Unit 1 : Water Education

Chapter 3 : Watershed area and water types

The area in which rainwater naturally flows from one place (rivulets, river, etc.) according to the geographical conditions, the whole area from which the rainwater flows in, assuming a water stream (rivulets, tributary, river, etc.) as a measure, is called the catchment area/watershed area.

Types and sizes of watersheds :

Each surface reservoir and each body of water has its own catchment area. When many such small watersheds come together, they form large watersheds, and when many such streams come together, they form a river valley.

Watershed classification by area :

Micro Watershed	Upto 10 hectares
Mini Watershed	Upto 200 hectares
Sub Watershed	Upto 4000 hectares
River Valley	No area limit

Watershed properties :

Before preparing a watershed development plan, it is necessary to check all the properties of that watershed. Watersheds are divided into three types- geographical, rainfed/rainy and geophysical.

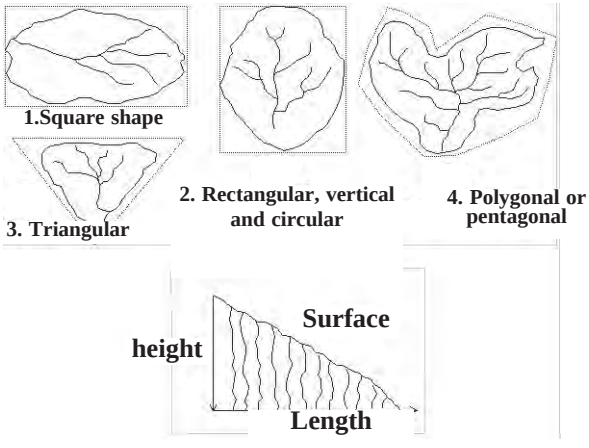
Let us know the properties on which the characteristics of the catchment area/ watershed area depend.

1. Dimensions :

How much watershed is to be managed in the catchment area depends on the size of the catchment area. Similarly, a large catchment area is beneficial for drainage. However, as the catchment area expands, so does the variation in its geological composition, soil type, slope, etc. Therefore, the right way is to study each watershed area separately and come up with the right solution.

2. Size :

The size of the catchment area affects the source flowing through that area. The proportion of watershed coming from the catchment area is related to the ratio of its length and width, it is inversely proportional to the length and directly proportional to the width. If the length of the catchment area is greater than its width, it takes longer for water to come out of the catchment area. This allows water to accumulate and seep into the soil and less water is released. If the same situation is reversed, that is, if the width is greater than the length, then the water in the entire catchment area falls into the source early. Therefore, it is less blocked and less seeped in the soil.



1.3.1 Watershed size

3. Slope :

The average slope of a watershed is determined by the height of the highest point in the catchment area and the maximum length of the slope. The time it takes for a drop of water flowing from the farthest point to reach the source to get out of the catchment area is inversely proportional to the height along the horizontal distance from that route. This means that it takes less time to carry water in a steeply sloping catchment area than in a flat catchment area. If it takes longer for the catchment to be carried away, more water seeps into the soil and the catchment is reduced. The watershed at the source of the steep slope catchment area is always higher than the watershed in the flat catchment of the same area.

4. Ground cover :

Ground cover is the surface vegetation, which affects both the surface watershed and the soil erosion. If there is grass everywhere on the ground, it keeps the soil particles tight and reduces soil erosion. If there is dense vegetation on the ground, the intensity of the rain falling on the ground is reduced by getting stuck in it and hence the soil particles will be less blown and the erosion will be reduced. But if the land is cultivated and crops are taken, then there is a lot of erosion as the soil particles are free in such land. This will allow you to decide which type of soil to treat. Also the roots of the plants increase the porosity of the soil. As a result, more and more water seeps into the soil, reducing the catchment area.

5. Flow density:

It is also necessary to study the number of watercurrents (brooklets, runnels, rivulets, streams etc.) flowing in the catchment area. Because it also depends on the amount of watershed in the catchment area, soil erosion and flood problem. Similarly, the division of the watershed and the direction of departure from the area make it easier to plan the management of the watershed and the measures to reduce soil erosion.

6. Land use :

To study how the land in the catchment area is being used now and how to use it in the future according to the usability of the land? It is very important to plan this. Watershed use, infiltration and drainage in the catchment area depend on the land use, the crops grown on it and the cultivation method adopted. It also determines the intensity of soil erosion to some extent.

7. Water infiltration :

The water holding capacity and drainage capacity of the soil depends on the amount of water infiltration in the soil. If the water holding capacity of the soil is high, it will absorb a large portion of rain water. However, due to lack of natural drainage of water in such soils, there is a risk of infertility due to water. Conversely, in lands with high drainage capacity, maximum water will be absorbed and surface runoff will be reduced. Watersheds from lands with low water holding and drainage capacity will be more.

8. Soil :

This is a very important factor. The water holding capacity, drainage and inflow of soil depends on it. This means that the amount of watershed and erosion also depends on it to a large extent. For this, the type of soil has to be decided by studying the composition, texture, color etc. of the soil. This work is done through a soil survey system. The amount of soil erosion depends on the type of soil.

9. Geological componants :

The type of soil depends on the subsoil and the rock. Therefore, it is important to study this from the point of view of watershed management.

10. Soil depth :

Soil depth is also a factor affecting soil erosion, watersheds, etc. This is also studied in soil surveys.

Rain (Precipitation) and its properties :

Rainfall is the largest and most important factor determining the amount of watershed and soil erosion. So it is simply impossible to plan watershed management without studying the rainfall in the catchment area. Many of the properties of rainfall affect the extent of the watershed and the erosion of the soil in different ways.

Rainfall :

Rainfall is rainwater falling on the surface. It is measured in millimeters. The amount of rainwater that falls on a given surface area over a period of time is considered to be the rainfall over that area over a period of time. The water measured in this way up to a given date throughout the year is the accumulated rainfall up to that date and the total rainfall of such measured rain throughout the year is considered as the annual rainfall of the area. Thus the average annual rainfall of an area is determined by averaging the rainfall over the last few years (e.g. 10, 25, 50). This rainfall determines the total watershed of a catchment area.

Rainy Season :

Rain does not usually fall continuously, but sometimes stops falling and then starts falling again after some time. The period of time when rain falls at one time is called the rainy season. If the rainfall in this season is short, maximum water is absorbed into the soil and the amount of surface runoff decreases. Conversely, if the rainfall in this season is high, the land becomes saturated and its water absorption capacity decreases.

Rainfall Density :

Rainfall density is the amount of rain that falls over a period of time. This is usually calculated as millimeters per hour. The total rainfall in a given hour is the density of rainfall in that hour. Automatic drawing type rain gauges have to be used to determine the rainfall density. From this graph, the rainfall density of each day, every hour is calculated. The hour in which the maximum rainfall density is thus found throughout the year is considered to be the maximum rainfall density of that catchment area for that year. Considering the rainfall density of the last few years (e.g. 10, 25, 50) which is the highest, it is considered to be the reversible peak density of those periods. Reversible peak rainfall density of a period of 10 to 25 years is generally considered to determine the pattern of soil conservation measures.

Frequency :

Considering the total annual rainfall, the maximum rainfall in the last few years (e.g. 10, 25, 50) is the frequency of that rainfall. E.g. 1250 mm of an area. The frequency of rainfall is a maximum of 1250 mm of rainfall which falls once in 10 years in that area

Distribution :

Rain does not fall uniformly throughout the region. Or it does not fall every time, so its distribution depends on the area in which it falls and the period in which it falls.

The above properties of rainfall are generally related to each other. For this, it will be useful to remember some key points.

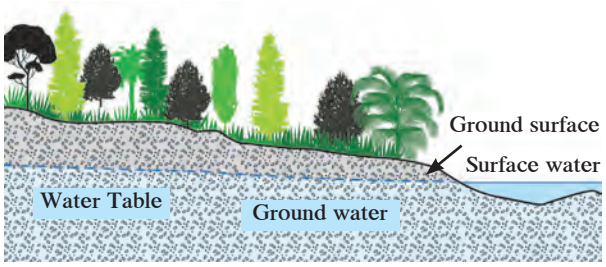
- The frequency of high rainfall is low and the density is high. Also its duration is short.
- The high density rainfall has low duration and frequency.

Let's Recall?

What are the two main components of the earth's surface?

Groundwater:

Ground water is the water beneath the land. It can be in porous soil, in rocky crevices, or in a cavity.



1.3.2 Ground Water

1. The chemical composition of this water is simple, easy and plain. Also, since the water is trapped in rocks and sometimes very deep in the ground, it is free from turbidity, offensive colors or harmful microorganisms. So it doesn't need much processing to use it properly.
2. This water is relatively much safer than surface water, as it is free from any chemical, radioactive or biological pollution.
3. Since this water is underground, it is not affected much by any kind of climate change, even drought.
4. Since this water is generally available locally, the means of supply may be available at cheaper rates. So this water is also economically beneficial.

Groundwater sources:

1. Rainfall :

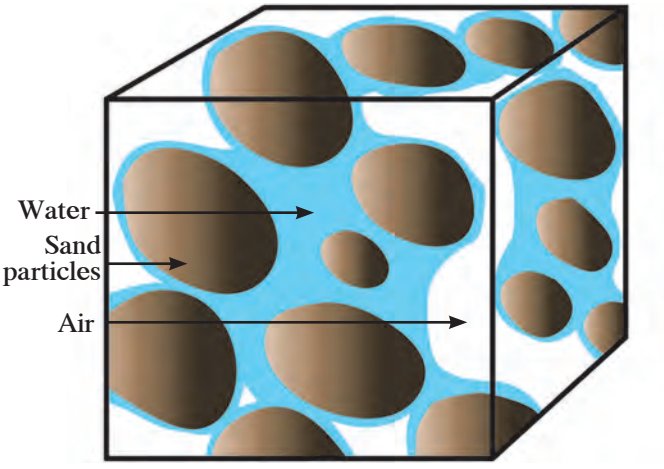
This is the source of water. Rain, snow, or water seeps underground from the earth's surface. The amount of water that will accumulate in an area depends on the type of rocks in that area and their characteristics. Normally, where there are sedimentary rocks, the infiltration rate is higher. This is because these rocks have the most cavities.

Along with rain and snow, rivers and lakes can also be sources of this water.

If the porosity of soil and rocks is high, then the groundwater table is above a water current. For example, suppose two water currents are at more and less height from each other. If the porosity of the rocks is high, then water will seep from the higher current into the lower current.

2. Connate Water :

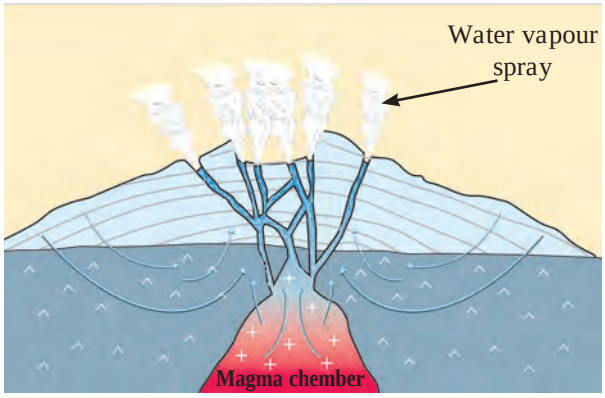
This water does not seep into the soil from the surface. The water that gets stuck in the sedimentary rock is called connate water.



1.3.3 Connate Water

3. Magma / Volcanic Water :

When water vapor in molten rocks is formed due to underground magma, it tries to rise through the available notches. If it does not find a place to rise, it eventually condenses and transforms into water. This is 'magma/ volcanic water'.



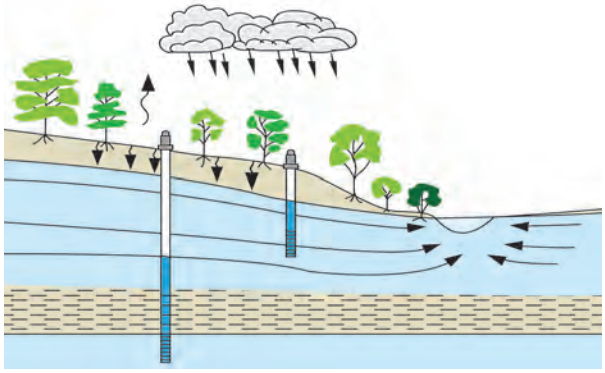
1.3.4 Magma water formation

Groundwater again returns to the surface in the following way.

1. Water in a nearby reservoir e.g. Rivers, Springs, Ponds, Lakes etc.
2. As the groundwater travels downhill according to the law of gravity, it is found to flow out in the form of springs in mountainous areas where it penetrates the surface.
3. Extracted for use from wells.

Can you tell?

What differences can you see among the terrane layers in the picture?

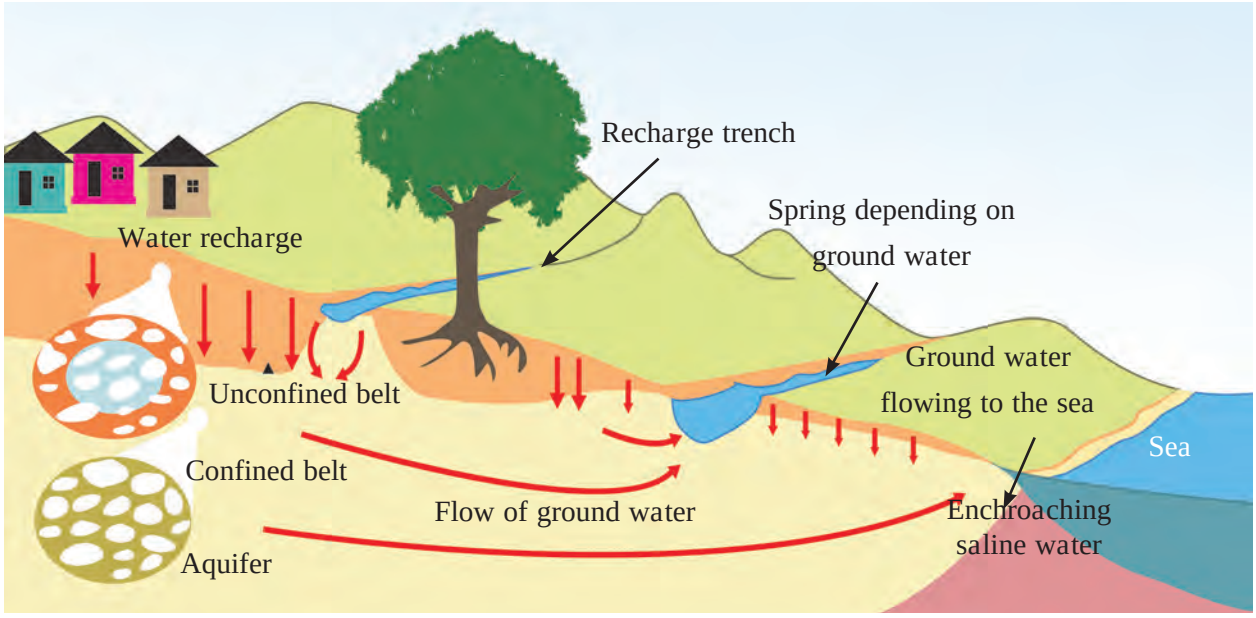


1.3.5 Terrane layers

Briefly :

The journey of rainwater falling on the earth is as follows:

1. Water falls into the reservoir.
2. It flows from the ground to the nearby reservoir.
3. Groundwater reserves increase by seeping into the soil.

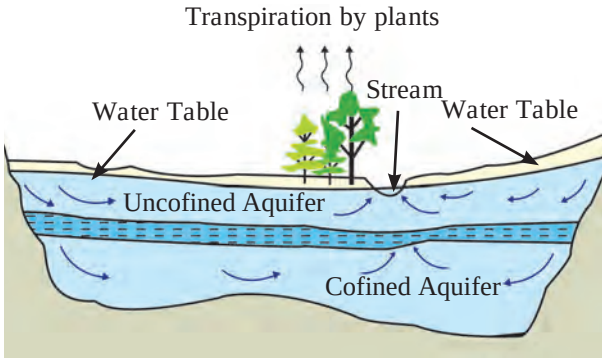


1.3.6 Flow of ground water

On the basis of geographical formation groundwater is classified as follows :

1. Aquifer : Aquifer is made up of soil, sandy soil, muddy, cracked rock, limestone etc. These areas have hollow spaces that can be connected to each other, through which water can seep. The velocity of groundwater seeping through depends on the size of the cavities in the soil or rocks and how they are connected to each other. Its main feature is that the reservoir can store water as well as supply water due to its permeability.

They have two types depending on their location on the ground



1.3.7 Aquifer

(A) Unconfined aquifer : The soil and rock pores in this area contain air as well as water. Being close to the surface, it is affected by atmospheric pressure. Where there is a lake as well as a swamp, this part does not exist, but in the desert region it covers hundreds of meters.

Groundwater plays an important role in providing water and nutrients to living creatures.

Characteristics :

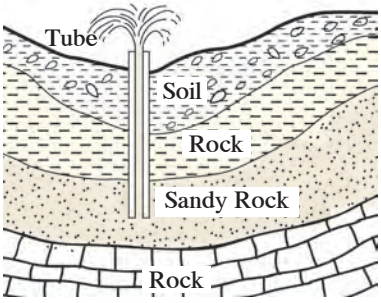
- This unsaturated aquifer controls the flow of water from the surface to the saturated aquifer.
- This affects the recharge of the aquifer.
- It is crucial in groundwater use and management.
- This helps in removing unwanted substances.

(B) Confined aquifer : The layer of saturated aquifer is below the unsaturated layer. Similarly gaps between these cracked rocks and all other gaps are fill with water.

Since there are many layers on the saturated layer, this layer is detached from the surface or atmosphere.

Can you tell ?

What happens if there is a huge pressure on the saturated water table?

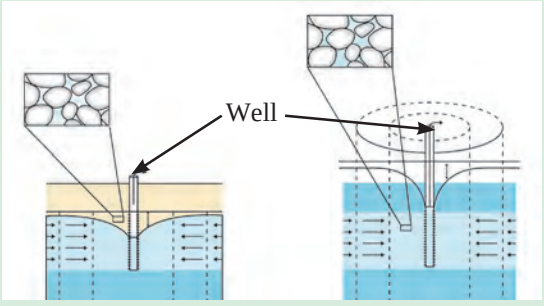


1.3.8 Fountain well and its internal structure

Fountain well : If water comes to the surface due to natural pressure after digging a well, then that well is called a fountain well.

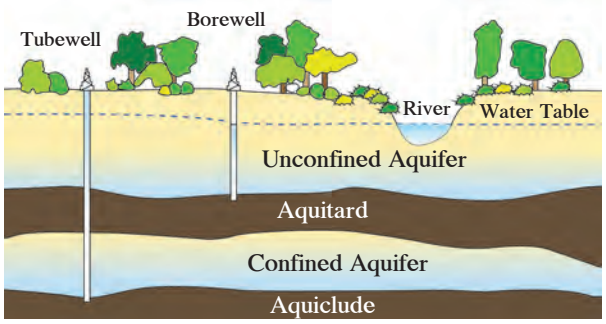
Can you tell?

What happens if water is pumped out of the well from different water holding layers?



- When water is pumped out of unsaturated aquifers, the water level decreases and the water in the empty spaces decreases.
- When water is pumped out of saturated reservoirs, the water pressure decreases, but the spaces remain filled with water.

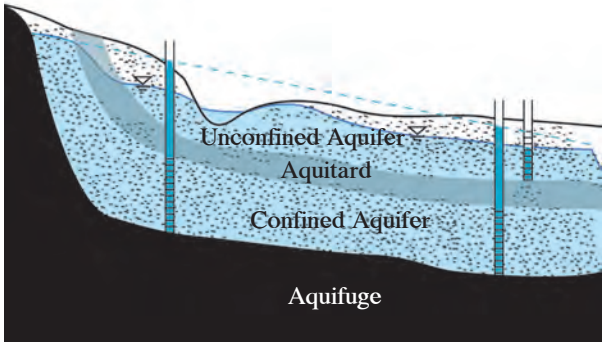
2. Aquitard : Water is not readily available due to low permeability of this layer. But if there is a reservoir below this layer, the water in it seeps into the reservoir. Sandy soil is an example of this layer.



1.3.9 Aquiclude

3. Aquiclude : As this layer is porous, it has good water holding capacity, but it does not seep water. Therefore, water is not available from it. Soil is an example of this.

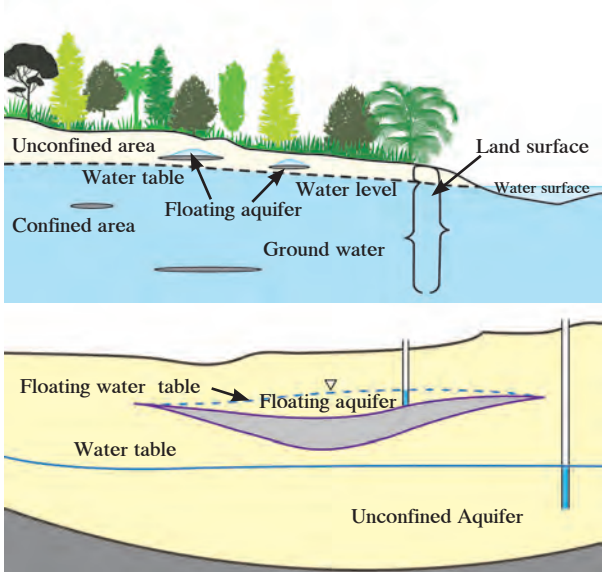
4. Aquifuge : This layer is impermeable and not porous. Therefore, it cannot hold water and water does not seep through it. Hard rock is an example of this.



1.3.10 Aquifuge

Geographical Formation / Characteristics	Aquifer	Aquitard	Aquiclude	Aquifuge
Water holding capacity	Yes	Yes	Yes	No
Permeability	Permeable	Semi-permeable	Im-permeable	Im-permeable
Ability to provide water	Yes	Yes, but slower	No	No
Example	Sand, gravel.	Sandy soil	Soil	Hard rocks e.g. Granite, basalt

5. Hanging aquifer : This layer is on top of unsaturated aquifer. Its size is generally small. The amount of water in it depends on the weather conditions.



1.3.11 Hanging aquifer and its Cross section

Surface water :

Surface water is water found on the surface. These include rivers, lakes, springs, reservoirs, ponds, creeks. Although seawater is salty/ brackish, it is still surface water.

There are three types of surface water.

1. Perennial: It has water all year round. If the rainfall is low, it is recharged by

groundwater.

1.3.12 Surfacewater

2. Temporary: It contains water only for a few months of the year. These include small creeks, coastal creeks.

3. Man-made: Water from dams as well as constructed catchment areas, in short, artificially stored water.

Maharashtra State Water Reserves :

Dams: Total 1821 large dams

Region	Capacity (Million liters)	Status in 2019 (Million liters) Approx
Amaravati	4131000	2531000
Konkan	3511000	2661000
Marathwada	7259000	4544000
Nagpur	4604000	2996000
Nashik	5823000	4848000
Pune	15199000	11942000

Reservoir in Maharashtra State :

Type of Reservoir	Total number	Water lifting (BCM)
Wells	21 Lakhs	> 14. 85
Tubewells	1.91 Lakhs	1.29

(BCM =Billion Cubic Meters)

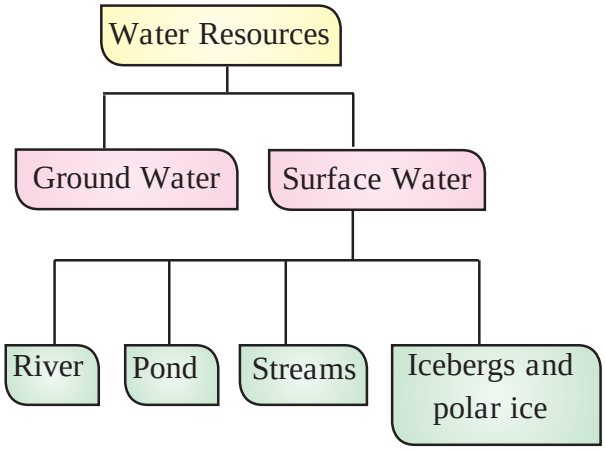
Observe and discuss.

1.3.13 Hand pump

What is common in these two pictures? Where does the water from the borewell in the picture come from? Think about it. Where did this groundwater come from?

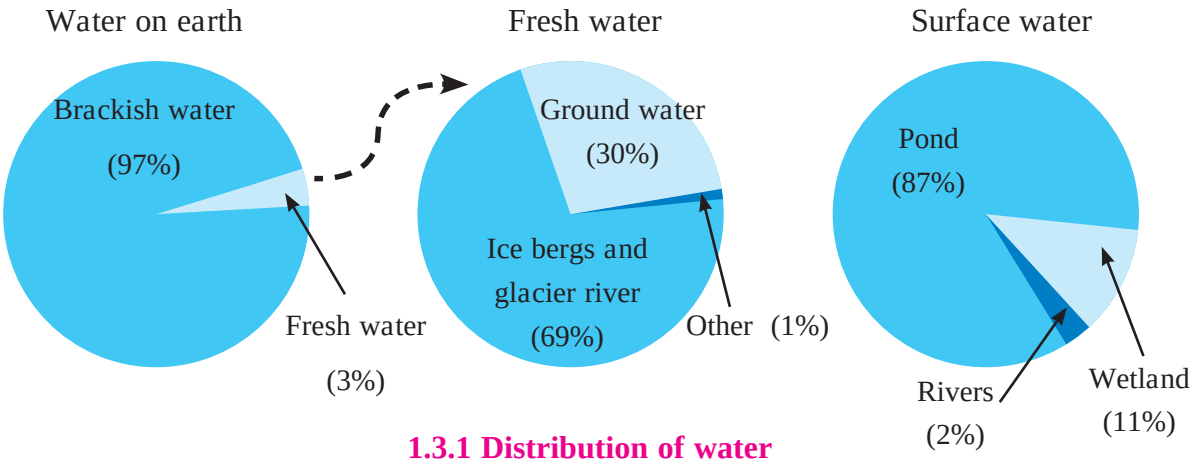
There are two main types of water resources :

1. Groundwater 2. Surface water



Observe and discuss.

How is the distribution of water on earth?



1.3.1 Distribution of water

The figure shows that,

- Most of the water on Earth is in the oceans, which is brackish.
- Much of the freshwater is in the form of snow and ice, while the rest consists of rivers, lakes, groundwater, and air vapor.
- This means that even though the amount of water on Earth is high, the usable water is much less than 1%.

1.3.2 Water resources

Let's recall.

How many types of water resources are there on earth?

1.3.3 Glaciers

Exercise

1. Write the classification of watershed areas/catchment areas.
2. Write any four properties of the watershed area/catchment area.
3. Write the type of watershed area/catchment area found in your surroundings.
4. Using the Internet, write down the average rainfall in your district.
5. Briefly explain any two properties of rain.
6. What are the key points about the density and frequency of rainfall in your area?
7. Write the names of various groundwater sources.
8. Write how magma water is formed.
9. Explain the distribution of water on the earth with the help of a diagram.
10. Write the characteristics of unsaturated aquifers.
11. Explain the types of surface water by stating what it means.
12. Find out the percentage of how groundwater and surface water is used in your state for the above purpose from the internet.
13. Write the classification of groundwater according to geographical location.