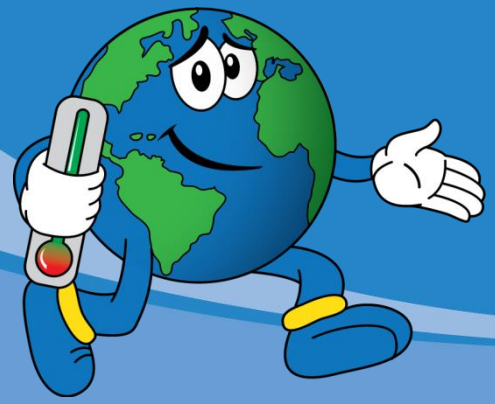
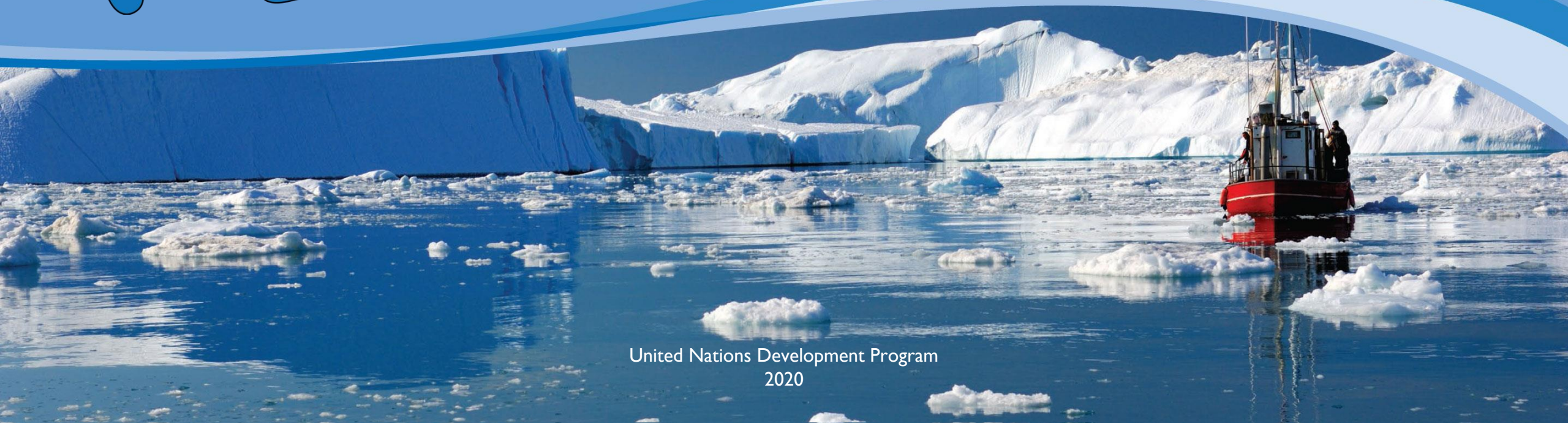
# CLIMATE BOX

With financial support from the Russian Federation

Empowered lives.
Resilient nations.



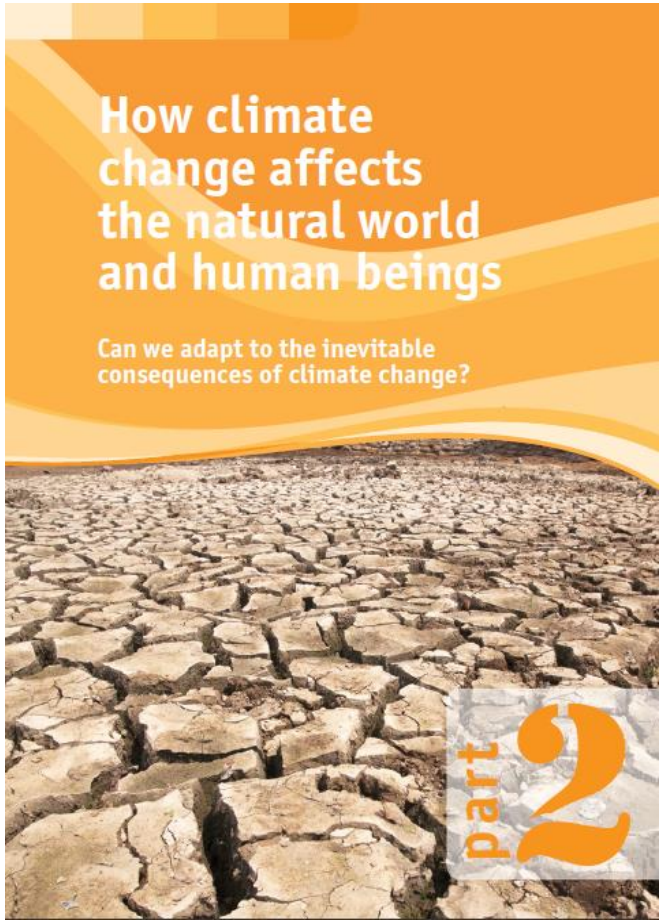
## Module 1. Basic course on climate change.
## Topic 1.2.2. How climate change affects the natural world and human beings. Can we adapt to the inevitable consequences of climate change?



United Nations Development Program
2020

# Part 2. How climate change affects the natural world and human beings.

## | Can we adapt to the inevitable consequences of climate change?




**2. How climate change affects the natural world and human beings. Can we adapt to the inevitable consequences of climate change?**

2.1. How climate change affects... **the weather**

2.2. How climate change affects... **plants and animals**

2.3. How climate change affects... **forests**

2.4. How climate change affects... **water resources**

2.5. How climate change affects... **agriculture**

2.6. How climate change affects... **coastal regions**

2.7. How climate change affects... **mountain regions**

2.8. How climate change affects... **the Arctic region**

2.9. How climate change affects... **cities and human health**

2.10. How climate change affects... **social problems**

# Part 2. How climate change affects the natural world and human beings.

## | Can we adapt to the inevitable consequences of climate change?

### Global warming or climate change?

It is more correct to say '**climate change**' because the rise in temperature, that is warming, is only one part of the processes of climate change on Earth.

As temperatures rise, we observe other warming-related processes:

- the precipitation regime is changing,
- the level of the world ocean is rising,
- glaciers and permafrost are melting,
- the frequency and power of extreme weather events is increasing year by year.

These and other climate changes are dangerous for plants and animals, threaten the economy, health and even human life.


# Examples of the effects of climate change on different regions

# Part 2. How climate change affects the natural world and human beings.

## | 2.1. How climate change affects... the weather

### Unsettled weather

Scientists have noted that during the past 50 years the weather around the world has become much more extreme, and the number of extreme weather events is constantly growing every year.

A recent study published in the Nature magazine found that hazardous weather events that used to occur once every 1,000 days now occur every 200-250 days, or 4-5 times more often.

Scientists believe that this is most likely due to global climate change.

**NOTE: earthquakes, volcanic eruptions and tsunamis do not depend on climate, so they are not extreme WEATHER phenomena.**

Weather 'whims' are scientifically called **weather anomalies**.

***Weather anomalies*** *are any deviation from the 'usual' weather in a particular season, month or day, where 'usual' is to be understood as the average state of the weather in that region during a specific past period, most usually 1961–1990.*

***Extreme weather (meteorological) phenomena*** *are natural processes and events associated with weather conditions that arise in the atmosphere, or on inland or ocean waters, and the effects of which can lead to the destruction of people, animals and plants, and can cause serious damage to the economy.*

*Extreme weather events include: prolonged heat or extreme cold, very strong wind, hurricanes, tropical storms (typhoons), dust storms heavy rain, heavy snow, whirlwind or tornado, flood, drought, avalanches, landslides and many others.*

# Part 2. How climate change affects the natural world and human beings.

## | 2.1. How climate change affects... the weather

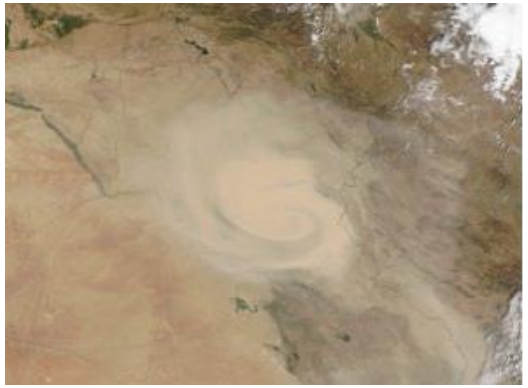
### Examples of weather anomalies in the last decade

***Cold wave in the Middle East, 2013***. *Due to snowfalls, classes in schools were canceled, banks were closed, hundreds of flights were delayed, and local residents were advised not to leave their homes.*

***Super-typhoons in the Philippines, 2013***. *First, the super-typhoon 'Yolanda' raged, which claimed the lives of 1.8 thousand people, then a new storm came to the islands – 'Zoraida.' According to the Philippine authorities, 6.94 million Filipinos suffered from the super typhoon, more than 580 thousand people lost their homes, since the disaster completely destroyed 21.2 thousand homes and damaged almost 20 thousand.*

***Flooding in the Russian Far East, 2013***. *Due to heavy and prolonged torrential rains, the water in the Amur River has risen to extreme levels - in some places over 9 m! Almost 150 settlements on the Amur were flooded, 20 thousand people were forced to leave their homes and live in temporary accommodation centers or with relatives.*

***Severe dust storm in the Middle East, 2015***. *In early September 2015, a massive dust storm swept through Iraq, Iran and other countries of the Persian Gulf and Eastern Mediterranean. The news bulletins described winds ~~gusts~~ of up to 80 km per hour. There were reports of road closures and flight cancellations. Thousands of people ended up in hospitals due to breathing problems.*



# Part 2. How climate change affects the natural world and human beings.

## | 2.1. How climate change affects... the weather

### Can we predict extreme weather?

- **The maximum** weather forecast range is **up to 14 days**, as the atmosphere changes completely every two weeks.
- **Short-term forecasts are much more accurate**. Weather forecasts for tomorrow, made by European meteorological services, are correct in 96% of cases, predictions for the day after tomorrow are right in 93% of cases, and 90% of three-day forecasts come true.
- **Long-term warning** of severe weather events is **only possible in a very general form** by building climate models.
- **People's omens about the weather should not be trusted**. Currently, these signs are completely associated with the place of their origin and only lead to confusion.

It is important to remember that **unusual weather is not equivalent to climate change**.

For example, a very cold winter does not necessarily mean that the climate has become cooler. Data must be collected over a long period of time, 'trend', (about ten years or more) before we can speak of climate change.

For example, models predict extreme high temperatures in northern Eurasia:

- now they occur once every 20 years,
- by the middle of the 21st century they can repeat three times more often - once every 7 years, and
- by the end of the 21st century they can repeat themselves once every 3–5 years.

# Part 2. How climate change affects the natural world and human beings.

## | 2.1. How climate change affects... the weather

**What should we do? How to deal with dangerous weather events?**

## Discussion

# Part 2. How climate change affects the natural world and human beings.

## | 2.1. How climate change affects... the weather

### Questions to recap:

**1. Is it possible to predict weather anomalies in advance?**

A. It is impossible for any time, it arises spontaneously.

B. Can be predicted for a maximum of two weeks.

C. Can be predicted for a long period - up to tens of years.

**2. Earthquakes, volcanic eruptions, tornadoes and tsunamis are hazardous weather phenomena?**

A. Only applies to tornadoes.

B. Does not apply.

C. All apply.

**3.Have there been any extreme weather events of the kind we are seeing now – like strong winds, floods, 'heat waves' and others – in the past?**

A. There were, but not as often as in the last 50 years.

B. There were and as often as in the last 50 years.

C. They had not happened until the industrial revolution.

**4. Could an abnormally warm winter in your city this year signal ~~about~~ climate change?**

A. Definitely can: this is an example of a weather anomaly.

B I cannot at all - this is just a special case.

C. This could be a manifestation of climate change. But we need more accurate data for a longer period.

# Part 2. How climate change affects the natural world and human beings.

## | 2.2. How climate change affects... biodiversity

### What is biodiversity?

***Biodiversity*** *is all the various species of plants and animals, fungi and micro-organisms, as well as the many combinations of environments (landscapes) and the huge number of variants between the genes of similar organisms. In other words, biodiversity is the multiplicity of the forms and manifestations of life on Earth.*

Scientists distinguish three main types of biodiversity:

- **genetic** – between organisms of the same species;
- **species** – between all living beings on the planet;
- **landscape or ecosystem** – the variation of environments where organisms live.

# Part 2. How climate change affects the natural world and human beings.

## | 2.2. How climate change affects... biodiversity


**The diversity of species in nature is at its greatest around the equator and decreases towards the poles.**

*Rainforests cover about 7% of the planet's surface and contain more than 90% of all species known today.*

# Part 2. How climate change affects the natural world and human beings.

## | 2.2. How climate change affects... biodiversity

### Which animals react most quickly to climate change?

**Small animals** with short life cycles are particularly dependent on environmental conditions and therefore **respond faster to climate change**.

Of course, large organisms also react, but, in their case, the effect take much longer to see.

Machaon butterfly.

*Due to the rise in temperature in the mountains of Slovakia, thermophilic butterflies from the family of sailboats - **Podalirius and Machaon** - spread outside the forest-steppe zone in which they lived and began to appear in cooler and wetter meadows. In addition, instead of breeding twice a year, as was normally the case, they have started breeding three times a year.*

Coral reef.

***Corals** are organisms very sensitive to environmental changes. Too warm or too cold water, lack of light, excess of impurities - all this slows down the growth of corals or completely stops it. Microalgae, which assimilate the energy of sunlight for coral polyps, are highly dependent on water temperature. In many areas of Australia's Great Barrier Reef, scientists have noted algae death and coral bleaching that occurs when the reef dies.*

Salps.

*Warming in the polar regions is reducing the area of seasonal sea ice. **Phytoplankton** develops especially intensively on the lower ice surface. It is the start of the food chain that includes krill, fish, penguins and other seabirds, seals and ends with whales. If there is little ice, then there is not enough space for phytoplankton to reproduce. The krill ~~is~~ are leaving, and its place is being taken by jelly-like translucent **salps**, which is eaten by almost nothing. So the food chain is interrupted...*

Yellow-striped pygmy eleuth.

***Yellow-striped pygmy eleuth** lives in tropical forests, where fluctuations in temperature and humidity are very small during the day and throughout the year. Climate change makes it more dangerous for the frog its parasite (mold), which is much less vulnerable to changes in environmental conditions than its host. This threatens the entire population of the host species.*

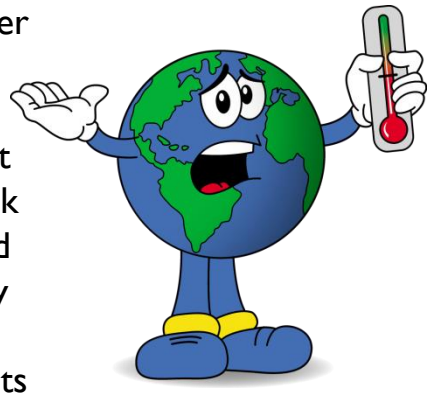
# Part 2. How climate change affects the natural world and human beings.

## | 2.2. How climate change affects... biodiversity

### Which animals react most quickly to climate change?

Shrinkage of the northern polar ice cap is the most visible sign of climate warming. *Polar bears* need ice for their migrations and in order to hunt for seals.

The ice is also vitally necessary for the *seals* themselves, as without it they have nowhere to rear their young. If the ice fields start to shrink more than is usual each summer, the seal population also shrinks and the hungry polar bears eat the whole carcass of the seals, which they catch, instead of devouring only the seal's layer of fat. Previously the remains of the polar bear's meal provided a feast for other inhabitants of the Arctic – the Arctic fox and numerous birds. But now there is nothing left over for them!



On the northern fringe of Eurasia the forest is slowly but surely advancing into the tundra at a rate of tens of kilometers each century. This changes the habitat and food sources of numerous types of birds.

Warm winters in the Arctic are also disastrous for both wild and domesticated *reindeer*, as thaws and rainfall in the winter cover the snow with a crust of ice, making it harder for the reindeer to find the lichens, which are their staple diet during the winter months.

# Part 2. How climate change affects the natural world and human beings.
## | 2.2. How climate change affects... biodiversity

### How to preserve biodiversity?
### National parks, reserves, sanctuaries and natural monuments

**It is necessary to protect not just individual species, but entire natural communities and landscapes.** It is exactly for these purposes that specially protected natural areas are created - reserves, wildlife preserves, national parks, natural monuments.

*A wildlife (biosphere) reserve is a protected territory, where no human activity is permitted, with the exception of scientific activity.*

*All biosphere reserves participate in the Man and the Biosphere international programme, which is run by UNESCO and which supports ongoing, long-term studies of the environment. Studies are now being carried out in many reserves of the impact of climate change on plant and animal life. Scientists working at the Caucasus biosphere reserve in Russia have found that forest cover on the slopes of mountains in the region is gradually moving higher as the climate becomes warmer.*

*Lahemaa national park (Estonia).*

*Jasper national park (Canada).*

*Kruger national park (South Africa).*

***A national park*** is a protected area that can be visited by tourists, but where human activity is limited by definite rules. National parks are usually created in places where there are many different landscapes (both typical and unique), rare or endangered animals and plants, and unique geological or water phenomena.

# Part 2. How climate change affects the natural world and human beings.

## | 2.2. How climate change affects... biodiversity

### How to preserve biodiversity?

#### Ecotourism

**Ecotourism** is the opportunity to see the environment in its untouched, natural state, to understand how diverse it is, how vulnerable to human activity, and to ponder the question: 'What can I do for my planet?'

Ecotourists study the laws of nature and do things that help to maintain and preserve it, they try to reduce their environmental impact to a minimum.

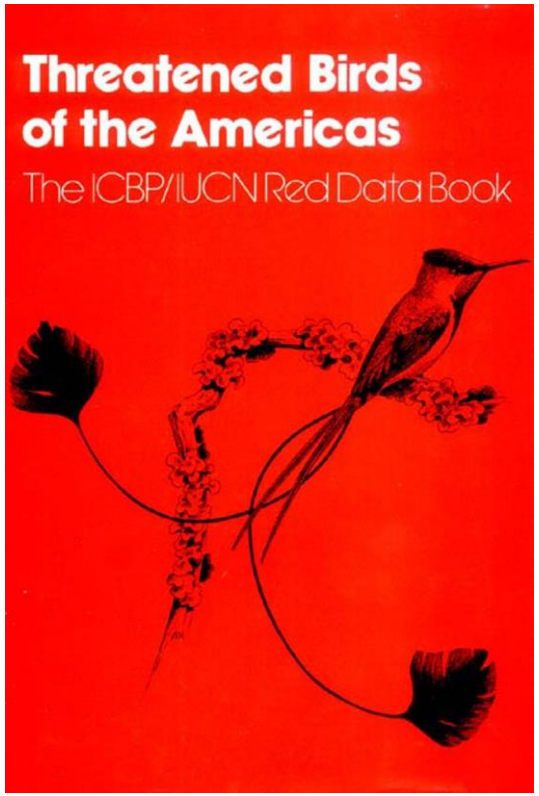
*An eco-hotel in Costa Rica.*

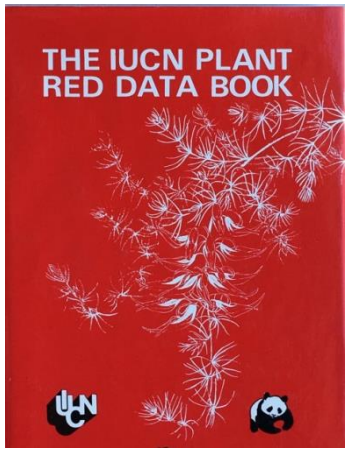
# Part 2. How climate change affects the natural world and human beings.

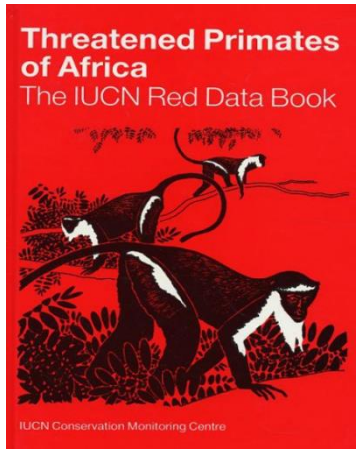
## | 2.2. How climate change affects... biodiversity

### How to preserve biodiversity?

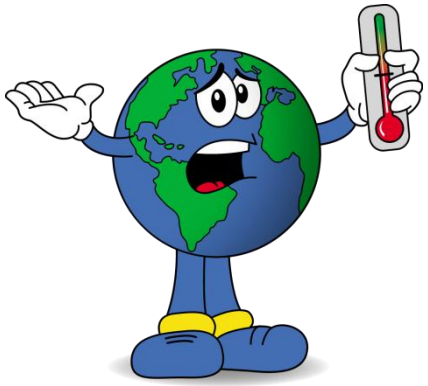
**Red Book**




The Red Book is a list of rare and endangered species of animals, plants and fungi. The colour red reminds us of the risk to these species and the urgent need to protect and preserve them.



# Part 2. How climate change affects the natural world and human beings.

## | 2.2. How climate change affects... biodiversity

### Questions to recap

**1. The richest ecosystem on Earth in terms of species diversity is:**

A. Savannah and tropical grasslands;

B. Temperate deciduous forests;

C. Rain rainforest.

**2. How climate warming affects reindeer?**

A. Their food supply is increasing;

B. Their food supply is decreasing;

C. This makes it easier for the reindeer to cope with harsh winters.

**3. What is the leading cause of coral death as it relates to climate change?**

A. The disappearance of algae that corals feed on due to the warming of the oceans;

B. Flourish of algae that corals feed on due to the release of pollutants into the ocean;

C. Active overfishing.

**4. Any economic activity is prohibited :**

A. In preserves;

B. In reserves;

C. In national parks.

# Part 2. How climate change affects the natural world and human beings.
## | 2.3. How climate change affects… forests

### What is a forest?

There are more than 800 different definitions for a forest around the world!

The most recognized approach to identify a forest, used also by the United Nations, includes such indicators as:

1) minimum height of trees of 5 m,
2) at least 10% for crown cover (proportion of the ground shaded by the crown of the trees) and
3) a minimum forest area size of 0.5 hectares.

- There are just under 4 billion hectares of forests on Earth, covering in all about 30% of the total land area.
- About half of the world's forest areas are located in three countries: Russia, Canada and Brazil.

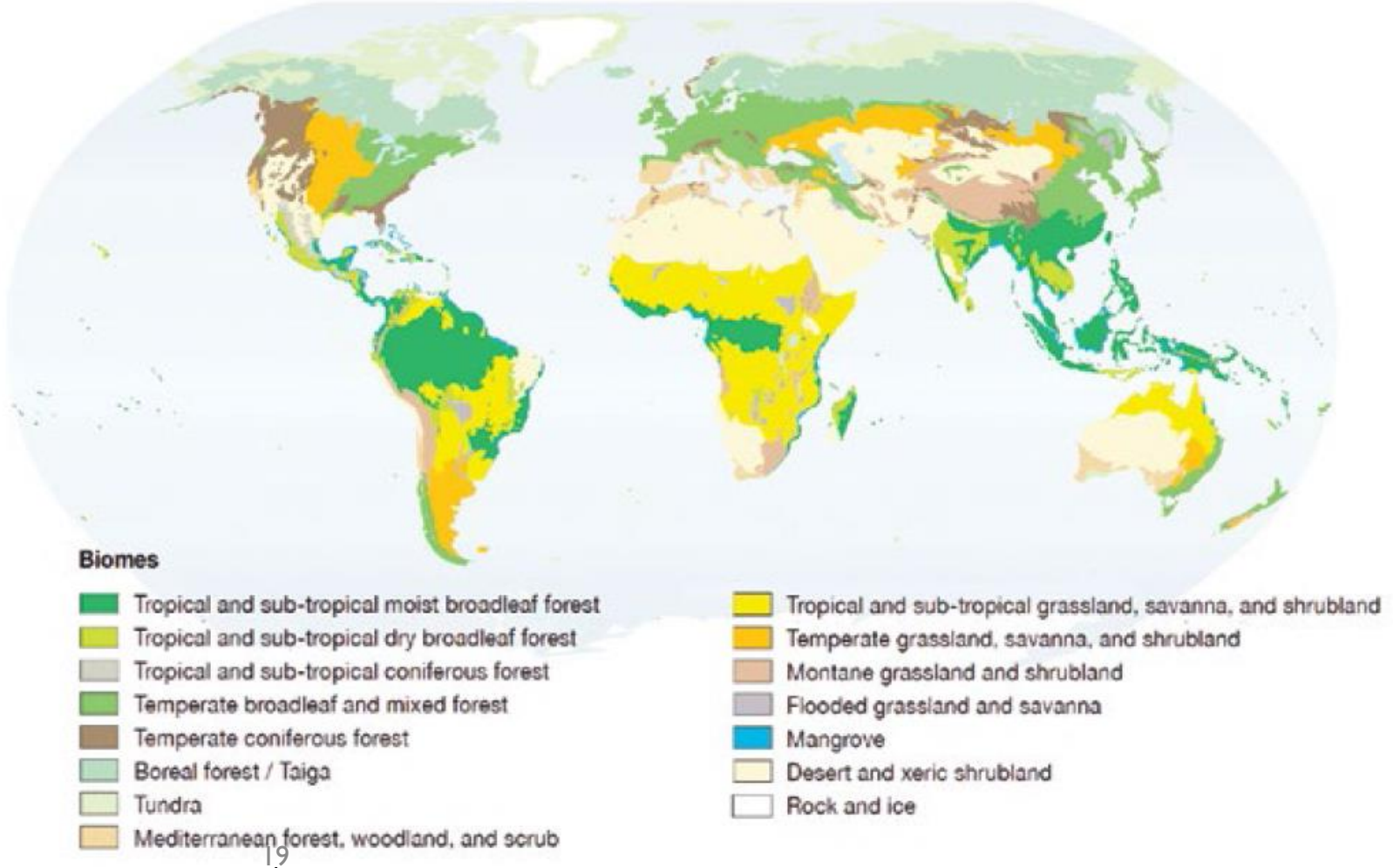
# Part 2. How climate change affects the natural world and human beings.
## | 2.3. How climate change affects… forests

### Types of forests

Forests are usually classified in terms of the predominant tree species (broadleaf, coniferous (needle-leaved), or mixed) and their leaf longevity (whether they are **evergreen** or **deciduous**).

The main forest types are:

- **Boreal forests (taiga)** are generally evergreen and coniferous.
- Broadleaf, coniferous and mixed **forests of a temperate climate**.
- **Mediterranean forests** are generally composed of evergreen broadleaf, coniferous and sclerophyll trees.
- **Tropical and sub-tropical forests** include moist broadleaf forests, dry broadleaf forests and coniferous forests.



# Part 2. How climate change affects the natural world and human beings.

## | 2.3. How climate change affects… forests

### Why are forests dependent on the climate?

*Rainforest.*

The life of the forest and its geographic distribution depend on **climatic conditions**, especially **air temperature** and **the amount of precipitation.**

**Relief, soil quality, water bodies and human activity** are also important for determining forest cover.

*Broadleaf forest temperate climate.*

*Southern taiga.*

# Part 2. How climate change affects the natural world and human beings.

## | 2.3. How climate change affects… forests

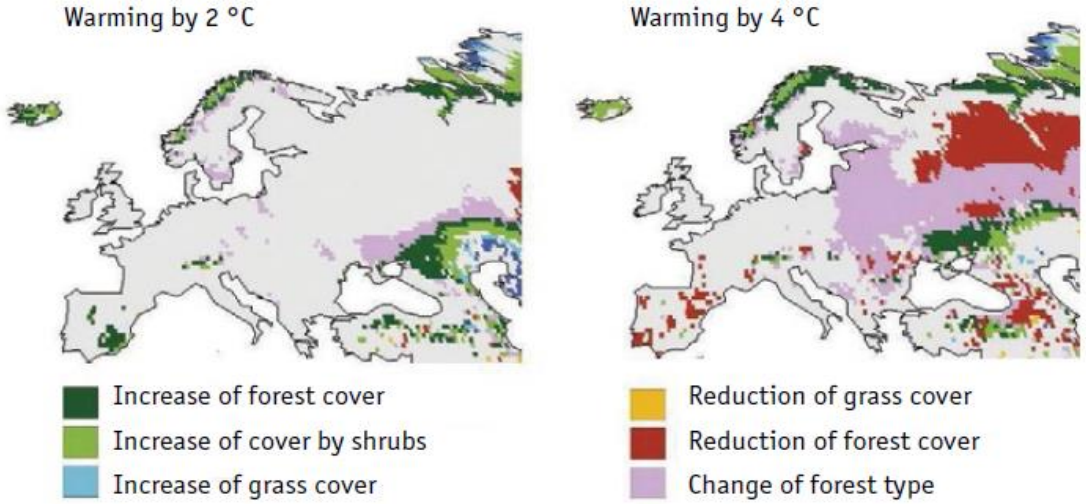
### How climate change affects forests

In the temperate climate of the Northern Hemisphere, changes associated with climate warming are manifested at the **northern border of the forest**. In the Polar Urals, trees and shrubs rise higher along the mountain slopes, gradually occupying the belt of mountain tundra.

**The southern border** of the forest is also changing. In the forest-steppe and steppe zones of the European part of Russia, the oak forests are gradually disappearing, mainly due to summer droughts.

*Most forecasts predict that forests in northern parts of Eurasia and North America will be more affected by global warming than forests elsewhere in the world, as their northern and southern boundaries are displaced.*

***Fig. 2.3.7.*** *Forecast changes in forest cover in Europe by 2100, assuming global warming by 2 °C and by 4 °C.*



# Part 2. How climate change affects the natural world and human beings.
## | 2.3. How climate change affects… forests

### How do forests affect climate?
### Carbon pool

The carbon storage component of the ecosystem scientists call a “pool”.

There are four main carbon pools in the forest ecosystem:

1. phytomass (the weight of living plants),
2. dead wood,
3. litterfall (dead leaves and branches on the forest floor),
4. organic matter in the soil.

*Fig. 2.3.11. The wood in tree trunks is the biggest part of the phytomass carbon pool.*

*Fig. 2.3.12. Dead trees are part of the dead wood carbon pool.*

*Fig. 2.3.13. The litterfall carbon pool is swollen when leaves fall in the autumn.*

*Fig. 2.3.14. If soil is dark, it contains a lot of carbon.*

# Part 2. How climate change affects the natural world and human beings.

## | 2.3. How climate change affects… forests

## How do forests affect climate?

### Carbon budget and differences in the impact of forests

- Forests that contain **many mature and old trees** absorb the same amount of carbon dioxide from the atmosphere as they release back into it.
- **Young forests** store carbon stocks by removing it from the atmosphere, helping to reduce the rate of climate change on Earth. Therefore, it is young forests that can be fully considered the 'green lungs' of the planet!

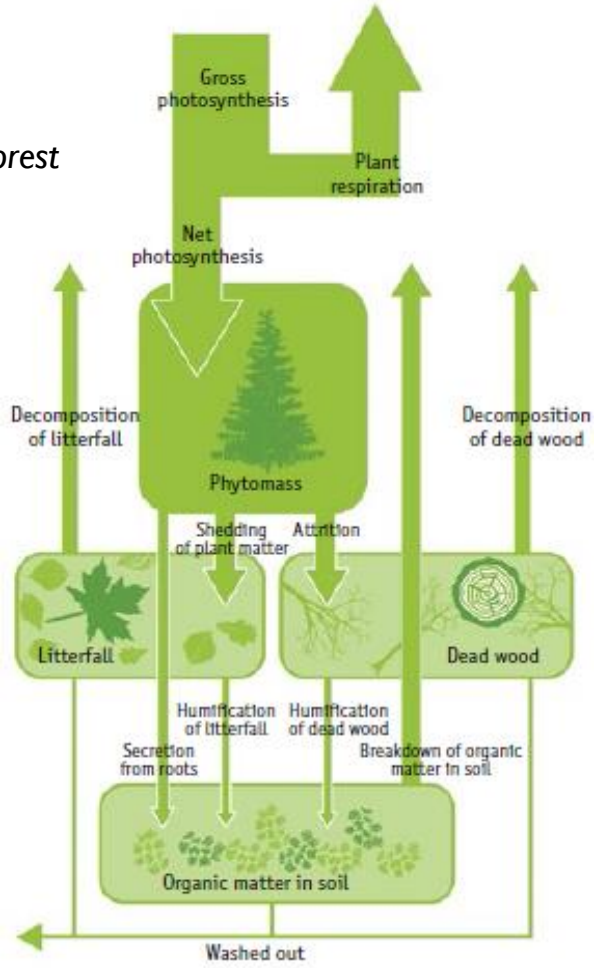
**If we want to use forest to prevent climate change, we need to:**
**1) plant new young forests-where there was no forest before;**
**2) take good care of existing forests.**

*The only **'income item'** in the forest ecosystem is photosynthesis.*

*Nearly half of the substance created by photosynthesis is used by the plants when they breathe, releasing the carbon from the substance back into the atmosphere.*

*The remainder of the substance is called **'net photosynthesis'**: it replenishes the phytomass pool.*

***Fig. 2.3.15.** The carbon budget of a forest ecosystem.*



# Part 2. How climate change affects the natural world and human beings.

## | 2.3. How climate change affects… forests

### How do forests affect climate?

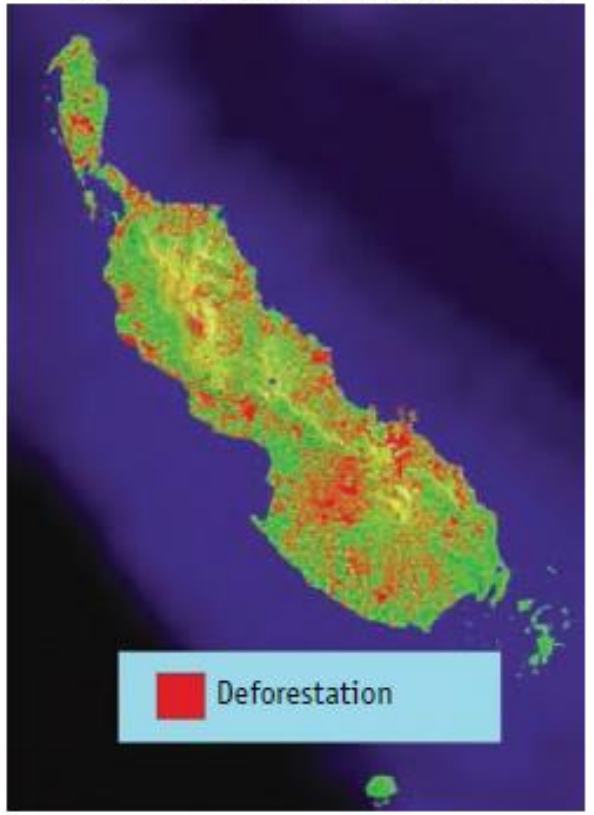
### The disappearance of tropical forests

**Tropical rainforests** play a very important role in regulating the Earth's climate.

***Today tropical rainforests cover only 5% of the Earth's surface compared with 12% a hundred years ago. An area of forest larger than the whole of England (130,000 km2) is being cut down or burnt each year.***

*The disappearance of tropical forests leads to the loss of fertile topsoil, loss of biodiversity and disruption of the ecological balance over large areas of the planet.*

*Fig. 2.3.18. Loss of forest cover on the island of Bougainville (Papua New Guinea), 1972-2002.*



# Part 2. How climate change affects the natural world and human beings.

## | 2.3. How climate change affects… forests

### How to manage the carbon balance of forests?

### Examples of forest projects for climate

*The World Wide Fund for Nature (WWF) in the Russian Far East implemented a project to manage the carbon balance of forests. The idea of the project is to halt largescale logging in the cedar and deciduous forests of the Bikin River basin, where only local inhabitants will be allowed to cut timber. The project is encouraging local residents to develop traditional forms of forest management: the collection of pine nuts, berries, mushrooms, ferns and herbs.*

*Fig. 2.3.20. Cedar-deciduous forest in the Bikin River basin.*

The carbon balance of forests depends on many factors, the most important of which are **human impact, disasters** (forest fires, plagues of pests, etc.) and **climate change**.

If the **felling of forests** for timber and other purposes **is reduced**, forests will absorb more carbon from the atmosphere.

It is also important to reduce **the risks of occurrence and damage from forest fires**.

# Part 2. How climate change affects the natural world and human beings.

## | 2.3. How climate change affects… forests

### Questions to recap

**1. What climatic factor determines the position of the northern border of the taiga?**

A. Temperature

B. Precipitation

C. Cloudiness

**2. A pine forest is taking over the steppe ecosystems in Eastern Siberia. What is the climatic cause of this phenomenon?**

A. Rise of temperature

B. Increase of precipitation

C. Decrease of precipitation

**3. How does carbon release and absorption compare in forests with many old trees?**

A. Absorption is approximately equal to excretion

B. More is absorbed than released

C. More is released than absorbed

**4. How does carbon absorption compare in young forests?**

A. Absorption is approximately equal to excretion

B. More is absorbed than released

C. More is released than absorbed

# Part 2. How climate change affects the natural world and human beings.

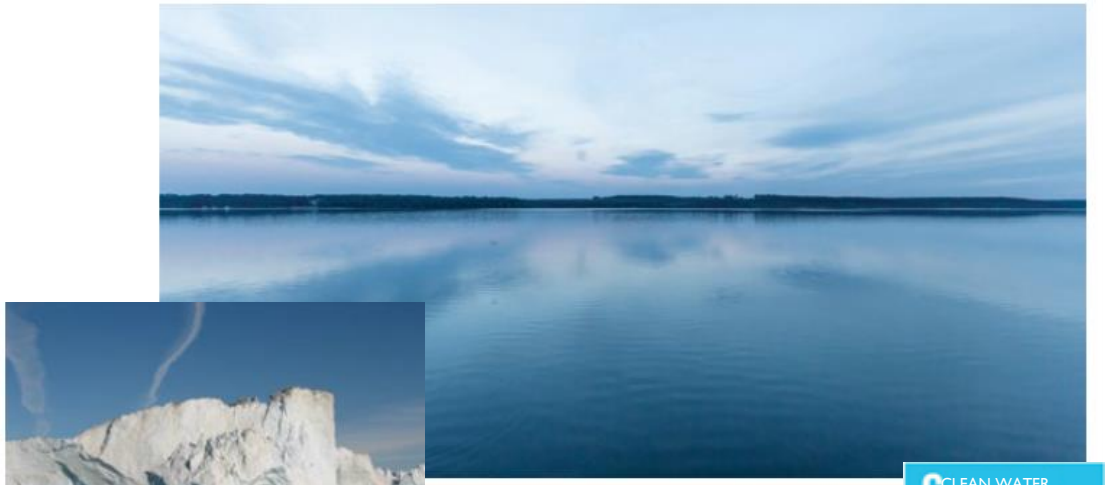
## | 2.4. How climate change affects… water resources

### Water in the natural world

All water on Earth that is used or could be used by humanity is called **'water resources'**. It includes all water in rivers, lakes, canals, reservoirs, seas and oceans, groundwater, soil moisture, the frozen water (ice) in mountain glaciers and polar ice caps, and even water vapour in the atmosphere.

*The science that studies water is called **hydrology**. It is believed that the first hydrological studies were carried out 5000 years ago by the ancient Egyptians on the River Nile: they measured the height of seasonal floods, by making marks on the walls of buildings, rocks or steps down to the river.*

More than 97% of all water on the planet is in oceans and seas, where the water is salty, and only 3% is fresh water. That is why it is so important to maintain the supply of fresh drinking water.



Drinking water is unevenly distributed across the continents: Asia is home to 60% of the world population, but it has only one third of the world's water resources. According to the World Health Organization, nearly 800 million people worldwide (40% of them in Africa) do not have access to clean drinking water.

In 2015, the United Nations adopted Sustainable Development Goals and associated targets. These included the target 'By 2030, achieve universal and equitable access to safe and affordable drinking water for all'.


SUSTAINABLE DEVELOPMENT GOALS

# Part 2. How climate change affects the natural world and human beings.

## | 2.4. How climate change affects… water resources

### How climate change affects water resources?

Water shortage problems **have become worse because of glob climate change** and also because of the increasing demand for foo and hygiene from the world's growing population.

Warming of the climate in many parts of the world will probably increase the frequency of heavy rains, causing disastrous flooding. In other areas precipitation is expected to decrease, so that extreme droughts will happen more frequently

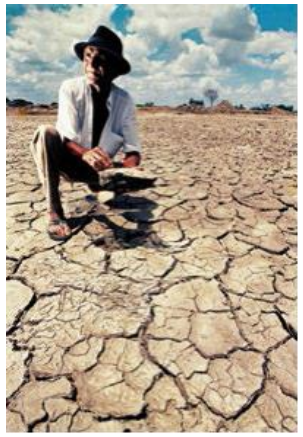
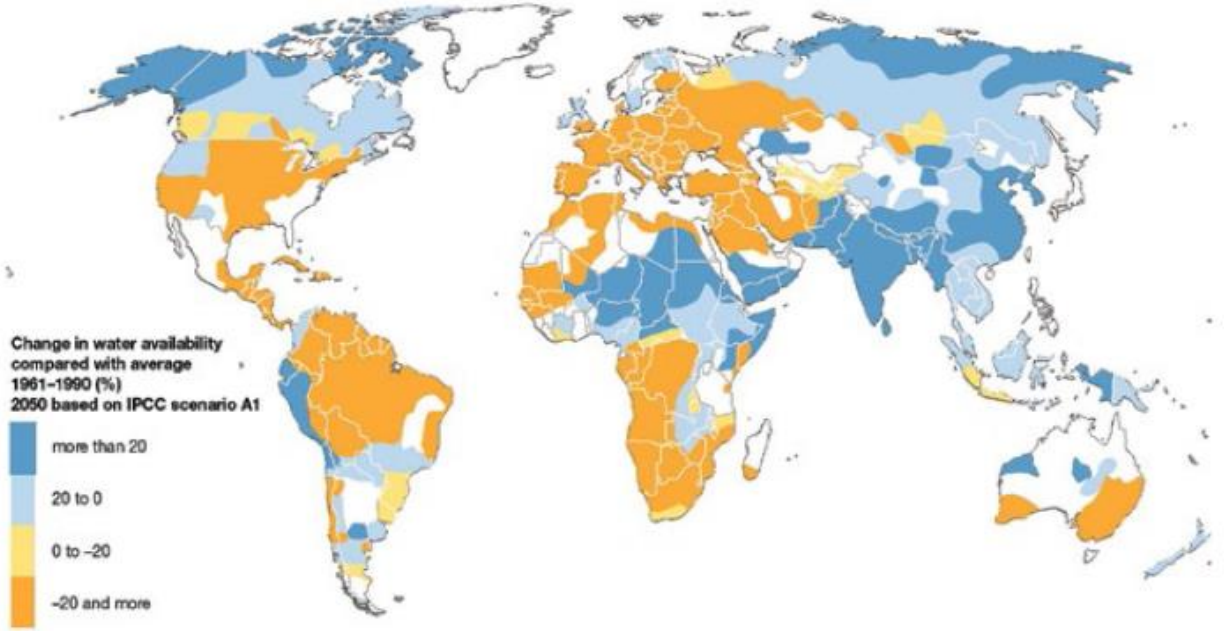


*Fig. 2.4.2. Water availability change by 2050 compared with average 1961–1990.*




Water shortages due to climate change will particularly affect arid regions of the world, most notably the Mediterranean countries, the western United States, Southern Africa and northeast Brazil.

# Part 2. How climate change affects the natural world and human beings.
## | 2.4. How climate change affects… water resources

### How can the risks be reduced?

**The first thing** needed is steady improvement of weather forecasting. This will help to predict the probable occurrence of severe weather events, whether heavy rain or extreme drought, in advance.

**Secondly**, there are many technology and engineering solutions that can reduce risks to people and infrastructure, from the construction of new dams and reservoirs along rivers to the creation of structures along river banks to protect the communities who live there from severe flooding.

**Thirdly**, we will have to reduce water consumption. This can be done, for example, by using rainwater or by using the same water twice for different needs.

**Fourth**, to desalinate sea water. Such installations already exist.

*Fig. 2.4.9. A seawater desalination plant in the United Arab Emirates.*

# Part 2. How climate change affects the natural world and human beings.

## | 2.4. How climate change affects… water resources

### Questions to recap

**1. 70% of all fresh water, which is consumed by humans, is used for :**

A. Drinking;

B. Sanitary needs;

C. Irrigation of fields.

**2. Which of these regions of the world is especially prone to severe droughts?**

A. Central Africa;

B. Southeast Asia;

C. Small islands of the Caribbean.

**3. The main climate problem which the countries of Central Asia will face in the coming decades due to climate change is:**

A. Water scarcity;

B. Melting permafrost;

C. Hurricanes.

# Part 2. How climate change affects the natural world and human beings.

## | 2.5. How climate change affects… agriculture

### Implications of climate change for agriculture

Agriculture is threatened by such effects of climate change as:

- rise of temperatures;
- changing rainfall patterns, rise of sea levels (affecting coastal lowlands);
- frequent droughts and floods, especially in areas that are prone to natural disasters.

Experts of the International Food and Agriculture Organization believe that crop yields in many parts of the world will decline after 2030 due to climate change.

Forecasts indicate that the most serious consequences are likely to occur in tropical regions, where further reduction of rainfall is likely.

# Part 2. How climate change affects the natural world and human beings.

## | 2.5. How climate change affects… agriculture

### Implications of climate change for agriculture

Agriculture is the main source of income for one third of all working people in the world. In some countries in Asia and Africa, more than half of the population is engaged in agriculture

***Coffee growing*** *is a major source of income for countries including Brazil, Indonesia and Costa Rica. Brazil alone grows more than 2 million tonnes of coffee beans each year. But higher temperatures, more frequent droughts and outbreaks of pests in areas where coffee is grown are reducing both the quantity and the quality of the coffee harvest.*

*The principal cereal crop in South-East Asia is* ***rice****, which is mostly grown in the deltas of large rivers. As water levels rise in the ocean, due to the effects of climate change, low-lying sections of rivers are becoming salty, which may lead to loss of crops. Regions of Vietnam in the Mekong Delta, which is one of the world's centres of rice cultivation, are particularly affected by the rise of sea levels. Even a 30 cm rise in the level of the ocean can reduce rice crops by 11%.*

**Agriculture everywhere in the world will have to adapt to the new climatic conditions.**

## How to reduce risks to agriculture and adapt?

### Discussion

# Part 2. How climate change affects the natural world and human beings.

## | 2.6. How climate change affects… coastal regions

### Coastal zone

**Coastal regions: 50% of the world's population and 70% of world production.**

Coastal zones are highly vulnerable to the effects of climate change. The main threat to them are:

- rising sea levels;
- more intense storms;
- flooding and shore erosion;
- increase in the frequency of extreme weather events.

# Part 2. How climate change affects the natural world and human beings.

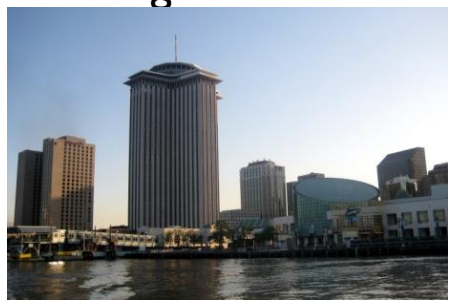
## | 2.6. How climate change affects… coastal regions

### The rising level of the world ocean

Honolulu

Bangkok

Venice



New Orleans

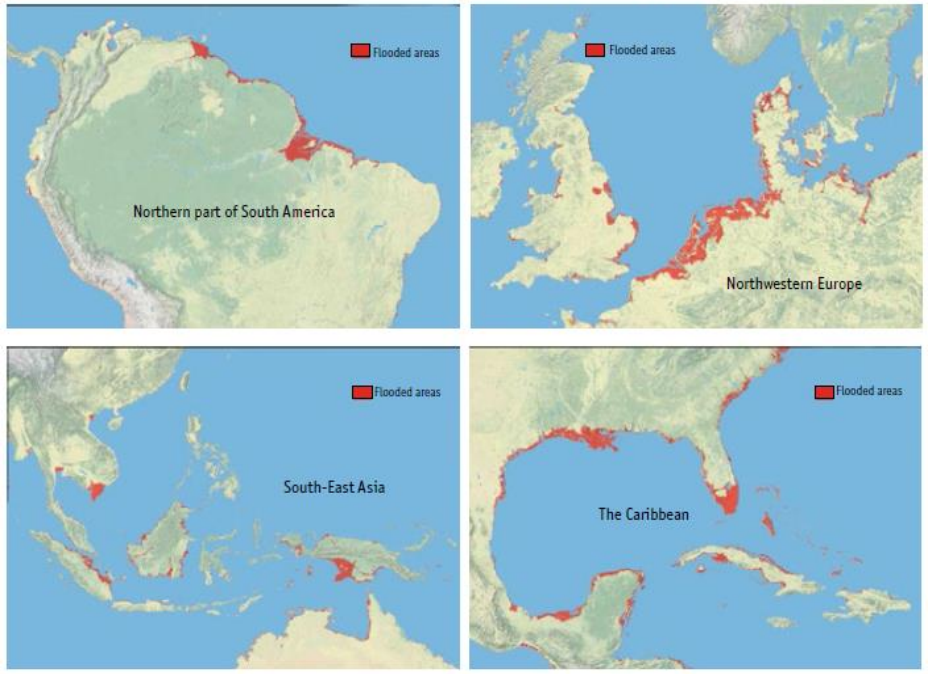
**Two causes of rising sea levels:**

1) the melting of glaciers in Greenland and Antarctica, which pours extra water into the world's oceans;

2) thermal expansion of water. As temperatures increase, water expands and takes up more space.

*Flooding of coastal regions*

***Fig. 2.6.1.*** *Forecasts of coastal flooding on different continents, assuming a rise of sea levels by 5 m.*




*The level of the world's oceans has been rising steadily for over 100 years. It rose by 17 cm over the course of the 20th Century.*

# Part 2. How climate change affects the natural world and human beings.

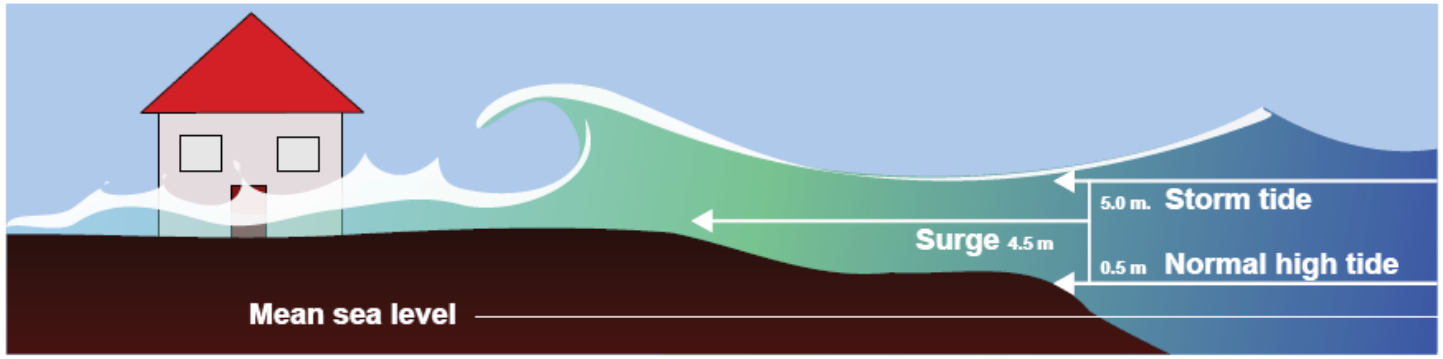
## | 2.6. How climate change affects… coastal regions

### Storm warning

### Erosion and destruction of coastline

**Erosion and destruction of coastline by the sea** is another consequence of rising sea levels. Erosion is a particularly serious problem along Arctic coastline, which was previously protected by ice, but is now losing ground rapidly as the ice cover has lessened and storm weather has become more frequent. The coast in the Arctic is retreating by as much as 10–25 m or more each year in some places.

*Storm surge scheme.*

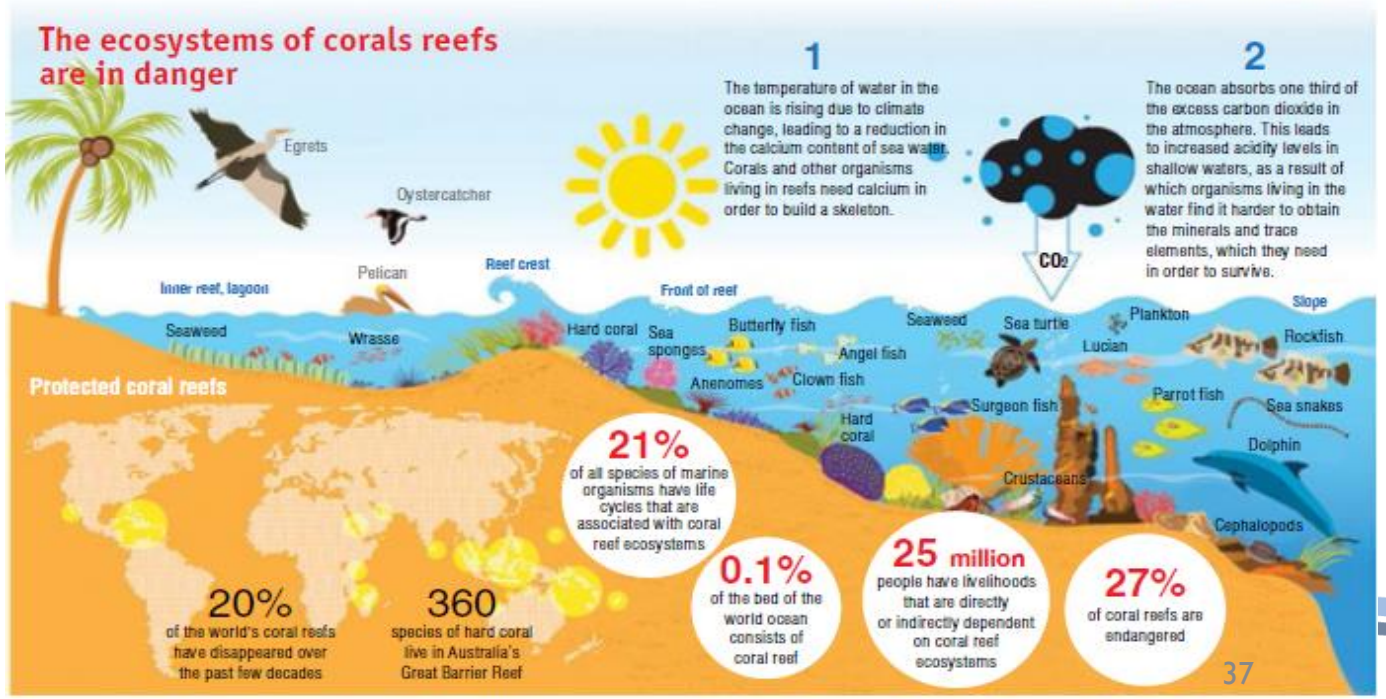


# Part 2. How climate change affects the natural world and human beings.
## | 2.6. How climate change affects… coastal regions

### Risk to ecosystems

As well as its impact on people and the economy, the rise of sea levels also affects both sea and land ecosystems along the coast.

*Fig. 2.6.6. Coral reef ecosystems at risk.*




- **Mangrove forests** will be affected by rising ocean levels.
- Ocean warming poses a significant threat to **coral reefs**.
- **Salt marsh** ecosystems are also threatened by ocean warming.

# Part 2. How climate change affects the natural world and human beings.

## | 2.6. How climate change affects… coastal regions

### Questions to recap and discuss

**1. With climate warming, the level of the world's oceans:**

A. rises;
B. goes down;
C. does not change;
D. impossible to assess.

**2. What are the main causes of rising ocean levels?**

**3. Why is the rise in ocean temperatures dangerous for coral reefs?**

# Part 2. How climate change affects the natural world and human beings.

## | 2.7. How climate change affects… mountain regions

### Mountains and climate

Mountains play an important role in shaping the climate. They create a barrier to air masses, which cannot easily pass the high peaks

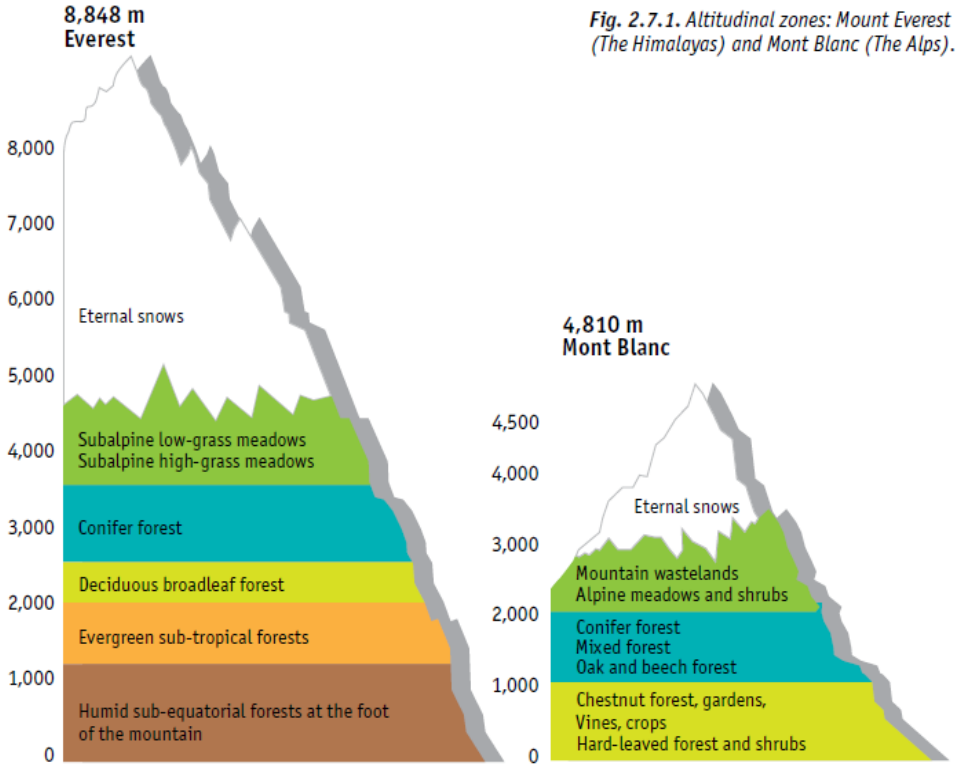



*Fig. 2.7.1. Altitudinal zones: Mount Everest (The Himalayas) and Mont Blanc (The Alps).*

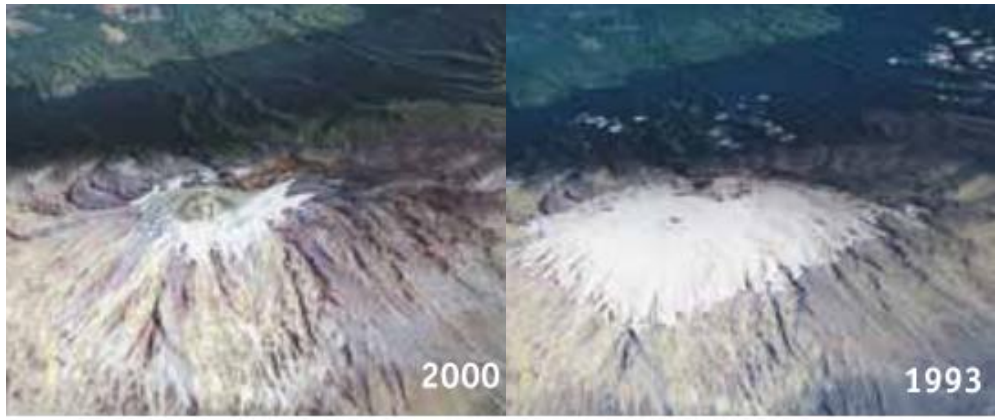
Mountains are also distinctive in that they bring together a large number of different climates in a small area: the climate and landscapes change at different levels from the bottom to the top of the mountain. They are therefore called 'altitudinal zones' ('altitude' means 'height').

# Part 2. How climate change affects the natural world and human beings.

## | 2.7. How climate change affects… mountain regions

### Mountain glaciers retreat

The main 'indicator' of climate change in the mountains is **glaciers**, which decrease or increase their mass as the temperature gets warmer or colder.




**The African volcano, Kilimanjaro**, has suffered perhaps the worst of all: its famous ice cap, which was immortalized in Ernest Hemingway's novel 'The Snows of Kilimanjaro' has almost entirely disappeared.

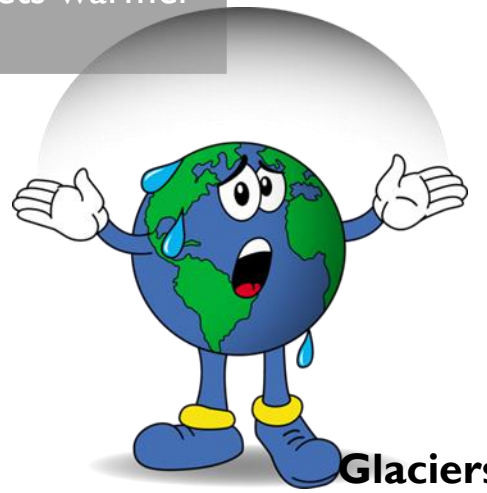


*Fig. 2.7.6.The Gangotri glacier.*

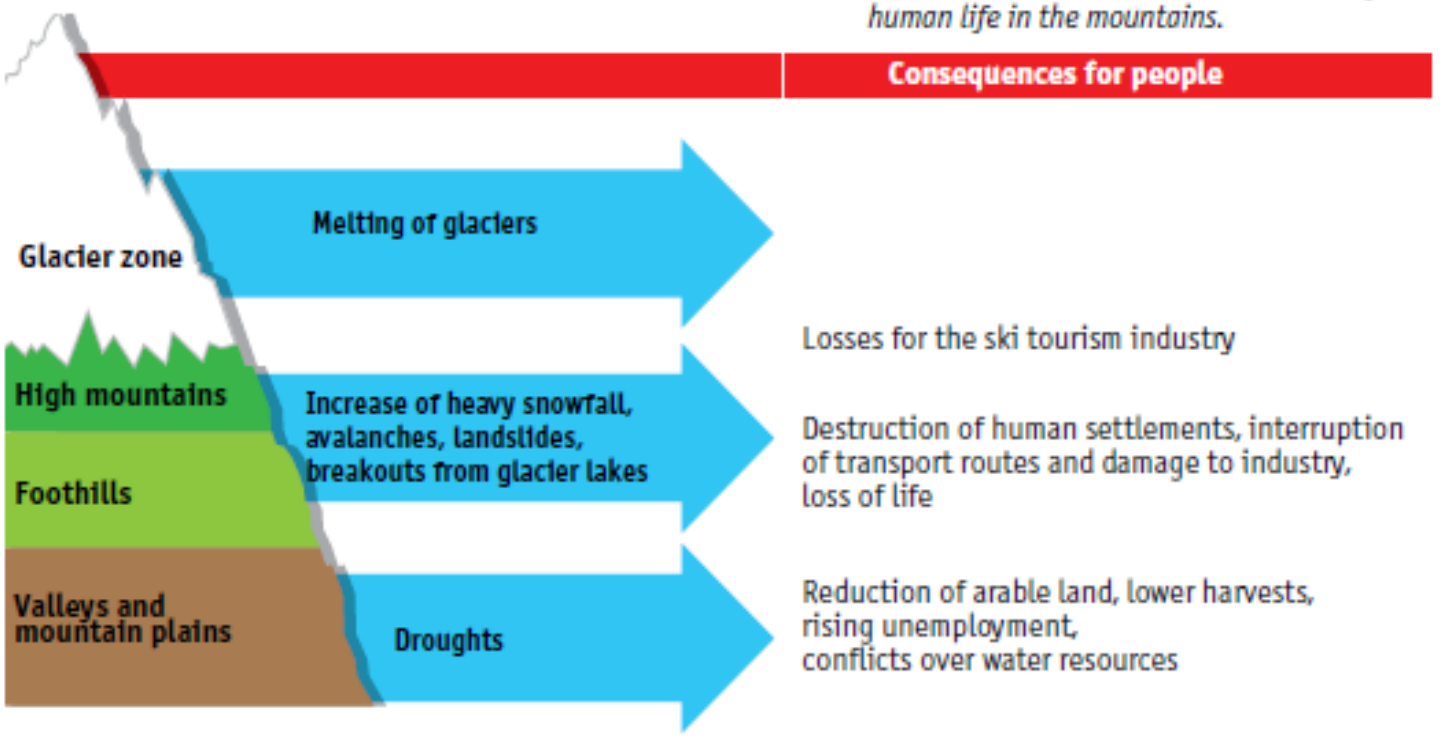
**Glaciers in the Himalayas** are retreating by an average of 10–15 m per year. The Gangotri glacier, which is the source of the River Ganges, is melting particularly fast, retreating by 30 m each year. Gangotri is one of the main sources of water for the 500 million people who live along the Ganges River.

# Part 2. How climate change affects the natural world and human beings.

## | 2.7. How climate change affects… mountain regions

### How climate change affects people who live in the mountains

*Fig. 2.7.11. The impact of climate change on human life in the mountains.*




# Part 2. How climate change affects the natural world and human beings.

## | 2.7. How climate change affects… mountain regions

### How climate change affects people who live in the mountains

#### Implications for tourism

The example of the Alps shows how **climate change** is affecting the tourist trade in mountain areas. For the 13 million people living in the Alps in Austria, Germany, Switzerland and France, **lack of snow is an economic catastrophe**: two thirds of all tourists who come here do so in order to enjoy skiing and snowboarding.

Ski tourism provides up to 20% of the income of Alpine countries.

Bridge over Trift Lake, Switzerland.

***Trift Lake*** *in the Swiss canton of Bern is an interesting instance of how global warming is affecting the Alps. In the 1990s, a nearby glacier began to shrink rapidly, the melt water formed a small lake and more of the valley became free of ice. Previously, people could walk from one mountain peak to another across the glacier. The local authorities decided to build a suspension bridge for walkers before the glacier had completely melted, and the bridge quickly became a major attraction, drawing visitors from all over the world.*

# Part 2. How climate change affects the natural world and human beings.

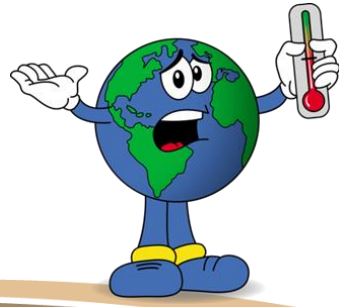
## | 2.7. How climate change affects… mountain regions

### How climate change affects people who live in the mountains

#### Natural disasters

Natural disasters: avalanches, landslides, floods, which, due to climate change, began to occur more often in the mountains. This results in large economic losses and risks to people's lives.

***An avalanche*** *is a huge mass of snow that falls or slides off mountain slopes. Avalanches can have disastrous consequences. In February 1999, an avalanche with a weight of 170,000 tonnes completely destroyed the village of Galtür in Austria and claimed the lives of 30 people. At the beginning of March 2012 a series of avalanches in Afghanistan destroyed homes, killing more than 100 people.*



# Part 2. How climate change affects the natural world and human beings.

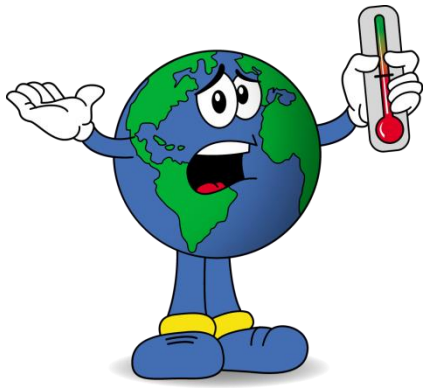
## | 2.7. How climate change affects… mountain regions

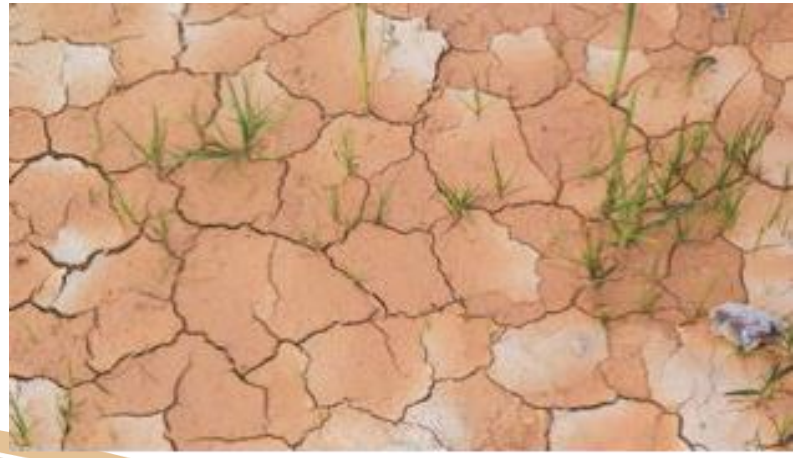
### How climate change affects people who live in the mountains

#### Fresh water stocks

Glaciers are one of the main sources of fresh water on Earth, since they are the source of many rivers. Reduction in volumes of ice will lead to water shortages in the regions around mountains.

Shortage of fresh water in areas near mountains is already leading to serious political conflicts.





# Part 2. How climate change affects the natural world and human beings.
## | 2.7. How climate change affects… mountain regions

### Questions to recap

**1. The main indicator of climate change in the mountains is:**
A. melting glaciers;
B. decline in the population of mountain gophers;
C. drying up of mountain rivers;
D. decrease in precipitation.

**2. Which of the following sectors of the economy is typical for mountainous regions, and is less susceptible to the effects of climate change?**
A. tourism;
B. mining;
C. agriculture;
D. hydropower production.

**3. Why do some glacial lakes pose a great danger as a result of climate change?**
A. harmful chemical compounds are formed in water;
B. water gets too hot due to temperature rise;
C. melting glaciers raise the water level in the lake, which can lead to flooding and landslide;
D. dangerous insects appear in the lakes, the bites of which are painful.

**4. A landslide in the mountains is :**
A. a mass of snow falling or sliding down a slope;
B. severe flood;
C. mudstone stream;
D. hurricane wind.

# Part 2. How climate change affects the natural world and human beings.

## | 2.8. How climate change affects… the Arctic regions

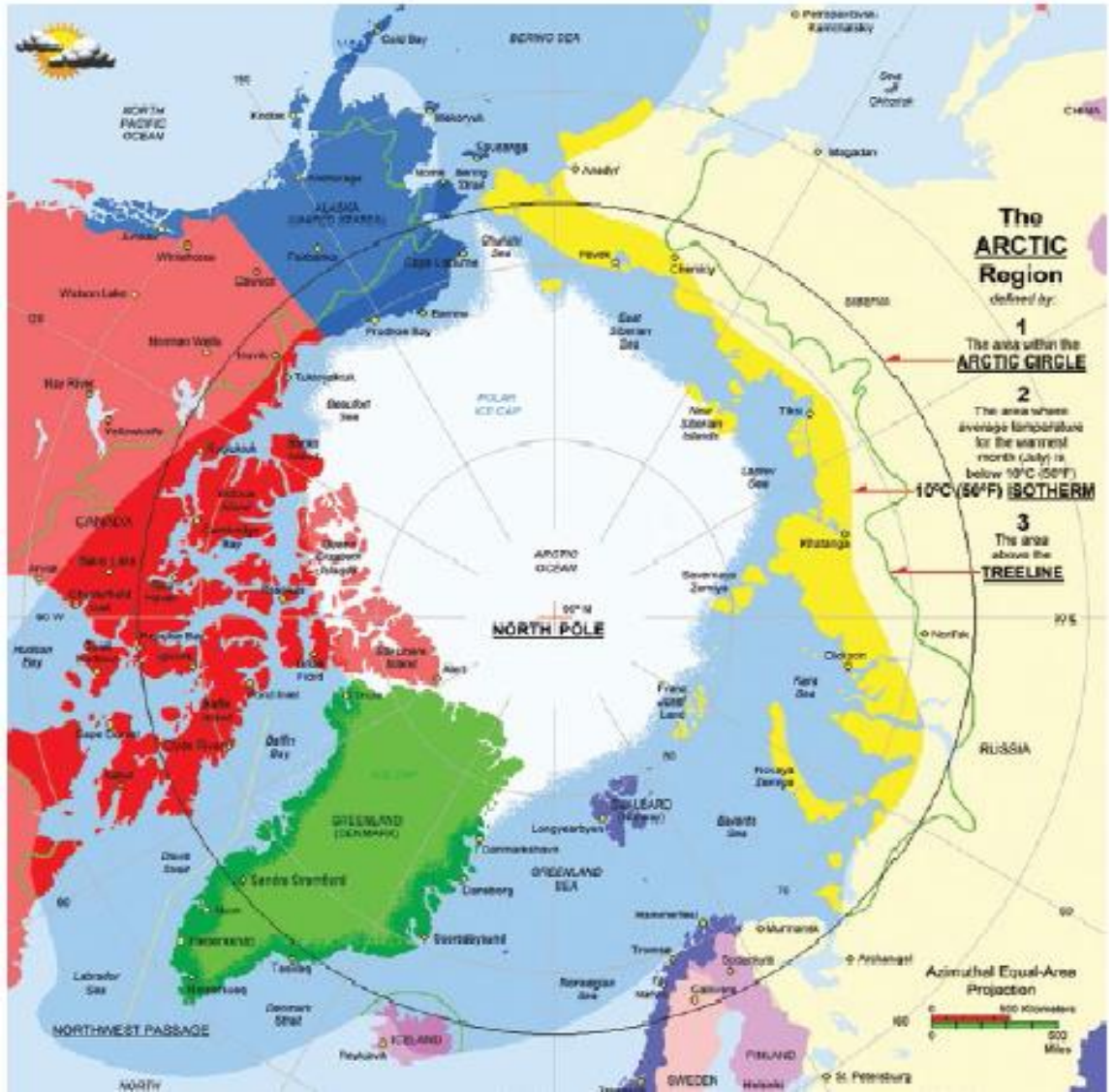
### What is the Arctic?

**The Arctic** is the Earth's northern polar region.

There are no hard and fast boundaries of the Arctic region.

*Climatic definition* of the Arctic region is the July **isotherm** – an imaginary line where temperatures in the warmest month of the year are not greater than 10 °C.

*Fig. 2.8.1. The Arctic and definition of its boundaries.*

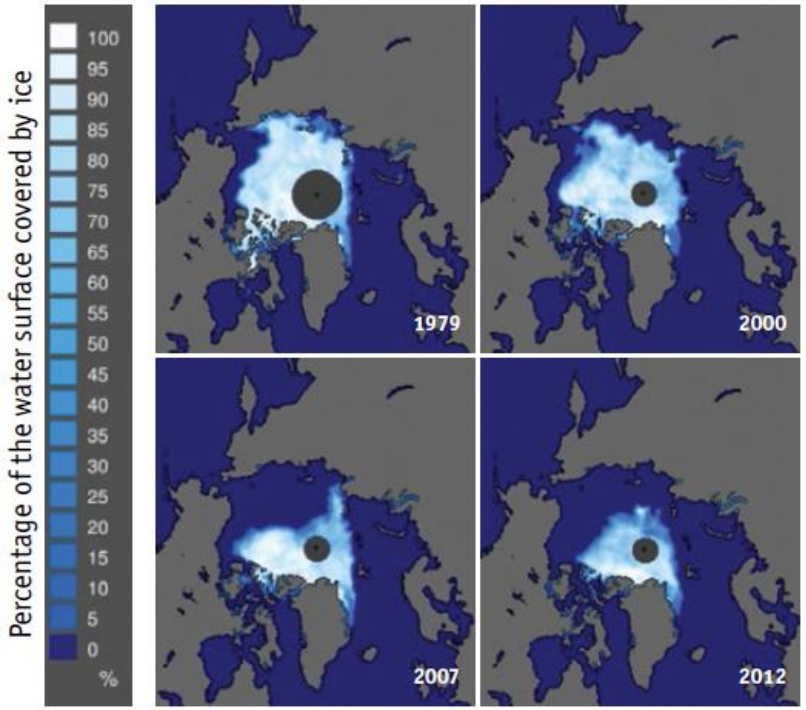


# Part 2. How climate change affects the natural world and human beings.

## | 2.8. How climate change affects… the Arctic regions

### The Arctic is getting warmer faster

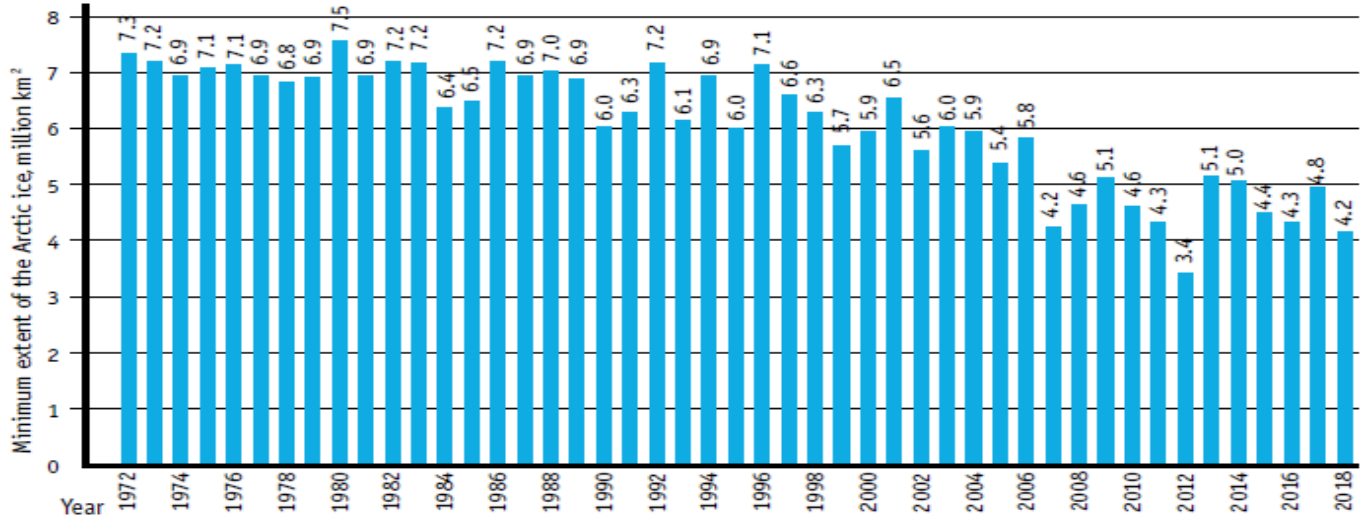
### The disappearing ice




Scientists have been monitoring ice in the Arctic since 1979 by means of satellites. Satellite data show that the amount of ice in the Arctic has declined dramatically.

Over the past 35 years, the extent of ice cover in the Arctic Ocean and its seas has decreased by 15–20%.

*Fig. 2.8.3. Extent of Arctic sea ice (annual minimum) between 1972 and 2018.*



# Part 2. How climate change affects the natural world and human beings.

## | 2.8. How climate change affects… the Arctic regions

### The Arctic is getting warmer faster

### Threats to the animals

The melting of ice in polar regions has a major impact on marine animals, including the 'king' of the Arctic – the **polar bear.**

The Barents and Kara seas are the habitat of the **Atlantic walrus**, which is listed in the Red Book. Because of the melting ice, the rookeries of these animals are reduced and their migration is hampered.

The survival of **harp seals** in the White Sea presents another challenge. Seals cannot live on the coast, and the ice continues to melt.

# Part 2. How climate change affects the natural world and human beings.

## | 2.8. How climate change affects… the Arctic regions

### The Arctic is getting warmer faster

### Melting of the permafrost

Another large-scale problem is the **melting of permafrost.**

Another important point is that large amounts of **greenhouse gases** are released from the tundra soil in the **process of permafrost melt**, **increasing the greenhouse effect and speeding up global warming**.

*As the climate changes and temperatures increase, the permafrost thaws to ever deeper levels in the summer. The depth of previously constructed piles may not be sufficient and they could begin to 'float', causing buildings to warp and collapse.*

Projected retreat of the permafrost boundary to the north by 2100

# Part 2. How climate change affects the natural world and human beings.

## | 2.8. How climate change affects… the Arctic regions

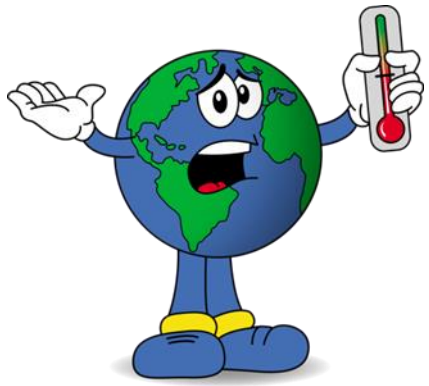
### The Arctic is getting warmer faster

### Indigenous peoples of the North

Native peoples in the Arctic are suffering as a result of climate change, since their way of life and traditional livelihoods are directly dependent on climate conditions. Hunting, fishing, gathering of natural harvests and reindeer herding provide people with food, are the main source of income and are very important for preserving the traditions and culture of these peoples and of the territories where they live.

*Climate change will bring more negative than positive impacts in all Arctic regions.*

*Climatologists and economists have concluded: adaptation to melting of the permafrost, coastal erosion, and all the other possible negative consequences of climate change is possible, but it is very expensive. So it is very important to find ways of minimizing global warming.*



# Part 2. How climate change affects the natural world and human beings.

## | 2.8. How climate change affects… the Arctic regions

### Questions to recap

**1. How much has the area of ice in the Arctic ~~has~~ decreased by over the past 40 years?**

A. 10 %
B. 20 %
C. 50 %
D. 100 %

**2. What proportion of the territory of Russia does permafrost occupy?**

A. 80 %
B. 60 %
C. 30 %
D. 20 %

**3 Which of the following climate change-related phenomena has <u>the least</u> impact on the life of people and ecosystems in the Arctic?**

A. strengthening winds (blizzards and storms);
B. reduction in the area and thickness of sea ice;
C. prolonged heat waves in summer;
D. melting permafrost.

# Part 2. How climate change affects the natural world and human beings.

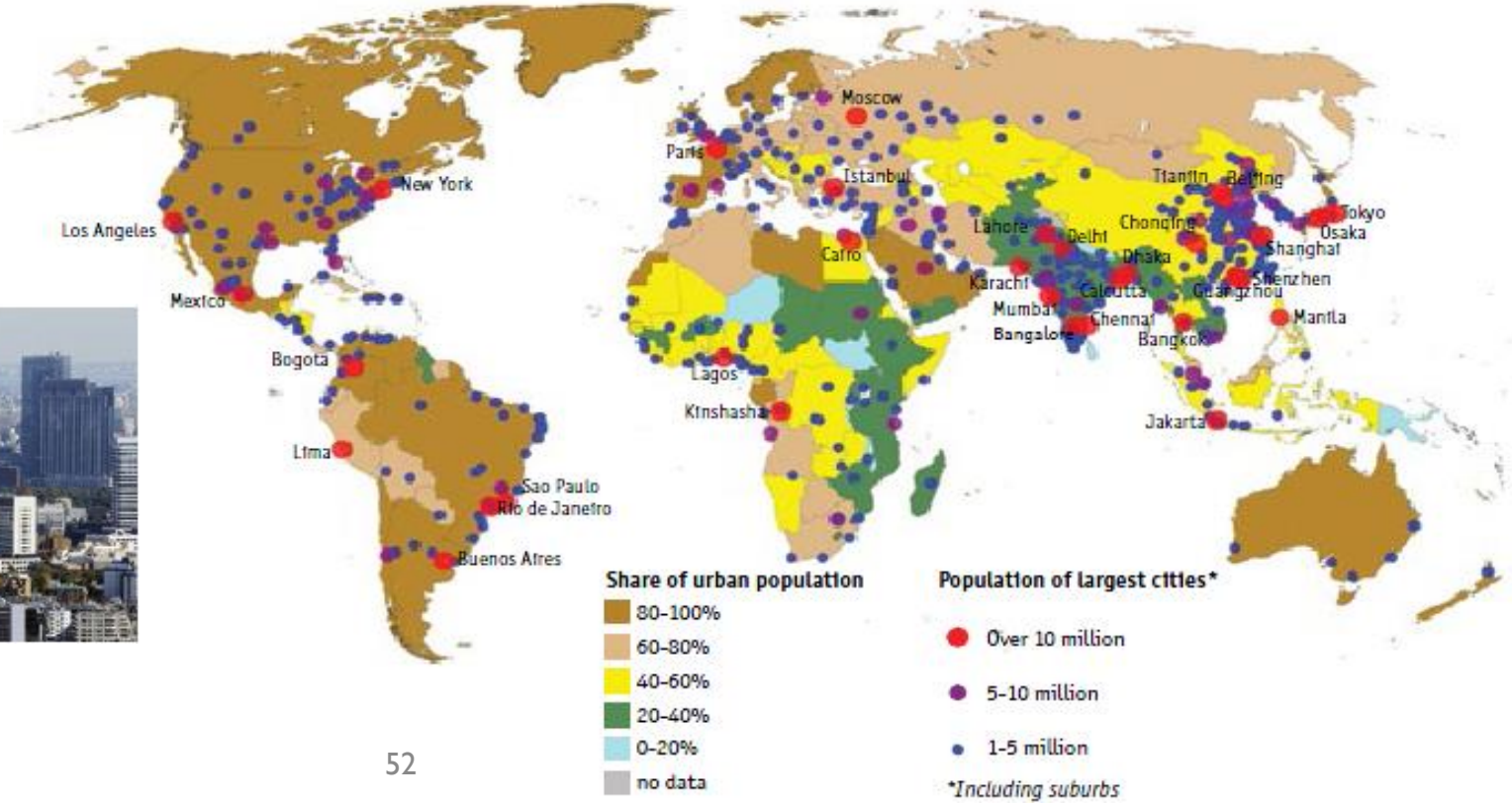
## | 2.9. How climate change affects… cities

### Half of the world's population live in cities

Since the end of the 19th century there has been a major influx of population to towns and cities. This process is called **urbanization**.

By 2008, as a result of urbanization, the share of the world's population living in cities rose above 50% for the first time.

***Urbanization*** *is the process by which towns and cities become dominant in a society. It is caused by growth of industry in cities, by development of their cultural and political functions and by deepening of the territorial division of labour.*



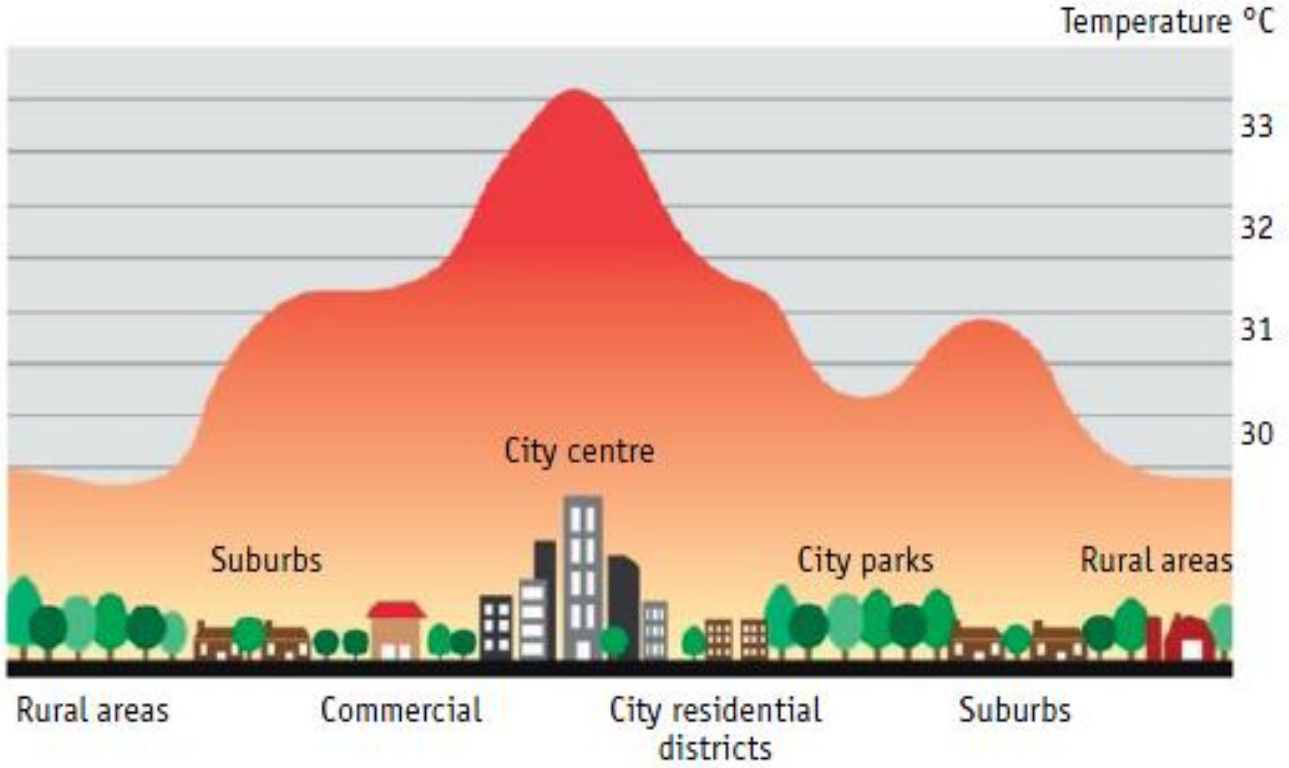
# Part 2. How climate change affects the natural world and human beings.

## | 2.9. How climate change affects… cities

### Cities are heat islands

Cities are unique environmental hot spots on our planet, taking the word 'hot' quite literally!

*Fig. 2.9.4. Air temperature distribution over a city (urban heat island).*




***A heat island*** *is an area in the centre of a big city, where the air temperature is higher than in outlying areas. The urban heat island effect is most noticeable in the evening and at night, especially in spring and autumn, when the temperature difference between the centre of the city and outlying areas can be as much as 10–15 °C.*

# Part 2. How climate change affects the natural world and human beings.

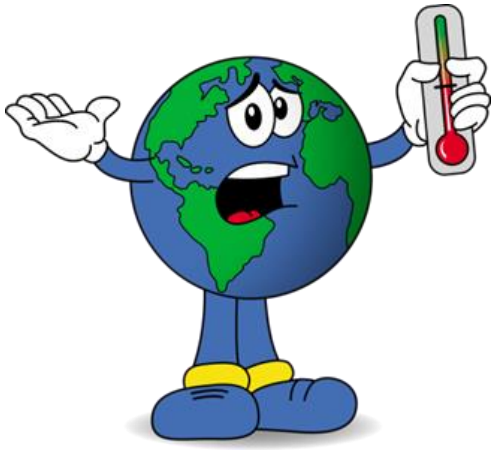
## | 2.9. How climate change affects… cities

### How does climate change affect the health of city dwellers?

Global warming will cause periods of extremely hot weather in cities to become more frequent, intense and long-lasting.

Intense heat is accompanied by higher concentrations of pollen and other particles that cause allergies and asthma.

*If a heat wave lasts for more than a week, it can lead to heart problems and even death among elderly people and people with poor health. The intense heat experienced in Europe in summer 2003 claimed the lives of 50,000 people.*

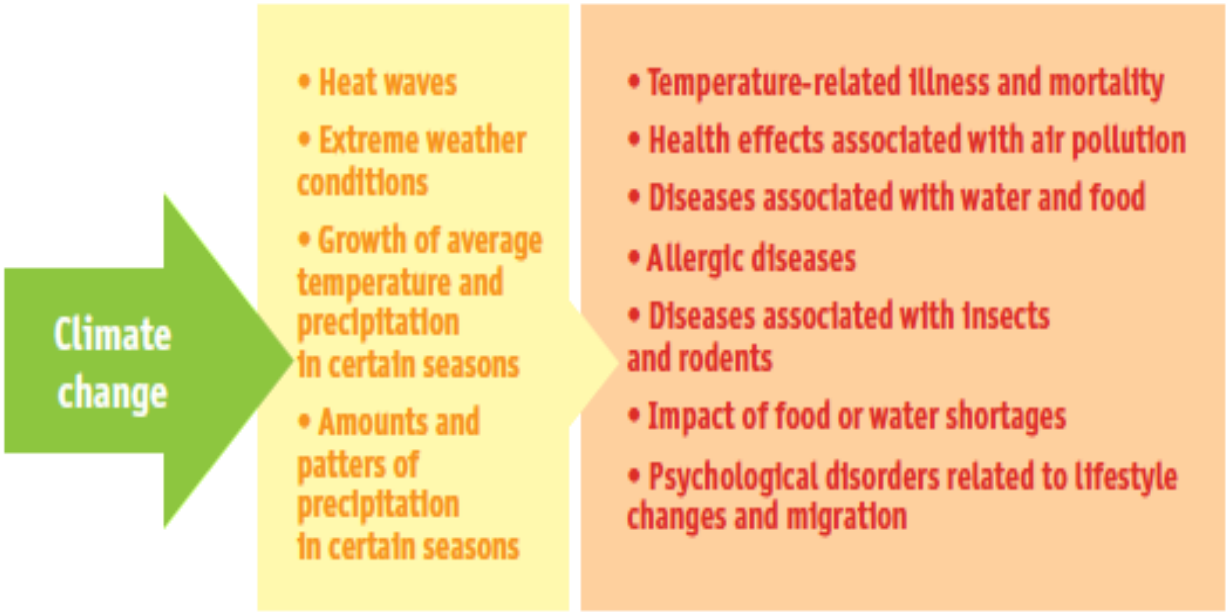


# Part 2. How climate change affects the natural world and human beings.

## | 2.9. How climate change affects… cities

### How does climate change affect the health of city dwellers?

*Fig. 2.9.6. Impacts of climate change on human health.*



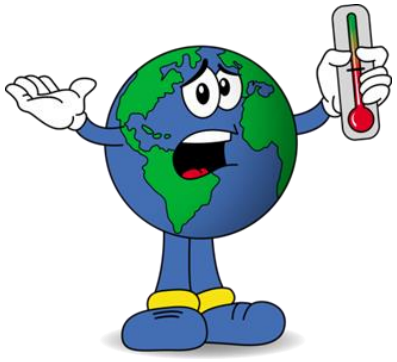

Climate change has a **negative impact** on human health. Dangerous infectious diseases, such as encephalitis and malaria, spread to areas where they were not previously present, and the **period of the year when there is danger of infection becomes longer**.

# Part 2. How climate change affects the natural world and human beings.

## | 2.9. How climate change affects… cities

### How does climate change affect the urban economy?

Extreme weather events can disrupt transport, electricity and water supply in cities.



Higher temperatures lead to faster deterioration of road surfaces, which need more frequent repairs. Sudden temperature drops in the winter cause the formation of ice that damages power lines.

Scientists have been studying the impact of climate change on cities in greater depth during the last decade.

## How can cities adapt to climate change?

### Discussion

# Part 2. How climate change affects the natural world and human beings.

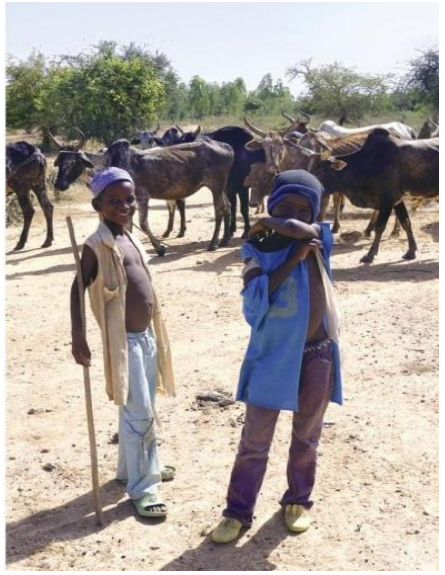
## | 2.10. How climate change affects... social problems

### Developed and developing countries

**Developed countries** are relatively rich countries with favourable living conditions and strong economies, in which industry, services and the financial sector play a major role.

**Emerging economies,** which are rapidly catching up with developed countries thanks to rapid growth of industrial production.

**Developing countries** have only recently begun to develop their economies. They are still heavily dependent on traditional industries: crop growing, cattle rearing and mining.



# Part 2. How climate change affects the natural world and human beings.
## | 2.10. How climate change affects... social problems

### Climate change and social issues

The majority of the world's people – 5.9 billion, or 84% of the total – live in developing countries and only 16% or 1.1 billion people live in developed countries.

The gap between the quality of life of the world's rich and poor is huge. Average incomes in the richest 20 countries are 37 times higher than those in the poorest 20.

*The contribution of people living in **developed** countries to global greenhouse gas emissions (their so-called 'carbon footprint') is much higher than that of people in **developing** countries.*

## Climate change and social issues

### Climate migration

In 2010, more than 40 million people were forced to flee their homes for reasons related to environmental changes. According to forecasts, by 2050 their number may reach 200-250 million people.

*The island nation of Kiribati consists mainly of coral islands, which are only 2 m above sea level on average, so that rising sea levels could inundate them within the next 50 years. In 2012, the government of the islands decided to buy land in the Republic of Fiji, where Kiribati citizens can resettle if their homes are at risk of disappearing under the sea.*

*In 2012, the government of the islands decided to buy land in the Republic of Fiji, where the inhabitants of islands, which may be lost to the sea, can be resettled.*

# Part 2. How climate change affects the natural world and human beings.

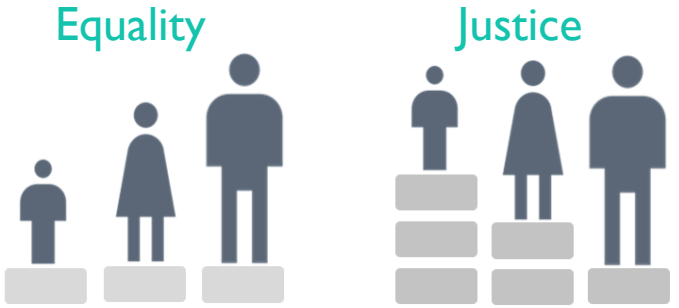
## | 2.10. How climate change affects... social problems

### Climate change and social issues

#### Gender inequality

Climate change in poor countries has a particularly major impact on women, who are mainly responsible for raising children, looking after the sick and elderly, feeding their family, growing crops, and collecting water and fuel. All of these tasks are seriously affected by climate change.

Climate change is further **exacerbating gender inequality**. This is why it is so important to **narrow the gender gap** and provide **equitable** opportunities for vulnerable groups.



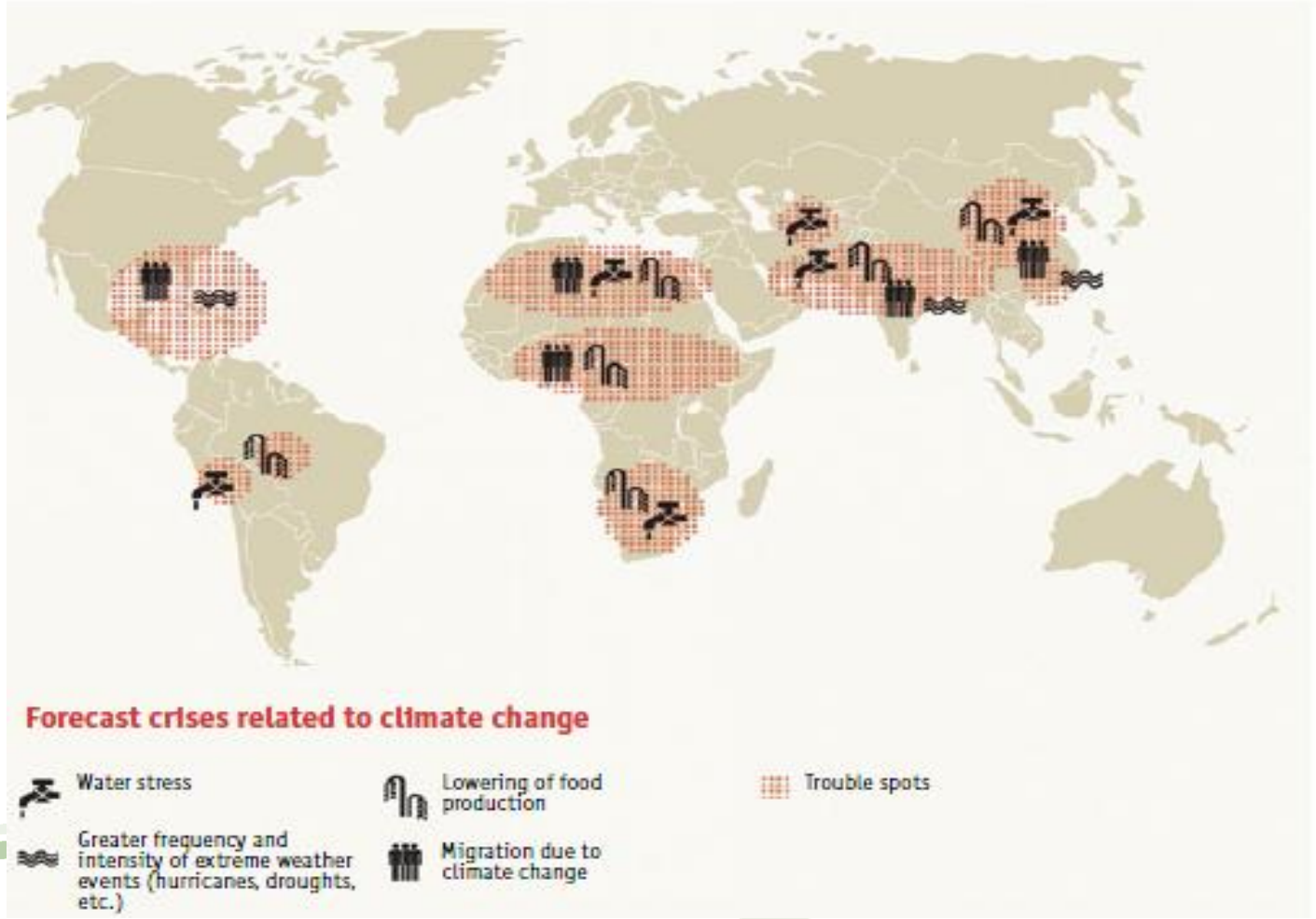

# Part 2. How climate change affects the natural world and human beings.

## | 2.10. How climate change affects... social problems

### Climate change and social issues

#### New conflicts

***Climate change*** *can cause* ***serious conflicts*** *between people, particularly over the issues of land rights, water scarcity and climate migration.*



# Part 2. How climate change affects the natural world and human beings.
## | 2.10. How climate change affects... social problems

Empowered lives.
Resilient nations.

### International cooperation

*Special programmes of assistance for the most vulnerable society groups are needed in order to reduce the social risks arising from climate change.*

Various funds and financial instruments have already been created to help developing countries overcome social problems associated with the adverse effects of climate change. The main donors are the governments of developed countries, large companies and international organizations, primarily the United Nations.


*At the United Nations General Assembly in September 2015, 193 countries adopted the 2030 Development Agenda and 17 Sustainable Development Goals (SDGs). Goal 13 aims at 'Taking urgent action to combat climate change and its impacts'.*

# Part 2. How climate change affects the natural world and human beings.
## | 2.10. How climate change affects... social problems

### Discussion

Which population groups are the most vulnerable to climate change? Why?

Give examples where the impacts of climate change can affect men and women in different ways.

# Part 2. How climate change affects the natural world and human beings.
## | Is it possible to adapt to their inevitable consequences?

**Final discussion:**

What aspects of climate changes are most pronounced in your area?


The photos and illustrations used in the module, where sources are not specified, are either taken from the Climate Box toolkit (see the List of illustrations at the end of the textbook) or provided by the program participants.

# THANK YOU FOR YOUR ATTENTION!

With financial support from the Russian Federation

Empowered lives.
Resilient nations.