Allama Iqbal Open University
Solved Assignments Spring 2026

Course Code:	**1421/5443 Code**
Course Name:	**Introduction to Environmental Science**
Class:	**BS/BA**
Total Credit Hours	**3**
Total Assignments	**2**

Assignment 1

Q. 1 Explain how Environmental Science integrates knowledge from natural sciences, social sciences, and humanities to address environmental issues, providing examples.

Environmental science is the systematic study of our environment and our proper place in it. It is highly interdisciplinary and multidisciplinary, meaning it does not rely on a single field of study but rather integrates knowledge from natural sciences, social sciences, and humanities to understand and solve environmental problems. This holistic approach is essential because environmental issues are complex and involve not only physical and biological processes but also human behavior, economics, and cultural values.

Integration of Natural Sciences:
Natural sciences form the core of environmental science. Disciplines such as chemistry, physics, biology, geology, and ecology help us understand the natural processes that operate in the world. For example:

- **Chemistry and biology** help us understand how pollutants react in the air and water, and how they affect living organisms.
- **Ecology** provides knowledge about energy flow, nutrient cycling, and species interactions within ecosystems.
- **Earth sciences** (geology, meteorology) explain tectonic processes, weather patterns, and soil formation.

Integration of Social Sciences:
Social sciences such as economics, political science, sociology, and geography help address human dimensions of environmental problems. For instance:

- **Economics** is used to analyze the costs of environmental degradation (e.g., pollution costing Pakistan's economy 6% of GDP) and to design market-based solutions.
- **Political science** helps formulate environmental policies and international agreements (e.g., banning CFCs to protect the ozone layer).
- **Sociology** examines how population growth, poverty, and consumption patterns drive environmental degradation.

Integration of Humanities:
Humanities, including philosophy, ethics, history, and religion, shape our attitudes and values toward nature. For example:

- **Environmental ethics** explores whether humans have a moral duty to protect nature. The book discusses anthropocentric (human-centered), biocentric (life-centered), and ecocentric (ecosystem-centered) worldviews.
- **Religious perspectives**, such as the Islamic concept of trusteeship (man as a caretaker of Allah's creation), provide moral guidance for sustainable living.
- **History** teaches us how past civilizations collapsed due to soil erosion and deforestation, offering lessons for today.

Example:
To address the problem of water pollution in Pakistan, environmental scientists use natural sciences to test water quality (chemistry, biology), social sciences to design fair water pricing and regulations (economics, political science), and humanities to raise public awareness through education and ethical appeals about the right to clean water.

Thus, environmental science integrates diverse fields to understand, analyze, and solve environmental issues effectively.

Q. 2 Describe how levels of biological organization interact and contribute to ecosystem functioning.

In ecology, living organisms are organized into hierarchical levels. These levels interact with each other and with the non-living environment to maintain ecosystem functioning. The main levels of biological organization, from simplest to most complex, are: individual, population, community, ecosystem, and biosphere.

1. Individual:
An individual is any single living organism (e.g., a deer, a tree, a bacterium). Individuals interact directly with abiotic factors such as temperature, water, and sunlight, which limit their distribution and survival. For example, a plant individual may grow only where sufficient sunlight and water are available.

2. Population:
A population is a group of individuals of the same species living in a specific geographic area (e.g., all Chiltan markhor in Hazarganji-Chiltan National Park). Population size is affected by natality (births), mortality (deaths), immigration (individuals moving in), and emigration (individuals moving out). Populations interact with the environment by consuming resources and producing wastes.

3. Community:
A community includes all living organisms (populations of different species) in a particular area.

For example, a forest community contains trees, shrubs, insects, birds, and microbes. Communities have properties such as species diversity (number of different species), dominance (species that control the community), and trophic structure (feeding relationships). Interactions within a community include predation, competition, mutualism, and parasitism, all of which shape the community's composition and functioning.

4. Ecosystem:
An ecosystem includes both the living community and its non-living (abiotic) environment (soil, water, air, nutrients). It is the functional unit of ecology. Ecosystems function through energy flow and nutrient cycling:

- **Energy flow:** Solar energy is captured by producers (plants) via photosynthesis, then passed to consumers (herbivores, carnivores) and decomposers. Energy flows in one direction (sun → producers → consumers → decomposers) and is lost as heat at each step.
- **Nutrient cycling:** Elements like carbon, nitrogen, and phosphorus are recycled between living organisms and the environment through biogeochemical cycles.

5. Biosphere:
The biosphere is the global sum of all ecosystems. It is the zone of life on Earth, interacting with the atmosphere, lithosphere, and hydrosphere. The biosphere has evolved over billions of years and performs essential functions such as photosynthesis, respiration, decomposition, and nitrogen fixation.

Interaction and Contribution to Ecosystem Functioning:
These levels are interconnected. For example, a change in population size (overhunting of a predator) affects the community (prey population increases), which alters the ecosystem (overgrazing reduces plant cover), eventually impacting the biosphere (altered carbon cycle). Conversely, abiotic factors like rainfall influence individual survival, population density, community composition, and ecosystem productivity. Thus, the interaction among levels ensures the flow of energy and cycling of materials, which sustains life on Earth.

Q. 3 Describe the composition and structure of Earth's atmosphere.

The atmosphere is the protective blanket of gases surrounding the Earth. It sustains life, protects us from harmful cosmic and solar radiation, and regulates temperature. The atmosphere is composed of major gases, trace gases, and aerosols, and is divided into distinct layers based on temperature changes.

Composition of the Lower Atmosphere:

Gas	Symbol/Formula	Percent by Volume
Nitrogen	N_2	78.08%
Oxygen	O_2	20.94%
Argon	Ar	0.934%
Carbon dioxide	CO_2	0.035%
Neon	Ne	0.00182%
Helium	He	0.00052%
Methane	CH_4	0.00015%
Krypton	Kr	0.00011%
Hydrogen	H_2	0.00005%
Nitrous oxide	N_2O	0.00005%
Xenon	Xe	0.000009%

- **Major Gases:** Nitrogen (78%) is largely inert. Oxygen (21%) is required for respiration and is highly reactive. Argon (0.93%) is a noble gas, also inert.
- **Trace Gases:** Carbon dioxide (0.035%) is a greenhouse gas essential for photosynthesis. Water vapor (0–4%) drives the hydrologic cycle and weather. Ozone (O_3) in the stratosphere absorbs harmful UV radiation. Aerosols (tiny particles like dust, smoke, sea salt) affect heat balance and cloud formation.

Structure of the Atmosphere (Vertical Layers):

1. **Troposphere (0–12 km):**
   - Contains over 80% of atmospheric mass and nearly all water vapor.
   - All weather phenomena occur here (clouds, rain, storms).
   - Temperature decreases with height (about 6.5°C per km).
2. **Tropopause:**
   - The boundary between troposphere and stratosphere.
   - Temperature remains fairly constant. Jet streams are found here.
3. **Stratosphere (12–50 km):**
   - Contains most of the ozone layer (15–35 km).
   - Temperature increases with height due to ozone absorbing UV radiation.
   - Polar stratospheric clouds (PSCs) play a role in ozone hole formation.
4. **Mesosphere (50–80 km):**
   - Temperature drops to about –100°C, the coldest region.
   - Meteoroids burn up in this layer.

5. **Thermosphere (80 km and above):**

- Temperature rises sharply (up to 2000°C) due to absorption of UV and X-ray radiation.
- Contains the Ionosphere (80–550 km), which reflects radio waves, and the Exosphere (550 km and beyond), where satellites orbit.

6. **Magnetosphere (from ~1000 km outward):**

- Not a layer of air but a region where Earth's magnetic field traps charged particles from the sun.

Ecological Significance:
The atmosphere's unique composition (free oxygen and water vapor) supports life. The greenhouse effect (water vapor, CO_2, methane) keeps Earth's surface about 33°C warmer than it would otherwise be. Ozone in the stratosphere protects life from harmful UV radiation. Thus, the atmosphere is essential for maintaining habitable conditions on Earth.

Q. 4 Discuss the tectonic processes that shape the Earth's surface.

Tectonic processes are driven by the immense heat and movement within the Earth's mantle. The lithosphere (the solid outer shell of the Earth) is broken into large segments called tectonic plates. These plates are in constant, slow motion (2–15 cm per year) due to convection currents in the mantle. The interactions between plates – moving apart, colliding, or sliding past each other – shape the Earth's surface, forming continents, mountains, ocean basins, volcanoes, and causing earthquakes.

Types of Plate Boundaries and Their Effects:

1. **Divergent Boundaries (Moving Apart):**

- Occur at oceanic ridges where plates move away from each other.
- New lithosphere is produced as magma rises from the mantle.
- On land, divergent boundaries create rift valleys (e.g., East African Rift).
- Oceans are born and grow wider at these boundaries.

2. **Convergent Boundaries (Moving Toward Each Other):**

- One plate moves beneath another in a process called subduction.
- Crust is destroyed and recycled back into the mantle.
- Three types of convergent boundaries:

- **Oceanic-Continental Convergence:** Dense oceanic plate subducts under continental plate, creating mountain ranges (e.g., Andes) and volcanoes.

- **Oceanic-Oceanic Convergence:** One oceanic plate subducts under another, forming deep ocean trenches and volcanic island arcs (e.g., Mariana Trench).
- **Continental-Continental Convergence:** Both plates are light, so neither subducts fully; instead, crust folds and pushes upward to form massive mountain ranges. The collision of the Indian Plate and Eurasian Plate created the Himalayas (including K-2, 8,610 m) and caused the 2005 Azad Kashmir earthquake.

3. **Transform Fault Boundaries (Sliding Past Each Other):**

- Plates slide horizontally past one another.
- Crust is neither created nor destroyed.
- These boundaries are marked by faults (e.g., San Andreas Fault in California) and cause frequent earthquakes.

Evidence and Examples:

- The movement of continents is called continental drift.
- The boundary between the Indian Plate and Eurasian Plate remains active, causing earthquakes in northern Pakistan.
- Volcanoes and earthquakes are concentrated along plate boundaries.
- Pakistan's Balochistan region has mud volcanoes (e.g., Chandragup, Neza e Sultan) formed by tectonic activity.

Tectonic Cycle and Other Cycles:
The tectonic cycle is part of the larger Geologic Cycle, which also includes the hydrologic cycle, rock cycle, and biogeochemical cycles. Tectonic processes provide water from volcanic activity and supply energy to form and change earth materials. They recycle crustal material over millions of years, shaping the landscape and influencing climate, soil formation, and the distribution of natural resources.

Q. 5 Describe the rock cycle and the formation of igneous, sedimentary, and metamorphic rocks.

The rock cycle is a continuous process of creation, destruction, and transformation of rocks on Earth. It is driven by internal forces (tectonic activity, heat, pressure) and external forces (weathering, erosion, transportation, deposition). There are three major rock types: igneous, sedimentary, and metamorphic. Each type can be transformed into another over geological time.

1. Igneous Rocks (Fire Rocks):

- **Formation:** Formed from the cooling and solidification of magma (underground) or lava (above ground).
- **Intrusive Igneous Rocks:** Magma cools slowly deep within the Earth, allowing large crystals to form. Example: Granite (mixture of quartz, feldspar, and mica).
- **Extrusive Igneous Rocks:** Lava cools quickly on the Earth's surface, forming fine-grained rocks. Example: Basalt.
- **Occurrence in Pakistan:** Granite, diorite, gabbro, dolerite, and peridotite are found in Dir, Swat, Chitral, Gilgit, Zhob, Chagai, Las Bela, and Nagarparkar.

2. Sedimentary Rocks (Secondary Rocks):

- **Formation:** Formed by the accumulation, compaction, and cementation of sediments (small pieces of rock, mineral grains, organic matter) over thousands to millions of years.
- **Process:** Weathering breaks down existing rocks; water, wind, or ice transport the fragments; layers build up in rivers, lakes, and oceans; pressure compresses lower layers into solid rock.
- **Three main types:**
  - **Clastic:** Accumulation of broken rock fragments (e.g., sandstone, shale).
  - **Chemical:** Formed when standing water evaporates, leaving dissolved minerals (e.g., rock salt, gypsum).
  - **Organic:** Accumulation of calcium-based shells or plant remains (e.g., limestone, coal).
- **Observation in Pakistan:** Sedimentary rock layers are visible in road cuts, such as in the Salt Range.

3. Metamorphic Rocks (Changed Form):

- **Formation:** Formed when existing igneous or sedimentary rocks are subjected to high temperature and pressure deep within the Earth. The original minerals change into new ones without melting.
- **Foliated (layered):** Compressed along one axis, creating bands or layers (e.g., slate from shale).
- **Non-foliated (non-layered):** Subjected to uniform pressure from all sides (e.g., marble from limestone or calcite).
- **Example in Pakistan:** Marble is widely found in NWFP, Northern Areas, Azad Kashmir, FATA, Balochistan, and northern Punjab. Pakistan is known for onyx (a high-quality decorative marble) in various colors (white, black, pink, green, camel, etc.).

The Rock Cycle Diagrammatically Explained:

1. Magma cools → **Igneous rocks**.
2. Igneous rocks are weathered, eroded, transported, and deposited → **Sedimentary rocks**.
3. Igneous or sedimentary rocks are subjected to heat and pressure → **Metamorphic rocks**.
4. Metamorphic rocks melt under extreme heat and pressure → **Magma** (cycle repeats).

In Pakistan, all three rock types are found. The Himalayan region contains metamorphic rocks (gneisses, slates, quartzite, marble). The rock cycle continuously recycles Earth's crustal materials, creating new rocks while destroying old ones, thus maintaining the dynamic nature of the lithosphere.