

# Climate Resilience, Energy Dynamics, and Environmental Impact Analysis: Inland Southern California

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# Executive Summary

This report provides a comprehensive evaluation of the climate, energy, and environmental landscape in the Thrive Inland SoCal region of California and presents a detailed analysis and strategic plan for the Thrive Inland SoCal Project. It outlines the initiatives under the Thrive Inland SoCal's High Road Transition Collaborative (HRTC) in collaboration with the Community Economic Resilience Fund (CERF), focusing on building a resilient, equitable, and sustainable economy in the region, with a special emphasis on transitioning to a carbon-neutral economy.

The Thrive Inland SoCal region, comprising Riverside and San Bernardino counties, possesses unique assets that make it a pivotal region for this initiative. It is a region characterized by diverse ecosystems, ranging from dense urban areas to vast desert landscapes. This diversity offers both challenges and opportunities in addressing climate change, energy production, and environmental conservation. Further, its geographical positioning and growing population make it a critical area for innovative energy solutions and sustainable urban development.

*It is a region characterized by diverse ecosystems, ranging from dense urban areas to vast desert landscapes.*

The project's primary goal is to facilitate the region's transition to a carbon-neutral economy, fostering long-term economic resilience. This includes enhancing the region's resilience against economic and environmental disruptions, thereby ensuring long-term sustainability, and steering Thrive Inland SoCal communities toward an equitable and sustainable economic model, emphasizing carbon neutrality and environmental stewardship.

Key deliverables include climate and energy datasets, a comprehensive data book, and a detailed section on climate and environment analysis for a regional summary report. These deliverables are critical in understanding the short- and long-term impacts of climate change on the region, especially on disinvested communities and industries, as well as in identifying major pollution sources and their effects.

Our analysis reveals the Thrive Inland SoCal's significant potential in the deployment of renewable energy, particularly solar and wind power, due to its geographical advantages. However, challenges such as regulatory barriers and the need for infrastructure development are highlighted.

The report also delves into the CERF Regional Plan Phases I and II (Community Economic Resilience Fund Program, 2022), outlining the baseline assessment of the region's economy, climate, and environment. In terms of climate mitigation strategies, the Thrive Inland SoCal is positioned to leverage its assets to combat climate change effectively. This includes promoting alternative travel modes, enhancing energy

efficiency, and managing waste effectively. The region's focus on green building practices and sustainable land use strategies demonstrates its commitment to environmental stewardship.

## Key Findings

The report identifies several key assets of the Thrive Inland SoCal that are critical in the context of climate, energy, and environmental sustainability:



### **Geographical Diversity**

The Thrive Inland SoCal's varied landscapes, including urban areas and deserts, provide unique opportunities for renewable energy development, particularly in solar and wind energy.



### **Economic Potential**

The region's growing population and industrial activities, particularly in logistics and warehousing, offer significant potential for green job creation and sustainable economic practices.



### **Environmental Challenges**

The region faces pressing environmental challenges, including air and water pollution and the impacts of climate change, such as increased temperatures and extreme weather events.

## **Based on these findings, this report recommends**

1. Capitalizing on the region's geographical diversity to expand renewable energy initiatives, particularly in solar and wind energy.
2. Promoting sustainable economic development through the creation of green jobs and investment in eco-friendly industries.
3. Implementing targeted climate adaptation strategies to address key environmental challenges, such as water management, air quality improvement, and conservation of natural habitats.
4. Encouraging collaborative efforts among local governments, businesses, and communities to ensure inclusive and effective implementation of the regional plan.

# Introduction

This report serves as a crucial tool in understanding and navigating the complexities and opportunities within the Thrive Inland SoCal region. Our primary objective is to provide stakeholders with a comprehensive understanding of the activities of the High Road Transition Collaborative (HRTC), focusing on economic resilience, environmental sustainability, and social equity.

The Thrive Inland SoCal Project, under the aegis of the HRTC, aims to foster a robust, inclusive, and sustainable economic environment. We are committed to identifying pathways that lead to equitable growth and environmental stewardship, ensuring that the Thrive Inland SoCal's prosperity is shared across all communities. This report synthesizes our findings, strategies, and recommendations, setting a roadmap for future endeavors and policy implementations.

Our research encompasses a wide array of topics crucial to the economic and environmental well-being of the Thrive Inland SoCal. We delve into various facets, from economic flows and labor market dynamics to climate change impacts and public health. This comprehensive analysis aids in identifying strengths, weaknesses, and potential areas of growth for the region.

We have gathered data from diverse sources, including the IE CERF Research Lead Proposal Notes, internal research notes, and multiple online repositories. These sources provided a wealth of information, enabling a multidimensional understanding of the region's current state and prospects. The integration of these diverse data points ensures a well-rounded analysis, crucial for formulating effective and sustainable strategies.

Our research methodology is a blend of secondary literature review, primary research interviews, and expert roundtables, culminating in a comprehensive gap analysis. The gap analysis revealed critical areas where further research and interventions are necessary. For instance, disparities in climate resilience among different communities and the need for more targeted environmental strategies emerged as significant gaps. By identifying these gaps, we lay the groundwork for focused action and policy development.

The key takeaways from our research include the urgent need for climate adaptation strategies, the potential for economic diversification, and the importance of enhancing public health infrastructure. These insights are pivotal in shaping Phase II of the CERF Regional Plan. Our future direction focuses on translating these findings into strategic projects and initiatives, aiming to bolster economic resilience, promote environmental sustainability, and ensure social equity across the Thrive Inland SoCal.

# Background

## Historical Context of the Thrive Inland SoCal Region

The Thrive Inland SoCal region, comprising Riverside and San Bernardino counties in Southern California, has a rich and diverse history. Initially inhabited by indigenous peoples, the region underwent significant transformations with Spanish colonization, the establishment of missions, and subsequent Mexican rule (The Inland Empire, 2023). The discovery of gold and the subsequent gold rush era brought a wave of settlers and economic activity. In the 20th century, the region saw a boom in agriculture, especially citrus farming, and later, a growth in the manufacturing and service sectors. Its geographic location made it a hub for logistics and warehousing industries, especially with the expansion of transportation networks. However, the region has also faced challenges, including economic fluctuations, environmental issues, and socioeconomic disparities (History.com Editors, 2022). Understanding this historical context is essential to grasp the current dynamics and future potential of the Thrive Inland SoCal.

## Community Economic Resilience Fund (CERF)

The Community Economic Resilience Fund (CERF) is a pivotal initiative by the state of California designed to foster economic resilience and inclusive growth across diverse communities. The CERF aims to empower regions to develop comprehensive economic strategies that are sustainable, equitable, and reflective of local needs and potentials. It focuses on collaboration among local governments, private sectors, nonprofits, and community-based organizations to create a unified vision for economic development that also addresses pressing issues such as climate change and social equity (Community Economic Resilience Fund, 2023).

CERF operates through a two-phase grant structure. Phase I involves planning and research to understand regional dynamics and develop a strategic framework. It includes stakeholder engagement, economic analysis, and identification of key sectors and opportunities. This phase is crucial for laying the groundwork for substantive project development. Phase II is implementation oriented, putting into action the strategies and projects developed from Phase I. This phase involves applying for and utilizing grant funds to execute projects, with a focus on long-term sustainability and impacts. This two-phased approach ensures a solid foundation of research and planning before moving into implementation, aligning with the fund's goals of resilience and inclusivity (Governor's Office of Planning and Research, Labor & WorkForce Development Agency, & California Governor's Office of Business and Economic Development, 2022).

The planning and implementation grants under CERF are designed to support the two phases of the economic development process. The planning grants, allocated in Phase I, are utilized for research, stakeholder engagement, and development of a strategic economic framework. These grants fund activities like data collection, analysis, community workshops, and preliminary project development. The



implementation grants, provided in Phase II, are larger in scope and directed toward executing the strategies and projects identified in the planning phase. This includes funding for infrastructure development, workforce training programs, industry support, and other initiatives that align with the regional economic strategy. The grants are intended to catalyze transformative projects that align with the broader goals of economic resilience, sustainability, and inclusivity (Governor's Office of Planning and Research, Labor & WorkForce Development Agency, & California Governor's Office of Business and Economic Development, 2022).

## Climate and Energy Research Plan

The Thrive Inland SoCal Project focuses on climate, environment, and energy research to address the challenges posed by climate change and contribute to the development of an equitable and sustainable economy in the Thrive Inland SoCal region. This plan outlines the methodology for climate and environmental impact analysis, assesses short- and long-term climate impacts, and incorporates gap analysis with a focus on equity considerations.

### Methodology for Climate Analysis

This segment introduces CalAdapt, a pivotal tool used to analyze climate change impacts in California, offering a statewide perspective on environmental changes.

1. **Utilization of Landsat 8 Surface Temperature Readings:** Landsat 8 TIRS data is employed to assess surface temperatures in the Inland SoCal region, particularly in disadvantaged and low-income communities. This data provides a granular view of the impacts at the neighborhood level, crucial for state-defined environmental analysis.
2. **Temperature Trend:** SoCal urban heatwave activity is increasing at a rapid rate with a greater tendency towards more humid and intense nighttime events. Heatwaves are persisting later in the year during peak fire season, potentially increasing the intensity of wildfires by enhancing aridity. Heatwaves have high probability of increasing by 42% in frequency, 26% in duration, and 2°C in temperature during severe drought conditions (Maizlish, English, Chan, Dervin, & English, 2017 and Hulley, Dousset, & Kahn, 2020)

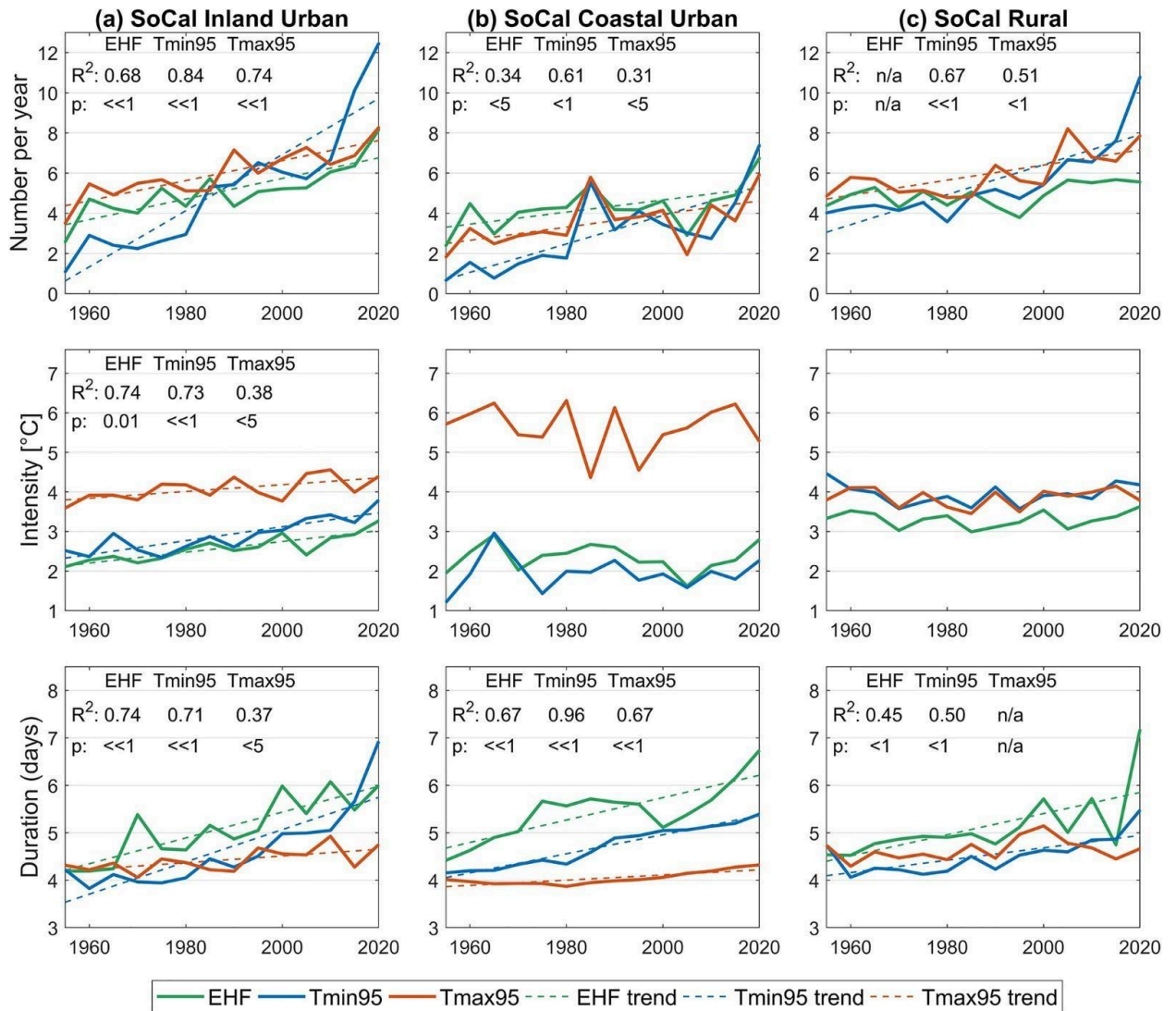


Figure 1: Heatwave Trend Analysis

Figure 1 shows time series and trends in heatwave metrics (frequency, intensity, duration) for each heatwave definition and SoCal subregion with data averaged over 5-year periods. Trend lines were plotted for each definition only when statistically significant ( $p < 5\%$ ).

3. **Data Selection and Analysis Methodology:** The study utilizes LOCA downscaled CMIP5 Climate Projections, focusing on temperature, precipitation, and relative humidity. The chosen models (CanESM2, CNRM-CM5, HadGEM2-ES, MIROC 5) offer detailed insights into climate trends from 2006 to 2099. The analysis involves filtering these models for specific regions, ensuring a comprehensive understanding of the state-defined environmental impacts. Figure 1 shows the graph of combined temperature trends (multimodal mean) illustrating the projected

temperature changes from 2010 to 2100 under different Representative Concentration Pathways (RCP) scenarios:

- **X-axis (Horizontal):** Represents the years, ranging from 2010 to 2100.
- **Y-axis (Vertical):** Indicates the temperature in degrees Celsius.
- **Maximum Temperature under RCP 8.5:** Represented by a broken line, this trend shows the projected higher temperature increases under the RCP 8.5 scenario, which assumes continued emissions rise throughout the 21st century.
- **Maximum Temperature under RCP 4.5:** Illustrated with a solid line, it depicts the temperature rise under the RCP 4.5 scenario, which is an intermediate pathway assuming some mitigation measures.
- **Minimum Temperature under RCP 8.5:** Also shown as a broken line in blue, this represents the minimum temperature projections under the RCP 8.5 scenario.
- **Minimum Temperature under RCP 4.5:** Displayed as a solid line, this trend shows the projected minimum temperature changes under the RCP 4.5 scenario.

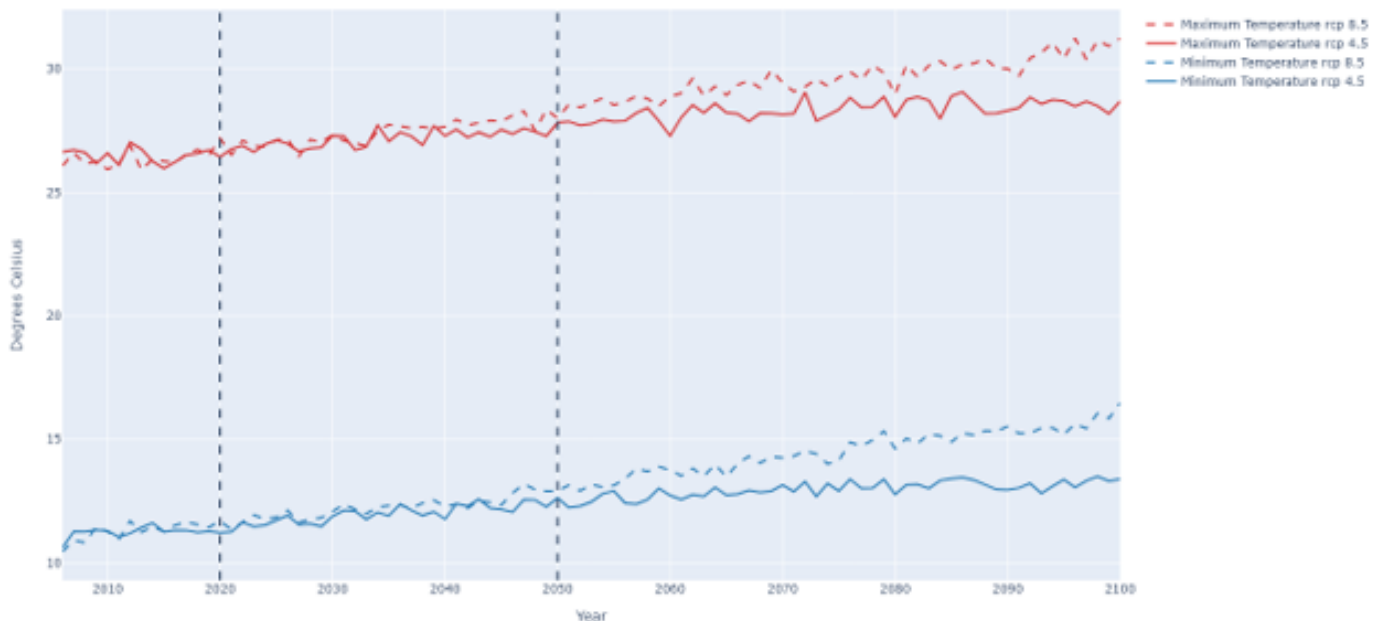


Figure 2: Combined Temperature Trends (multimodal mean)

The low desert area of eastern Riverside County indicates the highest baseline temperature. At growth consistent with other regions, temperature is projected at 5 degrees C higher than all other regions for all years.

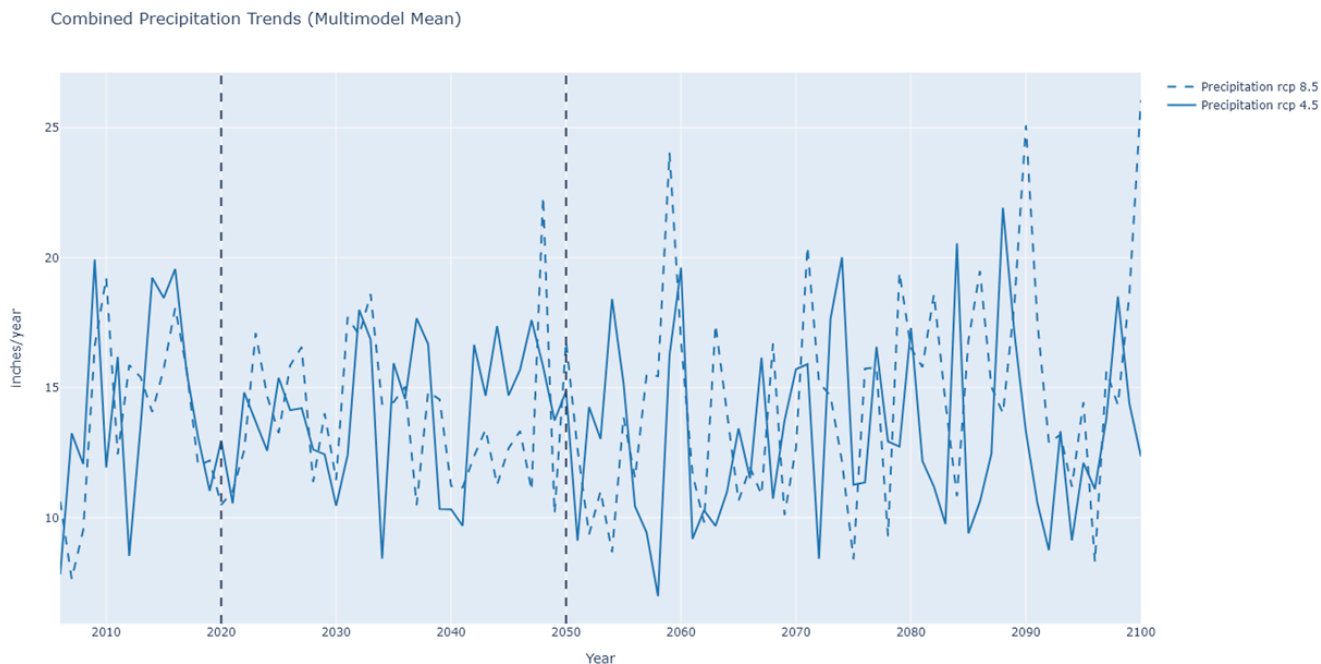


Figure 3: Combined Precipitation Trends (Multimodal Mean)

Figure 2 illustrates the combined precipitation trends from 2006 to 2100 under two RCP scenarios: RCP 8.5 and RCP 4.5. The x-axis represents the years, while the y-axis indicates the precipitation index per year. In this simulation, the maximum precipitation trend is depicted by the RCP 8.5 scenario (in broken lines), suggesting more intense precipitation patterns. Conversely, the RCP 4.5 scenario (solid lines) reflects the minimum precipitation trend, indicating less severe precipitation changes. The two lines area represents the range between these two scenarios, capturing the potential variability in future precipitation patterns under different climate change trajectories. This visualization aids in understanding the possible fluctuations in precipitation due to climate change over the coming decades.

Combined Humidity Trends (Multimodel Mean)

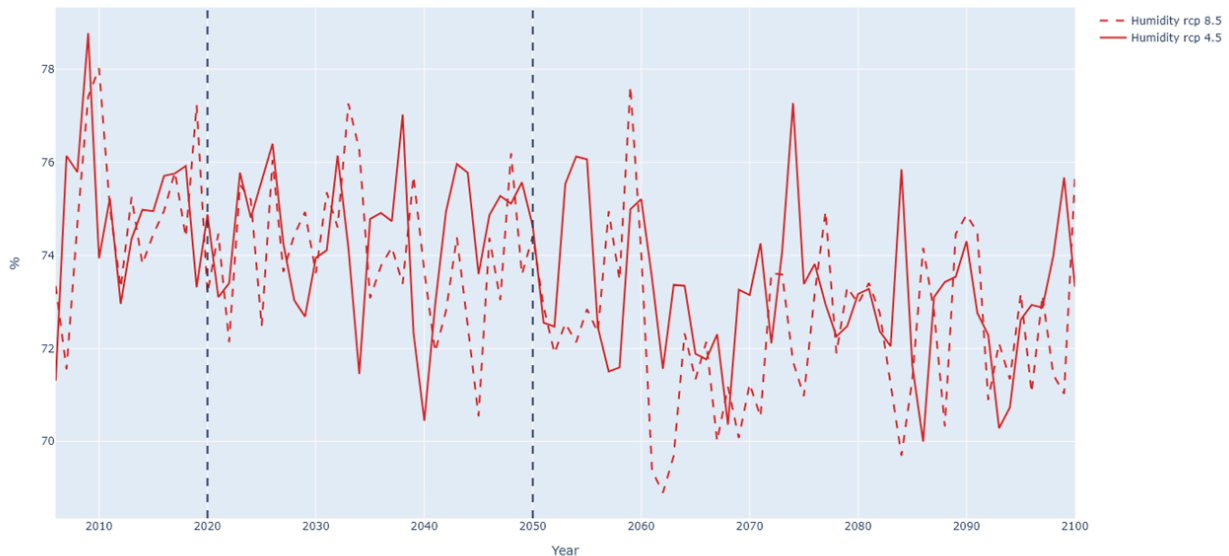


Figure 4: Combined Humidity Trends (Multimodal Mean)

Figure 3 depicts the projected trends in relative humidity from 2006 to 2100 under two different RCPs: RCP 8.5 and RCP 4.5. In this simulation:

- The broken line represents the relative humidity trend under the RCP 8.5 scenario, which assumes a more significant decline in relative humidity over time.
- The solid line depicts the trend under the RCP 4.5 scenario, characterized by a less steep decline in relative humidity.

The between these lines illustrates the range of variation between the two scenarios. As the years progress, a noticeable divergence develops between the two paths, reflecting the varying impacts of each scenario on relative humidity levels.

## Short- and Long-term Climate Impact Assessments

1. **Projection of Climate Variables:** The study delineates a consistent increase in daily temperatures through 2100, with significant variations under different RCP scenarios. Projections indicate rising temperatures, fluctuating precipitation patterns, and decreasing relative humidity.
2. **Impact on Specific Regions:** The analysis highlights the varying impacts across different regions of Inland Southern California. For instance, the low desert area in eastern Riverside County is projected to experience the highest temperature increases.
3. **Long-term Trend Analysis:** The study extends to 2100, providing a long-term view of climate impacts. This comprehensive time frame allows for a detailed understanding of how climate change will evolve and affect different areas over future decades.

## Gap Analysis and Equity Considerations

1. **Disparities in Climate Impact:** The research identifies disparities in temperature increases between affluent and less affluent neighborhoods, emphasizing the need for equity in climate adaptation strategies.
2. **Equity in Climate Mitigation Plans:** Among the 18 mitigation plans reviewed, 12 directly address equity in diverse communities, including low-income families, disadvantaged communities, and ethnic minorities. This reflects an emphasis on creating equitable climate policies.
3. **Future Projection and Equity Considerations:** As the region faces escalating heat, especially in the inland deserts, the study underscores the importance of tailored climate mitigation strategies that consider the unique vulnerabilities and needs of diverse communities.

This comprehensive climate and energy research plan for Inland Southern California highlights the critical methodology used for state-defined climate and environmental impact analysis, providing both short- and long-term assessments of climate impacts. The gap analysis and focus on equity considerations underscore the importance of inclusive and informed climate policies. This plan serves as an essential framework for policymakers and stakeholders in developing strategies that address the region's diverse and evolving climate challenges.

## Key Takeaways from Climate Analysis

### Summary of Major Climate Trends and Implications

In our analysis, a consistent and moderately strong upward trend in temperatures is evident from 2020 through 2100 across the region, particularly under the RCP 8.5 scenario. This trend suggests heightened heat stress, increased energy demand for cooling, and exacerbation of urban heat island effects, especially in densely populated areas. Additionally, precipitation and humidity data exhibit considerable variability with no clear long-term trends, though relative humidity shows a general decreasing trend. These patterns imply potential challenges in water resource management, agricultural productivity, and increased fire risk due to dryer conditions. Significantly, low-income and disadvantaged communities are more severely affected by these climatic changes, particularly in terms of heat exposure and access to cooling resources.

Our approach to conducting climate analysis involved a comprehensive review of secondary literature, including academic and government sources and interviews with experts. These were complemented by roundtable discussions to identify critical climate and environmental issues. A gap analysis was also conducted to pinpoint areas requiring further research, particularly in addressing equity in climate change impact.

Analysis of Landsat 8 data indicates significant urban heat island effects, particularly in disadvantaged neighborhoods, highlighting disparities between different socioeconomic groups in terms of exposure to extreme temperatures and access to mitigation resources.

Projections indicate significant increases in extreme heat events, particularly in the inland deserts, which will have profound impacts on energy demand, public health, and water resources (County of San Bernardino, 2021). Ongoing and planned efforts in Riverside and San Bernardino counties focus on renewable energy, energy efficiency, and sustainable transportation modes, providing a roadmap for emission reduction with specific targets and strategies tailored to local needs and conditions.

The climate and energy research in the region underscores the urgency of addressing climate change impacts, particularly for disadvantaged communities. The transition to a more sustainable and resilient future requires concerted efforts in mitigation, adaptation, and equitable policy implementation, ensuring that all sectors of society are included in the move toward a greener future.

## Impact on Regional Development, Jobs, and Public Health

The expected climate changes are likely to place economic and infrastructural strain on the region. Increased temperatures and altered precipitation patterns will necessitate significant investments in climate-resilient buildings, transportation, and energy systems. The job market is also anticipated to shift, with new opportunities emerging in renewable energy sectors as part of the transition to greener energy sources. However, this transition may disrupt existing industries, necessitating workforce retraining and education. Public health concerns are also paramount, with elevated temperatures and humidity changes potentially leading to increased heat-related illnesses, respiratory problems due to deteriorating air quality, and heightened vector-borne diseases.

The anticipated climate changes in the region pose significant challenges and opportunities for regional development. The increasing temperatures and altered precipitation patterns necessitate a shift toward more climate-resilient infrastructure. This involves redesigning urban spaces to reduce heat island effects, such as increasing green spaces and using solar-reflective materials in construction. Additionally, the variability in precipitation and humidity levels calls for innovative water management solutions, including advanced stormwater management systems and drought-resistant landscaping.

In the realm of agriculture, these climatic shifts may necessitate transitioning to more heat and drought-resistant crops and the adoption of new farming technologies and practices. This could reshape the agricultural landscape, impacting land use and rural economies.

Moreover, as renewable energy sources become more critical, there is an opportunity for regional development of new energy infrastructure, such as solar and wind farms. This transition aligns with environmental goals and presents opportunities for economic diversification and development in rural and underutilized areas.



The climate crisis is reshaping the job market in profound ways. As the region pivots toward renewable energy and sustainable practices, new job opportunities are emerging in these sectors. Roles in solar panel installation, wind turbine maintenance, and energy efficiency retrofitting are likely to see significant growth. This transition, however, may not be smooth for everyone. Workers in traditional industries, particularly fossil fuel-dependent sectors, may face job displacement, necessitating robust retraining and education programs to facilitate their transition to new roles in the green economy.

Additionally, the need for climate-resilient infrastructure and urban design will likely spur job creation in construction, urban planning, and environmental engineering. These roles will be crucial in designing and implementing solutions to mitigate the effects of climate change at a local level.

The public health implications of climate change are far-reaching. Elevated temperatures can lead to an increase in heat-related illnesses, particularly among vulnerable populations such as the elderly, children, and outdoor workers. Moreover, changes in humidity and precipitation patterns can exacerbate air quality issues, leading to respiratory problems, especially in urban areas.

The mental health impacts of climate change are also becoming increasingly recognized. The stress and anxiety related to experiencing or anticipating extreme weather events, displacement, or loss can have profound effects on mental well-being. Thus, healthcare systems need to be prepared not only for the physical health impacts of climate change but also for rising mental health needs.

The impact of climate change on regional development, jobs, and public health is complex and multifaceted. Lessening the effects requires a coordinated approach that encompasses sustainable urban planning, workforce transition strategies, and public health preparedness. While the challenges are significant, there are also opportunities to create a more resilient, sustainable, and equitable future for the region. As the region adapts to these changes, it is essential to ensure that policies and interventions are inclusive and equitable, addressing the needs of all communities, particularly those most vulnerable to the impacts of climate change.

## Gap Analysis in the Climate and Energy Research

This report identifies the current gaps in climate analysis, with its concerns and possible solutions to closing the gap. We also identified gaps beyond these research and data limitations.

### Identified Gaps and Addressed Concerns

1. **Data Resolution and Accessibility:** One key gap identified in our analysis was the resolution and accessibility of climate data, particularly for neighborhood-level analysis. While tools like CalAdapt provide downscaled climate projections, their resolution is often inadequate for detailed local analysis. To address this, we incorporated Landsat 8 Surface Temperature Readings, offering higher-resolution data to assess heat impacts at a more granular level.



2. **Disparities in Impact on Disadvantaged Communities:** Our research highlighted significant disparities in how climate change impacts disadvantaged communities (DACs) compared to more affluent areas. We found that DACs often face higher temperature increases and greater susceptibility to heat-related health issues. Addressing this gap required a targeted analysis of temperature trends and their socioeconomic implications in these communities.
3. **Integration of Renewable Energy Sources:** We identified a gap in the efficient integration and use of renewable energy sources at the regional level. To bridge this gap, we delved into the capacities and potential expansion of current renewable energy projects, particularly focusing on solar and wind energy.
4. **Economic Transition and Workforce Development:** The shift toward a green economy presents significant challenges in workforce transition. We addressed this by analyzing current job trends, identifying emerging opportunities in renewable energy sectors, and highlighting the need for workforce retraining programs.

## Gaps Beyond Scope or Data Limitations

1. **Long-term Health Impact Studies:** Assessing the long-term health impacts of climate change on the local population was beyond our project's scope and timeline. Longitudinal health data and comprehensive medical studies are required to accurately evaluate these impacts.
2. **Detailed Economic Impact Analysis:** While we touched upon the economic implications of climate change and energy transitions, a detailed economic impact analysis, including the cost-benefit analysis of various mitigation strategies, was outside our research scope due to time constraints and the complexity of economic modeling.
3. **In-depth Analysis of Water Resources:** Water resource management under changing climate conditions is critical but was not fully explored due to limited access to comprehensive water usage, quality data, and projections for the region.
4. **Infrastructure Adaptation Strategies:** Detailed strategies for adapting existing infrastructure to climate change, such as retrofitting buildings for energy efficiency or redesigning urban spaces for heat mitigation, were not fully covered due to the vast scope of such an analysis.
5. **Current GHG Data:** The current greenhouse gas (GHG) data for this region was unavailable at the time of the research. The latest GHG data available is from 2019 for this region. We are currently working with the Southern California Association of Governments to get this data before the end of the 2023.

# Energy Trends and Analysis

This report delves into the current and future energy landscape of Inland Southern California, focusing on energy demands, renewable energy adoption, infrastructure, and gaps in the energy sector. It draws from extensive research, expert interviews, and data analysis, intending to provide comprehensive insights and strategic directions for regional development.

Inland Southern California currently faces a dynamic energy landscape. The region's energy demand is significantly driven by its growing population and economic activities, especially in transportation and warehousing. The predominant energy sources include natural gas, solar, and wind, with a gradual shift toward greater use of renewables. However, the region grapples with challenges like managing climate-related issues and addressing environmental concerns, especially in terms of air quality and heat impact (Western Riverside Council of Governments [WRCOG], 2023).

Future energy demands in the region are expected to rise due to population growth and increasing temperatures. This demand will likely intensify the focus on renewable energy, electric vehicle infrastructure, and energy storage solutions. In Table 1, we see a continuous increase in recent energy consumption for both the residential and nonresidential sectors. Projections suggest this growth will persist in coming years. The region's commitment to sustainable energy practices and adoption of renewable sources is poised to reshape its energy landscape significantly (Coachella Valley Association of Governments, 2023).

Table 1: Energy Consumption from 2015 to 2022

County	Year	Residential Sector	Non-Residential	Total
San Bernardino	2022	6301.858375	10327.755820	16629.614195
San Bernardino	2021	6031.580795	10137.255897	16168.836692
San Bernardino	2020	6112.195914	9797.575011	15909.770925
San Bernardino	2019	5332.807265	9926.183260	15258.990525
San Bernardino	2018	5166.839880	10158.958013	15325.797893
San Bernardino	2017	5168.269909	10068.393502	15236.663411
San Bernardino	2016	4966.459776	9935.333655	14901.793431
San Bernardino	2015	4930.998541	9753.892696	14684.891237
Riverside	2022	9060.556508	8720.016764	17780.573271
Riverside	2021	8610.772069	8389.538460	17000.310529
Riverside	2020	8844.552883	7934.638383	16779.191266
Riverside	2019	7678.103798	8085.191661	15763.295459
Riverside	2018	7643.105779	8171.189819	15814.295598
Riverside	2017	7633.771197	8157.182763	15790.953961
Riverside	2016	7171.032032	8164.868098	15335.900130
Riverside	2015	7076.846074	8100.383540	15177.229615

Renewable energy adoption is gaining momentum in Inland Southern California, with solar energy leading the charge. The regional energy mix is evolving, with a notable decrease in natural gas usage and a significant increase in solar and wind energy generation. This shift is influenced by state mandates, economic incentives, and growing environmental consciousness. However, the transition is challenged by regulatory hurdles, the need for substantial investment in infrastructure, and the intricacies of integrating renewable sources into the existing grid (Coachella Valley Association of Governments, 2023).

Additional insights were gleaned from data provided by Southern California Edison (SCE) and Riverside Public Utilities (RPU), focusing on utility customers and the deployment of distributed energy resources (DERs). The study discovered over 1.5 million electric meters and approximately 808,711 natural gas meters across various market segments in the Thrive Inland SoCal region. Notably, the region has 284,817 SCE and RPU customers with DER installations, representing a substantial 21% penetration rate of DERs. This high penetration rate, especially in SCE's service area, is attributed to incentives such as the California Self-Generation Incentive Program, which spurred the adoption of solar PV systems and other DER technologies.

The report also highlights the pivotal role of DERs in bolstering energy resilience. These decentralized energy systems, comprising generation and storage facilities, are instrumental in reducing reliance on centralized grids. They are particularly crucial in managing peak load demands and enhancing overall grid

efficiency. Moving forward, the integration of hydrogen into the gas utility mix and the development of virtual power plants (VPPs) represent exciting advancements in the region's energy sector.

Significant utility-scale energy projects in the pipeline include the transformation of the Thrive Inland SoCal Energy Center into a large-scale energy storage facility and the Crimson Energy Project, a 350-megawatt battery storage system set to enhance regional energy reliability.

## Gap Analysis

Several gaps have been identified in the region's energy sector that are central to informed decision-making and strategic planning.

### Gaps We Will Address Before the End of 2023

1. **Gas Emissions Data:** Efforts are underway to obtain more current data on greenhouse gas emissions, particularly for Riverside and San Bernardino counties. This data is crucial for understanding the region's impact on climate change and for assessing the effectiveness of mitigation strategies.

### Gaps We Cannot Address Due to Scope/Timeline

1. **Long-term Renewable Energy Integration:** Comprehensive strategies for integrating renewable energy sources into the existing infrastructure over the long term remain a challenge. This includes addressing issues related to energy storage, grid stability, and the regulatory environment.
2. **Detailed Economic Impact Analysis:** A thorough economic impact analysis of the energy transition, including cost-benefit assessments of renewable energy projects, is beyond the scope of our current research.

### Gaps Due to Lack of Data

1. **Current GHG Data:** As noted, the lack of current greenhouse gas emissions data hinders a complete understanding of the region's environmental footprint and the efficacy of current climate initiatives.
2. **Detailed Infrastructure Analysis:** A detailed analysis of the existing energy infrastructure, its capacity to support renewable energy expansion, and the specific need for upgrades is limited by the availability of comprehensive data.

Inland Southern California is at a crucial juncture in its energy journey. The region's move toward a more sustainable energy mix, marked by increased adoption of renewables and a focus on energy efficiency, is indicative of a broader shift in response to climate change and environmental concerns. However, this

transition is not without its challenges. Addressing the identified gaps, particularly in data availability and long-term strategy formulation, will be pivotal in ensuring that the region can meet its future energy demands sustainably and efficiently.

## Environmental and Economic Impact

This report examines the environmental and economic impacts of climate change in the Thrive Inland SoCal region, with a focus on air quality, soil quality, and land use trends. The analysis incorporates data from academic literature, government agencies, and expert interviews, along with a gap analysis to identify areas needing further research or action.

### Air Quality Analysis

The region's air quality is primarily affected by pollutants such as ozone, particulate matter (both PM10 and PM2.5), nitrogen dioxide (NO<sub>2</sub>), sulfur dioxide (SO<sub>2</sub>), and carbon monoxide (CO). These pollutants originate from various sources, including vehicular emissions, industrial activities, agricultural operations, and natural occurrences such as wildfires (South Coast AQMD, 2023).

Ozone levels in the region have exhibited fluctuating trends, with large areas of the region experiencing several days each year when levels exceed national and state standards. Ozone formation is primarily driven by chemical reactions between oxides of nitrogen (NO<sub>x</sub>) and volatile organic compounds (VOCs) under sunlight. Particulate matter, particularly PM2.5, poses significant health risks and stems from vehicle exhausts, industrial emissions, and natural events such as wildfires. PM levels in some locations surpass safe thresholds many times each year. NO<sub>2</sub> levels, influenced mainly by vehicular traffic and industrial emissions, have shown improvement, yet some urban areas still record concentrations near federal limits. Fortunately, concentrations of sulfur dioxide and carbon monoxide have been on a decline due to improved emission controls and fuel standards and recorded values are well below limits (Petek, 2022).

Historical data from the 1980s onward show a general improvement in air quality, especially for the pollutants CO and SO<sub>2</sub>. This improvement is attributed to stringent regulations and technological advancements in emission controls. However, in recent years, certain pollutants like ozone have exhibited stalled or worsening trends in specific areas, signaling a need for more robust interventions (California Air Resources Board, 2023).

Poor air quality is a significant health hazard, leading to respiratory and cardiovascular diseases, aggravated asthma, and other lung conditions. Vulnerable groups such as children and the elderly are particularly at risk. Environmentally, air pollutants can harm wildlife, damage forests, and affect water bodies. Ozone, for example, can inhibit plant growth and reduce biodiversity (South Coast AQMD, 2023).

Urban areas, especially those with dense traffic and industrial activities, generally experience poorer air quality compared to rural areas. Communities near industrial zones or heavy traffic corridors, often disadvantaged, bear the brunt of air pollution, highlighting concerns of environmental justice (South Coast AQMD, 2023).

Wildfires have become a notable source of PM<sub>2.5</sub>, especially during dry seasons, impacting air quality over extensive areas and posing significant health hazards (Childs, et al., 2022).

The effects of climate change, such as rising temperatures and altered weather patterns, are expected to worsen air quality issues, particularly increasing levels of ozone and particulate matter. Moreover, continued urbanization and industrial growth, if not managed with adequate environmental safeguards, could lead to deteriorating air quality.

To address emerging air quality challenges, continuous monitoring and research are essential. Strengthening and enforcing air quality regulations, particularly in high-emission sectors, is crucial for improvement. Educating the public about air quality and its health impacts, along with promoting health initiatives, can help mitigate adverse effects.

The analysis highlights the importance of sustained efforts to enhance air quality through monitoring programs, regulation, and public engagement. Adapting to the evolving challenges posed by urbanization, industrial activities, and climate change is vital for protecting public health and environmental quality.

## Soil Quality Trends Analysis

This analysis provides an in-depth look into the trends in soil quality across the Thrive Inland SoCal region. It draws from a range of data sources, including agricultural studies, environmental assessments, and scientific research. The focus is on understanding the changes in soil composition, health, and productivity, as well as the factors influencing these trends.

Over the past decades, the region has seen significant shifts in land use, from predominantly agricultural to increased urbanization and industrial development. This transition has impacted soil quality in several ways. In agricultural areas, intensive farming practices have led to issues like soil erosion, nutrient depletion, and salinization. Conversely, conservation practices in some areas have improved soil health, promoting biodiversity and sustainable land use (Ayres, Kwon, & Collins, 2022).

In smaller farms, practices tend to align with sustainable soil management, including organic farming methods that enhance soil health. Larger agricultural operations, however, have varied impacts on soil quality, often depending on the level of industrialization and the types of crops grown. The use of chemical fertilizers and pesticides, along with monoculture practices, has contributed to soil quality degradation in some areas (Riverside County Agricultural Production Report, 2022).

Soil quality in urban areas is impacted by factors such as construction, pollution, and reduced natural vegetation cover. Industrial activities, especially those involving heavy metals and chemicals, have led to soil contamination, posing risks to human health and the environment. Remediation efforts are ongoing in several contaminated sites, but challenges remain in fully restoring soil health (Office of Environmental Farming and Innovation, 2023).

Climate change poses a new set of challenges for soil quality — increased temperatures, altered precipitation patterns, and extreme weather events like floods and droughts affect soil moisture, nutrient cycles, and erosion rates. Additionally, natural events like wildfires have a profound impact on soil structure and health, often leading to increased erosion and nutrient loss (Office of Environmental Farming and Innovation, 2023).

Looking forward, the region faces several challenges in maintaining and improving soil quality. Continued urbanization and industrial activities, if not managed sustainably, could lead to further soil degradation. Increasing climate change will likely exacerbate existing issues, necessitating adaptive strategies for soil conservation and management.

Effective soil management policies are crucial for the region's environmental and agricultural sustainability. Policies should focus on promoting sustainable agricultural practices, remediating contaminated soils, and conserving soil in urban development projects. Public awareness campaigns on the importance of soil health and community engagement in soil conservation efforts are also vital.

This analysis underscores the importance of proactive measures to maintain and improve soil quality in the face of changing land use patterns and environmental challenges. Sustainable management practices, coupled with strong policy support and community involvement, are key to ensuring the long-term health and productivity of the region's soils.

## Land Use Trend

The examination of land use trends over the last two decades reveals significant shifts in the way land is utilized. These changes, driven by both economic factors and societal needs, have had profound implications on the region's landscape, environment, and social fabric.

Traditionally, the region was dominated by agricultural land, which has gradually given way to urban and industrial development. This shift has been most pronounced in areas adjacent to urban centers, where the demand for housing and commercial space has escalated. The growth of logistics and warehousing, as seen in Figure 4, has transformed large tracts of previously agricultural or open land into industrial zones. This transition has not only altered the physical landscape but also impacted local economies and job markets.

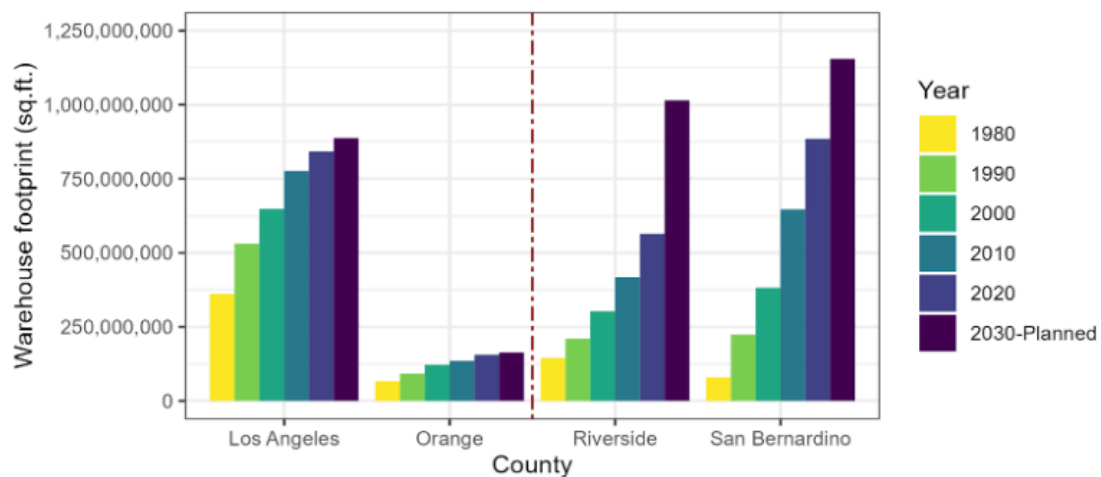


Figure 5: Warehouse Footprint from 1980 to 2030

Residential development has been a key aspect of land use change, characterized by a trend toward suburban sprawl. The push for affordable housing has led to expansion of residential areas into what were once rural or semirural areas. This sprawl has implications for infrastructure, transportation, and environmental sustainability, often leading to increased traffic, strain on public services, and loss of natural habitats.

Amid these changes, there has been a growing recognition of the importance of conserving natural areas and managing open spaces. Various habitat conservation and restoration initiatives have been implemented, aiming to balance development needs with environmental preservation. Protected areas have been established to safeguard biodiversity and maintain ecological balance (Western Riverside County Regional Conservation Authority, 2021).

The conversion of agricultural land to other uses has raised concerns about food security and the loss of farming heritage. While some of this land has been repurposed for urban development, there's also a trend toward more intensive agricultural practices in the remaining farmlands to compensate for the reduced acreage. This intensification, however, brings its own set of challenges, including environmental impacts and sustainability issues (Western Riverside County Regional Conservation Authority, 2021).

The growth of industry, particularly in previously rural areas, has brought economic benefits but also environmental concerns. Issues such as pollution, water usage, and habitat disruption are increasingly at the forefront of regional planning debates. The challenge lies in achieving a balance between industrial growth and environmental stewardship.

Looking ahead, the region faces significant challenges in land use planning. The ongoing demand for housing and commercial space must be balanced with the need to protect natural resources and



minimize environmental impact. Climate change adds another layer of complexity, influencing land use decisions through factors like rising temperatures, changing precipitation patterns, and increased frequency of extreme weather events.

Effective land use policies and strategic planning are critical to navigate these challenges. This includes zoning regulations that promote sustainable development, incentives for conservation, and infrastructure planning that accommodates growth while preserving essential natural areas. Community involvement and stakeholder engagement are key to ensuring that land use policies meet the diverse needs of the region.

The analysis of land use trends highlights the dynamic nature of how land is used and the complex interplay between development, conservation, and sustainability. As the region continues to evolve, strategic planning and policymaking will play a crucial role in shaping a sustainable and balanced future land use landscape.

## Economic and Trade Impact Analysis

The shift in land use trends and environmental changes has led to a significant transformation in the regional economy. This transformation is characterized by the diversification of economic activities, changes in the labor market, and the emergence of new trade opportunities.

The expansion of logistics and warehousing industries, driven by the rise in e-commerce and the strategic location of the region, has been a major economic influence. This growth has created numerous job opportunities, ranging from manual labor to technological and managerial roles. However, it has also brought challenges, including the need for infrastructure development and concerns about environmental impacts like increased traffic and air pollution (Western Riverside Council of Governments [WRCOG], 2023).

The increase in residential and commercial development has boosted the construction industry, generated employment, and stimulated local economies. This development also has attracted new businesses and services to the region, further diversifying the economy. However, it poses challenges such as the need for expanded public services and infrastructure and the potential for increased urban sprawl.

Environmental sustainability efforts have opened new economic avenues. The focus on renewable energy, waste management, and sustainable practices has spurred the growth of a green economy, creating jobs in sectors like solar energy, recycling, and environmental consulting. This shift toward sustainability also positions the region favorably in the global trade market, appealing to environmentally conscious consumers and businesses (Coachella Valley Association of Governments, 2023).

The economic changes have had a substantial impact on trade. The development of logistics hubs has facilitated smoother and more efficient trade, both domestically and internationally. The region's

strategic location has become a vital link in global supply chains. However, this increased trade activity also demands robust infrastructure and poses logistical challenges, particularly in terms of transportation and storage capacities.

The region's economic resilience will be tested by factors such as climate change, technological advancements, and global economic shifts. Adapting to these changes while maintaining economic growth and environmental sustainability will be a key challenge. Future economic success will depend on the region's ability to balance growth with sustainability, invest in infrastructure, and adapt to changing global trade dynamics.

The economic and trade impacts of the region's land use and environmental changes are profound and multifaceted. While there are significant opportunities for growth and diversification, there are also challenges that need to be addressed. Strategic planning, investment in infrastructure, and a focus on sustainable practices will be crucial in shaping a resilient and prosperous economic future.

## Gap Analysis

### Identified Gaps in Environmental Analysis

1. **Data Incompleteness:** There's a notable lack of comprehensive, long-term data in specific areas, particularly concerning the cumulative impact of land use changes on biodiversity and local microclimates. This gap hinders the ability to formulate effective conservation strategies and accurately predict future ecological trends.
2. **Community Engagement:** There's a gap in involving local communities, especially in disinvested regions, in environmental monitoring and policymaking. Their engagement is vital for the success of local environmental initiatives and in ensuring that policies align with community needs.
3. **Workforce Skill Discrepancy:** As the economy evolves, particularly with the growth of the green economy and tech-driven sectors, there's a growing gap in the skillset required by new industries versus what the existing workforce offers. This discrepancy could lead to higher unemployment rates or underemployment in certain sectors.
4. **Infrastructure Inadequacy:** The current infrastructure, especially in transportation and energy, is not fully equipped to handle the shift toward a more diversified economy and the increasing demands of trade and logistics. This gap could impede economic growth and efficient resource management.
5. **Policy and Regulatory Delays:** There's a lag in policy adaptation and regulatory frameworks catching up with the fast-paced economic and environmental changes. This delay can result in missed opportunities and inefficiencies in addressing emerging challenges.

## Addressing the Gaps

1. **Short-term Initiatives:** Immediate efforts can focus on enhancing data collection and analysis capabilities, investing in technology upgrades, and initiating workforce development programs to bridge skill gaps.
2. **Long-term Strategies:** These include infrastructure development plans aligned with future economic projections, policy reforms to facilitate swift adaptation to changing circumstances, and fostering long-term community engagement in environmental and economic planning.
3. **Not addressable Gaps:** Certain aspects, such as unpredictability in global economic trends or rapid technological advancements, remain challenging to address within the current scope and resources. These areas require continuous monitoring and flexible, adaptive strategies.

The gap analysis highlights the need for an integrated approach in addressing environmental and economic challenges. It calls for synergy between technological advancements, policy reforms, community involvement, and strategic planning. Bridging these gaps will not only foster a sustainable environment but also ensure economic resilience and growth in the face of changing global and local dynamics.

## Mitigation Strategies and Statewide Initiatives

Statewide initiatives have been formulated with six priorities, including strengthening protections for climate-vulnerable communities, bolstering public health, building a climate-resilient economy, accelerating nature-based solutions, making decisions based on robust climate science, and fostering partnerships to maximize resource leverage (Nature-Based Climate Solutions California Climate Smart Lands Strategy, 2022). These statewide efforts are mirrored in regional strategies, like those in the Thrive Inland SoCal Project, which focus on efficient energy use, renewable energy harnessing, waste recycling, and sustainable transportation modes. These local initiatives are crucial in achieving the state's ambitious GHG emission reduction goals. However, the effectiveness of these initiatives varies across regions, and their success depends on overcoming existing barriers such as cost-benefit transparency, funding clarity, and technological adaptation.

## Key Takeaways

### The key takeaways from this analysis

1. The primary focus on energy and transportation sectors for GHG emission reduction is evident in both state and regional strategies.

2. There is a growing need for alignment between statewide initiatives and regional action plans, especially in terms of resource allocation, policy support, and technological investment.
3. The efforts toward addressing climate change are comprehensive but require more focused implementation, considering the unique needs and vulnerabilities of different regions.

## Gap Analysis

This gap analysis aims to critically evaluate the climate mitigation strategies and initiatives at both state and regional levels, identifying areas where improvements are necessary and highlighting challenges that impede the effective implementation of these strategies.

### Identified Gaps in Climate Mitigation Strategies

#### 1. Data Collection and Analysis:

- **Current Status:** There's a notable deficiency in real-time data collection and advanced analytical capabilities.
- **Impact:** This gap hampers the ability to assess the effectiveness of mitigation strategies accurately and adaptively respond to changing climate scenarios.
- **Proposed Solution:** Investment in advanced monitoring technologies and data analysis tools.

#### 2. Workforce Development:

- **Current Status:** A significant gap exists in the skilled workforce needed to support emerging green technologies and sustainable practices.
- **Impact:** This limits the region's capacity to implement new technologies and adapt to sustainable practices effectively.
- **Proposed Solution:** Development and expansion of targeted training and educational programs.

#### 3. Infrastructure Upgrades:

- **Current Status:** Aging infrastructure, particularly in energy and transportation sectors, is not fully equipped to support emerging climate mitigation needs.
- **Impact:** This leads to inefficiencies and reduced effectiveness of climate action plans.

- **Proposed Solution:** Accelerated investment in infrastructure upgrades and integration of sustainable technologies.

#### 4. **Comprehensive Long-term Strategy:**

- **Current Status:** There is a lack of comprehensive, long-term strategies addressing the cumulative impacts of climate change.
- **Impact:** Short-term initiatives may not align with or contribute effectively to long-term climate goals.
- **Proposed Solution:** Development of integrated long-term strategies with clear goals and milestones.

#### 5. **Community Engagement and Equity:**

- **Current Status:** Insufficient engagement with diverse and disinvested communities in the planning and implementation phases.
- **Impact:** This can lead to inequitable distribution of resources and benefits.
- **Proposed Solution:** Enhance community involvement and ensure equitable distribution of climate mitigation benefits.

#### 6. **Technology Adaptation and Innovation:**

- **Current Status:** Slow adaptation of advanced renewable technologies due to regulatory, financial, and technical challenges.
- **Impact:** Hinderance in the transition to a sustainable, low-carbon economy.
- **Proposed Solution:** Streamlining regulatory processes, providing financial incentives, and fostering public-private partnerships.

#### **Notable Gap: Continuity of Programs**

- **Current Status:** A significant gap is the lack of continuity in climate mitigation programs, often due to changing political landscapes, funding inconsistencies, and shifting priorities.
- **Impact:** This discontinuity leads to fragmented efforts, loss of momentum in climate action, and inefficiency in resource utilization.
- **Proposed Solution:** Establishing policies and frameworks that ensure the longevity and consistency of climate programs regardless of political or economic changes.

Addressing these gaps requires a cohesive approach that combines technological innovation, policy reforms, enhanced data capabilities, and active stakeholder engagement. Ensuring the continuity and consistency of programs is crucial for long-term success. Collaborative efforts among government bodies, private sectors, and communities will be key to closing these gaps and achieving sustainable climate mitigation goals.

## Extreme Events and Resilience

This section examines the impacts of extreme weather events on Riverside and San Bernardino counties, exploring the regional risks and resilience strategies in place. Key areas of focus include heat events, droughts, wildfires, flooding, and landslides, with an emphasis on analyzing the current hazard prevention efforts and policies incentivizing risk mitigation. Additionally, the report provides a gap analysis to identify areas needing further attention or data.

### Analysis of Risks from Extreme Events

1. **Heat Events:** Riverside and San Bernardino counties face significant heat exposure risks, with a substantial portion of residences vulnerable to high heat due to climate trends. This risk is expected to increase energy use by about 10% in the next 30 years (Heat Risk Overview, 2023).
2. **Droughts:** Agriculture and ecosystems face the brunt of droughts, with impacts on water allocations and ecosystem health. Droughts intensify the likelihood and severity of wildfires (Escriva-Bou, Josué Medellín-Azuara, Ellen Hanak, & Joshua Viers, 2022).
3. **Wildfires:** These pose a notable risk, particularly in forested and rural areas and at the wildland-urban interface. Wildfires also degrade air quality across broader regions (Western Riverside Council of Governments, 2023 and Forest Service Region: Pacific Southwest, 2023).
4. **Floods:** Though overall flood risk is moderate, both counties are preparing for increased heavy precipitation events with infrastructure investments.
5. **Landslides and Debris Flows:** Exacerbated by wildfires and precipitation patterns, these pose threats to critical infrastructure and necessitate extensive recovery efforts (Western Riverside Council of Governments, 2023 and San Bernardino County).

### Strategies for Enhancing Regional Resilience

1. **Heatwave Mitigation:** Efforts are currently focused on public education and providing cooling centers, especially for vulnerable groups (California Governor's Office of Emergency Services, 2020).

2. **Drought Resilience:** Strategies include adjusting water delivery systems for better stormwater capture and groundwater recharge.
3. **Wildfire Prevention:** Programs encourage fire risk assessment and abatement, alongside strategies like the Fireshed Risk Reduction Strategy (Southern California Fireshed Risk Reduction Strategy, 2023).
4. **Flood and Landslide Management:** Investment in infrastructure, both green and gray, is crucial for managing stormwater and mitigating flood risks (Cal OES Governor's Office of Emergency Services, 2023).

## Preparedness Plans for Extreme Events

1. **Heatwave Response:** Establishing more cooling centers and public awareness programs.
2. **Drought Management:** Implementing water-saving technologies and alternative farming practices.
3. **Wildfire Preparedness:** Enhancing community awareness and readiness and strengthening emergency response systems.
4. **Flood and Landslide Readiness:** Upgrading drainage systems and establishing early warning systems.

## Gap Analysis

### Addressable Gaps

- Insufficient data on the impact of heatwaves on specific vulnerable populations.
- Limited public awareness and preparedness programs, particularly for wildfires.

### Long-Term Gaps

- Need for infrastructure upgrades to better withstand extreme weather events.
- Development of comprehensive plans for ecosystem management under changing climate conditions.

### Not addressable Gaps

- A gap in data on the impact of extreme events on the homeless population.
- Lack of an economic impact assessment of extreme events.

Riverside and San Bernardino counties are at a critical juncture in managing the risks posed by extreme events. A multifaceted approach that involves robust data collection, community engagement, adaptive policy development, and leveraging existing programs is essential. Filling the identified gaps and maximizing the use of existing strategies will be key in enhancing the region's resilience and readiness against these challenges.

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