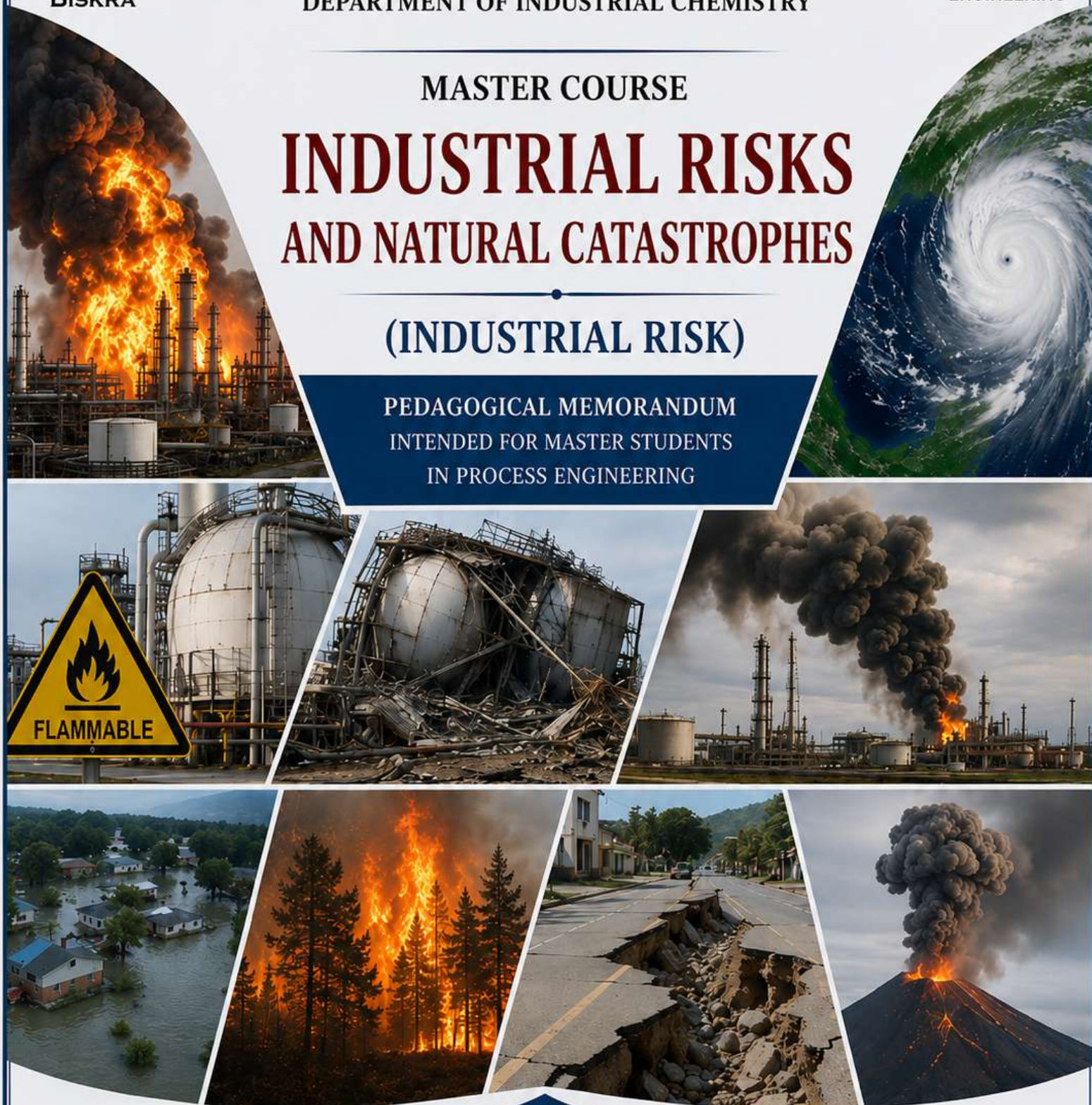


MASTER COURSE

INDUSTRIAL RISKS AND NATURAL CATASTROPHES

(INDUSTRIAL RISK)

PEDAGOGICAL MEMORANDUM
INTENDED FOR MASTER STUDENTS
IN PROCESS ENGINEERING



PREPARED BY:
Dr. KALTOUM ADAIKA



ACADEMIC YEAR:
2025 – 2026

Ministry of Higher Education and Scientific Research

“Mohamed Khider University of Biskra”

Faculty of Sciences and Technology

Department of Industrial Chemistry

MASTER COURSE

PROCESS ENGINEERING

INDUSTRIAL RISKS AND NATURAL CATASTROPHES

Prepared by:

Dr. KALTOUM ADAIKA

Intended for Master Students in Process Engineering

Academic Year:

2025 – 2026

TABLE OF CONTENTS

- General Introduction
- **Chapter I: Fundamentals of Industrial Risk**
 - I.1 Definition of Industrial Risk
 - I.2 Hazard and Risk Concepts
 - I.3 Classification of Industrial Risks
 - I.4 Industrial Accident Sources
 - I.5 Fire and Explosion Risks
 - I.6 Toxic and Environmental Risks
 - I.7 Human and Organizational Factors
 - I.8 Risk Assessment Methodologies
 - I.9 HAZOP Method
 - I.10 FMEA Method
 - I.11 Fault Tree Analysis
 - I.12 Event Tree Analysis
 - I.13 Quantitative Risk Assessment
 - I.14 Industrial Safety Management
 - I.15 Safety Barriers
 - I.16 International Regulations and Standards
 - I.17 Industrial Disaster Case Studies
 - I.18 Modern Technologies in Risk Prevention
 - I.19 Sustainable Industry and Industrial Safety

- General Conclusion
- Glossary
- List of Tables
- List of Figures
- Bibliographical Ref

I. GENERAL INTRODUCTION

Industrial activities play a central role in modern economic development. Chemical industries, petrochemical facilities, energy production systems, pharmaceutical manufacturing, and advanced industrial processes contribute significantly to technological progress and social welfare. However, these industrial activities involve numerous hazards capable of causing severe human, environmental, and economic consequences.

The increasing complexity of industrial systems, combined with the use of hazardous substances under high pressure and temperature conditions, has considerably increased the necessity for efficient industrial risk management.

Industrial risk engineering has therefore become one of the most important scientific disciplines in Process Engineering. Its primary objectives are:

- prevention of industrial accidents,
- reduction of accident probability,
- minimization of consequences,
- protection of workers and populations,
- environmental preservation,
- enhancement of industrial reliability and sustainability.

Industrial risk management integrates multidisciplinary scientific approaches including:

- process safety,
- reliability engineering,
- occupational safety,
- environmental engineering,
- human factors engineering,

- crisis management.

This pedagogical memorandum aims to provide Master students in Process Engineering with advanced scientific knowledge concerning industrial risks, accident prevention methodologies, risk assessment tools, international safety regulations, and modern industrial safety management systems.

CHAPTER I

FUNDAMENTALS OF INDUSTRIAL RISK

I.1 Definition of Industrial Risk

Industrial risk may be defined as:

“The combination of the probability of occurrence of a hazardous industrial event and the severity of its consequences on humans, industrial installations, environment, and economic systems.”

Industrial risks are generally associated with:

- chemical industries,
- petrochemical plants,
- oil and gas facilities,
- nuclear installations,
- pharmaceutical industries,
- food industries,
- energy production systems.

The concept of industrial risk combines two essential parameters: 1. Probability of occurrence, 2. Severity of consequences.

The mathematical representation of risk is generally expressed by:

[Risk = Probability Consequence]

The higher the probability or severity, the greater the industrial risk.

I.2 Hazard and Risk Concepts

I.2.1 Definition of Hazard

A hazard is any source or situation capable of causing:

- injury,
- illness,
- death,
- environmental damage,
- equipment destruction,
- production interruption.

Examples of Industrial Hazards

Hazard Type	Example
Chemical hazard	Chlorine leakage
Mechanical hazard	Rotating turbines
Thermal hazard	High-temperature furnaces
Electrical hazard	High-voltage systems
Biological hazard	Bacterial contamination
Radiological hazard	Nuclear radiation

I.2.2 Difference Between Hazard and Risk

A hazard represents the dangerous potential, whereas risk represents the probability that this danger will actually produce harmful effects.

Example

Gasoline is hazardous because it is flammable.

However, the associated risk depends on:

- quantity stored,
- temperature,
- ventilation conditions,
- ignition sources,
- operator behavior.

I.3 Classification of Industrial Risks

Industrial risks can be classified according to their origin and nature.

I.3.1 Chemical Risks

Chemical risks are associated with hazardous substances capable of generating:

- toxicity,
- flammability,
- corrosivity,
- reactivity,
- explosiveness.

Types of Chemical Hazards

a) Toxic Substances

Toxic substances may enter the human body through:

- inhalation,
- ingestion,
- skin absorption.

Acute Toxicity

Immediate effects after short exposure.

Chronic Toxicity

Long-term effects after repeated exposure.

b) Flammable Substances

Flammable substances can ignite under specific conditions.

Examples:

- methane,
- propane,
- gasoline vapors,
- hydrogen.

c) Corrosive Substances

Examples:

- sulfuric acid,
- hydrochloric acid,

- sodium hydroxide.

Consequences:

- material degradation,
- skin burns,
- equipment corrosion.

I.3.2 Mechanical Risks

Mechanical risks originate from:

- moving machines,
- conveyors,
- turbines,
- rotating shafts,
- pressurized systems.

Main Mechanical Injuries

Injury Type	Description
Crushing	Compression injuries
Cutting	Blade-related injuries
Entanglement	Rotating equipment accidents
Impact	Falling object injuries

I.3.3 Electrical Risks

Electrical hazards include:

- electric shocks,
- electrocution,

- arc flash,
- electrical burns,
- fire initiation.

Preventive Measures

- grounding systems,
- insulation,
- lockout/tagout procedures,
- protective equipment.

I.3.4 Thermal Risks

Thermal hazards are associated with:

- boilers,
- furnaces,
- steam systems,
- molten metals.

Consequences include:

- burns,
- heat stress,
- thermal explosions.

I.4 Industrial Accident Sources

Industrial accidents generally result from multiple interacting factors.

I.4.1 Human Errors

Human factors constitute one of the principal causes of industrial accidents.

Types of Human Errors

Error Type	Description
Skill-based error	Operational mistake
Rule-based error	Incorrect procedure application
Knowledge-based error	Lack of expertise

I.4.2 Technical Failures

Technical failures may result from:

- corrosion,
- fatigue,
- aging,
- manufacturing defects,
- overpressure.

I.4.3 Organizational Failures

Examples:

- poor safety culture,
- insufficient training,
- inadequate maintenance,
- communication deficiencies.

I.5 Fire and Explosion Risks

I.5.1 Fire Definition

Fire is a rapid oxidation reaction producing:

- heat,
- flames,
- smoke.

I.5.2 Fire Triangle

The fire triangle includes:

- fuel,
- oxidizer,
- ignition source.

Without one of these elements, combustion cannot occur.

I.5.3 Explosion Risks

Explosion is defined as: > “A sudden release of energy generating pressure waves.”

Types of Explosions

Explosion Type	Description
Physical explosion	Pressure vessel rupture
Chemical explosion	Rapid combustion
Dust explosion	Combustible powder ignition

I.6 Toxic and Environmental Risks

Industrial toxic releases may contaminate:

- atmosphere,
- groundwater,
- rivers,
- soils.

Consequences include:

- human poisoning,
- ecosystem destruction,
- long-term environmental degradation.

I.7 Human and Organizational Factors

Modern industrial safety strongly depends on:

- operator competence,
- safety culture,
- leadership,
- communication quality,
- stress management.

Poor organizational culture often contributes to major industrial disasters.

I.8 Risk Assessment Methodologies

Risk assessment is a systematic scientific process involving: 1. hazard identification, 2. probability analysis, 3. consequence evaluation, 4. risk reduction.

I.8.1 Preliminary Hazard Analysis (PHA)

Used during early project stages.

Advantages:

- rapid implementation,
- simple methodology,
- low cost.

I.8.2 What-If Analysis

Based on hypothetical accident scenarios.

Examples:

- What if cooling fails?
- What if pressure increases?

I.8.3 HAZOP Method

HAZOP (Hazard and Operability Study) is one of the most important industrial risk analysis methods.

Main Guide Words

Guide Word	Meaning
No	Complete absence
More	Increase
Less	Decrease
Reverse	Opposite operation

I.9 Failure Mode and Effects Analysis (FMEA)

FMEA identifies:

- failure modes,
- causes,
- effects,
- corrective actions.

Risk Priority Number:

[RPN = Severity Occurrence Detection]

I.10 Fault Tree Analysis (FTA)

FTA is a deductive methodology used to determine accident causes using logical gates:

- AND gate,
- OR gate.

Applications:

- reliability engineering,
- accident investigation,
- safety analysis.

I.11 Quantitative Risk Assessment (QRA)

QRA quantitatively evaluates:

- individual risk,
- societal risk,
- accident frequencies,
- consequence severity.

Used extensively in:

- petrochemical industries,
- LNG facilities,
- refineries.

I.12 Industrial Safety Management Systems

Industrial safety management systems integrate:

- safety policies,
- operational procedures,
- audits,
- training,
- emergency planning.

ISO 45001 Standard

International standard for occupational health and safety management systems.

Main principles:

- continuous improvement,
- worker participation,
- risk-based approach.

I.13 Major Industrial Disaster Case Studies

I.13.1 Bhopal Disaster (India, 1984)

Causes

- methyl isocyanate leakage,
- poor maintenance,
- inadequate safety systems.

Consequences

- thousands of deaths,
- long-term contamination.

I.13.2 Chernobyl Accident (1986)

Causes

- reactor instability,
- operational errors.

Consequences

- radioactive contamination,
- environmental disaster.

I.13.3 Texas City Refinery Explosion (2005)

Causes

- hydrocarbon vapor release,
- deficient safety procedures.

I.14 Modern Technologies in Industrial Safety

Modern industrial safety integrates:

- artificial intelligence,
- IoT sensors,
- predictive maintenance,
- digital twins,
- real-time monitoring systems.

Advantages:

- early failure detection,
- accident prediction,
- optimization of maintenance operations.

GENERAL CONCLUSION

Industrial risk management represents a strategic discipline in modern Process Engineering. Industrial safety is no longer limited to technical protection systems but includes:

- human reliability,
- organizational excellence,
- environmental responsibility,
- technological innovation.

Future industrial systems will increasingly rely on:

- smart industries,
- artificial intelligence,
- predictive safety,
- sustainable engineering approaches.

The integration of advanced risk management methodologies is essential for ensuring safe, reliable, and sustainable industrial development.

GLOSSARY

Term	Definition
Hazard	Source of potential harm
Risk	Probability × consequence
HAZOP	Hazard and Operability Study
FMEA	Failure Mode and Effects Analysis
QRA	Quantitative Risk Assessment

Term	Definition
PPE	Personal Protective Equipment

DETAILED BIBLIOGRAPHICAL REFERENCES

BOOKS

1. Crawl, Daniel A.; Louvar, Joseph F.
Chemical Process Safety: Fundamentals with Applications.
4th Edition.
Pearson Education, Boston, USA, 2019.
ISBN: 978-0134811283.
-
2. Lees, Frank P.
Lees' Loss Prevention in the Process Industries: Hazard Identification, Assessment and Control.

4th Edition.
Elsevier Butterworth-Heinemann, Oxford, United Kingdom, 2012.

3. Mannan, Sam.
Lees' Process Safety Essentials: Hazard Identification, Assessment and Control.
Elsevier, Amsterdam, Netherlands, 2014.
-

4. Kletz, Trevor.
Learning from Accidents.
4th Edition.
Gulf Professional Publishing, Houston, USA, 2001.
-

5. Casal, Joaquim.
Evaluation of the Effects and Consequences of Major Accidents in Industrial Plants.
2nd Edition.
Elsevier, Amsterdam, Netherlands, 2018.
-

SCIENTIFIC ARTICLES

6. Khan, Faisal I.; Abbasi, S. A.
"Major accidents in process industries and an analysis of causes and consequences."
Journal of Loss Prevention in the Process Industries,
Vol. 14, No. 3, pp. 187–198, 2001.
-

7. Reniers, Genserik; Cozzani, Valerio.
"Domino Effects in the Process Industries."
Elsevier Science Publishing, 2013.
-

8. Amyotte, Paul.
"An Introduction to Dust Explosions."
Process Safety Progress,
Vol. 25, Issue 2, pp. 95–99, 2006.
-

9. Paltrinieri, Nicola; Khan, Faisal.
"Dynamic Risk Analysis in the Chemical and Petroleum Industry."
Elsevier, 2016.
-

INTERNATIONAL STANDARDS

10. ISO 45001:2018.

Occupational Health and Safety Management Systems — Requirements with Guidance for Use.

International Organization for Standardization (ISO), Geneva, Switzerland, 2018.

11. ISO 31000:2018.

Risk Management — Guidelines.

International Organization for Standardization (ISO), Geneva, Switzerland, 2018.

12. IEC 61511.

Functional Safety — Safety Instrumented Systems for the Process Industry Sector.

International Electrotechnical Commission, Geneva, Switzerland.

13. OSHA 29 CFR 1910.119.

Process Safety Management of Highly Hazardous Chemicals.

Occupational Safety and Health Administration, USA.

14. Seveso III Directive (2012/18/EU).

European Parliament and Council Directive on the Control of Major-Accident Hazards Involving Dangerous Substances.

Official Journal of the European Union, 2012.

CHAPTER II

NATURAL DISASTERS

(Catastrophes Naturelles)

TABLE OF CONTENTS

- II.1 General Introduction
- II.2 Definition of Natural Disasters

- II.3 Difference Between Natural Hazard and Natural Disaster
- II.4 Classification of Natural Disasters
- II.5 Geological Disasters
- II.6 Hydrological Disasters
- II.7 Meteorological Disasters
- II.8 Climatic Disasters
- II.9 Biological Disasters
- II.10 Technological-Natural Interactions (NaTech Events)
- II.11 Causes of Natural Disasters
- II.12 Environmental and Human Factors
- II.13 Impacts of Natural Disasters
- II.14 Natural Disaster Risk Assessment
- II.15 Vulnerability and Exposure Analysis
- II.16 Prevention and Mitigation Measures
- II.17 Monitoring and Early Warning Systems
- II.18 Emergency Management and Crisis Response
- II.19 Natural Disaster Management in Industrial Areas
- II.20 Climate Change and Disaster Intensification
- II.21 International Regulations and Frameworks
- II.22 Case Studies of Major Natural Disasters

- II.23 Modern Technologies in Disaster Prediction
- II.24 Sustainable Development and Disaster Reduction
- General Conclusion
- Glossary
- Detailed Bibliographical References

TABLE OF CONTENTS

- General Introduction
- Chapter II: Natural Disasters
 - II.1 Definitions and Fundamental Concepts

- II.2 Classification of Natural Disasters
- II.3 Geological Disasters
- II.4 Climatic and Meteorological Disasters
- II.5 Hydrological Disasters
- II.6 Biological Disasters
- II.7 Environmental and Ecological Consequences
- II.8 Human and Economic Impacts
- II.9 Vulnerability and Risk Assessment
- II.10 Disaster Prevention and Mitigation
- II.11 Early Warning Systems
- II.12 Crisis and Emergency Management
- II.13 Climate Change and Natural Disasters
- II.14 Natural Disasters in Algeria
- II.15 Flood Risks in Algeria
- II.16 Earthquake Risks in Algeria
- II.17 Desertification and Drought in Algeria
- II.18 Forest Fires in Algeria
- II.19 Algerian Disaster Management Policies
- II.20 Sustainable Development and Disaster Reduction
- General Conclusion
- Glossary

- List of Tables and Figures
 - Bibliographical References
-

GENERAL INTRODUCTION

Natural disasters constitute one of the most serious threats affecting modern societies. Their frequency and intensity have significantly increased during recent decades due to climate change, environmental degradation, rapid urbanization, demographic growth, and ecosystem instability.

Natural catastrophes generate severe consequences on:

- human populations,
- infrastructure,
- industrial systems,
- agriculture,
- water resources,
- ecosystems,
- national economies.

For Process Engineering students, understanding natural disasters is essential because industrial facilities are frequently exposed to natural hazards such as:

- earthquakes,
- floods,
- storms,
- wildfires,
- droughts,
- extreme temperatures.

Natural disasters may also trigger technological accidents known as: > “NaTech Accidents” (Natural Hazard Triggering Technological Disasters).

Examples include:

- chemical leakage after earthquakes,
- refinery explosions during floods,
- toxic releases caused by storms.

This chapter aims to provide advanced scientific knowledge concerning:

- natural disaster mechanisms,

- classification,
 - risk assessment,
 - environmental impacts,
 - prevention strategies,
 - Algerian natural disaster challenges.
-

CHAPTER II

NATURAL DISASTERS

II.1 Definitions and Fundamental Concepts

II.1.1 Definition of Natural Disaster

A natural disaster may be defined as:

“A sudden or progressive natural event causing severe disruption to human societies, environmental systems, infrastructures, and economic activities.”

Natural disasters exceed the affected community’s capacity to respond using its own resources.

II.1.2 Difference Between Hazard and Disaster

Natural Hazard

A potentially dangerous natural phenomenon.

Examples:

- earthquake,
- volcanic eruption,
- cyclone.

Natural Disaster

Occurs when the hazard affects vulnerable populations and infrastructures.

II.1.3 Disaster Risk Concept

Disaster risk depends on:

- hazard intensity,
- exposure,
- vulnerability,
- resilience capacity.

The risk relationship can be simplified as:

[Disaster Risk = Hazard Vulnerability Exposure]

II.2 Classification of Natural Disasters

Natural disasters are classified into several categories.

II.2.1 Geological Disasters

Associated with geological processes.

Types

a) Earthquakes

Sudden release of energy within the Earth's crust.

b) Volcanic Eruptions

Emission of lava, ash, and gases.

c) Landslides

Movement of rocks and soil masses.

d) Tsunamis

Large sea waves generated by underwater disturbances.

II.2.2 Meteorological Disasters

Related to atmospheric conditions.

Types

Disaster	Description
Cyclones	Rotating tropical storms
Tornadoes	Violent rotating air columns
Heat waves	Prolonged extreme temperatures
Cold waves	Severe temperature decrease

II.2.3 Hydrological Disasters

Associated with water systems.

Examples

- floods,
 - flash floods,
 - coastal flooding,
 - mudflows.
-

II.2.4 Climatological Disasters

Long-duration climate-related events.

Examples:

- droughts,
 - desertification,
 - forest fires.
-

II.2.5 Biological Disasters

Generated by biological agents.

Examples:

- epidemics,

- pandemics,
 - invasive species,
 - crop diseases.
-

II.3 Geological Disasters

II.3.1 Earthquakes

An earthquake is the sudden release of accumulated tectonic energy.

Causes of Earthquakes

- tectonic plate movement,
 - volcanic activity,
 - fault rupture.
-

Seismic Waves

Wave Type	Characteristics
P waves	Primary compression waves
S waves	Secondary shear waves
Surface waves	Most destructive

Earthquake Effects

- ground shaking,
 - infrastructure collapse,
 - fires,
 - tsunamis,
 - industrial accidents.
-

II.3.2 Volcanic Eruptions

Volcanic eruptions release:

- lava,
 - ash,
 - toxic gases,
 - pyroclastic materials.
-

Consequences

- atmospheric pollution,
 - destruction of ecosystems,
 - aviation hazards,
 - respiratory diseases.
-

II.4 Climatic and Meteorological Disasters

II.4.1 Cyclones and Hurricanes

Cyclones are intense atmospheric systems characterized by:

- strong winds,
 - heavy rainfall,
 - low atmospheric pressure.
-

Main Consequences

- flooding,
 - coastal destruction,
 - power outages,
 - industrial damage.
-

II.4.2 Heat Waves

Heat waves are prolonged periods of extremely high temperatures.

Impacts

- dehydration,
 - heat strokes,
 - agricultural losses,
 - energy crises.
-

II.5 Hydrological Disasters

II.5.1 Floods

Floods are among the most frequent natural disasters worldwide.

Causes

- heavy rainfall,
 - river overflow,
 - dam failure,
 - urban drainage insufficiency.
-

Types of Floods

Type	Characteristics
River floods	Overflowing rivers
Flash floods	Sudden flooding
Coastal floods	Sea water invasion

Consequences

- population displacement,
 - infrastructure destruction,
 - water contamination,
 - industrial accidents.
-

II.6 Biological Disasters

Biological disasters involve:

- infectious diseases,
- pandemics,
- agricultural infestations.

Examples:

- COVID-19,
 - cholera,
 - avian influenza.
-

II.7 Environmental and Ecological Consequences

Natural disasters severely affect ecosystems.

Main Environmental Impacts

- soil erosion,
 - biodiversity loss,
 - water pollution,
 - forest destruction,
 - habitat degradation.
-

II.8 Human and Economic Impacts

Natural disasters generate:

- deaths,
 - injuries,
 - homelessness,
 - unemployment,
 - economic recession.
-

Economic Losses

Include:

- infrastructure repair,
 - industrial shutdown,
 - agricultural losses,
 - insurance costs.
-

II.9 Vulnerability and Risk Assessment

II.9.1 Vulnerability

Vulnerability refers to the susceptibility of populations and systems to damage.

Types of Vulnerability

Type	Description
Physical vulnerability	Infrastructure fragility
Social vulnerability	Poverty and inequality
Environmental vulnerability	Ecosystem degradation

II.10 Disaster Prevention and Mitigation

Disaster mitigation aims to reduce disaster impacts.

Preventive Measures

- land-use planning,
 - seismic-resistant buildings,
 - flood barriers,
 - environmental protection,
 - public awareness.
-

II.11 Early Warning Systems

Early warning systems include:

- monitoring networks,
- communication systems,
- evacuation planning.

Examples:

- tsunami warning systems,
 - meteorological forecasting,
 - seismic monitoring.
-

II.12 Crisis and Emergency Management

Emergency management includes: 1. Preparedness, 2. Response, 3. Recovery, 4. Reconstruction.

II.13 Climate Change and Natural Disasters

Climate change increases:

- extreme weather events,
 - drought frequency,
 - flood intensity,
 - heat waves,
 - forest fires.
-

II.14 Natural Disasters in Algeria

Algeria is exposed to multiple natural hazards due to:

- geographical diversity,
- Mediterranean climate,
- seismic activity,
- desertification processes.

Main natural disasters in Algeria:

- earthquakes,
 - floods,
 - droughts,
 - forest fires,
 - desertification.
-

II.15 Flood Risks in Algeria

Flooding represents one of the most damaging disasters in Algeria.

Major Flood Events

Bab El Oued Floods (2001)

Located in [\[“city”, “Algiers”, “Algeria”\]](#).

Consequences:

- more than 700 deaths,
 - severe infrastructure destruction.
-

Causes

- intense rainfall,
 - poor urban drainage,
 - uncontrolled urbanization.
-

II.16 Earthquake Risks in Algeria

Algeria is located in a seismically active region.

Major Earthquakes

El Asnam Earthquake (1980)

Located in [\[“city”, “Chlef”, “Algeria”\]](#).

Magnitude:

- 7.3 Richter scale.

Consequences:

- thousands of victims,
 - major urban destruction.
-

Boumerdes Earthquake (2003)

Located in [entity](#) [\[“city”, “Boumerdès”, “Algeria”\]](#).

Consequences:

- infrastructure collapse,
 - industrial damage,
 - fatalities.
-

II.17 Desertification and Drought in Algeria

Algeria faces severe desertification risks due to:

- climate aridity,
 - overgrazing,
 - deforestation,
 - water scarcity.
-

Consequences

- agricultural degradation,
 - rural migration,
 - ecosystem instability.
-

II.18 Forest Fires in Algeria

Forest fires frequently affect northern Algeria.

Main Causes

- heat waves,

- drought,
 - human negligence,
 - climate change.
-

Consequences

- biodiversity destruction,
 - air pollution,
 - economic losses.
-

II.19 Algerian Disaster Management Policies

Algeria has implemented several disaster management strategies:

- civil protection systems,
 - seismic construction regulations,
 - flood prevention plans,
 - environmental protection policies.
-

II.20 Sustainable Development and Disaster Reduction

Sustainable development contributes to disaster reduction through:

- environmental protection,
 - resilient infrastructure,
 - renewable energy,
 - ecosystem preservation.
-

GENERAL CONCLUSION

Natural disasters constitute major challenges for sustainable development and industrial safety. Their impacts are amplified by:

- climate change,
- environmental degradation,
- rapid urbanization,
- population growth.

For Process Engineers, understanding natural disaster mechanisms and prevention strategies is essential for:

- protecting industrial installations,
- reducing technological accidents,
- improving resilience,
- ensuring environmental sustainability.

Algeria remains particularly vulnerable to:

- earthquakes,
- floods,
- droughts,
- forest fires.

Therefore, strengthening:

- scientific research,
- early warning systems,
- risk management strategies,
- sustainable planning,

is fundamental for reducing future disaster impacts.

GLOSSARY

Term	Definition
Hazard	Potentially dangerous phenomenon
Vulnerability	Susceptibility to damage
Resilience	Recovery capacity
Flood	Overflow of water
Earthquake	Sudden crustal energy release
Drought	Long-term water deficiency

DETAILED BIBLIOGRAPHICAL REFERENCES

BOOKS

2. Alexander, David.
Natural Disasters.
Springer Science & Business Media, Dordrecht, Netherlands, 1993.
3. Bryant, Edward.
Natural Hazards.
2nd Edition.
Cambridge University Press, Cambridge, United Kingdom, 2005.
4. Keller, Edward A.; DeVecchio, Duane E.
Natural Hazards: Earth's Processes as Hazards, Disasters, and Catastrophes.
4th Edition.
Routledge, New York, USA, 2019.
5. Smith, Keith.
Environmental Hazards: Assessing Risk and Reducing Disaster.
6th Edition.
Routledge, London, United Kingdom, 2013.
6. Wisner, Ben et al.
At Risk: Natural Hazards, People's Vulnerability and Disasters.
2nd Edition.
Routledge, London, 2004.

SCIENTIFIC ARTICLES

7. UNDRR (United Nations Office for Disaster Risk Reduction).
Global Assessment Report on Disaster Risk Reduction.
United Nations Publications, Geneva, Switzerland, 2022.
8. IPCC.
Climate Change 2021: The Physical Science Basis.
Intergovernmental Panel on Climate Change, Cambridge University Press, 2021.

9. Mimouni, Z.; et al.
“Flood Risk Assessment in Algeria.”
Arabian Journal of Geosciences, Vol. 13, 2020.

10. Bensaibi, M.; et al.
“Seismic Risk in Northern Algeria.”
Natural Hazards Journal, Springer, 2018.

11. FAO.
Desertification in North Africa.
Food and Agriculture Organization Reports, Rome, Italy, 2019.

INTERNATIONAL REPORTS AND STANDARDS

12. United Nations Disaster Risk Reduction Framework (Sendai Framework 2015–2030).
13. World Meteorological Organization (WMO) Disaster Reports.
14. UNESCO Natural Disaster Prevention Publications.
15. World Bank Climate Risk Country Profile: Algeria.
16. Algerian National Office of Meteorology Reports.