



It's time to

MONMUNC' 22 | RENEWAL

Topic A: Achieving Net Zero while guaranteeing the economic safety of nations

Topic B: Combatting the issue of pollutants in consumable water sources

United Nations Environment Programme (UNEP)



@monashmunmalaysia

Chair Introductions

Head Chair: Loy Jun

I am Loy and I will be your chair for MONMUNC '22's UNEP. I will save my formal introduction for the event itself so for now, I apologise in advance for any shortcomings and hope that your research goes well.

Contact: loyjun.acad@gmail.com

Co-Chair: Kim Osman

Sup. I'm Kim, and I'll be your chair for these next few days, or weeks, I guess-- depending on when you're reading this. If I make any mistakes throughout the council, then I wish to apologise beforehand. Here are some things I would like to clarify:

- i. Primo, the notion that MUNs are the playing-pens of the more experienced, and that beginners are simply subsided. To tell you the truth, 'MUN Experience' is just a number. Even I've seen the most, /experienced/ of delegates falter to beginners willing to grasp the opportunity MUN provides in voicing out their opinions freely. Even if you're shy, then put yourself out there, and surely you'll push through. To the experienced delegates: Don't get comfortable. If I hear anything resembling "Oh this is my [x] ever MUN conference," then I'll chair's discretion you out of council! /j
- ii. This Research Report (hereinafter referred to as 'RR'). Take note that this RR merely serves as a stepping-stone for your research, as it is expected that you read up on other sources prior to council, and as assistance for your Position Paper.

Was that scary? I sure hope not... If you have any questions at all, don't hesitate to reach out to me via Instagram @kimosmn or email at mxskly@gmail.com.

Committee Introduction

United Nations Environmental Programme (UNEP)

The United Nations Environmental Programme (UNEP) is a subsidiary body of the United Nations formed in June 1972 by former Secretary-General of the United Nations Conference on Human Environment, Maurice Strong (Ivanova, 2007). Initially, the UNEP focused on coordinating organisational activities vis-a-vis the environment and assisting developing countries in formulating sustainable environmental policies. However, following the Rio+20 Summit in 2012, environmental issues rose to become a prominent centre of discussion globally– leading to the eventual strengthening and upgrade of the committee as a whole.

Currently, the role and mandate of UNEP includes, but not limited to:

1. Promoting international cooperation on environmental issues
2. Providing guidance to UN organisations on environmental policies
3. Encouraging the international scientific community to participate in formulating environmental policies
4. Promoting sustainable use of the world's natural resources
5. Serving as a forum for summits and discussions on environmental issues
6. Raising awareness on environmental polemics for the public

Serving as a biannual forum and governing body under the jurisdiction of the UNEP, the United Nations Environment Assembly (UNEA) acts as a platform for world leaders to discuss environmental issues in-person, similar to that of the General Assembly (GA). Subsequently, the work of the UNEP can be divided into seven broad categories, namely: climate change, disasters and conflicts, ecosystem management, environmental governance, chemicals and waste, resource efficiency, and the environment under review.

Position Paper

The submission of a position paper is mandatory for this council. Further guidelines can be found in the Google Classroom.

Topic A: Achieving Net Zero While Guaranteeing the Economic Safety of Nations

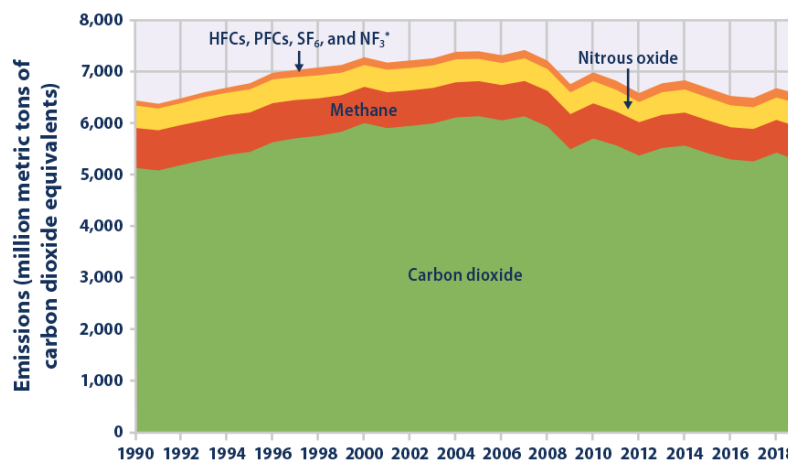
Written by: Kim Osman

Topic Introduction

Greenhouse Gas Emissions and Climate Change

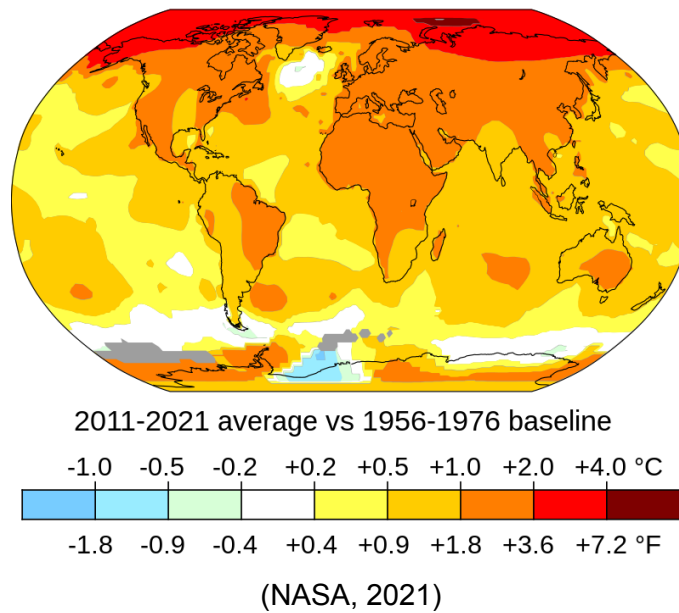
With rising tides, melting ice caps, and intensifying temperatures, climate change is a unifying issue affecting all lives across the globe, the only difference being in whether its consequences are felt at a diminutive or detrimental scale. Surely, climate change, global warming, the greenhouse effect, or whatever name it is known by, is a topic taught to most, if not all students from a young age— and knowingly, it is public knowledge that greenhouse gases, primarily made up of minute gases such as carbon dioxide and methane are direct contributors to the effects of climate change.

By absorbing large amounts of heat, permeating the Earth's atmosphere to sunlight, and reflecting radiant energy back towards the Earth, the 6,558 trillion metric tons of greenhouse gases emitted per year (EPA, 2021) is a clear showcase to represent the overwhelmingly large quantities of greenhouse gases emitted by us that causes the drastic effects of global warming.



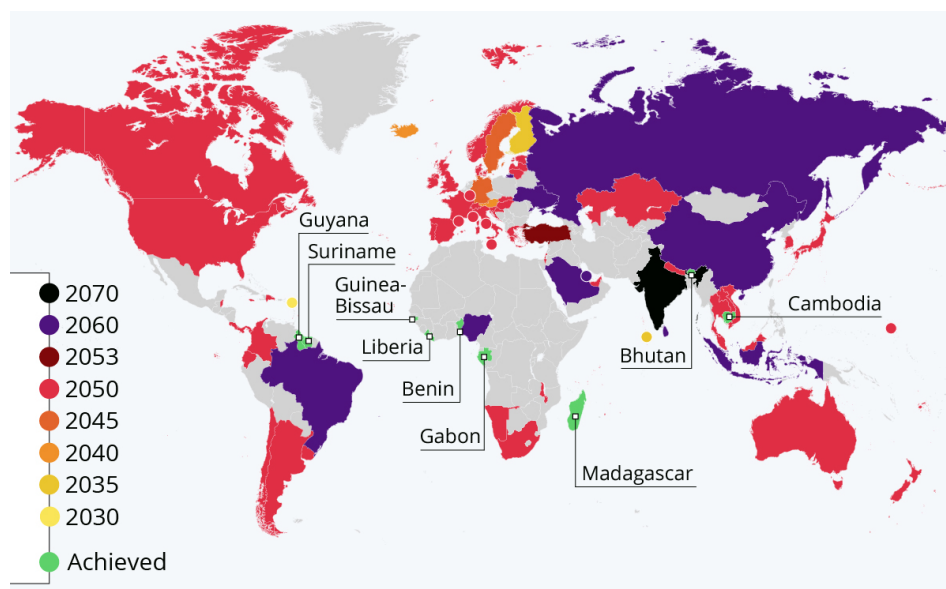
(EPA, 2021)

More specifically, a bulk of greenhouse gases are released from the sector of energy usage, whether it be by the burning of fossil fuels or the production of natural gas and petroleum (Hannah, 2020). Moreover, agricultural, steelmaking, industrial, and production sectors are fields which emit large amounts of greenhouse gases (Hannah, 2020). As such, the temperature change of nations in the next 50 years have been recorded as below, with more industrial nations shown to emit much more greenhouse gases compared to others.



Understanding 'Net Zero'

The term 'Net Zero' can be defined as the state of net-zero carbon dioxide and carbon dioxide-equivalent gases (i.e. greenhouse gases) emissions to the Earth's atmosphere, also known as carbon neutrality (European Parliament, 2019). Regarded as a vital step towards combating climate change by greatly reducing and/or balancing greenhouse gas emissions, both countries and corporations have made pledges to achieve carbon neutrality by varying target years— albeit, such a transition may cause financial consequences to industries in the aviation, agricultural, and production fields that tend to produce more greenhouse gas emissions compared to others.



(Energy and Climate Intelligence Unit, 2021)

* Net Zero is not to be confused with the total elimination of greenhouse gas emissions.

Achieving a Carbon-Neutral Status

Generally, most methods undertaken by governments and companies in the pursuit of achieving a carbon-neutral status can be divided into two strategies: balancing greenhouse gas emissions via carbon offsets and the removal of greenhouse gas emissions entirely by utilising renewable energy (European Parliament, 2019).

To balance greenhouse gas emissions, carbon offsetting serves as a compensation process that cancels out and neutralises greenhouse gases to a net zero. This is done through different kinds of markets, namely a compliance market and voluntary market. In a compliance market, governments and companies purchase carbon offsets to comply with mandatory and legally binding thresholds on the total amount of greenhouse gases they are allowed to emit per year, and should they fail to comply with such standards, they will be met with legal and financial fines as a penalty. On the other hand, voluntary markets involve many different parties such as offset providers, quality assurance agents, and third party verifiers; easy to say that such a market relies on the free trade of carbon offset among civilians and corporations.

In reducing greenhouse gas emissions, a transition towards a low-carbon economy through renewable energy is imperative to achieve a net-zero status. Potentially being able to reduce methane production by 40% (Smith, 2019) in the industrial and agricultural sector by 2030, carbon scrubbing processes and emissions trading can also be used to reduce carbon emissions and prevent greenhouse gases from entering the atmosphere entirely.

When applied by multiple parties on a multilateral and collaborative scale, all stakeholders, ranging from businesses to local administrations, can utilise environmental management systems to work towards climate neutrality not only for reducing or balancing the emissions of greenhouse gases, but also for research purposes in environmental analysis, evaluation, and check-and-balancing. Truly, the only way to achieve carbon neutrality is via a method that is inclusive, multilateral, and engaging between all relevant stakeholders.

Key Challenges

Equally important with the need to combat climate change is also a clean and “secure” transition towards net-zero carbon emissions. Thus, quality services for the daily functioning of people’s lives, economic activities, and public services must be maintained at optimum capacity so as to not compromise the domestic and global reliability of such systems (Zhai, n.d.). Included below are some, but not limited to, challenges faced in the pursuit of carbon neutrality:

Transitional Resource Strain

As demand surges for renewable energy, costs for acquiring such forms of energy have decreased heavily (Materson, 2021). As countries continue to pledge to achieve carbon neutrality, the construction of renewable energy sites such as hydroelectric dams, wind farms, and solar farms have resulted in large swaths of land being taken up for construction. Hence, the natural environments of both animals and local ecosystems may be disrupted as a result, and lead to more greenhouse gas emissions given that not only are trees being

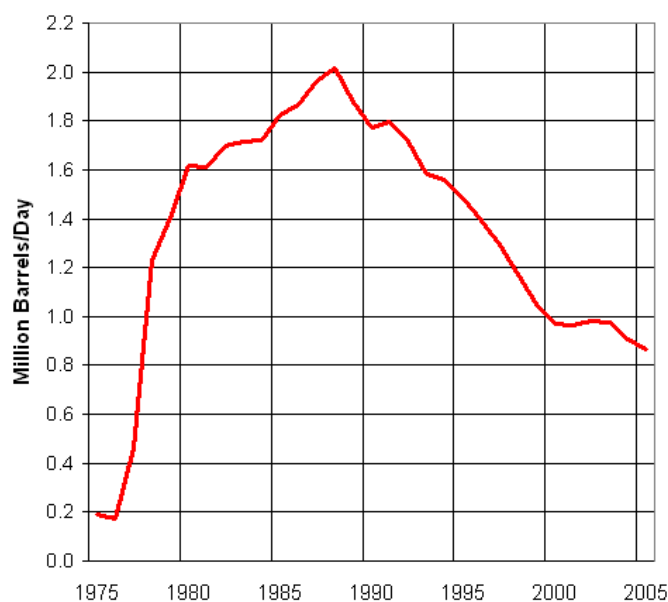
actively chopped down, but also that the vehicles and tools utilised to develop such areas may not be too eco-efficient. Thus, ensuring that the surrounding area or area utilised to develop renewable energy is preserved represents a step towards ensuring the financial stability of nations in achieving a net-zero status.

Additionally, while renewable energy may now be fairly cheap, it still does not negate the need to purchase resources necessary to develop such forms of energy– thus causing a higher financial strain on governments and businesses. Without a proper amount of money, no sources of renewable energy can actually be developed; and as such, certain incentives may be necessary to stimulate the development of renewable energy in tackling climate change.

Unemployment in Non-Renewable Energy

As demand for non-renewable energy slowly decreases, unemployment may be a rising issue faced by those working in fields such as mining and oil and gas. With declining oil well productions and depleting oil reserves, governments and corporations have realised the need to switch to a working model based on sustainable forms of energy categorised as more productive on a long-term basis.

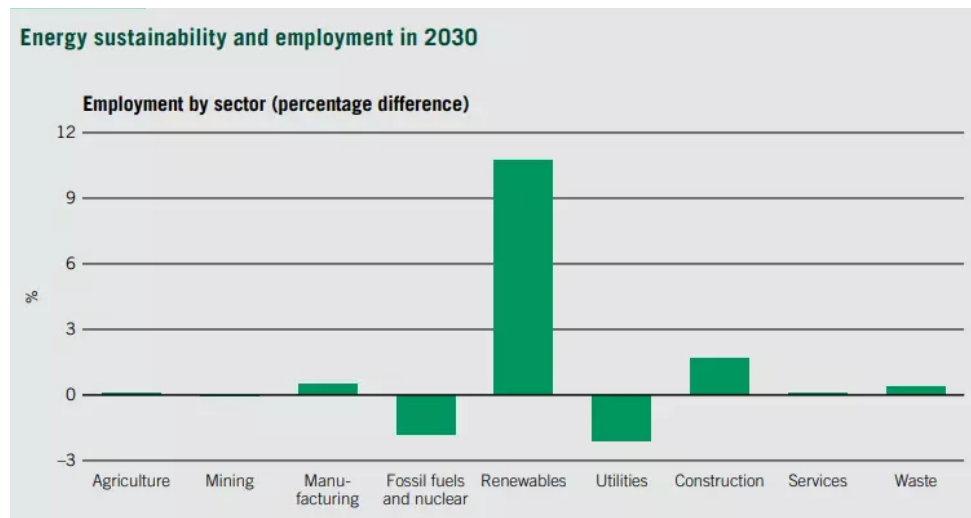
In countries such as the United States which has historically been heavily reliant on oil, statistics of oil production in oil-producing states such as Alaska have declined rapidly (EIA, 2022), showing signs of a general transition towards other forms of renewable energy and a lower demand in oil entirely.



(EIA, 2022)

Consequently, there is sure to be a general surge in unemployment in the oil and gas industry as shown below, where employment in the field of fossil fuels and nuclear energy is predicted to have a 3% drop by 2030 (ILO, 2021). In turn, governments should formulate a

reasonably-paced balance in the transition towards renewable energy so as to mitigate the detriment workers in the oil and gas industry may face with regards to unemployment.



(ILO, 2021)

Ensuring Inclusivity in the Transition

The key to any relationship is that of communication– and this is no different to any form of government. In transitioning towards the usage of renewable energy, it is crucial that governments allow all stakeholders affected by the change to engage in proper dialogue to further their very own concerns.

Either through unions (where such is permissible) or joint-dialogues, a degree of inclusivity must be maintained to ensure that the transition towards renewable energy in certain areas is done respectfully and ethically. Where marginalised groups or workers may be consulted, countries such as Spain have publicly outlined dialogues and participatory processes to protect fossil fuel workers from unemployment via a “Just Transition Strategy”. As a consequence, by November of the same year in 2020, more than 1500 people had participated in joint-dialogues and negotiations to sign off on the policies proposed by the Spanish government regarding the transition towards renewable energy.

Past Actions and Agreements

When discussing carbon neutrality, a key agreement to highlight is the Kyoto Protocol (UNFCCC, 2005). Under the basis that global warming is occurring and driven by human-made carbon dioxide emissions, such a treaty seeks to commit state parties to reduce greenhouse gas emissions through a plethora of methods, namely, flexibility mechanisms, the stabilisation of greenhouse gas emissions, and global financial commitments. While the protocol may have multiple takeaways, one that is particularly relevant to the economic security of nations would be that of flexibility mechanisms vis-a-vis international emissions trading, whereby studies have shown that national losses in the national GDPs of state parties can be reduced by the use of the flexibility mechanisms listed (Hourcade, 2012). For example, project-based mechanisms are listed under the protocols to

set a quantitative restriction of emissions and encourage the production of emissions reductions within nations.

Following the end of the commitment period of the Kyoto Protocol in 2020, the Paris Agreement was adopted by 193 state parties as a separate instrument with the goal of reaching a net-zero on global carbon emissions (UN, 2015). With long-term sights on keeping the rise in the mean global temperature from the range of 1.5°C to 2°C, it is widely thought that global greenhouse gas emissions need to be cut out by roughly 50% by 2030. Through the agreement, climate litigation, emissions monitoring via the Global Stocktake, and regular reports are conducted to ensure such goals are reached.

Similarly, the Montreal Protocol and the subsequent Kigali Amendment was ratified by 197 state parties (UN, 1987). With rapid greenhouse gas emissions depleting the ozone layer, the Montreal Protocol was designed to protect the ozone layer from phasing out. The subsequent Kigali Amendment was tabled and accepted in 2016 to bind state parties to gradually reduce the consumption and production of hydrofluorocarbons (HFCs) that contribute to the phasing of the ozone layer. Often mentioned to as well is the CORSIA agreement ratified by the International Civil Aviation Organisation (ICAO) (ICAO, 2019) in 2019, which seeks to act as a carbon offset and carbon reduction scheme to lower carbon dioxide emissions for international flights to curb the aviation impact on climate change.

Thus, such state parties that rely on fields that emit high carbon emissions have imposed certain regulations in accordance with such agreements to ensure their very own financial safety in their pursuit of achieving carbon neutrality. In largely industrial nations such as the United States and China, market-based mechanisms have been enacted to incentivise companies to cut pollution (Batson, 2006). In countries such as Australia, New Zealand, and the European Union, national and regional carbon trading schemes have been formulated to provide caps on carbon emissions and encourage investing in clean technologies and low-carbon solutions for credits to be utilised in the trading scheme.

On a larger basis, countries engaged within the United Nations Conference of the Parties (COP) on Climate Change have mutually agreed on a general coal phase-down during its 26th convening in 2021. While other transitions are currently being discussed, inefficient fossil fuel subsidies have also been largely agreed upon to be mitigated entirely. Truly, innovative financing which is both multilateral and consultative in nature is to be pursued in order to achieve carbon neutrality whilst also ensuring the economic stability of nations.

Possible Solutions

Listed below are a few possible solutions handpicked by the chair which may be of relevance to the council, albeit, delegates are meant to look into other solutions in their own research. By no means are they to be plagiarised or copied whatsoever, and in fact, delegates are meant to expound upon them when provided the chance.

Globally, countries have pledged their often-voluntary commitments to achieve carbon neutrality, which may, in certain occasions, be overly-ambitious and therefore not be consistent with the achieving of a global net zero. Thus, governance, accountability, and report mechanisms must be improved as their long-term ambition is more often than not, not

backed up by any sufficient action. As a result, such pledges have been accused of amounting to little more than 'greenwashing' (Friends of the Earth, 2021).

As the world steers full-speed-ahead towards decarbonisation, costs for renewable energy have been decreased so heavily that zero-carbon electricity is now difficult to stop. Thus, industries that produce large amounts of carbon emissions may consider themselves to be at stake— for tackling all emissions requires an equally comprehensive approach to the involvement of all stakeholders (IEA, 2020). Truly, wide societal support for the transition towards renewable energy is essential for a successful net zero; and thus, methods must be formulated to gain the support of all stakeholders in such a transition, including those that may have themselves at stake.

It cannot be denied that the carbon offsetting process is inseparable from achieving a true net zero (Fankhauser, 2021), however, the voluntary carbon market has suggested that the environmental integrity of carbon offsets may have questionable quality standards and are scrupulously enforced (Heya, 2020). This is because only a few organisations in certain countries (which are mostly considered as developed countries) will be able to balance residual emissions and removals via carbon offsets, with most emissions conversely contributing to the global greenhouse effect. Thus, some governments may look into procuring carbon offsets centrally through regular purchases to balance their national carbon account, or otherwise structuring a private market for carbon offsets.

Widely, the solutions towards achieving an economically-feasible net zero encompasses not only economic solutions, but also those that are biological and socio-economic. Nature-based solutions such as protecting or restoring natural ecosystems can in theory, simultaneously help limit surface warming, slow biodiversity declines, and also support human societies in forms of public health, livelihoods, and food security (Seddon, 2021). Therefore, when considering nature-based solutions, it is essential to keep in mind that such solutions must be biology-based and people-led, and that the acknowledgement of a full range of ecosystem services must be taken into consideration for the safety of socio-ecological stability and ecological resilience.

Questions A Resolution Must Answer (QARMAs)

1. Through international treaties such as (but not limited to) the Kyoto Protocols and the Paris Agreement, it is clear that the solutions towards achieving a net zero are already present. Thus, how is it that countries can act upon and/or around such agreements in ensuring their economic stability in the pursuit of a net zero status?
2. The transition towards a net zero is one that is multilateral and has the potential to be a detriment towards many stakeholders. How will such stakeholders be involved and secured in such a transition?
3. Given the cultural, territorial, governmental, and often varying nature of countries, how will the economic stability of nations be ensured for transitioning towards a net zero in a way that is both standardised internationally and equitable?

4. What are some primary flaws of the current systems that are in place in achieving a net zero, and what are some improvements and/or modifications that can be made to such systems in order to ease such a transition?
5. Aside from economic solutions which serve to ensure the economic stability of nations in the pursuit of an et zero, what are some other solutions in the field biology and socio-economics that can serve to achieve a similar goal?

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Topic B: Combatting the Issue of Pollutants in Freshwater Sources

Written by: Loy Jun

Please note that the wording in the topic has been changed, i.e., from “consumable water sources” to “freshwater sources”. This change does not significantly alter the topic.

Notes on Material

- This material provides a very brief insight into the topic and should by no means be used as a delegate's only research material.
- For context on more complex content, delegates are recommended to perform a quick search.
- Delegates are highly encouraged to go through the bibliography.

Topic Introduction

Introduction

Freshwater makes up only 2.53% of the water in the Earth's hydrosphere, which is the total amount of water on the planet in all its states. Of the 2.53%, 1.74% exists in solid form as either ice sheets or glaciers, and of the rest, approximately 99% exists as groundwater (Shiklomanov & Rodda, 2003).

As the human population grows and economies expand, it is no surprise that demand for this essential commodity is increasing as well. Thus, there exists a problem in the availability of water resources, the mounting threat of water security (Rosegrant et al., 2002; Shiklomanov & Rodda, 2003). Water pollution is closely associated with this scarcity.

For the purpose of limiting debate, the term “pollutants” are defined as the following mostly non-living substances:

- litter (e.g., plastic pollution),
- organic matter (e.g., nutrients),
- chemicals (e.g., agricultural and industrial chemicals); and
- pathogens.

Sustainable Development Goal 6

Access to clean and safe drinking water, as well as sanitation are fundamental human rights, as enshrined in resolution 69/242 adopted by the United Nations General Assembly in 2010 (GA, 2010).

The Sustainable Development Goal most closely associated with this ideal is SDG 6: [to] ensure availability and sustainable management of water and sanitation for all. While the COVID-19 pandemic has hampered the progress towards sustainability, the world was not on track to meet SDG 6 even before then (GA, 2015).

To be more specific, target 6.3 explicitly relates to freshwater pollution. Target 6.3 is: by 2030, improve water quality by reducing pollution, eliminating dumping and minimising release of hazardous chemicals and materials, halving the proportion of untreated wastewater and substantially increasing recycling and safe reuse globally (GA, 2015).

Past Actions

Past agreements

Listed below are several UN agreements and their basic descriptions.

1989 - The Basel Convention on the Control of Transboundary Movements of Hazardous Wastes and Their Disposal (or the Basel Convention) aims to reduce hazardous waste generation, promote sound management and restrict transboundary movements of hazardous wastes. The extensive list of hazardous waste listed in Annex I of the convention includes several waste streams, and wastes having constituents of substances such as arsenic, cadmium and lead (Secretariat of the Basel Convention, 2019).

1992 - The Convention on the Protection and Use of Transboundary Watercourses and International Lakes (simply known as the Water Convention) is a legal instrument and intergovernmental platform which promotes the sustainable use of transboundary water resources by preventing conflicts and facilitating regional integration (UNECE, 2022b).

1992 - The Protocol on Water and Health is a region-specific legally binding instrument which aims to protect human wellbeing by better management of water and water-related diseases in Europe. It is jointly serviced by the UN Economic Commission for Europe (UNECE) and the World Health Organization Regional Office for Europe (WHO/Europe) (UNECE, 2022a).

1998 - The Rotterdam Convention on the Prior Informed Consent Procedure for Certain Hazardous Chemicals and Pesticides in International Trade (or the Rotterdam Convention) is a multilateral treaty which promotes the sharing of responsibility and cooperation in the trade of certain hazardous chemicals, and contributes to the environmentally sound use of said chemicals (Secretariat of the Rotterdam Convention, n.d.).

2001 - The Stockholm Convention on Persistent Organic Pollutants (or the Stockholm Convention) is a global treaty which protects human health and the environment from chemicals that remain intact for long periods of time or become widely distributed geographically. These chemicals are known as persistent organic pollutants (POPs) (Secretariat of the Stockholm Convention, n.d.).

2006 - The Strategic Approach to International Chemicals Management (SAICM)'s objective is to achieve the sound management of chemicals throughout their life cycle (SAICM, n.d.).

2013 - The Minamata Convention on Mercury is a global treaty to protect human health and the environment from the adverse effects of mercury. Article 9 concerns the general release of the substance and its compounds into water in addition to land. (UNEP, 2019b)

More recent progress

The SDG 6 Global Acceleration Framework is a relatively new initiative coordinated by UN-Water that is part of the UN Secretary-General's Decade of Action to deliver the SDGs by 2030. In brief, the framework aims to better access to, or enhance the quality of the following 5 accelerators: financing, data and information, capacity development, innovation, and governance (UN-Water, 2020).

The United Nations Environment Assembly resumed its fifth session (UNEA-5.2) in March and passed the "End plastic pollution: Towards an international legally binding instrument" resolution (UNEP/EA.5/L.23/Rev.1). Like its namesake, the resolution aims to form a legally binding instrument by 2024 to end plastic pollution. It has been heralded by the UNEP Executive Director, Inger Andersen as "the most important international multilateral environmental deal since [The] Paris [Agreement]". Relevant resolutions also passed during the session include the Resolution on Sustainable Lake Management (UNEP/EA.5/L.8) and the Resolution on the Sound Management of Chemicals and Waste (UNEP/EA.5/L.13) (UNEP, 2022).

Key Challenges

The following challenges have been handpicked by the chair as they believe them to be the most relevant issues that delegates may overlook. The list is by no means an exhaustive list of all the issues surrounding the topic.

Data gaps

The Global Freshwater Quality Database, GEMStat is the premier data-provider for scientifically-sound data and information on the state and trend of global inland water quality, and it exists within the framework of the Global Environment Monitoring System for Freshwater (GEMS/Water) (GEMStat, n.d.), itself an international programme on water quality monitoring and assessment, jointly implemented by the UNEP, the UN Education and Scientific Organization (UNESCO), the World Health Organization (WHO), and the World Meteorological Organization (WMO) (Allard, 1992).

GEMStat is the major source of data for indicator 6.3.2 monitors the proportion of bodies of water with good ambient water quality (UNSD, n.d.).

According to UN-Water (2021a), 72% of the world's monitored water bodies meet the standard of indicator 6.3.2. Even though the figure itself looks promising, it does not paint the full picture due to the lack of comprehensive data. Only 35% of the world population and 51% of the world economy were covered in reporting since 2017 (UN-Water, 2021a).

For example, over 3/4 of the 75,000 water bodies reported on in the 2020 data drive for indicator 6.3.2 were in 24 MEDCs and the poorest 20 countries reported on just over 1000 water bodies. Additionally, only 52 out of the 89 countries with data reported information about groundwater (UNEP, 2021).

Data that is available may also lack detail, with calculations made using relatively few measurements and without suitable standards (UNEP, 2021). The problem with data is also widely present in the other challenges and is a prevalent issue in the topic.

Lack of industrial wastewater treatment

Indicator 6.3.1 tracks the percentage of wastewater flows that are safely treated before discharge or reuse. Wastewater flows can be classified into the following:

- total,
- industrial; and
- household.

The UNEP defines 3 classifications for wastewater treatment which can be found in UNSD & UNEP (2020). Nonetheless, wastewater flows are defined as being safely treated if discharges comply with national or local standards, or in the absence of such data, flows treated by secondary or higher technologies.

In 2015, 42 countries representing 18% of the global population reported 32% of all wastewater flows receive at least some treatment, although the treatment may not be necessarily safe. Of the available data from 14 countries representing 4% of the global population, only 30% of all wastewater flows from industrial sources received at least some treatment.

In 2020, 56% of all wastewater flows generated by households were collected and considered safely treated, based on estimates produced for 128 countries and territories representing 80% of the global population.

Contrasting the industrial and household wastewater statistics, there exists an immense disparity of data concerning the former. As such, monitoring remains a large barrier to solving wastewater treatment problems.

The lack of disaggregation of wastewater volumes and pollution loads also creates problems when it comes to equitable and sustainable management of water. Additionally, there is also the underlying problem of safe wastewater management infrastructure or the lack thereof (UN-Habitat & WHO, 2021).

According to Inter-Divisional Water Group (2022), industrial discharge that includes heavy metals and other contaminants cause freshwater bodies to become for use in many countries.

Rise of emerging pollutants

Emerging pollutants (EPs) are chemicals that are not commonly monitored but can lead to disastrous effects on the ecosystem and human health (Geissen et al., 2014). Due to their status as “emerging”, meaning that there is a rising level of concern, there may not be legislation, be it on a national or international level, to regulate these pollutants (UNEP, 2019a). This only exacerbates the eventual management or treatment of water.

Geissen et al. (2014) says that the NORMAN network, which helps facilitate the exchange of information on emerging environmental substances, has categorised 700 substances found in the European aquatic network into 20 classes. The most prominent of these EPs are pharmaceuticals, pesticides, disinfection by-products, wood preservation and industrial chemicals.

One notable example is antibiotics. Due to the rise of use of the medication, antibiotics are reaching the aquatic environment from a range of sources, including both treated and untreated human waste. As a result, antibiotic-resistance bacteria can now be found in freshwater sources. Infections that are antibiotic- or antimicrobial-resistant are projected to become a main cause of deaths worldwide by 2050 (Inter-Divisional Water Group. 2022).

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