

# **CO<sub>2</sub> Emissions Analysis Across New Zealand Regions (2007–2023)**

## **1. Project Objective**

The primary objective of this project is to **analyse and visualise carbon dioxide (CO<sub>2</sub>) emissions across New Zealand regions over time**, in order to:

- Understand **regional and temporal emission patterns**
- Identify **which regions and years recorded the highest CO<sub>2</sub> emissions**
- Examine **industry-level contributors** to emissions within each region
- Support **evidence-based sustainability and policy decision-making**

An interactive **R Shiny application** was developed to allow users to explore emissions dynamically by region, year, and industry.

## **2. Business Questions (Project Requirements)**

This project was designed to answer the following **key business and policy questions**:

1. **Which New Zealand region contributes the most to CO<sub>2</sub> emissions, and in which year?**
2. **How have CO<sub>2</sub> emissions changed over time within each region (2007–2023)?**
3. **What industries are the major contributors to CO<sub>2</sub> emissions in each region?**
4. **Are there observable reductions in emissions in recent years, and where are they most significant?**
5. **How can regional emission patterns inform sustainability strategies and policy interventions?**

These questions align closely with **public-sector, environmental monitoring, and sustainability analytics requirements**.

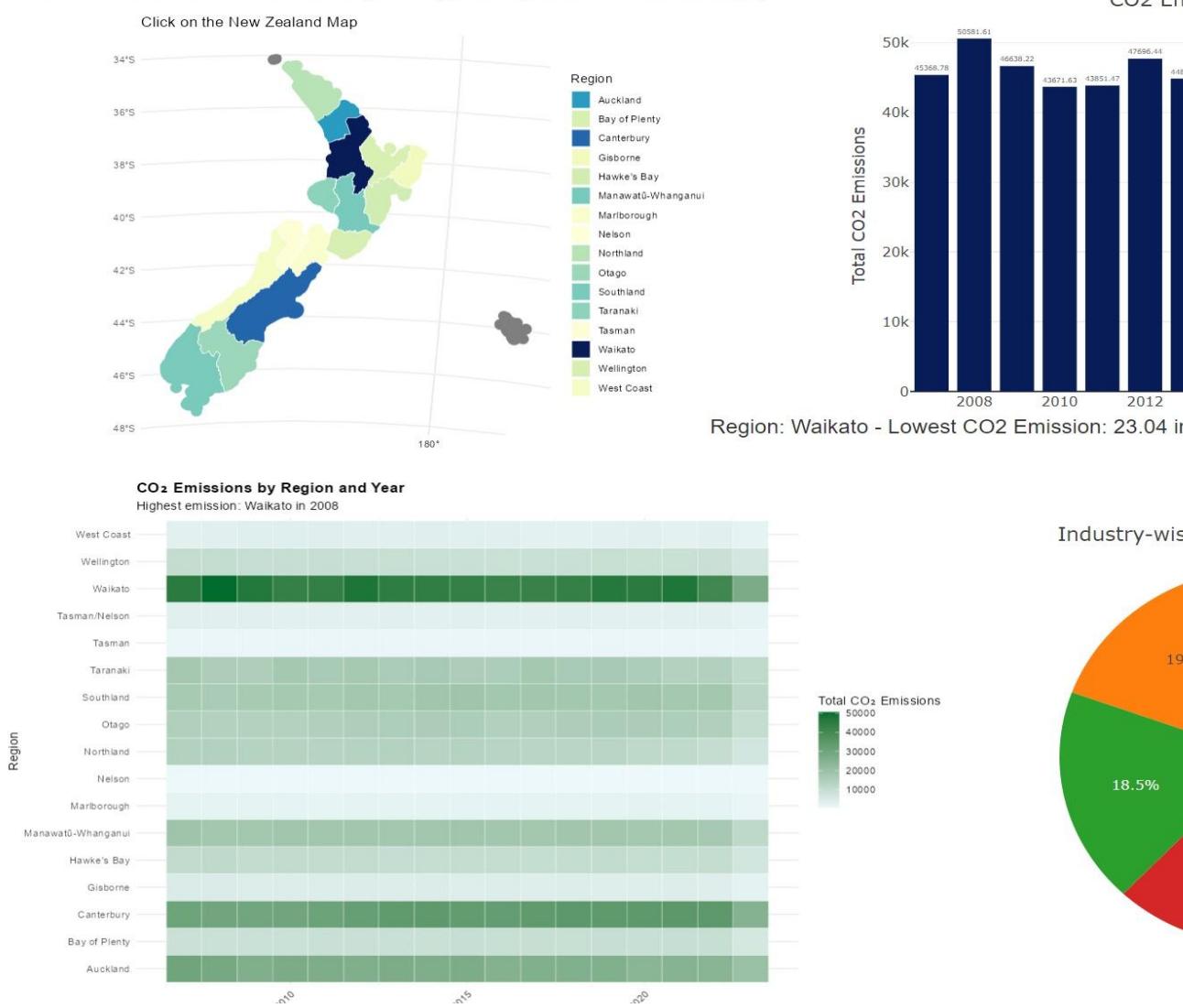
## **3. Data Overview & Preparation**

- **Source:** Stats NZ – Greenhouse gas emissions by region, industry, and household (Year ended 2023)
- **Time period:** 2007–2023
- **Records after cleaning:** ~7,800+
- **Gas type analysed:** Carbon dioxide equivalents only

## Key preparation steps included:

- Removing aggregated totals (“Total” and “Total all industries”) to avoid double counting
- Standardising region names to align with official New Zealand regional boundaries
- Aggregating emissions by **region, year, and industry**
- Handling missing and duplicate records

## CO2 Gas Emissions by Region (Clickable Map)



## 4. Visual Analytics & Insights

### 4.1 Regional Emissions Overview (Clickable Map)

The interactive New Zealand map provides a **high-level spatial overview** of CO<sub>2</sub> emissions by region.

### **Insight:**

- Regions such as **Waikato, Canterbury, and Auckland** consistently show **higher emission intensities** compared to smaller regions.
- The map acts as an entry point, allowing users to **drill down into region-specific trends**.

### **4.2 Emissions Trend by Region (Bar Chart)**

For a selected region, annual CO<sub>2</sub> emissions from **2007 to 2023** are displayed as a bar chart.

#### **Key observations:**

- Most regions show **relatively stable or rising emissions until the mid-2010s**.
- A **noticeable decline in emissions appears post-2020**, particularly in 2022–2023.
- This reduction is consistent across multiple regions, indicating **systemic rather than localised change**.

### **4.3 Highest Emitting Region and Year (Heatmap Analysis)**

A heatmap comparing **Region × Year** reveals the **global maximum emission point**.

#### **Key finding:**

- **Waikato recorded the highest CO<sub>2</sub> emissions in 2008**, making it the peak emission region-year combination in the dataset.

#### **Why this matters:**

- The heatmap enables **rapid identification of high-risk regions and periods**
- It supports **long-term trend monitoring** rather than isolated year analysis

### **4.4 Industry-Wise Emissions Breakdown (Pie Chart)**

For each selected region, emissions are broken down by industry.

#### **Consistent insights across regions:**

- **Primary industries**
- **Agriculture, forestry, and fishing**
- **Agriculture alone**

Together, these sectors account for **over 70–80% of total CO<sub>2</sub> emissions** in many regions.

#### **Regional variation:**

- Urban regions (e.g., Auckland) show relatively higher contributions from **households and service industries**
- Rural regions (e.g., Waikato, Canterbury, Manawatū-Whanganui) are dominated by **agriculture-related activities**

### **5. Key Takeaways**

1. **Waikato is the highest CO<sub>2</sub>-emitting region**, with the peak recorded in **2008**, highlighting its long-term environmental impact.
2. **Agriculture and primary industries are the dominant drivers of emissions** across most New Zealand regions.
3. **Post-2020 emission reductions** are visible across multiple regions, likely influenced by:
  - Increased renewable energy adoption
  - Changes in industrial activity
  - Post-COVID shifts such as remote and hybrid work
4. Emission patterns vary significantly by region, reinforcing the need for **region-specific sustainability strategies** rather than a one-size-fits-all approach.
5. Interactive visualisation (maps, trends, and industry breakdowns) enables **faster insight generation and better stakeholder understanding**.

### **7. Conclusion**

This CO<sub>2</sub> emissions analysis project successfully transforms complex, multi-year environmental data into **clear, actionable insights** through interactive visual analytics. By identifying emission hotspots, dominant industries, and long-term trends, the project supports informed decision-making and demonstrates the practical application of **data analytics in sustainability and public-sector contexts**.