MetLink
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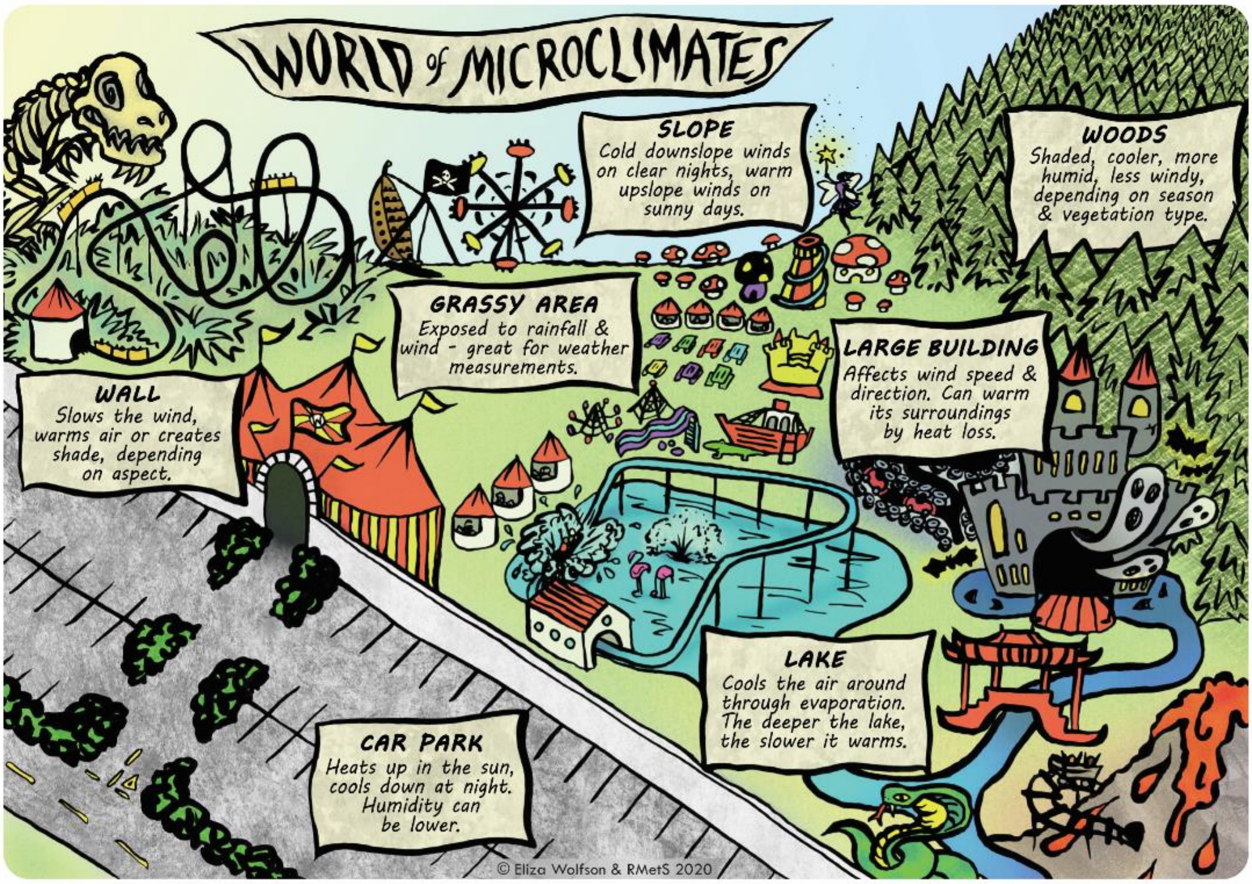
Microclimates

Background Information for Teachers



Many factors including aspect, surface materials, vegetation, altitude and the proximity to water can affect microclimates

When Does ‘Climate’ Become ‘Microclimate’?

A microclimate is the distinctive climate of a small-scale area, such as a garden, park, valley or part of a city. The weather variables in a microclimate, such as temperature, rainfall, wind or humidity, may be subtly different to the conditions prevailing over the area as a whole and from those that might be reasonably expected with a given weather pattern.

The microclimate is affected by such things as aspect, shelter (by buildings or vegetation), the colour of the surface, proximity to water, proximity to a heat source (e.g. a building), air pollution, altitude etc.

Sometimes, a space scale of less than 100m is used to define a microclimate.

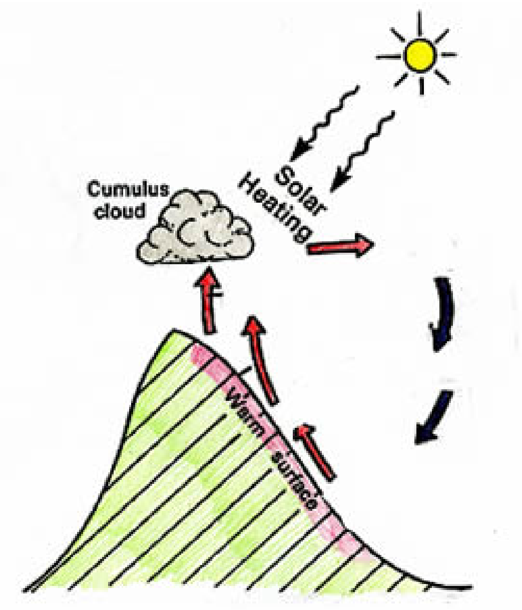
Examples of Microclimates

Upland regions

Upland areas have a specific type of climate that is notably different from the surrounding lower levels. Temperature usually falls with height at a rate of between 5 and 10 °C per 1000 m, depending on the humidity of the air. This means that even quite modest upland regions, such as The Cotswolds, can be significantly colder on average than somewhere like the nearby Severn Valley in Gloucestershire.

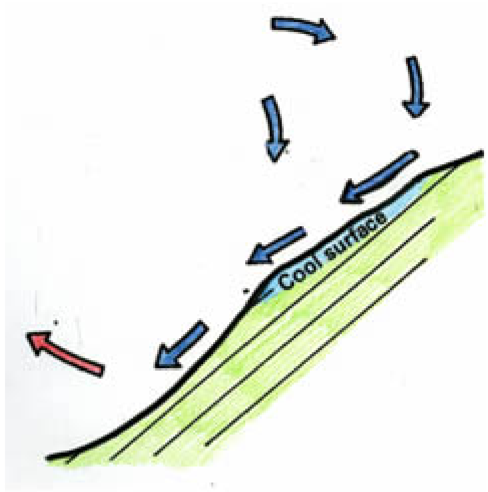
Occasionally, a temperature inversion can make it warmer above, but such conditions rarely last for long. With higher hills and mountains, the average temperatures can be so much lower that winters are longer and summers much shorter. Higher ground also tends to be windier, which makes for harsher winter weather. The effect of this is that plants and animals are often different from those at low levels.

Hills often cause cloud to form over them by forcing air to rise, either when winds have to go over them or they become heated by the sun. When winds blow against a hillside and the air is moist, the base of the cloud that forms may be low enough to cover the summit. As the air descends on the other (lee) side, it dries and warms, sometimes enough to create a Föhn effect (see Chapter 9). Consequently, the leeward side of hills and mountain ranges is much drier than the windward side. The clouds that form due to the sun's heating sometimes grow large enough to produce showers, or even thunderstorms. This rising air can also create an anabatic wind on the sunny side of the hill. Sunshine-facing slopes (south-facing in the Northern Hemisphere, north-facing in the Southern Hemisphere) are warmer than the opposite slopes.



Anabatic Winds

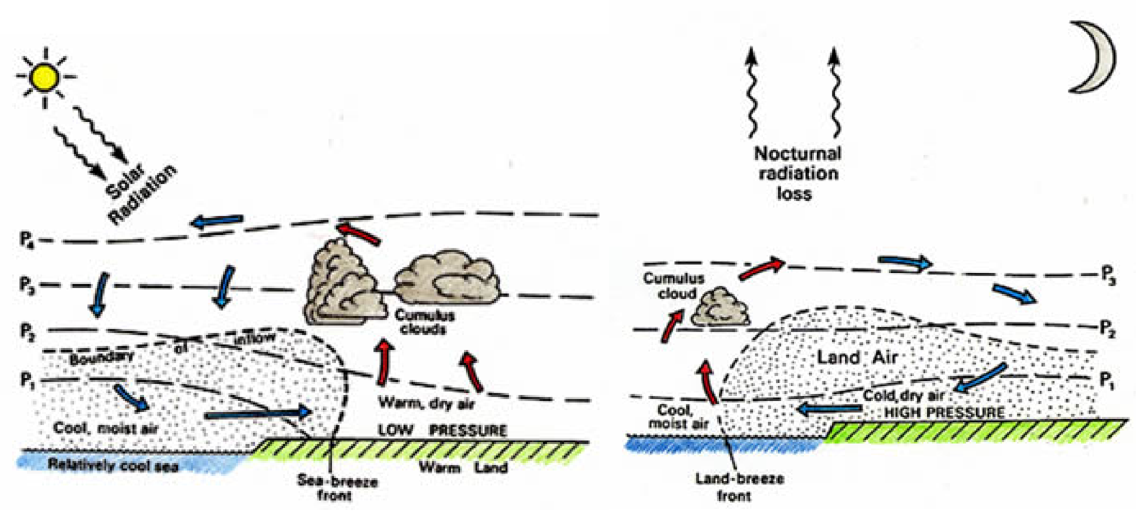
Apart from temperature inversions, another occasion when hills can be warmer than valleys during clear nights with little wind, particularly in winter. As air cools, it begins to flow downhill and gathers on the valley floor or in pockets where there are dips in the ground. This can sometimes lead to fog and/or frost forming lower down. The flow of cold air creates what is known as a katabatic wind.



Katabatic Wind

Coastal regions

The coastal climate is influenced by both the land and sea between which the coast forms a boundary. The higher heat capacity of water means that the sea maintains a relatively constant day to day temperature compared with the land. The sea also takes a long time to heat up during the summer months and, conversely, a long time to cool down during the winter. In the tropics, sea temperatures change little and the coastal climate depends on the effects caused by the daytime heating and night-time cooling of the land. This involves the development of a breeze from off the sea (sea breeze) from late morning and from off the land (land breeze) during the night. The tropical climate is dominated by convective showers and thunderstorms that continue to form over the sea but only develop over land during the day. As a consequence, showers are less likely to fall on coasts than either the sea or the land.



A sea breeze (left) and land breeze (right)

Around the Poles, sea temperatures remain low due to the presence of ice, and the position of the coast itself can change as ice thaws and the sea re-freezes. One characteristic feature is the development of powerful katabatic winds that can sweep down off the ice caps and out to sea.

In temperate latitudes, the coastal climate owes more to the influence of the sea than of the land and coasts are usually milder than inland during the winter and cooler in the summer. However, short-term variations in temperature and weather can be considerable. The temperature near a windward shore is similar to that over the sea whereas near a leeward shore, it varies much more. During autumn and winter, a windward shore is prone to showers while during spring and summer, showers tend to develop inland. On the other hand, a sea fog can be brought ashore and may persist for some time, while daytime heating causes fog to clear inland. A lee shore is almost always drier, since it is often not affected by showers or sea mist and even frontal rain can be significantly reduced. When there is little wind during the summer, land and sea breezes predominate, keeping showers away from the coast but maintaining any mist or fog from off the sea.

Forests

Tropical rainforests cover only about 6% of the earth's land surface, but it is believed they have a significant effect on the transfer of water vapour to the atmosphere. This is due to a process known as evapotranspiration from the leaves of the forest trees.

https://youtu.be/LBe4LTLOLvU

Woodland areas in more temperate latitudes can be cooler and less windy than surrounding grassland areas, with the trees acting as a windbreak and the incoming solar radiation being 'filtered' by the leaves and branches. However, these differences vary depending on the season, i.e. whether the trees are in leaf, and the type of vegetation, i.e. deciduous or evergreen. Certain types of tree are particularly suitable for use as windbreaks and are planted as barriers around fields or houses.

Microclimate Fieldwork

Most schools will be able to investigate the impact of the built environment on the microclimate. This might just be the school buildings, or it might be in a nearby industrial or residential development or park.

What is the impact of a particular building on the microclimate – the local temperature, wind speed and direction?

What is the impact of a wall, a pond, a small wooded area or a large expanse of concrete or tarmac?

In the winter, when the heating is on, you could use an infrared thermometer to see where the building is losing most heat. When the sun is shining, infrared thermometers are a great way to visualise albedos – the proportion of the Sun's light that is being reflected rather than absorbed.

In the summer, on a calm, sunny day, you could use simple digital thermometers to make a temperature map around the building. That would also be interesting in the winter in the early morning after a clear, calm night.

On a windy day, use bubbles to investigate the wind pattern around the building. Watch which direction the bubbles are blown in – with a compass you can turn that into a wind direction. In some places, the bubbles will just get caught in eddies and blow around in circles.

These will be the places where leaves or litter get trapped.

You can estimate wind speed by marking out 5 paces – roughly 5m, in the direction the bubbles are travelling and time how long the bubbles take to go that far. Make a wind map around the building.

How do the windy, cold or hot places relate to where your students like to wait around?

You can even do a microclimate investigation inside the school – how does the temperature and humidity vary between classrooms on a day when the heating is on or when the sun is hot?

How does this relate to the students experience of the classroom, or of the teachers experience of behaviour or attention?

If you have a barometer, you should be able to see a pressure drop between different floors of the school – pressure drops approximately 1millibar for every 10m height rise. Some phones will let you measure this – try the Phyphox app.

Most schools will be able to investigate the impact of the natural environment on the microclimate. This might be a school field, or a nearby park or a local rural area. How does the proximity to water affect the microclimate? This will work best on a calm, sunny day. You could measure the temperature with a simple digital thermometer, infrared thermometer or even a USB temperature datalogger. Many digital thermometers will also tell you the humidity – how does that vary around a pond or river? This could be linked to urban heat islands and ways of reducing the impact of summer heat waves, which are predicted to increase as the climate changes.

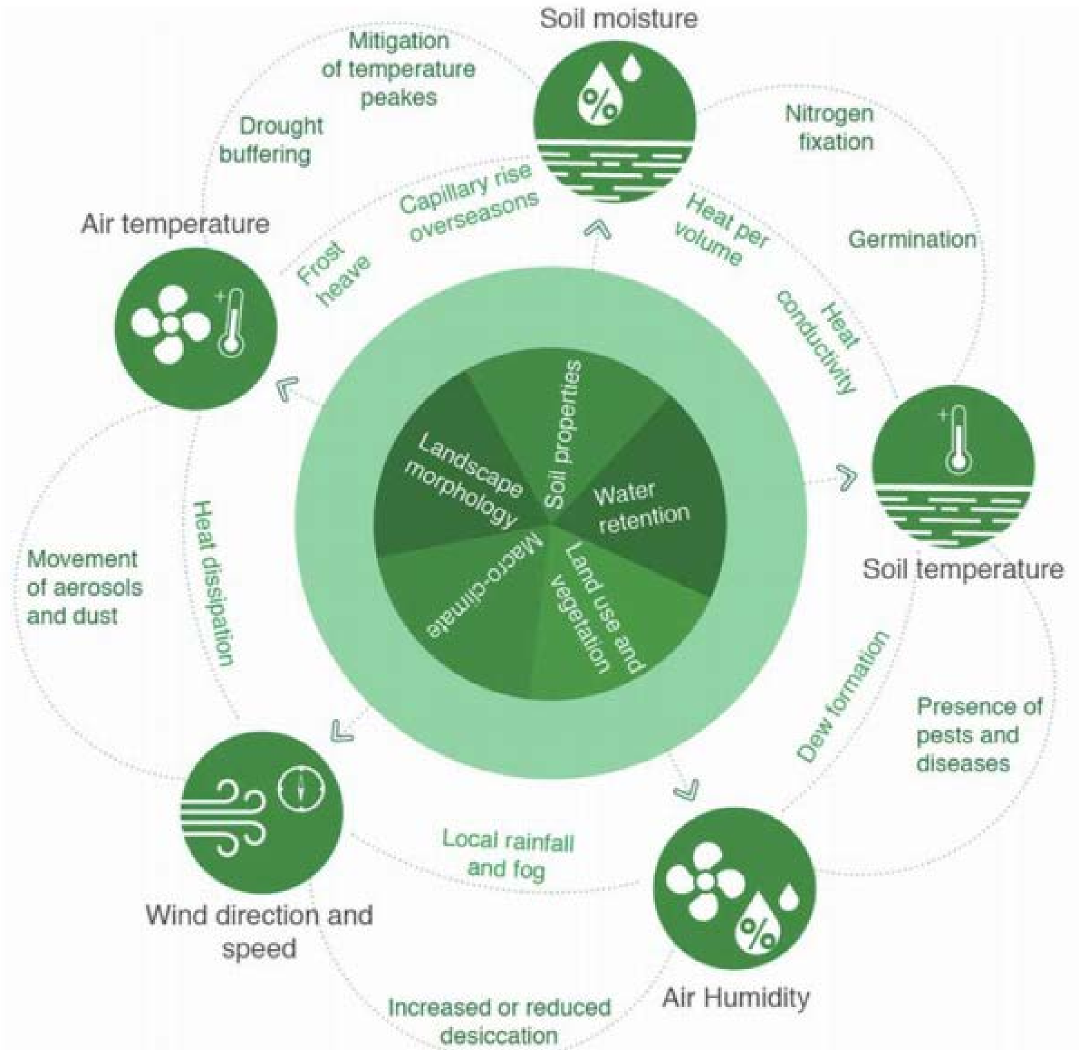
How does a hedge affect the microclimate? This will work best on a windy day – you could use bubbles to make a wind map upstream and downstream from the hedge. Does wind speed vary with height? Does the orientation of the hedge matter? How does the air temperature vary around the hedge? USB temperature data loggers would be useful for this too, you could look at the impact of the hedge on the diurnal range of temperature.

Hedges can be linked to biodiversity, erosion and agriculture.

Managing Microclimates for Farming

When changes are made in a landscape, changes are made to the microclimate. When farmers plant trees in or around their fields, and when communities dig reservoirs to improve water retention, they change the local climate around them.

The Spate Irrigation Network Foundation claim “Micro-climate management offers much potential as a third way next to adaptation and mitigation that builds ecosystem resilience and brings positive impact for agricultural systems and biodiversity. Focusing on the microclimate is a pro-active approach to improve the landscape.”



Managing the Microclimate. Flood based Livelihood Network – practical note 27, 2016, DOI: 10.13140/RG.2.2.15110.78409

Managing Microclimates for Biodiversity in a Changing Climate

Managing microclimates is mostly thought of in an urban context (see chapter 19) however there are important rural applications too.

For example, Wallis de Vries *et al*. (2006) suggested that earlier spring growth in environments which have been fertilised may actually serve to cool microclimates relative to current baselines, and this in turn may affect species, in this case certain butterfly species. Their work highlights the complex interactions which can occur between environment, management and a changed climate and it underlines the need to develop a greater understanding of environment and land use change on species and habitats.

To help biodiversity to adapt to emerging threats such as climate change, existing populations of threatened species can be protected by making use of the microclimates that are created by different features of the landscape, and that can buffer the effects of climate change. Conservation organisations already carry out activities that influence microclimate, for example by grazing livestock to create hot conditions for plants or invertebrates in short or broken vegetation. https://www.researchgate.net/publication/281840796_British_Wildlife_article-_Microclimate_climate_change_and_wildlife_conservation

Sources of Information

http://wow.metoffice.gov.uk

https://www.metoffice.gov.uk/binaries/content/assets/metofficegovuk/pdf/research/library-and-archive/library/publications/factsheets/factsheet_14-microclimates.pdf