TEACHING PRIMARY EARTH SCIENCE
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Issue 66

FLOODING

Causes and associated problems

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Introduction
The previous PEST (issue 65) deals with sea level rise. This issue adds to that by considering the problems caused by flooding both on the coasts and inland. The causes of flooding are not just the rise in sea level, but increased rainfall and in some cases the result of preventing water flow. The subjects in these 2 issues cover a variety of aspects of the National Curriculum programmes of study, key stages 1 and 2. These include many parts of Geography (1-7) and Science (Sc1-4) also areas within Literacy, Mathematics and ICT, producing a truly cross curricular topic such as – **Is flooding predictable, inevitable or avoidable?**
Pupils could consider these words within class investigations and use them to help draw conclusions.

Causes – Extreme Weather.
When normal amounts of precipitation fall on the top layer of the land surface, if that layer is soil or porous rock, it usually percolates through by entering the pore space within. These pore spaces are small gaps between the grains which contain air or liquids. When water falls onto the soil/rock the pores are filled as the water seeps down from the surface. This water is held in the pores, the amount of water that can be held is the porosity. Some of these pores are interconnected which allows the water to move through the soil/rock (its permeability) until it meets an impermeable layer. The capacity of the rock or soil to absorb water is known as the infiltration rate. This rate decreases as the water content of surface layers increases. As the pore spaces fill up there is less room for more water. During very heavy or long periods of rainfall, or following the melting of large amounts of snow, the movement of water into the ground (the infiltration rate) slows as capacity is exceeded and flooding occurs.

There is a large amount of water stored deep underground in aquifers, often areas of gravel, sand or very porous rock which can hold groundwater like a giant sponge. These underground reservoirs are fed by water percolating through from the upper layers of rock and soil. The soil/rock can only hold so much, depending on its porosity, so any excess has to flow away. It can flow underground, often along the top of an impermeable layer and may eventually come out on the surface in the form of a spring into a stream. The streams flow into the rivers which in turn flow to the sea. This movement relies on gravity and the pressure of the overlying volume of water. However, the river system of water movement has a maximum capacity and if that maximum is reached excess water has to leave the system. That is when floods occur.

If the rain falls onto a non-porous area the water runs off until it can enter a porous surface or into a river or drain. There are a lot of areas which are naturally impermeable such as exposed igneous rocks but there are also an increasing amount of man-made areas covered in impermeable surfaces, such as roads, buildings, driveways, car parks or even school playgrounds. Because the water cannot soak away it is held on the surface. It will run away if the surface is sloping or if drains are constructed within or at the edge of the area, but if the area is large the drains may not be adequate to cope with the amount of water accumulating.

Inland Flooding

When water reaches the rivers it is still constrained. Rivers have natural embankments or levees on each side. These hold the water in but sometimes cannot cope with higher water volumes. The water can then break the banks, or may flow over the top of them, flooding adjoining land. The land at the sides of the rivers may be able to absorb some of the river's overflow but that land may already be too saturated to take any more water. The result is that a larger area of land is flooded as the water spreads.

The river itself will, in most cases, continue to flow thereby removing some of the excess water and preventing an increase in the flooding, but in other cases, particularly where the river banks have been broken, the river may have changed course and be less able to move water away very quickly. Some of the low lying flat fields adjacent to rivers are left for the purpose of taking the water when the rivers flood. These floodplains or water meadows reduce the risk of more valuable land and buildings being flooded. They also allow the flood water to soak away over time. There are, however, cases where these have been used for housing. This not only puts such developments at a high risk of being flooded but by taking away a floodplain's absorbing role and capacity it increases the chance of flooding further away and creates greater run off due to the impermeable nature of the surfaces.

Flash floods can take people by surprise if excessive rainfall is deposited in a short space of time. With too much water to soak away it collects and flows downhill extremely fast following rivers, streams or even previously dry gullies. The energy within the water can cause considerable damage to the river banks, bridges and buildings in its path. Without warning these flash floods can be hazardous to human and animal life in addition to the damage to property.

As the climate changes and warms with the present amount of carbon dioxide emissions the predictions are that there will be an increase in the amount of rain falling. The atmospheric temperature is thought to be increasing due to the greenhouse effect (issue 65) this could, in the short term, increase the evaporation of the seas and rivers which may subsequently lead to an increase in annual precipitation volumes.

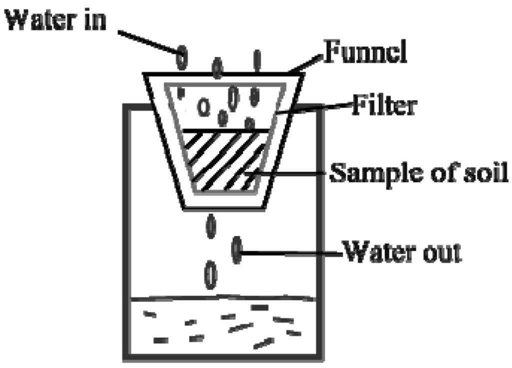
Coastal Flooding

During storm surges (issue 65) coastal areas are subjected to higher than normal sea levels coupled with strong winds and very rough seas which batter the shorelines. Such storms can cause local flooding, cliff and/or beach erosion and physical damage to coastal defences and property, especially in low-lying areas. These higher sea levels, particularly if they coincide with spring tides, can also force salt water much further up river systems than normal which may flood onto adjacent land. Salt inundation is a serious problem that can affect coastal aquifers as well as coastal and inland farmland (salt reduces soil fertility and can kill crops).

The amount of damage inflicted on a shoreline as a result of high sea levels and storms depends on the type of shoreline. Cliffs can protect land from flooding but are subject to increased erosion during storms. Properties are often lost when cliffs are undermined and collapse, especially on Britain's east coast (Holderness, East Yorkshire). Beaches can also be vulnerable to erosion and it has been known for them to be completely stripped of their sediment during a severe storm. This can cause further problems as the coast's natural protection is removed or drastically reduced (Christchurch, Dorset). Sometimes man-made sea defences, such as imported large boulders or sea walls are damaged or breached, leaving low-lying properties and land at risk of flooding.

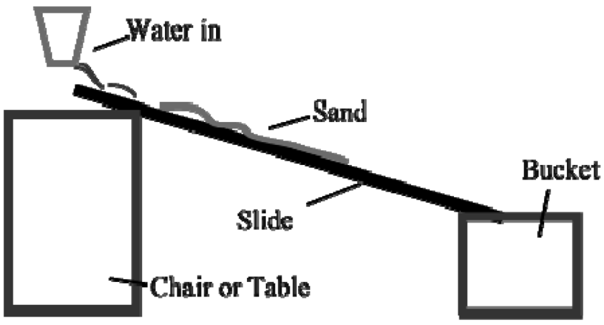
Activities

1) Demonstrate the flow of water through soil (a more detailed version of this activity can be found in PEST issue 3 and the Working with Soils pack – see ESTA web site for sources)



To show how water can percolate through soil. Cut a plastic bottle to use the top as a funnel and the bottom as the collector. Place the top of the bottle upside down in the top of the bottle. Place a filter (coffee filter or paper towel or J cloth). Place soil or rock into the filter and make sure that there is no gap between the filter and the side of the funnel. Gently pour a fixed amount of water onto the sample. Allow it to stand for a while for the water to percolate through. Some soils take longer than others. Measure the amount of water that has percolated through. The difference between the amount in and the amount out equals the amount of water retained in the pores.

2) Demonstrate the flow of rivers (a more detailed version of this activity can be found in PEST issue 16)



Use a child's plastic slide extension. Place one end on a table and the other onto a bucket or plastic box (to collect the water). Experiment with the gradient. Place sand and pea gravel onto the slide. At this point you may start a route for the river with your finger or let the water find its own route. You could also place small stones or wooden blocks to represent buildings at various places along a route you feel that the water will take. Using bottles, watering can or a hose, gently pour water onto the top of the slide in front of the sand and allow it to form a river. You may then place objects in the way to change the route to prevent (or cause) flooding.

3) Investigate the porosity of rocks
Choose several contrasting rock samples of a similar size. Fill large beakers, one per sample, about half to two thirds full of water. Submerge the dry rocks and mark the displaced water level. If the rocks are porous this level should drop as the rock absorbs water.

4) Out and about around school.
Investigate the permeability of various surfaces. Equipment needed: stop watches, data recording sheets, buckets or watering cans and access to water. Work in groups and pour a measured amount of water onto different areas of the school grounds such as the playground, playing field (a goalmouth where soil will be quite compacted compared with an area of lighter use near the perimeter), a flower bed, sand pit, gravel path, sloped area etc. How long does one bucket or watering can or one gallon of water take to soak away, run off?

5) Checking possible flood risks.
To see what chances you have of being flooded look on an Ordnance Survey map of your area and check the position and altitude of your school. You can find this by looking at the contour lines on the map. These lines join points of equal height above sea level. Even if your school is situated on higher land, check the location of the nearest rivers to see if the water could flow towards your school if it flooded. If the route of the river is in hills near your school and there is no high ground between it and your school then there is a possibility that water can run through the area of your school. If school has access to Google Earth it may be possible to follow rivers, find floodplains, check out coastal environments, look for signs of past flooding, spot enhanced erosion or sediment deposition and see flood risk areas.

Problems caused by flooding seem obvious – everything is submerged or soaked but looking in more detail we can see that there is more to it than that:

- Property damage – this kind of damage is probably the type most associated with flooding. However it must be borne in mind that the floodwater is not clean rainwater or even murky river water but will be heavily polluted. When towns, villages or housing estates flood, so do the drains and sewers which can then no longer carry away waste and this filthy water can flood properties and adds further complications.
- Pollution – flooded industrial areas, farms and trapped vehicles can all add significant amounts of pollution to flood waters. Pollutants such as harmful industrial chemicals; dissolved pesticides and fertilisers; heating and engine fuel or oil and untreated sewage can all be mixed together. These pollutants can affect large areas and then be carried by streams and rivers polluting those and eventually the beaches as they reach the sea.
- Aquifers – coastal freshwater aquifers (often the main supply of clean drinking water) are vulnerable during floods and rising sea levels as they can be subject to salt contamination, especially after dry spells when a lot of freshwater is extracted, because this lowers the freshwater level and allows more space for seawater to intrude making the groundwater undrinkable. During floods inland aquifers are also at risk from contamination by pollutants such as those mentioned above. Any contamination is extremely difficult to clean from these deep underground reservoirs.
- Threat to communities – flood water can be heavily polluted, carry disease and hide dangers such as uncovered drains and dangerous debris. Floods can take a long time to subside and the time and resources needed to dry out, decontaminate and repair buildings can be considerable.

Human activities that intensify flooding.

- Building on floodplains (see also page 2) – The lower courses of rivers have natural floodplains which accommodate and soak up floodwater. However, floodplains are generally flat, and can make excellent areas for development. Building on floodplains, results in the water causing more damage over a larger area than it would do over a non-developed floodplain.
- Roads and hard-surface areas – large roads, such as motorways, are vast areas of impermeable man-made surfaces. Large quantities of water runs off these into drains and flows into pond systems or treatment plants but sometimes this polluted water gets into streams and rivers and the extra volume adds to flooding potential.

Forthcoming Events. Full information is available from the respective web sites.
ESTA Primary Team Members will be providing practical workshops, resources and useful information at:-

Geographical Association Conference, Manchester 17th – 18th April 2009. www.geography.org.uk
Rivers and Coasts in Action. Hands on workshop on rivers and coasts, their formation, erosion and evolution. Participants build their own rivers or coasts and watch them evolve through time. Ideas will be provided to help transfer this to individual classroom situations, using unusual everyday items and how to adapt resources.
ESTA Conference Southampton 18th – 20th September 2009. www.esta-uk.org Primary INSET Saturday 19th.
Practical workshops on minerals, rocks, soils, rivers and coasts with an emphasis on cross curricular themes.

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