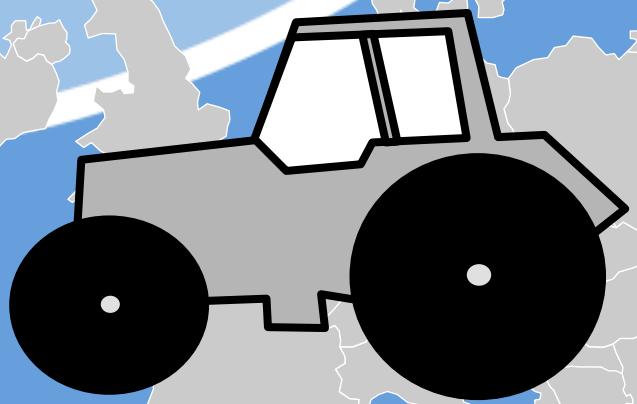
Europe's agriculture in a changing climate

Part 3: Travelling around Europe in 31 sheets



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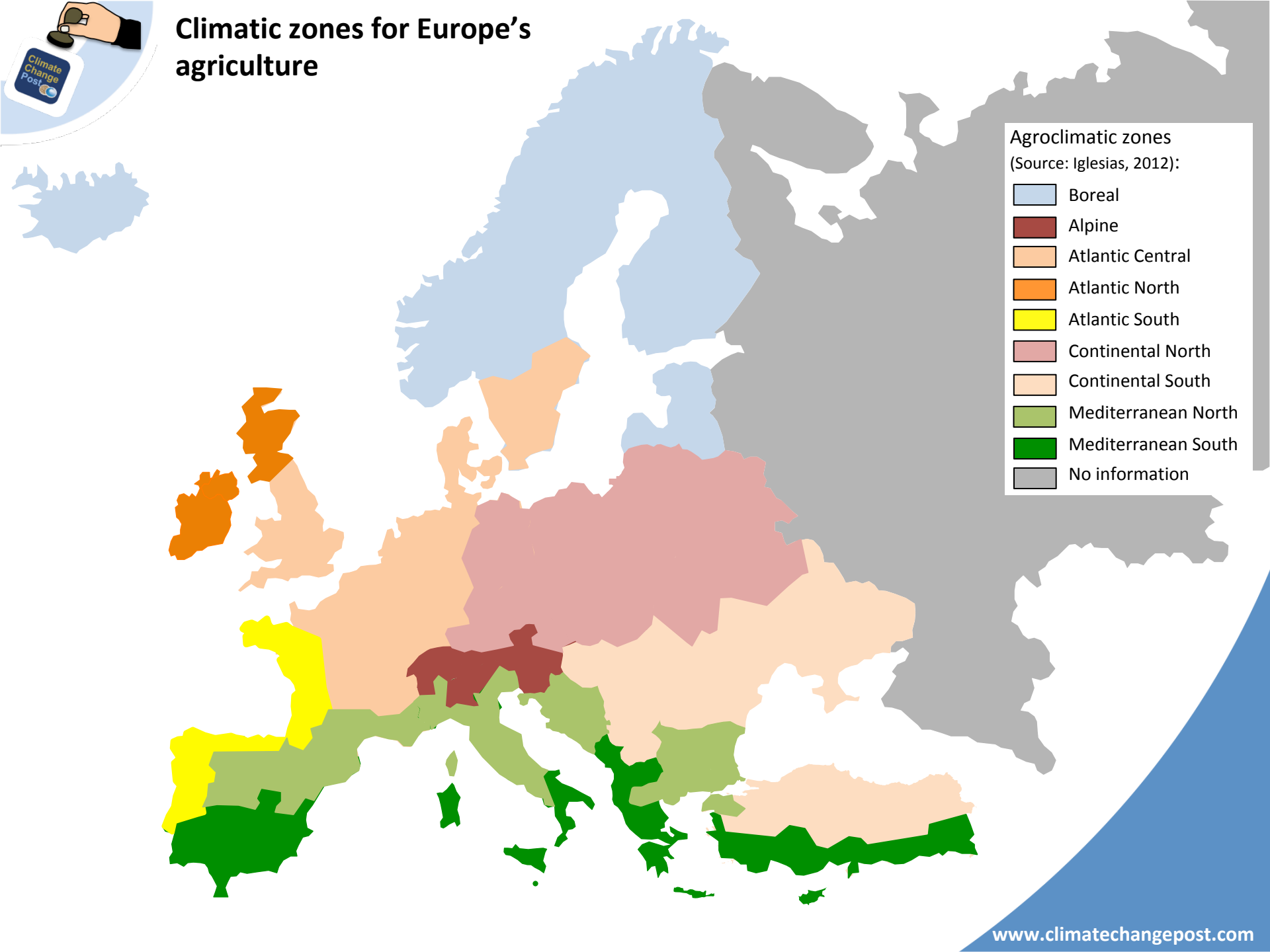
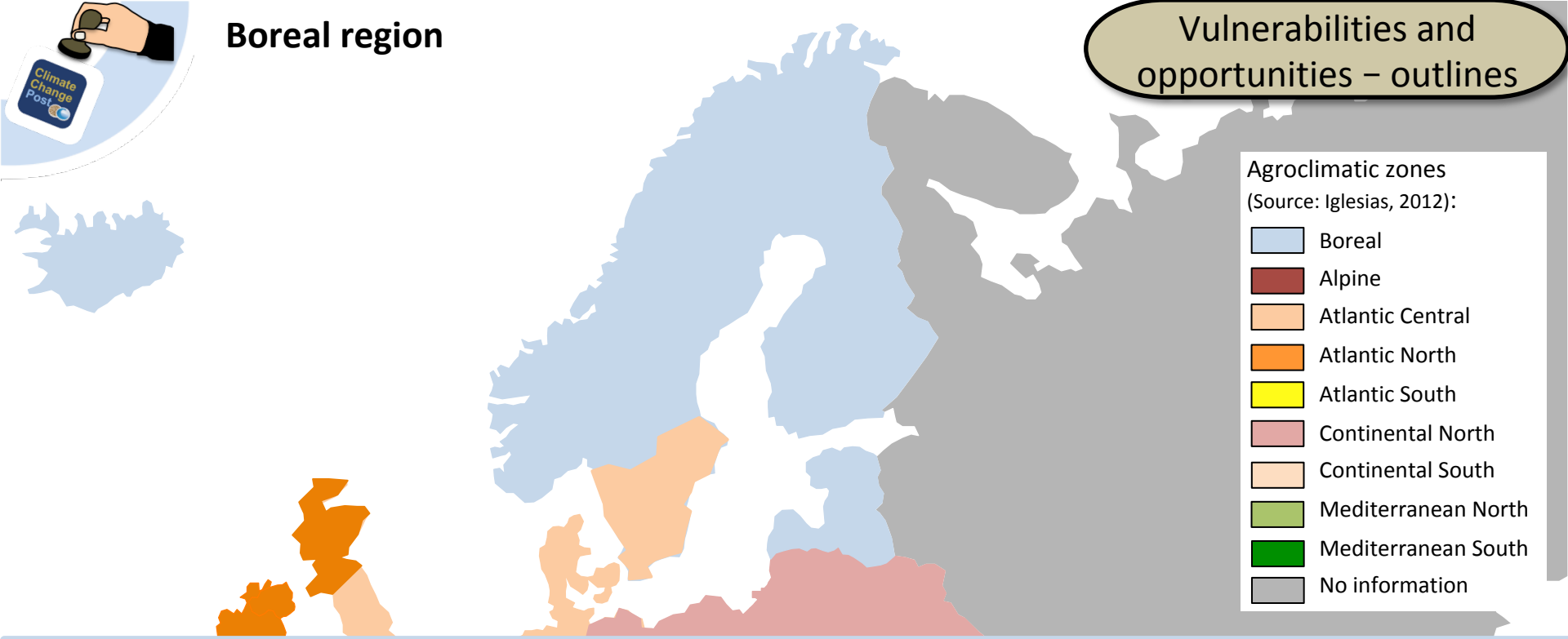
Climatic zones for Europe's agriculture



Boreal region

Vulnerabilities and opportunities – outlines



Vulnerabilities and opportunities:

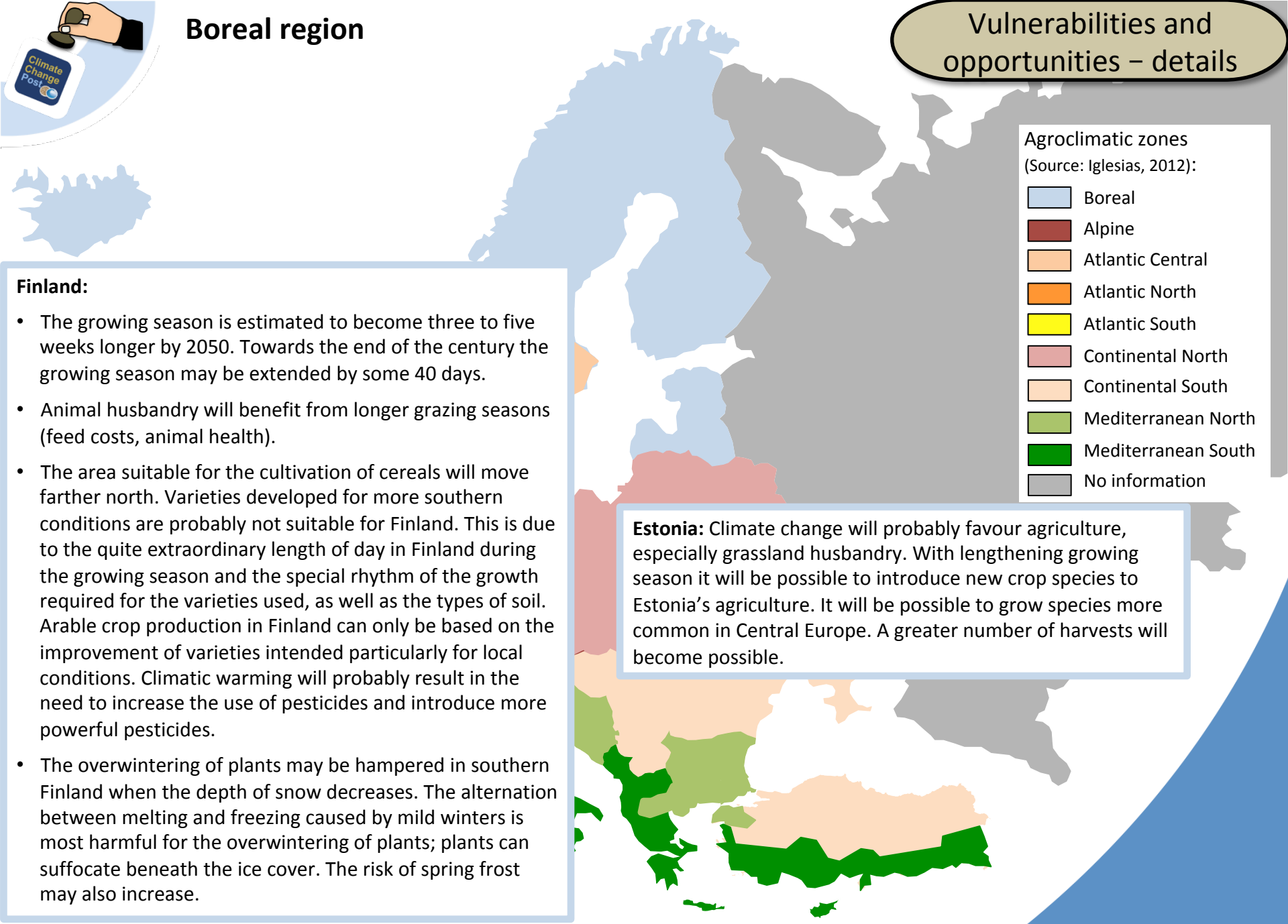
In the Boreal region, increased temperatures may increase both the cultivable area and crop yields within the entire zone, as well as provide opportunities for increased livestock production. A longer growing season may enable growing more heat demanding species and varieties of crops. This could increase use of legumes and more productive perennial forage grasses and potentially increase the production of vegetables and grains.

However, the soil types in this zone may limit the potential for increased agricultural production. In addition, increased rainfall may lead to increased waterlogging, flooding risk and perhaps also a decrease in water quality.
In the short term economic benefits of climate change may outweigh disadvantages due to longer growing seasons and increasing plant productivity. However, negative impacts could grow more serious in the longer term. The need for irrigation water will increase. Stress arising from dryness and heat during the growing season may increase. Also an increased occurrence of pests and weeds is expected to increase crop losses.

Productivity improvements in northern countries could reach 40-50% by the 2080s.

Boreal region

Vulnerabilities and opportunities – details



Finland:

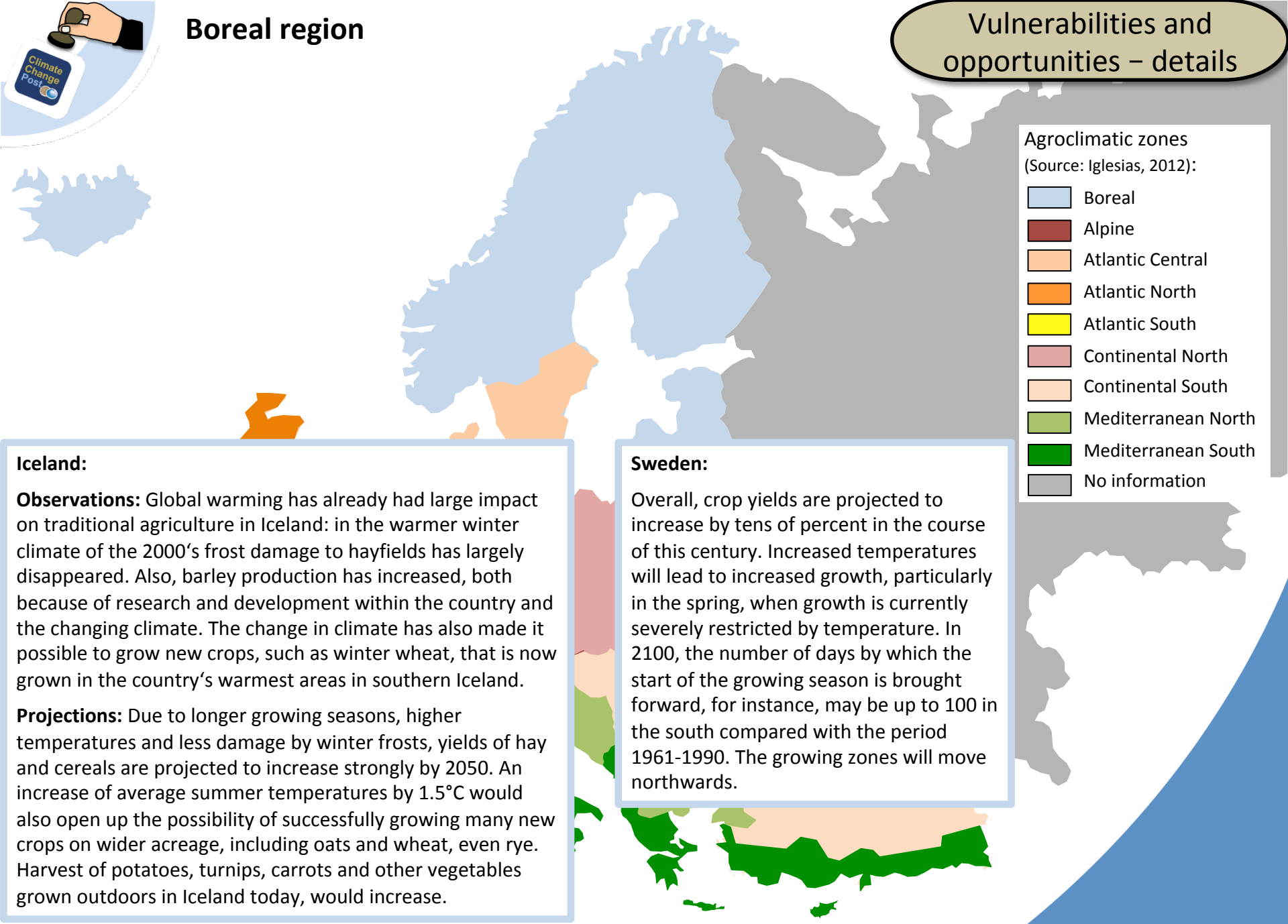
- The growing season is estimated to become three to five weeks longer by 2050. Towards the end of the century the growing season may be extended by some 40 days.
- Animal husbandry will benefit from longer grazing seasons (feed costs, animal health).
- The area suitable for the cultivation of cereals will move farther north. Varieties developed for more southern conditions are probably not suitable for Finland. This is due to the quite extraordinary length of day in Finland during the growing season and the special rhythm of the growth required for the varieties used, as well as the types of soil. Arable crop production in Finland can only be based on the improvement of varieties intended particularly for local conditions. Climatic warming will probably result in the need to increase the use of pesticides and introduce more powerful pesticides.
- The overwintering of plants may be hampered in southern Finland when the depth of snow decreases. The alternation between melting and freezing caused by mild winters is most harmful for the overwintering of plants; plants can suffocate beneath the ice cover. The risk of spring frost may also increase.

Estonia: Climate change will probably favour agriculture, especially grassland husbandry. With lengthening growing season it will be possible to introduce new crop species to Estonia's agriculture. It will be possible to grow species more common in Central Europe. A greater number of harvests will become possible.

Sources: Marttila et al. (2005); Kentala-Lehtonen (2008); Ministry of the Environment of Estonia (2009)

Boreal region

Vulnerabilities and opportunities – details



Iceland:

Observations: Global warming has already had large impact on traditional agriculture in Iceland: in the warmer winter climate of the 2000's frost damage to hayfields has largely disappeared. Also, barley production has increased, both because of research and development within the country and the changing climate. The change in climate has also made it possible to grow new crops, such as winter wheat, that is now grown in the country's warmest areas in southern Iceland.

Projections: Due to longer growing seasons, higher temperatures and less damage by winter frosts, yields of hay and cereals are projected to increase strongly by 2050. An increase of average summer temperatures by 1.5°C would also open up the possibility of successfully growing many new crops on wider acreage, including oats and wheat, even rye. Harvest of potatoes, turnips, carrots and other vegetables grown outdoors in Iceland today, would increase.

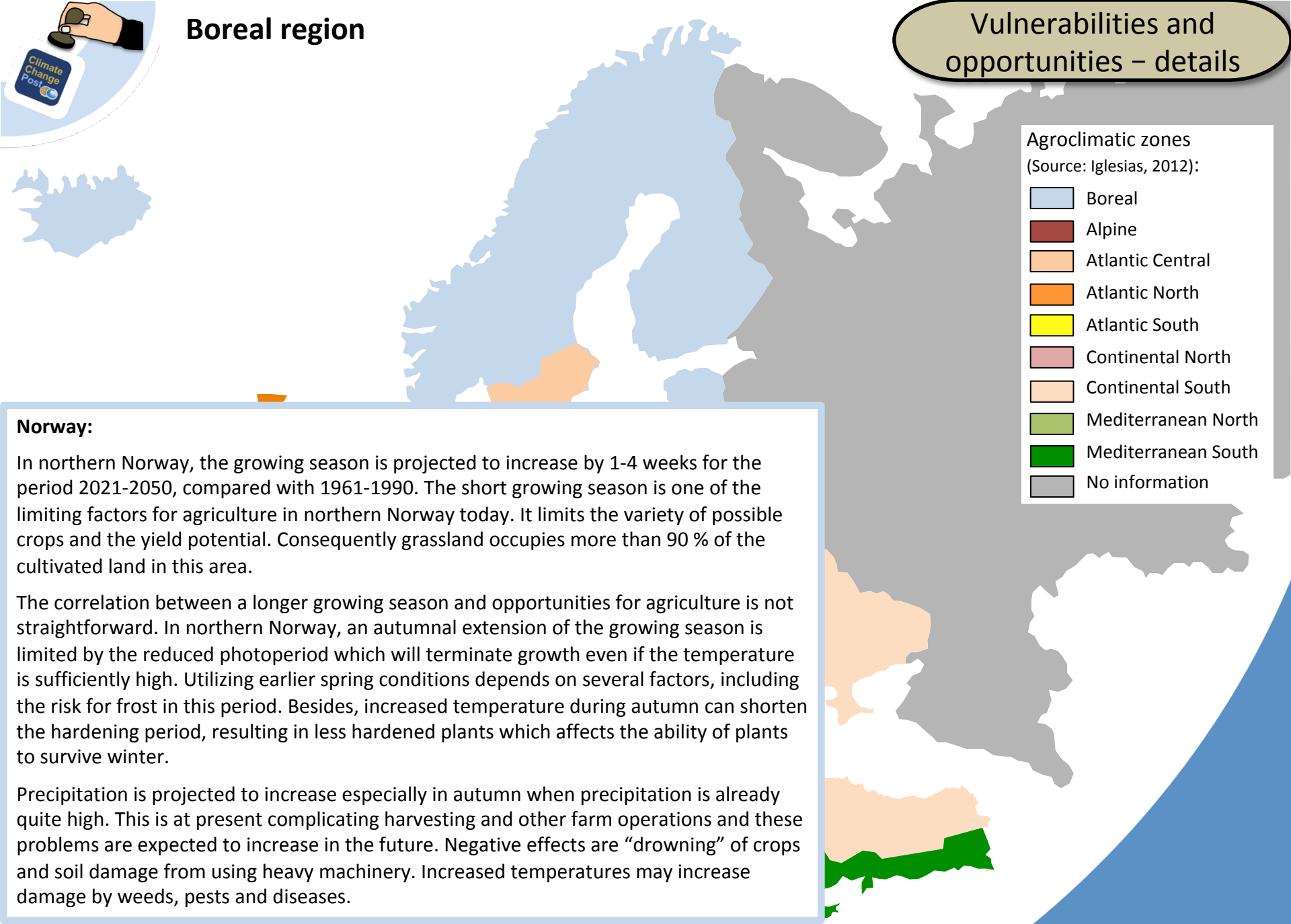
Sweden:

Overall, crop yields are projected to increase by tens of percent in the course of this century. Increased temperatures will lead to increased growth, particularly in the spring, when growth is currently severely restricted by temperature. In 2100, the number of days by which the start of the growing season is brought forward, for instance, may be up to 100 in the south compared with the period 1961-1990. The growing zones will move northwards.

Sources: Swedish Commission on Climate and Vulnerability (2007); Ministry for the Environment of Iceland (2010)

Boreal region

Vulnerabilities and opportunities – details



Norway:

In northern Norway, the growing season is projected to increase by 1-4 weeks for the period 2021-2050, compared with 1961-1990. The short growing season is one of the limiting factors for agriculture in northern Norway today. It limits the variety of possible crops and the yield potential. Consequently grassland occupies more than 90 % of the cultivated land in this area.

The correlation between a longer growing season and opportunities for agriculture is not straightforward. In northern Norway, an autumnal extension of the growing season is limited by the reduced photoperiod which will terminate growth even if the temperature is sufficiently high. Utilizing earlier spring conditions depends on several factors, including the risk for frost in this period. Besides, increased temperature during autumn can shorten the hardening period, resulting in less hardened plants which affects the ability of plants to survive winter.

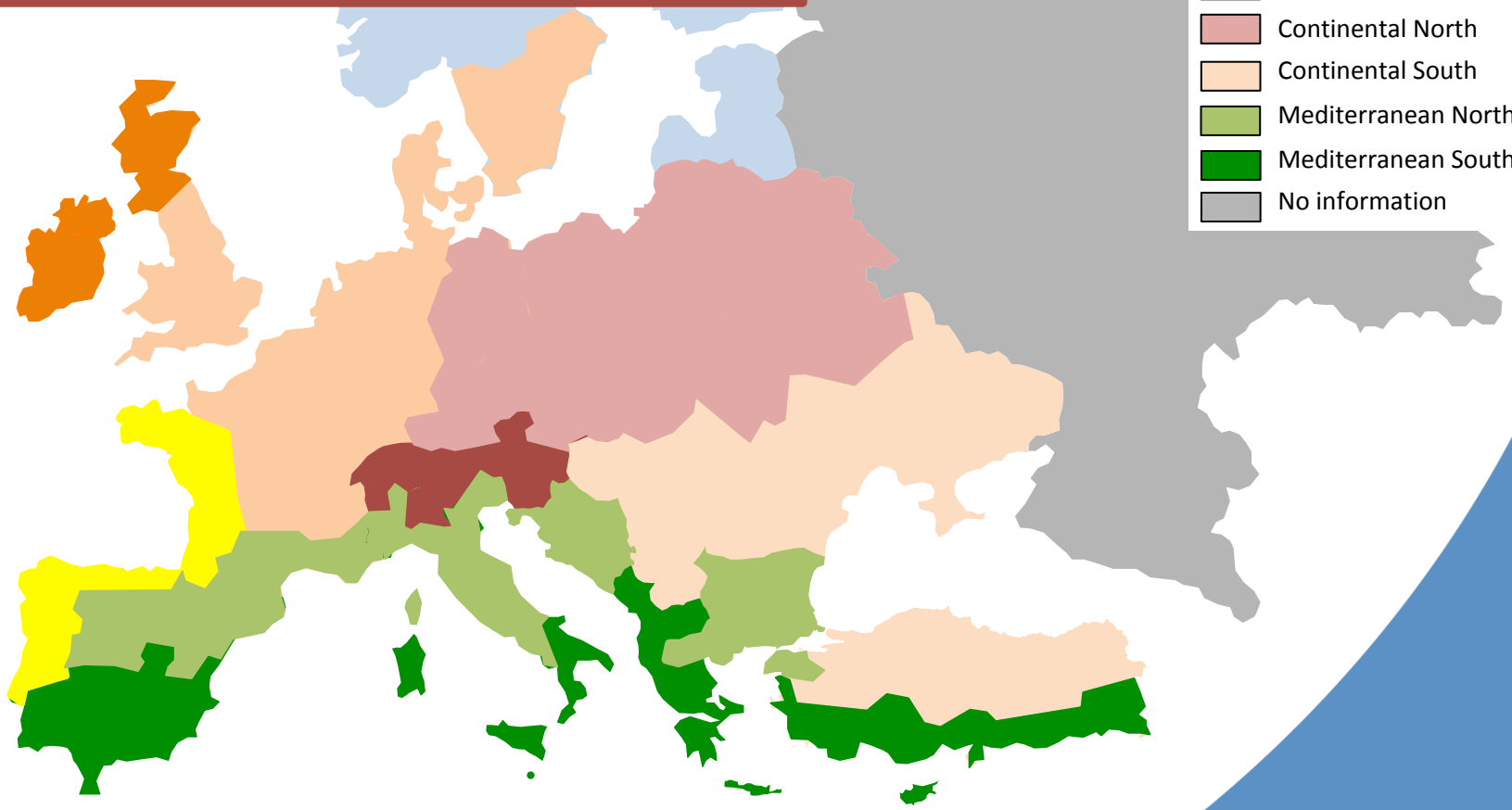
Precipitation is projected to increase especially in autumn when precipitation is already quite high. This is at present complicating harvesting and other farm operations and these problems are expected to increase in the future. Negative effects are “drowning” of crops and soil damage from using heavy machinery. Increased temperatures may increase damage by weeds, pests and diseases.

Sources in Uleberg et al. (2014)

Alpine region

Vulnerabilities and opportunities – outlines

Vulnerabilities and opportunities:
Changes in precipitation pattern and increased frequency of extreme events appear to pose the greatest risks in the Alpine region. There may be benefits from a longer growing season and the ability to grow some crops at higher altitudes, but this potential may not be realised due to soil limitations.



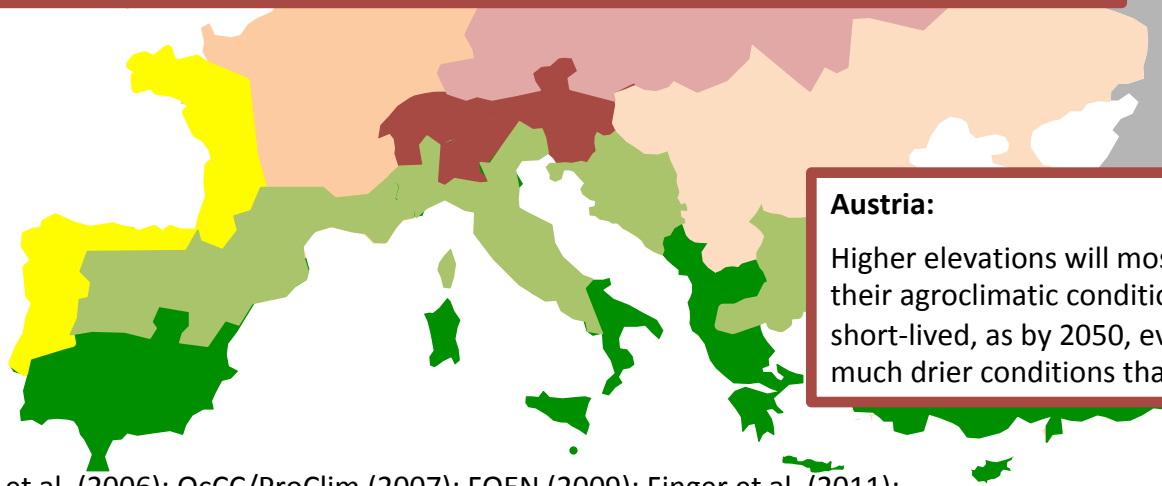
Alpine region

Vulnerabilities and opportunities – details

Switzerland:

Under present conditions, a moderate warming of less than 2 to 3°C would probably have a positive overall effect on Swiss agriculture. Climate change is expected to have small positive effects on winter wheat production, which represents the majority of the Swiss cereal production. The estimated impacts of climate change on maize yields are subject to large uncertainties: up to around 2050 grain maize yield in Switzerland could either increase or decrease. Future grain maize production may benefit from higher temperatures. On the other hand, there may be negative effects due to heat and drought stress, and through accelerated crop development, particularly during vegetative growth, flowering and maturation. For winter wheat, the relevance of heat stress is likely to increase with increasing temperatures.

If temperature rises by more than 2 to 3°C by 2050, the disadvantages will outweigh the advantages of warming. The increase in heat waves and drought periods is particularly problematic. During the vegetation period water scarcity will become more frequent. Faster plant development will result in harvest losses for cereals and grain legumes. The risk of damage for arable crops and of yield loss in animal feed production will increase. Weeds and insect attacks are expected to occur more often as will damages caused by extreme events. New pests and diseases can occur or persist.



Austria:

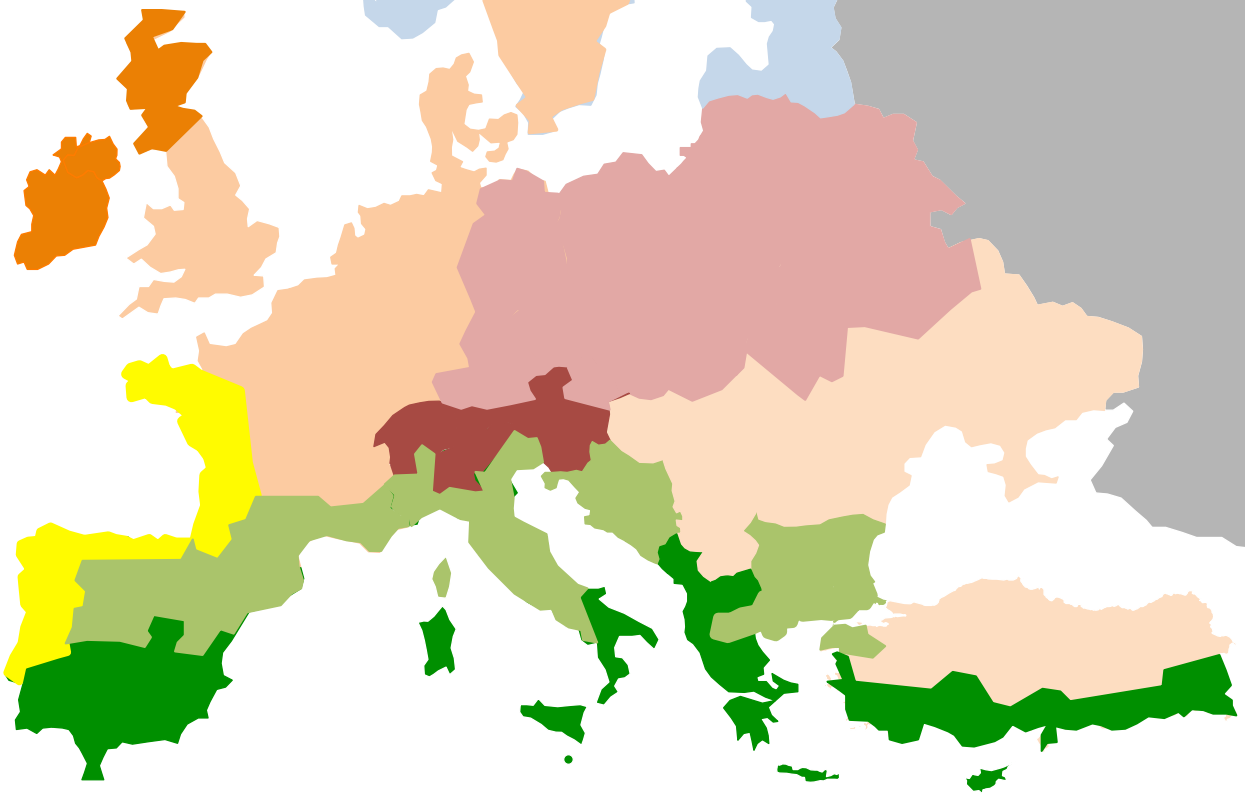
Higher elevations will most likely experience improvement in their agroclimatic conditions. This positive effect might be short-lived, as by 2050, even these areas might experience much drier conditions than observed currently.

Sources: Fuhrer et al. (2006); OcCC/ProClim (2007); FOEN (2009); Finger et al. (2011); Holzkämper et al. (2015, 2015b)

Atlantic central region

Vulnerabilities and opportunities – outlines

Vulnerabilities and opportunities:
Some increases in agricultural production in the Atlantic central region are possible from increased yields of cereals and the introduction of new crops. However, it may be difficult to maintain the yields of more moisture- or temperature-sensitive crops if summer rainfall decreases and insufficient water is available for irrigation.

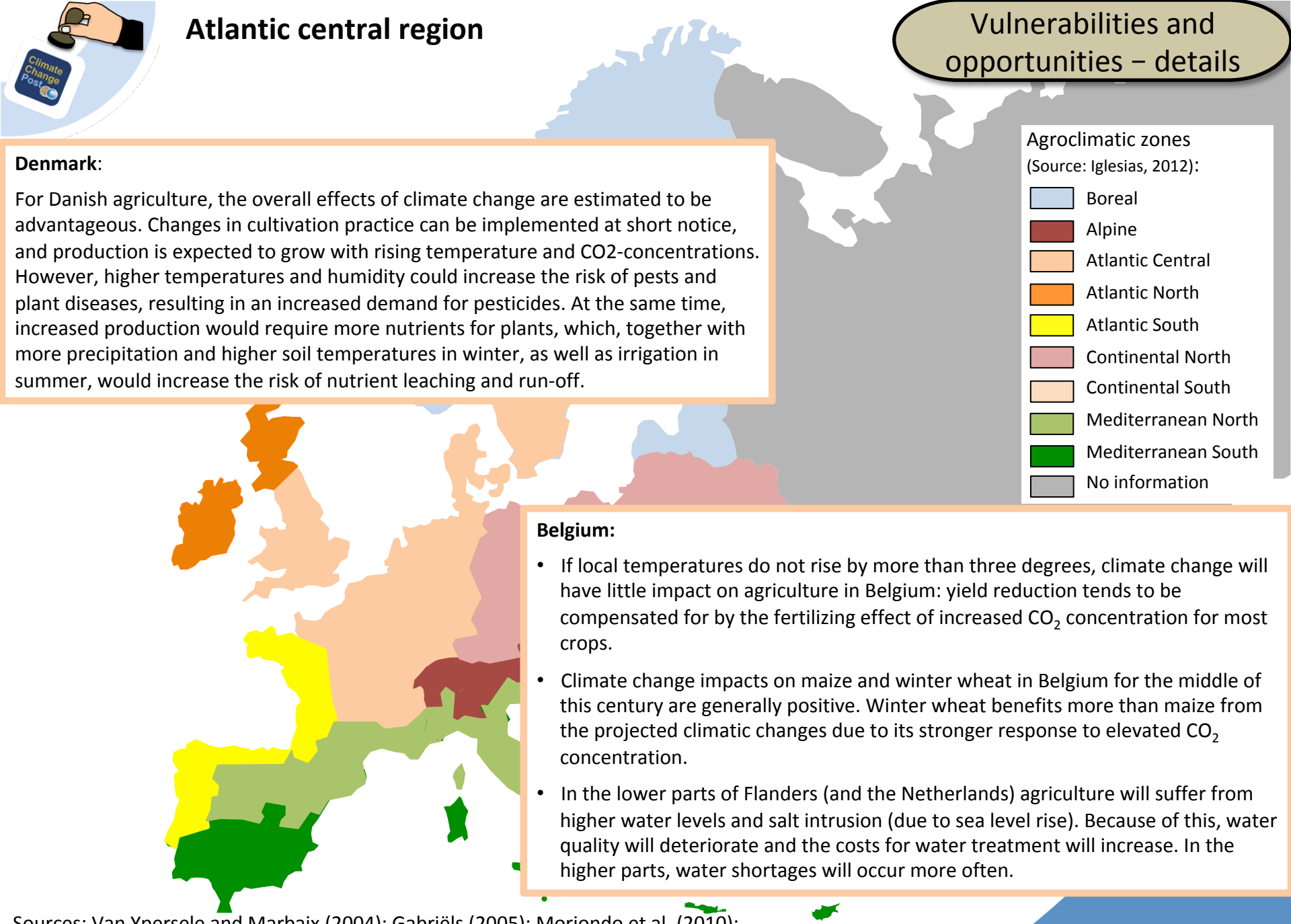


Atlantic central region

Vulnerabilities and opportunities – details

Denmark:

For Danish agriculture, the overall effects of climate change are estimated to be advantageous. Changes in cultivation practice can be implemented at short notice, and production is expected to grow with rising temperature and CO2-concentrations. However, higher temperatures and humidity could increase the risk of pests and plant diseases, resulting in an increased demand for pesticides. At the same time, increased production would require more nutrients for plants, which, together with more precipitation and higher soil temperatures in winter, as well as irrigation in summer, would increase the risk of nutrient leaching and run-off.



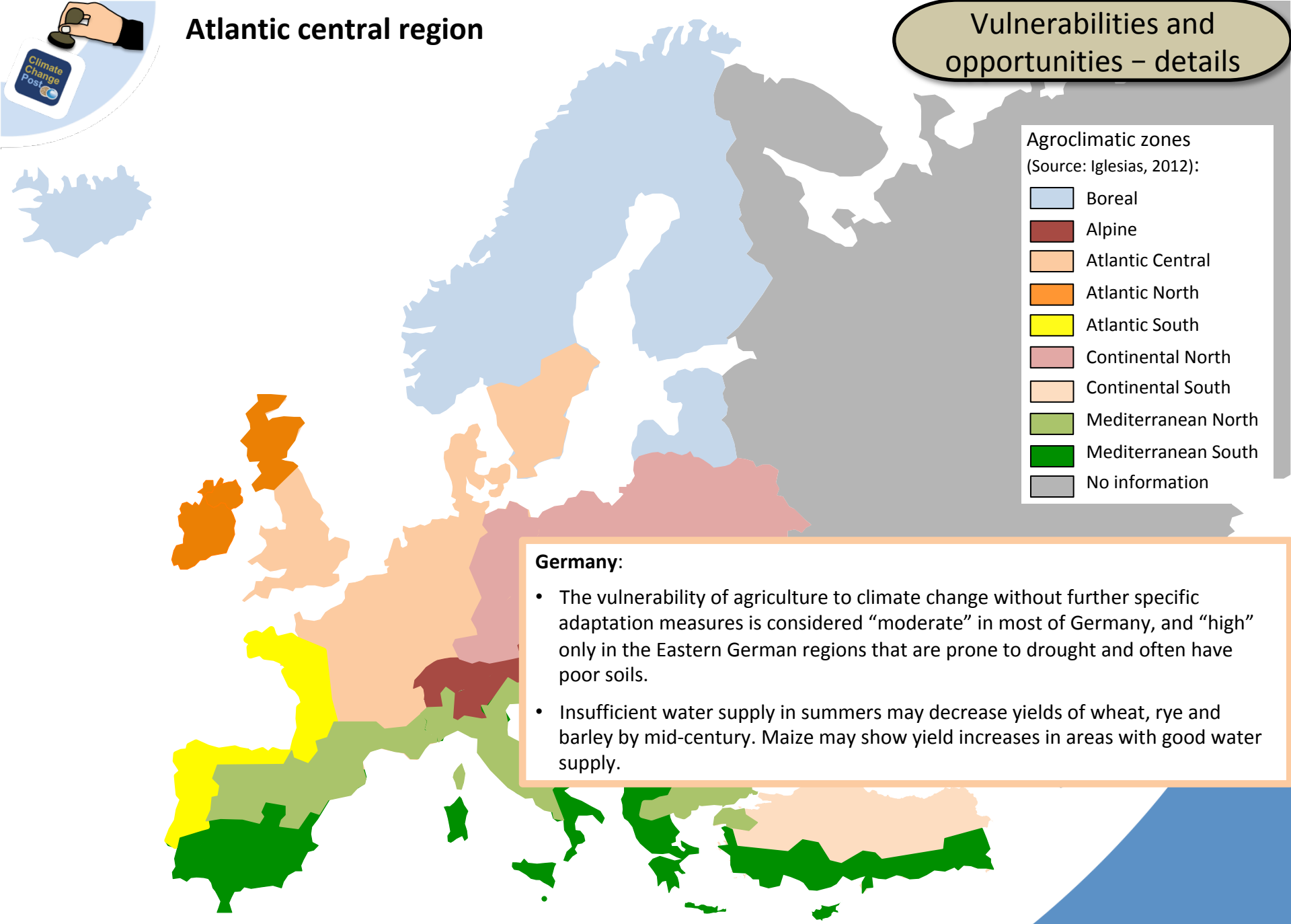
Belgium:

- If local temperatures do not rise by more than three degrees, climate change will have little impact on agriculture in Belgium: yield reduction tends to be compensated for by the fertilizing effect of increased CO_2 concentration for most crops.
- Climate change impacts on maize and winter wheat in Belgium for the middle of this century are generally positive. Winter wheat benefits more than maize from the projected climatic changes due to its stronger response to elevated CO_2 concentration.
- In the lower parts of Flanders (and the Netherlands) agriculture will suffer from higher water levels and salt intrusion (due to sea level rise). Because of this, water quality will deteriorate and the costs for water treatment will increase. In the higher parts, water shortages will occur more often.

Sources: Van Ypersele and Marbaix (2004); Gabriëls (2005); Moriondo et al. (2010); National Climate Commission Belgium (2010)

Atlantic central region

Vulnerabilities and opportunities – details



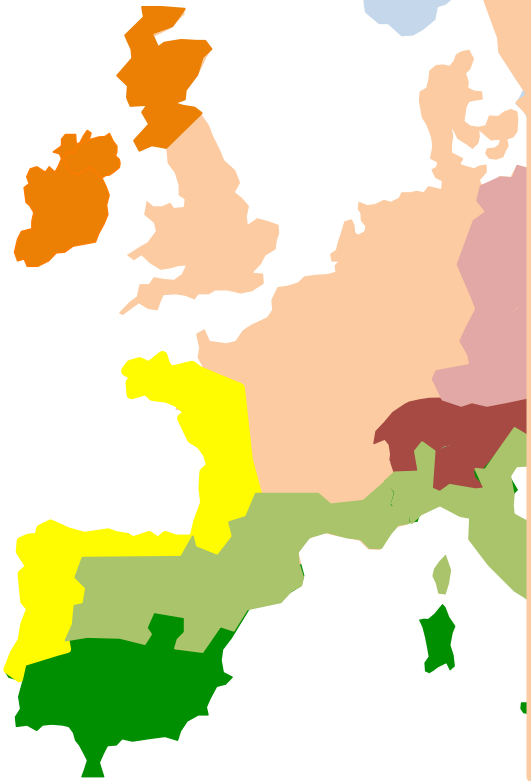
Germany:

- The vulnerability of agriculture to climate change without further specific adaptation measures is considered “moderate” in most of Germany, and “high” only in the Eastern German regions that are prone to drought and often have poor soils.
- Insufficient water supply in summers may decrease yields of wheat, rye and barley by mid-century. Maize may show yield increases in areas with good water supply.

Sources in Zebisch et al. (2005)

Atlantic central region

Vulnerabilities and opportunities – details



France:

Observations:

The changing climate has already negatively affected winter wheat yields in the country; in the Picardy region, one of the breadbaskets in France, climate change has likely caused a 11% decrease in winter wheat yield between 1973 and 2010.

Projections:

- By mid-century, projected yield declines (compared with 1977-2005) range from 3.5% to 12.9% for winter wheat and 2.3% to 12.1% for winter barley. By the end of the century, under a low-end scenario of climate change, yield declines are comparable to those observed for the mid-century period. Under a high-end scenario of climate change, projected yield declines of winter wheat and winter barley are 17.2% and 14.6%, on average, by the end of the century.
- Projected yield declines are related to higher temperatures, not to changes in precipitation.
- Spring barley yield is predicted to decline by 7.0% - 25.2% by mid-century. By the end of the century, effects are more pronounced except under the lowest warming scenario. Under the most rapid warming scenario, yield is predicted to decline by 16.7% - 45.8%.
- Continuing technology trends may counterbalance most of the effects of climate change.
- Under a moderate scenario of climate change, for Western Europe a maize yield loss of around 40% was projected for 2100, relative to the baseline (1961-1990) in the absence of adaptation and mitigation strategies.
- For 2030-2060, yield gains are on average expected for sunflower and durum wheat on application of certain adaptation methods.
- For 2070-2100 under different scenarios of climate change, a general decline in crop yields for winter wheat, spring wheat, rice, grassland, maize and soybeans was projected for the end of the century, especially in the western and south-western parts of the country.

Sources: UK Met Office (2011); Licker et al. (2013); Gammans et al. (2017)

Atlantic central region

Vulnerabilities and opportunities – details

The Netherlands:

Climate change will likely lead to both positive and negative effects on agricultural production and the agricultural economic situation in the Netherlands. Positive factors are: higher CO_2 concentration and temperature, and the extension of the growing season; the worsening situation in the southern countries of Europe may also provide Dutch agriculture with extra market opportunities. The negative effects will increase as more extreme weather and climate conditions occur more frequently or persist for longer periods (water logging and drought). Dutch agriculture can often react flexible to changing climatic conditions; smaller yields in dry years will often be compensated by higher prices. Extreme weather is expected to have only a limited effect on the economic success of the sector.

- **Wetter winters:** Sowing and harvesting problems, and glass damage (hail) and crop damage due to extreme rainfall.
- **Drier summers:** Especially for arable land on sandy soils, crop yields may decrease due to expected decreased summer precipitation and an increased frequency of high-intensity rain showers. Among the most drought sensitive crops are summer vegetables, leaf vegetables, flower bulbs, fruit and tree crops.

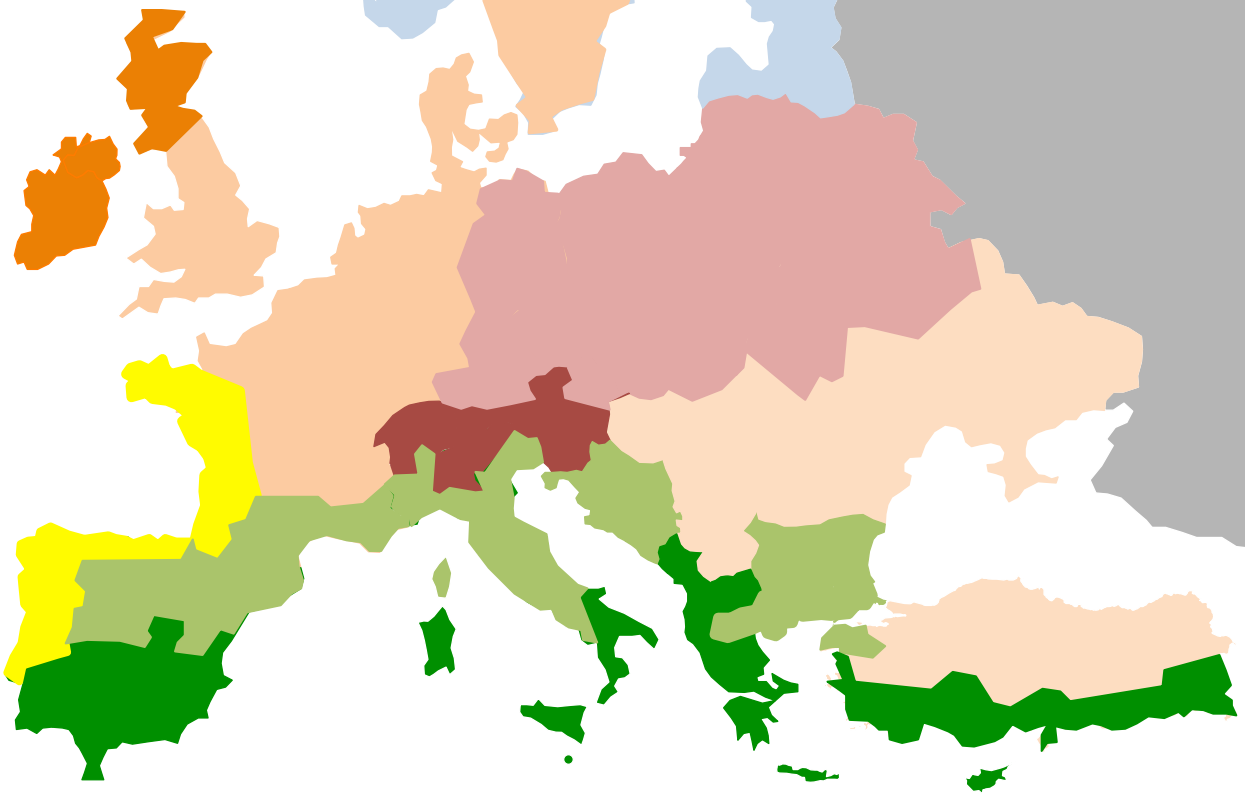
- The **fen-meadow areas** in the western part of the Netherlands experience several interconnected problems: farmland subsidence, water shortage during the dry summer period, excess water during wet periods and saline intrusion related to sea-level rise. Groundwater levels are kept low in agricultural land. This results in accelerated oxidation of peat and soil subsidence.
- **Higher temperatures:** Compared to 1961-1990, the growing season is now more than 3 weeks longer. Grain crops do not benefit from the higher temperature and longer growing season because grain ripens earlier and therefore the plants have less time to grow. A disadvantage of early germination/budding is the greater risk of night frost damage in early spring; this risk is particularly high for fruit growers.
- **Higher CO_2 - concentrations:** The combined effect of an increasing CO_2 - concentration and a temperature rise of up to 2-3°C can lead to increased potential yields of wheat, seed, consumable and industrial potato and sugar beet in the Netherlands. Temperature increases beyond 3-4°C will negatively influence crop yields, except for maize.
- **Salt intrusion:** Sea level rise will cause an increase of the salt water seepage in the coastal zones of the Netherlands, and an increase of the salt water intrusion in the main rivers in combination with lower river discharges in summer. This can harm salt sensitive crops in agriculture and horticulture.

Sources in Van Nillesen and Van Ierland (2006)

Atlantic north region

Vulnerabilities and opportunities – outlines

Vulnerabilities and opportunities:
There is potential for increased agricultural production in the Atlantic north region, especially in the livestock sector. Measures need to be introduced to enable adaptation to drier summers, as currently summer rainfall usually enables unrestricted growth of crops and forage.

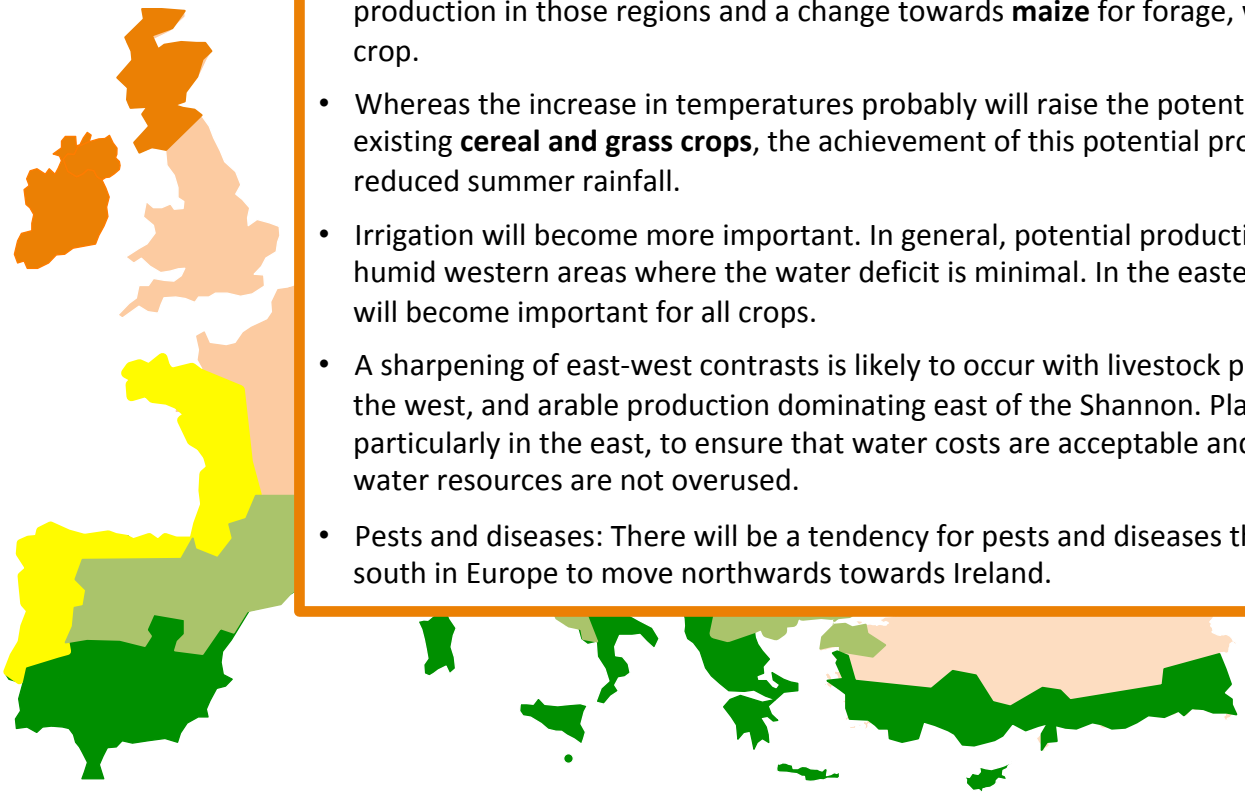


Atlantic north region

Vulnerabilities and opportunities – details

Ireland, mid-century:

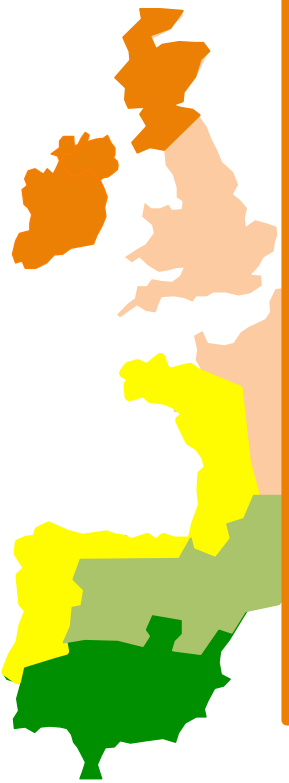
- Expected positive impacts on crop yield. **Barley** remains a viable crop. With climate change, **maize** grain production increases drastically making maize more valuable than it is currently.
- **Potato** will suffer most, from increasing water stress during the summer months. Its value as a commercial crop is likely to depend on irrigation. Viability of potato production as a commercial crop may be maintained with irrigation, but this would require water storage from the increased rainfall in winter to survive the drier summer.
- **Grass** represents the most important crop in Ireland at present, and underpins the entire livestock industry. A summer drought stress (particularly in the east and south-east) may lead to less grass production in those regions and a change towards **maize** for forage, which should become a viable crop.
- Whereas the increase in temperatures probably will raise the potential for production in the existing **cereal and grass crops**, the achievement of this potential probably will be limited by reduced summer rainfall.
- Irrigation will become more important. In general, potential production is greater in the more humid western areas where the water deficit is minimal. In the eastern half of the country irrigation will become important for all crops.
- A sharpening of east-west contrasts is likely to occur with livestock production dominating more to the west, and arable production dominating east of the Shannon. Planning for irrigation is needed, particularly in the east, to ensure that water costs are acceptable and summer surface and ground water resources are not overused.
- Pests and diseases: There will be a tendency for pests and diseases that are currently found further south in Europe to move northwards towards Ireland.



Source: Environmental Protection Agency (2003)

Atlantic north region

Vulnerabilities and opportunities – details



UK – Vulnerabilities:

- **Wetter winters:** Saturated soil cannot support the weight of tractors. Seeds in flooded land are prone to rotting, and plants can drown if the ground is waterlogged and air cannot get to the roots. Water logging will limit the release of nitrogen from the soil, restricting the nutrients available for plant growth. Some agricultural land is likely to be lost due to fluvial and coastal flooding. Damage will increase due to run-off. Standing crops will be damaged more often by heavy precipitation, high winds, flash floods etc. In fact, some crops currently grown on light soils (e.g. potatoes) may become inappropriate due to unpredictable weather events such as intense storms.
- **Drier summers:** Warm weather hastens crop development and brings earlier harvests. However in cereals, the reduced duration of the growth period tends to reduce yields. Similarly a shortage of water tends to slow growth development and reduce yield. Warm weather causes earlier flowering than usual and this causes yield formation to occur earlier in the summer, which is normally before soil moisture reserves have been exhausted. So historically in the UK hot dry summers have been associated with higher than average yields. However, the exact impact on yields depends crucially on the timing of the drought relative to the development of the crop, and this may vary from year to year and from location to location.
- **Higher temperatures:** Higher winter temperatures may negatively affect cereal and fruit production because plants and trees need low winter temperature for flowering and growth. Higher winter temperatures will also stimulate pests and diseases. Many fruit trees and bushes also require cold winter weather to move from dormancy to flowering and growth. As with winter cereals, these crops, including blackcurrant, apple and raspberry, require an accumulation of temperature below a particular threshold in order to form flower buds. Therefore, an increase in winter temperatures could delay formation of flower buds, or result in abnormality or failure of flowering, which would thereby reduce the subsequent crop of fruit. Warmer summers may become a risk for livestock. The amount of available land well suited for winter wheat may decline with a rise in temperature and little change in precipitation. Maize may replace some wheat but needs irrigating to avoid drought.
- **Diseases and pests:** For arable farming, milder winters and warmer summers carry the risk of more diseases and pests. This will be exacerbated by increased wet weather in the winter.

Sources: a.o. Farrar and Vaze (2000); Kersey et al. (2000); Anderson et al. (2003); C-CLIF and GEMRU (2003); Richter and Semenov (2005); Ciscar et al. (2009); Iglesias et al. (2009); Moriondo et al. (2010)

Atlantic north region

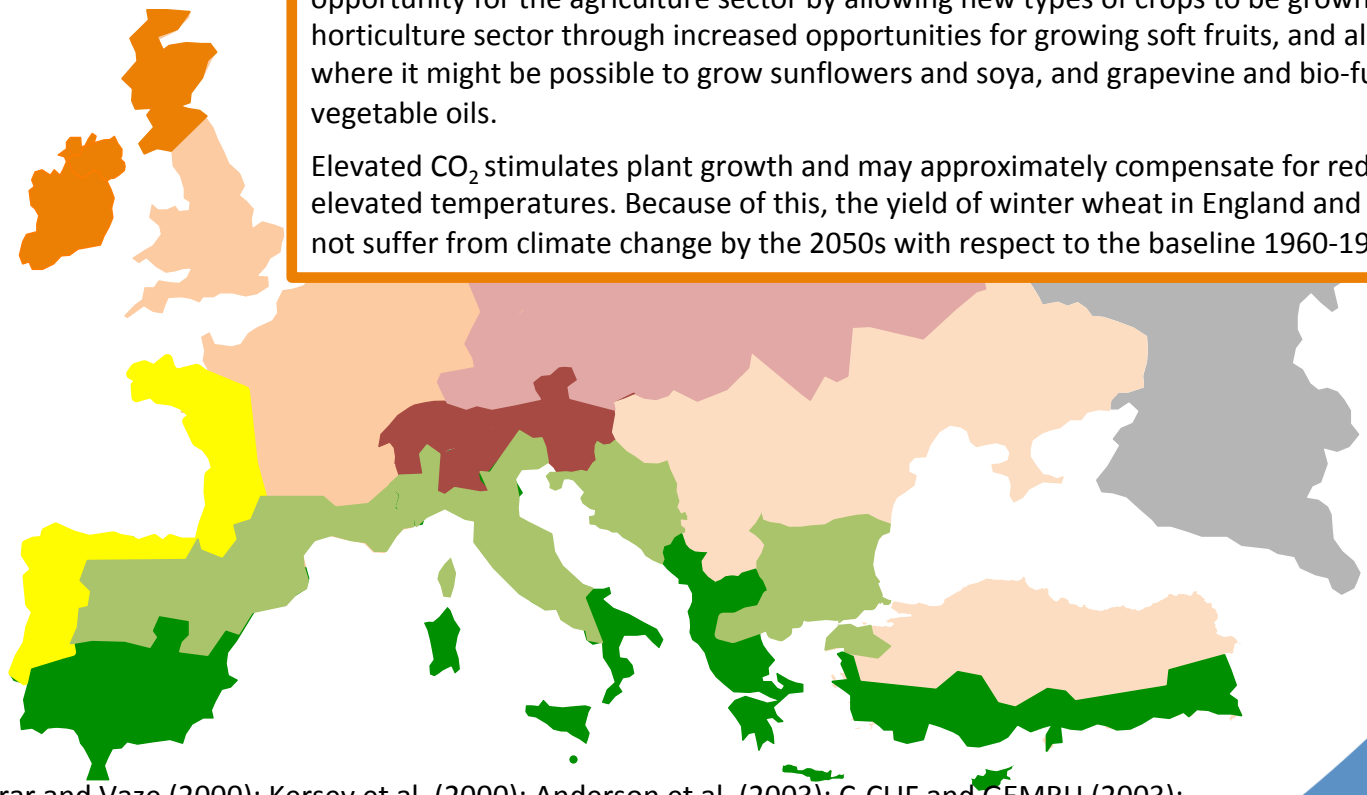
Vulnerabilities and opportunities – details

UK - Benefits and opportunities:

Research results indicate that the balance for UK agriculture is much more towards areas of increased rather than decreased cropland suitability due to climate change. There are significant regional differences across the UK, though: the north of the UK is generally associated with yield increases with climate change, whereas the south is associated with yield decreases.

Agriculture may benefit from climate change in several ways, such as higher crop growth through changes in the growing season, and more diversification through the introduction of new crops. Horticulture may benefit from reduced heating costs for glasshouse crops. In general, a warmer climate will assist in increasing the diversity of crops. This would leave farmers less dependent on one commodity and therefore more insulated against the market. The drier summers might also offer an opportunity for the agriculture sector by allowing new types of crops to be grown. This might affect the horticulture sector through increased opportunities for growing soft fruits, and also for agriculture where it might be possible to grow sunflowers and soya, and grapevine and bio-fuels including vegetable oils.

Elevated CO_2 stimulates plant growth and may approximately compensate for reduced yields caused by elevated temperatures. Because of this, the yield of winter wheat in England and Wales probably will not suffer from climate change by the 2050s with respect to the baseline 1960-1990.



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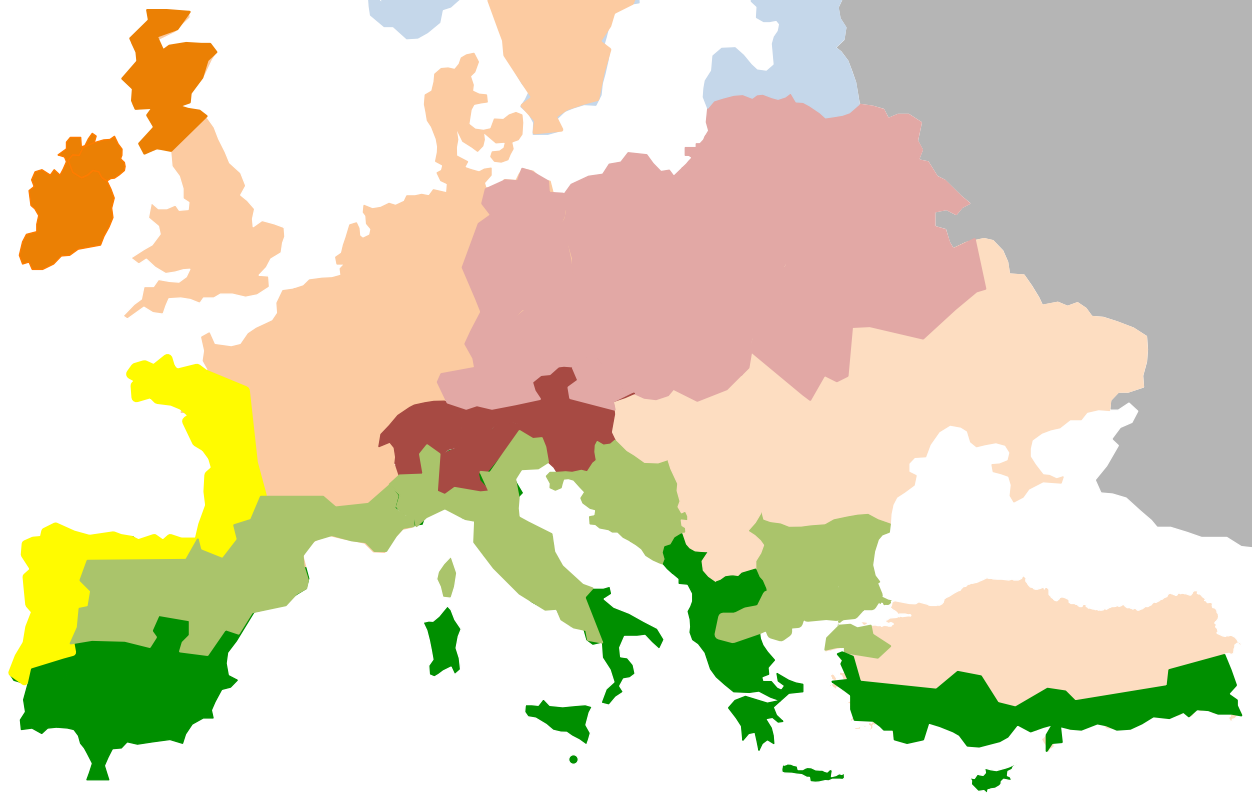
Atlantic south region

Vulnerabilities and opportunities – outlines

Vulnerabilities and opportunities:
The priority for the Atlantic south region will be to conserve water to reduce the risk of decreases in crop yields and to avoid conflict with other water users. There may also be opportunities to grow crops more tolerant to heat and drought.



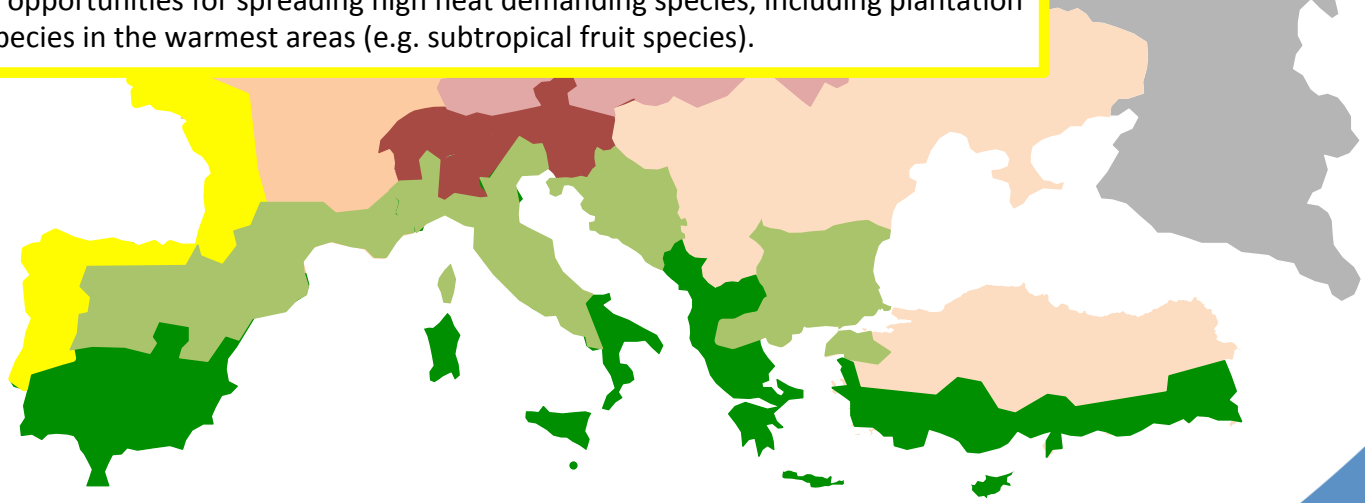
Source: Iglesias (2012)

Atlantic south region

Vulnerabilities and opportunities – details

Portugal:

- For Portugal, the change of crop yield in 2080 compared with 1990 has been estimated based on several combinations of models and scenarios; the outcomes show a decrease ranging from 4.0% to almost 30%.
- **Fruit production** might be particularly vulnerable to climatic change, particularly in southern Europe. A period of low temperatures is needed for regular budburst (chilling accumulation), while a period of warm temperatures (heat accumulation) is needed for adequate blooming and ripening. Climate change may significantly alter these conditions, thus threatening fruit production.
- Inner southern Portugal is expected to undergo the most detrimental climatic changes for temperate fruit and nut trees (too much heat stress).
- On the other hand, the north-eastern areas are projected to experience an increase in heat accumulation, which may indeed be beneficial, while winter chill is expected to decrease only slightly, likely without major impacts on trees.
- There may be opportunities for spreading high heat demanding species, including plantation of new fruit species in the warmest areas (e.g. subtropical fruit species).

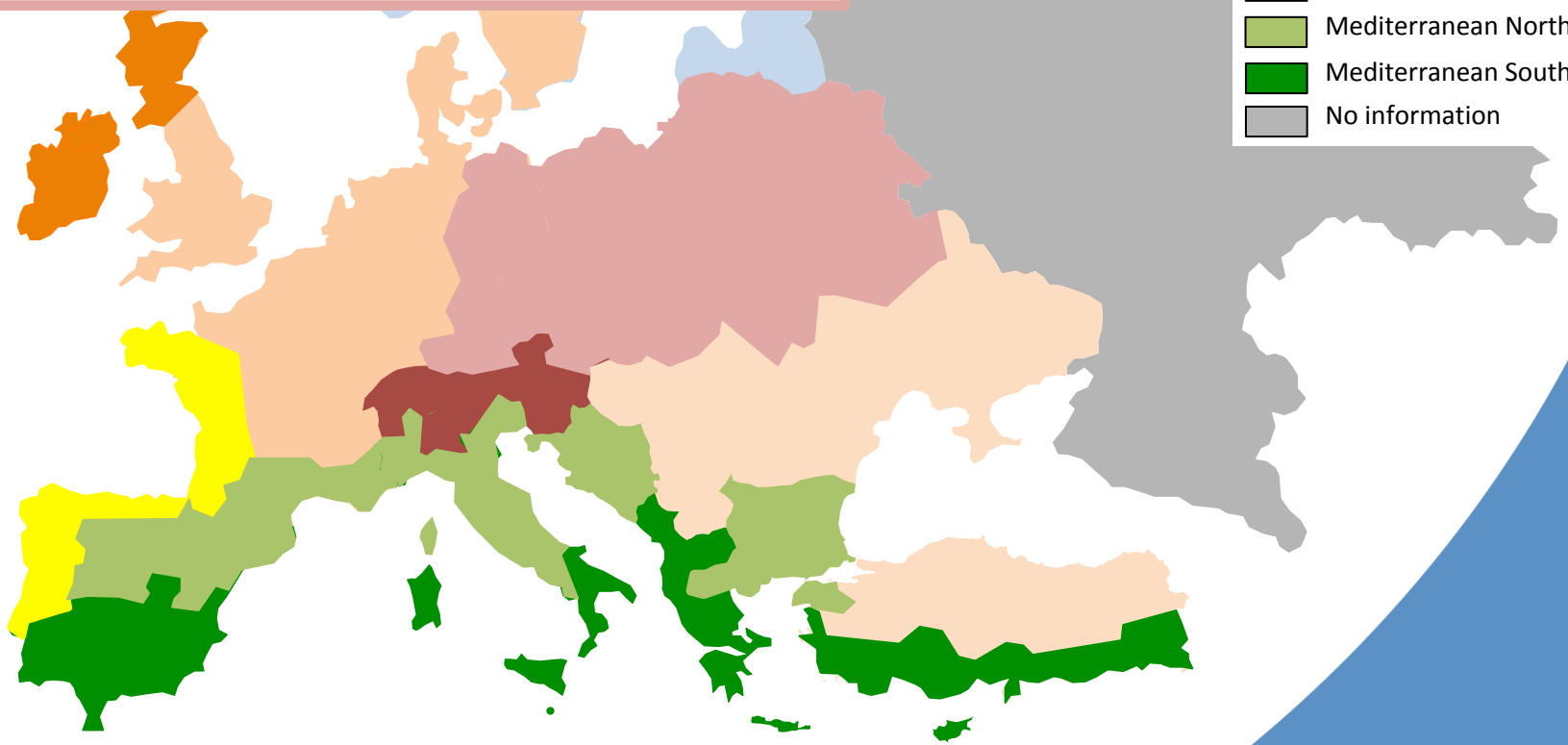


Sources: Ciscar et al. (2009); Santos et al. (2017)

Continental north region

Vulnerabilities and opportunities – outlines

Vulnerabilities and opportunities:
In the Continental north region the increase in the northern range of crops and longer growing season offers the potential for increased crop and livestock production. However water stress in summer and infertile soils may limit this potential. Flooding is also a serious risk. Priority needs to be given to manage water supplies to reduce the risk of flooding and to conserve water to increase availability for agriculture.

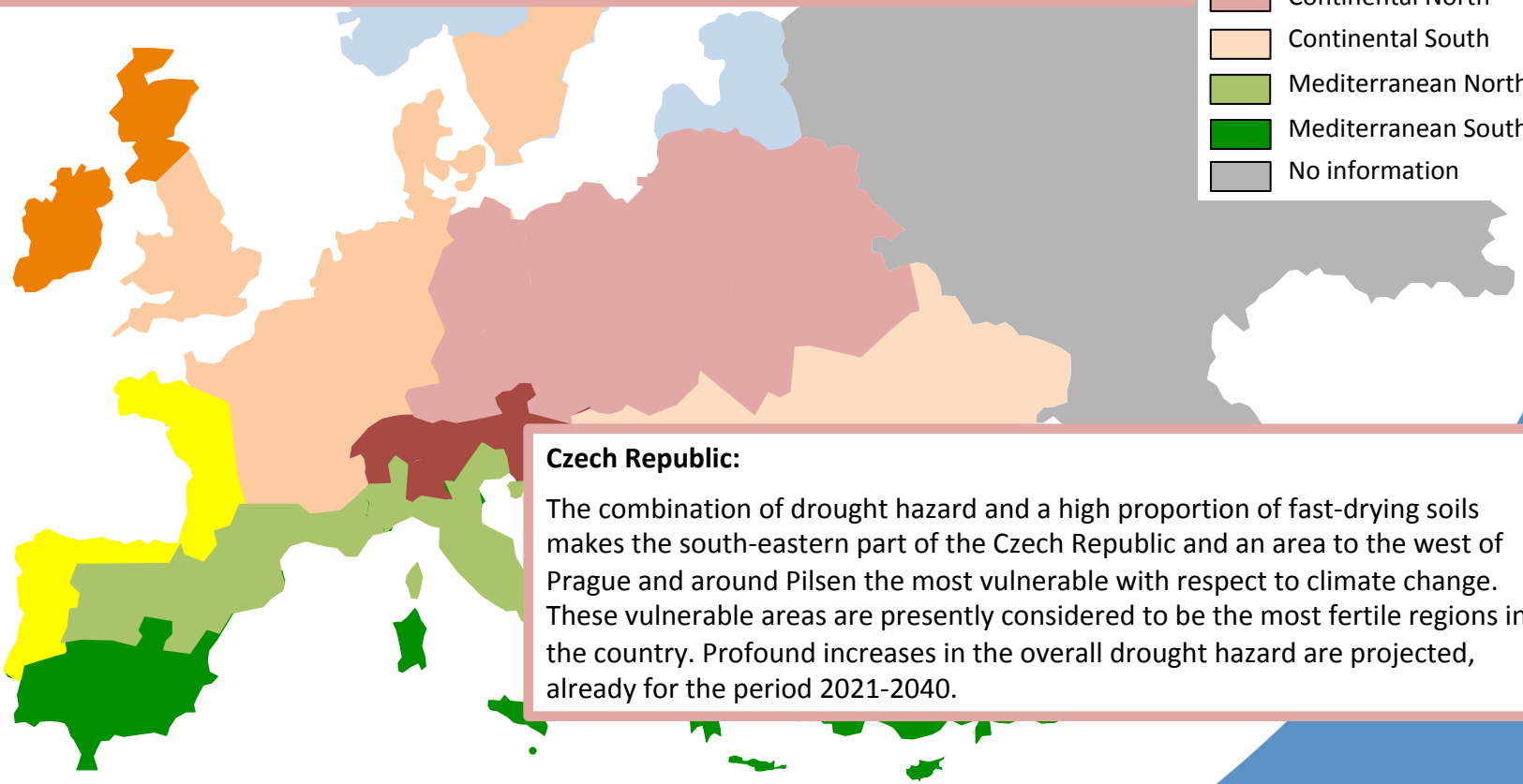


Continental north region

Vulnerabilities and opportunities – details

Poland:

Between now and the end of this century average crop yield in Poland will probably change slightly. Initially, owing to warmer temperatures, the decrease in precipitation and the longer growing seasons, there may be an improvement in crop productivity (cereals, oilseeds and sugar beet) in countries such as Bulgaria, the Czech Republic, Hungary, Poland and Romania. In order to use the agro-potential of the environment, higher additional water supplies would be needed. However, already the present scanty water resources of Poland do not allow massive irrigation and the situation is likely to become more severe in the future.



Czech Republic:

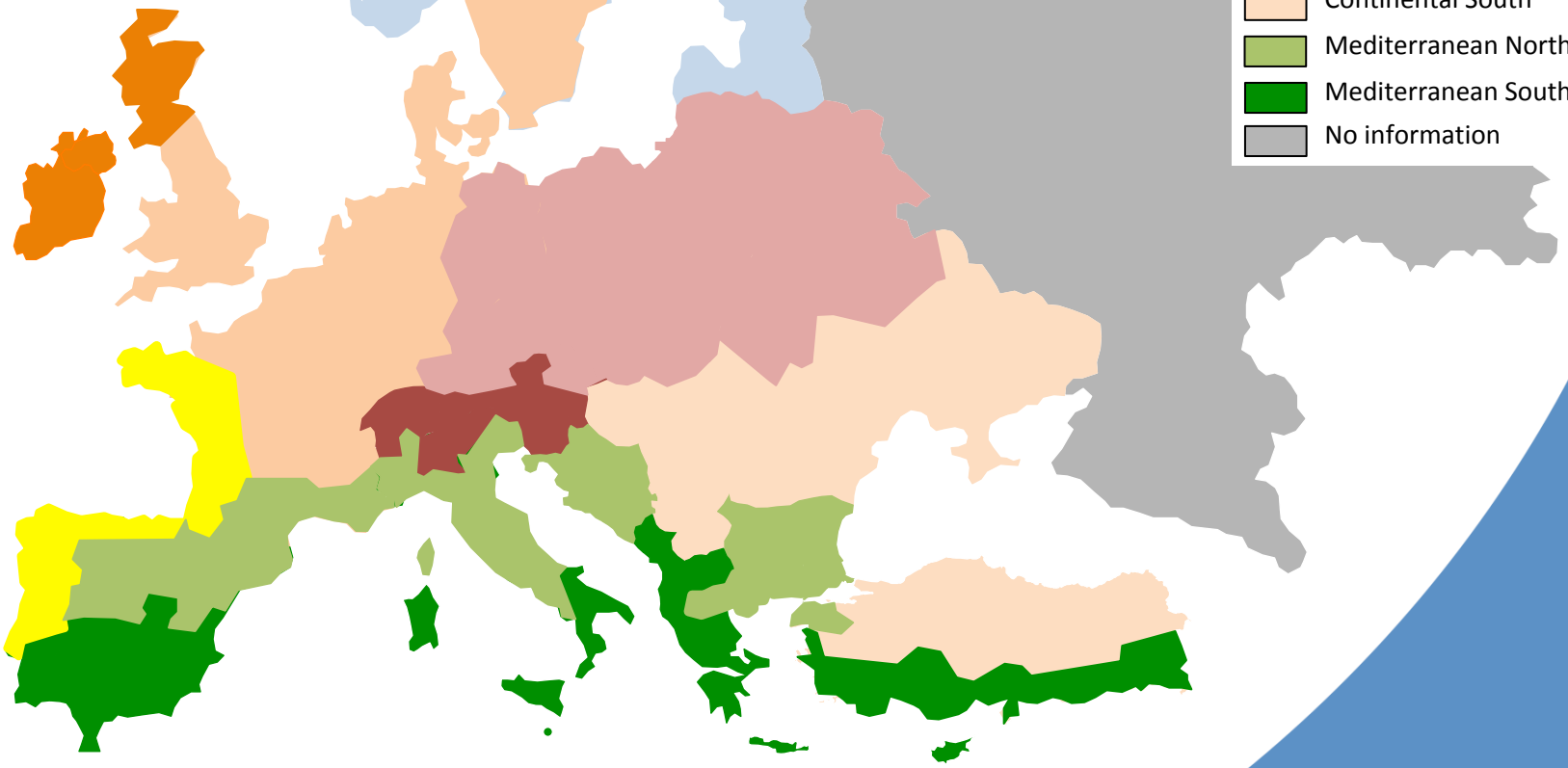
The combination of drought hazard and a high proportion of fast-drying soils makes the south-eastern part of the Czech Republic and an area to the west of Prague and around Pilsen the most vulnerable with respect to climate change. These vulnerable areas are presently considered to be the most fertile regions in the country. Profound increases in the overall drought hazard are projected, already for the period 2021-2040.

Sources: Behrens et al. (2010); Szwed et al. (2010); Trnka et al. (2016)

Continental south region

Vulnerabilities and opportunities – outlines

Vulnerabilities and opportunities:
Agriculture in the Continental south region is likely to be adversely affected by hotter drier summers with yields of crops such as potatoes, sugar beet and forage crops most likely to be reduced. Priority needs to be given to ensuring water supplies for agriculture and also promoting the growth of crops, such as soya, that could replace vulnerable crops.

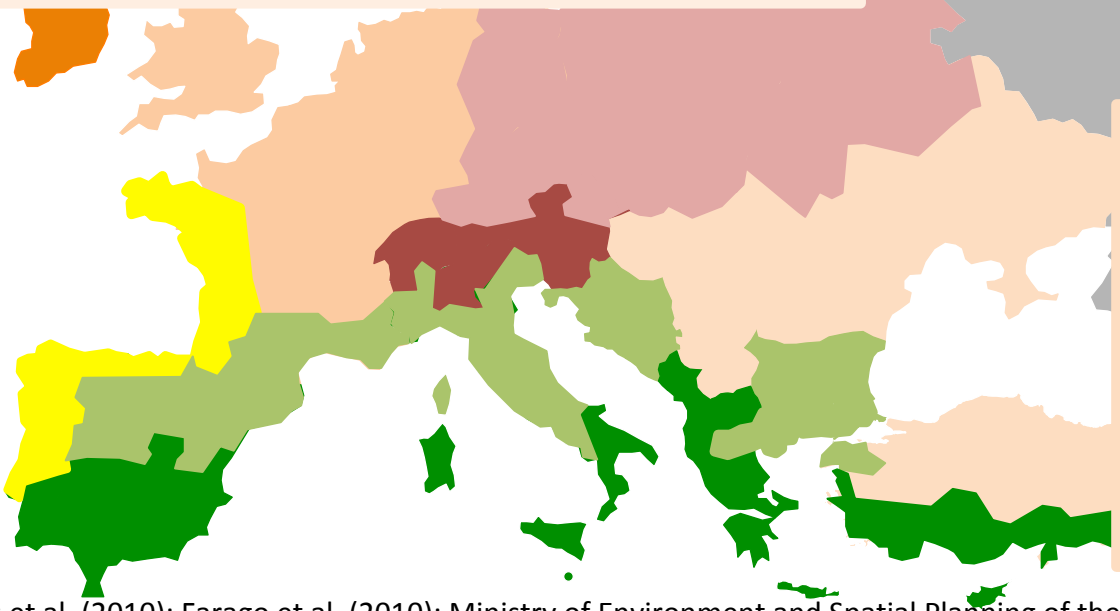


Continental south region

Vulnerabilities and opportunities – details

Hungary:

- Initially, owing to warmer temperatures, the decrease in precipitation and the longer growing seasons, there may be an improvement in crop productivity (cereals, oilseeds and sugar beet) in countries such as Bulgaria, the Czech Republic, Hungary, Poland and Romania.
- In Hungary, around 98% of the agricultural land is not irrigated, mainly due to the large number of small farms. Under a moderate scenario of climate change, maize production will probably only be possible with irrigation in the second half of the century.
- For vegetables, yield risk due to frost damages and hailstorms may increase. Vulnerability of fruit species is rather diverse; cherry, walnut, plum and apple will be less endangered in the future in comparison with other species.



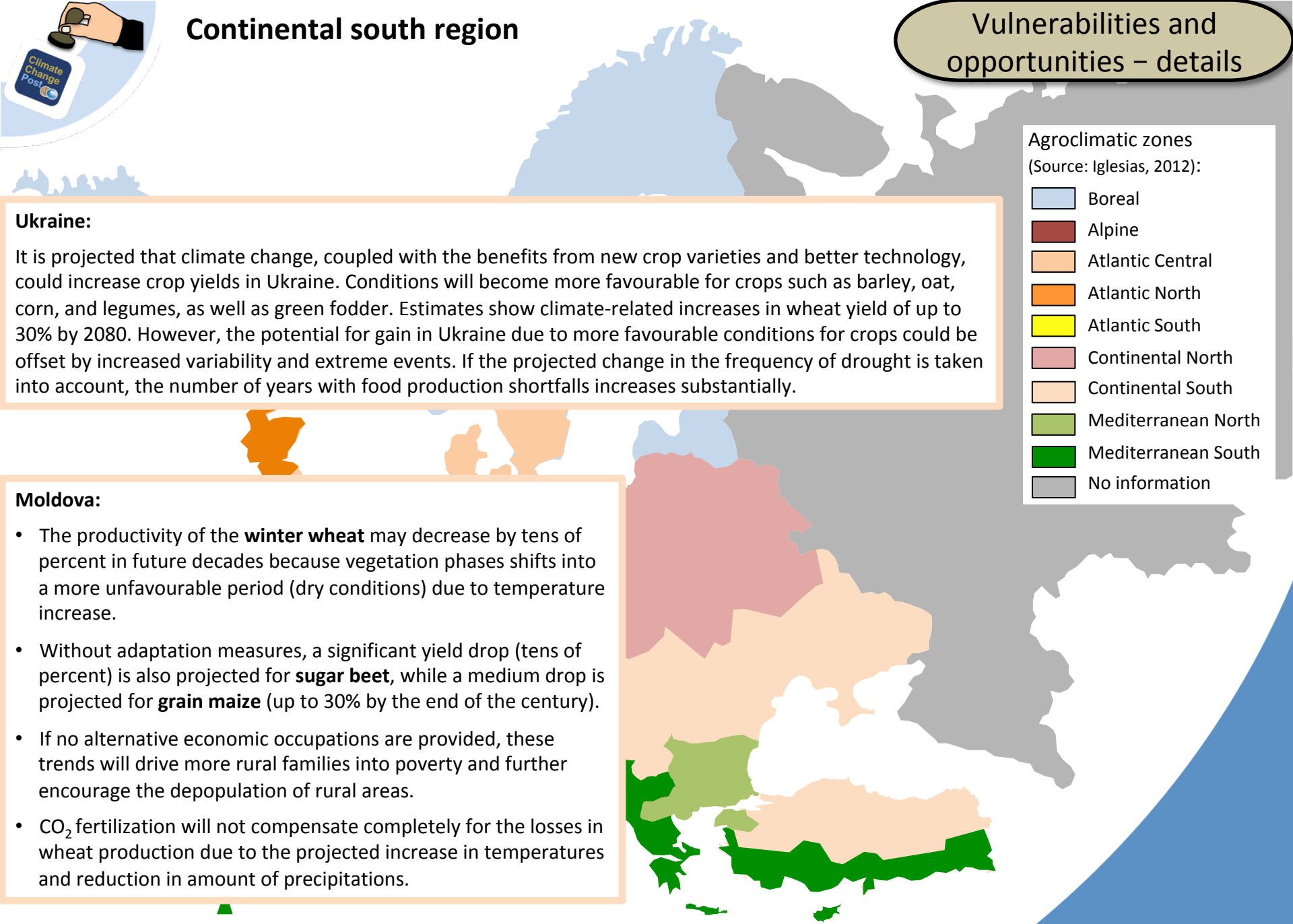
Serbia:

Projections for future decades that neglect the CO_2 fertilizer effect indicate a yield drop in all considered crops (corn, sunflower, soy, potato and wheat). Projections that include this CO_2 fertilizer effect show smaller decreases or increases (especially wheat) of crop yield, depending on the crop and the scenario of climate change.

Sources: Behrens et al. (2010); Farago et al. (2010); Ministry of Environment and Spatial Planning of the Republic of Serbia (2010); Lalic and Mihailovic (2011); Zemankovics (2012)

Continental south region

Vulnerabilities and opportunities – details



Ukraine:

It is projected that climate change, coupled with the benefits from new crop varieties and better technology, could increase crop yields in Ukraine. Conditions will become more favourable for crops such as barley, oat, corn, and legumes, as well as green fodder. Estimates show climate-related increases in wheat yield of up to 30% by 2080. However, the potential for gain in Ukraine due to more favourable conditions for crops could be offset by increased variability and extreme events. If the projected change in the frequency of drought is taken into account, the number of years with food production shortfalls increases substantially.

Moldova:

- The productivity of the **winter wheat** may decrease by tens of percent in future decades because vegetation phases shifts into a more unfavourable period (dry conditions) due to temperature increase.
- Without adaptation measures, a significant yield drop (tens of percent) is also projected for **sugar beet**, while a medium drop is projected for **grain maize** (up to 30% by the end of the century).
- If no alternative economic occupations are provided, these trends will drive more rural families into poverty and further encourage the depopulation of rural areas.
- CO_2 fertilization will not compensate completely for the losses in wheat production due to the projected increase in temperatures and reduction in amount of precipitations.

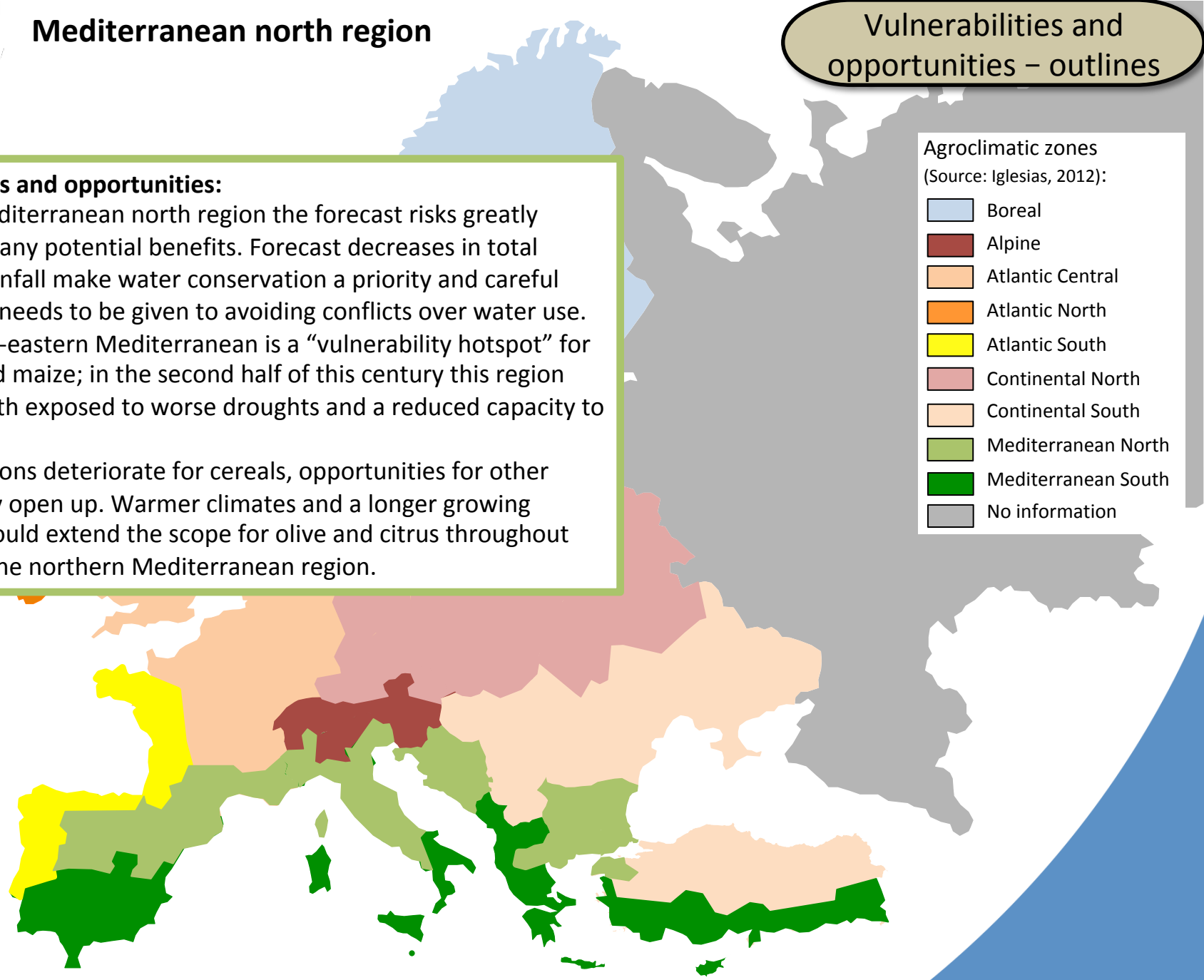
Sources: Ministry of Environment and Natural Resources Molvova (2009); UNDP (2009); sources in Met Office Hadley Centre (2010)

Mediterranean north region

Vulnerabilities and opportunities – outlines

Vulnerabilities and opportunities:

- In the Mediterranean north region the forecast risks greatly outweigh any potential benefits. Forecast decreases in total annual rainfall make water conservation a priority and careful attention needs to be given to avoiding conflicts over water use.
- The north-eastern Mediterranean is a "vulnerability hotspot" for wheat and maize; in the second half of this century this region will be both exposed to worse droughts and a reduced capacity to adapt.
- As conditions deteriorate for cereals, opportunities for other crops may open up. Warmer climates and a longer growing season would extend the scope for olive and citrus throughout much of the northern Mediterranean region.

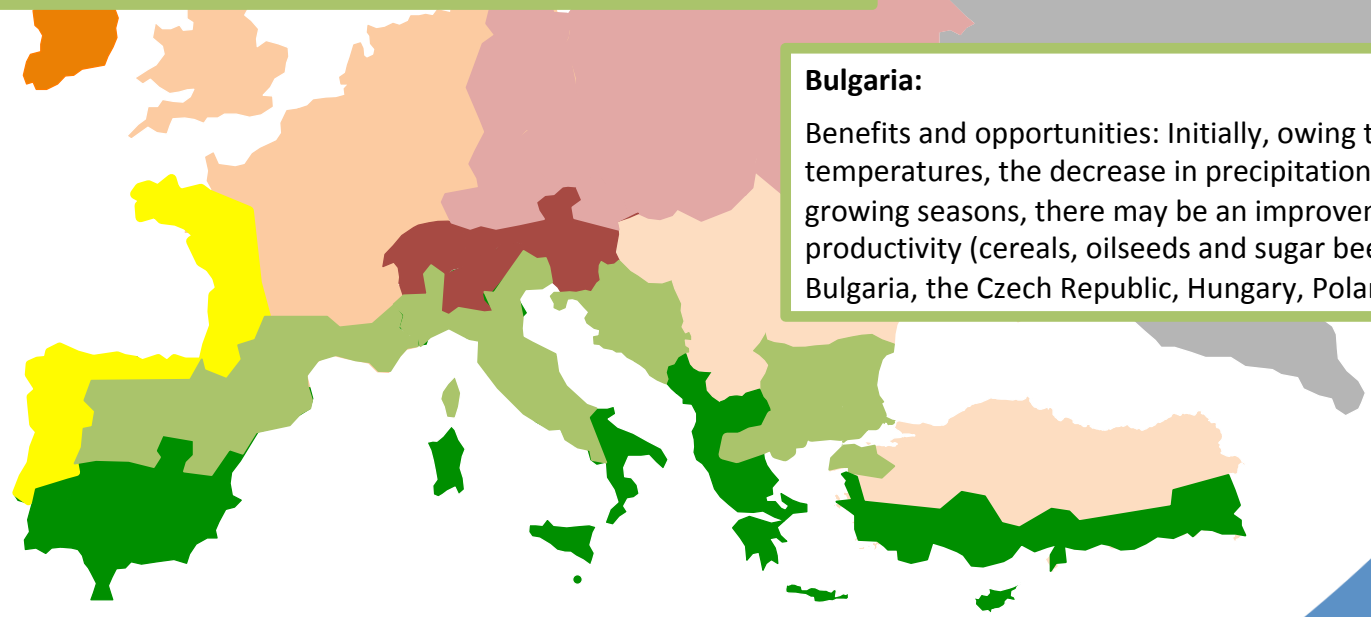


Mediterranean north region

Vulnerabilities and opportunities – details

South-eastern Europe, including Bosnia and Herzegovina:

- Increasing temperatures will promote the development rate of all winter crops such as wheat, which therefore might face a higher probability of crop failure from frost damage. More hot days and a decline in rainfall or irrigation could also reduce yields.
- Temperature increases in spring and summer will accelerate the course of crop development. This will reduce the grain-filling periods. On the other hand, improvements in the rate of dry-matter production can be expected from enhanced CO_2-concentrations.
- Warmer winters can reduce the yields of stone fruits that require winter chilling (moderate coldness) and livestock would be adversely affected by greater heat stress.



Bulgaria:

Benefits and opportunities: Initially, owing to warmer temperatures, the decrease in precipitation and the longer growing seasons, there may be an improvement in crop productivity (cereals, oilseeds and sugar beet) in countries such as Bulgaria, the Czech Republic, Hungary, Poland and Romania.

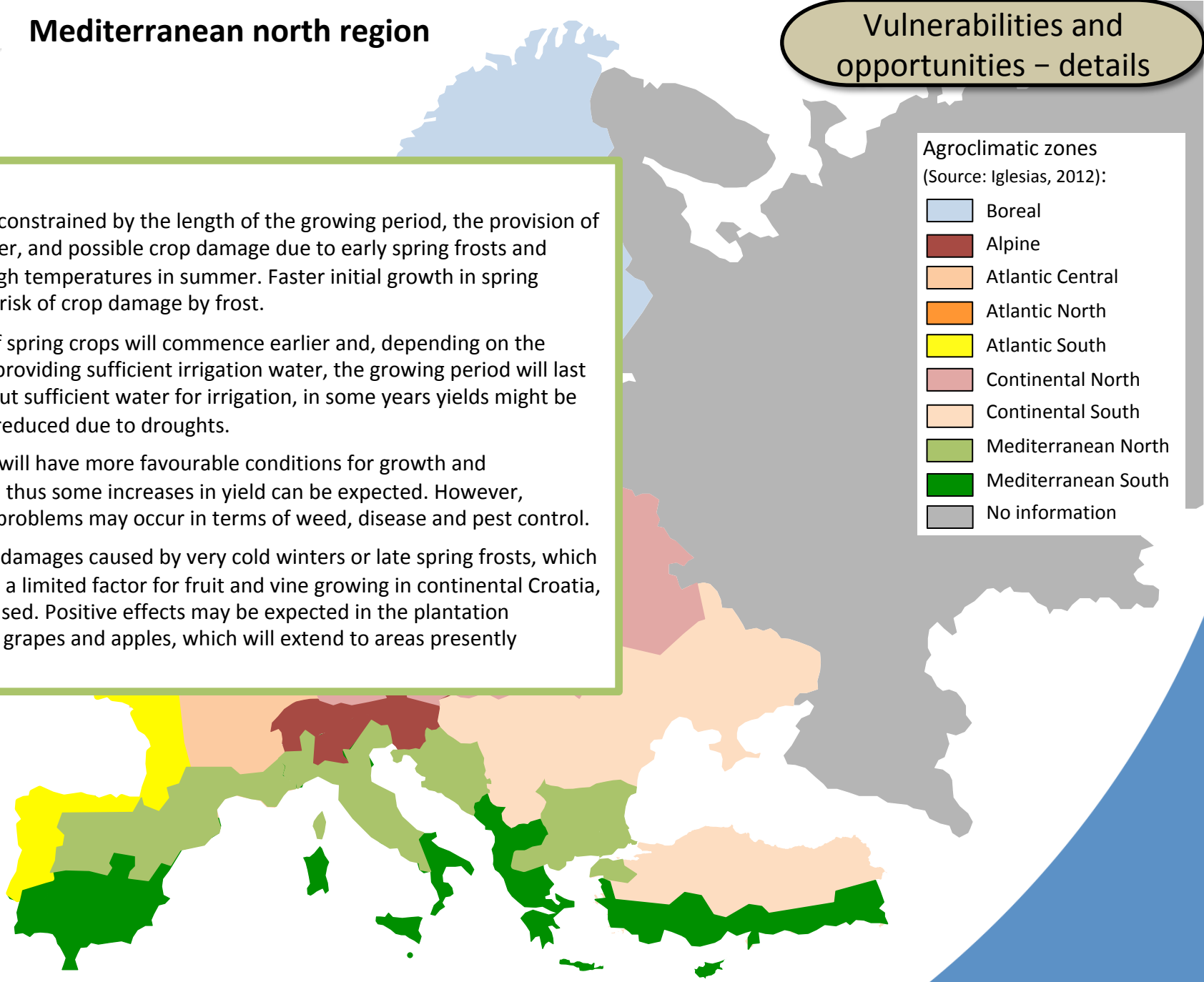
Sources: Behrens et al. (2010); Fraser et al. (2013); Malek and Verburg (2018)

Mediterranean north region

Vulnerabilities and opportunities – details

Croatia:

- Yields will be constrained by the length of the growing period, the provision of sufficient water, and possible crop damage due to early spring frosts and excessively high temperatures in summer. Faster initial growth in spring increases the risk of crop damage by frost.
- The sowing of spring crops will commence earlier and, depending on the possibility of providing sufficient irrigation water, the growing period will last longer. Without sufficient water for irrigation, in some years yields might be substantially reduced due to droughts.
- Winter crops will have more favourable conditions for growth and development, thus some increases in yield can be expected. However, considerable problems may occur in terms of weed, disease and pest control.
- In the future, damages caused by very cold winters or late spring frosts, which are nowadays a limited factor for fruit and vine growing in continental Croatia, will be minimised. Positive effects may be expected in the plantation production of grapes and apples, which will extend to areas presently unsuitable.



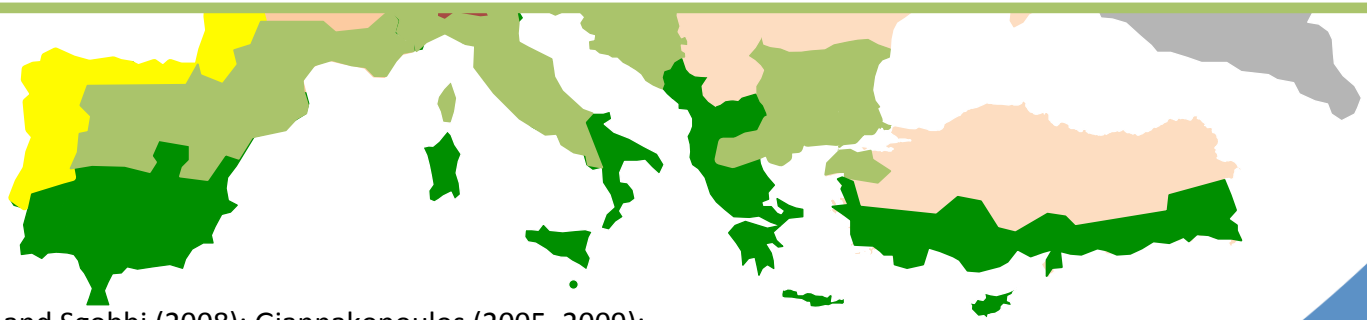
Source: Mesic (2011)

Mediterranean north region

Vulnerabilities and opportunities – details

Vulnerabilities Italy

- In southern Europe large yield declines are expected for spring-sown crops (e.g. maize, sunflower and soybeans), spring-summer crops (e.g. tomatoes) as well as for autumn-sown crops (e.g. winter and spring wheat). In particular, in the European Mediterranean region increases in the frequency of extreme climate events during specific crop development stages (e.g. heat stress during flowering period, rainy days during sowing time), together with higher rainfall intensity and longer dry spells, are likely to reduce the yield of summer crops (e.g. sunflowers, soybean).
- Lengthening of the growing period of about 10-15 days per each °C of rise in yearly average temperature and consequent shortening of cold winter periods are expected. Consequently, olive tree, citrus tree and vine cultivations would be favoured in the north of Italy, whereas corn cultivations would be disadvantaged in the south.
- Mid-century: negative impacts of climate change (drier and hotter conditions) have been suggested for the southeast of Italy on wine production (decrease by 20-26 %) and olives production (harvest decrease by 8-19 %), and minor impacts on wheat harvest; in these results, no adaptation of crops and no fertilization effect of CO_2 was considered.
- End of the century: under a moderate scenario of climate change, both negative (soybean, maize, sweet potato, green beans; up to a few %) and positive (wheat, potato, maize; up to 10.8%) yield changes are projected for Southern Europe (compared with the 1990s). Under more extreme scenarios, yield reductions of 0 to 27% have been estimated for winter wheat, spring wheat, rice, grassland, maize, and even of 71-80% for durum wheat.
- Up to 2°C, an increase of atmospheric CO_2 may favour the growth of several species, provided that sufficient water and soil nutrients are available. Problems will arise for those regions where climate change is causing processes of aridity and soil degradation, and for those regions where frequency and intensity of extreme meteorological events are increasing.

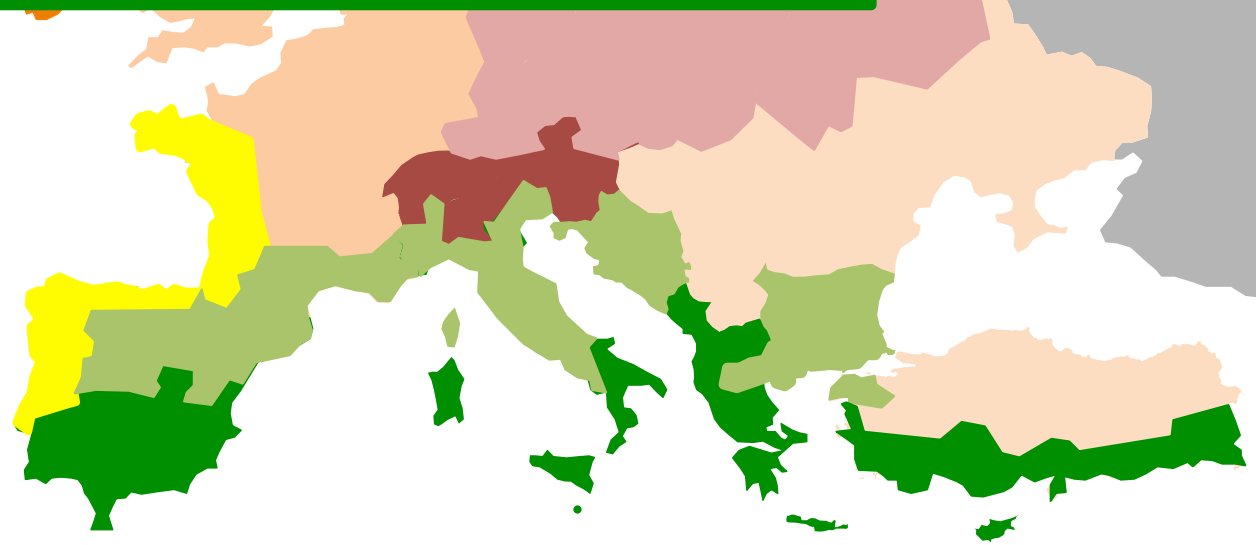


Sources: Carraro and Sgobbi (2008); Giannakopoulos (2005, 2009); sources in MET Office (2011); Ventrella et al. (2012); Lionello et al. (2014)

Mediterranean south region

Vulnerabilities and opportunities – outlines

Vulnerabilities and opportunities:
For the southern Mediterranean, the main risks concern the consequences of potential reductions in total precipitation. Hence strategies need to be considered to conserve as much water as possible over winter to maintain supply during the summer. No significant opportunities were identified in this zone. The impacts of climate change are forecast to be so serious that it may lead to land abandonment.
The southern Mediterranean is likely to experience an overall reduction of crop yields (legumes, cereals, tuber crops) due to the change in climate. Increases in CO_2 help to reduce the loss in yield arising from a warmer and drier climate, but is not able to completely offset the losses.



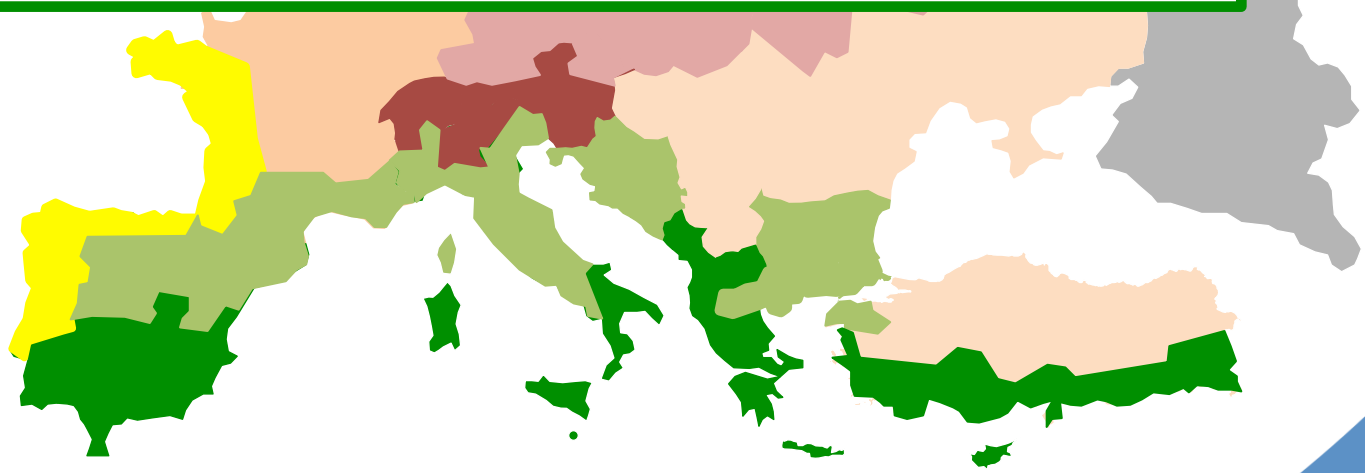
Sources: Giannakopoulos et al. (2005); Iglesias (2012)

Mediterranean south region

Vulnerabilities and opportunities – details

Albania:

- Higher temperatures during the growth season will increase the development rate of all winter crops, which will therefore face extreme events (cold spells) at a later stage when they are more sensitive.
- In general, higher temperatures may shorten the reproductive cycle of many pests, thus the risk of crop damage from pests and diseases may increase.
- A rise in mean temperatures tends to lower the yields of many crops. This is mainly a consequence of faster plant growth, resulting in more rapid maturity and reduced accumulation of organic matter
- Other impacts are: increased risk of drought and water scarcity; increased irrigation requirements; soil erosion, salinization, and desertification (soil erosion is a huge problem in Albania: 60% of the territory is affected); deterioration of conditions for livestock production; sea-level rise and intrusion of salt water into the soil.
- The direct impacts of changes in temperature and precipitation in the future will be mixed. Climate change is forecast to improve yields of wheat and irrigated alfalfa, to reduce harvests of grapes and olives, and to have relatively modest effects on tomatoes, watermelons, maize, soybean, grassland and non-irrigated alfalfa.



Source: Diku (2011)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