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# The Philippine Mining and Quarrying Industry: Mitigation and Regulatory framework to Address Water Pollution, Challenges and Opportunities

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## **Outline of the presentation**:

- Current status of the Philippine mining and quarrying industry

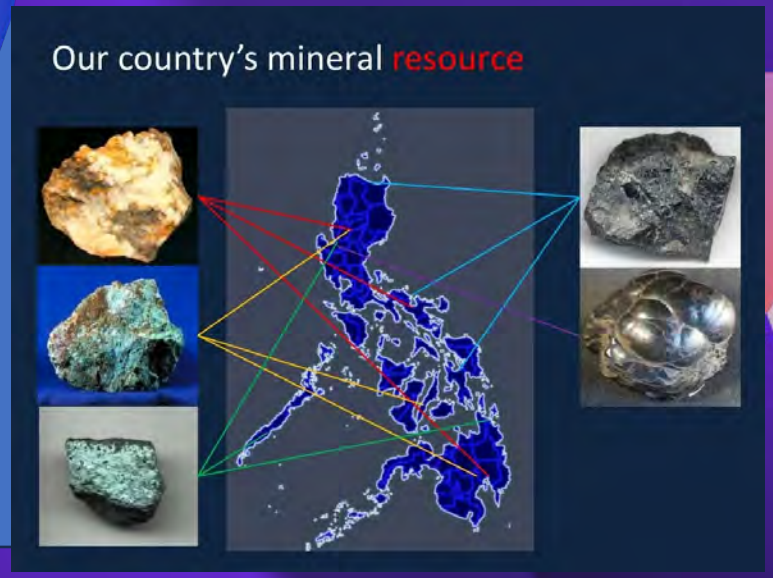
- Impact of indiscriminate mining and quarrying operations on water environment
  - Effects on water resources
  - Eco-toxicological pathway of heavy metals via water environment from mining operation and its effect on human health
  - Factors influencing the release of heavy metals into water bodies from mining operations
  - Process to remove heavy metals from mining wastewater

- Regulatory framework
  - Environmental regulations and permitting process
  - Water Quality Guidelines for secondary parameters-Metals
  - Significant effluent quality parameters for mining and quarrying Sector
  - Compliance monitoring and audit
  - Records of mining disaster in the Philippines and its impact on water resources

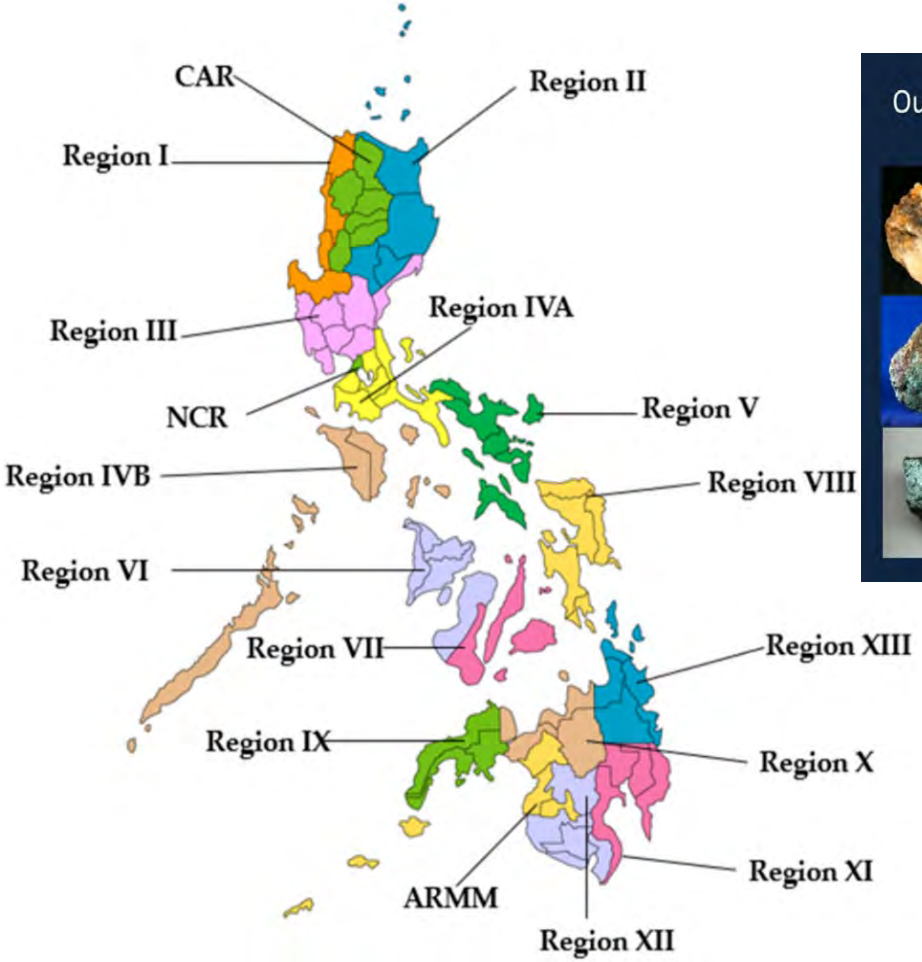
- Mitigating strategies and measures
- Challenges and opportunities
- References

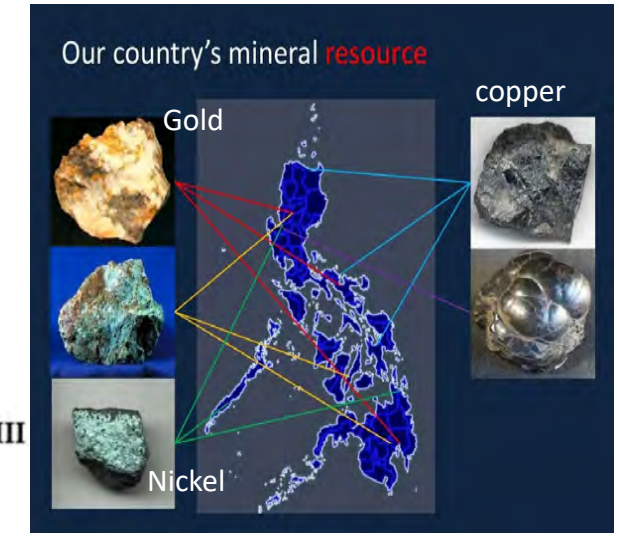
Background/current Status

# The Philippine Mining and Quarrying Industry

# PHILIPPINE MINERAL PROFILE




Scale of mining operations in the country:

- Small, informal mines
- Large open-pit mines.

*Mining tenement refers to a legal instrument, like a license, permit or lease, that grants rights to explore for and/or extract minerals from a specific area of land. It essentially defines the boundaries and conditions under which a company or individual can conduct mining operations

**Status of Mining Industry (**as of June 30, 2024):

TOTAL LAND AREA: 30 million hectares

TOTAL Area of high mineral potential: 9.0 million hectares

Percentage of the Total Land Area with High Potential Mineral deposits: 30 percent

Total Land Area covered with Approved Mining Tenement*:
755,960.10 hectares (As of June 30, 2024) subject to the mandatory relinquishment by contractors as provided by law. This constitute 2.52% of the country's total land area.

Mineral Resources Development Projects:

- 59 metallic mines
- 61 non-metallic mines
- 5,691 LGUs issued permits
- 58 Declared minahang bayan (small-scale mining)

## Mining metrics

Status, Benefits and future potential of mining industry in the Philippines:

- The Philippine government promotes the rational exploration, development , utilization and conservation of mineral resources guided by its commitment to responsible minerals development.

- Environmental protection and rehabilitation. Ensures the primary protection of the environment before, during mining operations and beyond the life of the mine.

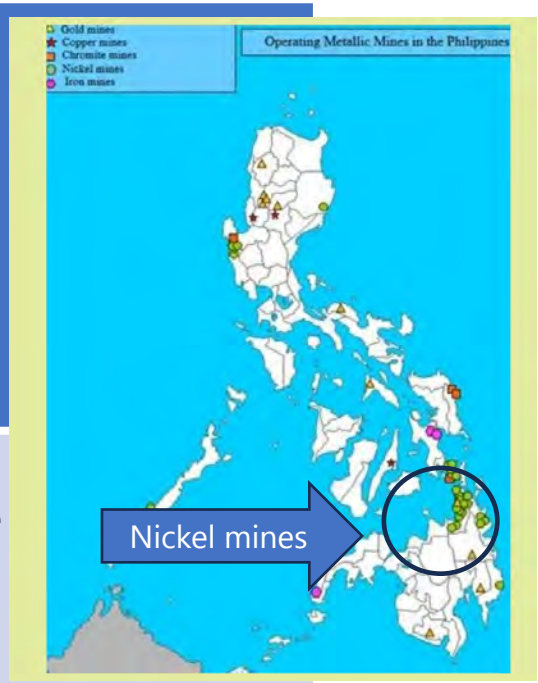
- Mineral exports, USD7.32 Billion in 2023 (PSA). Gold, nickel ore, and nickel products and copper are the country's top mineral exports to major trading partners including Japan, China, Switzerland, India and Hongkong.



- Employment. 212,247 in 2023 (PSA). It is conservatively assumed in the industry, about four indirect jobs may be generated in the upstream and downstream sectors.

# Status of Metallic Operating Mines, as of June, 2025

| Type of Operating Mines | Mineral mines/ commodity | Total Area covered Per MPSA (Mineral Production Sharing Agreement), hectares | Regions Covered |
|---|---|---|---|
| A. Metallic Mine | 1. Gold | 20,584.6330 | Cordillera Administrative Region (CAR), RII, RV, RIX, RXI, RXIII |
| | 2. Copper | 8,629.3763 | CAR, RII, RVIII |
| | 3. Chromite | 6,895.1236 | RIII, RVIII, RXIII |
| | 4. Nickel* | 105,382.9590 | RII, RIII, MIMAROPA (R4B), RVIII, RXI, RXIII |
| | 5. Iron | 10,454.8910 | RIII, RVIII, RIX |
| TOTAL | 5 | 151,946.983 | |



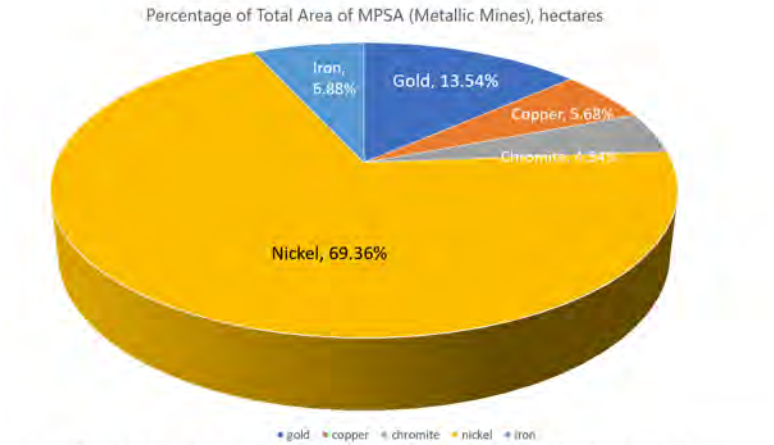
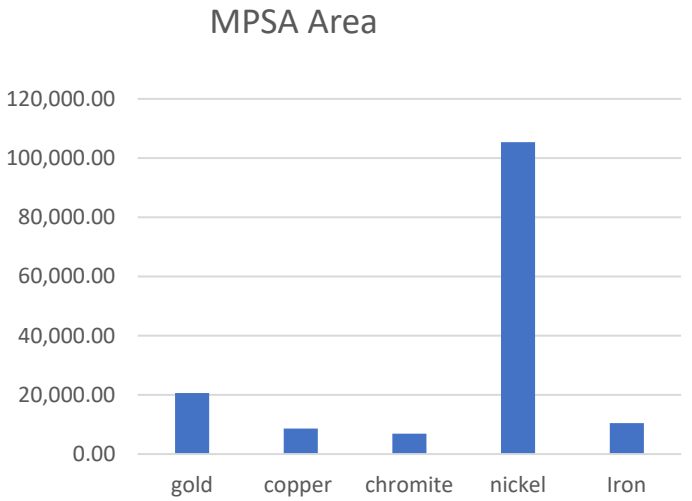




Figure 1. Pie chart showing percentage distribution of MPSA (Mineral Production Sharing Agreement) area of each metallic mines relative to the total area of MPSA issued as of June, 2025

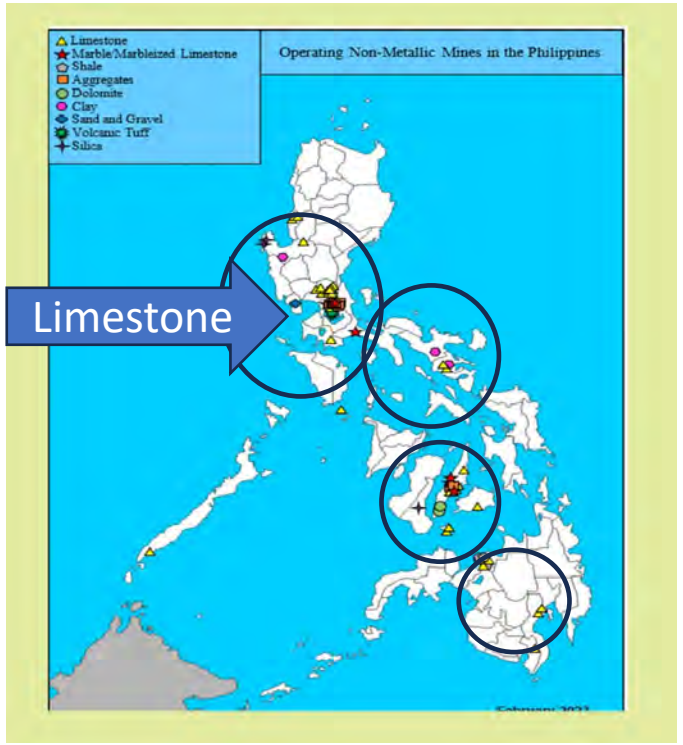



MPSA Area covered by metallic mineral resource

*Nickel is resistant to corrosion, for producing stainless steel, essential for high energy lithium-ion batteries in electric vehicles.

# Status of Non-Metallic Operating Mines, As of June, 2025

| Type of Operating Mines | Mineral mines/ commodity | Total Area covered Per MPSA (Mineral Production Sharing Agreement), hectares | Regions Covered |
|---|---|---|---|
| B. Non-Metallic Mines | 1. Limestone | 23,970.7636 (Rank 1) | RI, RIII, CALABARZON (R4A), MIMAROPA (R4B), RV, RVI, RVII, RX, RXI |
| | 2.Marbleized limestone | 2,203.5001 (Rank 2) | RVII |
| | 3. Silica | 1,639.2787 | RI, CALABARZON, VII |
| | 4. Zeolite and Bentonite | 761.8320 | RI |
| | 5. Perlite | 417.3691 | RV |
| | 6. Basalt/ Aggregates | 1,659.4464 (Rank 3) | CALABARZON, RVII |
| | 7. dolomite | 524.6103 | RVII |
| | 8. Shale | 518.0196 | RX |
| | 9. Volcanic tuff | 101.3300 | CALABARZON |
| TOTAL | 9 | 30,156.8711 | |




Limestone is a sedimentary rock primarily used for construction, manufacturing and agriculture.

In the Philippines, limestone is being mined in almost all regions. It constitute 79.50 percent of the total MPSA area approved as of June 2025

# Impact of Indiscriminate Mining and Quarrying Operation On Water Environment



# Effects of Mining and Quarrying on Water Resources

- Acid Mine Drainage
- Heavy Metals Contamination
- Sediment And Erosion
- Processing Chemicals Pollution

Inset Photos: MARCOPPER mine tailings and wastewater contaminating bodies of water in Marinduque, Philippines, 1996

## Effect of mining and quarrying on the quality of water resources:

- Acid Mine Drainage

Mining introduces various contaminants into water sources. One critical issue is acid mine drainage (AMD). This process occurs when sulfide-containing minerals are exposed to air and water, leading to the formation of sulfuric acid. This acid then dissolves heavy metals, including lead, arsenic, and cadmium, which leach into rivers, streams, and groundwater. AMD can persist for decades, contaminating water supplies long after mining operations cease. The resulting toxic water endangers fish and other aquatic organisms and poses health risks to humans who depend on it for drinking and agriculture


## Heavy Metals Contamination of Water Bodies

- Mining companies employ various chemicals to aid in mineral extraction such as cyanide and mercury.
- Cyanide is commonly used in gold mining. It can have devastating effects on aquatic life. Spills and leaks can contaminate water supplies, rendering them unsafe for drinking, bathing, and irrigation. A contaminated river and groundwater can devastate communities, leading to severe waterborne illnesses and economic hardship.

## Sedimentation of river and lakes

- Mining operations frequently lead to substantial soil erosion, particularly during excavation and construction phases.
- This eroded soil washes into nearby rivers and lakes, clouding the water and reducing sunlight penetration, which is critical for aquatic plants' photosynthesis.
- Increased sediment levels can also clog the gills of fish, leading to suffocation and ecosystem disruption.
- Municipalities face increased costs and complexities in treating this turbid water for safe consumption.

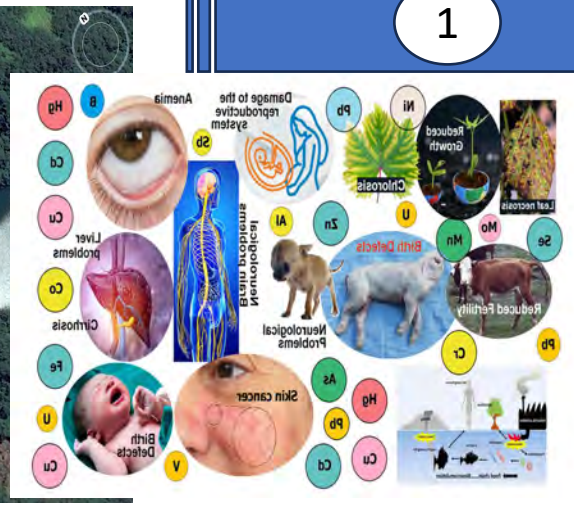

1

Wastewater and tailings containing heavy Metals

Mercury, cyanide, lead, arsenic, cadmium, Cobalt, zinc, chromium heavy metals, etc

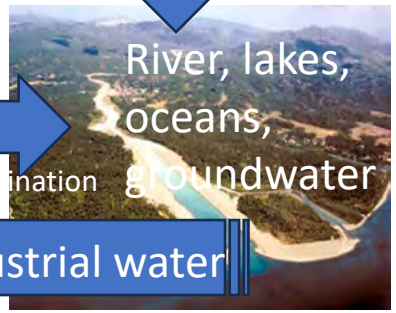
2

3



Crop/food intake

4c


Domestic and industrial water

4b

4a

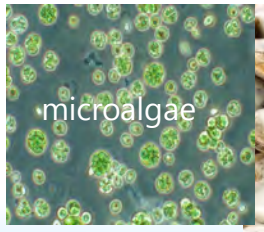
Eco-toxicological pathway of heavy metals via water environment from mining operation and its effect on human health

Seafood tissue ingestion

7

Food Chain







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Bio-accumulation of heavy metals in biota, aquatic life

Schematic illustration by Dr. Vicente Tuddao, Jr. for WEPA-IGES 21st conference September 8, 2025

**A summary of mining effects on agricultural industry, marine life and Drinking water**

Soil

Marine life

Ground and Surface water

Agriculture
- Affects Rhizosphere bacteria
- Less food production

Marine life
- High aquatic animal mortality
- Fish to humans carcinogenic risks (liver kidney and bone cancer)

Drinking water
- Humans and animals

Cancer and diabetes risks, renal injuries, neuronal damage, cardiovascular disorder, etc.

**Factors influencing the release of heavy metals into water bodies from mining operations**:

- Extraction method used. Underground extraction methods typically cause less pollution than open methods. Employing low polluting extraction methods like solvent extraction can significantly reduce the emission of heavy metals. Minerals with higher concentrations of heavy metals pose a greater pollution risk. The type of mineralization and the presence of metals in the ore can also affect the release of heavy metals.

- Effectiveness of Wastewater treatment facilities. Proper management of mining wastewater by using high efficiency and effective technologies on wastewater treatments. Pollution control systems such as filters, water collection and drainage systems can significantly reduce heavy metal emissions.

- Proper design of tailings pond/dams to receive high volume capacity must be reinforced/fortified hereby preventing collapse and discharges of heavy metals laden wastewater and tailings especially during inclement/heavy rainfall weather.

- Abandon mines  operators and artesanal/small-scale mining workers should strictly comply with regulatory requirements and should be monitored regularly

- Completed mining operations must comply with regulatory requirements such as rehabilitation plans, closure and remediation process.

- Strict regular monitoring of mining activities and immediate action to mitigate discharges of tailings and wastewater due to leaks

- Older mines often produce more pollution due to the lack of modern pollution control systems.

Over time, accumulated mineral tailings can erode, releasing heavy metals into the environment. Mines located in dry and windy areas have the potential to emit more heavy metals due to the lack of vegetation and humidity.

- Weather conditions and topography can also influence the release and dispersion of heavy metals in the environment. T

The type and volume of mineral wastes generated can impact the amount of heavy metal emissions. Tailings with high sulfide content have the potential to produce acid drainage and release heavy metals.



Preventing mining water pollution with proper mine operation design and effective wastewater treatment technologies

# **Process to remove heavy metals from mining wastewater**:

- ❑ Chemical precipitation. Converts dissolved metals into soluble solids; adsorption, where contaminants stick to a solid material like biochar or activated carbon; and ion exchange, which uses resins to swap out metal ions for other ions.

  - Precipitation of coagulants
    How it works:
    Chemical like lime (calcium hydroxide) or other coagulants are added to the water to adjust the pH and convert dissolved metal ions into insoluble particles (precipitates).

    Removal:
    These precipitates are then separated from the water through settling, clarification, flotation, or filtration.

  - Adsorption

    Heavy metals bind to the surface of a solid material known as adsorbent. Materials like biochar, activated carbon or certain biosorbents with high surface afreas and specific functional groups are used

- Ion Exchange
  How it works:
  Wastewater passes through a system containing ion exchange resins, which replace metal ions with other ions (like sodium or hydrogen)

  Application
  This process is effective for removing  dissolve metal ions

❑ Membrane Filtration

How it works:
Specialized membranes, such as nanofiltration (NF)  or reverse osmosis (RO) , are used to separate heavy metals based on their size or charge.

Advancement:
Modifications like adding nanofillers can enhance performance, improving both permebility and the ability to capture metal ions.

## Electrochemical Methods

- Electrocoagulation (EC):
  An electric current creates sacrificial anodes that release metal ions, destabilizing suspended particles and dissolve metals to form flocs, which are then removed.

- Electrodialysis:
  Uses an electric field to transport ions through semi-permeable membranes, separating them from the water.

- Biological treatment
  How it works:
  - Microorganisms and plants are used to absorb, concentrate, or transform heavy metals into less toxic form.
  - Example are *Rinorea niccolifera* (scientific name given by Filipino scientists in 2014, common name: Madre de Agua)- found in Zambales (the common local name is still being contested),
  - A shrub known as nickel-accumulating plant; P. erythrotrichus (common local name: closely related to sampa-sampalukan) also discovered in the province of Zambales;
  - P. securinegoides (common local name: tagum-tag), a nickel-hyper accumulator found in Surigao del Norte;
  - A Philippine fern demonstrated ability to absorb and store copper and arsenic from toxic mining soil.

Biological processes. Using microorganisms and plants

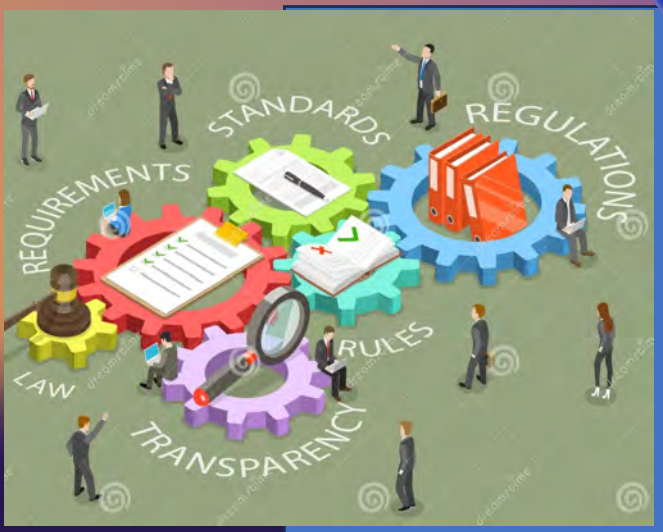
- These plants utilize a process called phytoremediation, using their natural ability to extract and sequester heavy metals from contaminated land.

Microorganisms. Use mechanisms like biosorption and intracellular sequestration to bind, detoxify or transform toxic metals from their environment. These microbes can be used in a process called bioremediation to clean up heavy metal pollution in soil and water.

- Bacteria. Example are Bacillus, Pseudomonas, Acinetobacter.
- Fungi. Example is Glomus genus.

❑ Flotation. Using air bubbles to lift metals to the surface

# Regulatory Framework





# Regulations relative to mining activities in Philippines

- The Philippine Mining Act of 1995 (Republic Act No. 7942) and its IRR contain provisions on environmental protection.

  Mining contractors are required to institute an environmental protection and enhancement program prior to the commencement of mining operations and to submit final mine rehabilitation or decommissioning plans to ensure environmental protection beyond the life of the mine

The Department of Environment and Natural Resources (DENR), and the agencies under it -- the Mines and Geo-Sciences Bureau (MGB) and Environmental Management Bureau (EMB) ensure compliance with environmental laws for mining activities. Most regulations, including those on mining and water, are enacted and enforced by the central government. However, enforcement of environmental laws and regulation of small-scale mining and quarry/sand and gravel mining operations have been shared with local government units for a more effective and efficient execution of the said laws and delivery of services needed for the said operations

## Principal Environmental Regulations for Mining Activities in the Philippines:

- Clean Water Act of 2004 (Republic Act No. 9275)
- Toxic Substance and Hazardous and Nuclear Wastes Control Act of 1990
- DENR Administrative Order No. 2016-08. Water Quality Guidelines and General Effluent Standards
- Ecological Solid Waste Management Act (Republic Act 9003)
- Clean Air Act of 1999

# Permitting process and environmental assessments in mine operation:

The Philippine Mining Act of 1995 (Republic Act No. 7942) is a law that governs all mining operations in the Philippines, focusing on the rules and regulations for exploration, extraction, and environmental protection. It is essentially the playbook that ensures that all mining operations benefit everyone while also preserving the environment.

RA 7942 ascertains that mining operations go through the correct process including (1) acquiring necessary permits, (2) environmental assessments, and (3) mitigation measures before, during, and after mining activities. Such permits include the following:

- Mineral Production Sharing Agreements (MPSA)
- Financial or Technical Assistance Agreements (FTAA)
- Small-Scale Mining Permits

The law also promotes environmental protection as it requires covered businesses to secure environmental impact assessments (EIA), environmental compliance certificates (ECC) and implementation of mitigation measures to minimize adverse effects on the environment and communities.

*Environmental review and permitting process for mining projects:*

# An environmental compliance certificate (ECC) is required for mining projects as mining poses a potential environmental risk or impact

To secure an ECC from Environmental Management Bureau, a proponent must prepare and submit an environmental impact statement (EIS). The EIS should include, among others, the following:'

- Baseline environmental conditions focusing on the sectors (and resources) most significantly affected by the proposed action;
- Impact assessment focused on significant environmental impacts (in relation to project construction and commissioning, operation and decommissioning), taking into account cumulative impacts;
- Supporting documents, including technical and socio-economic data used and generated, certificate of zoning viability and municipal land use plan, proof of consultation with stakeholders; and
- Proposals for environmental monitoring and guarantee funds, including a justification of the amount.

The environmental impact assessment (EIA) process involves four steps: scoping, conduct of EIA study and report preparation, review and evaluation of the EIA report, and decision making. The EMB takes at least 40 days to process an ECC application.

# Importance of Legal Compliance

Mining permits are vital tools for ensuring that mining operations are conducted responsibly and sustainably. By securing the required permits and adhering to regulations, businesses can help **protect the environment**, uplift local communities, and promote ethical practices in the industry.

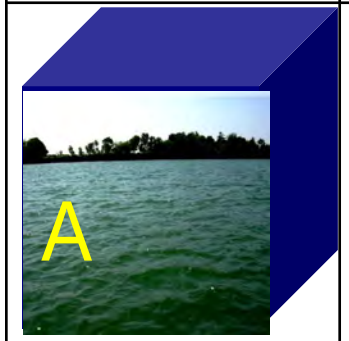



Permits requirement compliance → Compliance to rules and regulations; Enforcement of laws → Environmental protection → Compliance to water quality standard/clean water and safe drinking water

**Philippine Clean Water Act of 2004 (RA 9275)**: This is the cornerstone legislation addressing water pollution. It mandates the protection and rehabilitation of the country's water resources, establishing a framework for managing wastewater and implementing control measures for discharges into water bodies. The Act aims to achieve sustainable water quality management by integrating various laws related to water pollution and promoting environmentally friendly practices among industries

**DENR Administrative Orders**: These orders provide specific guidelines on water quality standards and effluent discharge. For example, DENR Administrative Orders No. 2016-08 and No. 2021-19 outline Water Quality Guidelines (WQG) and General Effluent Standards (GES), setting allowable pollutant levels in discharges from industrial and municipal sources. DAO 2021-19 provides for the Updated WQG and GES of some parameters.

# Water Body Classification and Usage of Freshwaters (Rivers, Lakes)

| Classification | Intended Beneficial Use |
|---|---|
|   | Public Water Supply Class I – Intended primarily for waters having watersheds, which are uninhabited and otherwise protected, and which require only approved disinfection to meet the Philippine National Standards for Drinking Water (PNSDW) |
|   | Public Water Supply Class II – For sources of water supply requiring conventional treatment (coagulation, sedimentation, filtration and disinfection) to meet the latest PNSDW |

| Classification | Beneficial Use |
|---|---|
|   | Recreational Water Class I – intended for primary contact recreation (bathing, swimming, skin diving, etc.) |
|   | Fishery Water for the propagation and growth of fish and other aquatic resources<br>Recreational Water Class II (Boating, fishing or similar activities)<br>For agriculture, irrigation, and livestock watering) |

# Water Body Classification and Usage of Marine Waters

| Classification | Intended Beneficial Use |
|---|---|
|  | Protected Waters – Waters designated as national or local marine parks, reserves, sanctuaries, and other areas established by law.<br>Fishery Water Class I –suitable for shellfish harvesting for sirect human consumption |
|  | Fishery Water Class III –fro propagation and growth of fish and other aquatic resources<br>Recreational Water Class II – for boating, fishing or similar activities<br>Marshy and/or mangrove areas declared as fish and wildlife santuaries |

| Classification | Intended Beneficial Use |
|---|---|
|  | Fishery Water Class II – waters suitable for commercial propagation of shellfish and intended for spawning areas for milkfish (chanos chanos) and similar species.<br>Tourists Zone –for ecotourism and recreational activities<br>Recreational Water Class I – intended for primary contact recreation (bathing, etc) |
|  | Navigable Waters |

# Water Quality Guidelines for Secondary Parameters-Metals*

| Parameter | Unit | Water Body Classification | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | | AA | A | B | C | D | SA | SB | SC | SD |
| Arsenic | Mg/L | 0.01 | 0.01 | 0.01 | 0.02 | 0.04 | 0.01 | 0.01 | 0.02 | 0.04 |
| Barium | Mg/L | 0.7 | 0.7 | 0.7 | 3.0 | 4.0 | 0.1 | 0.7 | 1 | 4 |
| Cadmium | Mg/L | 0.003 | 0.003 | 0.003 | 0.005 | 0.01 | 0.003 | 0.003 | 0.005 | 0.01 |
| Chromium as Hexavalent Chromium (Cr6+) | Mg/L | 0.01 | 0.01 | 0.01 | 0.01 | 0.02 | 0.05 | 0.05 | 0.05 | 0.01 |
| Copper as Dissolved Cu | Mg/L | 0.02 | 0.02 | 0.02 | 0.02 | 0.04 | 0.02 | 0.02 | 0.02 | 0.04 |
| Copper as Total Copper** | Mg/L | 0.2 | 0.2 | 0.2 | 0.2 | 0.4 | 0.2 | 0.2 | 0.2 | 0.4 |
| Iron | Mg/L | 1 | 1 | 1 | 1.5 | 7.5 | 1.5 | 1.5 | 1.5 | 7.5 |
| Lead | Mg/L | 0.001 | 0.001 | 0.001 | 0.05 | 0.1 | 0.01 | 0.01 | 0.05 | 0.1 |
| Manganese | Mg/L | 0.2 | 0.2 | 0.2 | 0.2 | 2 | 0.4 | 0.4 | 0.4 | 4 |
| Mercury | Mg/L | 0.001 | 0.001 | 0.001 | 0.002 | 0.004 | 0.001 | 0.001 | 0.002 | 0.004 |
| Nickel | Mg/L | 0.02 | 0.02 | 0.04 | 0.2 | 1 | 0.02 | 0.04 | 0.06 | 0.3 |
| Zinc | Mg/L | 2 | 2 | 2 | 2 | 4 | 0.04 | 0.05 | 0.8 | 1.5 |

*Refers to limit set for heavy metals in water bodies to prevent negative impacts on ecosystem and human health as these metals can be toxic even at low concentration, which are part of the comprehensive assessment system. WQG established per DAO 2016-08.

**Per DAO 2021-19. Updated Water Quality Guidelines and General Effluent Standards. June 30, 2021

# Significant Effluent Quality Parameters for Mining and Quarrying Sector*

(The specific physical, chemical and biological indicators of pollutants in the discharged wastewater that are most critical to monitor and control to protect the receiving water body and comply with the regulations)

| Industry category: Mining and quarrying | Significant parameters* |
|---|---|
| Mining of coal and lignite (Brown coal or lowest rank of coal) | Color, pH, Total Suspended Solids, Nitrate, Sulfate, Manganese, Iron, Arsenic, Cadmium, Mercury, Lead |
| Extraction of crude petroleum and natural gas, and support activities | pH, Total Suspended Solids, Sulfate, Fluoride, Barium, Chromium, Nickel, Copper, Zinc, Mercury, Oil and Grease, Phenol & Phenolic Substances, Benzene, Toluene, Ethylbenzene, Xylenes, Benzo(a)pyrene |
| Mining of iron ores | Color, pH, Total Suspended Solids, Nitrate, Manganese, Iron, Arsenic, Cadmium, Lead |
| Mining of precious metal ores | |
| Gold ore mining | pH, Total Suspended Solids, Nitrate, Cyanide, Copper, Zinc, Arsenic, Mercury, Lead |
| Silver ore mining | pH, Total Suspended Solids, Nitrate, Cyanide, Copper, Zinc, Arsenic, Mercury, Lead |

*DENR Administrative Order No. 2016-08. Water quality guidelines and general effluent standards of 2016. May 24, 2016. Table 8. Significant effluent quality parameters per sector.

# Significant Effluent Quality Parameters for Mining and Quarrying Sector*

| Industry category: Mining and quarrying | Significant parameters* |
|---|---|
| Mining of precious metal ores | |
| • Platinum ore mining | pH, Total Suspended Solids, Nitrate, Sulfate, Cyanide, Manganese, Iron, Copper, Zinc, Arsenic, Cadmium, Mercury, Lead |
| Copper ore mining | pH, Total Suspended Solids, Nitrate, Sulfate, Cyanide, Iron, Copper, Zinc, Arsenic, Cadmium, Mercury, Lead |
| Chromite ore mining | pH, Total Suspended Solids, Nitrate, Chromium, Arsenic, Cadmium, Mercury, Lead |
| Manganese ore mining | pH, Total Suspended Solids, Nitrate, Manganese, Arsenic, Cadmium, Lead |

*DENR Administrative Order No. 2016-08. Water quality guidelines and general effluent standards of 2016. May 24, 2016. Table 8. Significant effluent quality parameters per sector.

# Significant Effluent Quality Parameters for Mining and Quarrying Sector*

| Industry category: Mining and quarrying | Significant parameters* |
|---|---|
| Nickel ore mining | pH, Total Suspended Solids, Manganese, Arsenic, Cadmium, Lead, Nickel |
| Pyrite mining | pH, Total Suspended Solids, Sulfate, Manganese, Iron, Copper, Arsenic, Lead |
| Rock phosphate mining | PH, COD, Total Suspended Solids, Ammonia, Phosphate, Fluoride, Surfactants |

*Significant parameters are key characteristics of wastewater that indicate potential environmental harm, focusing on substances specific to mining processes, such as heavy metals, acidity (pH), TSS, and dissolved solids (TDS). Monitoring these parameters is crucial for assessing compliance with regulations and managing the environmental impact of mining operations.

*DENR Administrative Order No. 2016-08. Water quality guidelines and general effluent standards of 2016. May 24, 2016. Table 8. Significant effluent quality parameters per sector.

# Significant Effluent Quality Parameters for Mining and Quarrying Sector*

| Industry category: Mining and quarrying | Significant parameters* |
|---|---|
| Mining of precious metal ores | |
| • Platinum ore mining | pH, Total Suspended Solids, Nitrate, Sulfate, Cyanide, Manganese, Iron, Copper, Zinc, Arsenic, Cadmium, Mercury, Lead |
| Copper ore mining | pH, Total Suspended Solids, Nitrate, Sulfate, Cyanide, Iron, Copper, Zinc, Arsenic, Cadmium, Mercury, Lead |
| Chromite ore mining | pH, Total Suspended Solids, Nitrate, Chromium, Arsenic, Cadmium, Mercury, Lead |
| Manganese ore mining | pH, Total Suspended Solids, Nitrate, Manganese, Arsenic, Cadmium, Lead |

*DENR Administrative Order No. 2016-08. Water quality guidelines and general effluent standards of 2016. May 24, 2016. Table 8. Significant effluent quality parameters per sector.

# Significant Effluent Quality Parameters for Mining and Quarrying Sector*

| Industry category: Mining and quarrying | Significant parameters* |
|---|---|
| Nickel ore mining | pH, Total Suspended Solids, Manganese, Arsenic, Cadmium, Lead, Nickel |
| Pyrite mining (Iron sulfide/sulfide mineral) | pH, Total Suspended Solids, Sulfate, Manganese, Iron, Copper, Arsenic, Lead |
| Rock phosphate mining | PH, COD, Total Suspended Solids, Ammonia, Phosphate, Fluoride, Surfactants |

*Significant parameters are key characteristics of wastewater that indicate potential environmental harm, focusing on substances specific to mining processes, such as heavy metals, acidity (pH), TSS, and dissolved solids (TDS). Monitoring these parameters is crucial for assessing compliance with regulations and managing the environmental impact of mining operations.

*DENR Administrative Order No. 2016-08. Water quality guidelines and general effluent standards of 2016. May 24, 2016. Table 8. Significant effluent quality parameters per sector.

# Compliance Monitoring and Audit of Mining Operations

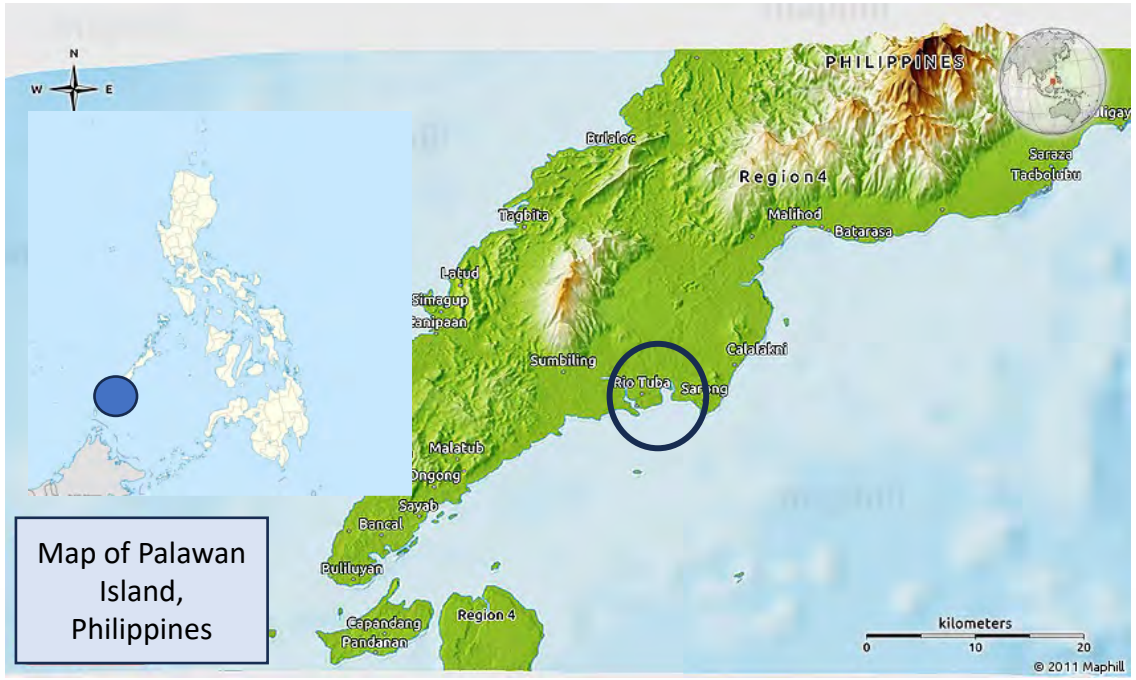

In compliance with the various environmental laws, rules and regulations, all mining projects shall submit Modules 1 to 6 of the Self-Monitoring Reports (SMRs) to the EMB Regional Office (RO) concerned and Module 7 of the SMRs to the MGB RO concerned quarterly. Said modules are the following:

| Module | Title | Explanation |
|---|---|---|
| 1. | General Information | |
| 2. | RA No. 6969 Compliance Monitoring | Toxic Substances and Hazardous and Nuclear Waste Control Act |
| 3. | RA No. 9275 Compliance Monitoring | Clean Water Act |
| 4. | RA No. 8749 Compliance Monitoring | The Philippine Clean Air Act |
| 5. | PD No. 1586 Compliance Monitoring | The Philippine Environmental Impact Statement (EIS) System |
| 6. | RA No. 9003 Compliance Monitoring | Solid Waste Management Act |
| 7. | RA No. 7942 Compliance Monitoring | Clean Water Act |
| 7.a | EPEP/FMR/DP Implementation | Environmental Protection and Enhancement Program (EPEP)/ Final Mine Rehabilitation/Decommissioning Plan(FMR/DP) |
| 7.b | SDMP Implementation | Social Development and Management Program |
| 7.c | SHP Implementation | Safety Health Program (DAO 2000-98, Mine Safety and Health Standards |

Source: DENR Administrative Order No. 2015-02. Harmonization of the Philippine Environmental Impact Statement System and the Philippine Mining Act of 1995 in relation to mining projects. March 10, 2015.

**Audit of Mining Activities**: DENR conducted audit of RTN

- Entry and exit conference
- Documentation
- Site inspection relative to the compliance to mining and environmental rules and regulations
- Interviews
- Reporting


Map of Palawan Island, Philippines

The **Rio Tuba mine** is a large nickel mine run by Nickel Asia Corporation in the west of the Philippines in Bataraza, Palawan. It represents one of the largest nickel reserves in the Philippines having an estimated reserve of 60.2 million tonnes (59,200,000 long tons; Production started in 1969.

RTNMC to complete its goal of 5 million trees planted, in 2025.

Rio Tuba Nickel Mining Project (RTNMC), a subsidiary of Nickel Asia Corp. was recognized at the Presidential Mineral Industry Environmental Awards (PMIEA) in Baguio City in 2023

RTNMC and RTN - Gotok Limestone received the following awards:
- PMIEA Selection Committee Platinum Achievement Award
- Winner, Safest Surface Mining Operation
- Winner, Most Improved Safety Performance
- PMIEA Selection Committee Titanium Achievement Award (Gotok Limestone)
- Winner, Safest Quarry Mining Operation (Gotok Limestone)
- Overall Winner, Safest Mining Operation Award (Gotok Limestone)

# Major mining disasters (and Regulatory Failures) damaging water environment in the Philippines

| Mining Operators | Date/ Location | Environmental damage/ Policy change | Water Resources Affected | Heavy metals pollution | Legal Action |
|---|---|---|---|---|---|
| MARCOPPER Mining Corp. (copper mine) | March 24, 1996 Marinduque Province (Mt. Tapian ore deposit and later San Antonio copper mine) | • Collapsed of abandoned tailing dams resulted to spillage of over 1.6 million cubic meters contaminated/ Polluted mine tailings*/ wastewater.<br>• The disaster led to significant changes in mining policies to revise the rules of the Mining Act and focus more on the protection of the environment and address social issues. Higher standards for rehabilitation were set and stronger provisions on no-go areas were put into place.<br>• Consultations with local governments and indigenous communities also became a priority. | Boac river (most heavily contaminated rendering it unusable), Mogpog river which were polluted by toxic mine tailings. Additionally, Calancan Bay was also affected as the mine had been dumping waste directly into it for years. | Copper, zinc, arsenic, chromium and sulfur. Elevated levels of these metals were found in water, sediments of biota ( aquatic organisms and plants of the affected rivers. | Cases filed in court/ under litigation, RTC decision in favor of 30 plaintiffs. Violations of Clean Water Act. Provincial govt filed lawsuit against MARCOPPER for USD100M damage |

*Tailings refers to the byproducts of mining and mineral processing, consisting of the leftover materials after valuable minerals have been extracted. It is stored in designated facilities and require careful mgt.

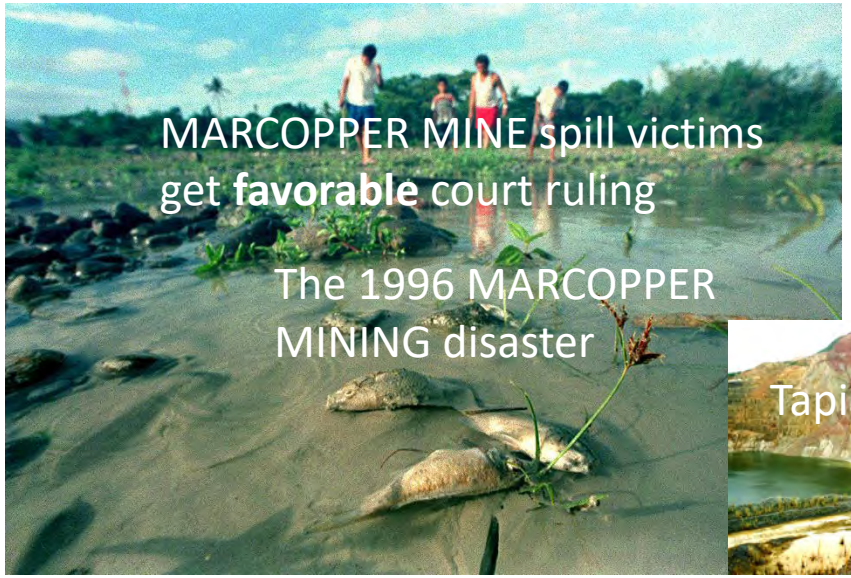
Some of the major mining disasters (and Regulatory Failures) that affect water environment in the Philippines

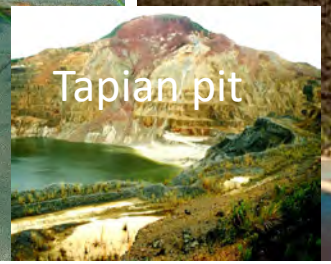
| Mining Operators | Date/ Year/ Location | Environmental damage/ Policy change | Water Resources Affected | Heavy metals pollution | Legal Action for violating relevant regulation |
|---|---|---|---|---|---|
| Philex Mining Corp. (Gold-copper mine) | August 1, 2012, involved multiple spills throughout August and September 2012 | Series of mine tailings spills from Padcal mine. A breach in a drainage tunnel of tailings pond releasing approx. 5 million tons (3 million cu m) of water and tailings. The total weight of solids discharged is estimated at 21 million tons making it the largest mining disaster by volume of toxic tailings*. | The spill flowed into Balog river, then into Agno river and eventually into the San Roque dam | Cobalt, copper, zinc and arsenic Exceeding permitted levels and causing significant ecological damage | Imposed with high monetary penalty amounting to USD18.5 million (P1.034B) fine per penal provisions of Clean Water Act. |

*Tailings refers to the byproducts of mining and mineral processing, consisting of the leftover materials after valuable minerals have been extracted. It is stored in designated facilities and require careful mgt.

# Mining Disaster: the Case of MARCOPPER
## Mining in the province of Marinduque



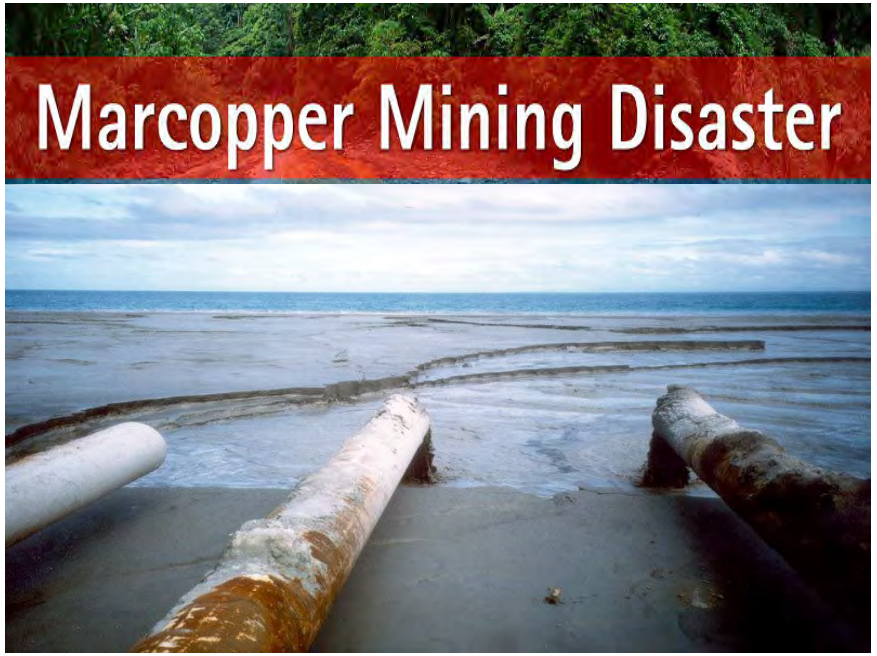


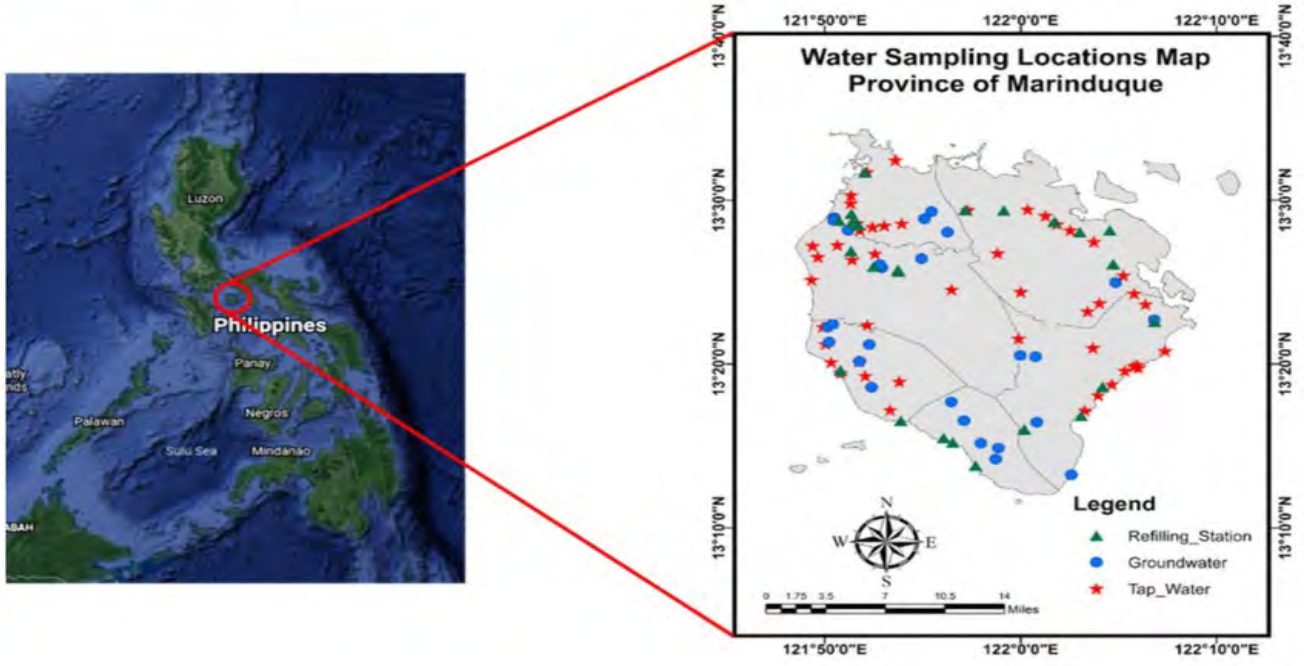







A fracture in the drainage tunnel of a large pit containing left over mine tailings led to a discharge of toxic mine waste into the Makulapnit-Boac river system and caused flash floods in areas along the river. One village, Barangay Hinapulan, was buried in six feet of muddy floodwater, causing the displacement of 400 families. Twenty other villages had to be evacuated. Drinking water was contaminated killing fish and freshwater shrimp. Large animals such as cows, pigs and sheep were overcome and killed. The flooding caused the destruction of crops and irrigation channels. Following the disaster, the Boac River was declared unusable.



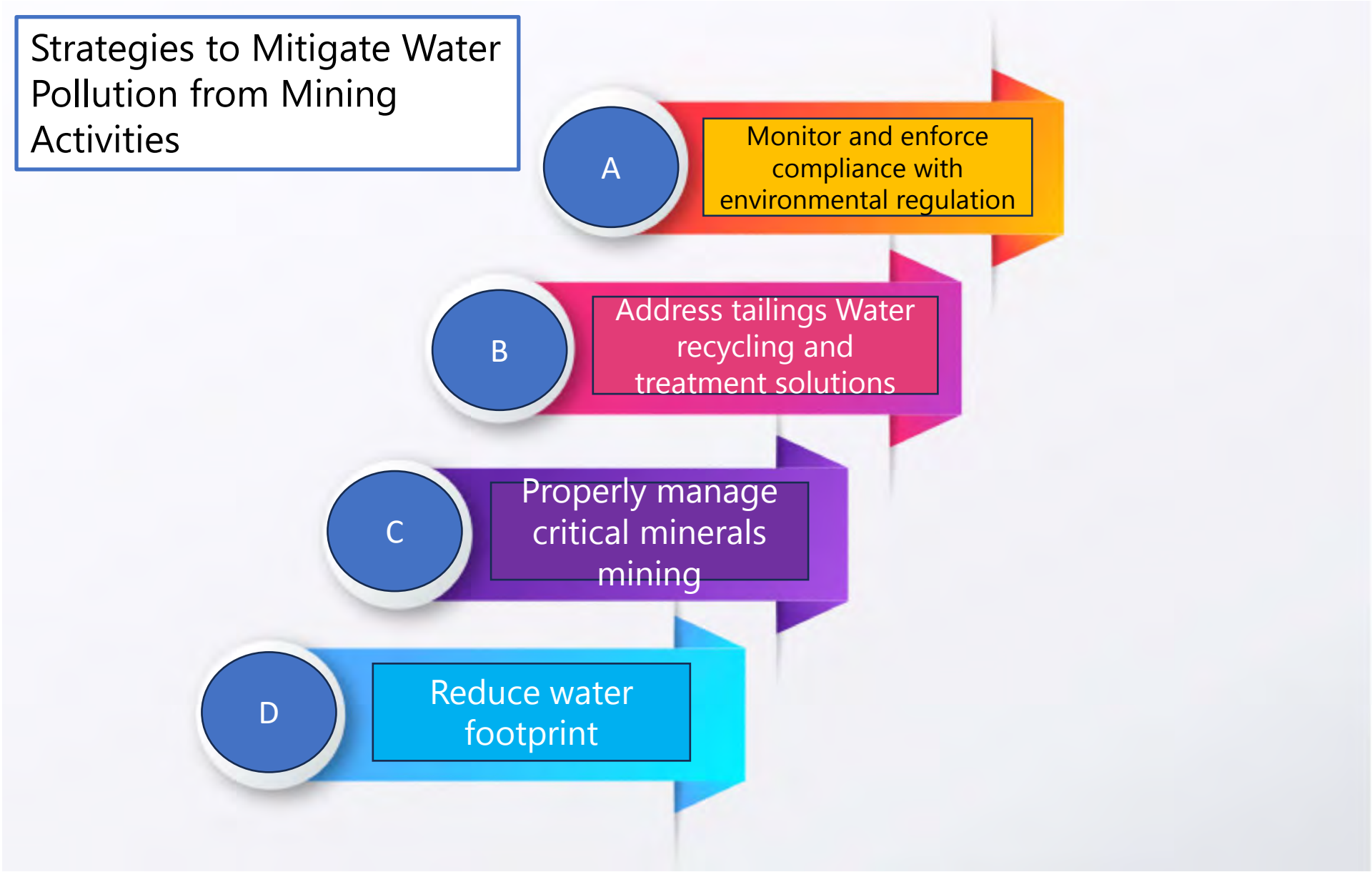

- In a study conducted by Gigantone, et al, 2020, the Mogpog river has had difficulty in reversing habitat loss since the mining incident.
- The continuous discharge of mine wastes impeded the natural succession of the aquatic ecosystem.
- Lack of aquatic biota suggests that the mine waste discharge is toxic and poses lethal effects to the aquatic ecosystem of the Mogpog river.

- Results of the study showed the contiuous outflow of mine waste affects the Mogpog river. The present study recorded significantly high levels of Cr, Cu and S in sediments and biota, among other heavy metals, compared to the control site.
- Acid mine drainage occurs in Bocboc, as indicated by its low pH. The level of pH affects the speciation and bioavailability of heavy metals in water and sediments and is also a factor in the recuperation and succession of aquatic life in the river.

# Mitigating Strategies/ Measures

Challenges and Opportunities


# Strategies to Mitigate Water Pollution from Mining Activities



## Mitigating Measures:

Specifically, in order to prevent or reduce the risk or impact of water pollution from mining activities, the following mitigating measures were adopted in the country:

- Strengthening Monitoring of mining operations

  The institutionalization and regular mobilization of tri-partite monitoring team to assess, evaluate and investigate mining operations

- Strict compliance by the contractors/mining operators on the submission of the Self Monitoring Report to the concerned Regional Environmental Management Bureau (EMB) under DENR

- Strict enforcement of penalty provisions to violations of Mining law and Clean Water Act by the operating contractors/permit holders.

- Strict implementation of Environmental Protection and Enhancement Program (EPEP)/ Final Mine Rehabilitation/Decommissioning Plan(FMR/DP) by the mining contractors/operators subject to the compliance monitoring requirement pursuant to Clean Water Act.

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- Installation and operations of effective wastewater treatment facilities pursuant to the requirement under the Clean Water Act by the contractors/mining operators.

- Compliance to the Contingent Liability and Rehabilitation fund for the establishment of a final mine rehabilitation and decommissioning fund pursuant to DENR Administrative Order No. 2005-07, section 180-181 thereof.

A mine rehabilitation fund (MRF) shall be established and maintained by each operating contractor/permit holder as a reasonable environmental deposits to ensure availability of funds for the satisfactory compliance with the commitment and performance of the activities stipulated in the EPEP/AEPEP during the specific project phase. The MRF shall be deposited as a trust fund in the government depository bank and shall be used for the physical and social rehabilitation of areas and communities affected by mining activities and for research on social, technical and preventive aspect of rehabilitation.

## **Challenges and Opportunities**:

- The future of the mining industry in the Philippines appears promising due to approximately $1 trillion in untapped mineral resources. The country is becoming the second-largest nickel producer in the world, which may lead to more investments and higher production levels. The Philippines has an estimated $1 trillion in untapped mineral resources, but only 5% of its mineral reserves have been explored. Currently, mining contracts only cover 3% of these reserves. This shows a big chance for growth in the mining industry. The country ranks fourth in the world for copper reserves and fifth for cobalt and nickel reserves.

  However, the regulatory environment presents challenges which requires detailed environmental assessments.

- To address environmental issues, sustainability practices are crucial. These practices can help ensure that the industry benefits the economy while protecting the environment.

  The current Responsible Mining Law offers sustainable practices provisions??? By understanding these factors, the mining industry can better navigate its challenges and maximize its potential .

## **Challenges and Opportunities**:

- Updating the Effluent Quality Parameters for Mining and Quarrying Sector- significant parameters particularly heavy metals associated with the effluent released during the mining activities and ore processing.

- Promotion on the establishment of ore processing facilities/plants in the country for the production of value -added semi-processed/fully processed metallic minerals for export but this requires review and updating of the Effluent standards or effluent quality parameters/significant parameters.

- Review and update policy guidelines and standards for mine wastes and mill tailings management with the expected increase in the global demand for metallic resources hence, the need to increase production capacity and areas covered with the issuance of mining tenements increases. This requires the installation of state of the art/modern wastewater technologies and ound mine wastes management methodologies.

# Thank you

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