

SUSTAINABLE MINING AND GEOINFORMATION

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Week – 06

Lecture 27: Sustainable Development for Mining Industry-I

Welcome students to the NPTEL online certification courses on sustainable mining and geo-information. Today is lecture 27, and the topic of the lecture is sustainable development for the mining industry. So, this topic, which is sustainable development as applicable to the mining industry, will take a series of classes, maybe three classes, and today is the first part of this topic. So, in today's class, we will cover what sustainable development is, we will give the definition of sustainable development, we will present the historical journey of sustainable development, how through different timelines, the concept of sustainable development was developed.



Then, we will talk about the different pillars or components of sustainable development. Then, we will discuss how this concept of sustainable development can be applied to the minerals and mining industry. And lastly, in today's class, we will discuss what the difficulties or challenges are in applying the concept of sustainable development to the mining industry. So, first, we will talk about the historical evolution of sustainable development. How did the topic of sustainable development or the concept of sustainable development come into being?

HISTORY OF SD

- Developmental projects have environmental consequence;
- Adverse impact on physical, biological and ecological resources.
- Environmental activists urged nations, policy makers to develop policy for striking balance between development and environment.
- 1984: UN established an independent group of 22 nations from member states (developing/ developed) to develop long-term environmental strategies for international development funding.
- 1987- World Commission on Environment and Development report- Our Common Future (Brundtland Report)
- Brought sustainable development in international development thinking.



So, as you can appreciate, we have discussed this in previous classes, that every country undertakes some developmental projects which are intended for the development of the people, development of the society, and development of the state and the country. So, for example, mining is one example of a developmental project. Similarly, different infrastructure projects like airports, ports, hydroelectric dams, irrigation projects, these are all examples of developmental projects, and these projects are executed for the development of the country.

Now, when we execute these developmental projects, there will be some unintended environmental impacts or environmental consequences. There will be adverse impacts on the physical, biological, and ecological environments and resources. We have discussed this in the context of mining in earlier classes. So, any developmental project will have side effects as environmental impacts.

Now, environmental activists have been, since the 70s or maybe a little before that, urging states, nations, or policymakers to develop policies to strike a balance between development and the environment. Now, because of the pressure from environmental activists or intellectuals, the United Nations has conducted different studies and even conferences to discuss how to strike a balance between developmental projects and the environment. So, from the perspective of sustainable development, some of these conferences or summits are very, very important. For example, in 1984, the United Nations established an independent group of 22 nations from member states, both developing and developed, to develop long-term environmental strategies for international developmental funding to different countries. So, in that, particularly in 1987, the United Nations established the World Commission on Environment and Development, which produced a report. The name of the report was Our Common Future.

Many of you might have known this, and this report was also known as the Brundtland Report because it was written under the leadership of Brundtland.

Now, this report, the Brundtland report, for the first time introduced the concept of sustainable development. And brought the concept of sustainable development into international development thinking. So, after this, some other milestones, many conferences related to sustainable development happened, and some of the prominent ones are: in June 1992, the Earth Summit in Rio de Janeiro, Brazil. Where 178 countries adopted Agenda 21, which is a comprehensive action plan to build a global partnership for sustainable development. Now, this Agenda 21 documented the issues of importance, the actors who would be leading the programs for sustainable development and the means for achieving sustainable development by the start of the 21st century.

HISTORY OF SD

- June 1992 - Earth Summit in Rio de Janeiro, Brazil
- 178 countries adopted Agenda 21, a comprehensive plan of action to build global partnership for sustainable development.
- 'Agenda 21' document detailed the issues, the actors and the means for achieving SD by the start of the twenty-first century.
- Millennium Summit, New York, 2000;
- World Summit on SD in Johannesburg 2002, attended by 191 national governments, UN agencies, financial institutions.
- World Summits, New York, 2005.
- U.N. Conf. on Sustainable Development, 2012, Rio de Janeiro.
- U.N. Summits on Sustainable Development 2015, New York.
- UN Conf. on Env. and Sustainable Development, 2022, Stockholm.

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So, these are important events. After that, several events also took place. For example, the Millennium Summit that took place in New York in the year 2000. Similarly, the World Summit on Sustainable Development in Johannesburg in 2002, which was attended by 191 national governments, United Nations agencies, and many financial institutions. Then we have the World Summits in New York in 2005. The United Nations Conference on Sustainable Development in 2012 in Rio de Janeiro, Brazil. Then the United Nations Summits on Sustainable Development in 2015 in New York. And then, recently, the United Nations Conference on Environment and Sustainable Development in the year 2022, which was in Stockholm. So, in all these conferences, the topic was how to achieve sustainable development, what should be the policies that the member nations should be implementing for sustainable development of the different countries and also in the global perspective.

Sustainable Development

- World Commission on Environment and Development report- **Our Common Future** (Brundtland Commission, 1987)
- Coined and defined "Sustainable development"
- "Developmental process which meets the needs of the present without compromising the ability of the future generations to meet their own needs".

Key features:

- a) Needs of present society especially poor;
- b) resource availability;
- c) intergenerational equity;
- d) "limits" or the ability of the environment



Now, if we come to the definition or the concept of sustainable development, as I have discussed a little before, the initial concept was introduced in the World Commission on Environment and Development report, "Our Common Future." It was in the Brundtland Commission in 1987 that coined the term sustainable development and defined the term also.

So, what is the definition? The definition of sustainable development is a developmental process that meets the needs of the present generation without compromising the ability of future generations to meet their own needs. I repeat it, what is the definition? A developmental process that meets the needs of the present generation without compromising the ability of future generations to meet their own needs. Now, if we look at the definition very carefully, there are some three or four concepts that are hidden in the definition. So, now what are these points or the key features? The key feature is that for development, we need the development of society and development when we are planning for development, we want development for all, but especially for the poor people. So, when a country or a society plans for a development project, it will keep the poor at the center of things.

So, the development of the poor section of society is very critical. Now, the second point is that any development or any developmental project will depend on the availability of resources. For example, the basic necessities, our basic developmental requirements, are food, shelter, and clothing. So, for example, food. So, to develop food, we require physical resources like good soil. So, that is a resource. For food, we require basic resources like water. For developing food, we require basic resources like fertilizer. So, these are resources.

So, now for development to happen, resources have to be available, and without resources, there cannot be any development. So, that means if I want to develop as a society, I have to make the resources available. For example, if I take the mineral resources, any manufacturing economy is critically dependent on these resources. Mineral resources. So now, if I want to develop my manufacturing sector, which in turn will generate employment and develop society, we have to have mineral resources. Without that, it cannot be. So, I have to make mineral resources available; that is a prerequisite. So, resource availability is very critical for sustainable development. The third feature which is hidden in the definition, or which is actually present in the definition, is intergenerational equity. That means, as the current generation, we want to develop using the resources available at present, but when we are developing using the resources available today, we also want our future generations. It should also be developed. And for that, we have to leave sufficient resources. For the future generation. Otherwise, they cannot be developed.

So that means, the resources, whatever they are, of the society. We have to enjoy and we also have to leave a significant amount or sufficient amount of resources to the future generation also. So that means the intergenerational equity that each generation has right over the resources. So that is also a requirement of sustainable development. So, this is also one key feature. So, another feature is the limits or the ability of the environment. So, we have discussed previously also that whenever we are utilizing our resources for developmental goals, invariably it will result in the degradation of the environmental quality. It will degrade the physical, biological, and ecological resources. Now if on one hand we are developing, but on the other hand our resources are depleted or degraded So then, the degradation of the resources will also lead to the degradation of our quality of life, degradation of our health, of humans, animals, plants, and degradation of the ecosystem. So, this development on one hand, degradation of our health and this ecosystem on the other hand. So, we have to see that the degradation of the ecological health happens within certain limits. It does not exceed that limit because if it exceeds the limit of the ecosystem for cleaning of the system, then there will be permanent degradation, then just economic prosperity, economic development will not have any meaning, because we are suffering, our health is suffering, the ecological health is suffering. So, when the health of the man's, human's ecosystem suffers, just having economic prosperity will not mean anything. So that means whatever our developmental activity, it has to be within the limits or the ability of the environment or the ecosystem to remediate.

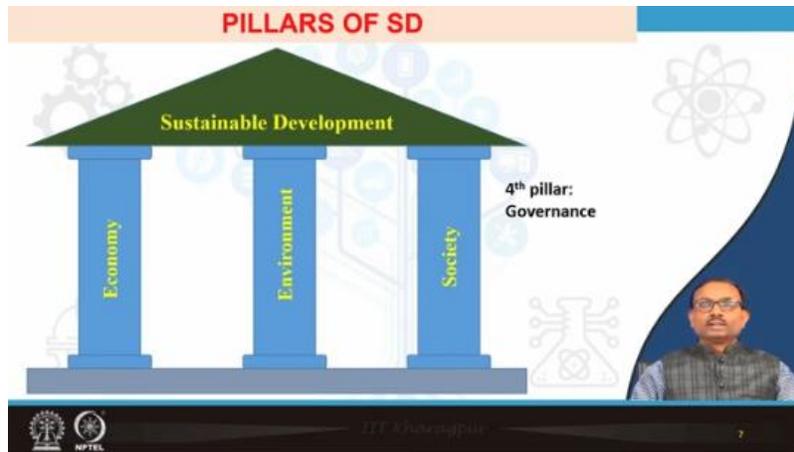
So, you might have heard the term called carrying capacity. And there are so many other definitions also there. So, that is also inherently hidden in, and present in, the definition of sustainable development. Now, again, if you, go to the taxonomy of sustainable development, there are two terms. One is sustainable, and the second is development.



So, sustainable, what is to be sustained? So, you can see this table that shows what is to be sustained. That nature is to be sustained. Earth systems, biodiversity, ecosystems, they have to be sustained. Life support has to be sustained.

Ecosystem services, natural resources, environmental resources, they have to be sustained. Then, from the people side, communities have to be sustained. Their culture needs to be sustained. The heritage needs to be sustained. Society has to be sustained. Then, what is to be developed? So, development for whom? For people, so that the quality of life improves. The education, health infrastructure, it improves. Equitable resource distribution becomes better. Equal opportunity for all. So, these are the social issues. Developmental issues. Then, what is to be developed? The economy has to be developed. Wealth creation. Then, the production sectors. Consumption in society has to be improved. And then, what is to be developed? Society has to be developed. Different institutions need to be developed. Social capital development is essential. Different infrastructures, such as schools, colleges, and hospitals, need to be developed. There has to be regional development and development of the country. So, these are the concepts of sustainable development.

Now, to summarize, what is sustainable development? So, as per the current understanding, sustainable development rests on three pillars. It rests on three pillars. What are the three pillars? So, one is the economy, the second is the environment, and the third is society.



So, as a society, we want economic development utilizing the resources that are available to us. But when we develop and exploit the resources, there will be environmental degradation. So, we have to make sure that environmental degradation is within a limit, within a balance. Now, thirdly, all this economic activity we are doing is for the benefit of society. So, the economic benefit that is happening because of the developmental project has to go to society. So, these three things are the pillars of sustainable development. Now, a recent addition in recent literature is that there may be a fourth pillar of sustainable development, which is governance. So, what are the mechanisms, procedures, and policies that should be followed so that the objective of sustainable development, which is economic development, is transferred to society while keeping a balance in environmental degradation? That is the objective of sustainable development. So, this was, in general, for any developmental project, the concept of sustainable development that we have discussed. Now, coming to the specific sector of mining and minerals.

MINING & DEVELOPEMNT

- Mining is the foundation of manufacturing/materials economy.
- Minerals important for human basic needs (food/ health/ shelter/ prosperity)
- Triggers economic activity in remote areas.
- Creation of infrastructure (connectivity, roadways, electricity, communication, internet, etc.)
- Creation of services: education, health, markets,
- Creates jobs for local youth (direct, indirect)
- Creates business opportunity

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So, as you know, minerals are very essential, critical resources for the development of a country. Mining is the foundation or basis of the manufacturing and materials economy. Minerals are very important to meet basic human needs of food, health, shelter, and prosperity. The mining industry triggers economic activity, particularly in remote areas where mineral deposits and mineral resources are located by nature. Mineral reserves are present wherever nature has intended. So, mostly, they are located in remote areas under forests. And when we start the mining project to exploit these mineral resources, economic activity is created or triggered in those remote areas. And because of the mining project, we create infrastructure, connectivity, roadways, electricity, communication networks, internet networks, and the like. And we also create different services like education, health services, and markets. So, different services are created in those remote areas. And because of the mining industry, jobs are created where the local youth will get jobs. Some direct jobs are created, and some indirect jobs are created. In addition to the jobs that are created, business opportunities are also created by the mining industry, and this will cater to the local community. So, like any developmental project, when it is started, there will be adverse environmental consequences.

MINING Vs ENVIRONMENT

Impact on physical environment:

- Air emissions (PM, gaseous effluents)
- Water (mine drainage water, acid mine drainage)
- Soil/ land (erosion, degradation)
- Generation of wastes (OB dump, tailings.)
- Buildings, structures etc. (Damage, stability, aesthetic loss)
- Impact on topography and drainage

Impact on biological environment:

- Destruction of forest (flora and fauna);
- Destruction of wild habitat
- Loss of bio-diversity

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So, whenever we have a mining project, let's say open-cast mines or underground mines, more so in open-cast mining, there will be an impact or degradation of the physical environment, degradation of the biological environment, and an impact on the socio-economic environment. So, what are the impacts on the physical environment? We have discussed this in earlier classes. So, there will be air pollution because of the particulate matter or the gaseous effluent. There will be water pollution because of the mine drainage, particularly acid mine drainage. Then, there will be soil erosion. There will be degradation of the land. A lot of huge amounts of waste will be created as overburdened domes or the tillings.

And these wastes will also degrade the soil, water, air, land, everything. There will be damage to the buildings. To any heritage structures, there will be aesthetic loss in that area, and there will be an impact on the topography, drainage, and groundwater. So, these are the physical impacts on the physical environment. And apart from this, there will be an impact on the biological environment, an impact on the flora and fauna.

Destruction of forests is involved. There will be destruction of wild habitats and loss of biodiversity. So, there will be socio-economic impacts because of the mining project. Because when we acquire the land to open the mine, there will be displacement of people. And there will be loss of agricultural land, traditional livelihoods, land rights, and disruption to the age-old socio-cultural and economic life.

MINING Vs ENVIRONMENT

Socio-Economic Impact

- Displacement of people,
- Loss of traditional livelihood,
- Loss of land rights
- Disruption to the age-old socio-cultural life,
- Change in demography (immigration of outsiders),
- Increase in the cost of living and of land value,
- Water scarcity,
- Environmental pollution and
- Health hazards.

There will be changes in demography. People from outside, skilled and unskilled, will come. And there will be immigration from outside to the mining area. There may be conflicts with the local people. The cost of living in the mining area and periphery will increase. Land value will increase. There will be scarcity of water resources. Of course, there will be environmental pollution, which the local community will bear the brunt of. There may be health hazards because of the different wastes: solid, liquid, and gaseous, which will result in health hazards to the local community. Now, mining and sustainability: minerals are essential in contemporary society and economy, as we have discussed.

MINING AND SUSTAINABILITY

- Minerals essential in contemporary societies and economy.
- Minerals are raw materials for manufacturing, energy, consumer goods etc.
- Mining provide many economic benefits:
 - *providing jobs directly and indirectly,*
 - *aiding in the development of national economies,*
 - *helping in energy and resource availability.*
- Mining industry facing most difficult challenges – **lack of trust of people, NGOs etc.** due to adverse environmental impacts.
- Mining industry struggling across world, to **gain confidence of society** and other stakeholders how to justify the '**social license to operate**'




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Minerals are raw materials for manufacturing, energy, and consumer goods. They provide economic benefits, as we have discussed. Now, the mining industry is facing the most difficult challenges because of the lack of trust from the community, the people, and the NGOs due to the adverse environmental impact created by the mining industry. Now, the mining industry across the world they are struggling to gain the confidence of society.

They need to gain the confidence of environmental activists and other stakeholders. So, the mining industry is struggling to justify the social license to operate. So, unless the mining industry earns the social license to operate, it will be very difficult for them to continue their operations. If the local community does not have a good relationship with them, they may create a lot of social problems. So, why? What is the challenge? The countries and society expect the mining industry to be the engine of economic growth. Local communities expect that the industry will provide employment, infrastructure, and different services to them. The employees of the mining industry expect safer and healthier working conditions, a better community, and social life for themselves. NGOs and environmental communities expect better ecological and environmental protection measures from the mining industry.

MINING AND SUSTAINABILITY

- Countries expect mining industry to be engine of economic growth.
- **Local communities expect that the industry will provide employment, infrastructure, and other economic benefits.**
- The industry's employees expect **safer and healthier working conditions, a better community life.**
- NGO/community expect **better ecological/ environmental protection;**
- Mining business should be profitable.
- Establishing balance is a step towards **Sustainable Development.**
- 9 large mining companies initiated a project to develop framework for sustainable development in minerals sector.
- **World Business Council for Sustainable Development, and International Institute for Environment and Development developed – the Mining, Minerals and Sustainable Development Project (MMSD).**




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But at the same time, these are the expectations of different stakeholders. But mining companies, what do they want? They want their business to be profitable. Unless their business is profitable, they cannot meet the demands of different stakeholders. So, there are two forces, one is that mining wants better profitability, and whatever the revenue they earn, with those profits only they can spend to meet the demand of different stakeholders. So, establishing a balance between the economic benefit, economic profitability of the mining company, and the requirement of the society, requirement of the country. So, achieving the balance, the requirement of the community, and while maintaining the ecological health. So, that establishing that balance between these three factors is the objective of Sustainable development, and when we take different measures, basically we are trying to achieve a balance among these three pillars of sustainable development. So now, sustainable development, this is a definition which is generic to any industry, and how we are now going to apply this concept to the mining business. So, with this in mind with this in mind, nine big mining companies initiated a project to develop a framework for sustainable development in the mineral sector. Because we know the concept, we know the definition, but how exactly we will achieve this sustainable development in the mining business or how we will implement sustainable development in this mining business, it was not known. So, they initiated a research project to develop the framework along which, once the framework is clear, they can implement this thing. So, the World Business Council for Sustainable Development and the International Institute for Environment and Development developed the Mining, Minerals, and Sustainable Development Project, MMSD.

So, they Initiated a project which created a sustainable development framework for the mining project, and that framework can be adapted by mining companies in order to achieve sustainable development in the mineral sector. So, if I give a diagrammatic representation of sustainable development for mining, whatever we have discussed, you can see this is the diagrammatic representation of the Concept of sustainable development for the mining industry. So here we have a triangle, in the triangle in the center we have a mining industry, and the mining industry is resulting or giving economic benefit, and while it is giving the economic benefit, there is environmental degradation, and it also has an impact on society. So, the mining company is trying to Keep a balance between these three competing segments or pillars.



So, it wants to give economic benefit. For the mining company itself, and it wants to give economic benefit to the society and the country in terms of different taxes. It wants to give social benefits to society in terms of developing different services, infrastructure, social capital, and at the same time, when the mining industry is producing a lot of waste material, it will take a lot of environmental measures. Protection measures so that the environmental degradation is kept within an acceptable limit. So, the survival of the mining industry depends on three pillars. One is the economic, social growth, or societal development, and the environment.

The slide is titled 'SUSTAINABLE DEVELOPMENT'. It contains a bulleted list of three points:

- Survival of Mining Industry depends on 3 pillars: **economics, society and environment.**
- Sustainable Development to be achieved by integrating economic activity with environmental integrity, social concerns.
- Goal should be to maximize the contribution to the well-being of the current generation in a way that ensures an equitable distribution of its costs and benefits, without reducing the potential for future generations to meet their own needs.

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Sustainable development is to be achieved by integrating economic activity with environmental integrity and social concerns. The goal should be to maximize the contribution to the well-being of the current generation in a way that ensures equitable distribution of its cost and benefit without reducing the potential of future generations to meet their own needs. Now, this is the concept and definition. There are many challenges, so how do we implement this concept in the mineral industry or mining industry? There are challenges because, according to the definition, intergenerational equity means we

want mineral resources for our development, but we have to leave sufficient mineral resources for future generations. How is it possible? Mineral resources are non-renewable and depleting in nature. Now, if the resource was renewable, I could use the resource, and then after some time, that resource would be created again, so my future generation could use that resource and enjoy it.

SD CHALLENGES IN MINING

- Minerals resources are non-renewable and depleting in nature.
- Mining is a hazardous industry.
- Mining industry causes degradation of physical, biological and ecological resources.
- Mining industry may cause social disruption, adverse socio-economic impacts.

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But mineral resources are non-renewable. They are depleting in nature. So, if I am consuming some mineral resources for setting up a manufacturing industry, steel industry, or power industry, now whatever mineral resources I am consuming, that is gone forever. So, the total resource has become less. So how can I leave sufficient resources for them while consuming a definite, limited amount of resources is a big challenge. I want to consume the resources, and I want to leave sufficient resources for my future generation. So, how to make both things possible? It is impossible theoretically. So, that is a challenge of how the concept of sustainable development will be implemented for the mineral industry, which is a non-renewable resource, which is of a definite, limited quantity. And I want to enjoy the resources and leave the resources for future generations. It is a challenge. We will discuss in future classes how to do this.

Then, Mining is a hazardous industry. So, we want the benefit and betterment of all the people, workers, and the community. But the mining industry, a hazardous industry, creates a lot of environmental degradation. So, these are responsible for creating health issues for society. So, again, it is a contradictory thing.

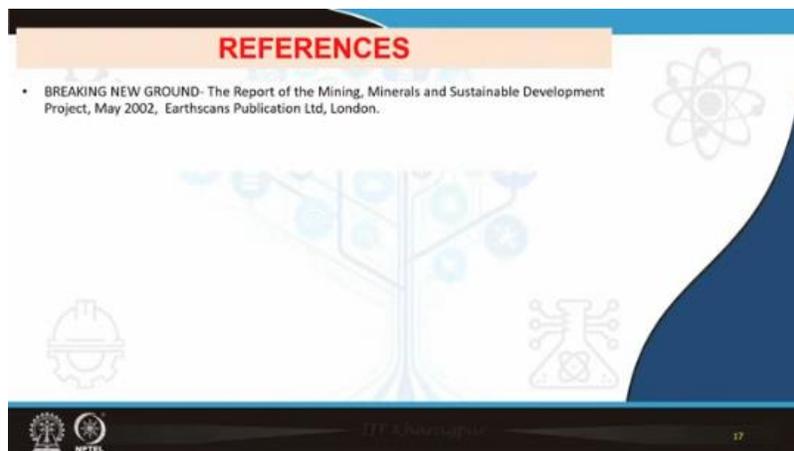
The mining industry may cause social disruption and adverse socioeconomic impacts also. The mining industry creates some economic benefits, job creation, and resource generation, but at the same time, it causes social disruption. And in many cases, it may cause adverse socioeconomic impacts, conflict among the people, and conflict between

local people and outsiders. So, how to achieve a balance? How to develop a harmonious relationship among different sections of the society where mining projects are going on.

That is also a challenging topic. So, these are the challenges of how to implement sustainable development in the mining industry. So, to summarize in today's class, we defined sustainable development with respect to developmental projects. We discussed what the components or pillars of sustainable development are. Three pillars of sustainable development.



How to apply the sustainable development definition for the mining industry, which is a non-renewable resource. Then, what are the challenges of sustainable development in the mining industry? So, these are the discussions that we had in today's class. So, this is the reference that I have taken. This is a report.



2002 Report of the Mining, Minerals, and Society, which is available in the public domain. This report can be downloaded from the internet, and it is a huge document, a 400-page document. Once you go through this document, you will understand what the

challenges are. How are we going to implement sustainable development in the mineral sector? What are the challenges? So, with this, I am concluding today's lecture. And this lecture will continue in the next class.

That is lecture 28. Also, we will continue this lecture. Thank you very much for your patient listening. Thank you.