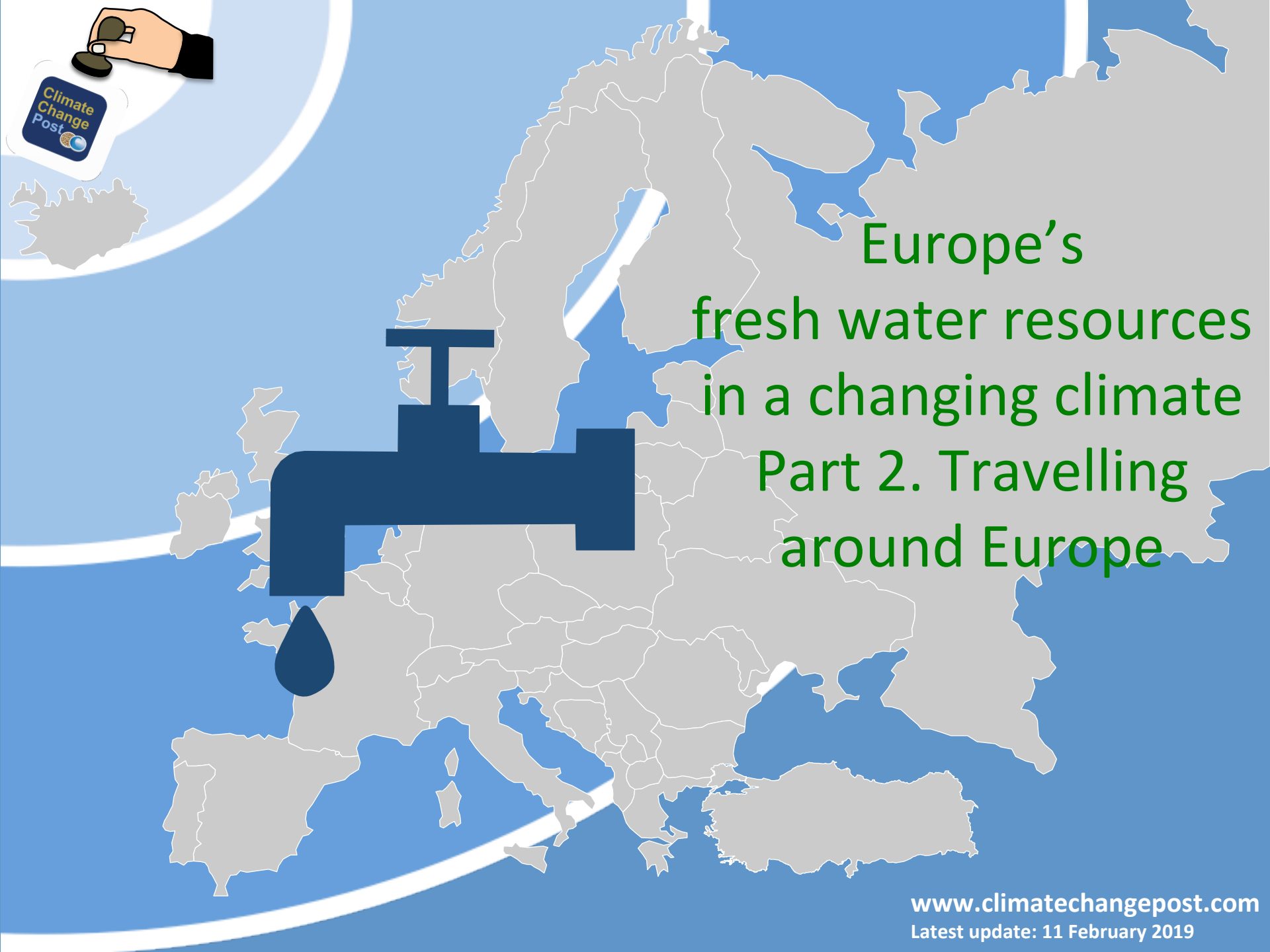

Europe's fresh water resources in a changing climate Part 2. Travelling around Europe

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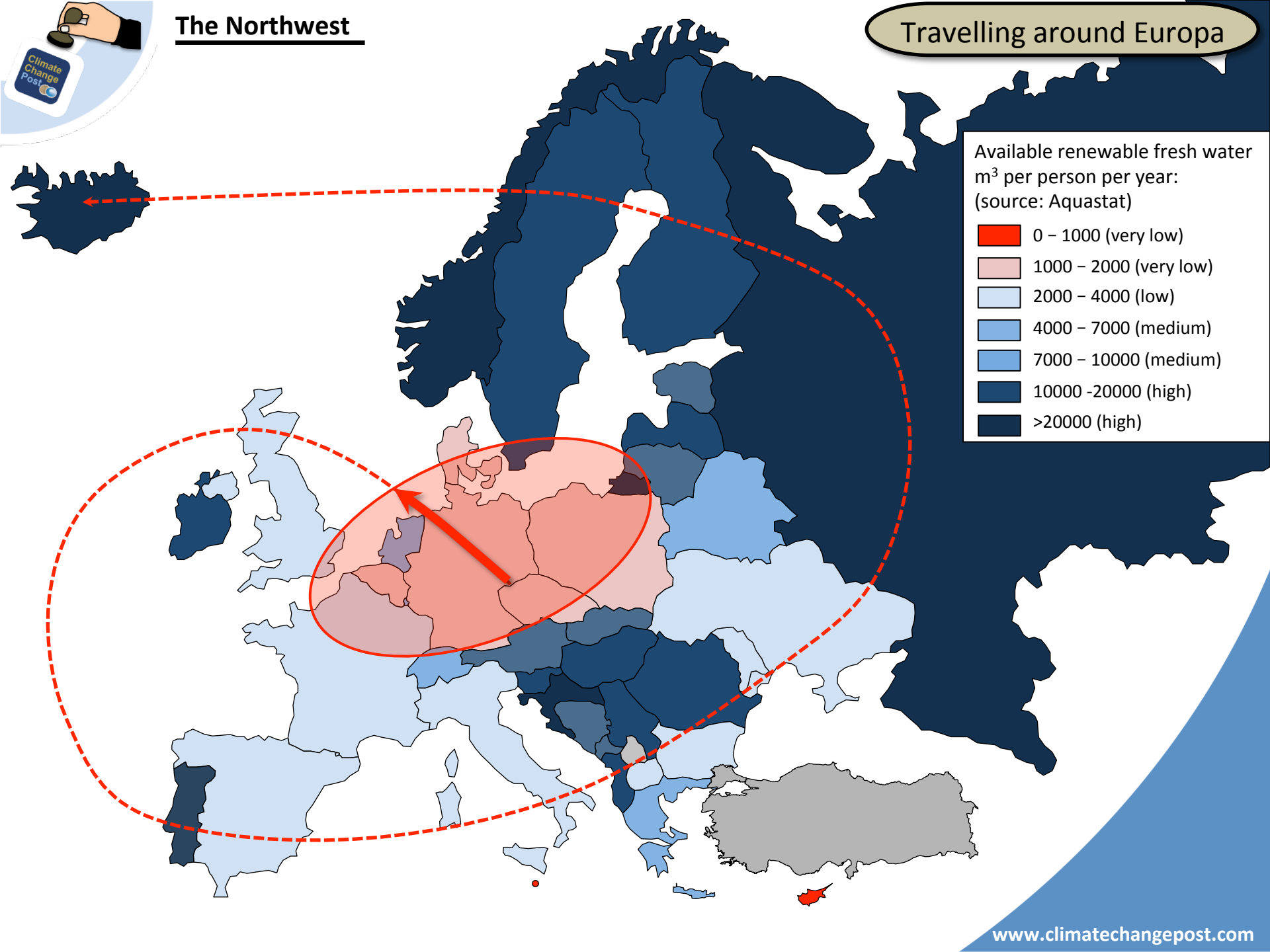
Latest update: 11 February 2019

The Northwest

Travelling around Europa

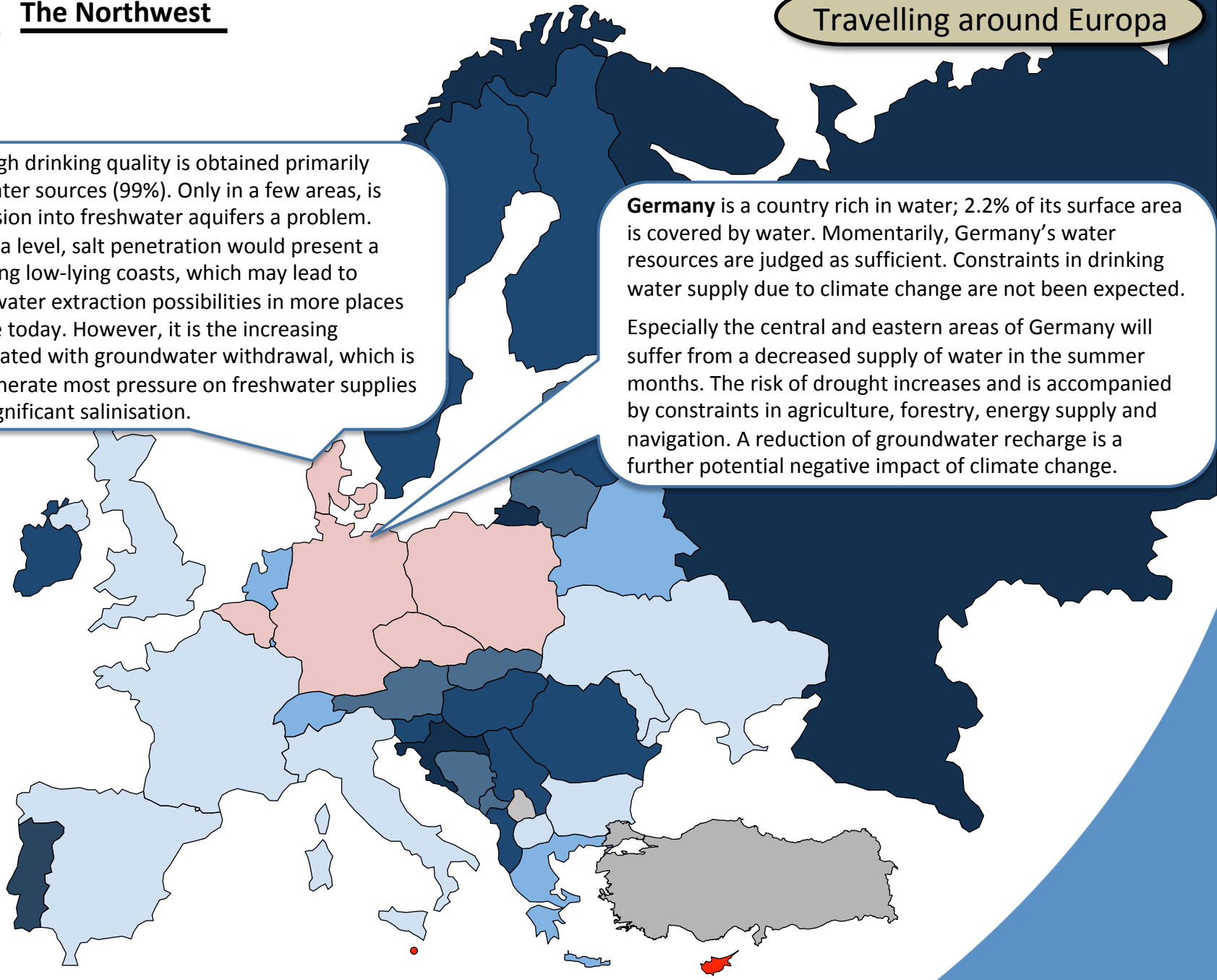


The Northwest

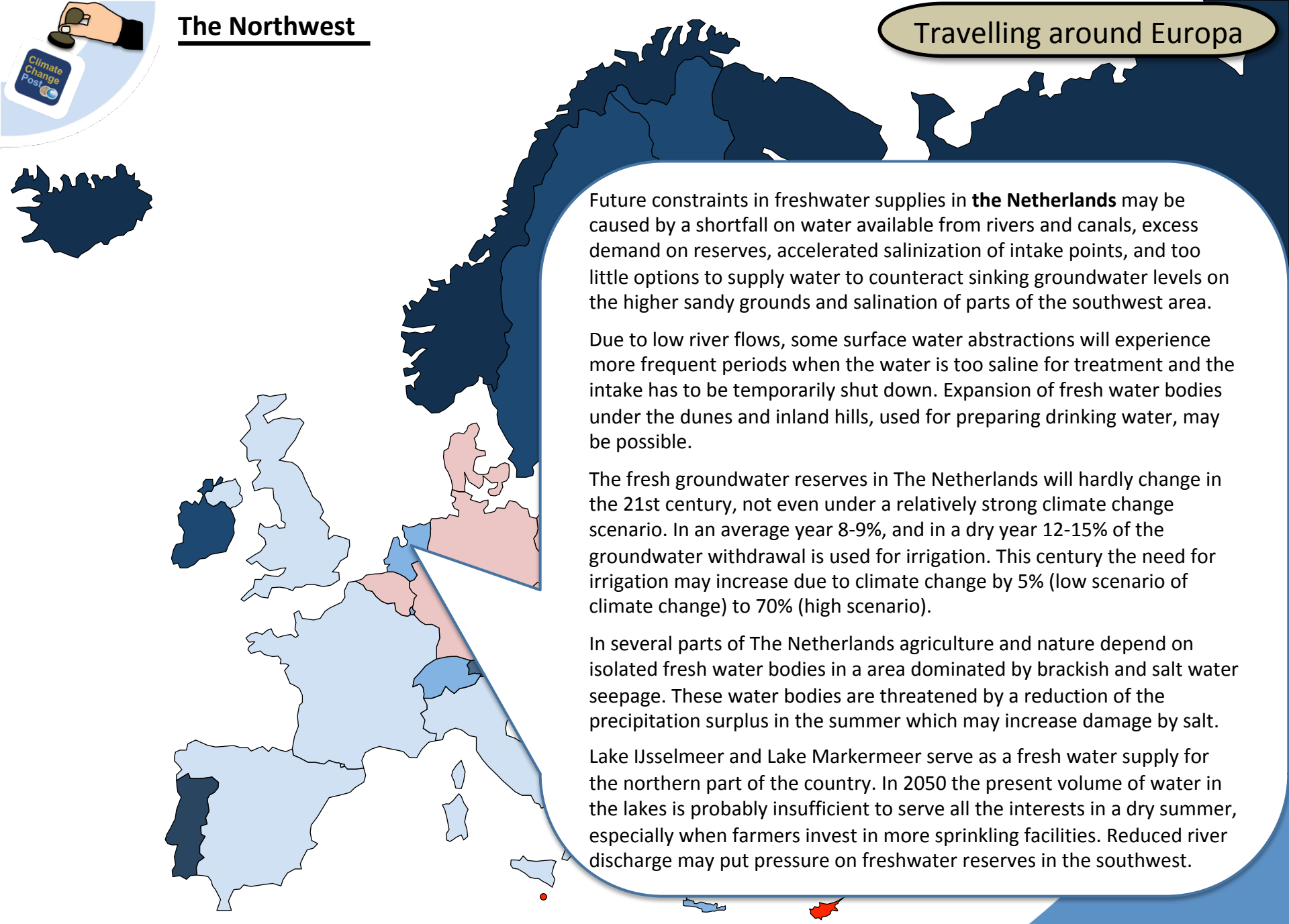
In **Denmark**, high drinking quality is obtained primarily from groundwater sources (99%). Only in a few areas, is seawater intrusion into freshwater aquifers a problem. With a rising sea level, salt penetration would present a greater risk along low-lying coasts, which may lead to limitations on water extraction possibilities in more places than is the case today. However, it is the increasing pressure associated with groundwater withdrawal, which is expected to generate most pressure on freshwater supplies and result in significant salinisation.

Germany is a country rich in water; 2.2% of its surface area is covered by water. Momentarily, Germany's water resources are judged as sufficient. Constraints in drinking water supply due to climate change are not been expected.

Especially the central and eastern areas of Germany will suffer from a decreased supply of water in the summer months. The risk of drought increases and is accompanied by constraints in agriculture, forestry, energy supply and navigation. A reduction of groundwater recharge is a further potential negative impact of climate change.



The Northwest



Future constraints in freshwater supplies in **the Netherlands** may be caused by a shortfall on water available from rivers and canals, excess demand on reserves, accelerated salinization of intake points, and too little options to supply water to counteract sinking groundwater levels on the higher sandy grounds and salination of parts of the southwest area.

Due to low river flows, some surface water abstractions will experience more frequent periods when the water is too saline for treatment and the intake has to be temporarily shut down. Expansion of fresh water bodies under the dunes and inland hills, used for preparing drinking water, may be possible.

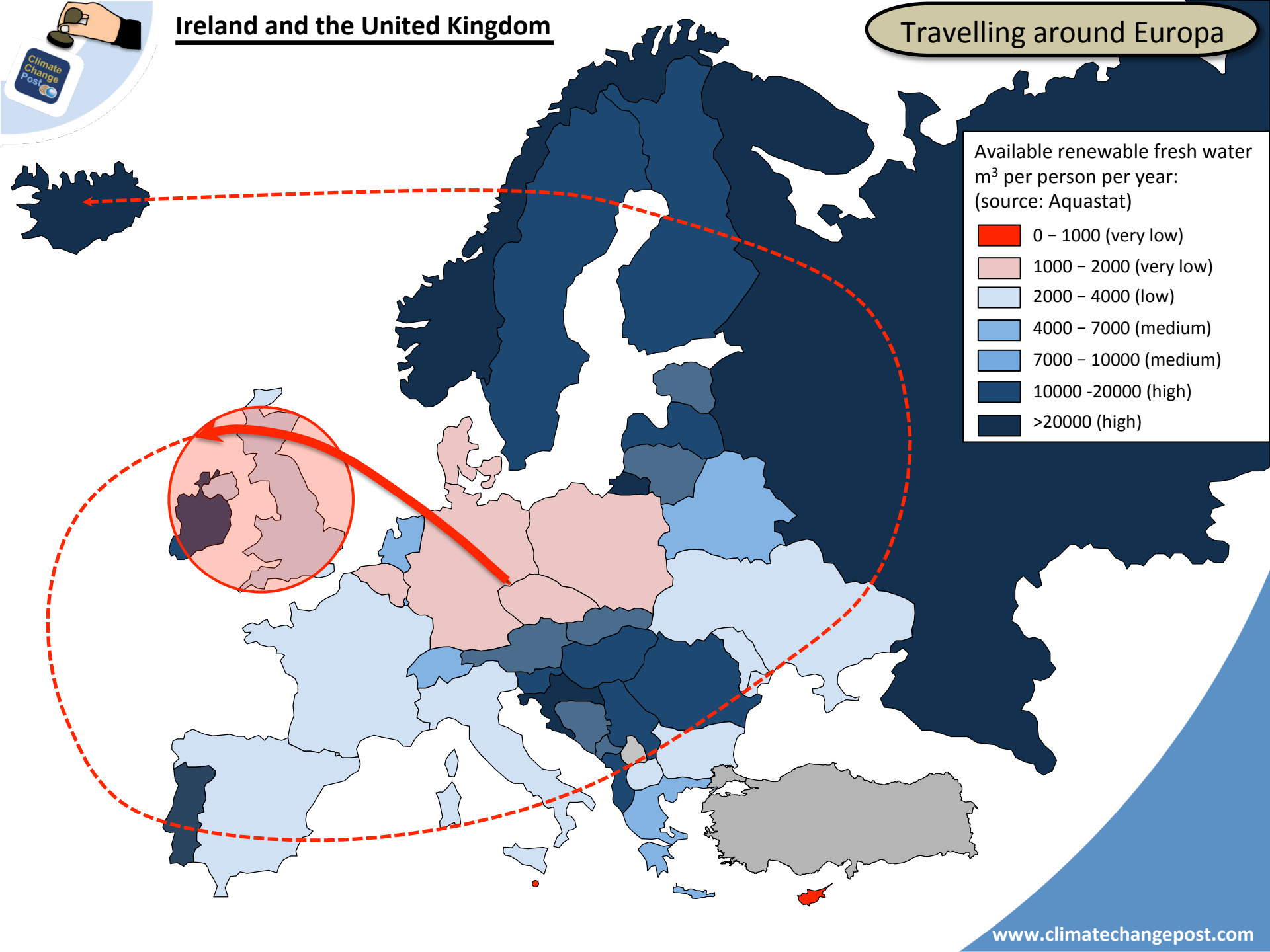
The fresh groundwater reserves in The Netherlands will hardly change in the 21st century, not even under a relatively strong climate change scenario. In an average year 8-9%, and in a dry year 12-15% of the groundwater withdrawal is used for irrigation. This century the need for irrigation may increase due to climate change by 5% (low scenario of climate change) to 70% (high scenario).

In several parts of The Netherlands agriculture and nature depend on isolated fresh water bodies in a area dominated by brackish and salt water seepage. These water bodies are threatened by a reduction of the precipitation surplus in the summer which may increase damage by salt.

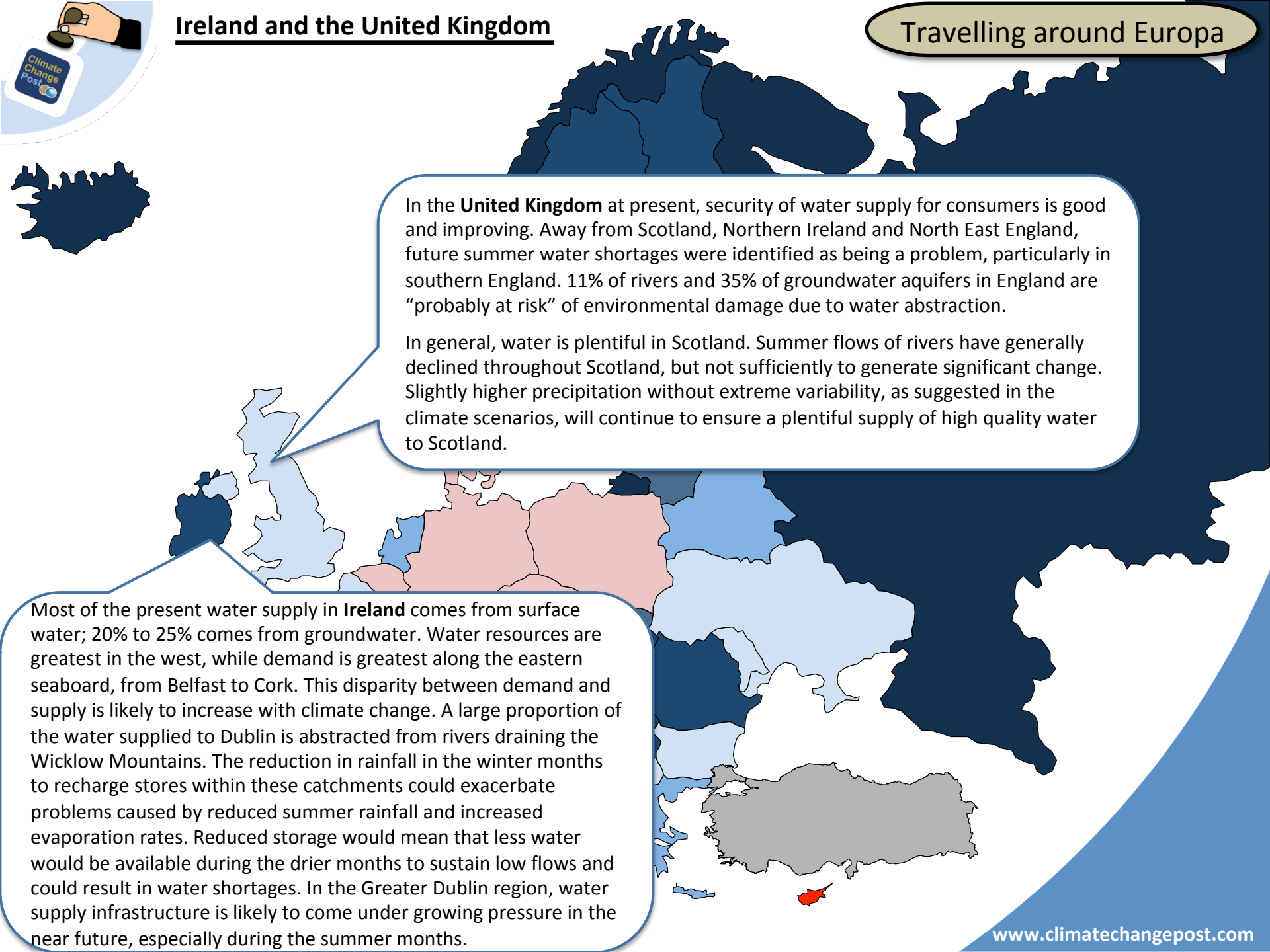
Lake IJsselmeer and Lake Markermeer serve as a fresh water supply for the northern part of the country. In 2050 the present volume of water in the lakes is probably insufficient to serve all the interests in a dry summer, especially when farmers invest in more sprinkling facilities. Reduced river discharge may put pressure on freshwater reserves in the southwest.

Ireland and the United Kingdom

Travelling around Europa



Ireland and the United Kingdom

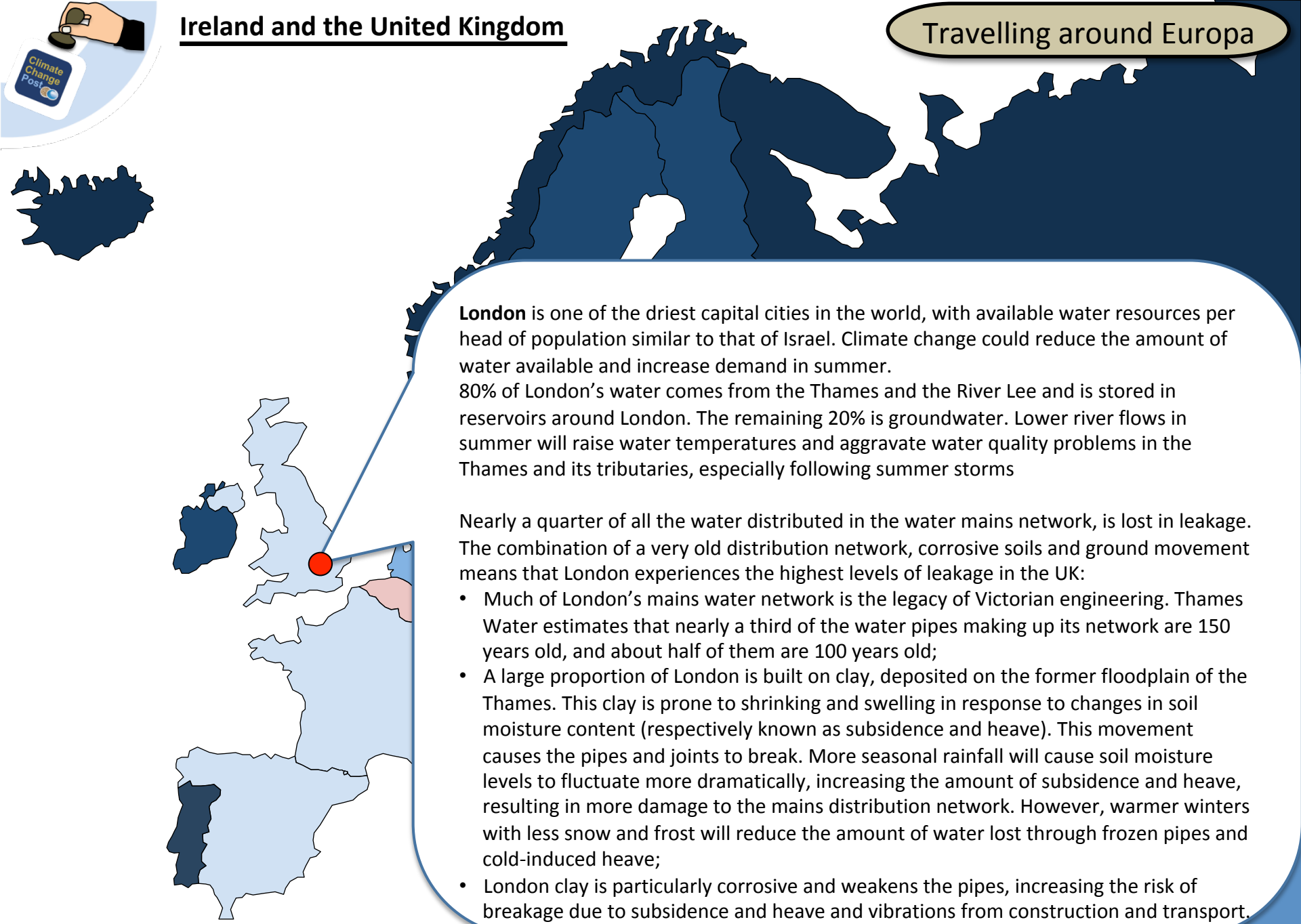


In the **United Kingdom** at present, security of water supply for consumers is good and improving. Away from Scotland, Northern Ireland and North East England, future summer water shortages were identified as being a problem, particularly in southern England. 11% of rivers and 35% of groundwater aquifers in England are "probably at risk" of environmental damage due to water abstraction.

In general, water is plentiful in Scotland. Summer flows of rivers have generally declined throughout Scotland, but not sufficiently to generate significant change. Slightly higher precipitation without extreme variability, as suggested in the climate scenarios, will continue to ensure a plentiful supply of high quality water to Scotland.

Most of the present water supply in **Ireland** comes from surface water; 20% to 25% comes from groundwater. Water resources are greatest in the west, while demand is greatest along the eastern seaboard, from Belfast to Cork. This disparity between demand and supply is likely to increase with climate change. A large proportion of the water supplied to Dublin is abstracted from rivers draining the Wicklow Mountains. The reduction in rainfall in the winter months to recharge stores within these catchments could exacerbate problems caused by reduced summer rainfall and increased evaporation rates. Reduced storage would mean that less water would be available during the drier months to sustain low flows and could result in water shortages. In the Greater Dublin region, water supply infrastructure is likely to come under growing pressure in the near future, especially during the summer months.

Ireland and the United Kingdom



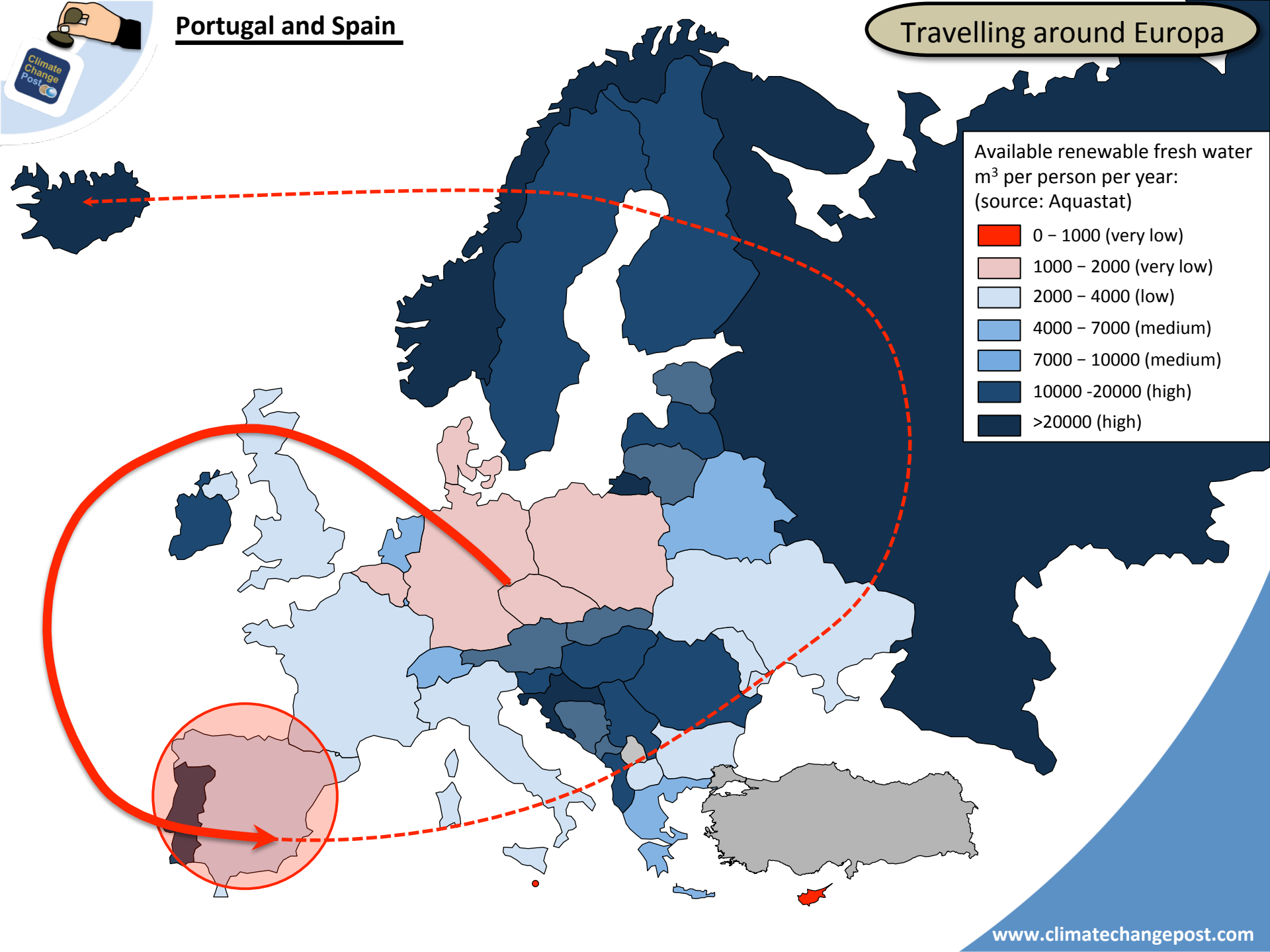
London is one of the driest capital cities in the world, with available water resources per head of population similar to that of Israel. Climate change could reduce the amount of water available and increase demand in summer.
80% of London's water comes from the Thames and the River Lee and is stored in reservoirs around London. The remaining 20% is groundwater. Lower river flows in summer will raise water temperatures and aggravate water quality problems in the Thames and its tributaries, especially following summer storms

Nearly a quarter of all the water distributed in the water mains network, is lost in leakage. The combination of a very old distribution network, corrosive soils and ground movement means that London experiences the highest levels of leakage in the UK:

- Much of London's mains water network is the legacy of Victorian engineering. Thames Water estimates that nearly a third of the water pipes making up its network are 150 years old, and about half of them are 100 years old;
- A large proportion of London is built on clay, deposited on the former floodplain of the Thames. This clay is prone to shrinking and swelling in response to changes in soil moisture content (respectively known as subsidence and heave). This movement causes the pipes and joints to break. More seasonal rainfall will cause soil moisture levels to fluctuate more dramatically, increasing the amount of subsidence and heave, resulting in more damage to the mains distribution network. However, warmer winters with less snow and frost will reduce the amount of water lost through frozen pipes and cold-induced heave;
- London clay is particularly corrosive and weakens the pipes, increasing the risk of breakage due to subsidence and heave and vibrations from construction and transport.

Portugal and Spain

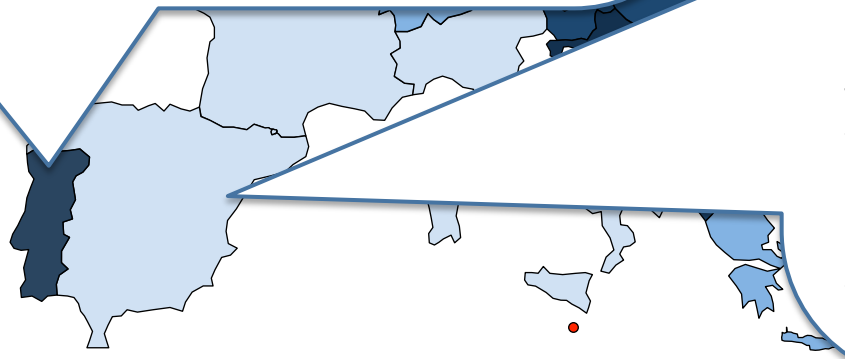
Travelling around Europa



Portugal and Spain

Particularly in the south of **Portugal**, water quality will deteriorate as a result of a rise in temperature and a reduction in river flows in the summer season. Groundwater tables will sink due to the expected reduction in the replenishing rate and the increase of the evaporation. For the Algarve, projections indicate a decrease of groundwater recharge at the end of the century of >25 %. The response of groundwater flow to the projected decreases in recharge and increases in pumping rates will be a strongly reduced outflow into the coastal wetlands. There will also be an increase in saline contamination of coastal aquifers due to saline intrusion as a result of sea level rise. However, intensive pumping near the coast in combination with a decrease of groundwater recharge is a more important trigger of seawater intrusion than sea level rise itself.

In the long term, water availability in the Algarve region is projected to decrease substantially and, together with increasing water demands, may seriously affect the wellbeing of humans and ecosystems that depend on groundwater for their subsistence.

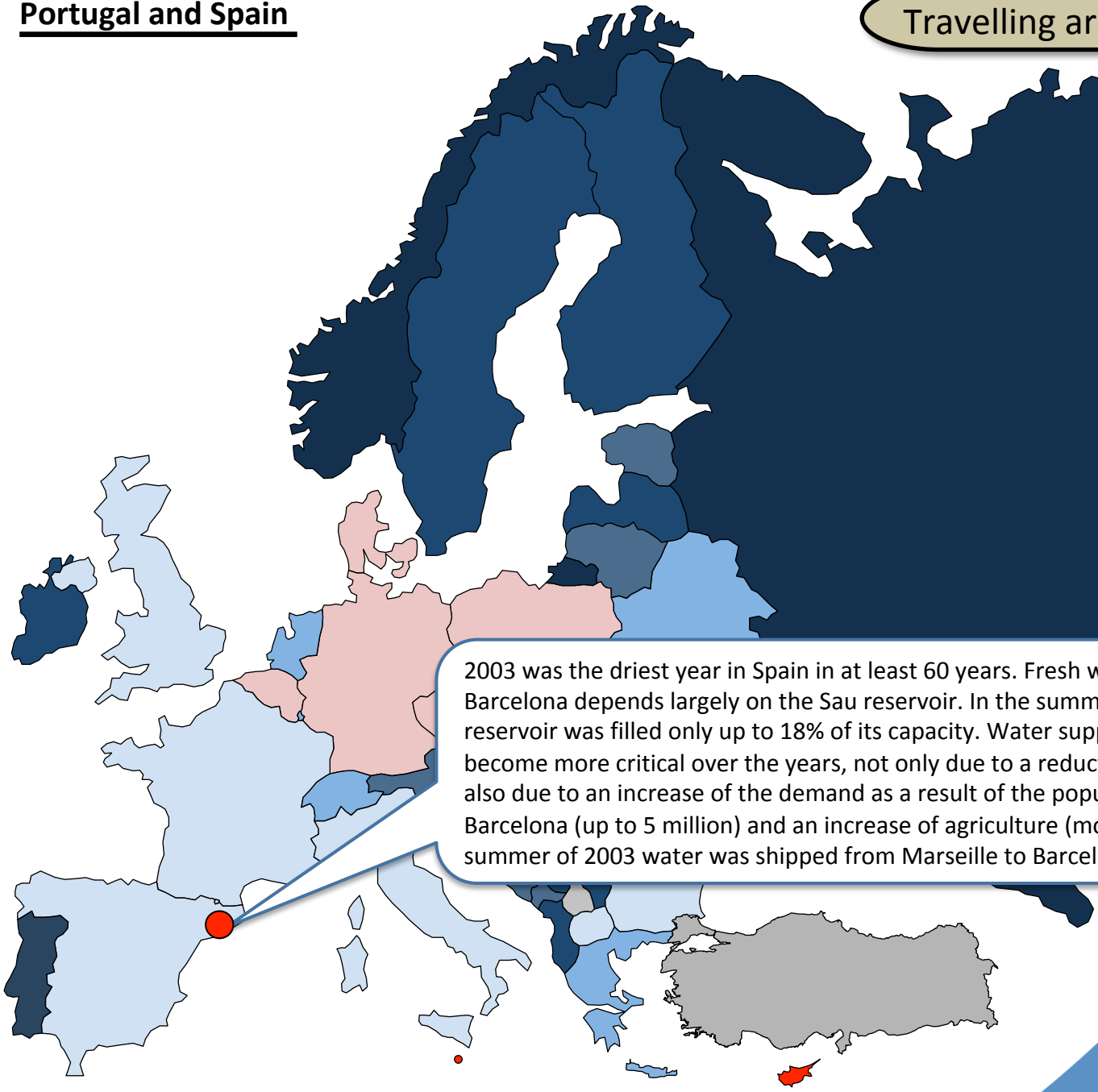


In large parts of **Spain** groundwater levels have dropped tens of metres over recent decades, and the average groundwater recharge is projected to decrease, for instance by 17% for the southeast of Spain by 2100. Water availability may be significantly lower in the future throughout the year, but most notably during a 3-month longer, extended hotter and drier summer season. By 2100, annual groundwater recharge may be reduced by 50%, and annually averaged catchment runoff may be reduced by 60% in central Spain.

The Pyrenees have lost almost 90% of their glacier ice in the previous century and the rest may disappear within a few decades. The loss of these glaciers will have a severe impact on summer water supplies in the foothills and southern plains south of the Pyrenees. There may be dramatic effects to agriculture as glaciers that feed rivers disappear, taking away a major source of summer water. The major river basins (the largest of which are the Ebro, the Garonne and the Adour), situated downstream of the region, are supplied from the Pyrenees water resources. Reductions of up to 40 % of the flow of the Garonne river, 0-35 % of the flows of the Catalan rivers and 20 % of the flow of the Ebro river in the summer season have been projected for 2060.

Portugal and Spain

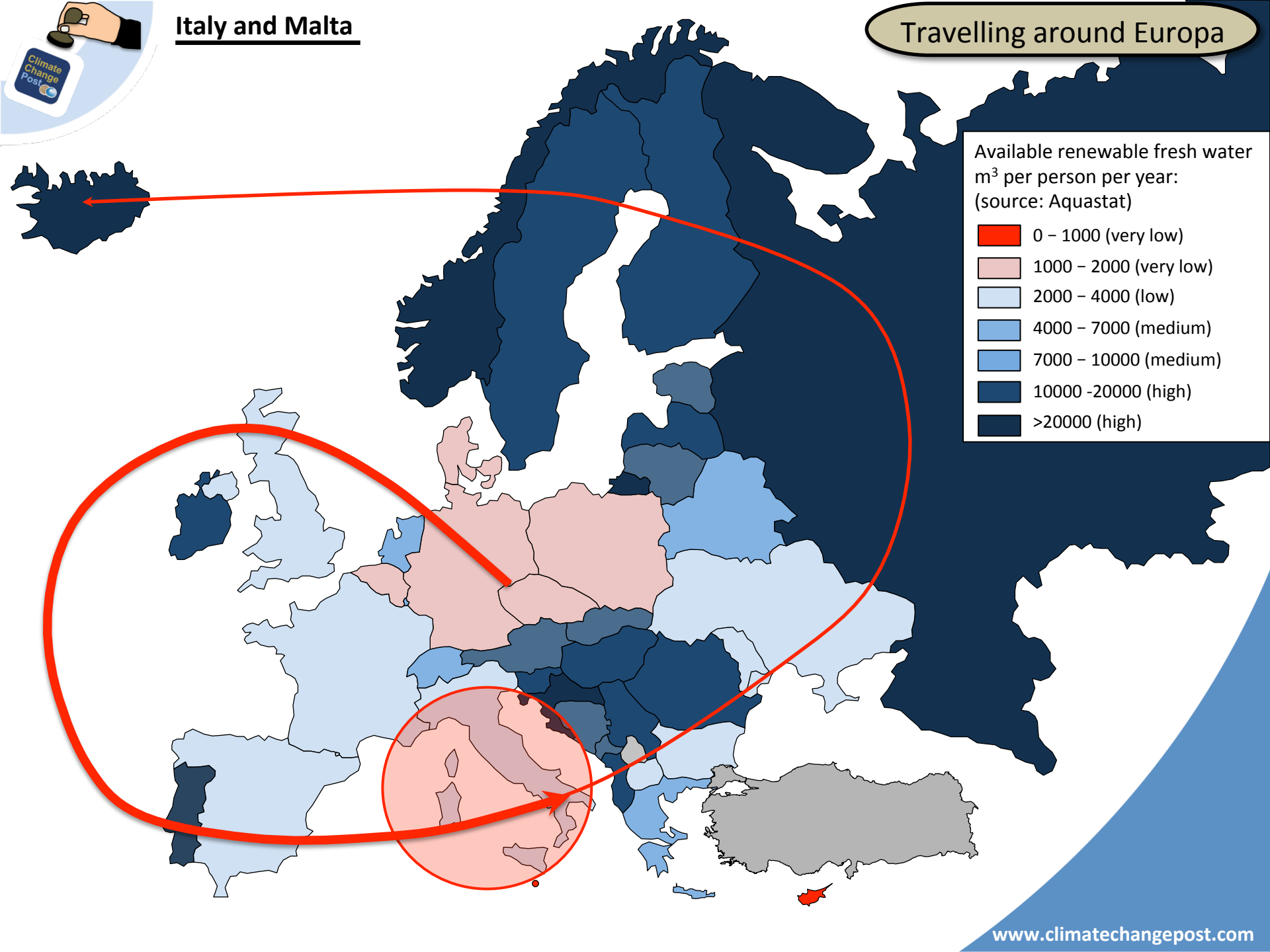
Travelling around Europa



2003 was the driest year in Spain in at least 60 years. Fresh water supply of Barcelona depends largely on the Sau reservoir. In the summer of 2003 this reservoir was filled only up to 18% of its capacity. Water supply in this area has become more critical over the years, not only due to a reduction of rainfall, but also due to an increase of the demand as a result of the population growth of Barcelona (up to 5 million) and an increase of agriculture (more irrigation). In the summer of 2003 water was shipped from Marseille to Barcelona.

Italy and Malta

Travelling around Europa

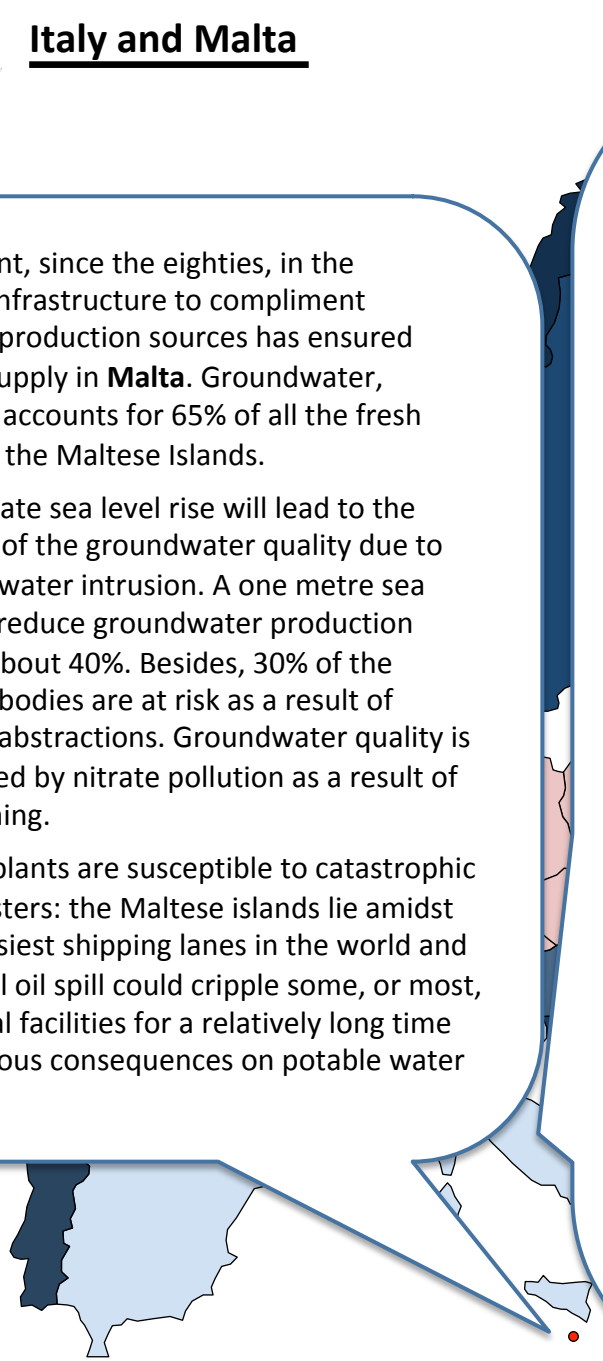


Italy and Malta

The investment, since the eighties, in the desalination infrastructure to compliment groundwater production sources has ensured reliability of supply in **Malta**. Groundwater, however, still accounts for 65% of all the fresh water used in the Maltese Islands.

Even a moderate sea level rise will lead to the deterioration of the groundwater quality due to increased seawater intrusion. A one metre sea level rise will reduce groundwater production potential by about 40%. Besides, 30% of the groundwater bodies are at risk as a result of groundwater abstractions. Groundwater quality is also threatened by nitrate pollution as a result of livestock farming.

Desalination plants are susceptible to catastrophic offshore disasters: the Maltese islands lie amidst one of the busiest shipping lanes in the world and any accidental oil spill could cripple some, or most, of the national facilities for a relatively long time with very serious consequences on potable water production.



72% of the fresh water supply in **Italy** is derived from springs, rivers, and lakes, and 28% from groundwater reserves. Almost 53% of the utilizable surface resources are localized in northern Italy, 19% in central Italy, 21% in southern Italy, and 7% in the two largest islands. About 70% of the groundwater reserves are in the large flood plains of northern Italy. Usable groundwater in southern Italy is confined to short stretches of coastal plains and a few inner areas.

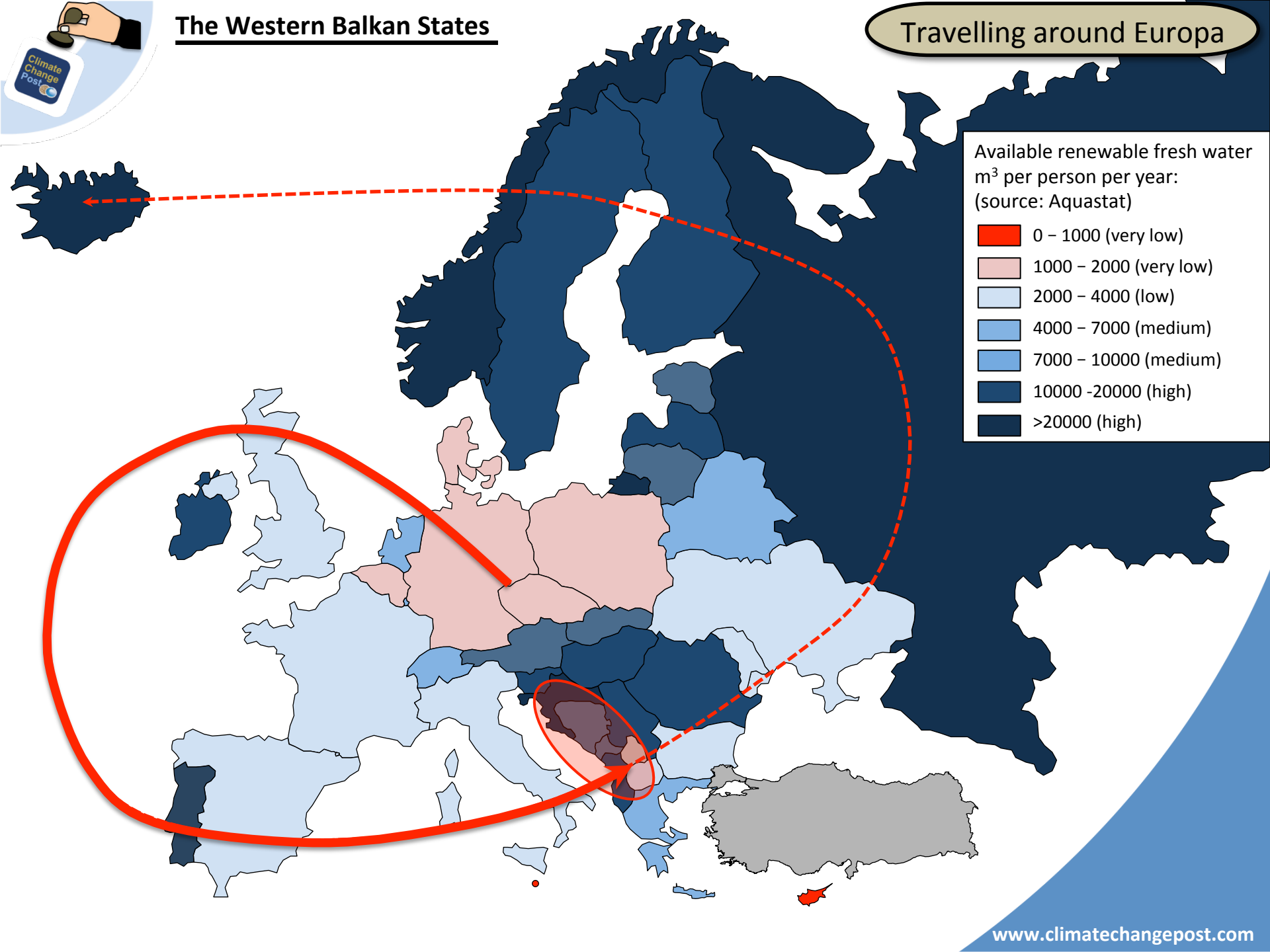
In many parts of Italy, particularly in the south, it has become ever more difficult to meet demand for water. The recent years of drought and the constant increase of water demand for the civil sector have made irrigation supply more problematic. The economic damage to agriculture, particularly in the Po valley with its extensive irrigation, may become considerable.

In particular, with reference to water stress, Italy might experience:

- water stress increase by 25% in the present century, with a growing demand for irrigation water;
- socio-economic emergency concerning safe water supply in several regions, such as Puglia, Basilicata, Sicilia and Sardegna, primarily because of increasing water demand and lack of management practices, aggravated by further decreases in mean precipitation;
- reduced availability of water resources affecting drinking water supply, water supply for irrigation and for hydropower generation in the Po river valley;
- increased soil dryness and increased frequency of droughts in the areas of plains;
- water quality depletion;
- increased seasonal water deficit due to significant pressures of summer tourism peaks on already scarce water resources, especially in small Mediterranean islands;
- intensification of conflicts among multiple uses of water resources;
- navigation of lakes and rivers impaired by a reduction of precipitation and water levels.

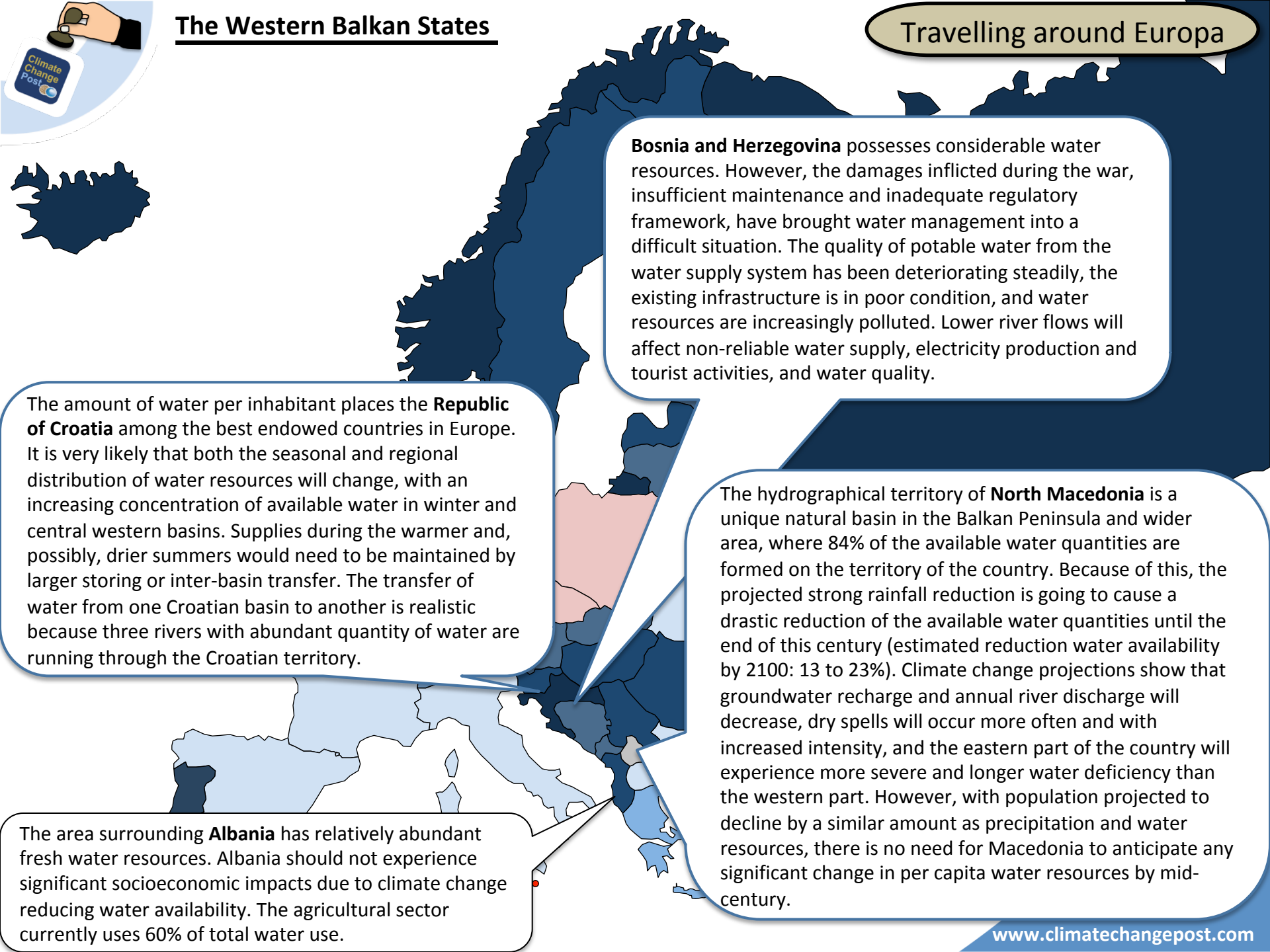
The Western Balkan States

Travelling around Europa



The Western Balkan States

Travelling around Europa



Bosnia and Herzegovina possesses considerable water resources. However, the damages inflicted during the war, insufficient maintenance and inadequate regulatory framework, have brought water management into a difficult situation. The quality of potable water from the water supply system has been deteriorating steadily, the existing infrastructure is in poor condition, and water resources are increasingly polluted. Lower river flows will affect non-reliable water supply, electricity production and tourist activities, and water quality.

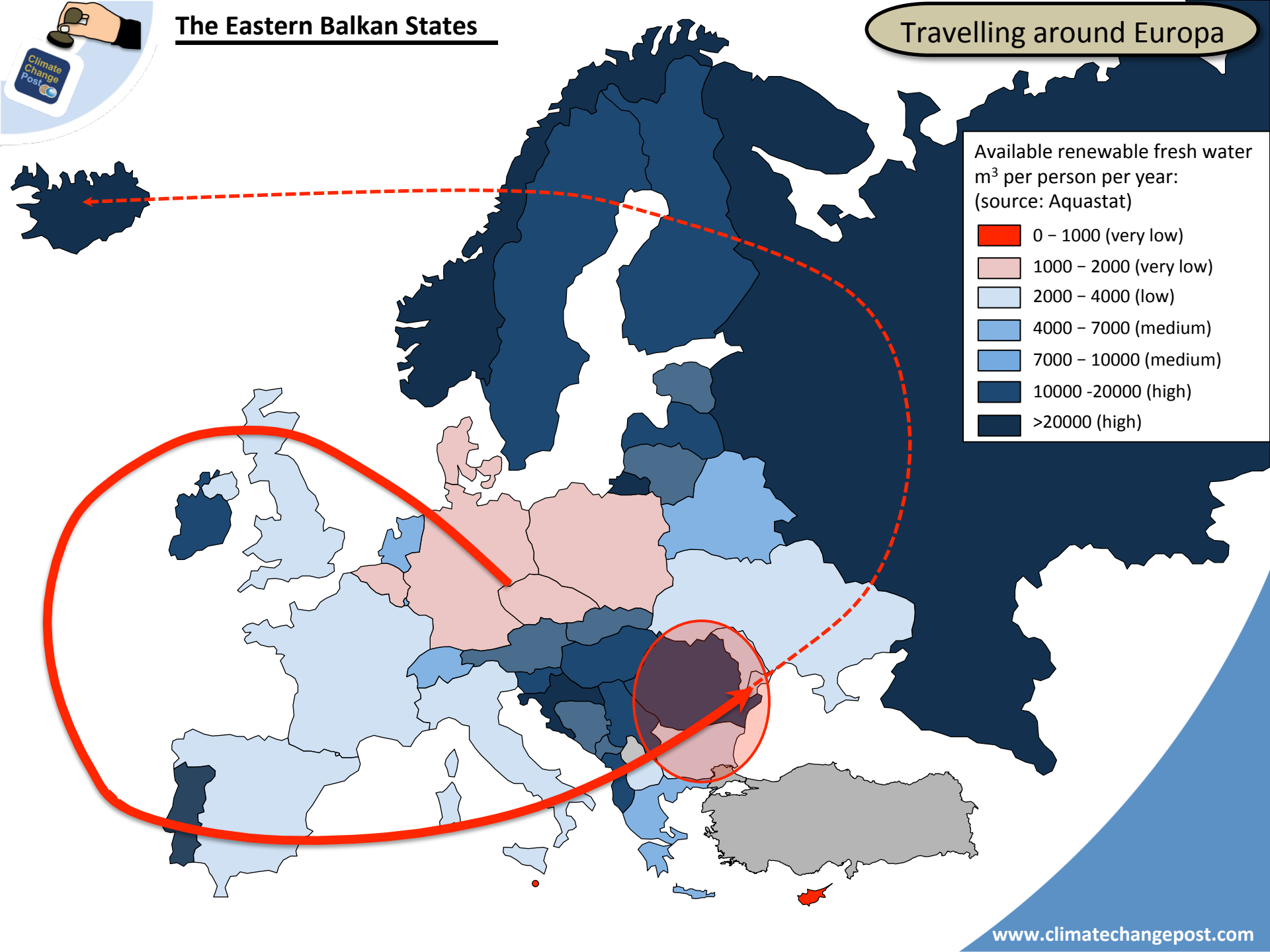
The amount of water per inhabitant places the **Republic of Croatia** among the best endowed countries in Europe. It is very likely that both the seasonal and regional distribution of water resources will change, with an increasing concentration of available water in winter and central western basins. Supplies during the warmer and, possibly, drier summers would need to be maintained by larger storing or inter-basin transfer. The transfer of water from one Croatian basin to another is realistic because three rivers with abundant quantity of water are running through the Croatian territory.

The hydrographical territory of **North Macedonia** is a unique natural basin in the Balkan Peninsula and wider area, where 84% of the available water quantities are formed on the territory of the country. Because of this, the projected strong rainfall reduction is going to cause a drastic reduction of the available water quantities until the end of this century (estimated reduction water availability by 2100: 13 to 23%). Climate change projections show that groundwater recharge and annual river discharge will decrease, dry spells will occur more often and with increased intensity, and the eastern part of the country will experience more severe and longer water deficiency than the western part. However, with population projected to decline by a similar amount as precipitation and water resources, there is no need for Macedonia to anticipate any significant change in per capita water resources by mid-century.

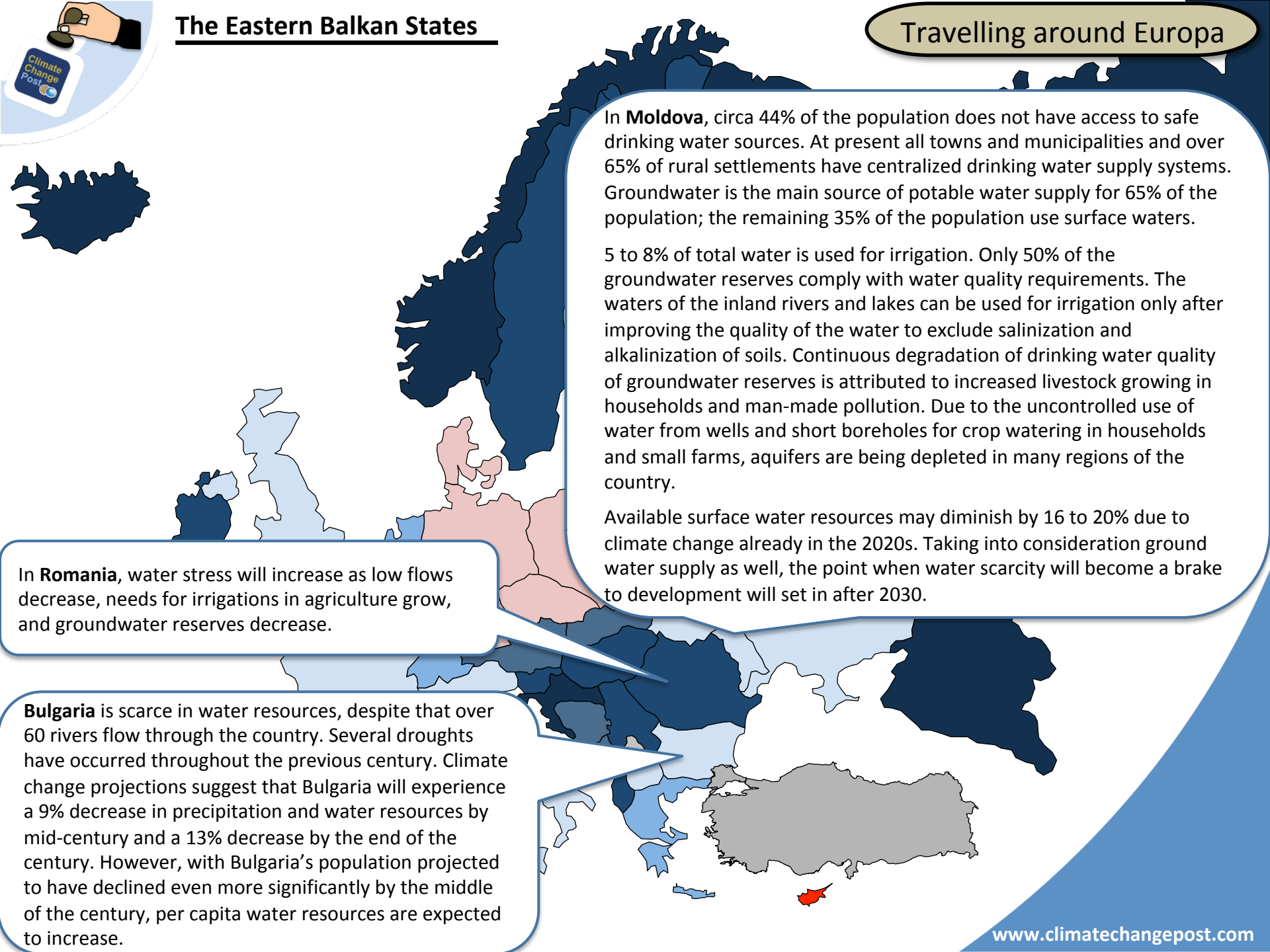
The area surrounding **Albania** has relatively abundant fresh water resources. Albania should not experience significant socioeconomic impacts due to climate change reducing water availability. The agricultural sector currently uses 60% of total water use.

The Eastern Balkan States

Travelling around Europa



The Eastern Balkan States



In **Moldova**, circa 44% of the population does not have access to safe drinking water sources. At present all towns and municipalities and over 65% of rural settlements have centralized drinking water supply systems. Groundwater is the main source of potable water supply for 65% of the population; the remaining 35% of the population use surface waters.

5 to 8% of total water is used for irrigation. Only 50% of the groundwater reserves comply with water quality requirements. The waters of the inland rivers and lakes can be used for irrigation only after improving the quality of the water to exclude salinization and alkalinization of soils. Continuous degradation of drinking water quality of groundwater reserves is attributed to increased livestock growing in households and man-made pollution. Due to the uncontrolled use of water from wells and short boreholes for crop watering in households and small farms, aquifers are being depleted in many regions of the country.

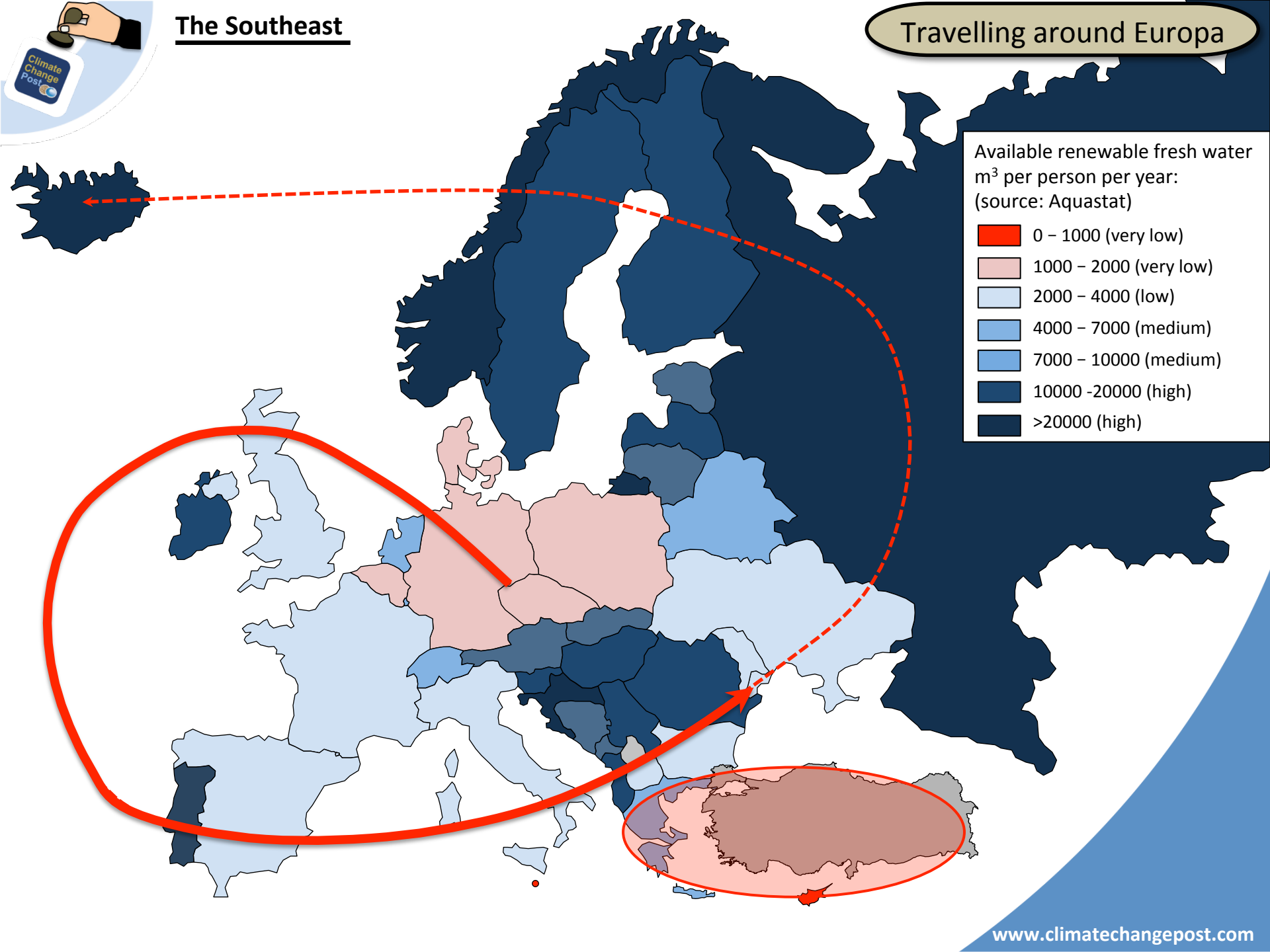
Available surface water resources may diminish by 16 to 20% due to climate change already in the 2020s. Taking into consideration ground water supply as well, the point when water scarcity will become a brake to development will set in after 2030.

In **Romania**, water stress will increase as low flows decrease, needs for irrigations in agriculture grow, and groundwater reserves decrease.

Bulgaria is scarce in water resources, despite that over 60 rivers flow through the country. Several droughts have occurred throughout the previous century. Climate change projections suggest that Bulgaria will experience a 9% decrease in precipitation and water resources by mid-century and a 13% decrease by the end of the century. However, with Bulgaria's population projected to have declined even more significantly by the middle of the century, per capita water resources are expected to increase.

The Southeast

Travelling around Europa



The Southeast

Cyprus is severely over-stressing groundwater resources since it is exploiting groundwater beyond what has been set as the ecological limit. Cyprus progressively relies on desalination for covering drinking water needs.

Tourists use a lot of fresh water with swimming pools, water parks and golf courses. Moreover, most tourists visit the region during the summer months when water resources are already subject to considerable stress.

Due to projected precipitation decrease and population growth, per capita water resources by mid-century are expected to be only slightly in excess of half their current levels. Such a change will severely impact upon both Cyprus' agricultural sector and also its urban water supply systems. Agriculture will have to rely increasingly on treated wastewater, while desalination is expected to supply an increasing proportion of the urban water supply.

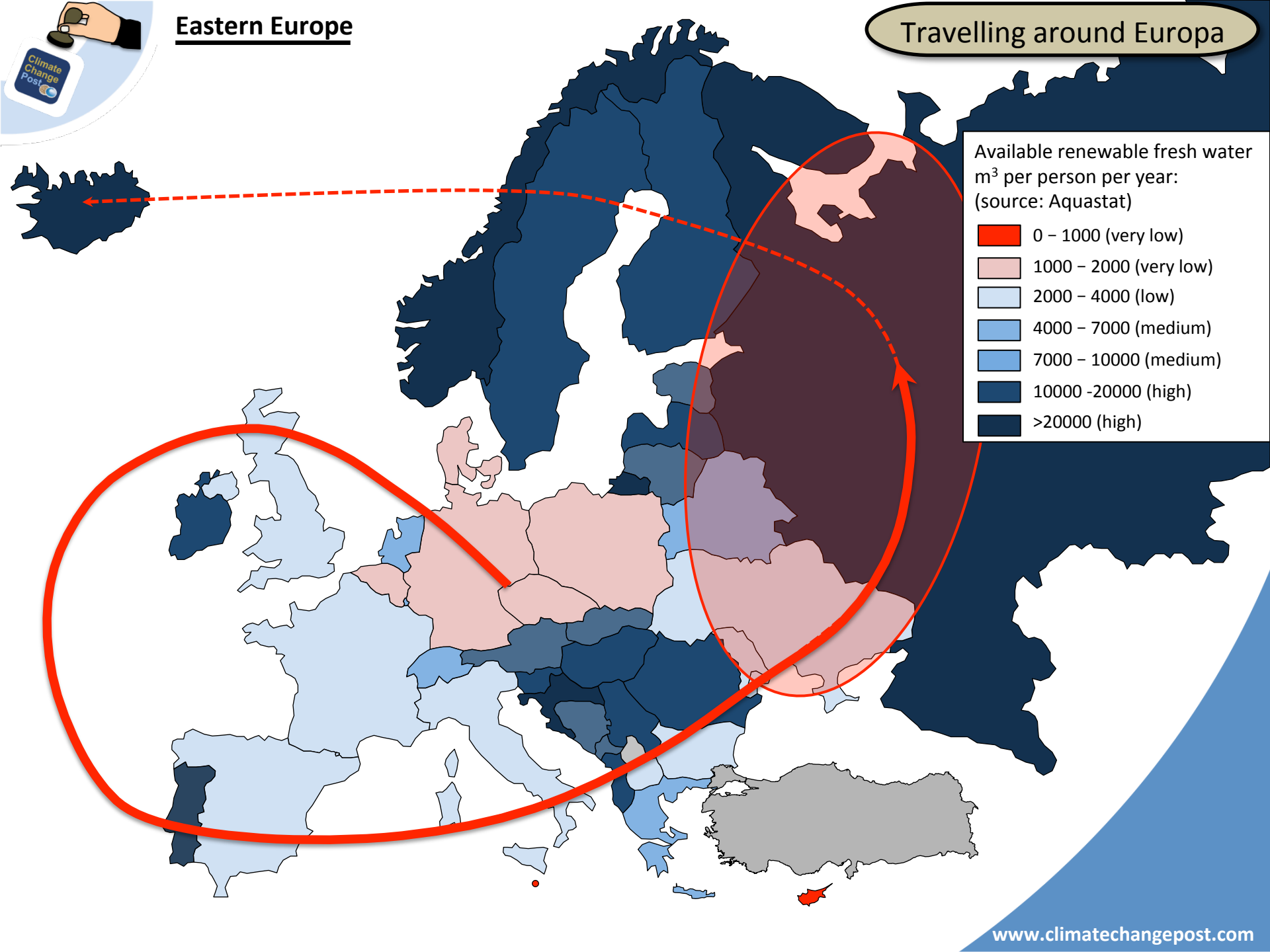
Turkey is one of the most water rich countries of the Mediterranean, but due to an enormous population increase the availability of water resources has strongly decreased. Water demand in Turkey approximately has doubled in the second half of the last century. The overall water demand in Turkey continues to increase, even more in the light of the effects of drought (or climate change). Turkey will suffer from water scarcity in the future.

73.2% of the total water supply of Turkey is used for agricultural irrigation. While water resources as a whole for the country remain relatively plentiful, Turkey is still facing having its per capita water resources decrease by nearly one third by mid-century. Turkey's agricultural sector will therefore be forced to become more water efficient.

According to climate change projections, **Greece** is expected to have an 18% precipitation decrease by mid-century, and 22% by the end of the century. The projected change in internal water resources is assumed to be the same as the projected change in precipitation. With modest population decline expected, Greece's per capita water resources are expected to decline somewhat by mid-century but still remain high compared to the majority of surrounding countries. Thus, climate change is likely to necessitate modest changes to Greece's water resources management. A strong increase of water deficits is projected for Crete.

Eastern Europe

Travelling around Europa



Eastern Europe

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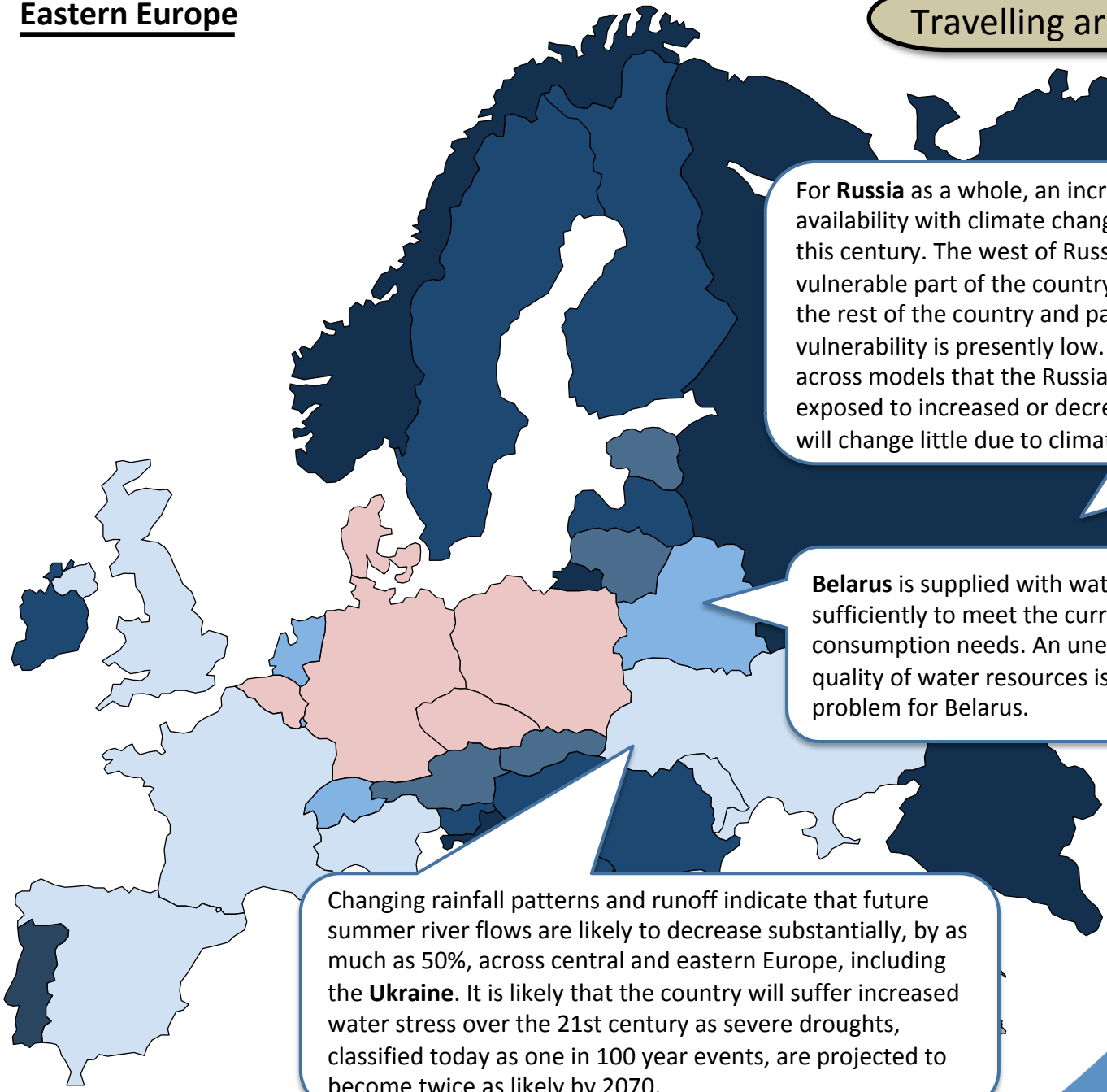


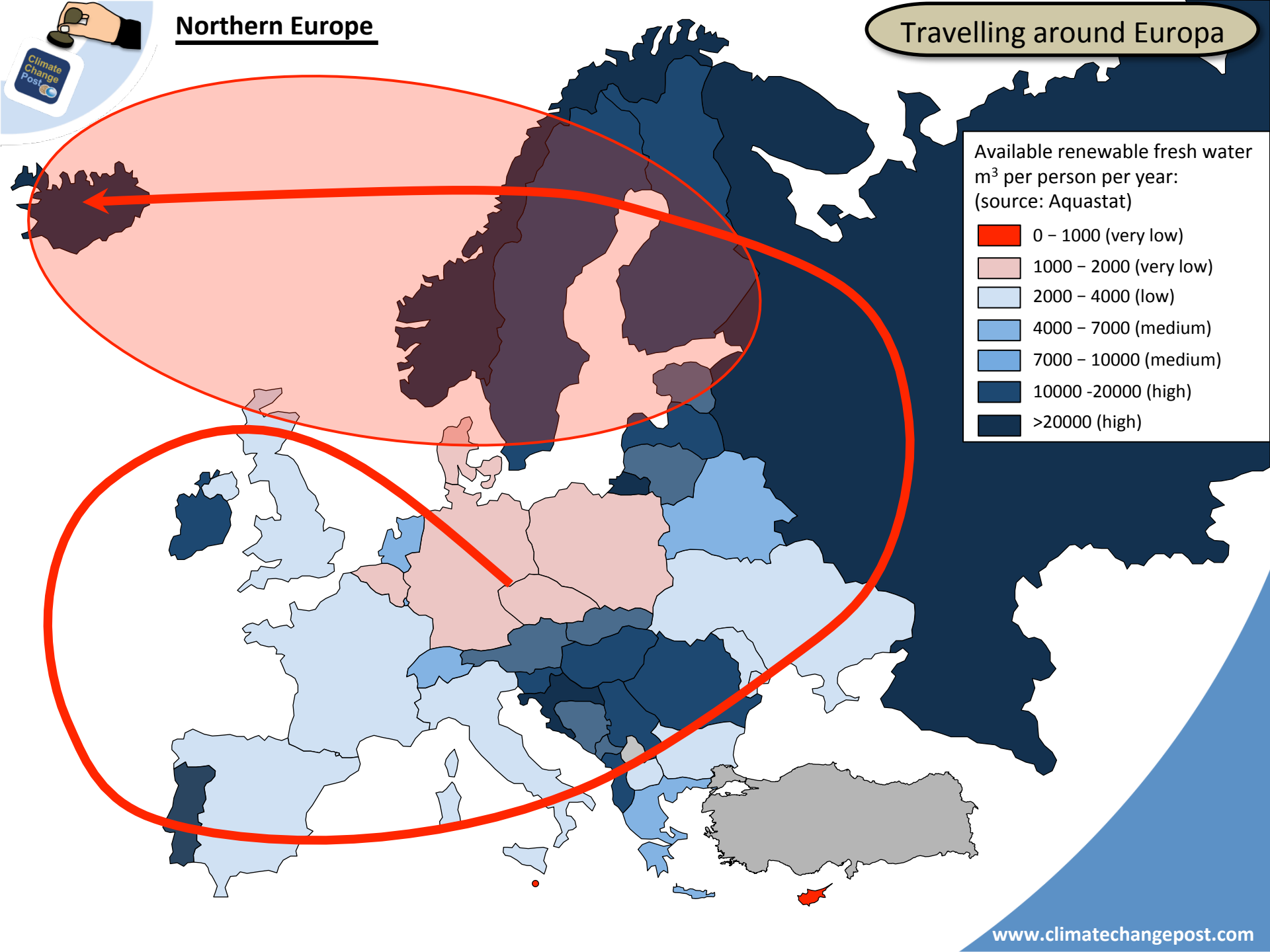
For **Russia** as a whole, an increase in water availability with climate change is projected for this century. The west of Russia is the most vulnerable part of the country to water stress. For the rest of the country and particularly the east, vulnerability is presently low. There is consensus across models that the Russian population exposed to increased or decreased water stress will change little due to climate change.

Belarus is supplied with water resources sufficiently to meet the current and future consumption needs. An uneven distribution and quality of water resources is the most essential problem for Belarus.

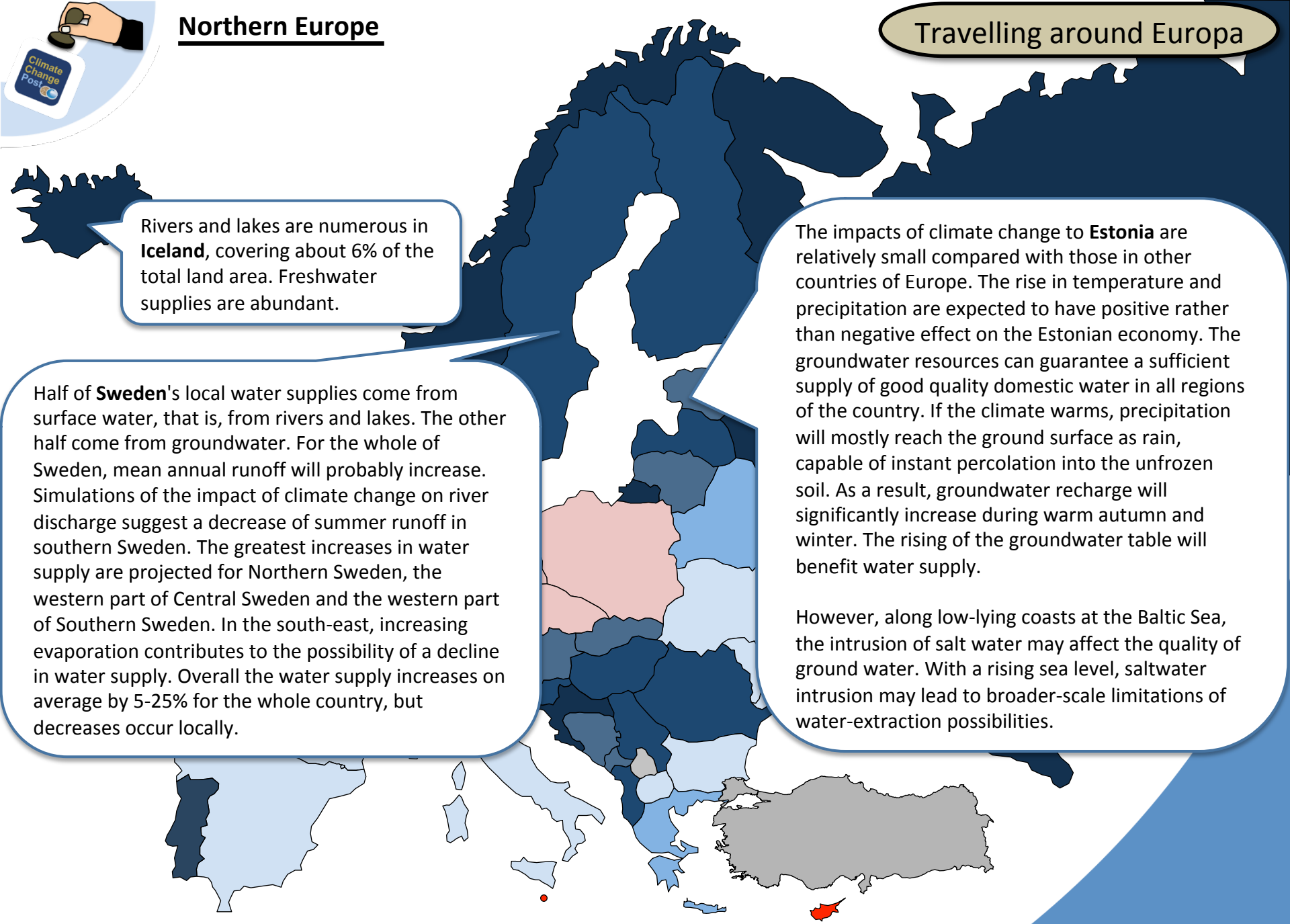
Changing rainfall patterns and runoff indicate that future summer river flows are likely to decrease substantially, by as much as 50%, across central and eastern Europe, including the **Ukraine**. It is likely that the country will suffer increased water stress over the 21st century as severe droughts, classified today as one in 100 year events, are projected to become twice as likely by 2070.

Northern Europe

Travelling around Europa



Northern Europe



Rivers and lakes are numerous in **Iceland**, covering about 6% of the total land area. Freshwater supplies are abundant.

Half of **Sweden**'s local water supplies come from surface water, that is, from rivers and lakes. The other half come from groundwater. For the whole of Sweden, mean annual runoff will probably increase. Simulations of the impact of climate change on river discharge suggest a decrease of summer runoff in southern Sweden. The greatest increases in water supply are projected for Northern Sweden, the western part of Central Sweden and the western part of Southern Sweden. In the south-east, increasing evaporation contributes to the possibility of a decline in water supply. Overall the water supply increases on average by 5-25% for the whole country, but decreases occur locally.

The impacts of climate change to **Estonia** are relatively small compared with those in other countries of Europe. The rise in temperature and precipitation are expected to have positive rather than negative effect on the Estonian economy. The groundwater resources can guarantee a sufficient supply of good quality domestic water in all regions of the country. If the climate warms, precipitation will mostly reach the ground surface as rain, capable of instant percolation into the unfrozen soil. As a result, groundwater recharge will significantly increase during warm autumn and winter. The rising of the groundwater table will benefit water supply.

However, along low-lying coasts at the Baltic Sea, the intrusion of salt water may affect the quality of ground water. With a rising sea level, saltwater intrusion may lead to broader-scale limitations of water-extraction possibilities.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