

THE EXPERIMENTALIST

An Encyclopedia of Science and Technology for young people

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Children with their pinhole cameras

Technology: Air Pressure and Drilling a Well

Construction: A Pin Hole Camera

Community: Extracting Water from the Soil

How to carry water on your shoulders

World Technology: Lightning



Editorial

Mozambique is beginning to suffer a long-term shortage of water. Agricultural reports have noted this for many years. Typical is this report from 2005:

"More than a quarter of a million families were affected by drought in southern and central Mozambique this year, according to the latest government statistics."

It is important for our rural people to know how to collect water efficiently and how to preserve it and use it with care, either for agriculture or for domestic consumption.

This issue of our magazine includes this topic.

Extracting Water from the Soil

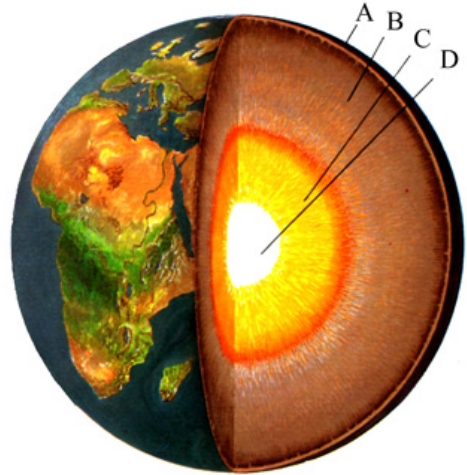
The Temperature of the Earth

The center of the earth is very hot, consisting of molten iron and, below this, solid nickel, continuously heated by radioactivity.

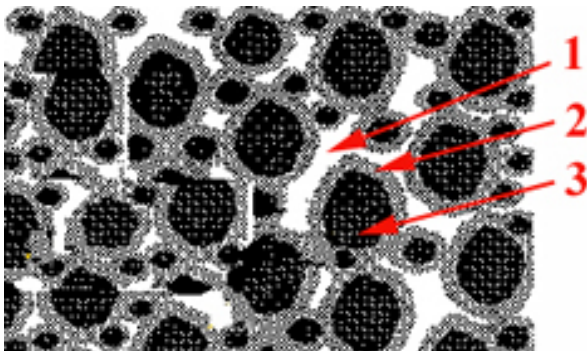
- A - Surface layer from 0 to 800 degrees C
- B - 800 to 3,000 degrees
- C - 3,000 to 5,000 degrees
- D - 7000 degrees

This heat comes slowly to the surface. At the bottom of a diamond mine or coal mine 1,000 metres deep, the temperature is around 35 degrees centigrade. If you dig a hole about one meter deep, it is slightly warmer at the bottom than at the surface.

All soils contain some moisture. The plant roots suck the water by osmosis (the suction of pure water through a membrane, because the water on the other side of the membrane is salty). But in arid and semi-arid conditions, ground water is tightly bound to the soil, and is not easily available to plants because of its shallow root system and low suction osmosis.



But even in very dry regions, the soil particles below the surface have a very thin layer of water around them. This is due to water vapour coming from the depths of the earth.



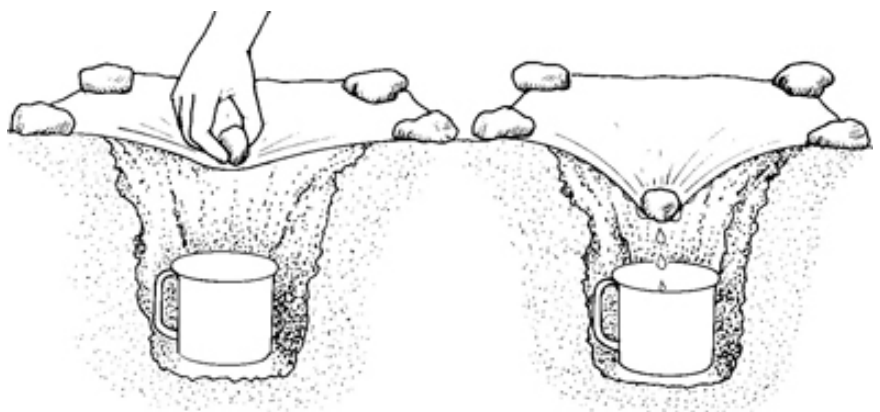
- 1 - Air
- 2 - Thin layer of water
- 3 - Particles

If this earth is hot, the water evaporates and goes into the air above the surface.

Extracting water from the soil

Open up a big transparent plastic bag so you have a plastic sheet – transparent so you can see what is happening.

Dig a hole in the sand in your backyard. It should be almost as wide as the plastic sheet and about 20 cm deep.



Place a cup in the middle of the hole. Place the plastic over the hole and secure the edges with stones.

Place a small rock in the middle of the plastic above the cup (but not touching it). This presses the plastic down in the middle of the sheet.

When the water vapour comes out of the warm earth, it condenses on the plastic and drips into the cup.

In the photo you can see the drops of water running down the lower surface of the plastic.



It works best at night when the plastic gets cold and the water vapour condenses as well. Make sure that the stones hold the plastic well so that the water vapour does not escape. During the day, if the plastic is transparent, the heat from the sun warms the inside of the hole and vaporises more water in the bottom of the hole.

You may think that the sand in your backyard is dry, but there is always some water vapour coming through the sand from deep down in the earth.

In the morning you will be surprised to see how much water has condensed.

It is said that people lost in the desert without water can collect enough for this method to stay alive. About 4 square metres of plastic is needed to produce 4 litres of water per day.

Air pressure and drilling a well

Pull the tab off the top of an empty can of Coca-Cola.

Make a small hole in the bottom of the can. Fill the can with water. The water goes out through the hole.



Place your finger on the hole at the top of the can. The water stops flowing out of the hole in the bottom. If air can not enter the top hole, the water can not exit the hole in the bottom. Atmospheric pressure holds it in.

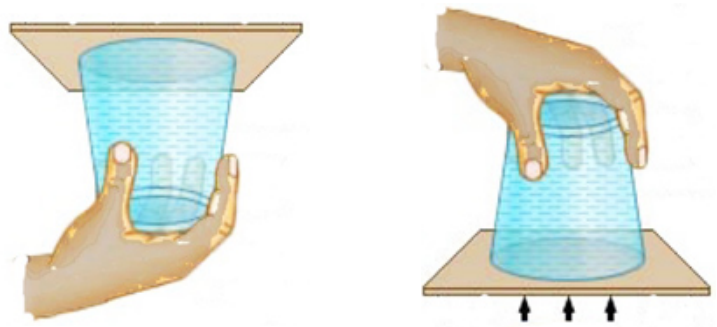
Lift your finger from the upper hole. Air can now enter, and the water can flow out of the hole at the bottom.



A Trick for a Party

Fill a glass with water. Place a piece of cardboard on top of it.

Hold the card in place and quickly invert the cup. Then remove your hand. The card remains where it is and the water does not fall. (It is the same principle as a can of Coca-Cola in the example above.) Air pressure keeps the card pressed against the glass.



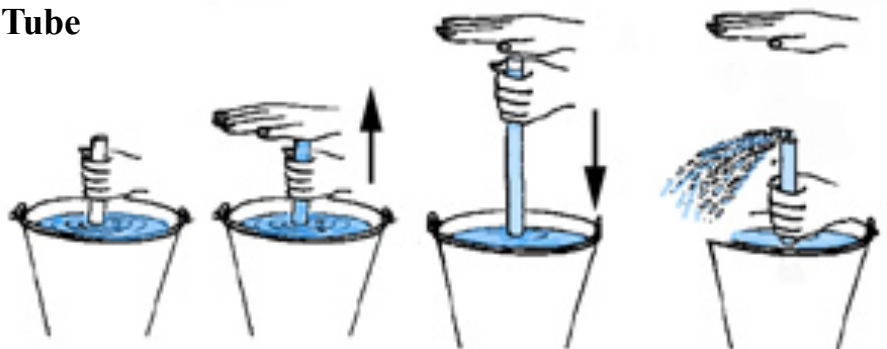
Here is a pump that works on the same principle:

A Simple Pump made from a Tube

You need a bucket, a tube and water.

Fill the bucket with water.

Place the tube down in the water.
The water fills the tube.



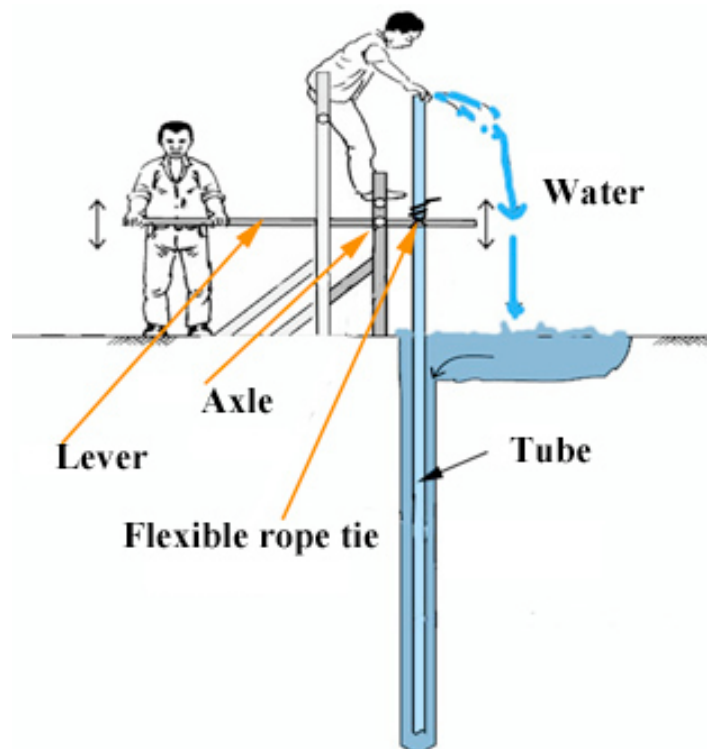
Close the top of the tube with your hand and lift the tube until it is almost out of water. In this position the tube is still full of water. It does not fall because the air cannot enter the top of the tube.

Take your hand off and immediately push the tube down quickly in water. The tube goes down, but the water stays where it is because of its inertia. That is, it falls out of the top tube.

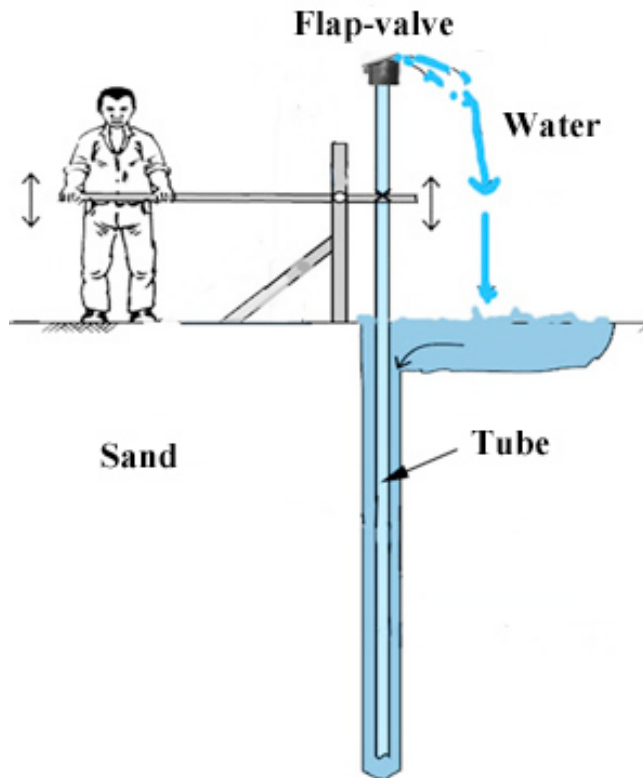
How to Operate a Tubewell Drill

A very simple method of drilling a well just using an iron pipe, diameter of about 6 cm.

This method only works on light sand or earth, easy to drill.



Dig a small hole. Place the tube in it vertically, so that it rests on the bottom. Fill the tube with water.



The tube needs a valve at the top to open and close at the right time. You can use your hand, but better is a "flap valve" as shown in the photo. > Start to lift the tube with the lever. Immediately press your hand on top of the tube. (Or, the valve closes.)

The tube and the water inside it rise together because air cannot get in the top.

Now let the tube fall, immediately removing your hand. The tube falls but the water inside the tube stays where it is (because of its inertia). So it comes out of the top and falls down into the hole.

Again, lift the tube with your hand on it. (Or, if you are using a valve, the valve closes automatically.)

This time the water that comes in the tube contains sand from the bottom of the hole. So now you are pumping sand and water. The tube is already digging

into the ground. That is, you are digging a well. Continue the process.

When you have reached the water under the ground, it needs a pump.

Remove the iron pipe and put a plastic tube in place. This will be connected to the pump.

The lower metre of the tube must have holes to allow water to enter. But you do not want to let sand in, so wrap sisal rope around the pipe to serve as a filter.



[The description above is very brief, just to give you the idea. In fact it is necessary to be trained in practice.]

For anyone who has access to the Internet, there are two videos with the URLs:

<http://www.youtube.com/watch?v=nIvgg6QTKj4>
<http://www.youtube.com/watch?v=xZqgvyorcHQ&feature=related>

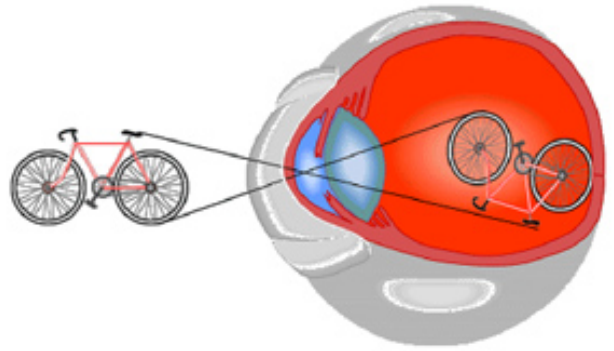


A Pin Hole Camera

Rays of light

Long ago, people thought that in order to see something (such as a bicycle) their eyes sent invisible 'fingers' to feel the bike, like their fingers tried to touch and recognize a real bike.

Today, we know that is not true. The bike sends (reflected) lines of particles of light (which are called "rays of light ") and these enter the eye



Our eye is a camera. It receives these rays on an internal screen, thus making an image of the bike. The screen sends this picture (as pulses of electricity) along the nerves to the brain. The image is inverted but the brain turns it into the right position.

The Pin Hole Camera

The pinhole camera is a kind of photography that does not use any kind of photographic apparatus, such as film and lenses. To make the camera shown here, it only takes a tin can and translucent paper (tracing paper).

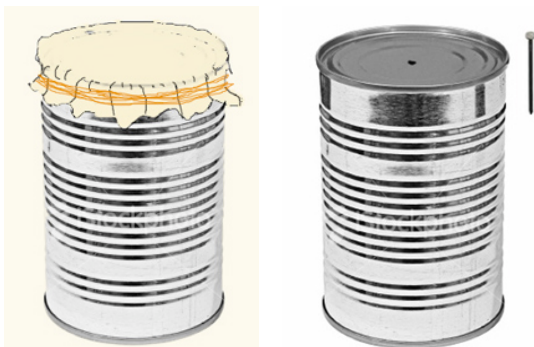
It uses a basic principle of photography, discovered simultaneously by several scientists in Europe in the sixteenth century, among them Leonardo da Vinci.

The photo shows a wooden hut with a hole at one side. Rays of light coming from the woman pass through the hole, and create an image of the woman on a glass screen. On the other side of the glass there is thin paper. The image is visible to the artist and he draws the woman.



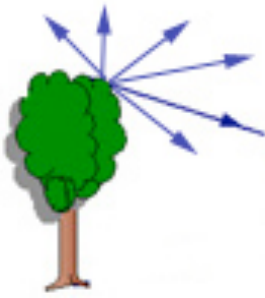
How to make a pinhole camera

Make a small hole in the base of a can with a thin nail. At the open end stretch thin paper rubbed with a little cooking oil and hold it in position with string or tape. The oil makes the paper 'translucent'.



In a dark room, point the camera through an open door or a window at a scene well lit by the sun (for example a tree).

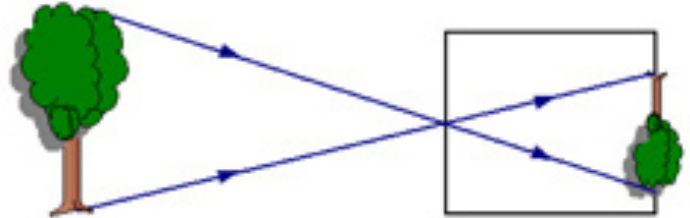




In daylight, the picture is weak. So wrap thick layers of newspaper around the tin to make a tube. Secure the paper with string or tape. Now, when you look, the screen is dark and the picture is clear.

Many rays of light come from each point of the tree. But only one ray from one point can pass through the hole and get to the screen.

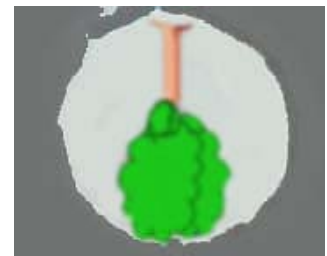
A The same thing happens with every point of the tree. Thus, an image of the tree appears on the screen.



The appearance of the image in the camera.

The smaller the hole, the better is the sharpness of the image but it is darker.

If you make the hole bigger, it makes the image lose 'focus'. It is less clear but more brilliant.



The World Pinhole Photography Day is an international event created to promote and celebrate the art of pinhole photography. In 2010, the DMFP was on April 25. The photo shows a poster to advertise the event.



Pictures taken with a pinhole camera are not sharp. The photo taken in Kenya during the DMFP 2009 shows the typical quality.



Real cameras work in much the same way, but use a lens of glass or plastic to make the image sharper and clearer. The photo shows one of the first cameras of this kind.

How to Carry Water on Your Shoulder

The problem

Women in Mozambique carry loads on their heads, often 20 kg (eg 20 litres of water). Often they have to go long distances. They must go often because 20 litres of water are too little for the daily needs of a family.

Twenty or thirty kilograms on the head of a woman can be physically harmful. The pressure on the bones of the neck is very high.



In many parts of the world, people use 'shoulder yokes' to carry loads.

A shoulder yoke is basically a wooden stick on your shoulder on a cushion of grass with buckets of water (or other loads) on the ends of the stick.



The best kind of yoke is slightly elastic. It bends slightly up and down while the woman walks.



This makes a smaller force on your shoulder and smooths out the force on your shoulder, like the springs on the axle of a car.



The photos are of Alberto Chapola experimenting beside the workshop of the Grupo Faísca in KaTembe.



In East Asia, people use a flexible bamboo pole over one shoulder to carry loads. The loads at the ends oscillate up and down. As their body rises, the bamboo and the load also rise, but the shoulders have less force than if the stick was not flexible, though for a longer time. And as their body goes down, the stick presses less on their shoulder and during this period there is very little pressure on bones and muscles. In fact, at a certain walking speed and an elastic bamboo, the bamboo sometimes actually leaves the shoulders for a moment.

In Mozambique, a woman carries 20 kg of water on the head or up to 50 kg of firewood. But in countries that use shoulder yokes, a full load can be up to 110 kg. In China, a water carrier that can not carry 75 kg per day for eight hours is considered no good as a porter.



They are also used for other tasks such as carrying firewood, grass and water.

Lightning

Lightning is one of the most beautiful displays in nature. It is also one of the most deadly natural phenomena known to man. It's hotter than the sun's surface and with shock waves radiating in all directions, lightning is a lesson in physical science.

The Water Cycle

One aspect of lightning is the "water cycle" (the movement of water from land, rivers and sea, and then the rain falls back to earth). To fully understand how the water cycle works we must first understand the principles of evaporation and condensation:



Evaporation is the process by which a liquid absorbs heat and changes into water vapour. A good example is a pool of water after rain. The puddle dries because the water in the pool absorbs heat from the sun and the environment and escapes as vapour. When the water is heated, its molecules move faster. Some of the molecules move fast enough to break the surface of the liquid and exit as steam or gas. Once free from the constraints of the liquid, the steam begins to rise into the atmosphere.

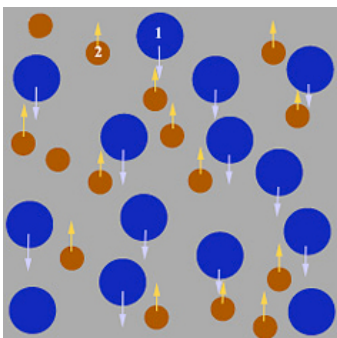
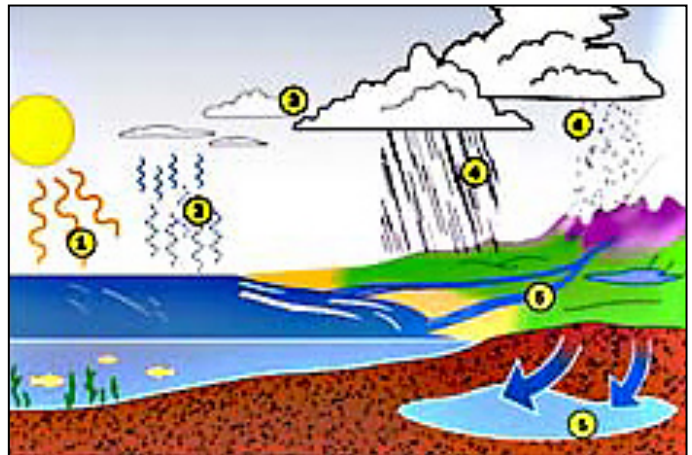
Condensation is the process by which a vapour or gas loses heat and becomes a liquid.

The atmosphere near the Earth's surface contains gases and vapours. They are warmer than the air above them, so they rise. As they ascend, the air temperature around them drops more and more. Soon the vapour, begins to lose heat to the atmosphere.

As it climbs to high altitudes and lower temperatures, it loses enough heat to condense and turns into water droplets (which are the clouds).

Sometimes, the droplets merge and become larger. They fall as raindrops or, if the temperature around them is very low, they freeze as ice particles, or hail.

- 1 - The sun heats the sea
- 2 - The sea water evaporates and rises into the air
- 3 - The steam cools and condenses into droplets and forms clouds
- 4 - If enough water condenses, the droplets grow and are heavy enough to fall as rain or hail
- 5 - The rain (or hail or snow) falls on land and in rivers, the sea, etc..



The Production of Electricity

As this hail (1) falls, it collides with the droplets of water that go up (2) and produces electricity. The importance of these collisions is that they remove electrons from moisture that is rising, thus creating a charge separation.

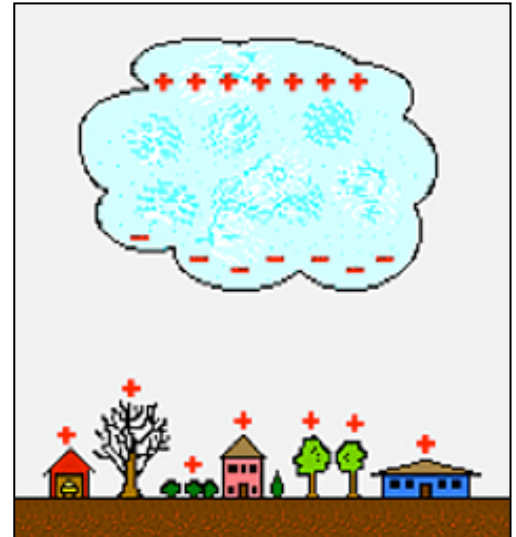
Jumping to the Earth

The cloud emits electrically charged thin electrical currents (called 'leaders') extending towards the earth. These leaders are negative (electrons) and emit a faint purple glow.

Jumping to the sky

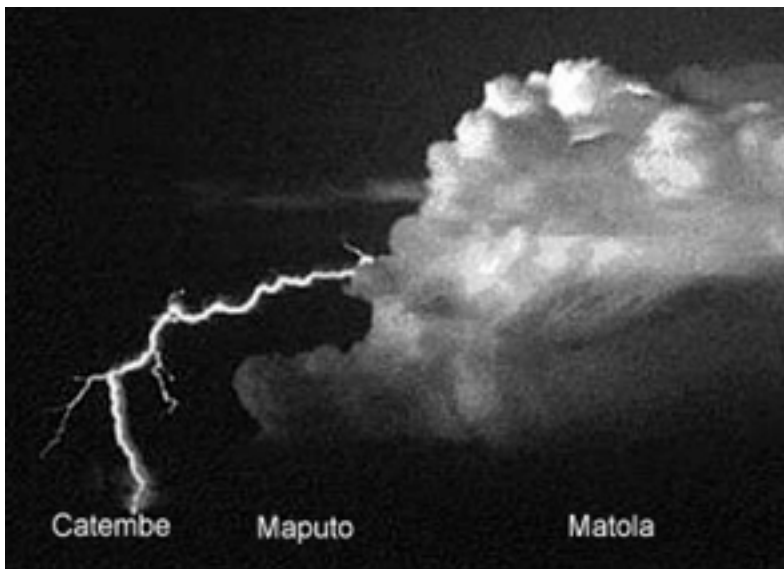
As the leaders approach the earth, the objects on the surface begin to respond. Objects send thin currents of positive (positive leaders) up towards the cloud. Anything on the surface of the earth has the potential to send a positive leader.

The positive leaders wait patiently, extending upward, waiting for the negative approach of the leaders from the cloud.



When the positive and negative leaders meet, there is a conductive path from the cloud to the earth and current flows between the earth and cloud. This is lightning – a giant spark.

The path of the lightning can be up to 14 miles long, so the cloud that produces lightning can be in Matola, but can strike at KaTembe.



Exploding Air

Every time there is an electric current, there is also heat associated with the current. Since there is a huge amount of current in a lightning strike, there is also an enormous amount of heat. In fact, a spark of lightning is hotter than the sun's surface. This heat is the cause of the brilliant blue-white spark that we see. It's so hot that it actually explodes because the heat causes the air to expand so rapidly. The explosion is the thunder.



A Lightning Rod

A lightning rod is very simple - it is a thick pointed metal rod (a stick), on the roof of a building, connected to a thick wire of copper or aluminum attached to a metal plate buried in the ground.

Lightning rods provide a low resistance path that leads electric currents to the ground when lightning strikes. A lightning rod carries the dangerous electric current safely to the ground. The system has the ability to accept the huge electrical current associated with the strike.

If the lightning hits a material that is not a good conductor, eg a tree, the tree will suffer great damage from heat. The sap of the tree boils immediately, turns into steam and explodes.

If you do not want to put the rod on the building you are trying to protect, you can put it beside it..

In Niassa, Mozambique, there were about 500 lightning strikes in November 2005. Lightning was responsible for 236 deaths in Brazil in 2008.



Security

If you are caught in a storm, seek proper shelter - a building or a car. Avoid taking shelter under trees. Trees attract lightning.



Place your feet as close as possible and crouch down with your head as low as possible without touching the ground.

Do not go near a phone. If lightning strikes a telephone line, the current will travel to every phone on the line. (A cell phone is ok.)

References

If you have a computer with Internet access, you can find a lot of information at URL:

<<http://en.calameo.com/books/0007154400a3a29de1ab4>>

This address has articles by Dr. Alberto Macamo, Department of Physics, Faculty of Science, University Eduardo Mondlane, Maputo, Mozambique.

