




Indus Ecoregion Education Kit Student's Workbook





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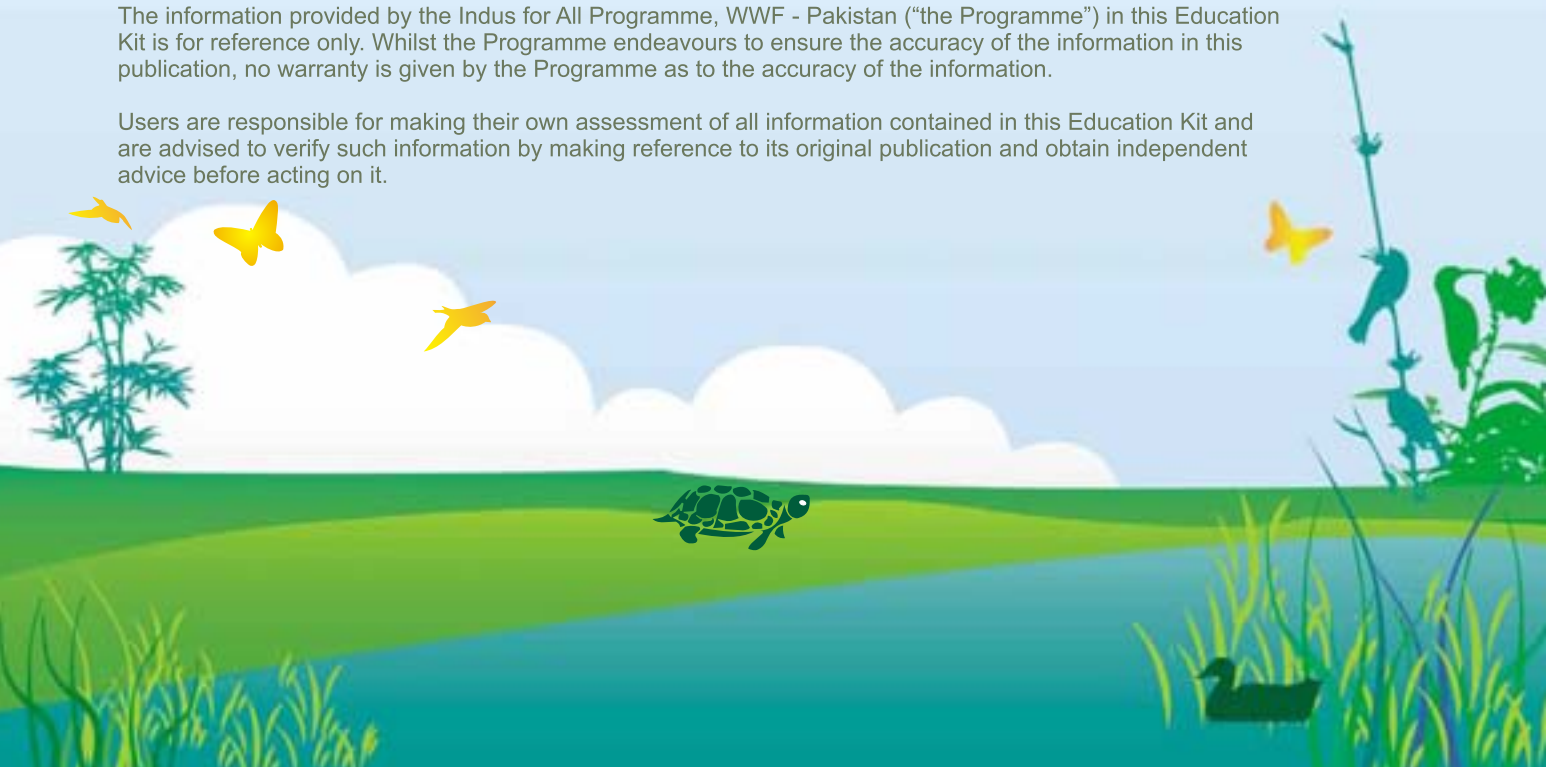
We acknowledge that some of the learning concepts and ideas for this Education Kit have been taken from a publication of Hong Kong Wetlands Park cited as below:

AFCD (2006). *Hong Kong Wetland Park Education Kit*. Hong Kong Wetland Park of Agriculture, Fisheries and Conservation Department, HKSAR Government.”

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About the Education Kit

How, where, when and who to use this kit?

Indus Ecoregion Education Kit-Students' Workbook, comprising numerous worksheets and other hands-on activities, aims to enhance knowledge and understanding on the Indus Ecoregion, associated ecosystems and natural resources.

The kit has been developed to cater to learning and awareness needs of schoolchildren between 7 and 14 years. A simple-to-complex learning approach has been adopted so that students of various grades can perform certain tasks or activities according to their level of understanding.

Initially, this education kit would be distributed among schoolchildren at four priority sites of the Indus for All Programme (Keti Bunder and Keenjhar Lake in Thatta district, Pai Forest in Shaheed Benazirabad district and Chotiari Wetlands Complex in Sanghar district). Moreover, it would be utilized in educating schoolchildren at various information and resource centres such as Wetlands Centre Sandspit Karachi, Keenjhar Conservation Information Centre, and Chotiari Conservation Information Centre.

The kit is best suited for multiple applications in full or parts. It can be utilized in environmental resource or information centres where some relevant workbooks can be used for doing various activities with students visiting such centres. For instance, it can be used to enhance students' understanding about a wetland ecosystem when a group of students visit a resource centre located at that particular wetland site.

Tips for Students

- ✎ Don't worry if you cannot answer a question or fill a worksheet. If so, move on to the next and try to do some other one.
- ✎ Seek guidance of your teachers or parents if you find something difficult.
- ✎ Don't remove and throw away the pages or worksheets, just keep them for your record even after completion of the activities.
- ✎ You can add more pages or worksheets from collection of your home work or class projects.
- ✎ If you find something interesting, for instance a drawing, a picture, a poster, a newspaper article etc, put it in your kit. Thus it can be your ENVIRONMENTAL COMPENDIUM.

Introduction

Why an Education Kit on the Indus Ecoregion?

In 1997 the World Wide Fund for Nature (WWF) with support of such organizations as the United Nation's Environment Programme and the National Geographic Society carried out an assessment of the earth's important ecosystems. Consequently 238 important areas known as ecoregions were identified. These are ecologically outstanding land and seascapes. Their analysis (report) was called Global 200 (G200) and was used to develop conservation programmes for these important habitats and ecosystems.

Of the 238 ecoregions, five are in Pakistan including the Tibetan Plateau, Western Himalayan Temperate Forests, Rann of Kutch, North Arabian Sea and the Indus Ecoregion. Of these, only the Indus Ecoregion lies fully within Pakistan, while the rest share their boundaries with the neighboring countries.

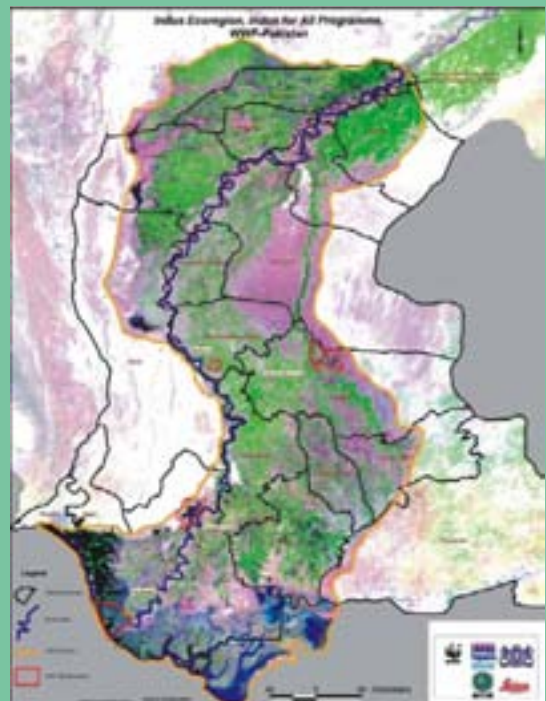
The Indus ecoregion lies in the lower Indus basin covering nearly 65% of the Sindh Province starting downward from Sukkur to Keti Bunder including Karachi. It consists of six distinct ecosystems, namely: marine, coastal, freshwater wetlands, desert, riverine and agricultural ecosystems. For each ecosystem the kit covers background information, various components, functions and values together with associated threats and call for actions

With the joint efforts of WWF-Pakistan and the Government of Sindh, a long-term conservation programme has been developed for the Indus Ecoregion.

Environmental education is a vital component of the Indus Ecoregion Programme and therefore, acknowledging the fact that educating youth and school children is a long-term investment in conservation initiatives, the Programme has launched a comprehensive environmental education campaign in schools. The campaign focuses on building competencies of schoolteachers, developing nature clubs and integrating environmental education in schools' curricula.

The education kit aims to:

- Enhance students' understanding about environment in general and various ecosystems of the Indus Ecoregion, in particular;
- Evolve a thinking process among school children to understand the functions and services of various ecosystems ;
- Provide useful information about various concepts of environment to be integrated with textbook topics for enriching the schools' curriculum; and
- Enable schoolchildren to initiate small research projects on various environmental themes.





Foreword

Educating children in environmental concepts is like investing in nature conservation. A greener generation is guarantee of a sustainable future. Therefore, WWF - Pakistan always puts a greater focus on school outreach programmes in all conservation initiatives.

This publication entitled "**Indus Ecoregion Education Kit- Students Workbook**" is a unique learning tool for schoolchildren to know about a region which has been marked as one of the most outstanding ecological areas in the world. The region is known as the Indus Ecoregion, comprising important ecosystems like mangrove and riverine forests, fresh and brackish water lakes, desert and irrigated landscapes.

To conserve the Indus Ecoregion, WWF - Pakistan is currently implementing a long-term conservation initiative Indus Ecoregion Programme. Under its first six-year implementation phase, known as the Indus for All Programme, numerous initiatives are underway to educate schoolchildren about environment and nature conservation. Formation of nature clubs in schools to involve students in environmental education activities is one of the examples.

I hope this Education Kit will be helpful for schoolchildren to learn about the Indus Ecoregion and its various ecosystems. The kit takes children through a learning process involving hands-on practices and various skills like reading, thinking, colouring, matching, etc. I believe, not only the schoolchildren but their parents and teachers would also like to use this kit to enrich school curriculum as well as to enhance their understanding about the environment.

Dr. Ghulam Akbar
Regional Director
WWF - Pakistan



Understanding & Global 200 & Indus Ecoregion

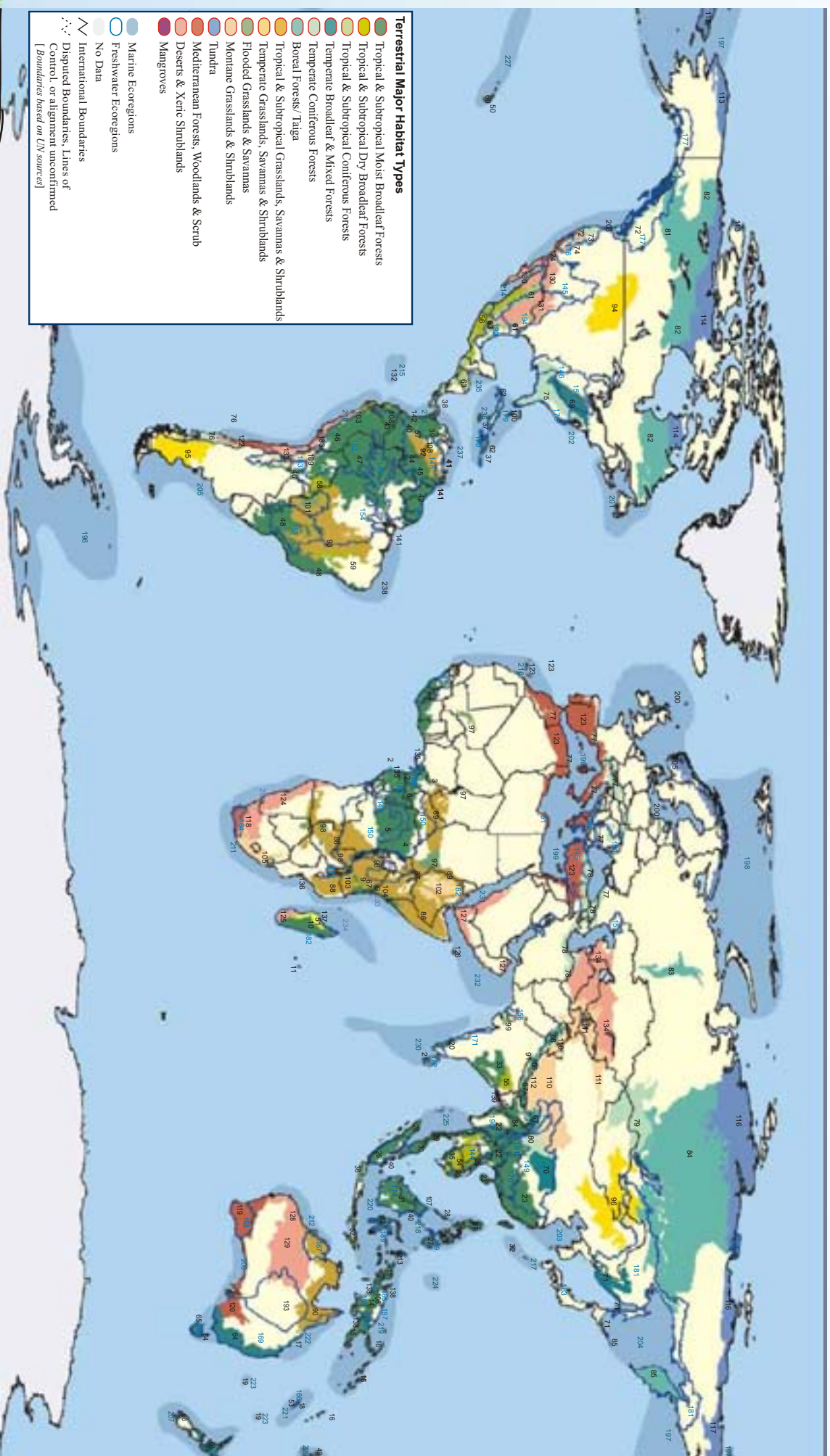


1.1 Do you know what Global 200 Ecoregions are?

The word “ecoregion” comes from:

- The Latin word 'oeco' meaning household, home, habitat or environment; and
- The Anglo-French word 'regiun' meaning a broad geographic area distinguished by similar features.

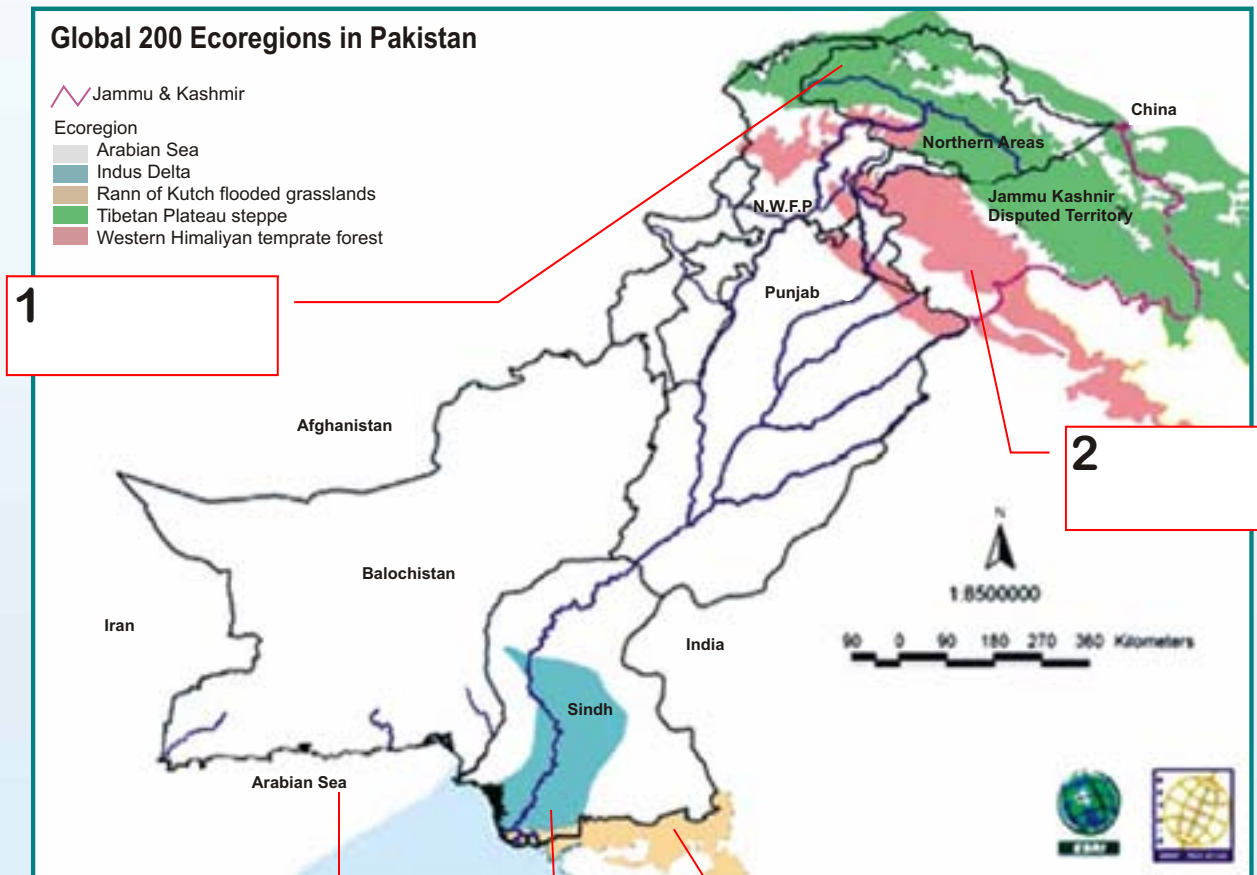
Therefore, the word 'ecoregion' literally means a large unit of land or water sheltering a separate group of species, people and environmental



1.2. Ecoregion in Pakistan

According to the Global 200 analysis, five ecoregions identified in Pakistan are: Tibetan Plateau, Western Himalayan Temperate Forests, Rann of Kutch, North Arabian Sea and the Indus Ecoregion. Out of these five, only the Indus Ecoregion lies fully within Pakistan, while the rest share their boundaries with the neighbouring countries.

1.2.1 Please look at the map of Pakistan and write the name of the ecoregion in the given text box:



1

2

3

4

5



1.2.2 Find Pakistan in the Global 200 map and see which habitat/ecosystem types have been marked:

1: _____ 2: _____ 3: _____

4: _____ 5: _____

1.2.3 Fill in the blank by using the following keywords for four of the five ecoregions in Pakistan:

Tibetan Plateau Rann of Kutch Western Himalayan Temperate Forests
North Arabian Sea Desert ecosystem Snow capped mountains and Alpine meadows
Iran
Marine ecosystem Gilgit-Baltistan Snow leopard Gilgit-Baltistan and Khyber-
Pakhtoonkhwa
Himalayan foothills Thar Desert Pakistan's coastal areas Temperate Forest Green
turtles



Name of Ecoregion

a

Location

Borders shared with

Unique feature of the area

Important species

Location

Borders shared with

Unique feature of the area

Important species



b

Name of Ecoregion

Location

Borders shared with

Unique feature of the area

Important species



c

Name of Ecoregion

Location

Borders shared with

Unique feature of the area

Important species



d

Name of Ecoregion

1.3. Indus Ecoregion

Among the five ecoregions in Pakistan, the Indus Ecoregion with its mineral-rich soil and the country's largest mangrove forests in the Indus delta is one of the important ecoregions. It is ranked as the 40th most significant ecoregion in the world. The Indus Ecoregion completely falls within the geographic boundaries of Pakistan. It covers approximately 65% of Sindh and is home to several unique species such as Gavia, Hog deer, Marsh crocodile, Blind Indus dolphin and Palla fish.

The ecoregion consists of six distinct ecosystems, each having unique species of animals and plants. These are:

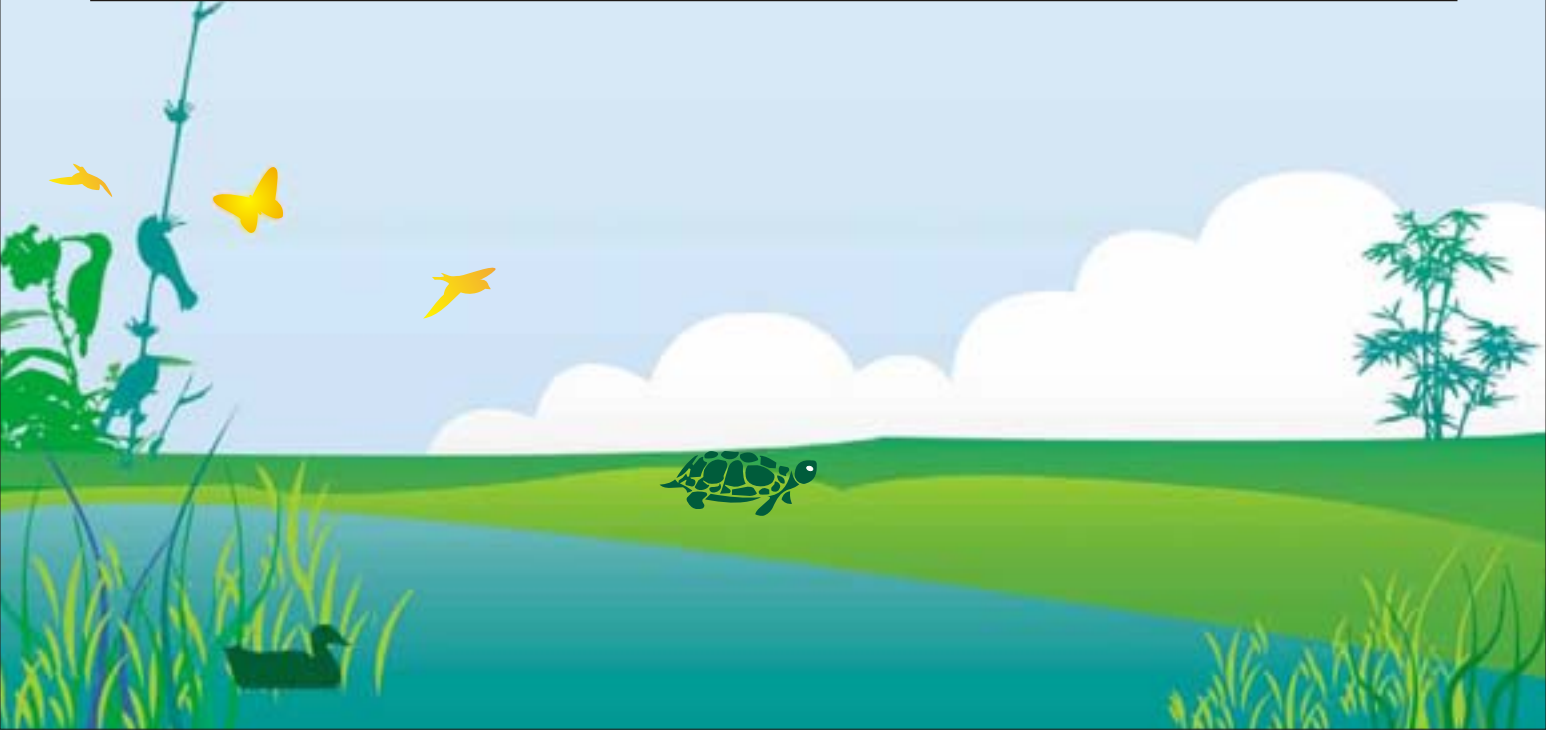
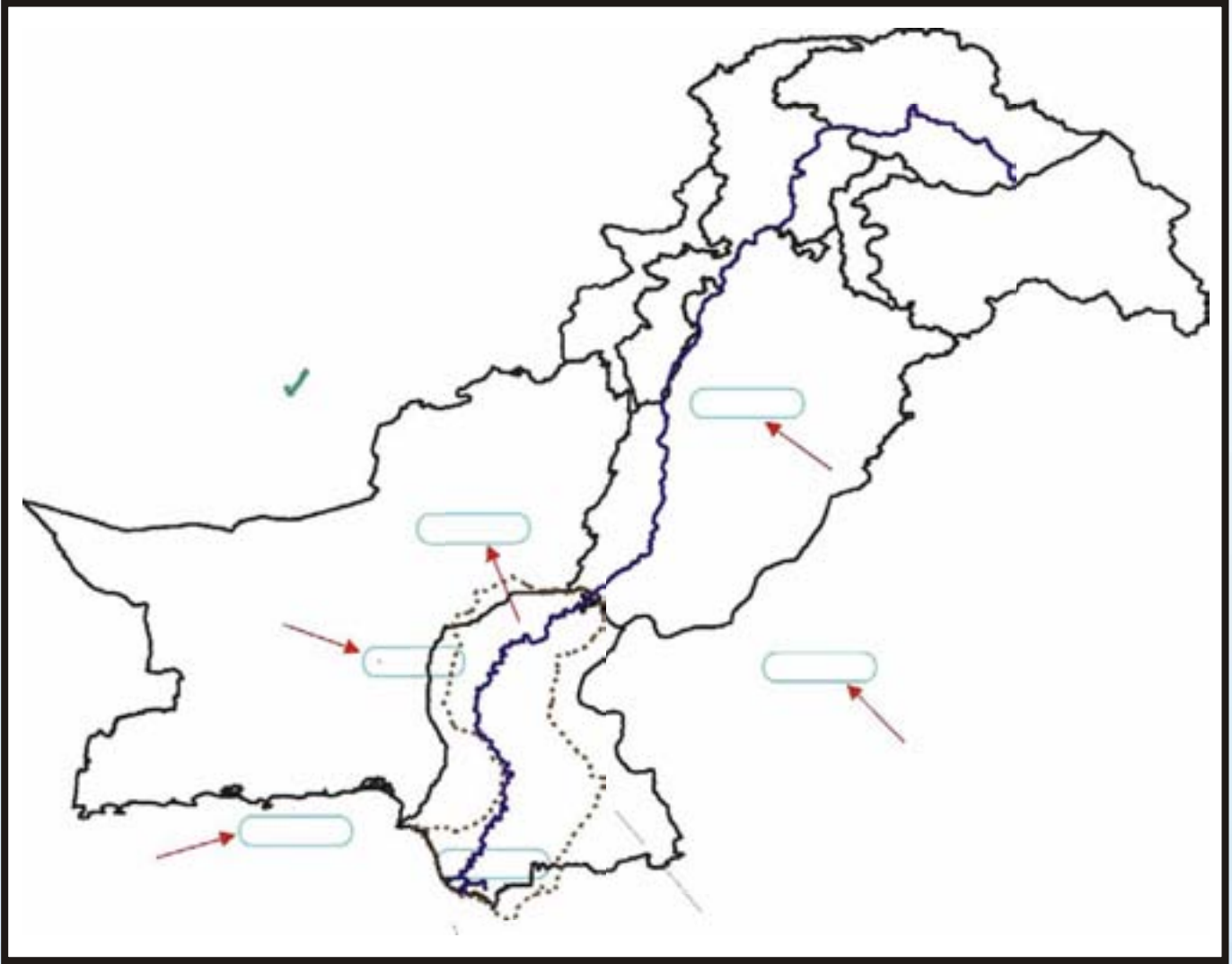
- a. Marine ecosystem
- b. Coastal ecosystem
- c. Freshwater wetlands ecosystem
- d. Riverine ecosystem
- e. Desert ecosystem
- f. Agriculture ecosystem

Local communities, dependent on natural resources, comprise mainly of fishermen and farmers. Some people also rear livestock while others are engaged in occupations like mat making from typha grass. However, lack of freshwater flow into the Indus delta, global warming and climate change, increased pollution, deforestation and over-exploitation of natural resources have had a negative effect on the ecosystems and people living in the Indus Ecoregion. The underlying cause of environmental degradation in the Indus delta is the lack of freshwater flow from the Indus River into the Delta.

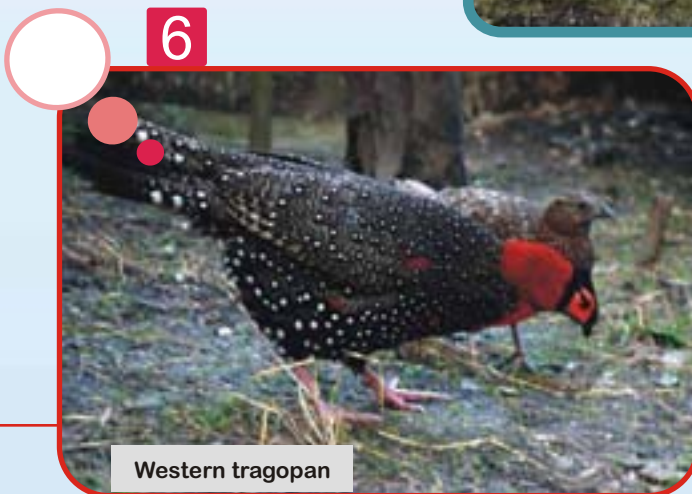
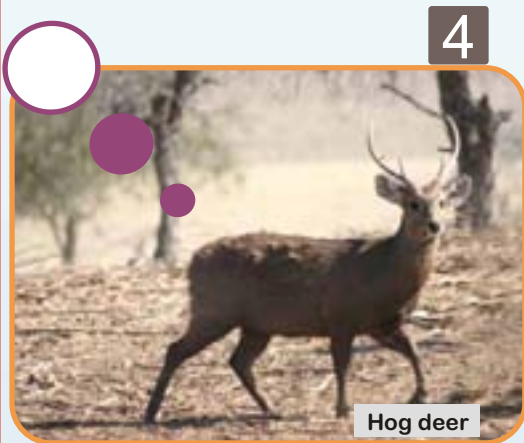
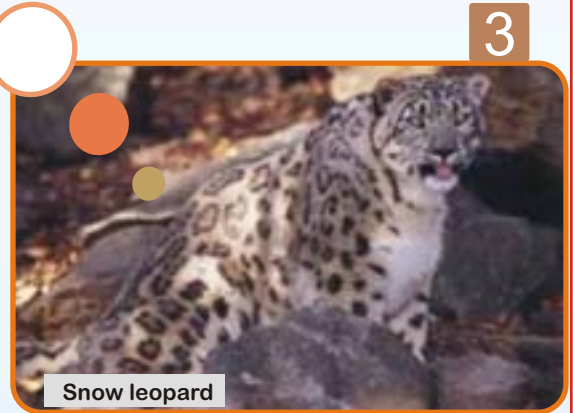
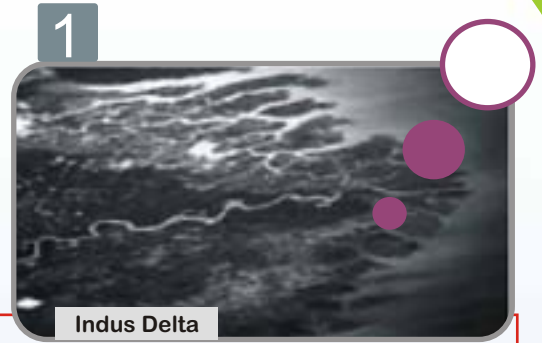
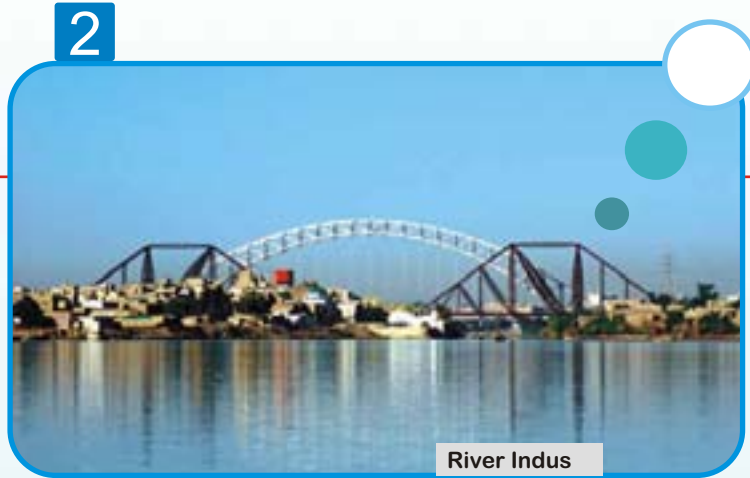


1.3.1 Join the dots in the map of Pakistan to locate the Indus Ecoregion and colour it. Put the following words in their given space on the map:

(Balochistan, Punjab, India, North Arabian Sea, Indus River, Indus Delta)



1.3.2 Please mark (✓) on pictures which make the Indus Ecoregion an important place in the world:



1.3.3 Name the river in Pakistan which connects the ecoregions with each other: _____

Marine Ecosystems

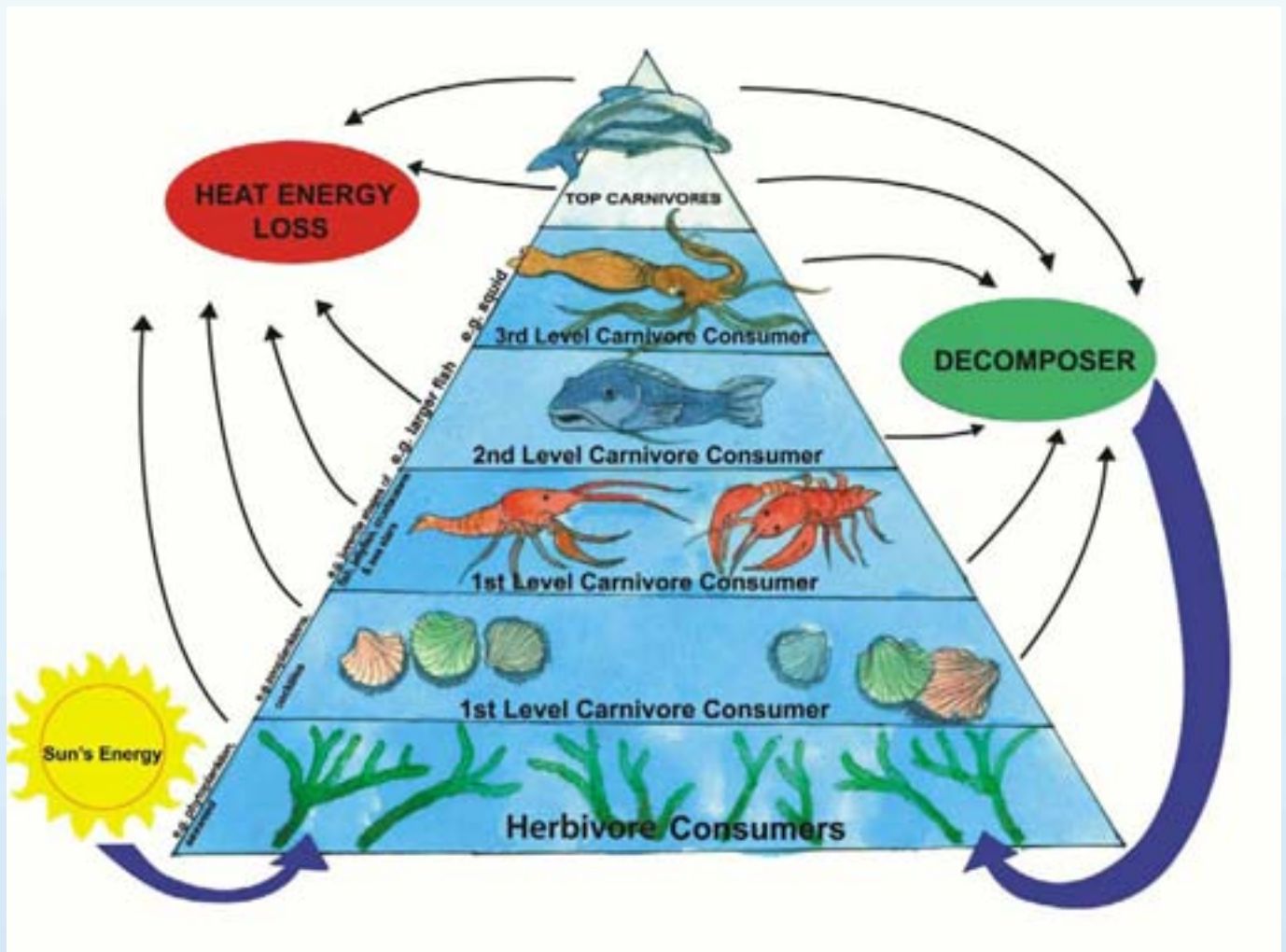


2.1 What is a Marine Ecosystem?

Marine ecosystems are a part of the largest aquatic system on the planet, covering over 70% of the Earth's surface. This includes ecosystems and habitats of unique nature such as shorelines of temperate and tropical oceans, salt marsh and intertidal ecology, estuaries and lagoons, mangroves and coral reefs, deep sea and sea floor.

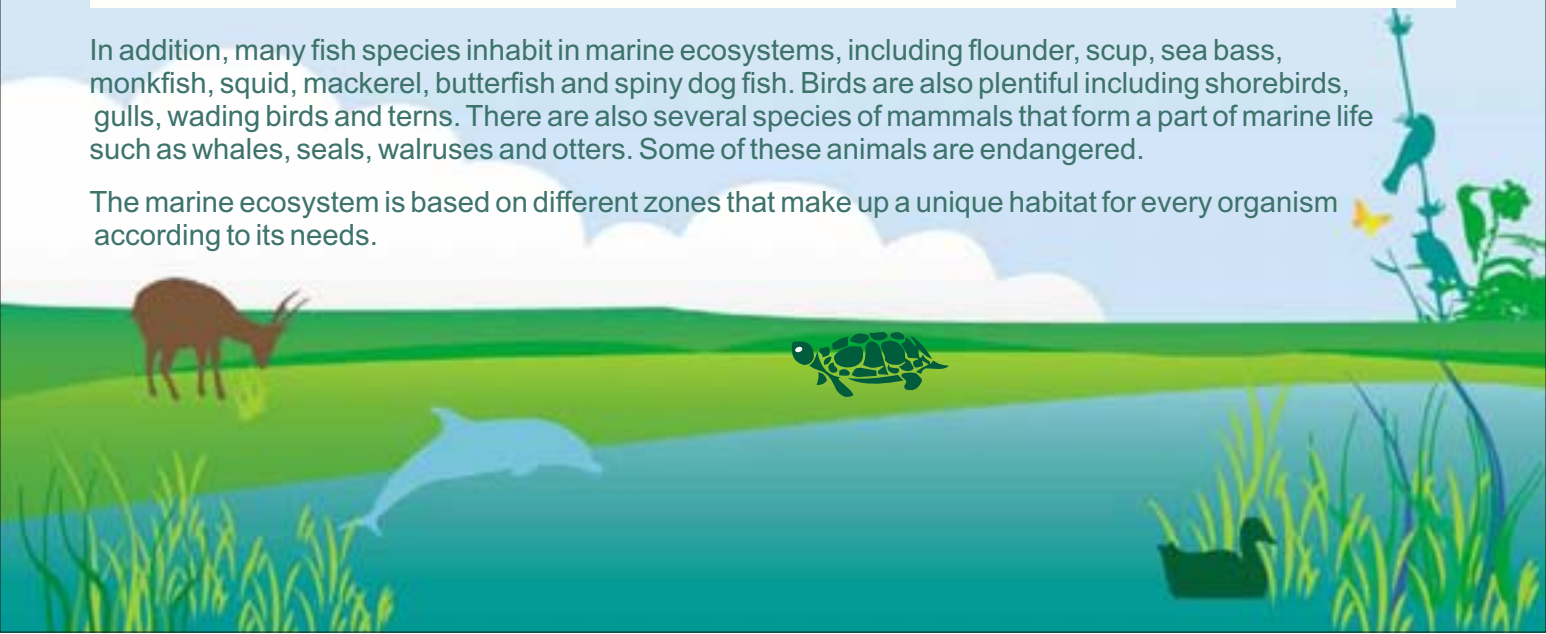
In Pakistan, some areas of Sindh and Balochistan consist of marine ecosystem and possess rich biodiversity which are adapted to live in the salt water of the Arabian Sea.

Marine ecosystems are home to different species ranging from tiny planktonic organisms, such as seaweed that are at the base of the marine food webs to large marine mammals like whales, manatees and seals. Following is a marine trophic pyramid that depicts the marine food chain:



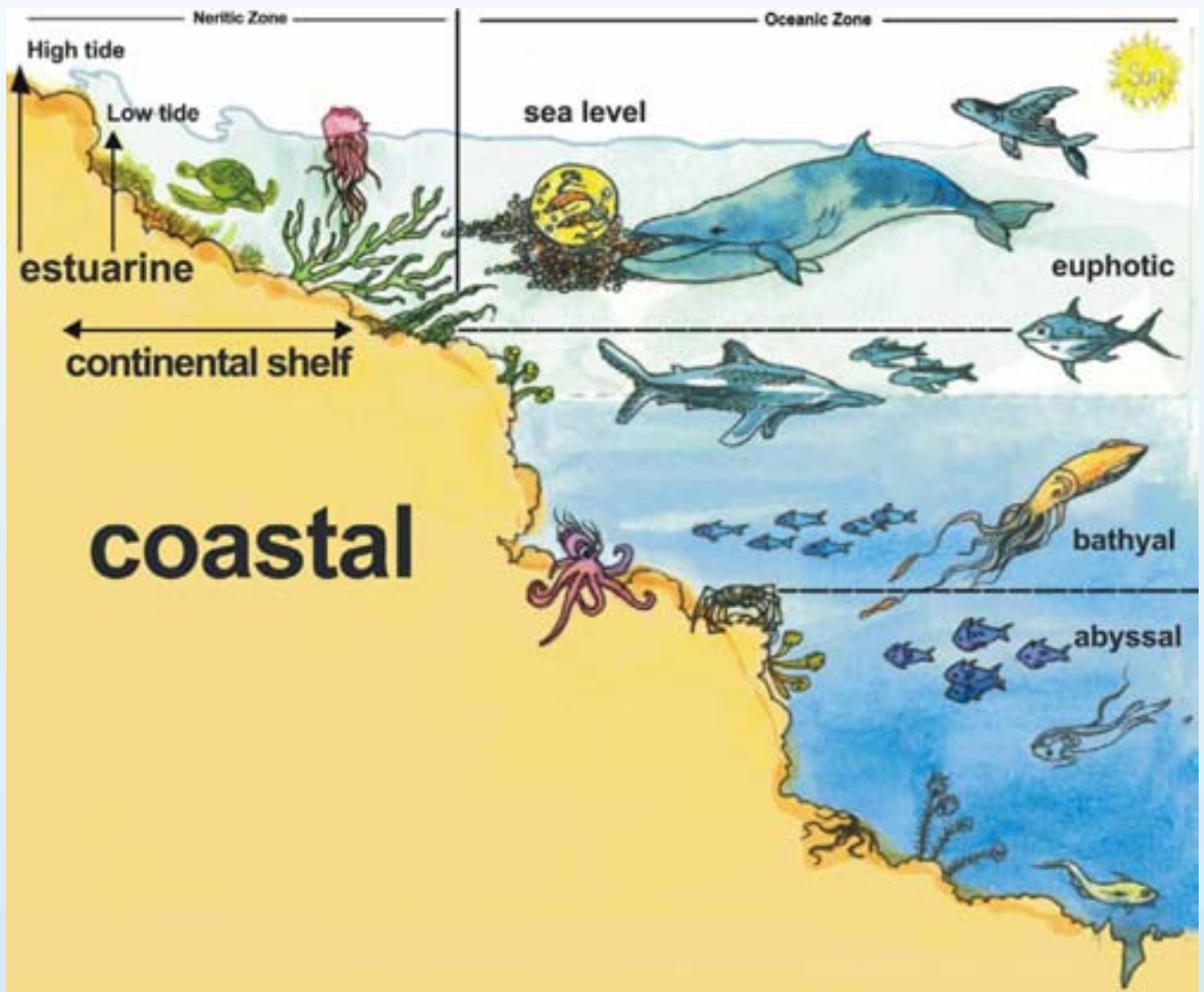
In addition, many fish species inhabit in marine ecosystems, including flounder, scup, sea bass, monkfish, squid, mackerel, butterfish and spiny dog fish. Birds are also plentiful including shorebirds, gulls, wading birds and terns. There are also several species of mammals that form a part of marine life such as whales, seals, walrus and otters. Some of these animals are endangered.

The marine ecosystem is based on different zones that make up a unique habitat for every organism according to its needs.



The following figure depicts these different zones and the type of organisms that inhabit it. To understand the diagram below fully, one must be aware of the terminology used. Let's begin from the top of the figure, moving horizontally:

1. **Neritic Zone** is the part of the ocean extending from the low tide mark to the edge of the continental shelf, with a relatively shallow depth extending to about 200 meters. It features well oxygenated water and low pressure along with the presence of light, and thus encourages the existence of species such as phytoplankton.



2. **Oceanic Zone** is the region of open sea beyond the edge of the continental shelf and includes 65% of the ocean's completely open water. The oceanic zone has a wide array of undersea terrain, including crevices that are often deeper than the height of Mount Everest, as well as deep-sea volcanoes and ocean basins.

Now, moving vertically along the diagram below, the different zones are defined as follows:

1. **Epipelagic (Euphotic) Zone** is the well lit zone which supports photosynthesis and includes two categories of fish, which are small forage fish and large predator fish.

2. **Bathyal Zone** which can be subdivided into two:

a. **Mesopelagic Zone** also known as the middle pelagic or twilight zone is a pelagic zone extending from 200 meters down to around 1000 meters.

b. **Bathypelagic Zone** also known as the midnight zone is the pelagic zone that extends from a depth of 1000 to 4000 meters below the ocean surface. Because of the lack of light, some species that live here do not have eyes, but one of the species that does is the viperfish. Another is the frill shark. Many forms of nekton live in the bathyal zone, such as squid, large whales, and octopuses, but this zone is difficult for fish to live in.

3. **Abyssal zone** is the abyssopelagic layer of pelagic zone that contains the very deep benthic communities near the bottom of oceans. "Abyss" is from the Greek word meaning "bottomless sea". At depths of 4,000 to 6,000 meters, this zone never receives daylight.

4. **Hadal Zone**, derived from the name of the ancient Greek god of the Underworld "Hades" and means "unseen", also known as trench zone or Hadopelagic zone, is the marking out of the deepest trenches in the ocean. This zone is found from a depth of around 6,000 meters to the bottom of the ocean.

2.1.1 Marine Ecosystems are very important in the overall health of both marine and terrestrial environments. The diversity and productivity of marine ecosystems are also important to human survival and well being. List down, what these habitats provide?

1. _____
2. _____
3. _____
4. _____
5. _____

2.1.2 The habitats that make up the vast system ranging from shore regions to barren ocean floor. Give names of various zones found in a marine ecosystem?

1. _____
2. _____
3. _____



2.1.3 Name at least 3 endangered species belonging to a marine habitat?

1. _____ 2. _____ 3. _____

2.1.4. Match the correct answers:

Column A	Column B
marine ecosystem include	a group of marine mammals which include dolphins and whales
marine ecosystems have	pollution, habitat destruction, unsustainable fishing, tourism development
Cetaceans	two zones
Estuaries	shallow depth extending to about 200 meters
Some marine fish species are	depth to around 6000 meters
Threats to marine ecosystem	bottomless sea
Horizontally a marine ecosystem is divided into	shorelines, temperate and tropical oceans, salt marsh and intertidal zones, estuaries and lagoons, mangroves and coral reefs, deep sea and sea floor
Vertically a marine ecosystem is divided into	trenches, volcanoes
Neritic zone	a Greek God meaning unseen
Hadopelagic zone	Viper fish, Frill shark
Abyss means	salty water and creatures are adapted to living in salty water.
Oceanic zone	Mackerel, Butterfish and Spiny dog fish
Hades means	four zones
Midnight zone species	mixture of salt and freshwater



2.1.5. Please complete biological profile of the following marine life:



Name: _____
Characteristics: _____
Favourite food: _____
Living places: _____



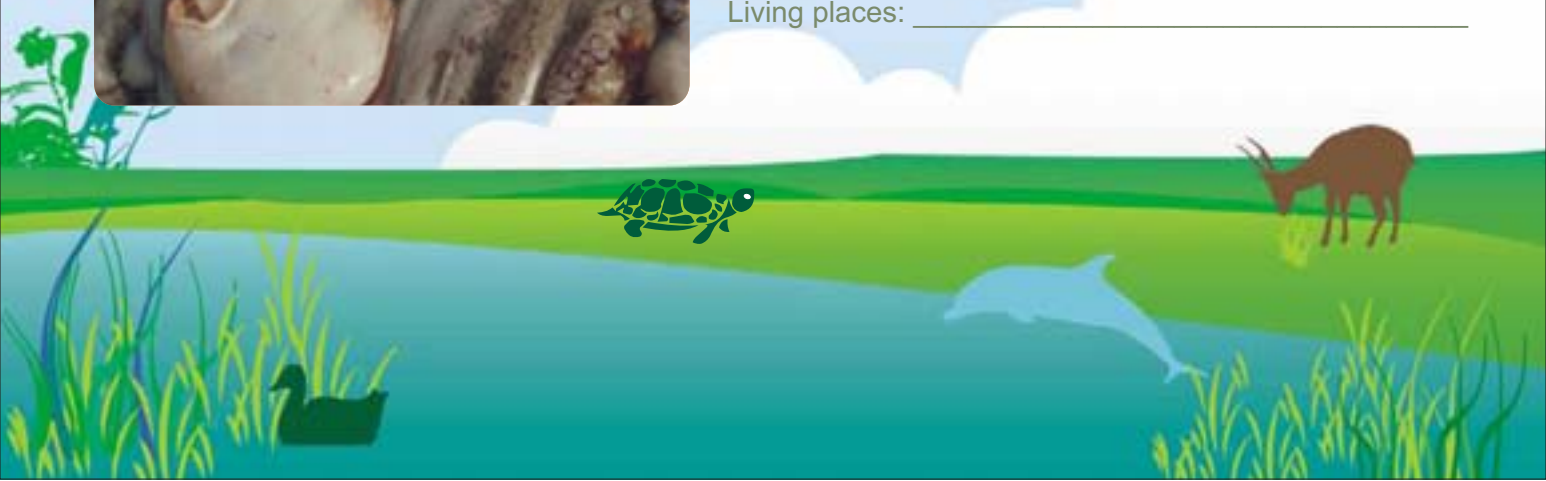
Name: _____
Characteristics: _____
Favourite food: _____
Living places: _____



Name: _____
Characteristics: _____
Favourite food: _____
Living places: _____



Name: _____
Characteristics: _____
Favourite food: _____
Living places: _____

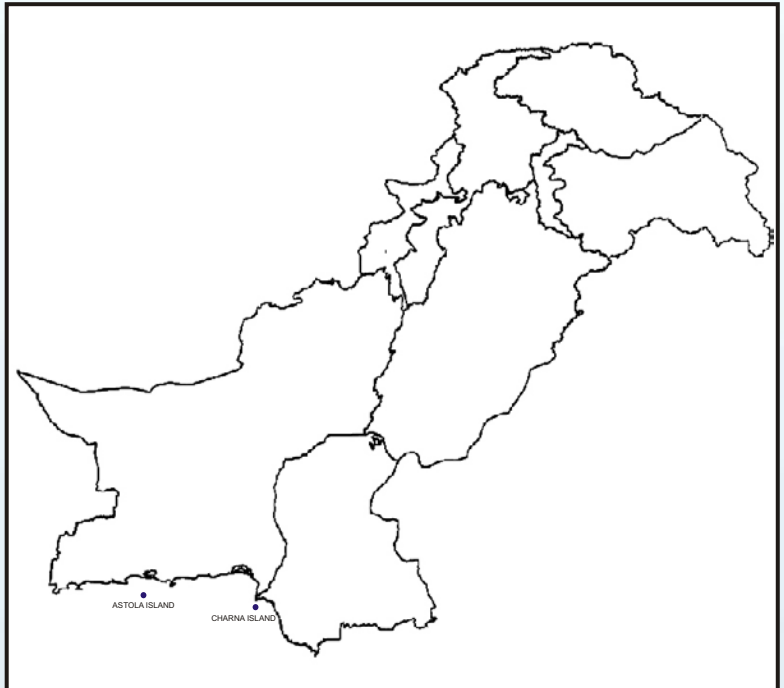


2.2 Corals



Coral reefs are aragonite structures (common carbonate mineral) which are produced by living animal colonies found in marine habitats. In most reefs, the predominant organisms are stony corals, colonial polyps that secrete an exoskeleton of calcium carbonate. The coral reefs are found only in shallow warm water.

- The reef is made up of thousands of corals. When a coral dies, it leaves its skeleton of calcium carbonate behind. Each new generation is built upon the remains of the previous generation. The actual animal that makes up the physical coral is called a polyp. It is column shaped and attaches itself to the floor of the reef. The top end extends into the water and is free to move about. Thousands of individual polyps form a colony, which in turn forms a reef. During the daytime, they retreat into their skeleton, so divers usually only see their skeletons. Because of warm



water and abundant food supply, coral reef communities are bustling with life.

The accumulation of skeletal material, broken and piled up by wave action and bioeroders, produces formation that supports the living corals and a great variety of other animal and plant life.

Often called “rainforests of the sea”, coral reefs form some of the richest and most diverse ecosystems on earth. They occupy less than one percent of the world ocean surface (about half the area of France), yet they provide a home for 25% of all marine species, including fishes, mollusks, echinoderms and sponges.

There are two main types of coral: hard coral, the major reef-building species; and soft coral, such as sea whips and sea fans. Like the tropical rainforests, coral reefs are normally found in the tropical and semitropical areas of the world where water temperatures range between 16 and 30 degrees Celsius (61 and 86 degrees Fahrenheit). However, there are some corals in the North Atlantic termed as cold water coral, but they are a fraction of the coral throughout the ocean. The optimal temperature for coral usually occurs within 30 degrees latitude of the equator.

Coral reefs are classified into three types: barrier reefs, fringing reefs and atolls. Barrier reefs occur offshore separated by water from the mainland. Fringing reefs are continuous with the land mass and atolls are islands made of coral surrounding a central lagoon.

Reefs with their bush like shape offer many nooks and crannies for fish to hide in. Small fish can hide from big predators inside a coral reef. Because of this, many small tropical fish are found in coral reefs.

Pakistan has been included in the list of 100 countries in the world where coral reefs are found. In Pakistan coral reefs are found in Astola island (Balochistan) and Charna island (Sindh).

2.2.1 Name two places along Pakistan's coast where coral reef exist:

1. _____ 2. _____

2.2.2. Fill in the blanks with a suitable option given below:

1. Coral reefs are found only in _____ and _____ waters.

- a. Cold and freshwater b. Shallow and warm waters c. Warm and freshwaters

2. The reef is made up of thousands of _____

- a. Corals b. Sand c. Cement

3 The actual animal that forms the coral is called _____.

- a. Jellyfish b. Polyp c. Shark

4. _____ makes the reef hard.

- a. Stones b. Calcium carbonate c. Rocks

5. Coral reefs are used in _____, _____, _____ and medicine

- a. Jewels b. Ornaments c. Decoration pieces d. Cooking e. Playing

6. Pakistan will now be included in the list of _____ countries in the world where coral reefs are found.

- a. 10 b. 50 c. 100 d. 1000

7. Threats to coral reefs include:

- a. Trawler fishing b. Pesticides and fertilizers c. Sewerage water d. Climate change
e. Human contact f. All of above

2.2.3 How corals are formed?

2.2.4 What does the phrase "rainforests of the sea" refer to?

2.2.5 How many types of coral are there?



2.2.6. Following are some images, mark (✓) on the ones that appear as corals.

a



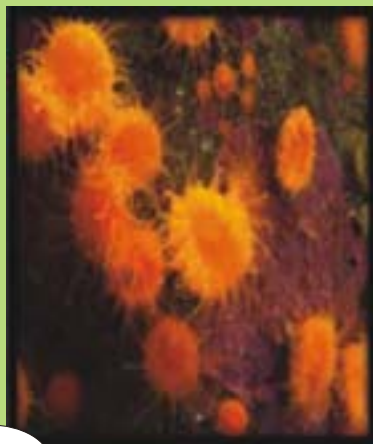
b



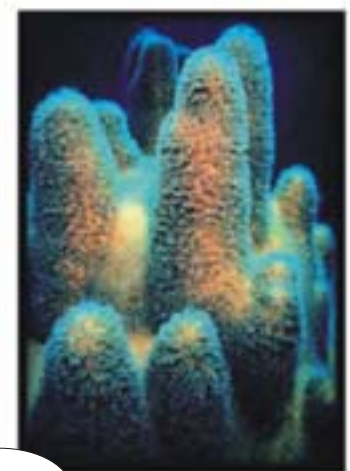
c



d



e



2.3 Dolphins

Dolphins are magnificent creatures among marine cetaceans. Cetaceans are a group of aquatic mammals like dolphins and whales. There are 33 known species of ocean dolphins and 5 known river dolphins, all stemming from the whale family. Some of the most common species that are most recognisable are: Bottlenose, Spinner, Pacific White-sided, Pusky, Rough Tooted, Hourglass, Fraser, Risso, Vanquita, Beiji, Northern Right Whale, etc.



Dolphins are really just small whales. Their chemical make-up is almost exactly the same. They could also appear to look like large fish, but they are mammals. They need oxygen to survive. They bear live offspring and feed the young with milk. They are warm blooded like humans and give birth to live ones. They breathe through a blow hole into their lungs. They are highly sociable animals and live in groups called school, herd or pod.

Dolphins typically eat cat fish and clams. They have few enemies, consisting of sharks, killer whales, and humans. Humans can be an enemy because of the fishing nets in which dolphins can get trapped, although rarely are dolphins poached or hunted. In most cases it is just an accident that a dolphin is caught. Typically dolphins are a light grey colour, although colour can range from black, white, yellow, tan, to pink and they can also have spots.





Four types of dolphins most frequent Pakistan's marine water include Bottlenose, Humpback, Spinner dolphin and Finless porpoises.

2.3.1 Do you know what cetaceans are?

2.3.2 Which of the following is true for marine ecosystem?

- 1) Dolphins are a type of fish.
- 2) Indus blind dolphin lives in the Arabian Sea.
- 3) Coral reefs support biodiversity.
- 4) The Indian Ocean is a part of India only.

Fun facts about dolphins:

-  Male dolphins are called Bulls and female dolphins are called cows.
-  Dolphins sleep by resting one half of their brain at a time so that one eye is always open.
-  Each dolphin has its own signature whistle to identify itself.
-  Dolphins have a thick layer of fat under their skin called blubber, which helps them to keep warm.

2.3.3 Complete the following crossword with the help of the given clues:

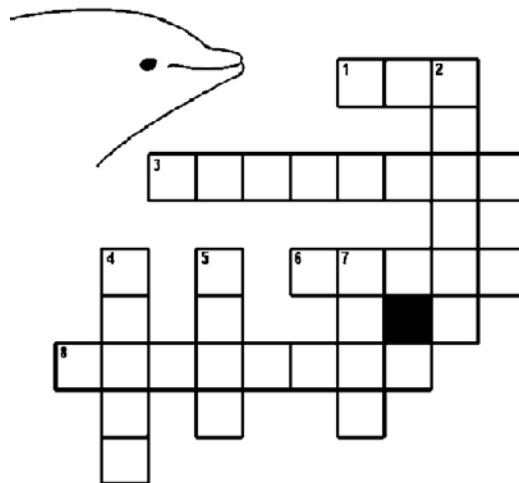
Down

2. Fin is located on a dolphin's back.
4. Male dolphins.
5. Female dolphins.
7. A baby dolphin.

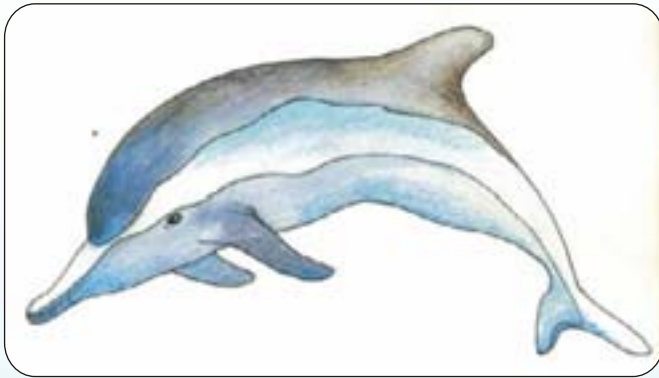
Across:

1. A group of dolphins.
3. Instead of arms, dolphins have these.
6. Dolphins live in this.
8. A dolphin breathes through this.

Dolphin Crossword Puzzle



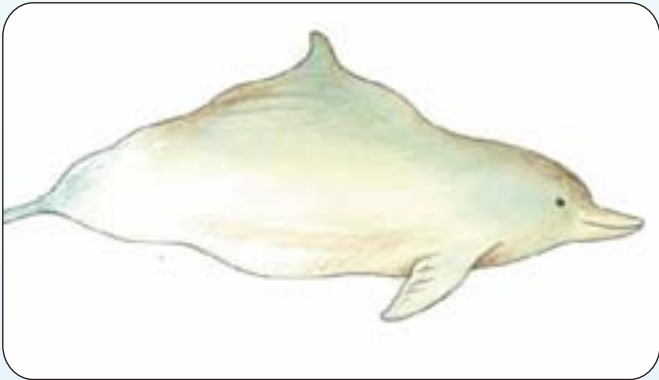
2.3.4 Following is an ID checklist of two species of dolphins. With its help make your own ID checklist for the provided species of cetaceans.



1. Spinner dolphin: Local Name: Malhar

ID checklist:

- i. Long and comparatively thin beak
- ii. Three-toned colourised body
- iii. Dark on top to grey
- iv. Belly is light in colour
- v. Live in groups

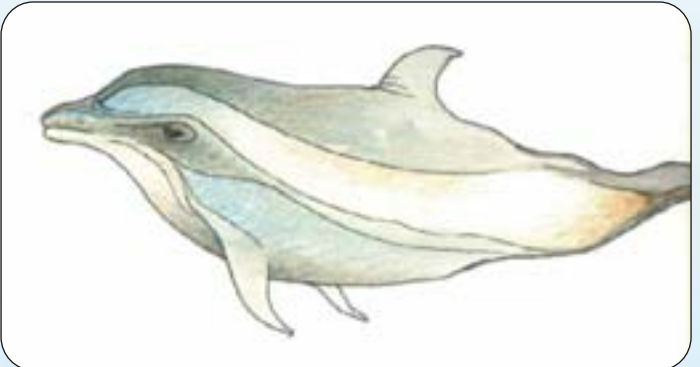


2. Humpback dolphin: Local Name: Humma

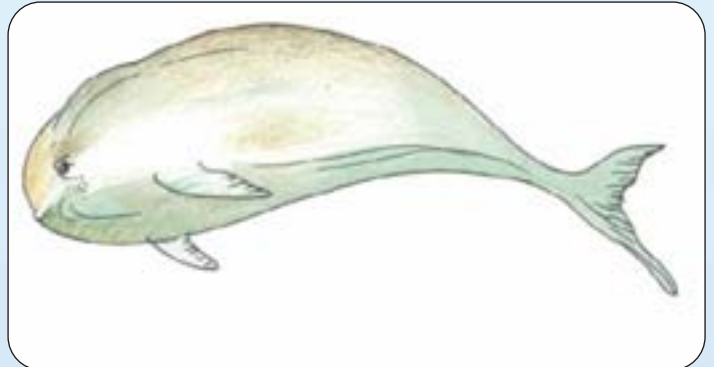
ID checklist:

- i. Robust body
- ii. Elongated hump on back
- iii. Long slender beak
- iv. Beak exposed on surfacing
- v. Beak strongly arched on diving
- vi. Tail raised on diving

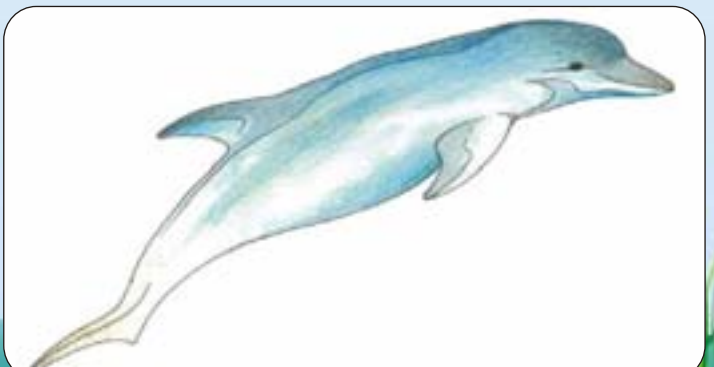
3. Bottlenose dolphin



4. Finless porpoise



5. Common dolphin



2.4. Whales



Whales are huge and highly intelligent animals with an elaborate social life. These are mammals as are humans, dogs, cats and elephants. This means that they are not fish. They breathe air and so must return to the surface at regular intervals to get a breath. They give birth to live young that stay with the mother for over a year and feed on milk produced by the mother.

Whales are warm-blooded and have a skeleton similar to our own (though greatly modified) the fore-limbs are their front flippers and have similar bones in them to our arms and hands. The hind-limbs are generally not present at all, though are represented in many species by a tiny pair of "free floating" bones (pelvic vestiges) - not attached to any others - towards the rear of the animal.

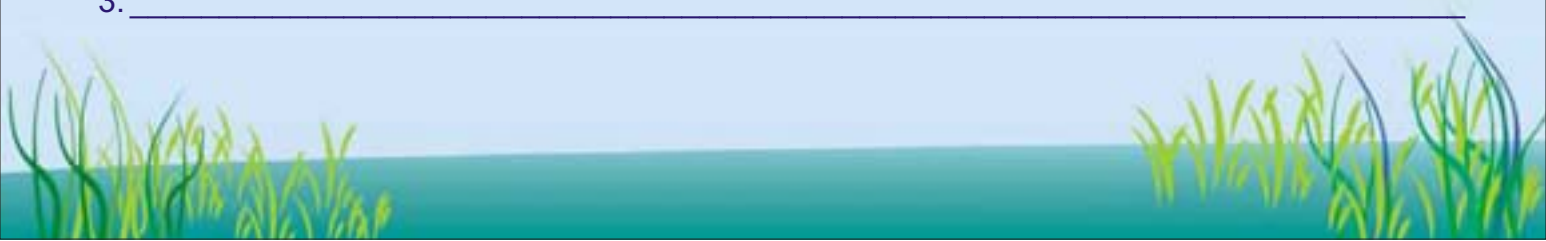
The rear flippers of a whale are called flukes. These have no bone in them at all, being made of tough fibrous material. It is flukes that provide propulsive power in all cetaceans with the fore-limbs controlling direction and being used for swimming.

For centuries whales have been hunted for meat and as a source of raw materials. By the middle of the 20th century; however, industrial whaling had left many species seriously endangered and whaling has ended in all but a few countries. Several organizations have been founded to try to eliminate hunting of whales and other threats to whale survival.



2.4.1 Suggest at least three actions that how can you stop whaling?

1. _____
2. _____
3. _____



2.5 Sea turtles

Sea turtles are large, air-breathing reptiles that inhabit tropical and subtropical seas throughout the world. Their shells consist of an upper part (carapace) and a lower section (plastron). Hard scales (or scutes) cover all species except the Leatherback, and the number and arrangement of these scutes can be used to determine the species.

Sea turtles come in many different sizes, shapes and colours. The Olive ridley is usually less than 100 pounds, while the Leatherback typically ranges from 650 to 1,300 pounds. The upper shell, or carapace, of each sea turtle species differs in length, colour, shape and arrangement of scales.

Sea turtles do not have teeth, but their jaws have modified "beaks" suited to their particular diet. They do not have visible ears but have eardrums covered by skin. They hear best at low frequencies, and their sense of smell is excellent. Their vision underwater is good, but they are nearsighted out of water. Their streamlined bodies and large flippers make them remarkably adapted to life at sea. However, sea turtles maintain close ties to land.



Major threats to Green turtles are the intentional harvests of eggs, juveniles and adults. Other threats include pollution, noise, traffic and fishing activities along the beaches.

Moreover, marine turtles feed on many species in the open ocean. Small turtles eat tiny animals that they find in the floating seaweed concentrations where they live. Fish, sharks and birds in turn prey upon the young turtles. The marine turtles fill an important ecological role by controlling prey species and themselves providing food to larger predators. The disappearance of marine turtles could, therefore, have widespread effects in open ocean and coastal ecosystems.

2.5.1 Why are turtles an important part of the ecosystem?

2.5.2 How many types of turtles are found in Pakistan?

2.5.3. Mark (✓) on marine turtle and (X) on freshwater turtle.

a



b



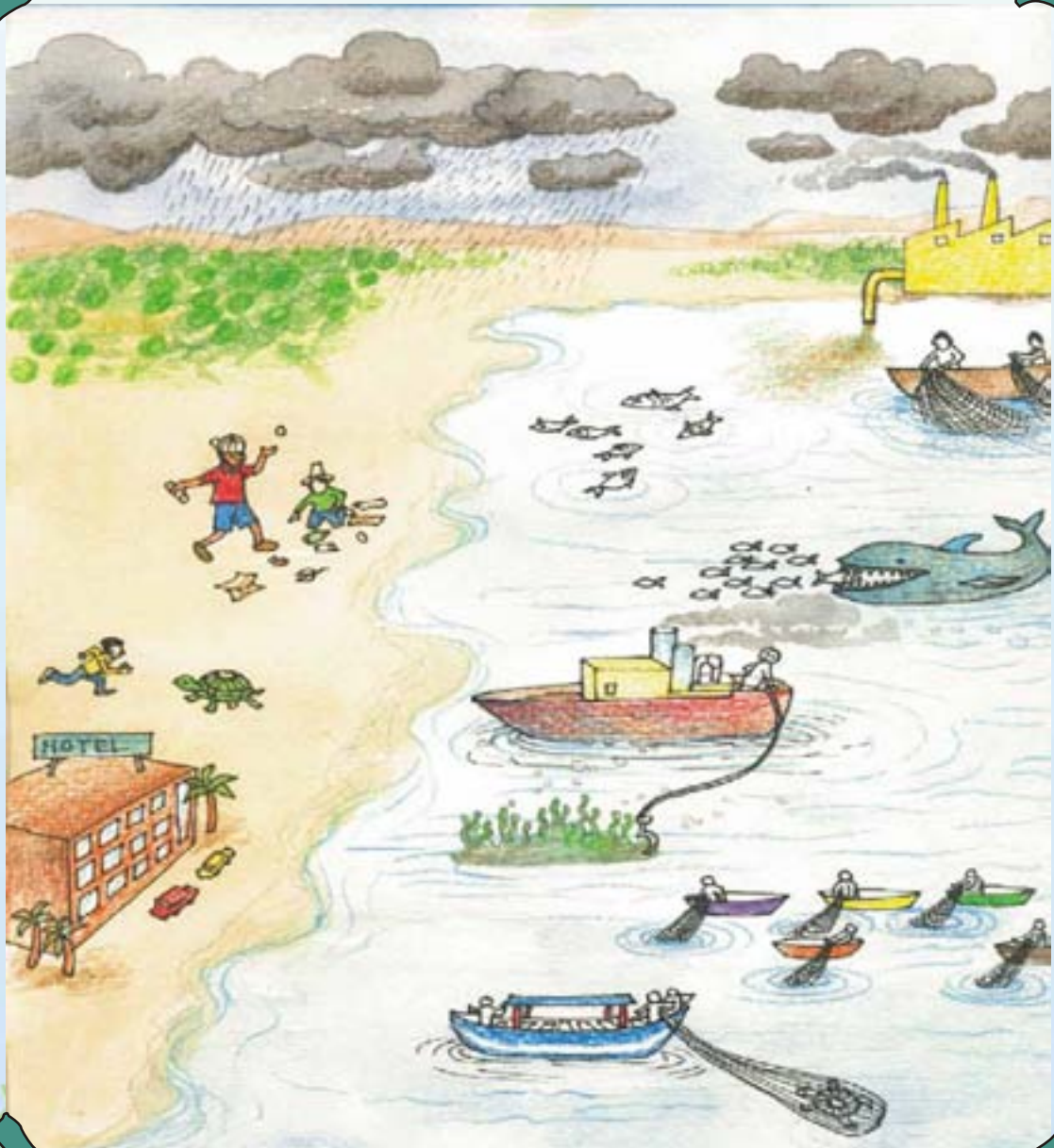
2.6.1 Threats to Marine Ecosystem

Marine ecosystems face a range of threats including:

- oil spills;
- untreated sewage;
- heavy siltation;
- invasive species;
- persistent organic pollutants;
- marine litter;
- over fishing;
- destruction of coastal and marine habitats;
- acidification;
- radioactive substances;
- heavy metal accumulation; and
- eutrophication - a process whereby water bodies receive excess nutrients that stimulate excessive plant growth such as algae. This reduces dissolved oxygen in the water causing other marine organisms to die.

A major threat beyond over exploitation of fisheries and physical destruction of marine coastal habitats by dredging is undoubtedly the strong increase in coastal development and discharge of untreated sewage into the near shore waters.

2.6.2 See the given diagram of marine ecosystem. Encircle at least 5 things which are threat to it:



2.6.3 Chalk out/give brief account of at least 3 hazards highlighted in the previous exercise (2.6.2):

1) _____

2) _____

3) _____

2.7. What you can do to save marine life?

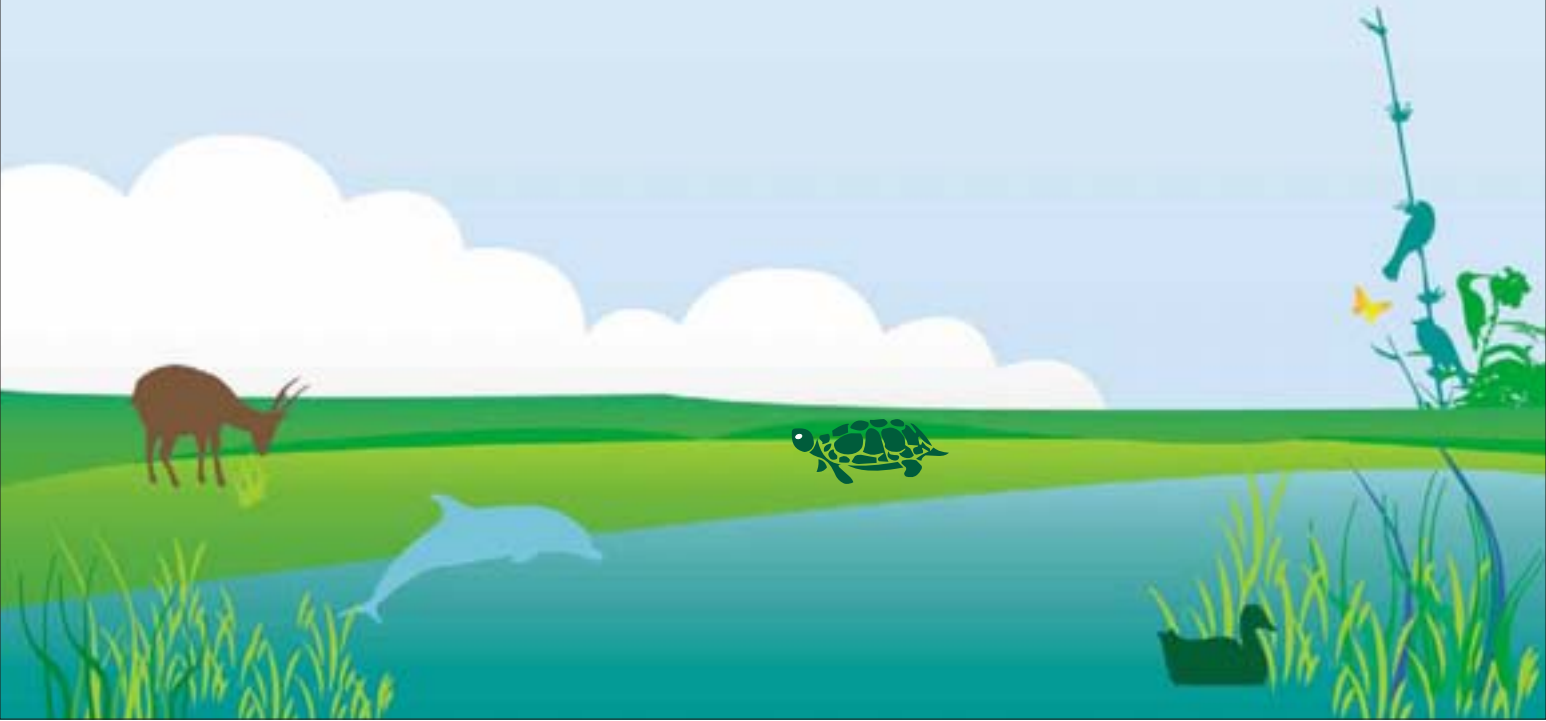
2.7.1 Every year, thousands of marine animals die from man-made trash that ends up in the world's oceans. Try some of these suggestions to do your part to keep our oceans clean:

1. Reduce, reuse and recycle materials at home, work and school.
2. Buy products made from recycled materials and that have little or no packaging.
3. Keep storm drains clean. Remember they drain away to watersheds, beaches and rivers.
4. Recycle used motor oil.
5. Reduce carbon dioxide in the air by planting trees and driving fuel-efficient cars.

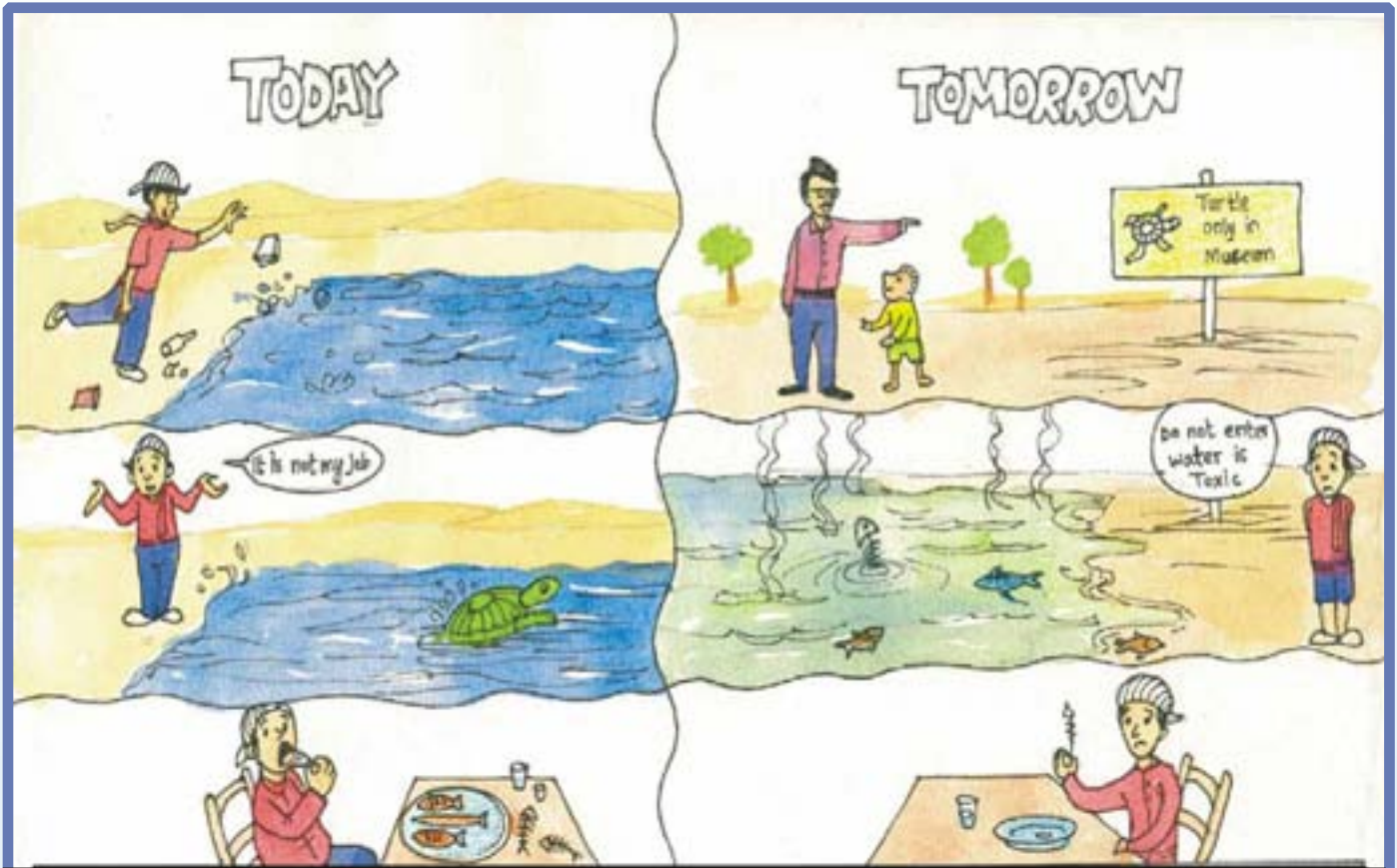
The more you know, the more you can help coral reefs. Read newspapers, magazine articles and web resources to stay on top of marine issues and be aware of the many threats to marine life.

So, get your feet wet and be part of a team that sets out to conserve and preserve the natural habitats. Be a part of Coral Reef Conservation Team. Explain how you can address the following issues by being a part of Coral Reef Conservation Team?

- a) Climate change
- b) Blast fishing
- c) Over use of reef resources



2.7.2 Make your own PLEDGE to save marine life.



I believe, I can change. I believe in change. Life is a sea in motion. Everything changes. The very way we express ourselves changes very fast. I want to change life for good. I will change my current lifestyle for a better tomorrow.

Signature: _____

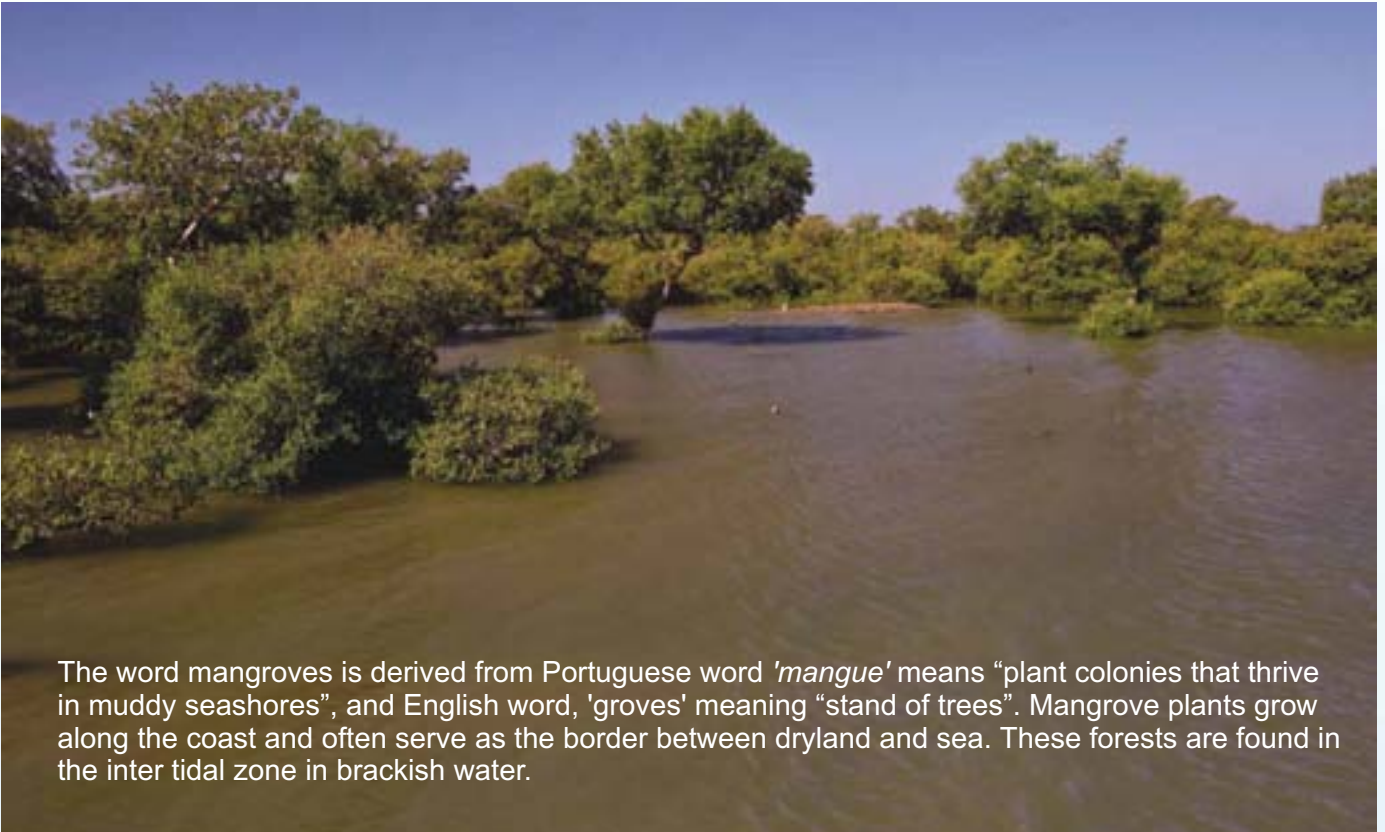
Name: _____

Date: _____

Coastal / Mangrove
Ecosystem



3.1 What are mangroves?



The word mangroves is derived from Portuguese word '*mangue*' means "plant colonies that thrive in muddy seashores", and English word, 'groves' meaning "stand of trees". Mangrove plants grow along the coast and often serve as the border between dryland and sea. These forests are found in the inter tidal zone in brackish water.



Mangrove forests require the following conditions to thrive:

- They grow in areas where the seawater mixes with freshwater. Such a habitat is called an estuary;
- Shores must be free of strong waves and tidal action; and
- Areas where fresh silt and water come regularly.

These forests are found in:

- Deltas (a landform that is created at the mouth of a river where river flows into an ocean or sea); and
- Estuaries (the point at which rivers enter the sea).

3.2 Adaptation of mangroves

Mangrove trees grow where no tree has grown before. They are able to survive inundation by salt water twice a day, and in "soil" which is unstable and poor in oxygen (anaerobic). Mangroves have adapted very well to this type of environment through the following:

- 1 All mangrove trees exclude some salt at the root level, and all can tolerate more salt in their tissues than "normal" plants, often in quantities that would kill other plants. They then secrete the excess salt through special cells on their leaves.
- 2 Mangrove roots not only provide support in unstable soils and to withstand currents and storms, but also breathe air. To avoid suffocation in the oxygen poor mud, mangrove trees snorkel for air. They develop aerial or air-breathing roots with special tiny pores to take in air. These pores are like pneumatophores (meaning "air carrier" in Greek).
- 3 Seeds germinate while still attached to the plants before they drop and the mother tree channels nutrients to the growing seedling (vivipary).
- 4 Thus mangroves have many water conserving features of desert plants. To minimise water loss through evaporation they may have thick waxy leaves or hairy leaves. They may also store water in succulent leaves.



3.2.1. Match the photos on the next page with phrases given below by putting down the correct alphabet :

A. Pneumatophores

Mangroves have root projections called pneumatophores, which help to supply the plant with air in submerged soils.

B. Prop roots

These extensive root systems protect the coast from erosion and storm damage.

C. Cable roots

Bind the plant with the soil surface under water. Mangrove roots not only provide support in unstable soils and withstand currents and storms, but also breathe air.

D. Vivipary

The fruit does not fall away when it ripens. Instead, the seed within the fruit starts to germinate while it is still on the mother tree, and the mother tree channels nutrients to the growing seedling.

E. Desiccation

Stem with intercellular space and tannin. Thick cuticle of the leaves.

F. Salinity

Salts are accumulated in the glands under the leaves. and after some time they fall in the water



1



2



3



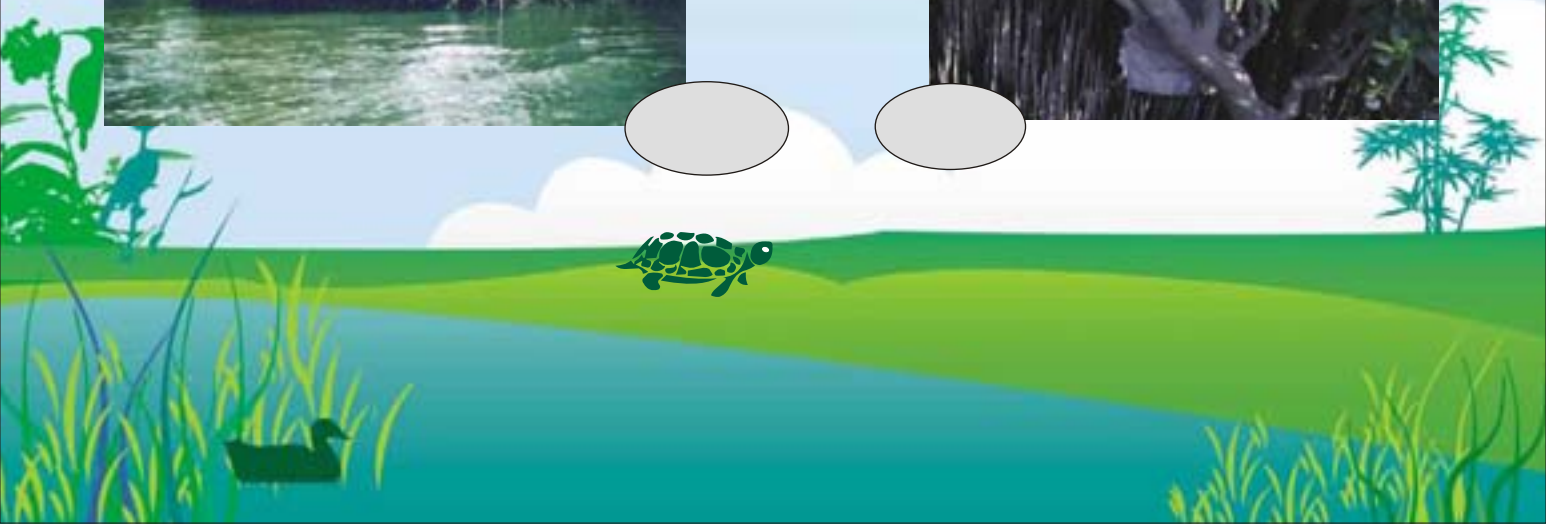
4



5



6



3.3. Mangroves species in Pakistan (past and present)

More than thirty species of mangrove plants are found in the world. Eight species were present in Pakistan, of which only four have survived along the coastline. These are:

Grey Mangrove or Timer (*Avicennia marina*)

This type of mangroves has pencil-sized roots called pneumatophores. These specialized aerial roots enable plants to breathe air in habitats that have waterlogged conditions. The roots may grow down from the stem, or up from typical roots.

True or Red Mangrove (*Rhizophora mucronata*)

The red mangrove has prop or stilt roots. These are adventitious (which in botany, refers to structures that develop in an unusual place) support roots common among mangroves. They grow down from lateral branches.

Yellow Mangrove (*Ceriops tagal*)

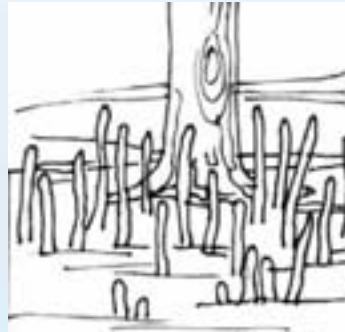
Yellow mangrove has knee roots or buttresses at the base of the trunk. These are aerial roots that emerge from the ground then loop back in.

River Mangrove (*Aegiceras corniculatum*)

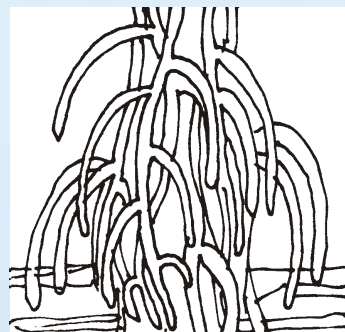
The river mangrove has no obvious roots above the ground.

3.3.1. Write down names of the different mangrove species in the first column by observing their root system (second column) and canopy (third column)

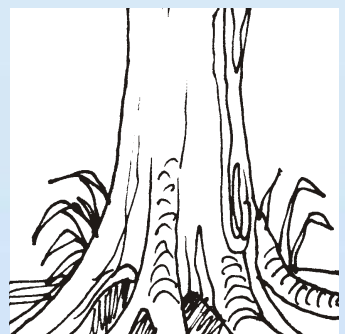
Name of Species:



Name of Species:










Name of Species:



3.4. Why are mangroves important?

3.4.1. Mangroves form an important part of the ecoregion because they:

-  support our fisheries as nursery grounds of fish, shrimps and crabs;
-  comprise of a unique diversity of fauna and flora;
-  serve as feeding, breeding and staging grounds of many species of birds;
-  are a source of timber, charcoal, traditional medicines and fodder for livestock;
-  are a check against wave erosion and offer protection to the coasts;
-  serve as a barrier and wind breaker against heavy storms, cyclones and tsunamis; and
-  provide support to fishermen.

3.4.2. Match the column for the correct answers

Learn about importance of mangroves by matching the statement in column A with column B

Column A	Column B
1. The mangrove plants contain tannins and insects don't like this substance	a) Crabs, spiders, prawns, shrimps, snails, snakes and birds
2. Mangroves provide food and shelter to:	b) Harvest them for fuel wood, fodder for livestock and timber for construction of their houses.
3. Mangrove areas are tourist attraction	c) Tsunamis, cyclones and wind storms
4. Mangrove litter supports numerous organisms like	d) They support numerous species of birds, reptiles, fish, crustaceans molluscs and insects
5. Mangroves provide nursery ground for:	e) Ecotourism can be promoted and be a source of income generation for local community
6. Local community living near mangroves	f) Fish, prawns and crabs
7. Mangroves are rich in biodiversity	g) Many bird species
8. Mangroves protect the coastal areas from many disasters like	h) So, the wood of the mangrove trees are highly resistible to insects

3.5 Life in Mangroves

Mangroves provide a pool of diversity for different animals. Following are the commonly occurring plants and animals.

TELESCOPIUM: Telescopium is a gastropod shell. It is called “telescopium” due to its telescopic appearance found within the mangrove vegetation. Sizes range from 3 to 4 inches. It grazes on algae and is used as bait to catch fish.



MUD CRAB: It is a large-sized edible crab found within mangrove vegetation. Its “carapace” or “shell” is greater in width than length (sizes range from 5-9 cm in length and 7-13 cm in width). Local community people catch them to earn money and many are exported to Sri Lanka and USA. Costs depend on the size of the crab. The amount of catch is high in summer and low in winter because of hibernation period.

FIDDLER CRAB: A fiddler crab is easily recognized by its remarkable large “chela” which is a large pincers-like claw of such arthropods as the crab and scorpion. It has been named the fiddler crab because of the continuous movement of its “chela”. Fiddler crabs are found outside as well as inside the mangroves. They are small in size ranging from 7-15 mm in length to about 9-24 mm in width. They make burrows in the soil for their protection, emerging in search for forage only when the tide is low. They are deposit feeders, i.e. those animals which live on or in the sediment of the sea floor, and swallow mud rich in organic matter in order to obtain nutrients.

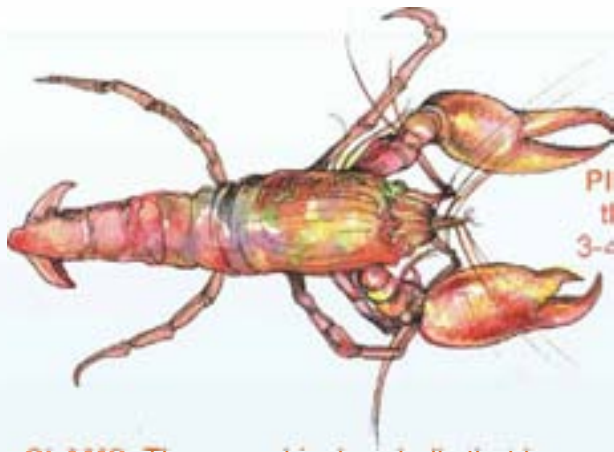


MUD SKIPPER: These are fish like creatures that move in mud by means of small jumps, thus named as mud skipper. They are small in size ranging from 8-12 cm in length. They are found in the muddy substratum where they make burrows in the soil. They are omnivores.



SEA SLUG: Soft oval shaped animal having tubercles on the body and yellowish brown in colour. Slugs graze upon seaweed. Their faeces acts as manure for the growth of seaweed.





PISTOL SHRIMP: They produce a “pistol fire” like sound thus they are called pistol shrimp. These are small sized shrimps, 3-4 cm in length that live in burrows. Large “*chelipeds*”, that is, one of the pair of legs that bears the large “*chela*”, are the characteristic feature of these shrimps.

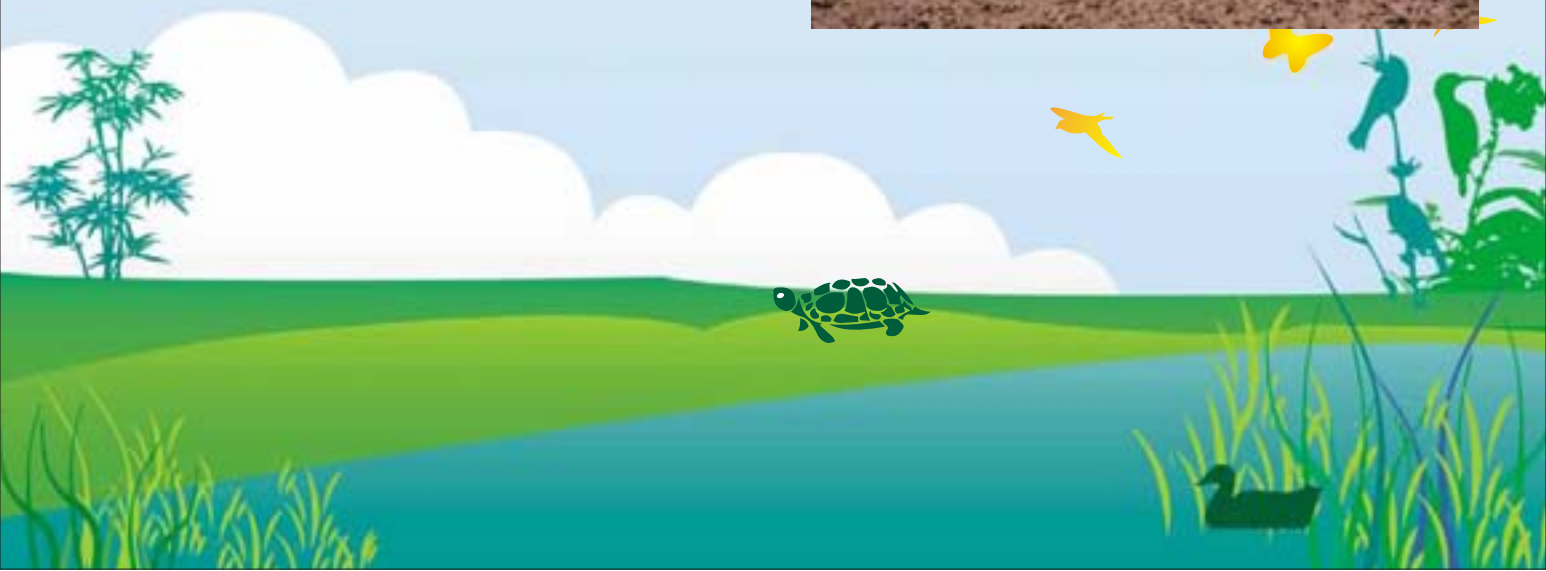
CLAMS: These are bivalve shells that burrow in the mud or sand. In these type of shells the two “valves” are hinged together by a ligament. They take water inside through a tube like structure, filter their food from it and remove the remaining water. Therefore, they are filter feeders. They are edible and their shells are used to make dolls, baskets and different ornaments.



BARNACLE: Barnacles are always found attached to the stems and roots of the mangroves. They are also filter feeders like clams and spend their whole life attached to a substratum. Therefore, they are known as “sessile organisms”.



BIRDS: The mangrove forest are the nesting, roosting and feeding habitat of many birds like Pariah Kite, Herons, Egrets, Waders, Kingfishers, etc.





3.5.1. Who Am I? See the pictures on next page and write their names in the spaces given below:

1 I have 10 legs,
live in small holes in the mangrove
soil, distinctive asymmetric claws.
I am _____

2 Amphibious
kind of fish,
lives in water and crawl on the
muddy ground freely
Can you guess?

3 I also have 10 legs,
but live in big hole in the mangrove
soil, short projecting tail, thick
exoskeleton, and single pair of
claws
I am: _____

4 I live in a conical hard shell. This
shell is for protection. I live in
muddy water but you can also
find me on the ground lying any
where in the mangrove. I am?

5 I have long filamentous white
feather and long legs. I can wade
in the water to hunt fish for food; I
roost on the mangrove trees. I
am? _____

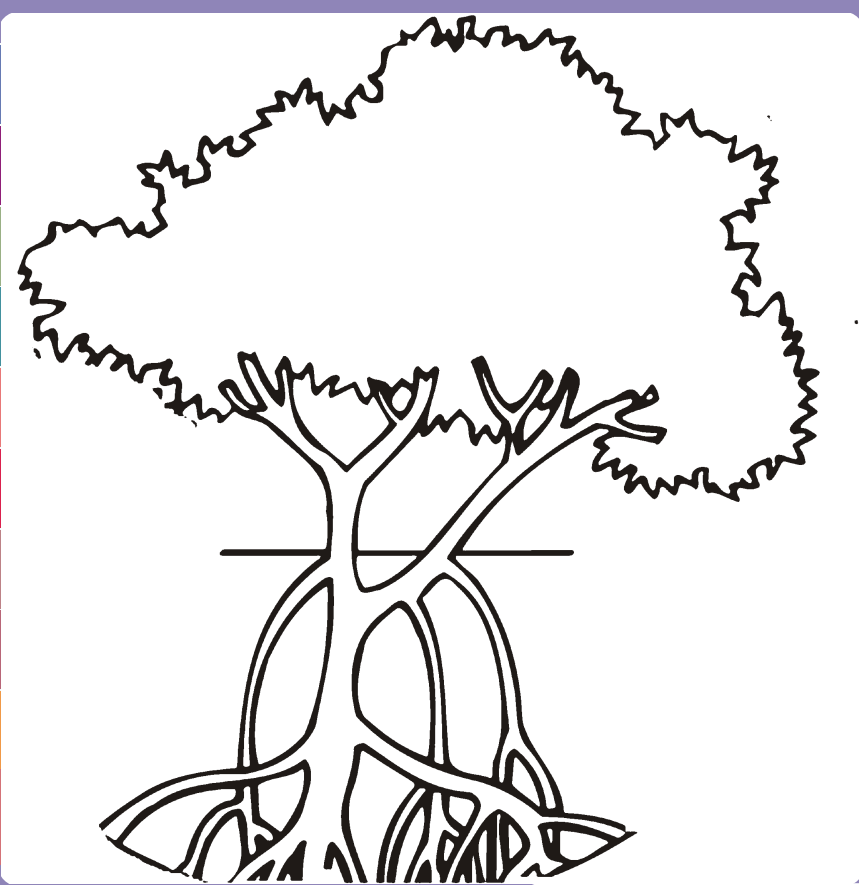
6 I have grey and sometimes white
feathers thicker bill, duller legs, and
a less elegant appearance; I can
hunt fish for food. I am?

7 Coastal inter-tidal plants.
We have specialized roots called
prop roots, pneumatophores and
cable roots. We are?

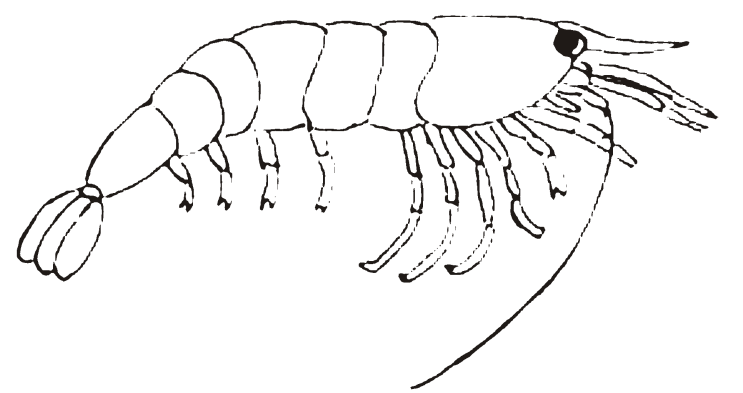
Who am I?



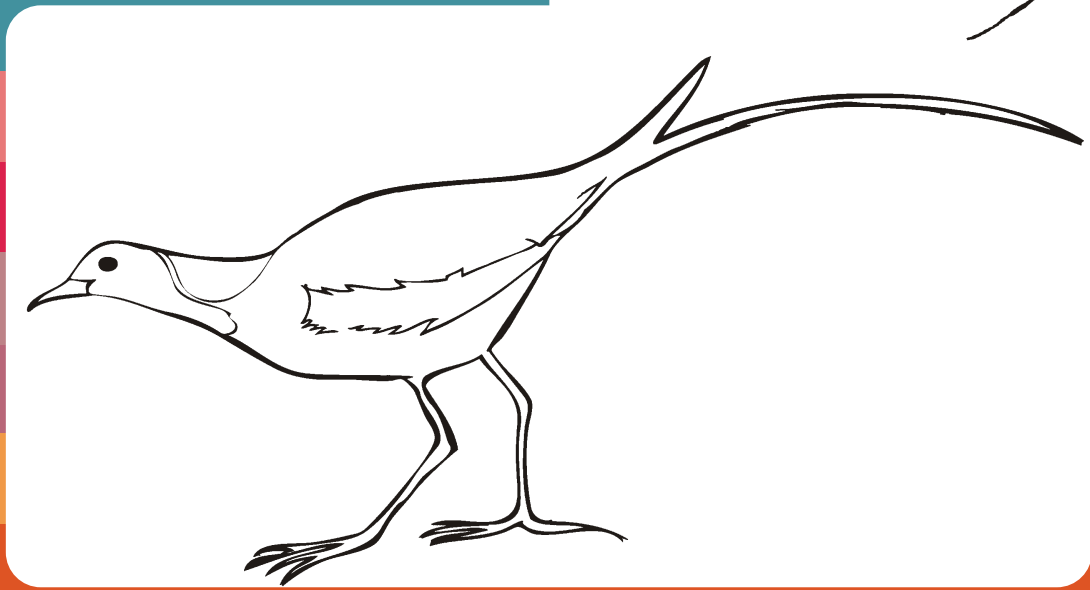
3.5.2 Colour me and write my name



Mangrove

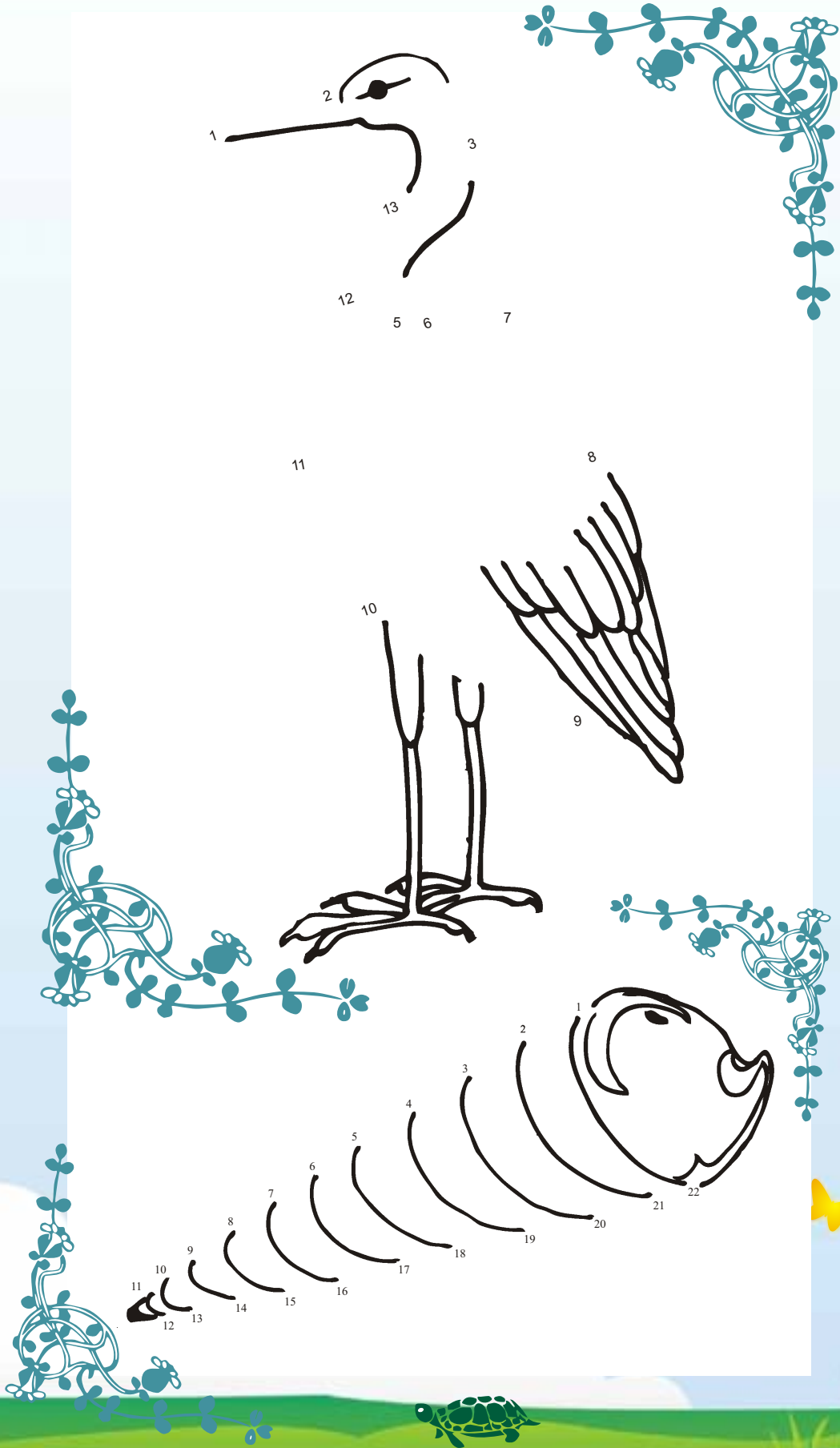
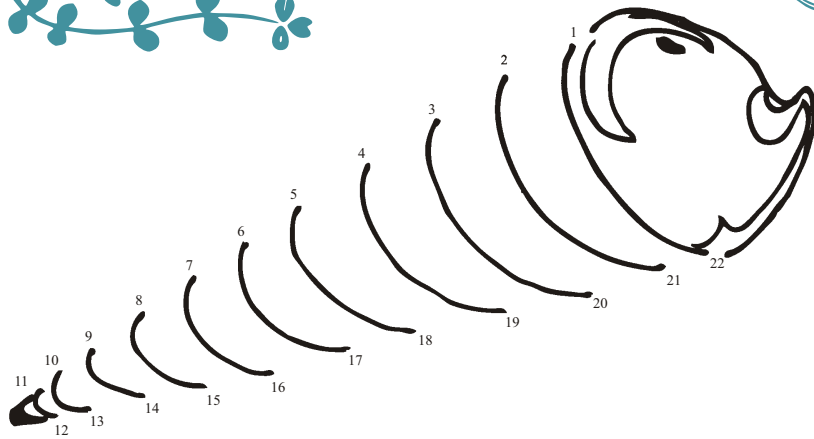
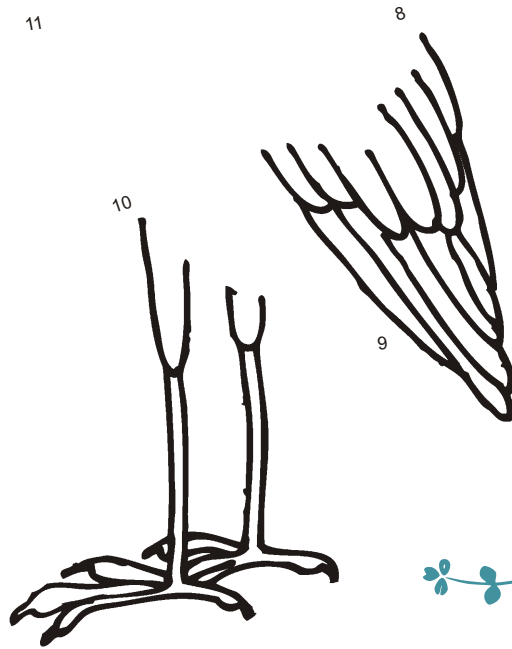
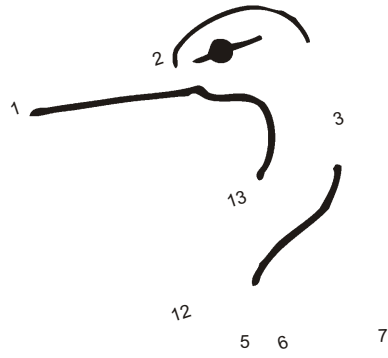


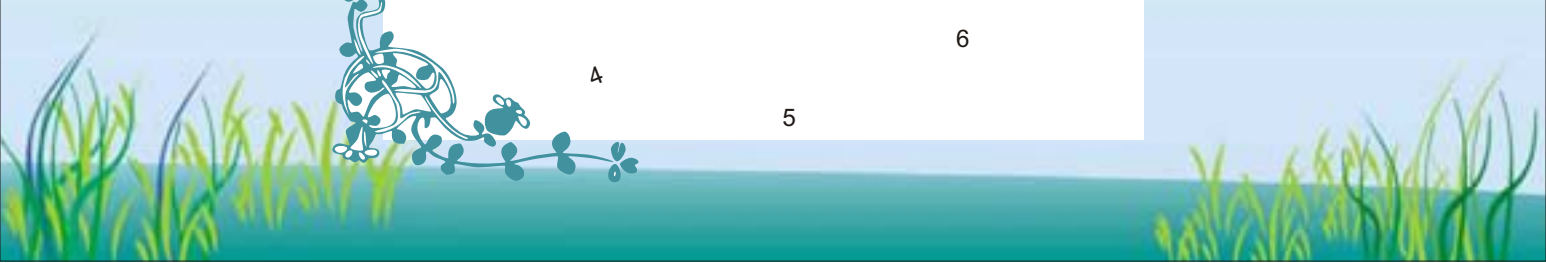
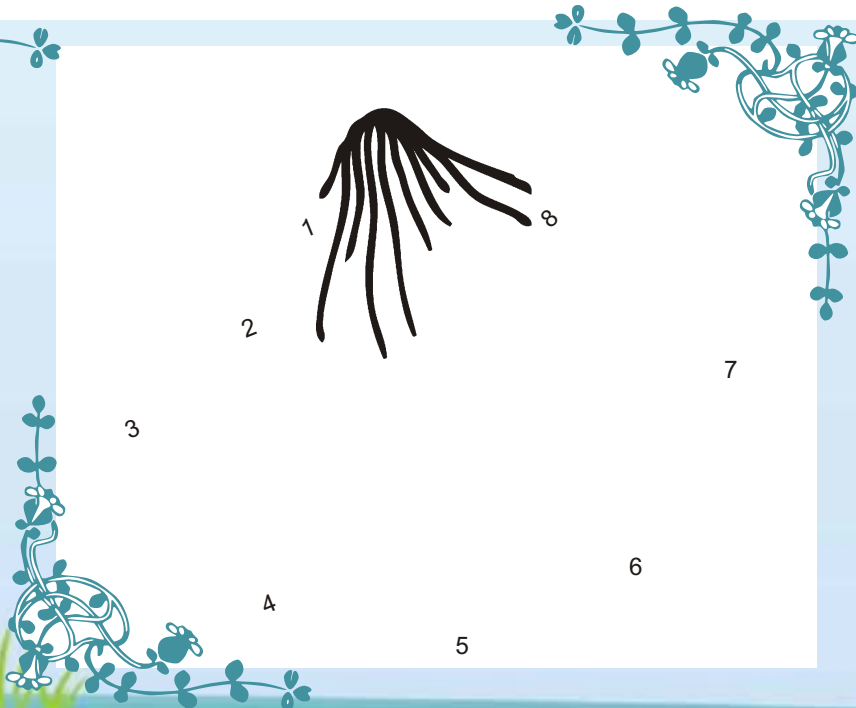
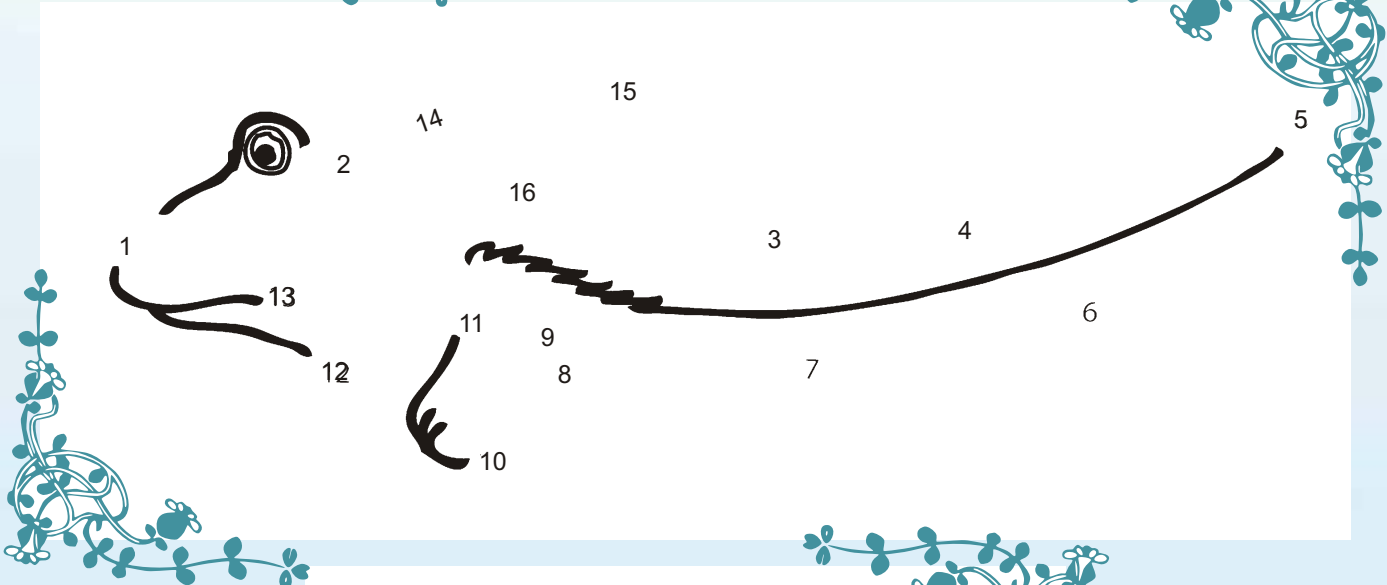
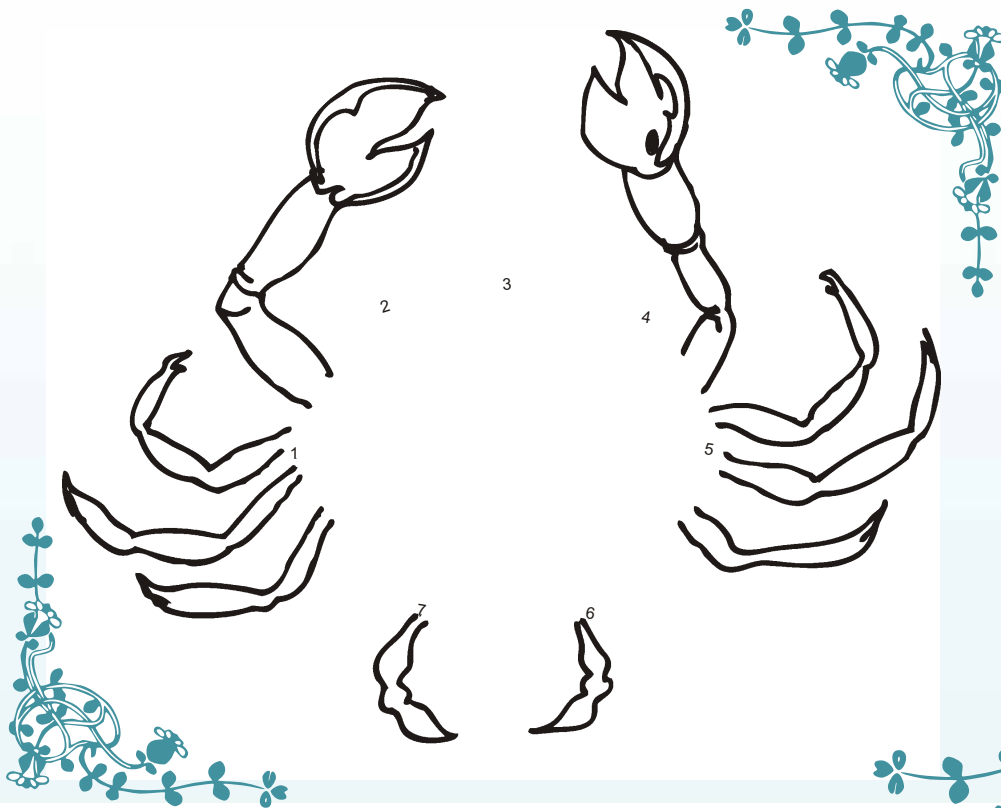
Prawn



Pheasant-tailed jakana

3.5.3 Join the numbers and see who am I?



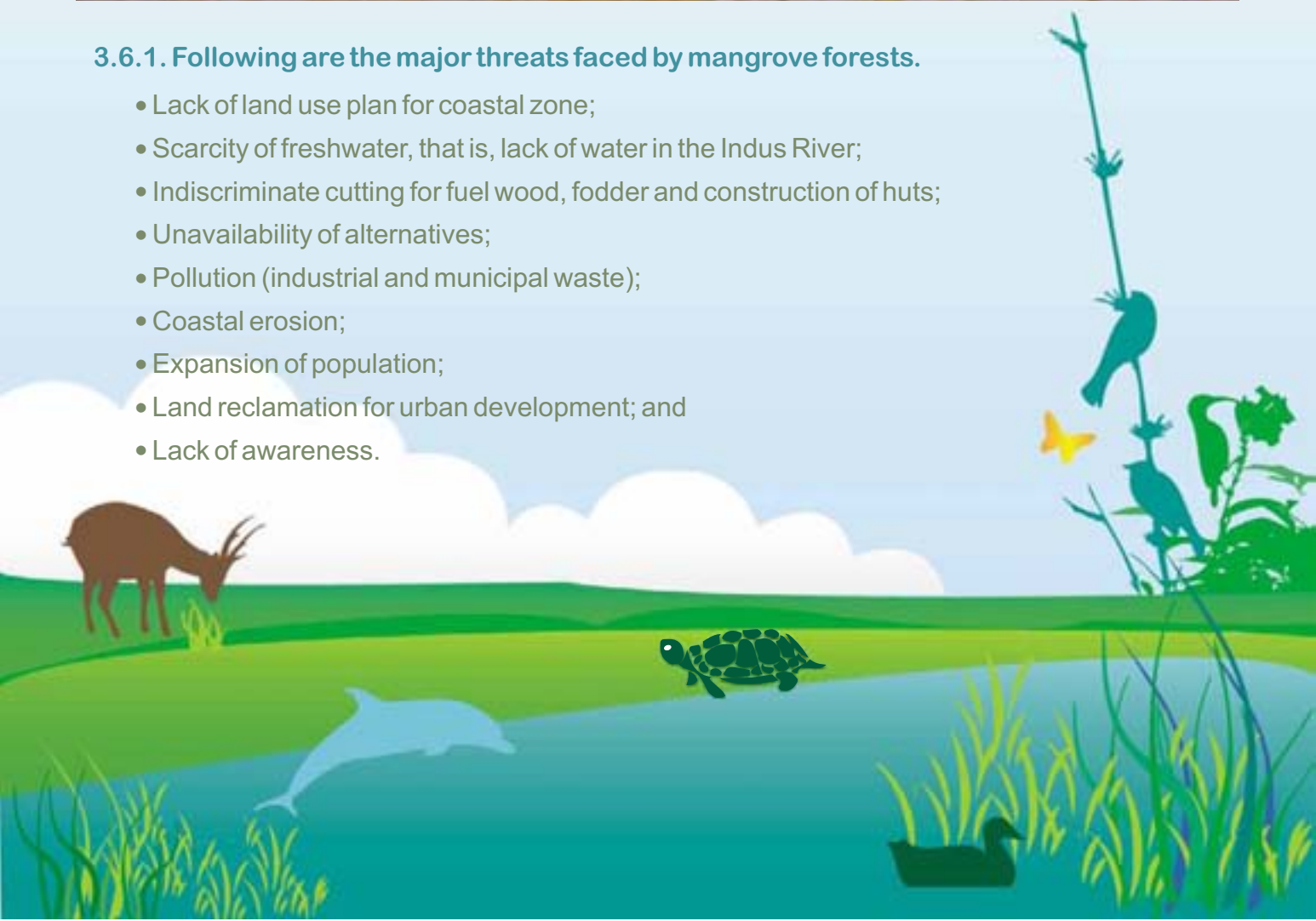


3.6 Why are mangroves threatened?



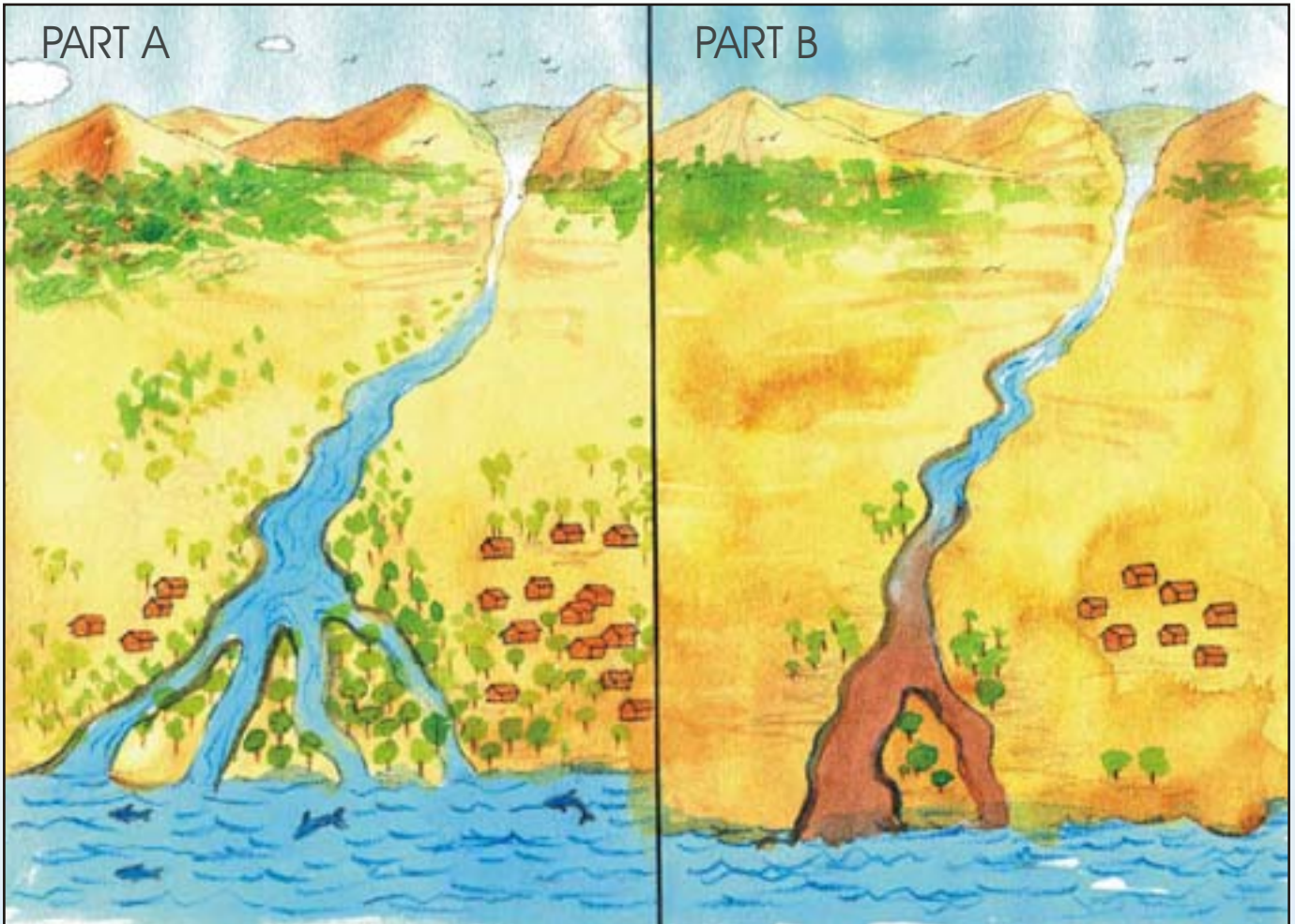
3.6.1. Following are the major threats faced by mangrove forests.

- Lack of land use plan for coastal zone;
- Scarcity of freshwater, that is, lack of water in the Indus River;
- Indiscriminate cutting for fuel wood, fodder and construction of huts;
- Unavailability of alternatives;
- Pollution (industrial and municipal waste);
- Coastal erosion;
- Expansion of population;
- Land reclamation for urban development; and
- Lack of awareness.



3.6.2. Impact of freshwater flow from the Indus River on the mangrove ecosystem in the Indus Delta

See below the two parts of the given picture and find out what is lacking or looking different in part B. It will tell you the effects of lack of freshwater flow from the Indus River into the delta. In your own words write below in the given space the effects of lack of freshwater flow:



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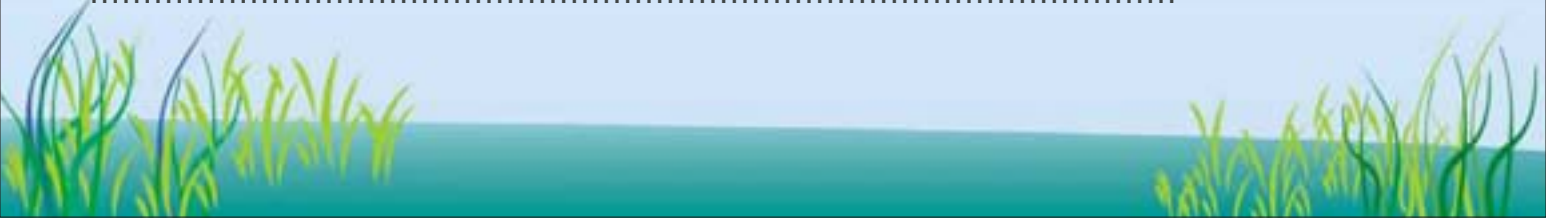
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3.6.3. Describe the pictures below in your own words to elaborate the threats to mangrove ecosystem:



1

1

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2



3

3

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4



4

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3.7.1 Mangrove quiz

1) What is the common name of mangroves?

- a) Timar b) Ficus c) Palm

2) What are the stick like roots called that help mangroves breathe?

- a) Propagules b) Pneumatophores c) Polychaetes

3) Mangrove seeds are specialized in their modification and are called as _____

- a) Vivipar
b) Seeds in the cones
c) Naked seeds

4) What habitat do mangroves survive in?

- a) Muddy estuaries of river's intertidal coastal areas
b) Rain forests
c) On the mountains

5) How many species of mangroves are there in Pakistan?

- a) 4 b) 2 c) 10

6) Most common species of mangroves in Pakistan is

- a) *Avicennia marina* b) Rose c) Palm

7) Mangroves are found in _____ provinces of Pakistan

- a) 3 b) 1 c) 2

8) Mangroves are commonly found in the areas of:

- a) Khyber- Pakhtoonkhwa and Punjab b) Khyber-Pakhtoonkhwa and Balochistan
c) Sindh and Balochistan

True or False

1) Mangroves are not found in Pakistan.

- True False

2) Lions are commonly found in mangroves.

- True False

3) Only single species of mangroves is found in Pakistan.

- True False

4) Mangroves are water resistant plants.

- True False

5) Mangroves are aquatic plants.

- True False

6) Mangroves in Sindh are the richest source of shrimps in Pakistan?

- True False

7) Mud skipper is a kind of fish, amphibious in nature.

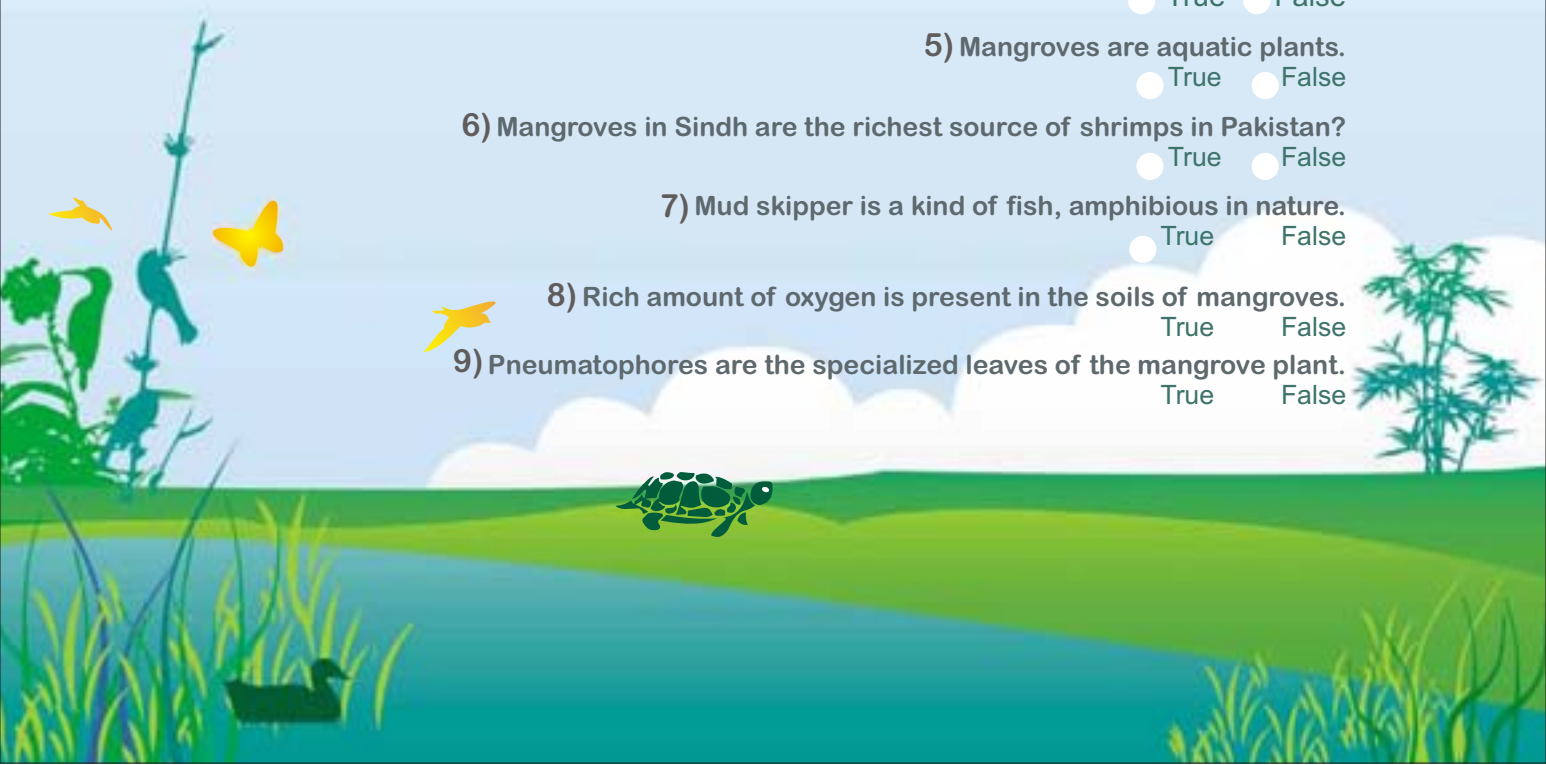
- True False

8) Rich amount of oxygen is present in the soils of mangroves.

- True False

9) Pneumatophores are the specialized leaves of the mangrove plant.

- True False



3.7.2 General questions about mangroves

Mangroves are found in deltaic regions

YES

NO

Mangroves are salt resistant plants

YES

NO

Mangroves are not very important

YES

NO

Rich amount of oxygen is present in the soil of mangroves

YES

NO

Pneumatophores are the thick leaves of mangrove plants

YES

NO

YES

NO

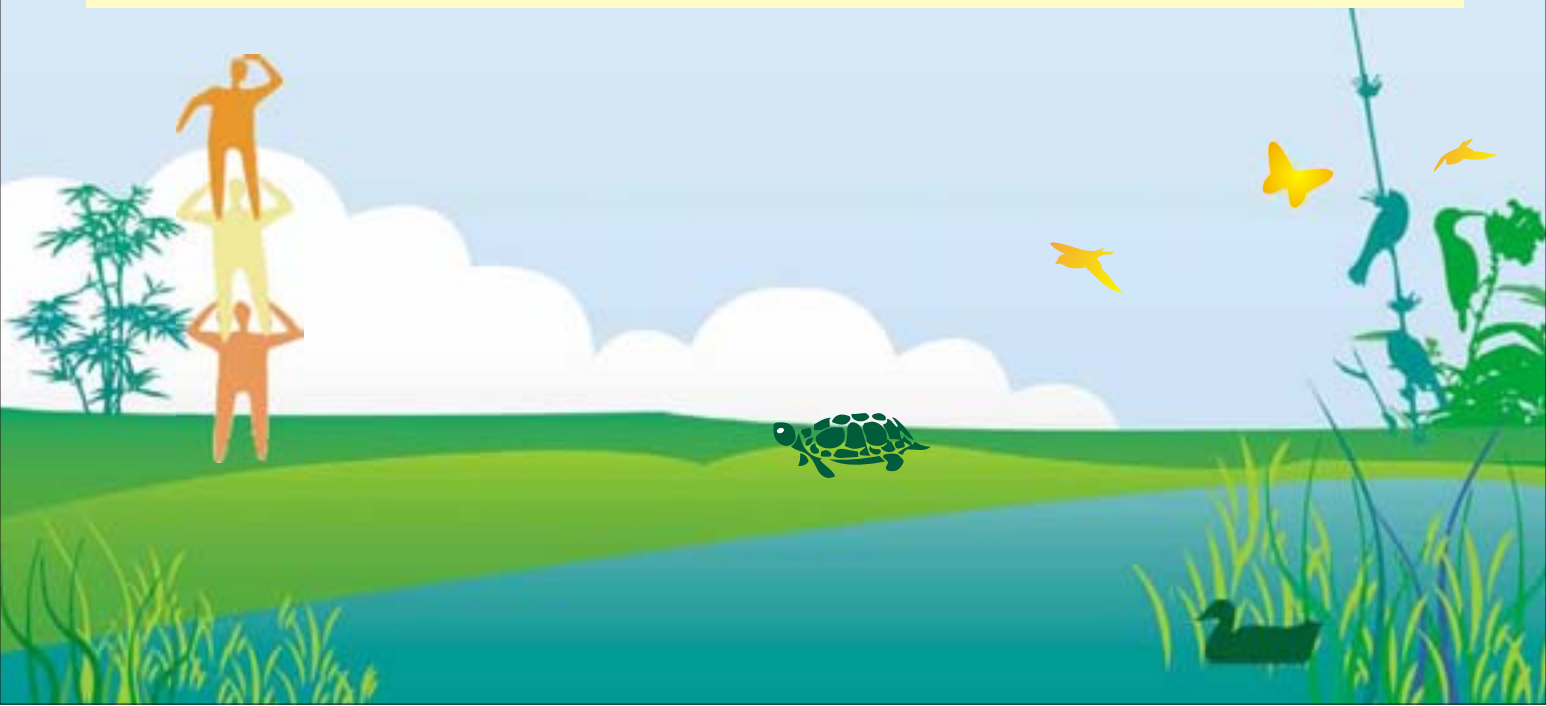
Mangroves are breeding grounds for

There are _____ types of mangrove species in Pakistan

Roots of *Avicennia* tree are called as _____

_____ type of roots are found in *Rhizophora* sp.

Most common mangrove species in Pakistan is _____



3.8 What you can do to help reduce degradation of mangrove forests?



Avoid polyethene shopping bags, use reusable cloth bags for shopping

Use water



Plant



Use dustbins for disposal of garbage.

Organize beach, lake, river or creek clean up campaigns



Raise your voice against over grazing



Wetland Ecosystem



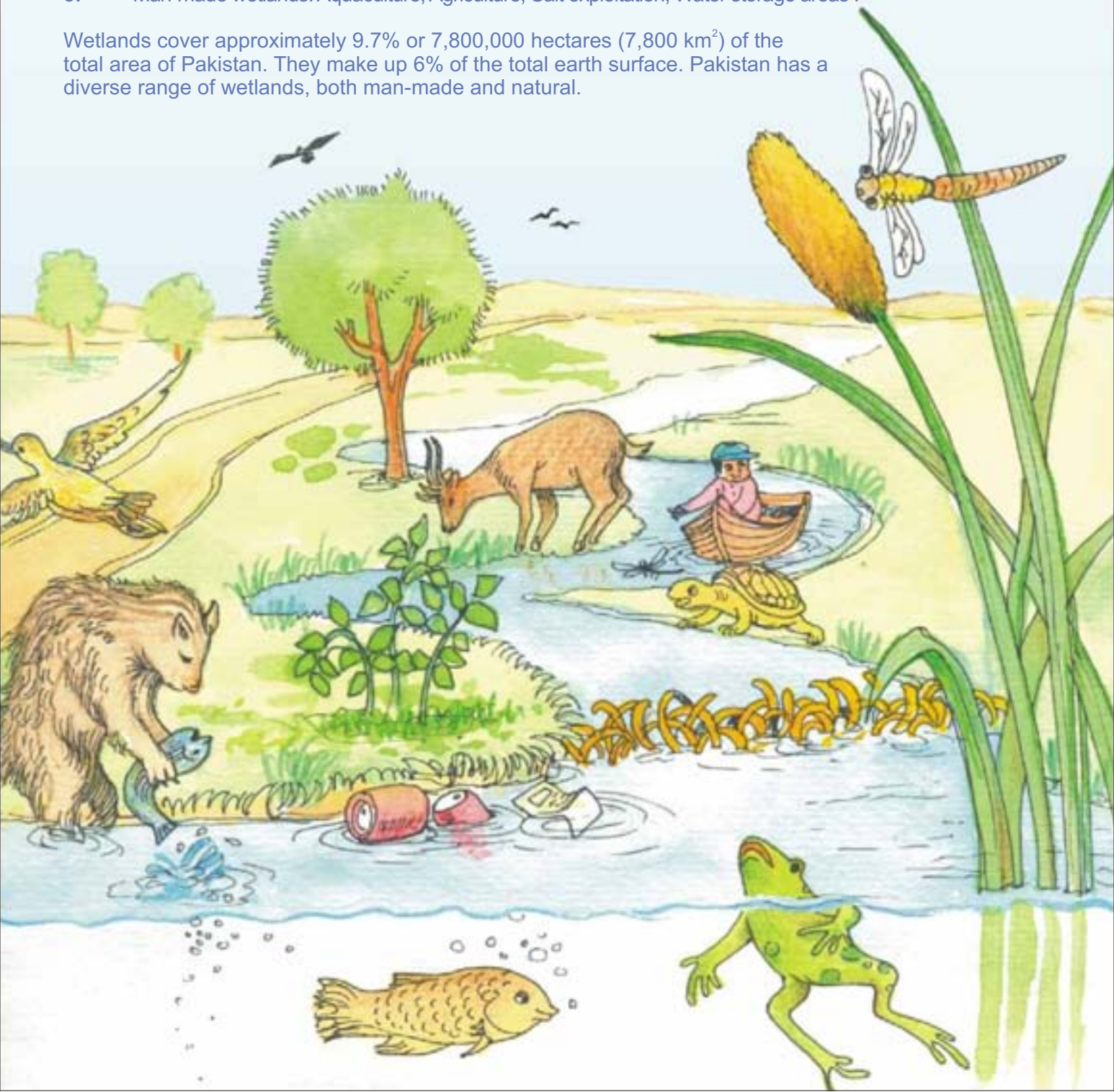
4.1. Introduction

Wetlands are a combination of water and land. The water either covers the land or is present near land surfaces. The water may be standing, such as, ponds or marshes or moving, like rivers, canals, etc. These are also known as swamps, marshes and bogs. The water may be a few inches deep or several feet in depth at which low tide does not exceed six meters. The water is fresh or salty or sometimes a combination of both kinds.

Due to different conditions in climate, vegetation, geography and hydrology, wetlands can be classified as marshes, estuaries, mudflats, ponds, swamps, deltas, open coasts, coral reefs, lagoons, shallow seas, bogs, lakes, peat lands and freshwater swamps. However, these can be broadly classified into three main groups which have their own sub-groups:

1. Salt water: Marine, Estuarine and Lagoons;
2. Freshwater: Riverine, Lakes;
3. Man-made wetlands: Aquaculture, Agriculture, Salt exploitation, Water storage areas .

Wetlands cover approximately 9.7% or 7,800,000 hectares (7,800 km²) of the total area of Pakistan. They make up 6% of the total earth surface. Pakistan has a diverse range of wetlands, both man-made and natural.

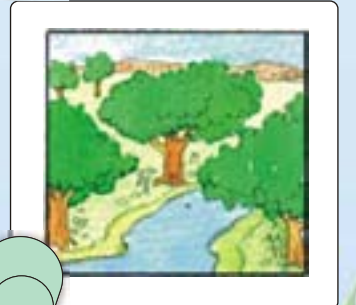
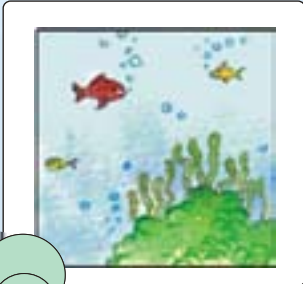
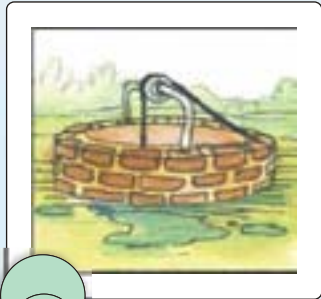
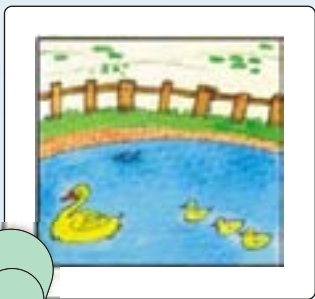
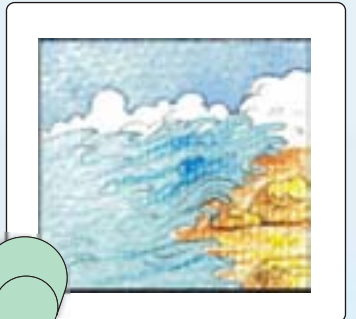
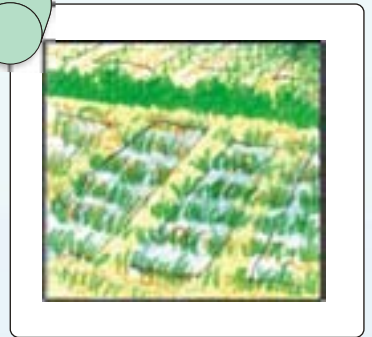
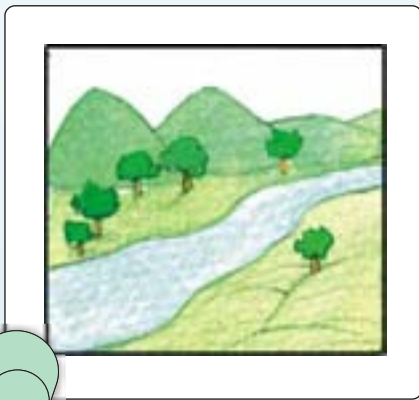


4.1.1. Put (✓) on the correct answer that describes what wetlands can be:

- A place of natural environment
- A place of artificial environment
- A place with permanent water
- A place with temporary water
- A place with flowing water
- A place with stagnant water
- A place of same size and shape
- A place of freshwater only
- A place of salty water only
- A place that provides natural habitat to plants and animals
- An area in sea where water depth is more than six meters
- A place without living organisms

4.1.2 Identify wetlands

Put (✓) mark on the wetlands and (×) which are not wetlands



4.2. Wetlands Organisms in Sindh

Wetlands provide support for aquatic and terrestrial species of plants and animals. Due to multiple benefits these are considered as a highly productive ecosystems of the world and regarded as “biodiversity supermarkets”. Many varieties of plants, animals, insects, amphibians, reptiles, mammals, fishes and birds are special features of wetlands

Flora:

Wetland plants are especially adapted to waterlogged soils and are an important resource for people living in the wetland environment. Many are economically important, such as rice, a staple food, which is a primary food source of over half of the world's population. Another example can be given of mangroves which are salt tolerant plants and provide a breeding ground for fishes, prawns, shells and birds.

Fauna:

Wetlands are a great gene pool for vertebrate and invertebrate fauna.

Mammals:

There are several wetland mammals in which the only known endemic or endangered mammal is the Indus dolphin (*Palatanista minor*). Other common mammals are: Otter, Fishing cat, Hog deer, etc.

Birds:

Wetlands host many migratory birds as well as resident birds. Approximately, one third of the recorded species are water birds. Some common birds include the Siberian crane, Black winged stilt, Dalmatian pelicans, Marbled teal, Osprey, etc.

Reptiles:

There are many internationally threatened reptiles dependent on wetlands. Some of the species are the Green turtle, Olive ridley turtle, Spotted pond turtle, Crocodile or Mugger, Gavial or Gharial, Monitor lizard etc.

Fish:

The Indus River plains and the Khirthar mountain range are the richest areas in terms of variety of fish. However, there are a number of species which have shown a significant decrease in quantity over the years. Some of these are: Karlee, Black Rohu, Kharni, Khagga, Palla etc.

Amphibians:

There are relatively few amphibians because of the arid and semi-arid climate. Few of these are Indus valley toad and bullfrog.



4.2.1 Wetland organisms and their homes in the Indus Ecoregion

Try to find out their homes in different types of wetlands.

Home: mudflats, bank of river, ponds and lakes, dry forested areas, desert and wetlands mix, freshwater wetlands, junction of fresh and salt water in coastal belt



Otter (I am a fish eating mammal having webbed feet and sharp claws)

1



White-headed stilt (My legs are long and reddish, my bill is also long and curved which helps me to prey on mud).

4



Walking crab (I have a soft body covered with hard shell. I live on the edges of watery areas)

3



Mangroves (We are very unique plants with aerial roots. We provide breeding ground to fishes, prawns, shells and birds)

2



Marine turtle (I have a very hard shell around my body and I come out of water to lay eggs)

6



Crocodile (I am a large reptile with webbed feet and rough skin)

5



Monitor lizard (I can monitor my surroundings by flicking tongue. I have long, strong tail and sharp teeth)

7

4.2.2. Unscramble the words below to know more about wetland biodiversity:



Plohdni

a

I am a mammal not a fish

A kind of fish

b

Lapal

I am a slow-moving reptile and lay eggs on the beach

c

Trulte

we are unique plants with aerial roots and provide habitat for fish, birds and crabs

d

Grmanoevs

e

I am a water bird that prefers lakes

Sopeyr

I am a combination of water and land

f

Lawtend

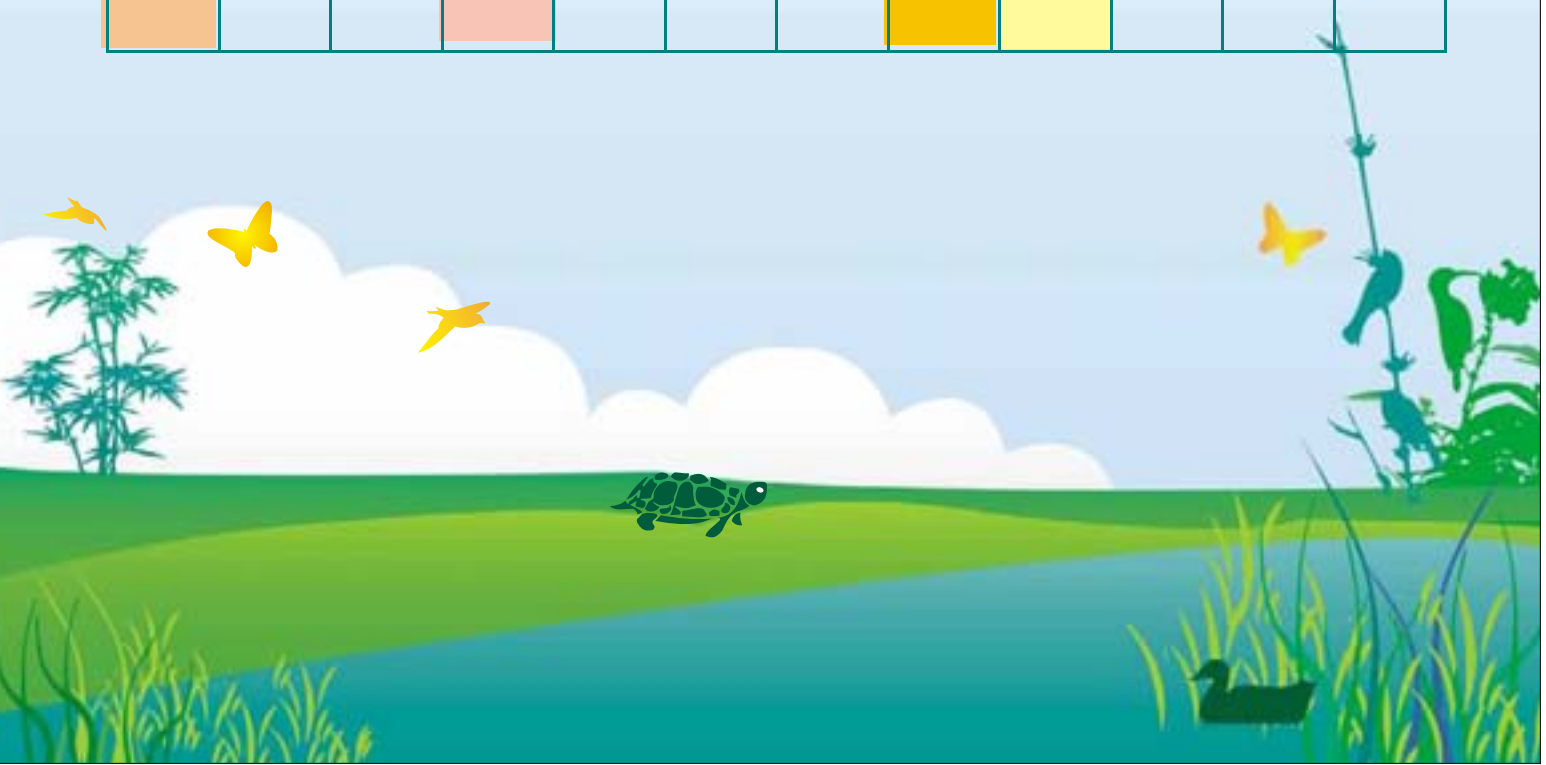




4.2.3 Wetlands crossword puzzle

Wetland, turtle, swamp, bogs, pond, marshes, fish, sea, river, dolphin, mangroves, lagoon, delta, beach, lake, peat, forest

T	U	T	P	O	N	D	W	E	T	B	L
R	U	U	O	P	Q	O	E	W	E	B	A
A	E	R	F	I	S	H	T	R	B	O	G
S	B	T	T	T	A	W	L	M	D	G	O
W	D	L	A	D	P	O	A	A	O	S	O
F	P	E	E	N	O	N	N	R	L	F	N
O	P	L	R	H	G	D	D	S	P	O	R
R	T	S	A	R	M	I	P	H	H	R	L
A	L	E	O	K	I	L	E	E	I	E	V
V	I	V	U	T	E	V	O	S	N	S	I
E	E	B	E	A	C	H	E	I	E	T	G
S	E	A	D	P	E	A	T	R	T	N	T



4.3 Benefits of Wetlands

Wetlands provide us various types of food and other products. Fish and rice are typical wetland products that we usually use in our food. In addition, lots of products in rural areas of Sindh such as material for thatched huts, bamboos, baskets, etc are obtained from wetlands.



4.3.1. Functions of Wetland ecosystems

- Flood control;
- Water storage;
- Water purification;
- Role in nutrient cycling;
- Protection to shorelines;
- Home for different types of flora (plant species) and fauna (animals and birds);
- Biological productivity;
- Recreational activities like hunting, boating, bird watching and wildlife photography; and
- Economical values as furbearing and leather producing species, fish harvest, timber, fuel wood etc.



4.3.2 Match the following statement describing functions and values of wetlands.



A wetland is a kidney

A wetland is a pillow

A wetland is a ship

A wetland is a book

A wetland is a sponge

A wetland is a strainer

A wetland is a food web

A wetland is a sun hat

A wetland is a guard

A wetland is a home

it provides recreational opportunities

that filters out sediments and pollution

it functions as remover of wastes

many plants and animals live in it

it provides shade and cooling

it protects shorelines from erosion

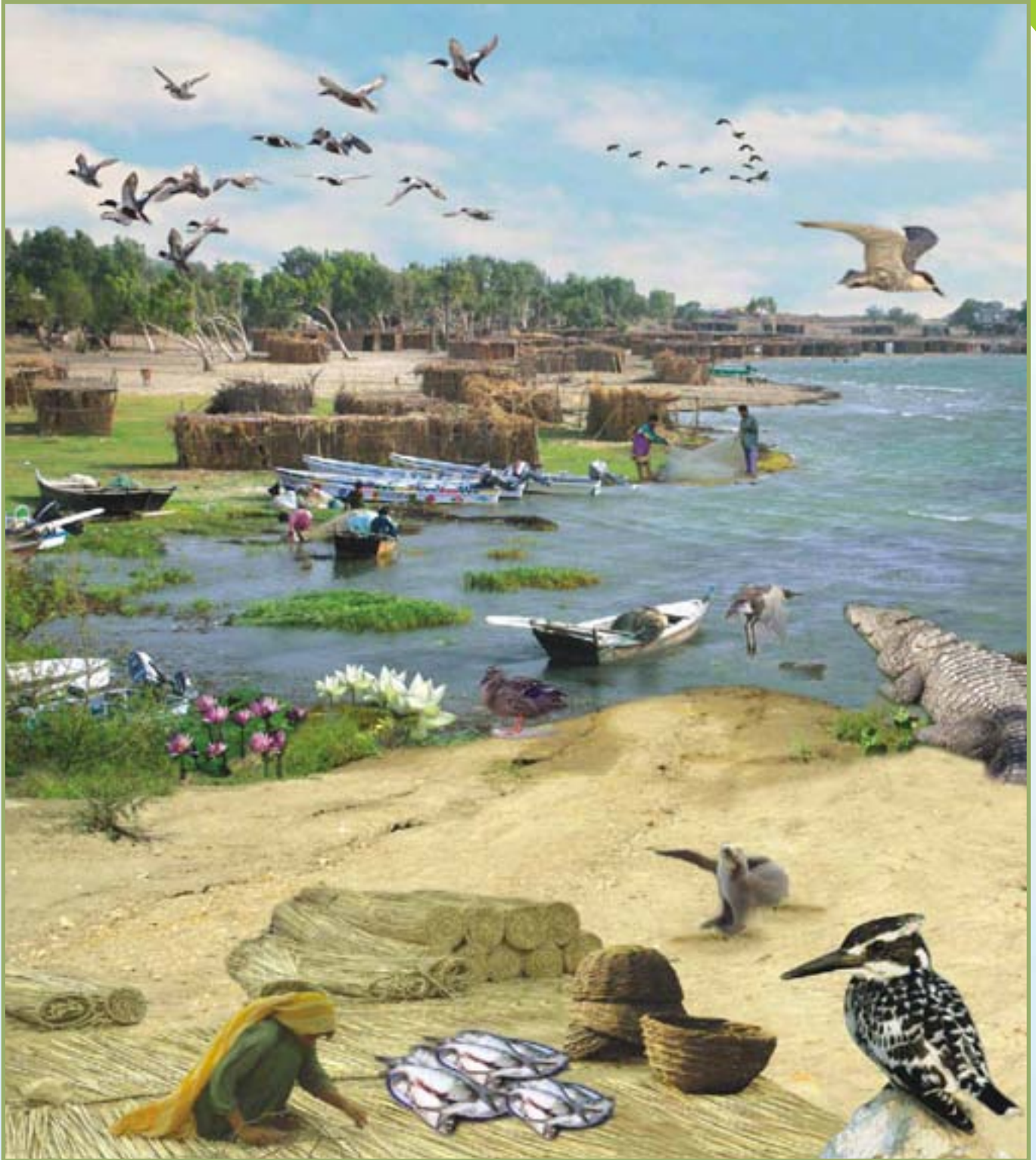
it is the resting place for migratory birds

it provides food for wildlife and humans

people can learn a lot from wetlands

it soaks up water and prevents flooding

4.3.3 Wetland Products and Services



By observing the given picture describe the following:

1. Types of activities people do at wetlands

2. Type of products that people obtain from wetlands

3. Name animals and birds found at wetlands

4.3.4 The following fish are common in the freshwater wetlands of Sindh, including Kuriro or Rohu (*Labeo rohita*), Morakho (*Cirrhinus mrigala*), Theeri or Theeli (*Catla catla*), Dahi (*Labeo calbasu*) and the famous Palla fish (*Tenualosa illisha*). Write down names next to the photos. (You can ask your families if you are not sure about their names).











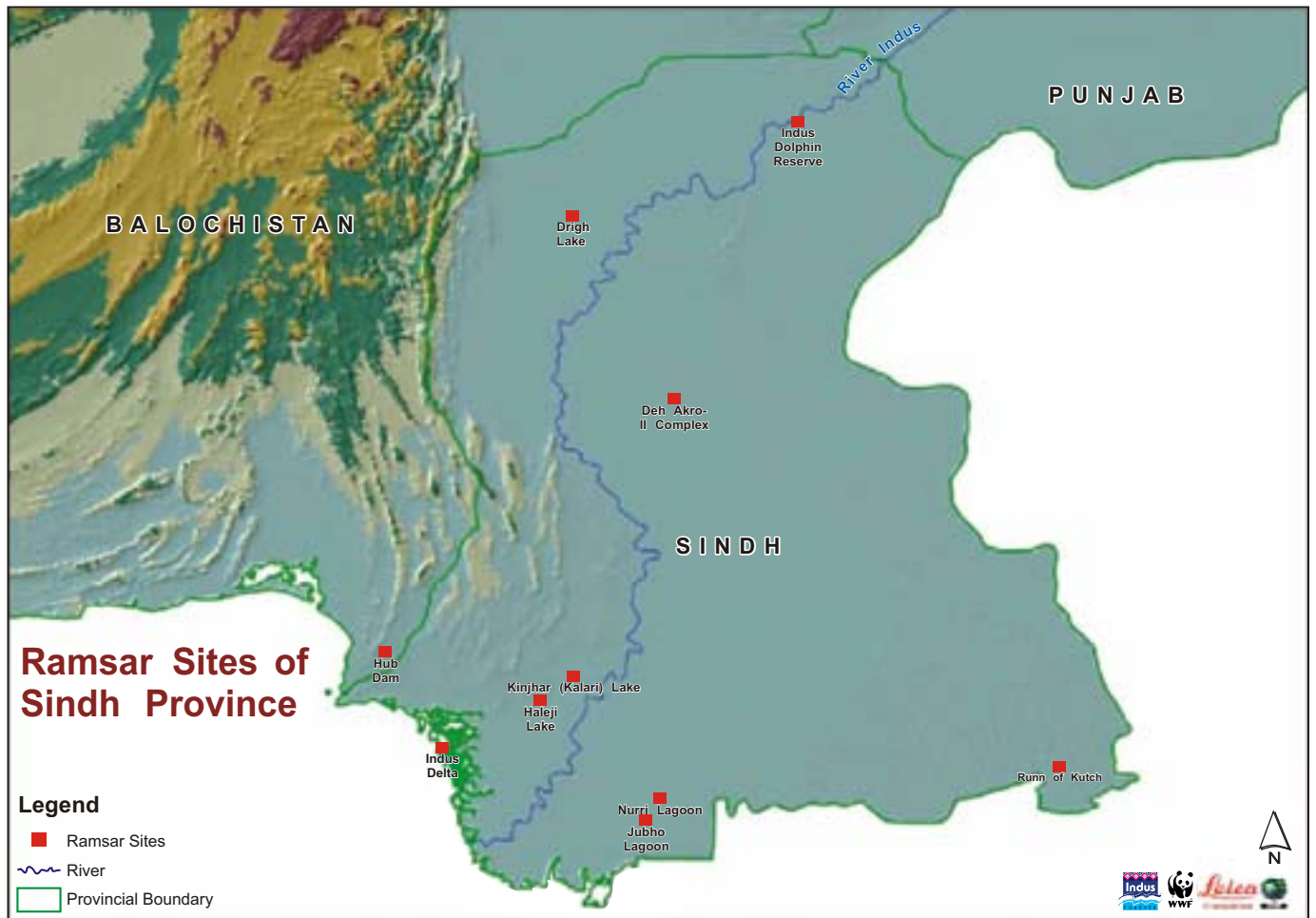
4.3.5. Name any three products raised in wetlands that you use in your food?

1.
2.
3.



4.4. Ramsar Sites in Sindh

In Pakistan, 19 wetlands covering an area of 1,343,627 hectares have been declared as “Ramsar sites”, of which 10 are in Sindh. Ramsar sites are wetlands of international importance designated under the Ramsar Convention on Wetlands, 1971. These wetlands are known for their ample biodiversity, extensive, rich food webs and high economical and ecological benefits.



Following are the Ramsar sites in Sindh:

1. Deh Akro-II Desert Wetland Complex
2. Drigh Lake
3. Haleji Lake
4. Hub Dam
5. Indus Delta
6. Indus Dolphin Reserve
7. Jubho Lagoon
8. Keenjhar (Kalri) Lake
9. Nurreri Lagoon
10. Rann of Kutch

4.4.1. Various types of habitats and animals can be found in these Ramsar sites. Please fill the spaces below with the correct animals/species name and habitat type for the corresponding Ramsar site.



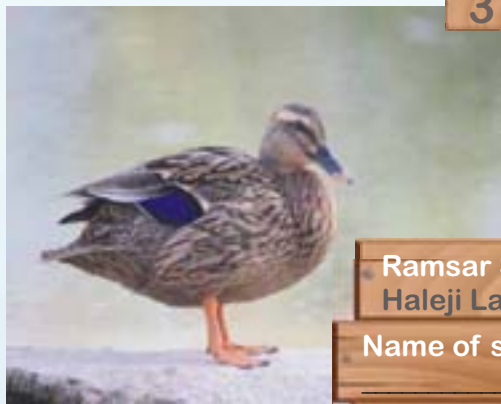
1

Ramsar Site:
Indus River
Name of species:
Habitat Type:



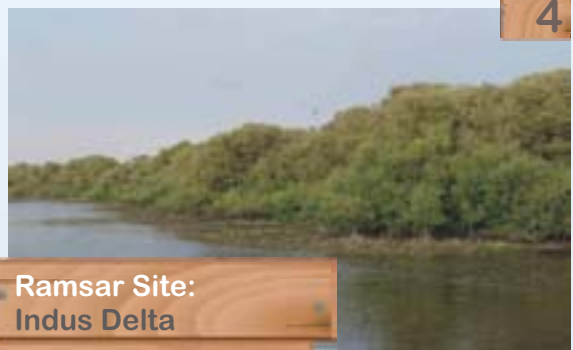
2

Ramsar Site:
Deh Akro-II Desert Wetland Complex
Name of species:
Habitat Type:



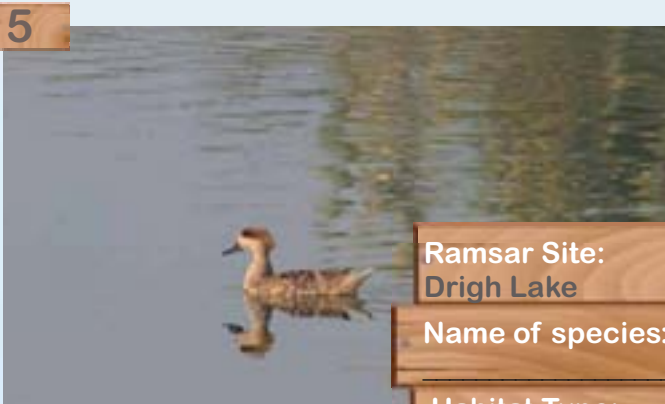
3

Ramsar Site:
Haleji Lake
Name of species:
Habitat Type:



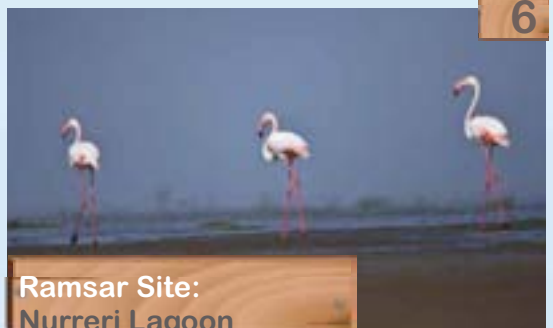
4

Ramsar Site:
Indus Delta
Name of species:
Habitat Type:



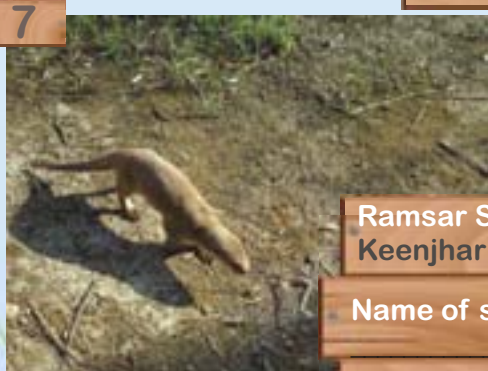
5

Ramsar Site:
Drigh Lake
Name of species:
Habitat Type:



6

Ramsar Site:
Nurreri Lagoon
Name of species:
Habitat Type:



7

Ramsar Site:
Keenjhar Lake
Name of species:
Habitat Type:






4.5.1 Causes of Wetland Loss and Degradation



4.5.1 Human Actions

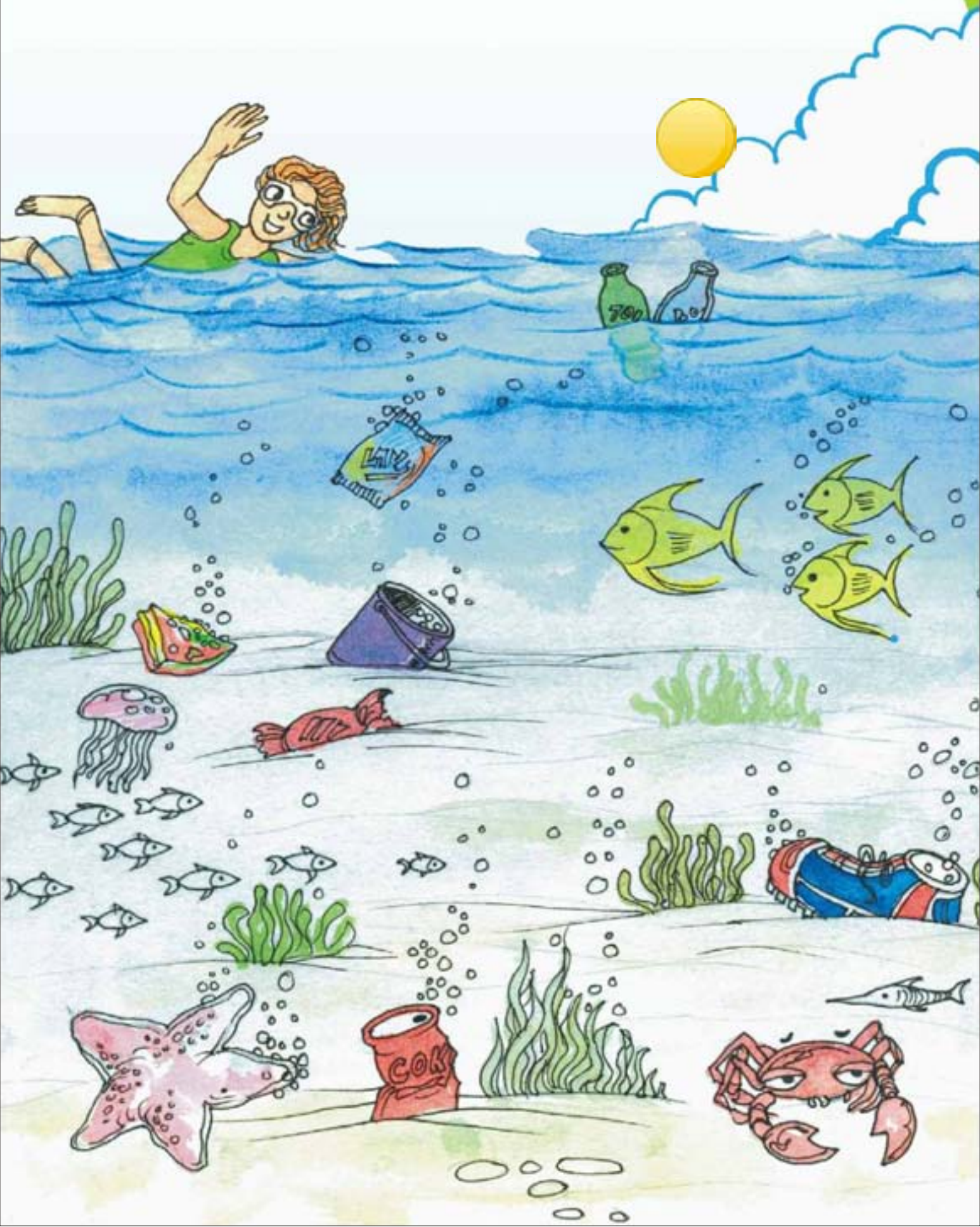
-  Drainage
-  Stream channelization
-  Deposition of fill material
-  Damming
-  Tilling for crop production
-  Logging
-  Mining
-  Construction
-  Runoff
-  Air and water pollutants
-  Changing nutrient levels
-  Releasing toxic chemicals
-  Introducing non-native species
-  Grazing by domestic animals

4.5.2 Natural Threats

-  Erosion
-  Subsidence
-  Sea level rise
-  Droughts
-  Cyclones and other storms

4.5.3. How do our actions damage wetlands

Encircle the actions/things in the given diagram that cause harm to wetlands.





4.6 ABC of the Indus Ecoregion/ Wetlands

A for aquatic (water, water everywhere)

B for bogs (wetlands characterized by a waterlogged, spongy mat, featured by sedges, evergreen trees and shrubs)

C for coral reef (found in marine water containing few nutrients and produced by living organisms)

D for dolphin (an aquatic mammal not a fish, very intelligent and friendly creature)

E for ecosystem (relationship of living organisms and non-living organisms among themselves within a specific area of environment)

F for fens (peat-accumulating wetland that generally receives water from surface runoff and (or) seepage from mineral soils in addition to direct precipitation)

G for groundwater (freshwater located under ground)

H for habitat (a place where animals and plants occur naturally)

I for Indus River (longest river of Pakistan and also known as 'Father of Rivers')

J for Jungle cat (also known as swamp lynx, is a medium size cat having yellowish grey or reddish brown fur)

K for Keenjhar Lake (is the largest freshwater lake of Pakistan in Thatta, Sindh)

L for lagoon (a shallow stretch of seawater (or lake water) near or communicating with the sea (or lake) and partly or completely separated from it by a low, narrow, elongate strip of land)

M for marshes (an area of soft, wet, lowlying land, characterized by grassy vegetation), mangroves (tropical evergreen trees grown in wetland areas)

N for Native (an animal or plant certain endemic to certain regions)

O for organisms (a living thing)

P for ponds (a relatively small body of standing, freshwater; usually shallow enough for sunlight to reach the bed), pollution

Q for quadrat (an area of a certain size (generally from 1 to 20 square meters) within which biodiversity is monitored)

R for riverine wetland (wetlands within river and stream channels), Ramsar Convention (an intergovernmental treaty for the conservation of wetlands)

S for swamps (a wetland where the soil is saturated and often inundated and dominated by shrubs or trees)

T for tidal wetland (a wetland that is subject to the periodic rising and falling of sea level generated by gravitational forces of the moon and the sun)

U for upland (a general term for non-wetland)

V for vegetation (plants or plant life)

W for wetlands (combination of water and land, water either covers the land or is present near the land surface)

X for xerophytes (desert plants in dry arid habitat)



























Y for yellow wagtail (a long-tailed bird with yellow upper and lower parts living in damp grasslands)

Z for zooplankton (free floating animals ranging from micro organisms to larger animals)



4.7. What we can do to save wetlands?

Decode the words in these messages to find out what you can do to save wetlands. Replace code with alphabets as given in the list

- A= 
- B= 
- C= 
- D= 
- E= 
- F= 
- G= 
- H= 
- I= 
- J= 
- K= 
- L= 
- M= 
- N= 
- O= 
- P= 
- Q= 
- R= 
- S= 
- T= 
- U= 
- V= 
- W= 
- X= 
- Y= 
- Z= 

1







2



3



Desert Ecosystem



5.1 Introduction.

Desert areas are characterized by large tracts of barren land that receive very little rainfall leading to frequent drought-like conditions. The vegetation is sparse and primarily comprises of stunted scrubs. Deserts are fragile environments.

The desert region in Sindh covers an area of approximately 88,000 Km² and comprises of Thar, Nara and Kohistan. It forms nearly 61% of the Sindh Province. The Thar region is mainly in the Tharparkar district and extends southwards along the Runn of Kutch. It extends over an area of 23,000 Km² and has a population of one million people. The Nara region spans 22,000 Km² and it lies in five districts: Sukkar, Shaheed Benazirabad (formerly Nawabshah), Khairpur and Sanghar. Finally, Kohistan, with coverage of 43,000 Km² comprises parts of Dadu, Larkana and Thatta districts.

Desert areas in Sindh form an important ecosystem harbouring a variety of flora and fauna. Desert fox, Chinkara gazelle, Sawscale viper and Sandgrouse are some of the important species of this ecosystem.

The desert areas are among the poorest in Pakistan, with lack of infrastructure facilities in health, education etc. Majority of the people are involved in dairy production and raising cattle. However, due to limited or no access to resources, and lack of education and training, people are not able to maximize their economic potential. Traditional methods of livestock breeding are still being practiced and animal mortality rate remains quite high due to malnourishment during droughts. Since rain is the main source of water and therefore agriculture and livestock activities are dependent on rainfall, the failure of monsoon means no fodder for the cattle and livestock. Further, to compound the problem poor transportation links make import of fodder from other areas quite expensive and therefore unaffordable for the locals.

Sources: IUCN (2004), Sindh State of Environment and Development, Sindh Programme Office, Karachi, Pakistan.



5.1.1 Circle the correct answer:

1. Desert areas are mainly:

- a. Large barren tracts with little rainfall
- b. Sand dunes
- c. Land with no plants
- d. Land with no water

2. Desert areas in Sindh, comprise of:

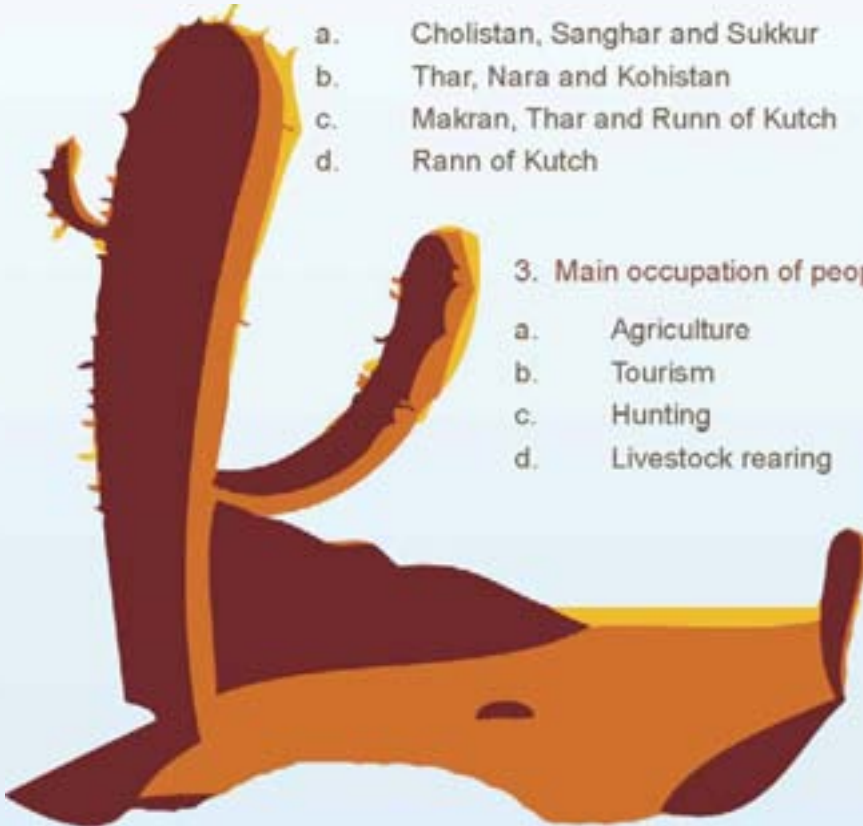
- a. Cholistan, Sanghar and Sukkur
- b. Thar, Nara and Kohistan
- c. Makran, Thar and Runn of Kutch
- d. Rann of Kutch

3. Main occupation of people in desert areas of Sindh is:

- a. Agriculture
- b. Tourism
- c. Hunting
- d. Livestock rearing

4. What percentage of Sindh comprises of sub-tropical desert areas:

- a. 21%
- b. 41%
- c. 61%
- d. 71%



5.2 Identifying Species of Desert in Sindh



Monitor Lizard is a carnivorous lizard. They are intelligent creatures and some can even count!



Sawscale vipers are quick-tempered and strike readily. They have a characteristic threat display, rubbing sections of their body together to produce a "sizzling" warning sound.



Sandgrouse have small, pigeon-like heads and necks, but sturdy compact bodies. They are principally seed eaters.

Desert cat, is a nocturnal creature. It eats mainly small mammals and rodents.



Chinkara gazelle is a shy animal and avoids human habitation. It can go without water for long periods and can get sufficient fluids from plants

Desert fox has such strong legs that it can run at a speed of roughly 72 km/h. However, the desert fox has very "poor" eye-sight.



5.3 Roll the dice, play the game and explore the desert ecosystem

Welcome, tourist! You have entered the desert's realm of beautiful wildlife creatures. Your journey will now begin. But, beware! You must follow the instructions or you will never reach the buried treasure!

1. You would need to arrange one dice and two to three tokens to race along the given route.
2. A maximum of three tourists (players) can have camel safari per game.
3. You will roll the dice on your turn and move the number of spaces shown by your dice.
4. You will then refer to the 'Travel Guide' given on the next page and follow the instructions given to you by the genie's wildlife creatures to reach the treasure.



Travel Guide: Thar Desert Safari

1. Hullo, traveller! I am the Ring Dove of the Thar desert. You can also find me in semi-arid regions where some vegetation exists.

As a luck charm for your journey, I allow you to move directly to 3.

2. Ho, ho, ho, traveller! Meet me; I am the cactus. I am an extremely unusual plant with special powers. Did you know that these spines of mine were once leaves? I can store water in my fat stem. That is why I am able to survive in the desert.

I give you a chance to roll the dice one more time. If you score 1, 2 or 3. I shall let you move one space ahead. But, if you score 4, 5 or 6 you will have to start from the beginning. Good luck.

3. Traveller, you have landed safely on number 3. Wait for your next turn here.

4. Ah, traveller! I was warned that I might be meeting you. Who am I, you're wondering? I am the Grey Partridge of the Thar Desert. Have you heard of me? I am very popular among hunters. Ah, yes! That is why you will not see most of us around anymore. We are an endangered species.

You have been kind to me! That is why I will allow you to move directly to 7.

5. Traveller! Welcome to my humble abode. I am the lizard around here! No, no, no do not be afraid. I mean no harm to you. I come from a family of 3800 species! Unfortunately, I am too small to do anything for you. You will have to wait here for your turn. Good luck!

6. Traveller, you have landed safely on number 6. Wait for your next turn here.

7. Traveller, you have landed safely on number 7. Wait for your next turn here.

8. Hiss! Oh, did I scare you? I apologise for my misconduct. I usually do not like people coming into my habitat. I am the Sand viper - a very small desert dweller that can bury itself in the sand during the day's heat.

I like you traveller, but you have woken me during the day! Thus, your fate lies within your score. Roll the dice! You may move two steps forward if you roll an even number. But, if you roll an odd number, move back to 3!

9. How! I am the Desert Fox. My scientific name is *Vulpes vulpes pusilla*. Do you like my soft fur? It is reddish-brown. Half my family lives in Thar and the other half lives in Kutch, Gujarat.

Are you in search of the buried treasure? I can help you but only if you roll a one or a six on that big dice of yours. If you do, I will allow you to move three steps forward. Otherwise, you will remain here and wait for your next turn.

10. Uh-oh! Traveller, you have been caught up in a sandstorm. You have lost your camel. Move to the start, get a new camel and begin again.

Travel Guide: Thar Desert Safari

11. Moo! I am a cow. I feed the Thari people here. They refer to me as a livestock animal. Why don't you try some of my milk and then move onto 12.

12. Traveller, you have landed safely on number 12. Wait for your next turn here.

13. Bad move, traveller! Number 13 is the forbidden red square! Move back to the start and begin your game again.

14. Traveller, you have reached a *Chonra*. These are local huts where the Thari people live. Take rest here, have food and move on when your turn comes next.

15. At last, we meet good traveller! I have been waiting for you. I am the Chinkara of the Thar Desert. You can also call me *Gazella bennettii*. I was hoping to meet you because I desperately need help. Evil hunters kill my family for game and now we are near extinction!

You must find the buried treasure and use it to save us. May you succeed. As a token for gratitude, you can ride on my back and I will take you to 19.

16. Traveller, you have landed safely on number 16. Wait for your next turn here.

17. Hello, hello! My friend Grey Partridge has told me all about you! I am the Sandgrouse. Did you know that the feathers on my belly are specially adapted to absorbing water and retaining it, allowing me to carry water to my chicks that may be many miles away from watering holes?

Even though I cannot help you like the others, I can tell you one thing for sure! You, my dear traveller, are very close to the treasure you seek! Wait, patiently, for your next turn here.

18. You see a tube well and suddenly realize how thirsty you and your camel are. You draw water from it and feel instantly refreshed. Move to 19.

19. Traveller, you have landed safely on number 19. Wait for your next turn here.

20. Uh-oh! Traveller, you have been caught up in a sandstorm. You have lost your camel. Move to the start, get a new camel and begin again.

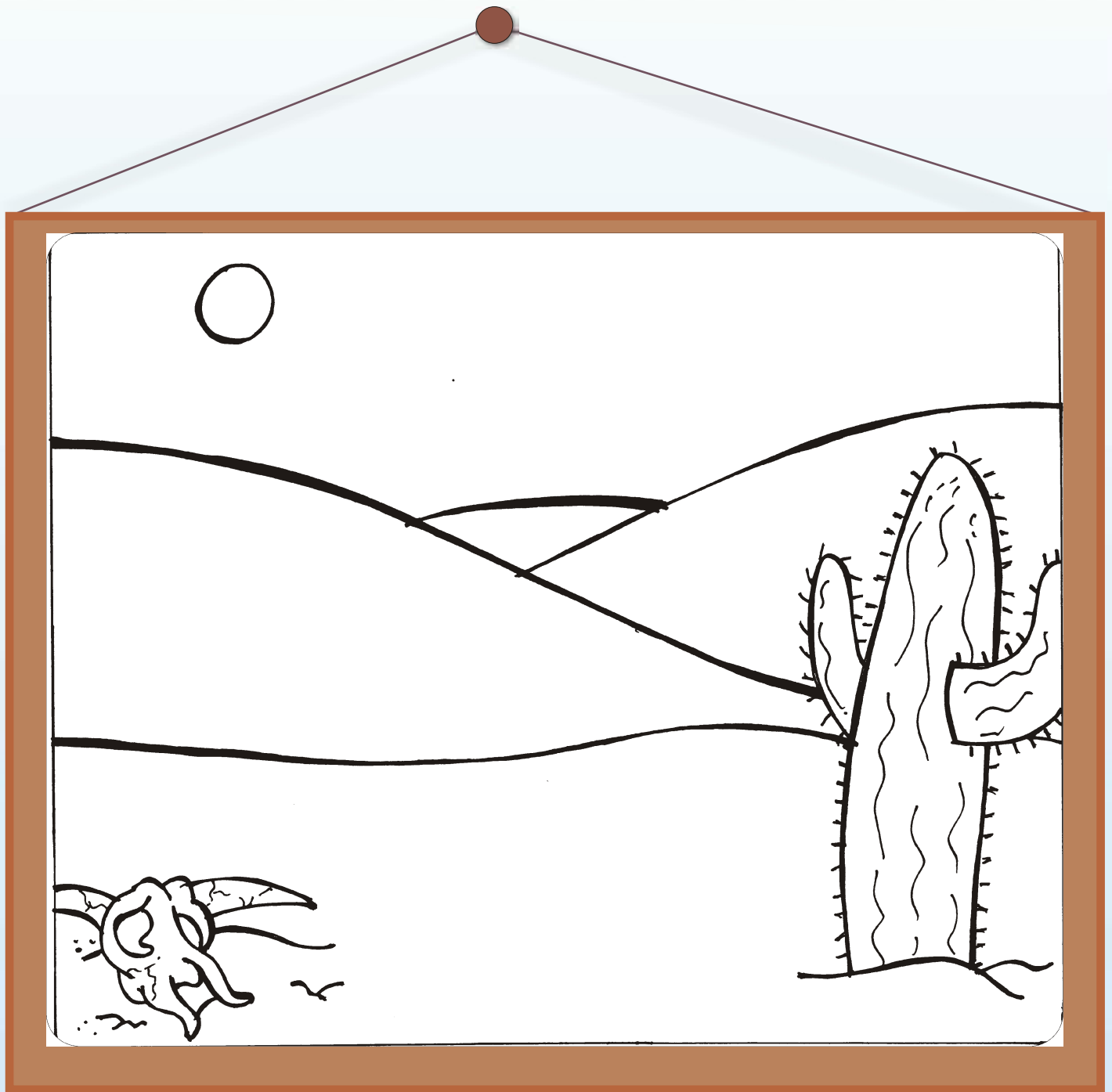
21. Traveller, you have landed safely on number 21. Wait for your next turn here.

22. Hello, traveller! My name is Govind. I am one of the Thari people and believe that guests are a gift from God. Please give me a chance to serve you. You can wait at my *Chonra* for your next turn. And one more thing, traveller. You are now closer to the treasure than you think! Keep rolling till you get 1 on your dice.

23. Congratulations, traveller! You have found the buried treasure before anyone else. Use this to save the desert's beautiful wildlife creatures from becoming extinct. They need your help!



5.4. In the diagram given below, add by drawing and colouring five organisms, whether plant or animal, that you expect to find in a desert ecosystem and label them.



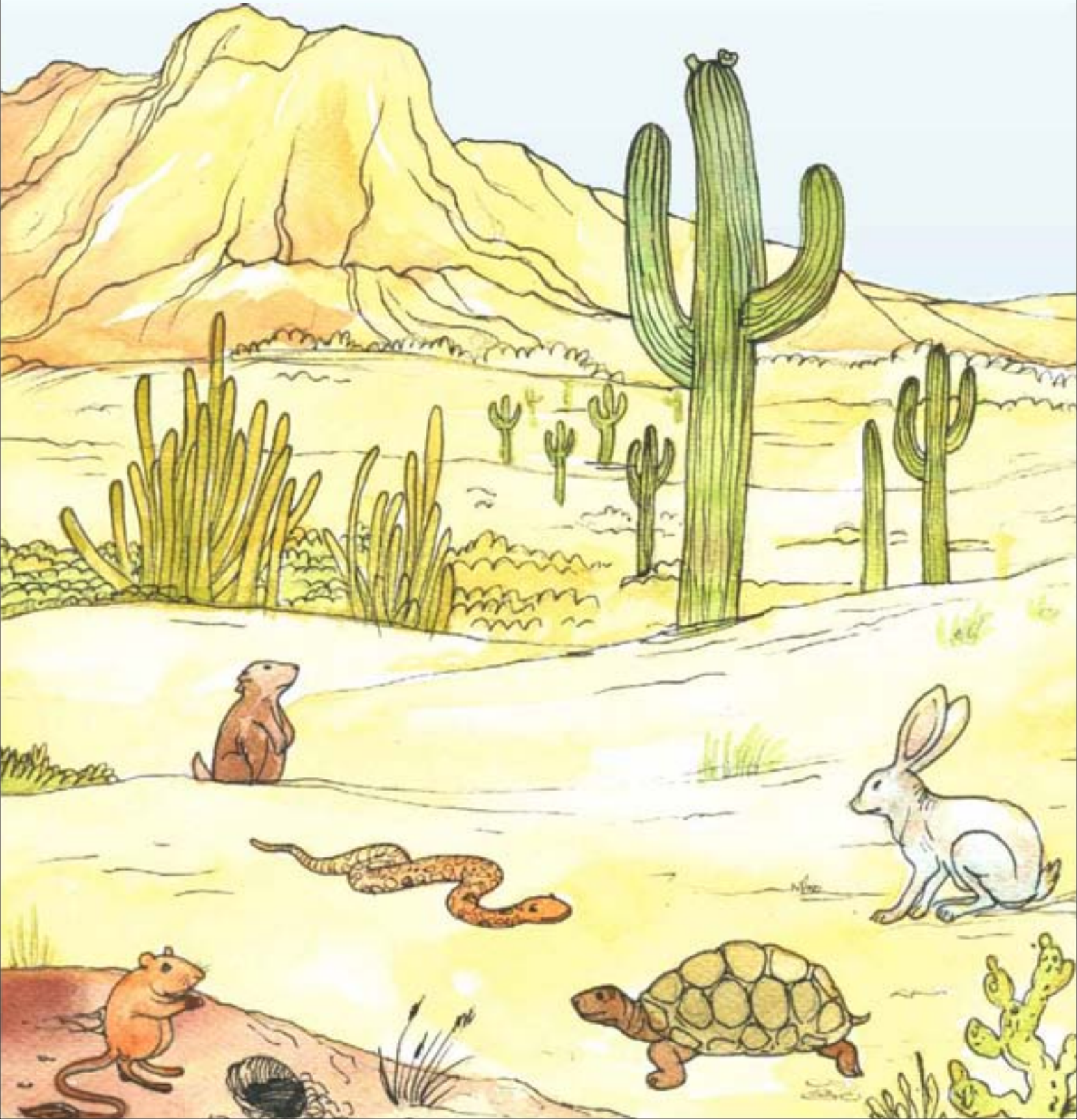


5.5 Living in Desert

People: Most of people in desert live a nomadic life, which means they keep on shifting their living place in search of water and fodder for their livestock.

Water supply and housing: Lack of freshwater resources plays a vital role in shaping the life in all parts of Thar. The drinking water for humans and animals is obtained from natural ponds or depressions called Tarai and man-made water storage points known as Tanka.

Animals and plants: Animals and plants living in the desert areas have to adapt to the conditions like high winds, blowing bits of sand and dust, hot climatic conditions and lack of water. Animals develop special characteristics like sleeping during the day and creeping out during the night; for example, foxes and lizards; getting water from prey like snakes. Some plants like Cacti store water in their stems, while others like bushes conserve water by growing few leaves or by having large root systems to gather water. Some desert plant species have a short life cycle of a few weeks that lasts only during periods of rain.



5.5.1. Choose the correct answer:

How animals live successfully in severe desert conditions?



1. They escape heat by migrating to other areas
2. Animals have adapted to desert conditions by developing special characteristics
3. They don't need water

Desert plants have special adaptive characteristics like:



1. Large and more leaves with small root systems
2. Small and few leaves with large root system
3. Thin stems and branches

Most of the people in deserts live a nomadic life; this means:



1. They live in houses built of sand
2. They are hospitable
3. Cut trees and bushes to build their houses
4. They keep on shifting their living place in search of water and fodder for their livestock

5.6 Issues of the Desert Ecosystem



Hunting and Poaching:

Excessive hunting and poaching of species like Chinkara, Black buck and Houbara bustard pose significant threats to desert wildlife.

Overgrazing:

Thar desert in Sindh is said to be one of the world's densely-populated deserts. Grazing of livestock, mostly sheep and goats, is intensive, affecting soil fertility and destroying vegetation.

Excessive cutting of desert vegetation:

Trees, shrubs and even roots of the plants are indiscriminately cut for fuel, feed, fencing and the construction of thatched huts called "Chhora" in Sindhi by the people of desert areas.

Climate change effect:

Uncertain, unpredictable rainfall, low humidity and extremes in temperatures caused by changes in climatic conditions also affect the desert ecosystem.

Soil erosion:

Extreme drought condition and loss of vegetation cause soil erosion and desertification.

Road networks and land encroachment:

Construction of roads and conversion of lands in desert ecosystems to agriculture fields is increasing day-by-day. These types of development activities also have a negative impact on the desert ecosystems.



5.6.1. Underline the sentences which denote issues of the desert ecosystem.

1. Animals sleep during the day and creep out during nights
2. Desert plants need less water
3. They have started to construct roads in the desert
4. People live in huts called "Chhora"
5. Excessive cutting of plants for fuelwood and construction material
6. Excessive use of tap water
7. Lots of domestic animals graze in one place on many consecutive days
8. Plants and animals are adapted to severe conditions
9. Hunting and bird shooting
10. Keep changing their places in search of water



5.7. Case Study and Comprehension: Govind's Life in the Thar Desert

Read Govind's biography carefully.

Hello everyone! My name is Govind and I live in the Thar Desert of Pakistan. The desert is a wonderful place to live in. The desert brings its own rich multifaceted culture, heritage, traditions, folk tales, dances and music to its inhabitants who belong to different religions, sects and castes. The main tribes of Thar Desert in Pakistan are Sindhi Muslim and Hindu tribes such as Menghwars, Kohlis, Bheels, Thakkars and Brahmans. I am a farmer and we also rear livestock. These are the two main occupations that the Thari people are involved in. Another important source of income for us is tourism. I simply love showing new people, especially foreigners, around the desert! Why do you not visit the desert sometime? I am sure that you will particularly enjoy observing the biodiversity of the desert which includes Chinkara gazelle, Houbara bustard, Monitor lizard and Desert fox. I hope you will not get too inconvenienced by our lifestyle. It is nothing like the city! We live in small huts called "**Chonras**". Lack of freshwater resources also affects our lifestyle. We fetch drinking water from natural ponds or natural depressions called Tarai and we have to construct man-made water storage points known as Tanka. We live a nomadic lifestyle moving from one place to the other in search of food and water. But nevertheless, desert life is great! However, in recent years several issues have surfaced which have made life difficult for all inhabitants of the desert humans, plants and animals. Excessive hunting and poaching of species like Chinkara, Black buck and Houbara bustard pose significant threats to desert wildlife. Did you know that the Thar desert in Sindh is said to be one of the world's densely populated deserts? Grazing of livestock, mostly sheep and goats, is intensive, affecting soil fertility and destroying vegetation! Also, trees, shrubs and even roots of the plants are indiscriminately cut for fuel, feeding animals, fencing and the construction of our "**Chonras**". Uncertain, unpredictable rainfall, low humidity and the extremes in temperatures caused by changes in climatic conditions also make life very difficult. Such extreme drought conditions and loss of vegetation cause soil erosion and desertification. Construction of roads and conversion of lands in desert ecosystems to agriculture fields is increasing day-by-day. These types of development activities also have a negative impact on the scenic beauty of our environment.

 **Now that you have read Govind's story, answer the following questions:**

1. What are the two main occupations in the desert ecosystem?

i) _____ ii) _____

2. Name two wildlife species that can be found in the desert ecosystem.

i) _____ ii) _____

3. What is the name given to the huts that Thari people live in? _____

4. Identify six issues that Govind points out in the desert ecosystem.

i) _____ ii) _____

iii) _____ iv) _____

v) _____ vi) _____

5. Now explain each of the reasons that you gave in point 4, in your own words, to highlight the areas of concern surfacing in the desert ecosystem?

Riverine Ecosystem



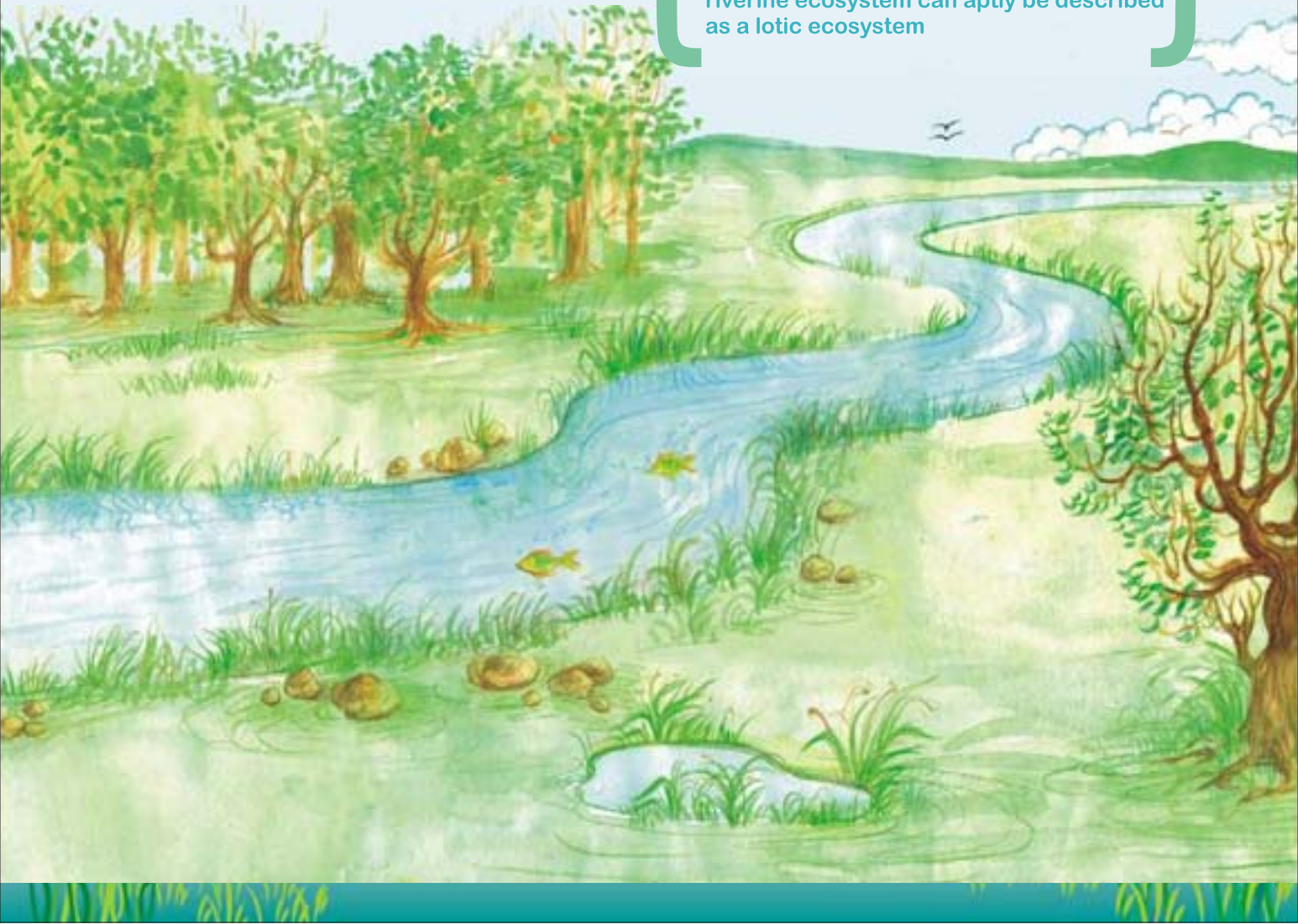
6.1 Introduction

Also known as the “lotic” ecosystem, the riverine ecosystem is any spring, stream, or river viewed as an ecosystem. There are two major zones in a riverine ecosystem:

1. Rapids: shallow water where currents are strong enough to keep the bottom clear and firm;
2. Pools: deeper waters where currents are reduced and silt and other debris collect on the bottom.

The two main components of a riverine ecosystem are: a) Main river course, and b) Riverine forests

The term 'lotic' means of or relating to or living in actively moving water. Since the riverine ecosystem is based on area surrounding the river, which quite literally means 'running or moving water', the riverine ecosystem can aptly be described as a lotic ecosystem



6.2. The Main River Course

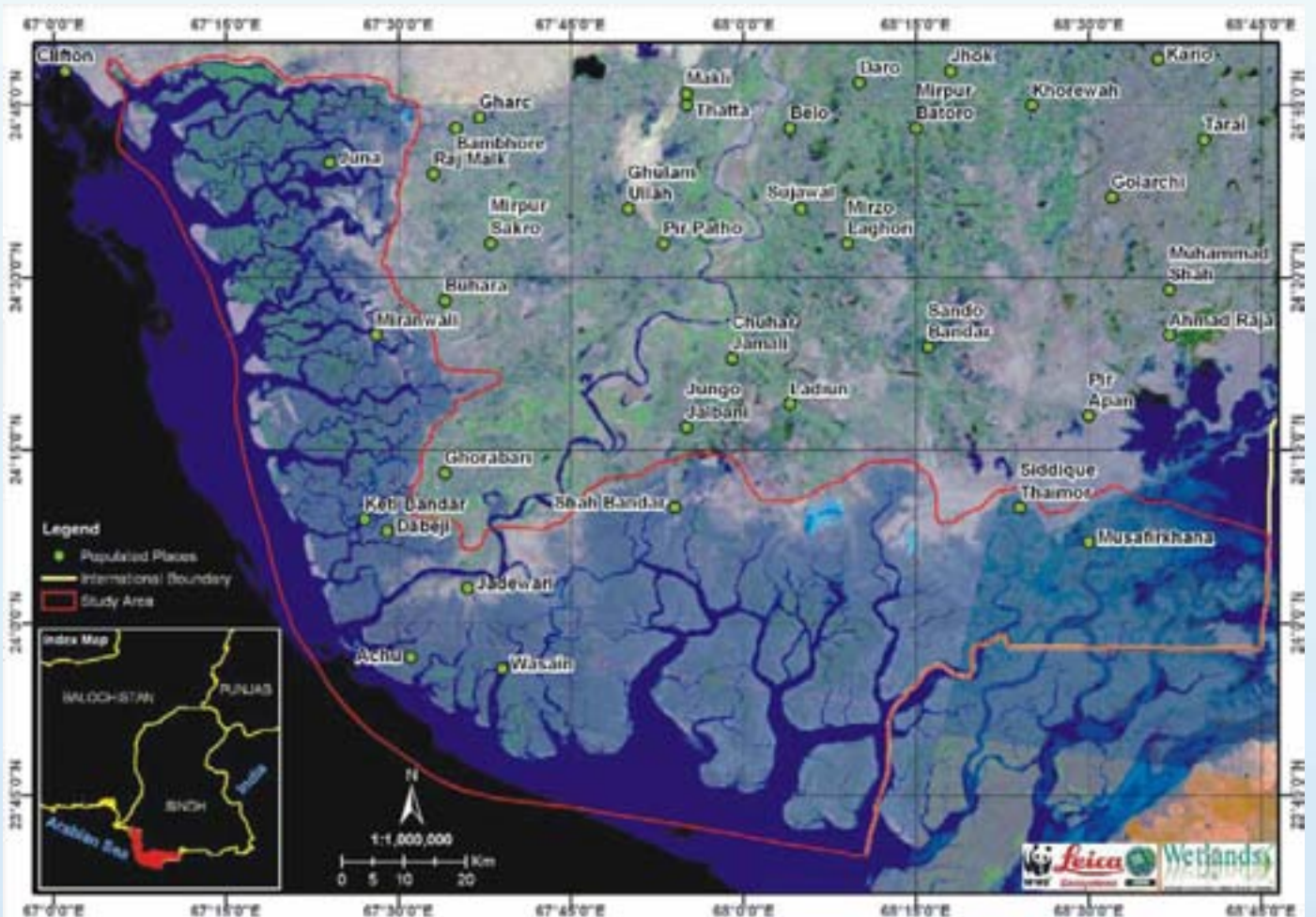
The Indus River is the main river that passes through the Indus Ecoregion supporting natural ecosystems and human populations. Indus River is one of the world's largest rivers. It rises from a place called Mansarover Lake in the Himalayan mountain ranges in Tibet and flows more than 2880 km creating a wide delta of swamps, streams, and extensive mangroves before entering into the Arabian Sea. It enters the sea via the Indus Delta near Keti Bunder, a small coastal town, situated at about 200 km south-east of Karachi.

The Indus Delta is the sixth largest delta in the world. It is a fan shaped delta covering an area of about 600,000 hectares. There are 17 major and numerous minor creeks and extensive mud flats in the delta. It also supports mangrove forests which are said to be the largest arid zone mangrove forests in the world.

Delta is called for the area between the branches of the mouth of a river, stream or creek

The Indus River provides home to the endangered Indus Dolphin. In the Indus Delta one can also find Palla fish, which lives in marine waters and swims upstream in the river to breed.

Due to construction of dams on the River Indus, the flow of water into the Indus Delta has been reduced, causing degradation of mangrove forests and related natural resources in the deltaic region.



Map of Indus Delta showing its numerous creeks.

6.2.1. You have just read the previous text about the riverine ecosystem, now chose the correct answer:

1) The river that flows down the whole country including Indus Ecoregion, falling into the Arabian sea is _____

- a, Indus b, Jhelum c, Ravi

2) The area covering numerous creeks along the coastline at the tail-end of the Indus River is called _____

- a, Beach b, Tropical forest c, Indus Delta

3) Flow of Indus River into the delta has been _____ over the period of time

- a, Increased b, Decreased c, Constant

4) Indus delta supports a large tract of _____ forests

- a, Man-made b, thorn forest c, mangrove

5) Indus delta is _____ shaped

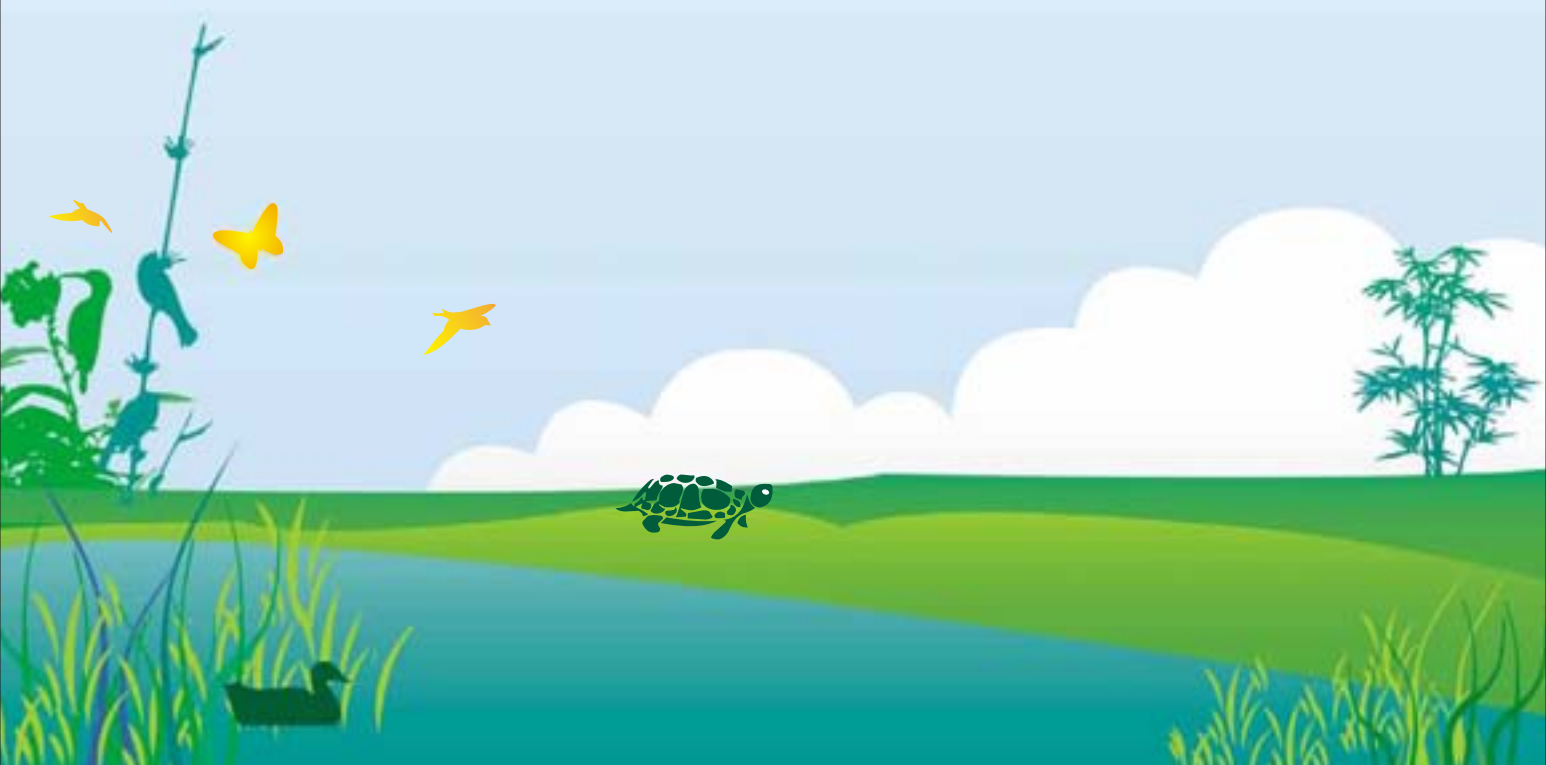
- a, Cup b, Ball c, Fan

6) Total length of Indus River is about _____

- a, 2180 km b, 2880 km c, 3080 km

7) The Indus River originates from a lake called _____

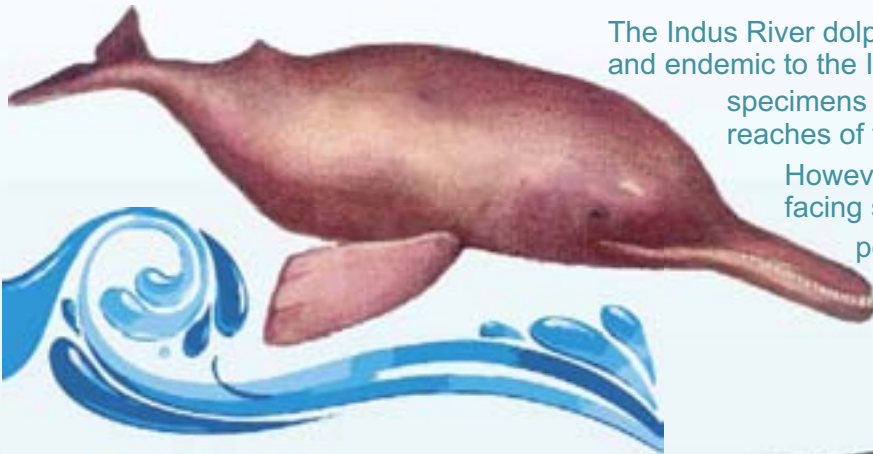
- a, Shosar Lake b, Mansarovar Lake c, Skardu Lake



6.2.2. Aquatic Life in Indus River

The River Indus is home to a variety of aquatic life, the most significant of which is the Indus dolphin. Alongside this, there are numerous other fish species found in the River Indus.

a) Indus Dolphin (*Platenista minor*)



The Indus River dolphin is one of the world's rarest mammals and endemic to the Indus River. Approximately 1,100-1,300 specimens of this species exist today in the lower reaches of the Indus River in Pakistan.

However, the population of this species is facing serious issues such as water pollution, poaching, fragmentation of habitat due to barrages and dolphin stranding in irrigation canals.

b) Palla/Pallo Fish (*Tenuulosa illisha*)

Palla is the national fish of Bangladesh. It is anadromous in nature, *i.e.* it lives in seawater and travels upstream in the Indus River to spawn. The fish was usually found in abundant quantities in the district of

Thatta before the construction of dams and barrages upstream on Indus River. Due to reduced flow of Indus River into the delta, the population of this species has declined.



c) Rita catfish (*Rita rita*)



Rita catfish are capable of attaining a length of 150 centimeters. This large size is distinct to the Rita catfish only. It is a sluggish, bottom-dwelling catfish. It inhabits rivers and estuaries, preferring muddy to clear water. It is a carnivorous catfish; the bulk of its diet consists of mollusks.



6.3 Riverine Forests

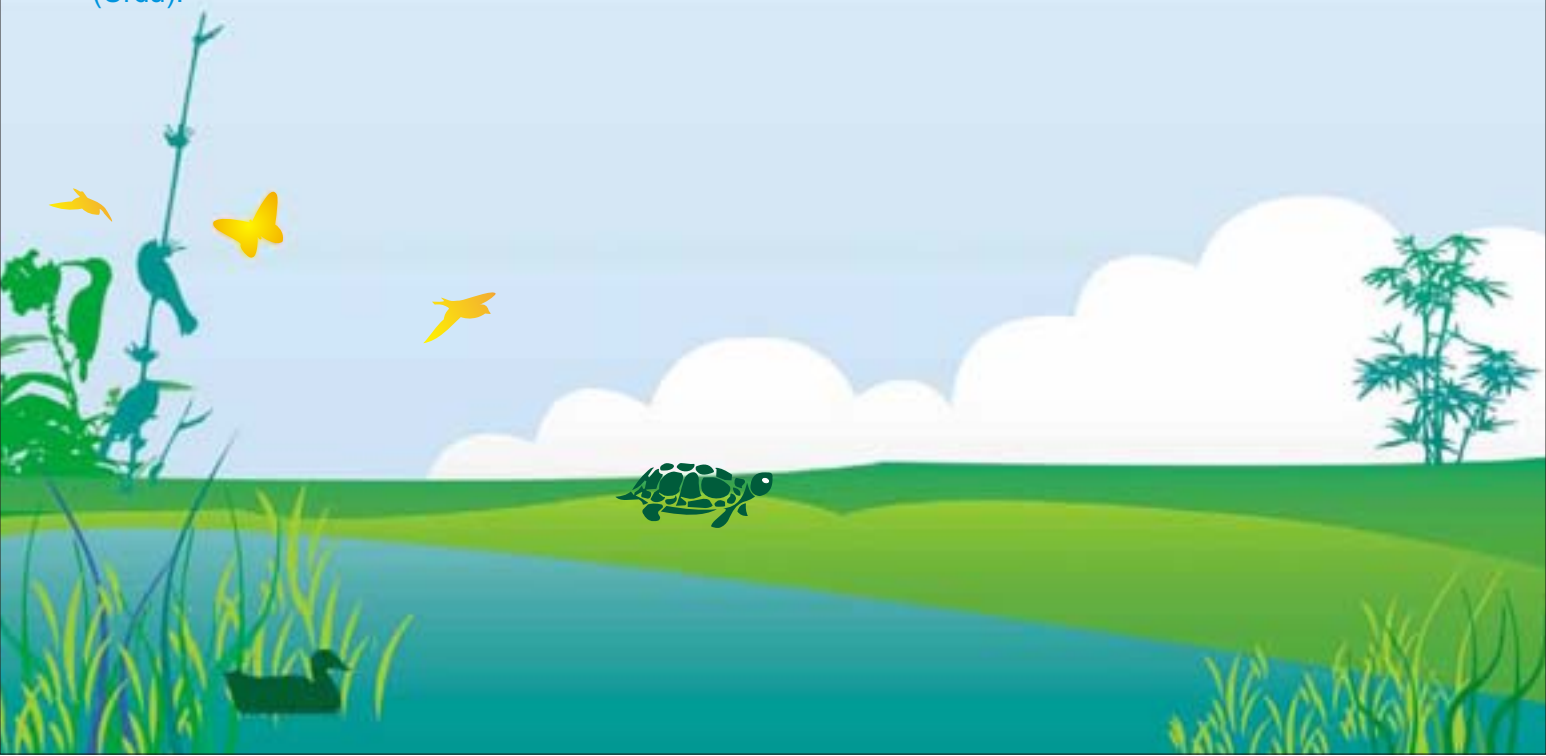


The riverine forests in Sindh occur along both banks of the Indus River. They rely on inundation by the river for irrigation and therefore, their existence is heavily dependent on the intensity, duration and frequency of river water flow.

Riverine forests are one of the major forest types in Sindh. Besides providing a source of livelihood for thousands of people in the form of fuel wood, timber, fodder, honey and tannin, these forests serve as carbon sinks and also protect surrounding areas from the severity of floods. Riverine forests give shape to a unique ecosystem harbouring important species such as Hog deer, Otters, Crocodiles, Small Indian Civet cat and Black partridges.

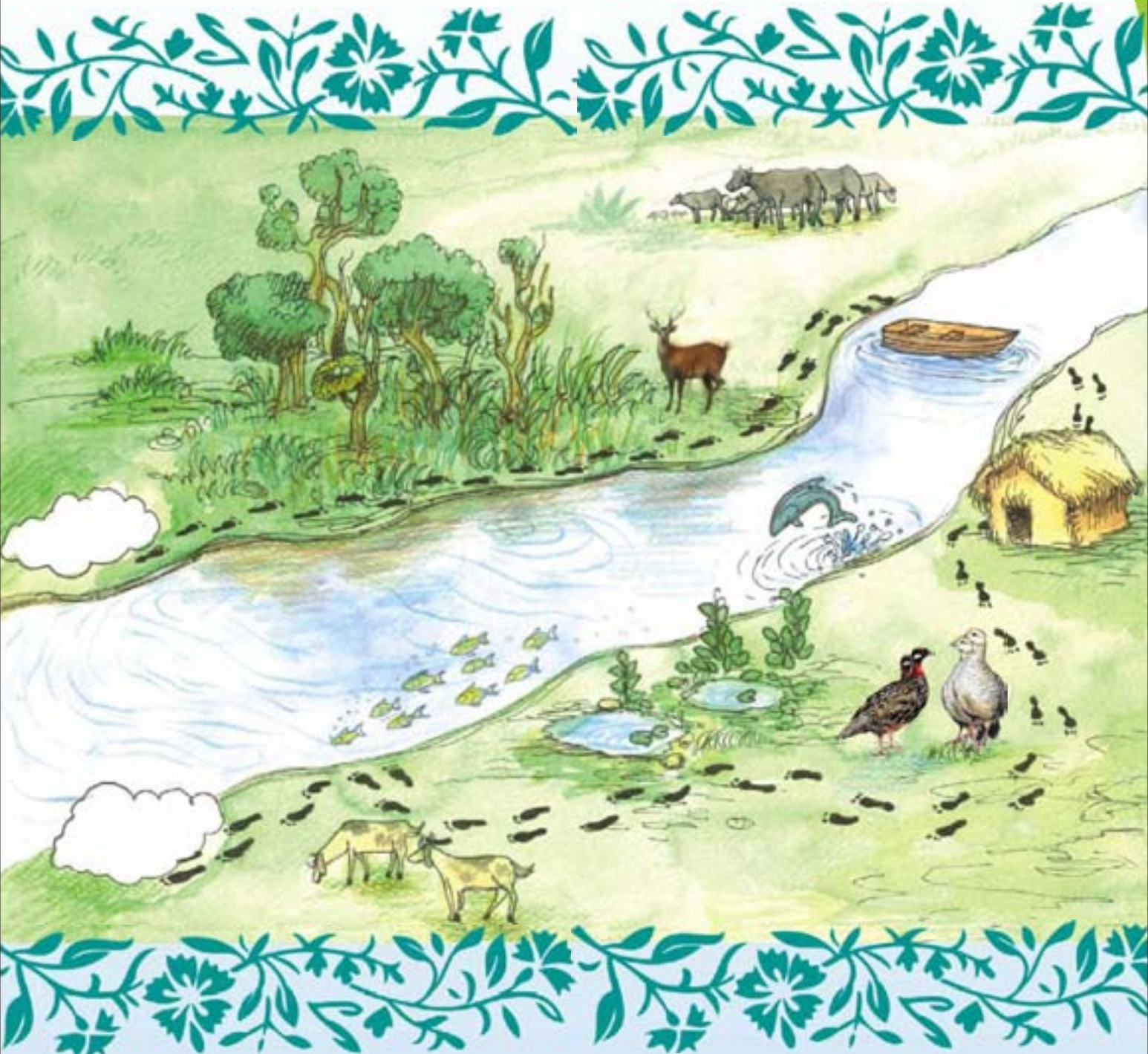
In recent times, only 50 percent of the gross area of riverine forests is inundated even in high floods. As a result, the riverine forest area is shrinking alarmingly while less salt tolerant species have almost disappeared. The existing condition is likely to further deteriorate with the construction of new dams and barrages, enabling only 20 percent of the original forest area to get inundated.

The dominant tree species of the riverine forest is ***Acacia nilotical*** Acacia (English) Babur (Sindhi), Babul (Urdu).



6.3.1 A trip to a Riverine Forest

Follow the footsteps and list down below in the given spaces the animals, plants and other objects that you observe during your trip to a riverine forest



- 1.....
- 2.....
- 3.....
- 4.....
- 5.....
- 6.....
- 7.....
- 8.....
- 9.....
- 10.....
- 11.....
- 12.....



6.3.2. See the diagram given in 6.3.1 and name at least 5 products or services that the local people living near or within riverine forests obtain them.

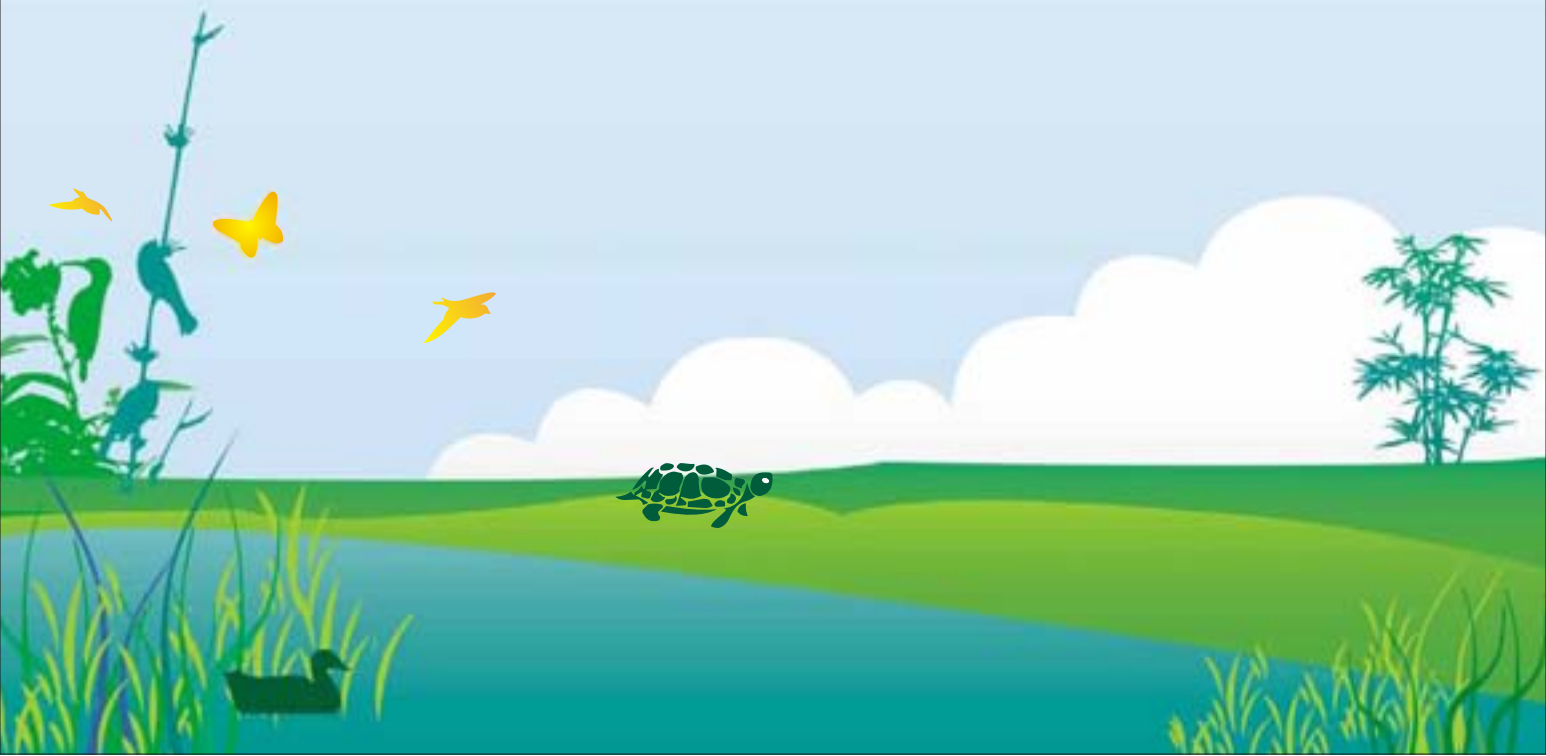
1. _____

2. _____

3. _____

4. _____

5. _____





6.3.3. Match the words, phrases and sentences in both columns for appropriate meaning or connotation:

Riverine forests

Hog deer

Annual inundation

Timber and fuel wood

Dams and barrages on Indus river

Sindh



survival of the riverine forests

a threat to riverine forests

forests growing along banks of river

livelihood of local communities

historically famous for riverine forests

a species of riverine forests



6.3.4. Learn about species of the riverine forests in Sindh and draw their pictures.



For name of species, look upside downwards on this page

This is a _____



Place here your own drawing of the above species

A large rectangular area for drawing, featuring a vertical line on the left side with ten binder clip icons attached to it, indicating where to place a drawing.

Gray Partridge





For name of species,
look upside downwards
on this page

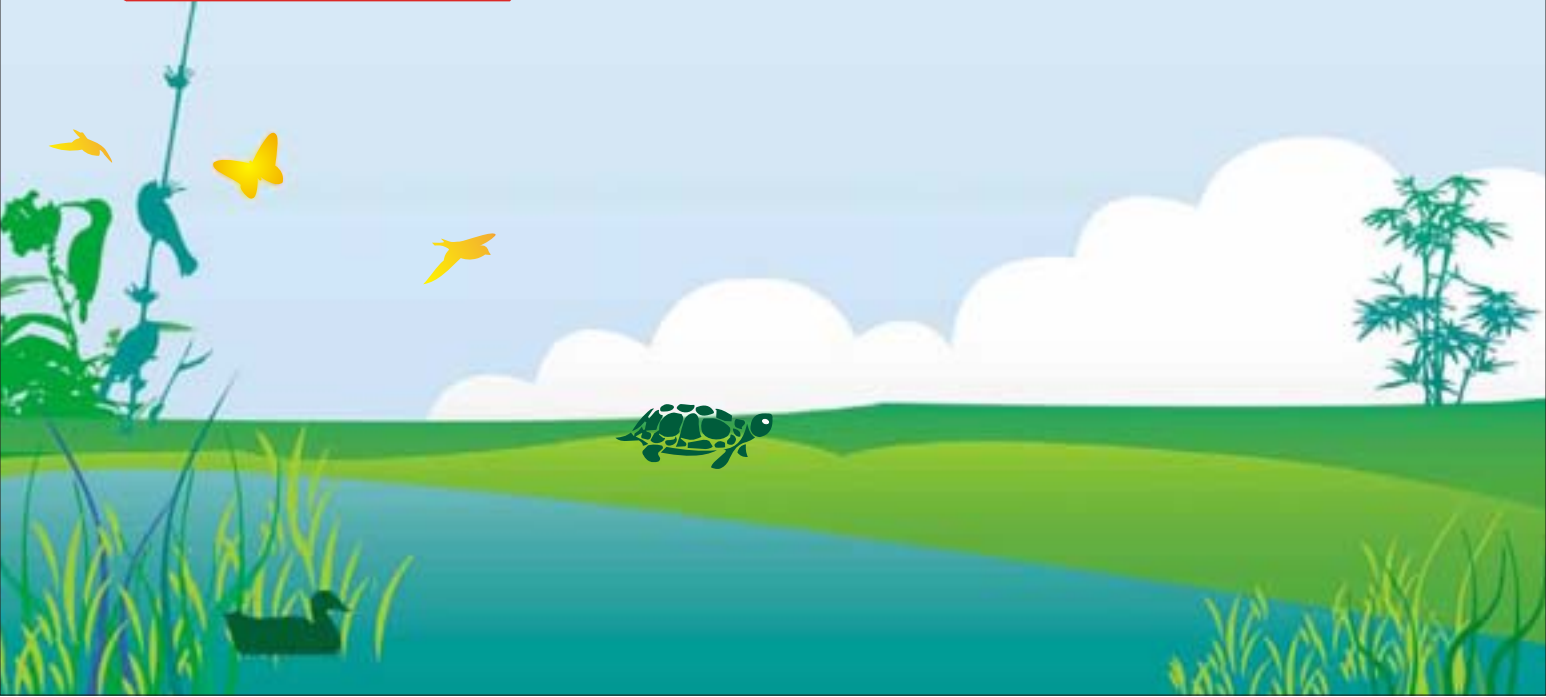
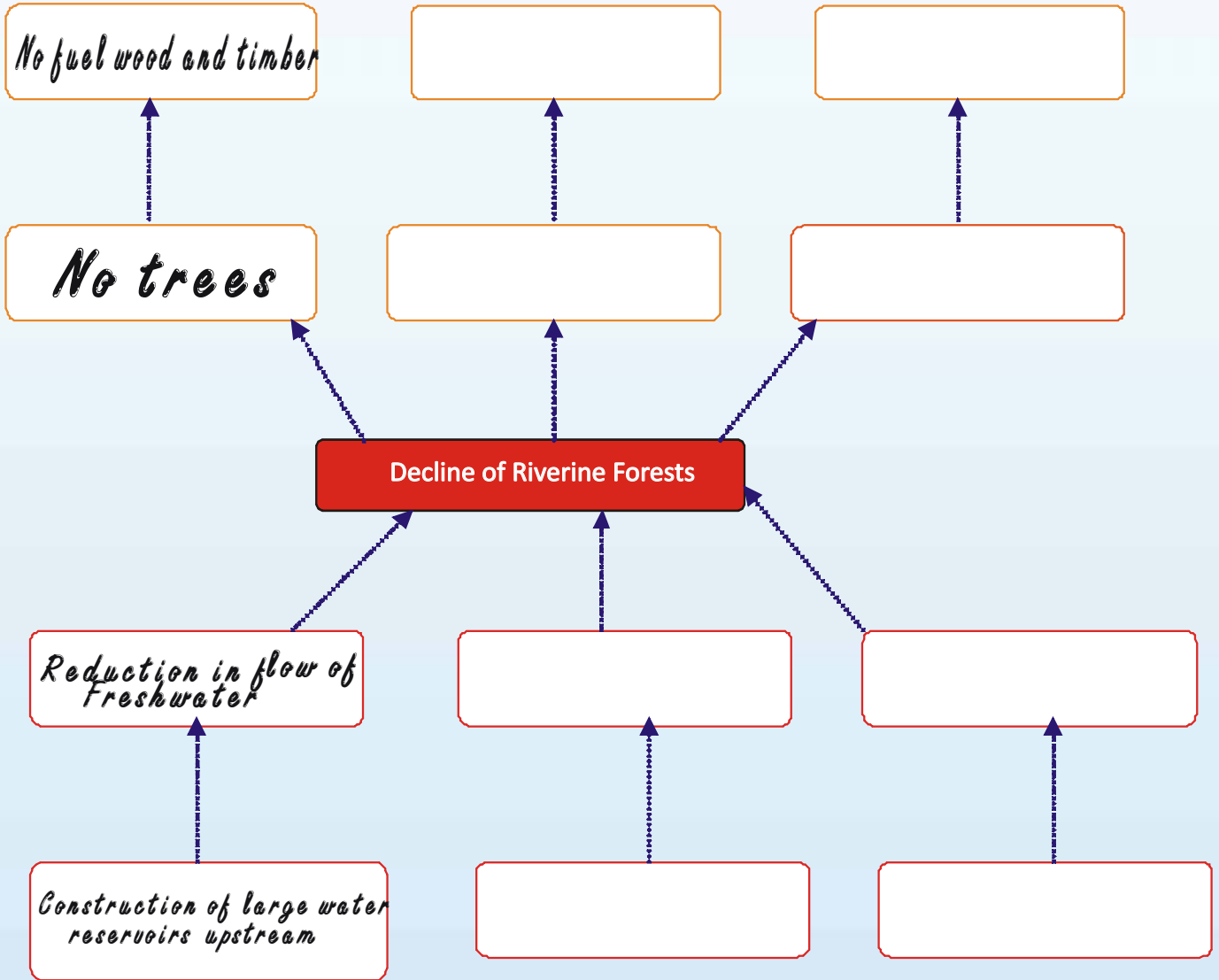
This is a _____

Place here your own
drawing of the above
species

Hog Deer

6.4. Decline of Riverine Forests

Develop a cause and effect diagram by listing the causes below and effects above in the given spaces. One example has already been given to you for reference. Ask your teachers and family members to help. You can add more steps upward or downward



6.4 Save Indus: Spreading the Word

As you have seen, the Indus River is of great importance to all of us! Therefore, it is very important that we must create awareness to stop misuse or pollution of Indus River. Now, create a slogan as a part of your “Saving the Indus” campaign in the space given below.

A large, empty rectangular box with a thin black border, intended for the student to write their slogan. The box is centered on the page and occupies most of the middle section.

6.5 Make your own water saving pledge

I will use water wisely



I will never use freshwater for fun



I will turn off the tap After use



I will re-use rice-rinsing water for watering plants.



I will use water wisely



I will never throw litter into water



I will raise my voice for sufficient flow of water from the river indus into the Delta



I believe, I will not be a big spender of natural resources

Signature: _____ Name: _____ Date of signature: _____

Agricultural Ecosystem



7.1 Introduction.

About 40 percent of the land in Sindh is arable (used or suitable for growing crops) and 5 percent of it is rangeland (the large open area used to graze animals). The total cultivated area in Sindh is 5.9 million hectares, of which cropped area is 53 percent.

The irrigated areas of the province have been divided into three major agro-ecological zones, two of which are further divided into sub-zones, as given below.

1. Zone A:

Rice/ Wheat zone of the right bank of Indus River (upper Sindh):

- a. Sub-zone A1 Main area
- b. Sub-zone A2 Piedmont soil region

2. Zone B:

Cotton/ Wheat zone of the left Bank of Indus River

- a. Sub-zone B1 Guddu Barrage command area
- b. Sub-zone B2 Sukkur Barrage command area

3. Zone C:

Rice/ Wheat/ Sugarcane



Sindh grows a variety of field and horticultural crops. Wheat, cotton, rice, and sugarcane are the major crops, which constitute 68 percent of the total cropped area, while mango, banana and chillies are the major horticultural crops.

A major challenge faced by the irrigated areas is decreased flow of water from Indus River. This lack of irrigation water forces people to extract groundwater where feasible to cultivate their lands, thus exacerbating the problem of water logging and salinity. It has been estimated that due to flawed irrigation practices and lack of drainage facilities half of the cultivated area in Sindh has been affected by the menace of water logging and salinity, significantly reducing the crop yield and thereby negatively impacting the livelihood of people.

In addition to growing crops, vegetables and fruits, the agriculture ecosystems are home to a variety of wild animals, birds and insects. Moreover, these ecosystems support a range of wild flora.



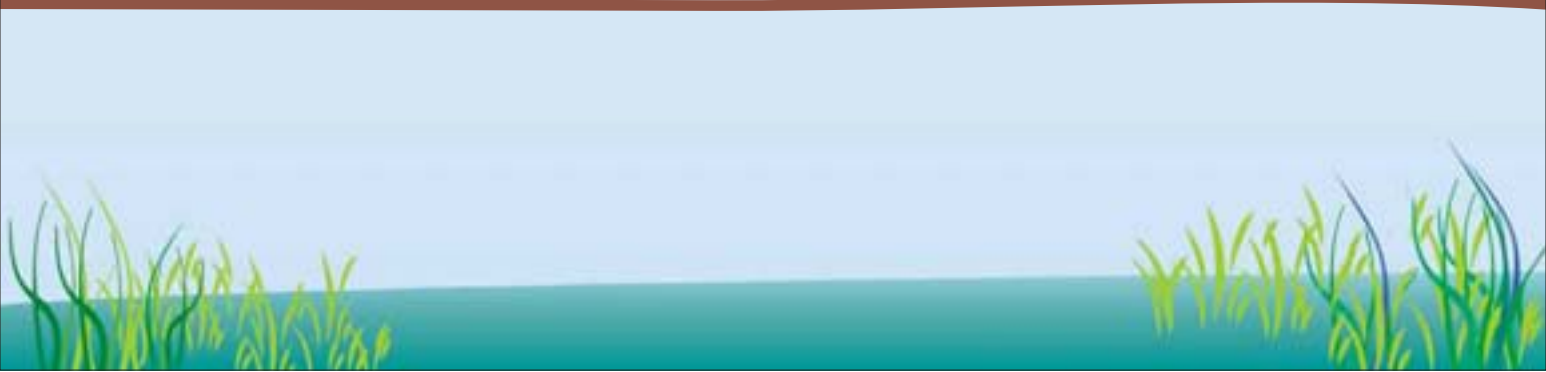
7.2 Can farming affect biodiversity?

The way that farmers grow crops and raise animals can be either good or bad for biodiversity. On one hand, farmers can support biodiversity through careful farming methods. On the other hand, if farmers are not careful, the environment and organisms in and near the farm can be harmed.

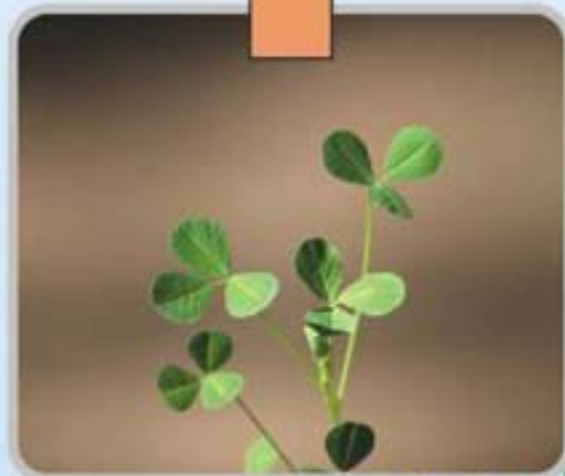
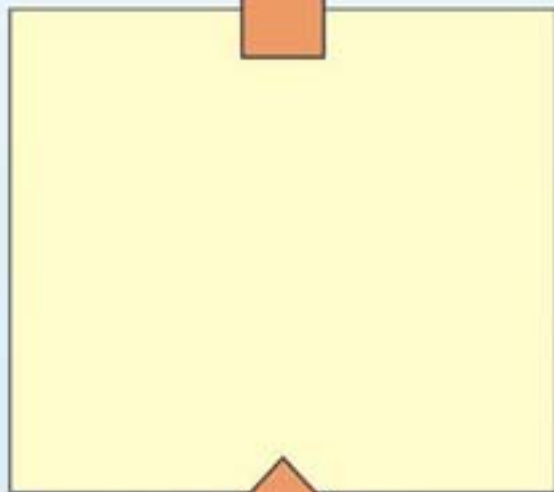
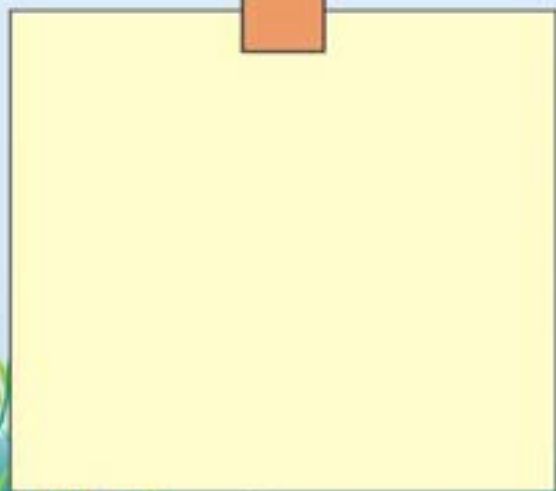
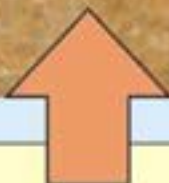
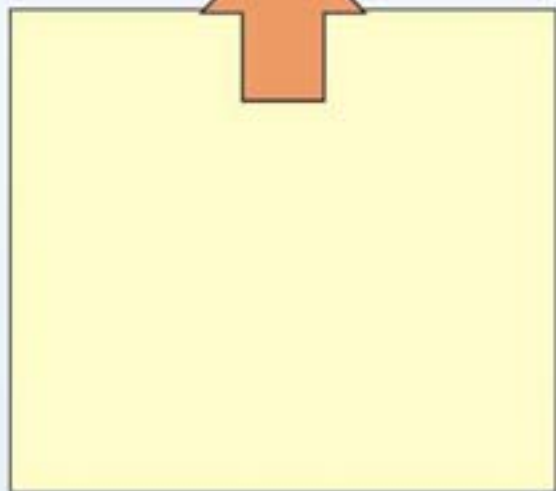
Even a handful of farm dirt is rich in biodiversity! Soil biodiversity includes animals, bacteria, fungi and even the roots of plants growing above. Soils form complex ecosystems that make farming possible. There are millions of organisms that live in soil: micro organisms, such as bacteria and fungi, and macro organisms, such as worms, mites, ants and spiders. These organisms can help farmers to reduce the negative effects of farming. When they eat and dig underground earthworms, termites and other burrowing organisms mix the upper layers, redistribute nutrients and increase the amount of water absorbed by the soil. Some macro organisms are critical to local farming techniques. Farmers in Burkina Faso and in other areas of West Africa encourage termites to live and burrow in their farm plots because they improve the soil.

Sources: <http://www.cbd.int/ibd/2008/youth/>

Trees can act as natural water filters. Their roots absorb rainwater, and minimize the amount of runoff entering rivers and lakes. Runoff often carries pesticides from farmers' fields that can damage aquatic ecosystems.



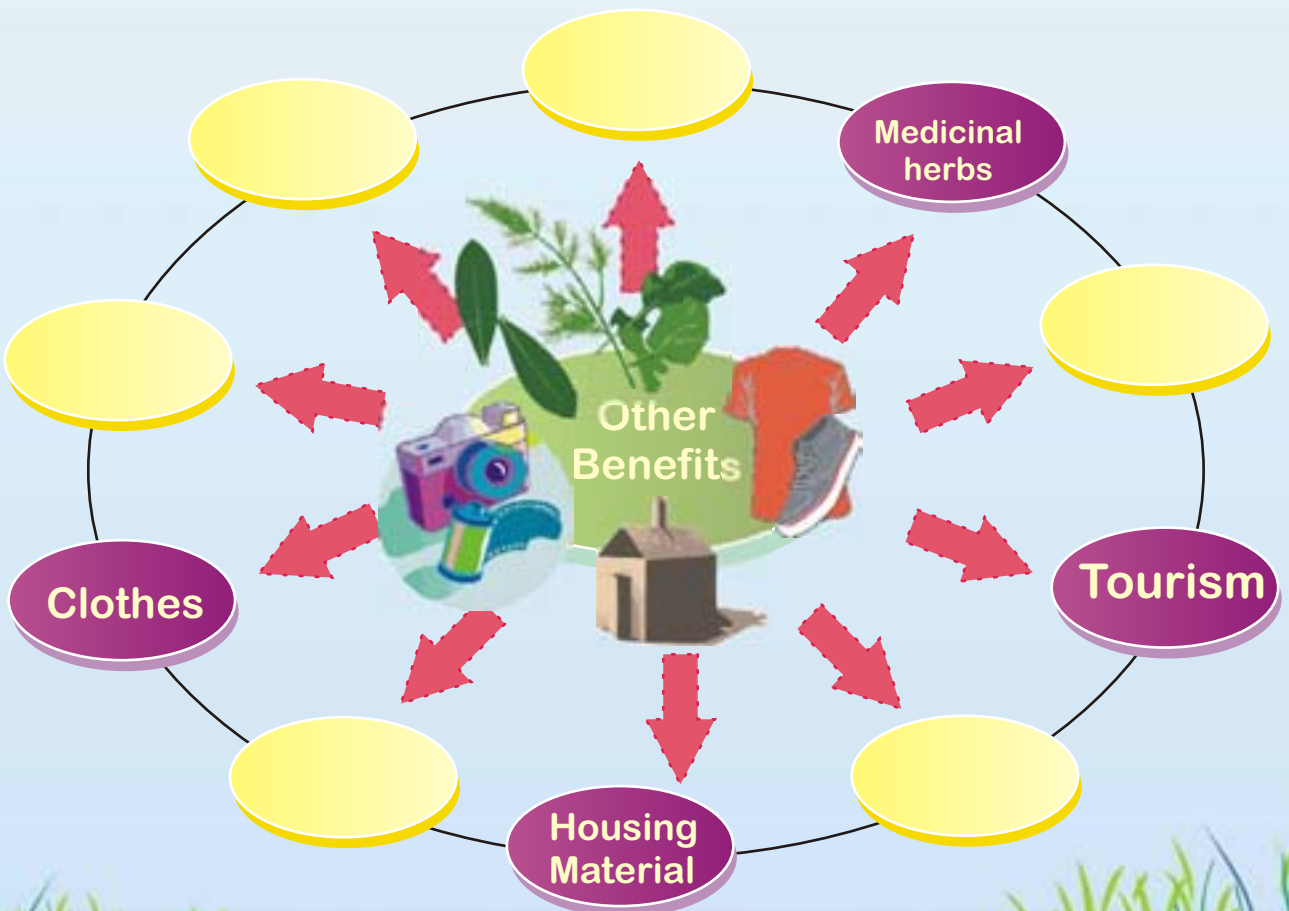
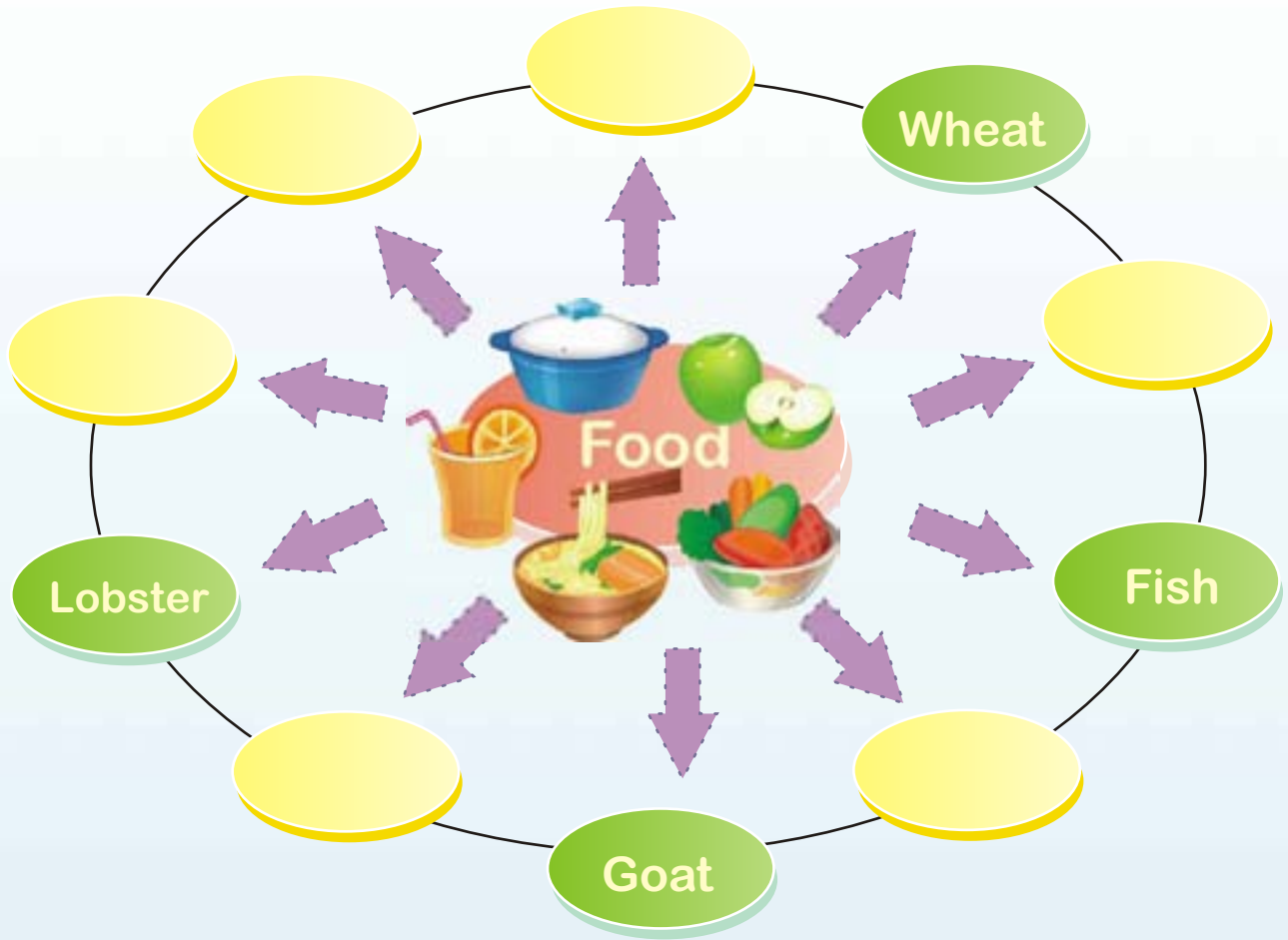
7.3. Complete the following food chains in agricultural ecosystems by cutting the given pictures and pasting them on relevant spaces





7.4 What does biodiversity have to do with our food and other benefits?

Fill in the blanks with numerous forms of biodiversity that provide us food items:



7.5 Growing crops with poisons

7.5.1 Pesticides

Pesticides are those poisonous chemicals, which are used by farmers to kill unwanted plants or animals. There are many types of pesticides like Bactericides, Baits, Fungicides, Herbicides, Insecticides, Lures, Rodenticide and Repellents etc. Agricultural pesticides come in granular, powdery and liquid forms. Pesticides are applied to crops with many kinds of sprayers like hand-operated, motorised, boom, and air-blast sprayers. Aircrafts and helicopters also spray these poisons upon croplands. Granular pesticides are mixed with the soil by granular applicators.



7.5.2 Chemical Fertilisers

Plants need many elements like nitrogen, potassium and phosphorus for their growth. These are called nutrients. They exist naturally in the soil from where plants absorb them through their roots. Plants use these nutrients with air, water and sunlight to make their food through the process of photosynthesis. Although these nutrients are found in the soil, still farmers apply additional amounts of these nutrients to soil to provide additional quantity of nutrients to crops in order to get high yields. One source of these additional nutrients is chemical fertilizers. Like pesticides, chemical fertilizers are in granular, powdery and liquid forms and sell to farmers who apply them to crops.



7.5.3. Effects of Pesticides and Chemical Fertilizers

All over in the world, pesticides and chemical fertilisers are being used in huge quantities. Only in Pakistan, about 31,460 tons of pesticides and 3,270,313 tons of chemical fertilisers are used annually. Crops do not take all the quantity of chemical fertilisers that is applied to them. Crops leave behind a considerable portion of chemical fertilisers. Nearly all the quantity of poisonous pesticides after its application to crops is infused in the environment. The collection of “unutilised portion of chemical fertilisers” and “infused poisonous pesticides” is increasing in the environment day by day. It has become a very dangerous kind of pollution. Following are some ways by which this pollution takes place and causes harmful effects:



Human Health:

Human Health: Poor people work and spend more time in fields. In poor countries, pesticides cause more deaths than infectious diseases. Every year these poisons, in only poor countries, affect about 28,000,000 persons, among which many die. Villagers and their children face diseases like asthma, brain cancer, skin cancer, infertility and many more as they work in crops where pesticides are applied.



Atmospheric Pollution:

Application of pesticides and chemical fertilisers is one of the major sources of atmospheric pollution. Nitrogenous fertilisers also emit greenhouse gases like nitrogen oxides, nitrous oxide, ammonia and carbon dioxide into the atmosphere where they harm the beneficial layer of ozone gas that protects us from dangerous rays. As pesticides are applied to crops, a portion of these is taken by wind, which reaches high in the atmosphere. This also causes acid rains, which are very harmful for all plant life. Sometimes it destroys entire forests and animals therein. It causes acidification in rivers and lakes and kills all fishes in these resources. It also weakens big buildings, roads and bridges.



Water Pollution:

Apart from acid rain, the remains of chemical fertilisers and those pesticides that remain on the surface of land are carried by irrigation or rain water, and accumulate in lakes, rivers and coasts. Due to the nitrogen and other nutrients, the growth of algae increases. Increased algae growth reduces oxygen in water and due to this, the fish population decreases. Pesticides also kill fish and thus, rivers, lakes and coasts become poisonous and eventually die, that is, devoid of fish. Irrigation and rainwater also seeps down in the land and pollutes underground water with these poisons. When people use this underground water through tube wells and pumps, they develop many diseases.





Breaking Food Chain:

Pesticides destroy many native insects, reptiles and weeds, which play an important role in the stability of any ecosystem. Birds then eat the dead insects. Many birds die after eating those dead insects. Others develop reproductive deficiencies. A quantity of pesticides remains in the leaves of plants and fodder. When livestock forage, these poisons are collected in its flesh and milk. They are subsequently transported to human beings. Pesticides are also transported to human bodies by fruits and vegetables, upon which they are applied. This transportation of poisons into the human body generates dozens of recurrent problems like memory disorders, depression, neurological deficits, miscarriages and birth defects.



3.5.4 Know more about poisons

Plan a trip to fields near your school. Meet farmers and ask them to show you the chemical fertilizers and pesticides that they use.

See below the common pesticides and chemical fertilizers.

Check how many you find in your trip. Then answer the following questions:

(a) How many liquid pesticides did you find?

(b) How many powdery pesticides did you find?

(c) How many granular pesticides did you find?

(d) How many types of fertilizers do they use? Write their names.

(e) Write the names of those pesticides and chemical fertilizers that the farmers use.

(f) Write a paragraph on your observations and highlight harmful effects of these chemicals.



3.5.5. Harmful effects of chemicals pesticides

Below is a list of pesticide-originated diseases. Plan a visit to a village where people's major occupation is agriculture. Meet people and ask them which diseases, from the list given below, are present in the village. If villagers tell about some other disease, then write its name in the empty cell.



Name of disease	Yes/ No	Name of disease	Yes/ No
Infertility		Blood cancer in babies	
Miscarriages		Brain cancer	
Deformed babies		Breast cancer	
Poor growth of both mother and child		Skin cancer	
Psoriasis (red spots on the skin)		Depression	
White spots on skin		Neurological disorders	
Red and black allergic spots		Diabetes	
Irritation (itching) resulting in bleeding, infectious gashes		Parkinson's diseases (movement disorders)	
Abdominal pain		Memory disorder	
Dizziness		Asthma (respiratory disorders)	
Headaches		Eye problems and small eye size	
Nausea and vomiting			

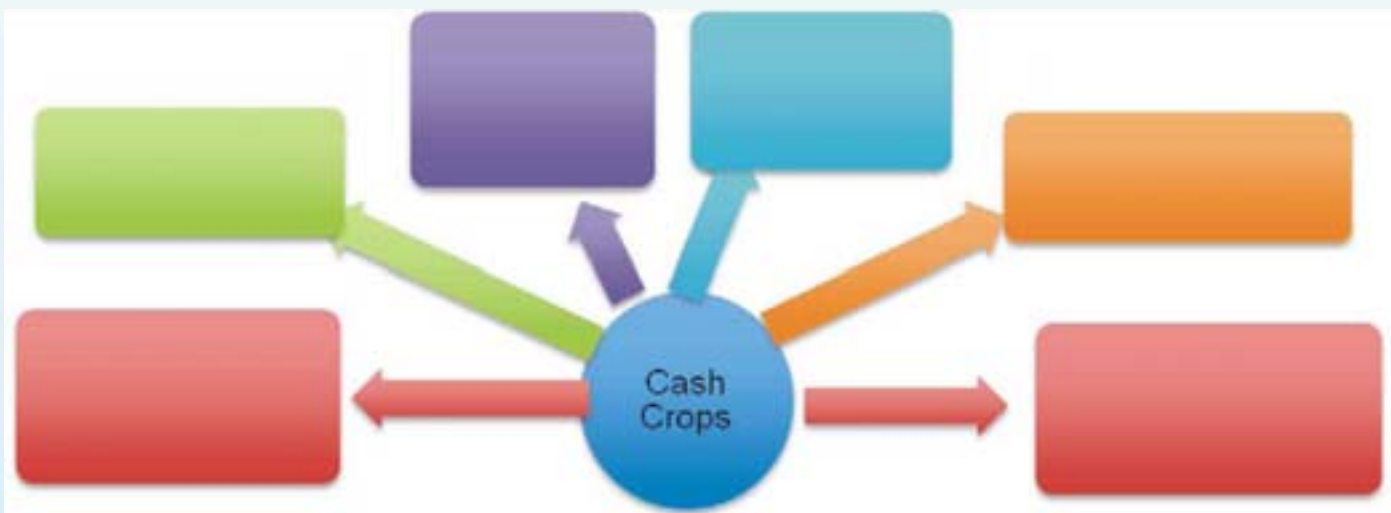
3.6. Other Issues in Agricultural

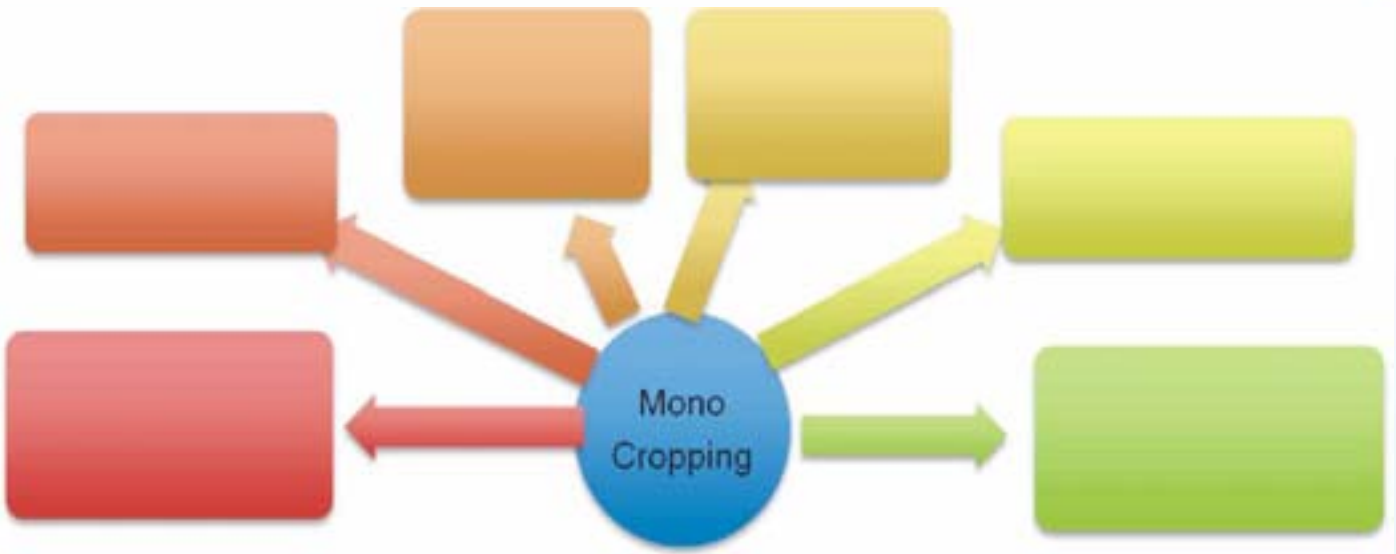
The use of chemical fertilizers and pesticides is not the only issue in agricultural ecosystem. There is a wide range of other issues that come under the umbrella of intensive farming. The intensive farming is a way of agriculture in which those methods are adopted that result in high yields from crops in short time and from small pieces of land. But as time passes, their negative impacts appear. Besides use of chemical fertilizers and pesticides, these methods include:

The method	Why and how it is used?	What result in short time?	What result in long time?
<p>Cash Crops Cotton, Banana, Sugarcane,</p> <p>Monocropping Growing one crop again and again in the same area</p> <p>Irrigation without proper drainage</p>	<p>Cash crops are sold in markets in country or abroad to earn cash income.</p> <p>It does not require different types of machinery and labour. It saves time.</p> <p>Drainage of irrigated lands is necessary but it is very costly and time-consuming activity. Therefore, farmers do not properly drain irrigated lands.</p>	<p>By selling cash crops, farmers earn money and become able to buy many goods, heavy machinery, chemical fertilizers etc.</p> <p>Growing the same crop again and again does not require new expenses but the yield gradually decreases. To maintain the yield additional efforts and expenses are required.</p> <p>The money and time that could be used to drain irrigated lands properly, is saved.</p>	<ul style="list-style-type: none">✍ Agricultural markets often fall and farmers are forced to sell their production very cheap. They remain no more independent. They become dependent on markets.✍ In the pursuit of cash crops, farmers do not grow subsistence crops. Subsistence crops are those crops, which are consumed by local community, like vegetables, pulses, wheat and rice. Thus, when markets of cash crops fall, farmers also do not have subsistence crops and become victims of food crises.✍ This increases population of pests and pathogens that cause diseases.✍ In any incident of a single pest or pathogen, the whole fields of crop are destroyed.✍ By growing only one plant, other kinds of plants become extinct.The animals that depended on other plants, also die.✍ Lands under monocropping become empty of nutrients. Their soil structure becomes weak, so soil is eroded by wind or water and thus, such land is degraded.✍ To grow on such degraded lands, much chemical fertilizers and pesticides are applied, and at last lands become so poisoned that nothing can be grown on them. They become completely barren.✍ Below the surface of land, much water is collected. The air cannot pass through such land. Thus, the oxygen supply is also restricted. The land becomes waterlogged. Crops cannot grow well in these lands because their roots are unable to get oxygen from the land.✍ After a time, the water below the surface of land comes up to the surface. The water evaporates and salts in water are left on the surface of land. When these salts gather up in much quantity over a time, land becomes saline. Crops cannot grow well in saline lands because the excessive salt in soil makes it very harsh for plants.



Read the text in section 3.6 and fill the blank charts below to know about the harmful effects of various farming options. The first one has been done for your reference.





Environmental Cycles



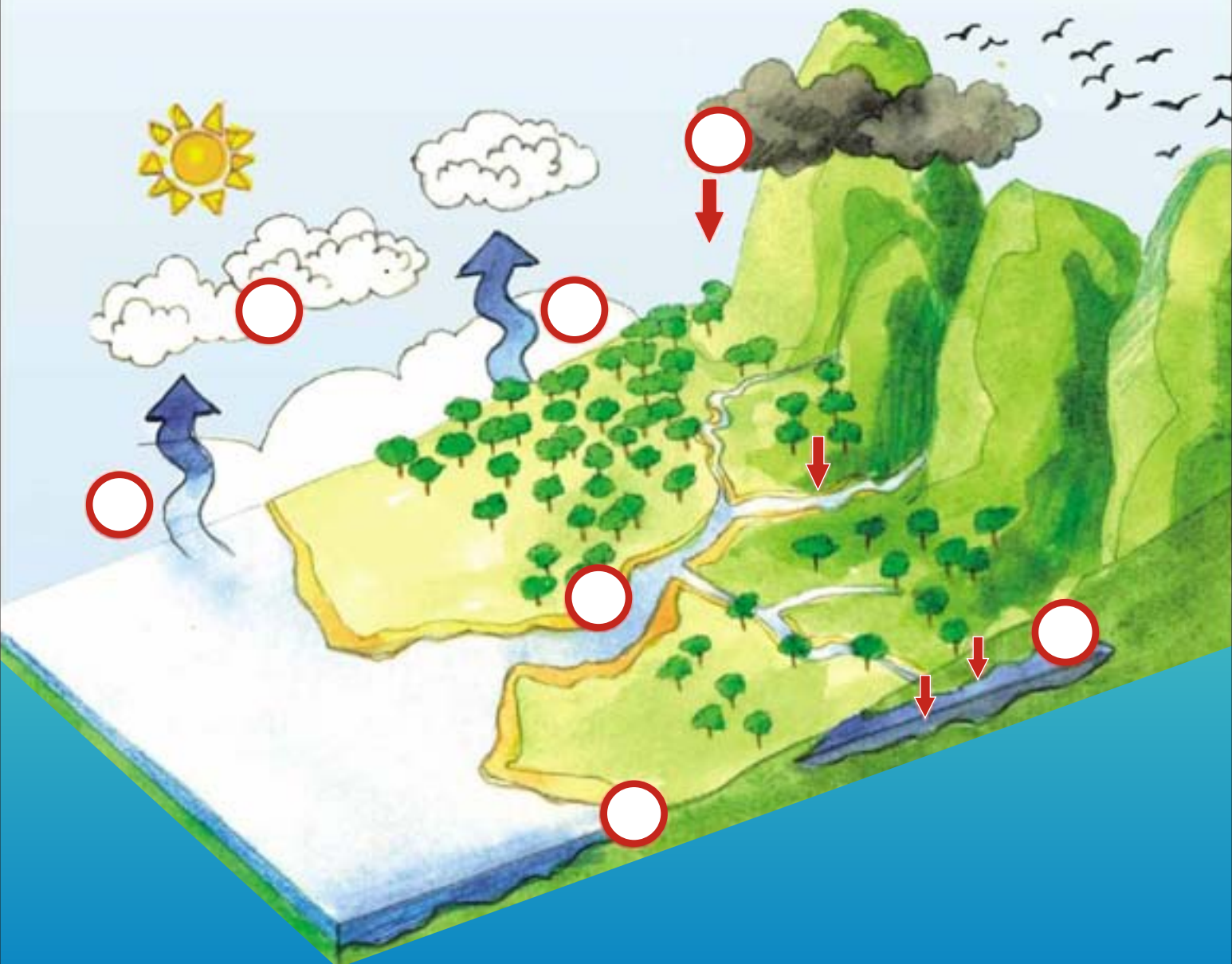
8.1 Water Cycle

Water exists in the forms of gas, liquid and solid. It can be found in the ocean, atmosphere and underground, as well

Water cycle is a process by which water travels in a sequence from air to the surface of the Earth and returns to the atmosphere through condensation, precipitation and evaporation.

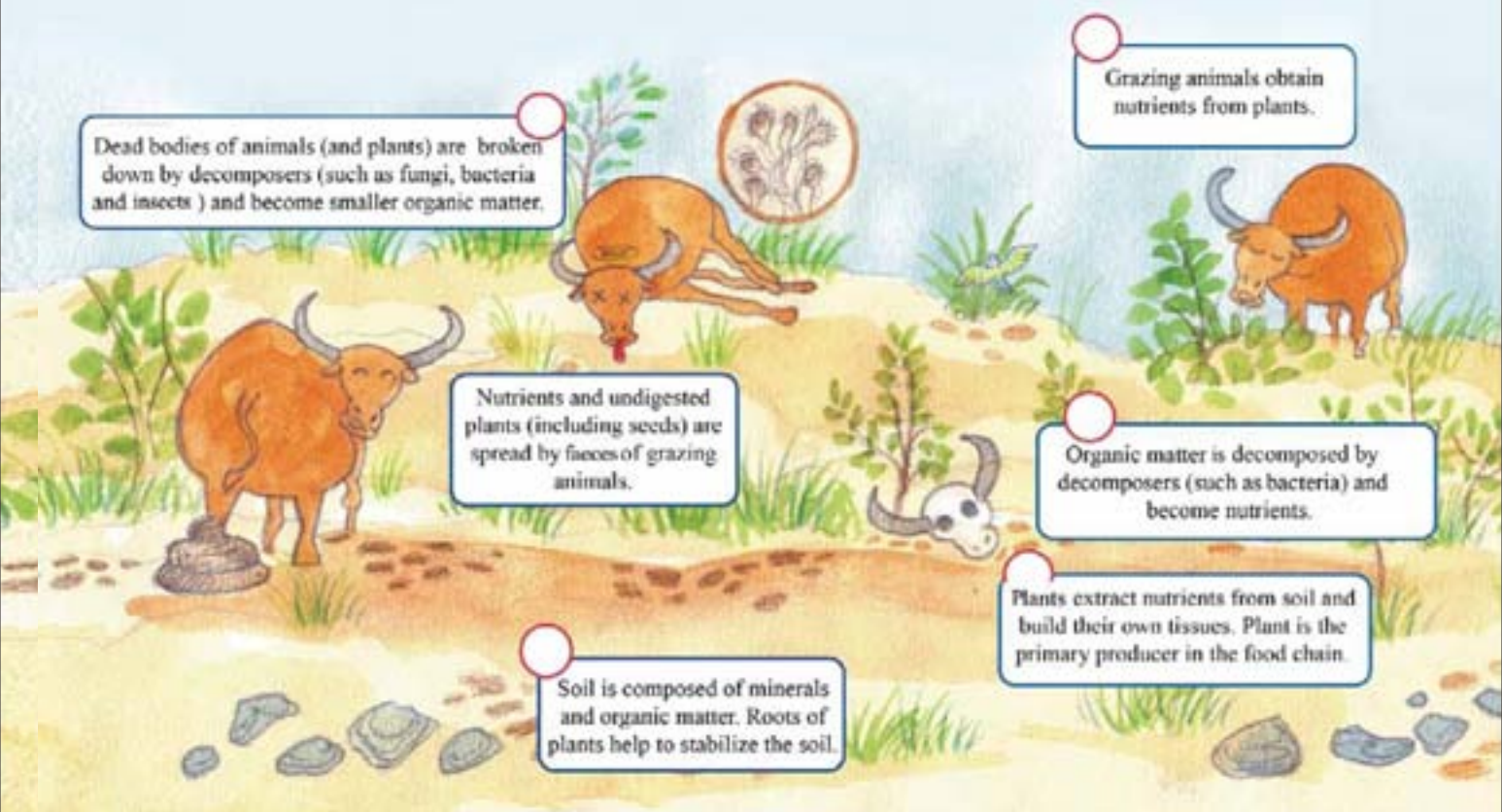
The following are the main processes in the water cycle. Fill the number in the spaces provided in the below diagram.

1. Condensation
2. Precipitation
3. Surface Runoff
4. Infiltration
5. Evaporation
6. Transpiration (it is a biological process by which water escapes from a plant through pores on leaves).
7. Underground water flow



8.2 Nutrient Cycle

By putting numbers please arrange the process in the nutrient cycle in correct sequence



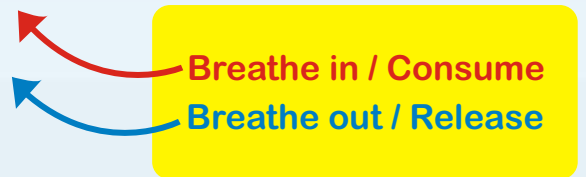
8.3 Air cycle

The air contains about 21% of oxygen and 0.03% of carbon dioxide (by volume). Most living organisms require oxygen (except those able to live in an anaerobic environment).

As we know, plants produce oxygen as a by-product when undergoing photosynthesis. However, logging and other environmental impacts reduce the net output of oxygen of many ecosystems.

Starting from 1750, the concentration of carbon dioxide increased from 280 parts per million (ppm) to 376 ppm. Of which, 60% of the increase had occurred by 1959. This significant increase was caused by industrial development, logging and change in the mode of agricultural practices.

Please use the arrows to link oxygen and carbon dioxide to their sources.



School Nature Clubs



9.1 What is a Nature Club?

A nature club is the friendly association of a school's head teacher, teachers and students and possibly the outside community having common goals and objectives to save nature and make this part and parcel of schools' curricula and culture. Through the nature club, students learn about significance of natural resources and environment.

9.2 Why establish a nature club in school?

The establishment of a nature club in school and its further development can benefit students in the following manner:

- ✎ Promotes learning about the natural environment;
- ✎ Enhances knowledge of students about nature and ecological processes;
- ✎ Fosters skills among students to interact positively with their natural environment;
- ✎ Promotes green actions among the school community such as cleanliness, waste management, plantation etc;
- ✎ Enhances leadership, research and presentation skills among students through co-curricular activities like nature painting, debate, nature collection, poetry etc; and
- ✎ Creates a caring attitude among students for their environment.



9.3 How to establish a nature club in school?

Below are the tips that may support the establishment of a nature club in the school:

- ✎ Hold a meeting with principal/head teacher, teachers and other students and explain the benefits of a nature club in the school;
- ✎ If a group agrees to establish a club, then give a proper name to your nature club, e.g, Earth Lovers, Green Minds, Hog deer, Dolphin Club etc.
- ✎ Invite all students to be members of the school's nature club.

- ✎ Under the leadership of the school head, select a group of teachers and students who take responsibility of organizing the club.

This group would sit and devise the plan for the school's nature club;

- ✎ Make sub groups of the teachers and students and assigning them different tasks according to their interests;
- ✎ Start doing the activities; and
- ✎ Monitor the activities of your club and keep trying to strengthen it.



9.4. What could be the activities of a nature club?

There could be several activities that might be performed in a nature club. These activities may be categorized as:

- Motivation/awareness activities, for example: lecturing by an expert, watching documentaries, mentoring juniors, etc.
- Health and hygiene activities for example: keeping a first aid box, cleaning the school, managing waste in school, etc.
- Development/improvement activities, for example: tree plantation, keeping a recycle bin, placing a notice board for displaying active persons' photos, developing teaching resources, setting up a library, etc.
- Research/enquiry activities, for example: collecting and identifying natural objects, observations of the environment, interviewing people, reading literature and taking notes, etc.
- Art/crafts activities, for example: making drawings, posters, charts, sceneries, models, pottery, performing dramas, poetry, developing portfolios, etc.
- Outdoor activities, for example: nature walks, tours, visits, etc.
- Sports activities, for example: playing cricket, hockey, volleyball, table tennis, badminton, etc. .



9.5. How to sustain a nature club in school?

You can make your nature club active by:

- Collecting membership fee;
- Getting donations;
- Organising fundraising campaign in and outside school;
- Maintaining discipline, cooperation, coordination in all ranks;
- Doing activities continuously as a part of the curriculum; and
- Monitoring and evaluating activities regularly to maintain a check and balance.



9.6. What can you do in a nature club?

I am working on a nature painting



I have developed a 3-D model on wetlands



We are presenting a tableau on environment



Here we are developing a garden in our school yard



Here we have established a nature corner in our school



We are in a nature study camp



We go for beach cleaning to save the habitat of endangered marine turtles



We plant trees in our school yard



We are studying about plants



ANSWERS

Unit 1:

Understanding Global 200 and Indus Ecoregion

1.1.1

1. c
2. d
3. a

1.1.2

- An ecoregion is a small unit of land or water like my school ground or a lake
- So far 158 ecoregion have been identified all over the world
- Ecoregions' study was carried out in 1997
- Ecoregion can only be land area
- Global 200 is a map in which the world's most important habitat types and ecosystems have been demarcated
- So far 238 ecoregions have been identified in the world
- Ecoregions may be terrestrial, marine or freshwater
- An ecosystem shelters specific groups of species, people and environmental conditions
- An area with lots of wildlife but no human interventions is an ecoregion
- WWF conducted the study of ecoregions in the world
- Only a forest can be a good ecoregion

Unit 1:

Understanding Global 200 and Indus Ecoregion

1.1.3

(to be answered by students)

1.2.1

1. Tibetan Plateau
2. Western Himalayan Temperate forest
3. North Arabian Sea
4. Indus Ecoregion
5. Rann of Kutch

1.2.2

1. Motane grasslands and shrublands
2. Temperate broadleaf and mixed forests
3. Marine Ecoregions
4. Freshwater Ecoregions
5. Flooded grasslands and savannas

ANSWERS

1.2.3

a:

Tibetan Plateau
Gilgit-Baltistan
China
Snow-capped mountains and alpine meadows
Snow leopard

b:

Western Himalayan Temperate forests
Gilgit-Baltistan and Khyber-Pakhtoonkhwa
India
Coniferous forests
Markhor

c:

Rann of Kutch
Thar Desert
India
Desert ecosystem
Chinkara gazelle

d:

North Arabian Sea
Pakistan's coastline
Iran
Coastal mangroves and cetaceans
Green turtle

1.3.1

(to be answered by students)

1.3.2

1. ✓

2. ✓

3. ✗

4. ✓

5. ✓

6. ✗

1.3.2

Indus River

ANSWERS

Unit 2: Marine Ecosystem

2.1.1
to be answered by students

2.1.2

1. Euphotic zone
2. Bathyal zone
3. Abyssal zone
4. Hadal zone

2.1.3

1. Green turtle
2. Blue whale
3. Hump backed dolphin

2.1.4	A	B
Marine ecosystem include		shoreline, temperate and tropical oceans, salt marsh and intertidal zones, estuaries and lagoons, mangroves, coral reefs, deep sea and sea floor.
Cetacean		a group of marine mammals which include dolphins and whales
Horizontally a marine ecosystem is divided into		two zones
Vertically a marine ecosystem is divided into		four zones
Neritic zone		shallow depth extending to about 200 meters
Threats to marine ecosystem		pollution, habitat destruction, unsustainable fishing, tourism development
Estuaries		mixture of fresh and salt water
Mid night zone species		Viper fish and Frill shark
Some marine species are		Mackerel, Butterfish and Spiny dog fish
Hades means		unseen
Abyss means		Bottomless
Oceanic zone		Trenches, volcanoes
Hadopelagic zone		Depth to 6,000 metres

2.1.5

(to be answered by students)

2.2.1

1. Astola Island (Baluchistan)
2. Charna Island (Sindh)

ANSWERS

2.1.5

to be answered by students

2.2.1

1. Astola Island (Balochistan)
2. Charna Island (Sindh)

2.2.2

1. b
2. a
3. b
4. b
5. a,b,c
6. c
7. g

2.2.3

to be answered by students

2.2.4

to be answered by students

2.2.5

to be answered by students

2.2.6

- a.

2.3.1

to be answered by students

2.3.2

to be answered by students

2.3.3

1. Pod
2. Dorsal
3. Flipper
4. Bulls
5. Cows
6. Ocean
7. Calf

2.3.4

to be answered by students

2.4.1



- Encourage your local politicians to lobby at the national level for an end to whaling
- Raise your voice to enforce laws to stop illegal hunting of whales
- Be part of anti-whaling campaigns in your country/ region

ANSWERS

2.5.2

Eight species of freshwater and four species of marine ecosystem

2.5.3

1

2

2.5.4

to be answered by students

2.6.1

to be answered by students

2.6.2

to be answered by students

2.6.3

to be answered by students

2.7.1

to be answered by students

2.7.2

to be answered by students

Unit 3

Coastal/ Mangroves Ecosystem

3.2.1

1) a

2) d

3) e

4) f

5) c

6) b

3.3.1

to be answered by students

3.4.2

1	j
2	h
3	e
4	a
5	g
6	b
7	d
8	c

3.4.3

to be answered by students

ANSWERS

3.5.1

1. c Fiddler crab
2. b Mud skipper
3. f Mud crab
4. d Telescopium
5. g Reef heron
6. a White heron
7. e Mangrove

3.5.2.

to be answered by students

3.5.3

to be answered by students

3.6.2

to be answered by students

3.6.3

to be answered by students

3.7.1

1. a
2. b
3. a
4. a
5. a
6. a
7. c
8. b

9) True and false

1. False
2. False
3. False
4. True
5. True
6. True
7. True
8. True
9. False

3.7.2

to be answered by students

3.8

to be answered by students

ANSWERS

Unit 4

Wetlands Ecosystem

4.1.1

- A place of natural environment
- A place of artificial environment
- A place with permanent water
- A place with temporary water
- A place with flowing water
- A place with stagnant water
- A place of same size and shapes
- A place of fresh water only
- A place of salty water only
- A place that provides natural habitat to plants and animals
- A place without organisms
- A place where water depth is more than eight meter

4.1.2

to be answered by students

4.2.1

1. Freshwater Lake
2. Junction of the fresh and salt water in the coastal belt
3. Mudflats
4. Freshwater wetlands
5. Deserts and wetlands mix
6. Beach
7. Banks of rivers, ponds and lakes

4.2.2

- a) Dolphin
- b) Palla
- c) Turtle
- d) Mangroves
- e) Osprey
- f) Wetland

ANSWERS

4.3.2

A wetland is a kidney	it functions as remover of wastes
A wetland is a pillow	it is the resting place for migrating birds
A wetland is a ship	It provides recreational opportunities
A wetland is a book	people learn a lot from wetlands
A wetland is a sponge	it soaks up water and prevents flooding
A wetland is strainer	that filters out sediments and pollution
A wetland is a food web	it provides food for wildlife and humans
A wetland is a sun hat	it provide shade and cooling
A wetland is a guard	it protects shoreline from erosion
A wetland is home	Many plants and animals live in it

4.3.3

to be answered by students

4.3.4.

to be answered by students

4.3.5

to be answered by students

4.4.1

1.

Indus dolphin
Freshwater (River)

2.

Marsh crocodile
Desert- wetlands mix

3.

Gadwall
Freshwater (Lake)

4.

Mangroves
Coastal area

5.

Marbled teal duck
Fresh water (Lake)

6.

Flamingos
Brackish water (coastal lagoons)

7.

Freshwater otter
Freshwater (Lake)

ANSWERS

4.5.3 (to be answered by students)

4.7

1. Don't throw junk into the stream
2. Save Indus
3. Let's recycle

Unit 5

Desert Ecosystem

5.1.1

1. a
2. b
3. d
4. c

Unit 6

Riverine Ecosystem

6.2.1

1. a
2. c
3. b
4. c
5. c
6. b
7. b

6.3.3

Riverine forests	forest growing along the banks of rivers
Hog deer	a species of riverine forest
Annual inundation	survival of the riverine forest
Timber and fuel	livelihood of local communities
Dams and barrages on riverine sindh	a threat to riverine forest
Sindh	historically famous for riverine forests

Note:

Questions and exercises in the remaining units are to be done by students themselves.

Our Mission

WWF - Pakistan aims to conserve nature and ecological processes by:

- Preserving genetic, species and ecosystem diversity
- Ensuring that the use of renewable natural resources is sustainable, both now and in the longer term
- Promoting actions to reduce pollution and the wasteful exploitation and consumption of resources and energy

Vision of the Indus Ecoregion Programme

"People coexist with nature in complete harmony and biodiversity flourishes in its entirety"

Indus for All Programme

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