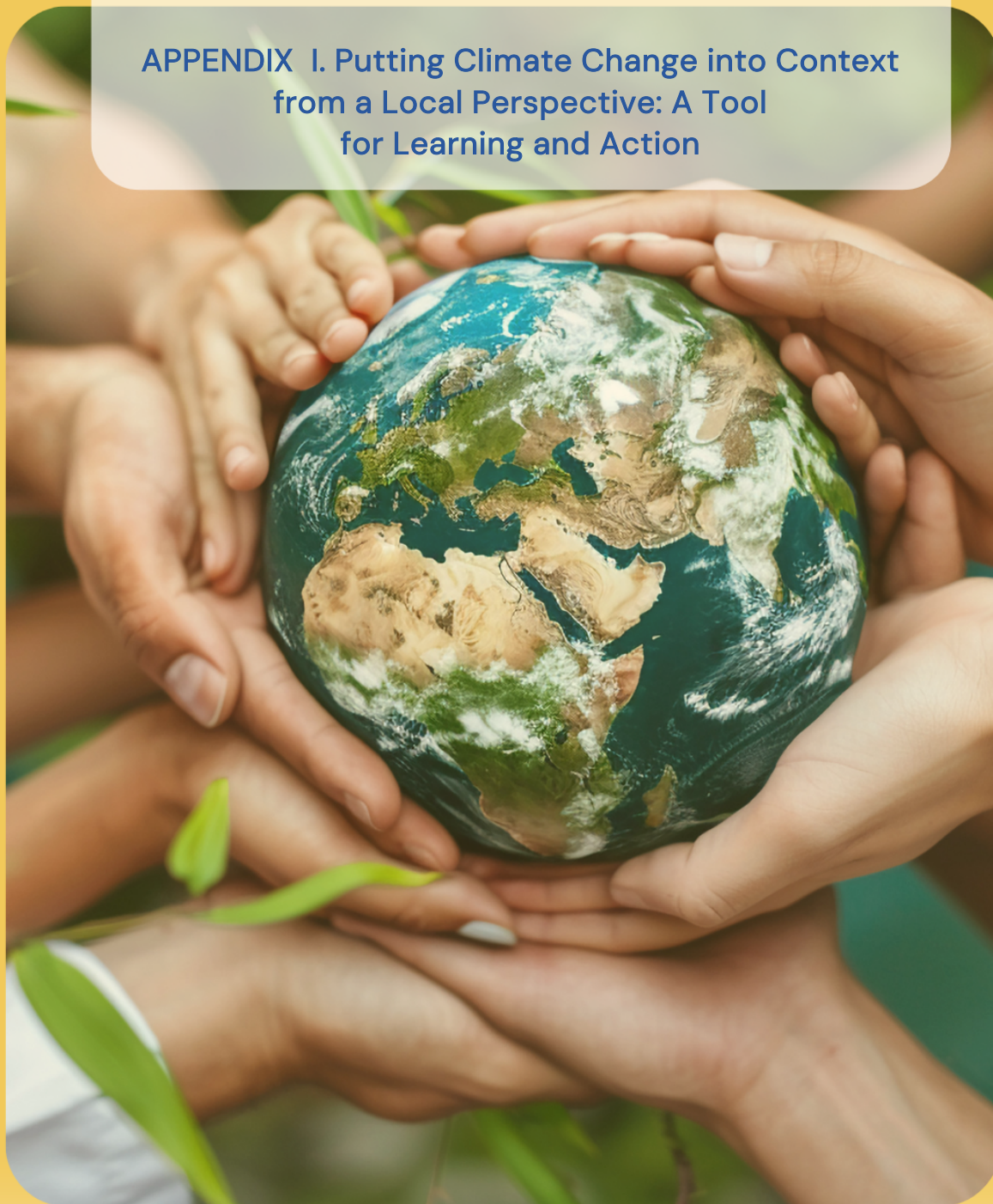


# PRACTICAL METHODOLOGICAL GUIDE

## APPENDIX I. Putting Climate Change into Context from a Local Perspective: A Tool for Learning and Action



**“UN SOLO PLANETA PARA TODAS LAS PERSONAS”**



## Appendix I. Putting Climate Change into Context at the Local Level: A Tool for Learning and Action

One of the methodological principles of No Filter Climate is to connect climate change to students' everyday lives. This phenomenon is often perceived as a distant, abstract problem or one associated exclusively with remote locations and future scenarios. However, understanding how the climate is changing in their own municipality is key to fostering greater environmental awareness, strengthening trust in scientific evidence, and promoting informed civic participation.

For this reason, the project included a specific analysis of the climatic and environmental context of Andalusia, supplemented with information tailored to each of the participating municipalities. This approach shifted the discussion from broad global figures to the students' immediate reality, helping them understand that the effects of climate change are already present in their environment and directly impact aspects such as water availability, heat waves, biodiversity, and the quality of life in their communities.

The information used was compiled from scientific sources and official agencies, combining historical and current data from the State Meteorological Agency (AEMET), regionalized projections from MapaClima, the Andalusian Climate Change Portal, the Andalusian Environmental Information Network (REDIAM), and scientific evidence synthesized by the Intergovernmental Panel on Climate Change (IPCC). Furthermore, to contextualize environmental challenges and potential responses, reference documents prepared by international organizations such as the United Nations Environment Programme (UNEP), the Food and Agriculture Organization of the United Nations (FAO), the International Energy Agency (IEA), and the Intergovernmental Science-Policy Platform on Biodiversity and Ecosystem Services (IPBES) were consulted. These sources provided rigorous, up-to-date information tailored to both the regional and local levels.

All of this information was used primarily for educational purposes. During the sessions, students analyzed historical temperature and precipitation data series, identified trends in indicators such as extreme heat days and tropical nights, interpreted climate projections, and compared their own perceptions with scientific data. This work formed the basis of the Climate Mini-Lab, where groups developed skills in data interpretation, critical thinking, and scientific literacy, learning to distinguish between evidence and opinions and to identify misinformation narratives about climate change.

In addition, knowledge of the local context served as the foundation for the deliberative spaces developed throughout the project. The proposals developed by the students for intergenerational meetings, awareness campaigns, and dialogues with city councils were based on needs identified through the analysis of local data, ensuring that the proposed measures addressed real issues in each municipality. In this way, scientific knowledge ceased to be perceived as purely academic content and became a useful tool for understanding the environment, combating misinformation, and promoting informed, participatory climate action tailored to the characteristics of each region.

### **Climate and Environmental Context of Andalusia. Climate Change in Andalusia. Mitigation and Adaptation Strategies.**

Andalusia is characterized by great climatic and geographic diversity, ranging from areas with an oceanic Mediterranean climate to subtropical and mountainous Mediterranean zones. This variety is due to its strategic geographic location—straddling two seas and two continents—and its complex topography, which gives rise to multiple internal climate regions with distinct patterns of temperature, precipitation, and humidity.

An analysis of the climate regions defined by the Regional Government of Andalusia reveals the following:

- **Atlantic Coast and Guadalquivir Basin:** an oceanic and continental Mediterranean climate with average annual temperatures between 17°C and 19°C and annual precipitation of 500–700 mm.
- **Mediterranean Coast and Southeastern Sub-Desert:** subtropical Mediterranean influences with dry summers and precipitation of less than 300 mm.
- **Inland Mountains and Ranges (Sierra Morena, Sierras Béticas):** mountain climates with greater temperature variations, more regular precipitation, and seasonal frost days.

These conditions give rise to distinct climate patterns throughout the region, with dry, hot summers; mild winters in coastal areas and colder ones at higher elevations; and irregular rainfall throughout the year, concentrated in the fall and winter. Andalusia, as a whole, enjoys more than 3,000 hours of sunshine per year and an average annual temperature higher than the Spanish average, giving it particularly warm and sunny conditions.

## Climate Indicators and Recent Trends

According to the 2024 Andalusia Environment Report, historical temperature and precipitation data show clear trends associated with climate change:

- **Average temperatures have risen steadily** in recent decades, with many recent years exceeding historical reference values (1991–2020).
- **Average precipitation has decreased and become more irregular**, with years of precipitation deficits exacerbating episodes of drought and water stress throughout the region. These trends are consistent with the expected behavior of Mediterranean climates subject to global warming.

## Vulnerability and Climate Projections

**Planetary boundaries** are a way of understanding how much pressure humanity can place on the planet without compromising its balance. This concept was proposed by **Johan Rockström and his team**, and it posits that the Earth functions as a system with certain natural thresholds that should not be exceeded. These boundaries define a “safe space” for human development and are related to key processes such as climate, biodiversity, nitrogen and phosphorus cycles, land use, and ocean acidification. Currently, nine main boundaries have been identified:

1. **Climate change:** This refers to the rise in global temperature and the concentration of greenhouse gases in the atmosphere.
2. **Biosphere integrity / biodiversity loss:** protects the diversity of species and ecosystems that maintain the Earth’s stability.
3. **Nitrogen and phosphorus cycles:** regulate the nutrients essential to ecosystems; excesses can cause pollution and eutrophication.
4. **Land use:** changes such as deforestation affect climate, biodiversity, and carbon sinks.
5. **Ocean acidification:** resulting from the absorption of CO<sub>2</sub> by seawater, it affects marine ecosystems.
6. **Freshwater:** Its availability limits life and ecosystems; its overexploitation can lead to critical shortages.
7. **Atmospheric aerosols:** Particles in the air that affect solar radiation, regional climate, and human health.
8. **Chemical load / emerging pollutants:** Chemical substances such as plastics and heavy metals that can disrupt ecosystems and human health.
9. **Ozone layer integrity:** It protects life from ultraviolet radiation; its destruction poses environmental and health risks.

Rockström proposes that when human activity exceeds any of these limits, the risk of serious and difficult-to-reverse environmental changes increases, which can directly affect ecosystems and human well-being (Rockström et al., 2009).

Andalusia is particularly vulnerable to climate change due to its warm climate, high levels of solar radiation, and already limited water resources. Regional climate projections show that temperatures will continue to rise in the coming decades, with heat waves and tropical nights occurring more frequently and with greater intensity, while precipitation will tend to decrease or remain erratic, exacerbating water stress across large areas of the region.

These changes not only have a physical impact on climate variables such as temperature and rainfall but also affect essential resources such as water and biodiversity, and place additional pressure on key socioeconomic sectors such as agriculture, tourism, and the management of natural ecosystems. The environmental report highlights the need to integrate climate change considerations across regional public policies, as well as the development and implementation of municipal plans and local mitigation and adaptation strategies, which by 2025 are already being adopted by most Andalusian municipalities.

### **Climate Change as an Observable Reality**

Andalusia has a wide variety of climates due to its geographic location, topography, and the influence of nearby oceans and seas. This variability results in multiple internal climate regions—ranging from Atlantic Mediterranean climates to sub-desert zones, including mountainous areas with marked temperature variations—with temperatures and precipitation levels that differ significantly from one another.

Scientific evidence collected by the CLIMA Subsystem and other climate monitoring tools confirms that the climate in Andalusia has undergone changes clearly attributable to global warming. Records of indicators such as the Global Warming Index (GWI) show that average temperatures at stations such as Córdoba, Granada, and Jerez have consistently exceeded historical reference values, indicating a trend of rising temperatures over the past century.

This local evidence is complemented by data from the Intergovernmental Panel on Climate Change (IPCC), which documents global warming on a worldwide scale—caused primarily by the increase in greenhouse gases emitted by human activities—and serves as the basis for understanding the trends also observed in Andalusia.

## Causes of Climate Change

Climate change is not an isolated phenomenon, nor is it solely the result of natural climate variations. According to internationally accepted definitions applied in the Andalusian context, climate change is understood as the alteration of the climate attributed directly or indirectly to human activities that modify the composition of the atmosphere, in addition to the natural variability of the climate system.

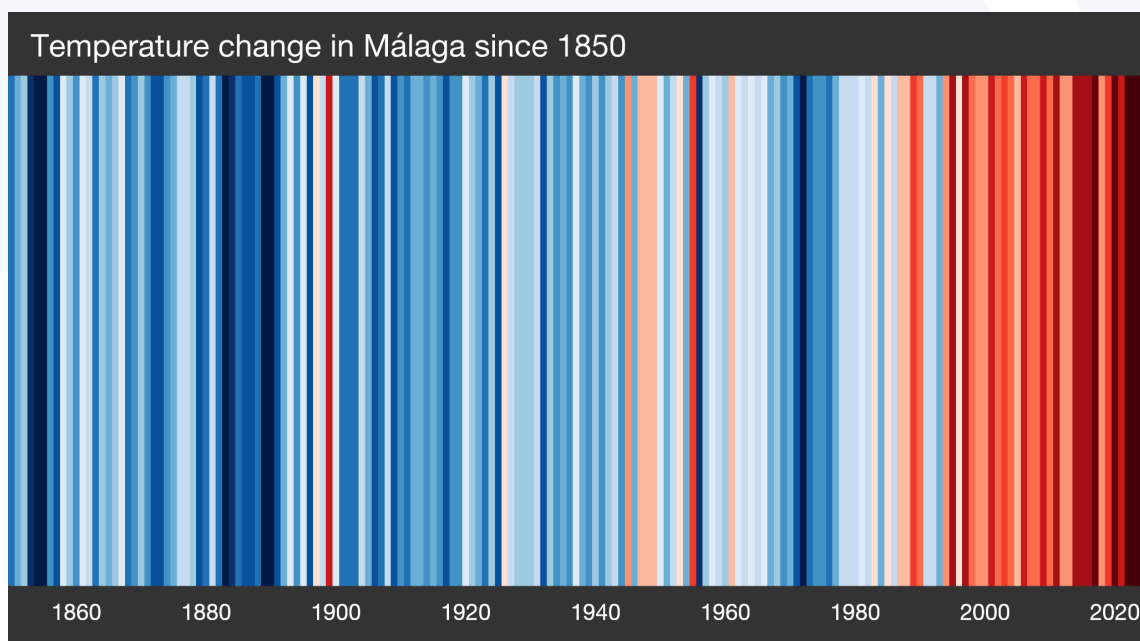
The main cause of this change is the increase in greenhouse gases—such as carbon dioxide (CO<sub>2</sub>), methane (CH<sub>4</sub>), and others—resulting from the burning of fossil fuels (coal, oil, and natural gas), deforestation, intensive agriculture, and other land uses. These gases act as a “thermal blanket” that traps heat in the atmosphere beyond historical levels, gradually raising the planet’s average temperature.

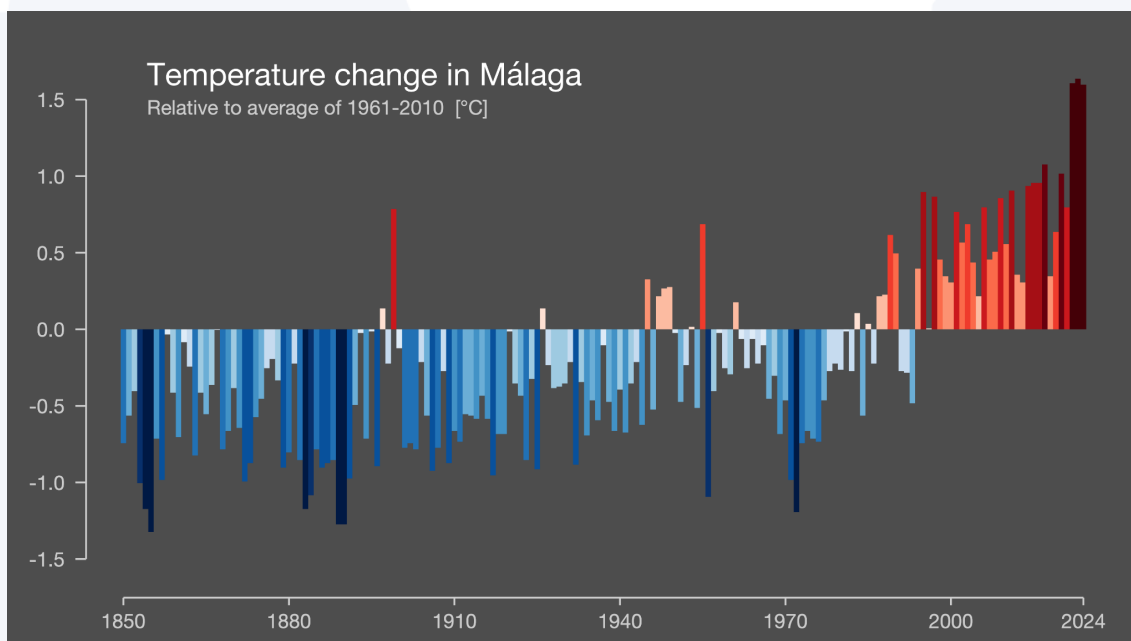
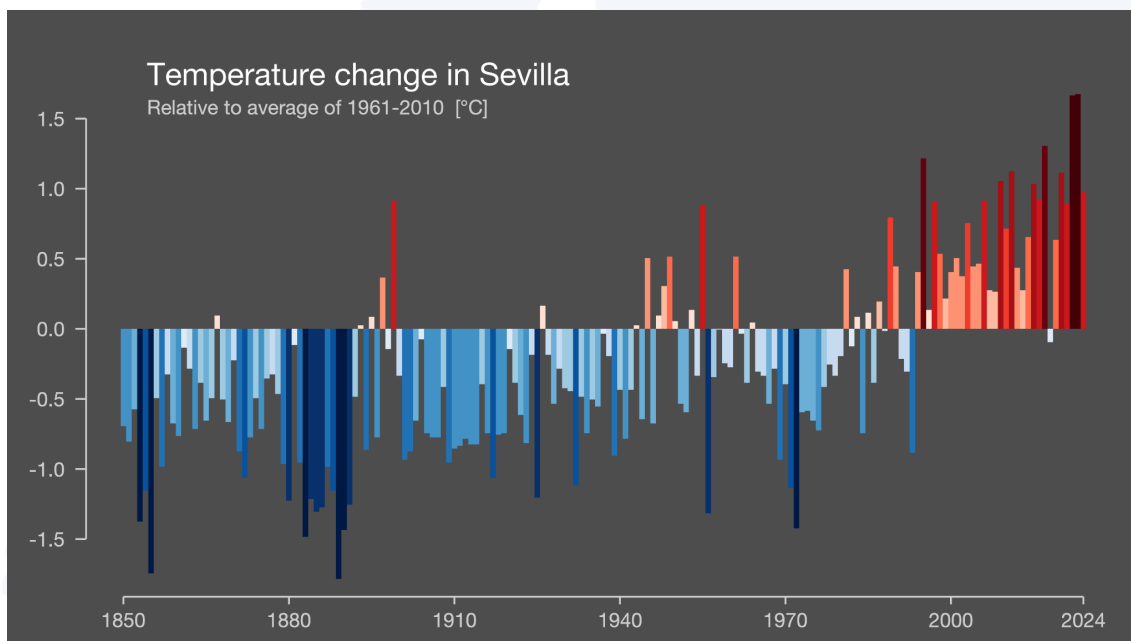
Although Andalusia has undertaken efforts to mitigate these emissions—for example, by reducing its diffuse greenhouse gas emissions by 14% since 2005—the region remains vulnerable to the effects of global warming and depends on integrated adaptation and mitigation strategies that involve both government agencies and the public.

## Observable Evidence in Andalusia

In terms of climate, the region has experienced:

- **A sustained increase in average temperatures**, with readings exceeding reference values by nearly 2 °C in recent decades.





\*Source: [www.showyourstripes.info](http://www.showyourstripes.info)

- **A reduction and uneven redistribution of precipitation**, which have led to longer periods of drought and water shortages in key river basins such as the Andalusian Mediterranean and the Guadalquivir.
- **Changes in climate patterns that favor an alternation between prolonged dry periods and episodes of torrential rain.** All these trends are consistent with scientific predictions regarding global warming in Mediterranean climates.

This evidence has an impact on natural resources and living conditions—for example, on the water available for human consumption, agriculture, and ecosystems, as well as on vegetation patterns and biodiversity.

## **Impact of Climate Change in Andalusia**

The effects of climate change in Andalusia are already noticeable and affect various areas:

### Water Resources and Droughts

Irregular rainfall patterns and an overall decrease in precipitation have exacerbated the occurrence of prolonged droughts, with consequences for reservoirs, water management, and agriculture, especially in rural areas.

### Extreme Temperatures

Heat waves, which are becoming increasingly frequent and intense, have become a health and environmental risk, particularly affecting vulnerable groups such as the elderly, children, and outdoor workers.

### Ecosystems and Biodiversity

Average warming may lead to the redistribution of plant and animal species, altering traditional ecological communities and contributing to the loss of sensitive habitats.

### Agriculture and the Economy

Key economic sectors such as agriculture and tourism, which are highly dependent on the climate and available water, face greater uncertainty due to the loss of climatic regularity and extreme weather events.

## **Territorial Vulnerability**

Andalusia's geographic location as a Mediterranean region places it among the areas most vulnerable to climate change in Europe, given its exposure to high temperatures, recurring droughts, and water stress. These conditions cause adaptive capacities to vary significantly among municipalities and territories, depending on their combination of water resources, population density, productive activities, and climate governance measures.

## **Adaptation and Mitigation**

The following are some strategies aimed at mitigating the impact of human activities on global warming.

## 1. Carbon Capture and Storage

This approach aims to remove carbon and other gases from the atmosphere or prevent them from entering it.

**Reforestation and ecological restoration:** Trees and plants capture CO<sub>2</sub> through photosynthesis and store it in their biomass and in the soil. Restoring native ecosystems is key because they are more resilient and store carbon over the long term than monospecific plantations.

**Wetlands, mangroves, and peatlands:** These ecosystems store enormous amounts of carbon in their water-saturated soils. When they degrade, they release CO<sub>2</sub> and methane; protecting them prevents emissions and maintains natural carbon sinks.

**Regenerative agriculture:** Practices such as reduced tillage, cover crops, and crop rotation increase soil organic carbon, improving soil fertility and water-holding capacity.

**Biochar:** This involves transforming biomass into stable charcoal, which is incorporated into the soil and can sequester carbon for hundreds of years, while also improving soil structure.

## 2. Reduction of Greenhouse Gas (GHG) Emissions

Reducing the temperature means lowering the amount of energy trapped in the climate system.

**Phasing out fossil fuels:** This is the most direct measure to slow global warming. Replacing coal, oil, and gas reduces ongoing emissions that accumulate heat in the atmosphere.

**Reducing short-lived pollutants:** Methane and black carbon cause intense warming but for a shorter duration. Reducing them yields rapid climate benefits.

**Urban green infrastructure:** Trees, parks, and green roofs reduce heat absorption, increase evapotranspiration, and improve the urban microclimate.

**Energy efficiency:** Using less energy to provide the same services (thermal insulation, efficient lighting, public transportation) reduces emissions and costs.

**Smart land-use planning:** Compact, well-connected cities reduce long commutes and energy consumption.

### 3. Increased Biodiversity

Biodiversity increases the resilience of ecosystems to climate change.

**Protection of Key Habitats:** Diverse ecosystems sequester carbon, regulate the local climate, and mitigate extreme events such as droughts or floods.

**Ecological restoration:** Restoring degraded ecosystems reestablishes food webs, nutrient cycles, and ecosystem services.

**Agroecology:** Diverse agricultural systems reduce dependence on chemical inputs and support pollinators and soil microorganisms.

### 4. The Nitrogen and Phosphorus Cycles

Excess nitrogen and phosphorus contribute to global warming, water pollution, and biodiversity loss.

**Organic fertilizers and composting:** Recycle nutrients, reduce dependence on synthetic fertilizers, and improve soil health.

**Nutrient recovery from wastewater:** Closes the cycle of phosphorus—a finite resource—and prevents eutrophication of rivers and oceans.

**Vegetated buffer zones:** Filter excess nutrients before they reach bodies of water.

**Reducing intensive livestock farming:** This decreases the release of reactive nitrogen and methane.

### 5. Ocean acidification

Acidification occurs when the ocean absorbs CO<sub>2</sub>, altering its chemistry.

**Reducing CO<sub>2</sub> emissions:** This is the only fundamental solution. Less atmospheric CO<sub>2</sub> means less CO<sub>2</sub> dissolved in the ocean.

**Protection of marine ecosystems:** Reefs, mangroves, and seagrass beds help regulate carbon and protect coastlines.

**Control of coastal pollution:** Nutrients and pollutants exacerbate the stress on marine organisms caused by acidification.

**Sustainable fishing:** Healthy marine ecosystems are more resilient to chemical changes.

## 6. Energy Efficiency

**Efficient Transportation:** Urban planning projects aimed at transforming cities into so-called “15-minute cities”—capable of providing transportation solutions through alternative means such as bicycles and an efficient public transit system—contribute to a significant reduction in CO<sub>2</sub> emissions.

**Solar and Wind Energy:** These are the most mature technologies, capable of rapid deployment, with steadily decreasing costs.

**Energy Storage:** It allows for managing the intermittency of renewables and stabilizing the grid.

*\*Reference sources:*

*The strategies and information regarding the climate and environmental context of Andalusia described in this section have been developed based on scientific evidence synthesized by the Intergovernmental Panel on Climate Change (IPCC), the Intergovernmental Science–Policy Platform on Biodiversity and Ecosystem Services (IPBES), the United Nations Environment Programme (UNEP), the Food and Agriculture Organization of the United Nations (FAO), the International Energy Agency (IEA), and other international organizations specializing in climate change, biodiversity, and the energy transition. Additionally, at the regional level, the Andalusian Environmental Portal and the Andalusian Climate Change Portal*



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