Lesson Description

In this lesson we:

- Take a look at Valley Climates and consider the following:
  - Slope aspect, anabatic winds and katabatic winds,
  - Inversions/thermal belt, frost pockets and radiation fog
  - Valley climate’s influence on human activities

- Focus on Urban Climates and consider the following:
  - Reasons for differences between rural and urban climates,
  - Urban heat islands, causes of urban heat islands/factors contributing to higher city temperatures, effects of urban heat islands, Strategies to reduce the urban heat island effect and pollution domes

Summary

Valley Climates

Micro-climate

Also known as local climate, is the climate of a local area e.g. valley climate

Slope Aspect

- Slope aspect is the angle at which the sun’s rays strike a slope.
- In the northern hemisphere, the south-facing slopes receive more sunshine than north-facing slopes. In the southern hemisphere, the north-facing slopes receive more sunshine than south-facing slopes.
- In the southern hemisphere the north-facing slopes are hot, sunny and drier and the south-facing slopes cool, shady and retain moisture.
- Soils on cooler south-facing slopes as they are on the shadow zone.
- Farmers have to select a slope which is best suited for certain crops. For example crops that require less moisture and more sunlight will grow on the north facing slopes in the southern hemisphere. Trees and shade loving plants such as ferns will grow on the south facing slopes.
Also note that humans tend to build their houses on north-facing slopes in the southern hemisphere because they are warmer.

Katabatic Winds

- Occurs at night when the slopes cool due to terrestrial radiation.
- The air above the slopes becomes cold and dense and blows down the valley sides.

Anabatic Winds

- Occur during the day when the slopes warm due to insolation.
- The air above the slopes warms, becomes lighter and rises up the slopes.
Inversions/Thermal Belt

- It is a layer of warm air trapped between two layers of cold air.
- Occurs during the nights, especially a cold and calm winter’s night.
- Due to terrestrial radiation upper slope air cools, becomes dense and flows down the slope pushing the warm air up.
- We have cold air above and cold air below with the warm air in between.

Normal Situation

<table>
<thead>
<tr>
<th>COLD AIR</th>
<th>COOL AIR</th>
<th>HOT AIR</th>
</tr>
</thead>
</table>

Temperature Inversion

<table>
<thead>
<tr>
<th>COLD AIR</th>
<th>INVERSION LAYER (WARMER AIR)</th>
<th>COLD AIR</th>
</tr>
</thead>
</table>

Night Time Inversion
Impact on man and environment:

- Traps pollutants, this will differ depending on the activity in the area e.g. industries result in more pollutants being trapped.
- Acid rain occurs
- Damages fauna and flora
- Decreases visibility
- Effects people health e.g. respiratory illnesses.

Frost Pockets

- It is the name for low-lying area (e.g. a valley bottom or a smaller hollow) where frosts occurs more frequently than in the surrounding area.
- This is normally after a dry, clear and cold night cold
- Air drains down neighbouring slopes
- If dew point temperature is below freezing point, it condenses to form ice crystals
- Forming frost pockets where the cold air collects.
- Damages vegetation and crops
- Could plant frost resistant crops.
Radiation Fog

- The ground becomes cool at night due to terrestrial radiation.
- The air above the ground also cools.
- When this air is below the dew point temperature, it causes water vapor to condense around the dust and other particles in the atmosphere to create radiation fog.
- In the morning, the sun’s rays heat the surface.
- The warm air rises and evaporates. (Fog lifts)

Urban Climates

Reasons for differences between rural and urban climates

- Human activities in urban areas contribute greatly differences between rural and urban climates.
- They alter the local climate e.g. through industries.
- Higher temperature, due to artificial surfaces, buildings, factories, fuel combustion etc.
- More cloud cover, fog and precipitation due to more hydroscopic nuclei. Moisture comes from rural area.
- Slower wind speeds due to Friction from buildings
- Low relative humidity due to less vegetation and urban drainage system.

**Urban Heat Islands**

**Definition:** An urban area of higher temperature surrounded by a rural area of lower temperature
Causes of urban heat islands/factors contributing to higher city temperatures:

- Industries
- Removal of water via Urban drainage system
- Artificial surfaces – concrete, steel and tar absorb heat
- Less vegetation
- Vehicles- fuel combustion
- Large amount of people
- Air conditioner and other equipment in offices and shops

The Urban Heat Island Effect

Little vegetation or evaporation causes cities to remain warmer than the surrounding countryside.
Effects of urban heat islands:

- Heat-related illness and fatalities, due to the incidence of thermal discomfort on the human cardiovascular and respiratory systems. Heatstroke, heat exhaustion.
- Increased pollution results in respiratory problems.
- Smog creates reduced visibility.
- High temperatures may produce physiological disturbances on plants.

**Pollution Dome**

**Definition:** Is a layer of air pollution above an urban area.
Causes of Pollution Domes:

- Contributing factors are human activities, industries, vehicles etc
- Stable air over urban area traps the pollution

Point to note:

- Pollution dome is higher during the day and lower during the night

Effects of Pollution Domes:

- Contributes to the formation of heat islands
- Respiratory related illnesses
- More pollutants, more condensation nuclei, more precipitation
- Lead poisoning from trapped petrol fumes

Strategies to reduce the Urban Heat Island Effect:

- Energy saving strategies e.g. solar panels
- Green development

- Appropriate building design
Test Yourself

Question 1

Refer to the diagram below and answer the questions that follow. Choose the correct answer from the options given.

![Diagram A and B showing anabatic and katabatic winds]

1.1 Diagram A represents (anabatic/katabatic) wind.
1.2 Diagram B represents (anabatic/katabatic) wind.
1.3 Katabatic winds occur mostly during the (day/night).
1.4 In diagram B the slopes are (heated/cooled).
1.5 Katabatic winds are (upslope/downslope) winds.
1.6 (Katabatic/anabatic) winds cause temperature inversion.
1.7 (Katabatic/anabatic) are also known as valley winds.

Question 2

Match column A with column B.

<table>
<thead>
<tr>
<th>A</th>
<th>B</th>
</tr>
</thead>
<tbody>
<tr>
<td>2.1 Slope aspect</td>
<td>A. A layer of air pollution above an urban area</td>
</tr>
<tr>
<td>2.2 Micro-climate</td>
<td>B. An increase in temperature with height</td>
</tr>
<tr>
<td>2.3 Frost pockets</td>
<td>C. The direction towards which a slope faces</td>
</tr>
<tr>
<td>2.4 Radiation fog</td>
<td>D. A layer of warm air found in the valley</td>
</tr>
<tr>
<td>2.5 Thermal belt</td>
<td>E. Is the climate of a local area?</td>
</tr>
<tr>
<td>2.6 Pollution dome</td>
<td>F. Forms where the cold air collects in the valley.</td>
</tr>
<tr>
<td>2.7 Urban heat island</td>
<td>G. An urban area of higher temperature surrounded by a rural area of lower temperature.</td>
</tr>
<tr>
<td>2.8 Temperature inversion</td>
<td>H. Is caused by air cooling to dew point as a result of terrestrial radiation.</td>
</tr>
</tbody>
</table>
Improve your Skills

Question 1

Study the diagram below and answer the questions that follow

1.1 Explain the concept slope aspect

1.2.1 In which hemisphere is this valley situated?

1.2.2 Provide reasons for your answer for your answer to QUESTION 1.2.1.

1.3 The houses are situated on the slopes of the valley. Give possible reasons for this location.

1.4.1 State the type of wind that people, living on the slopes, will experience during the day

1.4.2 Explain the formation of this wind, answer to QUESTION 1.4.1.

Question 2

Study the diagram and answer the questions that follow

Source: Anderson, 1975

HOW AN INVERSION TRAPS ATMOSPHERIC POLLUTANTS

Warm Air

INVERSION LEVEL

Cold Air
2.1 Explain the term *temperature inversion*

2.2 Does a temperature inversion in a valley generally occur during the day or night?

2.3 Identify and explain, the local wind associated with a temperature inversion in a valley.

2.4 Explain why a temperature inversion traps atmospheric pollutants on the valley floor.

2.5 The inversion layer will be closer to the valley floor during winter than summer. Why is this the case?

**Question 3**

Study the graph and answer the questions that follow.

![Graph: Difference between Melbourne temps and other locations](image)

3.1 Define the term *urban heat island*.

3.2 Describe the general trend illustrated by the graph.

3.3 Mention THREE factors causing heat islands in large urban areas.

3.4 Discuss THREE sustainable methods that can be introduced to reduce the heat island effect in large urban areas.