

INTEGRATING POLLUTANT REGISTERS FOR THE CLIMATE CHANGE RISK EVALUATION OF INDUSTRIAL COMPANIES IN AUSTRALIA, EUROPE AND NORTH AMERICA

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ABSTRACT

We present a methodology for the **integrated climate change transition and physical risk assessment** of industrial companies in Europe, North America, and Australia, based on publicly available pollutant release and greenhouse gas reporting data.

- **70,000 companies** and **170,000 plants** across 30+ countries, drawn from harmonised PRTR and GHG reporting programs
- **Transition risk:** measured via reported GHG emissions
- **Physical risk:** flood exposure (historical water depth), EO heat risk (cooling degree days), and EO meteorological photovoltaic power potential
- **Key finding:** transition and physical risks are *not correlated* — firms with low emissions may face high physical risk and vice versa

Keywords: PRTR, GHG reporting, climate risk, transition risk, physical risk, TCFD, CSRD, ESG, flood, heat, photovoltaic

KEY RESULTS

Table 1: Descriptive statistics (N = 69,028 plants; GHG: 2019)

| Indicator | Mean | SD | Min | Max | Unit |
|-----------------|--------|---------|-----|------------|----------------------|
| Heat risk (CDD) | 397 | 491 | 0 | 3,904 | degree-days |
| Flood risk | 0.4 | 2.1 | 0.0 | 30.0 | m depth |
| PV potential | 3.6 | 0.8 | 0.0 | 5.6 | kWh/kWp |
| GHG emissions | 66,852 | 495,241 | 0 | 32,700,000 | t CO ₂ eq |

Table 2: Pairwise Pearson correlations at plant level

| | GHG | Flood | CDD | PV |
|------------------|------|-------|---------------|---------------|
| GHG (transition) | 1.00 | ≈0 | ≈0 | ≈0 |
| Flood risk | ≈0 | 1.00 | ≈0 | ≈0 |
| Heat risk (CDD) | ≈0 | ≈0 | 1.00 | +0.57* |
| PV potential | ≈0 | ≈0 | +0.57* | 1.00 |

≈0 = consistently low across countries; *significant. Exception: CDD–PV positive correlation driven by shared solar exposure. All other pairs near zero at plant level in all 30+ countries.

Key finding — transition and physical risks are not correlated. GHG vs. flood: $r \approx 0$ in all countries. GHG vs. heat: $r \approx 0$. A clean-energy firm may face severe flood or heat risk; a large emitter may operate in a climate-benign location. Carbon footprint alone is an *insufficient* climate risk indicator.

Geographic risk patterns:

- **Heat risk highest:** US (Southern states), Spain, Italy, Australia; *lowest:* Canada, Northern Europe
- **Flood risk highest:** Central Europe; Eastern US states
- **PV potential highest:** Australia, Spain; *lowest:* Northern Europe
- **GHG concentrated:** Central EU, UK, Eastern US; highest average in Iceland, US, Denmark, Greece
- **CDD–PV correlation:** positive in HU (0.82), ES (0.61), PT (0.58), AU (0.52); *negative* in LT (−0.80), CY (−0.52), BE (−0.50) — place-variant, interpret with caution

MOTIVATION & POLICY CONTEXT

Climate risk disclosure is now a regulatory requirement in many jurisdictions. The **EU Corporate Sustainability Reporting Directive (CSRD)** and global **TCFD** frameworks demand standardised, granular, and comparable assessments — yet most tools cover only the largest listed companies.

This study contributes:

- First **cross-continental** integration of PRTR and GHG data for climate risk: E-PRTR (EU), TRI (US), NPRI (Canada), NPI (Australia)
- Assessment of **both transition and physical risks** at the facility level and parent company level
- Demonstrates that **carbon footprint alone** is insufficient as an overall climate risk indicator
- Supports **CSRD and ESG rating** coverage extension to ~70,000 companies beyond the few thousand covered by standard providers
- Methodology freely reproducible from public data; tables in Mendeley Data (doi:10.17632/bcw3b2jcx.1)

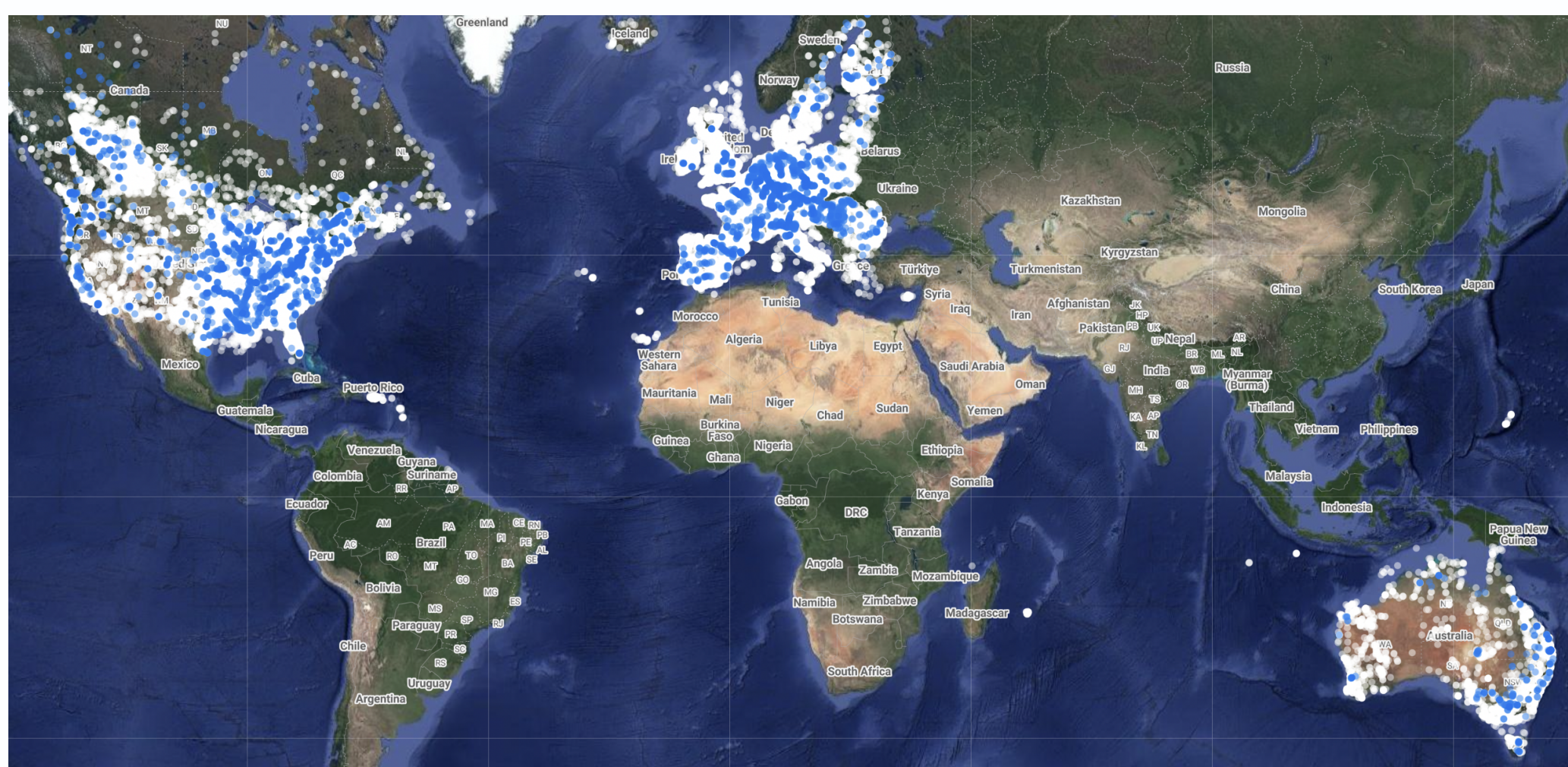


Figure 1: Flood exposure of industrial company sites (blue bubbles = flood risk; white = no historical flood risk)

DATA SOURCES & INTEGRATION

Pollutant Release & Transfer Registers (PRTRs):

- E-PRTR — EU + CH, NO, IS (27+ countries)
- TRI — United States EPA
- NPRI — Canada
- NPI — Australia

GHG Reporting Programs: US EPA GHGRP, Australia NGER, Canada GHG reporting, **Facilities matched across programs** using unique identifiers; ~170,000 plants with annual emissions and coordinates.

Climate risk indicators (at facility level):

- **Transition risk:** GHG emissions (CO₂eq, kt)
- **Flood risk:** historical water depth in metres from GloFAS river discharge data (0–30 m range in sample)
- **Heat risk:** cooling degree days (CDD), 1970–2018 historical average (0–3,904 CDD range)
- **Solar potential:** photovoltaic power potential (kWh/kWp/year) from satellite irradiance data

REFERENCES

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- [2] Erhart, S. & Erhart, K. Environmental ranking of European industrial facilities by toxicity and global warming potentials. *Sci. Rep.* **13**, 1772 (2023).
- [3] Data: Mendeley Data V1. doi:10.17632/bcw3b2jcx.1

DISCUSSION

Why standard ESG ratings are insufficient:

- Most ESG rating providers cover only a few **thousand listed companies**; this methodology covers ~70,000 industrial companies using public data
- **GHG emissions alone** capture transition risk but miss physical risks: a clean-energy firm may be in a flood plain or extreme-heat zone
- **Fragmented registers** (PRTR, GHG programs) need harmonisation; methodology demonstrates this is achievable across 30+ countries
- **Facility-level granularity** enables parent-company aggregation — essential for investors and CSRD compliance

Regulatory implications:

- The **EU CSRD** and analogous frameworks require standardised physical and transition risk disclosures — this methodology provides a low-cost, publicly-data-based template
- **TCFD alignment:** both transition (GHG) and physical (flood, heat) pillars covered at facility level
- Methodology supports the **EU Omnibus ESG Regulation** simplification goal: comparable, verifiable data from existing reporting infrastructure

CONCLUSIONS

- **Transition and physical risks are not correlated** — integrated assessment of both dimensions is essential for investors, regulators
- **PRTRs and GHG reporting programs** are a rich, underutilised resource for large-scale climate risk assessment
- **Carbon footprint alone** cannot serve as a proxy for overall climate performance
- The methodology is **reproducible, scalable, and regulation-ready**: supports CSRD, TCFD, and ESG rating extension
- **Next steps:** integrate real-time physical risk data (satellite flood, SAR) — see companion flood-risk study

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Paper: doi.org/10.1038/s41598-024-82533-1

Corporate risk platform: <https://www.r6bros.eu>