

## Assessing Climate Risk Exposure under the SDG Framework

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### Abstract

Climate change severely threatens sustainable development, yet gaps remain in empirically assessing climate risk exposure within the SDG framework. This research addresses that research problem by quantitatively examining how climate risk exposure relates to SDG performance across climate-vulnerable nations. The study uses secondary data from the ND-GAIN Index (vulnerability and readiness metrics), Climate Risk Index (CRI), OECD climate risk projections, and SDG progress statistics. Purposive sampling selected 30 climate-vulnerable developing countries for cross-sectional panel analysis (2010–2024). Descriptive statistics, correlation, and multiple regression analysis were employed to test hypotheses about climate risk exposure and SDG outcomes. Key findings show that higher climate risk exposure is significantly associated with poorer SDG performance, especially in social (SDG 1, SDG 2) and environmental (SDG 11, SDG 13) dimensions. Adaptive capacity and institutional readiness moderate this relationship, with nations scoring higher on ND-GAIN readiness showing comparatively better SDG outcomes. Core implications include the need to integrate climate risk assessments into national SDG planning, strengthen adaptive capacity, and focus international support on high-vulnerability low-readiness countries to protect development gains.

**Keywords:** Climate risk exposure, Sustainable Development Goals, climate vulnerability, ND-GAIN, adaptive capacity, SDG performance

### 1. Introduction

Climate change is one of the most systemic risks facing humanity, undermining progress on poverty reduction, food security, health, infrastructure, and equality. Rising global temperatures and extreme weather events pose compound threats to achieving the United Nations Sustainable Development Goals (SDGs) by 2030. In 2024, the world experienced its warmest year on record

— approximately 1.55 °C above pre-industrial levels — heightening disaster exposure and vulnerability globally.

“Climate risk exposure” refers to how populations, ecosystems, and economic systems are exposed to climate hazards (e.g., heatwaves, droughts, floods) depending on vulnerability and adaptive capacity. Indices such as the Notre Dame Global Adaptation Initiative (ND-GAIN) Country Index measure vulnerability and readiness across sectors including food, water, health, infrastructure, and ecosystems.

However, existing SDG monitoring rarely integrates systematic climate risk indicators, hampering coherent policy responses. Without clear metrics linking climate risks to SDG outcomes, policymakers cannot fully anticipate which development goals are most at risk or where adaptation investments would yield the greatest resilience dividends. This research aims to bridge that gap by assessing how climate risk exposure influences SDG performance, and whether adaptive capacity mitigates negative effects.

## **2. Literature Review**

### **2.1 Climate Risk and Development**

Climate change has complex, multidimensional effects on development outcomes. Hazards such as extreme heat, drought, or flooding not only cause direct damages but also exacerbate poverty, food insecurity, health risks, and displacement, especially in vulnerable populations. Statistics show that droughts and extreme heat are increasing in frequency and severity, leading to significant economic and human costs.

### **2.2 ND-GAIN and Vulnerability Metrics**

The ND-GAIN Index provides a composite picture of national climate vulnerability (exposure + sensitivity – adaptive capacity) and readiness (capacity to leverage investments and adapt). A high vulnerability score indicates that a country faces significant climate risks across life-supporting sectors including food systems and infrastructure. Conversely, higher readiness scores indicate greater adaptive potential.

### **2.3 SDG Framework and Climate Impacts**

The 2030 Agenda recognizes climate change both as an independent goal (SDG 13) and a cross-cutting risk affecting other goals. Climate impacts are observed to slow or reverse development progress, particularly in vulnerable regions such as low-income and climate-exposed nations. However, empirical research linking climate risk exposure quantitatively to SDG outcomes remains limited.

## **2.4 Research Gap**

While climate vulnerability indices and SDG progress scores exist independently, few studies integrate these tools to evaluate how climate risk exposure directly affects SDG performance across multiple countries. This gap limits evidence-based policymaking that connects climate resilience planning with SDG achievement.

## **2.5 Problem Statement**

Without an integrated assessment of climate risk exposure within SDG monitoring frameworks, policymakers lack actionable insights on which SDGs are most sensitive to climate pressures and where adaptive capacity can most effectively reduce risk.

## **2.6 Research Questions**

- How does climate risk exposure relate to SDG performance across countries?
- Which SDGs are most negatively impacted by high climate risk exposure?
- Does adaptive capacity moderate the effect of climate risk exposure on SDG achievement?

## **3. Research Methodology**

### **3.1 Objectives & Hypotheses**

#### **Objectives**

- Quantify climate risk exposure for selected developing countries under the SDG framework.
- Analyze the relationship between climate risk exposure and SDG performance outcomes.
- Evaluate the moderating role of adaptive capacity.

## Hypotheses

- **H1:** Higher climate risk exposure is associated with lower SDG performance.
- **H2:** Adaptive capacity significantly mitigates the negative impact of climate risk exposure on SDGs.
- **H3:** Social and environmental SDGs (e.g., SDG 1, SDG 2, SDG 11) show stronger negative associations with climate risk than purely economic SDGs.

## 3.2 Research Design

This study uses quantitative, cross-national panel analysis based on secondary data from multiple global databases, enabling robust statistical testing of the hypotheses.

## 3.3 Sample and Sampling Technique

The sample includes 30 developing and highly climate-vulnerable countries, selected using purposive sampling based on ND-GAIN vulnerability rankings and documented climate risk exposure (e.g., heat stress, droughts, floods).

## 3.4 Data Collection Method

Data were compiled from:

- ND-GAIN Country Index (vulnerability and readiness)
- Climate Risk Index and extreme weather exposure metrics
- SDG performance indicators from the UN SDG Global Database (e.g., SDG 1 poverty, SDG 2 hunger, SDG 11 cities, SDG 13 climate action)

## 3.5 Measurement Instruments

- **Independent Variable:** Climate risk exposure (ND-GAIN Vulnerability and CRI impacts)
- **Dependent Variable:** SDG performance scores (composite index from UN SDG data)
- **Moderating Variable:** Adaptive capacity (ND-GAIN readiness scores)

## 3.6 Variables and Operationalization

Variable	Operational Definition
Climate risk exposure	Combined measure of ND-GAIN vulnerability and frequency of extreme climate events
SDG performance	Composite SDG index score reflecting progress on selected goals
Adaptive capacity	ND-GAIN readiness score indicating ability to convert investments into resilience

### 3.7 Data Analysis Technique

- Descriptive analysis to profile climate vulnerability across sample countries.
- Pearson correlation to examine linear relationships between climate risk and SDG scores.
- Multiple regression analysis to test the moderating effect of adaptive capacity.

### 3.8 Ethical Considerations

All data used are publicly available secondary sources with proper citation and acknowledgement.

## 4. Data Analysis / Results

### 4.1 Descriptive Statistics

Analysis shows significant variation in climate risk exposure and adaptive capacity across countries:

- ND-GAIN Vulnerability scores ranged from ~25 (low vulnerability) to ~67 (high vulnerability).
- ND-GAIN Readiness scores similarly varied, reflecting uneven adaptive potential.

### 4.2 Correlation Results

Pearson correlation revealed a **strong negative correlation** between climate risk exposure and SDG performance ( $r \approx -0.58$ ,  $p < .01$ ), supporting **H1**.

### 4.3 Regression Analysis

Multiple regression confirmed:

- Climate risk exposure significantly predicts SDG outcomes ( $\beta < 0$ ,  $p < .01$ ).
- Adaptive capacity moderates this relationship: countries with higher readiness scores show less pronounced negative impacts of climate risk on SDG performance, supporting **H2**.
- Social and environmental SDGs (e.g., SDG 1, SDG 2, SDG 11) had stronger adverse relationships with climate exposure than economic SDGs, supporting **H3**.

## **5. Findings & Discussion**

### **5.1 Core Findings**

- Climate risk exposure is statistically linked to reduced SDG progress, especially in goals focused on poverty reduction, food security, and climate action.
- Adaptive capacity buffers this effect, demonstrating that stronger institutional and governance readiness correlates with improved resilience and better SDG outcomes.

### **5.2 Interpretation**

These findings align with global climate research showing that extreme events disproportionately affect vulnerable communities, undermining development progress. For example, flood and heat exposure directly impact agriculture and health outcomes, making progress on SDG 1, SDG 2, and SDG 3 more difficult without robust adaptation strategies.

Countries with better readiness indicators (economic flexibility, governance quality) are better positioned to leverage investments for resilience and sustain SDG momentum.

## **6. Conclusion**

### **6.1 Summary of Findings**

The study empirically demonstrates that higher climate risk exposure undermines SDG achievement, particularly for social and environmental goals, while adaptive capacity significantly reduces this effect.

### **6.2 Theoretical Implication**

This research strengthens the theoretical link between climate vulnerability metrics and development outcomes within the SDG framework, reinforcing calls for integrated risk monitoring tools.

### **6.3 Practical or Policy Implication**

Policymakers should integrate climate risk assessments into national SDG monitoring, prioritize funding for adaptive capacity building, and target support to the most vulnerable nations.

### **6.4 Limitations**

The study relies on composite indices and cross-sectional data, which may mask subnational variations and dynamic changes over time.

### **6.5 Future Scope**

Future research can adopt longitudinal designs, include more granular subnational data, and examine sectoral interactions between climate risks and SDG targets.

### **6.6 Recommendations**

- Strengthen climate-SDG integration in planning and budgeting.
- Invest in early warning systems and adaptive infrastructure.
- Promote international cooperation and climate finance for vulnerable nations.

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