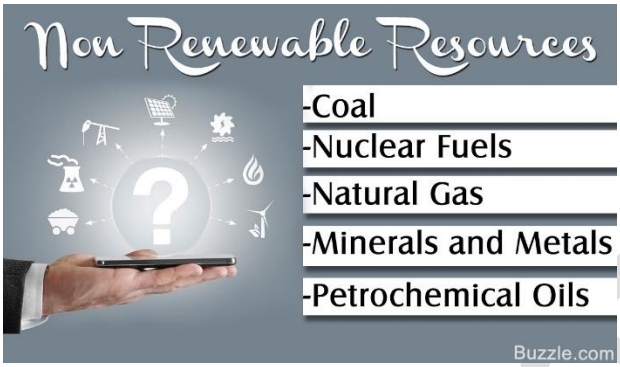
Module 13: Sustainability of Non-Renewable Mineral Resources

OVERVIEW:

This module focuses on the sustainability of non-renewable mineral resources, examining their extraction, use, and management. Students will explore the environmental, economic, and social impacts of mineral resource extraction and utilization. Emphasis will be placed on sustainable practices, regulatory frameworks, and technological innovations that aim to minimize adverse effects and ensure the longevity of these vital resources. Case studies will provide practical insights into the challenges and strategies for sustainable management of non-renewable minerals.

INTRODUCTION TO NON-RENEWABLE MINERAL RESOURCES



Non-renewable mineral resources are natural substances that are extracted from the earth and cannot be replaced on a human timescale once depleted. These include metals such as *gold, silver, and iron, and non-metallic minerals like limestone and gypsum*. Sustainability of these resources involves managing their extraction and use to minimize environmental damage, extend their availability, and promote economic and social well-being. Sustainable practices include recycling, efficient resource use, and implementing regulations to mitigate negative impacts.

Teacher' Note: Non-renewable mineral resources are essential for modern civilization, providing materials for construction, technology, and manufacturing. However, their extraction and processing can lead to significant environmental degradation, including habitat destruction, water pollution, and greenhouse gas emissions. Sustainable management of these resources aims to balance the benefits of their use with the need to protect the environment and ensure resource availability for future generations.

Example: Recycling metals such as aluminum reduces the need for new mining operations, conserves natural resources, and decreases energy consumption. Aluminum recycling uses only 5% of the energy required to produce new aluminum from ore, illustrating a sustainable practice that benefits both the environment and the economy.

ENVIRONMENTAL IMPACT OF MINERAL EXTRACTION

Teacher's Note: The extraction of non-renewable minerals often involves extensive land disruption, leading to habitat loss and soil erosion. Mining activities can also result in water pollution due to runoff containing heavy metals and chemicals used in processing. Additionally, the release of dust and emissions contributes to air pollution and climate change. Addressing these impacts requires stringent environmental regulations, rehabilitation of mined areas, and the adoption of cleaner mining technologies.

Example: Acid mine drainage is a common environmental issue where sulfide minerals exposed during mining react with air and water to produce sulfuric acid. This acid can leach heavy metals from surrounding rocks, contaminating water supplies, and harming aquatic ecosystems.

Case Study: ***"Environmental Rehabilitation of the Sudbury Mining District"*** - This case study explores how Sudbury, Ontario, has implemented extensive environmental rehabilitation efforts to address the severe ecological damage caused by decades of mining and smelting activities.

ECONOMIC AND SOCIAL IMPLICATIONS

Teacher's Note: Mining can drive economic development by creating jobs, generating revenue, and providing raw materials for various industries. However, it can also lead to social challenges, including displacement of communities, health risks from pollution, and conflicts over resource control. Sustainable mineral resource management seeks to maximize economic benefits while minimizing social disruptions and ensuring fair distribution of resources and wealth.

Example: The mining industry in Botswana has significantly contributed to the country's GDP, particularly through diamond mining. However, efforts are being made to diversify the economy and implement fair labor practices to address social issues related to mining.

Case Study: ***"The Social and Economic Impact of Diamond Mining in Botswana"*** - This case study examines how diamond mining has transformed Botswana's economy and the measures taken to ensure sustainable and equitable growth.

SUSTAINABLE PRACTICES IN MINERAL RESOURCE MANAGEMENT

Teacher's Note: Sustainable practices in mineral resource management include recycling, using alternative materials, improving mining efficiency, and adopting cleaner technologies. These practices help reduce the environmental footprint of mining activities, conserve natural resources, and extend the lifespan of non-renewable minerals. Governments and industries must work together to develop policies and standards that promote sustainability in mineral resource use.

Example: Urban mining, which involves recovering valuable metals from electronic waste, exemplifies a sustainable practice. By extracting metals like gold, copper, and palladium from discarded electronics, urban mining reduces the need for new mining operations and minimizes electronic waste.

Case Study: ***"Urban Mining and E-Waste Recycling in Japan"*** - This case study explores Japan's innovative approaches to e-waste recycling and urban mining, highlighting the environmental and economic benefits of these practices.

POLICY AND TECHNOLOGICAL INNOVATIONS

Effective policies and technological innovations are crucial for promoting the sustainability of non-renewable mineral resources. Policies such as stricter environmental regulations, incentives for recycling, and international agreements on responsible mining practices play a vital role. Technological advancements, including improved mining techniques, better waste management, and the development of alternative materials, can significantly reduce the environmental impact of mineral extraction and processing.

Example: The development of bioleaching, a process that uses microorganisms to extract metals from ores, offers a less environmentally damaging alternative to traditional mining methods. Bioleaching can be used to extract metals like copper and gold with reduced energy consumption and fewer harmful emissions.

Case Study: ***"Bioleaching in Chile's Copper Mining Industry"*** - This case study examines how Chile has adopted bioleaching techniques in its copper mining industry to enhance sustainability and reduce environmental impact.

CONCLUSION

This module has provided an in-depth understanding of the sustainability of non-renewable mineral resources, covering their environmental, economic, and social impacts, and exploring sustainable practices, policies, and technological innovations. Through case studies, students have seen real-world applications and challenges in managing non-renewable mineral resources sustainably, equipping them with the knowledge to contribute to more sustainable resource use in their future careers.

ADDITIONAL RESOURCES

Books:

"Sustainable Materials Management: Making Better Use of Resources" by OECD

"Mining and the Environment: From Ore to Metal" by Karlheinz Spitz and John Trudinger

Journals:

"Resources Policy"

"Journal of Cleaner Production"

Websites:

International Council on Mining and Metals (ICMM) - www.icmm.com

U.S. Geological Survey (USGS) - www.usgs.gov