Atlas of Climate Change and its Agricultural Impacts in the Americas

Effects on crop productivity, irrigation water requirement, climatic risks and effects on ecosystems

Vulnerability and adaptation to climate extreme in the Americas

VACEA Project

UNIVERSITY OF CHILE
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ATLAS OF CLIMATE CHANGE AND ITS AGRICULTURAL IMPACTS IN THE AMERICAS

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INTRODUCTION

Ever since humans developed agriculture and settled in the territory about 8,000 to 10,000 years ago, they have had to cope with adverse weather conditions such as drought, heavy rains and extreme temperatures. They learned that the crop production was subjected to large uncertainties which contributed to their rising food insecurity lifestyle. In response, they learned how to store seeds and food, and began to create an incipient agricultural irrigation technology, seed selection and fertilization. With this, a basic principle of economics was also born, which produced better and more products with fewer resources consumed.

Little has changed after 8,000 years and modern agriculture is continuing to face the same problems; to a some extent that the planet has begun to show signs of stress. This paradigm has become more complex, adding an urgent need for eco-efficient production systems designed to generate the smallest environmental footprint.

In recent decades there has been a growing perception that agriculture, like other economic activities, has left important traces such as the reduction of biodiversity, soil erosion, water pollution, ecosystem fragmentation and, to a lesser extent than other human activities, has contributed to climate change. Projections suggest that, this century, our planet will lose 30% of its biodiversity. Desert regions could expand by 10 million Km2, cultivable lands per person may drop below 0.15 ha, climate could become hostile for agriculture in 450 of the 1500 million cultivable lands on Earth, and ice bodies may be reduced by 50% before the end of this century. Moreover, humankind will need to continue producing foods and agriculture will continue to be one of the most powerful tools to fight poverty and social exclusion. The paradox is that the human footprint on the planet is threatening to marginalize millions of small farmers in the world, which could be rigorously affected by a widespread climate change.

To prevent climate change from becoming a social disaster, there is a need to revise the paradigms of food production in order to harmonize it with a biosphere that is showing signs of exhaustion. This could complicate the food security of the 9000-11,000 millions of earth's inhabitants that will populate the planet during this century. This reflection is a small step in that direction.

• What the change represents for agriculture

Climate change is not just a simple projection of atmospheric science; it is a phenomenon that we have been living with for almost a century. Changes in climate behavior have been more evident in some regions of the planet than in others, depending on the macroclimatic mechanisms operating in each. Temperatures have risen by almost one degree in the last century, but in very specific areas. Temperatures have also fallen as a paradoxical result consisting in a reinforcement of the flow of polar air masses into middle latitudes or the increasing flow of air masses entering from the ocean to the continent (occidental coasts). Rainfall has tended to decline in areas where the climate is influenced by cyclones (desert boundaries) and to increase in cyclonic regions (intertropical areas). Rainfall has tended to increase in intensity throughout much of the planet, creating risk for the population and ecosystems (Valdes et al., 2010, Cote et al., 2010, Santibañez et al, 2014).

Wind frequency and speed, extreme temperatures, hail, heat and cold waves, and polar frosts have also shown signs of changing towards a more unstable and threatening regime. All these changes are in line with what is expected by climate science, following the logic of a perfectly unstable thermodynamic system. In general there is enough scientific consensus that the atmosphere could change abruptly if the warming trend takes the average global temperature from the current 15 ° C to over 18 ° C. Above that limit, the earth's atmosphere could tend to find a new balance between the kinetic energy of winds, ocean currents, pressure gradients, air density, and vapor content. This could completely change the current climate zones of the planet, forcing humanity to face major problems of unknown proportions. This justifies the concern of the COP 21 to reach an agreement that will prevent global warming beyond 2°C (IICA, 2015).

Agriculture is extremely vulnerable against climate change considering that it is based on only about 30 species, which provide 90% of human food. (FAO, 1997). With domestication, many of the species that feed us have almost completely lost their ability to survive without the help of man. They were subjected to a selection that made them lose their hardiness in favor of productivity. This change has made it humankind's duty to help them survive, which puts us in a situation of extreme vulnerability to face a changing global climate scenario. Agriculture occupies territories where the physical environment enables crop species to meet their bioclimatic requirements. A rise of 2°C could significantly decrease the current climatic suitability for wheat, maize, potato and rice cultivation; forcing a dramatic drop of crop yields (Santibañez et al., 2014). This will cause a lot of agricultural activities in the world to migrate, seeking to maintain productivity. Today it is difficult to predict whether a change of geographical area will not encounter other problems, making this change an uncertain solution. This also causes social imbalances, because small farmers do not have the geographical mobility they require (FAO, 2007). This raises the need to work on adaptation strategies that enable small farmers to cope with climate change while maintaining their economic viability. The new climatic times will require: new technologies, new genotypes, improved management systems of natural resources, more efficient management of inputs and crop protection practices, superior processing and storage systems, and better systems of risk assessment and management. This will ensure sustainability and competitiveness of food production under different climate scenarios.

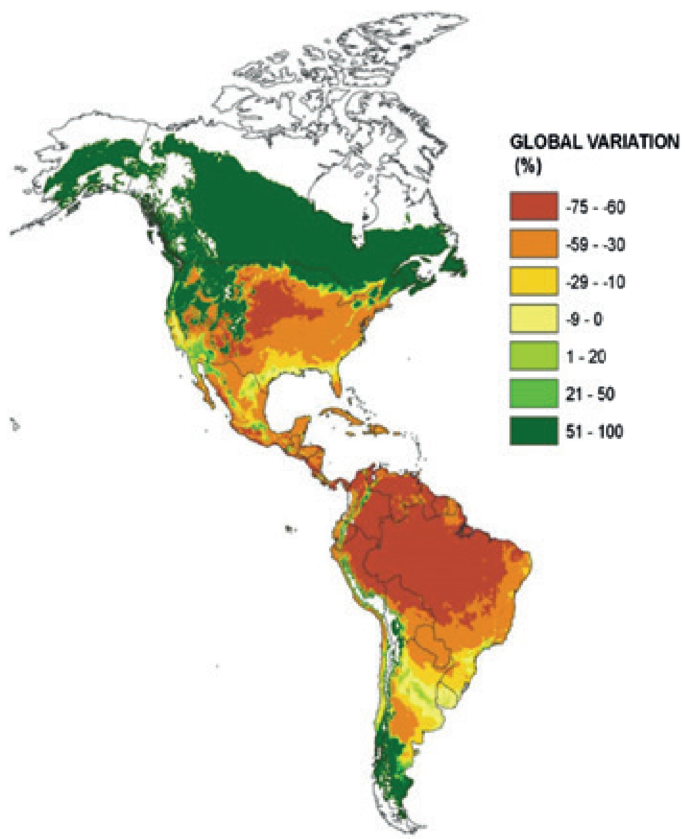

Figure 1: Average change in wheat, maize and rice yields. The yellow-brown colors are areas where yields would decrease and green would improve with respect to the current situation. This projection assumes no adaptation measures. *(Source: Atlas of Climate Change in the Americas, unpublished work of the author).*

• What is at risk in agriculture for the Americas due to climate change?

The main expected climatic changes are different depending on latitude. The arid and semiarid subtropical climates (deserts and steppes) like those of Sonora, Chihuahua, Arizona, and the Atacama desert in South America are likely to move toward the poles, making the important agricultural areas in California and central Chile more arid. In these areas, water availability will become the main limitation for agriculture. The intertropical zone could register a deterioration in weather conditions due to the intensification of a convective rainfall regime, creating risks of soil erosion, landslides, and hydrological acceleration. Likely to the point that climate could become more arid in much of Mesoamerica.

In parts of the Andes of Ecuador and Colombia, rainfall could increase due to greater transport of moisture from the Pacific to the continent. However, in most parts of Brazil, and the south of Argentina and Chile, rainfall seemingly will decline during this century. Some rainfall increase is likely to occur in southern Brazil, Uruguay and northeastern Argentina. Rainfall will decline in the most part of Mexico and the western United States, to increase in eastern and much of Canada. The paradox is that in many of the regions where precipitation might increase, does not mean an increase in the water availability. This is because heavier rains are less effective and increase evaporation due to the rise in temperature. Finally, these changes contribute more negatively than positively to agriculture. Without adaptation measures, the combination of reduced water availability and a more stressful temperature could lead to a yield drop of up to 50% in the warmer parts of the continent. Changing planting dates to the fall could mitigate this problem but never avoid it. The northern and southern limits of the growing areas could shift several hundred kilometers towards the poles, which could induce strong changes in land use in middle and high latitudes.

The more continental cultivated lands would be most affected because of the increased frequency of heat waves and extreme temperatures that can be very harmful to yields. The increase in the number of hours with temperatures above 32°C leads to a sharp reduction in the number of hours a day that plants can take advantage of the light, which requires hours with temperatures below this threshold during the light period. South and north of the parallel ±40° agricultural potential may have significant improvements, especially for corn, wheat and potatoes. In Central America and the Caribbean, almost all crops yields would drop due to heat stress (meanly daytime) and shortened life cycles. In many cases, growing areas would advance on lands that do not have productive infrastructure (irrigation, communications, roads, processing centers), which involve a strong development and investment effort. The arrival of intensive agriculture to areas that may be currently occupied by native vegetation can accelerate degradation of coastal, southern, boreal, and highland ecosystems. Climate change scenarios show that the western coastal zones (Pacific) could register a more moderate rise in temperature due to the cooling effect of the air masses coming from the Pacific Ocean. These coastal areas could host a large part of agriculture displaced from the more continental areas. The highlands along the Andes could play an equal role in the future.

The flat continental lowlands could be subjected to extreme flood events, hail, heat waves and intense cold and drought. Even if rainfall does not decrease, evapotranspiration could increase significantly in continental areas, increasing crop water requirements. This suggests that new cultivation methods will require the use of sheltered crops, avoiding the negative effect of wind, extreme heat, frosts, hail and insects.

• What does agriculture need in order to address climate change?

Current agricultural systems are characterized by high inputs, energy and the use of genetically homogenous plants. Production systems are designed to produce as quickly and as much as possible, under management systems in which all factors of production are controlled. This should not change radically under a new climate scenario. However, part of the subsidiary energy added by humans should go to protection and prevention of the negative effects of climate extremes. This would be in order to mitigate the increased aggressiveness of physical and biological agents that will threaten production, so as to provide a similar microclimate to current conditions. It is likely that any future agroforestry project will need more rigor in considering the nature and intensity of agroclimatic risks, before deciding the viability of a particular land use or production system to be adopted in each case.

Today, when designing an agricultural project, the agroclimatic risks are incorporated intuitively but are not part of the rigorous calculations of the financial flow of the project. There are numerous examples in which agricultural projects have failed for lack of a detailed analysis of the risks associated with land use strategy, making projects economically unfeasible. This however, doesn't become evident until several years after the decision. Similarly, protection systems against climate extremes are just emerging in modern agriculture (irrigation systems to reduce stress, higher synthetic protections, anti-insect mesh, windbreaks, chemical screens, and invigorating products to recuperate periods of stress). In each system the what, when and how to be used has not been systematically addressed. This is an issue that is up to the initiative of each project manager. To cope with these decisions also requires a wealth of information in real and deferred time. This now is just emerging as a necessity. However, there are no broadcast channels, no systems to translate instrumental data into information with added value, and no platforms that incorporate real-time and deferred risks to the decision systems as needed for farmers. Finally, a key piece is the necessity of capacity building at the level of farmers, managers and technical advisors. This essential approach enables the interpretation of both climate information and associated risks, translating it into decisions that reduce exposure of production systems. Equal levels of training are required to design less vulnerable and more resilient systems to a more unstable and threatening climate (Government of Chile, 2013).

An adaptation plan components

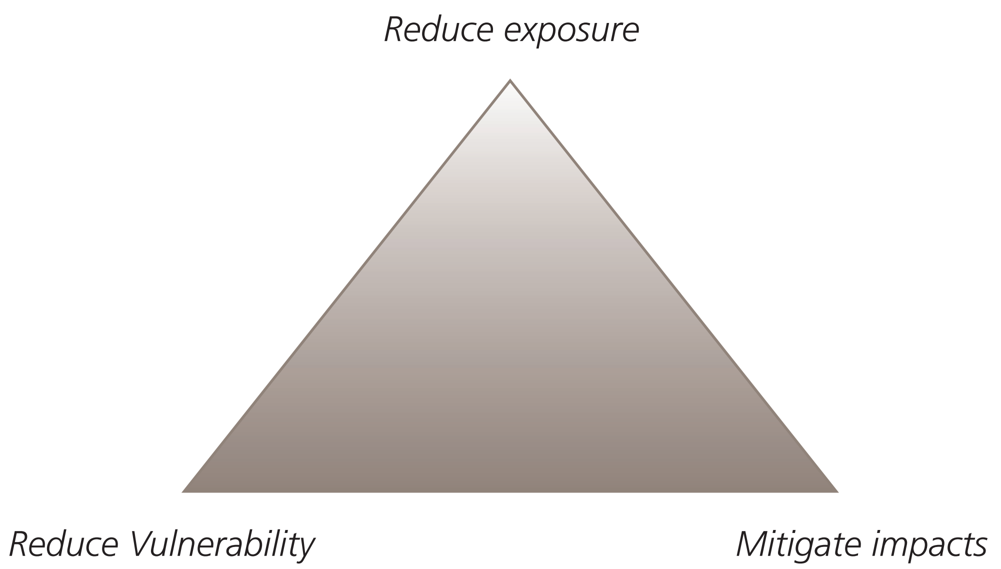

Figure 2: An adaptation plan components. An adaptation plan should contain a balance between the three dimensions. It should reduce exposure, reduce vulnerability and mitigate impact.

• How to overcome the gaps towards adaptation

A sound adaptation plan should balance three components: reducing the exposure of agriculture against risks, mitigating the impacts of these risks, and improving the resilience of farming systems (Ministry of Environment, Ministry of Agriculture (CHILE), 2011). The first task involves a pattern of land use according to the effective risks of the local agro-climatic conditions, introducing the concept of passive risk prevention. The second component represents those technological interventions to address the risks, minimizing their negative action on returns. This involves promoting concrete actions for farmers to access new technologies that will mitigate the negative impact of a new climatic context. The third component refers to the capacity building at the level of decision and policy makers to design strategies that give sustainability to agriculture under the pressure of a new climate behavior. None of these three concepts can be neglected if there is a desired move towards a sustainable adaptation of agriculture (Ministry of Environment and Natural Resources (Mexico), 2013). An effective strategy must contain elements of territorial reorganization of land use, technological changes of the cropping system, and the installation of permanent human capacity to make the adaptation a dynamic and flexible process.

Reducing exposure towards risk requires an in depth knowledge of the levels of risk that local agriculture is subject to. Knowing these risks, one can guide the land use so as to ensure minimal exposure of crops to these. The basic principle is that each crop must be cultivated in the right place. In many cases risk minimization is achieved by finding the optimal planting date, in order to grow in the climatic windows allowing the least meteorological risk. When farmers have crop protection systems (frost, rain, hail, or wind), early warning systems are essential to alert them on extreme events, enabling the reaction time needed to manage protection systems.

When an extreme weather event materializes, it will be necessary to mitigate negative impacts by passive means. This includes redesigning production systems, diversifying land use, and using species and varieties that are resistant to climate threats. Furthermore, active practices such as protection systems based roofing systems, evaporative cooling, ventilation, chemical screens, insect and diseases control systems will be needed.

Cropping systems should consider greater biodiversity in the future. Monoculture does not seem to be the best strategy for small and medium-scale agriculture because it leads to high levels of instability, becoming incompatible with the objectives of small farmers. Farmers are better prepared to cope with climatic variability by adopting diversified cropping systems than just monoculture. Additionally, the combination of high woody and annual species can be more resilient to climatic extremes, considering the microclimate created by trees at the soil surface. Species diversity may also contribute to a better control of biological threats, improving the balance of predators or natural enemies of pests. In livestock systems, multilayered grazing systems are particularly useful to optimize the stocking rates and to stabilize inter-annual forage production (FAO, 2007).

Systems to reduce bioclimatic stress will take particular importance during this century. There are numerous technologies that protect cultivated plants from climate extremes and reduce stress levels caused by these. The technologies that reduce sun exposure range from synthetic roofs, frost control systems, protective cooling netting to chemicals. A major challenge is to create cost effective protection systems to make these technologies supported and compatible with smallholder agriculture.

Genetic resources that are resistant and resilient to climate extremes play a key role in adapting agriculture to more extreme weather. In Virtually all areas of the region, there are commercial varieties and breeds of cultivated species that have stopped growing. These represent an interesting genetic potential which can be improved or serve as a source of genes for hardiness to improve commercial varieties. An important role could be played by a comprehensive register of local genetic resources (land races) per species. This could serve to encourage a program of exchange of genetic material between regions so as to test the behavior environment x genome in a large number of combinations. This could also serve to identify genes having potential to adapt cultivated species to more extreme weather.

Reducing vulnerability of agriculture to address climate extremes implies profound changes in the agroforestry system. This is achieved by incorporating technology and having better decisions systems harmonizing agriculture activities with the nature and intensity of upcoming threats, and also with the natural environment in which the activity takes place. These changes involve capacity building at different levels, from farmers to policy makers.

Efficient water management cannot be absent from any climate change adaptation program, considering that most of the agricultural regions of the continent will be affected by reduced availability of this resource. Agriculture is the largest consumer of water; however this is very often, administrated with low rates of efficiency. Small farmers usually have limited access to water resources, exacerbating the problem. It is necessary to design cost effective irrigation and water conservation systems to maximize efficiency, applicable to small farms. Many of these systems should be designed considering the available resources and capacities of local farmers. Some examples of these technologies are rainwater harvesting, infiltration systems, subsurface irrigation systems, and water recycling. It is important to make a compilation of traditional techniques, which were abundant in the pre-colonial period in America.

The efficient management of energy and inputs will be essential in maintaining the competitiveness of agriculture. The self-generation of energy (biogas, biomass, wind, solar), recycling of nutrients and organic matter (compost, digestate, biofertilizers), and changing the use of chemicals by agro-ecological practices (biodiversity, natural predators, low impact inputs, ecological soil management) can greatly help maintain the sustainability and competitiveness of small farms; making more efficient input/output ratio on a small scale.

The integration of agriculture to landscape (or territory) is the paradigm of the century. Agriculture is a consumer and producer of ecosystem services so it is necessary to design strategies that enhance the interactions between agriculture and the biophysical system supporting food production (biodiversity, water infiltration, food chains of beneficial organisms, aesthetic goods, conservation of threatened species and ecological niches). We must move forward in identifying protocols, evaluation and integration of ecosystem services between agricultural systems and the environment (De Fries and Rosenzweig, 2010). The concept of collective protection of natural heritage into territorial units has been underdeveloped. Smallholder agriculture can be the supplier and recipient of these services, including agrotouristic services that could result from these actions.

Giving sustainability to production systems is more than just a good agricultural practice; a good system of risk-based decisions, timely information, and low environmental impact management protocols (reducing carbon, water and ecological footprints) is required. Additional components of a sustainable production system are a rational management of economic resources, marketing systems for inputs and outputs with a capacity to react to the unexpected, and an integration of added value chains that stabilize marketing channels. So far research institutions have parceled knowledge and have transferred such without a necessary integration. The aim is to develop a systemic vision of the structure and dynamics of production units (farms) that allows assistance to farmers in managing a set of success factors, considering that a changing climate will require periodic adjustments of the system.

All this requires more trained actors to promote the transformations; we need farmers that are best prepared to accept changes, technical advisors that understand emerging problems, and public administrators and policy makers with a clear vision of the future. More clarity is needed on the nature of threats, vulnerability of systems, standards and treatment of agro-climatic risks, the role of technology, changes in land use, and prioritization of threats and solutions. These require models that allow effective multidisciplinary exercises in finding the optimum for each case. Agricultural research must move beyond the old concept of "technical optimal". The future of small farmers will need to work with the concept of "optimal strategy," which means those solutions that guarantee farmers stability, sustainability and compatibility with their production resources.

The State must take an active part in the design and promotion of instruments of development, and the financing of participation strategies, ethics and practices of environmental intelligence. It could be especially useful to provide the installation of prospective capacities, on the basis of multidisciplinary teams in charge of shaping the present in order to project the future. By looking towards the future we can judge whether we are doing well in the present. This would allow the state to prevent crises, anticipate problems and make public policies with an adequate vision of the problems that are to come.

States need to adequate governance, in order to make them more efficient in promoting adaptation. To do so requires structural and functional harmonization of the institutions responsible for carrying out adaptation policies.

An essential issue for adapting agriculture to new climate scenarios will be the capacity to model and assess agricultural vulnerability at different scales, from global territory to agricultural farms. This needs a capacity to integrate social, cultural, economic, technological, biological and environmental perspectives (Barrow, 2006). Modeling of agricultural vulnerability allows the finding of bottlenecks in successful adaptation strategies (which are essential to guide actions towards the barriers) that could limit the speed of the required changes. Vulnerability and adaptability are opposing concepts; no country can implement successful adaptation strategies without having a complete and comprehensive sight of the origin and intensity of the vulnerability characterizing different agricultural systems (Ahumada, 2015).

Avocados seriously affected by drought in Petorca Valley. Chile.

HIGH RESOLUTION CLIMATE SCENARIOS

Local weather will undergo important changes as a result of global warming. The spatial distribution of these changes will strongly be determined by the combination of local factors that model meso-climate: marine effect, terrain, altitude, cold marine upwelling, etc. In order to have a spatialized vision of future climate scenarios, under the framework of the VACEA project, a system has been developed to allow the integration of information from global and regional climate models, ground climatological information, satellite thermal images and the elevation model.

Global Circulation Models (GCM's) were used to project changes in atmospheric variables under climate change scenarios defined by the Intergovernmental Panel on Climate Change (IPCC). They have low spatial resolution, from 150 to 300 km approximately, so they cannot be used directly at the scale of local hydrographic basins in order to assess the impacts of climate change. For this, regional downscaling models that provide higher spatial resolution are required, typically from 10 to 50 km. For detailed studies, even greater resolution is required, particularly for models related to hydrological, agricultural and ecological systems. The models used in these applications generally require resolutions in the order of 1 km2 in order to represent the diversity and complexity of the territory. This is especially important in areas with strong vertical gradients of elevation. This chapter presents a methodology based on the above concepts, for the generation of high spatial resolution climate scenarios.

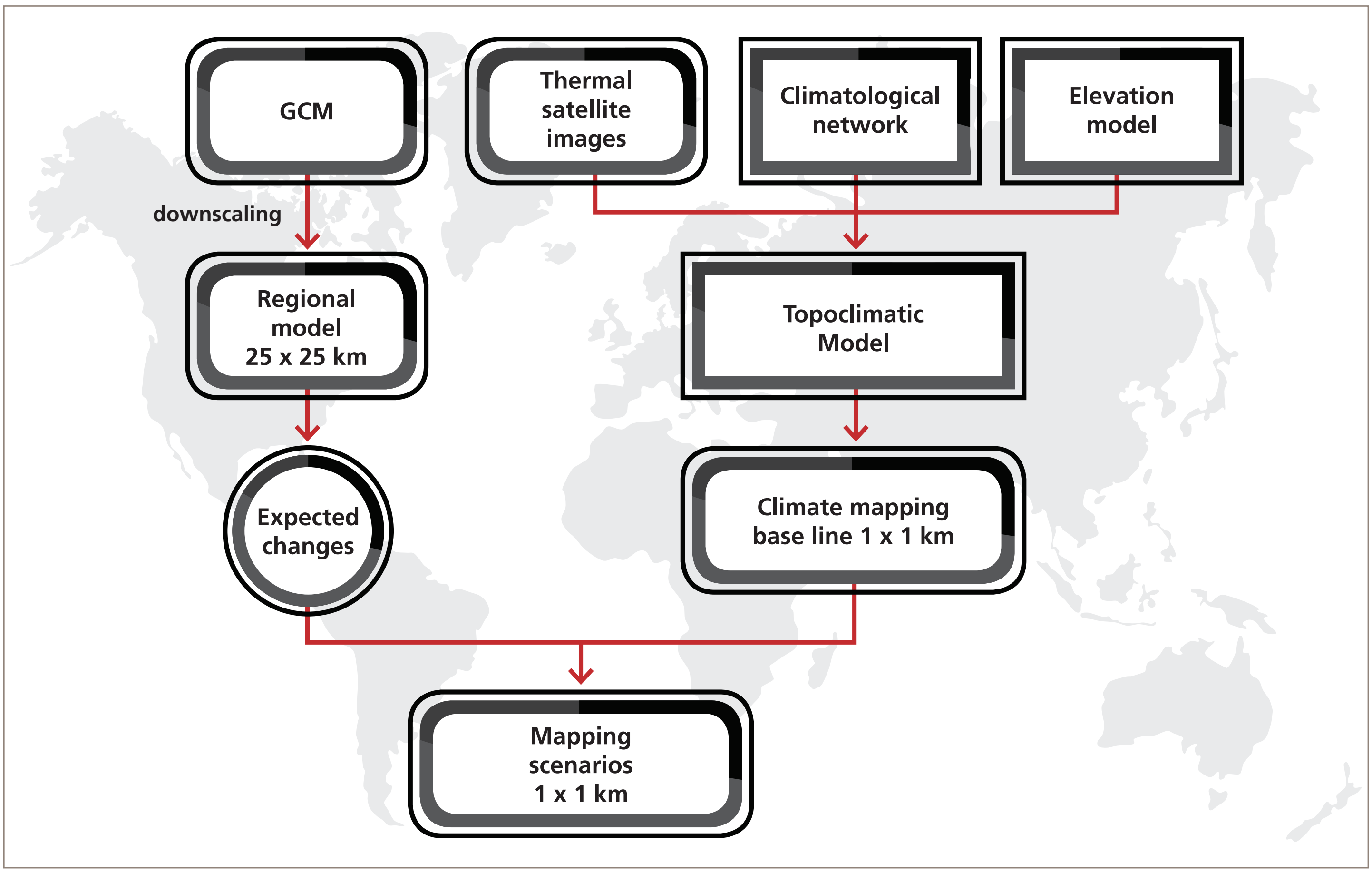

Figure 3: Methodology of the construction of high resolution scenarios.

Corrales dam almost empty in Choapa Valley. Chile.

• Large scale generation of high resolution scenarios

Under the framework of the VACEA project it was necessary to have a uniform basis of climatological information that allowed a perspective on a continental level of the effects of climate change. This in turn made possible the modeling comparison of impacts on agricultures, water resources, and ecosystems, among others. On the other hand it was necessary to have spatialized information that could be handled through Geographic Information Software (GIS). Due to the large amount of computational processes and requirements of these in terms of resources, the large scale scenarios that include the whole American continent, used a climate georeferenced database with a resolution of approximately 10km x 10 km (30").

• Temperature and rainfall

Temperature and rainfall variables were extracted from the climate database available through the WorldClim webpage (www.worldclim.org). Figure 4 shows the density of the weather stations networks used in this study.

a)

b)

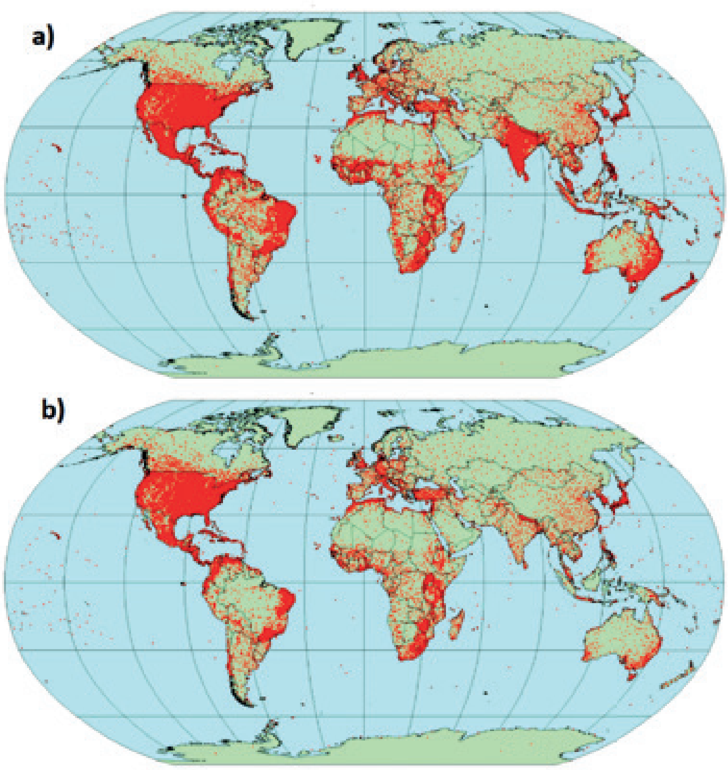

Figure 4: Location of weather stations for precipitation (a) and mean temperature (b).

MAXIMUM TEMPERATURE

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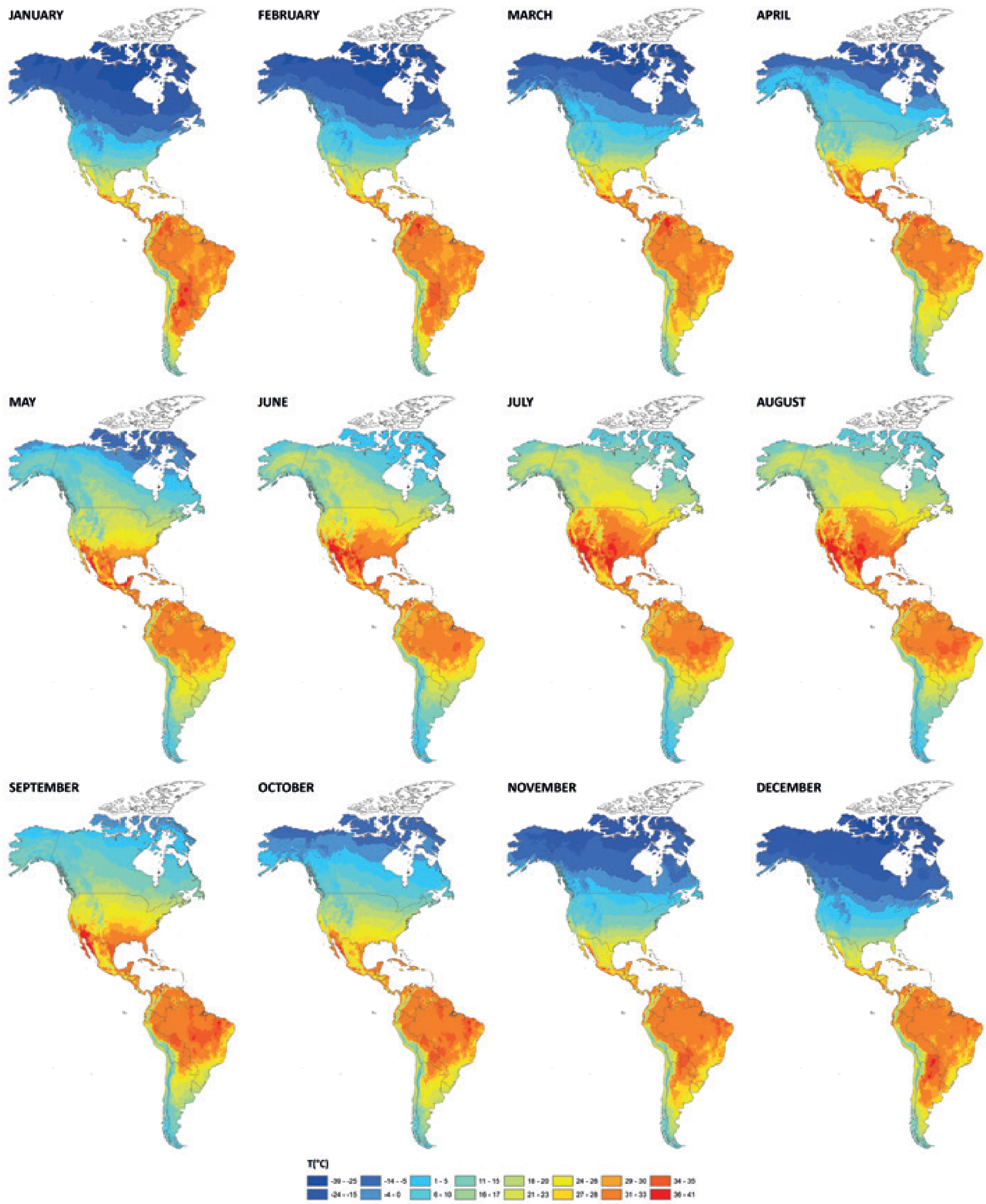

Figure 5: Maximum monthly temperature.

MINIMUM TEMPERATURE

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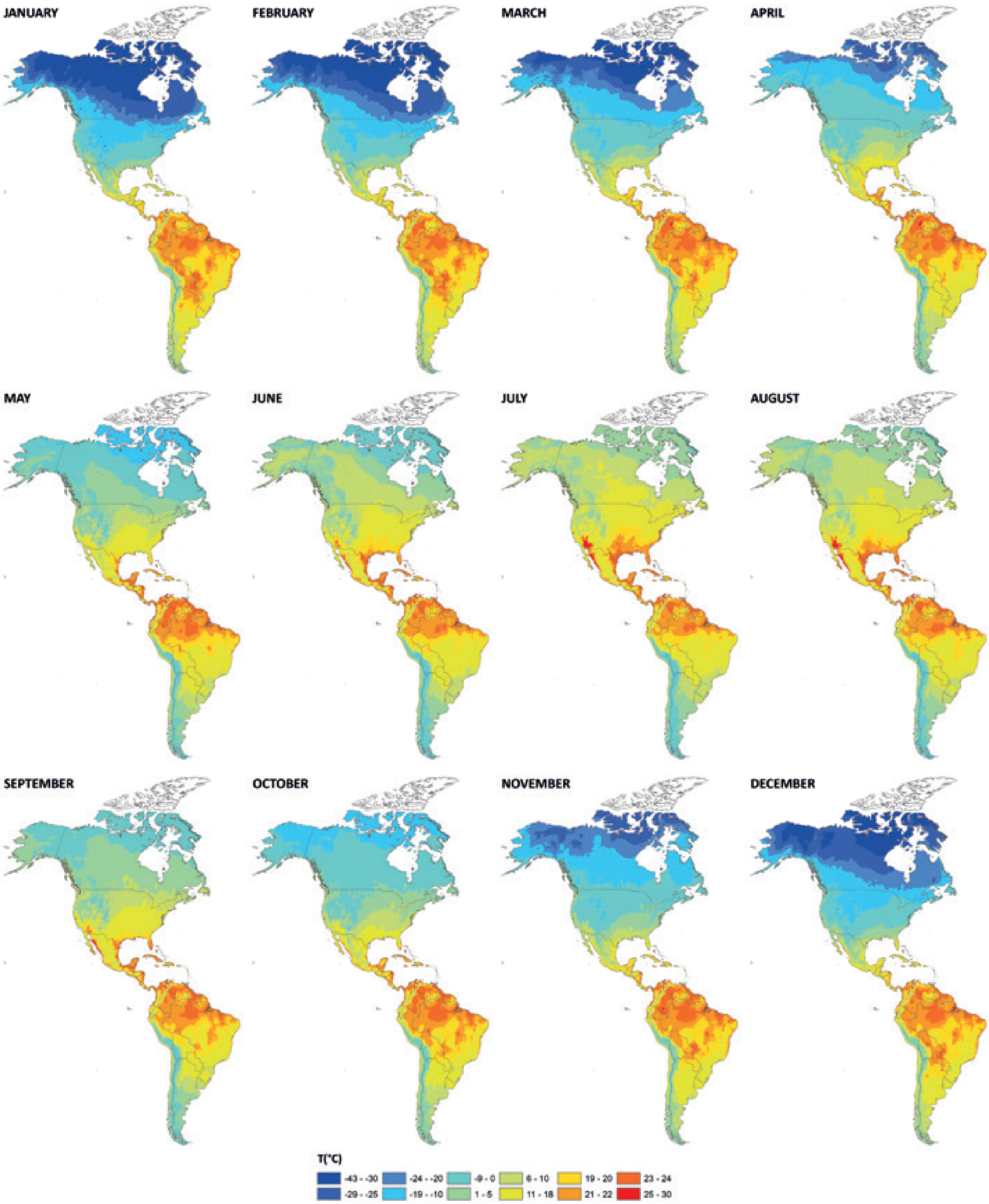

Figure 6: Minimum monthly temperature.

RAINFALL

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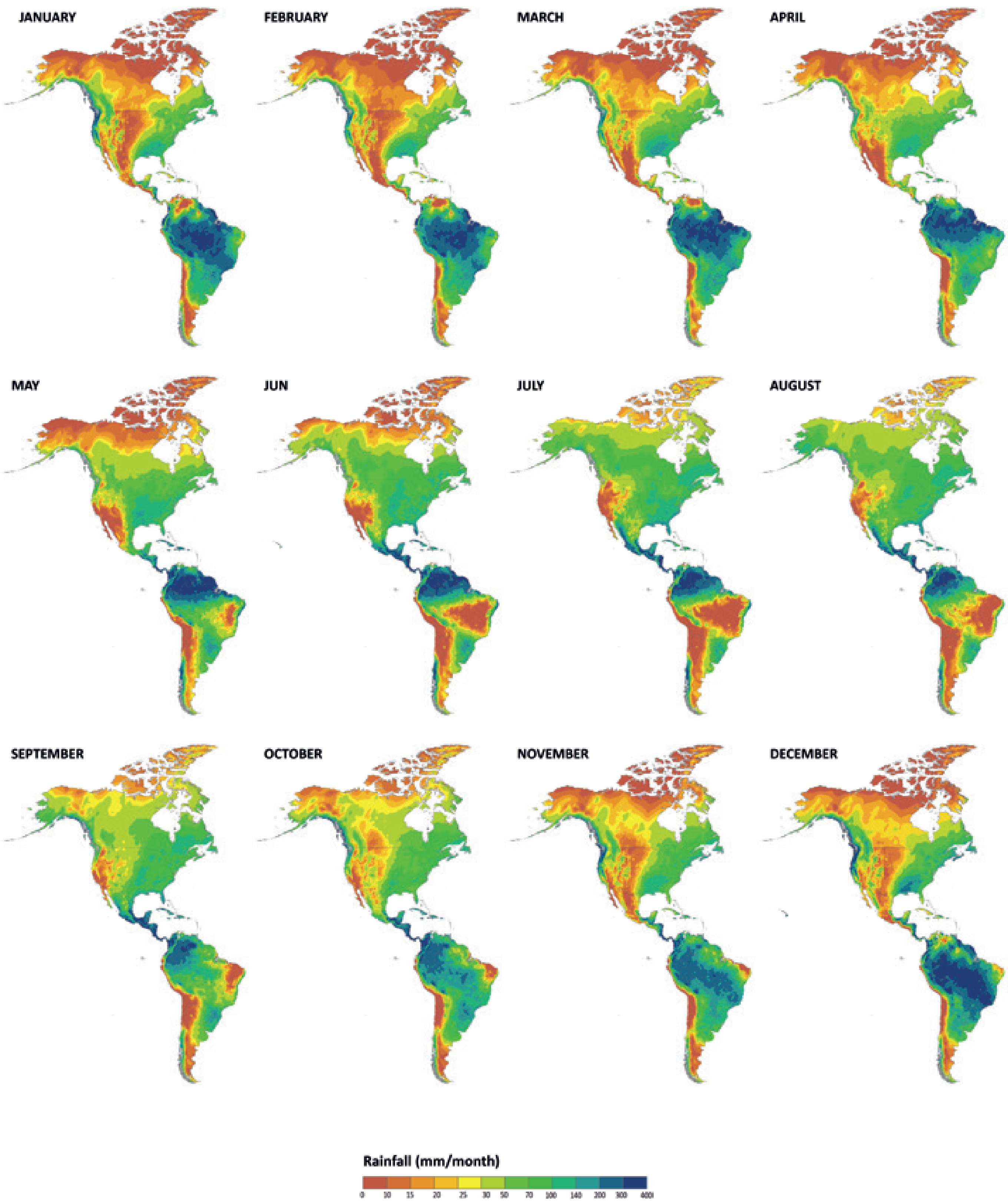

Figure 7: Monthly mean precipitation.

• Generation of baseline climate scenarios from local climate information

As it was possible to prove when analyzing the downloaded data, high resolution large-scale data perfectly meets its objective. But when approaching more detailed scales, which were needed in the pilot areas of the VACEA project, we could see that certain microclimatic surface details were not well represented through the WorldClim data. It is important to remember that high resolution scenarios are obtained from automatic interpolations, which in cases of small scales are not able to represent smaller scale orographic effects. Due to the above, a methodology was proposed to generate small scale scenarios. It was based on field data, corrections through satellite images, and multiple regression models to complete the information as accurately as possible, according to the required objectives. In our case the objective was modeling at a small scale the effects of the expected changes in climate on agricultural productivity.

• Obtaining vertical temperature gradients through the use of satellite images

Thermal images allow us to know the surface temperatures throughout the territory since they represent spatial variations within it. Through these images you can acquire details that the algorithms of spatial interpolation are not able to represent. For instance, thermic islands of concentrated cold air, the Foehm effect or rainfall shadow (climate contrast between east and west hillsides), the tempering effect of the bodies of water on the edges, and the boundary layer of the ocean on the coast, among other singularities.

In the VACEA pilot area in Chile there are about 100 weather stations subject to consideration based on reliability and data acquisition period. However, in some areas (such as mountain areas) there are low densities of stations. In these areas it is required to increase the density of climate data in order to build high spatial resolution cartography. There are some thermodynamic principles that allow temperatures to be modeled in highlands. The air temperature usually decreases 0.6°C per 100 meters of elevation. This value can be considered the normal thermal gradient in the lower layers of the troposphere. Nonetheless, this value may vary locally depending on the “climate drivers” present in each area, such as marine upwelling, water bodies, topography, latitude and other geographic peculiarities. An anomaly that modifies the value of the thermal gradient occurs during periods when temperature is inversed, as the air temperature instead of descending, increases with altitude. This situation is common after several days of stable weather, where the air tends to stratify according to density, leaving the colder air in the first layer near the surface, while the warmer air remains in higher strata. This phenomenon is typical during winter mornings in the central region of Chile in poorly ventilated valleys.

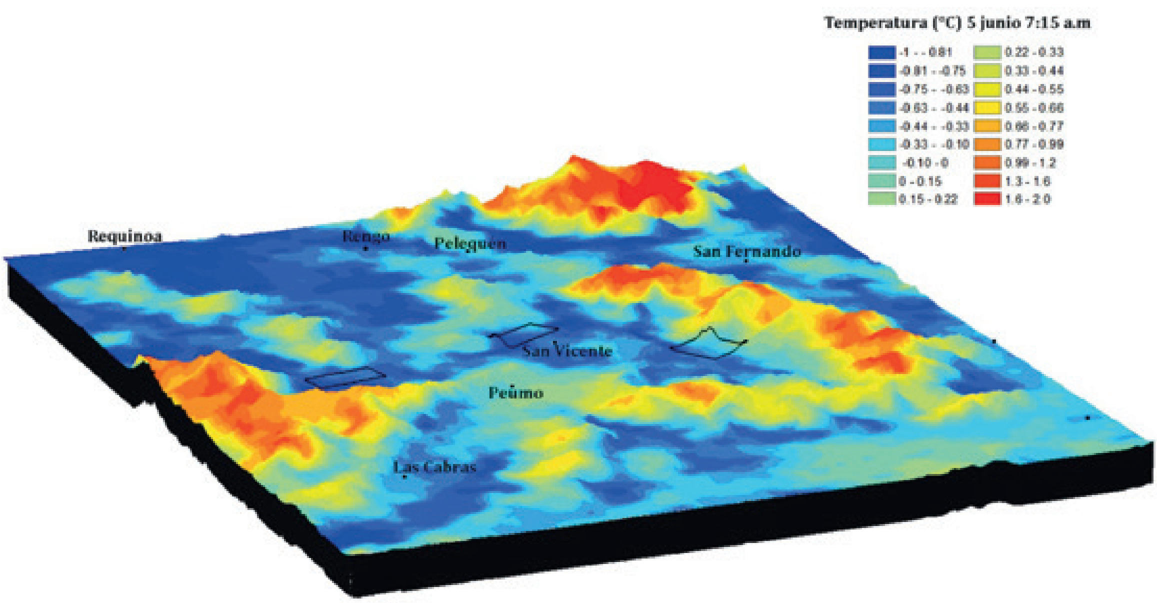

Figure 8: Variations in temperature at microscale during a frost (central valley of Chile). Each color represents a different temperature. The blue colors indicate lower temperatures and green to red, the highest temperatures.

• Densification of information from weather stations

In order to set the interpolation algorithms from the available weather stations, they were densified by the generation of virtual stations (Figure 9). These stations were generated from information coming from thermal satellite imaging (NOAA-AVHRR) and a digital elevation model. We developed a procedure to refine the spatial resolution of the NOAA images, by using an algorithm which adds in new pixels by interpolating the raw information of the original image. Combining these two elements we can determine in each zone the different vertical gradients of maximum and minimum temperatures. This allowed the partial completion of information gaps in certain areas of the territory, particularly highland areas.

• Obtaining high resolution climate cartography

The temperature and precipitation regime was modeled with a resolution of 90 m for the period from 1980 to 2010. This was done through multiple regressions that consider elevation, altitude and distance to the sea in each station as explanatory variables.

In order to obtain a good fit in the generation of regressions, the study area was divided into 3 zones. In some cases it was necessary to further divide the territory into two longitudinal sub-zones: those with more marine influence and those with continental interior sectors. Regressions were quadratic and in some cases cubic.

• Future climate scenarios generation methodology

In order to generate future climate scenarios an assembly was used (weighted average) with 19 models of general circulation of the atmosphere (CGM); which has been included in the Fifth Assessment Report (AR5, 2013) from the IPCC (Table 1). These models were originally generated considering the trajectory of concentration greenhouse gases RCP 8.5 (Representative Concentration Pathway) by 2050. This means that by then the Earth's atmosphere will absorb and convert heat into 8.5 watts/m2 on average, which in the past escaped to the exterior. Such scenario corresponds to the highest rank of forced radiated increase among the existing 4 (RCP 2.6, 4.5, 6.0 and 8.5) and has proven to be the most likely occurrence in consideration of the current trends of greenhouse gases emissions on the planet.

CGM Scenarios		
ACCESS1-0	GFDL-ESM2G	IPSL-CM5A-LR
BCC-CSM1-1	GISS-E2-R	MIROC-ESM-CHEM
CCSM4	HadGEM2-AO	MIROC-ESM
CESM1-CAM5-1-FV2	HadGEM2-CC	MIROC5
CNRM-CM5	HadGEM2-ES	MPI-ESM-LR
GFDL-CM3	INMCM4	MRI-CGCM3
		NorESM1-M

Table 1: CGM Scenarios considered for this study.

Choapa Valley. Chile.

• Future scenarios creation by combining model downscaling and current climatic topography

Once the assembly was made, differentials in temperature and precipitation were applied to the climate cartography baseline generated at a 90 m spatial resolution. In order to correct the value of all the points of the finer grid (micro-scaling) considering the 8.5 RCP variations, the following relation was used:

$$V_f = V_0 * \left(\frac{VH_f}{VH_0}\right)$$

Where:

V_f is the final value in the grid point of higher resolution,

V_0 is the value in the baseline at each point in the higher resolution grid,

VH_f is the final value of the variable in the RCP 8.5 point for the respective quadrant, and

VH_0 is the baseline value determined by the RCP 8.5 for each variable at each point (Figure 6).

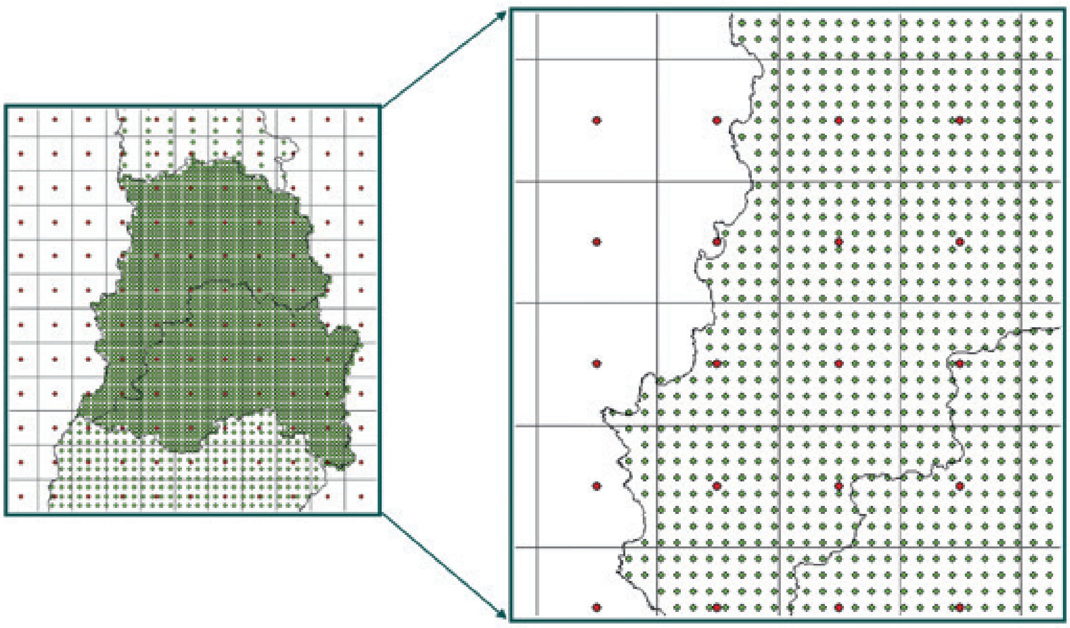

Figure 9: Green Net: climatic cartography at 90 m. Red Net: Data from GCM ensemble used to generate the changes in climatic data for future scenarios.

Thus obtained was a detailed climate cartography of 90m for baseline scenarios (1989-2010) and future scenarios for 2030 and 2050.

MAX TEMPERATURE OF WARMEST MONTH

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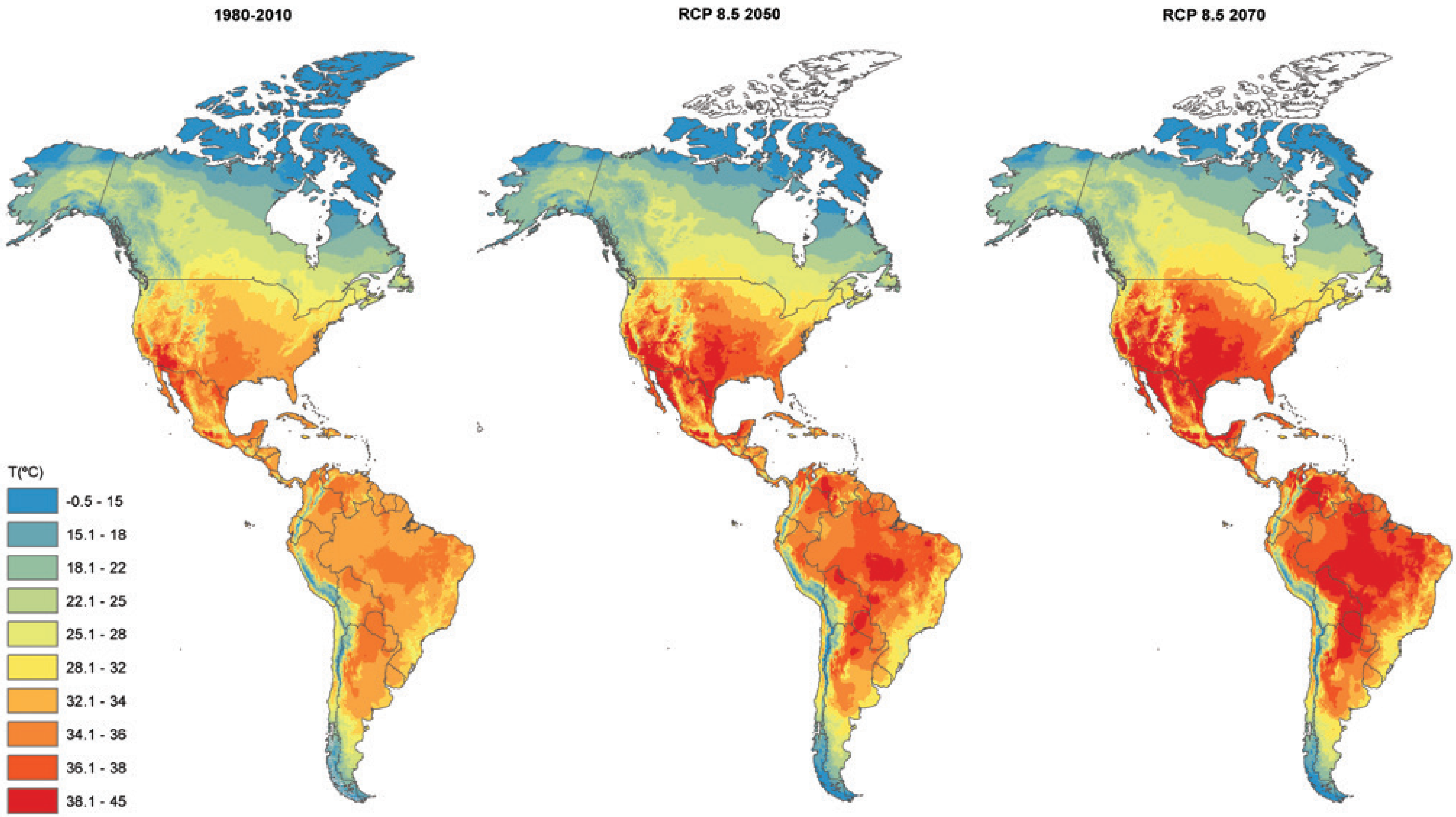

Figure 10: Maximum temperature of the warmest month is a good reference of how hot the summer is. Temperate species do not tolerate temperatures above 25°C for a long period. Contrary, tropical and equatorial species are tolerant to temperatures above 30°C. For this reason, increasingly warmer summers will push both kinds of species poleward.

MIN TEMPERATURE OF COLDEST MONTH

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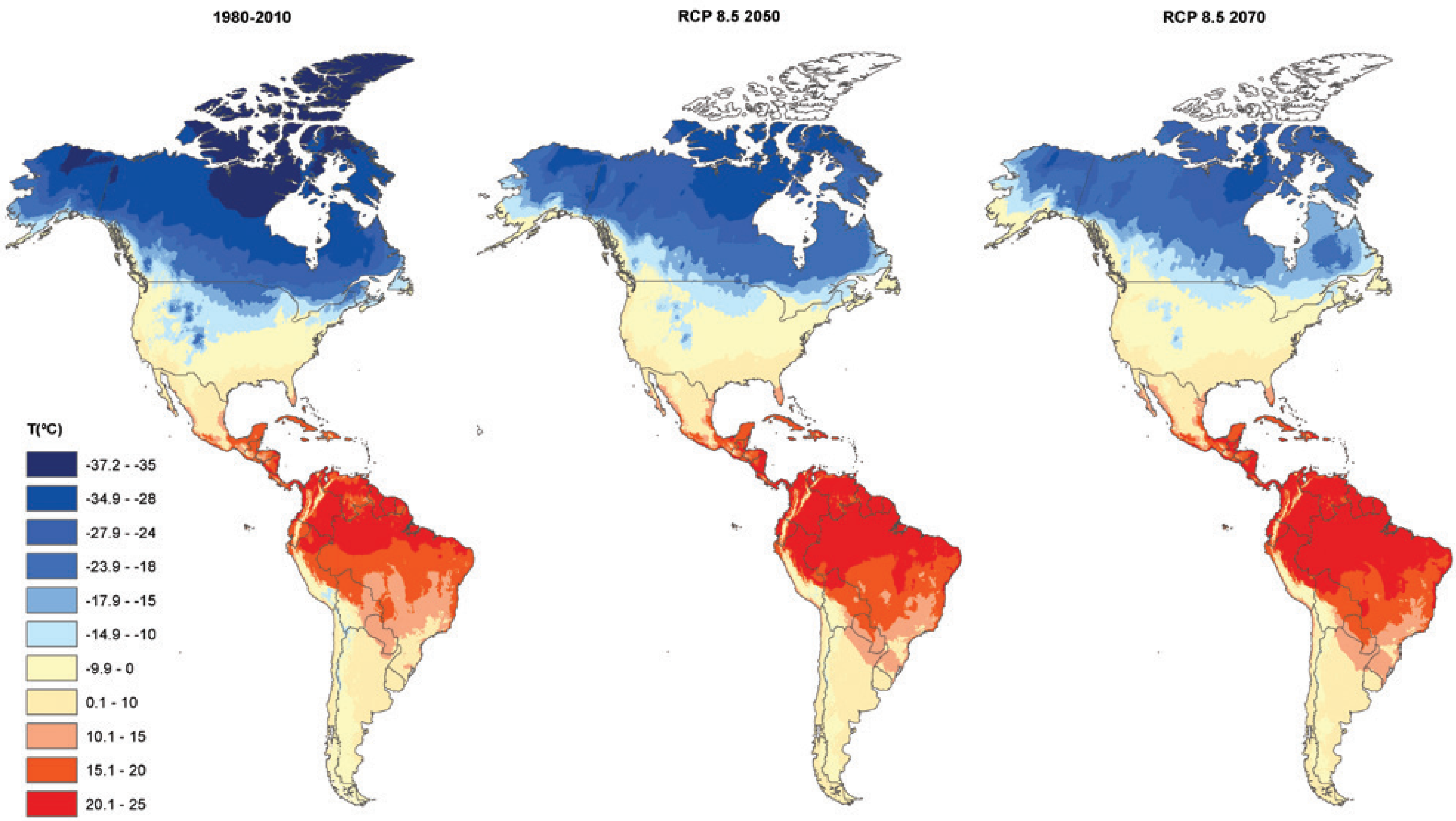

Figure 11: Minimum temperature of the coldest month (Tnc) is a powerful reference of how cold the winter season is. Many species do not tolerate cold and long winters. Equatorial species tend to disappear when minimum temperature drops below 15°C for a long period and temperate species tend to disappear when temperature drops below 0°C for a long period during the year. Tnc is one of the main climatic drivers influencing plant distribution in altitude.

ANUAL RAINFALL

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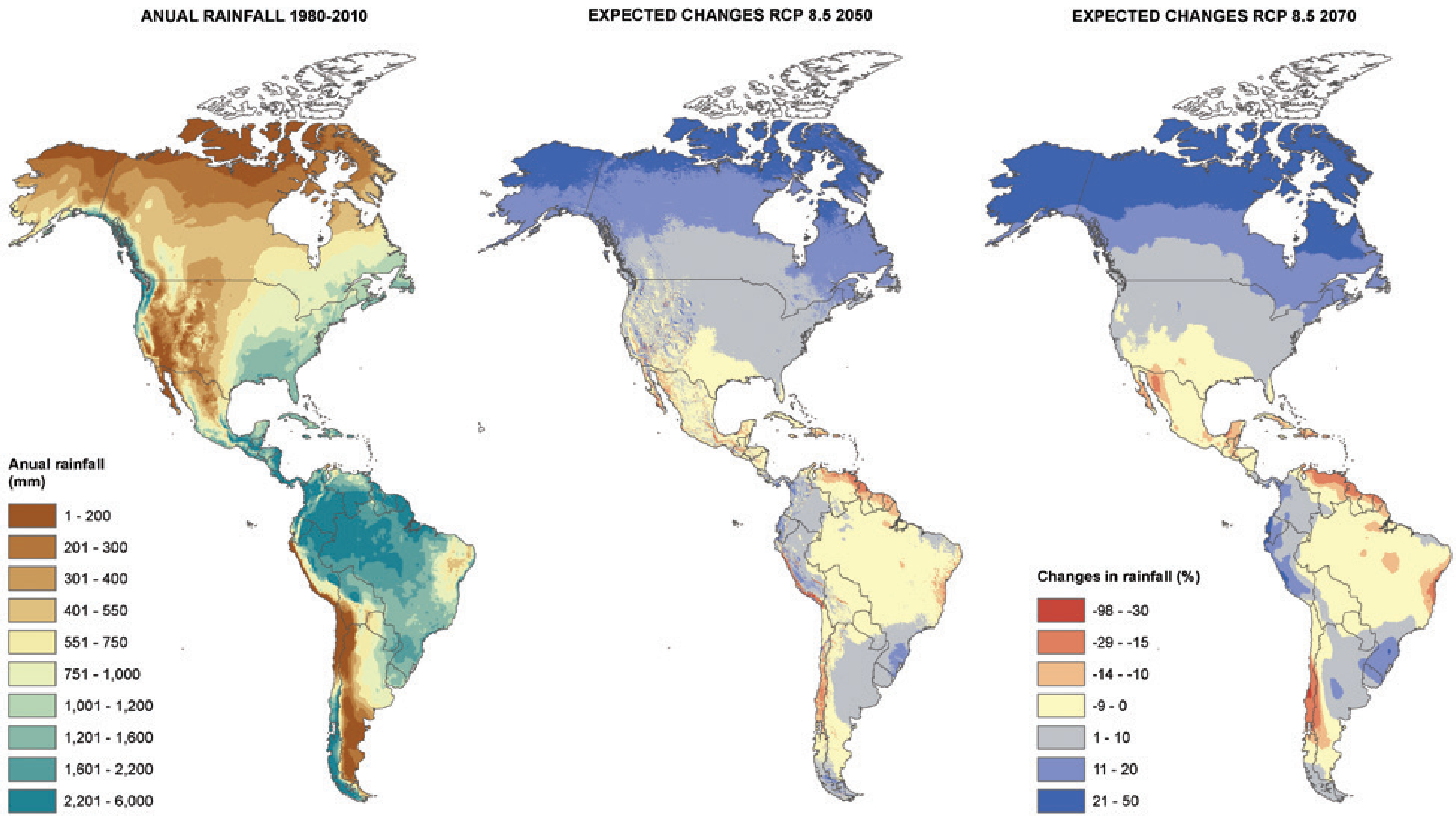

Figure 12: Annual rainfall is also a strong climatic driver for plant distribution. Normally, species has an interval of precipitation determined by a lower limit below which aridity is too intense for its survival, and a higher limit, above which other species are more competitive (too wet). Biomass production relies on precipitation by the concept of Rainfall Use Efficiency (RUE). Different ecosystems have RUE from 2 to 8 kg of biomass/ha per rainfall millimeter. RUE depends on eco physiological strategies of species, the rainfall regime, and the rate of evapotranspiration.

ANUAL HOT DAYS (T > 25°C)

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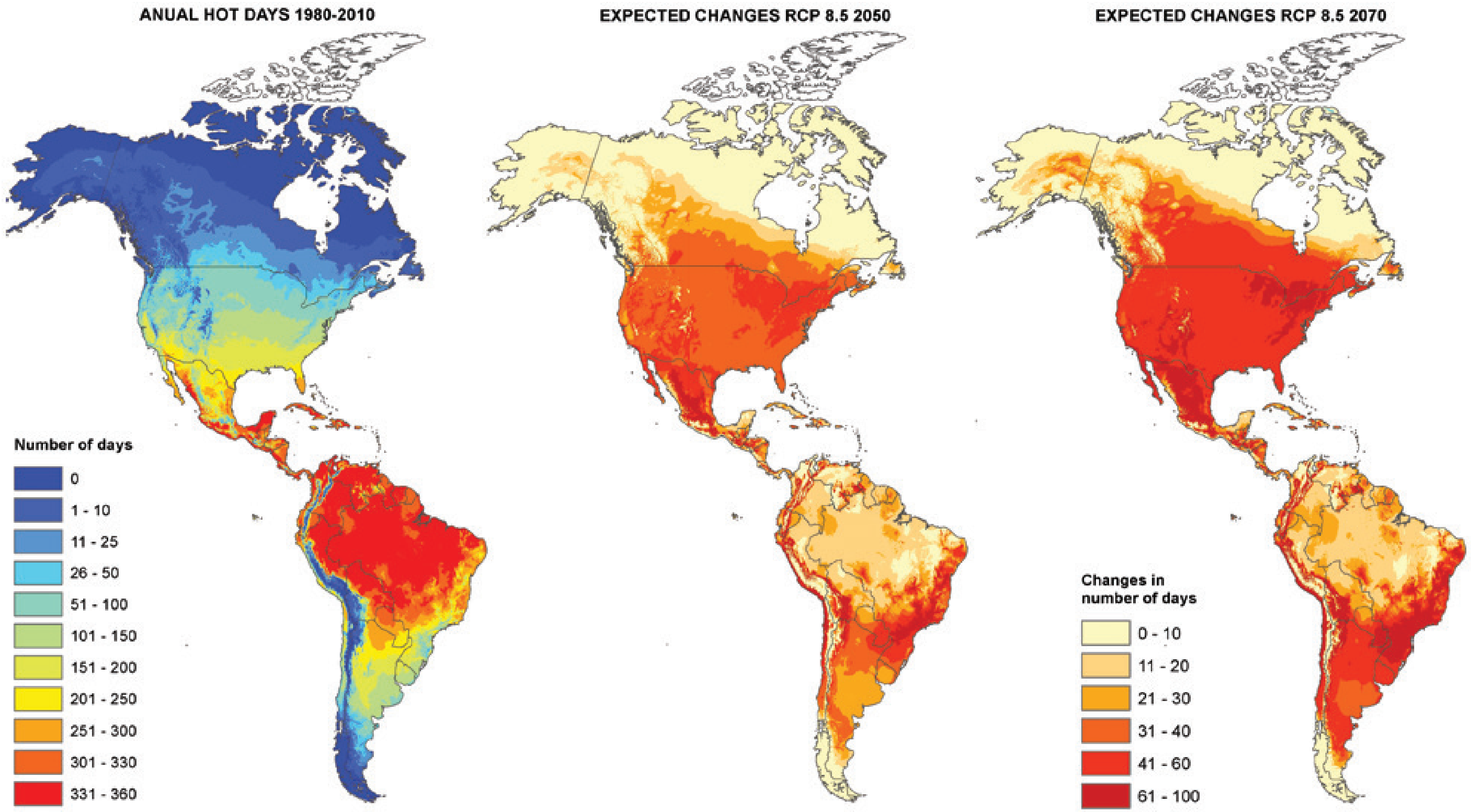

Figure 13: Most plants (mainly temperate species) and animals start having temperature stress above 25°C. Then, the number of days with maximum temperatures above 25°C are called "hot days." Human comfort starts to decay above this threshold. An increasing number of hot days may lower the production of biomass in temperate regions, lowering carrying capacity for herbivores and, as consequence, carnivores.

EFFECTIVE GROWING DEGREE DAYS

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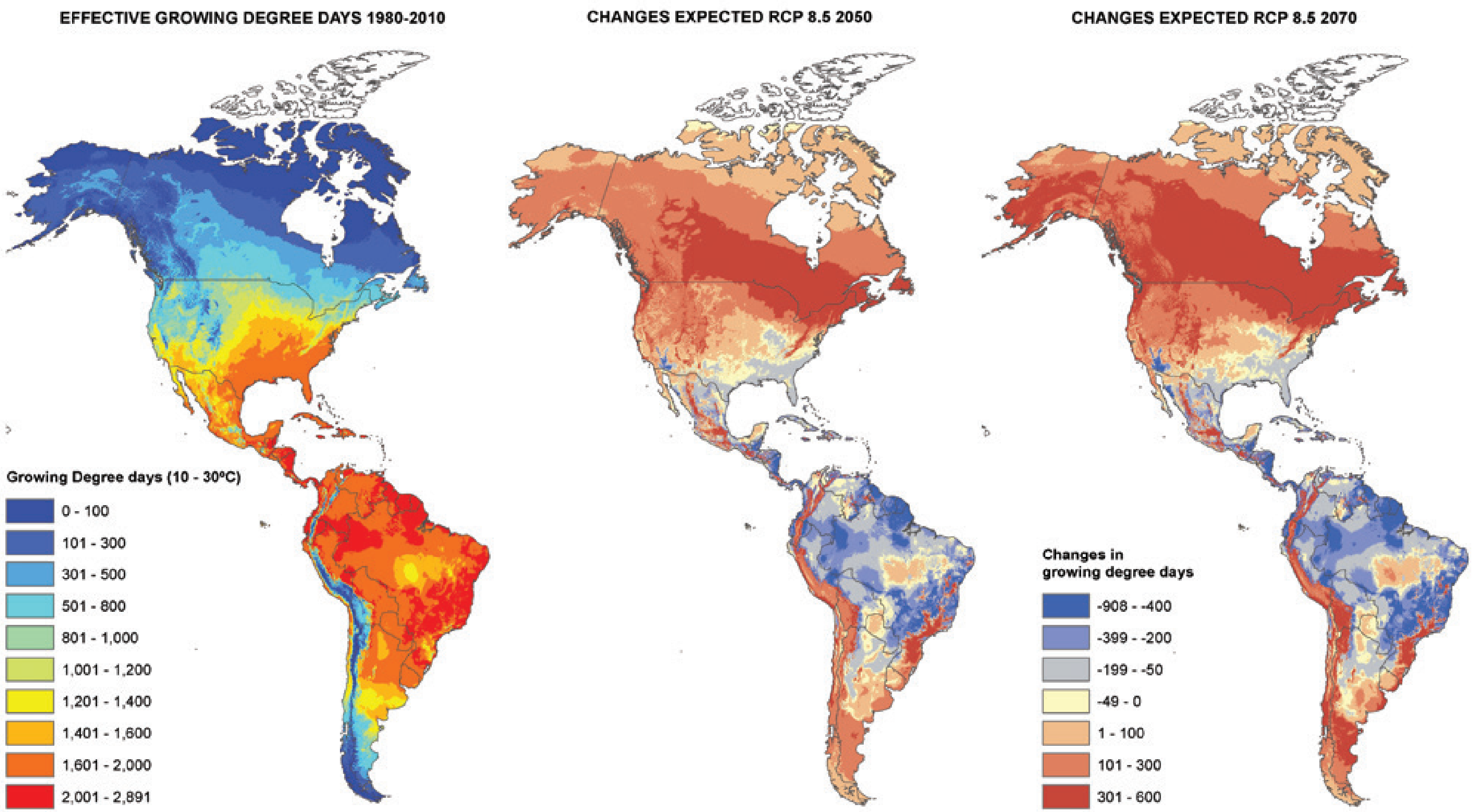

Figure 14: Growing degree days represent the global thermal regime considering the accumulated effective temperature all over the year. Effective temperature each day represents the positive difference among daily mean temperature minus the base growing temperature (depending on each species, in this case a base of 10°C was considered). To complete their life cycle, each species requires a specific amount of degree days. If degree days are increased, life cycles are shortened until a limit, beyond which excess of degree days may stop development, impairing growth and reproduction.

CHILLING HOURS

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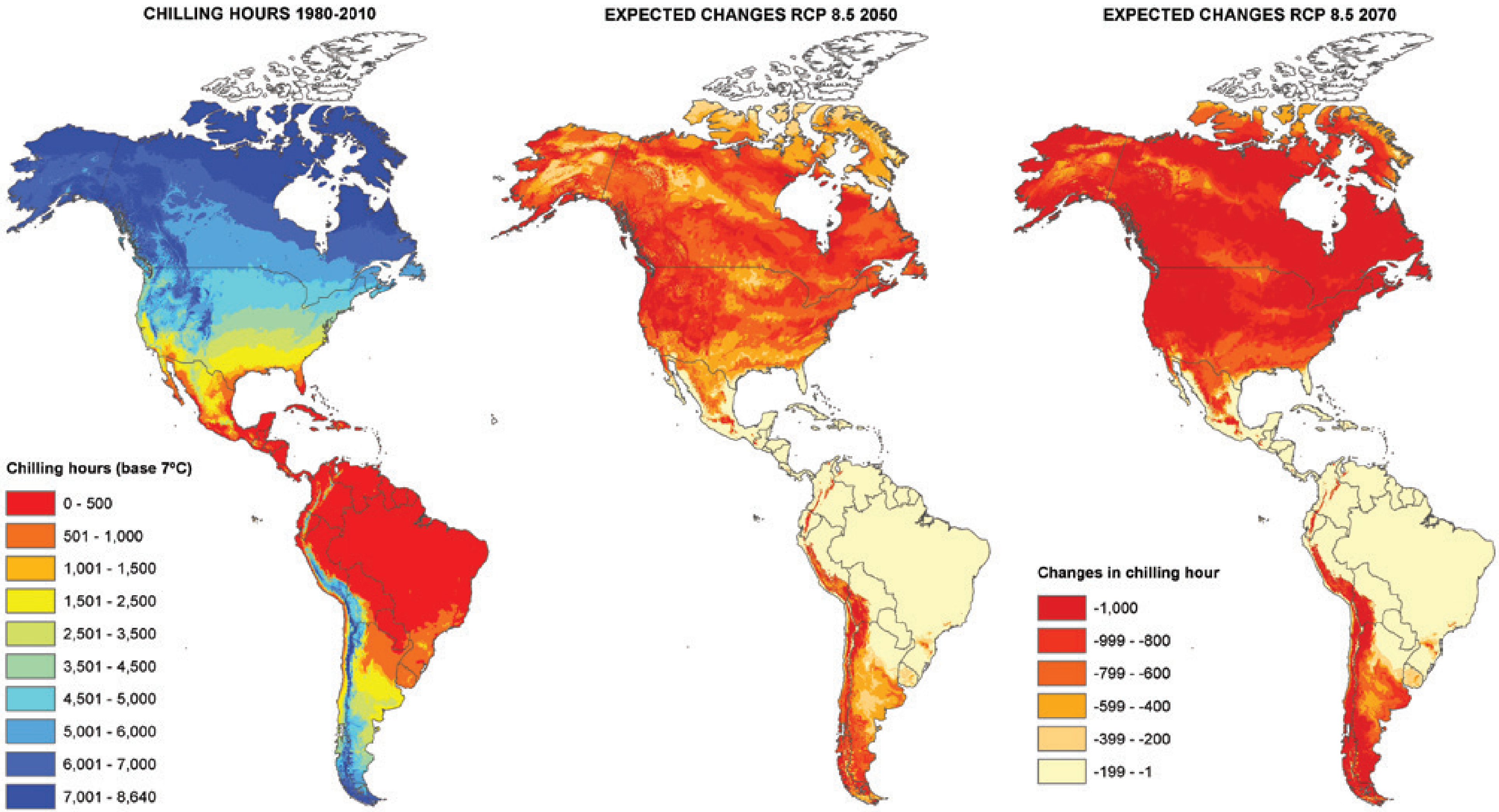

Figure 15: Most temperate species has a physiological rest during the winter season as a strategy to escape the freezing temperatures that may kill the plant. During the resting period, plants drop their leaves and the buds are the only tender organs responsible to face the winter cold. To face the freezing temperatures, buds prepare in the late fall, by means of a hardening process induced by the abscisic acid produced by the falling leaves.

ANUAL FROST EVENTS

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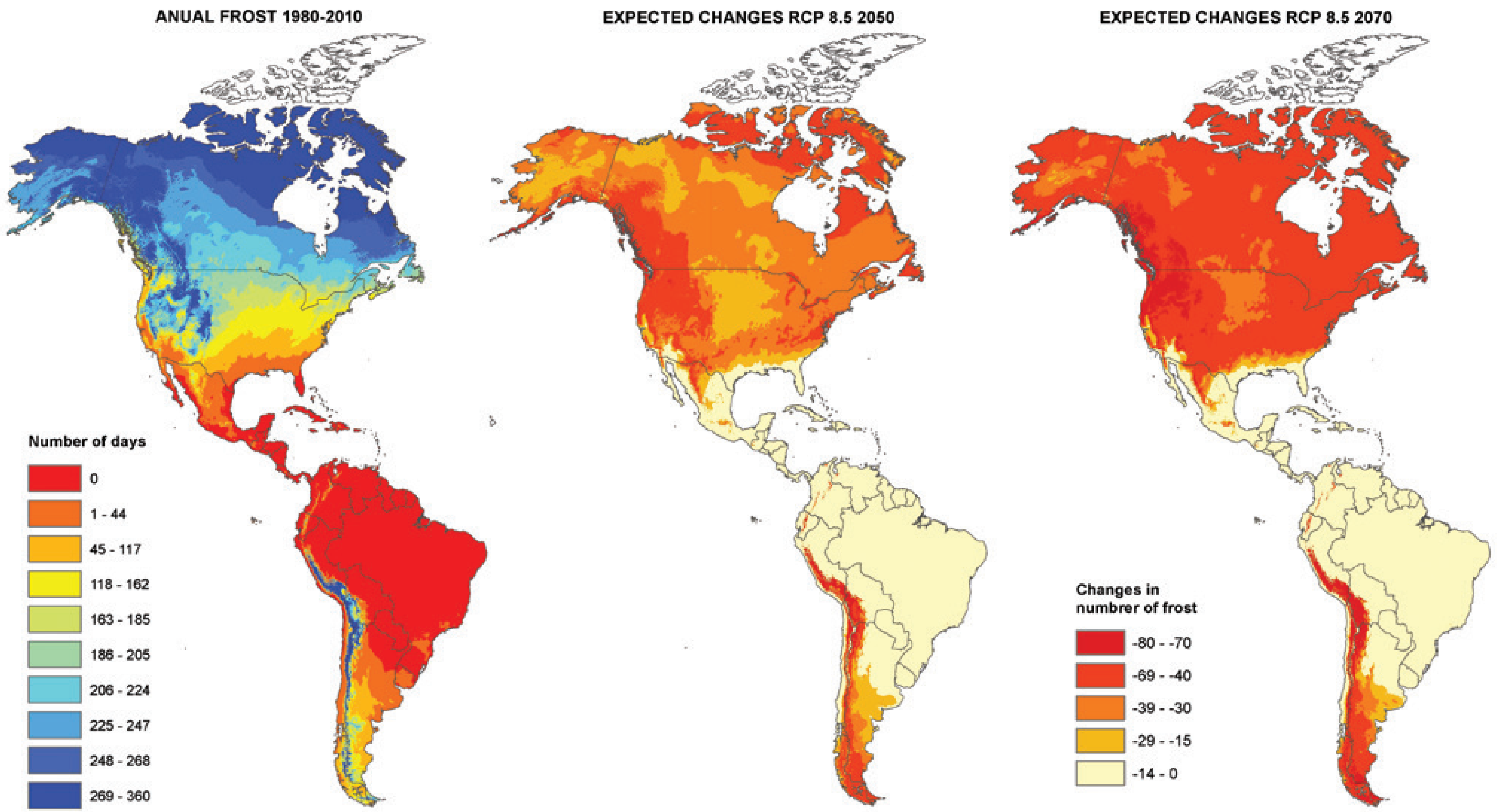

Figure 16: The number of days having minimum freezing temperature is relevant for frost sensitive species. All plant species are frost sensitive but differ in the threshold of tolerance to negative temperature, depending on the climate where the species evolved. The total number of freezing days is related with frost intensity. Places with low frost frequency also tend to have less intensity.

WATER SURPLUS

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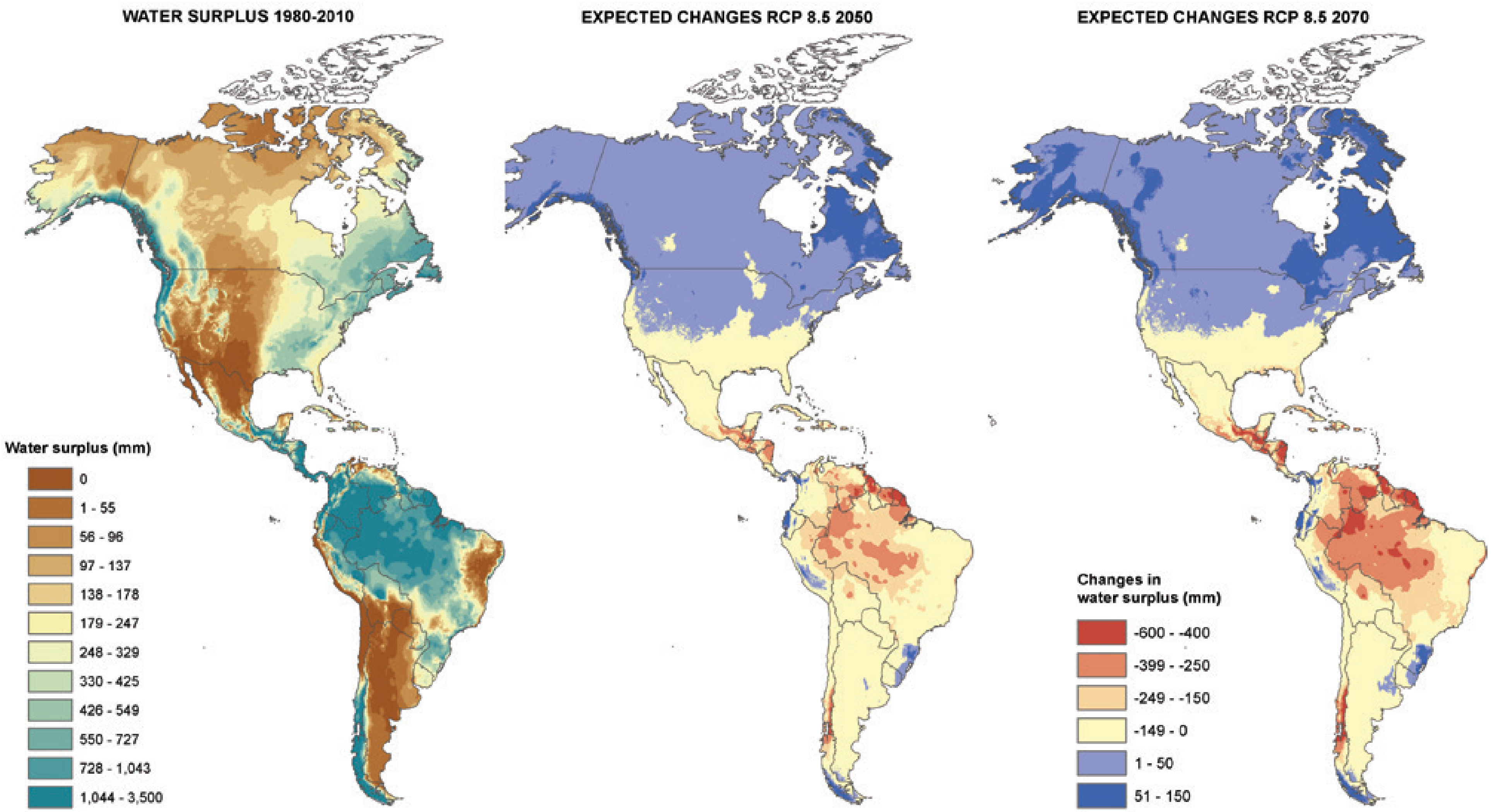

Figure 17: Water surplus is the positive difference among precipitation (P) and evapotranspiration (Et). Annual water surplus is calculated by adding monthly positive differences (P – Et). This variable represents the amount of water that is available to feed the hydrological cycle. Most part of water surplus corresponds to water runoff that feeds into the stream of rivers or infiltrates into soil, feeding groundwater.

WATER DEFICIT

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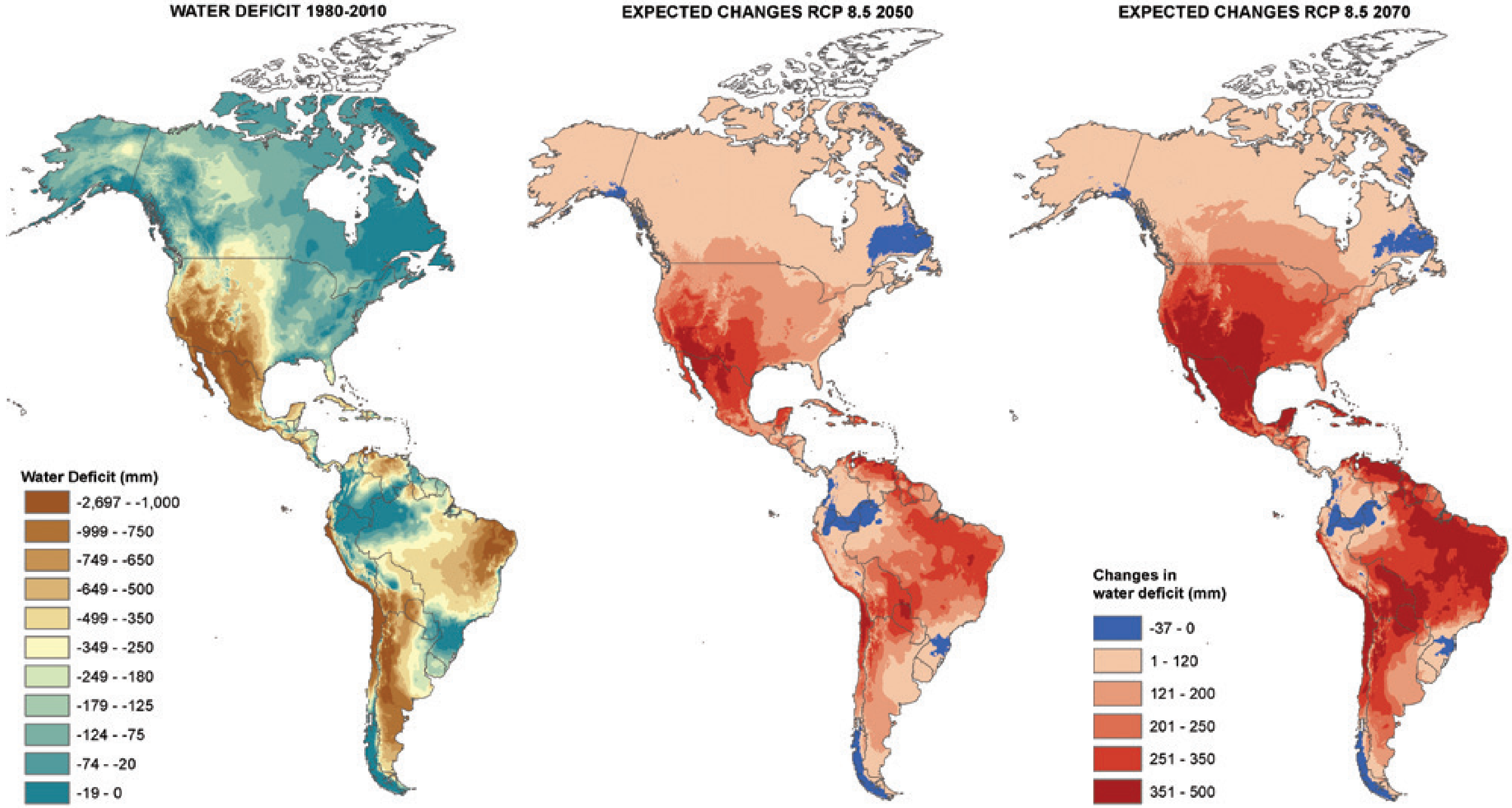

Figure 18: Water deficit is the negative difference among precipitation (P) and evapotranspiration (Et). This represents the amount of evaporated water that is not covered by precipitation. Considering that soils have limited capacity to store water, normally water deficit is an expression of water stress that plant communities have to endure. There is a proportional relationship between the water deficit and the degree of climatic aridity. Annual water deficit is calculated by adding monthly negative differences (P – Et).

DRY SEASON LENGTH

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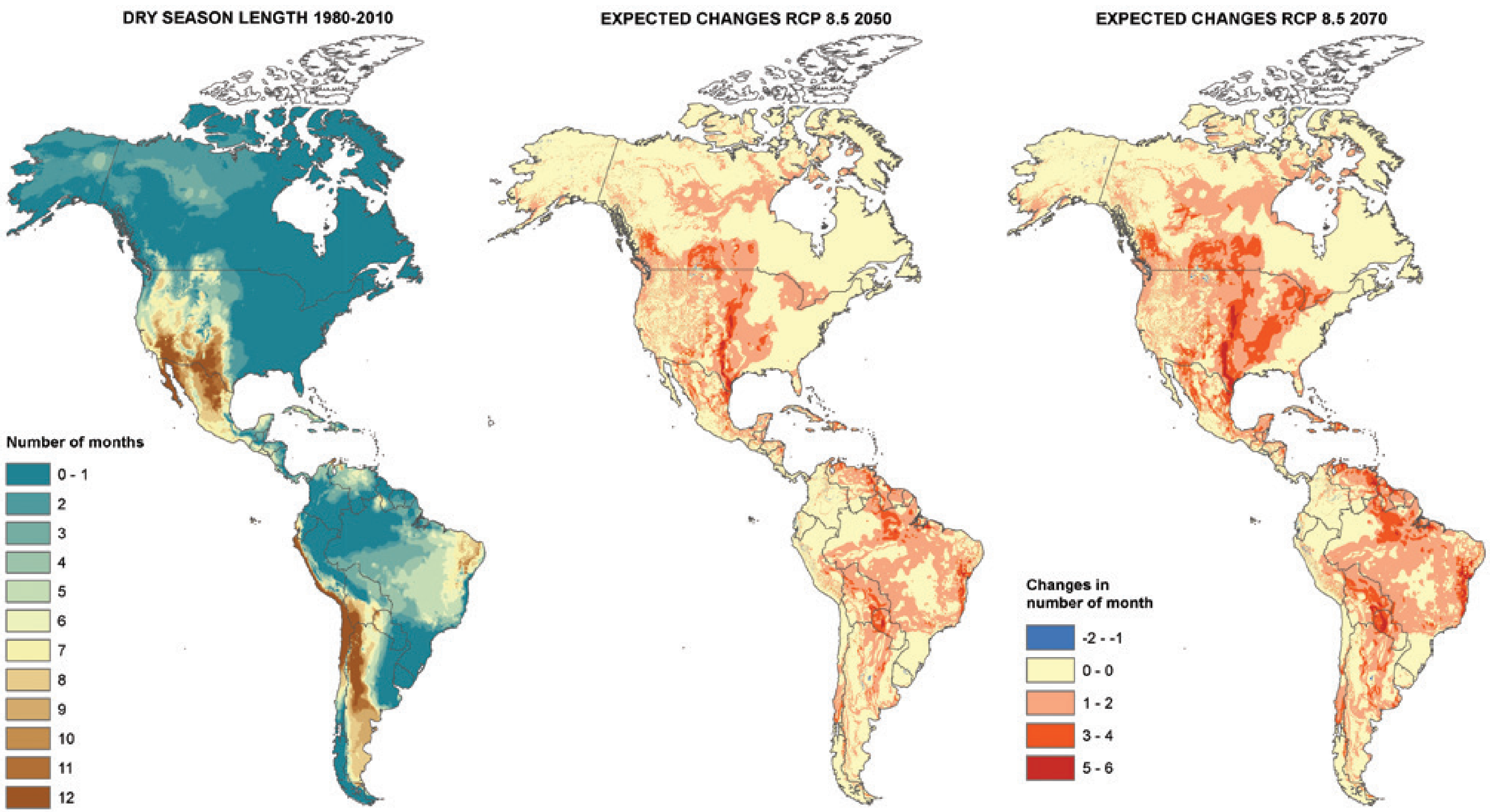

Figure 19: The length of the dry season is one of the main climatic drivers for species geographical distribution. By increasing the length of the dry season, climate turns more arid and ecosystems adapt by including species that are more xerophytic and adapted to survive a long dry season. This strategy also includes a lower biomass production (more energy is put in survival strategies, not in growing) and the emergence of defense structures (thorns, repulsive or toxic substances, fibrous structures).

NUMBER OF DAYS WITH TEMPERATURE ABOVE 30°C

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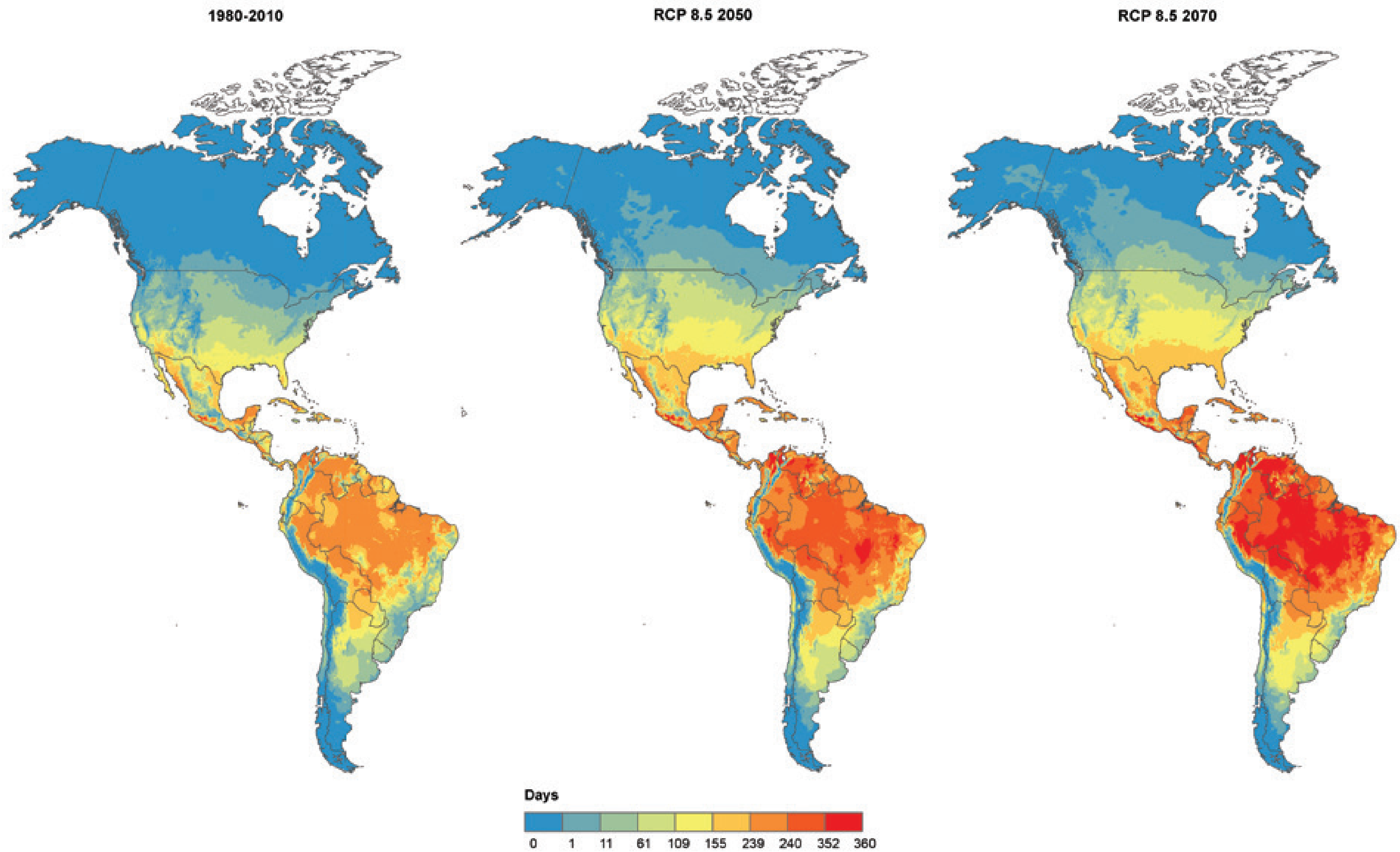

Figure 20: Maximum temperature above 30°C is normally associated with high levels of thermal stress to plants and animals, especially in temperate and high zones.

NUMBER OF DAYS WITH TEMPERATURE ABOVE 34°C

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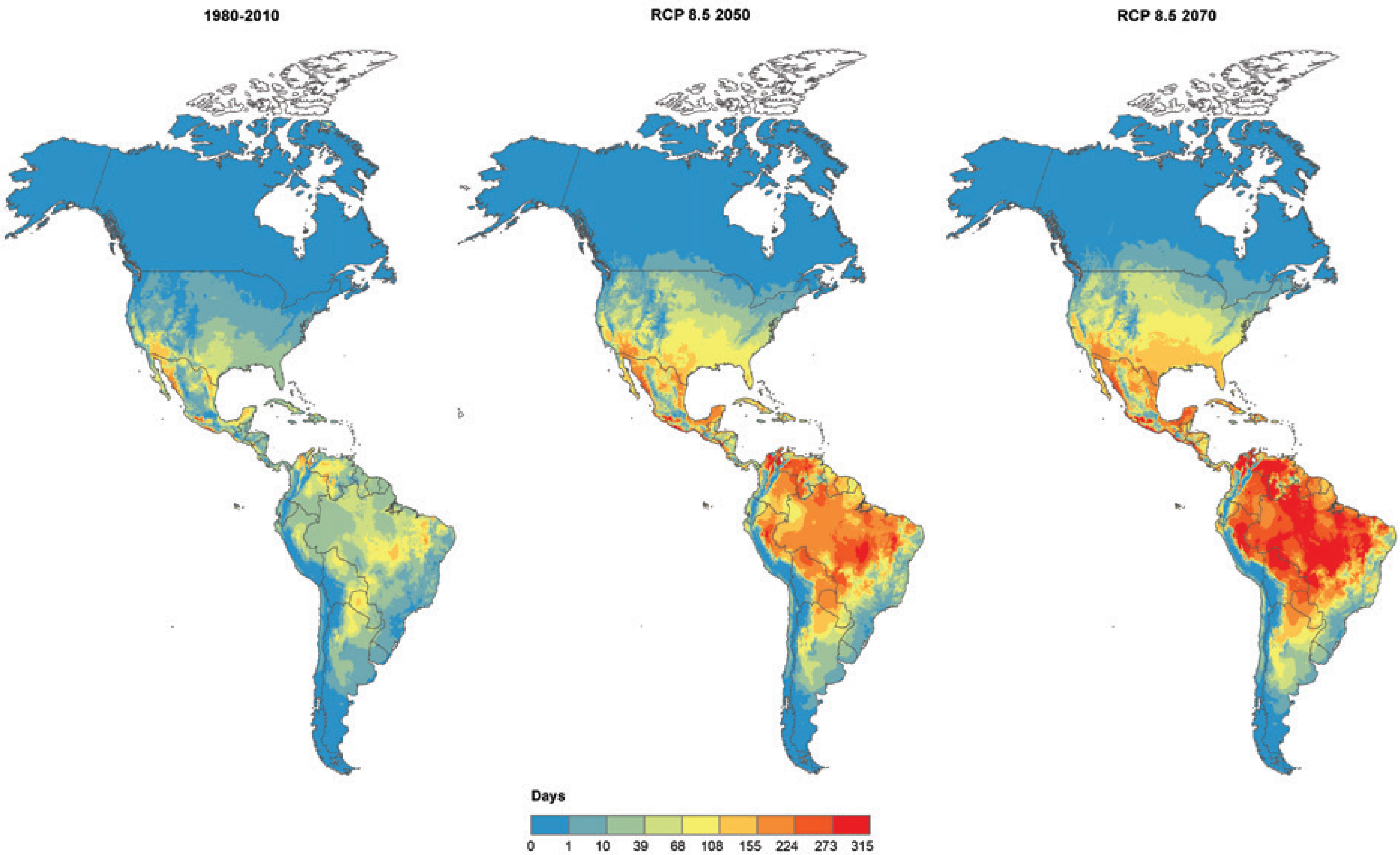

Figure 21: Maximum temperature above 34°C may have a deep influence on temperate ecosystems, inducing high levels of temperature stress.

NUMBER OF DAYS WITH TEMPERATURE ABOVE 38°C

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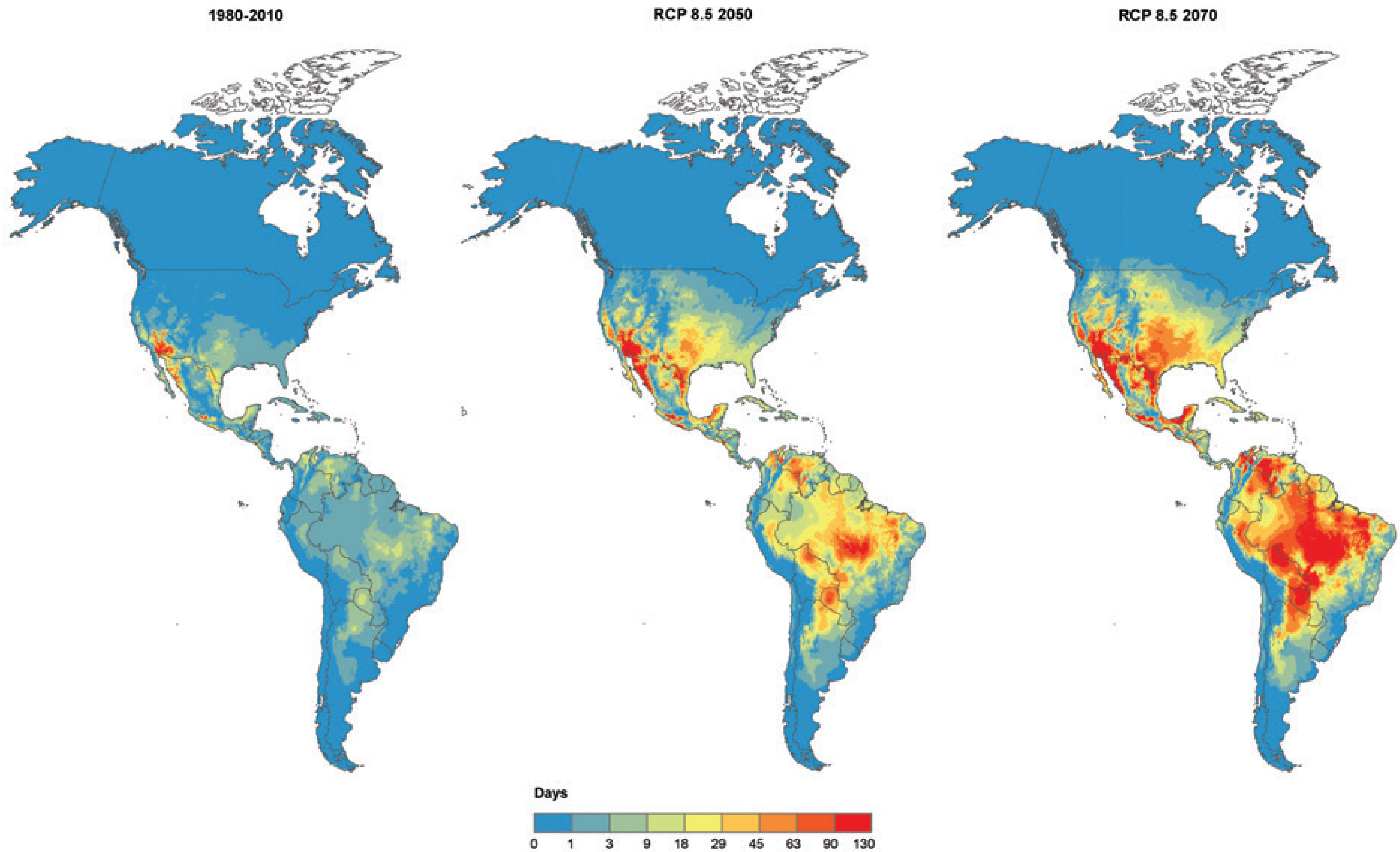

Figure 22: Maximum temperature above 38°C is normally associated with extreme levels of thermal stress to plants and animals. Frequent exposure of sensitive species to this may kill them.

THEMAL COMFORT INDEX

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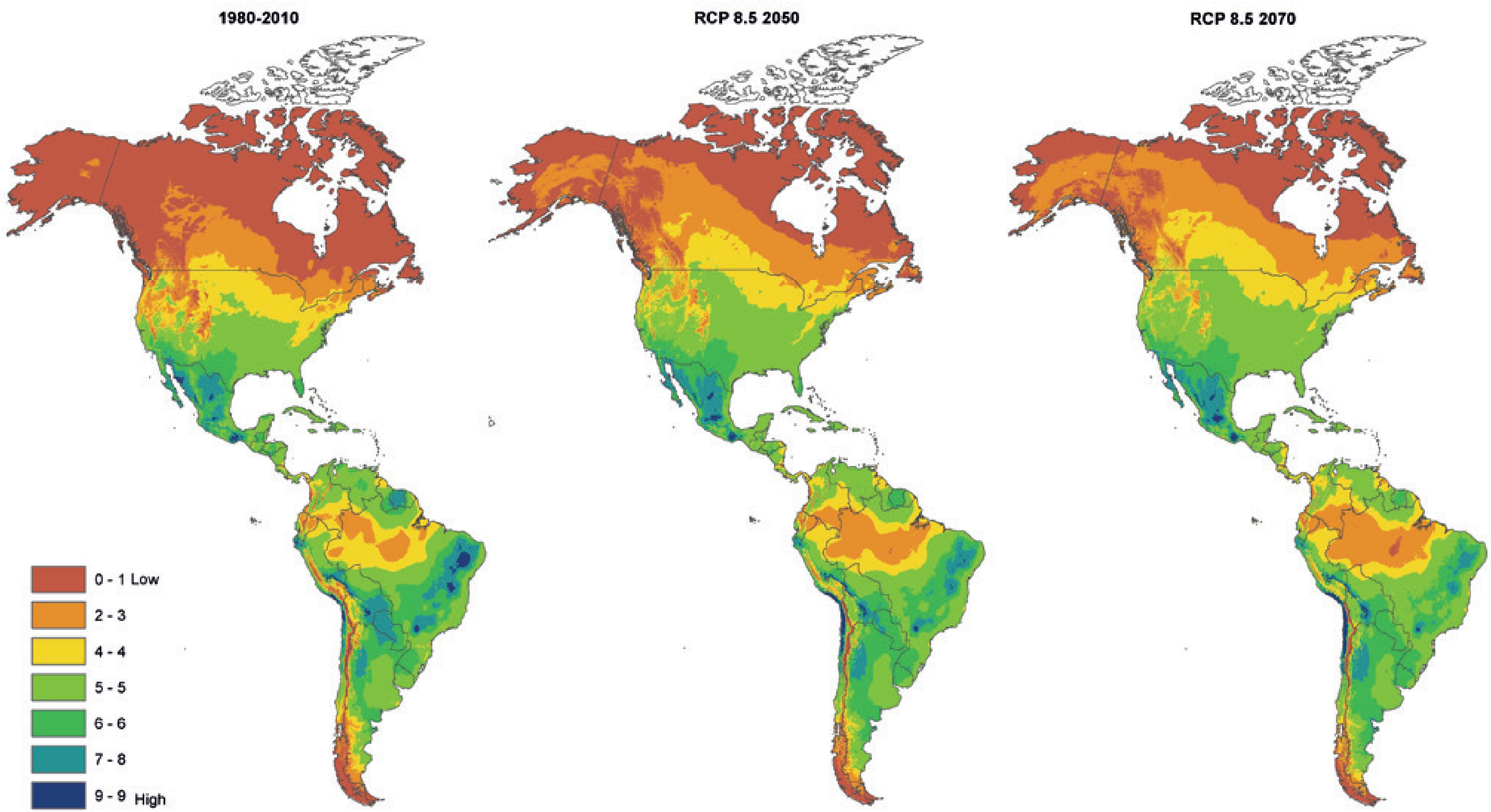

Figure 23: Human thermal comfort may increase in polar areas of North and South America, while decreasing in tropical areas of the continent.

CLIMATE CHANGE IMPACTS ON AGRICULTURAL PRODUCTIVITY

• Modeling crop production and phenology

A crop simulation model (SIMPROC) based on the complex climate-plant interactions was developed and validated for several annual cultivated species (wheat, maize, barley, potato, tomato, sugar beet, oat, bean and rice), perennial fruit species (apple, peaches, table grape, wine grape, cherry, walnut, coffee, orange) and pastures. Input data required by the SIMPROC model has high plasticity, working with different time steps (daily, weekly and monthly) depending on the required time resolution of the results. Another advantage of the model is its iterative concept, running all through the year, providing information on crop productivity and water consumption for different sowing dates. Additionally, this model was designed for a large number of simulations with relatively little input data, making simulations possible over vast regions. This model was conceived to be an efficient and simple tool to estimate the effects of new climatic scenarios on crop seasonality, productivity and water requirements. The following paragraphs describe the model structure, algorithms, inputs and outputs. The model includes an original capability, normally not included in published crop models, to model the effect of some extreme climatic events. For example, frost or eventual high temperatures as a limiting factor of crop seasonality and productivity. The model was validated using a set of experimental data, demonstrating a good degree of realism. SIMPROC simulations covering the whole continent, suggest, that in the RCP8.5 scenario, important changes could be expected in crop production, seasonality and water requirements. The most sensitive areas are the temperate arid subtropical climates as well as in cold temperate climates. The results suggest that shifting planting dates could play an important role in adapting crops to a warmer climate in order to avoid heat stress during fructification. Despite changes in sowing dates in inland warmer climates, yields of some species could fall by 5 to 15% as consequence of increased levels of heat stress and the shortened growing season. The boundaries of suitable zones for the most part of species could move poleward to about 300 km, incorporating temperate areas that presently have limited potential for agricultural production.

• SIMPROC model structure

Starting at emergence, daily dry matter accumulation is simulated at every stage of crop development according to absorbed photosynthetic active solar radiation *PARα*, which depends on the incoming solar radiation *IPAR*, exposed leaf area *LAI*, leaf albedo α and radiation transmitted to the ground according to the Lambert-Beer relation (Houghton, 1986).

$$PAR_\alpha = (1-\propto) * IPAR * (1-e^{K*LAI})$$

The biochemical assimilated light *A*, is regulated by absorbed *PARα* (W/m^2) and the photosynthetic efficiency ε_f, which varies according to the incident light intensity *IPAR*. The SIMPROC model uses an empirical formula which relates light intensity and photosynthetic efficiency derived from several published photosynthetic curves (Choudhury, 2001; Sowinski et al., 2007). The effect of CO_2 concentration C (μg/g) in the air on photosynthetic efficiency ∂c was estimated from experimental data presented by Heichel and Musgrave (1969) and Wang et al. (2012) and represent a dimensionless factor.

$$A = \varepsilon_f * PAR_\alpha$$

$$\varepsilon_f = \beta * IPAR^\lambda * \partial_c$$

$$\partial_c = \delta * LN(C) - \sigma$$

Where:

$\beta = 0.5$, $\lambda = -0.48$, $\delta = 0.8876$ $\sigma = 4.1104$.

Gross photosynthesis *GPHOT* (g/m2h) result from the product among *A* and two physical constants:

$$GPHOT = A * \varphi * \omega$$

Where:

$\varphi = 0.86$ is a conversion factor from Watts to Kcal/m2h and

$\omega = 0.2674$, the energy required in the formation of glucose (Newman, 2008).

Potential dry matter production *PDMP* correspond to the balance of gross photosynthesis, total maintenance respiration *Rm* and the biochemical metabolic growth efficiency *GE*, which vary with species between 0.5 and 0.75 (Penning de Vries 1975, Lambers 1979).

Maintenance respiration *Rm* is proportional to total plant living biomass *W* and temperature *T* (Ryan, 1990; Xu et al, 2006).

$$PDMP = (GPHOT - Rm) * GE$$

$$Rm = W * (Kmo * \exp(K_r * T))$$

Kmo is the dark respiration at a reference temperature, which depends on each plant organ. *Kmo* represents the daily carbohydrate consumption per biomass unit with a mean value of 0.015 kg CH_2O/day per kg of biomass at 20°C (Van Keulen and Wolf, 1986). Variations of *Rm* have a Q_{10} about 2, doubling its value when temperature varies in 10°C (Owen and Tjoelker; 2003 Wythers, 2013).

Temperature also regulates dry matter production according to the equation proposed by Yan and Hunt (1999) with the following thermal parameters: minimum temperature, *Tmin* (no growth); optimum temperature, *Topt* (maximum growth rate); and maximum temperature, *Tmax* (nil growth). The equation relating all cardinal temperatures is:

$$Tc = \left(\frac{T_{max} - T}{T_{max} - T_{opt}}\right)\left(\frac{T - T_{min}}{T_{opt} - T_{min}}\right)^{\frac{T_{opt} - T_{min}}{T_{max} - T_{opt}}}$$

Tc represents thermal regulation control of dry matter production rate, between *Tmin* and *Tmax*. Out of this thermal interval *Tc* is zero.

Additionally, the effect of water shortage is modeled by means of a water production function based on the FAO approach that relates production reduction with evapotranspiration deficit (Doorenbos and Kassam, 1979):

$$Wc = 1 - Ky * (1 - Etr/ETmax)$$

Ky represents the crop yield factor, *Etr* is the actual evapotranspiration and *ETmax* is the maximum crop evapotranspiration. *Wc* represents the water control of dry matter production rate.

Actual evapotranspiration is calculated considering soil water balance and reference evapotranspiration is calculated with the Penman-Monteith equation (Allen et al., 1998).

Considering the combined effect of temperature and water shortage on dry matter production, the real rate of dry matter production is *RDMP*:

$$RDMP = PDMP * Tc * Wc$$

Relative phenological age RPA varies from 0, at crop emergence and 1 at harvest maturity. *RPA* at time "t" is calculated as a fraction of degree-day accumulation from time zero to the moment "t," *ddt* having as reference total required degree days at harvest *DDo*:

$$RPAt = ddt/DDo$$

The change of phenophase occurs when *RPA* reaches specific thresholds (between 0 and 1) defined for each phenophase. Phenological phase modulates the partition of carbohydrates into different organs, in such a way as to cause a harmonic ontogenic progression. At any moment of the phenological cycle the sum of all partition coefficients (*μ1:leaves; μ2:stems;μ3:roots and μ4:fuits*) is equal to one:

$$\mu_{leaves} + \mu_{roots} + \mu_{stems} + \mu_{fruits} = 1$$

Phenology also modulates crop sensitivities to growing temperatures, frosts, and water deficits. Crop sensitivity may differ from one phase to another. The model contains algorithms to simulate frost injury and the effect of water shortage on production. The model simulates the loss of leaf area index due to frost occurrence. Frost effects, water stress sensitivity, and temperature thresholds are simulated by a phenological submodel that gives each phase a different sensitivity. Frost damage depends on frost intensity and the occurrence time during the phenological cycle (Santibáñez, 1994). The sensitivity of crop to frost intensity is represented by S_t which is a reduction factor affecting leaf area index. The effect of frost on leaf area index is then S_t elevated to frost probability *P*, within the simulation interval i and for a specific negative temperature interval *T*. The effect of a specific frost event, characterized by a given intensity *T*, occurring in the phenological phase "j" and a time interval "i," is represented by the dimensionless (between 0 and 1), Frost Injury Factor *FIF*, which is expressed as:

$$\mathrm{FIF}_{(i,j,T)} = S_{(i,j,T)}{}^{P(i,T)}$$

This algorithm is calculated for a number of negative temperature intervals until the probability becomes zero during the growing cycle. The total Frost Injury Factor *TFIF* for a given simulation interval is calculated as a multiple product:

$$TFIF_{(i,j)} = \prod_{T}^{0} S_{(j,T)}{}^{P(i,T)}$$

Leaf area index is calculated as a balance among leaf area increase, leaf senescence and leaf frost injury. Leaf area growing rate *gLAI* is a consequence of leaf biomass growth, μ_{leaves} * RDMP, and the leaf specific weight *Lsw* (g/m^2):

$$gLAI = \mu_{leaves} * RDMP \,/\, Lsw$$

Leaf senescence is a genetically programed process of cell death which is triggered by leaf age and environmental factors (Thomas and Stoddart, 1980; Santibáñez et al., 2014). Under non limiting climatic conditions, to the extent that the cycle progresses, senescence is triggered, following an exponential function toward the end of the cycle (Duru and Ducrocq, 2000). Normally, senescence *SEN*, is almost null before blooming, but accelerates exponentially by the end of the cycle, bringing about a dramatic reduction of leaf area at the end of the season. An empiric function was derived on the basis of field experiments conducted by the authors (R^2 = 0.91 and RMSE=0.051):

$$SEN_{rate} = \beta_1 * exp(\beta_2 * DDB)$$

Where:

SEN_{rate} = rate of senescence, between 0 and 1 (dimensionless)

DDB = degree days after full bloom, β_1 = 0.007 and β_2 = 0.0082.

The leaf area index balance is defined by the previous $LAI_{(t-1)}$, leaf senescence *SEN*, leaf total frost injury factor *TFIF* and the growth of new leaf area, $gLAI_t$:

$$LAI_t = LAI_{t-1} * (1 - SEN) * (1 - TFIF) + gLAI_t$$

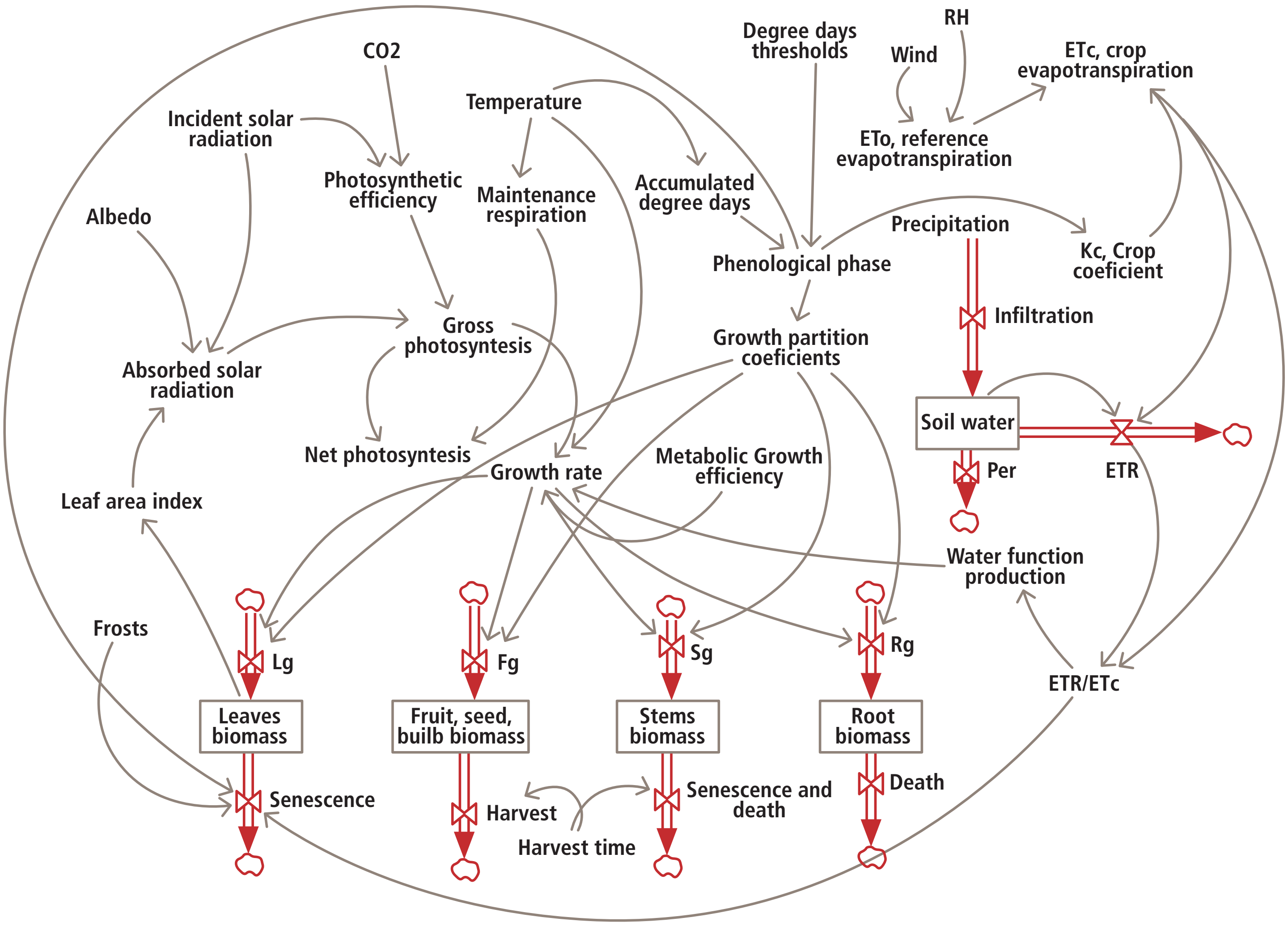

Figure 24: Basic structure of the Crop Simulator Model, SIMPROC.

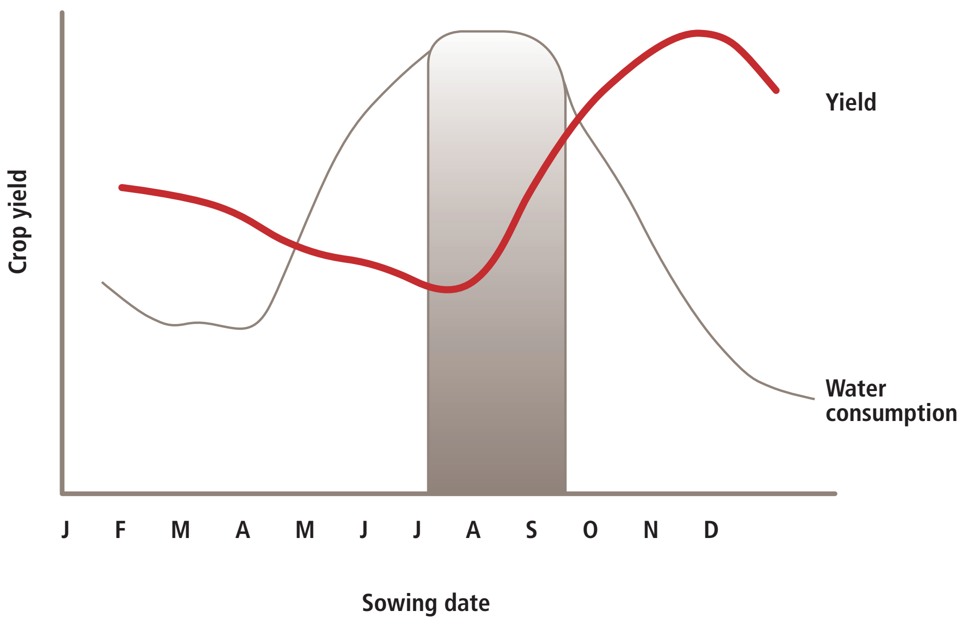

Figure 25: SIMPROC model simulates yield and water consumption of different sowing dates, covering the whole year.

MAIZE YIELD

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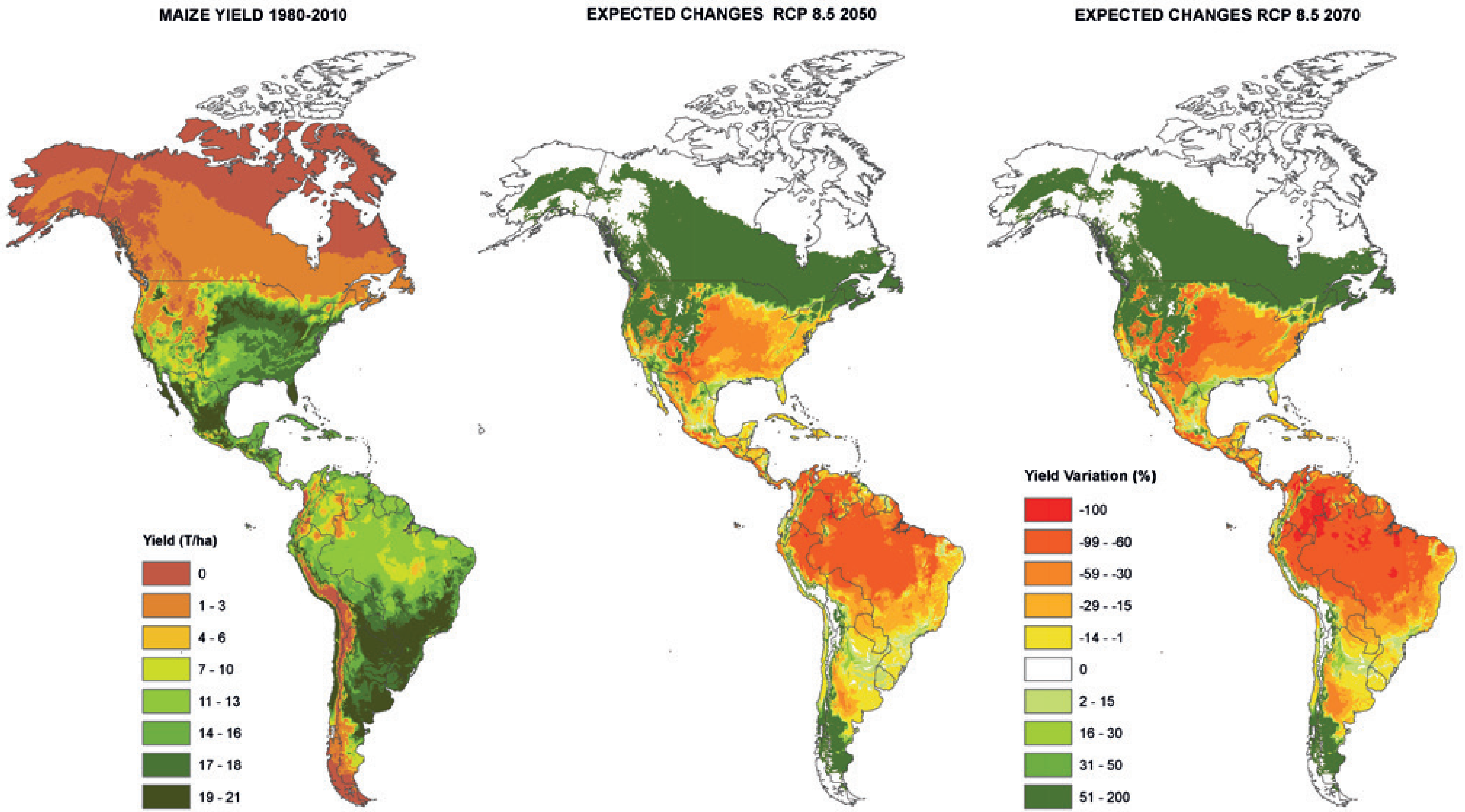

Figure 26: Global warming may push polar boundaries of suitable land for this specie. Potential yield may increase in the most part of Canada and the western USA, while decreasing in the rest of the USA. In the most part of South America maize yield decreases yet an inverse trend occurs in the south of Chile and Argentina.

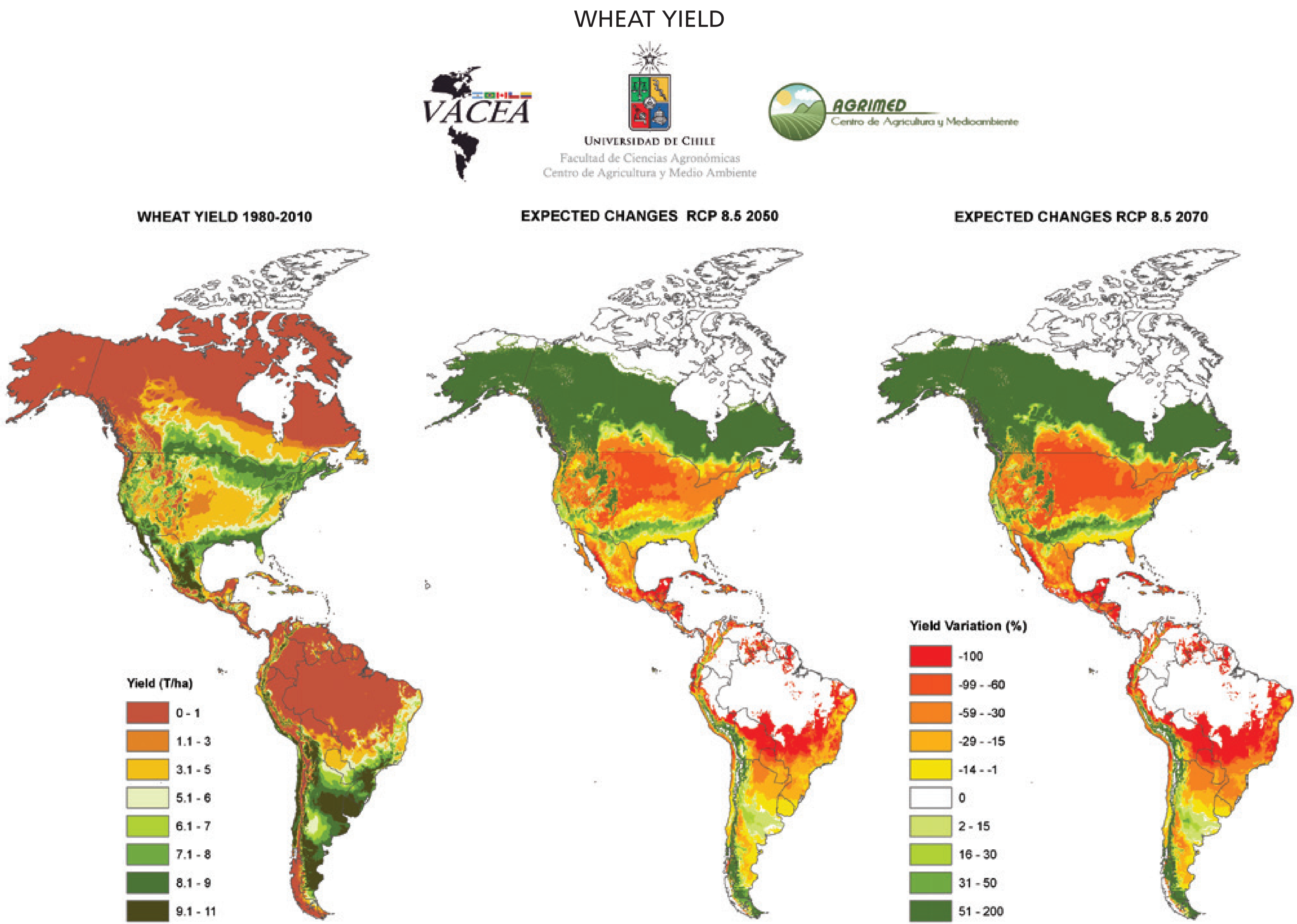

Figure 27: Wheat yield tends to decrease in the most part of the USA with the exception of some areas in the South and mountain highlands in the West. Slight improvement is observed in the humid Pampas of Argentina, the Andean hills and the Patagonian territory.

POTATO YIELD

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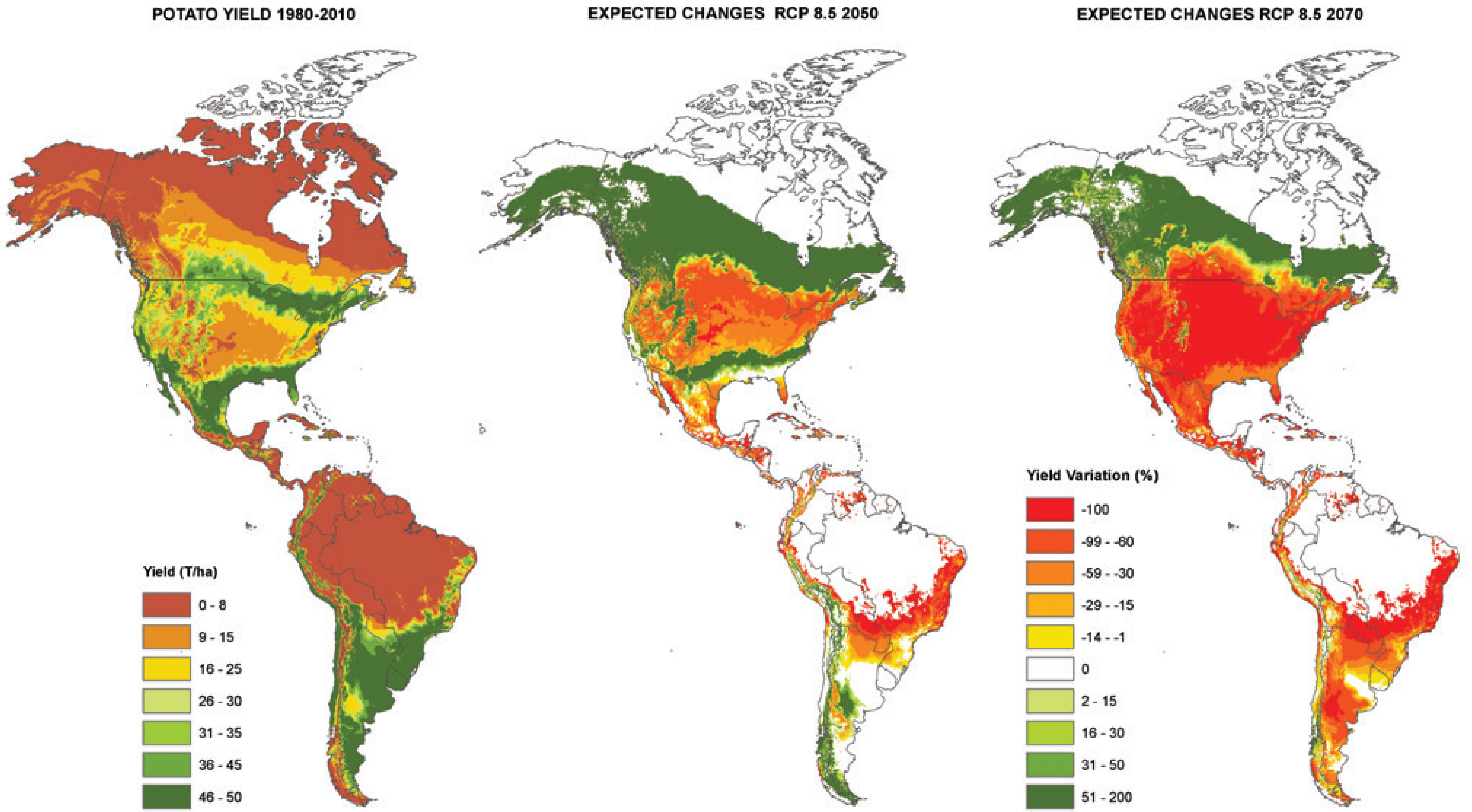

Figure 28: Potatoes seem to be very sensitive to global warming. Yield decreases in the most part of the South American territory, with the exception of southern Chile. Yield decreases in the USA yet improves in most parts of the Canadian territory.

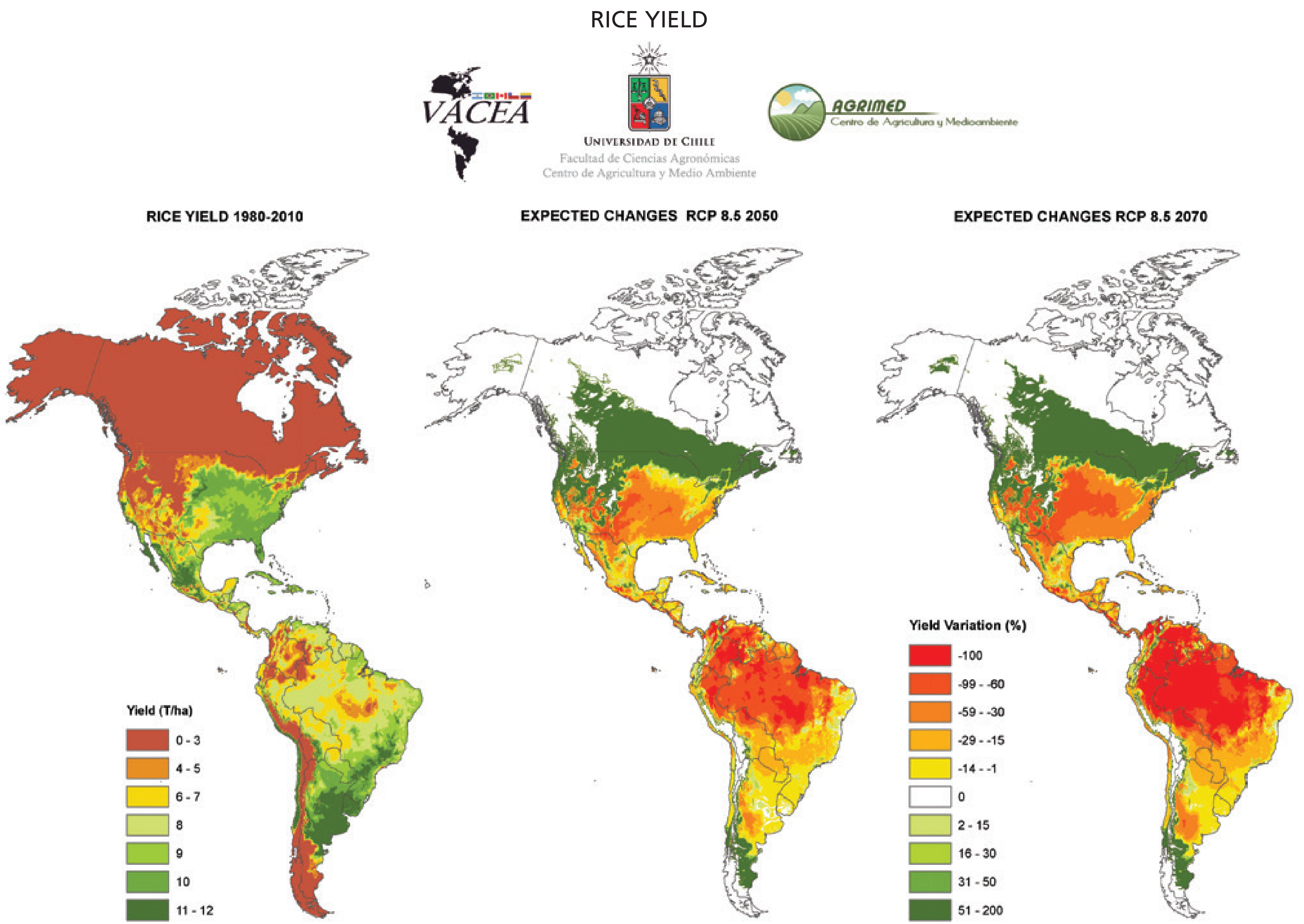

Figure 29: Global warming will push poleward the climatic suitability for rice. Potential production condition would increase in western USA mainly in coastal regions. Suitability decreases in southern USA, Mesoamerica, the Caribbean and the northern part of South America, while increasing in the south of Chile and Argentina.

TOMATO YIELD

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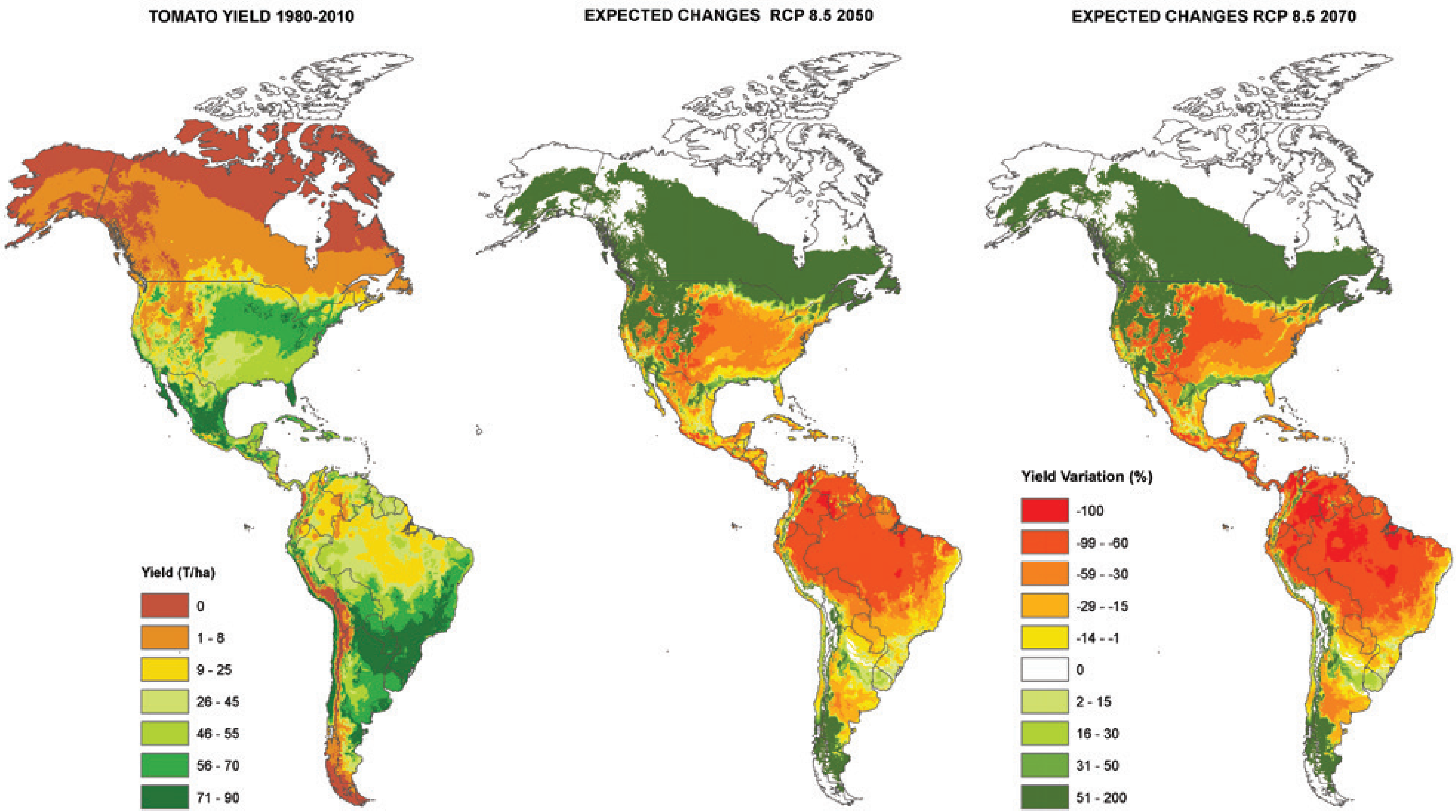

Figure 30: Global warming will push poleward the climatic suitability for tomatoes. Potential production condition would increase in western USA and southern Canada. Suitability decreases in continental lands of southern USA and increases in coastal areas from Florida to Louisiana, Mesoamerica, the Caribbean and the northern part of South America. It seems an increase will also occur in the south of Chile, Argentina and the pre Andeans hills in South America.

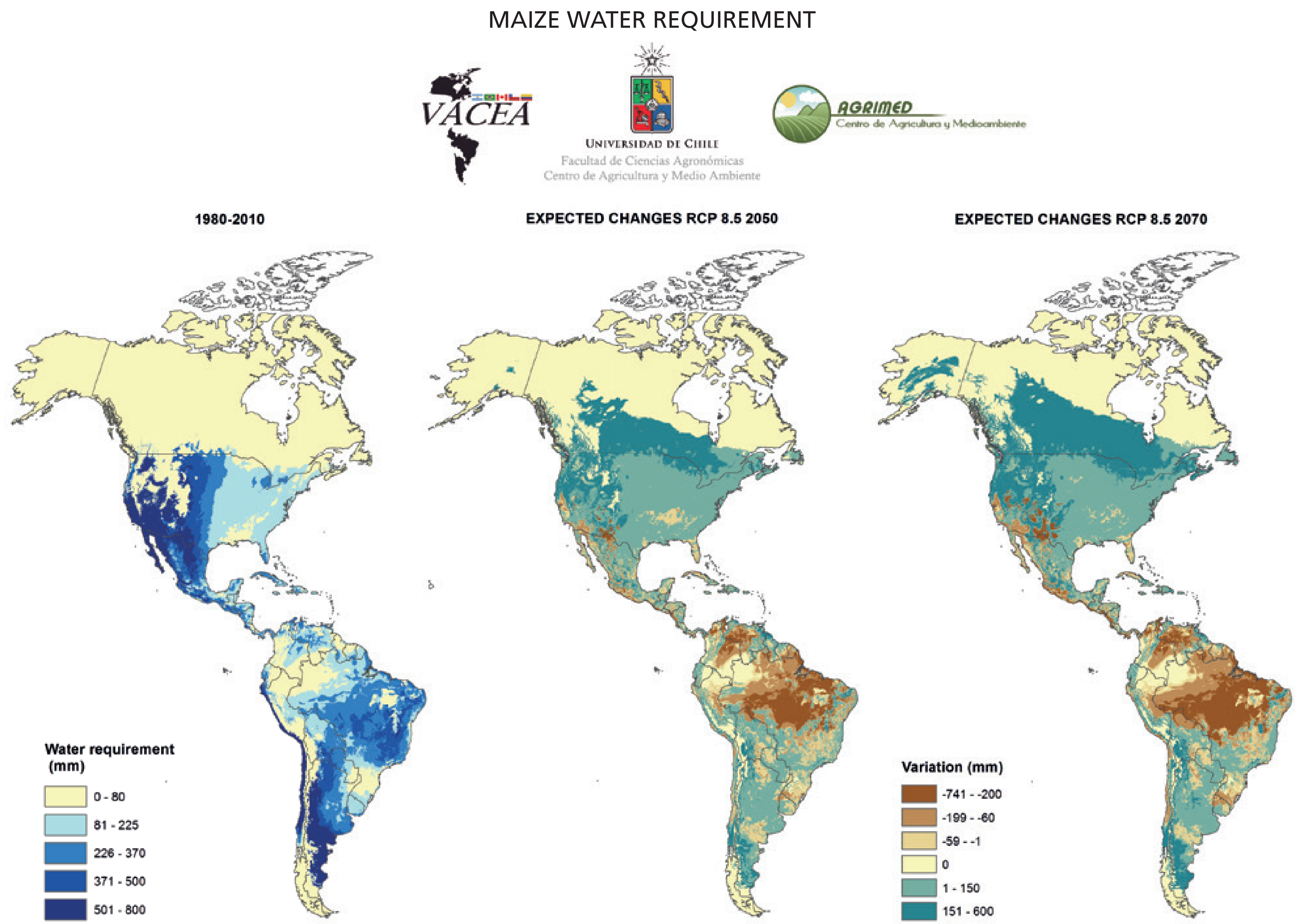

Figure 31: Despite the increase of the reference evapotranspiration due to higher temperatures, irrigation requirements of maize could paradoxically decrease in some areas like western USA, central Chile and Argentina. This is a consequence of the shift of sowing dates to the winter months, which allows a better use of soil humidity in the Mediterranean climate having high rainfall concentration in winter. Water consumption shows a positive trend in areas where yields increase, as in the central part of Canada, western USA, and the south of Chile and Argentina.

WHEAT WATER REQUIREMENT

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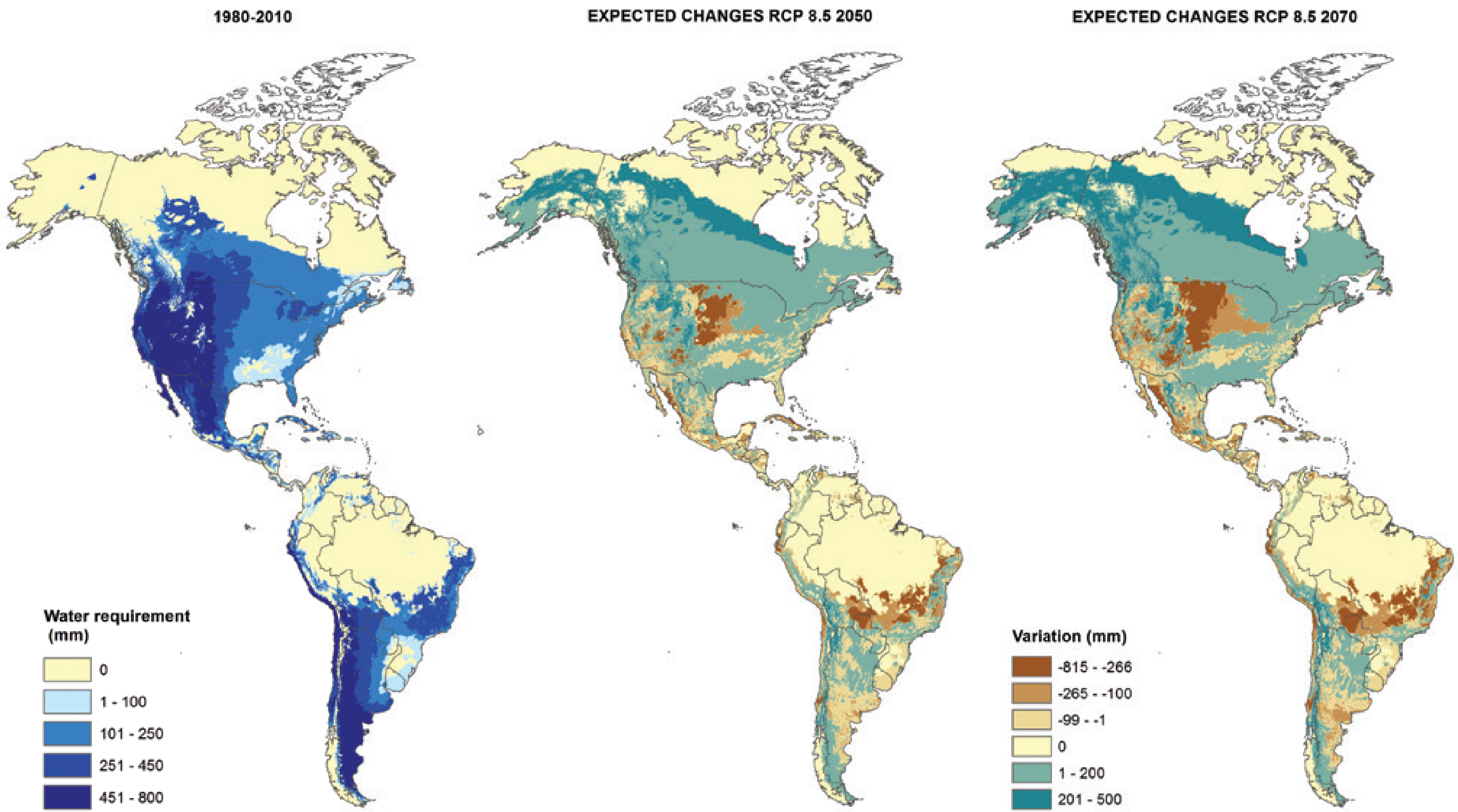

Figure 32: Water requirement will drop or remain almost constant in areas where yield shows a decreasing trend due to the shortening of the life cycle or in some cases due to the changes of sowing dates. Water consumption shows a positive trend in areas where yields increase, such as the central part of Canada, central-western USA, and southern South America.

POTATO WATER REQUIREMENT

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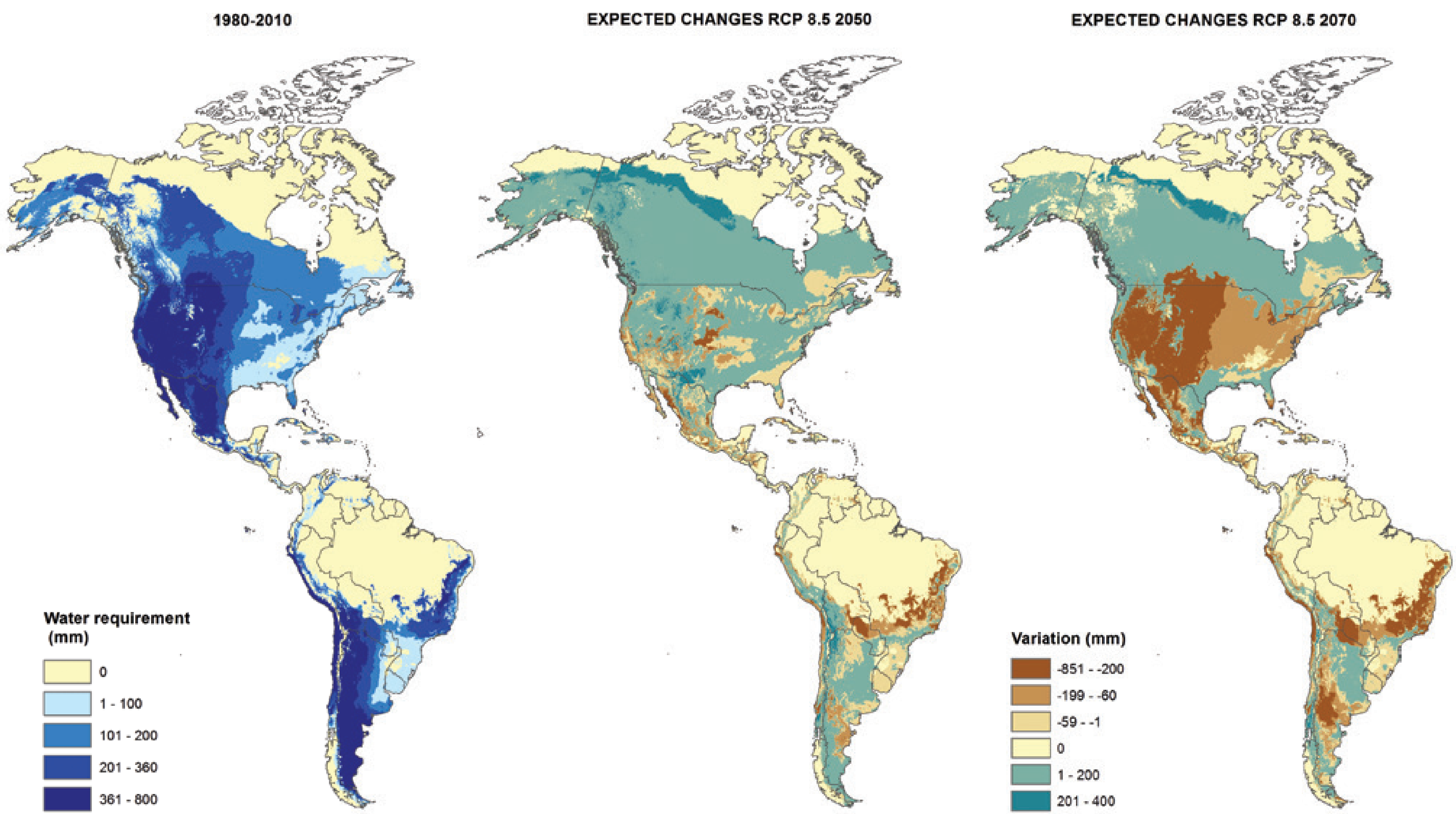

Figure 33: Water requirement will drop in areas where yield shows a decreasing trend, this is due to the shortening of the life cycle or in some cases it is due to changes of sowing dates; this is the case for spring varieties which would shift to autumn sowing. Water consumption shows a positive trend in areas where yields increase, such as the central part of Canada, central USA, and southern South America.

RICE WATER REQUIREMENT

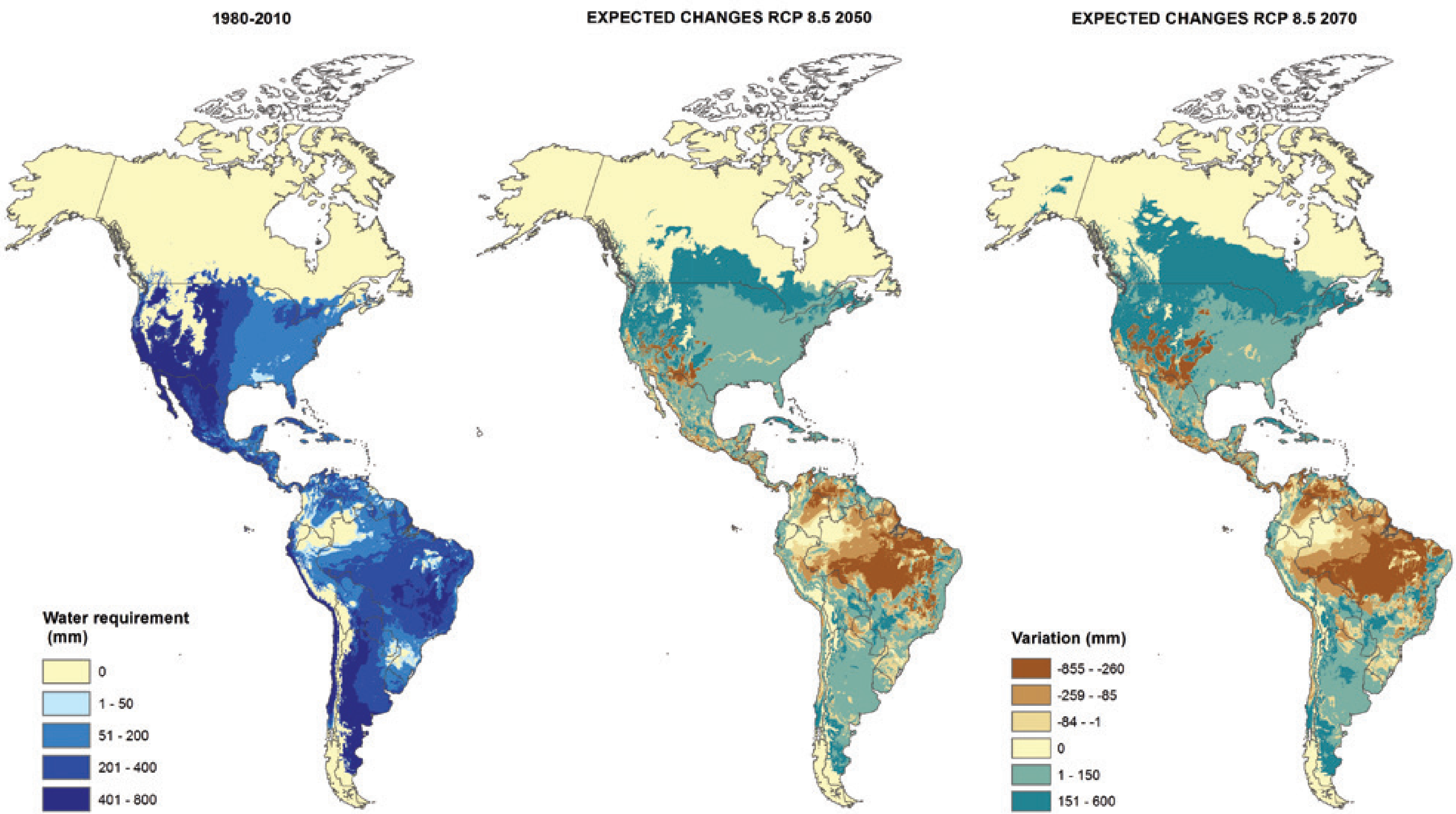

Figure 34: Despite the increase of the reference evapotranspiration due to higher temperatures, irrigation requirements of rice could paradoxically decrease in some areas. This is a consequence of the shift of sowing dates to the winter months, which allows a better use of soil humidity in the Mediterranean climate having high rainfall concentration in winter. Water consumption shows a positive trend in areas where yields increase, as in central parts of Canada, central USA, and the south of Chile and Argentina.

TOMATO WATER REQUIREMENT

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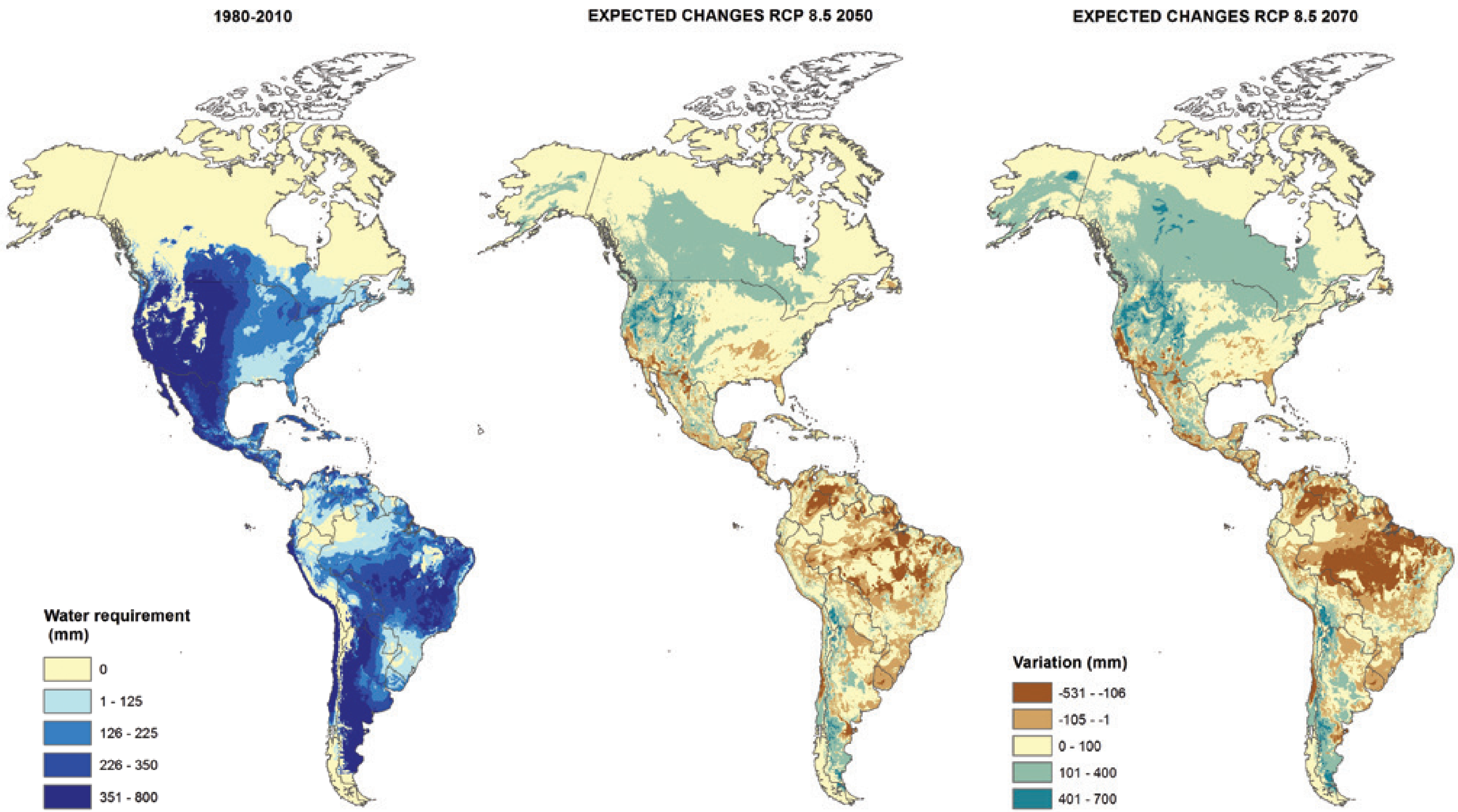

Figure 35: Water requirement could decrease in areas where yield shows a decreasing trend, this is due to the shortening of the life cycle or in some cases it is due to the changes of sowing dates; this is the case for spring varieties which would shift to autumn sowing. Water consumption shows a positive trend in areas where yields increase, as in central parts of Canada, western USA, and southern South America.

DRYFARM MAIZE YIELD

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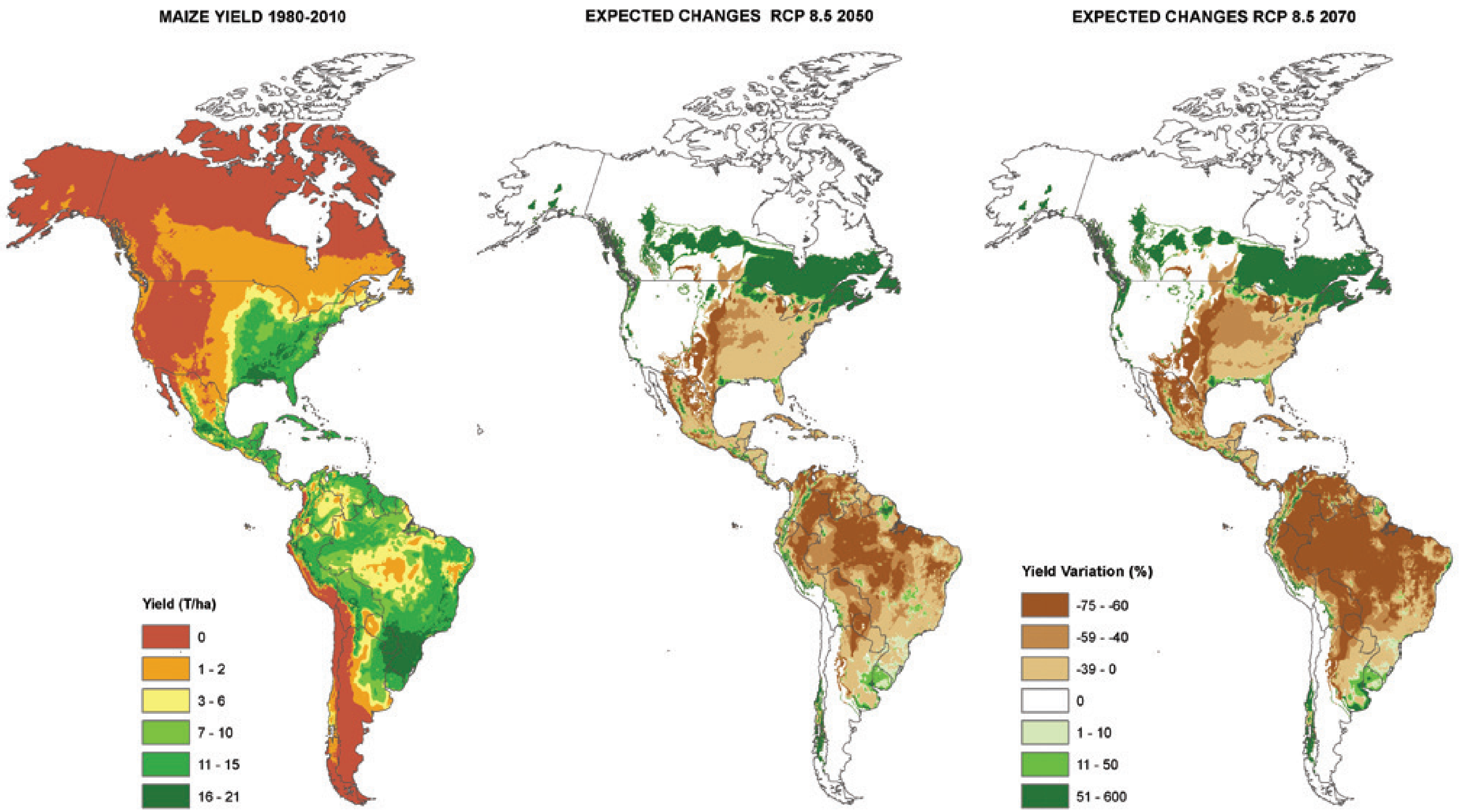

Figure 36: Dryfarm cultivation is highly sensitive to the variation of seasonal rainfall. In areas where rainfall declines, maize yields show the same trend. This is the case for most parts of the USA, Brazil, Argentina, Central America and the Caribbean. Without irrigation, yields increase just in southern Brazil, the humid pampa of Argentina and Uruguay, the southern part of Chile, and around the Great Lakes zone in North America.

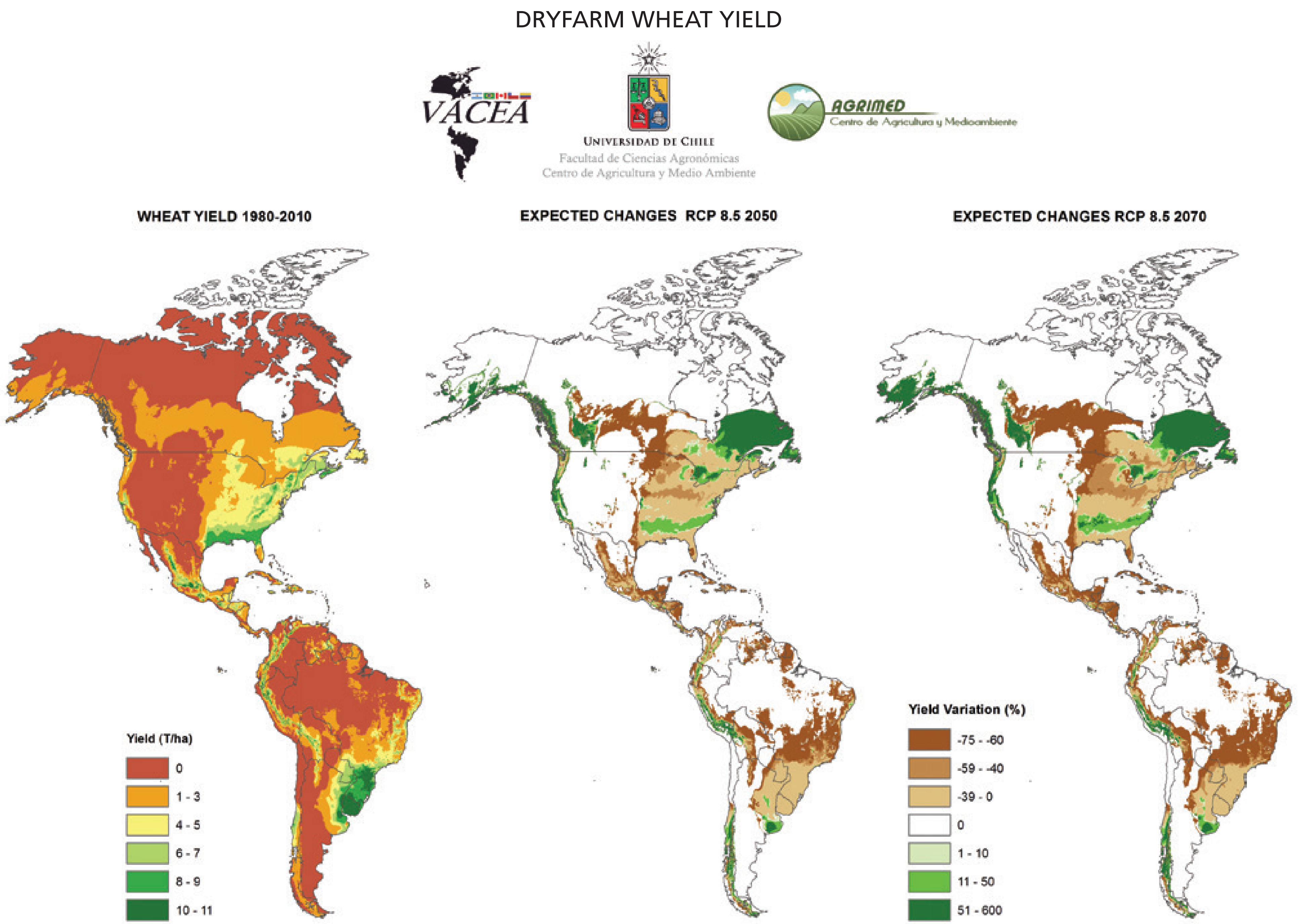

Figure 37: Wheat yields increase in the Pacific coast of North America, the Atlantic coast of Canada, in southern Chile and in the humid pampas of Argentina. Important reduction is foreseen in southern Brazil and central Canada, which are currently important production regions.

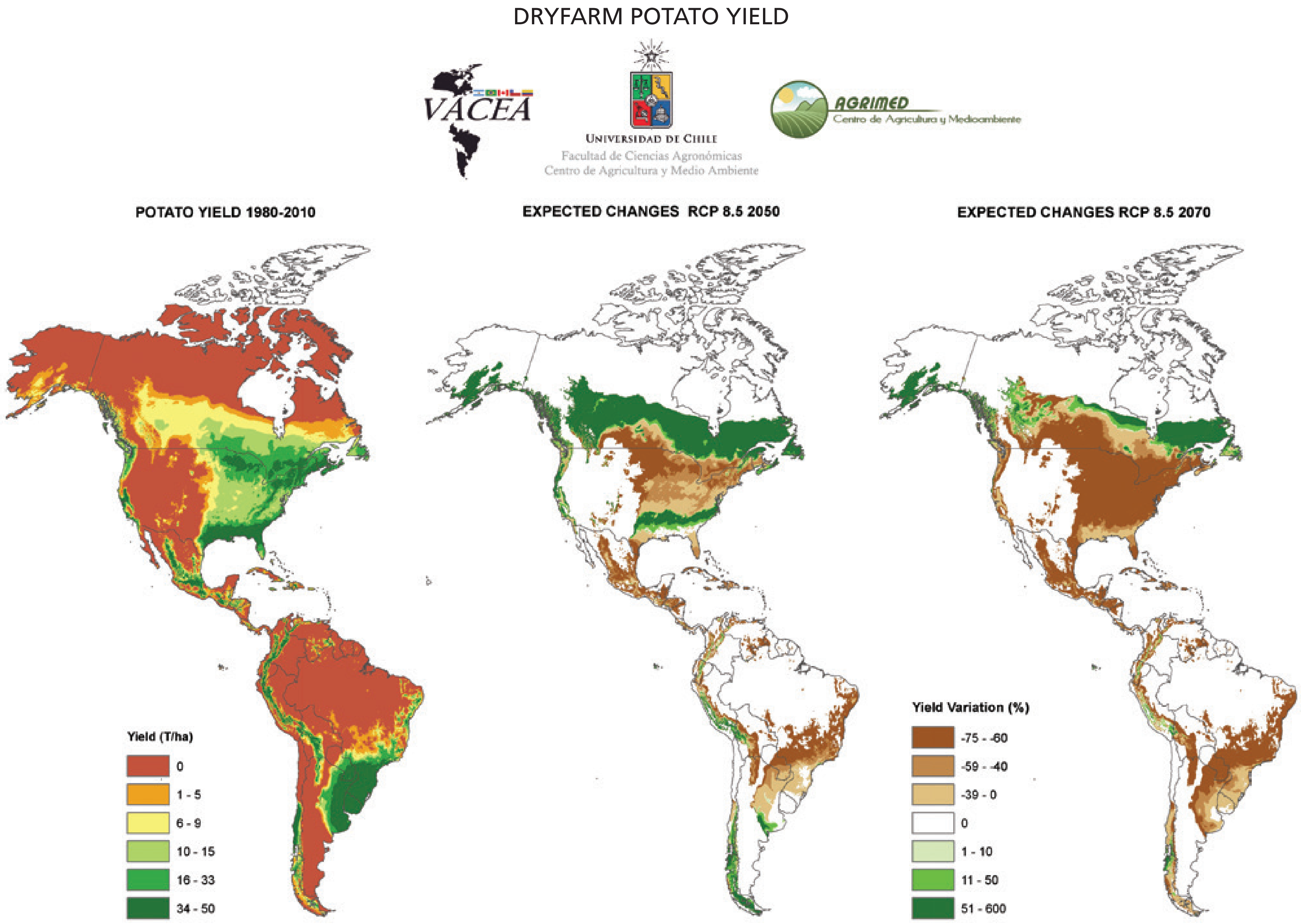

Figure 38: Potato yields could increase in southern Canada, some parts of southern Chile and the Pacific coast of Canada.

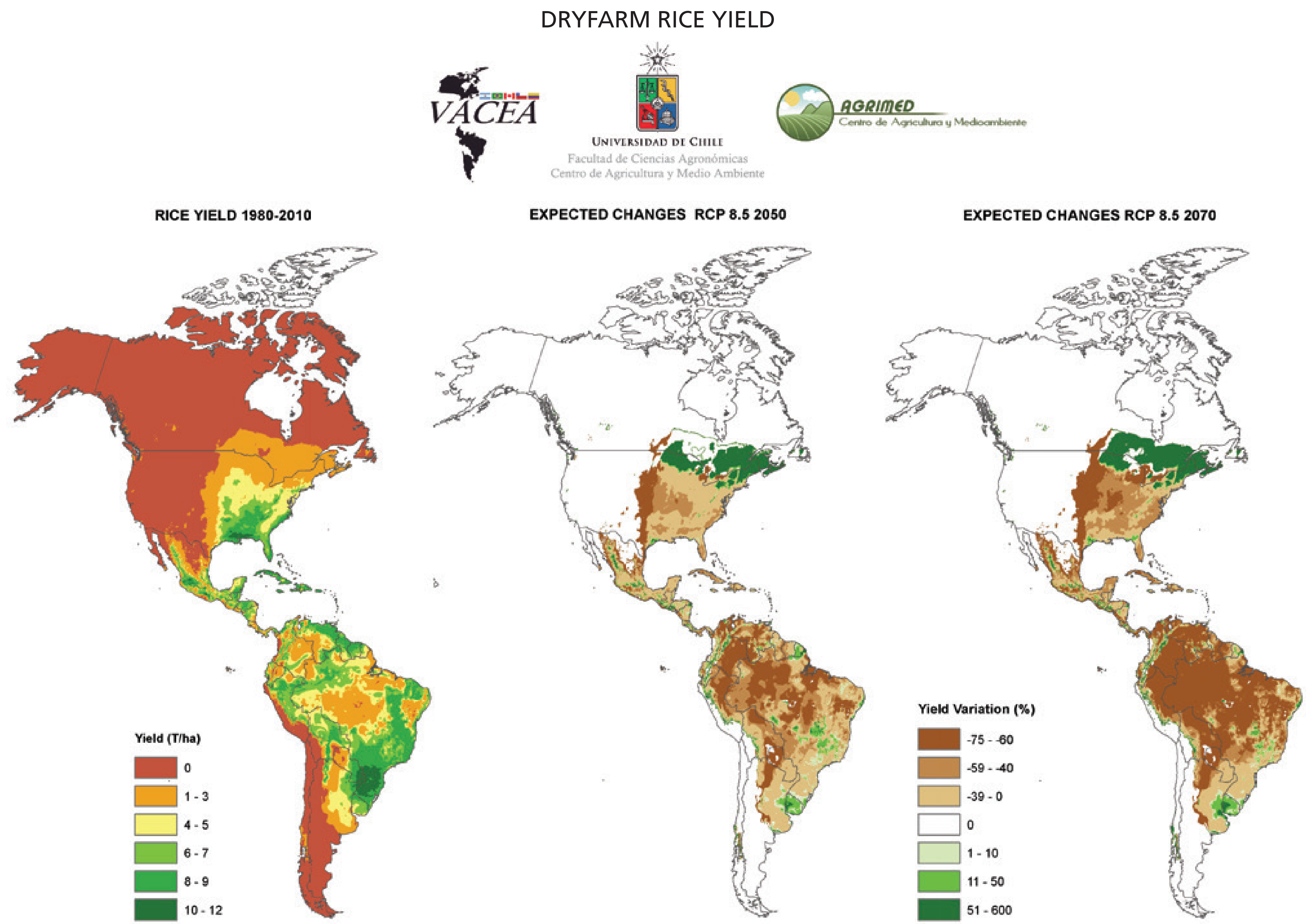

Figure 39: Considering that rice is presently cultivated in hot areas, important drop yields could affect this species mainly in the intertropical zone. It is possible that coastal areas register yield increases due to the oceanic effect. Also, the pre-andean hills of Peru and Ecuador may gain some productivity in the next decades.

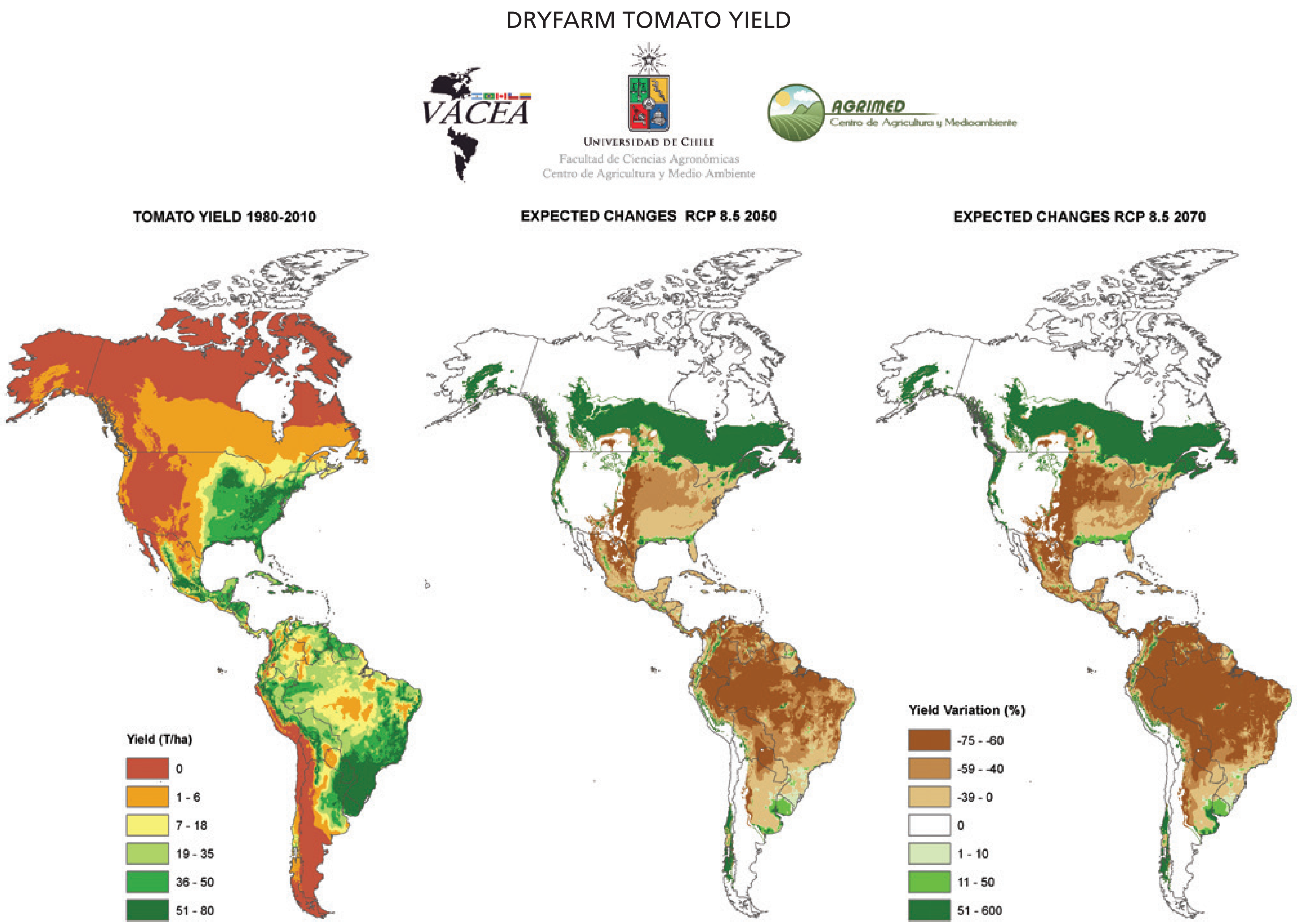

Figure 40: Tomatoes are presently cultivated in a variety of climates, even under controlled conditions. For that reason the impact of climate change is difficult to foresee. Global conditions could improve in the Pacific coast of the northern USA, in southern Canada, Chile and Uruguay, and in some areas of the humid pampas of Argentina.

GLOBAL CLIMATE CHANGE IMPACT ON AGRICULTURE PRODUCTIVITY

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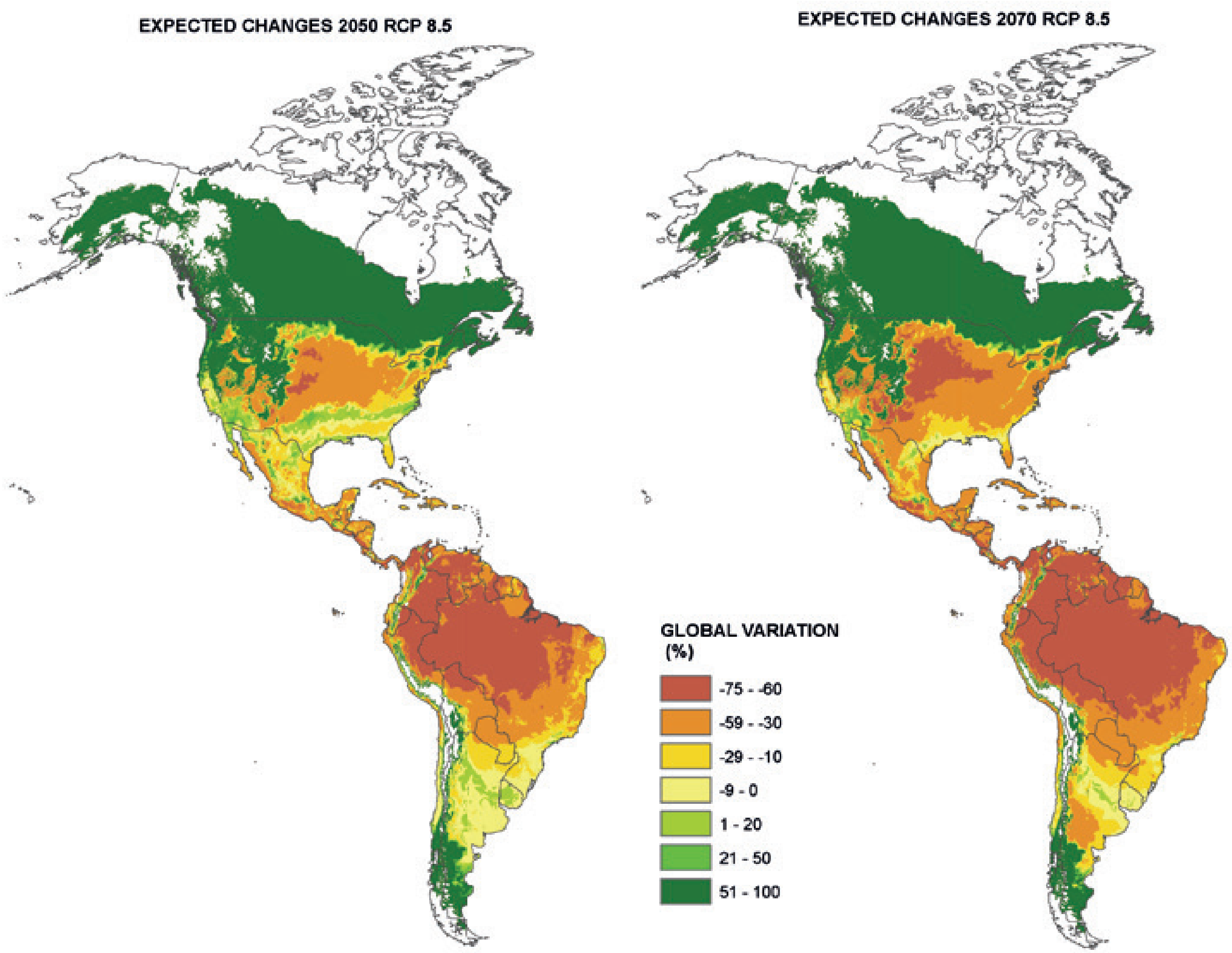
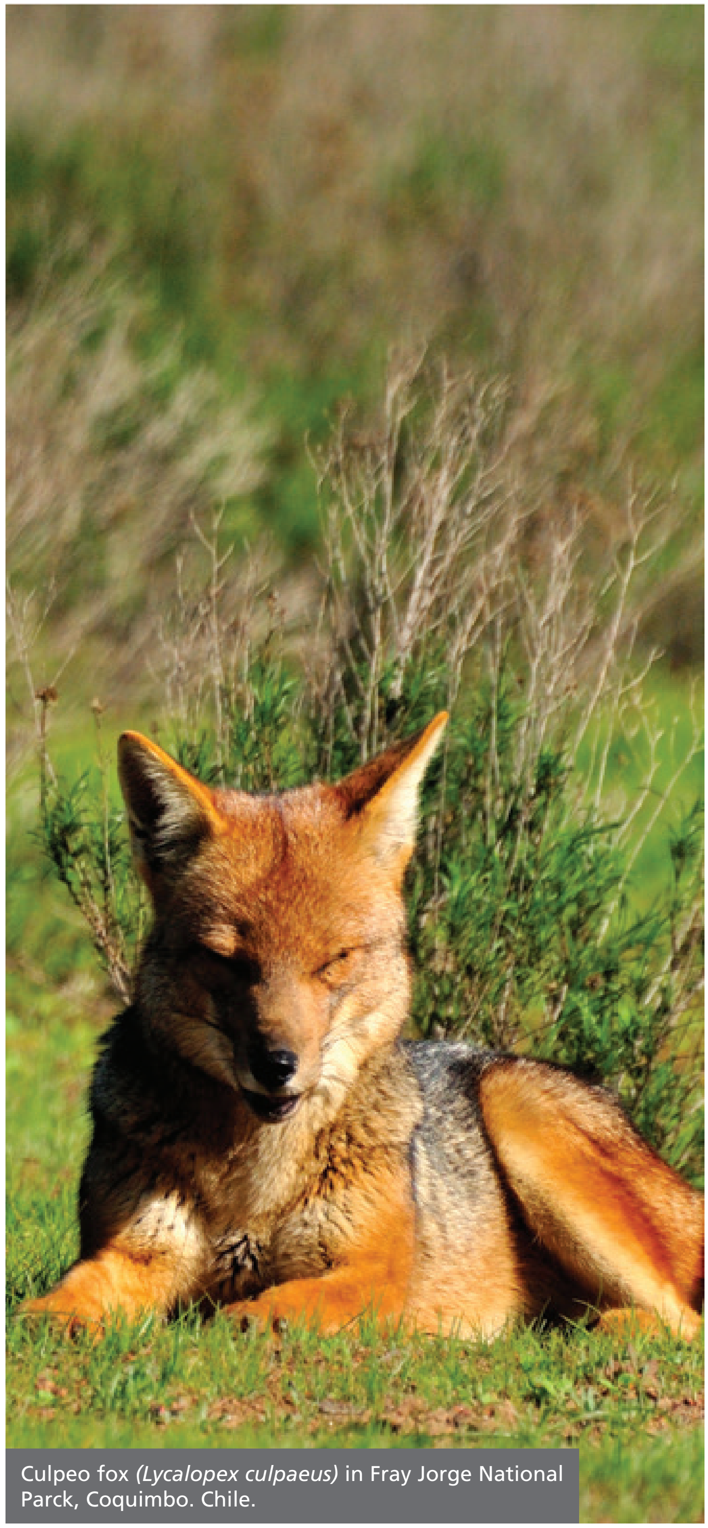


Figure 41: Global climatic change will be positive for agriculture productivity in the boreal and septentrional region of the continent. Some positive effects of climatic change are also observed in coastal areas of the Pacific and the highlands of Andean and North American mountains. For the rest of the continent however, climatic change could have a negative balance on agriculture productivity.

IMPACT OF CLIMATIC CHANGE ON REGIONAL ECOSYSTEMS

Climate change will create new environmental scenarios for plant and animal communities. It is very likely that living organisms won't have time to adapt to the new climatic conditions, considering that adaptations of plants and animals take several generations to fully express. The life cycle for temperate forests takes between 50 to 80 years to be completed. The activation of a gene may occur in several generations. This means that the adaptation to a new climatic scenario may take several centuries, a rate that is not compatible with the speed of climatic changes that have currently taken place. It is important to consider that a rise of 2°C of global temperature is like to move the area of distribution of a living community to several hundred kilometers or move its current territory between 300 and 400 m in altitude. Therefore, it is important to project the magnitude of climate change expected in different areas, so as to establish to what extent each ecosystem will be subjected to stress-inducing climate changes in the future.



Culpeo fox *(Lycalopex culpaeus)* in Fray Jorge National Parck, Coquimbo. Chile.

BIOMASS AND ECOREGIONS OF AMERICA

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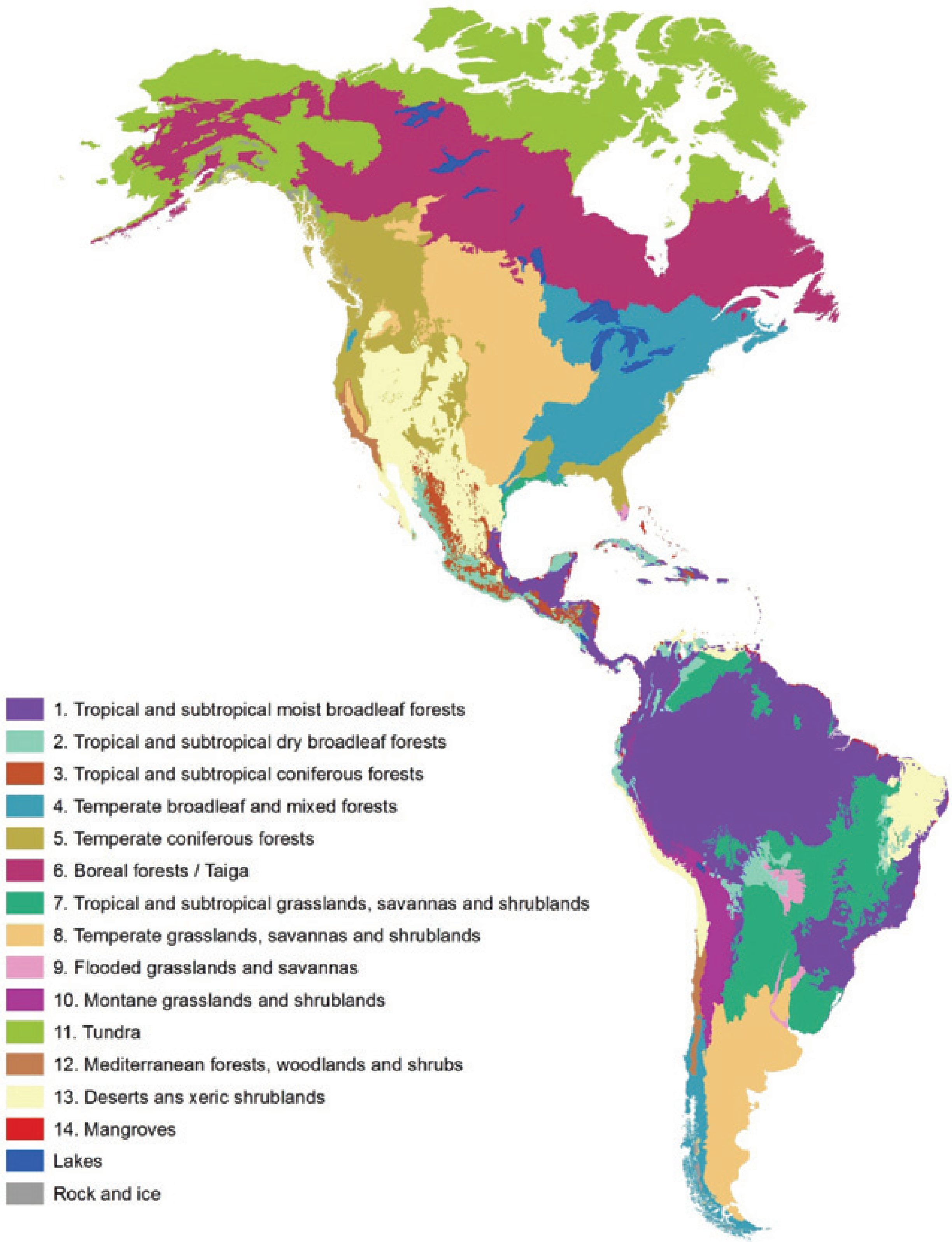

Figure 42: Biomass and ecoregions of America.

• Bioclimatic stress of ecosystems

To determine levels of stress that a climate change scenario can induce in an ecosystem, it is necessary to know the current spectrum of bioclimatic tolerance of the ecosystem. The main aspects determining geographical distribution of species are:

How hot the summer is. How cold the winter is. And how arid/humid the climate is. To answer these questions it is necessary to select bioclimatic variables describing:

- The summer thermal regime: temperature of the hottest month.
- The winter thermal regime: temperature of the coldest month.
- The annual water regime: aridity index (precipitation/evapotranspiration or the length of the dry season). Also water deficit (evapotranspiration – evapotranspiration) is a powerful driver for plant distribution.

To establish the bioclimatic profile of each ecosystem, the geographical distribution of it was overlapped with each bioclimatic variable. To do that, a 1 km bioclimatic grid was used. The resulting histograms give a clear indication of how each variable may determine the geographic distribution of a specific ecosystem.

It is supposed that the frequency is associated with the degree of bioclimatic stress. Lesser frequency means higher bioclimatic stress. It is likely that beyond the extreme values, the ecosystem does not find climatic conditions to subsist.

Once the upper plateau is established, as the mean value of the X higher frequencies, two lines connect the lower and upper border with the extreme borders of the distribution. This expresses that levels of bioclimatic stress will increase until a point, and beyond that, the extreme values are not present in the ecosystem.

A reasonable hypothesis is that lower and upper linear functions are expressing levels of bioclimatic stress when this variable moves away from the optimal condition (upper plateau). At the upper plateau bioclimatic stress is 0, and at the extreme value (lower and higher) bioclimatic stress is 1.

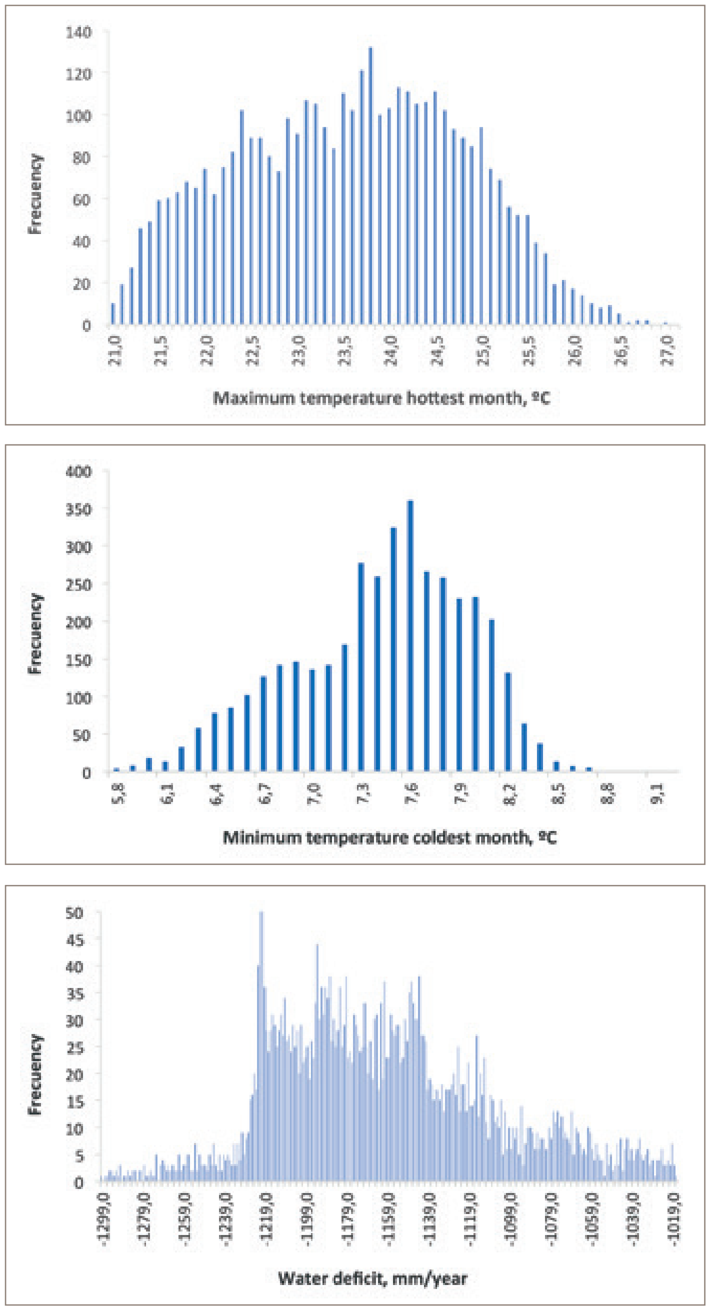

Figure 43: Bioclimatic profile of the Arid Mediterranean coastal chaparral of Oxalis gigantea and Heliotropium stenophyllum in Chile.

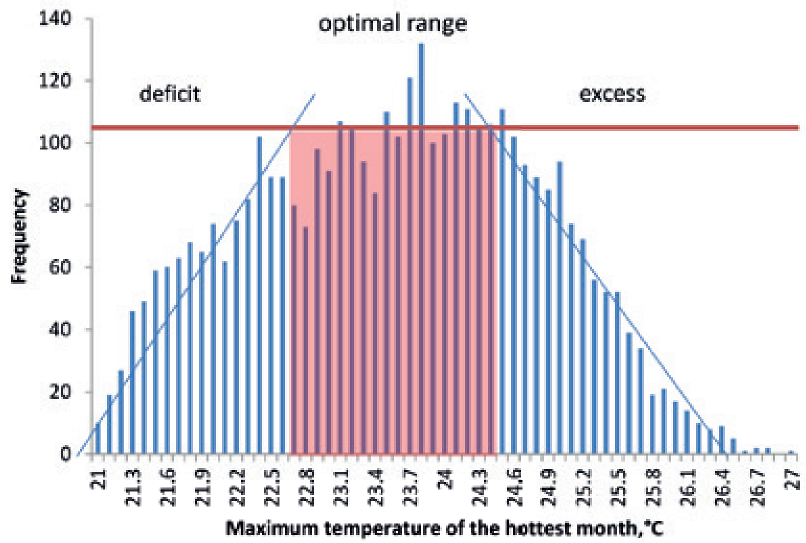

Figure 44: Frequency of maximum temperature of the hottest month.

By applying the stress equations derived of this procedure to the whole bioclimatic grid we evaluated the stress at each point of the grid for the three main variables:

- Summer heat stress (Shs), ability to adapt to higher temperature.
- Winter cold stress (Wcs), ability to survive the freezing temperature or to support low subfreezing temperature.
- Water stress (Ws), ability to adapt to survive the dry season or to face water deficit.

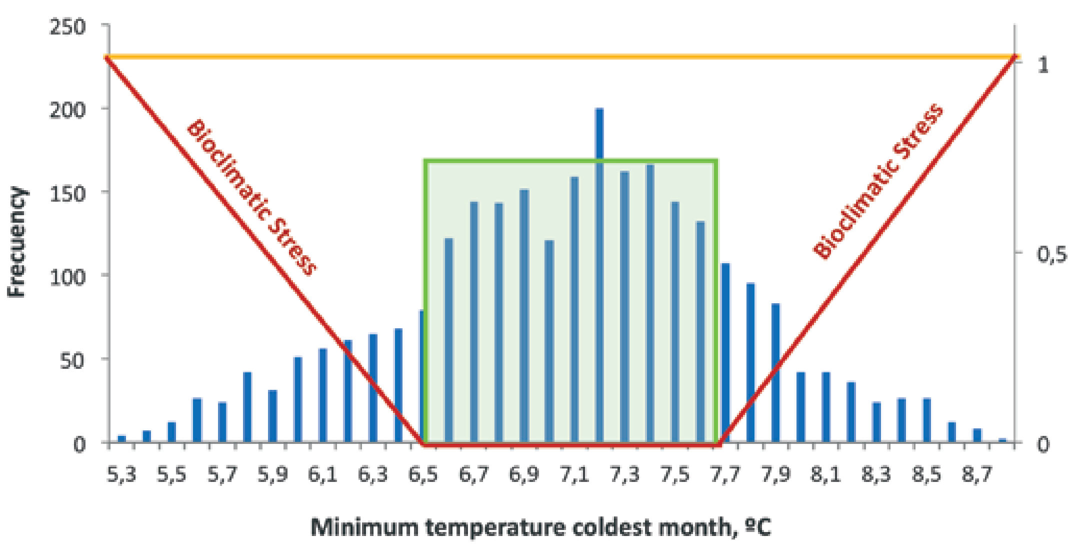

Figure 45: Bioclimatic stress follows an inverse tendency with respect to the histogram of tolerance of a specific variable. It is assumed that in the central part of the distribution of an ecosystem, conditions are not stressing at all. As we move toward the end of the distribution, bioclimatic stress increases until reaching a maximum level, beyond the boundaries of the present distribution of the ecosystem.

In order to establish the total bioclimatic stress that an ecosystem as to endure facing climatic change, an integration of the three dimensions is necessary. Using an additive model, the integrated bioclimatic stress (IBs) in a climate change scenario is:

$$IBs = Shs + Wcs + Ws$$

The IBs was standardized between 0 and 1, divided by 3, in order to use the same scale that the other Indices use.

SUMMER THERMAL STRESS OF AMERICA ECOREGIONS

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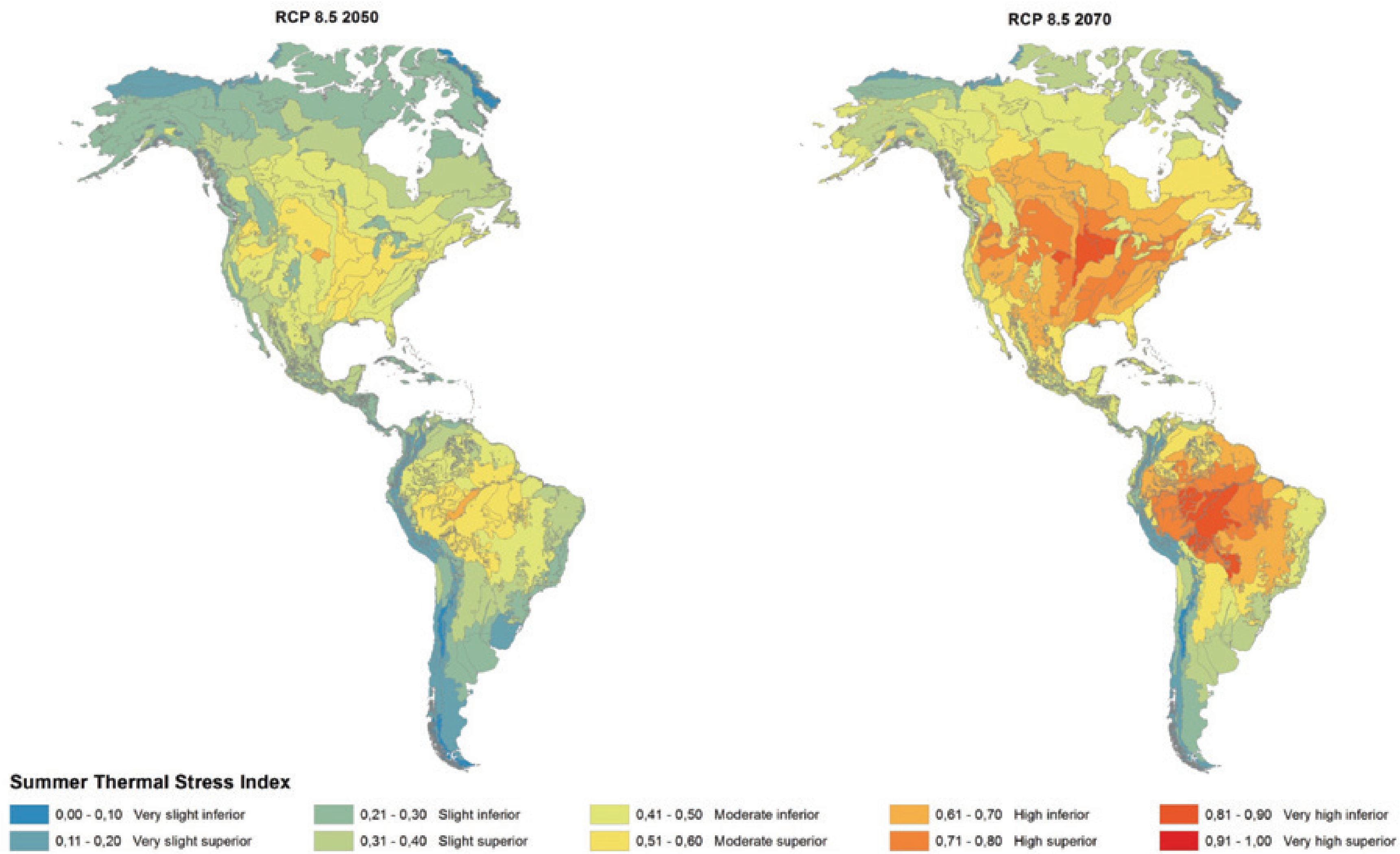

Figure 46: When ambient temperature goes above a maximum threshold (depending on each species), plants start to be stressed. The stress level increases as the temperature moves away from the threshold of tolerance of each species. Stress is highest when the tolerated maximum temperature is reached. Above this level, survival is under risk.

WINTER THERMAL STRESS OF AMERICA ECOREGIONS

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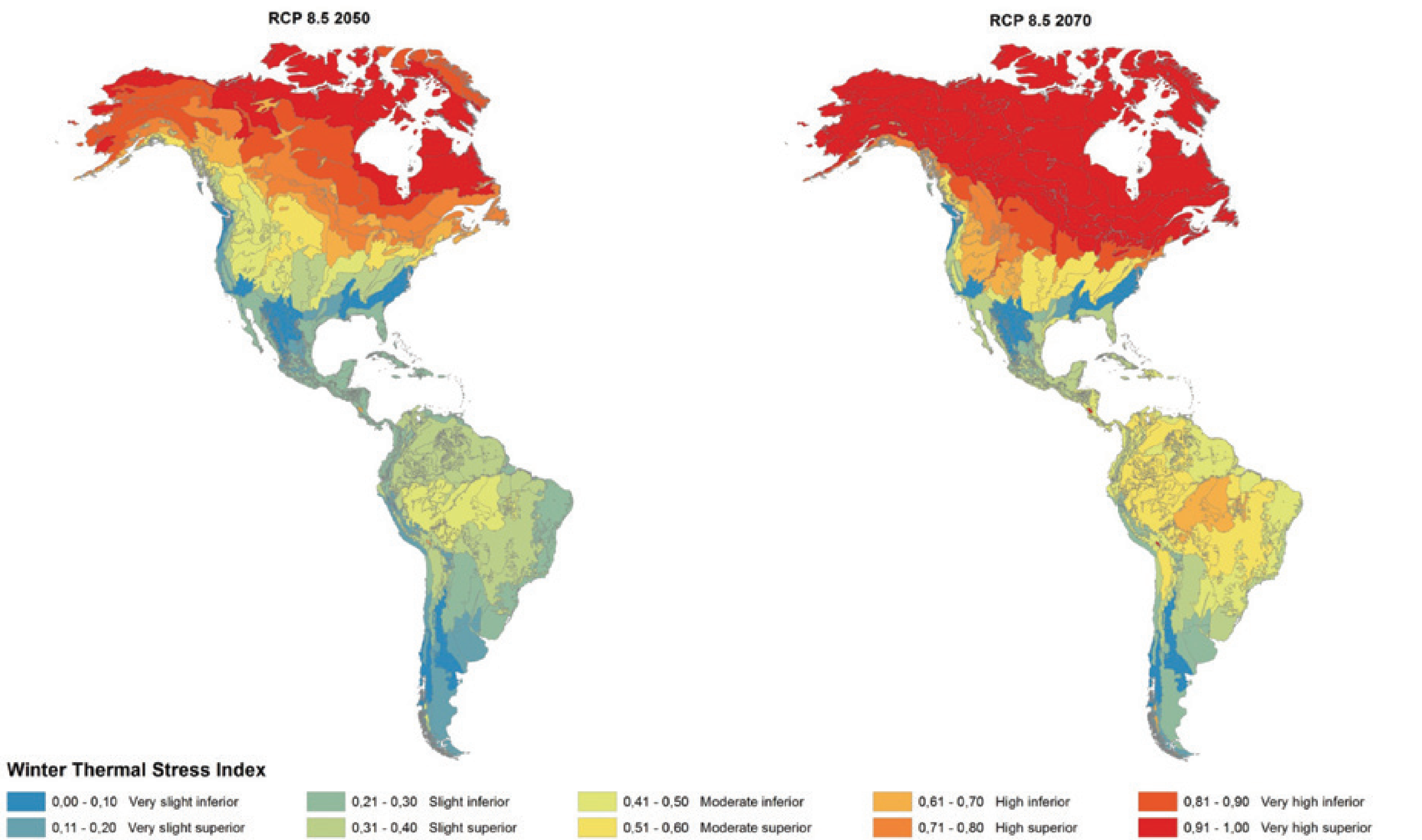

Figure 47: Minimum winter temperature should drop below a cold threshold for temperate species. This guarantees an adequate resting period which is needed by these species. Excessively "mild" winters may create problems to temperate species for completing the physiological need of rest, creating a potential problem to reproduce (flowers tend to be unfertile).

WATER STRESS OF AMERICA ECOREGIONS

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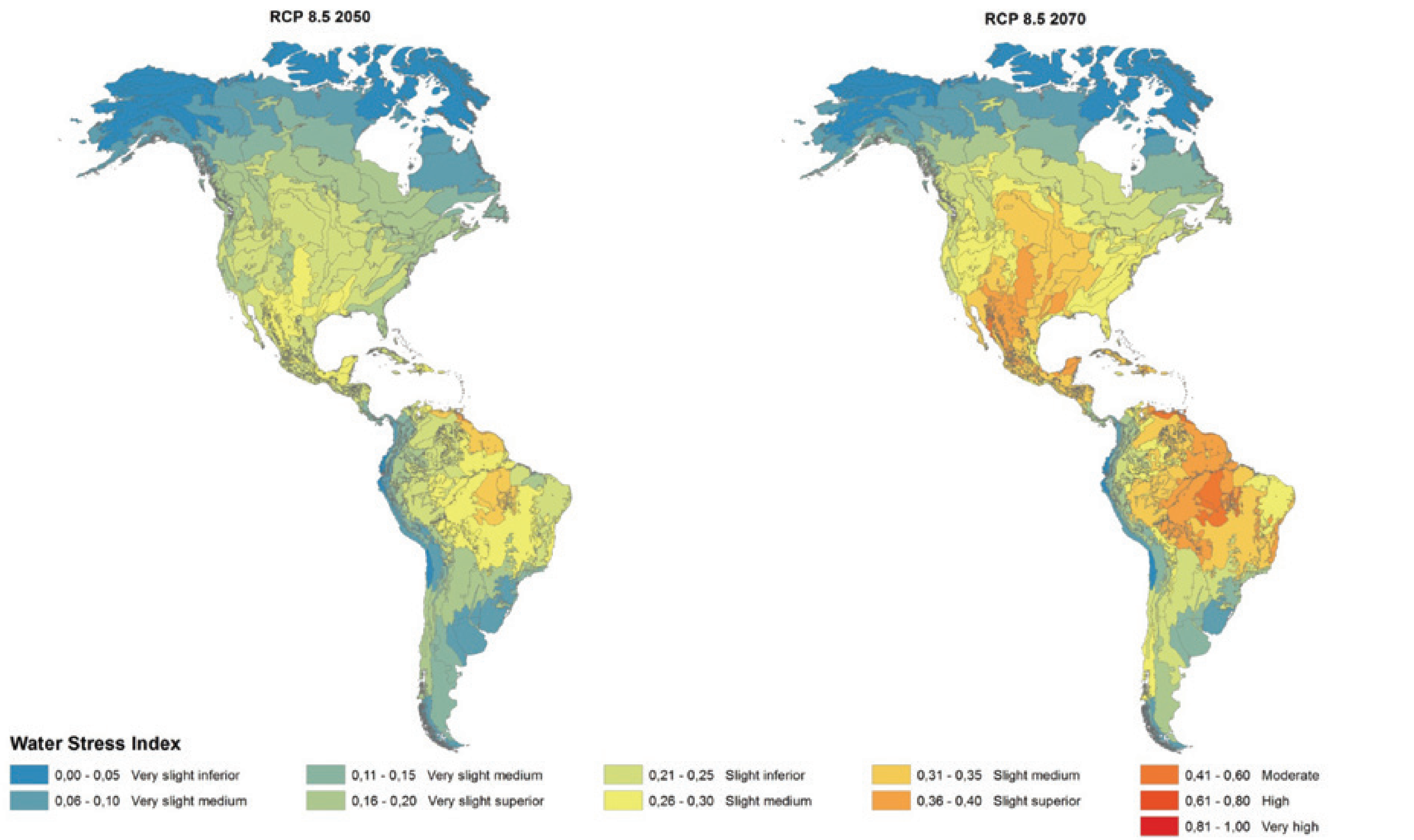

Figure 48: Water stress is relative to the adaptation mechanism that each specie have, in order to face water shortage. Water stress will be high in warm climates because of the increase of the rate of evapotranspiration. Water stress could trigger ecosystems degradation in the Amazonian region, Meso America and continental areas of North America. This stress will be attenuated in climates that have a high degree of marine influence and in the northern part of North America.

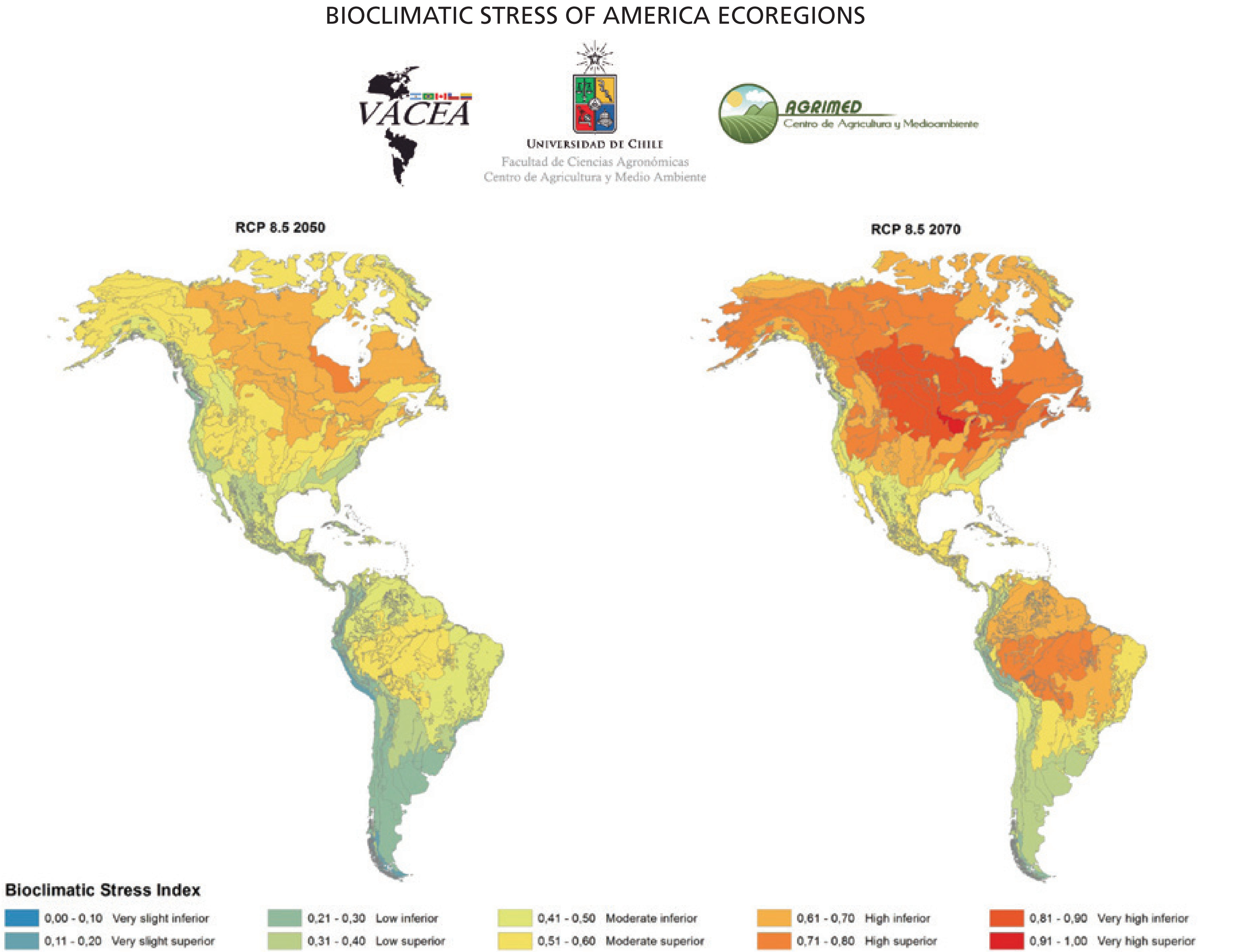

Figure 49: The most threatened ecosystems could be those of the Amazonian region, and those of the continental part of North America, including center and north Canada. The fact that winter temperatures will become milder, may force a vegetation change as consequence of a loss of the capacity of present vegetation to compete if winters become more favorable for other species.

AGRICULTURE VULNERABILITY TO WEATHER THREATS IN LATIN AMERICA AND THE CARIBBEAN

Vulnerability of each country to climate change results from combining a number of factors that influence, on one hand, the sensitivity or susceptibility of the agricultural sector to a change in the climate scenario, and on the other hand, their adaptation capacity to changes in agriculture climate context. The sensitivity of agricultural systems, as well as the adaptive capacity, is obtained by integrating environmental, social, economic and technological variables that determine them.

The risk level of each farming system depends on their exposure to extreme weather events or changes that may threaten productivity. To determine the exposure, it is necessary to know the location of the cultivated land, the magnitude of the expected climate change and the scale of agriculture (cultivated land and population dependent on this activity). An agricultural region is more exposed when it is more extensive (productive dimension) or when there are more people working in agriculture (social dimension). The dimension of the impact is calculated combining the vulnerability and exposure, either economic or social, that climate change will have on a region of the continent.

Information was obtained from international sources to quantify each component of vulnerability and exposure; these were the CEPALSTAT statistical database from the Economic Commission for Latin America and the Caribbean (ECLAC), the World Bank, the United Nations Development Program (UNDP) and the statistical databases FAOSTAT and AQUASTAT of the United Nations Food and Agriculture Organization (FAO). The agriculture sensitivity in each area was determined by comparing the potential yields of various crops with yields that they will have in the new climate scenarios. Both yields were estimated with the SIMPROC model developed at the Center for Agriculture and Environment (AGRIMED) of the University of Chile.

The following figure shows a diagram depicting the integration model of the indices used to estimate the agricultural impact, in addition to the factors or indicators used to construct the Sensitivity, Adaptive Capacity and Exposure indices.

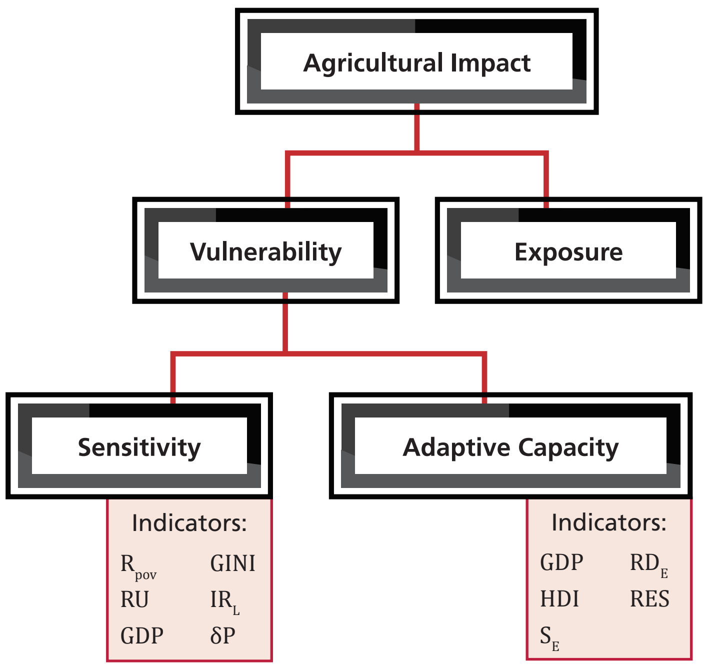

Figure 50: Integration model of the agricultural impact within a territory.

Below a description is presented of each index from the model and the indicators that compose it.

• Sensitivity of Agricultural Production Systems

The sensitivity translates the degree to which an agricultural system can be altered by a change of context in their environment. In this case we have defined the sensitivity as the susceptibility to changes in the climate system. The Sensitivity Index considers socioeconomic factors such as:

- Fraction of the rural population living in poverty
- Percentage of population living in rural areas.
- Total annual Gross Domestic Product (GDP) per capita
- GINI Concentration Index
- Agricultural area effectively irrigated in regards to total agricultural area
- Changes in crop yields under climate change scenarios

Fraction of the rural population living in poverty
Corresponding to the percentage of the population living in rural areas whose average per capita income is below the poverty and extreme poverty line. The approach used by ECLAC to define a condition of poverty indicates that income per capita of a person`s household must be less than the minimum amount needed to meet basic needs, determined by the cost of a basket of basic goods and services estimated for each country.

Percentage of population living in rural areas
The percentage of population living in rural areas is basically obtained from national population censuses. The higher the fraction of rural population in a country, the more sensitive to climate changes.

Total annual Gross Domestic Product (GDP) per capita
Gross Domestic Product (GDP) is the market value of all final goods and services produced within a country during a given time period and it is commonly used as an indicator of the economic health of a country. A country with more financial resources will have a less sensitive agricultural system than one that has a low GDP per capita.

GINI Concentration Index
Measures inequality in income distribution. The GINI coefficient is an index that takes values between 0 and 1, where zero corresponds to absolute equality and one to absolute inequality. Commonly, a country with more inequality will present higher sensitivity.

Agricultural area effectively irrigated in regards to total agricultural area
This indicator represents the level of access to irrigation. The higher is the proportion of surface with effectively irrigated croplands in regard to total agricultural area, the less sensitive is the agricultural system.

Changes in crop yields under climate scenarios (δP)
The changes in crop yields can be positive or negative, adding or subtracting sensitivity to the production system. For this factor, the projected situation of major crops such as wheat, potato, corn, and rice was considered.

$$\delta P = \frac{dY_W + dY_P + dY_C + dY_R}{4}$$

Where:

dY_W, Variation in wheat yields between the baseline (1980 -2010) and the 2070 scenario,

dY_P, Variation in potato yields between the baseline (1980-2010) and the 2070 scenario,

dY_C, Variation in corn yield between the baseline (1980-2010) and the 2070 scenario,

dY_R, Variation in rice yied between the baseline (1980-2010) and the 2070 scenario.

The following table shows a description of the indicators used to develop the Sensitivity Index and the consulted sources.

CODE	INDEX	DESCRIPTION	SOURCE
R_{POV}	Percentage of rural population in poverty conditions	The percentage of rural population in regards to the national population, whose average income per capita is below the poverty line and indigence (extreme poverty).	CEPALSTAT
RU	Percentage of population living in rural areas	Percentage of population living in rural areas, in other words, percentage of rurality. This figure corresponds to the number of rural dwellers accounted for by mid 2015, divided by the total population.	CEPALSTAT
GDP	Gross Domestic Product (GDP) at constant prices in dollars	The Gross Domestic Product (GDP) is the value of the flow of goods and services produced in a country at market prices for a base year, in this case 2010. The figures are expressed in US dollars, using the ECLAC official exchange rate for 2010.	CEPALSTAT, THE WORLD BANK
GINI	GINI Concentration Index	The GINI coefficient is used to measure income distribution. It is an index that takes values in the [0,1] range, where zero corresponds to absolute equality and 1 to absolute inequality.	CEPALSTAT, THE WORLD BANK
IR_L	Agricultural area effectively irrigated in regards to total agricultural area	The percentage of area equipped for irrigation with total control that is actually irrigated in a given year, in regards to total cultivated area in the country. It refers to physical surfaces. Lands that are irrigated more than once a year are counted only once.	FAOSTAT, AQUASTAT
δP	Variation in yield of agricultural crops	Variation in performance between the baseline (1980-2010) and the 2070 scenario.	AGRIMED, SIMPROC model

Table 2: Indicators for the elaboration of the Sensitivity Index.

The sensitivity of the agricultural system to climate change is the result of the integration of the different indicators mentioned above, which are combined according to an additive model. In order to integrate the information for modeling, it is necessary to normalize each variable on a standard scale from 0 (no sensitivity) to 1 (extremely sensitive), considering the minimum and maximum values found on the continent for each variable:

$$Iv = \frac{V_i - V_{min}}{V_{max} - V_{min}}$$

Where:

V_{max} is the maximum value obtained for a variable,

V_{min} corresponds to the minimum value of such variable,

V_i is the value of the same variable in each country or region.

The maximum and minimum values for each variable are found in the Annex III.

This standardization applies directly when sensitivity increases with the value of Vi (the case with poverty, rurality and the Gini index). When the sensitivity varies inversely with the value of Vi, the standardized Iv index is equivalent to 1 - Iv (the case with GDP per capita, access to irrigation).

Standardized rates of each variable are combined in an additive model that combines variables according to the following algorithm:

$$S = \left(\frac{R_{POV} + RU + (1 - GDP) + GINI + (1 - IR_L) - \delta P}{6} \right)$$

Where:

R_{POV} = Rural Poverty (Percentage of rural population living in poverty),

RU = Rurality (Percentage of population living in rural areas),

GDP = Gross Domestic Product per Capita in dollars,

$GINI$ = Gini Index,

IRL = Actual irrigated agricultural land divided by the total agricultural area,

δP = Variation in yields of the 4 major crops.

The results of the Sensitivity Index in Latin America and The Caribbean are presented in the map of Figure 51. The highest levels of sensitivity are found in Central America, where several factors are combined such as low crop yields, significant levels of rural poverty, and low income levels measured by the Gross Domestic Product per capita.

The highest levels of sensitivity coincide with those countries with the highest percentages of rural poverty, such as Honduras, Paraguay, Guatemala and Bolivia. These countries also belong to the quintile with the lowest levels of GDP and equity in income distribution, in addition to small fractions of area equipped for irrigation and significant levels of loss in yields crops.

On the contrary, the countries of south and west of South America as Chile, Uruguay, Peru, Ecuador and Argentina, exhibit a lower sensitivity of their farming systems.

CLIMATE CHANGE SENSITIVITY INDEX

Represents the sensitivity of cultivated crop species and social weaknesses to face climate

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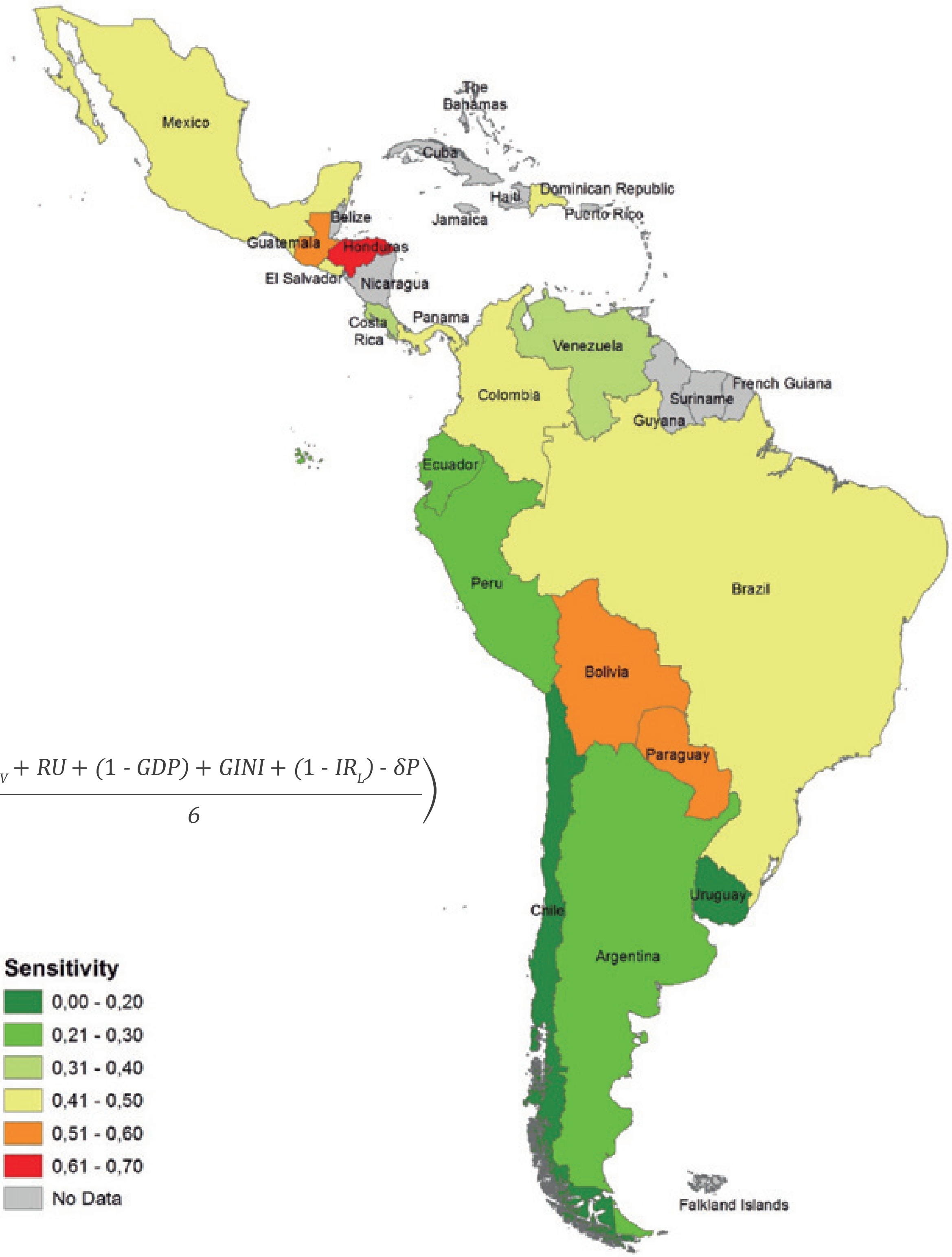

$$S = \left(\frac{R_{POV} + RU + (1 - GDP) + GINI + (1 - IR_L) - \delta P}{6} \right)$$

Figure 51: Climate Change Sensitivity Index.
S = Sensitivity Index; R_{POV} = Rural Poverty; RU = Rurality; GDP = Gross Domestic Product per Capita; IR_L = Actually irrigated agricultural land divided by the total agricultural area; δP = Variation in crop yield between the baseline and the scenario 2070.

• Adaptive Capacity of the Agricultural System

The ability to adapt among regions basically depends on the variables associated with their development, management or governance capacity, and the available resources to adopt new technologies and scientific technological infrastructure. It is expected that a country with higher incomes and greater capabilities in science and technology will be better prepared to face the threats of climate change. To describe the capacity for adaptation of the different countries we have considered the following variables:

- Total Annual Gross Domestic Product (GDP) per capita
- Human Development Index (HDI)
- Social public expenditure per capita
- Expenditure on Research and Development (R & D) as a percentage of GDP
- Number of full-time researchers per million people

Total annual Gross Domestic Product (GDP) per capita
Globally measures the ability of society to access technological solutions to mitigate the effects of climate change. A country with more financial resources can confront in a better way the threats imposed by climate change.

Human Development Index (HDI)
This indicator is a summary measure of average achievement in three key dimensions of human development: level of health, education and quality of life. These three factors allow to obtain an estimation of how prepared is the society in each country to confront the threats of climate change.

Social public expenditure per capita
This indicator provides an estimate of the importance that governments give to social development of countries. A country with greater social development could be more trained to confront natural threats and adapt to changes.

Expenditure on Research and Development (R & D) as a percentage of GDP
Efforts by countries to increase their capabilities in research and development contribute improving their capacity to react to new scenarios and increasing the knowledge of the effects of climate change.

Number of full-time researchers per million people
As in the previous case, this indicator provides an estimate of the level of scientific development and research in each country.

The calculation of the Adaptive Capacity Index was based on a simple average of the chosen indicators. Following the same procedure described for Sensitivity Index, the indicators must be standardized on a scale from 0 to 1. In the case of the Adaptation Capacity Index, the values close to 1 suggest a more favorable situation than in the case of those closer to 0, as they reflect management capacity and administrations with more advantage in these countries; unlike what happens with the other indices where values closer to 1 reflect a more unfavorable situation (increased sensitivity, greater exposure, higher vulnerability).

The following algorithm was used for the Adaptive Capacity Index:

$$AC = \frac{GDP + HDI + S_E + RD_E + RES}{5}$$

Where:

GDP = Gross Domestic Product per Capita in dollars,

HDI = Human Development Index,

S_E = Social Public Expenditure per Capita,

RD_E = R & D Expenditure as a percentage of GDP,

RES = Number of full-time researchers per million people.

CODE	INDEX	DESCRIPTION	SOURCE
GDP	Gross Domestic Product (GDP) per capita at constant prices in dollars	The Gross Domestic Product (GDP) is the value of the flow of goods and services produced in a country at market value for a base year, in this case the year 2010. The figures are expressed in US dollars, using the ECLAC official exchange rates for that year.	CEPALSTAT, THE WORLD BANK
HDI	Human Development Index (HDI)	This indicator reflects the average achievements in basic dimensions of human development, namely a long and healthy life, to acquire knowledge and enjoy a dignified standard of living. For this, it combines factors such as "life expectancy at birth," "years of schooling," and "GDP per capita." The HDI is the geometric mean of the normalization of each of the indices in all three dimensions. It is measured on a scale of 0 to 1.	UNDP
S_E	Social Public expenditure per capita	The estimate, per person, of the allocation of public resources for spending on social sectors.	CEPALSTAT
RD_E	Expenditure on R&D as a percentage of the GDP	Expenditure on research and development is periodic and it comes from national capital (public and private) to suport creative work undertaken systematically to increase knowledge. The area of research and development includes basic research, applied research and experimental development.	THE WORLD BANK
RES	Nº of full time researchers per million people	Number of full-time researchers dedicated to research and development per million people.	THE WORLD BANK

Table 3: Indicators for the development of the Adaptive Capacity Index.

Within the countries for which data are available, countries with lower resilience are Guatemala, Nicaragua, Bolivia, Paraguay and Peru (Figure 52). This can be explained because these countries are among the 12 countries with the lowest GDP per capita of the Region and, in the case of Nicaragua and Guatemala, also are among the countries with the lowest human development index. Considering the extent of per capita public expenses on social development, Bolivia, Nicaragua and Guatemala are among the countries with less investment. On the other hand, the efforts of countries to allocate resources on science and technology directly contribute to strengthening the capacity to face natural and climatic threats. Countries which give more importance to scientific development, expressed through the expenditure on R & D as a percentage of GDP and the number of full-time researchers per million people, are Brazil, Argentina, Mexico and Costa Rica. At the other extreme, the countries that invest less in these items are Nicaragua, Guatemala, Panama and El Salvador.

• Vulnerability Index of Agricultural Activity in the face of Climate Change

Vulnerability is an intrinsic property of agricultural systems in a given country. It depends on the attributes of local agriculture, not on climate hazards to which it is exposed. The combination of the level of sensitivity of agricultural systems with their adaptive capacity allows for an estimation of their vulnerability. To combine both indices, an additive model was adopted, where vulnerability is the average of the indices of sensitivity and adaptive capacity, assigning, in this case, equal weight to each of them. However, it should be noted that the vulnerability is greater while an agricultural community has lower adaptive capacity, so, for this operation the complement of the Adaptive Capability Index (1 – CA) should be considered.

$$V = \frac{\alpha S * \beta \, (1 - AC)}{2}$$

Where:

V = Vulnerability (0 to 1),

S = Sensitivity (0 to 1),

AC = Adaptive Capacity (0 to 1),

α = Weighing of sensitivity,

β = Weighing of adaptive capacity,

$\alpha + \beta$ = 1

As result, the vulnerability of individual countries to future climate change scenarios is obtained by combining their sensitivity of production systems and their capacity to adapt to a new climatic context (Figure 53). Countries with the highest Vulnerability are Guatemala and Paraguay, followed by Bolivia, Panama and Colombia. On the contrary, the countries better prepared to face the expected changes are, in descending order, Argentina, Uruguay, Chile, Costa Rica and Brazil.

ADAPTIVE CAPACITY INDEX

Represents the combined effect of development level, human development and scientific activity

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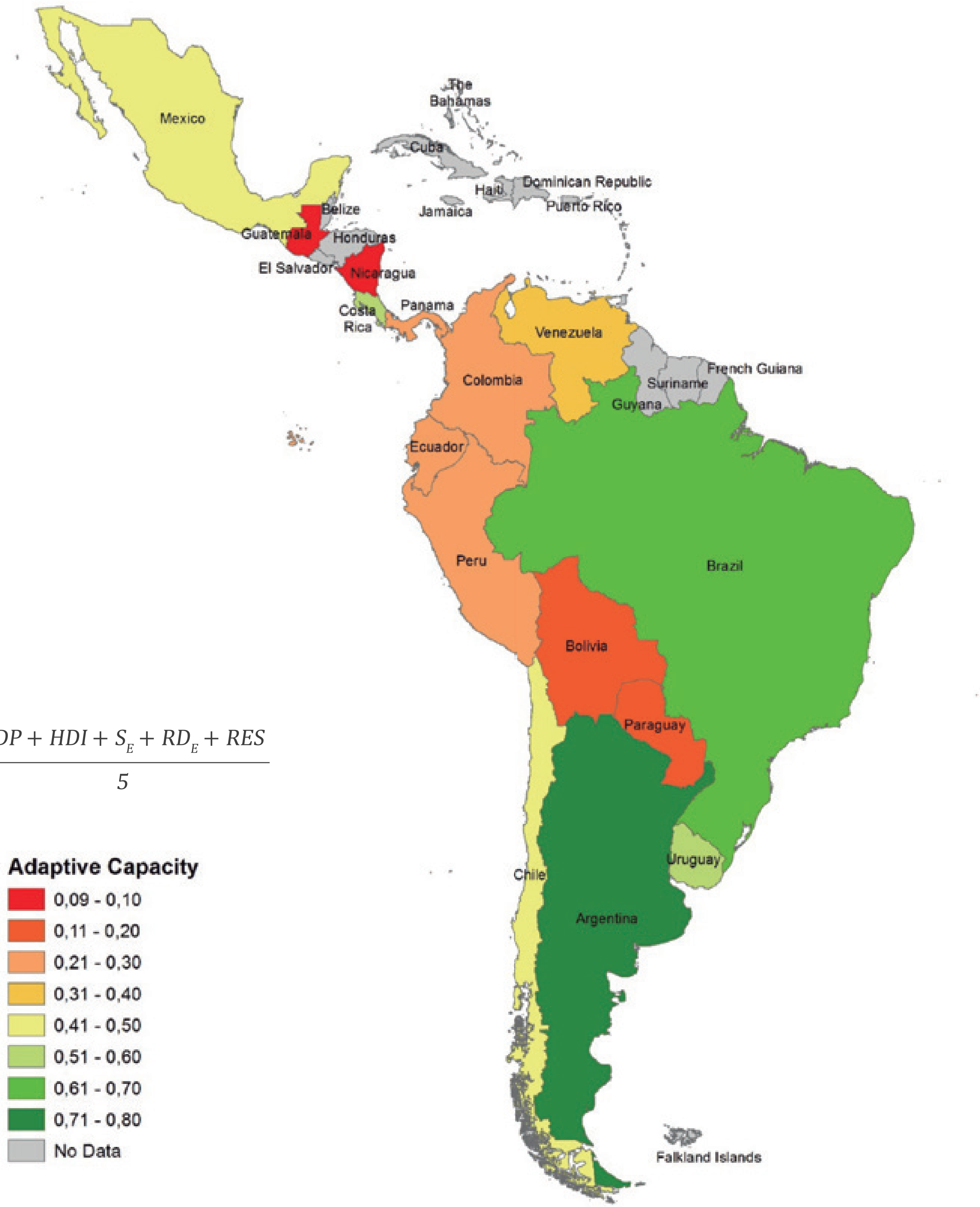

$$AC = \frac{GDP + HDI + S_E + RD_E + RES}{5}$$

Figure 52: Adaptive Capacity Index.
AC = Adaptive Capacity Index; GDP = Gross Domestic Product per Capita in Dollars; HDI = Human Development Index; S_E = Social Public Expenditure per Capita; RD_E = R & D Expenditure as a percentage of GDP; RES = Number of full-time researchers per million people.

VULNERABILITY INDEX

Represents the combined effect of production sensitivity and adaptation capacity

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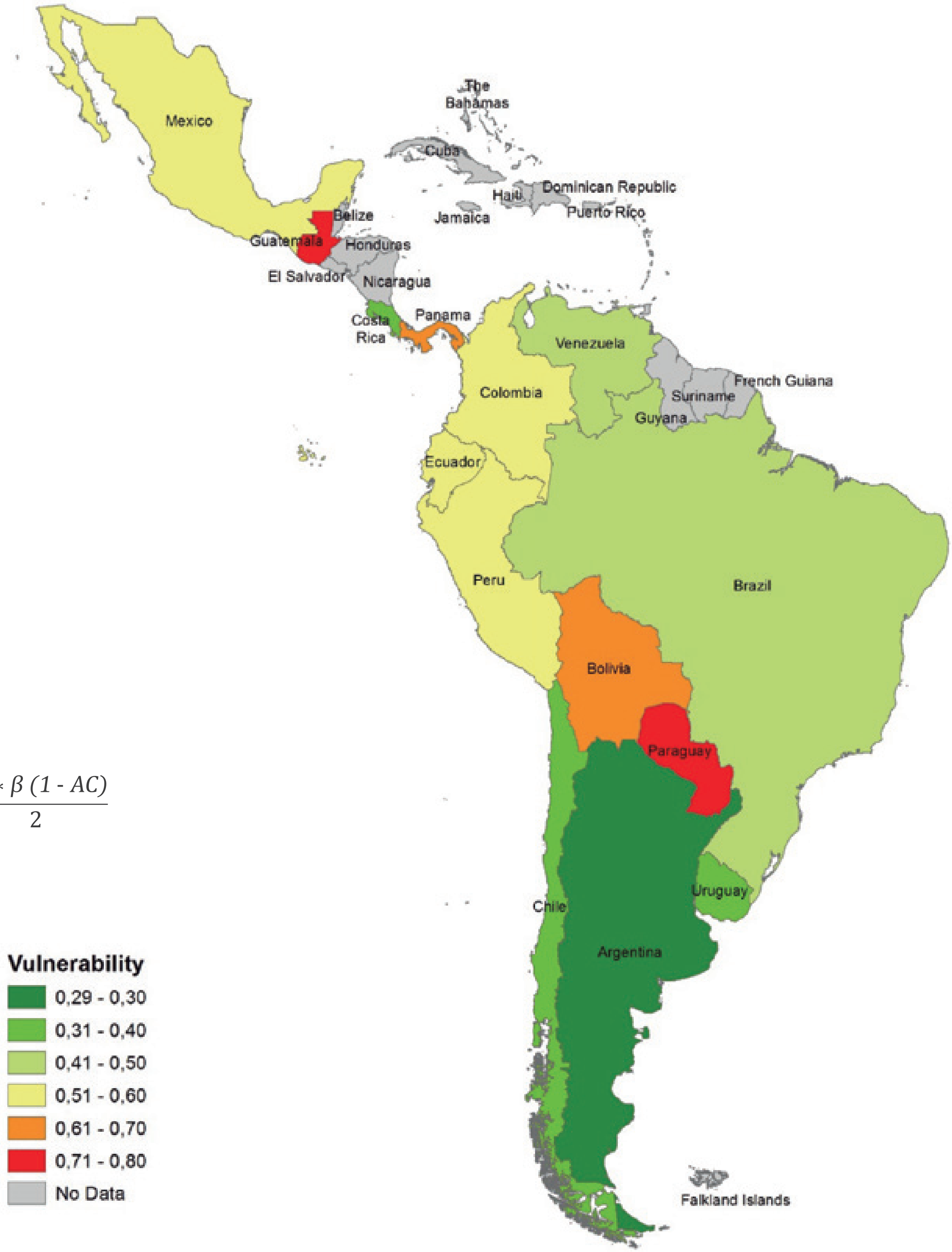

$$V = \frac{\alpha S * \beta\,(1 - AC)}{2}$$

Figure 53: Vulnerability Index.
V = Vulnerability Index; S = Sensitivity Index; AC = Adaptive Capacity Index.

• Exposure of Agricultural Activity to Climate Change

The degree of exposure of the system to climatic hazards depends on the geographical location of each agricultural area, changes expected in each place and, crucially, the magnitude of the activity, either by its territorial extension or number of people who depend on it. For simplicity reasons, the exposure by the affected population (rurality) and the exposed agricultural land (cultivated land) are represented.

Cultivated Area

It was considered as cultivated areas the arable lands and permanent crops, according to the FAOSTAT database. Clearly, the larger the agricultural area of a country, regardless of how extensive is the country, will be more exposed to the climatic threats of future scenarios.

Rural population

The number of people directly exposed to the changes expected in agricultural systems is a key factor in assessing the degree of damage.

The description of these factors is presented in the following table.

CODE	INDEX	DESCRIPTION	SOURCE
C_L	Cultivated Area	This corresponds to the total national cultivated area (ha) of each country. Cultivated area was considered as arable lands and permanent crops.	FAOSTAT
R_{POP}	Rural population	Number of people living in rural areas. This figure corresponds to the number of rural inhabitants accounted for by mid 2015.	CEPALSTAT

Table 4: Indicators for the development of the Exposure Index.

In order to get an estimate of the degree to which the agricultural systems of countries are exposed to variations in climate, the mean was obtained on the standardized values of the cultivated area and the number of inhabitants living in rural areas. The values closest to 0 are those that contribute to a reduced exposure and the values near 100 represent higher levels of exposure. The algorithm used is as follows:

$$E = \frac{C_L + R_{POP}}{2}$$

Where:

CL = Cultivated Land,

R_{POP} = Number of people living in rural areas.

Figure 54 shows the Climate Change Exposure Index map, which combines, in absolute terms, the exposed cultivated surface, and the size of the affected rural population. As area and population is expressed in absolute terms, largest countries inevitably will be more exposed to the threats of climate change than smaller countries. Thus the countries with the highest exposure are Brazil, Mexico, Peru, Colombia and Argentina and the less exposed are Turks and Caikos Islands, Montserrat, United States Virgin Islands, British Virgin Islands, Saint Kitts and Nevis and Aruba.

CLIMATE CHANGE EXPOSURE INDEX

Represents the dimension of territorial or demographic affected target

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$$E = \frac{C_L + R_{POP}}{2}$$

Figure 54: Climate change Exposure Index.
E = Exposure Index; C_L = Cultivated Land; R_{POP} = Number of people living in rural areas.

• Potential Agricultural Impact Index in the Context of Climate Change

The potential impact of climate change strongly depends on the vulnerability of agricultural systems and their exposure. Highly vulnerable and large-scale systems based on the extension of cultivated area or rural population dependent on agriculture, are exposed to greater potential impacts; that is, social and economic consequences of greater magnitude that will represent greater economic efforts for countries. By contrast, systems that have lower vulnerability and have a reduced range will not generate big impacts and can be addressed with relatively little effort.

$$PAI = V * E$$

Where:

PAI = Potential Agricultural Impact,

V = Vulnerability (Intrinsic properties of the agricultural system),

E = Exposure (Social and productive dimension of the agricultural activity).

The global impacts of the new climate scenarios on Latin American and Caribbean agriculture are represented firstly through the integration of the sensitivity of the agricultural system with adaptive capacity among countries, which allows to estimate their level of vulnerability, and secondly through the integration of vulnerability with exposure to climate hazards for each country. Impact on the agricultural system is defined numerically on a scale from 0 to 100, where the closer to 100, impacts are more severe either by a high level of exposure, by a lack of capacity response to threats, or by increased sensitivity of the production system. Below is presented the map with the results of the Agricultural Impact Index.

The map of Figure 55 shows the results of the Potential Agricultural Impact Index, which is the result of multiplying the Vulnerability and Climate Change Exposure Indices. The Potential Agricultural Impact Index is a dimension of how big will be the expected impacts of climate change on agricultural production systems, considering the "size of the exposed agriculture" in Latin America and the Caribbean. This is a projection of the extent of climate change impacts in terms of territorial extension or in terms of affected population. This projection does not tell about the local effect that climate changes may have, it is just a dimension of the economic or social impact within the region.

Countries with the highest agricultural impact would be, in descending order, Mexico, Brazil, Peru and Colombia, while the lowest impacts are expected in Costa Rica, Panama, Uruguay and Chile.

POTENTIAL AGRICULTURAL IMPACT INDEX

Represents the dimension of territorial or demographic impacts

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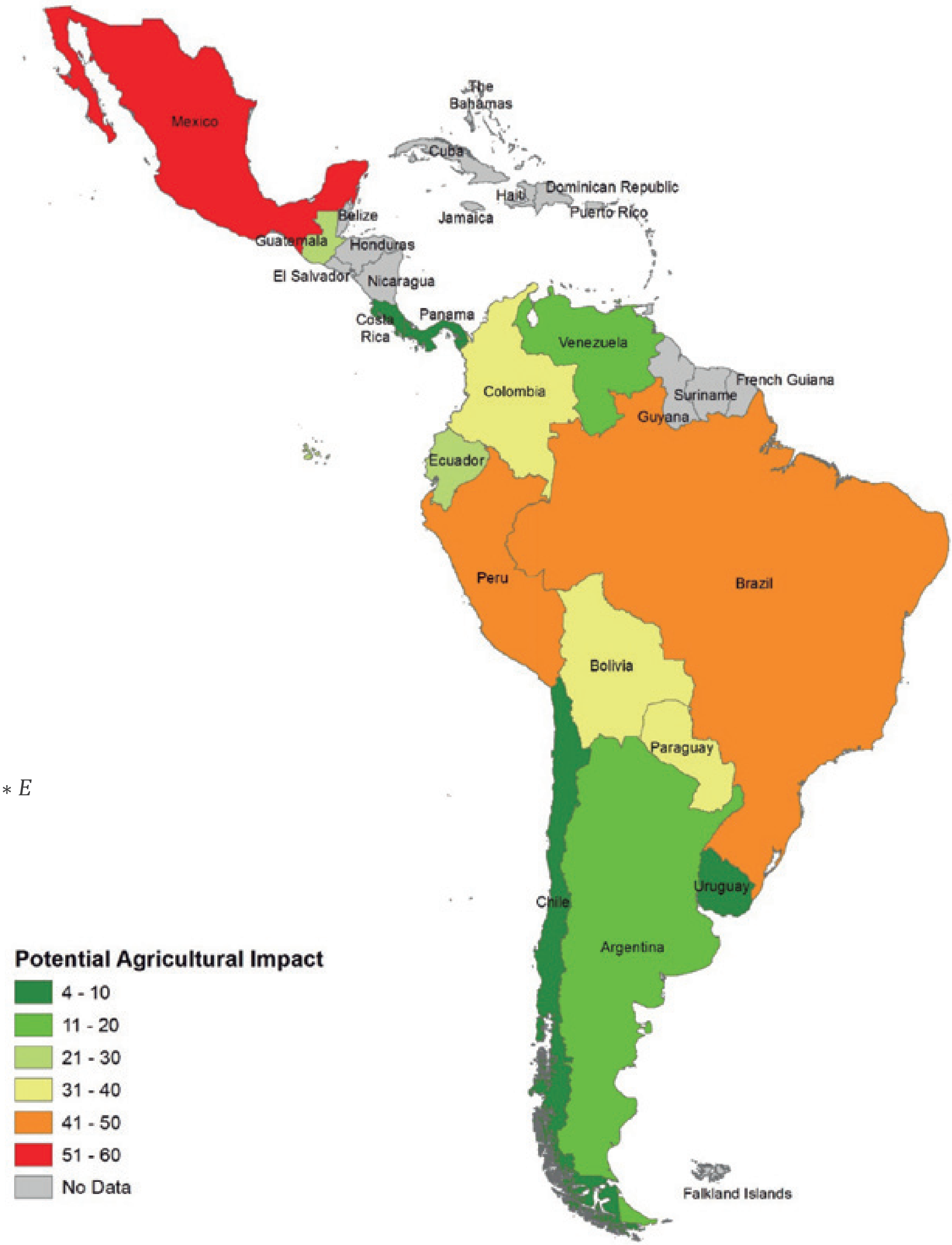


$$PAI = V * E$$

Figure 55: Potential Agricultural Impact Index.
PAI = Potential Agricultural Impact Index; *V* = Vulnerability Index; *E* = Exposure Index.

THE ADAPTATION AGENDA

Climate change will change the environmental context for agriculture to produce food for our world. Scientific evidence shows that conditions for plant growth and production could become increasingly worse because of climatic variability, extremes weather events, lack or excess of water, high temperatures, higher activity of pests and diseases, shortening of life cycles, higher frequency of warm and cold waves, and wind /hails threats. Several of these variables could go beyond the capacity of cultivated and wild plants to recover after the bioclimatic stress and could cause the loss of equilibrium among their internal physiological functions (which are necessary for their growth and reproduction). The following figure synthesizes some of the main impacts of climatic change on agricultural systems.

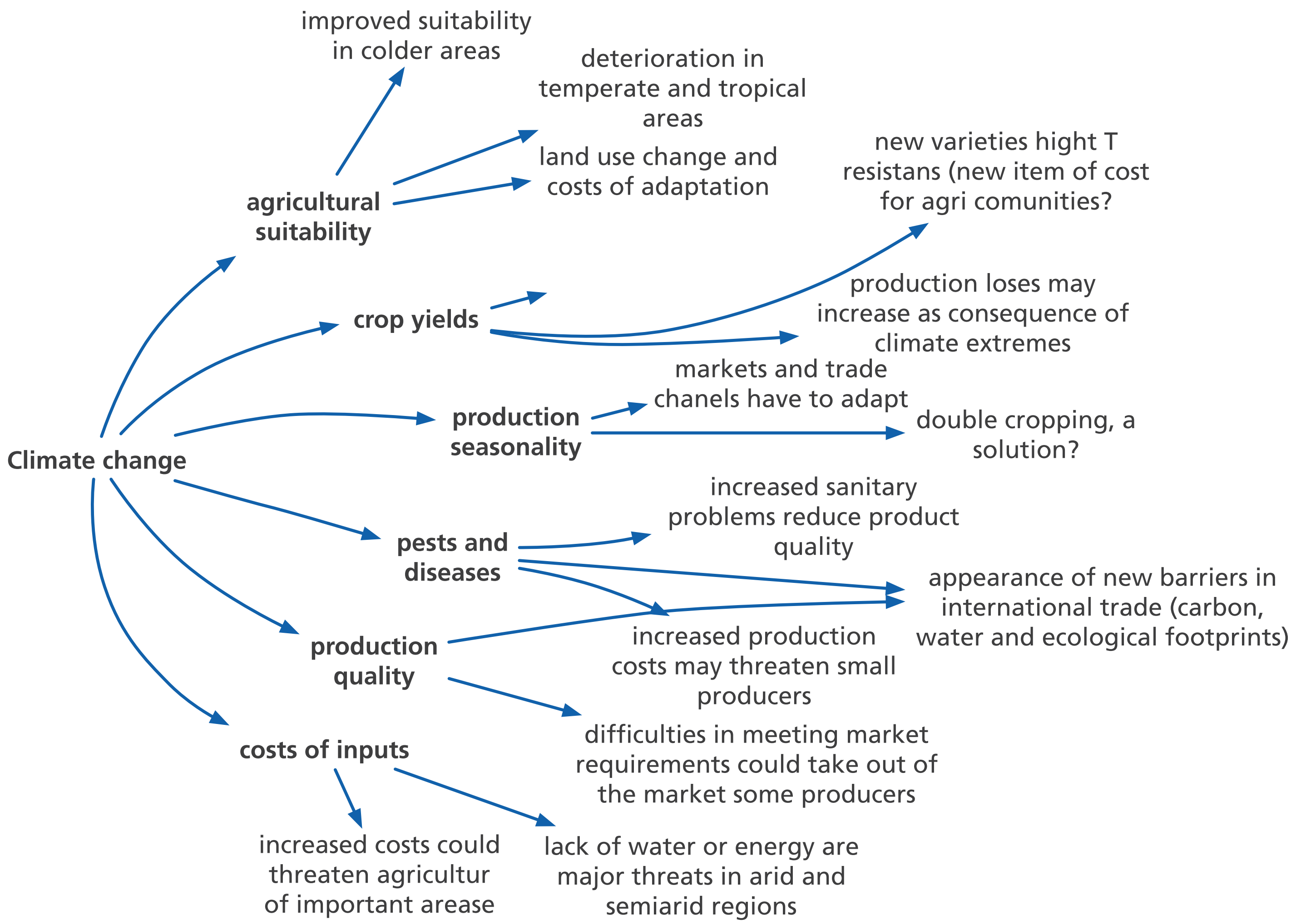


Figure 56: Main climate change consequences on agricultural systems. This system simplify the diagnosis which arose from participatory workshops in the VACEA pilot area.

The main components of the adaptation model are: climatic stressing variables (part of exposure), cropping systems, biological sensitivities of cultivated plants (land use, the second half of the exposure), socio-economic attributes of the agricultural system (vulnerability), and external factors acting as positive or negative drivers (sound public policies, markets, economic context, demography, culture, political tensions, human development, funding).

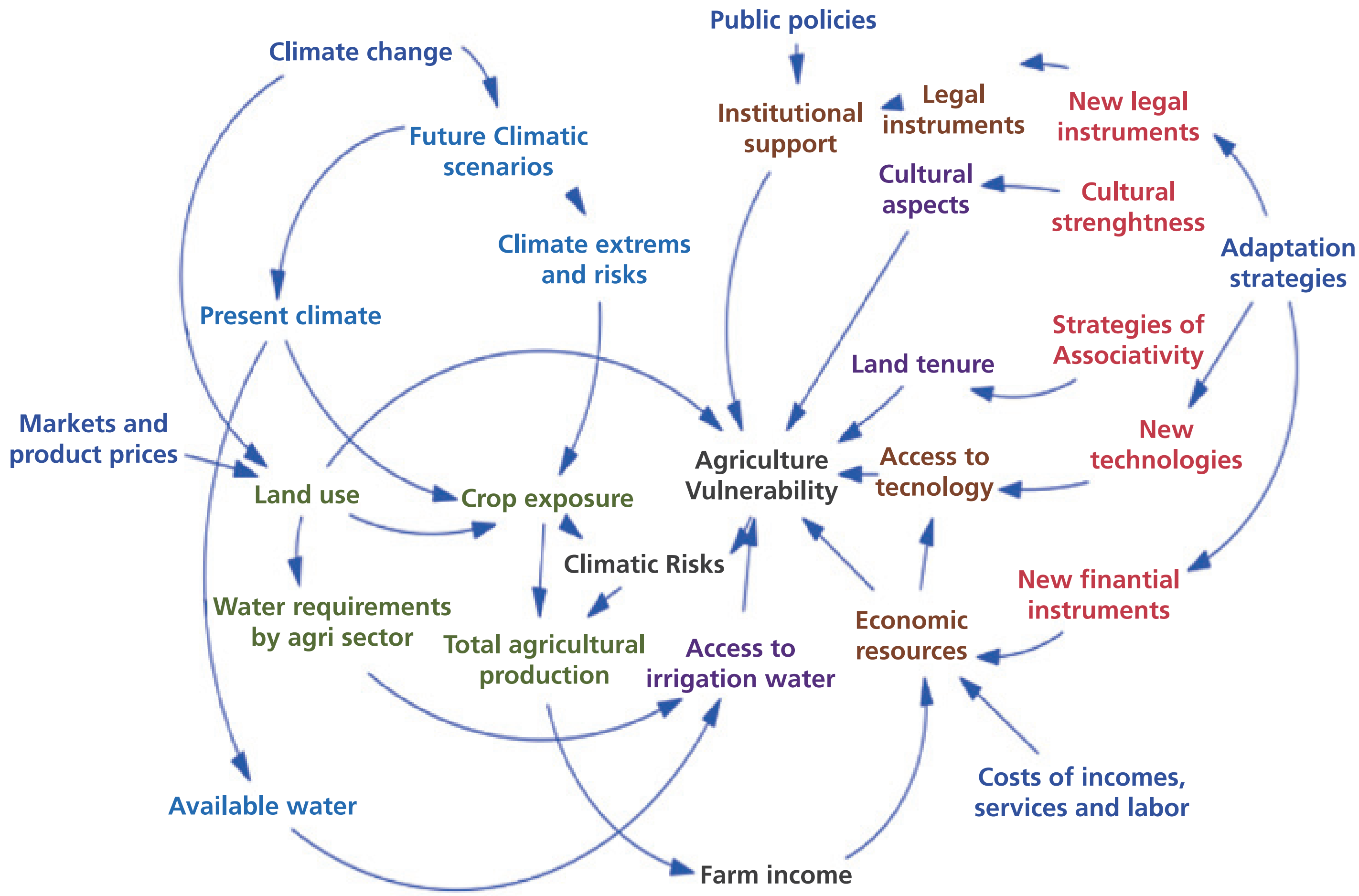


Figure 57: VACEA approach for climate change adaptation. Main relations among climatic variables (blue), crop (green), socio-economic context and governance (purple) and public policies (red) to adapt the production system to a new climatic context.

An adaptation agenda must consider a variety of strategies focusing on different dimensions of the various problems created by a change within the climatic context of the agriculture. An intelligent adaptation strategy has to take maximum advantage of the autonomous capacity of farmers to adapt to the new climatic context. This means that it is necessary to identify what changes in the production systems could be recommended in order to minimize climatic risks in order to avoid negative potential impact of climatic risk on crop productivity, quality or production costs. Farmers have the possibility to cope, to some extent, with moderate risks by changing their sowing date, crop species, crop varieties, and / or soil management practices. Part of the autonomous adaptation is geared toward improving their capacity to organize and share information and knowledge in order to better face climatic risks. This autonomous phase of the process is necessary in order to prepare farmers to be an active agent of change during the second phase, where public policies have to help the process of changing the production system by incorporating new technologies as:

- Efficient irrigation, new cropping systems, crop diversification, crop protection, water and energy efficient technologies, decision systems based on risk analysis and early warning systems, better use of the agricultural insurance, capacity building on sustainable production systems, agricultural organizations and information management.

This agenda requires the active involvement of the State by means of sound public policies helping farmers to acquire the capacity to cope with these necessary challenges. Public policies may be classified into two categories:

- Policies to promote production systems transformation by new cropping systems, new decision and management systems, incorporating technology to better face climatic extremes, accessing information and technical support, incorporating better and sustainable agricultural practices.

- Policies to improve the production infrastructure at local and regional level by enhancing irrigation systems, communications, technical agencies, storage, distribution and processing infrastructure. Policies to promote the optimization of the whole production chain, ensuring a stable market for agricultural products.

Research institutions have the mission of creating pertinent knowledge which can be utilized to make agricultural systems that are more resistant to climate extremes. This challenge requires more research on:

- Technologies for highly efficient water and energy use will be needed, new resistant genotypes to bioclimatic stresses, protection technologies against climatic extremes, risk assessment and management, cleaner technologies strategies for sanitary protection of crops, cropping systems to minimize climatic risks.

From a social perspective, various objectives should be addressed,

- Better access to information, funding and technologies, improvements of farmers capacities to cope with more complex risk contexts, more articulated institutions to support agriculture, more efficient farmers organization, participatory mechanisms functioning, monitoring systems based on environmental and socioeconomic indicators for an early detection of situations going the wrong way, stable programs of capacity building.

From an environmental perspective the adaptation needs:

- Ecosystem providing environmental services protection, water protection against contamination and over exploitation, soil conservation programs, biological equilibria restoration, enhancement of strategic ecosystem services, improving the tuning among agricultural lands and the surrounding environment, low carbon emissions cropping systems, lowering ecological footprint of agricultural systems.

The success of the strategy depends on the ability to combine, and prioritize, these actions when addressing the weaknesses of the local system. In consequence, the initial diagnosis is a key element in creating an efficient adaptation strategy. The diagnosis should arise from the participation of the several actors of the agricultural strategy. If the diagnosis comes from a consensus among the various actors, the adaptation strategy will probably be effective and could easily be adopted by farmers in order to continue producing foods in a new climatic context.

GLOSSARY

Annual hot days: Total annual days with maximum temperature above 25° C.

Annual frost events: Average number of days with freezing temperature (minimum temperatures <0 ° C).

Chilling hours: Total number of hours with T<7°C (7°C corresponds to the threshold of cold required by deciduous species to successfully break the winter rest).

Dry season length: Number of months with water deficit, where the ratio between precipitation to potential evapotranspiration is less than 0,5. Values greater than 1 indicate that the precipitation is in excess of evapotranspiration. Values less than 0,5 indicate that vegetation will suffer water shortages (dry month).

Effective Growing Degree Days: Correspond to the Total Growing Degree Days accumulated during the growing season. This index reveals the possibilities for a plant species to complete normally its life cycle. More precocity is obtained in places with the greatest amount of degree days, which consider as physiologically effective, the temperatures between 10 (minimum growing threshold) and 30° (maximum growing threshold).

Human comfort index: is a combination of temperature and air humidity, considering that human comfort maximizes at certain intervals, and decreases to lower (cold sensation) and higher (hot sensation) temperatures.

Water deficit: Corresponds to the negative difference among PRECIPITATION minus POTENTIAL EVAPOTRASNPIRATION. It is an indicator of the irrigation requirements of irrigated agriculture.

Water surplus: Corresponds to the positive difference among PRECIPITATION minus POTENTIAL EVAPOTRASNPIRATION. It is an indicator of water available for surface runoff during a period.

REFERENCES

- Ahumada R., G. Velázquez, H. Rodríguez, E. Flores, R. Gastélum, J. Romero, A. Granados. 2015. An indicator tool for assessing local vulnerability to climate change in the Mexican agricultural sector. Mitig Adapt Strateg Glob Change (Springer), Published on line on 15 July, 2015, DOI 10.1007/s11027-015-9670-z.

- Allen RG, Pereira LS, Raes D, Smith M. 1998. Crop evapotranspiration. FAO Irrig Drain Pap. N° 56. Rome, Italy.

- Barrow C.J. 2006 Environmental management for Sustainable Development (Second Ed.), Routledge, London, New York, 454 p.

- Choudhury BJ. 2001. Modeling radiation - and carbon - use efficiencies of maize, sorghum, and rice. Agric For Meteorol 106: 317-330.

- Côté M., P. Martin,J. Gonzales, A. Cardona. 2010. Mainstreaming Climate Change in Colombia, "Integrating climate change risks and opportunities into national development processes and United Nations country programming", United Nations Development Programme. Bogotá.

- De Fries, R. y C. Rosenzweig. 2010. Toward a whole-landscape approach for sustainable land use in the tropics. Proceedings of the National Academy of Sciences 107: 19627–32.

- Duru, M., Ducrocq, H. 2000. Growth and senescence of the successive grass leaves on a tiller. ontogenic development and efect of temperature. Ann Bot 85: 635-643.

- ECLAC. 2016. CEPALSTAT Statistical database from the Economic Commission for Latin America and the Caribbean (ECLAC). [Online]. Available at: http://estadisticas.cepal.org/cepalstat/WEB_CEPALSTAT/estadisticasIndicadores.asp?idioma=i. [Accessed 26 Apr. 2016].

- FAO. 2007. Adaptation to climate change in agriculture, forestry and fisheries: Perspective, framework and priorities, Rome, Italy.

- FAO. 2016. AQUASTAT website. Food and Agriculture Organization of the United Nations (FAO). [Online]. Available at: http://www.fao.org/nr/water/aquastat/main/index.stm. [Accessed 08 May 2016].

- FAO. 2016. FAOSTAT website: Food and Agriculture Organization Corporate Statistical Database. Food and Agriculture Organization of the United Nations (FAO). [Online]. Available at: http://faostat3.fao.org/browse/G1/*/E. [Accessed 04 May 2016].

- Heichel GH, Musgrave RB. 1969. Relation of CO2 compensation concentration to apparent photosynthesis in maize. Plant Physiol 44: 1724-1728.

- Houghton JT (1986). The Physics of Atmospheres 2nd ed. Chapter 2. Cambridge University Press, United Kingdom.

- Chilean Government (Ministry of Environment and Ministry of Agriculture). 2013. Plan for Adaptation to Climate Change in Agriculture and Forestry Sector. German Society for International Cooperation (GIZ). Santiago, Chile, 65 p.

- Inter-American Institute for Cooperation on Agriculture (IICA). 2015. Climate Change and Agriculture in Argentina, Institutional Aspects and Information Tools for Policy Making. Buenos Aires, 124 p.

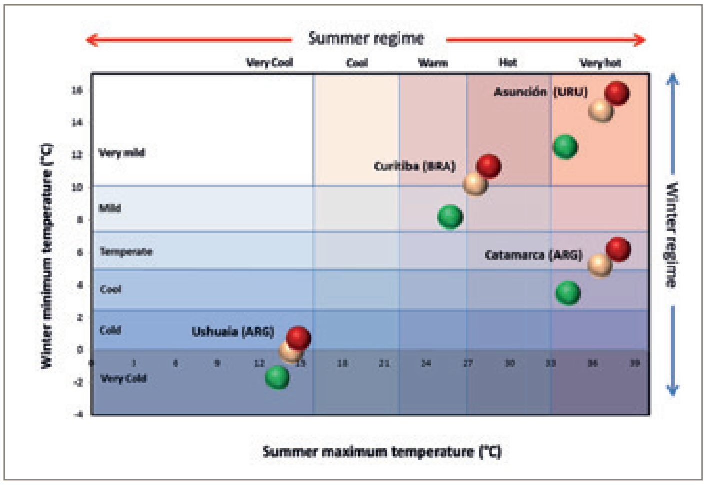
- IPCC. 2013. The Physical Science Basis. Contribution of Working Group I to the Fifth Assessment Report of the Intergovernmental Panel on Climate Change. Stocker, T.F., D. Qin, G.-K. Plattner, M. Tignor, S.K. Allen, J. Boschung, A. Nauels, Y. Xia, V. Bex and P.M. Midgley (eds.). Cambridge University Press, Cambridge, United Kingdom and New York, NY, USA, 1535 pp.

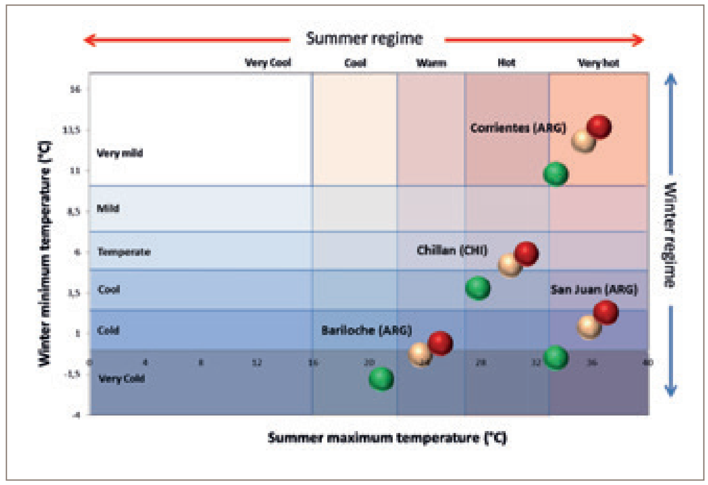
- Lambers, H. 1979. Eficciency of roots respiration in relation to growth, morphology and soil composition. Physiol Plant 46: 192-202.
- Ministry of the Environment and Natural Resources (Mexico). 2013. National Climate Change Strategy. 10-20-40 Vision, 60 p.
- Ministry of Environment and Ministry of Agriculture (CHILE). 2011. Portfolio of Proposals for the Program of Adaptation of Agriculture and Forestry Sector to Climate Change in Chile, Santiago, 300 p.
- Owen A. and M. Tjoelker. 2003. Thermal acclimation and the dynamic response of plant respiration to temperature. Trend in Plant Sci 8:343-351.
- Penning de Vries FWT. 1975. The cost of maintenance processes in plant cells. Ann Bot 39:77–92.
- Santibañez, F. 1994. Crop requirements-Temperate crops. In: Griffiths JF (ed) Handbook of Agricultural Meteorology. Oxford University Press, New York, 174-188.
- Santibañez F., P. Santibañez, C. Caroca, P. González P. Perry. 2014. Atlas of Climate Change of the arid and semiarid zones of Chile, University of Chile, 110 pp.
- Sowinski P, Bilska A, Baranska K, et al. 2007. Plasmodesmata density in vascular bundles in leaves of C4 grasses grown at different light conditions in respect to photosynthesis and photosynthate export efficiency Environmental and Experimental Botany 61 74–84.
- The World Bank. 2016. World Databank. [Online]. Available at: http://databank.worldbank.org/data/home.aspx. [Accessed 28 Apr. 2016].
- Tsimba R, Edmeades GO, Millner JP, Kemp PD. 2013. The effect of planting date on maize: Phenology, thermal time durations and growth rates in a cool temperate climate. Field Crops Re 150:145-155.
- UNDP. 2015. Human Development Report 2015: Work for Human Development. United Nations Development Programme (UNDP). [Online]. Available at: http://hdr.undp.org/sites/default/files/2015_human_development_report.pdf. [Accessed 20 Apr. 2016].
- Valdes C., Ch. Arriola, A. Somwaru, J. Gasques. 2010. Brazil's Climate Adaptation Policies: Impacts on Agriculture (MAPA), IATRC Public Trade Policy Research and Analysis Symposium "Climate Change in World Agriculture: Mitigation, Adaptation, Trade and Food Security" Stuttgart, Germany.
- Van Keulen H, Wolf J. 1986. Modelling of agricultural production: weather, soils and crops. Pudoc Wageningen.
- Wang Z, Kang S, Jensen CR, Liu F. 2012. Alternate partial root-zone irrigation reduces bundle-sheath cell leakage to CO2 and enhances photosynthetic capacity in maize leaves. J Exp Bot 63: 1145-1153.
- Wythers K, P B. Reich, J B. Bradford. 2013. Incorporating temperature-sensitive Q10 and foliar respiration acclimation algorithms modifies modeled ecosystem responses to global change, Journal of Geophysical Research: Biogeosciences, 118:1-14.
- Xu Z, Zheng X, Wang Y, et al. 2006. Effect of free-air atmospheric CO2 enrichment on dark respiration of rice plants (Oryza sativa L.) Agriculture, Ecosystems and Environment 115:105-112.
- Yan W, Hunt LA. 1999. An equation modeling the temperature response of plant growth and development using only the cardinal temperatures. Ann Bot 84: 607-614.

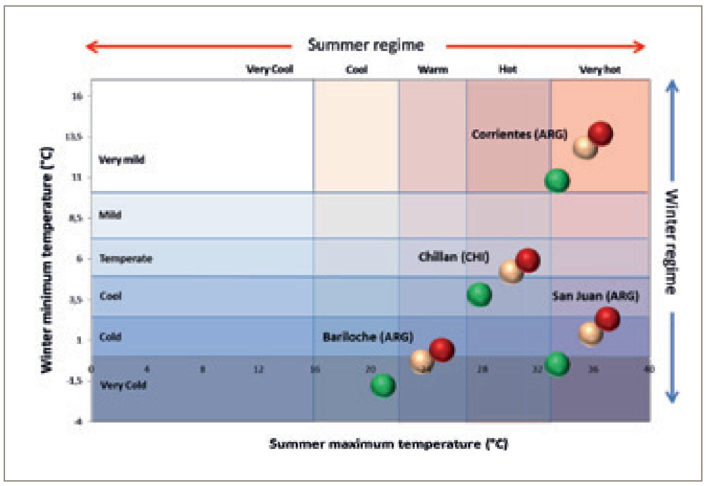
ANNEX I

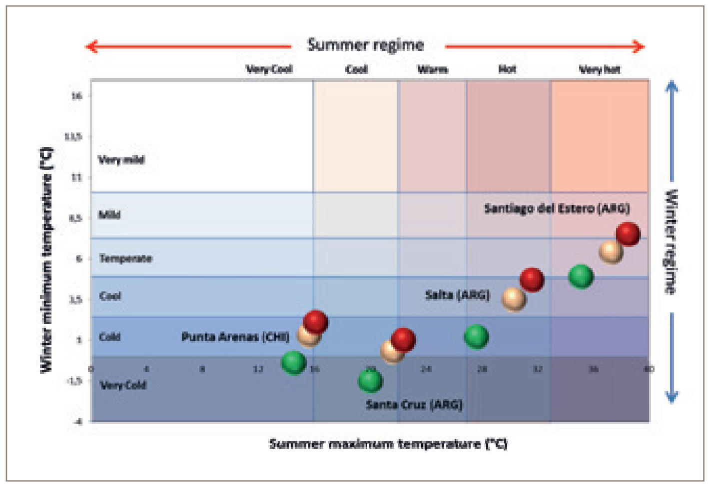
• Graphs of the present and future thermal regimen in America

Figure 58. Localities used to describe present and future climate.









Present climate (base line) **Year 2050 position** **Year 2070 position**

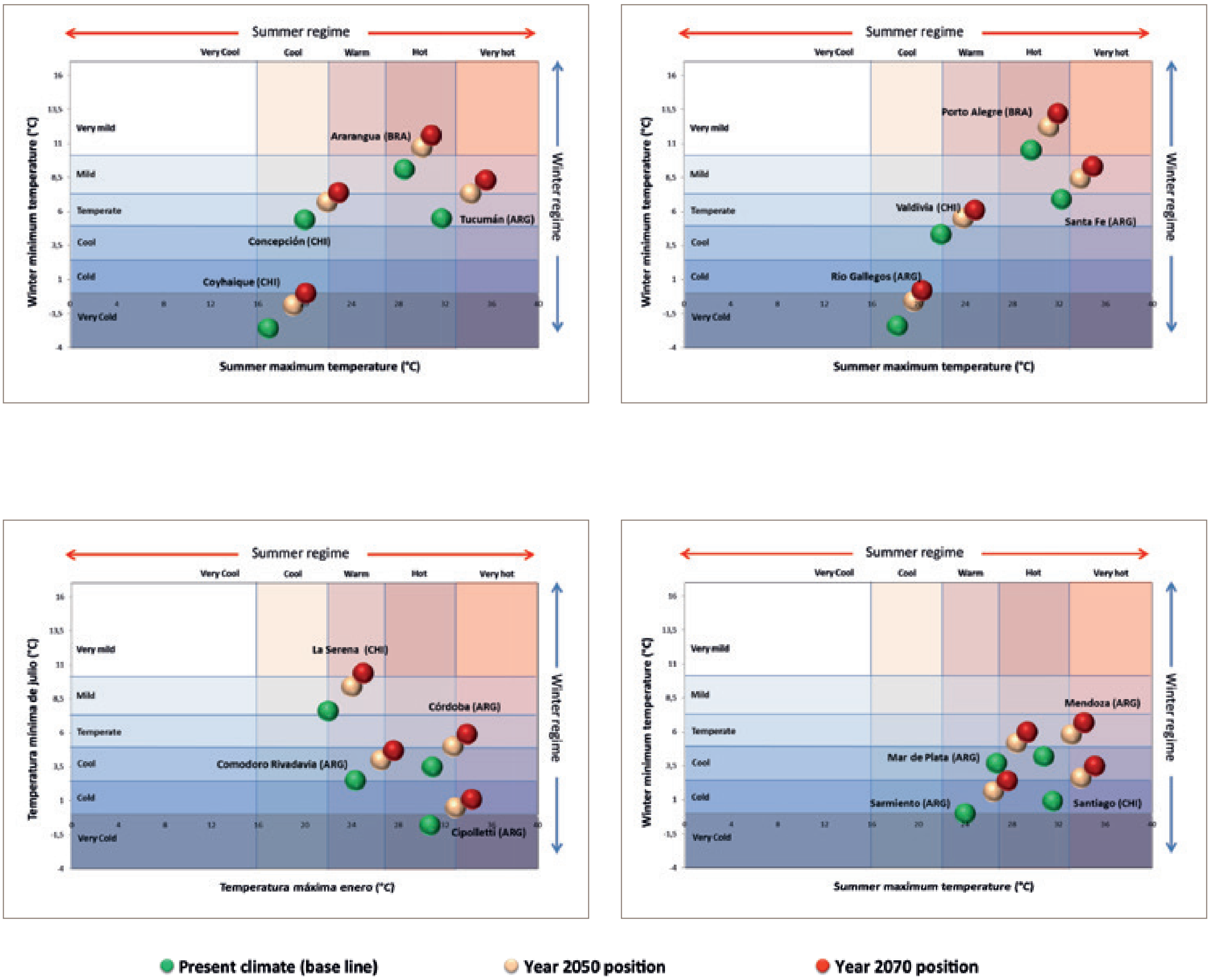
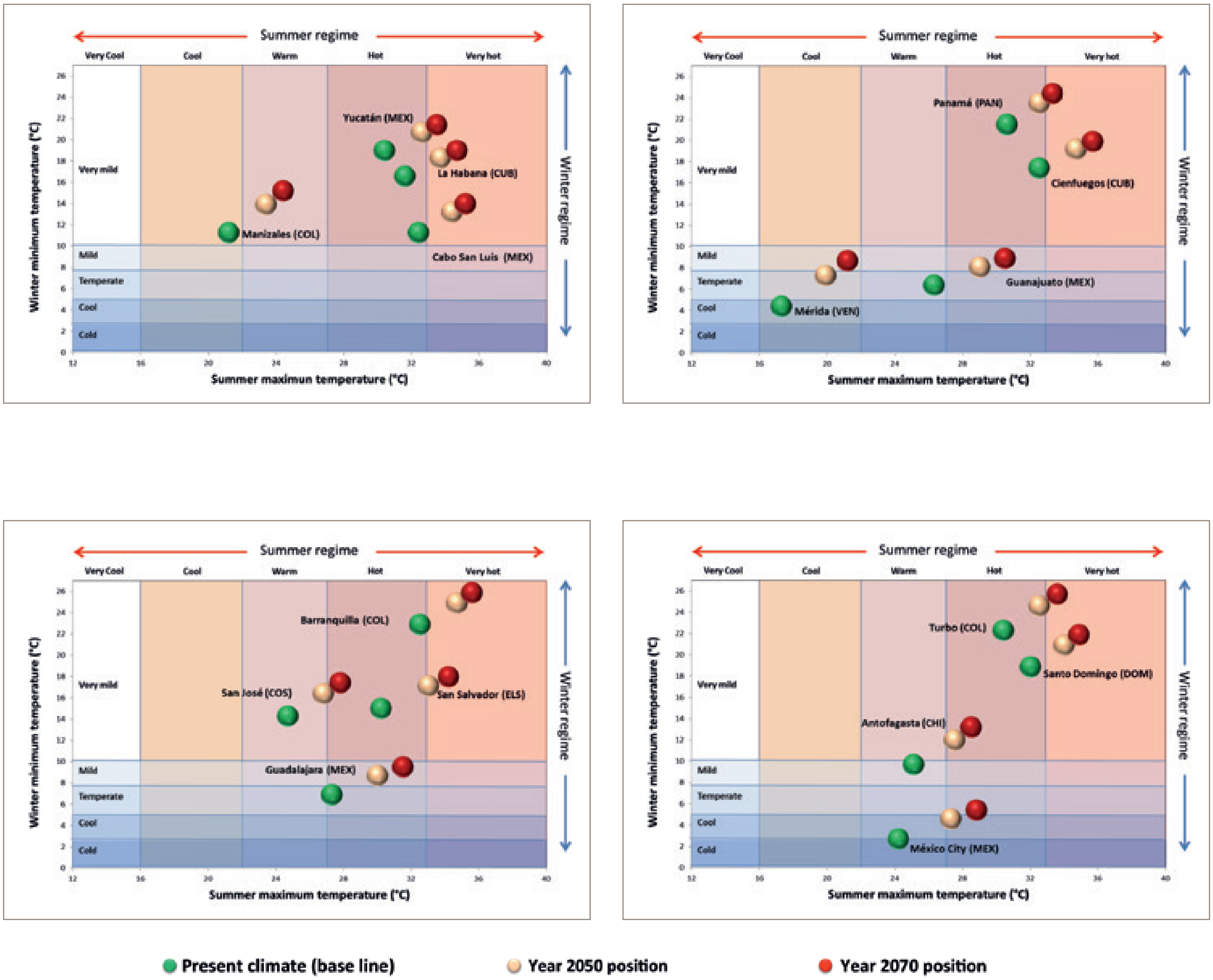


Figure 59. Present and future thermal regimen in South America.


Summer regime
Very Cool
Cool
Warm
Hot
Very hot
Winter regime
Very mild
Mild
Temperate
Cool
Cold
Winter minimum temperature (°C)
Summer maximun temperature (°C)
Yucatán (MEX)
La Habana (CUB)
Manizales (COL)
Cabo San Luis (MEX)
Summer regime
Winter regime
Winter minimum temperature (°C)
Summer maximum temperature (°C)
Panamá (PAN)
Cienfuegos (CUB)
Guanajuato (MEX)
Mérida (VEN)
Summer regime
Winter regime
Winter minimum temperature (°C)
Summer maximum temperature (°C)
Barranquilla (COL)
San José (COS)
San Salvador (ELS)
Guadalajara (MEX)
Summer regime
Winter regime
Winter minimum temperature (°C)
Summer maximum temperature (°C)
Turbo (COL)
Santo Domingo (DOM)
Antofagasta (CHI)
México City (MEX)
Present climate (base line)
Year 2050 position
Year 2070 position

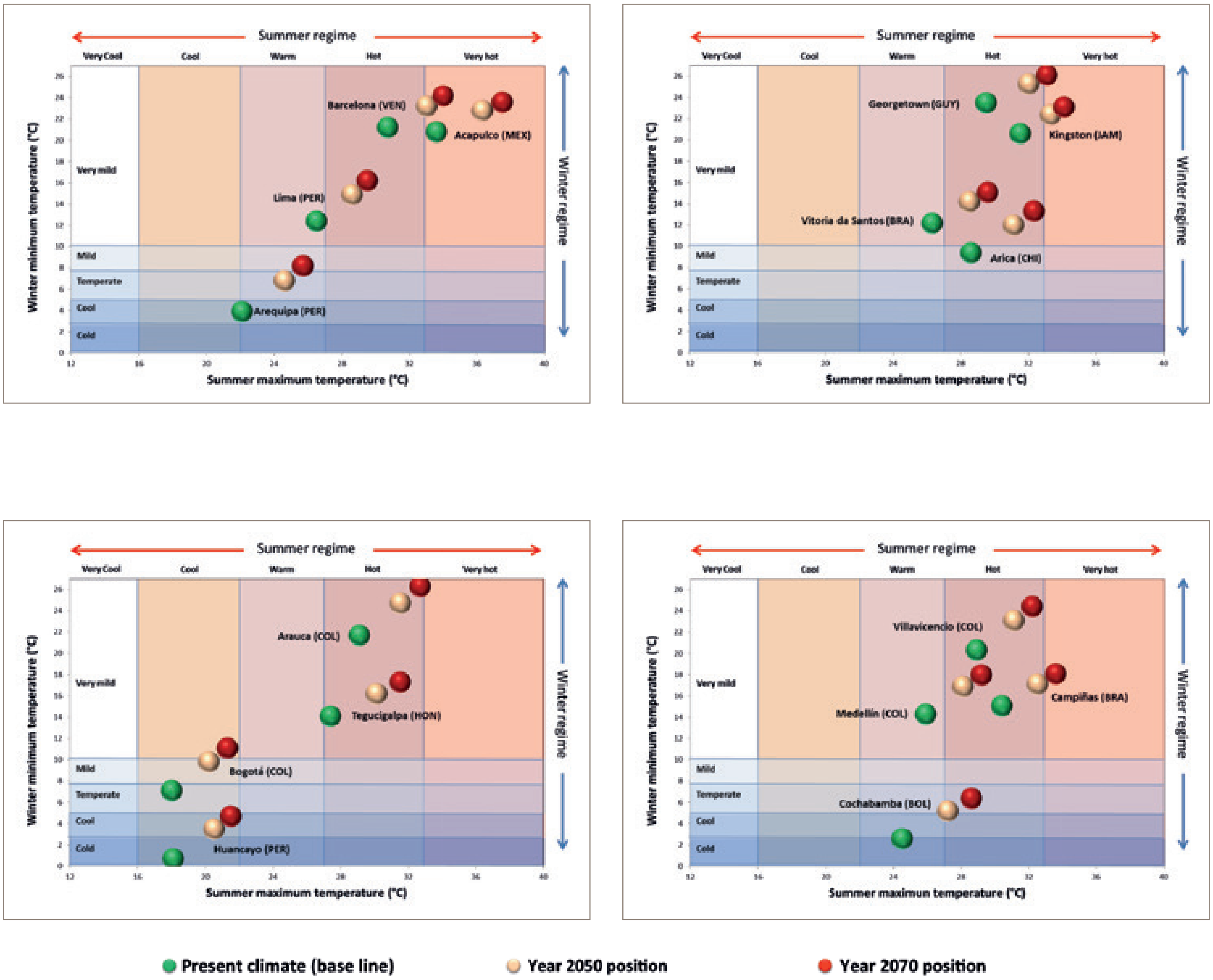
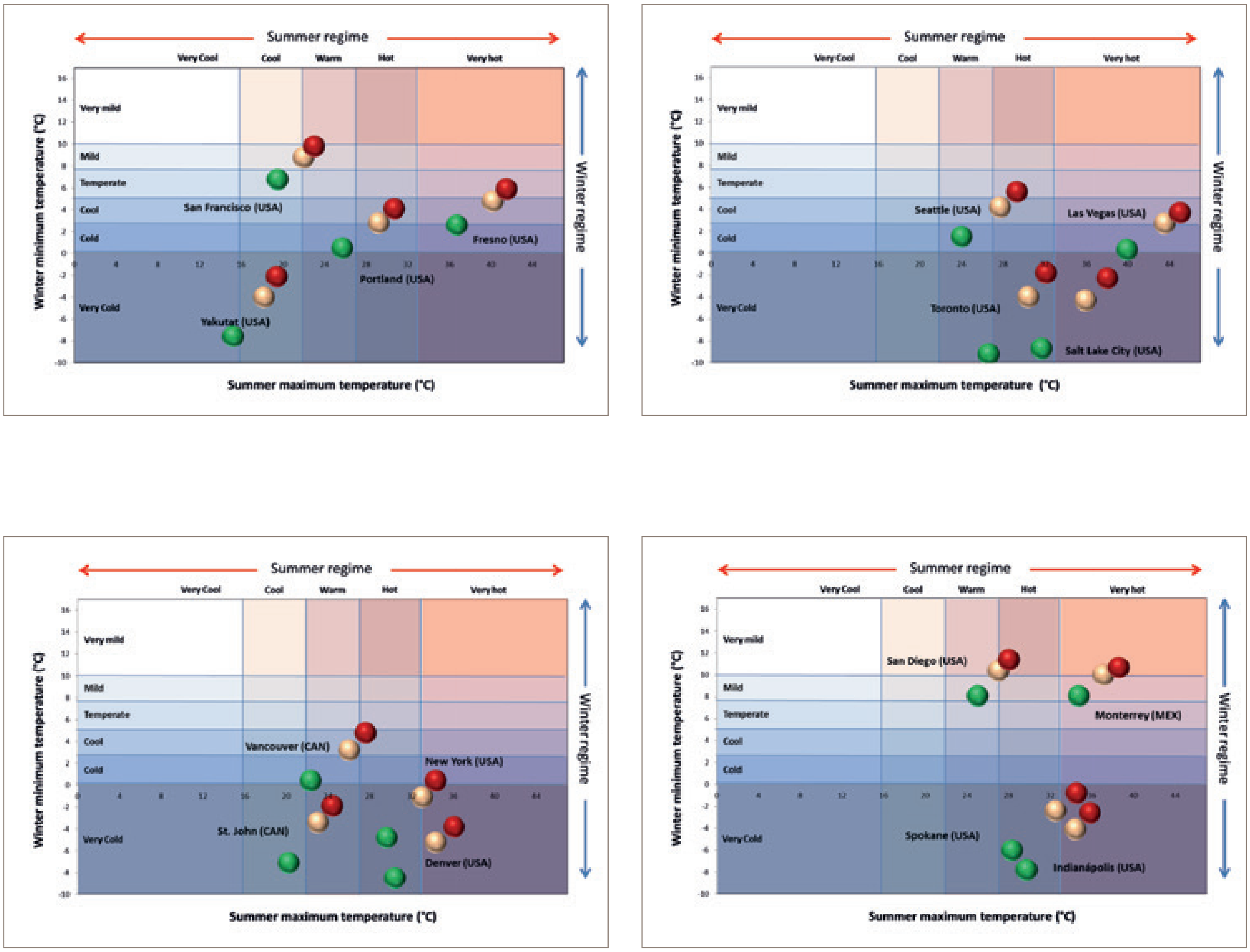


Figure 60. Present and future termal regimen in Central America.



● Present climate (base line) ● Year 2050 position ● Year 2070 position

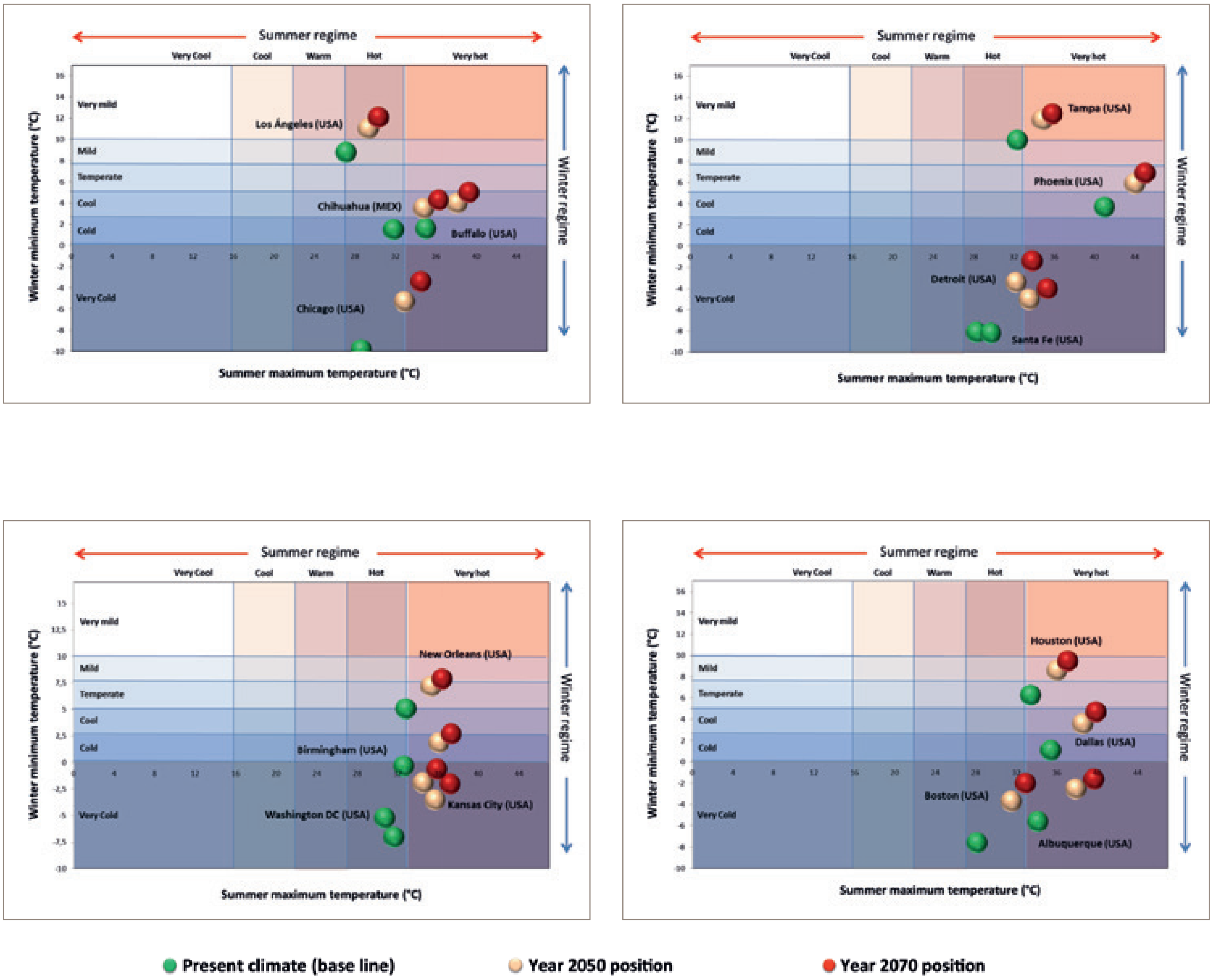


Figure 61. Present and future thermal regimen in North America.

ANNEX II

TABLE OF CLIMATIC VARIABLES FOR PRESENT AND FUTURE SCENARIOS IN AMERICA.

Code	Variable
JXT	January maximum temperature (°C)
JNT	January minimum temperature (°C)
JLXT	July maximum temperature (°C)
JLNT	July minimum temperature (°C)
RHJ	Relative humidity january (%)
RHJL	Relative humidity july (%)
SRJ	Solar radiation january (cal cm2 d)
SRJL	Solar radiation july (cal cm2 d)
ETJ	Reference evapotranspiration january (mm)
ETJL	Reference evapotranspiration july (mm)
ADD	Annual degree day (T > 10°C)
EDD	Effective annual degree day (10°C < T < 30°C)
AChH	Annual chilling hours (T < 7°C)
FFS	Frost free season (days)
TFN	Total frost number (days)
THD	Number of hot days
DSL	Dry season lenght
WSL	Wet season lenght
AR	Annual precipitation (mm)
AE	Annual evapotranspiration
AWD	Annual water deficit (mm)
AWS	Annual water surplus (mm)
ASR	Annual solar radiatim
Iaw	Winter aridity index
Ias	Summer aridity index
Iaa	Annual aridity index
BRP	Biological resting period
PCI	Precipitation concentration index
SDD	Stress degree days
HCI	Human Comfort index

Table A1. Climatic variables for present and future scenarios in America.

COD	COUNTRY	CITY	LAT	LON	Scenarios	JXT	JNT	JLXT	JLNT	RHJ	RHJL	SRJ	SRJL	ETJ	ETJL	ADD	DGE	AChH	FFS	TFN
1	ARG	MAR DEL PLATA	-37,97	-57,10	Base Line	26,7	14	12,5	3,7	76	85	599	191	146	33	1554	1260	1679	238	14
					2050	28,4	15,8	13,9	5,2	76	85	599	191	166	37	1975	1543	1029	287	4
					2070	29,3	16,8	14,6	6	76	85	599	191	177	39	2213	1706	653	339	2
2	ARG	SANTA FE	-31,64	-60,52	Base Line	32,2	18,8	17,9	6,9	71	80	589	247	157	52	2599	1850	243	345	0
					2050	33,8	20,7	19,4	8,4	71	80	589	247	179	58	2817	1830	61	365	0
					2070	34,9	21,9	19,9	9,3	71	80	589	247	194	61	2850	1741	12	365	0
3	ARG	CHOS MALAL	-37,10	-70,30	Base Line	24	5,3	6,3	-4,1	43	62	688	160	168	6	689	638	5190	0	223
					2050	26,8	7,6	8,1	-2,6	43	62	688	160	202	7	966	863	4303	83	177
					2070	28,2	8,7	8,8	-1,9	43	62	688	160	219	7	1138	995	3705	110	156
4	ARG	ROSARIO	-32,90	-60,80	Base Line	30,9	16,9	16,3	4,6	72	82	599	234	156	45	2307	1736	915	271	6
					2050	32,5	18,8	17,8	6,1	72	82	599	234	178	50	2465	1721	361	339	1
					2070	33,6	20	18,2	6,9	72	82	599	234	192	53	2621	1785	216	345	0
5	ARG	TRELEW	-43,20	-65,30	Base Line	27,9	13,3	11,2	0,7	43	65	628	154	181	24	1554	1315	2159	188	54
					2050	29,9	15	12,5	2	43	65	628	154	208	27	1929	1589	1838	215	31
					2070	30,8	15,8	13,3	2,8	43	65	628	154	220	28	2047	1646	1521	231	22
6	ARG	CORRIENTES	-27,50	-58,80	Base Line	33,4	21,4	20,9	10,8	72	78	574	273	157	65	3195	1865	0	365	0
					2050	35,4	23,7	22,8	12,8	72	78	574	273	184	75	3510	1804	0	365	0
					2070	36,5	24,8	23,6	13,7	72	78	574	273	197	79	3650	1787	0	365	0
7	ARG	SANTA CRUZ	-50,02	-68,57	Base Line	20	8	5	-1,5	54	78	526	91	118	6	552	517	4361	96	130
					2050	21,6	9,3	6,7	0,3	54	78	526	91	132	7	724	658	3700	133	89
					2070	22,4	9,9	7,5	1	54	78	526	91	138	7	830	743	3283	148	72
8	ARG	SANTIAGO DE ESTERO	-27,80	-64,30	Base Line	35,1	19,7	21	4,9	70	67	545	289	150	65	2705	1678	350	287	3
					2050	37,3	21,9	22,7	6,4	70	67	545	289	176	73	2820	1529	157	339	0
					2070	38,5	23,1	23,4	7,5	70	67	545	289	191	78	2958	1532	102	345	0
9	ARG	CIPOLLETTI	-38,95	-67,98	Base Line	30,7	13	12,9	-0,8	48	68	681	188	193	28	1727	1413	2405	172	81
					2050	32,9	15,2	14,3	0,5	48	68	681	188	227	31	1803	1384	2008	199	55
					2070	34,3	16,3	15	1,1	48	68	681	188	246	32	1878	1398	1775	212	44

COD	COUNTRY	CITY	LAT	LON	Scenarios	JXT	JNT	JLXT	JLNT	RHJ	RHJL	SRJ	SRJL	ETJ	ETJL	ADD	DGE	AChH	FFS	TFN
10	ARG	SAN JUAN	-31,50	-68,70	Base Line	33,4	17,5	15,7	-0,5	54	60	646	269	187	47	2061	1540	1799	202	59
					2050	35,8	19,8	17,8	1,4	54	60	646	269	222	54	2183	1464	1338	230	30
					2070	37	21	18,7	2,3	54	60	646	269	240	58	2318	1498	1097	244	21
11	BRA	BELLO HORIZONTE	-9,78	-37,85	Base Line	31,2	21,3	25,1	17,6	66	79	530	370	144	96	4335	2089	0	365	0
					2050	33,3	23,5	27,1	19,5	66	79	530	370	169	111	4217	1797	0	365	0
					2070	34,2	24,5	28	20,4	66	79	530	370	180	118	4057	1751	0	365	0
12	BRA	MANAUS	-3,13	-60,01	Base Line	30,8	23,4	32,6	23,1	87	81	367	406	105	116	3992	2057	0	365	0
					2050	33,3	25,9	35,7	26,1	87	81	367	406	126	144	3573	1808	0	365	0
					2070	34,7	27,1	37,2	27,5	87	81	367	406	137	158	3237	1654	0	365	0
13	CAN	OTTAWA	45,40	-75,70	Base Line	-6,1	-15,3	26,3	15	70	69	136	477	1	119	1018	23	4507	137	169
					2050	-2	-9,6	30	18,4	70	69	136	477	1	153	1575	68	3758	172	135
					2070	-0,3	-7,1	31,8	20	70	69	136	477	1	169	1590	96	3557	189	122
14	CAN	CALGARY	51,12	-114,02	Base Line	-4,8	-16,9	22,8	8,5	66	61	91	525	1	117	498	10	5590	78	225
					2050	-2,1	-13	26,6	11,8	66	61	91	525	1	150	876	38	4851	121	187
					2070	-0,6	-11	28,5	13,4	66	61	91	525	1	166	1086	52	4618	139	175
15	CHI	ARICA	-18,50	-70,30	Base Line	28,6	15,6	23	9,4	71	73	541	249	162	78	3010	1836	19	365	0
					2050	31,1	17,7	25,7	12	71	73	541	249	192	95	3610	1969	0	365	0
					2070	32,3	18,7	27	13,3	71	73	541	249	206	103	3657	1800	0	365	0
16	CHI	ANTOFAGASTA	-23,43	-70,46	Base Line	25,1	17,6	19	9,7	71	68	550	265	156	81	2646	1723	5	365	0
					2050	27,5	19,6	21,4	12	71	68	550	265	183	96	3475	2128	0	365	0
					2070	28,5	20,5	22,5	13,2	71	68	550	265	195	104	3859	2311	0	365	0
17	CHI	CRISTO REDENTOR	-32,83	-70,08	Base Line	9,3	-5,9	-2,7	-14,3	53	55	663	209	31	1	0	0	8070	0	360
					2050	11,7	-3,6	-0,4	-12,4	53	55	663	209	37	1	16	16	7583	0	360
					2070	12,9	-2,4	0,5	-11,6	53	55	663	209	40	1	46	46	7320	0	358
18	COL	TURBO	8,12	-76,73	Base Line	30,4	22,3	30,4	22,4	80	84	446	428	123	119	4949	2550	0	365	0
					2050	32,5	24,6	32,5	24,6	80	84	446	428	145	140	3855	1931	0	365	0
					2070	33,4	25,7	33,6	25,6	80	84	446	428	155	149	3719	1869	0	365	0

COD	COUNTRY	CITY	LAT	LON	Scenarios	JXT	JNT	JLXT	JLNT	RHJ	RHJL	SRJ	SRJL	ETJ	ETJL	ADD	DGE	AChH	FFS	TFN
19	DOM	SANTO DOMINGO	18,48	-69,89	Base Line	29,3	18,9	32	22,1	77	77	377	539	103	148	4159	2260	0	365	0
					2050	31,2	20,9	34	24	77	77	377	539	119	172	3613	1848	0	365	0
					2070	32,1	21,9	34,9	24,9	78	81	377	539	127	182	3535	1790	0	365	0
20	HON	TEGUCIGALPA	14,05	-87,22	Base Line	25,7	14,1	27,4	17,7	76	80	368	451	93	117	4058	1848	0	365	0
					2050	27,9	16,2	30,1	20	76	80	368	451	109	141	4134	2119	0	365	0
					2070	28,8	17,3	31,5	21,1	76	80	368	451	116	152	3906	2130	0	365	0
21	MEX	YUCATAN	21,30	-89,60	Base Line	26,2	19	30,4	23,5	72	78	380	598	101	162	4629	2431	0	365	0
					2050	27,9	20,7	32,6	25,6	72	78	380	598	115	190	4291	2421	0	365	0
					2070	28,5	21,4	33,5	26,6	72	78	380	598	120	202	4260	2441	0	365	0
22	PER	HUANCAYO	-12,06	-75,21	Base Line	18,1	6,7	19,3	0,7	73	55	368	394	74	72	1040	527	2910	69	61
					2050	20,5	9	22,1	3,5	73	55	368	394	88	88	1527	782	1184	178	15
					2070	21,5	10,1	23,4	4,7	73	55	368	394	94	95	1796	935	700	232	6
23	USA	BUFFALO	31,46	-96,05	Base Line	14,2	1,6	35	21,9	63	59	228	549	37	153	2367	665	1253	254	25
					2050	16,8	4	38,1	24,8	63	59	228	549	45	189	2631	932	660	293	6
					2070	17,9	5	39,3	25,9	70	67	228	549	47	204	2738	1018	368	314	2
24	USA	TAMPA	27,96	-82,53	Base Line	21,1	10	32,3	23,4	74	77	286	491	67	137	3348	1424	0	365	0
					2050	22,9	11,9	34,8	25,8	74	77	286	491	77	164	3531	1647	0	365	0
					2070	23,7	12,5	35,8	26,9	73	77	286	491	81	175	3544	1756	0	365	0
25	USA	MIAMI	25,80	-80,30	Base Line	23,9	15,3	31,5	24,5	74	77	313	539	80	150	4272	2015	0	365	0
					2050	25,6	17	33,6	26,5	74	77	313	539	91	175	4215	2174	0	365	0
					2070	26,3	17,7	34,4	27,4	72	75	313	539	95	185	4242	2267	0	365	0
26	USA	NEW YORK	40,79	-73,97	Base Line	3	-4,8	29,6	19,4	75	73	161	484	6	129	1738	106	3378	197	111
					2050	6	-1,1	33	22,6	75	73	161	484	8	163	1983	245	2424	232	64
					2070	7,4	0,4	34,3	24	62	65	161	484	8	177	2052	317	2051	248	44
27	USA	MEMPHIS	35,10	-90,00	Base Line	8,7	-1,2	32,9	22	74	70	196	526	19	145	2052	303	2018	230	61
					2050	11,4	1,4	36,9	25,4	74	70	196	526	23	188	2279	532	1392	261	27
					2070	12,5	2,4	38,3	26,7	67	69	196	526	25	204	2329	658	1186	274	16

COD	COUNTRY	CITY	LAT	LON	Scenarios	JXT	JNT	JLXT	JLNT	RHJ	RHJL	SRJ	SRJL	ETJ	ETJL	ADD	DGE	AChH	FFS	TFN
28	USA	WASHINGTON DC	38,95	-77,45	Base Line	D	5,3	-5,2	30,7	18,2	76	70	169	479	1	128	1745	150	0	190
					2050	D	8,2	-1,9	34,5	21,6	76	70	169	479	1	165	1890	288	0	223
					2070	D	9,5	-0,6	35,9	23	65	72	169	479	1	179	1943	374	0	237
29	USA	BIRMINGHAM	33,57	-86,75	Base Line	11,2	-0,3	32,6	20,8	74	70	208	497	27	137	2101	397	1808	233	52
					2050	13,5	1,9	36,1	23,8	74	70	208	497	32	173	2287	641	1296	262	23
					2070	14,4	2,7	37,3	25	67	74	208	497	34	186	2410	767	1096	275	15
30	USA	PHOENIX	33,50	-112,00	Base Line	19,4	3,7	41	24,7	45	42	272	584	64	209	2317	853	985	288	11
					2050	22	5,9	44	27,9	45	42	272	584	76	261	2397	1103	344	350	1
					2070	23,3	6,9	45	29,3	44	33	272	584	82	285	2364	1258	163	180	0
31	USA	OKLAHOMA	35,40	-97,60	Base Line	8,9	-3,2	34,2	21,4	61	57	220	579	17	163	1944	299	2232	214	91
					2050	11,8	-0,5	37,8	24,7	61	57	220	579	21	208	2227	530	1635	243	51
					2070	13	0,7	39,2	26,1	66	60	220	579	22	226	2293	658	1362	256	34
32	USA	SALT LAKE CITY	40,80	-111,90	Base Line	2,5	-8,7	31,7	13,4	68	52	189	622	1	191	1050	67	4353	146	179
					2050	5,7	-4,3	35,9	17	68	52	189	622	1	251	1322	150	3406	189	128
					2070	7,4	-2,3	38	18,8	69	37	189	622	1	281	1365	202	2909	210	100
33	USA	DENVER	39,80	-105,00	Base Line	6,4	-8,5	30,4	14,5	43	45	194	567	4	164	1274	89	3924	155	175
					2050	8,9	-5,2	34,3	17,7	43	45	194	567	5	210	1452	190	2909	188	143
					2070	10,2	-3,8	36,1	19,2	55	48	194	567	5	232	1553	260	2622	202	124
34	VEN	MERIDA	8,60	-71,20	Base Line	18,2	4,4	17,3	7,2	78	81	431	449	81	88	953	476	1436	185	9
					2050	21,3	7,3	19,9	9,6	78	81	431	449	100	106	1575	778	300	180	0
					2070	22,7	8,7	21,2	10,8	78	81	431	449	109	114	1965	968	50	365	0
35	USA	LOS ANGELES	33,93	-118,40	Base Line	19,7	8,8	27,1	16,8	67	74	258	628	59	157	2654	954	54	365	0
					2050	21,9	11	29,3	19,2	67	74	258	628	70	186	3487	1374	0	365	0
					2070	23	12,1	30,3	20,3	68	72	258	628	75	199	3572	1570	0	365	0
36	USA	OMAHA	41,36	-96,01	Base Line	-0,7	-11,3	30,2	18,7	70	69	164	537	1	142	1630	79	3818	167	151
					2050	2,8	-7,3	34,4	22,1	70	69	164	537	1	185	1693	163	3145	196	124
					2070	4,5	-5,6	36,1	23,7	71	68	164	537	1	204	1789	236	3028	209	111

COD	COUNTRY	CITY	LAT	LON	Scenarios	JXT	JNT	JLXT	JLNT	RHJ	RHJL	SRJ	SRJL	ETJ	ETJL	ADD	DGE	AChH	FFS	TFN
37	USA	BOISE	43,59	-116,19	Base Line	2,8	-5,8	32,7	13,6	74	53	152	633	4	199	1116	91	3981	160	153
					2050	5,8	-1,8	37,2	17,2	74	53	152	633	5	264	1419	196	3088	206	87
					2070	7,4	0	39,2	18,9	70	36	152	633	6	293	1464	263	2558	228	56
38	MEX	CABO SAN LUIS	22,90	-109,90	Base Line	24,6	11,3	32,4	22,2	67	66	370	576	89	158	3509	1615	0	365	0
					2050	26,4	13,2	34,4	24,1	67	66	370	576	102	183	3574	1785	0	365	0
					2070	27,3	14	35,2	24,9	67	66	370	576	108	193	3564	1836	0	365	0
39	CAN	IQALUIT	63,75	-68,52	Base Line	-22,7	-30,8	10,7	2,9	68	76	13	456	1	62	3	0	8115	0	304
					2050	-14,9	-22,5	14	5,9	68	76	13	456	1	78	48	0	7575	0	265
					2070	-11,3	-18,7	15,5	7,3	68	76	13	456	1	85	87	0	6925	55	248
40	CAN	HALIFAX	44,88	-63,52	Base Line	-1,3	-10,4	23,3	12,9	79	80	130	467	1	110	713	22	4992	136	174
					2050	2	-6	26,6	16,2	79	80	130	467	1	139	1167	59	3930	175	138
					2070	3,4	-4,2	27,9	17,5	79	80	130	467	1	151	1394	85	3802	191	121
41	CAN	ST JOHN	47,62	-52,73	Base Line	-0,2	-7,1	20,2	10,4	82	82	103	432	1	95	397	2	5520	131	184
					2050	2,5	-3,4	23	13,2	82	82	103	432	1	116	714	27	4734	173	142
					2070	3,6	-1,9	24,4	14,5	82	82	103	432	1	126	901	44	4292	194	115
42	USA	BILLINGS	45,80	-108,53	Base Line	1,4	-11	31,1	13,2	72	53	131	569	1	168	1070	65	4328	137	183
					2050	3,9	-7,4	35,5	16,6	72	53	131	569	1	220	1317	132	3576	172	148
					2070	5,5	-5,6	37,7	18,2	60	46	131	569	1	246	1427	178	3175	188	130
43	MEX	CHIHUAHUA	28,65	-106,08	Base Line	17,9	1,5	31,8	18,8	43	51	326	546	68	158	2399	734	1373	242	33
					2050	20,8	3,5	34,8	21,4	43	51	326	546	81	193	2535	1046	898	278	11
					2070	21,9	4,3	36,3	22,9	43	51	326	546	87	212	2579	1085	597	295	6
44	BRA	BELEM	-1,28	-47,92	Base Line	30,4	22,2	31,4	21,7	82	82	397	491	111	135	4220	2243	0	365	0
					2050	32,5	24,2	34,1	24,1	82	82	397	491	129	162	3611	1840	0	365	0
					2070	33,3	25,2	35,3	25,2	82	82	397	491	137	175	3555	1798	0	365	0
45	GUY	GEORGETOWN	6,80	-58,15	Base Line	28,8	23,5	29,5	23,4	80	85	448	495	123	136	5469	2742	0	365	0
					2050	31	25,3	32	25,5	80	85	448	495	142	161	3994	2028	0	365	0
					2070	32	26,1	33,1	26,4	80	85	448	495	152	172	3762	1896	0	365	0

COD	COUNTRY	CITY	LAT	LON	Scenarios	JXT	JNT	JLXT	JLNT	RHJ	RHJL	SRJ	SRJL	ETJ	ETJL	ADD	DGE	AChH	FFS	TFN
46	TYT	PORT SPAIN	10,70	-61,50	Base Line	29,9	20,6	30,7	22,2	78	83	476	532	129	145	4196	2186	0	365	0
					2050	31,6	22,3	32,6	24,1	78	83	476	532	147	167	3652	1830	0	365	0
					2070	32,4	23,1	33,4	24,9	80	84	476	532	155	176	3589	1792	0	365	0
47	BRA	SAO LUIS	-2,60	-44,23	Base Line	30	23	31	22,7	87	83	437	481	121	133	4606	2434	0	365	0
					2050	31,9	25,1	33,3	25	87	83	437	481	140	158	3774	1918	0	365	0
					2070	32,7	26	34,5	26,1	87	83	437	481	149	170	3665	1848	0	365	0
48	CHI	LORD COCHRANE	-47,23	-72,55	Base Line	13,9	5,8	4,1	-5,2	65	74	507	123	118	33	99	99	6428	0	202
					2050	15,9	7,1	5,7	-3,2	65	74	507	123	133	38	206	204	5288	66	163
					2070	16,7	7,7	6,6	-2,2	65	74	507	123	140	40	266	259	4830	88	141
49	CHI	COYHAIQUE	-45,60	-72,10	Base Line	16,9	8,9	8,8	-2,6	68	75	502	122	126	33	347	323	3900	111	133
					2050	19	10,3	10,3	-0,9	68	75	502	122	144	37	573	503	3075	143	94
					2070	20,1	10,9	11,1	0	68	75	502	122	152	39	709	603	2932	158	76
50	ARG	BARILOCHE	-41,20	-71,19	Base Line	20,9	6,2	5,3	-1,8	60	81	645	146	134	8	521	493	5168	25	167
					2050	23,7	7,9	6,7	-0,3	60	81	645	146	158	9	745	687	4121	102	120
					2070	25,1	8,8	7,4	0,4	60	81	645	146	170	9	883	802	3757	126	102
51	COS	SAN JOSE	9,93	-84,08	Base Line	24,1	14,3	24,7	16	86	89	351	318	88	83	3398	1612	0	365	0
					2050	26,2	16,4	26,8	18	86	89	351	318	103	96	4143	1993	0	365	0
					2070	27,2	17,4	27,8	18,9	78	84	351	318	110	103	4485	2165	0	365	0
52	COL	MANIZALES	5,03	-75,47	Base Line	21,4	11,3	21,2	11,7	84	83	397	442	91	100	2073	1020	0	365	0
					2050	23,8	13,9	23,4	14	84	83	397	442	109	118	2885	1436	0	365	0
					2070	24,7	15,2	24,4	15	84	83	397	442	117	126	3259	1627	0	365	0
53	VEN	MARACAY	10,23	-67,59	Base Line	30,6	17,4	29,8	19,7	69	81	469	512	125	137	3957	1820	0	365	0
					2050	32,9	19,5	32,2	21,8	69	81	469	512	147	162	3343	1612	0	365	0
					2070	34	20,5	33,4	22,8	69	81	469	512	157	174	3321	1606	0	365	0
54	COL	BARRANQUILLA	11,00	-74,78	Base Line	30,6	22,9	32,5	24,4	79	80	524	563	144	157	3924	2043	0	365	0
					2050	32,6	24,9	34,7	26,4	79	80	524	563	167	183	3645	1839	0	365	0
					2070	33,5	25,9	35,6	27,2	79	80	524	563	178	194	3545	1802	0	365	0

COD	COUNTRY	CITY	LAT	LON	Scenarios	JXT	JNT	JLXT	JLNT	RHJ	RHJL	SRJ	SRJL	ETJ	ETJL	ADD	DGE	AChH	FFS	TFN
55	BRA	ARARANGUA	-28,88	-49,51	Base Line	28,5	18,8	20,9	9,1	83	83	482	246	127	58	3111	2025	16	365	0
					2050	30	20,5	22,5	10,7	83	83	482	246	143	65	3689	2310	0	365	0
					2070	30,8	21,4	23,1	11,6	83	83	482	246	152	69	3769	2255	0	365	0
56	ARG	USHUAIA	-54,80	-68,30	Base Line	13,3	4,7	4,4	-1,7	76	82	436	56	71	4	86	86	6465	0	170
					2050	14,3	5,7	5,8	-0,1	76	82	436	56	77	4	144	143	5880	0	118
					2070	14,8	6,2	6,6	0,7	76	82	436	56	80	5	187	181	5438	34	94
57	BRA	RIO DE JANEIRO	-22,96	-43,23	Base Line	29,8	22,1	24,2	16,3	79	79	463	312	127	81	4531	2552	0	365	0
					2050	31,5	23,8	25,9	18	79	79	463	312	144	92	4742	2447	0	365	0
					2070	32,3	24,7	26,8	18,9	79	79	463	312	153	98	4701	2253	0	365	0
58	ARG	RIO GALLEGOS	-51,66	-69,26	Base Line	18,2	6,9	4,7	-2,4	58	81	487	77	101	3	425	403	5235	60	159
					2050	19,6	8,1	6,3	-0,6	58	81	487	77	112	3	557	511	4426	102	112
					2070	20,3	8,7	7,2	0,2	58	81	487	77	117	4	630	570	4015	120	90
59	USA	SAN FRANCISCO	37,76	-122,43	Base Line	13,8	6,8	19,5	12,2	68	76	194	646	39	140	1368	465	209	180	0
					2050	15,7	8,8	22	14,6	68	76	194	646	45	167	2080	761	36	365	0
					2070	16,6	9,8	23	15,7	77	70	194	646	48	179	2438	933	5	365	0
60	ARG	BUENOS AIRES	-34,51	-58,48	Base Line	29,7	17,3	15	5,9	69	80	601	216	155	42	2280	1774	620	329	2
					2050	31,2	19,2	16,4	7,4	69	80	601	216	176	47	2662	1972	212	345	0
					2070	32,3	20,3	17	8,2	69	80	601	216	189	49	2729	1937	101	365	0
61	CHI	LA SERENA	-29,92	-71,25	Base Line	22	14,4	15	7,6	80	83	522	202	136	49	1610	1158	210	365	0
					2050	24	16,3	17	9,4	80	83	522	202	158	57	2273	1518	13	365	0
					2070	25	17,3	18	10,4	80	83	522	202	168	60	2614	1688	0	365	0
62	BRA	FORTALEZA	-3,76	-38,55	Base Line	30,1	23,5	29	21,5	79	79	507	493	139	133	5517	2771	0	365	0
					2050	31,9	25,5	30,9	23,5	79	79	507	493	160	154	4119	2010	0	365	0
					2070	32,7	26,4	31,8	24,4	79	79	507	493	169	163	3873	1913	0	365	0
63	CHI	PUNTA ARENAS	-53,00	-70,85	Base Line	14,5	6,8	5	-0,4	65	74	411	31	111	24	140	140	5558	68	106
					2050	15,6	7,9	6,6	1,3	65	74	411	31	121	27	215	210	4704	120	62
					2070	16,1	8,4	7,4	2,1	65	74	411	31	125	29	265	255	3811	142	44

COD	COUNTRY	CITY	LAT	LON	Scenarios	JXT	JNT	JLXT	JLNT	RHJ	RHJL	SRJ	SRJL	ETJ	ETJL	ADD	DGE	AChH	FFS	TFN
64	PAN	PANAMA	9,05	-79,37	Base Line	31,3	21,5	30,6	23,1	77	89	455	379	126	107	4561	2225	0	365	0
					2050	33,3	23,5	32,5	25	77	89	455	379	146	123	3764	1847	0	365	0
					2070	34,1	24,4	33,3	25,9	77	89	455	379	155	130	3677	1815	0	365	0
65	NIC	MANAGUA	12,15	-86,28	Base Line	31,4	20,5	31,2	22,8	66	78	425	429	118	120	3797	1899	0	365	0
					2050	33,5	22,6	33,5	24,9	66	78	425	429	138	141	3510	1740	0	365	0
					2070	34,4	23,6	34,7	25,9	66	78	425	429	147	152	3468	1728	0	365	0
66	ARG	COMODORO RIVADAVIA	-45,80	-67,50	Base Line	24,3	12	10,1	2,5	43	61	591	128	162	22	1120	981	2186	201	35
					2050	26,5	13,7	11,7	4	43	61	591	128	187	25	1502	1265	1782	240	15
					2070	27,6	14,5	12,5	4,7	43	61	591	128	200	26	1712	1414	1391	265	8
67	USA	ANCHORAGE	61,25	-149,80	Base Line	-7,1	-14,9	18,3	10,6	74	79	26	423	1	90	322	0	5845	106	211
					2050	-2,9	-9,3	21,2	13,7	74	79	26	423	1	112	673	0	4786	146	177
					2070	-0,9	-6,6	22,6	15,1	72	72	26	423	1	122	853	0	4558	166	161
68	CAN	QUEBEC	46,80	-71,38	Base Line	-6,7	-16,4	25,2	13,5	70	72	130	430	1	106	799	7	4935	125	184
					2050	-2,4	-10,4	28,8	16,8	70	72	130	430	1	135	1294	44	4307	161	146
					2070	-0,7	-7,9	30,5	18,4	70	72	130	430	1	149	1495	66	3841	178	133
69	CUB	LA HABANA	23,04	-82,41	Base Line	26,4	16,6	31,6	22,4	77	80	353	592	93	161	4338	2195	0	365	0
					2050	28,1	18,3	33,7	24,5	77	80	353	592	106	188	4195	2350	0	365	0
					2070	28,7	19	34,7	25,4	77	80	353	592	111	200	4073	2276	0	365	0
70	CAN	TORONTO	43,67	-79,40	Base Line	-1,8	-9,2	26,6	16,2	78	70	125	504	1	127	1154	41	4306	162	149
					2050	2,1	-4	30,4	19,5	78	70	125	504	1	163	1661	97	3505	202	108
					2070	3,8	-1,8	32,1	21	78	70	125	504	1	179	1709	152	3158	220	85
71	PAR	ASUNCION	-25,27	-57,63	Base Line	34	21,4	23	12,5	68	71	567	290	156	72	3427	1775	0	365	0
					2050	36,6	24	25,3	14,7	68	71	567	290	188	85	3641	1655	0	365	0
					2070	37,7	25,1	26,3	15,8	68	71	567	290	202	91	3652	1655	0	365	0
72	CHI	CHILLAN	-36,62	-72,09	Base Line	27,8	11,7	12,4	3,8	60	82	600	166	183	42	1514	1218	1767	223	13
					2050	30,1	13,6	13,9	5,2	60	82	600	166	214	47	1975	1535	921	278	4
					2070	31,3	14,6	14,7	5,9	60	82	600	166	230	49	2068	1544	719	325	2

COD	COUNTRY	CITY	LAT	LON	Scenarios	JXT	JNT	JLXT	JLNT	RHJ	RHJL	SRJ	SRJL	ETJ	ETJL	ADD	DGE	AChH	FFS	TFN
73	PER	IQUITOS	-3,75	-73,25	Base Line	31,3	21,6	30,3	20,8	81	82	402	371	113	103	3975	1885	0	365	0
					2050	33,9	24,2	33,1	23,5	81	82	402	371	136	126	3534	1743	0	365	0
					2070	35,1	25,3	34,6	24,8	81	82	402	371	147	137	3493	1739	0	365	0
74	USA	DALLAS	32,85	-96,85	Base Line	12,7	1,1	35,4	23,7	63	59	229	567	34	165	2313	558	1331	254	30
					2050	15,4	3,6	38,6	26,8	63	59	229	567	41	207	2567	872	821	290	8
					2070	16,6	4,7	39,9	28	67	61	229	567	44	223	2557	944	488	310	3
75	PER	LIMA	-12,05	-77,01	Base Line	26,5	17,6	18,9	12,4	81	85	514	421	131	94	2965	1764	0	365	0
					2050	28,6	19,6	21,5	14,9	81	85	514	421	153	113	3798	2160	0	365	0
					2070	29,5	20,7	22,7	16,2	81	85	514	421	163	122	4015	2170	0	365	0
76	CAN	WINNIPEG	49,90	-97,23	Base Line	-13,5	-24	25,7	12,9	78	69	104	502	1	121	809	4	5085	107	203
					2050	-9,2	-18,3	29,5	16,4	78	69	104	502	1	157	1301	40	4507	138	171
					2070	-7,1	-15,5	31,3	18	78	69	104	502	1	173	1327	59	4325	152	162
77	USA	ATLANTA	33,70	-84,40	Base Line	10,8	-0,3	31,4	20,1	74	70	213	494	27	134	2121	337	1952	230	57
					2050	13	1,9	34,8	23,2	74	70	213	494	32	169	2330	574	1223	261	26
					2070	14	2,6	36	24,3	64	74	213	494	34	181	2378	689	1199	272	17
78	CHI	CHILE CHICO	-46,55	-71,69	Base Line	17,1	9,2	8,2	-4,1	58	74	549	128	150	30	348	329	4061	107	155
					2050	19,3	10,5	9,8	-2,2	58	74	549	128	171	34	576	516	3205	136	119
					2070	20,2	11,2	10,7	-1,2	58	74	549	128	181	37	709	619	3050	151	100
79	CHI	COPIAPO	-27,35	-70,33	Base Line	30,1	13,7	21,2	5,2	62	58	618	279	194	93	2498	1648	720	279	4
					2050	32,6	15,7	23,6	7,4	62	58	618	279	230	110	2721	1569	214	345	0
					2070	33,7	16,8	24,9	8,7	62	58	618	279	246	120	2813	1480	55	365	0
80	BOL	SANTA CRUZ	-17,78	-63,16	Base Line	31,2	21,3	25,7	15,3	74	68	464	344	128	92	3957	1944	0	365	0
					2050	33,9	23,7	28,4	17,6	74	68	464	344	154	110	3750	1721	0	365	0
					2070	35,3	24,9	29,6	18,7	74	68	464	344	167	119	3735	1723	0	365	0
81	ARG	CORDOBA	-31,40	-64,12	Base Line	30,9	16,3	18	3,5	70	66	594	265	154	54	2481	1801	1083	245	13
					2050	32,7	18,3	19,4	5	70	66	594	265	177	60	2645	1787	624	286	4
					2070	33,9	19,5	20,1	5,9	70	66	594	265	192	64	2641	1689	323	330	2

COD	COUNTRY	CITY	LAT	LON	Scenarios	JXT	JNT	JLXT	JLNT	RHJ	RHJL	SRJ	SRJL	ETJ	ETJL	ADD	DGE	AChH	FFS	TFN
82	CHI	IQUIQUE	-20,25	-70,08	Base Line	28,2	16,3	21,5	10,4	68	67	540	255	172	96	3029	1865	0	365	0
					2050	30,8	18,3	24,2	12,9	68	67	540	255	204	116	3464	1833	270	365	0
					2070	31,8	19,2	25,3	14,1	68	67	540	255	217	125	3872	2051	0	365	0
83	CHI	SANTIAGO	-33,44	-70,69	Base Line	30,7	12,1	15	4,2	70	83	597	194	176	45	1877	1399	1384	236	10
					2050	33,1	14,2	17	5,8	70	83	597	194	207	52	2082	1402	580	314	2
					2070	34,2	15,2	17,9	6,7	70	83	597	194	223	55	2208	1416	191	345	1
84	USA	LAS VEGAS	36,20	-115,08	Base Line	14	0,3	39,9	24	44	41	242	584	44	220	2070	589	1590	248	46
					2050	16,8	2,7	43,5	27,6	44	41	242	584	53	283	2208	760	1077	280	18
					2070	18	3,7	45	29,2	43	23	242	584	57	312	2129	845	797	295	10
85	MEX	MONTERREY	25,70	-100,30	Base Line	20,2	8,1	34,7	21,9	62	62	289	549	66	154	3071	1261	65	365	0
					2050	22,5	10	37,1	24,6	62	62	289	549	77	185	3231	1552	0	365	0
					2070	23,6	10,7	38,6	25,9	62	62	289	549	82	203	3283	1625	0	365	0
86	ARG	MENDOZA	-32,88	-68,85	Base Line	31,5	15,3	14,6	0,9	56	63	639	233	176	41	2019	1564	1757	204	42
					2050	33,9	17,6	16,6	2,6	56	63	639	233	209	47	2206	1562	1249	236	19
					2070	35,1	18,8	17,5	3,5	56	63	639	233	226	50	2264	1519	965	255	12
87	VEN	CARACAS	10,48	-66,86	Base Line	25,3	13,7	26	16,4	77	82	481	545	117	136	3741	1757	0	365	0
					2050	27,4	15,7	28,3	18,4	77	82	481	545	136	159	4510	2148	0	365	0
					2070	28,4	16,6	29,3	19,4	77	82	481	545	145	170	4482	2215	0	365	0
88	BRA	BRASILIA	-15,80	-47,90	Base Line	26,7	17,1	26,5	13,3	77	57	462	451	118	125	3768	2014	0	365	0
					2050	29,2	19,4	29,2	15,7	77	57	462	451	141	150	4397	2392	0	365	0
					2070	30,3	20,5	30,5	16,9	77	57	462	451	151	163	4062	2066	0	365	0
89	GUA	GUATEMALA	14,63	-90,44	Base Line	23,6	12,1	24,7	15,5	74	82	381	464	92	115	3182	1439	0	365	0
					2050	25,9	14,2	27,8	18	74	82	381	464	108	141	4072	1855	0	365	0
					2070	26,7	15,1	29,1	19,1	74	82	381	464	115	152	4295	1997	0	365	0
90	USA	SANTA FE	35,70	-106,00	Base Line	6,5	-8,2	29,7	13,3	43	45	251	556	6	157	1313	104	3932	148	179
					2050	9,5	-5	33,5	16,5	43	45	251	556	7	201	1458	222	2893	182	148
					2070	10,9	-4	35,3	18	50	45	251	556	8	221	1547	299	2657	195	134

COD	COUNTRY	CITY	LAT	LON	Scenarios	JXT	JNT	JLXT	JLNT	RHJ	RHJL	SRJ	SRJL	ETJ	ETJL	ADD	DGE	AChH	FFS	TFN
91	MEX	MEXICO CITY	19,43	-99,13	Base Line	22,1	2,7	24,2	10,6	51	72	384	490	86	113	2034	824	1380	208	22
					2050	24,6	4,6	27,3	12,9	51	72	384	490	101	138	2723	1087	578	270	6
					2070	25,6	5,4	28,8	14,1	51	72	384	490	107	149	2792	1136	417	305	3
92	PER	AREQUIPA	-16,40	-71,50	Base Line	22,1	8	22	3,9	66	34	524	445	112	112	1572	822	1569	167	13
					2050	24,6	10,4	24,9	6,8	66	34	524	445	134	138	2236	1175	322	345	0
					2070	25,7	11,5	26,4	8,2	66	34	524	445	144	151	2637	1376	83	365	0
93	ECU	CUENCA	-2,88	-78,98	Base Line	21,8	10	19,7	8,5	81	79	376	358	86	77	1688	924	154	365	0
					2050	24	12,2	22,2	10,9	81	79	376	358	101	92	2469	1308	0	365	0
					2070	24,9	13,2	23,3	12,1	81	79	376	358	108	99	2831	1483	0	365	0
94	COL	BOGOTA	4,71	-74,08	Base Line	19,7	7,1	18	8,9	78	79	436	427	89	88	1223	622	365	180	0
					2050	22,3	9,8	20,2	11,1	78	79	436	427	108	104	1963	991	5	365	0
					2070	23,4	11,1	21,3	12,2	78	79	436	427	117	111	2364	1193	0	365	0
95	ECU	QUITO	-0,15	-78,48	Base Line	20,3	7,8	20,6	6,8	82	76	351	355	76	75	1353	671	658	345	1
					2050	22,4	9,9	22,9	9,1	82	76	351	355	89	89	1948	967	72	365	0
					2070	23,4	10,9	24	10,2	82	76	351	355	95	95	2293	1136	0	365	0
96	BOL	LA PAZ	-16,50	-68,13	Base Line	18,4	5,5	18	-2,3	73	45	448	388	86	67	958	526	3915	0	123
					2050	21	7,8	21,2	0,4	73	45	448	388	103	83	1424	761	2213	108	54
					2070	22,3	8,9	22,6	1,7	73	45	448	388	111	90	1682	908	1634	148	32
97	CAN	REGINA	50,40	-104,57	Base Line	-11,2	-22,2	26,1	11,4	79	62	97	526	1	129	768	8	5234	100	214
					2050	-7,5	-17,3	30	14,8	79	62	97	526	1	167	1234	42	4584	131	181
					2070	-5,6	-14,8	31,9	16,5	79	62	97	526	1	185	1190	59	4464	147	171
98	ARG	SARMIENTO	-45,58	-69,08	Base Line	24	10,7	8,3	0	43	69	607	125	163	15	967	866	3041	156	78
					2050	26,4	12,3	9,9	1,6	43	69	607	125	189	17	1306	1138	2307	189	47
					2070	27,6	13,1	10,8	2,4	43	69	607	125	202	18	1498	1287	2166	207	34
99	ARG	TUCUMAN	-26,85	-65,10	Base Line	31,7	19,3	19,9	5,5	70	67	499	305	135	68	2980	2026	225	306	2
					2050	34,2	21,6	21,9	7,3	70	67	499	305	161	78	2990	1737	135	345	0
					2070	35,5	22,7	22,8	8,3	70	67	499	305	174	84	3045	1644	48	365	0

COD	COUNTRY	CITY	LAT	LON	Scenarios	JXT	JNT	JLXT	JLNT	RHJ	RHJL	SRJ	SRJL	ETJ	ETJL	ADD	DGE	AChH	FFS	TFN
100	ARG	CATAMARCA	-28,50	-65,80	Base Line	34,2	20,9	19,6	3,5	58	60	548	299	160	68	2689	1749	718	261	8
					2050	36,5	23,1	21,4	5,2	58	60	548	299	189	77	2796	1599	335	301	2
					2070	37,8	24,3	22,2	6,2	58	60	548	299	204	82	2934	1610	216	339	1
101	ARG	SALTA	-24,90	-65,50	Base Line	27,6	14,8	19,5	1,2	78	63	548	362	137	71	2381	1666	1306	204	34
					2050	30,3	17,2	22,1	3,5	78	63	548	362	165	85	2908	1912	790	249	10
					2070	31,6	18,3	23,3	4,7	78	63	548	362	178	92	3003	1863	476	278	4
102	ARG	LA QUIACA	-22,10	-65,60	Base Line	25,6	5,9	14,3	-8	65	32	567	428	123	42	1263	903	3758	0	174
					2050	28,4	8,4	17,6	-5,3	65	32	567	428	149	52	1771	1201	2607	89	127
					2070	29,7	9,6	19,1	-3,8	65	32	567	428	161	57	2042	1367	2254	115	110
103	BOL	COCHABAMBA	-17,38	-66,15	Base Line	24,5	12,3	23,7	2,6	71	52	426	363	102	83	2368	1404	1069	205	22
					2050	27,2	14,5	26,8	5,2	71	52	426	363	122	102	3092	1774	465	282	3
					2070	28,6	15,6	28,3	6,4	71	52	426	363	132	111	3223	1817	189	339	1
104	BOL	ORURO	-18,05	-67,07	Base Line	18,8	4,1	14,9	-9,6	67	42	505	436	94	34	757	491	4755	0	225
					2050	21,6	6,4	18,4	-6,9	67	42	505	436	113	42	1197	723	3578	38	166
					2070	22,9	7,5	19,9	-5,6	67	42	505	436	122	46	1415	841	3078	71	141
105	BRA	NATAL	-5,90	-35,30	Base Line	31,6	21,9	28,1	19,6	76	82	564	449	154	120	4432	1961	0	365	0
					2050	33,4	23,8	29,8	21,4	76	82	564	449	177	137	4033	1797	0	365	0
					2070	34,2	24,7	30,7	22,2	76	82	564	449	187	145	3742	1775	0	365	0
106	BRA	PORTO ALEGRE	-30,00	-51,20	Base Line	29,6	20,1	19,3	10,5	76	82	512	234	137	55	3208	2156	0	365	0
					2050	31,1	21,9	20,9	12,2	76	82	512	234	155	62	3647	2284	0	365	0
					2070	31,9	22,9	21,6	13,2	76	82	512	234	165	66	3777	2272	0	365	0
107	BRA	CUIABA	-15,60	-56,10	Base Line	32,1	22,7	31	15,8	82	66	439	428	123	120	3627	1812	0	365	0
					2050	34,6	25	34,2	18,5	82	66	439	428	147	148	3311	1711	0	365	0
					2070	35,8	26,2	35,6	19,8	82	66	439	428	158	161	3304	1701	0	365	0
108	BRA	CAMPINAS	-13,97	-43,17	Base Line	30,4	19,3	29,2	15,1	67	55	533	460	142	133	4046	1991	0	365	0
					2050	32,5	21,6	31,3	17,1	67	55	533	460	167	155	3369	1717	0	365	0
					2070	33,6	22,6	32,4	18,1	67	55	533	460	179	166	3285	1686	0	365	0

COD	COUNTRY	CITY	LAT	LON	Scenarios	JXT	JNT	JLXT	JLNT	RHJ	RHJL	SRJ	SRJL	ETJ	ETJL	ADD	DGE	AChH	FFS	TFN
109	BRA	VITORIA DA CONQUISTA	-14,85	-40,83	Base Line	26,3	16,6	22,8	12,2	76	80	518	360	130	86	3334	1896	0	365	0
					2050	28,5	18,8	25	14,2	76	80	518	360	153	100	4124	2309	0	365	0
					2070	29,6	19,8	26	15,1	76	80	518	360	164	107	4492	2504	0	365	0
110	BRA	CURITIBA	-25,40	-49,30	Base Line	25,7	16	19,5	8,2	80	81	453	286	114	63	2340	1566	183	365	0
					2050	27,5	17,9	21,4	10,2	80	81	453	286	131	73	3017	1919	5	365	0
					2070	28,5	18,9	22,3	11,3	80	81	453	286	140	78	3360	2090	0	365	0
111	CAN	VANCOUVER	49,18	-123,17	Base Line	5,6	0,4	22,3	12,8	82	73	97	515	10	119	819	35	3474	197	65
					2050	7,8	3,2	26	15,8	82	73	97	515	12	151	1371	117	2134	254	16
					2070	9,2	4,8	27,6	17,3	82	73	97	515	13	165	1663	191	1307	293	5
112	CAN	MONTREAL	45,47	-73,75	Base Line	-4,8	-14,6	26,5	15,1	71	71	136	464	1	116	1047	28	4497	139	168
					2050	-0,7	-8,8	30,2	18,5	71	71	136	464	1	149	1576	73	3765	175	133
					2070	1	-6,3	31,8	20,1	71	71	136	464	1	164	1610	104	3437	193	120
113	CAN	SASKATOON	52,17	-106,68	Base Line	-12,9	-23	25,5	11,5	76	63	85	505	1	122	725	3	5227	99	209
					2050	-9,1	-17,9	29,3	14,9	76	63	85	505	1	157	1183	34	4521	131	177
					2070	-7,1	-15,3	31,1	16,5	76	63	85	505	1	173	1229	49	4424	145	166
114	CAN	EDMONTON	53,57	-113,52	Base Line	-8,9	-18,9	23,1	10,9	73	71	73	487	1	111	614	5	5204	101	203
					2050	-5,6	-14,4	26,5	14,2	73	71	73	487	1	141	1046	32	4580	134	173
					2070	-3,8	-12,1	28,3	15,7	73	71	73	487	1	156	1270	45	4399	150	163
115	CHI	VALDIVIA	-39,82	-73,23	Base Line	21,9	10,7	11,8	4,3	73	86	476	88	126	27	963	770	1863	226	10
					2050	23,8	12,2	13	5,5	73	86	476	88	143	30	1322	1028	1053	287	3
					2070	24,8	13	13,6	6,1	73	86	476	88	152	31	1517	1166	799	339	2
116	CHI	CONCEPCION	-36,80	-73,10	Base Line	20	11,9	13,7	5,4	80	85	549	139	126	39	1056	777	1042	279	4
					2050	21,9	13,5	15,1	6,7	80	85	549	139	144	43	1484	1066	287	345	1
					2070	22,9	14,3	15,8	7,4	80	85	549	139	153	45	1708	1213	298	345	0
117	COL	ARAUCA	7,07	-70,73	Base Line	32,3	21,7	29,1	22,2	66	84	452	386	126	107	4249	1843	0	365	0
					2050	35,4	24,7	31,5	24,5	66	84	452	386	157	127	3628	1743	0	365	0
					2070	37	26,3	32,7	25,6	66	84	452	386	173	137	3511	1692	0	365	0

COD	COUNTRY	CITY	LAT	LON	Scenarios	JXT	JNT	JLXT	JLNT	RHJ	RHJL	SRJ	SRJL	ETJ	ETJL	ADD	DGE	AChH	FFS	TFN
118	COL	VILLAVICENCIO	4,17	-73,62	Base Line	31,1	20,3	28,9	19,2	71	83	425	372	117	101	4457	2008	0	365	0
					2050	33,7	23,1	31,1	21,5	71	83	425	372	142	119	3650	1751	0	365	0
					2070	34,9	24,4	32,2	22,5	71	83	425	372	154	128	3536	1745	0	365	0
119	COL	CALI	3,45	-76,38	Base Line	29,7	18,6	30,2	18,1	75	74	371	390	101	106	4717	2396	0	365	0
					2050	31,8	20,9	32,4	20,3	75	74	371	390	119	125	3744	1923	0	365	0
					2070	32,6	22	33,3	21,3	75	74	371	390	126	133	3560	1808	0	365	0
120	COL	MEDELLIN	6,26	-75,58	Base Line	25,2	14,3	25,9	14,5	80	77	398	444	99	111	3389	1667	0	365	0
					2050	27,5	16,9	28,1	16,7	80	77	398	444	118	131	4199	2084	0	365	0
					2070	28,5	18	29,2	17,7	80	77	398	444	127	140	4567	2265	0	365	0
121	CUB	CIENFUEGOS	22,15	-80,40	Base Line	27,6	17,4	32,5	22,5	76	79	346	542	93	149	4179	2212	0	365	0
					2050	29,3	19,2	34,7	24,5	76	79	346	542	106	174	3957	2184	0	365	0
					2070	30	19,9	35,7	25,4	76	79	346	542	111	185	3779	2033	0	365	0
122	ECU	GUAYAQUIL	-2,20	-79,90	Base Line	30,8	21,9	28,6	19,7	81	79	372	333	105	92	4569	2219	0	365	0
					2050	32,7	23,9	30,6	21,9	81	79	372	333	121	108	3818	1848	0	365	0
					2070	33,6	24,8	31,6	23	81	79	372	333	129	115	3660	1797	0	365	0
123	ELS	SAN SALVADOR	13,70	-89,20	Base Line	30,6	15	30,2	17,6	67	80	413	496	109	131	3904	1823	0	365	0
					2050	32,7	17,1	33	20	67	80	413	496	127	158	3288	1606	0	365	0
					2070	33,5	18	34,2	21,1	65	81	413	496	135	170	3204	1561	0	365	0
124	JAM	KINGSTON	17,90	-76,80	Base Line	29,1	20,6	31,5	23,8	76	76	408	571	112	157	4868	2591	0	365	0
					2050	30,9	22,4	33,3	25,6	76	76	408	571	128	180	3930	2027	0	365	0
					2070	31,7	23,1	34,1	26,4	76	76	408	571	135	190	3796	1931	0	365	0
125	MEX	ACAPULCO	16,80	-99,90	Base Line	33	20,8	33,6	23,5	74	78	446	502	124	141	3423	1678	0	365	0
					2050	35,1	22,8	36,3	25,9	74	78	446	502	144	169	3371	1667	0	365	0
					2070	36	23,6	37,5	27	74	78	446	502	153	183	3326	1663	0	365	0
126	MEX	GUADALAJARA	20,66	-103,38	Base Line	24,3	6,9	27,3	15,2	48	72	410	508	104	128	2914	1211	223	180	0
					2050	26,9	8,7	30	17,5	48	72	410	508	123	154	3242	1461	44	365	0
					2070	28,1	9,5	31,5	18,6	48	72	410	508	131	167	3211	1571	8	365	0

COD	COUNTRY	CITY	LAT	LON	Scenarios	JXT	JNT	JLXT	JLNT	RHJ	RHJL	SRJ	SRJL	ETJ	ETJL	ADD	DGE	AChH	FFS	TFN
127	MEX	GUANAJUATO	21,00	-101,30	Base Line	22,7	6,4	26,3	13,9	45	63	386	513	98	128	2789	1056	315	354	1
					2050	25,1	8,1	29	16,2	45	63	386	513	114	154	3200	1379	83	365	0
					2070	26,2	8,9	30,5	17,4	45	63	386	513	121	168	3184	1461	30	365	0
128	PER	CHICLAYO	-6,80	-79,80	Base Line	29,8	19,5	24,3	15,3	73	80	474	392	127	98	3968	2079	0	365	0
					2050	31,8	21,6	26,4	17,7	73	80	474	392	148	116	4084	1966	0	365	0
					2070	32,6	22,5	27,3	18,8	73	80	474	392	156	124	4141	1977	0	365	0
129	PER	PUERTO MAL-DONADO	-12,63	-69,20	Base Line	31,2	21,5	29,4	17,5	79	71	401	403	112	108	3922	1915	0	365	0
					2050	33,7	23,7	32,2	20,2	79	71	401	403	133	132	3402	1736	0	365	0
					2070	34,8	24,8	33,6	21,4	79	71	401	403	143	143	3369	1716	0	365	0
130	PER	CAJAMARCA	-7,20	-78,50	Base Line	16	3,2	16,2	-1,3	76	63	415	410	71	62	559	288	4815	0	184
					2050	18,2	5,4	18,6	1,5	76	63	415	410	84	75	894	455	3953	0	79
					2070	19,2	6,4	19,7	2,8	76	63	415	410	89	81	1060	538	3158	67	44
131	PER	CUZCO	-13,55	-71,98	Base Line	18,1	5,4	17,8	-0,8	68	50	410	406	79	72	954	505	3803	0	101
					2050	20,6	7,8	20,6	1,9	68	50	410	406	94	88	1408	741	1940	130	36
					2070	21,6	8,9	21,7	3	68	50	410	406	101	94	1633	868	1406	170	19
132	USA	NEW ORLEANS	30,06	-89,96	Base Line	16,8	5,1	32,8	22,8	77	73	233	478	46	134	2802	869	375	313	2
					2050	18,9	7,2	35,3	25,2	77	73	233	478	54	160	3014	1194	34	180	0
					2070	19,7	7,9	36,4	26,3	73	79	233	478	56	172	3108	1281	70	365	0
133	USA	BOSTON	42,36	-71,03	Base Line	2,1	-7,6	28,1	16,9	70	76	153	497	2	128	1345	70	3932	172	140
					2050	5,3	-3,7	31,5	20,2	70	76	153	497	3	162	1725	153	3074	207	100
					2070	6,7	-2	32,9	21,6	63	69	153	497	3	176	1842	215	2595	223	80
134	USA	PORTLAND	45,60	-122,60	Base Line	7,2	0,5	25,7	11,7	83	77	109	544	12	128	1040	92	3241	187	66
					2050	9,4	2,8	29,2	14,4	83	77	109	544	14	160	1565	197	2194	239	23
					2070	10,7	4,1	30,7	15,8	79	63	109	544	15	174	1647	266	1564	271	9
135	USA	CLEVELAND	33,73	-90,73	Base Line	10,1	-0,1	33,5	22	77	73	208	522	25	145	2184	401	1605	238	45
					2050	12,7	2,3	37,3	25,3	77	73	208	522	30	186	2345	657	1181	270	17
					2070	13,6	3,2	38,7	26,7	69	73	208	522	32	203	2482	800	977	284	10

COD	COUNTRY	CITY	LAT	LON	Scenarios	JXT	JNT	JLXT	JLNT	RHJ	RHJL	SRJ	SRJL	ETJ	ETJL	ADD	DGE	AChH	FFS	TFN
136	USA	DETROIT	42,41	-83,01	Base Line	-0,7	-8,1	28,3	17,1	75	70	128	517	1	133	1411	61	3971	171	141
					2050	3	-3,4	32,2	20,4	75	70	128	517	1	172	1699	137	3197	209	101
					2070	4,6	-1,4	33,8	21,9	75	70	128	517	1	188	1782	205	3033	228	77
137	USA	CHICAGO	41,98	-87,90	Base Line	-1,1	-9,8	28,6	17,4	74	70	150	528	1	136	1458	72	3992	166	145
					2050	2,6	-5,3	32,9	20,9	74	70	150	528	1	178	1719	149	3184	201	111
					2070	4,3	-3,4	34,5	22,3	72	70	150	528	1	195	1783	218	3064	216	91
138	USA	SAN DIEGO	32,73	-117,16	Base Line	18,8	8,1	25	17,4	67	74	269	609	59	150	2473	850	127	365	0
					2050	21,1	10,4	27	19,6	67	74	269	609	70	175	3301	1259	0	365	0
					2070	22,2	11,4	28	20,7	66	74	269	609	75	188	3674	1449	0	365	0
139	USA	SEATTLE	47,53	-122,30	Base Line	7,1	1,5	24	12,3	84	75	102	530	13	124	928	61	3079	206	47
					2050	9,4	4,2	27,7	15,2	84	75	102	530	16	157	1500	182	1702	271	9
					2070	10,8	5,6	29,3	16,7	77	66	102	530	17	172	1807	274	948	322	2
140	USA	YAKUTAT	59,50	-139,70	Base Line	-0,5	-7,6	15,2	8,7	76	82	36	457	1	88	161	0	5999	101	202
					2050	2,3	-4	18,2	11,6	76	82	36	457	1	109	415	4	4960	152	154
					2070	3,8	-2,1	19,4	12,9	78	85	36	457	1	117	571	13	4573	176	121
141	USA	HOUSTON	29,77	-95,37	Base Line	16	6,3	33,4	23,7	77	73	231	522	47	146	2864	904	307	354	0
					2050	18,4	8,6	36	26,2	77	73	231	522	56	176	3164	1292	32	365	0
					2070	19,4	9,5	37,1	27,3	74	75	231	522	59	188	3198	1356	8	365	0
142	USA	FRESNO	36,79	-119,72	Base Line	12,1	2,6	36,7	17,3	67	74	216	688	34	216	1719	474	1684	249	24
					2050	14,4	4,8	40,2	20,5	67	74	216	688	40	274	1983	688	960	301	5
					2070	15,5	5,9	41,5	21,9	75	40	216	688	43	297	2101	734	562	347	2
143	USA	INDIANAPOLIS	39,70	-86,30	Base Line	1,4	-7,8	29,7	17,8	74	70	158	515	1	135	1662	92	3578	176	133
					2050	4,6	-4,1	34,4	21,5	74	70	158	515	1	180	1751	204	3038	209	100
					2070	6	-2,6	35,8	22,9	74	72	158	515	1	196	1788	280	2559	223	82
144	USA	MINNEAPOLIS	44,89	-93,22	Base Line	-5,6	-15,9	28,6	16,7	70	71	144	515	1	132	1319	47	4408	145	167
					2050	-1,6	-10,5	32,8	20,4	70	71	144	515	1	173	1594	98	3626	177	138
					2070	0,3	-8,2	34,6	21,9	70	66	144	515	1	191	1629	131	3296	191	125

COD	COUNTRY	CITY	LAT	LON	Scenarios	JXT	JNT	JLXT	JLNT	RHJ	RHJL	SRJ	SRJL	ETJ	ETJL	ADD	DGE	AChH	FFS	TFN
145	USA	CINCINNATI	39,10	-84,50	Base Line	3,3	-6,5	30,5	18,3	74	70	157	498	4	132	1725	124	3375	184	124
					2050	6,3	-3	34,8	21,8	74	70	157	498	5	173	1849	256	2576	217	87
					2070	7,5	-1,7	36,2	23,2	70	71	157	498	5	188	1885	335	2199	230	68
146	USA	KANSAS CITY	39,30	-94,70	Base Line	2,5	-7	31,6	20,5	68	70	181	538	2	145	1771	134	3161	191	123
					2050	5,7	-3,5	35,7	24,1	68	70	181	538	3	190	1983	286	2603	221	89
					2070	7,2	-2	37,2	25,4	70	68	181	538	3	206	2021	369	2295	234	69
147	USA	SPOKANE	47,64	-117,54	Base Line	0,1	-6	28,3	12	77	55	114	575	1	162	993	35	4572	146	166
					2050	2,6	-2,4	32,5	15,2	77	55	114	575	1	210	1189	79	3847	191	104
					2070	4,2	-0,8	34,5	16,9	78	45	114	575	1	234	1320	105	3309	212	73
148	USA	ALBUQUERQUE	35,10	-106,60	Base Line	9,2	-5,6	34,1	17,3	43	45	263	559	15	172	1496	230	2919	183	144
					2050	12,3	-2,5	37,9	20,6	43	45	263	559	19	221	1717	427	2248	216	106
					2070	13,7	-1,6	39,7	22	50	42	263	559	20	243	1849	545	2014	227	85
149	VEN	BARCELONA	10,10	-64,70	Base Line	31,1	21,2	30,7	22,3	72	81	500	560	136	152	3872	1909	0	365	0
					2050	33,3	23,2	33	24,4	72	81	500	560	159	179	3569	1767	0	365	0
					2070	34,3	24,2	34	25,4	72	81	500	560	169	191	3537	1754	0	365	0
150	VEN	MARACAIBO	10,65	-71,60	Base Line	31,4	22,7	33,3	24,7	72	73	460	528	128	149	3802	1949	0	365	0
					2050	33,8	25	35,9	27	72	73	460	528	152	178	3558	1794	0	365	0
					2070	35	26,1	37,1	28	72	73	460	528	164	191	3295	1716	0	365	0
151	BEL	BELICE	17,49	-88,19	Base Line	26,9	18,9	30,5	23,7	80	79	361	495	97	137	4631	2430	0	365	0
					2050	28,8	20,8	32,8	25,8	80	79	361	495	112	161	4258	2387	0	365	0
					2070	29,6	21,5	33,8	26,8	80	79	361	495	118	172	4028	2200	0	365	0
152	CAN	WHITEHORSE	60,72	-135,06	Base Line	-14,5	-23,1	20,5	7,5	72	63	26	463	1	97	317	0	6432	56	244
					2050	-10,9	-18,4	23,5	10,7	72	63	26	463	1	121	579	0	5550	100	202
					2070	-8,8	-15,5	24,8	12	72	63	26	463	1	131	733	0	4961	116	185

Table A2. Bioclimatic variables for present and future scenarios in America.

COD	COUNTRY	CITY	LAT	LON	Scenarios	THD	DSL	WSL	AR	AE	AWD	AWS	ASR	Iaw	Ias	Iaa	BRP	PCI	SDD	HCI
1	ARG	MAR DEL PLATA	-37,97	-57,10	Base Line	68	0	5	834	1016	-274	92	142	1,55	0,56	0,82	4	9	0	3
					2050	97	2	5	868	1148	-367	87	142	1,46	0,51	0,76	3	9	0	4
					2070	112	3	5	889	1218	-412	83	142	1,38	0,49	0,73	1	9	0	4
2	ARG	SANTA FE	-31,64	-60,52	Base Line	165	0	2	934	1220	-319	33	152	0,57	0,72	0,77	0	10	295	5
					2050	197	3	2	983	1395	-432	20	152	0,5	0,71	0,7	0	10	657	5
					2070	212	3	2	1005	1489	-507	23	152	0,49	0,67	0,67	0	10	933	6
3	ARG	CHOS MALAL	-37,10	-70,30	Base Line	32	6	4	442	939	-729	232	153	7,85	0,09	0,47	7	12	0	3
					2050	72	7	4	395	1111	-913	197	153	6,32	0,07	0,36	7	12	0	3
					2070	94	7	4	360	1196	-1010	174	153	5,63	0,06	0,3	7	12	0	4
4	ARG	ROSARIO	-32,90	-60,80	Base Line	143	0	2	992	1161	-224	55	150	0,75	0,75	0,85	1	10	103	5
					2050	173	1	2	1040	1325	-334	49	150	0,67	0,72	0,78	0	10	451	5
					2070	188	2	2	1075	1411	-392	56	150	0,66	0,71	0,76	0	10	569	5
5	ARG	TRELEW	-43,20	-65,30	Base Line	96	9	0	187	1145	-958	0	139	0,53	0,08	0,16	5	9	0	6
					2050	125	9	0	184	1292	-1108	0	139	0,47	0,07	0,14	3	9	0	6
					2070	139	10	0	179	1367	-1188	0	139	0,42	0,07	0,13	3	9	90	6
6	ARG	CORRIENTES	-27,50	-58,80	Base Line	223	0	4	1264	1303	-149	110	153	0,71	0,9	0,97	0	10	751	6
					2050	265	2	3	1311	1527	-289	73	153	0,57	0,82	0,86	0	10	1207	6
					2070	282	3	2	1373	1630	-329	72	153	0,54	0,82	0,84	0	10	1418	6
7	ARG	SANTA CRUZ	-50,02	-68,57	Base Line	5	8	3	189	701	-542	30	113	1,7	0,16	0,27	7	9	0	3
					2050	14	8	3	183	780	-623	26	113	1,48	0,13	0,23	6	9	0	3
					2070	21	8	3	179	817	-662	24	113	1,44	0,12	0,22	6	9	0	4
8	ARG	SANTIAGO DE ESTERO	-27,80	-64,30	Base Line	237	8	0	585	1305	-720	0	153	0,08	0,73	0,45	0	14	857	6
					2050	271	8	0	620	1522	-902	0	153	0,07	0	0,41	0	15	1409	6
					2070	283	8	0	622	1634	-1012	0	153	0,07	0,63	0,38	0	15	1616	6
9	ARG	CIPOLLETTI	-38,95	-67,98	Base Line	136	10	0	177	1233	-1056	0	153	0,41	0,07	0,14	4	9	76	5
					2050	163	11	0	185	1417	-1232	0	153	0,36	0,07	0,13	4	9	435	6
					2070	176	12	0	176	1517	-1341	0	153	0,33	0,06	0,12	3	9	609	6

COD	COUNTRY	CITY	LAT	LON	Scenarios	THD	DSL	WSL	AR	AE	AWD	AWS	ASR	Iaw	Ias	Iaa	BRP	PCI	SDD	HCI
10	ARG	SAN JUAN	-31,50	-68,70	Base Line	176	12	0	106	1433	-1327	0	172	0,08	0,1	0,07	3	12	517	6
					2050	208	12	0	104	1690	-1586	0	172	0,06	0,08	0,06	2	13	1015	7
					2070	223	12	0	104	1817	-1713	0	172	0,06	0,08	0,06	1	13	1188	7
11	BRA	BELLO HORIZONTE	-9,78	-37,85	Base Line	293	8	0	567	1527	-960	0	173	0,59	0,29	0,37	0	10	672	6
					2050	327	10	0	526	1776	-1250	0	173	0,47	0,25	0,3	0	10	1338	6
					2070	338	12	0	511	1894	-1383	0	173	0,4	0,24	0,27	0	10	1567	6
12	BRA	MANAUS	-3,13	-60,01	Base Line	344	1	9	2156	1342	-160	974	143	2,41	0,69	1,61	0	10	1002	3
					2050	356	3	7	2081	1650	-367	798	143	1,99	0,51	1,26	0	11	1759	3
					2070	358	4	6	2036	1803	-465	698	143	1,77	0,48	1,13	0	11	2164	2
13	CAN	OTTAWA	45,40	-75,70	Base Line	46	0	8	868	589	-101	380	111	62,67	0,74	1,47	7	9	0	3
					2050	88	0	7	945	751	-220	414	111	74,33	0,58	1,26	6	8	0	3
					2070	107	1	7	961	828	-291	424	111	78	0,51	1,16	5	8	0	3
14	CAN	CALGARY	51,12	-114,02	Base Line	15	0	5	424	518	-167	73	109	15,67	0,64	0,82	9	12	0	2
					2050	50	2	5	440	652	-296	84	109	18	0,48	0,67	7	11	0	3
					2070	68	2	5	451	713	-349	87	109	18	0,43	0,63	7	11	0	3
15	CHI	ARICA	-18,50	-70,30	Base Line	206	12	0	3	1418	-1415	0	144	0	0	0	0	33	0	6
					2050	284	12	0	3	1699	-1696	0	144	0	0	0	0	33	301	6
					2070	310	12	0	3	1825	-1822	0	144	0	0	0	0	33	663	6
16	CHI	ANTOFAGASTA	-23,43	-70,46	Base Line	83	12	0	1	1402	-1402	0	149	0	0	0	0	0	0	7
					2050	156	12	0	1	1658	-1658	0	149	0	0	0	0	0	0	7
					2070	192	12	0	1	1777	-1777	0	149	0	0	0	0	0	0	7
17	CHI	CRISTO REDENTOR	-32,83	-70,08	Base Line	0	2	9	368	79	-39	328	164	54	0,42	4,66	12	14	0	0
					2050	0	2	9	328	92	-54	290	164	48,33	0,32	3,57	12	14	0	0
					2070	0	3	9	301	101	-60	260	164	44,33	0,3	2,98	12	14	0	1
18	COL	TURBO	8,12	-76,73	Base Line	330	0	9	2384	1407	-99	1076	154	0,95	1,98	1,69	0	9	335	4
					2050	349	0	9	2554	1648	-146	1052	154	1,76	0,96	1,55	0	9	1342	3
					2070	353	0	9	2653	1756	-149	1046	154	0,99	1,67	1,51	0	9	1579	3

COD	COUNTRY	CITY	LAT	LON	Scenarios	THD	DSL	WSL	AR	AE	AWD	AWS	ASR	Iaw	Ias	Iaa	BRP	PCI	SDD	HCI
19	DOM	SANTO DOMINGO	18,48	-69,89	Base Line	336	3	5	1755	1541	-370	584	171	0,35	1,25	1,14	0	12	335	5
					2050	351	5	4	1569	1788	-547	328	171	0,3	0,88	0,88	0	12	1111	4
					2070	354	4	3	1379	1894	-554	39	171	0,47	0,77	0,73	0	10	1328	4
20	HON	TEGUCIGALPA	14,05	-87,22	Base Line	266	6	4	957	1360	-567	164	160	0,1	1,01	0,7	0	14	0	5
					2050	320	6	2	905	1619	-790	76	160	0,09	0,7	0,56	0	14	146	5
					2070	334	7	2	884	1742	-912	54	160	0,08	0,58	0,51	0	14	318	5
21	MEX	YUCATAN	21,30	-89,60	Base Line	305	10	0	470	1637	-1167	0	184	0,2	0,36	0,29	0	12	0	6
					2050	333	10	0	443	1897	-1454	0	184	0,18	0,25	0,23	0	12	339	5
					2070	340	11	0	428	2007	-1579	0	184	0,16	0,21	0,21	0	12	461	5
22	PER	HUANCAYO	-12,06	-75,21	Base Line	12	5	3	651	924	-388	115	143	0,1	1,36	0,7	2	13	0	4
					2050	59	5	3	736	1115	-498	119	143	0,08	1,31	0,66	0	13	0	5
					2070	92	5	3	774	1198	-541	117	143	0,08	1,3	0,65	0	13	0	6
23	USA	BUFFALO	31,46	-96,05	Base Line	191	9	0	494	1145	-651	0	140	0,46	0,32	0,43	3	11	0	6
					2050	227	11	0	479	1412	-933	0	140	0,33	0,26	0,34	1	11	63	6
					2070	242	3	4	986	1523	-614	77	140	1,41	0,29	0,65	0	9	139	5
24	USA	TAMPA	27,96	-82,53	Base Line	237	1	6	1367	1305	-166	228	151	0,94	1,17	1,05	0	10	0	6
					2050	278	1	3	1347	1543	-322	126	151	0,87	0,88	0,87	0	10	150	5
					2070	293	2	2	1184	1640	-487	31	151	0,81	0,9	0,72	0	10	195	5
25	USA	MIAMI	25,80	-80,30	Base Line	263	1	4	1367	1423	-244	188	161	0,79	1,1	0,96	0	10	0	6
					2050	303	1	2	1347	1648	-413	112	161	0,74	0,85	0,82	0	10	176	5
					2070	316	3	3	1337	1738	-527	126	161	0,57	0,78	0,77	0	10	221	5
26	USA	NEW YORK	40,79	-73,97	Base Line	91	0	8	959	776	-173	356	119	13,71	0,61	1,24	5	8	0	3
					2050	128	1	7	1041	971	-311	381	119	12,41	0,48	1,07	4	9	0	4
					2070	143	0	7	1259	1056	-237	440	119	12,83	0,63	1,19	4	8	0	5
27	USA	MEMPHIS	35,10	-90,00	Base Line	149	0	5	849	1013	-279	115	133	2,09	0,61	0,84	3	9	0	4
					2050	183	3	5	907	1273	-490	124	133	2,01	0,46	0,71	3	9	0	4
					2070	195	3	6	1315	1387	-495	423	133	3,65	0,41	0,95	3	9	0	5

COD	COUNTRY	CITY	LAT	LON	Scenarios	THD	DSL	WSL	AR	AE	AWD	AWS	ASR	Iaw	Ias	Iaa	BRP	PCI	SDD	HCI
28	USA	WASHINGTON DC	38,95	-77,45	Base Line	122	113	0	8	972	801	-137	308	120	9,77	0,7	1,21	5	8	0
					2050	78	152	1	6	1044	1012	-289	321	120	8,96	0,55	1,03	4	8	0
					2070	59	167	0	5	1088	1102	-326	312	120	8,69	0,56	0,99	4	8	0
29	USA	BIRMINGHAM	33,57	-86,75	Base Line	157	0	4	862	1026	-253	89	133	1,64	0,66	0,84	3	9	0	5
					2050	193	1	4	920	1269	-441	92	133	1,61	0,52	0,72	3	9	0	5
					2070	207	0	6	1416	1372	-344	388	133	3,16	0,59	1,03	1	9	0	5
30	USA	PHOENIX	33,50	-112,00	Base Line	239	11	0	274	1785	-1511	0	169	0,34	0,16	0,15	0	12	125	6
					2050	281	12	0	256	2225	-1969	0	169	0,26	0,12	0,12	0	13	244	6
					2070	299	12	0	200	2420	-2220	0	169	0,23	0,06	0,08	0	10	281	5
31	USA	OKLAHOMA	35,40	-97,60	Base Line	150	8	0	390	1056	-666	0	141	0,55	0,19	0,37	5	13	0	5
					2050	185	11	0	381	1325	-944	0	141	0,4	0,15	0,29	3	14	0	6
					2070	197	3	2	832	1443	-628	17	141	1,11	0,33	0,58	3	10	0	5
32	USA	SALT LAKE CITY	40,80	-111,90	Base Line	94	8	3	329	962	-654	21	146	3,33	0,27	0,34	7	12	0	3
					2050	130	8	3	333	1251	-939	21	146	2,75	0,19	0,27	5	12	0	4
					2070	145	5	5	590	1378	-1010	222	146	13,08	0,09	0,43	5	10	0	5
33	USA	DENVER	39,80	-105,00	Base Line	93	9	3	218	920	-720	18	141	2,06	0,21	0,24	6	13	0	4
					2050	132	9	3	209	1164	-965	10	141	1,48	0,16	0,18	5	13	0	5
					2070	149	7	3	409	1277	-897	29	141	2,32	0,18	0,32	5	10	0	5
34	VEN	MERIDA	8,60	-71,20	Base Line	4	3	8	1287	1005	-169	451	157	0,51	1,27	1,28	0	10	0	2
					2050	35	3	7	1248	1225	-257	280	157	0,41	1,03	1,02	0	10	0	4
					2070	65	3	6	1241	1322	-310	229	157	0,36	0,95	0,94	0	10	0	4
35	USA	LOS ANGELES	33,93	-118,40	Base Line	118	9	0	237	1307	-1070	0	167	0,64	0	0,18	0	15	0	7
					2050	192	10	0	224	1562	-1338	0	167	0,56	0	0,14	0	16	0	7
					2070	221	9	1	333	1673	-1348	8	167	0,85	0	0,2	0	18	0	7
36	USA	OMAHA	41,36	-96,01	Base Line	98	0	4	616	773	-222	65	125	18,33	0,69	0,8	6	11	0	3
					2050	135	2	4	638	981	-417	74	125	21	0,52	0,65	5	11	0	4
					2070	151	2	6	792	1082	-410	120	125	23,33	0,44	0,73	5	10	0	4

COD	COUNTRY	CITY	LAT	LON	Scenarios	THD	DSL	WSL	AR	AE	AWD	AWS	ASR	Iaw	Ias	Iaa	BRP	PCI	SDD	HCI
37	USA	BOISE	43,59	-116,19	Base Line	105	5	5	714	1005	-583	292	137	9,92	0,25	0,71	6	9	0	4
					2050	140	5	4	736	1294	-859	301	137	8,26	0,17	0,57	5	10	0	4
					2070	152	7	4	345	1420	-1185	110	137	3,68	0,04	0,24	4	10	0	5
38	MEX	CABO SAN LUIS	22,90	-109,90	Base Line	283	10	0	301	1559	-1258	0	184	0,14	0,24	0,19	0	21	89	7
					2050	317	11	0	297	1788	-1491	0	184	0,1	0,19	0,17	0	23	261	7
					2070	328	11	0	287	1887	-1600	0	184	0,08	0,15	0,15	0	24	353	7
39	CAN	IQALUIT	63,75	-68,52	Base Line	0	0	11	431	146	-3	288	77	21	1,21	2,95	12	10	0	0
					2050	0	0	11	515	181	-14	348	77	28,33	1,09	2,85	12	9	0	0
					2070	0	0	11	555	196	-17	376	77	31,33	1,06	2,83	11	9	0	0
40	CAN	HALIFAX	44,88	-63,52	Base Line	19	0	10	1435	534	-16	917	108	142,33	0,97	2,69	8	9	0	2
					2050	53	0	10	1561	668	-55	948	108	156,33	0,86	2,34	6	9	0	2
					2070	69	0	9	1581	728	-91	944	108	163	0,78	2,17	6	9	0	2
41	CAN	ST JOHN	47,62	-52,73	Base Line	3	0	11	1461	434	-20	1047	99	73,67	1,05	3,37	8	9	0	1
					2050	16	0	10	1553	527	-49	1075	99	68,43	0,88	2,95	8	9	0	1
					2070	27	0	9	1568	573	-76	1071	99	71,14	0,78	2,74	7	9	0	2
42	USA	BILLINGS	45,80	-108,53	Base Line	89	7	4	346	807	-506	45	123	8	0,31	0,43	7	11	0	3
					2050	124	7	4	354	1030	-722	46	123	7,43	0,23	0,34	5	11	0	4
					2070	138	5	4	382	1132	-801	51	123	6,5	0,15	0,34	5	11	0	5
43	MEX	CHIHUAHUA	28,65	-106,08	Base Line	205	9	0	392	1567	-1175	0	172	0,1	0,47	0,25	2	17	0	7
					2050	255	11	0	383	1927	-1544	0	172	0,06	0,39	0,2	0	19	0	7
					2070	278	11	0	382	2096	-1714	0	172	0,05	0,35	0,18	0	19	124	7
44	BRA	BELEM	-1,28	-47,92	Base Line	339	0	6	1461	1508	-188	141	166	1,28	0,68	0,97	0	9	635	4
					2050	354	1	4	1553	1786	-339	106	166	1,19	0,58	0,87	0	9	1431	3
					2070	356	1	4	1568	1907	-431	92	166	1,17	0,52	0,82	0	9	1642	3
45	GUY	GEORGETOWN	6,80	-58,15	Base Line	322	0	8	2309	1618	-147	838	179	1,69	1,89	1,43	0	10	211	3
					2050	348	2	5	1873	1898	-436	411	179	1,08	1,4	0,99	0	10	1301	3
					2070	353	3	4	1792	2022	-578	348	179	0,94	1,26	0,89	0	10	1594	3

COD	COUNTRY	CITY	LAT	LON	Scenarios	THD	DSL	WSL	AR	AE	AWD	AWS	ASR	Iaw	Ias	Iaa	BRP	PCI	SDD	HCI
46	TYT	PORT SPAIN	10,70	-61,50	Base Line	338	3	7	1765	1687	-363	441	188	0,79	1,55	1,05	0	10	580	4
					2050	351	4	4	1432	1928	-580	84	188	0,54	1,13	0,74	0	10	1250	4
					2070	354	5	3	1398	2031	-702	69	188	0,46	1,1	0,69	0	11	1434	3
47	BRA	SAO LUIS	-2,60	-44,23	Base Line	336	5	6	1681	1558	-640	763	171	1,3	0,61	1,08	0	14	512	3
					2050	351	6	5	1710	1826	-855	739	171	1,23	0,43	0,94	0	15	1408	3
					2070	355	6	5	1676	1950	-953	679	171	1,18	0,36	0,86	0	15	1648	3
48	CHI	LORD COCHRANE	-47,23	-72,55	Base Line	0	2	6	927	868	-234	293	115	2,65	0,49	1,07	12	9	0	1
					2050	0	4	6	880	981	-349	248	115	2,36	0,38	0,9	9	9	0	2
					2070	0	4	6	870	1033	-397	234	115	2,26	0,34	0,84	9	9	0	2
49	CHI	COYHAIQUE	-45,60	-72,10	Base Line	0	2	6	1074	924	-292	442	114	3,37	0,51	1,16	9	10	0	2
					2050	2	5	6	991	1041	-431	381	114	2,99	0,37	0,95	7	10	0	3
					2070	4	6	6	963	1099	-489	353	114	2,8	0,32	0,88	7	10	0	4
50	ARG	BARILOCHE	-41,20	-71,19	Base Line	9	4	6	763	744	-446	465	137	11,65	0,19	1,03	8	12	0	2
					2050	33	6	5	683	857	-577	403	137	9,86	0,13	0,8	7	12	0	3
					2070	51	6	5	636	914	-645	367	137	9,17	0,12	0,7	7	12	0	3
51	COS	SAN JOSE	9,93	-84,08	Base Line	177	0	12	4215	1095	0	3120	131	3,94	5,63	3,85	0	9	0	3
					2050	254	0	11	4251	1274	-11	2988	131	3,53	4,49	3,34	0	9	0	3
					2070	283	4	7	2011	1360	-431	1082	131	0,3	2,22	1,48	0	13	0	4
52	COL	MANIZALES	5,03	-75,47	Base Line	35	0	11	1892	1111	-20	801	148	1,4	1,04	1,7	0	9	0	3
					2050	98	0	10	1990	1310	-38	718	148	0,93	1,34	1,52	0	9	0	3
					2070	136	0	10	2075	1403	-50	722	148	0,9	1,4	1,48	0	9	0	3
53	VEN	MARACAY	10,23	-67,59	Base Line	338	6	3	944	1589	-713	68	179	0,08	1,17	0,59	0	14	715	5
					2050	353	6	0	809	1881	-1072	0	179	0,05	0,87	0,43	0	14	1341	5
					2070	356	7	0	757	2008	-1251	0	179	0,05	0,75	0,38	0	14	1534	5
54	COL	BARRANQUILLA	11,00	-74,78	Base Line	347	6	2	776	1769	-1058	65	194	0,06	0,48	0,44	0	15	1026	4
					2050	355	8	1	729	2051	-1340	18	194	0,07	0,36	0,36	0	15	1594	3
					2070	357	9	1	725	2182	-1472	15	194	0,06	0,32	0,33	0	15	1798	3

COD	COUNTRY	CITY	LAT	LON	Scenarios	THD	DSL	WSL	AR	AE	AWD	AWS	ASR	Iaw	Ias	Iaa	BRP	PCI	SDD	HCI
55	BRA	ARARANGUA	-28,88	-49,51	Base Line	156	0	10	1293	1111	-64	246	135	1,49	1,02	1,16	0	9	0	4
					2050	204	0	10	1449	1253	-65	261	135	1,46	0,97	1,16	0	9	0	4
					2070	225	0	9	1530	1325	-68	273	135	1,5	0,96	1,15	0	9	210	4
56	ARG	USHUAIA	-54,80	-68,30	Base Line	0	0	7	589	398	-58	249	87	10,36	0,77	1,48	12	8	0	1
					2050	0	0	7	610	431	-78	257	87	10,4	0,72	1,42	12	8	0	1
					2070	0	0	7	623	451	-90	262	87	9,41	0,68	1,38	12	8	0	1
57	BRA	RIO DE JANEIRO	-22,96	-43,23	Base Line	237	0	8	1423	1243	-76	256	141	0,74	1,35	1,14	0	9	0	5
					2050	288	0	6	1421	1421	-147	147	141	0,64	1,19	1	0	9	429	4
					2070	307	1	5	1406	1508	-187	85	141	0,61	1,11	0,93	0	9	786	4
58	ARG	RIO GALLEGOS	-51,66	-69,26	Base Line	1	7	4	240	593	-398	45	104	2,94	0,28	0,4	8	9	0	2
					2050	4	7	4	234	654	-463	43	104	2,68	0,24	0,36	7	9	0	3
					2070	7	7	4	235	686	-495	44	104	2,65	0,22	0,34	7	9	0	3
59	USA	SAN FRANCISCO	37,76	-122,43	Base Line	12	7	2	266	1097	-846	15	156	1,02	0	0,24	1	15	0	5
					2050	47	9	1	252	1296	-1057	13	156	0,91	0	0,19	0	15	0	6
					2070	68	7	5	666	1389	-969	246	156	2,35	0,02	0,48	0	16	0	6
60	ARG	BUENOS AIRES	-34,51	-58,48	Base Line	115	0	7	1033	1128	-194	99	146	1,33	0,68	0,92	1	9	0	5
					2050	145	0	6	1078	1282	-290	86	146	1,23	0,63	0,84	0	9	130	6
					2070	160	0	5	1111	1361	-342	92	146	1,2	0,63	0,82	0	9	334	6
61	CHI	LA SERENA	-29,92	-71,25	Base Line	19	12	0	84	1097	-1013	0	132	0,36	0	0,08	0	21	0	4
					2050	51	12	0	72	1275	-1203	0	132	0,26	0	0,06	0	21	0	4
					2070	73	12	0	68	1359	-1291	0	132	0,24	0	0,05	0	21	0	4
62	BRA	FORTALEZA	-3,76	-38,55	Base Line	320	6	5	1434	1678	-779	535	187	0,57	0,75	0,85	0	15	151	5
					2050	343	6	4	1467	1934	-973	506	187	0,42	0,75	0,76	0	16	1261	4
					2070	349	6	4	1457	2050	-1048	455	187	0,38	0,73	0,71	0	16	1517	4
63	CHI	PUNTA ARENAS	-53,00	-70,85	Base Line	0	0	7	1076	773	-72	375	81	3,38	0,82	1,39	11	9	0	1
					2050	0	0	7	1110	847	-110	373	81	3,2	0,75	1,31	9	9	0	2
					2070	0	0	7	1140	883	-131	388	81	3,19	0,71	1,29	9	9	0	2

COD	COUNTRY	CITY	LAT	LON	Scenarios	THD	DSL	WSL	AR	AE	AWD	AWS	ASR	Iaw	Ias	Iaa	BRP	PCI	SDD	HCI
64	PAN	PANAMA	9,05	-79,37	Base Line	337	3	7	1803	1403	-423	823	152	0,38	1,78	1,29	0	12	669	3
					2050	351	3	8	1956	1625	-496	827	152	0,43	1,63	1,2	0	12	1401	2
					2070	354	3	8	1994	1721	-531	804	152	0,42	1,55	1,16	0	12	1593	2
65	NIC	MANAGUA	12,15	-86,28	Base Line	345	6	4	1128	1509	-738	357	165	0,03	1,16	0,75	0	17	942	5
					2050	355	6	3	1085	1772	-951	264	165	0,03	0,82	0,61	0	18	1494	5
					2070	357	7	2	1064	1894	-1059	229	165	0,03	0,7	0,56	0	18	1677	4
66	ARG	COMODORO RIVADAVIA	-45,80	-67,50	Base Line	39	8	3	222	1024	-814	12	128	0,91	0,09	0,22	5	9	0	5
					2050	71	9	1	208	1163	-962	7	128	0,79	0,07	0,18	5	10	0	6
					2070	87	9	1	203	1231	-1032	4	128	0,73	0,06	0,16	3	9	0	6
67	USA	ANCHORAGE	61,25	-149,80	Base Line	1	0	10	723	393	-29	359	83	44,67	1,11	1,84	9	9	0	1
					2050	8	0	10	804	493	-66	377	83	51	0,97	1,63	7	9	0	2
					2070	17	2	7	534	539	-259	254	83	38,67	0,5	0,99	7	10	0	2
68	CAN	QUEBEC	46,80	-71,38	Base Line	32	0	12	1127	511	0	616	105	88,33	1,12	2,21	7	9	0	2
					2050	70	0	8	1252	648	-28	632	105	105	0,93	1,93	7	8	0	3
					2070	89	0	8	1275	715	-72	632	105	109	0,85	1,78	6	8	0	3
69	CUB	LA HABANA	23,04	-82,41	Base Line	300	3	5	1469	1562	-359	266	178	0,52	1,28	0,94	0	11	0	5
					2050	330	4	3	1397	1806	-536	127	178	0,49	0,92	0,77	0	11	178	4
					2070	338	4	2	1365	1908	-652	109	178	0,47	0,79	0,72	0	11	388	4
70	CAN	TORONTO	43,67	-79,40	Base Line	51	0	7	790	644	-164	310	112	43,5	0,62	1,23	7	8	0	3
					2050	94	2	7	853	820	-307	340	112	41	0,48	1,04	6	8	0	3
					2070	112	3	7	863	902	-389	350	112	43	0,42	0,96	5	8	0	3
71	PAR	ASUNCION	-25,27	-57,63	Base Line	269	0	7	1420	1360	-92	152	155	0,8	1	1,04	0	9	993	7
					2050	312	1	3	1434	1634	-283	83	155	0,62	0,85	0,88	0	9	1577	6
					2070	326	2	2	1488	1762	-353	79	155	0,56	0,84	0,84	0	10	1795	6
72	CHI	CHILLAN	-36,62	-72,09	Base Line	91	6	5	1054	1267	-757	544	140	4	0,12	0,83	3	14	0	5
					2050	129	7	4	890	1459	-998	429	140	3,23	0,08	0,61	3	15	25	5
					2070	147	7	4	789	1555	-1117	351	140	2,76	0,07	0,51	1	15	193	5

COD	COUNTRY	CITY	LAT	LON	Scenarios	THD	DSL	WSL	AR	AE	AWD	AWS	ASR	Iaw	Ias	Iaa	BRP	PCI	SDD	HCI
73	PER	IQUITOS	-3,75	-73,25	Base Line	342	0	12	2845	1322	0	1523	143	1,76	2,28	2,15	0	9	1040	4
					2050	355	0	12	2887	1602	0	1285	143	1,54	1,97	1,8	0	9	1657	3
					2070	358	0	12	2890	1738	0	1152	143	1,43	1,84	1,66	0	9	1883	3
74	USA	DALLAS	32,85	-96,85	Base Line	176	7	0	494	1156	-662	0	142	0,49	0,31	0,43	3	11	0	6
					2050	209	11	0	479	1438	-959	0	142	0,35	0,24	0,33	1	11	0	6
					2070	223	3	2	869	1554	-699	14	142	1,05	0,27	0,56	0	9	89	5
75	PER	LIMA	-12,05	-77,01	Base Line	115	12	0	17	1418	-1401	0	181	0,03	0	0,01	0	13	0	4
					2050	178	12	0	17	1677	-1660	0	181	0,02	0	0,01	0	13	0	4
					2070	208	12	0	18	1795	-1777	0	181	0,02	0	0,01	0	14	165	4
76	CAN	WINNIPEG	49,90	-97,23	Base Line	40	0	7	519	547	-140	112	109	19,67	0,69	0,95	7	11	0	2
					2050	81	2	6	537	701	-283	119	109	22,33	0,51	0,77	7	10	0	3
					2070	98	2	6	553	769	-344	128	109	24,67	0,45	0,72	6	10	0	3
77	USA	ATLANTA	33,70	-84,40	Base Line	143	0	4	862	1004	-235	93	133	1,67	0,68	0,86	3	9	0	4
					2050	181	1	4	920	1245	-421	96	133	1,64	0,53	0,74	3	9	0	5
					2070	195	0	5	1346	1340	-336	342	133	3,02	0,62	1	3	9	0	5
78	CHI	CHILE CHICO	-46,55	-71,69	Base Line	0	8	4	302	1035	-759	26	124	1,23	0,07	0,29	9	11	0	2
					2050	2	8	2	285	1171	-902	16	124	1,09	0,05	0,24	7	12	0	4
					2070	5	8	1	281	1235	-967	13	124	1,01	0,05	0,23	7	12	0	4
79	CHI	COPIAPO	-27,35	-70,33	Base Line	195	12	0	1	1703	-1702	0	164	0	0	0	0	100	25	7
					2050	259	12	0	1	2017	-2016	0	164	0	0	0	0	100	511	7
					2070	285	12	0	1	2166	-2165	0	164	0	0	0	0	100	795	8
80	BOL	SANTA CRUZ	-17,78	-63,16	Base Line	301	2	3	1181	1342	-273	112	150	0,59	1,23	0,88	0	10	833	7
					2050	338	4	1	1123	1629	-550	44	150	0,46	0,99	0,69	0	10	1536	6
					2070	347	4	1	1094	1769	-702	27	150	0,41	0,91	0,62	0	10	1776	6
81	ARG	CORDOBA	-31,40	-64,12	Base Line	165	5	0	742	1229	-487	0	156	0,19	0,76	0,6	0	12	103	6
					2050	201	5	0	792	1408	-616	0	156	0,17	0,72	0,56	0	12	467	6
					2070	218	6	0	793	1505	-712	0	156	0,18	0,67	0,53	0	12	761	6

COD	COUNTRY	CITY	LAT	LON	Scenarios	THD	DSL	WSL	AR	AE	AWD	AWS	ASR	Iaw	Ias	Iaa	BRP	PCI	SDD	HCI
82	CHI	IQUIQUE	-20,25	-70,08	Base Line	172	12	0	1	1577	-1577	0	145	0	0	0	0	0	0	8
					2050	226	12	0	1	1889	-1889	0	145	0	0	0	1	0	153	7
					2070	281	12	0	1	2016	-2016	0	145	0	0	0	0	0	419	7
83	CHI	SANTIAGO	-33,44	-70,69	Base Line	140	8	4	344	1287	-1003	60	144	1,37	0,02	0,27	3	17	76	4
					2050	178	8	2	293	1503	-1234	24	144	1,04	0,02	0,19	0	17	451	4
					2070	196	8	2	268	1610	-1350	8	144	0,9	0,02	0,17	0	17	621	5
84	USA	LAS VEGAS	36,20	-115,08	Base Line	194	12	0	69	1666	-1597	0	160	0,16	0,03	0,04	3	12	0	6
					2050	223	12	0	67	2089	-2022	0	160	0,13	0,02	0,03	2	12	125	6
					2070	236	12	0	94	2281	-2187	0	160	0,14	0,02	0,04	0	10	186	5
85	MEX	MONTERREY	25,70	-100,30	Base Line	241	9	1	596	1356	-782	22	156	0,24	0,46	0,44	0	13	0	7
					2050	286	10	1	570	1631	-1065	4	156	0,17	0,37	0,35	0	14	109	7
					2070	305	11	1	572	1766	-1201	7	156	0,16	0,33	0,32	0	14	242	7
86	ARG	MENDOZA	-32,88	-68,85	Base Line	151	12	0	220	1297	-1077	0	161	0,14	0,19	0,17	3	11	201	6
					2050	186	12	0	218	1526	-1308	0	161	0,12	0,16	0,14	2	11	611	7
					2070	202	12	0	214	1641	-1427	0	161	0,11	0,15	0,13	1	12	855	7
87	VEN	CARACAS	10,48	-66,86	Base Line	238	5	1	902	1553	-661	10	189	0,25	0,94	0,58	0	11	0	5
					2050	303	7	0	775	1818	-1043	0	189	0,18	0,72	0,43	0	11	0	5
					2070	321	8	0	729	1935	-1206	0	189	0,16	0,63	0,38	0	11	102	5
88	BRA	BRASILIA	-15,80	-47,90	Base Line	242	5	7	1662	1430	-503	735	168	0,08	2,21	1,16	0	13	0	7
					2050	318	5	5	1607	1737	-691	561	168	0,06	1,92	0,93	0	14	109	7
					2070	336	5	5	1604	1883	-793	514	168	0,06	1,82	0,85	0	14	663	6
89	GUA	GUATEMALA	14,63	-90,44	Base Line	171	6	6	1349	1294	-550	605	160	0,05	2,01	1,04	0	16	0	5
					2050	264	6	6	1243	1553	-664	354	160	0,04	1,36	0,8	0	15	0	5
					2070	292	6	5	1219	1664	-715	270	160	0,04	1,15	0,73	0	15	31	5
90	USA	SANTA FE	35,70	-106,00	Base Line	100	9	2	218	1030	-825	13	157	1,35	0,21	0,21	6	13	0	4
					2050	144	9	2	209	1304	-1103	8	157	1	0,16	0,16	5	13	0	5
					2070	162	8	2	335	1433	-1117	19	157	1,46	0,21	0,23	5	11	0	5

COD	COUNTRY	CITY	LAT	LON	Scenarios	THD	DSL	WSL	AR	AE	AWD	AWS	ASR	Iaw	Ias	Iaa	BRP	PCI	SDD	HCI
91	MEX	MEXICO CITY	19,43	-99,13	Base Line	152	7	3	629	1279	-676	26	167	0,08	1,04	0,49	0	15	0	6
					2050	247	7	0	594	1536	-942	0	167	0,06	0,78	0,39	0	15	0	6
					2070	281	7	0	575	1655	-1080	0	167	0,05	0,67	0,35	0	15	90	7
92	PER	AREQUIPA	-16,40	-71,50	Base Line	77	12	0	82	1478	-1396	0	187	0	0,17	0,06	0	29	0	5
					2050	181	12	0	86	1801	-1715	0	187	0	0,15	0,05	0	29	0	7
					2070	229	12	0	88	1946	-1858	0	187	0	0,14	0,05	0	29	0	8
93	ECU	CUENCA	-2,88	-78,98	Base Line	47	3	3	804	1009	-252	47	138	0,39	0,85	0,8	0	10	0	4
					2050	117	3	2	858	1190	-362	30	138	0,38	0,78	0,72	0	10	0	5
					2070	156	3	2	900	1271	-399	28	138	0,4	0,76	0,71	0	10	0	5
94	COL	BOGOTA	4,71	-74,08	Base Line	10	2	4	939	1052	-245	132	154	0,65	0,57	0,89	0	10	0	3
					2050	44	3	4	987	1247	-342	82	154	0,52	0,62	0,79	0	10	0	5
					2070	75	3	4	1021	1339	-379	61	154	0,49	0,63	0,76	0	9	0	5
95	ECU	QUITO	-0,15	-78,48	Base Line	27	2	8	969	916	-169	222	130	0,33	1,19	1,06	0	10	0	3
					2050	84	3	6	992	1076	-221	137	130	0,31	1,07	0,92	0	10	0	4
					2070	120	3	5	1007	1148	-256	115	130	0,31	1,03	0,88	0	10	0	4
96	BOL	LA PAZ	-16,50	-68,13	Base Line	9	8	2	550	1015	-507	42	161	0,11	1,15	0,54	5	14	0	4
					2050	55	8	2	560	1234	-690	16	161	0,08	0,99	0,45	0	14	0	4
					2070	97	8	1	558	1333	-783	8	161	0,07	0,92	0,42	0	14	0	5
97	CAN	REGINA	50,40	-104,57	Base Line	45	2	5	381	564	-258	75	110	16,33	0,49	0,68	7	11	0	3
					2050	83	3	5	397	718	-406	85	110	18	0,37	0,55	7	11	0	3
					2070	99	4	5	409	786	-468	91	110	18,67	0,32	0,52	7	11	0	3
98	ARG	SARMIENTO	-45,58	-69,08	Base Line	37	9	2	141	986	-850	5	131	0,79	0,05	0,14	5	9	0	4
					2050	70	9	2	131	1125	-994	0	131	0,68	0,04	0,12	5	10	0	5
					2070	88	9	0	124	1191	-1067	0	131	0,61	0,03	0,1	5	10	0	6
99	ARG	TUCUMAN	-26,85	-65,10	Base Line	206	5	4	994	1261	-448	181	150	0,17	1,32	0,79	0	14	296	6
					2050	251	6	3	1004	1488	-604	120	150	0,14	1,15	0,67	0	14	1025	7
					2070	267	6	3	1012	1598	-667	81	150	0,13	1,07	0,63	0	14	1328	7

COD	COUNTRY	CITY	LAT	LON	Scenarios	THD	DSL	WSL	AR	AE	AWD	AWS	ASR	Iaw	Ias	Iaa	BRP	PCI	SDD	HCI
100	ARG	CATAMARCA	-28,50	-65,80	Base Line	223	10	0	392	1432	-1040	0	159	0,08	0,44	0,27	0	14	855	7
					2050	257	12	0	391	1677	-1286	0	159	0,06	0,38	0,23	0	15	1410	7
					2070	271	12	0	387	1798	-1411	0	159	0,06	0,35	0,22	0	14	1611	7
101	ARG	SALTA	-24,90	-65,50	Base Line	154	8	2	643	1320	-713	36	173	0,04	1,03	0,49	1	18	0	5
					2050	230	8	1	655	1588	-937	4	173	0,03	0,88	0,41	0	18	210	6
					2070	260	8	0	663	1712	-1049	0	173	0,03	0,82	0,39	0	18	475	6
102	ARG	LA QUIACA	-22,10	-65,60	Base Line	89	9	0	307	1212	-905	0	192	0,01	0,57	0,25	5	19	0	4
					2050	164	11	0	312	1484	-1172	0	192	0,01	0,48	0,21	4	19	0	5
					2070	197	11	0	317	1606	-1289	0	192	0	0,45	0,2	2	19	0	5
103	BOL	COCHABAMBA	-17,38	-66,15	Base Line	188	8	2	508	1200	-723	31	151	0,03	1,05	0,42	0	17	0	6
					2050	285	8	1	512	1459	-953	6	151	0,03	0,89	0,35	0	17	88	7
					2070	316	8	0	510	1580	-1070	0	151	0,02	0,83	0,32	0	18	264	7
104	BOL	ORURO	-18,05	-67,07	Base Line	6	8	1	385	938	-553	0	181	0,11	0,82	0,41	7	16	0	3
					2050	42	10	0	391	1146	-755	0	181	0,08	0,71	0,34	4	17	0	4
					2070	76	10	0	388	1237	-849	0	181	0,07	0,65	0,31	4	17	0	4
105	BRA	NATAL	-5,90	-35,30	Base Line	327	5	5	1237	1707	-752	282	193	1,2	0,34	0,72	0	12	886	5
					2050	344	5	4	1166	1947	-912	131	193	0,89	0,32	0,6	0	12	1372	5
					2070	350	6	4	1133	2063	-1007	77	193	0,77	0,31	0,55	0	12	1548	4
106	BRA	PORTO ALEGRE	-30,00	-51,20	Base Line	154	0	8	1403	1139	-95	359	137	2,24	0,84	1,23	0	8	0	5
					2050	195	0	7	1569	1291	-115	393	137	2,18	0,81	1,22	0	8	174	5
					2070	214	0	7	1662	1368	-136	430	137	2,24	0,8	1,21	0	8	346	5
107	BRA	CUIABA	-15,60	-56,10	Base Line	345	5	6	1289	1453	-456	292	159	0,12	1,53	0,89	0	12	1143	5
					2050	357	5	4	1215	1793	-737	159	159	0,09	1,27	0,68	0	12	1741	5
					2070	359	6	4	1206	1951	-858	113	159	0,08	1,18	0,62	0	13	1988	4
108	BRA	CAMPINAS	-13,97	-43,17	Base Line	330	7	2	744	1647	-933	30	182	0	0,89	0,45	0	15	618	8
					2050	350	7	0	690	1945	-1255	0	182	0	0,77	0,35	0	16	1325	7
					2070	354	7	0	680	2091	-1411	0	182	0	0,7	0,33	0	16	1563	7

COD	COUNTRY	CITY	LAT	LON	Scenarios	THD	DSL	WSL	AR	AE	AWD	AWS	ASR	Iaw	Ias	Iaa	BRP	PCI	SDD	HCI
109	BRA	VITORIA DA CONQUISTA	-14,85	-40,83	Base Line	169	7	2	729	1313	-611	27	161	0,27	0,78	0,56	0	12	0	6
					2050	253	8	0	644	1546	-902	0	161	0,2	0,65	0,42	0	12	0	6
					2070	283	8	0	616	1655	-1039	0	161	0,17	0,59	0,37	0	12	0	5
110	BRA	CURITIBA	-25,40	-49,30	Base Line	89	0	12	1480	1055	0	425	136	1,35	1,53	1,4	0	9	0	4
					2050	150	0	10	1569	1222	-21	368	136	1,23	1,35	1,28	0	9	0	5
					2070	181	0	10	1639	1302	-26	363	136	1,22	1,34	1,26	0	9	0	5
111	CAN	VANCOUVER	49,18	-123,17	Base Line	14	3	7	1173	691	-252	734	108	11,63	0,37	1,7	7	11	0	2
					2050	52	3	6	1220	856	-399	763	108	10,35	0,25	1,43	5	11	0	3
					2070	70	3	6	1242	927	-464	779	108	9,64	0,22	1,34	4	11	0	3
112	CAN	MONTREAL	45,47	-73,75	Base Line	50	0	8	943	587	-81	437	109	71,67	0,81	1,61	7	8	0	3
					2050	92	0	7	1035	746	-184	473	109	84,33	0,65	1,39	6	8	0	3
					2070	110	0	7	1056	821	-249	484	109	88,67	0,58	1,29	5	8	0	3
113	CAN	SASKATOON	52,17	-106,68	Base Line	37	3	5	358	542	-262	78	105	16,67	0,49	0,66	7	11	0	3
					2050	75	5	5	374	686	-400	88	105	18,33	0,38	0,55	7	10	0	3
					2070	91	5	5	387	750	-456	93	105	19	0,34	0,52	7	10	0	3
114	CAN	EDMONTON	53,57	-113,52	Base Line	18	2	5	457	518	-151	90	101	20,33	0,78	0,88	7	12	0	2
					2050	53	1	5	486	648	-262	100	101	22,33	0,61	0,75	7	12	0	3
					2070	72	2	5	494	708	-319	105	101	23	0,55	0,7	7	11	0	3
115	CHI	VALDIVIA	-39,82	-73,23	Base Line	15	2	8	1803	872	-207	1138	103	8,73	0,48	2,07	5	11	0	3
					2050	36	3	6	1569	977	-366	958	103	7,58	0,31	1,61	3	12	0	4
					2070	50	4	6	1441	1029	-438	850	103	6,64	0,27	1,4	3	12	0	4
116	CHI	CONCEPCION	-36,80	-73,10	Base Line	5	6	5	915	971	-516	460	126	3,75	0,16	0,94	3	14	0	3
					2050	19	6	4	775	1093	-687	369	126	3,09	0,1	0,71	0	15	0	3
					2070	31	7	4	683	1158	-773	298	126	2,63	0,08	0,59	0	15	0	3
117	COL	ARAUCA	7,07	-70,73	Base Line	339	4	7	1617	1400	-456	673	152	2,31	0,1	1,15	0	12	1169	4
					2050	354	4	7	1615	1704	-589	500	152	1,97	0,09	0,95	0	12	1795	4
					2070	357	4	6	1611	1848	-675	438	152	1,85	0,08	0,87	0	13	2099	3

COD	COUNTRY	CITY	LAT	LON	Scenarios	THD	DSL	WSL	AR	AE	AWD	AWS	ASR	Iaw	Ias	Iaa	BRP	PCI	SDD	HCI
118	COL	VILLAVICENCIO	4,17	-73,62	Base Line	329	0	11	4543	1287	-47	3303	142	5,08	1,1	3,53	0	10	674	5
					2050	349	0	10	4742	1531	-75	3286	142	4,6	1,06	3,1	0	10	1381	4
					2070	354	0	10	4855	1646	-78	3287	142	4,36	1,07	2,95	0	10	1594	4
119	COL	CALI	3,45	-76,38	Base Line	319	1	5	1105	1223	-266	148	137	0,52	0,72	0,9	0	10	0	5
					2050	344	3	4	1139	1428	-366	77	137	0,66	0,49	0,8	0	9	858	5
					2070	350	2	3	1179	1520	-401	60	137	0,49	0,68	0,78	0	9	1144	5
120	COL	MEDELLIN	6,26	-75,58	Base Line	192	0	9	1769	1217	-80	632	148	0,76	1,39	1,45	0	9	0	4
					2050	271	0	9	1897	1436	-113	574	148	0,79	1,24	1,32	0	9	0	4
					2070	298	0	9	1982	1535	-116	563	148	0,84	1,19	1,29	0	9	0	4
121	CUB	CIENFUEGOS	22,15	-80,40	Base Line	323	6	4	1194	1481	-487	200	166	0,27	1,14	0,81	0	12	143	5
					2050	343	6	3	1136	1713	-662	85	166	0,25	0,82	0,66	0	12	512	4
					2070	348	7	2	1089	1816	-801	74	166	0,25	0,68	0,6	0	12	793	4
122	ECU	GUAYAQUIL	-2,20	-79,90	Base Line	328	8	4	746	1242	-719	223	135	0,02	1,19	0,6	0	21	574	5
					2050	347	8	4	856	1442	-837	251	135	0,03	1,19	0,59	0	21	1302	4
					2070	352	8	4	917	1533	-883	267	135	0,04	1,16	0,6	0	20	1516	4
123	ELS	SAN SALVADOR	13,70	-89,20	Base Line	326	5	6	2077	1469	-523	1131	169	0,1	2,66	1,41	0	14	369	6
					2050	349	4	6	1906	1740	-642	808	169	0,1	1,81	1,1	0	14	983	5
					2070	353	6	6	1642	1861	-778	559	169	0,05	1,46	0,88	0	15	1196	5
124	JAM	KINGSTON	17,90	-76,80	Base Line	329	6	1	838	1626	-850	62	180	0,28	0,44	0,52	0	12	153	5
					2050	347	8	1	784	1864	-1123	43	180	0,24	0,32	0,42	0	13	1042	4
					2070	351	9	1	761	1967	-1233	27	180	0,25	0,28	0,39	0	12	1279	4
125	MEX	ACAPULCO	16,80	-99,90	Base Line	354	7	4	1144	1649	-930	425	180	0,05	1,68	0,69	0	19	1325	5
					2050	358	7	4	1089	1943	-1117	263	180	0,03	1,27	0,56	0	19	1708	4
					2070	359	7	3	1053	2073	-1195	175	180	0,03	1,09	0,51	0	19	1877	4
126	MEX	GUADALAJARA	20,66	-103,38	Base Line	260	8	4	930	1584	-925	271	184	0,11	1,6	0,59	0	19	0	7
					2050	317	8	3	874	1902	-1163	135	184	0,07	1,23	0,46	0	19	126	7
					2070	334	8	3	849	2049	-1284	84	184	0,05	1,09	0,41	0	19	206	7

COD	COUNTRY	CITY	LAT	LON	Scenarios	THD	DSL	WSL	AR	AE	AWD	AWS	ASR	Iaw	Ias	Iaa	BRP	PCI	SDD	HCI
127	MEX	GUANAJUATO	21,00	-101,30	Base Line	210	8	3	672	1506	-874	40	175	0,09	1,05	0,45	0	17	0	8
					2050	284	8	0	642	1802	-1160	0	175	0,06	0,83	0,36	0	17	25	8
					2070	310	8	0	631	1947	-1316	0	175	0,05	0,73	0,32	0	17	126	8
128	PER	CHICLAYO	-6,80	-79,80	Base Line	237	12	0	21	1413	-1392	0	167	0	0,02	0,01	0	21	205	5
					2050	289	12	0	24	1651	-1627	0	167	0	0,02	0,01	0	22	691	5
					2070	308	12	0	25	1755	-1730	0	167	0	0,01	0,01	0	20	840	5
129	PER	PUERTO MALDONADO	-12,63	-69,20	Base Line	338	0	8	2249	1342	-148	1055	148	0,58	2,83	1,68	0	11	905	6
					2050	354	3	6	2164	1629	-304	839	148	0,44	2,38	1,33	0	11	1543	5
					2070	357	3	6	2115	1762	-386	739	148	0,39	2,19	1,2	0	11	1764	5
130	PER	CAJAMARCA	-7,20	-78,50	Base Line	0	3	7	1005	811	-146	340	156	0,33	1,67	1,24	12	11	0	3
					2050	5	3	7	1085	963	-180	302	156	0,35	1,51	1,13	4	11	0	3
					2070	12	3	7	1099	1031	-197	265	156	0,35	1,42	1,07	0	11	0	3
131	PER	CUZCO	-13,55	-71,98	Base Line	8	7	4	688	982	-454	160	154	0,06	1,58	0,7	4	15	0	4
					2050	49	7	4	748	1187	-588	149	154	0,05	1,46	0,63	0	15	0	5
					2070	79	7	4	759	1272	-644	131	154	0,05	1,4	0,6	0	15	0	5
132	USA	NEW ORLEANS	30,06	-89,96	Base Line	190	6	2	704	1163	-507	48	139	0,79	0,42	0,61	0	11	0	5
					2050	226	7	1	665	1389	-754	30	139	0,61	0,33	0,48	0	12	0	5
					2070	242	0	6	1418	1485	-296	229	139	2,03	0,71	0,95	0	9	76	5
133	USA	BOSTON	42,36	-71,03	Base Line	70	0	10	1107	715	-21	413	119	18,42	0,98	1,55	6	9	0	3
					2050	109	0	7	1217	898	-97	416	119	16	0,82	1,36	5	9	0	3
					2070	125	1	7	1230	978	-285	537	119	19,82	0,56	1,26	5	8	0	4
134	USA	PORTLAND	45,60	-122,60	Base Line	52	4	6	956	761	-400	595	113	8,52	0,19	1,26	6	12	0	2
					2050	95	5	6	1000	921	-541	620	113	7,71	0,13	1,09	5	12	0	3
					2070	110	4	6	1118	997	-540	661	113	7,75	0,15	1,12	3	12	0	4
135	USA	CLEVELAND	33,73	-90,73	Base Line	163	5	4	704	1053	-431	82	135	1,28	0,4	0,67	3	11	0	4
					2050	195	6	2	665	1316	-689	38	135	0,96	0,29	0,51	3	12	0	4
					2070	208	3	6	1377	1431	-482	428	135	3,26	0,43	0,96	1	9	0	5

COD	COUNTRY	CITY	LAT	LON	Scenarios	THD	DSL	WSL	AR	AE	AWD	AWS	ASR	Iaw	Ias	Iaa	BRP	PCI	SDD	HCI
136	USA	DETROIT	42,41	-83,01	Base Line	76	0	7	837	707	-160	290	115	27,83	0,68	1,18	6	9	0	3
					2050	117	1	6	896	896	-319	319	115	27,86	0,52	1	5	9	0	4
					2070	133	3	6	884	984	-416	316	115	24,38	0,45	0,9	5	9	0	4
137	USA	CHICAGO	41,98	-87,90	Base Line	81	0	7	838	733	-178	283	121	41,5	0,66	1,14	6	9	0	3
					2050	124	1	6	897	935	-352	314	121	38,8	0,5	0,96	5	9	0	4
					2070	140	2	6	977	1027	-373	323	121	34,2	0,49	0,95	5	9	0	4
138	USA	SAN DIEGO	32,73	-117,16	Base Line	82	9	0	237	1265	-1028	0	165	0,64	0	0,19	0	15	0	7
					2050	152	10	0	224	1502	-1278	0	165	0,56	0	0,15	0	16	0	7
					2070	185	10	0	246	1609	-1363	0	165	0,56	0	0,15	0	16	0	7
139	USA	SEATTLE	47,53	-122,30	Base Line	29	5	6	755	732	-410	433	110	6,44	0,18	1,03	6	12	0	2
					2050	72	5	6	787	902	-556	441	110	5,59	0,12	0,87	5	12	0	3
					2070	90	5	6	1027	977	-551	601	110	6,39	0,15	1,05	3	12	0	4
140	USA	YAKUTAT	59,50	-139,70	Base Line	0	0	12	997	393	0	604	86	44	1,34	2,54	10	9	0	1
					2050	1	0	10	1094	484	-12	622	86	35,43	1,15	2,26	8	9	0	1
					2070	2	0	12	3904	524	0	3380	86	145,43	2,05	7,45	7	9	0	1
141	USA	HOUSTON	29,77	-95,37	Base Line	189	5	1	704	1177	-517	44	139	0,8	0,4	0,6	0	11	0	5
					2050	229	7	1	665	1423	-783	25	139	0,6	0,3	0,47	0	12	0	5
					2070	245	2	2	1073	1526	-493	40	139	1,2	0,54	0,7	0	9	123	5
142	USA	FRESNO	36,79	-119,72	Base Line	176	8	2	237	1428	-1207	16	166	1	0	0,17	3	15	0	5
					2050	205	9	1	224	1774	-1561	11	166	0,87	0	0,13	2	16	51	5
					2070	215	9	2	295	1917	-1642	20	166	1,05	0	0,15	0	15	139	6
143	USA	INDIANAPOLIS	39,70	-86,30	Base Line	102	0	7	849	773	-168	244	120	15	0,67	1,1	5	9	0	3
					2050	143	1	6	907	994	-361	274	120	13,79	0,5	0,91	5	9	0	4
					2070	158	3	6	1099	1090	-380	389	120	17,29	0,5	1,01	5	9	0	4
144	USA	MINNEAPOLIS	44,89	-93,22	Base Line	75	0	7	693	663	-124	154	117	24	0,79	1,05	7	10	0	3
					2050	116	0	6	726	851	-284	159	117	27,67	0,58	0,85	5	10	0	3
					2070	131	1	5	776	938	-337	175	117	28	0,52	0,83	5	10	0	4

COD	COUNTRY	CITY	LAT	LON	Scenarios	THD	DSL	WSL	AR	AE	AWD	AWS	ASR	Iaw	Ias	Iaa	BRP	PCI	SDD	HCI
145	USA	CINCINNATI	39,10	-84,50	Base Line	111	0	6	849	792	-169	226	119	13,75	0,68	1,07	5	9	0	4
					2050	150	1	6	907	1008	-354	253	119	12,87	0,51	0,9	5	9	0	4
					2070	165	3	6	1113	1104	-379	388	119	15,75	0,49	1,01	4	9	0	4
146	USA	KANSAS CITY	39,30	-94,70	Base Line	115	0	4	663	852	-250	61	128	9	0,71	0,78	5	11	0	4
					2050	153	2	4	687	1082	-461	66	128	8	0,53	0,63	5	10	0	4
					2070	167	1	6	990	1184	-342	148	128	12,78	0,52	0,84	4	10	0	4
147	USA	SPOKANE	47,64	-117,54	Base Line	65	4	6	773	753	-378	398	119	52,4	0,34	1,03	7	9	0	3
					2050	102	4	6	805	948	-567	424	119	41,14	0,23	0,85	6	10	0	4
					2070	114	6	5	463	1035	-803	231	119	25,14	0,09	0,45	5	10	0	4
148	USA	ALBUQUERQUE	35,10	-106,60	Base Line	148	10	1	227	1262	-1035	0	160	0,48	0,21	0,18	5	13	0	5
					2050	185	11	0	216	1601	-1385	0	160	0,34	0,16	0,13	4	14	0	5
					2070	199	10	0	206	1755	-1549	0	160	0,31	0,11	0,12	3	11	0	6
149	VEN	BARCELONA	10,10	-64,70	Base Line	344	8	0	628	1779	-1151	0	198	0,09	0,75	0,35	0	14	988	5
					2050	355	9	0	545	2086	-1541	0	198	0,07	0,57	0,26	0	14	1519	4
					2070	357	10	0	512	2221	-1709	0	198	0,06	0,5	0,23	0	14	1706	4
150	VEN	MARACAIBO	10,65	-71,60	Base Line	349	10	0	394	1640	-1246	0	177	0,03	0,29	0,24	0	15	1150	5
					2050	357	11	0	348	1955	-1607	0	177	0,03	0,2	0,18	0	15	1747	4
					2070	359	12	0	332	2099	-1767	0	177	0,02	0,18	0,16	0	15	2028	4
151	BEL	BELICE	17,49	-88,19	Base Line	313	2	8	1994	1489	-275	780	166	1,13	1,69	1,34	0	10	31	4
					2050	340	3	7	1851	1738	-403	516	166	1	1,11	1,07	0	11	439	4
					2070	347	4	6	1766	1847	-499	418	166	0,91	0,92	0,96	0	11	779	4
152	CAN	WHITEHORSE	60,72	-135,06	Base Line	3	3	7	272	385	-223	110	90	18,33	0,38	0,71	9	10	0	1
					2050	20	4	7	312	485	-298	125	90	20,67	0,35	0,64	9	10	0	2
					2070	32	4	7	331	529	-331	133	90	22,67	0,34	0,63	7	10	0	2

ANNEX III

TABLES OF SENSITIVITY INDEX, ADAPTIVE CAPACITY INDEX, VULNERABILITY INDEX, EXPOSURE INDEX AND AGRICULTURAL IMPACT INDEX.

Table A3. Criteria for determining the Sensitivity Index.
Source: Prepared based on the information from CEPALSTAT, AQUASTAT, THE WORLD BANK and AGRIMED.

Country	Percentage of rural population in poverty (R_{POV})	Percentage of the population that lives in rural areas (RU)	Gross Domestic Product per person in US dollars (GDP)	Concentration Index of the GINI (GINI)	Actual irrigated agricultural area to total agricultural area (IR_L)	Variation in crop yields between the baseline and the 2070 scenario (δP)	Sensitivity Index
Anguilla	...	...	...	...	...	...	...
Antigua and Barbuda	...	76,2	13330,3	...	7,7	-0,219	...
Argentina	25,0	8,2	12240,3	0,423	5,3	-0,150	0,299
Aruba	...	58,5	25353,8	...	...	...	...
Barbados	...	68,5	15870,9	...	45,3	-0,151	...
Belize	...	56,0	4420,7	0,533	3,2	-0,186	...
Bermuda	...	...	85748,1	...	...	...	...
Bolivia	54,1	30,9	2315,3	0,491	6,4	-0,252	0,516
Bonaire	...	25,3	...	...	...	-0,053	...
Brazil	28,7	14,3	11669,1	0,548	5,4	-0,275	0,468
British Virgin Islands	...	53,8	...	...	...	...	...
Cayman Islands	...	...	64104,8	...	...	...	...
Chile	6,7	11,1	14406,5	0,509	61,9	0,008	0,142
Colombia	41,5	20,6	7306,9	0,535	18,9	-0,178	0,434
Costa Rica	22,0	23,4	8954,1	0,505	18,4	-0,150	0,362
Cuba	...	23,0	6214,2	...	13,7	-0,227	...
Curazao	...	10,7	...	...	...	-0,077	...
Dominica	...	30,5	7045,1	...	...	-0,121	...
Dominican Republic	43,6	21,2	6119,3	0,519	18,0	-0,205	0,445
Ecuador	27,3	35,6	5402,3	0,452	35,5	-0,074	0,295
El Salvador	49,3	31,0	3692,2	0,436	2,2	-0,144	0,422
Falkland Islands	...	...	...	...	...	...	...
French Guiana	...	...	...	...	...	-0,086	...
Grenada	...	64,4	7810,9	...	2,0	-0,129	...

Country	Percentage of rural population in poverty (R_{POV})	Percentage of the population that lives in rural areas (RU)	Gross Domestic Product per person in US dollars (GDP)	Concentration Index of the GINI (GINI)	Actual irrigated agricultural area to total agricultural area (IR_L)	Variation in crop yields between the baseline and the 2070 scenario (δP)	Sensitivity Index
Guadeloupe	…	1,6	…	…	12,7	-0,149	…
Guatemala	77,2	44,0	2984,7	0,553	15,3	-0,184	0,584
Guyana	…	71,4	3571,4	0,446	28,5	-0,274	…
Haiti	…	48,0	735,3	0,608	5,9	-0,224	…
Honduras	81,8	46,4	2278,3	0,564	5,5	-0,228	0,646
Jamaica	…	45,2	4861,4	0,455	14,3	-0,217	…
Martinique	…	11,1	…	…	25,5	-0,116	…
Mexico	44,7	22,7	9568,0	0,491	22,6	-0,219	0,420
Montserrat	…	91,0	…	…	…	…	…
Nicaragua	…	42,4	1775,2	0,478	8,1	-0,177	…
Panama	40,9	33,4	10326,8	0,519	4,3	-0,201	0,478
Paraguay	50,9	33,6	3764,0	0,536	3,0	-0,352	0,597
Peru	46,0	21,3	5828,1	0,439	32,7	-0,052	0,293
Puerto Rico	…	6,4	28681,7	…	18,9	-0,189	…
Saint Kitts and Nevis	…	68,0	14320,0	…	…	-0,254	…
Saint Lucia	…	81,5	6819,6	0,426	…	-0,181	…
Saint Vincent and the Grenadines	…	49,5	6435,4	…	0,0	-0,121	…
Suriname	…	34,0	9223,0	0,576	86,4	-0,276	…
The Bahamas	…	17,1	21457,9	…	…	…	…
Trinidad and Tobago	…	91,6	16723,8	…	10,6	-0,091	…
Turks and Caicos Islands	…	7,8	…	…	…	…	…
United States Virgin Islands	…	4,7	18728,2	…	…	-0,164	…
Uruguay	2,3	4,7	13929,1	0,379	8,5	-0,027	0,146
Venezuela	42,0	10,5	8503,8	0,407	28,8	-0,289	0,353

Table A4. Criteria for determining the Adaptive Capacity Index.
Source: Prepared based on information from CEPALSTAT, UNDP and THE WORLD BANK.

Country	Gross Domestic Product per person in US dollars (GDP)	Human Development Index (HDI)	Social public expenditure per capita (SE)	Expenditure on R & D as a percentage of GDP (RD_E)	Number of full-time researchers per million people (RES)	Adaptive Capacity Index
Anguilla	…	0,660	…	…	…	…
Antigua and Barbuda	13330,3	0,783	…	…	…	…
Argentina	12240,3	0,836	1868,2	0,58	1226,0	0,710
Aruba	25353,8	0,660	…	…	…	…
Barbados	15870,9	0,785	…	…	…	…
Belize	4420,7	0,715	…	…	…	…
Bermuda	85748,1	0,660	…	0,23	…	…
Bolivia	2315,3	0,662	144,2	0,16	166,0	0,150
Bonaire	…	0,660	…	…	…	…
Brazil	11669,1	0,755	1402,2	1,15	698,0	0,629
British Virgin Islands	…	0,660	…	…	…	…
Cayman Islands	64104,8	0,660	…	…	…	…
Chile	14406,5	0,832	1430,8	0,36	391,0	0,494
Colombia	7306,9	0,720	599,5	0,23	164,0	0,259
Costa Rica	8954,1	0,766	1325,3	0,47	1327,0	0,595
Cuba	6214,2	0,769	1842,2	0,47	…	…
Curazao	…	0,660	…	…	…	…
Dominica	7045,1	0,724	…	…	…	…
Dominican Republic	6119,3	0,715	344,5	…	…	…
Ecuador	5402,3	0,732	297,0	0,34	180,0	0,249
El Salvador	3692,2	0,666	443,5	0,03	…	…
Falkland Islands	…	…	…	…	…	…
French Guiana	…	…	…	…	…	…
Grenada	7810,9	0,750	…	…	…	…
Guadeloupe	…	0,660	…	…	…	…

Country	Gross Domestic Product per person in US dollars (GDP)	Human Development Index (HDI)	Social public expenditure per capita (SE)	Expenditure on R & D as a percentage of GDP (RD_E)	Number of full-time researchers per million people (RES)	Adaptive Capacity Index
Guatemala	2984,7	0,627	179,0	0,04	27,0	0,093
Guyana	3571,4	0,636	…	…	…	…
Haiti	735,3	0,483	…	…	…	…
Honduras	2278,3	0,606	184,0	…	…	…
Jamaica	4861,4	0,719	388,1	…	…	…
Martinique	…	0,660	…	…	…	…
Mexico	9568,0	0,756	904,8	0,50	383,0	0,402
Montserrat	…	0,660	…	…	…	
Nicaragua	1775,2	0,631	157,0	0,04	71,0	0,096
Panama	10326,8	0,780	488,6	0,18	119,0	0,272
Paraguay	3764,0	0,679	305,4	0,09	169,0	0,169
Peru	5828,1	0,734	375,5	0,10	180,0	0,217
Puerto Rico	28681,7	0,660	…	0,44	260,0	…
Saint Kitts and Nevis	14320,0	0,752	…	…	…	…
Saint Lucia	6819,6	0,729	…	…	…	…
Saint Vincent and the Grenadines	6435,4	0,720	…	…	…	…
Suriname	9223,0	0,714	…	…	…	…
The Bahamas	21457,9	0,790	…	…	…	…
Trinidad and Tobago	16723,8	0,772	1810,0	0,05	…	…
Turks and Caicos Islands	…	0,660	…	…	…	…
United States Virgin Islands	18728,2	0,660	…	…	…	…
Uruguay	13929,1	0,793	1752,0	0,23	529,0	0,506
Venezuela	8503,8	0,762	1355,9	0,22	291,0	0,391

Table A5. Criteria for determining the Vulnerability Index.
Source: Self prepared.

Country	Sensitivity Index	Adaptive Capacity Index	Vulnerability Index
Anguilla	…	…	…
Antigua and Barbuda	…	0,200	…
Argentina	0,299	0,710	0,295
Aruba	…	0,158	…
Barbados	…	0,207	…
Belize	…	0,140	…
Bermuda	…	0,336	…
Bolivia	0,516	0,150	0,683
Bonaire	…	…	…
Brazil	0,468	0,629	0,419
British Virgin Islands	…	…	…
Cayman Islands	…	0,249	…
Chile	0,142	0,494	0,324
Colombia	0,434	0,259	0,588
Costa Rica	0,362	0,595	0,383
Cuba	…	0,450	…
Curazao	…	…	…
Dominica	…	0,151	…
Dominican Republic	0,445	0,167	0,639
Ecuador	0,295	0,249	0,523
El Salvador	0,422	0,145	0,638
Falkland Islands	…	…	…
French Guiana	…	…	…
Grenada	…	0,168	…
Guadeloupe	…	…	…
Guatemala	0,584	0,093	0,745
Guyana	…	0,093	…
Haiti	…	0,000	…
Honduras	0,646	0,078	0,784
Jamaica	…	0,172	…
Martinique	…	…	…
Mexico	0,420	0,402	0,509
Montserrat	…	…	…
Nicaragua	…	0,096	…
Panama	0,478	0,272	0,603
Paraguay	0,597	0,169	0,714
Peru	0,293	0,217	0,538

Country	Sensitivity Index	Adaptive Capacity Index	Vulnerability Index
Puerto Rico	…	0,275	…
Saint Kitts and Nevis	…	0,184	…
Saint Lucia	…	0,154	…
Saint Vincent and the Grena-dines	…	0,148	…
Suriname	…	0,151	…
The Bahamas	…	0,223	…
Trinidad and Tobago	…	0,398	…
Turks and Caicos Islands	…	…	…
United States Virgin Islands	…	0,143	…
Uruguay	0,146	0,506	0,320
Venezuela	0,353	0,391	0,481

Table A6. Criteria for determining the Exposure Index.
Source: Prepared based on information from FAOSTAT and CEPALSTAT.

Country	National cultivated area (CL)	Number of people living in rural areas (R_{POP})	Exposure Index
Anguilla	...	...	...
Antigua and Barbuda	5000	69993	0,267
Argentina	40699000	2516400	58,381
Aruba	2000	60746	0,209
Barbados	12000	196997	0,754
Belize	110000	194749	1,632
Bermuda	300	...	...
Bolivia	4670000	3410500	53,555
Bonaire	...	5025	...
Brazil	82808100	27857000	100,000
British Virgin Islands	2000	15499	0,058
Cayman Islands	700	...	...
Chile	1766000	2092100	22,920
Colombia	3448000	9907800	64,175
Costa Rica	552000	1547900	10,137
Cuba	3576900	2419200	40,373
Curazao	...	17546	...
Dominica	23000	22139	0,270
Dominican Republic	1155000	3033300	20,537
Ecuador	2663000	5381600	41,992
El Salvador	945000	2390900	16,498
Falkland Islands	...	...	...
French Guiana	17600	...	...
Grenada	10000	68721	0,308
Guadeloupe	24200	7396	0,232
Guatemala	2035700	5871300	37,957
Guyana	448000	577018	5,960
Haiti	1350000	5057300	29,047
Honduras	1475000	3923500	26,396
Jamaica	215000	1271950	6,172
Martinique	19600	45092	0,316
Mexico	25668000	25136000	100,000
Montserrat	2000	4708	0,022
Nicaragua	1790000	2517200	24,554
Panama	748000	1151700	10,587
Paraguay	4585000	2509300	49,782
Peru	5534000	8105000	77,013

Country	National cultivated area (CL)	Number of people living in rural areas (R_{POP})	Exposure Index
Puerto Rico	111000	235521	1,777
Saint Kitts and Nevis	5100	37630	0,160
Saint Lucia	10000	150716	0,581
Saint Vincent and the Grena-dines	8000	54085	0,241
Suriname	66000	186236	1,206
The Bahamas	12000	66370	0,318
Trinidad and Tobago	47000	1232970	4,524
Turks and Caicos Islands	1000	2683	0,006
United States Virgin Islands	2000	4987	0,023
Uruguay	2363000	246750	22,162
Venezuela	3400000	1870400	36,945

Table A7. Criteria for determining the Agricultural Impact Index.
Source: Self prepared.

Country	Vulnerability Index	Exposure Index	Potential Agricultural Impact Index
Anguilla	…	…	…
Antigua and Barbuda	…	0,267	…
Argentina	0,295	58,381	17,196
Aruba	…	0,209	…
Barbados	…	0,754	…
Belize	…	1,632	…
Bermuda	…	…	…
Bolivia	0,683	53,555	36,579
Bonaire	…	…	…
Brazil	0,419	100,000	41,933
British Virgin Islands	…	0,058	…
Cayman Islands	…	…	…
Chile	0,324	22,920	7,422
Colombia	0,588	64,175	37,704
Costa Rica	0,383	10,137	3,885
Cuba	…	40,373	…
Curazao	…	…	…
Dominica	…	0,270	…
Dominican Republic	0,639	20,537	13,117
Ecuador	0,523	41,992	21,975
El Salvador	0,638	16,498	10,528
Falkland Islands	…	…	…
French Guiana	…	…	…
Grenada	…	0,308	…
Guadeloupe	…	0,232	…
Guatemala	0,745	37,957	28,297
Guyana	…	5,960	…
Haiti	…	29,047	…
Honduras	0,784	26,396	20,702
Jamaica	…	6,172	…
Martinique	…	0,316	…
Mexico	0,509	100,000	50,889
Montserrat	…	0,022	…
Nicaragua	…	24,554	…
Panama	0,603	10,587	6,386
Paraguay	0,714	49,782	35,539
Peru	0,538	77,013	41,437

Country	Vulnerability Index	Exposure Index	Potential Agricultural Impact Index
Puerto Rico	…	1,777	…
Saint Kitts and Nevis	…	0,160	…
Saint Lucia	…	0,581	…
Saint Vincent and the Grenadines	…	0,241	…
Suriname	…	1,206	…
The Bahamas	…	0,318	…
Trinidad and Tobago	…	4,524	…
Turks and Caicos Islands	…	0,006	…
United States Virgin Islands	…	0,023	…
Uruguay	0,320	22,162	7,092
Venezuela	0,481	36,945	17,770

Table A8: Minimum and maximum values used for the standardization of indicators that make up the Sensitivity Index.

	R_{POV}	RU	GDP	GINI	IR_L	δP
Maximum value	81,8	91,6	85748,1	0,608	86,4	0,008
Minimum value	2,3	1,6	735,3	0,379	0,0	-0,352

Table A9: Minimum and maximum values used for the standardization of the indicators that make up the Adaptation Capacity Index.

	GDP	HDI	S_E	RD_E	RES	δP
Maximum value	85748,1	0,836	1868,2	1,15	1327	0,008
Minimum value	735,3	0,483	144,2	0,03	27	-0,352

Table A10: Minimum and maximum values used for the standardization of the indicators that make up the Exposure Index.

	C_L	R_{POP}
Maximum value	5534000*	15000000**
Minimum value	300	2683

* Brazil, Argentina and Mexico were not considered in the CL indicator because the results were significantly out of range.
** Brasil and Mexico were not considered in defining the maximum value in the RPOP indicator because the results were significantly out of range.

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