

1. Climate Vulnerability Index

This index incorporates three dimensions: exposure (e.g., extreme heat and heavy precipitation), sensitivity (e.g., forest area as a buffer against climate events), and adaptive capacity (e.g., renewable energy adoption as a proxy for mitigation readiness). The final formula used is: $(0.25 * \text{extreme_heat_days} / 30 + 0.25 * \text{heavy_precip_days} / 20 + 0.25 * (1 - \text{forest_area_pct} / 100) + 0.25 * (1 - \text{renewable_energy_pct} / 100))$. The resulting value ranges from 0 to 1, where higher values denote greater climate vulnerability.

Data Source:

- The underlying data for this index comes from the World Bank World Development Indicators (WDI) for environmental variables and the NOAA Global Surface Summary of the Day (GSOD) dataset for climate metrics, both accessed via Google BigQuery.

Methodology:

- The Climate Vulnerability Index is a composite metric designed to capture a country's exposure and sensitivity to climate-related risks. It is calculated as follows:

Climate Vulnerability Index

$$= 0.25 \times \frac{\text{Extreme Heat Days}}{30} + 0.25 \times \frac{\text{Heavy Precipitation Days}}{20} + 0.25 \times \left(1 - \frac{\text{Forest Area \%}}{100}\right) + 0.25 \times \left(1 - \frac{\text{Renewable Energy \%}}{100}\right)$$

- Components:**
 - Extreme Heat Days* and *Heavy Precipitation Days* are derived from NOAA GSOD daily weather records.
 - Forest Area (% of land area)* and *Renewable Energy Consumption (% of total final energy consumption)* are from the World Bank WDI.
- Weighting:** Each component is equally weighted (25%).

2. Ecological Preservation Index

The formula used is: $(\text{forest_area_pct} / 100) * \text{SQRT}(\text{renewable_energy_pct} / 100)$. This captures the synergy between land conservation and clean energy use. Forest cover provides ecosystem services, while renewable energy reduces ecological stress.

Data Source:

- Both *Forest Area (% of land area)* and *Renewable Energy Consumption (% of total final energy consumption)* are sourced from the World Bank WDI.

Methodology:

- This index estimates the extent of ecological preservation by combining forest coverage and renewable energy adoption:

$$\text{Ecological Preservation Index} = \left(\frac{\text{Forest Area \%}}{100} \right) \times \sqrt{\text{Renewable Energy \%}}$$

- Interpretation:** Higher values indicate greater ecological preservation, reflecting both land protection and sustainable energy use.

3. Green Transition Score

Data Source:

- CO₂ Emissions (kt)*, *GDP (current US\$)*, and *Renewable Energy Consumption (% of total final energy consumption)* are all from the World Bank WDI.

Methodology:

- This score measures progress toward a low-carbon economy, balancing renewable energy uptake against carbon intensity:

$$\text{Green Transition Score} = \text{Renewable Energy \%} \times \left(1 - \left(\frac{\text{CO}_2 \text{ Emissions (kt)}}{\text{GDP (US\$)}} \times 0.00001 \right) \right)$$

- Interpretation:** Higher scores reflect a greater share of renewables and lower carbon intensity per unit of GDP.

3. Global Resilience Score

For years ≥ 2020 , the formula is: $(0.2 * (\text{gdp_per_capita} / 50000) + 0.2 * (1 - \text{co2_emissions_kt} / \text{gdp_usd} * 10000000000 / 1000) + 0.2 * (\text{life_expectancy} / 85) + 0.15 * (\text{internet_usage_pct} / 100) + 0.15 * ((\text{govt_effectiveness} + 2.5) / 5) + 0.1 * (1 - \text{case_fatality_rate}))$. Pre-2020 values omit the pandemic component and slightly adjust weights.

Data Source:

- This composite score integrates indicators from multiple sources:
 - Economic, health, environmental, and governance indicators from the World Bank WDI.
 - Digital indicators (internet and mobile use) from the World Bank WDI.
 - COVID-19 metrics from the Google BigQuery COVID-19 Open Data dataset.

Methodology:

- The score aggregates multiple normalized components, with weights adjusted for the pre- and post-pandemic periods. For years 2020 and later, the formula is:

$$\begin{aligned} \text{Global Resilience Score} = & 0.2 \times \left(\frac{\text{GDP per capita}}{50000} \right) + \\ & 0.2 \times \left(1 - \frac{\text{CO}_2 \text{ Emissions (kt)}}{\text{GDP (US\$)}} \times 10000000000 / 1000 \right) + \\ & 0.2 \times \left(\frac{\text{Life Expectancy}}{85} \right) + \\ & 0.15 \times \left(\frac{\text{Internet Usage \%}}{100} \right) + \\ & 0.15 \times \left(\frac{\text{Government Effectiveness} + 2.5}{5} \right) + \\ & 0.1 \times (\text{Pandemic Resilience Component}) \end{aligned}$$

- For years before 2020, the pandemic component is omitted and weights are slightly adjusted.
- **Pandemic Resilience Component:** Incorporates COVID-19 case fatality rate, hospital bed capacity, and vaccination coverage.

- The composite indices (Climate Vulnerability, Ecological Preservation, Green Transition, and Global Resilience) are custom calculations based on best practices in development and sustainability analytics. While inspired by frameworks such as the UNDP Human Development Index and various climate risk indices, the exact formulas are as detailed above and are not taken verbatim from any single published technical document.
- **To regenerate this dataset, run the SQL query provided in `worldbank_climate_covid_analysis.sql` through Google BigQuery (available via the [Google Cloud Console](#))**

Below are the public datasets referenced in the SQL code, all available in BigQuery:

1. World Bank World Development Indicators (WDI):

Contains economic, social, and environmental development metrics.

- [bigquery-public-data.world_bank_wdi.indicators_data](#)

2. World Bank Country Summary Metadata:

Country-level metadata such as region, income group, and currency.

- [bigquery-public-data.world_bank_wdi.country_summary](#)

3. NOAA Global Surface Summary of the Day (GSOD):

Daily climate data including temperature, precipitation, etc.

- [bigquery-public-data.noaa_gsod.gsod20*](#)
- [bigquery-public-data.noaa_gsod.stations](#)

4. COVID-19 Open Data by Google:

Includes country-level confirmed cases, deaths, recoveries, and vaccination data.

- [bigquery-public-data.covid19_open_data.covid19_open_data](#)