CAUSENTIA: Open-Source Sovereign Crisis Early Warning System — Software & Dataset

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Abstract

*This publication documents the CAUSENTIA software platform and its associated dataset. CAUSENTIA is an open-source sovereign crisis early warning system monitoring 80 countries using 25+ indicators from the World Bank, FRED, and GDELT. The software includes a Python FastAPI backend, JavaScript frontend, dual **AI** engine (Claude + GPT), and six RESTful API endpoints. The dataset includes current and historical Collapse Index scores, Human Development Index calculations, Monte Carlo simulation results, and contagion network definitions for all monitored countries. All materials are released under the MIT License.*

Keywords: open-source, sovereign risk, dataset, API, early warning system, reproducibility

1. Software Description

1.1 Architecture

Component	Technology	Description
Backend	Python FastAPI + httpx	Async data fetching, CI computation, API endpoints
Frontend	Vanilla JS + CSS + SVG	Interactive dashboard, charts, network visualization
AI Engine	Claude Sonnet + GPT-4o-mini	Dual-engine analysis with auto-routing
Deployment	Ubuntu 24 + Nginx + PM2	Production server with SSL and process management
Caching	File-based, 6hr TTL	Reduces API calls from 90s to 2s response time

Table 1: Software architecture components.

1.2 API Endpoints

Method	Endpoint	Description
GET	/api/health	System health check
GET	/api/data	Full dashboard (80 countries, all indicators)
GET	/api/country/{code}	Single country deep analysis
GET	/api/montecarlo/{code}	10,000-scenario Monte Carlo simulation
POST	/api/scenario	Custom what-if scenario simulation
POST	/api/chat	AI-powered natural language analysis

Table 2: RESTful API endpoints.

1.3 Platform Features (12 Innovations)

- **1.** Country Deep Dive (single-country analysis with 25+ indicators)

- **2.** Regional Heatmap with CI/HDI toggle
- **3.** Scenario Builder (6 preset macroeconomic shocks)
- **4.** Human Development Index integration (6 indicators)
- **5.** Country Comparison Engine
- **6.** AI Analyst Chat (Claude + GPT, English/Arabic)
- **7.** Custom Scenario Builder (8 interactive sliders)
- **8.** PDF Report Generator (professional A4 reports)
- **9.** Early Warning System (4-tier alerts + trajectory matrix)
- **10.** Interactive API Documentation
- **11.** Contagion Network (SVG visualization, 85+ links)
- **12.** Alert System with email subscription and webhooks

2. Dataset Description

2.1 Country Coverage

80 countries across 6 regions: MENA (15), Sub-Saharan Africa (18), Latin America (14), Europe (15), Asia-Pacific (15), North America (3). Coverage represents ~95% of global GDP and ~85% of world population.

2.2 Indicators

Category	Count	Examples
Economic Stress	8	Inflation, GDP growth, debt/GDP, reserves, unemployment
Absorption Capacity	5	Trade openness, FDI, M2/GDP, domestic credit, gov. expenditure
Governance (WGI)	5	Political stability, effectiveness, rule of law, corruption, regulatory
Human Development	6	Life expectancy, literacy, poverty, undernourishment, maternal mortality
Market Indicators	5	VIX, oil price, gold, DXY, EMBI spread (from FRED)
Sentiment	2	GDELT news tone and article volume

Table 3: Dataset indicator categories.

3. Installation and Usage

Requirements: Python 3.10+, Node.js 18+, pip, npm.

```
git clone https://github.com/causentia/causentia.git
cd causentia/backend && pip install -r requirements.txt
uvicorn api.main:app --host 0.0.0.0 --port 8000
```

4. License and Citation

All software and data are released under the **MIT License**. If you use CAUSENTIA in academic work, please cite:

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Ibrahim, M. (2026). CAUSENTIA: Open-Source Sovereign Crisis
Early Warning System. Zenodo. https://doi.org/10.5281/zenodo.18584024
```

5. Reproducibility

CAUSENTIA is designed for full reproducibility. Related computational capsules are published on Code Ocean (18 capsules, 11 featured on the platform's main page). The live system at causentia.org provides real-time verification of all published results.