution."
24 Wankhede, "What Is Dredging?."
25 "Nutrients: Phosphorus, Nitrogen Sources, Impact on Water Quality- A General Overview," *Minnesota Pollution Control Agency*, May 2008, https://www.pca.state.mn.us/sites/default/files/wq-iw3-22.pdf.
26 Wankhede, "What Is Dredging?"
27 Archis Ambulkar and Jerry A. Nathanson, "Wastewater Treatment," *Encyclopædia Britannica*, July 17, 2019, https://www.britannica.com/technology/wastewater-treatment.
28 "Ocean Pollution."
29 "Marine and Ocean Pollution: Statistics and Facts 2020."
30 Gwynn Guilford, "Cruise Ships Dump 1 Billion Gallons of Sewage Into the Ocean Every Year," *Quartz*, December 9, 2014, https://qz.com/308970/cruise-ships-dump-1-billion-tons-of-sewage-into-the-ocean-every-year/.
31 Frank Graff, "What Happens When Raw Sewage Is Dumped Into Water," *University of North Carolina Television* (blog), March 15, 2018, http://science.unctv.org/content/reportersblog/sewage.

causes a dense growth in plant life.[32] Eutrophication diminishes the clarity of the water and starves the algae of light. Without light, the plants can no longer produce oxygen and instead consume large amounts of it.[33] This proliferation of plant growth kills animal life from a lack of oxygen, and the entire ecosystem is thrown out of equilibrium. Additionally, sludge typically contains pathogens and chemicals that are toxic to fish, shellfish, animals, and other marine creatures.[34] For instance, outbreaks of white pox disease caused by sewage bacteria have killed more than 70 percent of corals in the Florida Keys since 1996.[35] To prevent sludge from harming marine life, improvement to outdated sewage treatment plants is necessary. In India, roughly two-fifths of sewage treatment plants and pumping stations failed to meet operation standards in 2012, resulting in discharges of untreated sludge directly into the environment.[36] Rivers receive about 100 times more sewage per capita from urban populations than from rural populations, furthering the necessity that treatment centers be more efficient in the places where they are most indispensable.[37]

Similar to sludge, another type of untreated dumped material is radioactive waste. As the amount of nuclear research increases, the issue of radioactive materials in oceans is continually more pressing. It often comes from nuclear power plants and the research or medical use of radioisotopes. While many believe that the vastness of the ocean can dilute nuclear contamination, research shows that elevated levels of radioactivity in water are dangerous to marine life. The disposal process for nuclear waste involves the materials being put in concrete drums, creating a barrier meant to prevent contamination, and then released into the ocean. Despite the waste being sealed into containers that prevent leakage, it remains radioactive for decades and poses a danger to marine life in areas surrounding the drums.[38] Though nuclear waste may constitute a small portion of overall marine pollution, its long-term effects harm animals just like other, more commonly dumped materials. The majority of radioactive waste in the oceans lies in the Kara Sea, which contains 17 dumped ships and barges and 17,000 containers loaded with radioactive waste.[39] In 1992, it was discovered that this came from the former Soviet Union's usage of the Arctic Ocean as a dumping ground for liquid and solid nuclear waste until 1991.[40] Sediment samples taken close to the waste containers have shown excessive radionuclides, which harms the deep-sea organisms in those areas.[41] Additionally, with rising carbon emissions and strong ocean currents, radioactive contamination can easily be carried to other continents. It is important to develop methods to ensure that dumped nuclear materials do not leak out of their containers and track where they move within oceans to reduce the spreading of radioactive waste.

Various global actions have been taken to control ocean dumping. The UN Conference on the Human Environment in June 1972 and the Inter-Governmental Conference on the Convention of the Dumping of Wastes at Sea in November 1972 were the first of many calls to action to reduce marine dumping and protect our seas.[42] These conferences resulted in the 1972 London Convention (LC-72), which has 80 member states, and was further modernized by the London Protocol in 1996. The protocol categorized waste dumped in the ocean into the black, gray, and white lists. The black list, which includes mercury compounds, plastics, and radioactive waste, is prohibited from being dumped. The gray list, which includes

32 Jeremy Mack, "Eutrophication," *Lake Scientist*, accessed July 4, 2020, https://www.lakescientist.com/eutrophication/.
33 Mack, "Eutrophication."
34 Graff, "What Happens When Raw Sewage Is Dumped Into Water."
35 Justine E. Hausheer, "Sewage Pollution: A Significant Threat to Coral Reefs," *The Nature Conservancy*, June 8, 2015, https://blog.nature.org/science/2015/06/08/sewage-pollution-great-threat-coral-reefs/.
36 "Wastewater Management: A UN-Water Analytical Brief," *UN Water*, accessed June 12, 2020, https://www.unwater.org/publications/wastewater-management-un-water-analytical-brief/.
37 "Better Sewage Treatment Critical for Human Health and Ecosystems," *United Nations Environment Programme*, April 5, 2019, https://www.unenvironment.org/news-and-stories/story/better-sewage-treatment-critical-human-health-and-ecosystems.
38 "Marine Dumping."
39 Thomas Nilsen, "Russia's Arctic Nuclear Dump May Become Promising Fishing Area," *The Barents Observer*, March 15, 2018, https://thebarentsobserver.com/en/ecology/2018/03/russias-arctic-nuclear-dump-may-become-promising-fishing-area.
40 Karen Graham, "Nuclear Waste in Kara Sea Could Spread to Other Continents," *Digital Journal*, October 27, 2013, http://www.digitaljournal.com/article/361035.
41 Aaron Jones, "Ocean Dumping of Nuclear Waste," *Stanford University*, March 7, 2018, http://large.stanford.edu/courses/2017/ph241/jones-a2/.
42 Engler, "Ocean Dumping."

acids and bases, scrap metal, and pesticides, requires a special permit from a designated national authority under strict control and conditions.[43] The white list contains materials and substances that can be dumped with an issued permit. The London Protocol also prohibited the incineration of industrial waste and sewage sludge on marine vessels.[44] In 2009, the protocol was amended to address the issue of exporting waste for dumping purposes.[45] Though the London Protocol has successfully brought the unregulated dumping or incineration of wastes to a halt, it continues to allow the dumping of certain substances like dredged material or industrial waste if guidelines are followed. The other significant global action taken is the 1973 International Convention for the Prevention of Pollution from Ships, known as MARPOL, which has 156 member states.[46] MARPOL bans the dumping of oil or toxic substances but leaves optional the disposal of hazardous substances, sewage, and plastics.[47] In 2017, the IMO, which is a UN agency, adopted a new set of guidelines for the implementation of MARPOL called Annex V. Annex V made a strong point to prohibit the discharge of all garbage in the sea, but still makes many exceptions with permission.[48] Furthermore, both the London and MARPOL conventions failed to address cleaning up past marine dumping—they only banned future actions.

Chemical Pollution

The presence of waste in the ocean from human activity is certainly not limited to dumped materials from dredging, sewage sludge, or radioactive waste. Chemicals that are manufactured by humans inadvertently pervade our entire environment as a result of unsafe disposal practices. In 2019, the UNEA found that the current chemical production capacity of 2.3 billion tonnes, which is the measure of the world's maximum economic potential from chemical production, is projected to double by 2030.[49] In highly industrialized areas, the effects of chemical pollution are prevalent in waterways due to biomagnification. This process begins with plankton or other bottom dwellers absorbing chemicals as they feed and burrow, which concentrates the toxic waste within them. As the predators of these bottom dwellers hunt, they ingest the chemicals stored within their prey.[50] Biomagnification concentrates chemicals up the food chain, showing how they can destroy entire marine ecosystems.

Industrial chemical waste includes metals, which can be toxic on their own and become even more toxic in combination with organic compounds. For example, when mercury is combined with carbon, it can form toxic compounds that disrupt the nervous system, such as methylmercury.[51] These metals are not always deliberately dumped—they are often the product of runoff and found downstream from their original sources, such as factories and mines. As a first step in combating chemical runoff, it is important to track their movement from industrial sources, especially near bodies of water. According to the European Environment Agency, the Baltic Sea is most affected by this, with 96 percent of its assessed areas showing problematic levels of dangerous chemicals.[52] Many

43 "Convention on the Prevention of Marine Pollution by Dumping of Wastes and Other Matter," *International Maritime Organization*, accessed June 11, 2020, http://www.imo.org/en/OurWork/Environment/LCLP/Pages/default.aspx.
44 "Learn about Ocean Dumping," *United States Environmental Protection Agency,* accessed June 11, 2020, https://www.epa.gov/ocean-dumping/learn-about-ocean-dumping.
45 "Key International Marine Environment Protection Convention Celebrates 40 Years of Progress," *International Maritime Organization*, October 25, 2012, http://www.imo.org/en/MediaCentre/PressBriefings/Pages/46-london-convention-.aspx#.XxO6Z5NKi3I.
46 "International Convention for the Prevention of Pollution from Ships (MARPOL)," *International Maritime Organization*, accessed June 11, 2020, http://www.imo.org/en/About/Conventions/ListOfConventions/Pages/International-Convention-for-the-Prevention-of-Pollution-from-Ships-(MARPOL).aspx.
47 Engler, "Ocean Dumping."
48 MEPC 71/17/Add.1, "2017 Guidelines for the Implementation of MARPOL Annex V," *International Maritime Organization*, July 7, 2017, http://www.imo.org/en/OurWork/Environment/PollutionPrevention/Garbage/Documents/MEPC.295%2871%29.pdf.
49 "UN Report: Urgent Action Needed to Tackle Chemical Pollution as Global Production is Set to Double by 2030," *United Nations Environment Programme*, March 11, 2019, https://www.unenvironment.org/news-and-stories/press-release/un-report-urgent-action-needed-tackle-chemical-pollution-global.
50 "Biomagnification," *US National Oceanic and Atmospheric Administration*, accessed July 10, 2020, https://oceanexplorer.noaa.gov/edu/learning/player/lesson13/l13la1.html.
51 "Chemical Pollution," *Ocean Health Index*, accessed June 12, 2020, http://www.oceanhealthindex.org/methodology/components/chemical-pollution.
52 Fiona Harvey, "Heavy Metals and Harmful Chemicals 'poison Europe's seas'," *The Guardian*, May 15, 2019, https://www.theguardian.com/environment/2019/may/15/heavy-metals-and-dangerous-chemicals-still-poisoning-europes-seas.

of these chemicals come from the nearly 85 million people living in the Baltic Sea catchment area, bringing lots of industrial activity, traffic, and intensive farming.[53] The natural stress that marine species face in this area is only amplified by the poor management of chemical runoff from local sources. The Baltic Sea is closely followed by the Black and Mediterranean Seas, which found similar problems in 91 percent and 87 percent of assessed areas, respectively.[54] Greater controls on chemical usage and monitoring of marine health are integral to preventing the spreading of ocean chemicals.

Another chemical intruder to oceans is oil, which has detrimental effects on marine life. Oil pollution elevates the concentration of toxic elements found in it, such as arsenic, which can kill marine life through ingestion, inhalation, or absorption.[55] Oil also sticks to the fur and feathers of animals like seabirds and seals, immobilizing them and removing their layer of insulation. Due to its low density, it can also form a layer on top of the water that prevents sunlight from reaching plants, reducing oxygen circulation under the water and suffocating marine life, similar to eutrophication.[56] The 2010 Deepwater Horizon spill, considered the largest oil spill in the history of the petroleum industry, leaked approximately 168 million gallons of oil into the Gulf of Mexico and "killed over 82,000 birds, 25,900 marine mammals, 6,000 sea turtles and tens of thousands of fish."[57] A faulty concrete cap on the rig paired with poor installation, a failure to maintain the equipment, and ocean pressure caused the cap to crack and shoot natural gas up to the platform of the rig, inducing a disastrous explosion.

This tragedy and many others could have been prevented with design standards for the oil rigs, an environmental review of the oil development process, and an overall enhancement of response mechanisms. For example, a massive oil spill off

Following the Deepwater Horizon Oil Spill, pelicans and many other seabirds found themselves covered in oil, reducing the water repellency of their feathers and exposing them to the harsh elements.

the coast of China in 2018 was met with a speedy response thanks to an online marine pollution reporting system called POLREP, which was developed by the UN Environment Programme Action Plan for the Protection, Management and Development of the Marine and Coastal Environment of the Northwest Pacific Region (NOWPAP).[58] The system allowed for rapid communication between China, Japan, the Republic of Korea, and the Russian Federation about the spreading spill and measures taken to contain it.[59] This timely exchange of information allowed the countries to contain the spill very quickly. Still, oil spills are not the only issue to tackle when it comes to keeping oil out of oceans. Despite the immense amount of oil released in spills, only 12 percent comes from such events; most come from boats and land-based runoff.[60] It is important to address these alternate causes as well.

Land-based runoff can also include the large amounts of fertilizers introduced to the ocean via agricultural runoff. When fertilizers are left unused in soil, they can run off into coastal waters and larger bodies. This alters the pH level of the water by alkalinizing it, which creates adverse conditions for marine

53 "Hazardous Substances in the Baltic Sea – An Integrated Thematic Assessment of Hazardous Substances in the Baltic Sea," *Helsinki Commission*, accessed July 10, 2020, https://www.helcom.fi/wp-content/uploads/2019/08/BSEP120B.pdf.
54 Harvey, "Heavy Metals and Harmful Chemicals 'poison Europe's seas'."
55 "Chemical Pollution."
56 Dewald Vorster, "Chemical Pollution in Oceans," *ArcGIS Story Maps*, November 16, 2019, https://storymaps.arcgis.com/stories/7b0f1053c7b14143840c64c0d02eebce.
57 Mohit Kaushik, "11 Major Oil Spills Of The Maritime World," *Marine Insight*, last modified January 10, 2020, https://www.marineinsight.com/environment/11-major-oil-spills-of-the-maritime-world/.
58 "UN Information Sharing Platform Speeded Response to Worst Oil Spill in Northwest Pacific," *United Nations Environment Programme*, August 9, 2018, https://www.unenvironment.org/news-and-stories/blogpost/un-information-sharing-platform-speeded-response-worst-oil-spill.
59 "UN Information Sharing Platform Speeded Response to Worst Oil Spill in Northwest Pacific."
60 "Marine and Ocean Pollution: Statistics and Facts 2020."

plants and animals. Moreover, the resulting algal bloom releases harmful toxins that, when in large amounts, can poison various types of marine life. Today, 38 percent of the bodies of water in the European Union are under pressure from agricultural pollution.[61] These affected ecosystems can take years to return to a healthy state and often "harm neighboring ecosystems that rely on the various fish and crustaceans to survive."[62] Regulations on fertilizing or transitions to farming systems that utilize organic fertilizer are necessary to protect marine life from this runoff.

Fertilizer and soil runoff are often loaded with pesticides, insecticides, and a host of other pathogens. Pesticides, worth over USD 35 billion annually in the global market, have been produced and used intensively to improve crop production, but they contain chemicals harmful to marine ecosystems.[63] These chemicals are called Persistent Organic Pollutants (POPs) and include pesticides such as DDT, herbicides, PCBs (found in many coolants and adhesives), and BPA (a compound found in many plastics).[64] DDT, a common insecticide, quickly accumulates in plankton and concentrates up the food chain via biomagnification. Gulls, which feed on clams, "may accumulate DDT to 40 or more times the concentration in their prey."[65] Moreover, POPs destroy plants and insects, which disrupts the food chain and harms biodiversity. They also break down very slowly in low temperatures, accumulating in high concentrations in bodies of water.[66] These toxic substances are made up of carcinogens like TCDD and chlordane that are deadly to marine organisms. The poison can be absorbed by the fatty tissue of animals and lead to the failure of their reproductive systems.[67] In Canada's St. Lawrence Estuary, the beluga whale population has some of the highest levels of POPs and toxic metals and, in turn, one of the highest rates of cancer known in any wild population.[68] The population has declined from about 5,000 at the beginning of the 1900s to about 650 animals today.[69] Some chemicals are not POPs and are less harmful than POPs, such as the natural insecticides Bacillus thuringiensis (Bt) and borax-based compounds, but their "natural" status does not mean they are safe.[70] Pesticides are so widely used that prohibiting them altogether poses a large challenge, but limiting their use and optimizing the type used is fundamental to preventing them from entering bodies of water.

Plastic Pollution

Globally, we produce about 300 million tonnes of plastic every year—nearly the weight of the entire human population.[71] Plastics, especially single-use plastics, are so integral to daily life that we throw them away without a second thought about where they are going. Our everyday water bottles, food containers, and bags are often made of plastic. Scientists have suggested that plastic waste is so ubiquitous in the environment that it could serve as a geologic indicator of the current Anthropocene era.[72] The UNEP finds that each year, approximately eight million tonnes of plastic are dumped in the ocean, a figure equivalent to a full garbage truck being dumped every minute.[73] It has been predicted that if current trends continue, by 2050, our oceans will contain more plastic than fish, by volume.[74]

61 Javier Mateo-Sagasta, Sara Marjani Zadeh, and Hugh Turral, "Water Pollution from Agriculture: a Global Review," *Food and Agriculture Organization of the United Nations,* 2017, http://www.fao.org/3/a-i7754e.pdf.
62 "The Damaging Effects of Fertilizers on Marine Ecosystems," *AquaViews*, accessed June 12, 2020, https://www.leisurepro.com/blog/ocean-news/damaging-effects-fertilizers-marine-ecosystems/.
63 Mateo-Sagasta, Zadeh, and Turral, "Water Pollution from Agriculture: a Global Review," 8.
64 "Chemical Pollution."
65 John W. Kimball, "Biomagnification of Pesticides," in *Biology*, (Boston, MA: Addison-Wesley, 1983), 5819.
66 "Chemical Pollution."
67 Vorster, "Chemical Pollution in Oceans."
68 Sonja K. Ostertag et al. ""That's how we know they're healthy': The Inclusion of Traditional Ecological Knowledge in Beluga Health Monitoring in the Inuvialuit Settlement Region," *Arctic Science* 4, no. 3 (2018): 294, doi: doi.org/10.1139/as-2017-0050.
69 Ostertag et al., ""That's how we know they're healthy': The Inclusion of Traditional Ecological Knowledge in Beluga Health Monitoring in the Inuvialuit Settlement Region," 297.
70 "Chemicals," *Santa Monica College*, accessed July 13, 2020, http://www.smc.edu/AcademicAffairs/Sustainability/Documents/SW_Workbook_SGP_Chemicals.pdf.
71 "Our Planet is Drowning in Plastic Pollution," *United Nations Environment Programme*, accessed June 13, 2020, https://www.unenvironment.org/interactive/beat-plastic-pollution/.
72 "Our Planet is Drowning in Plastic Pollution."
73 "Microplastics, Microbeads and Single-use Plastics Poisoning Sea Life and Affecting Humans."
74 "Our Planet is Drowning in Plastic Pollution."

The largest producers of plastic tend to lack efficient waste management systems, causing the global volume of plastic waste to rise rapidly. China, Indonesia, The Philippines, Thailand, and Vietnam are estimated to produce as much as 60 percent of the documented plastic waste in our oceans.[75] As they experience economic growth and population booms, there is a subsequent rise in the consumption of plastic goods. In China, the Yangtze River carries 1,469,481 tons of plastic waste directly into the Yellow Sea.[76] However, plastic polluters are not limited to these five countries. The United States, Japan, and many European countries also produce large amounts of plastics but have more effective management systems than the polluters mentioned above. This does not mean that these countries are not culprits behind plastic pollution--they just recycle much more than the countries listed as "worse" offenders. The United States is still the biggest generator of waste per capita worldwide, producing 12 percent of global municipal solid waste while only constituting 4.25 percent of the world population.[77] In contrast, China and India generate 27 percent of global municipal waste while accounting for 36 percent of the world population.[78] Plastic is found in oceans all around the world, and its harmful effects are complemented by its inability to biodegrade easily and the potential to linger indefinitely.

Given how much plastic stays in the ocean, it becomes nearly impossible for animals to avoid its deadly effects. Over 100 million marine animals from over 800 different species, some of which are endangered, die each year from plastic waste alone.[79] Most plastic sinks below the surface of the water and infiltrates marine ecosystems. Marine animals such as seabirds, whales, fishes, and turtles mistake plastic waste for prey and ingest it, filling their stomachs with plastic debris rather than actual food.[80] Even the smallest intake of plastic in an animal's diet increases the risk of death considerably: researchers have found that there is a 20 percent chance of death for a turtle that consumes one piece of plastic, rising to 50 percent for just 14 pieces.[81] Scientists estimate that by 2050, 99 percent of all seabird species will have eaten pieces of plastic.[82] Young animals are particularly susceptible to this, as they are less selective about what they eat, have underdeveloped organs, and often move with the currents alongside buoyant plastic. Many animals are often found dead with their stomachs full of plastic waste.

Animals can also become entangled in larger pieces of flexible plastic, restricting their mobility, growth potential, and ability to breathe. Evidence shows that 100,000 marine animals die from entanglement in plastic waste yearly.[83] Marine life can suffer from "lacerations, infections, reduced ability to swim, and internal injuries" that inhibit their full potential or reproductive capabilities.[84] This can lead to the endangerment of entire species, as it has with sea turtles, toothed whales, and various crabs. Floating plastics also spread invasive organisms and bacteria that make their way into ecosystems. Plastic encourages pathogen growth in oceans by providing a surface for microbes to colonize and thrive on.[85] A research study found that corals exposed to plastic have an 89 percent chance of developing a disease compared to just 4 percent for corals that have not been exposed.[86]

In the last 20 years, an especially harmful type of plastic known as microplastics has caused massive environmental problems. Microplastics are minuscule plastic particles less than five millimeters in diameter, which are so tiny that it is

75 "Marine Plastic Pollution," *Ocean Unite*, accessed June 13, 2020, https://www.oceanunite.org/issues/marine-plastic-pollution-2/.
76 "Our Planet is Drowning in Plastic Pollution."
77 Kirstin Linnenkoper, "Ranking the Biggest Waste Producers Worldwide," *Recycling International*, October 2, 2019, https://recyclinginternational.com/business/ranking-the-biggest-waste-producers-worldwide/27792/.
78 Linnenkoper, "Ranking the Biggest Waste Producers Worldwide."
79 "Microplastics, Microbeads and Single-use Plastics Poisoning Sea Life and Affecting Humans."
80 "Marine Plastics," *International Union for Conservation of Nature*, accessed June 13, 2020, https://www.iucn.org/resources/issues-briefs/marine-plastics.
81 Simon Reddy, "Plastic Pollution Affects Sea Life Throughout the Ocean," *The Pew Charitable Trusts*, September 24, 2018, https://www.pewtrusts.org/en/research-and-analysis/articles/2018/09/24/plastic-pollution-affects-sea-life-throughout-the-ocean.
82 Reddy, "Plastic Pollution Affects Sea Life Throughout the Ocean."
83 "Marine and Ocean Pollution: Statistics and Facts 2020."
84 "Marine Plastics."
85 Rosanne Skirble, "Bacteria Thrive on Ocean Plastic Debris," *Voice of America News*, July 2, 2013, https://www.voanews.com/silicon-valley-technology/bacteria-thrive-ocean-plastic-debris.
86 Reddy, "Plastic Pollution Affects Sea Life Throughout the Ocean."

The remnants of a dead albatross chick, found in the Midway Atoll National Wildlife Refuge in the Pacific in September 2009, include large amounts of plastic waste.

difficult to identify their presence and the true extent of its impact on marine life.[87] They are found in everyday personal care products, such as toothpaste and face scrubs, and synthetic textiles. Industrially, they are used in plastic resin pellets and microbeads for the production of larger products.[88] Regular plastics that are already in the oceans can also disintegrate and become microplastics as time goes on. Microplastics can travel very far in bodies of water because they remain out of sight and easily flow with the currents. Current technologies are not yet advanced enough to identify and remove them.[89] When aquatic creatures unknowingly ingest microplastics, they can face blocked digestive tracts, reduced urges to eat, altered feeding behaviors, and starvation.[90] Microplastics can also absorb POPs into their surfaces and alter the chemical makeup of water. These chemicals can leach out and into animals' bodies when ingested. The novel problem of microplastics and their ubiquity in marine ecosystems does not have an obvious solution, requiring innovation to resolve.

In February 2017, the UNEP began the global Clean Seas Campaign to tackle single-use plastics and microbeads and bring attention to the popularity of microplastics in everyday personal care products.[91] The five-year campaign aims to target some root causes of marine plastic pollution, particularly plastic usage in personal care products and the cosmetic industry, and address the consumption of these products. Aside from this campaign, 25 African countries have adopted a complete ban on the production and use of plastic bags, making Africa the leading continent to reduce plastic waste.[92] In addition to limiting plastic use, it is important to improve waste management systems for plastics. Only nine percent of all plastic waste ever produced has been recycled, creating a dire need for improved waste recycling methods and infrastructure.[93] The enormity of the plastic pollution epidemic calls for multifaceted approaches by the global community.

Rising Carbon Emissions

In 2019, the second warmest year on record, the amount of carbon dioxide (CO_2) and other greenhouse gases emitted into the atmosphere from the burning of fossil fuels surpassed 2018's record of 33.1 billion tons to reach a new record of 36.8 billion tons.[94] This is almost a 50 percent increase in global emissions since 1990.[95] As humans continue to burn fossil fuels, climate change is altering weather patterns, intensifying natural disasters, and causing widespread displacement of people and animals. The increasing global temperature warms oceans and melts ice caps, causing a greater quantity of water as well as expansion of the existing ocean water.

Of the CO_2 released into the atmosphere, about 30 percent of it is absorbed by the ocean.[96] Seawater and CO_2 naturally combine to form carbonic acid, which breaks down into hydrogen

87 "Microplastics," *United Nations Environment Programme,* accessed June 13, 2020, https://wedocs.unep.org/bitstream/handle/20.500.11822/12079/brochure-microplastics.pdf?sequence=1&amp%3BisAllowed=.
88 "Microplastics," 5.
89 "Microplastics," 4.
90 Elizabeth Royte, "We Know Plastic is Harming Marine Life. What About Us?," *National Geographic*, June 2018, https://www.nationalgeographic.com/magazine/2018/06/plastic-planet-health-pollution-waste-microplastics/.
91 "Microplastics, Microbeads and Single-use Plastics Poisoning Sea Life and Affecting Humans."
92 "Our Planet is Drowning in Plastic Pollution."
93 "Our Planet is Drowning in Plastic Pollution."
94 Deborah Netburn, "Q&A: Carbon Emissions Will Reach Record High in 2019, Thanks to the Burning of Fossil Fuels," *Los Angeles Times*, December 3, 2019, https://www.latimes.com/environment/story/2019-12-03/carbon-dioxide-emissions-fossil-fuels-record-high-2019.
95 "Goal 13: Take Urgent Action to Combat Climate Change and its Impacts," *United Nations Sustainable Development Goals*, accessed June 13, 2020, https://www.un.org/sustainabledevelopment/climate-change/.
96 "Ocean Acidification," *US National Oceanic and Atmospheric Administration,* last modified April 2020, https://www.noaa.gov/education/resource-collections/ocean-coasts/ocean-acidification.

ions, lowering the pH of the water.[97] This, in turn, leads to greater ocean acidification because the excess concentration of hydrogen ions translates to an approximately 30 percent increase in acidity of the water.[98] Ocean acidification is usually accompanied by eutrophication, which ultimately results in large dead zones. Dead zones are areas with low levels of oxygen, causing most marine life to either die or leave the area.[99] These cause large parts of oceans and other waterways to become underwater deserts that are costly to revive (if revival is even possible). Roughly 500 marine locations worldwide are now recorded as dead zones, adding up to the size of the United Kingdom's surface (245,000 square kilometers).[100] The largest dead zone spans over 163,169 square kilometers (roughly the size of Florida) in the Arabian Sea, followed by one in the Gulf of Mexico that is over 18,005 square kilometers.[101] The Gulf of Mexico dead zone is caused primarily by runoff from industrial and agricultural activity alongside the Mississippi River. However, the Arabian Sea dead zone is due to the international community's overall actions that cause climate change. Political instability in the region and the threat of piracy has hindered and delayed extensive study of the dead zone.[102] The dead zone is believed to be intensified by the warming of the Arabian Gulf, as warmer waters near the sea surface hamper the retention and circulation of oxygen.[103]

These changes in oceanic circulation and chemistry caused by acidification prove deadly to marine ecosystems. Many organisms, such as oysters and sea snails, build their hard shells by combining calcium and carbonate ions that occur naturally in seawater.[104] However, acidification damages the balances of these chemical constituents, essentially stealing them from organisms that need them to make and maintain their shells.[105] The shell-builders may even begin to see their shells dissolve as a result. In the Southern Ocean, which surrounds Antarctica, scientists observed ragged, dissolving shell ridges, severe abrasions, and clouded shells among pteropods, which are small sea snails.[106] Shell dissolution leaves animals vulnerable to attack since shells are essential to camouflage, hiding, and overall protection from predators. Many seaweeds also build calcium carbonate skeletons and suffer from the same consequences as shell-building creatures.[107] Fish also face the effects of acidification. It changes the acidity of their blood and requires them to expend more energy to excrete the excess acid out of their blood through their gills, kidneys, and intestines.[108] This slows their growth, alters their brain chemistry, and reduces their life expectancy.[109]

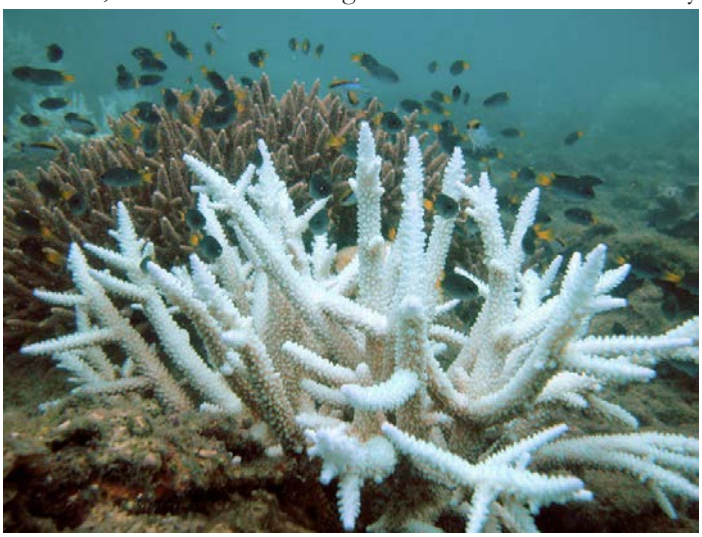
Acidification and its effects are especially noteworthy in the Arctic Ocean, with "a rapidly changing marine carbonate system."[110] The acidic water in the Arctic Ocean mixes with waters from the North Atlantic and Pacific oceans, creating an environment that destroys organic matter and reaches faraway ecosystems. This can have a shattering impact on entire food chains by changing interactions between species and the availability of certain nutrients for predators. In the Arctic, changes to low-level mollusks can have a far-reaching, amplified, but the direct effect on high-level predators like Pacific walruses or bearded seals.[111] Acidification in this region also has social and economic implications since fisheries are a valuable source of income and tradition. Many of the or-

97 "Ocean Acidification."
98 "Ocean Acidification."
99 Erik Solheim, "Bringing the World's Dead Zones Back to Life," *United Nations Environment Programme*, January 9, 2018, https://www.unenvironment.org/news-and-stories/story/erik-solheim-bringing-worlds-dead-zones-back-life.
100 "Marine and Ocean Pollution: Statistics and Facts 2020."
101 Tristan Baurick, "World's Largest 'dead zone' Discovered, and It's Not in the Gulf of Mexico," *The Times-Picayune,* May 11, 2018, https://gulfhypoxia.net/worlds-largest-dead-zone-discovered-and-its-not-in-the-gulf-of-mexico/.
102 Mindy Weisberger, "Massive 'Dead Zone' in the Arabian Sea Is the Biggest in the World," *LiveScience*, May 5, 2018, https://www.livescience.com/62489-dead-zone-arabian-sea.html.
103 Weisberger, "Massive 'Dead Zone' in the Arabian Sea Is the Biggest in the World."
104 "Ocean Acidification."
105 "Ocean Acidification."
106 "Ocean Acidification."
107 Jennifer Bennett, "Ocean Acidification," *Smithsonian*, accessed June 14, 2020, https://ocean.si.edu/ocean-life/invertebrates/ocean-acidification.
108 Bennett, "Ocean Acidification."
109 Bennett, "Ocean Acidification."
110 "Arctic Ocean Acidification," *US National Park Service*, last modified July 30, 2019, https://www.nps.gov/articles/oceanacidification.htm.
111 "Arctic Ocean Acidification."

ganisms that are affected by acidification are also important to this industry. Studies have shown that the southern region of Alaska faces a great risk with acidification because it relies on species at risk of endangerment.[112] Rural areas that depend on seafood for employment and survival are extremely vulnerable to these threats from environmental change. The International Alliance to Combat Ocean Acidification, an organization made up of several states from the United States and the Canadian province of British Columbia, was formed in 2008 to advance global efforts to confront ocean acidification.[113] The organization does grassroots work like engaging policymakers, scientists, and the public on the growing threat and securing sustained funding, nationally and regionally, for coordinated research on ocean acidification. It addresses both the environmental and economic impacts of ocean acidification to aid regions like southern Alaska and many more.

Acidification is not the only issue that rising carbon emissions bring to marine life. Some of the heat that would otherwise be lost to space is absorbed by CO_2 and returned to Earth, causing warming. Temperature changes in our oceans cause the sea level to rise, disrupting and displacing marine ecosystems. An underwater community is structured around the sea level, and a change in sea level can uproot that entire arrangement. Underwater habitats used for breeding, laying eggs, and rearing young are threatened by rapid sea-level change.[114] When these breeding grounds are no longer usable, marine species move in masses to search for favorable environmental conditions and interrupt the existing system. Moreover, the sea level rise is produced by the melting of continental ice as the air warms. The melting of ice caps removes boundaries for marine life and opens up outside ecosystems for them. This may seem beneficial to their growth and expansion. However, without glacier boundaries, marine animals can be exposed to pathogens and diseases that their internal systems are not suited to battle.[115] The animals do not have the antibodies to survive in the areas outside of their original ice boundaries.

Carbon emission pollution clearly affects all ecosystems, and one type that is especially burdened is coral reefs. The coral reef is a particularly unique type of ecosystem because it is not only a species in itself, but is also an ecological community for over a million species globally. UNEP estimates that climate change has destroyed approximately 25–50 percent of the world's coral reefs and that an additional 60 percent are considered to be threatened.[116] Acidification limits coral growth by corroding their skeletons and dissolving their thinner branches.[117] This breaks down their structural integrity and ability to grow and reproduce. Similarly, the harsher and more frequent storm patterns caused by climate change can also destroy the coral reef structure. The warming ocean introduces thermal stress and disease to the reefs and results in coral bleaching, which is the loss of their algae and subsequent loss of pigment.[118] For example, The Great Barrier Reef, the world's largest coral reef located off the coast of Australia, faced mass bleaching due to heat stress in February



The stark contrast between bleached branching coral (foreground) and healthy coral (background) can be seen in the Keppel Islands of the Great Barrier Reef.

112 "Arctic Ocean Acidification."
113 "Background," *International Alliance to Combat Ocean Acidification*, accessed June 14, 2020, https://www.oaalliance.org/background/.
114 "Sea Level Rise," *Marine Conservation Institute*, accessed June 14, 2020, https://marine-conservation.org/what-we-do/program-areas/climate-change/sea-level-rise/.
115 Rachel Crowell, "Will Melting Sea Ice Expose Marine Animals to New Diseases?," *American Geophysical Union*, December 16, 2019, https://eos.org/articles/will-melting-sea-ice-expose-marine-animals-to-new-diseases.
116 "Coral Reefs," *United Nations Environment Programme*, accessed June 14, 2020, https://www.unenvironment.org/explore-topics/oceans-seas/what-we-do/working-regional-seas/coral-reefs.
117 Bennett, "Ocean Acidification."
118 "How Does Climate Change Affect Coral Reefs?," *US National Oceanic and Atmospheric Administration,* last modified November 13, 2019, https://oceanservice.noaa.gov/facts/coralreef-climate.html.

2020, which was the hottest February on record since 1900.[119] This was its third large-scale bleaching in the past five years.[120]

Additionally, sea level rise can shift sediment around and also bring in runoff that causes eutrophication and suffocates the coral.[121] Coral reefs and their devastation impact many marine species, as they house 25 percent of all known marine life.[122] Coral reefs are just one of the many marine ecosystems that are being destroyed by rising carbon emissions. They are reflective of the global biodiversity that is being threatened by climate change.

Maritime Transportation

The transportation of goods across the seas is vital to the global economy. Today, 90 percent of international trade is transported by ship.[123] The Asia to North America trade route alone transported 26.57 million twenty-foot equivalent units (the standard shipping container unit, TEU) in 2017.[124] Marine vessels drive global interactions, moving over "10 billion tons of containers, solid, and liquid bulk cargo across the world's seas annually."[125] Countries with trade routes across warmer waters can utilize maritime transport year-round, whereas those with waters that frost in the winter engage with the active countries during their off-season.[126] This keeps maritime trade uninterrupted and utilizes the cheapest medium of transport. Many different countries utilize the Asia to North America route year-round for imports and exports. Maritime transport is also used to move people and promote tourism. Passengers use ships to travel for business, leisure, and more. In 2018, cruise ships serviced about 28.5 million passengers traveling all around the world.[127] The maritime transport industry provides employment opportunities, benefits economies greatly, and plays a pivotal role in creating international ties. However, the environmental implications of shipping pollution are harsh for marine life.

Ships generate three percent of the world's total greenhouse gas emissions, which contributes directly to acidification.[128] Gases emitted by ships can include carbon dioxide, sulfur dioxide, and nitrogen oxides. These greenhouse gases contribute to an increase in violent storm patterns that can destroy marine ecosystems. To reduce their emissions, ships can utilize different fuel formulations. For example, biofuels made from vegetables or cellulose, capable of reducing sulfur oxide, particulate matter, and greenhouse gas emissions, although limited, are "compatible with current fleet operations."[129] In May 2019, the IMO agreed to consider slow-steaming to "accelerate energy efficiency requirements for new container and cruise ships."[130] Slow-steaming is the operation of cargo ships at a significantly slower speed than they can travel at to maximize fuel efficiency. The International Council on Clean Transportation (ICCT) stated that between 2022 and 2050, this process could cut two percent of all CO_2 emissions.[131] This may not seem like a large improvement, but emissions rise by about two percent every year, and slow-steaming, paired with other reforms on marine transportation, could greatly reduce much of the harm the industry creates and grant more time to mitigating the climate crisis. Marine vessels also use or carry oil,

119 "Third Large-Scale Bleaching in Five Years," *Great Barrier Reef Foundation*, March 26, 2020, https://www.barrierreef.org/news/news/Third-large-scale-bleaching-in-five-years.
120 "Third Large-Scale Bleaching in Five Years."
121 "How Does Climate Change Affect Coral Reefs?"
122 "Marine and Ocean Pollution: Statistics and Facts 2020."
123 "Marine and Ocean Pollution: Statistics and Facts 2020."
124 Andrea van der Biest, "Main Shipping Trade Routes Across the World," *CargoFive*, May 7, 2019, https://cargofive.com/main-shipping-trade-routes-across-the-world/.
125 Tony R. Walker et al. "Environmental Effects of Marine Transportation," *World Seas: An Environmental Evaluation* 3, (2019): 505, doi: doi.org/10.1016/B978-0-12-805052-1.00030-9.
126 "What Is the Importance of Maritime Transport?," *Founder's Guide*, August 14, 2019, http://foundersguide.com/importance-of-maritime-transport/.
127 Jean-Paul Rodrigue, *The Geography of Transport Systems: Fifth Edition,* (New York: Routledge, 2020), https://transportgeography.org/?page_id=1762.
128 "2019 Review of Maritime Transport," *United Nations Conference on Trade and Development,* accessed June 15, 2020, https://unctad.org/en/PublicationsLibrary/rmt2019_en.pdf.
129 James C. Kruse, Lena M. DeSantis, Scott J. Eaton, and Richard Billings, "Marine Transportation and the Environment," *Transportation Research News* 313, (2018): 14, http://onlinepubs.trb.org/onlinepubs/trnews/trnews313.pdf.
130 Anjli Raval, Josh Spero and Chris Campbell, "Pollution: The Race to Clean Up the Shipping Industry," *Financial Times*, May 30, 2019, https://www.ft.com/content/642b6b62-70ab-11e9-bf5c-6eeb837566c5.
131 Raval, Spero, and Campbell, "Pollution: The Race to Clean Up the Shipping Industry."

Ballast water is pumped out of a ship at a port, releasing all the organisms in that water, potentially including plankton, fish, larvae invertebrates, and pathogens.

which is responsible for many detrimental effects on marine life. The use or consumption of oil by ships, including operational discharges, makes up 37 percent of the total amount of oil released into the sea every year.[132] Accidental spills from ships account for an additional 12 percent of the oil in oceans.[133] Aside from oil, ships release many chemicals into the ocean when they travel. Many ships use antifouling paints on their exterior surfaces, which release poisonous chemicals to prevent the accumulation of microorganisms and plants on the bottom of the vessel.[134] However, when these chemicals, called biocides, do not degrade after their release, they remain toxic and dangerous to marine life. Antifouling is necessary for the longevity of ships, but it is important to find methods that do not release destructive biocides such as mercury and arsenic into underwater environments.[135]

Since marine vessels are essential to international trade, they often carry massive amounts of cargo at a time. In January 2019, "general cargo ships had a combined capacity of around 116 million tons deadweight" and accounted for the majority of merchant ships.[136] This cargo can cause adverse effects on marine life, as it has been estimated that 50 percent of global ship cargo is considered dangerous to the environment.[137] Cargo released from ships brings foreign objects into marine ecosystems, posing similar risks to those of plastic. Items like toys and electronics bring chemicals into organisms' bodies, increase the risk of entanglement, and move species away from their comfortable environment. Items released by vessels can also include anchors, which cause major physical damage to any creatures they strike or plants they uproot. Given these points, ships bring an amalgamation of foreign objects and waste into oceans since they are the primary instrument for ocean dumping.

132 "How Does Oil Get into the Ocean?," *US National Oceanic and Atmospheric Administration,* last modified April 15, 2019, https://response.restoration.noaa.gov/about/media/how-does-oil-get-ocean.html.
133 "How Does Oil Get into the Ocean?"
134 J.A. Lewis, "Advances in Marine Antifouling Coatings and Technologies," *Woodhead Publishing Series in Metals and Surface Engineering,* (2009): 709, doi: doi.org/10.1533/9781845696313.4.709.
135 Lewis, "Advances in Marine Antifouling Coatings and Technologies," 709.
136 "2019 Review of Maritime Transport," 6.
137 "Marine and Ocean Pollution: Statistics and Facts 2020."

When ships travel long distances, they require mechanisms that maintain their stability for the duration of the voyage. Water is often used as a ballast, or vessel stabilizer, to ensure safe operating conditions. When a ship uses fuel from its tanks during operation, its weight fluctuates. The ballast operation helps to compensate for this weight loss. While ballast water keeps the ship steady when it is at sea, it is often filled with various sediments and an assortment of marine life. An estimated 3,000 different marine species are transported around the world within 12 billion tons of ballast waters.[138] When untreated ballast waters are discharged from ships, invasive species can enter delicate marine ecosystems and uproot them. These species can include bacteria, microbes, invertebrates, eggs, cysts, and larvae that reproduce, compete with, and overtake native species.[139]

The International Convention for the Control and Management of Ships' Ballast Water and Sediments, made by the IMO, entered into force in September 2017, and aims to prevent the introduction of invasive species from ballast waters into existing marine ecosystems, especially through the implementation of treatment systems for ballast waters.[140] There is still an urgent need for more stringent ballast water regulations as international trade and traffic continue to boom. The spreading of invasive species is acknowledged now to be a severe threat to ecology and the economy due to the enormous damage it does to biodiversity.[141]

An often-overlooked form of damage that comes from maritime transportation is noise pollution. Sound travels very quickly and for very long distances underwater, and marine animals are very sensitive to it because they use sound for much of their communication in the darkness of the ocean. Sonar used by submarines, passing commercial vessels, seismic surveys for oil exploration, and even leisurely jet skiing are a few examples of the many sources of noise pollution that have a much larger impact on marine life than it may seem.[142] Following World War II, the noise levels in the Pacific Ocean averaged around 10 decibels, which was 10 times what it had been 20 years earlier.[143] This resulted in species losing their ability to communicate due to hearing loss—in other words, species such as whales had to "speak louder."[144] Marine animals rely heavily on their sound communication for mating, hunting, and sharing vital information. Furthermore, these loud sounds can cause intense physical pain for animals. Hemorrhages, damage to internal organs, and intense panic are common responses to human-made noises.[145] For instance, in regions where sonar exercises are common like Greece, Hawaii, Madeira, Spain, and the coastal US, whales often beach themselves soon after a tactical sonar exercise.[146] The introduction of foreign noise can devastate marine organisms and ecosystems and have potentially fatal results.

Human Health Impact

It is important to acknowledge that the effects of ocean pollution extend much further than just marine life. Many of the impacts faced by marine life result in dangerous consequences for human health as well. In December 2017, the UNEA addressed this relationship between the environment and human health in UNEP/EA.3/Res.4. The resolution affirms the "strong interlinkages between environment and health," acknowledging the harmful health impacts of pollution.[147] Recognizing and generating awareness for the human health concerns raised by our destructive actions toward marine life can be a valuable way to push to reduce ocean pollution and protect sea life. Biomagnification extends past the animal food chain—humans fill oceans with plastics, metals, and chemicals

138 "Marine and Ocean Pollution: Statistics and Facts 2020."
139 "Ballast Water Management," *International Maritime Organization*, accessed June 16, 2020, http://www.imo.org/en/OurWork/Environment/BallastWaterManagement/Pages/Default.aspx.
140 "2019 Review of Maritime Transport," 70.
141 "Ballast Water Management."
142 Smita Singla, "Effects of Noise Pollution from Ships on Marine Life," *Marine Insight*, last modified December 9, 2019, https://www.marineinsight.com/environment/effects-of-noise-pollution-from-ships-on-marine-life/.
143 Les Blomberg, "Noise Pollution in the 21st Century," *Explore Sound*, accessed June 16, 2020, https://exploresound.org/2017/02/noise-pollution-21st-century/.
144 Singla, "Effects of Noise Pollution from Ships on Marine Life."
145 Singla, "Effects of Noise Pollution from Ships on Marine Life."
146 Singla, "Effects of Noise Pollution from Ships on Marine Life."
147 UNEP/EA.3/Res.4, "Environment and Health," *United Nations Environment Assembly*, January 30, 2018, http://wedocs.unep.org/bitstream/handle/20.500.11822/31019/k1800154.english.pdf?sequence=3&isAllowed=y.

that then come back to harm us in the form of contaminated food.

Seafood makes up a significant portion of the diet of people all over the world. According to the UNEP, the estimated worth of global seafood trade is around USD 140 billion."[148] Given how substantial the seafood industry is, the waste that sea creatures consume endangers human health. Plastic is particularly threatening in that it has started to be present in our food. Plastic ingestion can have adverse health effects on humans, causing congenital disabilities, impaired immunity, cancer, endocrine disruption, and developmental or reproductive issues.[149] It contains various toxins, such as diethylhexyl phthalate (DEHP), a carcinogen that has long-term effects on the human body.[150] Microplastics, in particular, enter the human body directly via many sources, especially water. A study conducted by the World Wide Fund for Nature found that in one week, "the average person consumes 2,000 tiny plastic particles and fibers, 1,769 of which come from drinking water alone."[151] This is equivalent to roughly five grams of plastic a week--the average weight of a credit card.[152] This unexpected intake of microplastics can affect the lungs, liver, brain cells, fertility, and sexual function. The amount of microplastics present in water varies geographically. Studies show that 98 percent of tap water in Lebanon contains plastic fibers, with the United States in a close second at 94.4 percent.[153]

Industrial chemicals, oil, fertilizers, sewage, and radioactive waste can also be detrimental to human health through contaminated food and water. For example, mercury emissions from factories are brought directly into oceans through precipitation. The mercury is absorbed by plants, which are consumed by small fish. This allows the mercury to move up through the food chain and ultimately onto dinner plates, where humans then ingest highly concentrated amounts of the toxic metal through biomagnification. Ingesting mercury can cause Parkinson's disease, Alzheimer's disease, heart disease, and lethal effects on organs.[154] People at the most risk from the effects of consuming contaminated seafood or water are typically those already vulnerable to health issues, such as pregnant women and young children.[155] The effects they face can include reproductive issues, hormonal problems, kidney damage, and nervous system breakdown.[156] Also, the excess nutrients in the water may seem beneficial to human health, but too many nutrients can have adverse effects. For example, high nitrate levels in drinking water can cause blue baby syndrome, which affects the infant body's ability to transport oxygen.[157] Additionally, some populations are especially defenseless against chemically contaminated foods because seafood is a primary part of their diets. For example, the marine-sourced food of the indigenous people of the Canadian Arctic and Greenland is often contaminated by POPs.[158] These populations are already exposed to the effects of pollution through rising ocean levels and harsh weather patterns to begin with, and having contaminated food without any technology to know if it has a poor nutritional quality or contamination level is an avoidable issue.

Even without ingesting them, contaminated sources can harm human health. The same tourists that consume large quantities of the single-use plastics that threaten underwater life also face the repercussions of their actions through exposure

148 "Supporting a Shift to More Sustainable Fishing," *United Nations Environment Programme*, February 19, 2018, https://www.unenvironment.org/news-and-stories/story/supporting-shift-more-sustainable-fishing.
149 Neeti Rustagi, S.K. Pradhan, and Ritesh Singh, "Public Health Impact of Plastics: An Overview," *Indian Journal of Occupational and Environmental Medicine*, (2011): 100, doi: 10.4103/0019-5278.93198.
150 Gianna Andrews, "Plastics in the Ocean Affecting Human Health," *Carleton College Science and Research Center*, last modified January 13, 2020, https://serc.carleton.edu/NAGTWorkshops/health/case_studies/plastics.html.
151 Justin Rohrlich, "Here's How You Eat a Credit Card's Worth of Plastic Each Week," *Quartz*, June 15, 2019, https://qz.com/1644802/you-eat-5-grams-of-plastic-per-week/.
152 Rohrlich, "Here's How You Eat a Credit Card's Worth of Plastic Each Week."
153 Rohrlich, "Here's How You Eat a Credit Card's Worth of Plastic Each Week."
154 Andrew Dilevics, "How Ocean Pollution Affects Humans," *Planet Aid* (blog), March 24, 2016, https://www.planetaid.org/blog/how-ocean-pollution-affects-humans.
155 Joanna Burger, "Ocean Dumping," *Encyclopedia of Public Health*, June 8, 2020, https://www.encyclopedia.com/earth-and-environment/geology-and-oceanography/geology-and-oceanography/ocean-dumping.
156 Brucker, "Ocean Pollution Facts, Stats, and Solutions."
157 "The United Nations World Water Development Report 2017- Wastewater: The Untapped Resource," *United Nations Educational, Scientific and Cultural Organization*, 2017, https://www.unido.org/sites/default/files/2017-03/UN_World_Water_Development_Report_-_Full_0.pdf.
158 "Marine and Ocean Pollution: Statistics and Facts 2020."

to hazardous or toxic materials that end up washed up on beaches. Physical contact with polluted water on beaches can cause severe rashes and other skin conditions.[159] Contact or inhalation of radioactive waste can also have malignant aftermath, including central nervous system damage, a raised risk of cancer, and death.[160] Untreated human waste in oceans is also invisible to the naked eye but causes unpleasant sickness when encountered. In the United States, over three million people get sick after touching water they thought was safe.[161] Contaminated water can spread disease in a multitude of ways. Ocean pollution can also bring in organisms or insects that carry disease. Plastic can travel great distances when carried by waterways or oceans and provides breeding grounds for disease-spreading pests. For example, plastic bags that clog sewers are suitable for mosquitoes which breed in stagnant water and can increase the transmission of malaria and other diseases[162]

Marine life has more benefits to human life than just providing food—it can be used to treat human ailments as well. As scientists make notable achievements in science, the potential for discovery is constantly evolving. The loss of marine biodiversity can affect the human race's chances of survival in the long-run. For example, sea sponges have been found to contain chemical compounds that can lead to medical innovations in cancer research.[163] Horseshoe crabs' blood is used to detect toxin-producing bacteria in things that are used in the human body, such as heart valves, needles, and drugs.[164] The species is endangered in many regions of the world, and if we continue to pollute our oceans, its benefits may never be explored fully. In Asia, traditional medicine frequently uses marine animals to "prepare powders, ointments and decoctions for many ailments."[165] While the over-harvesting of marine animals can drive them to extinction, utilizing them in moderation can potentially contribute to cures for the worst diseases faced by humankind. There are at least 18,000 products derived from 4,800 different marine species on the list of "chemotherapy agents, antibiotics, anti-virals, anesthetics, adhesives, marine genetic products (MGPs) and others being used or developed to treat cancer, leukemia, cystic fibrosis, heart disease, wounds and infections."[166] Marine pollution is rapidly killing the creatures that can save human lives.

Current Status

Recently Suggested Solutions

In recent years, various solutions have been proposed to mitigate the effects of various types of pollution on marine life. However, ocean dumping is one area where the overall worldwide regulation is far too low. The main notable international treaty is the London Convention, which has since become outdated and needs revitalization with current research. There is also the UNEP-sponsored Basel Convention, which focuses on "controlling transboundary movements of hazardous wastes and their disposal" and has the primary objectives of reducing the generation of hazardous waste, promoting environmentally sound management and disposal of hazardous waste when created, restricting the transportation of hazardous waste in oceans, and regulating this movement when permissible.[167] It was originally adopted in March 1989 but continues to be reviewed every two years to develop a "work programme" that improves up-to-date implementation and compliance under the convention.[168] The 2020-2021 work programme of the convention seeks to improve national reporting of countries' compliance with the regulations, prevent illegal maritime traffic with hazardous waste, push countries

159 Dilevics, "How Ocean Pollution Affects Humans."
160 "Ocean Pollution."
161 "How Sewage Pollution Ends Up In Rivers," *American Rivers*, accessed June 17, 2020, https://www.americanrivers.org/threats-solutions/clean-water/sewage-pollution/.
162 "Our Planet is Drowning in Plastic Pollution."
163 "Ocean Pollution."
164 Steve Katona, "Marine Animals in Human Medicine: Will a Sponge Save Your Life?," *Ocean Health Index*, January 22, 2015, http://www.oceanhealthindex.org/news/Marine_Animals_Human_Medicine.
165 Katona, "Marine Animals in Human Medicine: Will a Sponge Save Your Life?"
166 Katona, "Marine Animals in Human Medicine: Will a Sponge Save Your Life?"
167 "Overview," *United Nations Environment Programme- Basel Convention*, accessed July 2, 2020, http://www.basel.int/TheConvention/Overview/tabid/1271/Default.aspx.
168 "Work Programme (2020–2021)," *United Nations Environment Programme- Basel Convention*, accessed July 2, 2020, http://www.basel.int/Implementation/LegalMatters/Compliance/WorkProgramme/20202021/tabid/8023/Default.aspx.

to review their own national legislation on hazardous waste control, and encourage countries to find ways to further improve the implementation of the convention.[169]

While international legislation may not be meeting the necessary provisions, countries such as the Philippines are managing intentional and unintentional dumping in bodies of water. The Philippines' Boracay Island, for example, is a tourist hotspot where mismanaged drainage systems allowed raw sewage to leak into its clean waters. Because of this, in April 2018, President Duterte closed the island for six months to upgrade its wastewater treatment system and reopened with limited tourists.[170] Such an action had large implications regarding the loss of revenue generated from tourism but was a necessary improvement to prevent sewage from entering waters. In early 2019, the Philippines also began a comprehensive clean-up plan to connect all homes in the Manila Bay, one of the most polluted waters in the world, which included connecting all homes to sewage treatment plants over the next 20 years.[171] Governance that protects marine ecosystems has also been seen in South Korea, where new maritime spatial planning and management legislation took effect in April 2019.[172] This emphasizes sustainable marine development in industrial areas, preventing land runoff and consequently, dead zones. It also establishes a database that evaluates ecosystems in certain areas before determining if they can be used for any activity.[173]

Implementation of such systems across the world can hold countries accountable for checking the condition of marine space and conserving aquatic life. Abolishing the use of oceans for any activity, whether it be dumping, transport, or anything else, is unrealistic because of how integral they are to human activity, but spatially mapping and tracking which areas are better for use can be vital to protecting marine ecosystems. It is also important to have coastal governance that will protect ecosystems that may be extra vulnerable to ocean acidification. Mexico, for example, is one of the few countries under the Paris Climate Agreement that mentions "blue carbon" in its carbon reduction plans.[174] Blue carbon is the atmospheric CO_2 that is absorbed by ocean ecosystems, and Mexico is one of the main countries harboring ecosystems that take in lots of blue carbon. Blue carbon ecosystems are often brackish marshes, mangroves, and seagrasses capable of absorbing four times the atmospheric carbon than mature tropical forests.[175] In October 2018, the Mexican government held a conference to build a protocol that standardizes the information collected on blue carbon ecosystems and monitors these valuable areas.[176] The initiative has been supported by various projects that work with local communities to restore mangroves across the coastal regions of Mexico. The most documented project, led by the Global Mangrove Alliance, is currently still in phase one: "remote sensing assessment of the wetland to better understand the state of the mangroves and restoration options available."[177] The results from this assessment, paired with existing data about mangrove restoration, will help the country to have a better understanding of the blue carbon stocks in its water.[178]

Land-based activities that directly infiltrate oceans, such as chemical runoff or plastic pollution, were addressed by the UNEA in March 2019 in UNEP/EA.4/Res.11. This resolution encourages the mainstreaming of policies that protect marine ecosystems from environmental threats like increased nutrients, wastewater, marine litter, and microplastics and improved coordination among countries with these efforts.[179] It

169 "Work Programme (2020–2021)."
170 "Economist Intelligence Unit Reveals Leaders and Laggards on Coastal Governance," *World Ocean Initiative*, October 14, 2019, https://www.woi.economist.com/coastal-governance-index-2019/.
171 "Economist Intelligence Unit Reveals Leaders and Laggards on Coastal Governance."
172 "Publishing the 1st Master Plan on Marine Spatial Management for 2019-2028," *Korean Ministry of Oceans and Fisheries*, August 8, 2019, http://www.mof.go.kr/eng/article/view.do?articleKey=26976&boardKey=42&menuKey=486.
173 "Publishing the 1st Master Plan on Marine Spatial Management for 2019-2028."
174 "Economist Intelligence Unit Reveals Leaders and Laggards on Coastal Governance."
175 Damien Escalante, "New Information Shows Mexico's Blue Carbon Ecosystems to be in Danger," *Climate Scorecard*, November 28, 2018, https://www.climatescorecard.org/2018/11/new-information-shows-mexicos-blue-carbon-ecosystems-to-be-in-danger/.
176 Escalante, "New Information Shows Mexico's Blue Carbon Ecosystems to be in Danger."
177 "Mexico Blue Carbon: Restoring Mangroves in Marismas Nacionales," *Global Mangrove Alliance*, accessed July 18, 2020, http://www.mangrovealliance.org/mexico-blue-carbon/.
178 "Mexico Blue Carbon: Restoring Mangroves in Marismas Nacionales."
179 UNEP/EA.4/Res.11, "Protection of the Marine Environment From Land-Based Activities," *United Nations Environment Assembly*, March 28, 2019, http://wedocs.unep.org/bitstream/handle/20.500.11822/28340/K1901091%20-%20UNEP-EA-4-Res-6%20-%20Ad-

revolves around enhancing knowledge-sharing and information exchange between governmental institutions and non-governmental organizations (NGOs). While this resolution was essential to bringing more attention to land-based activities' effects on ocean ecosystems, it provides mostly recommendations. It leaves the implementation of specific policies to the individual countries.

Still, according to the UNEA Global Chemicals Outlook II of 2019, governments are regulating chemicals, leading companies are sustainably managing chemical innovations, and researchers are further analyzing life cycles of chemicals and their risks to marine life.[180] Many countries are shifting toward sourcing protein from farms that are committed to sustainable agriculture. France is the leading country for organic farming, which does not use toxic and hazardous chemical pesticides and synthetic fertilizer. From 2018-2019, France added 5,000 organic farms, bringing organic farms to comprise 9.5 percent of all French farms.[181] The government has set a target for 15 percent of all French farms to be organic by 2022.[182] This can greatly reduce and eliminate agricultural runoff into bodies of water and push for effective waste management through the use of animal waste for fertilizer. Additionally, Spain and other countries are developing systems to reduce oil presence in oceans. Spanish researchers are developing a system of buoys that use sensor technology to monitor coastal areas and detect if oil enters the water, notifying them if so.[183] This rapid detection can initiate an instant response that cleans the water before oil can harm ecosystems. This invention is inexpensive and can allow researchers to map oil spills in real-time and target cleanup measures quickly.[184] Technological solutions like this will be instrumental in tackling future chemical contamination in marine environments.

In March 2019, the UNEA also directly addressed plastic pollution in UNEA/EA.4/Res.6. This resolution focuses specifically on tackling marine plastic litter and microplastics to avoid detriment to marine ecosystems. It calls upon member states and other local, national, and international actors to strengthen scientific knowledge of marine litter, foster innovation to reduce microplastics, establish a database of technical information related to marine litter, and ultimately take immediate action towards the long-term elimination of microplastics.[185] Similar to the resolution on land-based activities, this is a strong call to action but does not go further than encouraging countries to implement their own policies. In May 2019, every country in the Basel Convention except the United States agreed on an amendment that requires countries to monitor and track plastic outside of their borders as a subgroup of hazardous waste.[186] This led to calls for plastic bag usage fees and bans across the globe, including Germany, several African countries, and certain states in the United States. It is important to note that when banning plastic consumption, it is equally important to emphasize the use of alternative materials, green chemistry, and improved plastic waste disposal practices. For example, Costa Rica is on its way to becoming the "first country in the world to eliminate plastic bags, bottles, cutlery, straws, and coffee stirrers by 2021."[187] Its objective is to replace all disposable, single-use plastics with non-petroleum-based renewable materials that are biodegradable, even in marine environments.[188] Rwanda has also banned plastic bags and has become one of the cleanest countries on Earth, replacing them with paper and cotton bags.[189] In other countries, turning back to traditional, sustainable plastic alternatives can be a simple transition. In India, people in some cultures serve meals on banana leaves, eat with their hands,

vance.pdf?sequence=3&isAllowed=y.
180 "UN Report: Urgent Action Needed to Tackle Chemical Pollution as Global Production is Set to Double by 2030."
181 Gus Trompiz, "Record Number of French Farms Convert to Organic Production," *Reuters*, June 4, 2019, https://www.reuters.com/article/france-food-organic/record-number-of-french-farms-convert-to-organic-production-idUSL8N23B40O.
182 Trompiz, "Record Number of French Farms Convert to Organic Production."
183 Abhilasha Belani, "These Breakthroughs Could Save Our Oceans From Harmful Oil Spills," *NBC News*, March 17, 2017, https://www.nbcnews.com/storyline/the-big-questions/these-new-devices-could-stop-oil-spills-their-tracks-n734536.
184 Belani, "These Breakthroughs Could Save Our Oceans From Harmful Oil Spills."
185 UNEP/EA.4/Res.6, "Marine Plastic Litter and Microplastics."
186 "180 Countries — except US — Agree to Plastic Waste Agreement," *Deutsche Welle*, October 5, 2019, https://www.dw.com/en/180-countries-except-us-agree-to-plastic-waste-agreement/a-48686333.
187 Lola Méndez, "13 Brilliant Ways Other Countries Are Replacing Plastic," *Reader's Digest*, October 31, 2019, https://www.rd.com/list/ways-other-countries-are-replacing-plastic/.
188 Méndez, "13 Brilliant Ways Other Countries Are Replacing Plastic."
189 Méndez, "13 Brilliant Ways Other Countries Are Replacing Plastic."

or upcycle traditional clothing to make shopping bags.[190] Such methods are great sustainable alternatives to single-use plastic.

Case Study: The Great Pacific Garbage Patch

Across the world, there are five offshore plastic accumulation zones in our oceans. The largest of these five is the Great Pacific Garbage Patch, which is estimated to cover a surface of 1.6 million square kilometers.[191] This patch collects marine debris in the North Pacific Ocean, spanning waters from the West Coast of North America to Japan.[192] The other garbage patches belong to the Indian, North Atlantic, South Atlantic, and South Pacific oceans. These areas are ocean-scale vortexes, bound by swirling ocean currents that draw debris towards their centers. This system of debris collection through swirling currents is called a gyre, and the center of a gyre is stable, causing garbage to whirl into the center and become trapped in the stagnant water. Because of these rapid currents surrounding an entire patch, dumped garbage from any surrounding country can gradually be drawn in and stay there forever. The Great Pacific Garbage Patch was discovered in 1997 by yachtsman Charles Moore, who found himself traversing a "sea of plastics" while passing through the North Pacific subtropical gyre.[193] It is not a colossal island of consolidated waste; rather, it consists of floating microplastics and larger items that make the water look like a "cloudy soup."[194] Researchers continue to go to the Pacific Ocean and examine the patch, finding that it is growing exponentially in extent and density each year.

The Ocean Cleanup Foundation performed the most in-depth research on the Great Pacific Garbage Patch in 2015, where 18 vessels traversed the patch and found an estimated 1.8 trillion plastic pieces weighing 80,000 tonnes floating in the center of the vortex.[195] This is equivalent to the weight of 500 jumbo jets and does not even include the outer areas of the patch.[196] Once these plastics and other garbage enter the gyre, it is unlikely that they will ever escape. Since very little of the garbage in the patch is biodegradable, much of the plastic is decades old. Also, not all of the plastic is buoyant. Much of it has sunk underneath the surface, making it impossible to detect how much waste there really is. Scientists have estimated that up to 70 percent of the plastic debris will sink to the ocean floor.[197] The Ocean Cleanup Foundation found that the "vast majority of plastics retrieved were made of rigid or hard polyethylene (PE) or polypropylene (PP), or derelict fishing gear," particularly nets and ropes.[198] 46 percent of the garbage came from ghost fishing materials--abandoned nets and ropes that are discarded largely due to inclement weather and illegal fishing.[199] Moreover, large pieces of plastic found in the patch break down into microplastics that are harder to identify but are toxic to marine life. This process of sunlight decaying and breaking down plastics into tiny pieces is called photodegradation.[200]

The marine life in the Great Pacific Garbage Patch faces deadly consequences from this extensive pollution. Researchers found that 180 times more plastic than food floats on the surface of the water, and animals will consume this and feed it to their offspring.[201] In this region, in particular, many birds and turtles feed at the surface of the water. In fact, research has shown that roughly 74 percent of the diet of sea turtles in the area is made up of plastic.[202] Plastic bags closely resemble jellyfish when underwater, so turtles unknowingly ingest these

190 Méndez, "13 Brilliant Ways Other Countries Are Replacing Plastic."
191 "The Great Pacific Garbage Patch," *The Ocean Cleanup,* accessed July 3, 2020, https://theoceancleanup.com/great-pacific-garbage-patch/.
192 "Great Pacific Garbage Patch," *National Geographic,* last modified July 5, 2019, https://www.nationalgeographic.org/encyclopedia/great-pacific-garbage-patch/.
193 Patricia Bauer, "Great Pacific Garbage Patch," *Encyclopædia Britannica*, January 8, 2019, https://www.britannica.com/topic/Great-Pacific-Garbage-Patch.
194 "Great Pacific Garbage Patch."
195 "The Great Pacific Garbage Patch."
196 "The Great Pacific Garbage Patch."
197 "10 Interesting Facts About the Great Pacific Garbage Patch," *Eradicate Plastic*, accessed July 3, 2020, https://eradicateplastic.com/10-interesting-facts-about-the-great-pacific-garbage-patch/.
198 "The Great Pacific Garbage Patch."
199 "The Great Pacific Garbage Patch."
200 "10 Interesting Facts About the Great Pacific Garbage Patch."
201 "The Great Pacific Garbage Patch."
202 "10 Interesting Facts About the Great Pacific Garbage Patch."

A sea turtle entangled in a ghost net, which can injure it or keep it from moving freely and rising to the surface for air.

toxic materials thinking it is a part of their diet. Laysan albatross chicks from Kure Atoll and Oahu Island also "have around 45 percent of their wet mass composed of plastics from surface waters."[203] This waste can not only leach toxic chemicals out, but also absorb harmful pollutants. The patch contains colorants and chemicals such as bisphenol A (BPA), which causes health problems for the animals that consume it.[204] Furthermore, on top of getting entangled in regular plastic, animals face ghost catches—the trapping of marine life in abandoned fishing nets. There is rarely a way out of ghost catches for entangled aquatic creatures, inevitably leading to their demise.

When marine debris blocks sunlight, algae and plankton cannot grow, affecting animals up the entire food chain.[205] Food webs have been severely disrupted in the patch, and by the principle of bioaccumulation, chemicals from plastics make their way up the chain and contaminate human food as well.

The Great Pacific Garbage Patch covers an area three times the size of France and will not stop growing until action is taken to combat it.[206] It is located so far from any country's coastline that no government wants to accept responsibility or provide the ample funding required to clean it up. There are some, but not many organizations whose purposes are dedicated to slowing down the growth of the patch and cleaning it up. The most notable of these projects is The Ocean Cleanup, a Dutch organization founded in 2013 by young entrepreneur Boyan Slat. In 2015, the project conducted initial research on the size, types of plastic, concentration, and horizontal and vertical distribution of the patch. Following this, in 2016, the nonprofit conducted an aerial survey of the region using a Hercules C-130 aircraft, identifying the areas with larger pieces of plastic and refining its original data.[207] All the data collected was then used for the official Ocean Cleanup, which commenced in October 2018. So far, the researchers have begun trawling the patch, which involves pulling a fishing net through the water behind ships, using manta trawl nets outfitted with mesh. The meshed nets are used to collect as much plastic as possible. As of their last report, the project has collected "1,136,145 pieces of debris that weighed a total of 668 kilograms and were made up of 99.9 percent plastic."[208] Slat has also designed an underwater plastic-collecting system with anchors that stabilize the structure and allow it to collect garbage efficiently.[209] While it is excellent that individuals have spearheaded the efforts to clean up the Great Pacific Garbage Patch, this extreme environmental emergency is caused by the mass production, consumption, and dumping of garbage into our oceans. Despite all the work of The Ocean Cleanup, the

203 "The Great Pacific Garbage Patch."
204 "Great Pacific Garbage Patch."
205 "Great Pacific Garbage Patch."
206 "The Great Pacific Garbage Patch."
207 Kevin Loria, "The Giant Garbage Vortex in the Pacific Ocean is Over Twice the Size of Texas — Here's What it Looks Like," *Business Insider*, September 8, 2018, https://www.businessinsider.com/great-pacific-garbage-patch-view-study-plastic-2018-3.
208 Loria, "The Giant Garbage Vortex in the Pacific Ocean is Over Twice the Size of Texas — Here's What it Looks Like."
209 Loria, "The Giant Garbage Vortex in the Pacific Ocean is Over Twice the Size of Texas — Here's What it Looks Like."

project has only removed less than one percent of the total plastic waste in the patch. The roots of the issue must be addressed by governments, as NGO action will never be able to outpace the new contaminants that are introduced. It is necessary for countries to not only assist in cleanup efforts but also to stop pollution from making it into the ocean in the first place.

Sustainable Development Agenda

In 2015, the UN 2030 Agenda for Sustainable Development introduced the 17 Sustainable Development Goals (SDGs).[210] This topic reflects the objectives of several of the SDGs, and it is important to address the issue of marine pollution with these targets in mind. The SDGs provide a blueprint for achieving prosperity for people and the planet, and preserving our ocean life is integral to accomplishing this. Most significantly, it is necessary to analyze this topic through the lens of SDG 14: Life Below Water, which aims to conserve and sustainably use the oceans, seas, and marine resources for sustainable development. As of December 2019, "more than 24 million square kilometers, or 17 percent, of waters under national jurisdiction (up to 200 nautical miles from shore) were covered by protected areas."[211] Although this is a step in the right direction, existing international policies are insufficient based on the evidence introduced earlier, speaking to the urgency of protecting our marine ecosystems.

Focusing on life below water will push us to stop filling our oceans with materials it does not need and create more protected areas. This ties into SDG 6: Clean Water and Sanitation, which aims to ensure availability and sustainable management of water and sanitation for all, because properly treating waste prevents sewage from entering bodies of water as a whole, whether they house aquatic species or are for drinking. When waste is dumped into the water, it has dangerous effects for humans because of what it does to the sea life we consume. SDG 3: Good Health and Well-Being, which aims to ensure healthy lives and promote well-being for people of all ages, can be associated with this topic because of the human health implications that contaminated seafood and water can have. The deadly effects of ocean pollution are not limited to marine life. This is why chemicals and other waste should be kept out of bodies of water, including runoff. SDG 2: Zero Hunger, which aims to end hunger, achieve food security, improve nutrition, and promote sustainable agriculture, includes organic farming, which avoids using chemicals in agriculture and prevents runoff from being harmful to aquatic creatures. Ocean pollution does not only come from agriculture; industrial areas and cities produce hefty amounts of toxic chemicals, metals, and plastic waste. SDG 12: Responsible Consumption and Production encourage responsible use of materials that infiltrate our oceans, especially plastics. These all tie together with SDG 13: Climate Action because firm action is necessary to protect our oceans. Rising carbon emissions warm our oceans, increase the sea level, cause acidification, and break down marine ecosystems. The pressing issue of climate change needs immediate, strict action if we hope to save marine life.

Bloc Analysis

While marine pollution affects all members, the points of division between countries depend on the significance of the marine industry in each country. Some countries with high marine product exports, such as China, the European Union, Norway, and the United States, export large quantities of marine products and prioritize preserving marine ecosystems for economical use. Many members of this bloc aim to keep their waters clean to maintain the quality of their marine products, but they are simultaneously industrialized and export manufactured goods as well. Given this, there are many seafood exporters in this bloc that overlap into the bloc of countries that are considerable contributors to marine pollution. Countries contributing most to marine pollution, including China, Indonesia, Nigeria, the Philippines, Russia, Sri Lanka, and Viet Nam, lack proper waste management systems and may also accept contaminated waste that they cannot dispose of properly from other countries. Improving waste management and refusing waste from wealthier countries may be priorities for these countries. For countries that are making efforts to reduce marine pollution, enhancing waste disposal systems is of equal importance to finding sustainable alternative materials or limiting consumption of harmful litter like plastic. While

210 "The 17 Goals," *United Nations Department of Economic and Social Affairs*, accessed July 17, 2020, https://sdgs.un.org/goals.
211 "The 17 Goals."

all countries aim to reduce marine pollution, some favor industry and exports, and others may focus on furthering improvements to existing sustainable systems, creating divisions in approaches to the issue.

Countries with High Marine Product Exports

Countries that export high amounts of marine products rely heavily on the industry for economic stability and nutrition. Some of these countries prioritize the fishing industry for its export revenue and contribute to the issue of overfishing, while other countries are highly dependent on fish for food. The leading fish and fishery product exporters in the world as of 2018 included the European Union, with USD 31.8 million in exports, followed by China with USD 25 million, and Norway with USD 12.1 million.[212] States such as Vietnam, India, Chile, the United States, Thailand, Canada, Ecuador, and Indonesia also fall on this list of the highest seafood exporters.[213] Countries that fall into this group may focus on meeting export safety requirements for their seafood, especially the criteria required from the countries that import from them the most. For example, Australia has a lengthy list of requirements for its seafood imports, which primarily come from the United States, Japan, and the European Union. It provides guidelines for the maximum tolerance amount of contaminants in its imports, such as 0.5 parts per million (ppm) of mercury, 1.0 ppm of arsenic, and 1.5 ppm of antimony.[214] This pushes exporters to protect their waters and marine life, even though it may be difficult because many of them are also plastic polluters.

Members of this bloc may also be keen on enforcing policies that limit fishing or place a clampdown on boats over long periods, rather than sudden changes. For example, China's 2016 "China Plan" aimed to reduce fishing capacity over the course of three years, reduce China's catch by 3.09 million tonnes, and implement a "zero-tolerance policy on illegal, unreported and unregulated (IUU) fishing."[215] The plan was a strong signal of China's dedication toward furthering the conservation of fisheries and promoting sustainable resource management, gaining lots of attention from the global community and setting an example for other heavy-fishing countries. The legislation has been successful so far. China has built over 550 national aquatic germplasm resource reserves, containing genetic material of aquatic creatures for growth and research, and over 80 provincial aquatic organism nature reserves.[216] China has also implemented a temporary ban on fishing each summer, and it is working to establish a total catch control system that designates a maximum amount of a type of fish that can be caught. In 2020, the government banned fishing in the Yangtze River for the next 10 years to protect its marine life.[217]

Some countries with high marine product exports also consume a lot of seafood on their own. According to the World Wildlife Fund, almost half of the world's population relies on wild-caught and farmed seafood as a major source of protein.[218] Countries that consider seafood a primary part of their diets prioritize having non-contaminated marine ecosystems and protecting areas from illegal fishing or overfishing to maximize the use of resources. They may create marine protected areas, such as Brazil, which in 2018 protected 559,000 square miles of ocean from fishing and mining.[219] These countries may also emphasize local fisheries to change the way fishing is done. Brazil, Indonesia, and the Philippines have partnered with the global conservation group Rare to help "local people register to fish legally and manage their own coastal waters"

212 M. Shahbandeh, "Leading Exporting Countries of Fish and Fishery Products Worldwide in 2018," *Statista*, August 9, 2019, https://www.statista.com/statistics/268269/top-10-exporting-countries-of-fish-and-fishery-products/.
213 Shahbandeh, "Leading Exporting Countries of Fish and Fishery Products Worldwide in 2018."
214 "Export Requirements by Country and Jurisdiction (A-F)," *US National Oceanic and Atmospheric Administration*, accessed July 18, 2020, https://www.fisheries.noaa.gov/export-requirements-country-and-jurisdiction-f.
215 Zhou Wei, "China Promises Reform of Coastal Fisheries," *China Dialogue*, December 18, 2017, https://chinadialogue.net/en/food/10302-china-promises-reform-of-coastal-fisheries/.
216 Shuolin Huang and Yuru He, "Management of China's Capture Fisheries: Review and Prospect," *Aquaculture and Fisheries* 4, no. 5 (2019): 173-182, https://doi.org/10.1016/j.aaf.2019.05.004.
217 Huang and He, "Management of China's Capture Fisheries: Review and Prospect."
218 "Sustainable Seafood: Overview," *World Wildlife Fund*, accessed June 26, 2020, https://www.worldwildlife.org/industries/sustainable-seafood.
219 Joe McCarthy and Erica Sanchez, "Brazil Just Protected 559,000 Square Miles of Ocean From Fishing and Mining," *Global Citizen,* March 29, 2018, https://www.globalcitizen.org/en/content/brazil-photos-massive-marine-reserves/.

and replenish fish sanctuaries.[220] Protecting marine life from fishing or contamination is vital to not only the health of the ocean but also the health and nutrition of those who are dependent on fish in their diet.

Countries Contributing Most to Marine Pollution

The countries that pollute our oceans the most, especially with plastic, do not always intend to do so. Rather, they may be industrialized and produce and consume plastic goods, all without proper waste management or disposal systems. Plastic and other industrial byproducts such as toxic metals, crude oil, or chemicals are integral to polluters' economies. However, policies are not in place to prevent mismanaged waste from being dumped in bodies of water. These ocean polluters are often found in Southeast Asia, including China, Indonesia, the Philippines, Sri Lanka, and Viet Nam.[221] Russia also falls into this bloc, as it has failed to "adequately regulate discharges of toxic chemicals since the Soviet era."[222] Researchers have found that up to 60 percent of Russian drinking water resources do not meet sanitation standards.[223] Nigeria also has much work to do to make up for lack of regulatory policies on marine pollution. Poor treatment systems for sewage sludge allow for heavy pollution in rivers. The only action the country has taken thus far is an initiative to shed light on the importance of keeping plastic out of oceans.[224]

Some efforts have been made in some of these countries to curb plastic debris, such as summits of the top polluting member states of the Association of Southeast Asian Nations (ASEAN). The countries have decided together to ban single-use plastics but left it in the hands of each country to implement the change.[225] These countries may rely on plastic so much that it is not easy to instantly place bans on products. Furthermore, countries contributing most to marine pollution often accept waste from wealthy nations for recycling. Developed countries like Belgium, Germany, Spain, the United Kingdom, and the United States export much of their waste. In a way, these wealthy countries indirectly contribute to marine pollution by keeping their waste out of sight while knowing it is not properly managed. The developing countries they export to may not have the technology and expertise to properly recycle the imported waste, resulting in its illegal dumping in the ocean. 78 percent of the United States' plastic waste exports go to countries with poor waste management systems like Malaysia, where materials often end up burned or dumped.[226]

The waste-accepting countries in this bloc may push to stop accepting recyclables contaminated with toxic waste to create lesser harm in oceans. For example, Indonesia began rejecting some shipping containers of waste from the United States in 2019 after inspections found sewage, plastics, electronics, and other hazardous waste in them.[227] Because of this, garbage began piling up in landfills and waste centers across the United States, exposing the deficiencies in the country's own waste management systems. Waste accepting countries can hold the rest of the world, particularly wealthy nations that export most of their waste, accountable for not having their own effective waste management systems. These marine polluters seek to greatly reduce their negative impact on our oceans by having less waste to deal with in general, allowing them to focus on their own structures. Countries in this highly polluting bloc are unlikely to favor policies that will inhibit their economic growth. However, this does not mean they will not support any solutions; the solutions coming from this bloc are likely to focus on economic diversification to lower reliance on pollutant industries rather than immediate regulation of said crucial industries. For example, bans on cheap plastic are much less likely to be viewed favorably by this bloc than technological

220 Hannah Summers, "World's Top Fishing Nations to be Given Millions to Protect Oceans," *The Guardian*, October 29, 2018, https://www.theguardian.com/environment/2018/oct/29/worlds-top-fishing-nations-to-be-given-millions-to-protect-oceans.
221 Wei, "China Promises Reform of Coastal Fisheries."
222 "Economist Intelligence Unit Reveals Leaders and Laggards on Coastal Governance."
223 "Economist Intelligence Unit Reveals Leaders and Laggards on Coastal Governance."
224 "Economist Intelligence Unit Reveals Leaders and Laggards on Coastal Governance."
225 Patpicha Tanakasempipat, "Southeast Asian Nations, Among Worst Ocean Polluters, Aim to Curb Plastic Debris," *Reuters*, June 21, 2019, https://www.reuters.com/article/us-asean-summit-environment/southeast-asian-nations-among-worst-ocean-polluters-aim-to-curb-plastic-debris-idUSKCN1TM0J5.
226 Kate Wheeling, "The EPA Blames Six Asian Nations That the U.S. Exports Plastic Waste to for Ocean Pollution," *Pacific Standard*, July 15, 2019, https://psmag.com/environment/the-epa-blames-six-asian-nations-that-the-u-s-exports-plastic-waste-to-for-ocean-pollution.
227 Wheeling, "The EPA Blames Six Asian Nations That the U.S. Exports Plastic Waste to for Ocean Pollution."

solutions that offer alternative avenues towards development that avoid plastic waste in the long term.

Countries Making Efforts to Reduce Marine Pollution

Many countries that do not already contribute greatly to marine pollution are still making an effort to reduce their waste production. Countries in this bloc are likely implementing policy solutions to reduce the production and exporting of waste and emphasize the importance of protecting marine ecosystems. This is not to say that the ASEAN countries discussed earlier as contributors to marine pollution do not value supporting marine life. Rather, they are direct ocean polluters and have to approach the issue differently.

Members of this bloc may place bans on various plastic goods or find ways to incentivize people to consume and recycle plastic responsibly. The African continent is home to many countries that have limited the use of plastic bags. More than half of the 25 African countries that have banned plastic bags have done so in the past four years alone.[228] Around the world, 127 countries regulate plastic bags, but this includes countries with only partial restrictions or countries that only restrict the construction of plastic bags.[229] In fact, as of 2019, Cape Verde is the only country in the world that includes an explicit production limit for plastic bags.[230] Countries like Costa Rica, India, Luxembourg, Mexico, Morocco, New Zealand, and Rwanda also regulate plastic bags and promote sustainable alternatives. Across Mexico, a reduction in single-use plastic has been accompanied by a transition to alternatives like straws made of agave fibers or avocado pits and cutlery made of cornstarch, all of which are 100 percent compostable.[231] New Zealand is involving its corporations, including international brands, in the movement toward compostable alternatives through a declaration committing to "use 100 percent compostable, reusable, or recyclable packaging by 2025."

Countries in this bloc may also seek to reduce marine pollution through direct restrictions on both the deliberate dumping and inadvertent runoff of toxic material into bodies of water. For example, Israel has taken tangible action to keep coastal areas clean of litter and runoff through its Clean Coast Program. As of July 2020, the program's index rated 71 percent of beaches "clean" or "very clean," meaning there was a maximum of only five plastic pieces on each beach.[232] These countries aim to address eutrophication and dead zones directly by keeping excess nutrients from fertilizers, untreated sewage, and urban areas from running off into oceans. The Australian government has stated that it aims to reduce nutrient pollution, primarily from farms, by 80 percent and passed laws restricting land-use changes.[233] To bring about an actual buy-in to such efforts, countries in this bloc will also focus on gaining involvement from agricultural stakeholders. The countries may utilize more sustainable farming methods that prevent marine pollution through organic approaches. Canada, Finland, France, Japan, and the Netherlands are highly ranked on the Food Sustainability Index, in which agricultural practices influence ranking.[234] These countries use organic farming, which avoids pesticides and fertilizers, limiting chemical runoff into bodies of water. They also devote a relatively large amount of land, around 22 percent, to biofuel production.[235] Biofuels can be used for marine transport engines and make the maritime shipping sector more sustainable by reducing emissions.

Committee Mission

The United Nations Environment Assembly (UNEA) was established in 2012 to strengthen UN Environment, placing the environment at the center of the international community's

228 "Our Planet is Drowning in Plastic Pollution."
229 Carole Excell, "127 Countries Now Regulate Plastic Bags. Why Aren't We Seeing Less Pollution?," *World Resources Institute*, March 11, 2019, https://www.wri.org/blog/2019/03/127-countries-now-regulate-plastic-bags-why-arent-we-seeing-less-pollution.
230 Excell, "127 Countries Now Regulate Plastic Bags. Why Aren't We Seeing Less Pollution?"
231 Méndez, "13 Brilliant Ways Other Countries Are Replacing Plastic."
232 "Clean Coast Index," *Israeli Ministry of Environmental Protection*, accessed July 18, 2020, https://www.gov.il/en/departments/publications/reports/clean_coast_index_data.
233 Sara Walker, "In World That Says It's Cutting Nutrient Pollution, Progress Is Lacking," *World Resources Institute*, March 4, 2019, https://www.wri.org/blog/2019/03/world-says-its-cutting-nutrient-pollution-progress-lacking.
234 "The Top 10 Countries for Sustainable Food," *Rodale Institute*, December 11, 2018, https://rodaleinstitute.org/blog/the-top-10-countries-for-sustainable-food/.
235 "The Top 10 Countries for Sustainable Food."

focus.[236] The UNEA is the governing body and policy-making organ of the United Nations Environment Programme (UNEP). It meets every other year to "set priorities for global environmental policies and develop international environmental law."[237] UNEA is mandated to "ensure the active participation of all relevant stakeholders in the governance of UNEP and to promote a strong science-policy interface."[238]As the world's highest-level decision-making body on the environment, the UNEA holds the responsibility to address the increasing environmental concerns surrounding marine pollution. Considering the devastation faced by underwater life due to polluting activities, this topic is a considerable environmental concern. The UNEA maintains the jurisdiction to spearhead an urgent global response to the anthropogenic impact on the ocean environment.

It is tempting to approach this far-reaching issue from various perspectives. However, as parties to the UNEA, delegates must ensure that even when debating an issue as pervasive as ocean pollution, they are developing acceptable solutions that adhere to the mandate of the committee by remaining focused on the environment. When addressing facets of the issue like the human health impact, it is out of the scope of the committee to tackle this aspect directly; rather, delegates should first cast their attention on aiding the sea life that is afflicted. The principle of biomagnification must be taken into account to focus on where the concentration of pollutants begins, not ends. Furthermore, many solutions will be geared towards controlling the production and consumption of pollutants such as plastic or chemicals. While this is important, delegates must note the significance of such materials to the global community and prioritize protecting the environment without compromising the livelihoods and economies of people around the world.

The primary concern of the UNEA should be reducing the amount of pollution that, directly and indirectly, enters our oceans. Delegates should appropriately address ocean pollution by evaluating existing regulations and expanding upon them. Delegates should research specific and achievable solutions that tangibly reduce the intrusive effects of human activity on ocean environments. The future of marine life across the globe is dependent on the swift action of the UNEA.

236 "About the United Nations Environment Assembly," *United Nations Environment Assembly,* accessed July 18, 2020, https://environmentassembly.unenvironment.org/about-united-nations-environment-assembly.
237 "About the United Nations Environment Assembly."
238 "United Nations Environment Assembly of the UNEP (UNEA)," *United Nations Environment Programme*, accessed July 30, 2020, https://www.unenvironment.org/events/civil-society-events/united-nations-environment-assembly-unep-unea.

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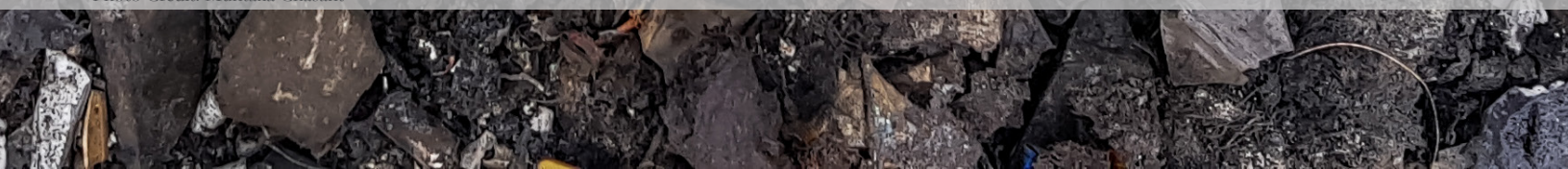
TOPIC B:

THE EFFECTS OF HAZARDOUS ELECTRONIC WASTE ON THE ENVIRONMENT

Photo Credit: Muntaka Chasant



Introduction

The 50 million tons of electronic waste (e-waste) produced annually is expected to rise to 120 tons by 2050 if current trends continue.[1] This waste describes electrical or electronic devices and encompasses a large variety of devices ranging from cell phones, computers, and printers to home appliances such as refrigerators and TVs. All of these electronics contain precious metals which, if not disposed of sustainably, is highly toxic to the environment. As of now, E-waste is worth over USD 62 billion and contains several precious metals that can be recycled for profit.[2] For example, there is 100 times more gold in a ton of e-waste than in a ton of gold ore.[3] Despite the economic benefits of recycling e-waste to reuse this metal, only 20 percent of e-waste is recycled globally.[4] The remaining e-waste is often discarded in landfills without proper steps taken to mitigate the toxic components of those electronic devices. Consequently, the improper disposal of electronic waste has long-term detrimental impacts on the environment through multiple mechanisms.

The issues with recycling arise from the lack of a formalized procedure to dispose of hazardous components of electronic devices. "Informal disposal practices" refer to the rudimentary practices used to break apart the e-waste, which often harms the workers and the environment. Formal disposal is a formalized procedure for each component of the electronic, which would result in the greatest yield of recycled products and the least harm to the environment. However, due to limited infrastructure and knowledge of most efficient processes, e-waste is often disposed of informally in landfills, incinerated, or taken apart by hand. These processes increase environmental pollution. For example, informal processes of disposal result in the leaching (contamination) of soil and the water with toxic metals such as mercury, which remain in the environment for decades.[5] Informally burning e-waste results in air pollution, which can further exacerbate soil and water pollution through acidic precipitation.[6] Consequently, these toxic metals can enter crops, bioaccumulate in animals, and also harm residents. Vulnerable marine life, which can store these toxic metals in blubber, is impacted most by water contamination while pregnant women are most impacted by these contaminants entering soil-crop-food pathways.[7]

These issues are further exacerbated due to a lack of sustainable production and consumption. There is a growing demand for the latest electronics, causing the lifespan of devices to decrease. More people are buying electronic devices and also replacing them sooner to keep up with growing technological advances. The advancing technology also results in difficulty recycling and separating the different components of electronic devices as the devices become smaller and more complicated to disassemble.[8] The environmental impacts and the difficulty in recycling results in developed countries illegally exporting e-waste to countries mainly in Asia and Africa.[9] However, this further exacerbates the environmental consequences because the countries which import e-waste often lack the infrastructure to deal with large amounts of e-waste.

The UN-E-waste Coalition, which includes the United Na-

1 UNEP - UN Environment Programme. "UN Report: Time to Seize Opportunity, Tackle Challenge of e-Waste," accessed July 13, 2020, http://www.unenvironment.org/news-and-stories/press-release/un-report-time-seize-opportunity-tackle-challenge-e-waste
2 UNEP - UN Environment Programme. "UN Report: Time to Seize Opportunity, Tackle Challenge of e-Waste."
3 UNEP - UN Environment Programme. "UN Report: Time to Seize Opportunity, Tackle Challenge of e-Waste."
4 UNEP - UN Environment Programme. "UN Report: Time to Seize Opportunity, Tackle Challenge of e-Waste."
5 Dharini, K, J Bernadette Cynthia, B Kamalambikai, J P Arul Sudar Celestina, and D Muthu, "Hazardous E-Waste and Its Impact on Soil Structure," *IOP Conference Series: Earth and Environmental Science* 80 (July 2017): 012057, https://doi.org/10.1088/1755-1315/80/1/012057.
6 Canada, Environment and Climate Change, "Air Pollution: Effects on Soil and Water," Program descriptions. aem, May 31, 2004, https://www.canada.ca/en/environment-climate-change/services/air-pollution/quality-environment-economy/ecosystem/effects-soil-water.html.
7 Jayapradha Annamalai, "Occupational Health Hazards Related to Informal Recycling of E-Waste in India: An Overview," *Indian Journal of Occupational and Environmental Medicine* 19, no. 1 (2015): 61–65. https://doi.org/10.4103/0019-5278.157013.
8 UL, "The Elements of Sustainable Design in the Consumer Electronics Industry," Accessed June 8, 2020, https://www.ul.com/news/elements-sustainable-design-consumer-electronics-industry.
9 Basel Action Network, "E-Waste Chokes Southeast Asia," accessed June 5, 2020, https://www.ban.org/news/2018/11/5/e-waste-chokes-southeast-asia.

tions Environment Programme (UNEP), the Global Environment Facility, the World Economic Forum, and the World Business Council for Sustainable Development have called for the urgent need to address the issue of e-waste.[10] The need for a circular economy, in which resources are reused rather than discarded, is essential to prevent damage to the environment due to improper e-waste disposal.[11] Delegates must address not only the immediate environmental issues of soil, water, and air pollution but also the underlying issues of a lack of formalized procedures and infrastructure for recycling along with gaps in sustainable production and consumption.

History and Description of the Issue

Issues with Recycling Electronic Waste

With the rapid production and consumption of new electronic devices, the proper management of their disposal is essential. Several developed countries export their electronic waste, which contains hazardous and toxic materials, to developing countries. For example, in 2019, 10 European countries, including the United Kingdom, Germany, and Austria, were found to be exporting 352,474 metric tons of electronic waste to Nigeria, Ghana, Pakistan, Tanzania, and Thailand.[12] In addition to this being an illegal practice banned by the 1989 Basel Convention, it also means that countries that are less equipped to handle this toxic waste are continually on its receiving end.[13]

The first reason why recycling electronic waste has continually been an issue is that, in most cases, there lacks effective infrastructure for the management of electronic waste. Ineffective e-waste infrastructure is a global issue for several reasons. For example, consumers are often unaware of recycling practices for e-waste and discard electronics in landfills. This poses significant challenges for an efficient and effective collection process. In addition, there is a lack of statistics regarding the number of electronics disposed of every year and limited formalization of recycling practices through the national legislature. As a result, disposal sites often undertake informal methods of recycling, such as merely burning the waste, which causes harmful toxins to be released into the atmosphere. Recently, there have been developments of more effective methods for recycling e-waste, such as carbon nanotube technology and using underwater sound waves to recover precious metals.[14] For example, new sound wave technology uses a 10-ton steel bar that can be vibrated at 50-60Hz. This vibration generates "10 tons of energy focused in three nodes" that can be used to "separate or size reduce, sheer, and change the makeup of matter" much more efficiently than using manual labor to separate the individual components.[15] The efficient separation of the different components and then using magnetic properties of meals to further separate them ensures that each part can then be broken down using specific techniques identified by environmental specialists and the manufacturer. Therefore, this technology is extremely promising for the promotion of sustainable disposal of e-waste. However, these technologies are not widespread. For example, researchers found that in Africa, most states do not have an efficient system for sorting, collecting, transporting, and disposing of electronic waste.[16] This also means that even in the facilities that exist, the cost of recycling often exceeds the revenue recovered. The same study in Africa found that an average of USD 500 is generated in materials from each computer recycled.[17] This number is alarmingly low, considering the safety risks workers undertake with the inefficient practices and the environmental cost of sending the remaining material to landfills.[18] Inefficient practices include incinerating e-waste

10 UNEP - UN Environment Programme. "UN Report: Time to Seize Opportunity, Tackle Challenge of e-Waste."
11 UNEP - UN Environment Programme. "UN Report: Time to Seize Opportunity, Tackle Challenge of e-Waste."
12 Electronic Recycling Association, "The Challenges Facing Electronic Recycling," September 30, 2019, https://www.electronicrecycling-association.ca/the-challenges-facing-electronic-recycling/.
13 "The Challenges Facing Electronic Recycling."
14 Brook Larmer, "E-Waste Offers an Economic Opportunity as Well as Toxicity," *The New York Times*, July 5, 2018, sec. Magazine, https://www.nytimes.com/2018/07/05/magazine/e-waste-offers-an-economic-opportunity-as-well-as-toxicity.html.
15 Philip Raphael, "Recycling riches sought in e-waste piles," *Richmond News,* Dec 3,2015, https://www.richmond-news.com/business/recycling-riches-sought-in-e-waste-piles-1.2125810.
16 Bhutta, M. Khurrum S., Adnan Omar, and Xiaozhe Yang, "Electronic Waste: A Growing Concern in Today's Environment," Research Article, Economics Research International, June 15, 2011. https://doi.org/10.1155/2011/474230.
17 Bhutta, Omar, and Yang, "Electronic Waste."
18 Bhutta, Omar, and Yang, "Electronic Waste."

to recover metals, which harms the environment through soil, water, and air pollution. Recycling electronic waste requires infrastructure that is proficient at sorting, disassembling, reusing parts, and safely dispose of parts that cannot be reused.[19]

The second reason for large amounts of electronic waste to be disposed of in landfills is the short lifespan of electronic devices not produced to be recycled. In 1992, the lifespan of a computer was 4.5 years.[20] However, now the lifespan of an average computer or cell phone is less than two years, meaning that consumers are using devices for only a short period before disposing of them.[21] The short lifespan and increased consumer demand for electronics result in an increased burden on the existing recycling facilities. To further exacerbate the issue, most electronic equipment producers do not design devices with recycling as a priority. Rather, producers prioritize cheaper devices in favor of a higher profit margin over sustainability.[22] This is significant to consider because it is often assumed that recycling e-waste is beneficial due to the recovery of metals. However, the costs of recycling and the decreased demand for metals reduce the rate of recycling. There is substantial room for compromise with sustainable design changing the devices slightly to still be profitable for the producer or government subsidies to promote sustainable design.

Thirdly, the ineffective collection of electronic devices also severely limits recycling. It is estimated that in the USA, collection and transportation of e-waste account for 80 percent of the cost associated with recycling electronic waste.[23] Many consumers are unaware of specific recycling policies for electronic waste or keep old electronics assuming they have value. For instance, it is estimated that 70 percent of consumer electronic devices are kept in storage because consumers assume they have value.[24] However, this reasoning is flawed since the production of improved electronics decreases the value of most older electronic devices. Countries have focused on starting several initiatives to address this issue. For example, in 2014, a UN Report concluded that India was the world's fifth-largest producer of electronic waste, with approximately 95 percent of the e-waste produced going to landfills.[25] To address this issue, a new initiative in collaboration with Chintan, a non-governmental organization (NGO), called for more waste collectors to collect and separate e-waste. As a result, in Delhi, more than 25,000 individuals were hired and continue to earn a living from segregating electronic waste.[26] Furthermore, more than 17 tons of e-waste are collected each year and thus prevented from going into landfills.[27]

The United States has also found special drop off events to be successful. These are one to two day events where consumers can drop off e-waste locally to have professional workers sort it.[28] These drop off events occurred primarily in smaller communities and saw notable success in collecting e-waste and preventing it from reaching landfills. In particular, these events address logistical issues with collecting e-waste, such as theft, which is common for methods such as curbside pick up in which residents merely place electronics outside their door and call collection centers.[29] A pilot study conducted by the United States Environmental Protection Agency found that special drop-off events were the most effective collection method for rural areas.[30] It is important that local policies for the collection of e-waste to prevent it from being disposed of in landfills considers the effectiveness of each method before choosing the optimal one.

Similar innovative solutions are required to address the issue of efficient and effective ways of recycling e-waste. In 2019, the UN released a report urging for a shift towards a circular

19 Kang, Hai-Yong, and Julie M. Schoenung, "Electronic Waste Recycling: A Review of U.S. Infrastructure and Technology Options," *Resources, Conservation and Recycling* 45, no. 4 (December 1, 2005): 368–400, https://doi.org/10.1016/j.resconrec.2005.06.001.
20 Kang and Schoenung, "Electronic Waste Recycling."
21 Bhutta, Omar, and Yang, "Electronic Waste."
22 "The Challenges Facing Electronic Recycling."
23 Kang and Schoenung, "Electronic Waste Recycling."
24 Kang and Schoenung, "Electronic Waste Recycling."
25 "E-Waste: From Toxic to Green | India | UNFCCC," Accessed June 3, 2020, https://unfccc.int/climate-action/momentum-for-change/lighthouse-activities/e-waste-from-toxic-to-green.
26 "E-Waste: From Toxic to Green | India | UNFCCC."
27 "E-Waste: From Toxic to Green | India | UNFCCC."
28 Kang and Schoenung, "Electronic Waste Recycling."
29 Kang and Schoenung, "Electronic Waste Recycling."
30 Kang and Schoenung, "Electronic Waste Recycling."

An e-waste recycling facility located in Rwanda

economy.[31] A circular economy would prioritize the reuse of parts in electronic devices to continue using them to produce other devices. This would not only benefit the environment by preventing contamination through hazardous materials but also help producers by providing them with a steady source of raw material. This report found that while 50 million tons of e-waste is generated each year, less than 20 percent is recycled.[32] The limited recycling is due to the ineffective infrastructure, the short lifespan of electronic devices not manufactured with sustainability as a priority, and issues with collecting and segregating e-waste. These low recycling rates are a large contributing factor to the scarcity of materials. For example, it is estimated that up to seven percent of the world's gold is contained in e-waste currently.[33] This UN report, titled "A New Circular Vision for Electronics: Time for a Global Reboot," urges a move to value and reuse resources to create sustainable jobs and mitigate harm to the environment. To do this, the report recommended improving product tracking using take-back programs from manufacturers and retailers. In addition to this report, the United Nations Environmental Programme (UNEP), in collaboration with the Nigerian Government and the Global Environment Facility, made a USD two million investment towards launching an electronic waste recycling industry in Nigeria.[34] Previously, the International Labor Organization estimated that 100,000 individuals informally worked in recycling e-waste in Nigeria. Following this investment, which will be used to formalize the industry and provide these workers safe employment, it is estimated that the facilities will be able to go through Nigeria's 500,000 tons of e-waste and collect valuable materials.

The manufacturer take-back programs mentioned in the UN report have gained significant popularity. The idea behind

31 Hub, IISD's SDG Knowledge, "UN Report Highlights Environmental, Health Risks from E-Waste, Urges Circular Economy Shift | News | SDG Knowledge Hub | IISD," Accessed June 1, 2020, https://sdg.iisd.org:443/news/un-report-highlights-environmental-health-risks-from-e-waste-urges-circular-economy-shift/.

32 Hub, "UN Report Highlights Environmental, Health Risks from E-Waste, Urges Circular Economy Shift | News | SDG Knowledge Hub | IISD."

33 Hub, "UN Report Highlights Environmental, Health Risks from E-Waste, Urges Circular Economy Shift | News | SDG Knowledge Hub | IISD."

34 Hub, "UN Report Highlights Environmental, Health Risks from E-Waste, Urges Circular Economy Shift | News | SDG Knowledge Hub | IISD."

extended producer responsibility is that the manufacturer assumes responsibility for mitigating environmental harm from the product for the duration of its life cycle, from production to disposal.[35] Ideally, these policies would push manufacturers to be more conscious of sustainable production. These policies have been successful to a large extent. For example, in 2009, Best Buy, a prominent business dealing with electronics, started collecting e-waste. The company was also able to make a profit through recycling by selling recovered materials and collecting fees from electronic brands, which are required in many states to recycle a certain percentage of electronics they produce.[36] This program was successful to such an extent that in 2014 Best Buy pledged to collect an additional two billion pounds by 2020.

However, the disadvantage of extended producer responsibility is that electronics are increasingly produced in ways that make them difficult to recycle. For example, designs such as glued-in batteries increase the time required to recycle and reuse them. This is quite commonly done by companies such as Samsung, which glued batteries on its phone model Note7.[37] Not only does this make it difficult to remove and replace batteries, resulting in more electronics discarded rather than repaired, but it also increases the risk of overheating and fire.[38] Electronic device parts, such as these batteries, are only recycled until they can be reused. However, once they reach the end of their usability, it is not profitable to recycle them. Unless these design issues are addressed through sustainable production, extended producer responsibility alone cannot mitigate this issue. Consequently, it is important to incorporate several policies to target different issues and form a cohesive solution.

The collection of electronic waste, having adequate infrastructure to properly recycle the materials, and the level of producer responsibility are major issues that the UNEP must address while prioritizing the mitigation of environmental harm.

Sustainable Production and Consumption of Electronic Devices

Electronic waste has previously been defined as the world's fastest-growing solid waste stream.[39] Between 2000 and 2019, e-waste production increased from 20–50 million tons per year.[40] More alarmingly, Solving the E-Waste Problem (StEP) Initiative, hosted by the United Nations University, estimated that by 2050, e-waste would double to 111 million tonnes per year.[41] This increase is largely due to an increased demand for the rapidly advancing technology brought by newer electronic devices.

UNEP has previously highlighted that Brazil, Mexico, and Senegal are generating more e-waste per capita than other countries.[42] In Brazil, the emerging middle class is contributing to the rising consumption of electronic devices.[43] In 2015, the e-waste production in Brazil was projected to increase from 6.5kg per year per inhabitant to eight kg per year per inhabitant.[44] The rising consumption of electronic devices is not endemic to Brazil. In the last two decades, electronics consumption doubled in Nordic countries as well.[45]

Unsustainable consumption is the primary result of individuals being unaware of the environmental impacts of their actions or due to consumers not paying the entire cost that is incurred. These additional costs include the collection of ma-

35 "Is There a Business Case for Product Take-Back? – Electronics TakeBack Coalition," Accessed June 7, 2020, http://www.electronicstakeback.com/2015/05/06/is-there-a-business-case-for-product-take-back/.
36 "Is There a Business Case for Product Take-Back?"
37 iFixit. "Batteries Explode—Stop Gluing Them Down," July 14, 2020, https://www.ifixit.com/News/8464/batteries-explode-note7.
38 iFixit. "Batteries Explode—Stop Gluing Them Down."
39 United Nations University, "With E-Waste Predicted to Double by 2050, Business as Usual Is Not an Option - United Nations University," Accessed June 3, 2020, https://unu.edu/news/news/with-e-waste-predicted-to-double-by-2050-business-as-usual-is-not-an-option.html.
40 "With E-Waste Predicted to Double by 2050, Business as Usual Is Not an Option - United Nations University."
41 "With E-Waste Predicted to Double by 2050, Business as Usual Is Not an Option - United Nations University."
42 World Bank, "Sustainable E-Waste Management, Key for Future Protection of Brazil's Environment," Text/HTML. Accessed June 3, 2020, https://www.worldbank.org/en/news/feature/2013/02/04/e-waste-management-tablets-phones-computers-Brazil-environment-sustainable-development.
43 "Sustainable E-Waste Management, Key for Future Protection of Brazil's Environment."
44 "Sustainable E-Waste Management, Key for Future Protection of Brazil's Environment."
45 "Nudging for Sustainable Consumption of Electronics | Nordic Cooperation," Accessed June 8, 2020, https://doi.org/10.6027/ANP2016-728.

terials for disposal and the cost to recycle them efficiently. The costs can be recovered through providing more information regarding proper disposal of the goods or collecting a tax at the time of purchase to account for future disposal counts.[46] Consequently, the producer is not paying the negative costs associated with environmental pollution by focusing on investing in the prevention of environmental harm at the start of an electronic device's life-cycle. Research questionnaires given out to consumers at the time of purchase of electronics by researchers indicate that younger consumers prefer sustainable consumption and would prefer to recycle mobile devices.[47] However, lack of knowledge regarding ways to recycle, where to buy older phones, repair devices, or other methods for reducing the environmental footprint prevent these consumers from acting sustainably.[48] The lack of sustainable consumption is indicated by the rising amounts of e-waste generated per person and the decreased life-span of electronic devices that are discarded rather than repaired.[49] A research study also found that presenting green alternatives and information regarding the environmental impact of electronic devices at the time of purchase can help these consumers act sustainably.[50] This indicates that policies that focus on providing information to consumers regarding proper disposal methods and options such as device repair and sustainable alternatives can increase sustainable consumption.

While sustainable consumption can include responsible disposal of devices, repairing devices when possible, and opting for more sustainable alternatives, there is also a need for sustainable production. One of the main efforts to offset the environmental impacts of increased electronic consumption has been placing an increased emphasis on producer responsibility. Ideally, all electronics would be returned to the producer upon disposal.[51] However, recently the United Nations has emphasized the need for managing electronics for the duration of their entire lifecycle.[52] A statement by the Issue Management Group on Tackling E-waste recognized that the production and design stages of electronic devices are often ignored when it comes to environmental policies.[53] There is a need to focus on mitigating the environmental impact of electronics at each stage of their lifecycle. Focusing specifically on policies for formalizing an effective recycling practice cannot reach its full potential until policies for sustainable production, which allow for easier repair and recycling, are also implemented. Both end-of-life and manufacturing level policies depend on sustainable consumption in which consumers actively repair electronic devices and recycle rather than dispose of them in landfills. The interconnected nature of production level, consumer level, and end of life disposal policies will be most effective when working together to address e-waste disposal.

A large aspect of sustainable production is changing the design of the product to mitigate environmental harm. Sustainable design can be defined as the design of devices, which reduces the amount of toxic material used and improves the ability to repair and recycle the device components.[54] Transporting electronics safely is a large issue for manufacturers. With increased globalization and shipping of electronics to

A modern computer electronics store

46 "Nudging for Sustainable Consumption of Electronics | Nordic Cooperation."
47 "Nudging for Sustainable Consumption of Electronics | Nordic Cooperation."
48 "Nudging for Sustainable Consumption of Electronics | Nordic Cooperation."
49 "Sustainable E-Waste Management, Key for Future Protection of Brazil's Environment."
50 "Nudging for Sustainable Consumption of Electronics | Nordic Cooperation."
51 "Nudging for Sustainable Consumption of Electronics | Nordic Cooperation."
52 "United Nations and E-Waste: system-wide action on addressing the full life-cycle of electrical and electronic waste," Accessed June 2, 2020, https://unemg.org/wp-content/uploads/2018/11/INF1.pdf.
53 "United Nations and E-Waste: system-wide action on addressing the full life-cycle of electrical and electronic waste."
54 "The Elements of Sustainable Design in the Consumer Electronics Industry."

various cities, the protection of fragile devices must be balanced with the sustainable use of foam. The generic term foam is used to refer to packaging materials that prevent damage to devices during shipment. To improve this, recently, a new biodegradable foam was engineered by researchers using agricultural waste and a fungus called mycelium.[55] While this discovery is relatively new, it shows promise for decreasing the environmental impact of electronics. While this can be done by making larger changes, such as replacing materials to be more easily recycled, several smaller actions can also be taken by private corporations. For instance, using this foam rather than to the older, less sustainable foam, which is currently used, reduces the waste associated with shipping electronic products to consumers. Reassessing the need for additional electronic accessories, such as an extra charger, can also reduce the environmental footprint. Designing products to be compatible with screwdrivers for easy repair and disassembly can also extend the lifetime of the device and improve recycling efficiency.[56]

The Waste Electrical and Electronic Equipment Directive (WEEE) has urged member states to ensure the production of electronic equipment with the ease of dismantling and recovery as a priority.[57] Extended producer responsibility (EPR) is a policy where the producer is responsible for the safe disposal and recycling of electronic devices, a popular method for encouraging sustainable design.[58] Countries such as Canada defend EPR as a form of "polluter-pays-principle" policy in which the producer, which incurs the environmental footprint, is responsible for paying for it. However, the increasing complexity of electronic products and the cost of labor mean that sustainable design is difficult to achieve for smaller producers.[59] Therefore, while EPR programs are sometimes voluntarily initiated, it is more often enforced through legislation.[60] Legislative enforcement is particularly common for devices that are harder to recycle and, therefore, less profitable for the producers to take back.

To overcome the issue of cost in recycling, Canada formed environmental handling fees (EHFs). EHFs are collected at the point of purchase to fund programs to subsidize producers for the costs of recycling the waste.[61] This program began with only a few electronic devices covered, such as printers and monitors, but has gradually grown to include more devices.[62] Therefore, EPR encourages producers to properly recycle electronic materials due to the incentive of recovered materials. It also prevents taxpayers from having to shoulder the entire cost of infrastructure and management of recycling facilities for electronic waste. These policies encourage sustainable design due to the incentive at the end of the product's life cycle. China and India, two countries with national legislation addressing e-waste, both have take-back policies covering over four billion people.[63] However, it is also important to note that just legislation on take-back policies does not necessarily make them successful. Gaps in legislation, such as take-back policies that only apply to certain appliances that are easier for the manufacturer to recycle, limit the impact these policies have. Consequently, expanding on these policies while prioritizing environmental concerns and economic concerns of the manufacturer is necessary for complete coverage.

Sustainable production and consumption are essential to mitigate the environmental impacts of electronic waste. Providing consumers alternative, more environmentally friendly options can decrease the environmental footprint of purchases and reduce waste produced at the end of a product's life cycle. Furthermore, providing information regarding the proper disposal of products at the point of purchase has also shown promising results for preventing electronics from being discarded in landfills. Shifting the responsibility to producers for

55 "The Elements of Sustainable Design in the Consumer Electronics Industry."
56 "The Elements of Sustainable Design in the Consumer Electronics Industry."
57 Lauridsen, Erik Hagelskjær, and Ulrik Jørgensen. "Sustainable Transition of Electronic Products through Waste Policy," *Research Policy*, Special Section on Innovation and Sustainability Transitions, 39, no. 4 (May 1, 2010): 486–94, https://doi.org/10.1016/j.respol.2010.01.021.
58 Lauridsen and Jørgensen, "Sustainable Transition of Electronic Products through Waste Policy."
59 Lauridsen and Jørgensen, "Sustainable Transition of Electronic Products through Waste Policy."
60 Canada, Environment and Climate Change. "Introduction to Extended Producer Responsibility," Frequently asked questions. aem, January 13, 2010, https://www.canada.ca/en/environment-climate-change/services/managing-reducing-waste/overview-extended-producer-responsibility/introduction.html.
61 "Electronics Recycling Stewardship Programs in Canada."
62 "Electronics Recycling Stewardship Programs in Canada."
63 "United Nations and E-Waste: system-wide action on addressing the full life-cycle of electrical and electronic waste."

the entire lifecycle of the product also ensures that sustainable design is implemented at the production stage and that taxpayers are not shouldering the entire burden of e-waste disposal. Through sustainable production and consumption, the environmental harm caused by e-waste can be drastically reduced.

Harmful Effects on Agriculture

Improper disposal of electronic waste can have detrimental impacts on soil and agriculture. E-waste contains several toxic elements such as lead, mercury, and beryllium.[64] When these elements are released into the environment, they often negatively impact both human health and the environment. Pollution of these toxic elements is due to the unregulated processing of e-waste, including burning, melting, and using acid baths to dispose of electronics.[65] As a result, toxic elements are released into terrestrial ecosystems. Many view this as particularly alarming since these toxic materials are non-biodegradable and will remain in the environment for several years.[66] For example, burning e-waste in landfills results in these toxic elements being released into the environment as smoke. The wind pattern can carry these elements to enter the soil-crop-food pathway and enter the food chain, impacting humans, and wildlife.[67]

Improper disposal of e-waste, such as disposal in landfills or incineration, releases toxins in an uncontrolled manner. For example, copper is used in printed wiring boards of electronic devices and seeps into the soil from landfills if not dismantled in a recycling facility.[68] The metal accumulates on the surface of the soil with limited downward migration.[69] Another mechanism of contamination of soil is through acid treatment, which is a hazardous process for disposing of electronic devices and collecting metals.[70] However, this method leaves residues in acid drums which are directly disposed of into the land, resulting in contaminated soil.[71] Therefore, this unregulated disposal practices result in significant environmental harm. The contamination of soil is particularly alarming due to the potential for these toxic elements to enter crops and, consequently, animals and humans through the consumption of those crops. As a result, this contamination has the potential to bioaccumulate, increasing in concentration as it goes up the food chain.

Soil contaminated by these toxic elements from e-waste disposal is also associated with the contamination of crops.[72] This is particularly important since the soil-crop-food pathway is the most common source of exposure to toxic elements for humans.[73] Moreover, the residual plant components are often fed to livestock, which is another route for toxic elements to impact animals and human consumers.[74] A research study done by independent researchers aimed to investigate the contamination of crops due to improper e-waste disposal. Researchers found that the majority of e-waste disposal sites are in rural areas close to farms.[75] It was found that soil samples near e-waste disposal sites were contaminated with high levels of toxic metals and were not suitable for healthy vegetation growth.[76] A second independent research study confirmed these results and additionally found that soil samples from near disposal sites had high levels of cadmium, copper, and

64 Dharini et al., "Hazardous E-Waste and Its Impact on Soil Structure."
65 Fu, Jianjie, Qunfang Zhou, Jiemin Liu, Wei Liu, Thanh Wang, Qinghua Zhang, and Guibin Jiang, "High Levels of Heavy Metals in Rice (Oryzasativa L.) from a Typical E-Waste Recycling Area in Southeast China and Its Potential Risk to Human Health," Chemosphere 71, no. 7 (April 1, 2008): 1269–75, https://doi.org/10.1016/j.chemosphere.2007.11.065.
66 Dharini et al., "Hazardous E-Waste and Its Impact on Soil Structure."
67 Dharini et al., "Hazardous E-Waste and Its Impact on Soil Structure."
68 Susmita Saha,"E-Waste Contaminating Delhi's Groundwater and Soil," Businessline, Accessed June 9, 2020, https://www.thehindubusinessline.com/news/science/ewaste-contaminating-delhis-groundwater-and-soil/article10039362.ece.
69 Saha, "E-Waste Contaminating Delhi's Groundwater and Soil."
70 Saha, "E-Waste Contaminating Delhi's Groundwater and Soil."
71 Saha, "E-Waste Contaminating Delhi's Groundwater and Soil."
72 Fu et al., "High Levels of Heavy Metals in Rice (Oryzasativa L.) from a Typical E-Waste Recycling Area in Southeast China and Its Potential Risk to Human Health."
73 Fu et al., "High Levels of Heavy Metals in Rice (Oryzasativa L.) from a Typical E-Waste Recycling Area in Southeast China and Its Potential Risk to Human Health."
74 Fu et al., "High Levels of Heavy Metals in Rice (Oryzasativa L.) from a Typical E-Waste Recycling Area in Southeast China and Its Potential Risk to Human Health."
75 Dharini et al., "Hazardous E-Waste and Its Impact on Soil Structure."
76 Dharini et al., "Hazardous E-Waste and Its Impact on Soil Structure."

mercury in particular.[77] Finally, a third scientific study in China compared soil contamination levels before and after the informal dismantling of electronic devices being made illegal.[78] It was found that contamination of soil decreased from 590ug per kg in 2011 to 407ug per kg in 2016.[79] While researchers noted the decrease, it was concluded that more significant action needs to be taken to mitigate the soil pollution caused by e-waste disposal.[80] These actions could be in the form of adding additional linings to landfills to catch any toxins before they are released into the soil. It is also important to note that the high levels of soil contamination, especially since most disposal sites are in rural agricultural areas, also translates into higher levels of toxins in crops as well as lower crop yield. It is important to note that incorporating advanced landfill linings has the added advantage of preventing leachate from other waste, not just electronics, from entering the soil. In addition to impacting the soil-crop-food pathways, these toxins also harm local ecosystems and organisms negatively. For instance, these toxic metals can bioaccumulate and cause severe reproductive and neurological harm to local species. Biomagnification refers to the increase in the concentration of the toxin in species higher up the food chain. From a human-centric standpoint, this idea of biomagnification is especially troubling considering human's placement at the top of the food chain, often consuming diets high in animal products. The toxicity can cause local organisms which are more sensitive to metal concentrations to die or have deformities preventing effective reproduction.[81]

In addition to individual governments tackling soil pollution, the UNEP is also committed to remediated soil contamination. UNEP/EA.3/Res.6, Managing Soil Pollution to Achieve Sustainable Development called for a report to analyze the contamination of soil from both point sources and from diffusion.[82] This progress report, presented at UNEA-4, highlighted the need for innovative solutions to clean previously contaminated soil and emphasized the negative impacts soil contamination has on ecosystems and agriculture.[83]

With this in mind, there are examples of countries that have taken action to regulate disposal practices. For example, in India, the use of acid drums to recover precious metals is illegal.[84] Acid drums are used to refer to the informal and unstandardized practice of dipping electronic devices into drums of acid, such as sulfuric acid, to separate their components. It is difficult to enforce this policy primarily due to the monetary incentive of recovering metals and then selling them for profit, which motivates locals to continue this activity illegally. However, in India, police have successfully shut down 600 illegal e-waste disposal sites in a year by monitoring spike in pollutants and observing air quality.[85] It is important to note that significant work still needs to be done globally to continue protecting the soil and agriculture from contamination.

Efforts have also been undertaken by UNEP to clean contaminated soil and restore it to be suitable for agriculture. In 2019, the Republic of Serbia identified 14 former industrial sites for

77 Fu et al., "High Levels of Heavy Metals in Rice (Oryzasativa L.) from a Typical E-Waste Recycling Area in Southeast China and Its Potential Risk to Human Health."
78 He, Mingjiang, Shiyan Yang, Jian Zhao, Chris Collins, Jianming Xu, and Xingmei Liu, "Reduction in the Exposure Risk of Farmer from E-Waste Recycling Site Following Environmental Policy Adjustment: A Regional Scale View of PAHs in Paddy Fields," *Environment International* 133 (December 1, 2019): 105136, https://doi.org/10.1016/j.envint.2019.105136.
79 He et al., "Reduction in the Exposure Risk of Farmer from E-Waste Recycling Site Following Environmental Policy Adjustment."
80 Fu et al., "High Levels of Heavy Metals in Rice (Oryzasativa L.) from a Typical E-Waste Recycling Area in Southeast China and Its Potential Risk to Human Health."
81 Ali, Hazrat, Ezzat Khan, and Ikram Ilahi. "Environmental Chemistry and Ecotoxicology of Hazardous Heavy Metals: Environmental Persistence, Toxicity, and Bioaccumulation." Review Article. Journal of Chemistry. Hindawi, March 5, 2019. https://doi.org/10.1155/2019/6730305
82 Wangu Mwangi, "UNEP Outlines Integrated Actions to Tackle Soil Pollution in Preparation for UNEA-4 | News | SDG Knowledge Hub | IISD," February 26 2019, https://sdg.iisd.org:443/news/unep-outlines-integrated-actions-to-tackle-soil-pollution-in-preparation-for-unea-4/.
83 Wangu Mwangi, "UNEP Outlines Integrated Actions to Tackle Soil Pollution in Preparation for UNEA-4 | News | SDG Knowledge Hub | IISD."
84 Abhijay Jha| TNN | Updated:, 2019, and 10:08 Ist. "Loni's Acid Drums Take Care of Delhi's e-Waste but Poison Air | Ghaziabad News - Times of India," The Times of India, Accessed June 10, 2020, https://timesofindia.indiatimes.com/city/ghaziabad/lonis-acid-drums-take-care-of-delhis-e-waste-but-poison-air/articleshow/71828104.cms.
85 Abhijay Jha, "Loni's Acid Drums Take Care of Delhi's e-Waste but Poison Air | Ghaziabad News - Times of India."

soil remediation from hazardous waste disposal.[86] UNEP is currently collaborating with the Serbian government to collect and analyze soil samples.[87] An important aspect of soil remediation is deciding which sites need to be prioritized for treatment, which is often based on their proximity to communities, impact on the soil-crop-food pathways, and vulnerability of the ecosystem. UNEP worked to train local officials on creating criteria for prioritizing clean-up and assisted in the creation of a hotspot map to manage data and document land degradation.[88] Collecting these soil samples and applying novel methodologies to analyze contamination levels is the first essential step towards remediating contaminated soil.

There have been several recent remediating contaminated soil. Photo-remediation, a process through which plants absorb contaminants from soil and make it safer, is a growing field in biology.[89] These specific plants can metabolize toxic chemicals, including hard metals from improper disposal of electronic wastes, into other metabolites. After harvesting these plants, they can be burned so that the toxins remain in their ash, which is significantly easier to dispose of than tons of contaminated soil.[90] It has also been suggested that, for example, edible plants that take up zinc can be given to individuals with zinc deficiencies.[91]

For example, Brazil had extraordinary success using photo-remediation. Abandoned gold mines were exposing mercury into the soil, and this toxic metal was taken up by grass, which was eaten by cows, and eventually entered foods for human consumption as well.[92] Contaminated crops mean that these toxic elements can enter humans and cause many issues ranging from neurological disorders to metabolic issues. It is particularly harmful due to bioaccumulation, where even if the crops have limited concentration of these elements, the concentration can grow exponentially by the time it reaches humans. By growing maize and canola in the contaminated soil, farmers could rid the soil of mercury and gold.[93] It was estimated that each hectare of planted maize and canola would recover a kilogram of gold to help pay for the costs of this project. The Willow tree is another example of a hyperaccumulator, absorbing copper, zinc, and cadmium, among other heavy metals.[94] Because of these biological differences, different species are harmed at varying degrees, and humans that rely on these species will feel the negative impacts of bioaccumulation disproportionately. These toxins are the same chemicals that are released through improper disposal of electronic waste. Therefore, it is promising that these techniques can be applied to the issue of e-waste and soil contamination as well.

However, it is important to note that photo-remediation is not the sole solution. There are certain limitations, such as the fact that the plants must be suitable for the climate of the area and not be an invasive species. They also require time to grow and take up the toxins. Therefore, to effectively prevent contamination, delegates must address the underlying issues and limitations of current regulations on the disposal of e-waste. This is important since proactive policies preventing contamination will likely have a larger impact than reactive policies working to fix contamination, which occurs at a higher rate than what can be remediated using techniques such as photo-remediation. On the other hand, the advantage of photo-remediation is that it is easy to scale by educating farmers even with limited funding and equipment.[95]

The improper disposal of electronic waste has detrimental impacts on soil. The toxic elements which enter the soil-crop-food pathway, including mercury and cadmium, are non-biodegradable and remain in the soil for several years. UNEP has stated its commitment to addressing soil pollution and undertaken projects to monitor the contamination and prioritize

86 UNEP - UN Environment Programme, "UNEP Lays the Groundwork for Cleaner Soil in Serbia," Accessed June 10, 2020, http://www.unenvironment.org/news-and-stories/press-release/unep-lays-groundwork-cleaner-soil-serbia.
87 "UNEP Lays the Groundwork for Cleaner Soil in Serbia."
88 "UNEP Lays the Groundwork for Cleaner Soil in Serbia."
89 Resilience, "Using Plants to Clean Contaminated Soil," August 11, 2014. https://www.resilience.org/stories/2014-08-11/using-plants-to-clean-contaminated-soil/.
90 "Using Plants to Clean Contaminated Soil."
91 "Using Plants to Clean Contaminated Soil."
92 "Using Plants to Clean Contaminated Soil."
93 "Using Plants to Clean Contaminated Soil."
94 "Using Plants to Clean Contaminated Soil."
95 "Using Plants to Clean Contaminated Soil."

clean-up. In addition to addressing unregulated disposal of electronic waste, such as acid treatments, cleaning previously contaminated soil is also a priority. The remediation of soil is essential to prevent toxic chemicals from harming ecosystems and contaminating crops to unsafe levels of consumption.

Impact of E-waste on Water Sanitation

In addition to contaminating soil, improper disposal of e-waste also has detrimental effects on bodies of water and water sanitation. A common misconception is that e-waste must directly be disposed of in bodies of water to contaminate it. However, e-waste disposed of in landfills, due to it not being biodegradable, can leach into the soil and ultimately also contaminate groundwater.[96] These contaminants can also travel to larger bodies of water and result in bioaccumulation of marine life, particularly in blubber. The unregulated burning of e-waste as a method of disposal also allows these toxins to be absorbed by the atmosphere and enter the water cycle as acid rain.[97]

An example of negative impacts on aquatic ecosystems is that the unregulated disposal of electronic wastes can release lithium into water systems. Lithium is commonly used in batteries to power smartphones, tablets, and even electric cars.[98] The mineral is also naturally in the Earth's crust, soil, and water. Therefore, low levels of lithium are naturally found in drinking water. To test the impacts of consumer electronics on lithium concentrations in the Han River, which travels through South Korea, researchers measured lithium upstream and then downstream of the metropolitan area of Seoul.[99] Researchers concluded that after the Han river ran through Seoul, concentrations of lithium were six times higher than they were upstream. After testing potential sources of the additional lithium in the river, researchers hypothesized that lithium entered the river from lithium-ion batteries disposed of at incineration systems and illegal landfills.[100] Therefore, it can be concluded that inefficient e-waste disposal can result in significant water pollution. More alarmingly, cleaning hard metals such as lithium from water would require more advanced infrastructure, which is often missing, and it is difficult to remove from drinking water.

The increased concentration of these heavy metals has large impacts on aquatic ecosystems. For example, mercury from circuit boards and batteries can contaminate marine life and impact the food chain.[101] It can reduce reproduction in fish, cause behavioral changes, and increase in concentration through the food chain to eventually reach human consumers as well.[102] The accumulation of toxic chemicals is harming the already endangered marine life. For example, polybrominated diphenyl ethers (PBDEs) are used as plastic casings for electronic equipment.[103] The concentration of these chemicals is rising exponentially and accumulates in the blubber of seals and killer whales, which are endangered species. PBDEs can cause a plethora of issues ranging from affecting neurological development to reducing reproduction.[104] It is essential to address toxins in bodies of water to protect aquatic ecosystems and these endangered species.

In addition to aquatic ecosystems, the contamination of water also directly impacts human health and sanitation of drinking water. The World Health Organization (WHO) recommends that the concentration of mercury, which has been shown to harm aquatic life, should be no higher than one ppb.[105] This is because, in addition to harming aquatic life, contaminating drinking water with this neurotoxin can drastically harm human health. Mercury is associated with harming the brain,

96 "Examining the Impact of EWaste on Marine Life," Belmont Trading, January 30, 2017, http://www.belmont-trading.com/2017/01/examining-the-impact-of-ewaste-on-marine-life/.
97 "Examining the Impact of EWaste on Marine Life."
98 Environment, P. M. N, "Lithium from Electronic Waste Can Contaminate Water Supply | National Post," December 18, 2019, https://nationalpost.com/pmn/environment-pmn/lithium-from-electronic-waste-can-contaminate-water-supply.
99 Environment, "Lithium from Electronic Waste Can Contaminate Water Supply | National Post."
100 Environment, "Lithium from Electronic Waste Can Contaminate Water Supply | National Post."
101 "Examining the Impact of EWaste on Marine Life."
102 "Examining the Impact of EWaste on Marine Life."
103 "Examining the Impact of EWaste on Marine Life."
104 "Examining the Impact of EWaste on Marine Life."
105 Oehmen, Adrian, Rui Viegas, Svetlozar Velizarov, Maria A. M. Reis, and João G. Crespo, "Removal of Heavy Metals from Drinking Water Supplies through the Ion Exchange Membrane Bioreactor," *Desalination*, Euromembrane 2006, 199, no. 1 (November 20, 2006): 405–7, https://doi.org/10.1016/j.desal.2006.03.091.

This plastic-lined leachate pond in a landfill helps prevent toxic contaminants from entering the soil and groundwater

heart, and kidneys, with unborn and young children most susceptible to nervous system damage.[106] The Minamata Convention, an international treaty focusing on protection from the harmful effects of mercury, highlighted the need for regulations for the safe storage and disposal of mercury in 2017. For example, the convention discussed controlling emissions for key industries, including the incineration of products containing mercury.[107] Mercury is also used in other industries; it is used in the process to make vinyl chloride and in small scale gold mining. However, there are some policies in place for these industries. For example, the Minamata Convention urges countries to use alternatives to medical equipment that use mercury, such as thermometers, and measures are in place to phase out the use of mercury in producing vinyl chloride.[108] However, mercury and other toxic elements continue to be used in manufacturing electronic devices. This is partly due to the historical infrastructure of electronic device design focused on using metals such as mercury. These factors result in an increased need to dispose of them safely.

Efforts have been made to reduce the amount of heavy metals used in electronic devices. Lead, another hard metal that can accumulate in humans and be taken up by bones, is also used in electronic devices. An excess of lead can result in lead poisoning, which can be fatal.[109] Most notably, transmitters and receivers in electronic equipment contain lead. To prevent lead from leaching into water sources, scientists have focused their research on replacing it with less hazardous materials. Through research, an innovative film, consisting of crystals, has been developed that can replace lead in electronic devices.[110] This film avoids using non-biodegradable metals such as lead and is, therefore, easier to dispose of and less harmful to the environment. Therefore, preventing hazardous elements from electronic waste from entering water systems has a close connection with sustainable production and changing the design of electronic equipment to be more sustainable.

106 UNEP - UN Environment Programme, "World Unites Against Mercury Pollution," accessed June 13, 2020, http://www.unenvironment.org/news-and-stories/press-release/world-unites-against-mercury-pollution.
107 "World Unites Against Mercury Pollution."
108 "World Unites Against Mercury Pollution."
109 ScienceDaily, "Harmless Elements Can Replace Toxic Lead in Electronics," accessed June 15, 2020, https://www.sciencedaily.com/releases/2017/07/170712074318.htm.
110 "Harmless Elements Can Replace Toxic Lead in Electronics."

To prevent the impact improper e-waste disposal has on water systems, it is essential to have regulations in place. Similar to contaminating soil, regulating the burning of and disposing of e-waste in landfills will decrease the contamination of water systems. Using liners such as 2-polyethylene for landfills can prevent leachate from entering groundwater.[111] Leaching, a process through which hazardous substances can enter the environment and contaminant soil and water after being disposed of in landfills, is prevented by having this additional barrier between the soil and groundwater and the landfill. These barriers also allow for the leachate to be collected and pumped to leachate treatment lagoons, where it can be treated in an environmentally safe method.[112] Ultimately, the issue starts at the ineffective recycling policies for e-waste. Consequently, policies focusing on improving landfills are reactionary rather than preventative policies focused on better recycling measures.[113] Therefore, there is a continued need to focus on recycling electronics and reusing materials rather than disposing of them in landfills.[114]

The issue of already contaminated water, which is no longer sanitary for drinking and is harmful to aquatic life, must also be addressed. In the past, the introduction of filtration methods such as ion-exchange resins, which utilize attraction between opposite charges to clear a solution from charged particles such as metals, have successfully removed heavy metals from water sources. However, the technology is often too expensive for developing nations or rural areas to implement.[115] More recently, the focus has been shifted to biosorbents that can be obtained at a low cost. Biosorption is the ability of biological materials to absorb toxins such as heavy metals from the soil or water. Consequently, the contamination of the soil or water is reduced, and toxins are accumulated in the biological material. For example, research has shown that cilantro is effective in removing hard metals such as lead from water sources as well.[116] By planting cilantro, often locally grown, in strategic locations, toxic elements from water sources can be reduced. These natural materials are often cheaper and more accessible, especially in rural areas, to purify contaminated water.

UNEA must address the issue of electronic waste contaminating water sources and harming both aquatic life and sanitation of drinking water. This is highly interconnected with sustainable production, by replacing hard metals in electronic devices, and regulations for disposal, to prevent leaching in landfills and promote recycling. Addressing water contamination resulting from improper disposal of electronic waste will increase water sanitation and protect marine life.

Improper E-waste Management and the Greenhouse Gas Effect

Heavy metals in e-waste not only contaminate soil and water but also have large impacts on the atmosphere. These toxic elements are resistant to decomposition, drastically altering the biogeochemical cycling of these toxic elements.[117] Informal recycling of electronic wastes such as printed circuit boards is often unregulated and resorts to the open burning of waste.[118] Using incineration as a method of disposal is illegal in many countries, such as India.[119] However, unregulated facilities continue to operate not only in India but in several countries despite being illegal. These disposal methods release fine particulate matter into the atmosphere and result in significant air pollution.[120]

Illegal operations often use rudimentary methods such as

111 Abd El-Salam, Magda M., and Gaber I. Abu-Zuid, "Impact of Landfill Leachate on the Groundwater Quality: A Case Study in Egypt," *Journal of Advanced Research* 6, no. 4 (July 1, 2015): 579–86, https://doi.org/10.1016/j.jare.2014.02.003.
112 Abd El-Salam and I. Abu-Zuid, "Impact of Landfill Leachate on the Groundwater Quality."
113 Dagan, Roi, Brajesh Dubey, Gabriel Bitton, and Timothy Townsend, "Aquatic Toxicity of Leachates Generated from Electronic Devices," Archives of Environmental Contamination and Toxicology 53, no. 2 (August 1, 2007): 168–73, https://doi.org/10.1007/s00244-006-0205-1.
114 Dagan et al., "Aquatic Toxicity of Leachates Generated from Electronic Devices."
115 American Chemical Society, "Cilantro, That Favorite Salsa Ingredient, Purifies Drinking Water," accessed June 15, 2020, https://www.acs.org/content/acs/en/pressroom/newsreleases/2013/september/cilantro-that-favorite-salsa-ingredient-purifies-drinking-water.html.
116 "Cilantro, That Favorite Salsa Ingredient, Purifies Drinking Water."
117 Gangwar, Charu, Ranjana Choudhari, Anju Chauhan, Atul Kumar, Aprajita Singh, and Anamika Tripathi, "Assessment of Air Pollution Caused by Illegal E-Waste Burning to Evaluate the Human Health Risk," *Environment International* 125 (April 1, 2019): 191–99, https://doi.org/10.1016/j.envint.2018.11.051.
118 Gangwar et al., "Assessment of Air Pollution Caused by Illegal E-Waste Burning to Evaluate the Human Health Risk."
119 Gangwar et al., "Assessment of Air Pollution Caused by Illegal E-Waste Burning to Evaluate the Human Health Risk."
120 Gangwar et al., "Assessment of Air Pollution Caused by Illegal E-Waste Burning to Evaluate the Human Health Risk."

Workers burn electronic cables to salvage the copper from the interior wires

acid baths to recover materials and often burn waste openly. These practices release toxic fumes, which result in significant air pollution. In a study, researchers found that areas around these informal e-waste disposal sites had up to 243ug/m^3 concentration of particulate matter.[121] This is significantly higher than the National Ambient Air Quality Standard of 100ug/m^3, indicating that the air quality surrounding informal e-waste disposal centers is poor, and there is a high concentration of toxic particulate matter polluting it.[122] It is important to note that while the immediate impacts of air pollution are apparent on residents, the potential for these pollutants to enter the water cycle as acid precipitation and their movement through the atmosphere means that there are drastic long term consequences as well.

In addition to air pollution, these toxic fumes have detrimental impacts on the health of residents, typically in rural areas. Inhaling fumes of heavy metals such as cadmium and copper can result in acute lung damage and pulmonary and cardiovascular disease.[123] In a study, researchers investigated the relationship between the illegal burning of electronic waste and the health of residents. It was concluded that chronic exposure to air pollution led to residents having a high prevalence of cardiovascular morbidities, such as hypertension.[124] They also found that high atmospheric concentrations of heavy metals correlated with high blood concentrations of these metals in local residents, emphasizing that the health risk of the pollution caused by e-waste is significant and cannot be ignored. UNEP has previously recognized the significant health risks associated with lead and cadmium and urged for legislation reducing their use in items such as paint.[125] Therefore, it is apparent that the release of large quantities of these heavy metals is a large environmental and health concern. The burning of e-waste is often considered a cheaper method of disposal. However, efficient and formal recycling methods such

121 Gangwar et al., "Assessment of Air Pollution Caused by Illegal E-Waste Burning to Evaluate the Human Health Risk."
122 Gangwar et al., "Assessment of Air Pollution Caused by Illegal E-Waste Burning to Evaluate the Human Health Risk."
123 Gangwar et al., "Assessment of Air Pollution Caused by Illegal E-Waste Burning to Evaluate the Human Health Risk.
124 Gangwar et al., "Assessment of Air Pollution Caused by Illegal E-Waste Burning to Evaluate the Human Health Risk."
125 "Resolutions and Decisions adopted by the United Nations Environment Assembly of the United Nations Environment Programme at its first session on 27 June 2014," Accessed June 14, 2020, https://wedocs.unep.org/bitstream/handle/20.500.11822/17285/K1402364.pdf?sequence=3&isAllowed=y.

as high-pressure water often result in the recovery of more material, are safer for workers, and are more sustainable.

Considering these health and environmental concerns, many countries have policies against rudimentary methods such as acid baths and incineration. For example, in 2018, the Pollution Control Department of Malaysia and the governor of the province of Kalasin banned the burning of electronic waste and the disposal of items containing lead into agricultural fields and water to protect crops from lead poisoning.[126] Before that, the Public Health Act of 1992 allowed officials to arrest and press charges against illegal e-waste disposal centers that release these toxic fumes. However, in 2018, the Pollution Control Department found 181 individuals continuing to informally sort and discard e-waste.[127] The issue is particularly nuanced since each individual earns approximately 20,000 Baht per month from these activities, indicating that households depend on these centers for income. Local residents of a village 2km from the burning sites are also suffering from pulmonary issues. While in 2016, 627 locals had breathing problems, in 2018, after the ban, this number dropped to 522.[128] Considering the small decrease, it is important to note that a large issue with e-waste is the lack of information and statistics available to government officials. Consequently, it is difficult to make concrete conclusions regarding the effectiveness of policies. Therefore, while there was a slight decrease, there is still significant work to be done to end the informal processing of electronic waste.

Furthermore, the United Nations has recognized the importance of considering the environmental impact of electronic devices through their whole lifecycle.[129] In addition to air pollution caused by the informal disposal of electronic devices, the manufacturing of these devices also poses significant environmental harm. For example, air emissions from the manufacturing of printed circuit boards produce sulfuric and hydrochloric acids, chlorine, and ammonia, among other toxic emissions.[130] Manufacturing of semiconductors, used in electrical circuits of electronic devices, is also responsible for the emission of toxic and hazardous gases; however, environmentally friendly policies can be implemented at the manufacturing stage to mitigate these issues. For instance, steps in the manufacturing of semiconductors which involve carcinogenic substances can be carried out in closed systems to prevent gas emissions.[131]

Several countries report a decrease in gas emissions due to electronic manufacturing. However, it is important to analyze the underlying reason for the decrease and the policies responsible. For instance, US data from the Toxic Release Inventory indicate that the chemical releases from the electronics manufacturing industry have declined over time.[132] However, this decline is largely due to manufacturing being shifted to other countries overseas rather than policies to protect the environment.[133] This indicates that national legislation has largely prioritized decreasing costs and avoiding the environmental protection aspect of electronics. Furthermore, consumption rates of electronic devices have increased globally, which drives up the demand for faster manufacturing. Therefore, it is important to note that while some countries may have higher rates of emission than others, the issue of gas emissions from electronic devices is an issue that must be addressed globally.

The issue of air pollution resulting from electronic devices is also crucial for addressing soil and water contamination. Air pollution results in contamination of precipitation, often in areas far from the site of e-waste disposal. For example, acid precipitation, which includes any form of precipitation with acidic components, can alter the chemistry of the soil and impact agriculture and crop production.[134] Increased soil acid-

126 The Isaan, "Kalasin's Burning e-Waste Dump Needs a Legal Fix," *The Isaan Record* (blog), September 23, 2019, https://isaanrecord.com/2019/09/23/kalasin-e-waste-burning-legal-fix/.
127 The Isaan, "Kalasin's Burning e-Waste Dump Needs a Legal Fix."
128 The Isaan, "Kalasin's Burning e-Waste Dump Needs a Legal Fix."
129 "United Nations and E-Waste: system-wide action on addressing the full life-cycle of electrical and electronic waste."
130 "Electronics Manufacturing Industry - Pollution Prevention Guidelines | Environmental XPRT," accessed June 15, 2020, https://www.environmental-expert.com/articles/electronics-manufacturing-industry-pollution-prevention-guidelines-1381.
131 "Electronics Manufacturing Industry - Pollution Prevention Guidelines | Environmental XPRT."
132 Josh Lepawsky, "Mapping USA Electronics Manufacturing Pollution," Discard Studies, March 18, 2019, https://discardstudies.com/2019/03/18/25-years-of-toxicants-from-us-computers-and-electronics/.
133 Lepawsky, "Mapping USA Electronics Manufacturing Pollution."
134 Canada, "Air Pollution."

A severe example of eutrophication, caused by pollutants that encourage the growth of algae

ity due to acid precipitation hinders its ability to retain nutrients and minerals, like potassium, which is essential for plant growth. Increased acidity of the soil increases the mobilization of heavy metals naturally found in the soil, which can then enter bodies of water at higher than normal rates.[135] Bodies of water can experience dramatic acidification in the spring, as contaminated snow from highland areas melt, releasing large amounts of contaminated water into rivers and streams.[136] For example, water bodies can experience large increases in plant and algae growth due to acid precipitation. Coastal waterways and estuaries, which are commonly deficient in nitrogen, are particularly vulnerable and can have an increase of nitrogen oxides due to acid precipitation. The culminated impact of this is eutrophication, which is the excessive growth of algae and microbes in bodies of water.[137] This growth is detrimental because once these plants die, their decomposition can deplete oxygen in the bodies of water. Consequently, this harms other organisms, such as fish, which would face lower levels of oxygen. It is important to note the interconnected nature of toxic gas emissions, which are a cause of acid precipitation and the contamination of soil and water systems.

Gas emissions released due to the production of and disposal of electronic devices pollute the air and negatively impact the health of residents. The issue of informal disposal facilities that rely on acid baths and incineration must be addressed. Sustainable production must also be a priority to prevent toxic gas emissions at the manufacturing stage of electronics. Due to the large environmental and health impact of electronic devices and gas emissions, the UNEA must address this topic.

Economics of E-waste

The majority of e-waste continues being generated in developed economies, with developing countries catching up quickly.[138] Historically, however, more developed countries have exported e-waste to less developed countries to avoid expensive

135 Canada, "Air Pollution."
136 Canada, "Air Pollution."
137 Canada, "Air Pollution."
138 China Water Risk, "Electronic Waste-Moving Mountains," accessed June 3, 2020. http://www.chinawaterrisk.org/resources/analysis-

disposal and environmental concerns.[139] It is estimated that 90 percent of electronic devices discarded by developed countries are exported to countries such as Pakistan and China.[140] Less developed nations often have fewer resources to effectively recycle e-waste and resort to disposal methods such as acid baths and incineration, further harming the environment and the health of local residents. The economics and responsibility of e-waste is a major global issue despite the UN and individual countries having stringent policies on the export of e-waste. These policies include legislation placing environmental responsibility on the producer, e-waste collection policies, and formal recycling procedures.

The UN Basel Convention on the Control of Transboundary Movement of Hazardous Wastes and their Disposal is a global effort to address the growing issue of e-waste disposal.[141] Most notably, the 1989 Basel Convention restricts the export of e-waste.[142] The treaty has been ratified by 186 states.[143] In particular, the Basel Convention regulates the transboundary movement of waste with parties to the convention having the obligation of disposing of the waste in an environmentally sound manner as close to the location of waste generation as possible. In 2006, the eighth meeting of the Conference of the Parties to the Basel Convention was the first world forum on addressing the issue of e-waste disposal.[144] At this forum, the Nairobi Declaration was adopted, which called for solutions for the environmentally safe management of e-waste. The Basel Convention is particularly concerned with the growing expansion of the transboundary transport of e-waste. Currently, the Basel Convention is the leading global instrument dealing with the export of e-waste, stronger enforcement of policies regarding e-waste, and the development of innovative solutions to develop sustainable and environmentally friendly e-waste management practices.[145] These policies, while well-intending, have significant limitations. Illegal export continues to occur due to a lack of shipment tracking, and the cheaper recycling options used in developing countries exacerbate the issue. As a result, delegates need to integrate various aspects, including recycling infrastructure, consumer education, and sustainable electronic design, to curb this complex issue.

There is still significant work to be done regarding the issue of exporting e-waste. The United States is the only developed country that has not ratified the Basel Convention.[146] Additionally, the US has no national legislation regarding e-waste, leaving management to individual states.[147] Along with the US, 15 states have no legislation regarding the management of e-waste.[148] On the other hand, the European Union has stringent laws regarding the export of electronic waste and has a 35 percent recycling rate, which is significantly higher than the recycling rate of the US.[149] However, illegal shipping of e-waste continues to occur even in Europe. For example, only three percent of shipments in Rotterdam, Netherlands, are checked, which means that an unknown number of illegal shipments continue to occur.[150] In one week, an average of one shipment is caught, which contains several containers with 800 monitors each.[151] In 2005, the European Commission estimated that 47 percent of e-waste being illegally exported was being shipped to Asia.[152] The primary reason these shipments continue to occur is that electronics are expensive and difficult to recycle and it is therefore easier to merely export them to developing countries.[153]

reviews/electronic-waste-moving-mountains/.
139 "Electronic Waste-Moving Mountains."
140 "Electronic Waste-Moving Mountains."
141 Oladele A. Ogunseitan, "The Basel Convention and E-Waste: Translation of Scientific Uncertainty to Protective Policy," *The Lancet Global Health* 1, no. 6 (December 1, 2013): e313–14, https://doi.org/10.1016/S2214-109X(13)70110-4.
142 "Electronic Waste-Moving Mountains."
143 Larmer, "E-Waste Offers an Economic Opportunity as Well as Toxicity."
144 Ogunseitan, "The Basel Convention and E-Waste."
145 Ogunseitan, "The Basel Convention and E-Waste."
146 Larmer, "E-Waste Offers an Economic Opportunity as Well as Toxicity."
147 Larmer, "E-Waste Offers an Economic Opportunity as Well as Toxicity."
148 Larmer, "E-Waste Offers an Economic Opportunity as Well as Toxicity."
149 Larmer, "E-Waste Offers an Economic Opportunity as Well as Toxicity."
150 Aidan Lewis, "Europe Shipping Electronic Waste," *BBC News*, August 4, 2010, sec. Europe, https://www.bbc.com/news/world-europe-10846395.
151 Lewis, "Europe Shipping Electronic Waste."
152 "Electronic Waste-Moving Mountains."
153 Lewis, "Europe Shipping Electronic Waste."

Electronic waste smuggled into China

There is clear economic value to exporting e-waste rather than undertaking its expensive disposal. The United States Environmental Protection Agency estimated that it was 10 times cheaper to ship electronic devices to China than to recycle them in the USA.[154] In 2017, it was estimated that China was handling approximately 70 percent of the world's e-waste, leading the Chinese government to take strong action against the foreign waste being exported to China.[155] A significant portion of this is disposed of through rudimentary methods mentioned earlier, such as acid baths and incineration. However, as China focused on implementing a ban on importing e-waste, this simply shifted the export of e-waste to other countries, which were still ill-equipped to effectively dispose of it. For example, following the increased efforts to enforce a ban on foreign e-waste in China, 24 tons of e-waste were illegally shipped to Thailand from various countries, and police shut down five illegal e-waste disposal centers.[156] This indicates that as China increases enforcement of a ban on import of e-waste, other developing countries are likely to see an increase in the amount of foreign e-waste exported to them.

The export of e-waste is defended on the idea that the electronics are being sent for reuse. For example, traffickers of illegal shipments from Europe label the shipment containers as equipment for reuse rather than as electronics.[157] While the shipments to developing countries are, partly, for the reuse and repair of devices, this reasoning is used often to defend exports made purely for the economic benefit of the exporting country. For example, a common argument for the export of e-waste is that it provides jobs and income. Researchers at the United Nations University estimate that the materials contained in e-waste are worth USD 61 billion.[158] Recycling e-waste is often compared to mining, considering that in 2016, the amount of gold in e-waste equaled more than 10 percent of the gold mined that year.[159] However, the elements involved in e-waste are toxic, and the methods for recycling them are hazardous in many cases. While the technology to recover raw materials from e-waste exists, it is not as widespread, especially in developing countries. As a result, these states resort to informal practices that result in significant harm to the environment and local residents. For example, backyard recyclers in Indonesia use hydrochloric acid baths, which break apart circuit boards to recover gold.[160] The use of acid baths results in hazardous chemicals being released into the environment through leaching and contaminating waterways and soil.[161] In Thailand, workers use stoves and shredders to break down electronics without using equipment to protect themselves from fumes.[162] These fumes contain toxic chemicals that not only cause respiratory diseases but also pollute the air. This air pollution results in acid precipitation, which once again contaminates soil and water.[163] The environmental impact is apparent in China, which has extraordinarily high concentrations of heavy metals in rice due to contamination from improper disposal of e-waste.[164] Therefore, the argued economic benefit comes at a high cost to the environment and local

154 "Electronic Waste-Moving Mountains."
155 Larmer, "E-Waste Offers an Economic Opportunity as Well as Toxicity."
156 Larmer, "E-Waste Offers an Economic Opportunity as Well as Toxicity."
157 Lewis, "Europe Shipping Electronic Waste."
158 Larmer, "E-Waste Offers an Economic Opportunity as Well as Toxicity."
159 Larmer, "E-Waste Offers an Economic Opportunity as Well as Toxicity."
160 Larmer, "E-Waste Offers an Economic Opportunity as Well as Toxicity."
161 Fu et al., "High Levels of Heavy Metals in Rice (Oryzasativa L.) from a Typical E-Waste Recycling Area in Southeast China and Its Potential Risk to Human Health."
162 Larmer, "E-Waste Offers an Economic Opportunity as Well as Toxicity."
163 Canada, "Air Pollution."
164 Fu et al., "High Levels of Heavy Metals in Rice (Oryzasativa L.) from a Typical E-Waste Recycling Area in Southeast China and Its Potential Risk to Human Health."

ecosystems of countries that receive foreign e-waste.

A significant barrier to addressing the economics of e-waste is the lack of monitoring and statistics. For example, it is estimated that 20 percent of electronics are recycled globally. However, the disposal method used for the remaining 80 percent is largely unknown.[165] Only 41 countries monitor and keep records of e-waste, which further exacerbates the issue.[166] Due to the lack of statistics on e-waste, it is difficult to track the illegal export to developing countries or its exact environmental impact. To truly address the economics of e-waste and its impact on the environment, a more effective method for monitoring and keeping statistics on e-waste is essential.

Developed countries have historically exported e-waste to developing countries to avoid the expensive disposal of and management of e-waste despite international treaties like the Basel Convention restricting the transboundary movement of e-waste. Several countries have not ratified the treaty, and those that have often continue to see illegal export of e-waste occur. A significant argument for this is the economic benefits of recycling the metals in e-waste and the income it provides. However, the environmental and health cost of e-waste is detrimental and must be addressed. The illegal export of e-waste and focus on economics often harms the environment and health of residents in the process.

Current Status

Impact of Improper E-waste Management on Workers

Due to the lack of formalized recycling practices globally, e-waste is continually disposed of using rudimentary techniques by untrained workers. These techniques include the dismantling of devices using hammers and bare hands, removing components by heating over coal grills or in acid baths with a lack of protective equipment.[167] Consequently, these informal disposal practices expose workers to harmful heavy metals and are a serious source of occupational health concern. In particular, the burning of e-waste, in addition to air pollution, also causes health issues for facility workers who often work in areas without proper ventilation. Polyvinyl chloride, which makes up 26 percent of the plastics found in electronic devices, generates organic pollutants when burned.[168] These pollutants can be inhaled, ingested, or absorbed through the skin resulting in decreased liver function and damage to the immune and nervous systems.[169] The changes to facility structure to accommodate more environmentally friendly and health-conscious practices of recycling electronics with sound waves and the right tools for dismantling the devices is a large next step, which will require significant time. However, the occupational hazards these workers face currently are enormous, and the chronic exposure to these pollutants until formal practices are established will cause permanent damage in many cases. Even the reworking of the existing infrastructure of the informal recycling facilities to provide for adequate ventilation is a large undertaking. However, it could likely provide some relief to workers until formal practices are established. Creating a global system that properly disposes of and recycles e-waste is a large undertaking, but incremental change to alleviate some of the most harmful disposal processes is a sensible start.

Furthermore, there is a lack of international standards to protect the health of workers in e-waste recycling facilities. For example, lead, used in computer and TV screens, affects kidneys and the nervous system after exposure and can remain in the bloodstream for years.[170] Children and pregnant women are particularly susceptible to the effects of lead.[171] However, it is important to note the economic connection to informal e-waste recycling facilities. These centers often exist because it is cheaper to hire local residents and dismantle devices using techniques such as burning than it is to formally train workers with more advanced methods of recycling, such as using

165 Larmer, "E-Waste Offers an Economic Opportunity as Well as Toxicity."
166 Larmer, "E-Waste Offers an Economic Opportunity as Well as Toxicity."
167 Jayapradha Annamalai, "Occupational Health Hazards Related to Informal Recycling of E-Waste in India: An Overview."
168 Jayapradha Annamalai, "Occupational Health Hazards Related to Informal Recycling of E-Waste in India: An Overview."
169 Jayapradha Annamalai, "Occupational Health Hazards Related to Informal Recycling of E-Waste in India: An Overview."
170 Jayapradha Annamalai, "Occupational Health Hazards Related to Informal Recycling of E-Waste in India: An Overview."
171 Jayapradha Annamalai, "Occupational Health Hazards Related to Informal Recycling of E-Waste in India: An Overview."

Employee at an e-waste recycling plant

strong currents of water for dismantling.[172] Employing children, despite the health risk of lead exposure, is likely to be more profitable than just employing adults due to the difference in wages. Moreover, since these facilities often operate illegally, there is a lack of standardization or regulation regarding workers and their risk exposure.

Analyzing conclusions drawn by researchers investigating the health impacts of exposure to pollutants, such as lead from e-waste disposal facilities can provide useful insight for future directions. For instance, it was found that health professionals had limited knowledge regarding the specific impacts of exposure to e-waste.[173] This indicates that in addition to training workers to implement safety practices and of potential hazards, it is also important to provide education for health professionals. This also brings up the important issue of both preventing hazardous working conditions but also prioritizing the health of workers already exposed to toxic metals and working in e-waste disposal facilities currently. While the issue of occupational safety and health of workers has existed for several years, it has recently gained increased focus from media coverage and policies directed towards it. This is largely due to the increasing amount of e-waste disposed of.

One of the few studies targeting the health of workers, conducted by independent researchers in Ghana in 2019, noted a substantial number of injuries such as lacerations during the study period of six months.[174] In this period, 46 workers reported 400 injuries, with one worker being injured 40 times.[175] It is important to note that the workers had repeated injuries over the study period, indicating a lack of paid leave for recovery. An example of unsafe procedures found by these same researchers was the lack of employer-provided personal protective equipment and the individual workers being unable to afford to buy this equipment from the market privately. In addition to procedural shortcomings, there was also an emphasis on profit over the rights of the workers. The actual number of injuries may even be higher, as workers may not have reported injuries due to fear of repercussions on their employment.[176] This further reinforces the indication of a lack of compensation or paid leave for injuries. However, due to the limited research, it is essential that the UNEA prioritizes increased monitoring of recycling facilities to reduce occupational hazards for workers and address these illegal employers. The high number of injuries clearly indicates that steps must be taken to address worker training and safety mechanisms in the facilities.

There has been work done to address this issue. In 2019, the International Labor Organization (ILO) hosted a meeting in Geneva, Switzerland, with workers and employers to address decent working conditions e-waste disposal in the Global Dialogue Forum on Decent Work in the Management of Electrical and Electronic Waste.[177] It was recognized that the violation of fundamental workers' rights, neglect of safety, and child labor were repeated concerns from the industry due to informal recycling practices. This meeting stressed that work-

172 "How Are CRT Monitors Recycled? | GreenCitizen," November 20, 2010, https://greencitizen.com/how-are-crt-cathode-ray-tube-monitors-recycled/.
173 Grant, Kristen, Fiona C Goldizen, Peter D Sly, Marie-Noel Brune, Maria Neira, Martin van den Berg, and Rosana E Norman, "Health Consequences of Exposure to E-Waste: A Systematic Review," The Lancet Global Health 1, no. 6 (December 1, 2013): e350–61. https://doi.org/10.1016/S2214-109X(13)70101-3.
174 Burns, Katrina N., Stephanie K. Sayler, and Richard L. Neitzel, "Stress, Health, Noise Exposures, and Injuries among Electronic Waste Recycling Workers in Ghana," *Journal of Occupational Medicine and Toxicology* 14, no. 1 (January 10, 2019): 1. https://doi.org/10.1186/s12995-018-0222-9.
175 Katrina N. Bruns, et al, "Stress, Health, Noise Exposures, and Injuries among Electronic Waste Recycling Workers in Ghana."
176 Katrina N. Bruns, et al, "Stress, Health, Noise Exposures, and Injuries among Electronic Waste Recycling Workers in Ghana."
177 IndustriAL, "It Is Time to Act on Decent Work for All E-Waste Workers," April 17, 2019, http://www.industriall-union.org/it-is-time-to-act-on-decent-work-for-all-e-waste-workers.

ers in the e-waste industry must have the right to safe, healthy, and sustainable jobs.[178] The ILO successfully identified the need for a circular economy with formalized procedures for recycling and responsibility on manufacturers to promote safe working conditions. However, more work needs to be done to enforce policies banning informal recycling of e-waste and address the economic concerns manufacturers have regarding changing the design to be more sustainable and offering to take back old electronic devices. As a result, delegates need to consider methods of enforcing legislation and potential subsidy programs for manufacturers before ILO recommendations can be effectively implemented.

The United Nations Environment Management Group (EMG) is a body chaired by the Executive Director of UNEP and a secretariat provided by UNEP. The EMG has particularly stressed the importance of providing safe work opportunities to e-waste recycling workers in 2017.[179] To achieve this, the group argued for the need for formalized recycling practices that would focus on environmental protection and the safety of workers. In 2018, UNEP also passed UNEP/EA.3/Res.4 on Environment and Health.[180] This noted that the impacts of pollution on health are often underestimated. Therefore, there is a need for more documentation and research into the impacts of environmental issues on health. The resolution also stressed the health impacts of air, water, and soil pollution in particular. Furthermore, the resolution requested the development and integration of methods and guidelines regarding occupational safety to mitigate health risks. This is particularly relevant to the development of standardized practices for recycling, which mitigate environmental harm and promote workers' safety.

Therefore, to protect workers from significant occupational hazards, the UNEP must address e-waste recycling. This issue cannot be mitigated until the education of workers, formal recycling facilities, and sustainable production and consumption are addressed.

Recently Suggested Solutions

Due to the increasing demand for electronic devices, there has been a lot of work targeting e-waste disposal. The recent COVID-19 pandemic illustrates the essential work done by workers in e-waste recycling facilities as they continue to remain open in many countries. In addition to the recent pandemic, there has been an increase in national legislation regarding e-waste. In the past, e-waste statistics and disposal faced a lack of documentation and legislation. However, this is rapidly changing as countries recognize its significance. Lastly, there has been an increased push for more formal recycling procedures that limit environmental harm and prioritize workers' safety.

For instance, during quarantine due to COVID-19, more individuals than ever are relying on electronic devices to stay connected and complete work.[181] It is important to consider the negative impacts COVID-19 has had on e-waste disposal in particular. With more individuals depending on electronic devices, the sales of computers and keyboards increased by 10 percent in the U.S. during March 2020.[182] However, this increased usage is also useful in drawing government attention towards this issue. For example, e-waste recycling facilities were part of the few facilities open in Ontario, Canada, during the quarantine. The increased focus on e-waste recycling has resulted in more policies targeting more efficient recycling. For instance, the Conference Board of Canada found that more effective recycling programs could enable Ontario alone to generate 13,000 new jobs by 2021.[183] The increase in employment is something that is particularly prioritized to aid with rising unemployment due to COVID-19. Consequently, this is an opportune time for states to invest in infrastructure for e-waste recycling to boost the economy, provide local jobs, and supplement the availability of precious metals from min-

178 IndustriAL, "It Is Time to Act on Decent Work for All E-Waste Workers."
179 United Nations Environment Management Group. "United Nations System-wide Response to Tacking E-waste." 2017, https://unemg.org/images/emgdocs/ewaste/E-Waste-EMG-FINAL.pdf.
180 UNEP/EA.3/Res.4, "Environment and health," *United Nations Environment Assembly of the United Nations Environment Programme,* January 30, 2018, http://wedocs.unep.org/bitstream/handle/20.500.11822/31019/k1800154.english.pdf?sequence=3&isAllowed=y.
181 BramptonGuardian.com, "Opinion | Ontario's e-Waste Opportunity," May 26, 2020, https://www.bramptonguardian.com/opinion-story/9995934-ontario-s-e-waste-opportunity/.
182 Deutsche Welle, "Can the Pandemic Help Us to Embrace Refurbished Electronics? | DW | 15.06.2020," *DW.COM*, Accessed June 30, 2020, https://www.dw.com/en/can-the-pandemic-help-us-to-embrace-refurbished-electronics/a-53741181.
183 BramptonGuardian.com, "Opinion | Ontario's e-Waste Opportunity."

ing. The European Union (EU) has also recently promoted the need for a circular economy, in which the continual reuse of resources is prioritized. In March 2020, the EU released a new Circular Economy Action Plan, which aims to keep the resources in the economy as long as it is feasible to do so.[184] There is also the belief that due to the unemployment and uncertainty during the COVID-19 pandemic, more individuals are willing to repair old electronic devices or buy used devices as compared to buying new devices.[185] This trend brings an important idea of sustainable consumption, which is equally as important as, if not more important, than promoting end-of-life policies for electronic devices and targeting producers for sustainable design.

There has also been an increase in formalized procedures for recycling. The initial stages of recycling include the collection and transportation of electronics to recycling facilities. Recently these methods have been improved significantly by analyzing the best collection method. For example, one to two-day recycling events in communities were much more effective than the curbside pickup of e-waste.[186] The next stage of recycling involves shredding, sorting, and separating. While informal recycling facilities often involve workers doing this stage by hand, more formal practices can use equipment to shred pieces as small as 100mm.[187] Industrial equipment, which has recently gained more popularity and is increasingly being integrated into recycling facilities, utilizes magnetic attraction to separate iron and steel from the remaining waste on a conveyor belt. Water separation technology is also used to separate plastic from glass.[188] These newly developed recycling practices are significantly more efficient at sorting the different components of e-waste as compared to the informal practices of sorting by hand. Furthermore, these techniques also reduce occupational hazards for workers by reducing their direct interaction with these hazardous elements. These techniques and the use of this equipment require workers to be trained, usually on the job. Therefore, shifting towards more advanced techniques for e-waste recycling and the issue of occupational safety and education are closely related. While these issues have been present for decades, the recent surge in electronics consumption has driven more policies to target this issue recently. Furthermore, many technological developments, such as using sound-waves for e-waste recycling, have recently been developed and just beginning to be used in recycling facilities.

Recently suggested solutions are focusing extensively on the impact of COVID-19 on e-waste disposal and advancing technology to more effectively recycle electronic equipment. While these have shown significant success, it is important to consider the interconnectedness of sustainable production, sustainable consumption, improving recycling facilities, and workers' rights in achieving a circular economy. Significant work must be done to monitor recycling and prevent contamination of the air, water, and soil. Delegates are urged to consider the solutions as a cohesive effort and how they fit into the larger picture of resolving the challenges associated with e-waste rather than as individual efforts to address a single facet of the topic.

Sustainable Development Goals

Several Sustainable Development Goals (SDGs) are directly applicable to the issue of e-waste disposal, making it an essential issue to be addressed. SDG 8: Decent Work and Economic Growth is closely related to this topic. Recycling e-waste ensures that resources stay in the economy as long as possible through promoting a circular economy and economic growth. The right to decent work for workers in informal recycling facilities that face several occupational hazards must be prioritized.[189] This issue is also closely related to SDG 3, regarding Good Health and Well-Being. Not only do the workers, who often lack personal protective equipment, face injuries such as lacerations and respiratory issues due to fumes, but the contamination of water and soil from toxic metals found in electronic devices result in contaminants entering food and crops. Consequently, consumers of these crops face tre-

184 Welle, "Can the Pandemic Help Us to Embrace Refurbished Electronics? | DW | 15.06.2020."
185 Welle, "Can the Pandemic Help Us to Embrace Refurbished Electronics? | DW | 15.06.2020."
186 Kang and Schoenung, "Electronic Waste Recycling."
187 Tajirul Haque, "Introduction to Electronics Recycling," The Balance Small Business, accessed June 30, 2020, https://www.thebalancesmb.com/introduction-to-electronics-e-waste-recycling-4049386.
188 Haque, "Introduction to Electronics Recycling."
189 Jayapradha Annamalai, "Occupational Health Hazards Related to Informal Recycling of E-Waste in India: An Overview."

mendous health concerns ranging from nervous system damage to reproductive issues.[190] Informal recycling also releases fumes that cause respiratory illnesses in residents. Improving recycling practices by developing and implementing a standardized procedure for recycling electronics would reduce pollution of the air, soil, and water resulting from informal processes. Consequently, the reduced exposure to pollutants, such as toxic metals, would improve the health and quality of life for local residents.

The contamination of water and soil also relates to SDG 6: Clean Water and Sanitation and SDG 15: Life on Land. The contaminants in the fumes released from burning e-waste, in addition to entering the atmosphere, also enter the water cycle and enter the soil and contribute to water and soil contamination as well.[191] The pollution is closely linked to the health of local residents and consumers of the crops making the issue extremely interconnected. Policies pushing for sustainable production, sustainable consumption, and efficient recycling would reduce informal recycling practices that release toxic chemicals into the air, water, and soil. For instance, decreased combustion of electronic devices would decrease air pollution and the acidic precipitation that results from it. Consequently, water bodies would not face eutrophication, and heavy metals would not enter local vegetation.

Some of the most effective methods of solving the issue of e-waste disposal include expanding infrastructure for recycling and sustainable production and sustainable consumption. SDG 9: Industry, Innovation, and Infrastructure applies to improving recycling infrastructure. Infrastructure development includes developing better methods for collecting e-waste and using more efficient technology to separate it. This technology could be switching to a large magnet rather than depending on individuals to sort waste by hand.[192] Consequently, this also closely relates to improving health and providing decent work for the workers in recycling facilities. In addition, innovation may lead to developing alternative materials to replace harmful elements such as lead in electronic devices. SDG 12: Responsible Consumption and Production is achieved through encouraging sustainable design and policies aiming to increase reusing older electronics and repairing devices to curb the increasing demand for electronic devices.

To adequately address this topic, it is essential to understand the interconnected nature of the topic. For example, working with producers to encourage sustainable design through innovative alternative components addresses both SDG 12 and SDG 9. Furthermore, sustainable design also makes it easier to develop recycling infrastructure, which can more easily take apart devices designed to be recycled. This addresses SDG 6 and SDG 15 by preventing the contamination of soil and water through efficient recycling. Finally, this also translates to better working conditions for workers who can use advanced technology to reduce occupational hazards and handle alternative components that avoid toxic metals like lead. This addresses SDG 3 and SDG 8. This demonstrates how the SDGs and the separate issues detailed above are intrinsically connected, and any effective solution must exhaustively encompass every aspect of e-waste management.

Bloc Analysis

The major points of division for the topic of e-waste disposal are likely to focus on exporting e-waste to avoid environmental responsibility. Countries that import e-waste are now increasing legislation to stop the practice due to the increasing environmental burden of accepting foreign e-waste. On the other hand, this forces countries which have traditionally exported waste to address the issue locally, despite lacking the infrastructure to dispose of e-waste in large quantities. The second main source of contention will stem from economic interests in the issue of electronics. Countries involved in providing raw materials electronics, for instance, through mining, would not favor policies to increase recycling or reduce the use of metals in electronics. Countries that have been importing e-waste have not had significant economic interests in it due to informal practices resulting in a limited recovery of precious metals. On the other hand, countries involved in mining and exporting e-waste would have significant economic costs

190 Fu et al., "High Levels of Heavy Metals in Rice (Oryzasativa L.) from a Typical E-Waste Recycling Area in Southeast China and Its Potential Risk to Human Health."
191 Canada, "Air Pollution."
192 Haque, "Introduction to Electronics Recycling."

associated with increased electronic recycling.

Countries that Export their Electronic Waste

Waste disposal is often costly and requires significant infrastructure, such as recycling facilities and collecting e-waste, to proceed smoothly. Unfortunately, these facilities and collection methods are expensive if carried out to mitigate environmental damage rather than merely disposing of the e-waste in landfills. As a result, several countries resort to exporting e-waste overseas to avoid facing the monetary costs of recycling and the environmental impact through contamination from informal disposal methods.

Countries such as the United States of America, Canada, Australia, and several European countries export e-waste despite the Basel Convention banning the transboundary movement of e-waste.[193] The US is the only developed country that has not ratified the convention and consequently continues to ship large amounts of e-waste overseas. However, even in countries that have ratified it, such as European countries, the export occurs illegally through individual actors carrying it out. This is largely due to shipments not being checked effectively and being mislabeled, the cost of recycling it being too high, and misinformed consumers regarding proper disposal methods for e-waste.[194]

These states would likely support policies that make disposal more cost-effective and easier to accomplish. For example, policies such as subsidizing electronics manufacturing companies to take back used devices and take responsibility for the entire life cycle of the electronics would be highly supported. Prioritizing sustainable design to make recycling easier by substituting harmful elements with more environmentally friendly ones, such as a crystal film instead of lead, would also be supported.[195] In addition, since the collection of e-waste has proven to be a large issue that drains financial resources, a formalized process to efficiently collect e-waste and enhance sustainable consumption would also be supported.

The overarching theme of policies supported by this bloc is to reduce the monetary costs of recycling and focus on making recycling practices more effective through technology. Essentially, this bloc would prioritize developing infrastructure and working with producers to make e-waste disposal less expensive and more environmentally friendly. This is largely because countries that had historically been importing e-waste are focusing on increasing legislation and enforcement of laws to prevent e-waste import. Consequently, states which had been exporting e-waste now need to develop local methods to dispose of it safely. It is important to note that while several states, such as the UK, have ratified the Basel Convention, high levels of export that continues to happen illegally. Therefore, until issues of sustainable production and consumption, recycling infrastructure, and limited statistics on e-waste are not addressed, the illegal export is difficult to prevent.

Countries that Import Foreign Electronic Waste for Disposal

Despite international bans and national legislation to mitigate the import of foreign e-waste, it continues to occur. With China estimated to handle 70 percent of the world's e-waste and Thailand receiving 37,000 tons of discarded electronics in 2018 alone, the burden of global e-waste falls disproportionately on states which import foreign e-waste rather than states that produce it.[196] The Basel Action Network estimates that 40 percent of e-waste from the U.S., Canada, and Europe is exported to Asia and Africa.[197]

Consequently, states in this bloc are concerned regarding the disproportionate and immense environmental impact the disposal of this e-waste will have on local ecosystems. China, Thailand, and India, among many other states, have also passed national legislation to ban the import of e-waste due to environmental and health concerns. Officials have been cracking down on the illegal import of waste through searching e-waste recycling facilities more diligently.

This bloc would likely support policies that further limit shipping of e-waste, such as more effective searching of shipments, sustainable consumption, and education regarding drop off locations of e-waste, and enforcement of national

193 Larmer, "E-Waste Offers an Economic Opportunity as Well as Toxicity."
194 Lewis, "Europe Shipping Electronic Waste."
195 ScienceDaily. "Harmless Elements Can Replace Toxic Lead in Electronics."
196 Basel Action Network, "E-Waste Chokes Southeast Asia."
197 Basel Action Network, "E-Waste Chokes Southeast Asia."

legislation through checking local recycling facilities. Additionally, this bloc would also prioritize reducing informal recycling of e-waste through acid drums and incineration, which occurs due to the large volume of e-waste that is dealt with in these facilities.[198] The import of e-waste is not economically beneficial to these countries due to the limited infrastructure which cannot cope with the influx of foreign waste. Consequently, informal recycling limits the amount of precious metals that can be recovered from electronics. Therefore, the environmental and health concerns of importing e-waste outweigh the limited economic benefits.

It is also important to note that, in countries that have historically imported e-waste, numerous residents depend on informal recycling for income. When developing policies to limit import, it is essential to consider the livelihood of these workers since the legislation cannot be effective until smaller "backyard recyclers" also comply. States such as India have attempted to solve this problem by creating alternative jobs in the collection of e-waste to employ these workers.[199] However, it is important to note that the economic aspect of informal recycling, despite being harmful to the health of residents, must be addressed before policies can be enforced. Because of this, countries in this bloc are likely to support alternative vocational programs that allow people reliant on recycling e-waste to remain self-sufficient through policy change.

Countries with Economic Ties to the Production of E-waste

While there is a significant overlap in policies regarding the safe disposal of e-waste and environmental concerns, states involved in mining for elements used in electronics and the production of devices are concerned regarding the economic impact of recycling e-waste and materials. For example, Zimbabwe, Paraguay, and Chile have several mines to collect lithium, a metal commonly used in electronic devices.[200] Recycling of the metal or replacing it with more environmentally friendly substances would have a detrimental impact on the mining industry in these states. The economic severity of reduced production of resources used in electronics is often due to the minimal economic diversification of the economies of countries in this bloc—when a national economy revolves around only a few industries, even minor declines in those industries can have seriously detrimental effects. It is important to note that these states would balance environmental protection with the economics of increasing recycling to an optimal middle-point.

This bloc would likely support policies that keep the momentum for the mining industries through limited recycling of electronics and mitigating the replacement of these mined elements with more sustainable products. However, this bloc would need to balance the environmental concerns regarding the improper disposal of e-waste and the economic benefits of producing more devices and mining more elements. The general theme of policies supported by this bloc would be a balance between environmental concerns, such as supporting adding more barriers to prevent leachate entering the environment from landfills and prioritizing the economy through limiting the replacement of these mined elements from electronic devices. However, it is important to note that there is significant room for compromise. For example, instead of focusing on sustainable production as the use of alternative elements instead of heavy metals, prioritizing sustainable secondary items such as more sustainable foam would be supported.

Committee Mission

UNEP is focused on addressing environmental concerns and mitigating harm to ecosystems by advocating for sustainability.[201] The committee is the leading global authority for implementing a cohesive and united plan to protect the environment. The mission is to improve the quality of life globally while still prioritizing future generations and sustainability. UNEP is intensively involved in the issue of e-waste disposal. Improper disposal can result in contamination of the air, soil,

198 Jha, "Loni's Acid Drums Take Care of Delhi's e-Waste but Poison Air | Ghaziabad News - Times of India."
199 "E-Waste: From Toxic to Green | India | UNFCCC."
200 "Zimbabwe's Growing Electronic Waste Becomes a Real Danger | Inter Press Service," accessed June 30, 2020, http://www.ipsnews.net/2014/03/zimbabwes-growing-electronic-waste-becomes-real-danger/.
201 U.N. Environment, "About UN Environment Programme." UNEP - UN Environment Programme, August 2, 2017, http://www.unenvironment.org/about-un-environment.

and water, and these toxic contaminants often remain in the environment for decades. The continued impact of current actions on the environment for future generations is a large part of UNEP's mandate. UNEP also aims to advocate for sustainability, and one of the largest ways to mitigate environmental harm from e-waste is to focus on the sustainable production of e-waste. In addition, e-waste is often exported illegally as countries avoid dealing with the economic and environmental impacts. UNEP focuses on a united global approach to address environmental concerns rather than forcing a small subset of countries to deal with environmental issues. Consequently, the committee has been involved in preventing this illegal export of e-waste.

While the pressing issue of e-waste is significant under the broader scope of UNEP, as the governing body of UN Environment, UNEA has the unique opportunity to address e-waste by tackling sustainable production, sustainable consumption, recycling infrastructure, and the illegal transboundary movement of e-waste. UNEA meets every other year and emphasizes the need to prioritize environmental concerns and develop international environmental laws.[202] With the transboundary movement of e-waste and rapid globalization, it is clear that UNEA must address e-waste disposal. Therefore, delegates are encouraged to consider the applications of the mandate in proposing novel solutions for this environmental issue. As the world globalizes and technological advances reach new heights, there is immense opportunity to tackle e-waste proactively and protect the environment. Innovative solutions to keep pace with the ever-growing pact of technological developments will ensure environmental protection and ensure future generations can sustainably use technology. If delegates focus on effective and prompt action, UNEA has the potential to mitigate further damage to the environment from e-waste disposal and also indirectly benefit the health of local populations.

202 "About the United Nations Environment Assembly," *United Nations Environment Assembly,* accessed July 26, 2020, https://environmentassembly.unenvironment.org/about-united-nations-environment-assembly.

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. What is your country's attitude toward marine life pollution? Has your country's government established any restrictions or policies on the matter? To what extent have they been effective?

2. How economically dependent is your country on marine transportation? How does it affect its international ties? In what ways can environmentally-sound marine transport be incorporated into existing systems? What type of solutions can be created for developing countries that thoroughly depend on marine transportation? Has your country used such solutions?

3. Considering that utilizing marine ecosystems is extremely important for the economies of many states, where does your country draw the line between marine life and economic profits?

4. Are there populations in your country that are at particularly higher risk from the harmful effects of biomagnification than others considering the low cost of some seafood-based diets? How can your country address such cases? What regulations can be implemented to decrease ocean dumping and other detrimental practices to protect these populations?

5. Does your country have experience with protecting endangered species from marine pollution? To what extent can the welfare of animals be equally prioritized with the welfare of humans?

6. Does your country believe that legal, economic, or social restrictions should be implemented on states that do not abide by environmental regulations? Do they apply equally to countries who cannot sustain themselves without marine practices and to those that can?

Topic B

1. What is your country's attitude toward electronic waste, and what are measures that have been implemented by public and private actors to mitigate it? What, if any, are the major sustainable practices being introduced concerning hazardous electronic waste management?

2. What is the socio-cultural attitude toward electronic waste mitigation within your country? What demographics are most affected by this issue?

3. How can policies be directed at the consumer level to mitigate electronics' environmental costs and the public's awareness of these costs? How has this already been attempted in your country and on a global scale?

4. What social or economic obstacles stand in the way of sustainable consumption within your country; have there been any recent developments in sustainable production within your country's major industries? What, if any, connection does this have to your country's trends in urbanization and wealth distributions?

5. How are the working conditions for e-waste management workers in your country? What major improvements have been made, and what is currently standing in the way of better conditions?

Important Documents

Topic A

Bennett, Jennifer. "Ocean Acidification." *Smithsonian*. Accessed June 14, 2020. https://ocean.si.edu/ocean-life/invertebrates/ocean-acidification.

This scientific article gives an in-depth overview of ocean acidification, starting with the chemistry of the process and then explaining how it impacts different ocean species, including coral reefs, oysters, mussels, urchins, starfish, zooplankton, plants, and fish. It backs up these claims with field experiments assessing acidification. It also talks about large-scale reforms and small-scale changes that people can take daily to prevent acidification.

"Chemical Pollution." *Ocean Health Index*. Accessed June 12, 2020. http://www.oceanhealthindex.org/methodology/components/chemical-pollution.

This article talks about chemical pollution in oceans, focusing on three general categories of chemicals of particular concern in the marine environment: oil, toxic metals, and persistent organic pollutants. It discusses the ecological, human health, and economic impacts of these three pollutants. To do so, it uses scientific studies and diagrams of their pollution cycles.

Immig, Joanna and Lloyd-Smith, Mariann. "Ocean Pollutants Guide: Toxic Threats to Human Health and Marine Life." *National Toxics Network*. Last modified October 2018. https://ipen.org/sites/default/files/documents/ipen-ocean-pollutants-v2_1-en-web.pdf.

This scientific journal gives an overview of ocean pollutants from all categories, identifies their impacts, and explains their impacts. It highlights the opportunities and challenges in addressing the presence of these pollutants in water. The source also highlights several UN and governmental actions taken throughout history to mitigate these effects.

Kruse, James C., Lena M. DeSantis, Scott J. Eaton, and Richard Billings. "Marine Transportation and the Environment." *Transportation Research News* 313, (2018): 14. http://onlinepubs.trb.org/onlinepubs/trnews/trnews313.pdf.

This article from a scientific magazine explores the different effects of marine transportation on marine life. It specifically discusses air pollution, changing trade routes, vessel discharges, and noise pollution. The source proposes various solutions for these concerns, including using alternative fuels, water discharge regulations, and controlling fuel sulfur. The article provides in-depth explanations and case studies about these different pollutants, highlighting why they must be addressed urgently.

"Microplastics." *United Nations Environment Programme*. Accessed June 13, 2020. https://wedocs.unep.org/bitstream/handle/20.500.11822/12079/brochure-microplastics.pdf?sequence=1&amp%3BisAllowed=.

This report from the UNEP discusses what microplastics are and why they are receiving increasing attention. The brochure provides information about the sources of microplastics and the physical and chemical effects they have on marine ecosystems. The report explains various actions the UNEP must take to reduce these effects.

"Wastewater Management: A UN-Water Analytical Brief." *UN Water*. Accessed June 12, 2020. https://www.unwater.org/publications/wastewater-management-un-water-analytical-brief/.

This policy brief from UN Water gives an overview of wastewater management and its role in the water, energy, and food industries. It discusses wastewater that comes from domestic sources and contains sewage, but also industrial and agricultural runoff that can contaminate bodies of water with fertilizers and other harmful chemicals.

Topic B

Jha, Abhijay | TNN | Updated:, 2019, and 10:08 Ist. "Loni's Acid Drums Take Care of Delhi's e-Waste but Poison Air | Ghaziabad News - Times of India." The Times of India. Accessed June 10, 2020. https://timesofindia.indiatimes.com/city/ghaziabad/lonis-acid-drums-take-care-of-delhis-e-waste-but-poison-air/articleshow/71828104.cms.

This news article discusses illegal acid treatment as a method of electronic disposal. It also explains India's policy of shutting down these illegal disposal facilities. The source is particularly useful to understand the issues faced by local governments regarding the informal disposal of e-waste and the limitations of current policies.

Mwangi, Wangu. "UNEP Outlines Integrated Actions to Tackle Soil Pollution in Preparation for UNEA-4 | News | SDG Knowledge Hub | IISD." Accessed June 10, 2020. https://sdg.iisd.org:443/news/unep-outlines-integrated-actions-to-tackle-soil-pollution-in-preparation-for-unea-4/.

This source describes UNEP's commitment to addressing soil contamination and is particularly useful to understand past resolutions and actions taken regarding this issue. This source also discusses the collaboration of UNEP with FAO to address soil contamination specifically and connects the issue of e-waste to UNEA's resolution 3/6 regarding "Managing Soil Pollution to Achieve Sustainable Development."

"United Nations and E-Waste: system-wide action on addressing the full life-cycle of electrical and electronic waste." Accessed June 2, 2020. https://unemg.org/wp-content/uploads/2018/11/INF1.pdf.

This report is important as it addresses the need for policies at all life-stages of electronics, including their production and consumption. It exceptionally explains the various subtopics to the broader issue of e-waste and connects each issue back to the Sustainable Development Goals.

United Nations University. "With E-Waste Predicted to Double by 2050, Business as Usual Is Not an Option - United Nations University." Accessed June 3, 2020. https://unu.edu/news/news/with-e-waste-predicted-to-double-by-2050-business-as-usual-is-not-an-option.html.

This source discusses the need for sustainable consumption and production to address e-waste issues. In particular, this source also provides useful to compare reactive versus proactive approaches towards addressing e-waste. It is particularly useful as it also describes initiatives taken by the United Nations to address this issue and the aims of each program.

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"Microplastics, Microbeads and Single-use Plastics Poisoning Sea Life and Affecting Humans." *United Nations News*, November 4, 2019. https://news.un.org/en/story/2019/11/1050511.

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Topic B

UN Sources

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This source describes the contamination of rice crops grown near e-waste disposal sites.

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This scientific article discusses the impact of illegally burning electronic waste as a method of waste management and its impact on air pollution. It also discusses the impact this has on the health of individuals living near the area.

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Haque, Tajirul. "Introduction to Electronics Recycling." The Balance Small Business. Accessed June 30, 2020. https://www.thebalancesmb.com/introduction-to-electronics-e-waste-recycling-4049386.

This article discusses the process of recycling electronics from the collection, transportation to sorting, and dismantling. It describes some techniques used to efficiently recycle electronics.

He, Mingjiang, Shiyan Yang, Jian Zhao, Chris Collins, Jianming Xu, and Xingmei Liu. "Reduction in the Exposure Risk of Farmer from E-Waste Recycling Site Following Environmental Policy Adjustment: A Regional Scale View of PAHs in Paddy Fields." *Environment International* 133 (December 1, 2019): 105136. https://doi.org/10.1016/j.envint.2019.105136.

This scientific article outlines the findings of high levels of toxins in the soil due to e-waste. Most importantly, it illustrates an example of how environmental policies were able to decrease the presence of these toxins.

"How Are CRT Monitors Recycled? | GreenCitizen," November 20, 2010. https://greencitizen.com/how-are-crt-cathode-ray-tube-monitors-recycled/.

This article discusses the need to properly dismantle discarded computers. It also provides descriptions of dismantling processes and the technology used.

Hub, IISD's SDG Knowledge. "UN Report Highlights Environmental, Health Risks from E-Waste, Urges Circular Economy Shift | News | SDG Knowledge Hub | IISD." Accessed June 1, 2020. https://sdg.iisd.org:443/news/un-report-highlights-environmental-health-risks-from-e-waste-urges-circular-economy-shift/.

This article describes the report released by 7 UN entities that describe the growing issue of recycling e-waste. The report called for ways to reuse resources.

iFixit. "Batteries Explode—Stop Gluing Them Down," July 14, 2020. https://www.ifixit.com/News/8464/batteries-explode-

note7.

This source discusses the issues with gluing down batteries using the example of Samsung's phone Note7. In particular, this article describes the issues with removing the glued-in batteries and the increased risk of overheating.

IndustriALL. "It Is Time to Act on Decent Work for All E-Waste Workers," April 17, 2019. http://www.industriall-union.org/it-is-time-to-act-on-decent-work-for-all-e-waste-workers.

This article discusses the occupational hazards faced by workers and the potential ways these could be mitigated. It also discusses the ILO Global Dialogue Forum on Decent Work in the Management of Electrical and Electronic Waste, emphasizing the importance of a circular economy.

"Is There a Business Case for Product Take-Back? – Electronics TakeBack Coalition." Accessed June 7, 2020. http://www.electronicstakeback.com/2015/05/06/is-there-a-business-case-for-product-take-back/.

This article discusses the financial viability of extended producer responsibility and uses the case study of Best Buy. This source is useful to understand the issues regarding the sustainable production of electronic devices as well.

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This source discusses illegal acid treatment as a method of electronic disposal. It also explains India's policy of shutting down these illegal disposal facilities.

Kang, Hai-Yong, and Julie M. Schoenung. "Electronic Waste Recycling: A Review of U.S. Infrastructure and Technology Options." *Resources, Conservation and Recycling* 45, no. 4 (December 1, 2005): 368–400. https://doi.org/10.1016/j.resconrec.2005.06.001.

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Larmer, Brook. "E-Waste Offers an Economic Opportunity as Well as Toxicity." *The New York Times*, July 5, 2018, sec. Magazine. https://www.nytimes.com/2018/07/05/magazine/e-waste-offers-an-economic-opportunity-as-well-as-toxicity.html.

This news article discusses the export of electronic waste to developing countries and the different policies on handling this waste. The export is justified based on the jobs it creates. However, the article makes important points regarding the lack of safety of workers, lack of regulations, and limited private sector responsibility to handle toxic materials.

Lauridsen, Erik Hagelskjær, and Ulrik Jørgensen. "Sustainable Transition of Electronic Products through Waste Policy." *Research Policy*, Special Section on Innovation and Sustainability Transitions, 39, no. 4 (May 1, 2010): 486–94. https://doi.org/10.1016/j.respol.2010.01.021.

This article discusses incentives for producers to improve product design to be more sustainable. It also outlines some of the issues producers face in changing the design of the product.

Lepawsky, Josh. "Mapping USA Electronics Manufacturing Pollution." Discard Studies, March 18, 2019. https://discardstudies.com/2019/03/18/25-years-of-toxicants-from-us-computers-and-electronics/.

This source discusses the decrease in gas emissions from the manufacturing of electronic devices in the USA.

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This news article discusses the shipping of e-waste that continues to occur from Europe despite stringent laws against it. This article also describes the harm export of e-waste causes to developing countries.

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Oehmen, Adrian, Rui Viegas, Svetlozar Velizarov, Maria A. M. Reis, and João G. Crespo. "Removal of Heavy Metals from Drinking Water Supplies through the Ion Exchange Membrane Bioreactor." *Desalination*, Euromembrane 2006, 199, no. 1 (November 20, 2006): 405–7. https://doi.org/10.1016/j.desal.2006.03.091.

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This source discusses the Basel Convention and the impact this treaty had on the global transport of e-waste. It is particularly useful to analyze the shortcomings of the convention for future directions.

Quantum | E-Waste Recycling. "Electronics Recycling Stewardship Programs in Canada: A Primer," August 29, 2016. https://quantumlifecycle.com/blog/electronics-recycling-stewardship-programs-canada-primer/.

This source describes subsidy programs to help producers with the cost of recycling electronic products. It also illustrates the advantages of Extended Producer Responsibility.

Raphael, Philip. "Recycling riches sought in e-waste piles." *Richmond News,* Dec 3, 2015, https://www.richmond-news.com/business/recycling-riches-sought-in-e-waste-piles-1.2125810.

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Resilience. "Using Plants to Clean Contaminated Soil," August 11, 2014. https://www.resilience.org/stories/2014-08-11/using-plants-to-clean-contaminated-soil/.

This source discusses photo-remediation and also provides examples of plants being used to remove heavy metals from soil.

Saha, Susmita. "E-Waste Contaminating Delhi's Groundwater and Soil." Businessline. Accessed June 9, 2020. https://www.the-

hindubusinessline.com/news/science/ewaste-contaminating-delhis-groundwater-and-soil/article10039362.ece.
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This source discusses an innovative method to replace lead from electronic devices with a crystal film. This is important because lead can lead to severe health issues and harm aquatic ecosystems.

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This report addresses the need for policies at all life-stages of electronics, including their production and consumption. Furthermore, it also connects each issue back to the Sustainable Development Goals.

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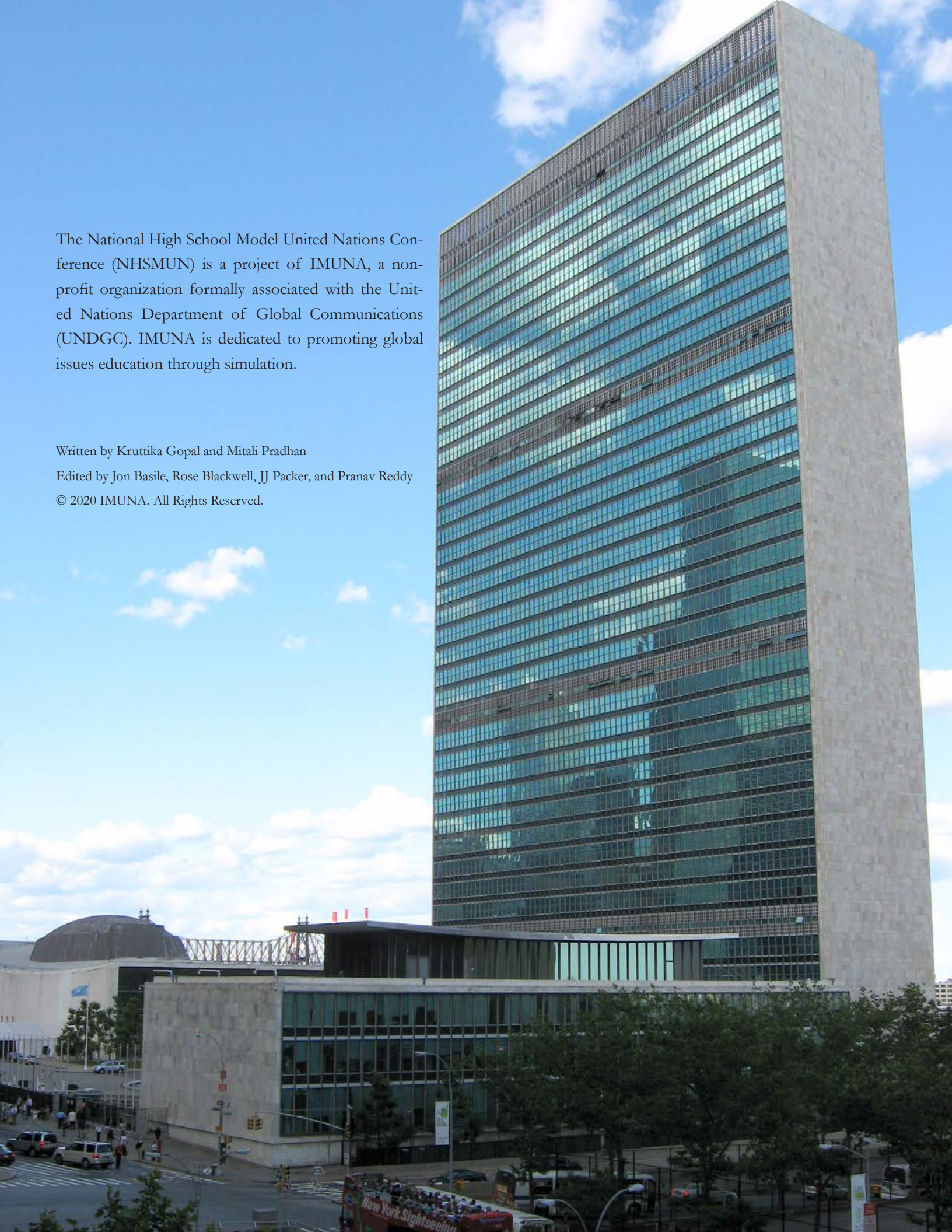
This article discusses the impact COVID-19 has had on electronic device consumption as well as disposal policies. It particularly addresses the increased demand for reusing old electronics and buying used devices due to the pandemic.

"Zimbabwe's Growing Electronic Waste Becomes a Real Danger | Inter Press Service." Accessed June 30, 2020. http://www.ipsnews.net/2014/03/zimbabwes-growing-electronic-waste-becomes-real-danger/.
This source discusses the economic incentives of countries that mine for metals like lithium. In particular, this article discusses the need to balance sustainable disposal of e-waste to prevent environmental harm with the economic incentive to continue producing more electronics.



The National High School Model United Nations Conference (NHSMUN) is a project of IMUNA, a nonprofit organization formally associated with the United Nations Department of Global Communications (UNDGC). IMUNA is dedicated to promoting global issues education through simulation.

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