

# **Integrating Sustainable Development Principles into Educational Process**

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# Outline

- Introduction
- Mineral Resources
- Sustainable Development
- Integration into Educational Process
- Conclusion

# History

`` The modern age has a false sense of security because of the great mass of data at its disposal. But the valid issue is the extent to which people know how to form and master the material at their command. ``

Goethe, 1832

# MINERAL DEVELOPMENT AND IMPACTS

- FAVORABLE

- economic development
- employment
- technological development, and
- diversification of income

- LESS FAVORABLE

- environmental and land use impacts
- accidents and health hazards
- economic-political-social-psychological impacts

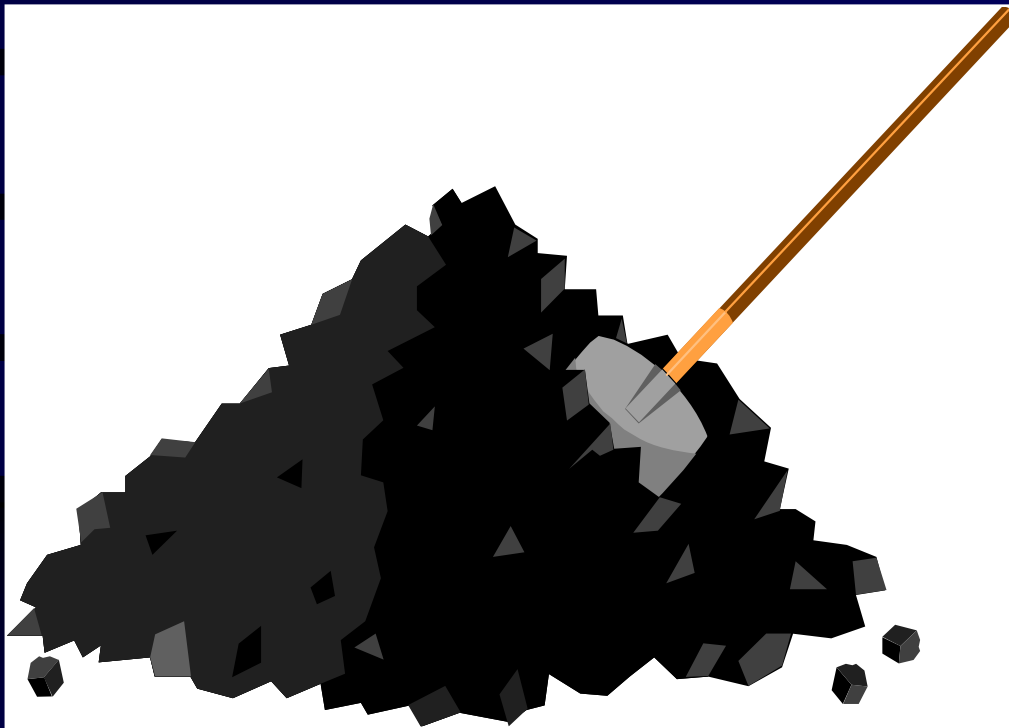
# Unique Features of Mining Industry

- Mining decision
- Depletion
- Long pre-production period
- Capital intensive
- High risk
- Post mining and Rehabilitation
- Externality
- Use/distribution of mining proceeds

# Depletion

- Economic vs. physical
- Fixed mineral stock
- Exploration augments reserves
- Post-mining plan

# STAGES OF THE MINING INDUSTRY



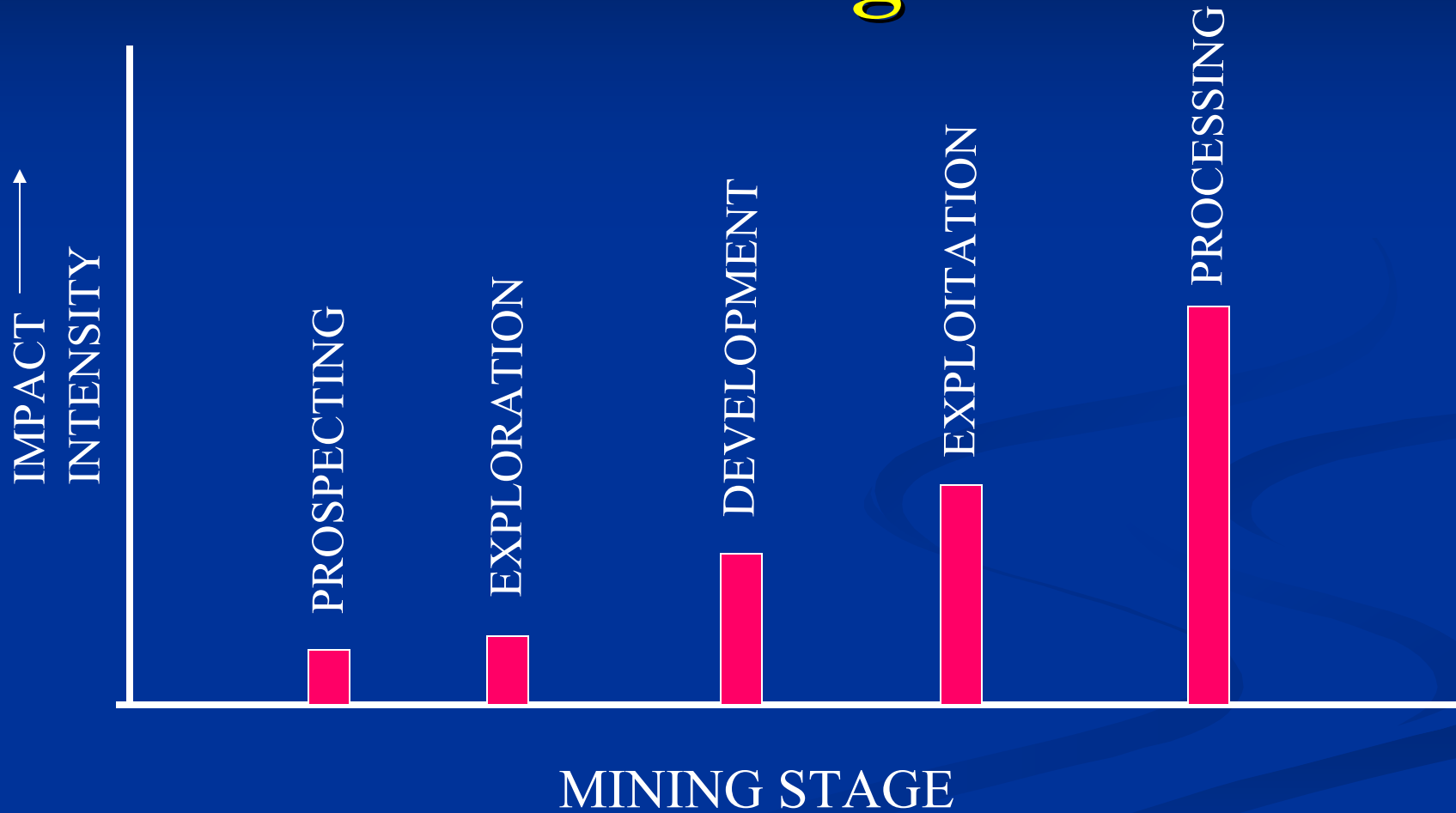
- Prospecting
- Exploration
- Development
- Exploitation
- Processing
- Abandonement

# High Risk

- Obvious risks associated with capital intensity and long lead times
- Geological risk
- Engineering risk
- Economic risk
  - Supply, demand, price, substitution
- Political risk
  - Outright expropriation



# Environmental Impacts of Mining



# Current Concerns

- Increasing urbanization, industrialization
- Environment impacted...inadequate treatment and disposal of hazardous waste, acid and tailings, global warming
- Seepage...impact on groundwater, sterility of water resources
- Damage to vegetation, human health, and biodiversity
- Poverty, illiteracy, displacement of people

# Mineral Wealth

- How is it distributed?
- Investment criteria?
- What are the priorities?
- Who makes these decisions?

Distribution of mineral wealth is not in the jurisdiction of mineral industry

# Mining Decision

- Who makes the decision?
- What are the bases for decision-making?
- What are the objectives?
- What time frame are we looking at?
- EIA and objectivity
- Post mining stage and ramifications

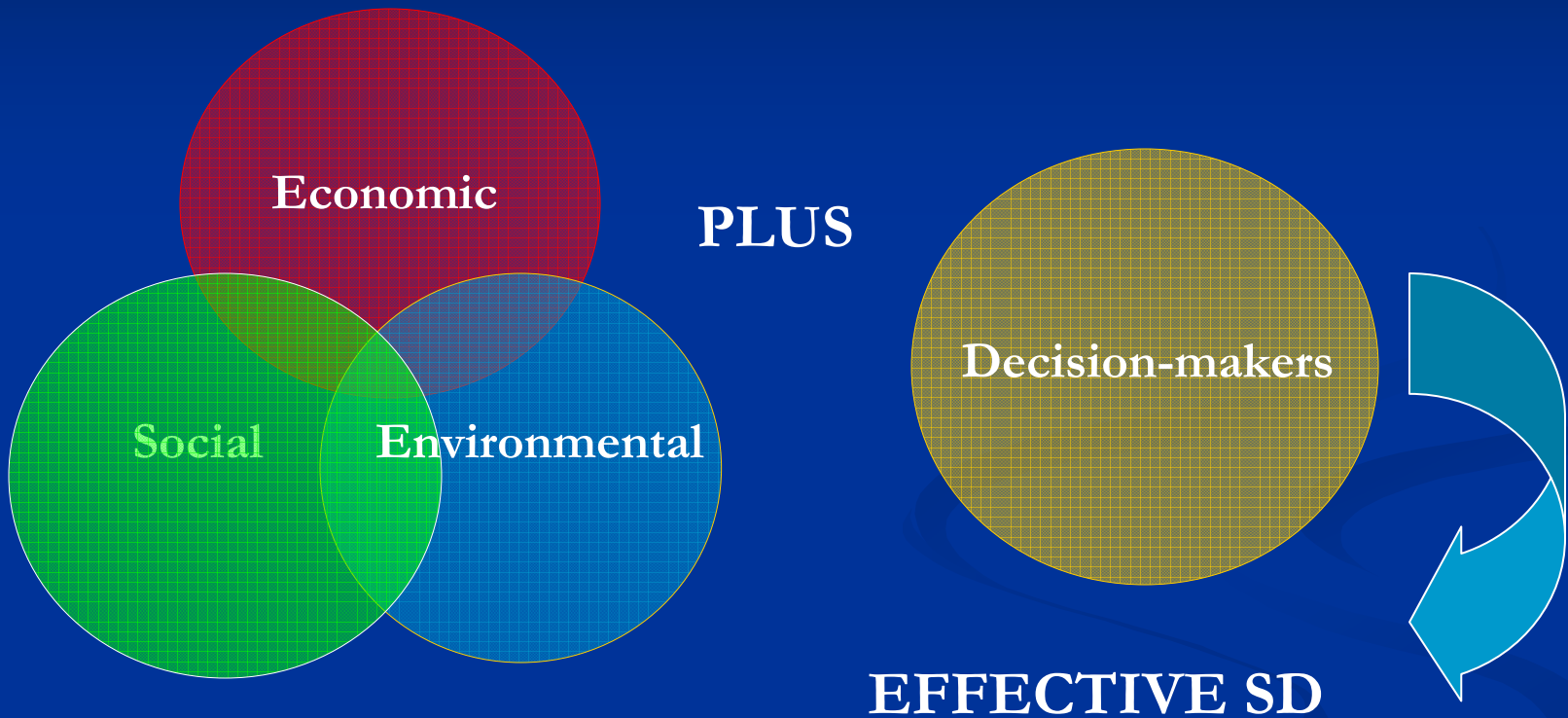
# **ATTRIBUTES OF SUSTAINABLE DEVELOPMENT**



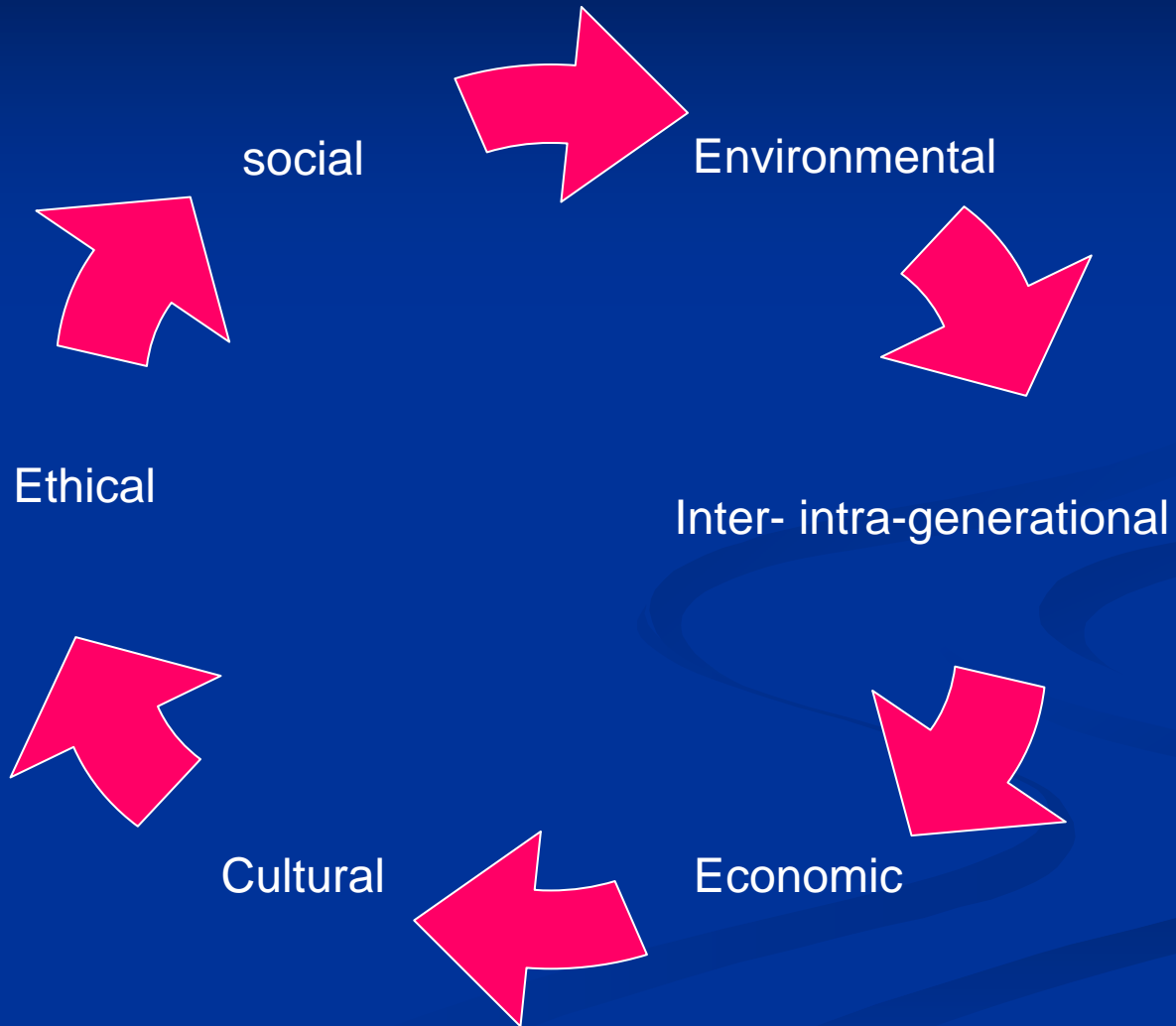
# Components of SD

- Economic:
  - Optimal and efficient use of natural resources; eradicate poverty
- Social:
  - Improving welfare of people, access to health and education, security and respect for human rights. Involvement in decision-making.
- Environmental:
  - Preservation and enhancement of the physical and biological resource base and eco-system

# Effective SD Components



# Sustainability Concepts





# Principles of SD

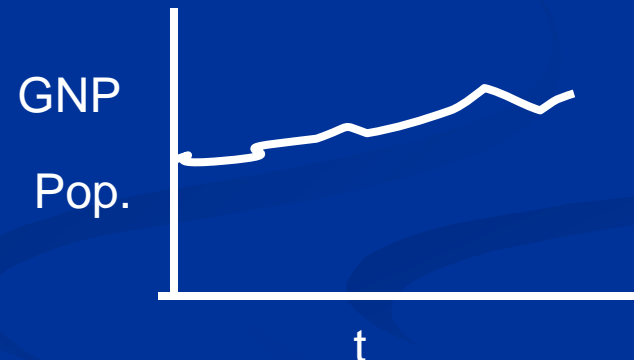
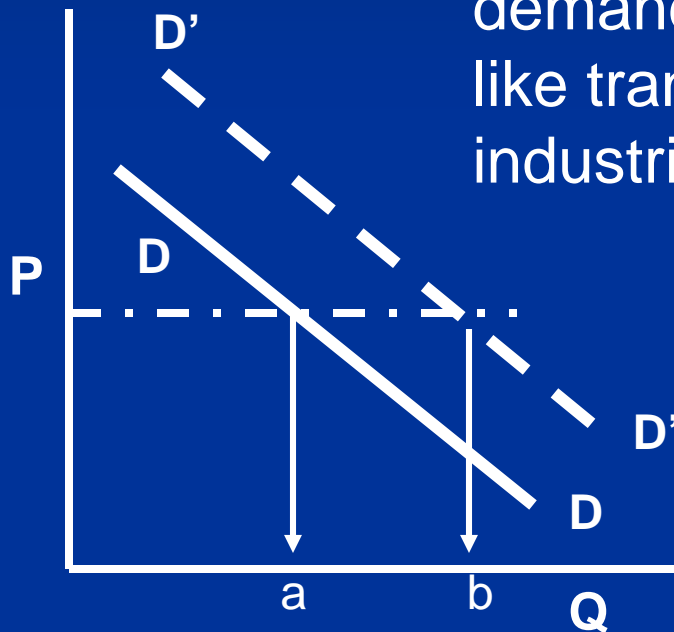
- Integrated economic, social, and environmental objectives.
- Community concerns and participation in national decision-making process.
- Value, culture, tradition preservation
- Time frame and linkage between components.
- Creative approach in conflict resolution.
- Transparency.


# Challenges of SD

- Population growth, industrial and economic development → more input requirement
- Use of resources → depletion of both commodity and amenity resources...right balance is needed.
- Distribution of proceeds, priority of investment, social development.
- Impact of development and globalization on local, regional species.

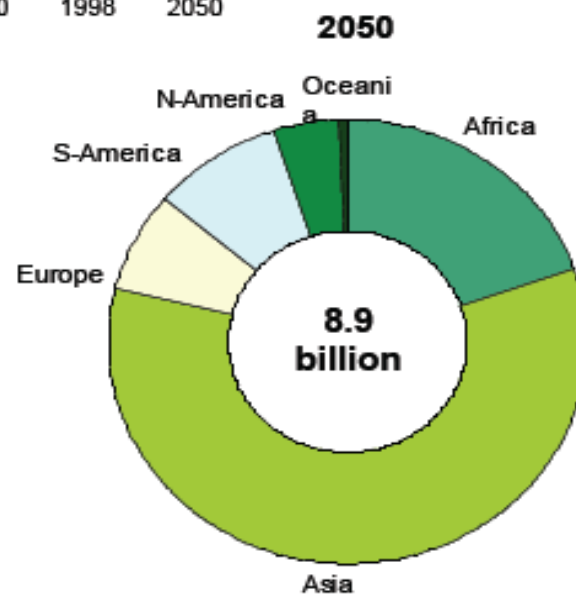
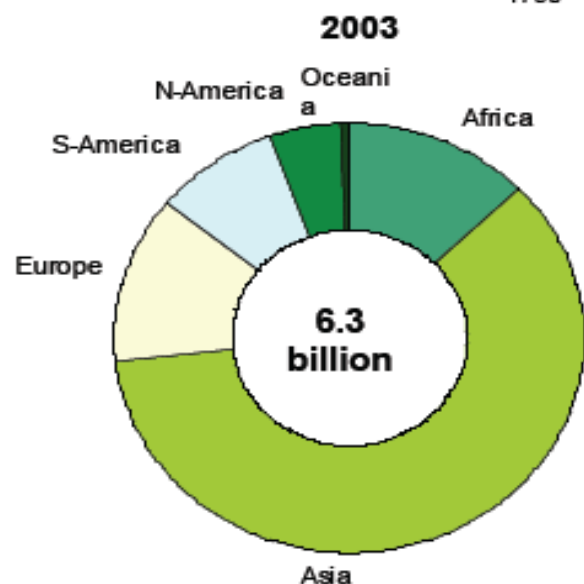
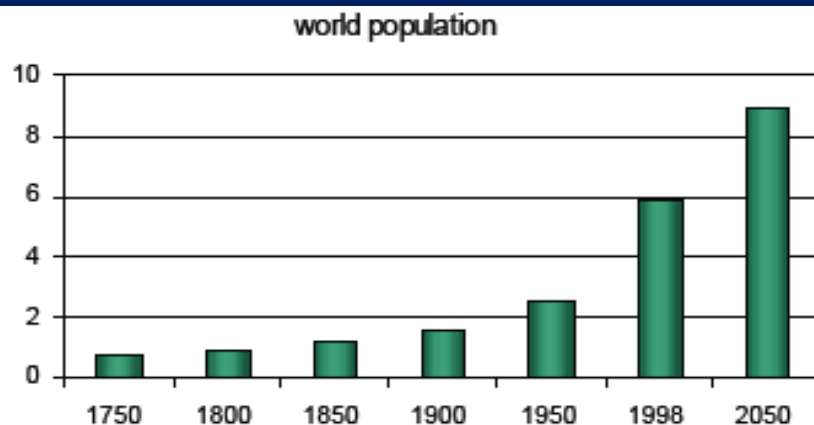
# Derived Demand for Minerals

Mineral Demand is dependent on demand for mineral-using sectors, like transportation, construction, industrial...



Population growth and economic development may imply an increase in mineral demand  environmental impact.

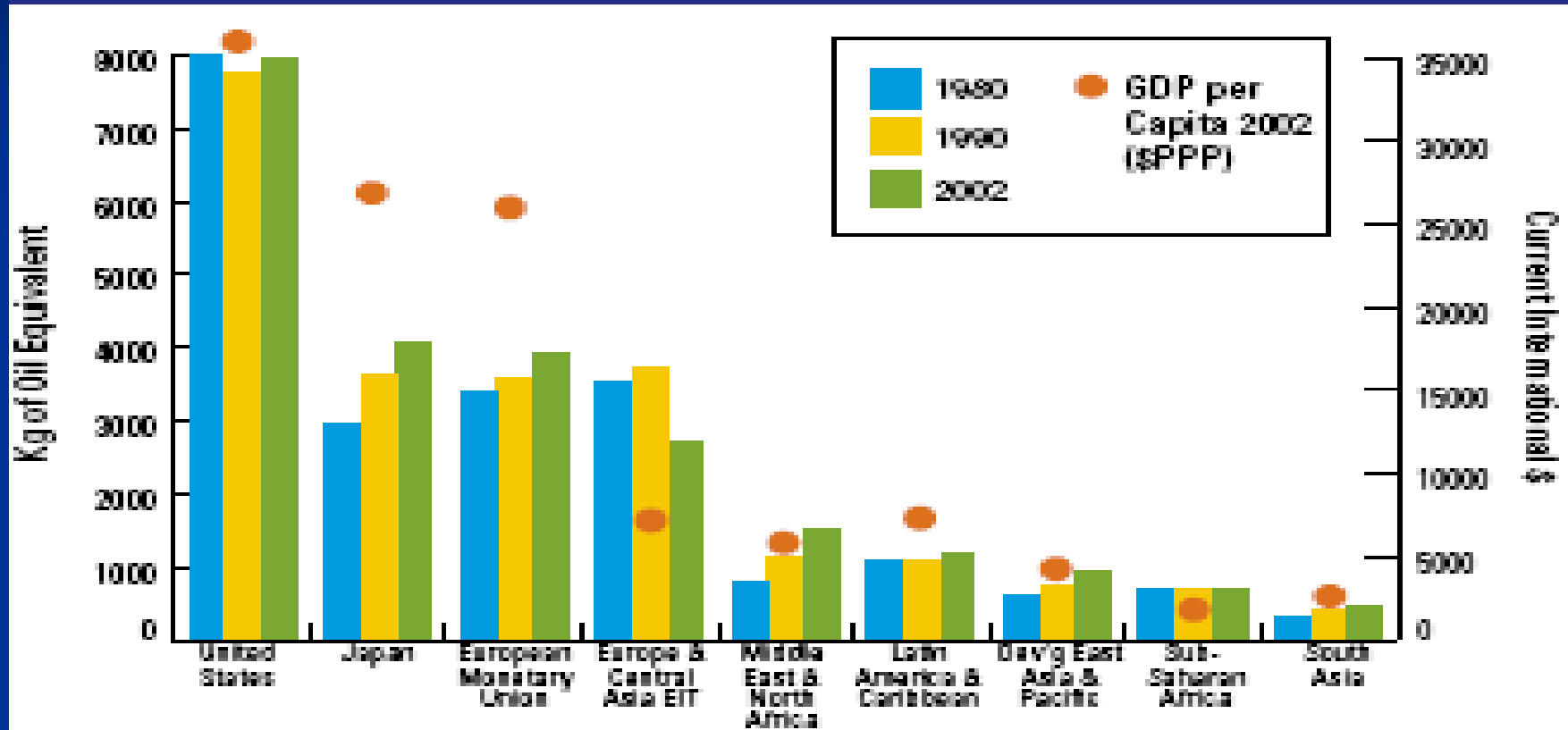
# What is the absorptive capacity of the planet?



source: United Nations

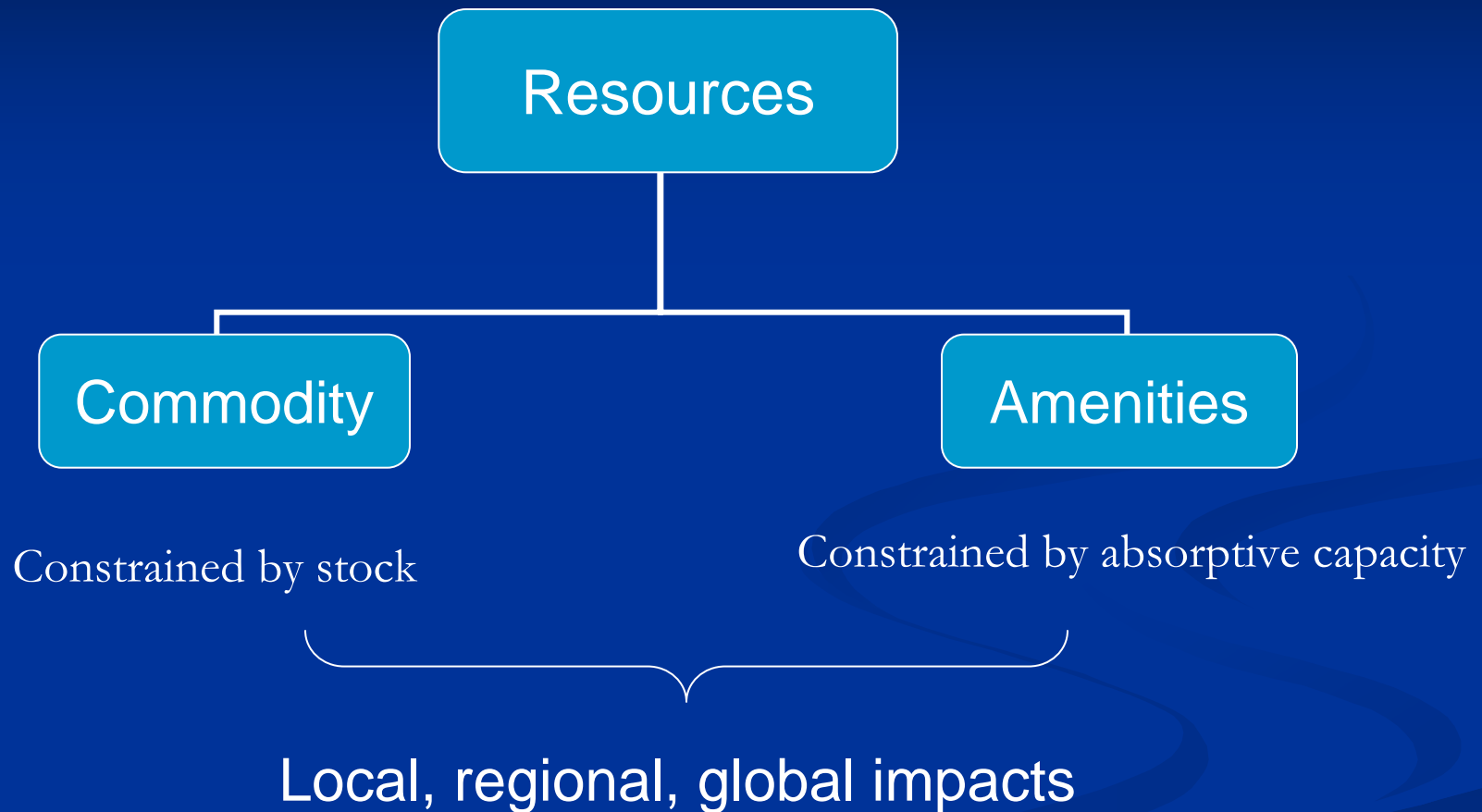
# Prosperity and Energy Use

## Energy Use per Capita & GDP per Capita



Note: Europe & Central Asia EIT (Economies in Transition) excludes EU accession countries.  
Source: World Bank, World Development Indicators 2006.

# Commodity and Amenity Resources



# **A Sustainable Mineral Industry**

The background of the slide is a solid dark blue. In the lower right quadrant, there are several overlapping, wavy, light blue lines that create a sense of movement and depth, resembling a stylized landscape or water ripples.

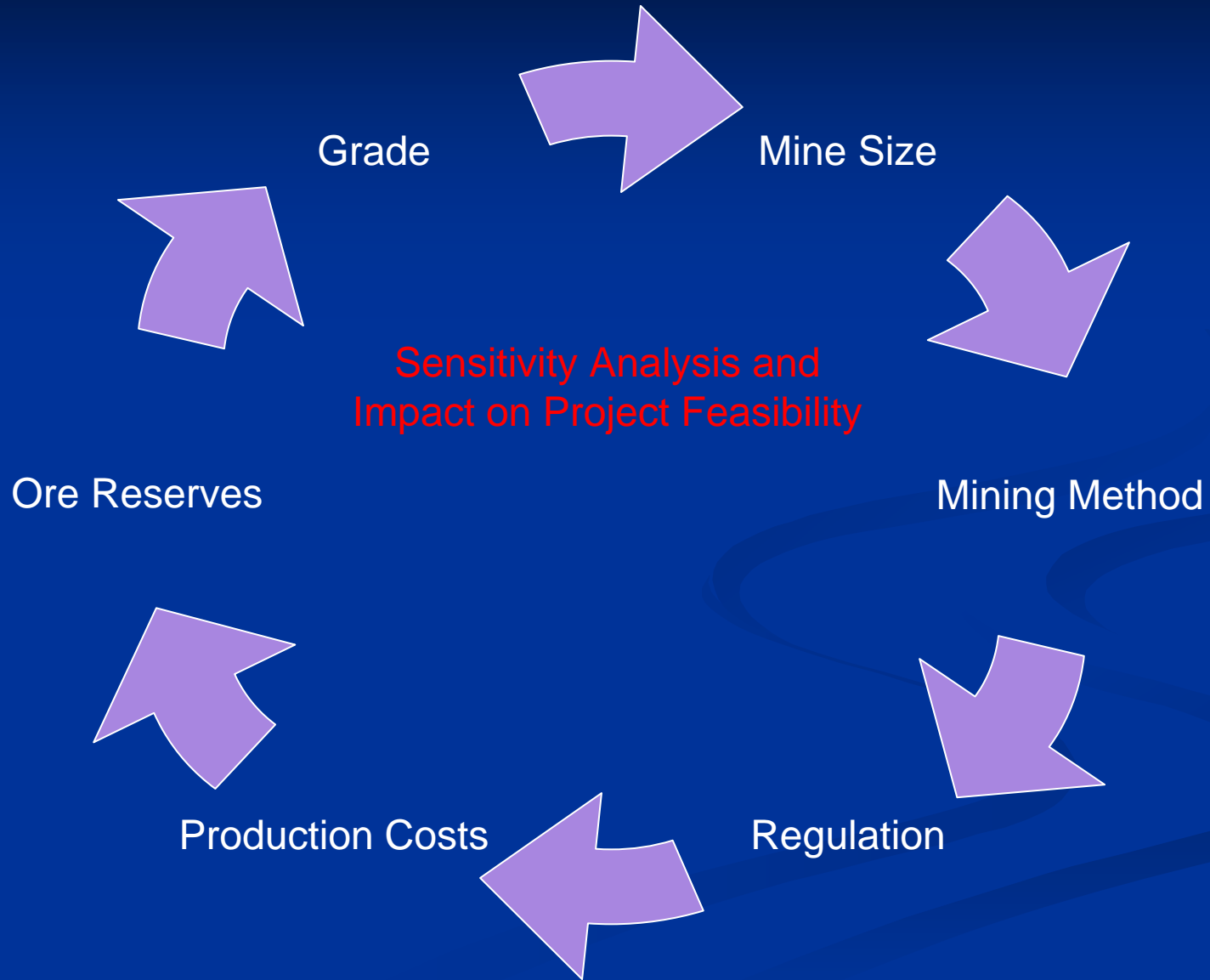
# Determinants of Mineral Production

An integrated system that includes:

- Geology
- Technology
- Economics
- Politics
- Social and Environmental Considerations



# Engineering Evaluation



# Elements of Investment Analysis

- Investment amount
- Receipts
- Costs, i-rate
- Lifetime of investment (yr)
- Reserves
- Depreciation, depletion
- Reclamation
- Salvage Value



Stochastic  
Parameters

# Constituents and Apparent Objectives

- Investor/Producer → maximize profit
- Regulating Agency → environmental
- Government → royalty, social being
- Society → jobs, incidental benefits,  
clean environment

# Apparent Conflicting Objectives

- Mineral development:  $\pi$  max.,  $\tau$  transfer
- Employment: social benefit
- Diversification of income sources
- Economic development
- Royalty
- Environmental and resources protection
- Sustainability

# New Challenges

- Sustainability-from something that is finite
- Temporal, Intergenerational
- Equity
- Externality
- Uncertainty: supply, prices
- Globalization: locals (community) feel disenfranchised

# Nature of a SD Mineral Industry

- Multidisciplinary
  - Engineer: mining, geological
  - Scientist: geologist, environmentalist
  - Economist: Feasibility, financial analysis
  - Planners, administrators
- Ethical, moral issues
- Intergenerational, intertemporal issues

# Topics to be Tackled

- Geologic
- Technical
- Logistical
- Technologic
- Economic
- Ethical
- Environmental
- Social, Legal

# Educational Requirements, and Integration





# Thus,

- SD requires institutions that are based on consensus building through processes such as negotiation, consultation, mediation on issues that are intra- and inter- temporal in nature →  
Good conceptual and communication skills.
- It is a multi-sector participatory decision-making approach where interests of the participants may differ.

# Engineering, Science, and Social Science Disciplines

- Core BSc. Program includes courses in:
  - Mathematics, Physics, Chemistry, Biology, Humanities, Social Sciences, and discipline engineering specialization courses (Petroleum, chemical, mechanical, etc.)
- Language
- Project, mini-research

## Need Emphasis on:

- A responsible, dependable, ethical HR
- Effective Inter-temporal allocation of resources
- Lifelong learning, Importance of R&D
- Team work, Diversity, and property rights.
- Management and resources management
- Probability, Risk and uncertainty
- Energy Conversion topics such as chemistry, biology, and physics.
- Synergy between science, engineering, management, economics, and environment.

# Unique Considerations for a SMI

- Multidisciplinary.
- Benefits and costs are uncertain
- Information is fragmentary
- Externalities and divergence of costs
- Equity
- Good conceptual skills to ‘see the big picture’

# Principle 1 of Rio Declaration

“Human beings are at the center of concerns for sustainable development. They are entitled to a healthy and productive life in harmony with nature.”

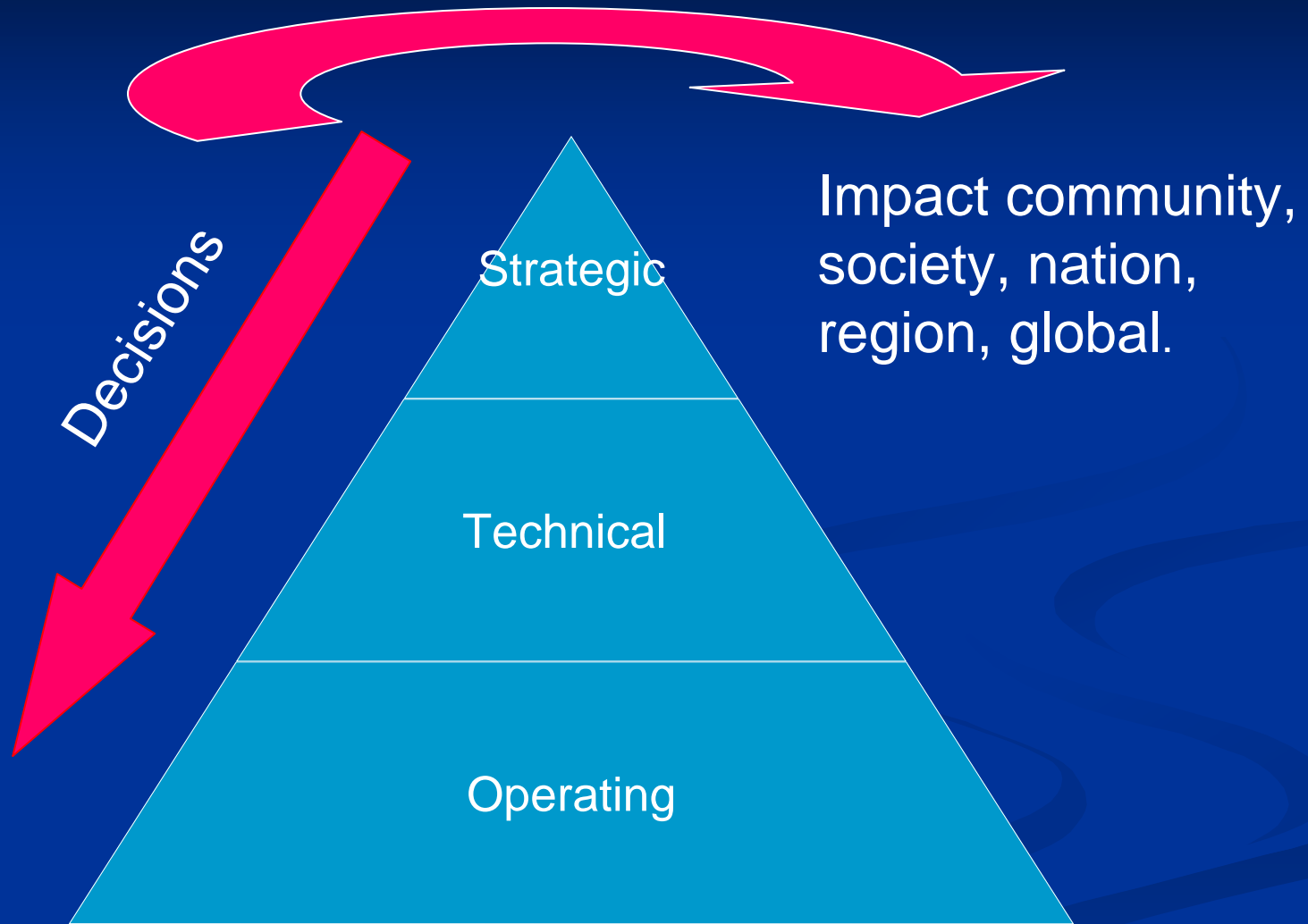
# Our Objective

- To produce 'leaders' who are knowledgeable in a sustainable mineral resources industry.
- High moral and ethical values are a prerequisite in making decisions that are in accordance with sustainable development.
- Decision-making is critical. Today's decisions will effectively map the future path for society and globe.
- Awareness, appreciation, and interaction of the various components of the earth's dynamic system, and the inherent relevant constraints in each component.
- Respect integrity and independence of the components

# Management and Optimization of Resources

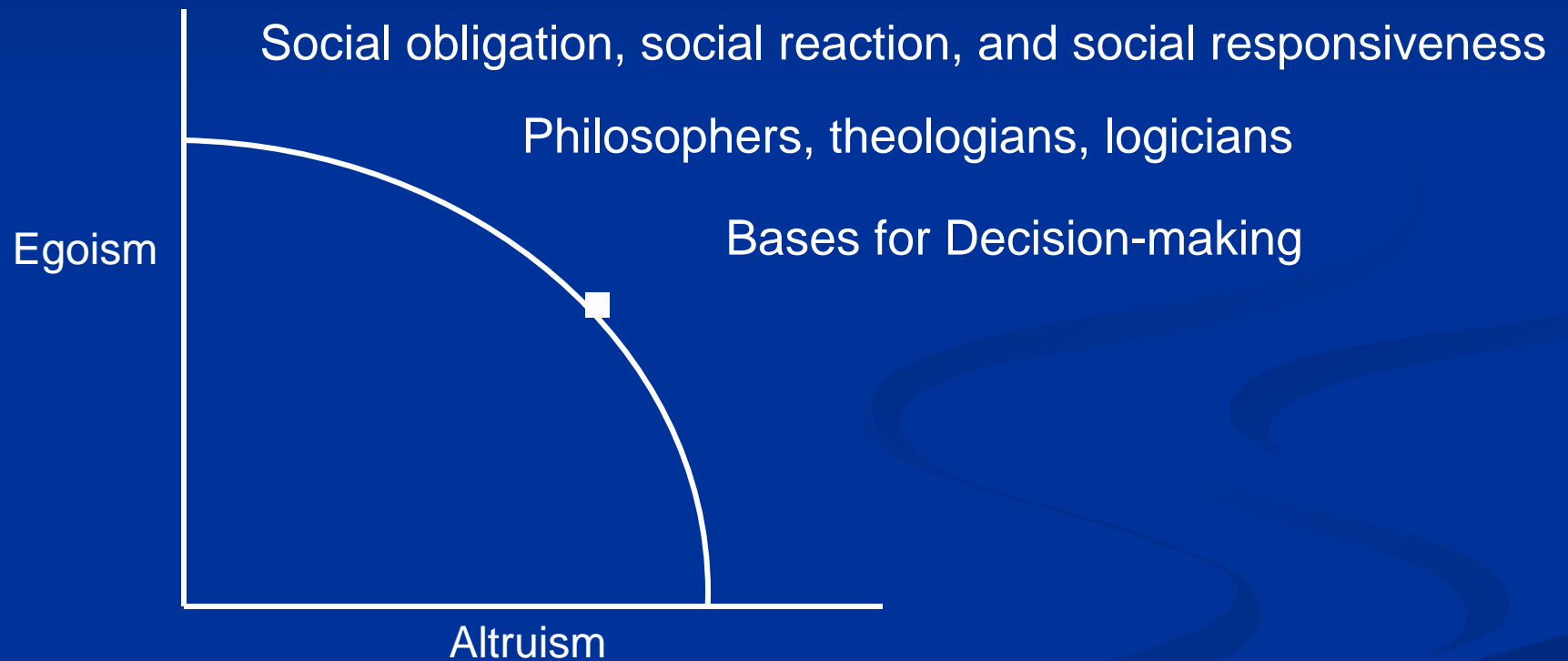
- Decision making:
  - A dynamic process, depends on manager's values, propensity for risk, potential for dissonance
- Planning:
  - Objectives, priorities, time-frame, conflicts, and resources
- Control:
  - Information, standards, corrective action

# Organization Management Levels





# Social and Ethical Responsibilities



# Empirical Evidence: Status of the Globe

- Corporate scandals involving major international multimillion dollar companies.
- Corruption, bribery, cheating
- Money laundering
- Insurance
- Mutual Funds

Why? Boils down to lack of ethics, and moral values

# Conclusion

- This is the only planet that can sustain life. It is currently threatened by human activity.
- We have to coexist with all of the other components of the earth's dynamic system.
- We need to understand the interrelationship between and constraints of the parts of the system. Failure to do so, may render the whole system out of equilibrium, with disastrous consequences for all.

# Conclusion (cont.)

- Energy and minerals are the foundations of any civilization. The consequences for mineral development are far-reaching and unpredictable (generational, environmental).
- Environmental resources are a public good. As population increases, mineral demand, and environmental impacts may also increase. A right balance is required.
- Cooperative/collaborative research between academic institutions, mining organizations, and NGOs, will promote sustainability, through engineering, science, and technology.

## Conclusion (cont.)

- A dependable, competent, knowledgeable, ethical, moral HR base is a first prerequisite to SD
- Multidisciplinary knowledge in engineering, science, social sciences, and humanities is important.

