



Basic Sciences for understanding floods

Continuing ideas for exploring the environment through International Years
- in 2022, the IY Basic Sciences for Sustainable Development.

By Jeanie Clark

Have your young people ever been involved in a flood? Even if they haven't, through the media recently, have they developed an idea of what it is like to live through one, what is lost, the clean-up and the causes? What are they thinking and understanding about this, and about what needs to be done about such flooding in the future?

Before something can be done to reduce the effects of a problem, e.g., flooding, understanding of its causes and then all effects of possible actions to reduce negative effects are needed. This is where basic sciences come in to understand the processes and test possible actions.

This article will explore some basic sciences involved in flooding and suggest some resources and activities for learning about it. These might be new for younger students or review for older ones, but for all it will be a practical application of 2022's United Nations International Year of Basic Sciences for Sustainable Development (IYBSSD) [1]. [Square brackets indicate web references found at the end.]



Flooding

What do your young people think causes flooding, like along the east coast of Australia this autumn? How deep can they go into explaining it?

The most obvious cause of flooding is a lot of rain! What processes are involved in rain? What causes floods? There are some basic sciences to explore for understanding about this from Meteorology (weather) and Geomorphology (landform).

Droplets form

Let's start with rain drops. Have you done the experiment with boiling water in a saucepan with a clear lid on it? As the water boils, droplets can be seen to form under the lid. That demonstrates two processes: evaporation and condensation. (Condensation is when water as a gas changes to liquid droplets, e.g. by hitting a cooler lid, or on the outside of a frozen container, in warmer air, e.g. [2].)

But how did the liquid water become a gas, water vapour, inside the saucepan? If you can alter the temperatures for heating the water in the saucepan, you might be able to find out at what temperature the bubbles start forming. Bubbles are an indication that some liquid water is turning to gas vapour. They are an exaggeration of the evaporation process caused by the sun's heat on any water body surface, from puddles to seas.

Evaporated water vapour is warm. Warm air rises, seeking air of a similar temperature. Then it condenses to make cloud droplets. Have your young people noticed how many different types of clouds there are? Or wondered why that happens?

There are many resources about clouds online. National Oceanic and Atmospheric Administration's SciJinks - it's all about weather has a short comprehensive introduction to clouds and a full ID chart [3]. What sort of clouds bring heavy flooding rains like those along the east coast of Australia?

Droplets fall

Without evaporation, there is no water vapour for condensation. Without condensation, there are no droplets to make clouds. Without clouds, no rain.

What makes the rain fall? When droplets grow too big, heavy or cold, they can no longer resist the pull of gravity to make them fall. This can be shown as a demonstration using a jar of hot water and bowl of ice (e.g. [4]). (It is also a mini- Water Cycle.)

As droplets join together, they become bigger and heavier. Rising air can help them stay up longer and higher and take on various forms. The process of falling is precipitation. The British Met Office provides a detailed explanation of how different types of precipitation are formed [5]. But regardless of being a liquid or solid, gravity will make all fall.

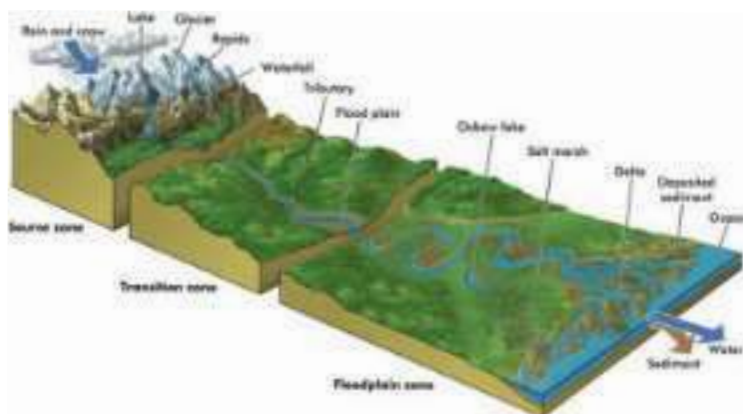
In the real world, does the water fall back from where it evaporated? Not often, because clouds up in the air are subject to winds (moving air). There are well established wind highways in the atmosphere – paths that winds follow. These are the trade winds which sailing ships in the past made use of to travel and explore the world. See these on world wind maps in atlases or online maps like [6].

So where do the water droplets go after having fallen from clouds? In ideal situations, they soak into the soil in a process called infiltration to go to plant roots and groundwater, while the rest runs off over the land, collecting in streams and flowing back to the sea. This completes the Water Cycle. There are many videos of this online, e.g. [7], [8], [2].

Infiltration and runoff can be demonstrated with a jug of water, tray, and two sponges – one wet, one dry. Pour the water over them and see how much is soaked in and how much runs off. If soil is already wet, then more rainfall will run off over the land – often making a flood.

Landscape

While what comes from the air may be most obvious in creating flooding, the landscape into



A typical river landscape with its landforms – note the floodplain. Source: [Geography pods 'What is a river?'](#)

which it falls is another major factor. Rain runs downhill (thanks to gravity) and gathers in streams and rivers as it moves towards the lowest place – seas or lakes. But when there is much more water than a river normally carries, it spills onto its floodplain. A floodplain's function is to carry flood water for the river! It is part of a river all the way to its mouth – as can be seen in the diagram below. Floodplains are fairly flat land, easy to build on (when not being flooded!) and close to water. So, they are useful for building and farming. When flooding rains come, water will flood whatever is on its plains: trees, animals, buildings, cars, etc.

Flood responses

What can we do about this human problem? Science has advanced to be able to predict how high rivers will rise, and 'break their banks' to flood over plains. Hence, warnings are given to put possessions up high and/or evacuate!

But floods seem to be coming higher resulting in some communities that were flooded this year are now discussing whether some floodplains should no longer be used for shops and homes? (They can still be used as open spaces and recreation - and floods can take place without so much property damage.)



Building levees (photo above), may solve flooding locally, but they send flooding waters downstream faster and at a bigger level to where some other community may have to deal with them. Returning to the IYBSSD, where does flooding fit into the United Nations Sustainable Development Goals (SDGs) [9]? These goals were agreed by the world's countries to aim for by 2030. Is flooding an issue of Sustainable Development? Yes, not just in Lismore and other towns which have had repeated flooding



this year, but in many places around the world. The ease of building and farming on floodplains combined with the increase in flood-creating weather systems from a warming atmosphere, makes this a **global problem**. Flooding issues are part of in **SDG 11** [above]: for **Sustainable Cities and Communities**: to make cities and human settlements inclusive, safe, resilient and sustainable. Are places where homes flood repeatedly sustainable places to live?

Flooding issues fall under “Target 11.5 : By 2030, significantly reduce the number of deaths ... people affected and ... direct economic losses ... caused by disasters, including water-related disasters,” [10].

The start of 2022 would suggest that the opposite of this target is occurring along our eastern seaboard! As our young people move into a future with a **warming climate**, understanding basic sciences involved in flooding aids better awareness of how floodplains work with rain systems and of choices and management for people wanting to live and work on them – and respect for warnings!

Global factors

After the Water Cycle, there is much climate science to explore. Seasons, air pressure, and winds are three of the basic global scale factors affected by warming seas and atmosphere, which also affect the weather. They too contribute to flooding.

Seasons - Try the demo with a ball with a flag on a tilt (Earth) revolving around a torch light (Sun) to show how the sun heats the hemispheres differently through the year, making the seasons. *California Academy of Science's* video [11] has lines

showing this difference in heat reaching the northern and southern hemispheres.

Air pressure changes when air is heated at ground level, creating the areas of High and Low pressures on a weather map. Try a simple experiment using a bowl, water, candle and a glass to demonstrate this, e.g. see *Stay at Home Science's* video [12]. This follows the Sun, giving a seasonal movement, so compare global Jan and July world pressure maps in an atlas or on-line e.g. January [13] and July [14].

Winds likewise follow the Sun and so have a seasonal movement. Look for seasonal changes around Australia on global wind pattern maps for January and July e.g. [15]. Look especially for the winds that run along south east Australia where the flooding rains have been – where has the rain started? Note that the air comes over warmed seas and so gains plenty of hot air, making lots of vapour, and clouds. Can that be expected to increase as the global temperature rises? And so make more flooding for places already at risk?

There is much more to explore about the sciences from Meteorology and Geomorphology. But even with these basic ones, our young people might be **better prepared for understanding and preparing for the changes** that will come with the warming climate, and for being able to avoid the impacts of flooding disasters. This IYBSSD focus on exploring sustainability issues through basic sciences can provide our young people with factual scientific understandings to use in future sustainable choices.

© Text and photos J. Clark, enviroed4all®, Warracknabeal 2022
IYBSSD logo used with IYBSSD permission.

Direct links to webpages in this article

- [1] [International Year of Basic Sciences for Sustainable Development](#)
- [2] [Untamed Science 'The Water Cycle'](#)
- [3] [National Oceanic and Atmospheric Administration's SciJinks 'Types of Clouds'](#)
- [4] [MsKrae18 'Let's make it rain'](#)
- [5] [British Met Office 'What is precipitation?'](#)
- [6] [Maps of the World](#)
- [7] [NASA 'Tour of the Water Cycle'](#)
- [8] [13WeatherKids 'Explaining the Water Cycle'](#)
- [9] [Sustainable Development Goals 'The 17 Goals'](#)
- [10] [Sustainable Development Goals 'Goal 11'](#)
- [11] [California Academy of Science 'Seasons'](#)
- [12] [Stay at Home Science 'How to create high and low pressures at home'](#)
- [13] [Britannica \[air-pressure map\]\(#\) \(Jan\)](#)
- [14] [Britannica \[air-pressure map\]\(#\) \(July\)](#)
- [15] [Geography of Transport Systems 'Seasonal variations in global wind patterns'](#)