

Module 7:

Non-Renewable Resource Economies of the North: Mineral Resources and Mining

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Overview

A main characteristic of northern market-based economies is the non-renewable resource sector, which involves large-scale exploitation of mineral resources. Mineral resources meet many basic needs in today's society. Producing, using and recycling minerals creates jobs directly and indirectly, and helps facilitate economic development by meeting market demands and achieving energy and resource efficiency targets. However, the non-renewable resource industry faces a number of difficult and evolving challenges. There are many expectations and questions about its contribution to socio-economic development. Some regions see the non-renewable resource industry as a potential engine of sustained economic growth and source of employment, infrastructure and other community benefits. Other regions are more concerned with environmental impacts, impacts on social and economic life in local communities and economic instability associated with the boom-and-bust cycle of the resource extraction industry. Increasingly, Arctic stakeholders and environmental organizations are calling for environmentally sound operations and protection of ecologically and culturally sensitive areas. The non-renewable large-scale industrial economy often leads to conflicts of interest among stakeholders over land-use and concerns about the industry's observed or potential consequences for the future of the landscape, the northern environment, and human society and well-being in the North.

Learning Objectives

Upon completion of this module, you should be able to:

1. Identify reserves of coal, iron and ferroalloy minerals, non-ferrous minerals and precious metal ores and industrial mineral extraction in the circumpolar North.
2. Outline the structure of mining coal, iron and ferroalloy minerals, non-ferrous minerals and precious metal ores and industrial mineral extraction in northern regions.
3. Describe mineral and non-mineral resource development in the Arctic.
4. Explain why many known reserves of Arctic mineral resources are not exploited.
5. How can non-renewable resource depletion be mitigated through investments in human capital and innovation?

Required Readings (including web sites)

Lindholt, L. (2009). *Comparative Analysis of Arctic Economies at Macro Level*. In **The Economy of the North**. S. Glomsrød and L. Aslaksen. (Ed.) Statistics Norway:
http://www.ssb.no/english/subjects/00/00/30/sa_economy_North/sa112_en/sa112_en.pdf

Key Terms and Concepts

- Arctic Economy
- Coal, Iron and Ferroalloy Minerals, Non-Ferrous Minerals and Precious Metal Ores
- Environmental Impacts
- Forward, Backward Linkages
- Human Capital
- Industrial Mineral Extraction
- Mining
- Multinational Corporations
- Non-Renewable Resource
- Regional Multiplier
- Resource Rents
- Stages of Development (Exploration, Decision, Construction)

Learning Material

Introduction

The economy of the North is characterized by significant market and non-market activity. The local economy is a mixed economy where market and non-market activities including hunting, trapping and gathering play an important role, while the formal economy is characterized by the growing role and presence of large-scale capital and skill-intensive industrial production.

Regional economies of the North are based in part on the extraction of non-renewable resources. A non-renewable resource is a natural resource that cannot be produced, re-grown, regenerated or reused on a scale that allows human society to continue its consumption at the existing rate and remain sustainable. Non-renewable resources such as coal, iron and ferroalloy minerals, non-ferrous minerals and precious metal ores are part of the resource wealth found in the North.

The mining industry can best be understood by first considering the basic and general characteristics that resource-based Northern economies have in common:

- Primary resources describe the narrow and resource-based Northern economy.
- Industrial development in the North and the rate of growth of the economy are closely tied with world demand for the region's resources.
- Lack of economic diversification makes the northern economy vulnerable to economic shocks and disturbances.

- Demand for natural resources is largely cyclical with demand for minerals and other non-renewable resources following boom-and-bust business cycles that make regional markets more volatile and which may affect the pattern of economic development in the North.
- Lack of financial resources combined with high extraction costs often means Northern resource development depends on multinational corporations and foreign investments.
- Physical terrain and lack of accessibility present challenges for economic viability.

Learning Highlight 1

The Northern economy is characterized by market and non-market activity. Formal and market based economic activity is characterized by large-scale resource exploitation of renewable and non-renewable resources.

Benefits to a region or local community from mineral development include income generated from taxes and royalties, employment creation, infrastructure such as roads and hospitals, linkages upstream to industries that supply goods and services or downstream to industries that process mineral outputs and technology transfer. Northern resource development and mining corporations face a number of challenges that may raise costs, including lack of accessibility to resources and markets where resources are traded, limited transportation networks, challenging physical landscapes that lead to high construction costs, high labour and imported technology costs, and a relatively short construction season.

In general, regions outside of the Arctic, including the Subarctic, can take advantage of better accessibility to foreign markets, milder climates and a more diverse resource base allowing for broader economic diversification, less economic volatility and better scope for economic sustainability. Many known reserves of Arctic mineral resources are not exploited because of high resource extraction costs and high risks associated with the industry. Where resource extraction occurs, resource depletion is generally the reality.

Resource depletion and its effects on communities in the North can partly be mitigated through investments in human capital and innovation. Industrial resource extraction activities in the Arctic will likely continue to expand for the foreseeable future despite observed or expected physical, environmental, and human and societal costs because of rising global demand and a growing desire for stable and secure resource supplies in world markets. Growth of the northern industrial economy raises new and challenging questions as the Arctic faces a new era of global change resulting from growing demand for resources and potentially increased accessibility due to a changing climate.

7.1 Mineral Reserves in the North

World demand for raw materials is increasing concurrently with economic development and growth. The Arctic is well endowed with a wide range of non-renewable mineral resources such as coal, iron and ferroalloy minerals, non-ferrous minerals and precious metal ores. Some of these minerals are non-accessible or too costly to exploit due to the physical terrain. All Arctic regions are endowed with minerals (e.g. coal, iron ore, nickel, cobalt, chromite, titanium, tungsten, bauxite, zinc, lead, copper, palladium, gold, silver, platinum, diamonds, phosphate, and vermiculite). Russia has the largest reserves. The North is a reserve of considerable resource wealth.

Coal is the most abundant and widely distributed of the fossil fuels. The Arctic accounts for about 2.1 percent of the world's coal production of which the Russian Arctic extracts the largest share.

Learning Activity 1

Where is the nearest mining activity in your community or region? What are the products? Where are they sold?

Economic growth and development translates into significant demand for iron ore which is used primarily in the iron- and steel-making industry. The Arctic region accounts for about two percent of world iron extraction, of which about seventy-five percent is extracted in Kiruna, Sweden. Similarly, nickel is an important resource in the North. Arctic Russia accounts for about eleven percent of the world's nickel production. Arctic Russia also figures prominently with respect to cobalt production at about eleven percent of world production.

Production of chromite takes place only in northern Finland, which accounts for four percent of total world production. Titanium from the Arctic does not figure prominently in overall global production with a share of only 0.3 percent of world production. Tungsten accounts for as much as nine percent of world production from Arctic Canada and Arctic Russia.

The Arctic is also endowed with a number of non-ferrous minerals such as bauxite, zinc, lead, copper and palladium. Arctic Russia extracts about two percent of global bauxite production. The Arctic extraction of zinc accounts for about eight percent of world production with most taking place in Alaska. Arctic production of lead accounts for about six percent of the global production mostly from Alaska and Russia. Russia produces almost the total Arctic share of global copper production of four percent and about forty percent of global production of palladium.

Arctic precious metal ores include gold, silver and platinum. Arctic Russia, and to a lesser extent Alaska and northern Canada, account for most of the Arctic's gold production. Some production also takes place in northern Finland and Sweden, but these are relatively smaller producers. The Arctic makes up about three percent of global production. The Arctic region extracts about four percent of the global silver with about eighty percent from Alaska and some production in Arctic Russia and Sweden. A relatively smaller amount of production takes place in Arctic Canada. Lastly, platinum is a significant resource in the Arctic with Russia accounting for about fifteen percent of global extraction.

Industrial mineral extraction is significant in the Arctic and includes diamonds, phosphate and vermiculite. Industrial diamond production makes up about forty percent of total diamond production. However, synthetic substitutes produced in laboratories are replacing natural diamonds in up to ninety percent of industrial applications. Arctic Russia accounts for the main share of Arctic diamond production and a significant share of world production (e.g. about twenty-one percent of global gem-diamonds and twenty-three percent of industrial diamonds). Phosphate and vermiculite are also important with Russia accounting for four and six percent of global production, respectively.

7.2 Structure of Mining in the North

Mining is the discovery, extraction, processing and transportation of mineral resources to the point at which they are further processed or used in the production of finished goods. This broad definition includes mining of base metals (e.g. iron, copper and zinc), precious metals (e.g. gold, silver and platinum) semi-precious metals (e.g. molybdenum), industrial minerals (e.g. graphite, carborundum or silicon), non-metallic minerals (e.g. sulphur, potash and limestone), quarry stone and gravel, strategic minerals (e.g. uranium, coal) and precious and semi-precious stones (e.g. diamonds and agate).

The process includes several stages. The first stage is exploration by geologists and prospectors who determine the potential of an area for mineral resources. Methods include geological, geochemical and geophysical investigation. The areas to be explored are identified by use of geological knowledge and satellite investigation. If an area looks promising, it is assessed to determine the quantity, quality, extent and depth of the mineral deposit. This usually involves drilling into the deposit and removing core samples for analysis.

If the results of this first stage are positive, (e.g. if there appears to be sufficient minerals for economic use), the second stage is to conduct feasibility studies involving economic and engineering evaluations. At this stage promoters attempt to determine the probable costs of constructing a mine, which are weighed against the probable value of the minerals that could be recovered and ends with a decision to proceed or cancel the project.

The third stage is the construction of the mine and needed infrastructure for production. At this stage the costs are very high and there is no income until construction is nearly complete and production begins.

There are two main types of mines: open pit (surface) mines and underground (subsurface) mines. Iron, bauxite and copper ores are often surface mined, while zinc, lead, silver and gold are usually extracted by subsurface mining.

The mining industry is strongly capital intensive. The exploration stage requires large amounts of risk capital. Construction involves even larger capital outlays and, because it normally takes a long time from discovery to production, money must be invested for extended time periods before there is a return on investment. When mineral resources are found in isolated areas in the North, construction and transportation costs are increased because of lack of infrastructure.

Resource development projects usually require a small but well-trained labour force leaving the potential for local permanent employment somewhat small. While the construction phase may require a large number of workers, the operational phase usually has a small labour demand, limiting economic spin-offs for local communities.

The mining industry is characterized by:

1. The capital-intensive nature of the industry determines ownership structure. Capital dependency requires ready access to large amounts of “free” capital (i.e., capital available for investment over long periods).
2. Demand is derived from world consumption and investment.
3. The resources are non-renewable meaning an eventual depletion of the reserves and sustainability considerations.
4. A low level of innovation in the industry.

Learning Highlight 2

Significant instability and fluctuations in earnings may result if production is concentrated in one or a few products and exports are geared only to a few external markets.

Due to large capital requirements ownership and control of the industry tends to be concentrated in a small number of multinational mining corporations. Big mining companies are a permanent fixture of the industry around the world and usually prefer large scale mining projects. The North has witnessed an increase in the role and presence of multinational corporations. Their financial capital, managerial expertise and technology has allowed them to become a leading force in the development of northern non-renewable resources. The involvement of multinational corporations in large-scale resource extraction and industrial development has also meant questions have been raised about actual benefits accruing to local communities as rents and profits leave the region and may not be reinvested locally. Economic leakage reduces the size of potential regional multiplier effects. The regional multiplier effect refers to the economic impact of development such as job creation, income generation and increased demand for local goods and services.

Learning Activity 2

Provide examples of local or regional economies in the North where the backbone of economic activity is non-renewable resource extraction.

There are also thousands of small and medium sized firms that account for less than 25 percent of world mining operations. Small and medium sized firms tend to concentrate on minerals with high market values such as gold, silver and diamonds and usually have more modest economies of scale.

Demand is influenced by business cycles and economic growth. Although there is a high degree of concentration of production within the industry, the world market for minerals is generally competitive. A slowing of the world economy reduces demand for minerals and is reflected in reduced prices and profitability for mines. World mineral prices are established through trading on commodity exchanges such as the London Metal Exchange (LME) and the New York Commodity Exchange (COMEX).

Individuals or partnerships own most small mines. Medium sized mining companies are often joint ventures and many have mining activities in different locations.

Horizontal integration (buying or merging with other companies) has been the traditional growth strategy for mining companies while vertical integration (downstream processing and manufacturing of minerals) is not typical. Because a variety of minerals are often found in the same mine, companies may diversify through production of various minerals.

7.3 Mineral and Non-Mineral Resource Development

7.3.1 Mining in Greenland

The two historically significant mines in Greenland were the cryolite mine in Ivittuut and the Black Angel zinc and lead mine in Marmorilik. Greenland's first cryolite mining company was founded in 1857. It was taken over by Öresund Ltd. in 1870. Cryolite was important for smelting aluminium. Although the Danish state had difficulties managing the governance of the mine, it provided an enormous direct surplus to the Danish state through fees and provided economic stimulus through the income created by Öresund. The mine lasted more than 100 years until the 1970s when the deposit ran out.

The zinc and lead deposit at Marmorilik was discovered in the 1930s during marble quarrying. A consortium led by Cominco Ltd. started the company Greenex in 1973 to operate the Black Angel Mine. It operated until 1990 and earned a high yield for the owners and the Danish state while providing employment. Greenex diversified the Greenland economy and provided a breakthrough for Greenlandic labour. It was the site of Greenland's first strike, which established the principle of equal salary for equal work in Greenland.

Greenland has no mineral or metals production, but it has shown great potential for gold, base metals and diamonds. About fifteen percent of Greenland is ice free with most of the remaining land area permanently frozen under the Inland Ice Cap, which reaches three km in thickness. Exploration is restricted to coastal areas of Greenland. The region remains relatively unexplored although exploration efforts have increased particularly for minerals and metals as Greenland looks for ways to diversify its narrow resource-based economy and find alternative sources of income.

7.3.2 The Klondike and Alaska Gold Rushes

Perhaps the most well-known mining activities in the Arctic occurred at the end of the nineteenth century when gold was found in the Klondike region of the Yukon. The initial find in 1896 led to a gold rush that lasted for several years. The Klondike find led to smaller finds and gold rushes in Alaska such as Nome in 1902 and later Fairbanks. The gold rushes brought in over 100,000 new migrants into Alaska and the Yukon but by 1914 the total (Indigenous and non-Indigenous) population of Alaska had stabilized at 65,000 and the Yukon at 27,000. The gold adventure has become an integrated part of the northern North American identity. Although many men became very rich in the gold rush era, the vast majority never made back their expenses and in the end the value of the gold extracted roughly equaled the overall investments made. However, the gold rushes did establish towns and shipping routes, gave people valuable experience in the north and established the north as a rich storehouse of mineral wealth. Other kinds of mining soon followed especially in Alaska.

7.3.3 The Red Dog Mine

One of the best-known modern mines is the Red Dog Mine, an open-pit zinc and lead mine located north of Kotzebue about 600 miles north of Anchorage in a remote region of the Arctic. It is the largest zinc mine in the world and accounts for about 10 percent of the world's zinc production. It has been estimated that the mine will exhaust its currently-permitted ore by the year 2012. Four of the eight largest known zinc deposits in the world are located in the Red Dog area. The mine is named after the late Bob Baker's dog. Baker was a miner and pilot who often took his rusty coloured dog on exploration trips. The Northwest Alaska Native Association (NANA) Regional Corporation, a Native corporation owned by the Inupiat peoples in Northwest Alaska, owns the mine and operates it in partnership with a commercial mining company, Teck Alaska Incorporated, headquartered in Vancouver, Canada. The Red Dog Mine is an example of how mining can align with Indigenous peoples' interests and values and how modern mining can successfully develop and integrate the local labour force, including Indigenous people. NANA must share approximately half the profits generated from the Red Dog mine with other regional Native corporations.

7.3.4 Canadian Mining

Mining is a major source of economic activity in Canada and takes place in all Canadian provinces and territories totaling around 250 mines and several thousand sand, stone and gravel operations. Canada is the world's largest producer of zinc and uranium and a world leader in the production of many other mineral commodities, including potash, cadmium, sulphur and nickel.

Mines in the Canadian territories include two lead and zinc mines (e.g. the Nanisivik mine on Baffin Island and the Polaris mine on Little Cornwallis Island). The Polaris lead-zinc mine on Little Cornwallis Island is the most northerly base-metal mine in the world. There are two major gold mines, the Lupin mine and the Colomac mine in the central territories, and many smaller ones. Diamond mining has become an important part of the northern Canadian economy. A base metal mine and a small jade mill are located in the Yukon Territory. Mineral deposits in northern Quebec and Labrador are important for the economies of Quebec and Newfoundland and Labrador. British Columbia is a major producer of base and precious metals, coal and industrial minerals. The Eskay Creek mine is one of the highest-grade gold and silver deposits in North America. Coal and bituminous sand are the principal outputs of mines in Alberta. Nearly half of Canada's coal production is mined in Alberta. In Saskatchewan, which is the world's largest producer of uranium, Key Lake is the world's largest high-grade uranium milling operation and the world's largest high-grade uranium deposit is found in McArthur River. Manitoba is also an important mining province. Mining began in Manitoba at the Flin Flon copper-zinc mine. Since, a number of towns in northern Manitoba have become major mining centres for copper, zinc, nickel and precious metals. Similarly, Ontario is a major producer of base metals, gold and precious metals. The Sudbury district is the world's most important nickel mining and smelting area.

7.3.5 Other Northern Regions

Iron ore deposits in northern Sweden have had an enormous impact on the Swedish economy and Swedish car production (e.g. Volvo, Saab). They also had a strategic role in both the First and Second World Wars. Sweden has a long history of steel production and is famous around the world for its high-quality steel. The Kola Peninsula and the Norilsk deposits include nickel, copper, platinum, uranium and iron, as well as high value minerals such as gold and diamonds. These deposits have been a major part of Russian economic development since the USSR was established in 1917. During the last decade northern mining has not followed the new, coherent industrial regime it has in other parts of the world mainly because of post-Soviet political uncertainty and different environmental programs. Consequently, a mining regime based on large-scale economics and technical solutions has not yet been realized for northern mining.

A significant amount of non-mineral resource development takes place alongside other types of development in the Arctic. An example is the significant logging and hydro industry, which can be found throughout much of the North. The boreal forest represents a significant resource in the North. The Canadian forest industry operates throughout the provinces and to a lesser degree the territories. Technological innovations have transformed forestry from a labour-intensive to highly capital-intensive industry. Like other resource industries, the forestry industry is dependent on demand conditions in foreign markets.

7.4 Industrial Mineral Extraction: Not all known reserves of Arctic mineral resources are exploited

Arctic economies are characterized by a number of unique features representing special challenges that add to the cost of resource development in the North. While the potential for Arctic natural resource development is enormous, a number of financial considerations affect the profitability of exploration rendering a resource development project economically unviable and leave mineral reserves untouched. Some include current and predicted world mineral prices, currency values, fuel costs, potential environmental damage and clean-up costs, the size of regional multipliers determining benefits accruing to local communities, availability of financial or human resources, ability to attract foreign capital and technology necessary for construction and production, and increasingly consideration of potential cost pressures associated with predicted climate change.

While resource development holds considerable potential for income and employment creation in the North, mineral activities may not succeed in bringing sustained economic development to regions or local communities. Sudden wealth may have detrimental effects on social life and fuel strong opposition to resource development projects as conflicts of interest arise over land use between stakeholders.

Learning Activity 3

Provide examples of different mines operating today with different types of ownership.

Many cost considerations can be linked to the high-risk nature of the mining industry such as:

1. Changing production levels depending on ore quality and the age of the mine.
2. Political risks.

3. Very high levels of risk during exploration and uncertainty during construction.
4. Mining involves a homogenous product in a fluctuating commodity market.
5. Investments and capital are tied up in fixed locations.
6. Resources are finite and assets eventually end.
7. Usually high degrees of political intervention and regulation.

Uncertain and fluctuating mineral prices introduce a considerable element of risk in resource development. Northern mining projects may be launched to supply world markets and the timing of a mine start-up determined by high world demand derived from the demand for commodities the resources help produce. Potential increases in mineral prices and the need for secure supplies in geopolitically stable regions means the great distance to global markets becomes less of a hindrance in northern resource development.

Projects are launched based on predicted future prices for resources and predictions suggesting prices will rise at the time of construction. Predicting future prices with certainty is nearly impossible because of a range of factors. This introduces considerable risk. When demand declines as markets fall into recession or overproduction occurs, declining prices may lead to mine closures and economic contractions in the local community.

Mining companies may face a range of challenges that complicate the start of a resource project, including access to a skilled and educated workforce, the ability to attract and maintain managerial expertise, access to capital, potential return on investment and sufficient community support. Conflicts of interest over land use and costs related to environmental protection present challenges. Mining projects are often confronted with critical issues such as compensation, population resettlement and Indigenous land claims. Managing environmental impacts requires handling immense quantities of waste, developing ways of internalizing environmental impact costs, improving impact assessment and environmental management systems, and planning for mine closure. These factors introduce risks and related costs that must be evaluated before resource development decisions can take place.

Learning Highlight 3

While resources may leave the region in vast quantities and economic benefits to the local community may be potentially small, resource extraction activity also has the potential to generate significant positive economic spinoff effects in terms of employment and income creation and economic diversification.

7.5 Multinational Corporations

Multinational corporations are a growing force in northern resource development. They have access to financial resources necessary to conduct exploration on a large scale. Private capital gravitates toward countries and regions with the highest financial returns and the greatest perceived safety. Multinational corporations tend to invest less in countries where the risk of capital loss is higher than Arctic countries. The main objective of multinational corporations is not to support local development efforts, but to maximize profits. They are powerful companies with substantial bargaining power and the capacity to finance, design, construct and operate large

resource development projects. While corporations can fill various gaps in the North including mobilizing the necessary investments, contributing to government tax revenues, and making available the necessary management, entrepreneurship, technology and skills, there are costs related to relying on private (foreign) investment. Potential costs may include lower regional savings and investment rates associated with reduced competition, lack of local reinvestment of profits and the import of intermediate products and technology from outside the region thereby inhibiting expansion of local firms. Addressing these potential costs involves more stringent regulation of foreign investment, tougher local bargaining, clear adoption of performance standards and requirements, and increased regional ownership and control.

7.6 Costs of Resource Development

Mineral development is hard to justify if it does not bring economic benefits particularly to regions lacking alternative development sources. Non-renewable resource exploitation of known reserves may not go forward because of potential negative impacts for regions and local communities. Some reserves may go unexploited because extraction costs outweigh potential benefits.

Costs may include:

- Low regional multiplier effects with profits and resource rents and other economic benefits flowing out of the region. Resource rent refers to a surplus value after all costs and normal investment.
- A low regional multiplier means fewer spin-offs for the local community. It means that industrial projects do not translate into much economic diversification and development. Industrial development can have potentially three types of impacts via the regional multiplier effect. The direct impact, which is income earned from the resource development project. The indirect impact, which is income generated from increased demand by the company for goods and services. The induced impact, which is income generated from increased demand for goods and services using income generated by the resource project.
- Unrealized economic benefits caused by manufacturing of infrastructure, technology and other equipment taking place in the South thereby reducing potential job creation associated with development in the North.
- Corporations bring managerial expertise and technology to the North and retain the experience and knowledge gained from exploration activities.
- Social costs imposed on local communities from the increase in the labour force associated with resource development, including pressure on community infrastructure and housing. Social costs may give rise to conflicts of interest between northern stakeholders and owners of mining corporations.

7.7 Environmental Impacts

The Arctic is vulnerable to environmental impacts of large-scale resource exploitation projects and industrial development for a number of reasons, including the cold climate. The cold climate means it takes longer for the biological regime to repair itself after environmental damage has

occurred. Industrial projects such as mining activity may disturb the permafrost layer, which in turn has negative consequences for topography and vegetation and may make it harder for reindeer to access food. Airborne pollutants may enter the Arctic food chain and impact the health of Arctic residents who depend on traditional foods. For these and other reasons large-scale industrial projects in the North may be discontinued, down scaled or denied permits to operate.

For most non-renewable materials supply has kept up with demand over the last century. New resources are continually being discovered and new technologies increase the efficiency of mineral extraction and processing. In the longer term, easily mined resources will become harder to find. This will cause price increases meaning lower grade and harder-to-reach deposits will become more economic to mine. Substitution by cheaper materials may also occur and recycling will increase. In the long-run depletion of non-renewable resources in high demand can be expected. The costs of this are enormous and the prospect of potential costs associated with resource depletion has put increasing pressure on finding ways of conserving existing reserves. This explains why some known reserves will go unexploited or be exploited at a slower rate in the future.

Learning Activity 4

Provide examples of environmental impacts from existing non-renewable resource development projects in the North. Outline what has been done to address those impacts.

Environmental impact assessments are conducted in the North and may lead to changes in the conduct of industrial development, its scale and location. Reducing environmental impacts to an acceptable level means significant costs in terms of clean-up, decommissioning and environmentally safer extraction methods. These added costs may prevent a resource development project from being financially viable. One of the greatest challenges is to achieve sustainable development by integrating economic activity with environmental integrity, social concerns and effective governance systems.

To reduce environmental costs, it is necessary to promote responsible stewardship of non-renewable resources, including minimizing waste and environmental damage, and exercising prudence where impacts are unknown or uncertain.

7.8 Climate Change

Climate change is another factor that may create future costs for the non-renewable mineral industry. Climate change has the potential to significantly raise extraction costs and make some exploration more difficult and other more accessible. Mining companies may experience increased costs from melting permafrost as it becomes more difficult to build and move heavy equipment on ground. Climate change is expected to increase access to the Arctic and its resources as the Arctic Ocean becomes increasingly ice-free. An ice-free Arctic Ocean means opening major sea routes such as the North-West Passage and the Northern Sea Route. Retreating ice and improved access may represent economic benefits for the mineral industry. However, operating costs may rise as industry may need to build new infrastructure with changes

in permafrost, and governments may need to build new institutions to protect the region and its resources in the face of increased access.

7.9 Non-renewable Resource Mitigation

When resources are depleted, mines close and large-scale industrial projects end. This can have significant economic consequences for regions and local communities.

Non-renewable resource depletion could be mitigated through investments in human capital and innovation. Human capital refers to the productive investments embodied in people, including skills, knowledge, managerial expertise and health, which result from investments in education, training and health.

Efforts to mitigate against non-renewable resource depletion could include:

1. Education to expand the quantity and quality of human resources.
2. Education to raise access to new and alternative economic and employment opportunities.
3. Education to raise environmental awareness and conserve resources.
4. Investments in research and development to develop substitute resources to reduce the rate of resource exploitation.
5. Economic diversification to spread risks and conserve natural resources, develop new industries, and new economic activities not based on or connected to non-renewable resource exploitation or mining. Economic diversification may require investments in human capital and innovation.
6. Investment of resource rents in special funds to prolong societal benefits of resource development and provide sustainable future income streams.

Sustainable development in non-renewable resource dependent regions is possible to achieve if resources (e.g. gold, diamonds, zinc, lead, nickel, etc.) are converted into assets that can provide a continuous future stream of economic benefits. Trust funds that fund investments in education, training, health and a more diversified economy are examples. Economic benefits derived from profits invested in resource funds must be weighed against lasting environmental damage some resource extraction may cause.

Environmentalists and others have called for reductions in material consumption – a consumption that supports many national economies, particularly in industrial countries. Such calls challenge those who directly influence the ways in which minerals are used in products and challenge users to reduce levels and patterns of use and disposal. Resource efficiency can be increased in numerous ways, including recycling, product re-manufacture and re-use, substitution and in some cases avoidance of use.

Society's current use of non-renewable resources faces major challenges. These reflect differing interests of northern stakeholders and may include concerns over environmental damage and waste minimization, reaching economic efficiency objectives, and concerns over health and

wellbeing. Some concerns can be addressed at various stages of mineral exploration and production by exploring ways of addressing new and alternative ways of recycling, re-use and re-manufacture of products.

Learning Highlight 4

Non-renewable resource depletion can be mitigated via investments in education and innovation to develop substitute resources.

Most countries or regions still do not have necessary frameworks in place to solve questions about sustainable development in economies based on non-renewable resource extraction, such as mineral exploration in the North. Part of the process involves stakeholder processes, adoption of voluntary codes and guidelines, and the introduction of systems promoting better practices among resource users.

Working towards more sustainable non-renewable resource use will require consideration of stakeholder interests, including participatory decision-making, avoidance of excessive concentration of power, ensuring transparency, providing access to accurate and relevant information, and ensuring accountability for actions and decisions.

Discussion Questions

1. What are key risks facing the non-renewable mining industry in the foreseeable future?
2. To what extent is sustainable development possible in a non-renewable resource based economy?
3. The North has been described as a region with considerable resource wealth. Why are economic benefits to local economies not larger than they are? Why are benefits not spread more equally throughout the population?

Study Questions

1. What is known about the size of coal, iron, and precious metal ore reserves in the Arctic?
2. Describe the different stages of mining. Explain why large corporations or multinationals primarily undertake large-scale resource projects.
3. Describe some well-known current mining operations.
4. List key reasons why some known mineral reserves are not exploited.
5. Explain how new technology innovation can help reduce the rate of non-renewable resource depletion.

Glossary of Terms

Business Cycle: Recurring and fluctuating levels of economic activity an economy experiences over a period of several months.

Capital Intensive Production: Production that uses relatively more capital (i.e., machinery and equipment) in production than labour and other factor inputs.

Derived Demand: Demand for a good that results from the demand for another good.

Gross Domestic Product: Total value of all final goods and services produced in a country in a given year.

Human Capital: Productive investments embodied in people, including skills, knowledge, managerial expertise and health, that result from investments made in education, training and health.

Multinational Corporation: International corporation operating in more than one country.

Regional Multiplier Effect: Effect on demand and income in a region resulting from an increase in investment.

Resource Rents: Surplus value after accounting for all costs and normal investment.

References

Bone, R.M. (2009). The Canadian North. Issues and Challenges. Third edition. Oxford University Press.

Glomsrød S., Mäenpää I., Lindholt L., McDonald H. and S. Goldsmith. (2008). *Climate change in the Arctic: A discussion of the impact on economic activity*. In Solveig Glomsrød and Iulie Aslaksen (Eds.), The Economy of the North. Statistics Norway. http://www.ssb.no/a/english/publikasjoner/pdf/sa112_en/kap4.pdf

Glomsrød S., Mäenpää I., Lindholt L., McDonald H. and S. Goldsmith. (2008). Arctic economy within the Arctic nations. In Solveig Glomsrød and Iulie Aslaksen (Eds.), The Economy of the North. Statistics Norway. http://www.ssb.no/a/english/publikasjoner/pdf/sa112_en/kap4.pdf

Larsen, J.N. (2010). Economies and Business in the Arctic Region. In: Natalia Loukacheva (Ed). Polar Law Textbook. TemaNord 2010:538. Nordic Council of Ministers, Copenhagen. <http://www.norden.org/en/publications/publications/2010-538>

Larsen, J.N. and L. Huskey. (2010). Material Well-being in the Arctic. In: J.N. Larsen, P. Schweitzer and G. Fondahl (Eds). TemaNord 2010:519. Nordic Council of Ministers: Copenhagen. <http://www.norden.org/en/publications/publications/2010-519>

Lyck, L. Module 11. Mining in the North Circumpolar World. University of the Arctic.

Supplementary Resources

Arctic Human Development Report (AHDR). (2004). Akureyri: Stefansson Arctic Institute. <http://www.svs.is/AHDR/index.htm>

Arctic Monitoring and Assessment Programme (AMAP). www.amap.no

Arctic Climate Impact Assessment. <http://www.acia.uaf.edu>

ASI (Arctic Social Indicators). (2010). J.N. Larsen, P. Schweitzer and G. Fondahl (Eds.). TemaNord 2010:519. Nordic Council of Ministers: Copenhagen.
<http://www.norden.org/en/publications/publications/2010-519>

Intergovernmental Panel on Climate Change. <http://www.ipcc.ch>

Larsen, J. N. (2010). Climate change, natural resource dependency, and supply shocks: The case of Greenland. In: Gorm Winther (Ed.) The Political Economy of Northern Regional Development. TemaNord 2010:521. Nordic Council of Ministers, Copenhagen.
<http://www.norden.org/en/publications/publications/2010-521>

The Economy of the North. (2009). S. Glomsröd and L. Aslaksen (Eds.). Statistics Norway.
http://www.ssb.no/english/subjects/00/00/30/sa_economy_north/sa112_en/sa112_en.pdf

The Economy of the North. (2008). S. Glomsröd and L. Aslaksen (Eds.). Statistics Norway.
http://www.ssb.no/english/subjects/00/00/30/sa_economy_north/sa84_en/