Documentary research finding on "Impact of the disposal of black water, solid waste and liquid waste into stream and rivers."

Abstract

"Impact of the disposal of black water, solid waste and liquid waste into stream and rivers were identified and mitigation measures were suggested based on the finding of the documentary research."

1. Introduction

Forest Resource Environment Development and Conservation Association (FREDA) is implementing the project on "Advancing Cooperation Between Lower Mekong Countries to support governance, transparency and local voices, concerning with water and Water Related Ecosystem" from 5th October, 2022 to 15 August 2023, with the financial assistant of Pact, Inc. under "Mekong Connections: Governance, Transparency, and Local Voices" funded by the US Department of State East Asia and Pacific Bureau. Documentary research finding on "Impact of the disposal of Black water, solid waste and liquid waste into stream and rivers." are reported.

In January 2015, the General Assembly began the negotiation process on the post-2015 development agenda. The process culminated in the subsequent adoption of the 2030 Agenda for Sustainable Development, with 17 SDGs at its core, at the UN Sustainable Development Summit in September 2015. The sixth SDG of united nations sustainable development summit is clean water and sanitation, which aims to ensure availability and sustainable management of water and sanitation for all, with associated eight targets as follow; [1]

Target 6.1, "Safe and affordable drinking water"

By 2030, achieve access to adequate and equitable sanitation and hygiene for all and end open defecation, paying special attention to the needs of women and girls and those in vulnerable situations.

Target 6.2, "End open defecation and provide access to sanitation and hygiene"

BY 2030, achieve access to adequate and equitable sanitation and hygiene for all and end open defecation, paying special attention to the needs of women and girls and those in vulnerable situations

Target 6.3, "Improve water quality, wastewater treatment safe reuse"

By 2030, improve water quality by reducing pollution, eliminating dumping and minimizing release of hazardous chemicals and materials, halving the

proportion of untreated wastewater and substantially increasing recycling and safe reuse globally.

Target 6.4, “Increase water-use efficiency and ensure freshwater supplies”

By 2030, substantially increase water-use efficiency across all sectors and ensure sustainable withdrawals and supply of freshwater to address water scarcity and substantially reduce the number of people suffering from water scarcity.

Target 6.5, “Implement integrated water resources management”

By 2030, implement integrated water resources management at all levels, including through transboundary cooperation as appropriate.

Target 6.6, “Protect and restore water-related ecosystems”

By 2020, protect and restore water-related ecosystems, including mountains, forests, wetlands, rivers, aquifers and lakes.

Target 6.7, “Expand water and sanitation support”

By 2030, expand international cooperation and capacity-building support to developing countries in water- and sanitation-related activities and programmes, including water harvesting, desalination, water efficiency, wastewater treatment, recycling and reuse technologies.

Target 6.8, “Support local engagement in water and sanitation management

Support and strengthen the participation of local communities in improving water and sanitation management.[1]

In Myanmar, water shortage is seen in dry zone due to the prolong period of drought, summer. Water shortage is the impact of climate change. It need to ensure sufficient water quantity of acceptable quality to meet the needs of communities in dry zone and delta area. Villagers, mainly women and children are spending a lot of time to collect water from long distance in neighboring villages on foot or by boat. Most of the communities in delta area do not have sufficient **“Potable water”**; simply means water that is safe to drink, and it is becoming scarcer. Water stress or scarcity occurs when demand for safe, usable water in a given area exceeds the supply. Most urban people drink bottle water that has been purified while in rural areas bottle water is not commonly used due to the constraints of transport and affordability. Most of the villages have insufficient knowledge on use of improved water supply and sanitation facilities, many households in rural villages still use water from unimproved sources. It need to ensure availability and sustainable

management of clean water and sanitation for all people living along the Ayeyarwady river, to eliminate common waterborne diseases. In general, the quality of water is not good due to water contamination such as saline water. Due to the poor management and operation and maintenance of water supply and sanitation facilities, water borne diseases often occurs, especially in monsoon seasons. Diarrheas are included in top ten leading cause of morbidity in current condition of Myanmar.

2. Literature review

National Environmental Policy of Myanmar builds on Myanmar's 1994 National Environment Policy and reaffirms its core values: (a) The wealth of the nation is its people, its cultural heritage, its environment and its natural resources. (b) It is the responsibility of the State and every citizen to preserve our natural resources in the interests of present and future generations. (c) Environmental protection should always be the primary objective in seeking development. [2]

National Environmental Policy of Myanmar also builds on the 1997 Myanmar Agenda 21, the 2009 National Sustainable Development Strategy. It is grounded in the environmental responsibilities in the 2008 Constitution of the Republic of the Union of Myanmar, and the obligations contained in the 2012 Environmental Conservation Law. It also aligns with, and expands upon, the environmental considerations in the 2015 National Comprehensive Development Plan and the 2018 Myanmar Sustainable Development Plan. The Policy recognizes and integrates Myanmar's commitments to Multilateral Environmental Agreements, including the 2015 Paris Agreement. The Government of the Republic of the Union of Myanmar recognizes the fundamental links between environmental protection, economic and social development, and poverty alleviation. The principles outlined in this National Environmental Policy reflect these linkages. This approach is consistent with the 2030 Agenda for Sustainable Development which includes 17 SDGs to end poverty, fight inequality and injustice, and tackle climate change by 2030. Putting this Policy into action will also ensure that Myanmar makes significant progress in meeting the SDGs. This National Environmental Policy will serve as a guide in mapping out detailed action plans for environmental protection and sustainable development, and set the direction for the on-going implementation and enhancement of relevant laws and policies. Further it will establish a foundation for mainstreaming environmental considerations into decision-making on economic and social development and activities by: (a) conceiving a long-term vision for environmental protection and sustainable development, supported by key national environmental policy principles;(b) providing a framework for incorporating environmental protection

and sustainable development into all relevant sectoral policies; and (c) setting a basis for enhancing environmental governance in Myanmar. Twenty three National Environmental Policy principles are the guiding framework for achieving: Pollution and waste is to be avoided and minimized at the source as more cost effective than remediation, enterprises will be encouraged to adopt clean production principles and best practices. Environmental governance arrangements will be responsive to peace process, and arrangements in state and regions including self-administered areas, recognizing that peaceful and just societies and environmental conservation and sustainable development efforts are mutually beneficial. Financial sustainability of environmental governance will be achieved through the application of the polluter pays principle and the use of green financial instruments. [2]
In Myanmar National Water Policy (August 2015), NWRC should pinpoint and control in cooperation with government authorities to address contamination and pollution of water bodies (rivers also) and sediment deposition in Myanmar due to various reasons and causes. and. National Water Resources Management Committee- NWRC must control water pollution and effluent discharge without proper treatment in conjunction with authorities. [3]
Nutrients, such as nitrogen and phosphorus, are essential for plant and animal growth and nourishment, but the overabundance of certain nutrients in water can cause several adverse health and ecological effects.[4]

The usage of fertilizers results in the discharge of nitrate, potassium and phosphates that pollute the water. The contamination of groundwater occurs as a result of leaching due to nitrate. The ground and surface waters are infested with heavy metals, whose concentration poses a threat to humans and animals. Besides, the emission of ammonia from fertilizers results in acidification that decreases the purity of water bodies.

Farmers use fertilizers for crops that help grow better quality, but at the same time, its harmful as the runoff from fields to rivers and water bodies make the quality deteriorate. Rainfall, snowfall, irrigation are the reasons why fertilizer makes its way to the nearby water bodies.[5]

1. A high concentration of nitrogen contaminates the drinking water. Nitrates can leach into groundwater, and when found in animals in higher concentrations, can cause nitrate poisoning.

2. A higher concentration of nutrients that runs off to the water bodies results in Eutrophication. Algal bloom occurs in the water body because of this phenomenon. The result is that the oxygen level decreases and aquatic animals die. Also, the passage of water transportation becomes difficult. Harmful algal blooms (HABs) occur when colonies of algae—simple plants that live in the sea and freshwater—grow out of control while producing toxic or harmful effects on people, fish, shellfish, marine mammals, and birds. In other cases, HABs may be linked to 'overfeeding.' This occurs when nutrients (mainly phosphorus, nitrogen, and carbon) from sources such as lawns and farmlands flow downriver to the sea and build up at a rate that 'overfeeds' the algae that exist normally in the environment.

3. Fertilizer runoff affects marine life badly. Since the drain of nutrients occurs, the chemicals result in the growth of microorganisms. This results in oxygen depletion, and the aquatic animals die due to suffocation.

4. Algal bloom occurs due to the drainage of fertilizers. This releases harmful toxins and has a great effect on marine creatures. These toxins suffocate the aquatic animals, and they are left to suffer and eventually die.

5. Due to excess of Eutrophication, an entire zone becomes affected, and they become dead zones. They show up near the major river mouths. The phenomenon causes a decrease in marine activity. Although algal activity can decrease with time, to get back to normalcy and previous healthy state, it takes considerable time.

Toxic runoffs of fertilizer into water bodies are considered harmful. Scientists have been conducting studies that state that limited usage of fertilizers is beneficial. In fact, the usage of organic fertilizer could be better in this respect as it doesn't support the ill effects.

Fertilizers, which are often considered as plant foods, consist of compounds of nitrogen and phosphorous. They are commonly owned by homeowners aimed at maintaining and improving the beauty of the landscape and quality. But the increased amount has caused concern about the quality of lakes and water bodies.

The several ill-effects of fertilizers are as follows:

1. The lawn and garden chemicals are generally absorbed by the groundwater mainly by the process of leaching and also runoff. The groundwater becomes polluted, and the quality of water deteriorates, which has several ill effects on crops and pisciculture (the breeding, rearing and tranplantation of fish by artificial means is called pisciculture..)

2. The excess of nutrients that occur from the fertilizers is instrumental in the algae bloom, which makes the passage of water transport impossible. When the algae die, it sinks to the bottom of the river bed that makes the aquatic animals impossible to survive due to the formation of dead zones.

3. When the chemicals from fertilizers have a run down into water bodies, the fishes ingest them and become diseased.

4. The crops which are produced as a result of irrigation from these infected waterbodies bear strains of the chemicals, and that could be harmful upon human consumption.

5. The chemicals, when get drained into rivers and other water bodies, can be infectious for the aquatic insects and caddie flies, which are the main food for the fish and frogs. Consumption of these aquatic foods could transmit the effect of chemicals on the human body.

6. Once the Eutrophication level of lakes increases, there is a problem in restoration and makes it fit for transportation.

In contrary to the effects mentioned above, organic fertilizers could be used so as to reduce the harmful effects on aquatic animals.

Fertilizers, also known as plant food, cause poisoning of plants. Fertilizers are meant to keep the plants healthy and enable them to grow fast, but the presence of certain chemicals will allow them to be pollutants, and in such cases, it's essential to know how to get rid of them.

Plant food can be harmful to humans and pets if they are accidentally ingested, inhaled or even if they come in physical contact. Touching the fertilizers can cause skin irritation, and that is regarded as poisonous. Nitrogen, although essential for plant growth, but can be dangerous for humans if present in higher levels. For the human body, nitrates are known to reduce the capacity of red blood cells to carry oxygen. Nonetheless, in case you are affected by plant food poisoning, you may develop the following symptoms.

1. Redness of skin

2. Burning sensation in the skin

3. Skin with an itchy feeling

4. Your eyes, throat and nose might appear to be burning.

However, if you ingest the plant fertilizers, you may experience these symptoms:

1. Fingernails, lips, and hands may turn blue due to lack of oxygen.

2. You might feel dizziness

3. You might likely have low blood pressure

4. You can experience seizures

5. You might be exposed to shortness of breath

6. You might experience stomach upset or feel stomach pain.

The use of fertilizers is permissible for non-edible plants. But, for edible plants, you must seek permission from consultants regarding the type of fertilizer you should use in plants. Various countries, including America, have experienced poisoning from indoor plants due to the use of fertilizers.

EFF or Environment-Friendly Fertilizers, the Least Harmful to the Environment

1. EFF has got a coating that can prevent the exposure in water, as they serve as a barrier. The physical barrier reduces the rate of urea Fertilizers are instrumental in keeping the soil fertile by making it enriched with minerals like potassium, nitrogen, phosphorus, iron, magnesium and other essentials. However, a significant portion of the fertilizers is known to cause environmental pollution.

In order to meet demands, EFF or Environment-Friendly Fertilizers are developed that are meant to reduce pollution. They can control the release of nutrients into the soil.

Environment-Friendly Fertilizers -EFFs are mainly applied in the form of coated fertilizers, which is the primary reason why they can be utilized as an environment-friendly product. More research is being carried on for fertilizers having a coating that is degradable but is super absorbent. Here are some of the attributes of EFF.

hydrolysis while also reduces the emission percentage of nitrogen dioxide and gaseous nitrogen.

2. Environment-Friendly Fertilizers -EFFs will increase the organic content in the soil.

3. Coated EFF's which are super absorbent, often act as a buffer to soil acidity or alkalinity.

4. These fertilizers can improve the water retention capacity of the soil.

The EFF fertilizers are effective in enhancing the efficiency of nutrients in the soil and reducing the pollution of the environment. Thus, they are used to have increased yield without causing any harm to the environment.

3. Objective

The objectives of the documentary research on "Impact of the disposal of black water, solid waste and liquid waste into stream and rivers" are;

1. to learn and share the knowledge on the sustainable development goals including clean water and sanitation for all
2. to learn and share the knowledge on the causes of sedimentation and siltation in rivers
3. to learn and share the knowledge on the "Plastic pollution in Myanmar
4. to learn and share the knowledge on the impact of open defecation or poor quality toilets
5. to learn and share the knowledge on the water pollution from agriculture and disposal of black water, solid waste and liquid waste such as chemical fertilizer and pesticides into stream and rivers, and
6. to give recommendation or suggestions to address the issues such as water pollution from agriculture, mining, deforestation, plastic and hazardous waste disposal

4. Materials and Method

4.1 Research Method

Desk research or Secondary research or "documentary research was used in this study. *Desk research* is a type of research that is based on the material published in reports and similar documents that are available in public libraries, websites, data

obtained from surveys already carried out, etc. Some organizations also store data that can be used for research purposes. It is a research method that involves the use of existing data. These are collected and summarized to increase the overall effectiveness of the investigation. Secondary research is much more cost-effective than primary research, as it uses existing data, unlike primary research, in which data is collected first-hand by organizations, companies, or may employ a third party to obtain the data in your name. It's also called "documentary research". One of the most popular ways to collect data for desk research is through the Internet. [6]

4.2 Research Orientation

4.2.1 Discussion and meeting were made with the consultants, NGO, CSO and people who had experiences in environmental conservation, sustainable agriculture, extension on plastic pollution control, and sustainable management of water related ecosystem. Questionnaire survey was conducted related to water pollution in November and December, 2022 to get information. SWOT analysis was done to address plastic waste disposal in Ayeyarwaddy river, by consultant and gave presentation on 28th December, 2022. Participants suggested to address issues. Literature review was done based on the literatures shown in the references.

5. Findings

5.1 Myanmar Development Research Institute (MDRI) conducted Ayeyarwaddy research in 2013, and found that the Ayeyarwaddy river is threatened by pollutants and sedimentary deposits due to the decades of neglect, over-exploitation, and extensive pollution associated with deforestation, urbanization, and industrialization. Myanmar Development Research Institute (MDRI) wrote the issues of arsenic and other pollutants from mining operations, and it was traced that high levels of arsenic 30 ppb and cyanide 0.14 mg/L seasonally in the river. A study by the WHO in 2005 found at least 3.4 million people were exposed to high levels of arsenic level along the Ayeyarwaddy River. The actual extent of exposure can likely be higher than that of the WHO study, but the reliable data is difficult to obtain due to lack of regular water quality monitoring and in the absence of reliable background public health data on water related health issues. [7]

5.2 Ecology of the river is under serious threat. The population of Ayeyarwaddy River dolphins, an indicator of the health of the ecosystem, has noticeably declined. Sighting of the dolphins has become very rare in the lower part of the river. *Estuarine crocodiles* (*Crocodylus porous*) and river terrapin (Botagur baska) are also on the verge of extinction in accordance with the World Wildlife Conservation's prediction. A new survey has revealed another hurdle facing Myanmar's already-

threatened turtle hatchlings: plastic. As if avoiding being harvested as eggs and enduring soaring nest temperatures were not enough, these helpless newborns must now clamber over washed-up plastic bottle caps, coffee sachets and food packaging on their hazardous journey down the beach to reach the relative safety of the sea.[7]

5.3 According to a global review on water pollution from agriculture, conducted by Food and Agriculture Organization (FAO) and the CGIAR research program on water, land and ecosystems (WLE), led by the international water management institute (IWMI), it was found that pollutants from agriculture such as nitrogen, phosphorus, pesticides, biochemical, sediments, salts, organic matter, pathogens reach to water bodies (e.g. rivers, lakes, aquifers, coastal waters, marine waters). the most common chemical contaminant found in groundwater aquifers is nitrate from farming. FAO found that the biggest source of water pollution today is agriculture. Water pollution from unsustainable agricultural practices poses a serious risk to human health and the planet's ecosystems, a problem often underestimated by policymakers and farmers alike, cautions a new report. In many countries the biggest source of water pollution today is agriculture — not cities or industry — while worldwide, the most common chemical contaminant found in groundwater aquifers is nitrate from farming, according to a new book titled More people, more food, worse water? A global review of water pollution from agriculture. [8]

5.4 Lack of institutional clarity – Conventionally the Government of Union of Myanmar (GOUM) has assigned multiple agencies for river water quality and quantity management. This has created duplications and confusions stemming from overlapping tasks and a lack of clear mandates among the agencies involved. Absence of a designated focal point and shortfalls in coordination and information sharing have undermined the efficiency and productivity of these agencies. Over the years, a number of laws and regulations have been adopted but these lack specificity, clear designation of responsibilities and authority among agencies, and well-articulated enforcement mechanisms, rendering them somewhat ineffective. The coordination capacity and the effectiveness of the new body, National Water Resources Management Committee- NWRM, to tackle present issues remain to be seen.[8]

5.5 Chemical fertilizers contain phosphates, nitrates that can actually be the main reason behind water pollution. Environmental nitrogen and phosphorous contribute to the process of Eutrophication, which enriches the water surface with nutrients. The trophic status of lakes is associated with the nutrients and growth of organic

matters of the lake. The effect of Eutrophication is that there is an abundance of algal bloom. [9]

5.6 Eutrophication presents as one of the most serious ecological problems of open water sources such as lakes, oceans and reservoirs. It is characterized by dense algal and plant growth owing to the enrichment by phosphorus and nitrogen nutrients needed for photosynthesis. As a result, it often contributes to the formation of extensive mats of floating plants. Examples of the plants include algal blooms, Nile cabbage and water hyacinths. [10]

5.7 The nutrients come from animal wastes, fertilizers and sewage, which are washed by rain or irrigation into the water bodies through surface runoff. Eutrophication can also take place naturally over thousands of years as the lakes grow old and get filled with sediments. The various symptoms of Eutrophication are as follows:

1. There is an increase in the production of biomass like phytoplankton, macrophytes (aquatic plants growing in or near water) and attached algae.

2. Since the assemblage in aquatic plants changes, there occurs a shift in the habitat characteristics.

3. The desirable fishes are replaced by a lesser desirable species.

4. The algae release various toxins.

5. While the algal bloom occurs, there is a change in the taste and odor of water.

6. When algal bloom occurs, there is a decrease in the oxygen level, which are fatal for fishes.

7. The irrigation canals get clogged with the excess of aquatic weeds.

8. There is a decrease in the recreational value of water as it’s infested with weed infestation, slime and noxious odor.

5.8 Workshop on "Plastic pollution in Myanmar: Focus on the Ayeyarwady River" was held in Nay Pyi Taw in 2019 and said that the plastic pollution is

damaging the beauty of Myanmar and affecting people's health. A new survey on plastic pollution in Myanmar conducted by Fauna and Flora International (FFI) in collaboration with Thant Myanmar reveals that 119 tons of plastic waste enter the Ayeyarwady River every day, and Myanmar's coastlines are heavily affected by micro plastics. Their findings show that the upper Irrawaddy regions contribute 58 tons of plastic pollution per day, with the lower delta region and Yangon, Myanmar's capital, adding a further 32 tons and 29 tons respectively. [9]

5.9 The 2014 Myanmar population and housing census showed that 25.7 percent of households have using traditional pit latrines, bucket surface latrines or no latrines at all. Open defecation or poor-quality toilets that ruin their health and pollute their environment. Inadequate sanitation systems spread human waste into rivers, lakes and soil, contaminating the water resources, and as a consequence waterborne diseases.

5.10 With the observation of high phosphate concentration, nutrient loading and pesticide contamination from the agricultural excess fertilizers and pesticides are also possible, especially in the delta (BOBLME, 2011). Myanmar used 352,698 tons of chemical fertilizers and 4940 metric tons of pesticides in 2009-10 (BOBLME, 2011). In addition, agricultural chemicals, communities and cities along the river directly dispose of untreated raw sewage, municipal wastes, and medical wastes in the river (BOBLME, 2011).

5.11 Specific issues affecting the river include: Siltation– Excessive sediment loading from mining activities and soil erosion along the river is a significant factor. The increase in sediment concentration leads to siltation. The Ayeyarwaddy River deposits around 360 million tons of sediment annually. According to data from 2005 data and experiments, the Ayeyarwaddy sediment load is the third highest in the world. The siltation creates frequent and rapid shifts in the course of Ayeyarwaddy with numerous sandbars, which have a major impact on river navigation, especially in the summer months. Deforestation also contributes to sedimentation and subsequent siltation. MacKinnon (1997) estimated that almost 75% of Myanmar's forest ecosystem was lost by the early 1990s. Despite the significance of siltation impacting the river, no recent studies could be found. More studies will be necessary to address siltation. Sedimentation and siltation at rivers, stream, lakes, ponds; Riverbank erosion and soil erosion are the impacts of the decrease of forests and excessive mining of gold and quarrying in the river's watershed. Massive rainfalls leading to a strong flow of water is another cause of sedimentation. River bank erosion prevention along Ayeyarwady river, is important. Villages along the Ayeyarwady river are at risk due to the collapse of the riverbanks, especially during

the monsoon. Siltation in lakes and ponds reduce water holding capacity and water supply to the community. To address the sedimentation, siltation and flood in water related ecosystems, we need to adopt the Target 6.6, "Protect and restore water-related ecosystems"[8]
Deforestation on river bank, watercourse buffer, watershed area and sand mining cause soil erosion, sedimentation, sand bed formation

5.12 According to a study led by the University of California, Irvine, exposure to a specific type of blue-green algae toxin known as cylindrospermopsin has shown to wreak havoc on gut bacteria and an increased probability of irritable bowel syndrome, inflammatory bowel disease, celiac disease, type 1 diabetes, obesity and inflammation of the liver – a precursor to liver cancer.[11]

5.13 Water pollution/ Water contamination; Water pollution results when contaminants are introduced into these water bodies. The villages' ponds near mangrove forest of delta area were contaminated with saline water (more commonly known as salt water). The quality of water is not good due to water contamination such as iron, Arsenic, Fluoride, Manganese, Nitrogen, Calcium, etc. The Ayeyarwady river is under the ten most polluted rivers in the world and the Bay of Bengal is highly contaminated with micro plastics because of high plastic consumption even in rural areas. Disposal of hazardous waste, solid waste, liquid waste, and black water are the main causes of water pollution, and water borne disease.

5.14 It was found that it need to implement the required activities to get the goal A to F, set in the National Waste Management Strategy And Master Plan For Myanmar (2018-2030)[12]

1. Promote stakeholder engagement in implementing the "National Waste Management Strategy and Master Plan For Myanmar (2018-2030)" to achieve the following goals A to F, and their respective target, and the proposed activities.

Goal A: Extending sound waste collection service to all citizens and eliminating uncontrolled disposal and open burning as a first step towards environmentally sound waste management.

Targets

(i) Achieve sound waste collection service for all citizens

(ii) Eliminate the uncontrolled dumping and burning in the cities and mandate the operation of environmentally sound disposal facilities

Activity.1: Expand access to municipal waste management service in order to ensure a minimum level of services for all citizens, irrespective of income levels

Activity 2. Safe treatment and disposal of waste in permitted/ officially approved landfill sites to protect uncontrolled dumping and open burning

Goal B: Extending sustainable and environmentally sound management of industrial and other hazardous wastes

Target

(i) Mandate separate collection and sound treatment of hazardous waste including infectious medical waste, agro-chemical waste from non- hazardous waste

(ii) Mandate sound collection and environmentally friendly treatment of all industrial waste and agro-chemical waste

(iii) 1: Establishing sound legal and regulated structure addressing industrial and hazardous waste.

(iv) Effective monitoring and incentive mechanisms

1.1 Goal C: Substantively prevent waste through 3Rs and thereby establish a resource circular society

Target

(i) Mandate the development of city waste management strategies and action plans with actual waste reduction targets by all CDCs and TDCs

(ii) Mandate the introduction of targets for diverting the food waste from landfills

(iii) Mandate the separate collection and set waste recycling targets for industrial, medical and other wastes

Activity

1: Promote waste reduction upstream through introduction of sustainable production (in the design, fabrication and manufacturing of products) and consumption

Promote reduce, reuse, recycle and recovery of waste materials before final disposal

Goal D: Ensure sustainable financing mechanisms

Target

(i) All City and Township Development Committees conduct full cost accounting for waste service

(ii) All City and Township Development Committees establish cost reflective tariffs for waste management services

: Enhanced financing options for waste management

Sustainably financed waste management at the CDCs and TDCs

Goal E: Awareness raising, advocacy and capacity building

Target

(i) Increase in the number of townships that have implemented standard awareness-raising programmes for their residents

(ii) Increase in the number of schools in the townships that have established environmental education programmes for their students

Activity

1.2 1: Mainstream environmental education and sustainable waste management in school curricula and programmes at all levels

1.3 2; Mobilise the support of all stakeholders by increasing awareness and participation in sustainable waste management practices

1.4 Goal F: Compliance, monitoring, enforcement and recognition

Target

(i) City and Township Development Committees establish benchmark performance indicators

(ii) Increase in the number of successful enforcement actions filed against non-compliant entities by City and Township Development Committees

1.5

: Institutionalize mechanisms for monitoring, enforcement and recognition

5.15 It was found that the summary tables of main findings in 2016, recommendations and proposed roles for relevant organizations for different thematic areas, to improve the implementation and enforcement of Environmental Conservation Law.[13] Need assessment was done in 2016, it needs to be updated with the information of the implementation of the recommended activities.

Thematic area: EIA and environmental licensing

Main findings in gap and needs analysis	Recommendations to improve the implementation and enforcement of ECL	Proposed role of relevant organizations
Regulation		
Regulatory instruments need to be finalized	EIA Procedure with Administrative Instructions and Guidelines for the ECC finalized and issued. Adjusting the thresholds for EIA / IEE activities and giving a transition period long enough for existing activities to submit their EMPs to MOECAF.	ECD
Coordination of environmental/sector licensing	One window procedure for investments. EIA to be integrated in the procedures. Time demands for EIA assessment must be realistic.	MIC, ECD, sector ministries

Main findings in gap and needs analysis	Recommendations to improve the implementation and enforcement of ECL	Proposed role of relevant organizations
Appeal and sanction mechanisms are not clearly defined or are weak.	Regulations should include mechanisms of appealing the conditions of the environmental license. Mechanisms for enforcement should be strengthened for dealing with non-compliance with ECCs and environmental standards. Procedures for using administrative fines should be developed.	ECD Union General Attorney's Office Regional/State Governments Support from relevant sector ministries
Practical implementation		
Technical staff for EIA assessment and licensing is under huge pressure.	On the job support for EIA review, ECC conditions. 1. Sector Guidelines for the most important industries are needed to support effective and coherent implementation of EIA. Oil and gas, mining, dam and hydropower, industry and Industrial zones, special economic zones and Infrastructure have been identified as priority sectors needing EIA guidelines. 2. Gradually delegating the state/regional ECDs the mandate to process IEEs and EMPs of small and medium size activities.	ECD sector ministries Industrial associations
Practices for Social impact assessment are vague.	Strengthening SIA requires social and socio-economic expertise both at MOECAF and at consultant companies and also strengthening the possibilities of the civil society participation in the processes.	ECD. Resettlement and compensation: M. of Resettlement etc Consultants, CSOs, CBOs
The capacity for processing EMPs and for compliance monitoring is very limited.	Enforce the obligation of licensed activities to monitor their environmental impacts (self-monitoring practices). On the job support to Central ECD and selected Regional ECDs and Regional Environmental Committees in designing and implementing compliance monitoring plans. On-the-job training for Regional ECDs on water and air quality sampling and monitoring, including interpretation of results and dissemination of findings. 3. There is a need to create a learning process for developing EIA practice. Intensive EIA capacity building is needed especially within ECD and regional/state administration but also within authorities at all levels and within industries and consultants. Joint seminars and conferences between different actors involved in EIA could raise common understanding and coherent implementation of EIA.	ECD Support from relevant sector ministries
Information management, monitoring capacity and research		

Main findings in gap and needs analysis	Recommendations to improve the implementation and enforcement of ECL	Proposed role of relevant organizations
EIAs, IEEs and EMPs are processed manually	ECD at central and regional level should be equipped with a computerized system for tracking the processing of environmental licenses. A compliance monitoring database is needed first for joint use by Central ECD and regional ECDs and in a second stage with linkages to the environmental inspectorates of the sector ministries and PCCDs of main cities. Organize the compiling and effective use of information accumulated from EIA and compliance monitoring reports, e.g. by conducting periodical sector wide benchmarking studies.	ECD
Public Participation and rule of law		
Unsystematic public participation and lack of capacity of local stakeholders to contribute to public consultations.	Development of Guidelines for the Public Consultation requirements. Good practices for solving environmental grievances at the local level. Strengthen collaboration between authorities and CSOs/ NGOs to utilize their capacity to express public concerns and grievances. Support to CSOs for capacity building of CBOs to enable their active participation in conflict resolution and reporting impacts.	ECDs at central and region/ state level CSOs INGOs

Thematic area: Pollution control

Main findings in gap and needs analysis	Recommendations to improve the implementation and enforcement of ECL	Proposed role of relevant organizations
Regulation		
The acceptable level of emissions from different activities is not legally defined.	Issue the emission standards and ensure coherence of standards issued by sector ministries.	ECD has a lead role. Collaboration with Ministry of Industry, Ministry of Mines, Ministry of Health, Pollution Control and Cleansing Department in major cities
Clarify the obligation for self-monitoring and reporting.	Ensure that the regulations related to ECCs include specific obligations to conduct self-monitoring and report to the monitoring authorities	ECD and inspectorates in relevant sector ministries.
Practical implementation		
Pollution control plans need to be followed by an investment program	Soft loans for central wastewater treatment facilities in existing industrial and special zones	Ministry of Planning and Investment CDCs of major cities
The capacity for processing EMPs and for compliance monitoring is very limited.	Develop sector specific technical guidelines for pollution control and compliance monitoring. On the job support to Central ECD and selected Regional ECDs and Regional Environmental Committees in designing and implementing compliance monitoring plans. On-the-job training for Regional ECDs on water and air quality sampling and monitoring, including interpretation of results and dissemination of findings. Field monitoring capacity at regional ECD and PCCD level in the major cities Training for industry in self-monitoring	ECD Support from relevant sector ministries

Main findings in gap and needs analysis	Recommendations to improve the implementation and enforcement of ECL	Proposed role of relevant organizations
Lack of services in environmental monitoring	Laboratory capacity for monitoring typical parameters in wastewater emissions, air pollution and toxic substances in wastes. Capacity building of local consultants and institutes in conducting voluntary cleaner production audits.	ECD and sector ministries Ministry of Industry
Information management, monitoring capacity and research		
ECD lacks the database of polluting industry.	Compliance monitoring database first for joint use by Central ECD and regional ECDs and in a second stage with linkages to the environmental inspectorates of the sector ministries and PCCDs of main cities	
Lack of national water quality monitoring program	Develop national water quality monitoring program On the job training for regional ECDs on water sampling TA to ECD on the interpretation and dissemination of findings	ECD, Watershed Conservation division of Forest Department, M. of Agriculture and Irrigation, M. of Health, Pollution Control and Cleansing Department of major cities
Public participation and access to information		
Unsystematic public participation and lack of capacity of local stakeholders	Good practices for solving environmental grievances at the local level. Support to CSOs for capacity building of CBOs to enable their active participation in conflict resolution and reporting impacts.	

Thematic area: Management of chemicals and hazardous substances

Main findings in gap and needs analysis	Recommendations to improve the implementation and enforcement of ECL	Proposed role of relevant organizations
Regulation		
The mandate of ECD is not recognized in the existing sector legislation on hazardous substances and their life cycle. Regulations on hazardous waste management are not based on ECL.	Preparation of hazardous waste strategy, Master Plan and HW regulations. Hazardous waste regulations should be issued taking into consideration both ECL and the chemical law, the mandates of respective Committees and Boards and the obligations of the international chemical conventions. Regulations for the prevention and control of health and environmental hazards from the production, transport, storage and use and for registration of chemicals in different fields of use should be synchronized between MOI, ECD and the other relevant sector Ministries. The notifications of regulated chemicals should be revised to take into consideration the international chemical conventions.	MOI has the coordinating role in chemical management. ECD has the duty of monitoring, assessing and regulating of the environmental hazards of chemicals in different sectors.
The concept of Environmental Emergency is not defined in ECL.	The roles of different authorities including NECC and ECD should be defined in the national disaster management plans. ECD could have a relevant role in regulating the environmental aspects of the mitigation and response actions in oil and chemical accidents, for example in providing guidelines for the management of wastes emerging from environmental emergencies.	
Practical implementation		
Non-existing facilities and services for hazardous waste management	The compiling of the Master Plan for HW management should be followed by an investment phase for establishing environmentally and economically sustainable treatment and disposal services.	ECD Ministry of Industry

Main findings in gap and needs analysis	Recommendations to improve the implementation and enforcement of ECL	Proposed role of relevant organizations
Low capacity in monitoring compliance with hazardous waste regulations.	ECD and DISI staff capacity building and on-the-job support for the inspection and enforcement of HW regulations in industry and service businesses.	
The role of ECD in HW management should be linked with the preparedness for chemical accidents.	Prepare guidelines for the management of oil and chemical spills and accidents and the management of the HW arising from the emergency response. This task should be performed in coordination with the Central Supervisory Board of the chemical law.	
Information management, monitoring capacity and research		
Limited laboratory capacity	Laboratory capacity for monitoring toxic substances in wastes	ECD, MOST, sector ministries, universities, companies
Information of defining and classifying hazardous waste	Regulations for identifying HW can be based on international guidelines and should be disseminated to the industry.	ECD sector ministries industrial associations
Hazardous waste inventory is lacking	National HW inventory should be performed using a sector specific approach. The effort should be linked to the establishment of a national HW generator database and reporting system.	ECD MOI other sector ministries

Thematic area: Urban environmental management

Main findings in gap and needs analysis	Recommendations to improve the implementation and enforcement of ECL	Proposed role of relevant organizations
Regulation		
National guidelines for urban environmental management have not been revised after the issuance of ECL.	Environmental concerns should be mainstreamed into the urban planning regulations and guidelines issued by the Ministry of Transport and other relevant sector ministries. The issues include zoning of activities, traffic planning, green area planning, water safety, waste and wastewater management.	ECD with MoT, City development committees, research institutes.
Practical implementation		
Poor level of municipal waste management and recycling.	The approval of the National Waste Strategy should be followed by an action plan. A waste management model for small towns should be developed and experiences from pilot towns disseminated throughout regions and states. Due to high organic content of municipal waste, biogas generation and production of organic fertilizers should be considered a priority option. The management of septic tank sludge should be included in the urban waste management plans. Low-cost, labor intensive technology is preferred, but to limit the number of dumping places regional level waste plans are needed. Develop effective systems for collecting service fees from house owners for ensuring sustainable environmental services.	The regional NEC could play a coordinating role in the regional development of urban waste management. Cooperation with private sector recycling businesses and environmental and social NGOs and CBOs is important for maximizing resource recovery and employment opportunities.

Main findings in gap and needs analysis	Recommendations to improve the implementation and enforcement of ECL	Proposed role of relevant organizations
Almost non-existing urban wastewater treatment.	Soft loans for central wastewater treatment. Affordable technology to reduce the emission of organic load, nutrients and fecal bacteria into the environment. Soft financing of the investments and capacity building for the operation and maintenance of the sewer network and the treatment facilities are needed. This work has already started in the big cities and the major regional/state level cities. More support is needed to expedite the development in the smaller towns, which lack financial resources, planning capacity and technical knowhow. Financing and TA for centralized industrial wastewater treatment facilities in industrial zones and TA for industrial wastewater treatment.	
Public participation and access to information		
Low awareness and poor access to information of the urban population	City development committees should cooperate with local NGOs and CBOs in raising environmental awareness (e.g. separation of wastes) and provide access to information about the state of relevant environmental indicators (e.g. water safety, air pollution).	

5.16 According to an investigation by Global Witness, Myanmar has seen a massive expansion of illegal mining of rare earth minerals used in green energy technologies and smartphones, fueling human rights abuses and environmental destruction. The Kachin Special Region 1 in Myanmar has become the world's largest source of supply for heavy rare earth mining within just a few years. Highly toxic rare earth mining has rapidly expanded in northern Myanmar, fueling deforestation and environmental contamination. Kachin State mining department released photos of ten-wheeler trucks, presumably from China's Yunnan Province, loaded with the ammonium sulfate used to extract the metals. Myanmar is the world's third-largest source of mined rare earths. Prized for their "fantastic magnetic properties," the 17 lustrous metals are used in high-tech products like electric cars, wind turbines, and fighter jets. Myanmar has rich deposits of dysprosium and terbium, sought-after heavy rare earth elements (HREEs) that are otherwise in short supply. In 2022, Myanmar's production of rare earths amounted to an estimated 12,000 metric tons of rare-earth oxide equivalent. This production volume made Myanmar the world's fourth-largest producer of rare earths. The following elements are among rare earths: cerium (Ce), dysprosium (Dy), erbium (Er), europium (Eu), gadolinium (Gd), holmium (Ho), lanthanum (La), lutetium (Lu), neodymium (Nd), praseodymium (Pr), promethium (Pm), samarium (Sm), scandium (Sc), terbium (Tb), thulium (Tm), ytterbium (Yb), and yttrium (Y). According to a report by Global Witness, people living close to the rare earth mines in Kachin state have

reported that the ecosystems and resources on which they depend have been impacted. Hazardous mining waste reportedly flows directly into tributaries of the Irrawaddy River, Myanmar's major waterway, severely limiting many communities' access to safe drinking water. [14,15,16,17,18,19,20,21,22,23]

5.17 Gold mining in Myanmar has been a source of income for the country due to its rich mineral resources and long history of mining. However, it has also had negative impacts on the environment and people's livelihoods. In some gold mines, cyanide and amalgam are used which can affect nearby streams or rivers. According to Myanmar Now, pollution of the Uru River started at least 20 years ago due to the effects of gold mining operations upstream in both Homalin and Hpakant, Kachin State. It has escalated since 2021. Satellite imagery shows the impact of gold mining in Nam San Yang, Kachin State between November 2019 and January 2022. The increase in gold mining has affected people's subsistence living. In 2021, a gold rush is increasingly despoiling rivers in the Myanmar state of Kachin, polluting water with mercury, destroying riverbanks and farmland, and disrupting the traditional way of life of the region's ethnic groups. Gold mining and agricultural concessions reduce tree cover, potentially reducing access to forest resources and further marginalizing these households. The analyses do not provide evidence that long-term resident communities contributed to forest cover loss between 2000 and 2010. It is assumed that landscape management, which recognizes local community rights to customary community use areas, and appropriate zoning for commercial land uses and protected areas could contribute to both local livelihoods and protect biodiversity throughout Myanmar during economic growth. [24,25,26,27,28]

5.18 Gold mining and jade mining at Irrawaddy river have caused serious environmental and social impacts in Kachin State. A study released by Myanmar Metals Watch Network (MMWN) showed that there is an increase in gold-mining activity downstream of the Irrawaddy River confluence which has led to serious environmental and social impacts in Kachin State. The report found that gold mining diverted river flows, destroyed riverbanks and riverbeds, caused fluctuating water levels, hastened deforestation, and brought about an "incalculable loss of biodiversity". Sedimentation in deep pools from gold mining and other dredging operations is destroying dolphin habitat, while mercury poisoning from gold mining operations is an added threat from modern development upstream. Jade mining is a lucrative but destructive industry in Myanmar, the world's biggest exporter of the gemstone. According to Global Witness, a watchdog group that exposes links between human rights abuses and the environment, jade mining is fueling conflict in Myanmar, channeling money into the coffers of someone. The report also warned that it could turn the jade industry into a "fund". Lahtaw Kai Ring, a former jade miner and a mother of six, recalls what the area was like when she first moved to the township in 1989. The Uru Stream was clean and clear, and people harvested a

freshwater oyster — called n-hypa law in the local Jinghpaw language — in its waters. "Now [people] don't even know what n-hypa law is," she says — they don't see that oyster in the stream anymore. "Hpakant's environment is destroyed. Mountains became valleys and valleys became mountains. Rivers, streams and creeks are upside-down, shifted into chaos." Jade mining also causes severe environmental damage and loss of life. The mining sites are often unstable and prone to landslides, especially during the rainy season. In July 2020, a landslide killed nearly 200 people, mostly freelance miners searching for jade stones. The mining waste, known as tailings, are piled up in heaps that can reach several hundred feet, exceeding government limits and posing a threat to nearby villages. The mining also pollutes the water sources and destroys the natural landscape of Hpakant, the jade-rich township in Kachin State. [29,30,31, 32,33,34,35,36,]

5.19 Lead mining in Myanmar has been reported to have a significant impact on the environment and human health. People living near lead mining sites in Myanmar are exposed to lead from contaminated soil, lead dust, or ingesting contaminated drinking water or food items . In a previous study conducted in the gold mining areas in Myanmar, it was reported that lead concentration was higher than any other heavy metal concentrations. Lack of adequate access to safe drinking water in those areas tends to increase lead consumption because of insecure water sources. It is also recognized that private investors, small-scale artisan extraction, and informal or undocumented groups also conduct lead mining. [37,38]

5.20 Impact of Bridges on river flow and sedimentation.

There are (48) bridges on the rivers in Myanmar, according to the list of bridges. Source; https://en.wikipedia.org/wiki/List_of_bridges_in_Myanmar

It was navigable in Irrawaddy river. Teak and other hardwood, bamboo can be extracted by rafting. After the construction of (48) bridges to communicate with the cities located both side of the river, there may be impact on river flow and sedimentation. According to my web search, the impact of bridge on river flow and sedimentation depends on several factors, such as the shape, size, and spacing of the bridge piers, the flow velocity and direction, the sediment concentration and size, and the river morphology. Some of the possible impacts are:

- Bridge piers may cause local scouring around them due to the formation of vortices and flow separation. This may affect the stability and safety of the bridge structure and increase the maintenance costs.
- Bridge piers may also influence the flow resistance and energy dissipation of the river, which may affect the flood-carrying capacity and water quality of the river.
- Bridge piers may alter the sediment transport and deposition patterns in the river, which may affect the riverbed elevation, boundary roughness, and ecological habitat.
- Bridge piers may create hydraulic structures that affect the fish migration and navigation in the river.

These impacts may vary depending on the design and location of the bridge piers. For example, some studies have suggested that using dimpled surface piers instead of cylindrical piers may reduce the sediment deposition and flow resistance around them**.** Similarly, increasing the spacing between the bridge piers may reduce the interference with the flow and sediment transport[3].Therefore, it is important to consider these impacts when planning and designing bridges over rivers and to adopt appropriate mitigation measures to minimize the negative effects and enhance the positive ones.[39,40,41]

5.21 On 28th December, 2022, Consult gave a presentation at online meeting organized by the project on "Advancing Cooperation Between Lower Mekong Countries to support governance, transparency and local voices, concerning with water and Water Related Ecosystem", and it include the causes of water pollution such as cropping systems, expansion of irrigation, trends in fertilizer use, trends in pesticide use, livestock production, and aquaculture production.

Disadvantages of fertilizers:

- They get washed away by water easily and cause pollution.
- They harm the microbes present in soil.
- They reduce soil fertility.
- They are expensive.
- They provide only short term benefits.
- They change the nature of soil, making it either too acidic or too alkaline
- Mekong region land governance made a case study at Chinese investment into tissue culture banana plantations in Kachin State, Myanmar, and found that the major impact on environment was from the intensive use of chemical fertilizers and pesticides in banana cultivation. Source https://www.mrlg.org/publications/publication-title-chinese-investment-into-tissue-culture-banana-plantations-in-kachin-state-myanmar/

Application of chemicals can cause significant loss of soil fertility and erosion even after three years and leaving the degraded land unusable for several years after that. These chemicals can enter and pollute the

water table. The disposal of chemical containers may further enter water sources, scattered plastic waste disrupts local ecosystems, and burnt containers emit toxic fumes. The chemical impacts have affected the health of humans, livestock and local biodiversity, including people working on plantations and those in the vicinity or downstream. Reported symptoms include dizziness, headaches, skin rashes, vomiting and diarrhoea. Plantations are also causing widespread changes to the surrounding landscape in Kachin State, because of the clearing of forest or scrubland, and as water courses are set up or diverted to feed the irrigation needs of banana production. This can cause water shortages for down- stream users. The setting up of plantations is also contributing to deforestation in the State, particularly when they encroach upon designated forest areas. Together with the use of chemicals, landscape changes are playing a role in the decline of bee pastures, with wider implications for biodiversity. In the last 50 years, a strain of Panama disease (Fusarium wilt), a soil-borne fungus known as Tropical Race 4 (Foc TR4), has spread across Southeast Asia, its expansion encouraged by banana plantations of the Cavendish variety. Management of this disease,

Ground Water Pollution

Using chemical fertilizers regularly causes the pollution of groundwater sources, also called leaching. Chemical fertilizers that are highly soluble get absorbed by the ground more rapidly than they are absorbed by the intended plants. Plants can absorb only a given level of nutrition at a time, leaving the rest of the fertilizer to leach.

Leaching is not only hazardous to groundwater sources but also to the health of the subsoil where these chemicals react with clay to create hard layers of soil known as hardpan. As a result of chemical fertilizer use, the health of soil and water is jeopardized, not to mention the waste of money and nutrient-deficient plants.

Soil Friability Effect

Having lots of acids in the soil, such as hydrochloric and sulfuric acids, creates a damaging effect on soil referred to as soil friability. The different acids in the soil dissolve the soil crumbs, which help to hold together the rock particles. Soil crumbs result from the combination of humus, or decomposed natural material such as dead leaves, with clay.[42,43,44]

5.22 Chemical fertilizers can change the nature of soil by making it either too acidic or too alkaline. The synthetic chemicals in chemical fertilizers change soil pH, which adversely affects the health of naturally found soil microorganisms. These altered levels of acidity in the soil eliminate the microorganisms that are beneficial to plant and soil health as they help to increase the plants' natural defenses against pests and diseases[1]. Long-term use of chemical fertilizers will accelerate the acidification of the soil and accelerate the leaching of Ca and Mg from the tillage layer, resulting in a decrease in base saturation and soil fertility. Studies on effect of inorganic chemical fertilizers to *Eudrilus eugeniae* Kinberg earthworms. The results revealed that, when the food material was incorporated with various inorganic fertilizers, there was wide variation among the treatments with respect to mortality of adult and juvenile earthworms ranging from 0.00 to 100 per cent. Significantly highest per cent mortality of 100 % was recorded with urea @10g/kg vermifeed Followed by MOP @ 10g/kg vermifeed (95.00%). The lowest mortality was found in mixed with single super phosphate (SSP) @ 5g/kg vermifeed (28%). The complex fertilizers cause relatively moderate toxicity to the adults *E. eugeniae* earthworm. Among the micro nutrients tested for their toxicity, Zinc (Zn) and Iron (Fe) were relatively toxic to earthworm adults at both tested dosages. Zero mortality of earthworms was noticed in the control treatment (0.00%), respectively. Among inorganic fertilizers were more dangerous to earthworms when incorporate in to food material of earthworms.[45]

5.23 Impact of the disposal of black water, solid waste and liquid waste, hazardous waste into lakes, stream and rivers, and mitigation measures.

Sr	Impact	Human Activities that Affect the Environment	Mitigation Measures
1	1. Water pollution 2. Waterborne disease (diarrhea, dysentery, viral hepatitis, typhoid, paratyphoid, cholera). 3. 3.4 million people die from water borne diseases every year, making it the leading cause of disease and death in the world 4. If sewage is discharged untreated, its nitrogen and phosphorus content can lead to pollution of lakes and reservoirs via a process called eutrophication	1. Disposal of black water, the mixture of urine, feces, wastewater from toilet(Sewage (or domestic sewage, domestic wastewater, municipal wastewater) 2. Open defecation 3. Bacteria like *Salmonella*, *Shigella*, *Campylobacter*, or *Vibrio cholerae*; 4. Viruses like hepatitis A, rotavirus, coronavirus,enteroviruses; 5. Protozoa like *Entamoeba histolytica*, *Giardia lamblia*, *Cryptosporidium parvum*; and 6. Helminths and their eggs including *Ascaris* (roundworm), *Ancylostoma*	1. End open defecation ('Open defecation free'- ODF) behavior change to promote the use of toilets. 2. Conduct sewage treatment (or domestic wastewater treatment, municipal wastewater treatment) 3. Decompose before they can be released safely into the environment. 4. The heat produced by naturally occurring thermophilic microorganisms will heat the compost to over 60 °C (140 °F), and destroy potential pathogens. 5. Management of sewage includes collection and transport for release into the environment, after a treatment level that is compatible with the local requirements for discharge into

Sr	Impact	Human Activities that Affect the Environment	Mitigation Measures
		(hookworm), and *Trichuris* (whipworm) 7.	water bodies, onto soil or for reuse applications. 6. Use of composting toilets and vermifilter toilets. 7. Use handy pod for floating community. The Pod uses microbes and fungi to break down the organic sludge into gases such as carbon dioxide, ammonia, and hydrogen. While some microbes in the waste survive the first step of filtration, they are then washed into a pod filled with water hyacinth. The hyacinth roots collect bacteria, leaving the water surrounding it safe enough to play and swim in, but not drink. 8. Apply Water Purification Methods: A. Iodine Treatment B. Solar Purification C. Boiling D. Distillation

Sr	Impact	Human Activities that Affect the Environment	Mitigation Measures
			E. Chlorination F. Reverse Osmosis G. Ultra-Violet Light 9. Use Electronic Health Management Information Systems (eHMIS) 10. "From Paper Based- To Electronic Health Information (DHIS2), tool for measuring waterborne diseases for early warning. 11. Waterborne Disease Risk Assessment Program 12. Drinking Water Monitoring 13. Apply one health approach 14. Promote Law enforcement such as 2016 Myanmar Pesticide Law enforcement, Environmental Conservation Law [13]

Sr	Impact	Human Activities that Affect the Environment	Mitigation Measures
2	1. eutrophication 2. algal and plant growth owing to the enrichment by phosphorus and nitrogen nutrients needed for photosynthesis. 3. extensive mats of floating plants. Examples of the plants include algal blooms, Nile cabbage and water hyacinths, 4. phytoplankton, macrophytes (aquatic plants growing in or near water) and attached algae. 5. algae release various toxins such as cylindrospermopsin has shown to wreak havoc on gut bacteria and an increased probability of irritable bowel syndrome, inflammatory bowel disease, celiac disease, type 1 diabetes, obesity and inflammation of the liver – a precursor to liver cancer[11] 6. algal bloom occurs, there is a change in the taste and odor of water.	The usage of organic fertilizers results in the discharge of nitrate, potassium and phosphates that pollute the water. animal wastes, fertilizers and sewage, which are washed by rain or irrigation into the water bodies through surface runoff.	1. Limited usage of fertilizers is beneficial. 2. The usage of organic fertilizer could be better in this respect as it doesn't support the ill effects. 3. Environment-Friendly Fertilizers -EFFs are mainly applied in the form of coated fertilizers, which is the primary reason why they can be utilized as an environment-friendly product. 4. Conduct the Agricultural wastewater treatment 5. Reduce the use of fertilizer and pesticides 6. Improve manure management 7. Change our consumption behavior

Sr	Impact	Human Activities that Affect the Environment	Mitigation Measures
	7. When algal bloom occurs, there is a decrease in the oxygen level 8. A high concentration of nitrogen contaminates the drinking water. Nitrates can leach into groundwater, and when found in animals in higher concentrations, can cause nitrate poisoning. ill effects on crops and pisciculture 9. the chemicals result in the growth of microorganisms. This results in oxygen depletion, and the aquatic animals die due to suffocation. 10. Due to excess of Eutrophication, an entire zone becomes affected, and they become dead zones. 11. Soil Friability Effect, Having lots of acids in the soil, such as hydrochloric and sulfuric acids, creates a damaging effect on soil referred to as soil friability. 12. The synthetic chemicals in chemical fertilizers change soil pH, which adversely affects the health		8. Prevent excessive nutrients from reaching the water 9. Raise the awareness of farmers on the topic of agricultural pollution 10.

Sr	Impact	Human Activities that Affect the Environment	Mitigation Measures
	of naturally found soil microorganisms. These altered levels of acidity in the soil eliminate the microorganisms that are beneficial to plant and soil health as they help to increase the plants' natural defenses against pests and diseases. These helpful microorganisms consist of antibiotic-producing bacteria and mycorrhizal and other fungi, which are found in healthy soil. The use of chemical fertilizers also jeopardizes the health of bacteria that fix the nitrogen balance in the soil. These nitrogen-fixing bacteria are responsible for converting the atmospheric oxygen into a form of nitrogen that can be used readily by plants. 13.		

Sr	Impact	Human Activities that Affect the Environment	Mitigation Measures
3	Toxic to humans and can have both acute and chronic health effects, depending on the quantity and the ways in which a person is exposed. organophosphates and carbamates, affect the nervous system. Others may irritate the skin or eyes. Some pesticides may be carcinogens (cancer causing). Others may affect the hormone or endocrine system in the body.	Use of pesticides to protect crops against insects, weeds, fungi, and other pests herbicides (weeds), insecticides (insects), fungicides (fungi), nematocides (nematodes), and rodenticides (vertebrate poisons).	1. Ban some of the older, cheaper pesticides which can remain in the soil and water for years. 2. 2016 Myanmar Pesticide Law enforcement 3. Ban (55) kinds of pesticide in Myanmar in accordance with the notification 2/2022 4. registers pesticides after stringent, science-based evaluation that ensures any risks are acceptable 5. re-evaluates the pesticides currently on the market on a 15 year cycle to ensure the products meet current scientific standards 6. promotes sustainable pest management

Sr	Impact	Human Activities that Affect the Environment	Mitigation Measures
			7. conducts ecological risk assessments to determine whether changes to the use or proposed use of a pesticide are necessary. Before allowing pesticide products to be sold on the market, they ensure that the pesticide will not pose any unreasonable risks to plants, wildlife, or the environment. 8. evaluate every active substance for safety before it reaches the market in a product. Substances must be proven safe for people's health, including their residues in food and effects on animal health and the environment. 9. Adopt the following suggested strategies :

Sr	Impact	Human Activities that Affect the Environment	Mitigation Measures
			1. reducing risk of pesticide transport to surface or ground water 2. decreasing amount of pesticide used 3. reducing the persistence or mobility of the active ingredients 10. Apply BMPs (Best Management Practices) that reduce runoff or soil erosion or increase soil organic matter content, help reduce pesticide transport as well. BMPs include: A. riparian buffers B. crop rotation C. contour farming D. strip cropping E. reduced tillage or zero tillage systems (herbicide use usually increases with reduced tillage

Sr	Impact	Human Activities that Affect the Environment	Mitigation Measures
			which may off set the pesticide-related benefits of the reduction in runoff associated with this practice) 11. Apply proper pesticide storage practices; Locking pesticides inside a fire resistant, spill proof storage system is the best way to prevent accidental spills. It is also very cheap compared to the consequences that can be very expensive to clean up such as accidents, spills, or fires. 12. Prevent pesticide contamination by selecting the appropriate pesticides, proper pesticide mixing, and loading procedures. Preparation of seedbeds and planting allows crops to

Sr	Impact	Human Activities that Affect the Environment	Mitigation Measures
			emerge quickly, potentially reducing early season disease and insect damage that reduces the amount of pesticides needed. 13. Properly dispose the pesticide containers because contaminated containers exposed to rain can leak pesticides into the environment. **14.** Apply biological pest control
4	1. The Bay of Bengal is highly contaminated with micro plastics. 2. Damage the beauty of Myanmar and people's health. 3. Myanmars coastline is heavily impacted by micro plastics with high	Plastic waste disposal Municipal Solid Waste Dumping site in waterway, gully, stream, river	1. Implement the National Environmental Policy, 2. Implement the National Waste Management Strategy And Master Plan For Myanmar (2018-2030)[12]

Sr	Impact	Human Activities that Affect the Environment	Mitigation Measures
	contamination rates reaching up to 28 000 MP/km2 recorded. 4. The Rakhine coast was the stronger contaminated then the Delta region or the southern part of Myanmar. 5. The global plastics crisis. They release an incredible amount of toxins into the air if they're burned. When plastic is burned in the open air, it releases large amounts of toxins, which pollutes the air. If the toxins are inhaled for a long period of time, it can lead to respiratory problems. 6. They can affect the groundwater and nearby wildlife 7. Commercial fishing nets are made of plastic. When the nets are submerged in the water, they leak toxins. They can also break or get lost, adding even more pollutants to the water. 8. Terrible impact on marine species. As a result, it can hurt the economy and food supply for communities that rely on fishing.	The Ayeyarwaddy as one of the most polluted rivers on the planet. The most responsible regions are the Delta Region with 32 tons followed by Yangon with 29 tons of plastic per day. Therefore, waste from the urban areas is still dominating .	3. TAXING plastic as an awareness tool. 4. Support from government and development sector to build systematic waste collection systems. 5. Apply public-private partnership in developing solid waste collection and disposal. 6. plastic reduction at source, banning single-use plastic 7. awareness raising 8. make organic products as package 9. forcing producers to use recycled plastics in their products 10. Tax exemptions for business, which is switching to environmentally friendly practices. 11. Provide facility for the collection, transfer and disposal of solid waste.

Commented [A1]: Added

Sr	Impact	Human Activities that Affect the Environment	Mitigation Measures
	9. Plastic can hurt tiny organisms like plankton, which larger animals rely on for food. The toxins work their way up the food chain and can even be present in the fish people eat. 10. Damage groundwater sources. Water sources everywhere are in danger because of plastic pollution. Plastic toxins in dumps and from litter can seep into the groundwater, which people drink every day. 11. When animals come into contact with this plastic waste, they risk consuming the toxins or becoming entangled in the plastic and suffocating. If an animal consumes a piece of plastic, the plastic can clog its stomach while also poisoning it with toxins. Almost 200 different species of animals are known to ingest plastic debris. 12. As the world's population increases, land becomes more valuable, and it will soon become difficult to find places to put garbage. Over time,		12. Conduct EIA, EMP for municipal solid waste dump site. Avoid choosing municipal solid waste dump site at waterway, gully, stream, river 13. Don't buy bottled water or hot drinks in disposable cups 14. Use your own shopping bags 15. Don't buy anything glittery 16. separate your recyclables and make use of recycling facilities 17. Choose glass or cans over plastic 18. Avoid using cling film and foil 19. Store your rubbish securely 20. choose natural fenders 21. When you buy new clothes, choose natural materials, such as cotton, linen, bamboo and hemp, avoid new clothes, which is made of materials that

Sr	Impact	Human Activities that Affect the Environment	Mitigation Measures
	landfills and dumps will take up more land, invading animals' habitats and coming even closer to groundwater sources. 13.		contain plastic, such as polyester and nylon. 22. Pledge to join our Plastics Challenge and do a litter pick 23. Speak to local restaurants, shops, or other businesses about environmentally-friendly packaging and bagging options 24. Adopt "Waste to Energy solution" that includes a sanitary landfill with methane gas extraction and a waste incinerator generating electricity.[13]
	1. **Sedimentation and siltation at rivers, stream, lakes, ponds;** 2. sediment concentration 3. Sandbars 4. loading from mining activities and soil erosion along the river 5. The Ayeyarwaddy River deposits around 360 million tons of	1. Deforestation also contributes to sedimentation and subsequent siltation. MacKinnon estimated that almost 75% of Myanmar's forest	1. Implement The Myanmar Climate Change Policy, Forest Policy, National Environment Policy. 2. Conduct river bank erosion prevention along Ayeyarwady river,

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Sr	Impact	Human Activities that Affect the Environment	Mitigation Measures
	sediment annually. According to data from 2005 data and experiments, the Ayeyarwaddy sediment load is the third highest in the world. The siltation creates frequent and rapid shifts in the course of Ayeyarwaddy with numerous sandbars, which have a major impact on river navigation, especially in the summer months. 6. Villages along the Ayeyarwady river are at risk due to the collapse of the riverbanks, especially during the monsoon. 7. Siltation in lakes and ponds reduce water holding capacity and water supply to the community.	ecosystem was lost by the early 1990s. 2. Riverbank erosion and soil erosion are the impacts of the decrease of forests and excessive mining of gold and quarrying in the river's watershed. 3. Massive rainfalls leading to a strong flow of water is another cause of sedimentation. 4. siltation with the rate of 360 million tons annually especially from mining operations, due to the result of deforestation, and lack of soil protection or over exploitation of land.	3. Adopt the Target 6.6, "Protect and restore water-related ecosystems" to address the sedimentation, siltation and flood in water related ecosystems, we need to [8] 4. Address the drivers of deforestation 5. Avoid soil erosion by planting all over the year 6. Plant trees or grasses along the edges of fields 7. Adjust the intensity of tillage of a field 8.

Sr	Impact	Human Activities that Affect the Environment	Mitigation Measures
		5. It was traced that high levels of arsenic 30 ppb and cyanide 0.14 mg/L seasonally in the river.	

6. Recommendations

It is recommended to promote stakeholder engagement in implementing the mitigation measure to address the human activities that affect the environment.

7. Conclusion

It need to address lack specificity in stakeholder engagement, clear designation of responsibilities and authority among agencies in implementing the environmental policy, forest policy and water resource policy.

We need political support, law enforcement, interest of department concerned, cooperation of key stakeholders, support of NGO ,CSO and CBO, people participation with full understanding, awareness raising, education, extension program to get clean water and sanitation. In conclusion, I would like to say to get clean water and sanitation;

Firstly "Conserve soil, protect fertile top soil, and prevent soil erosion. If the fertile soil had eroded you would have to use chemical fertilizer, which is not good for your health".
Secondly, "Conserve biodiversity, apply polyculture, because if biodiversity lost, many pests, insect would increase and you will have to use more and more pesticide. Pesticide will eradicate not only pest but also human.
Thirdly, "Conserve the forest, because only the forest can give us clean water."
Fourthly, "Stop open defecation, because open defecation is major cause of water borne disease, and food borne disease."
Fifthly, "Beat plastic before it destroys us"
Last, but not least, "Promote stakeholder engagement, Promote Partnership, Promote people participation, to get clean water and sanitation"

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