



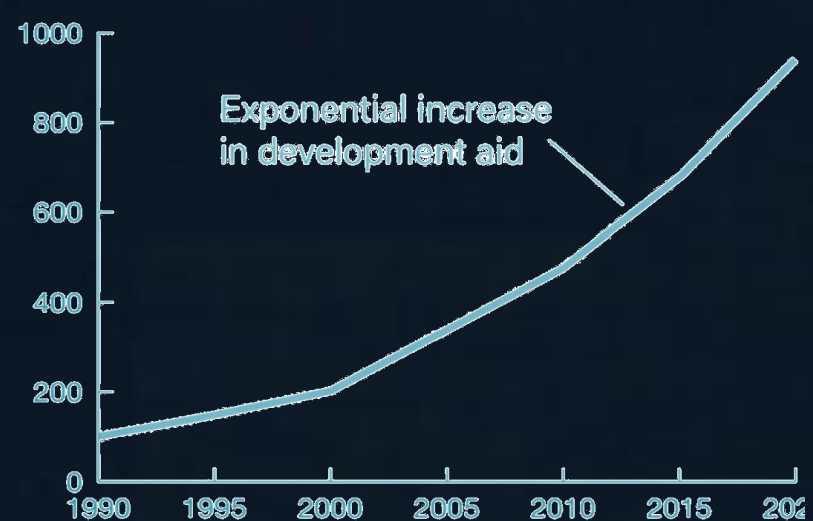
Fractal Mathematics of Global Deprivation: New Evidence for Scale-Invariant Complexity

Najoua Soudi, Dounia Zaidouni, Ikram El Asri. Mathematics and Networks Department National Institute of Posts and Telecommunications.

Introduction

- Despite decades of effort and trillions in aid, multidimensional poverty persists as a stubborn, systemic challenge. **This suggests a fundamental mismatch between the problem's nature and our tools for solving it.**
- Poverty is modeled on a line. What if its True Geometry is a Fractal? **Research Question: We investigate whether global poverty exhibits scale-invariant fractal properties.**

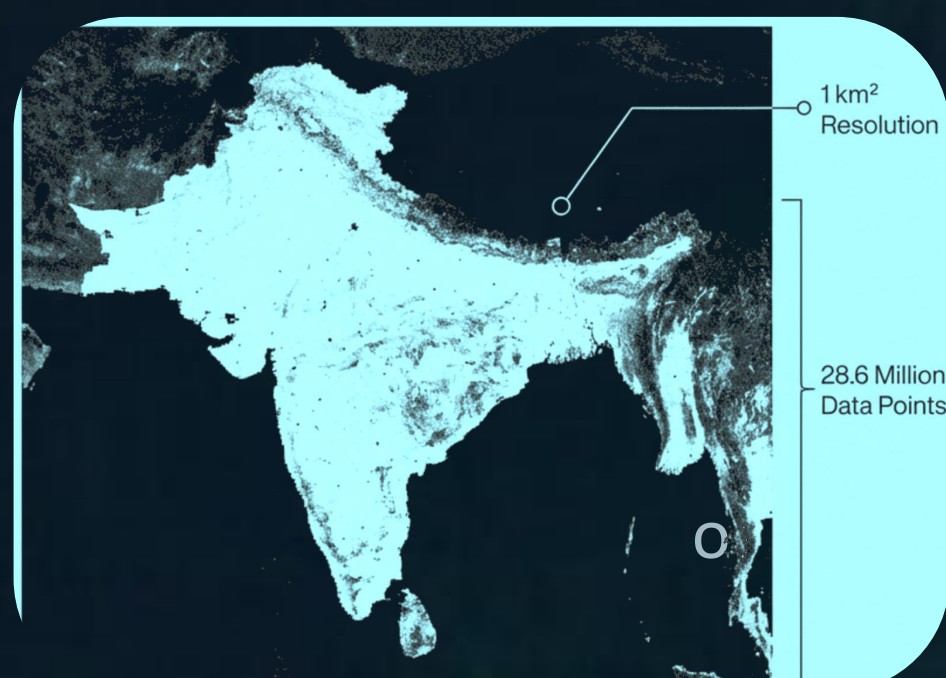
Global Resource Input (1990-2020)



Methodology

Resolution:

~1km²pixels synthesizing health, education, and living standards. We are no longer looking at averages; we are looking at the raw architecture deprivation.



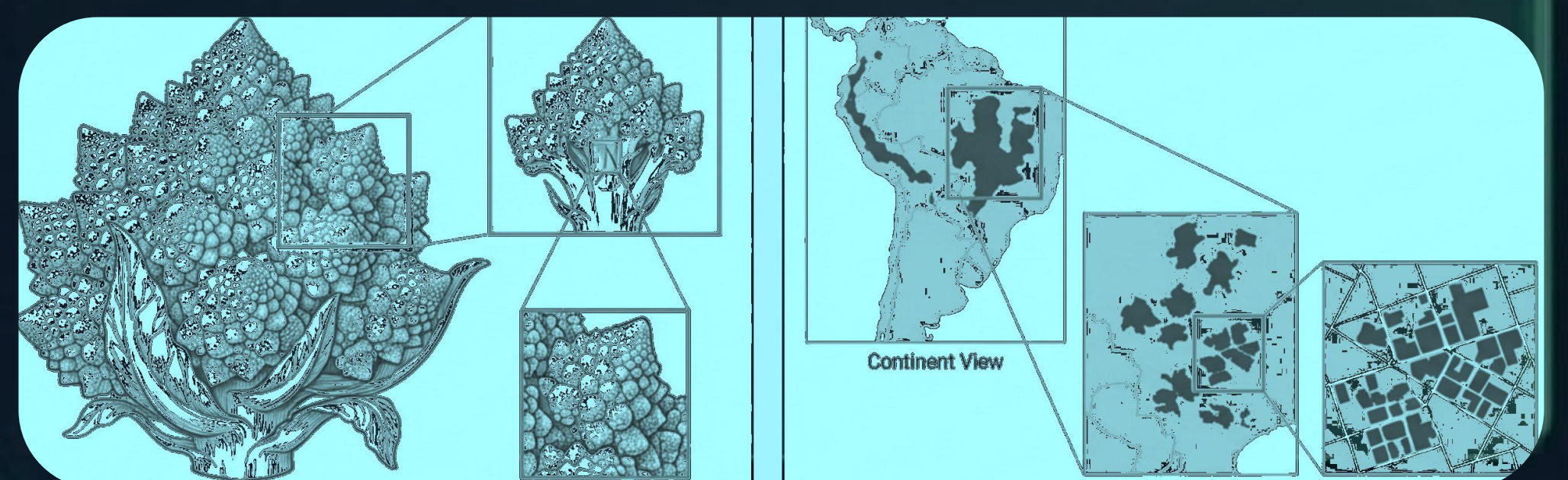
1. Binarize GRDI data (Deprivation Threshold ≥ 60).
2. Overlay square boxes of side length ϵ .
3. Count $N(\epsilon)$ (boxes with at least one deprived pixel).
4. Plot $\log N(\epsilon)$ versus $\log(1/\epsilon)$.

$$D = \lim_{\epsilon \rightarrow 0} \frac{\log N(\epsilon)}{\log \frac{1}{\epsilon}}$$

The slope of the resulting regression line is the Fractal Dimension (D). This quantifies the 'roughness' and space-filling nature of the deprivation.

Results & Discussion

Global deprivation exhibits robust fractal geometry. The Coefficient of Variation (CV) is < 5% across scales. Poverty won't be solved at the village level without understanding the regional, national (and continental) ripple effects. They are mathematically linked.

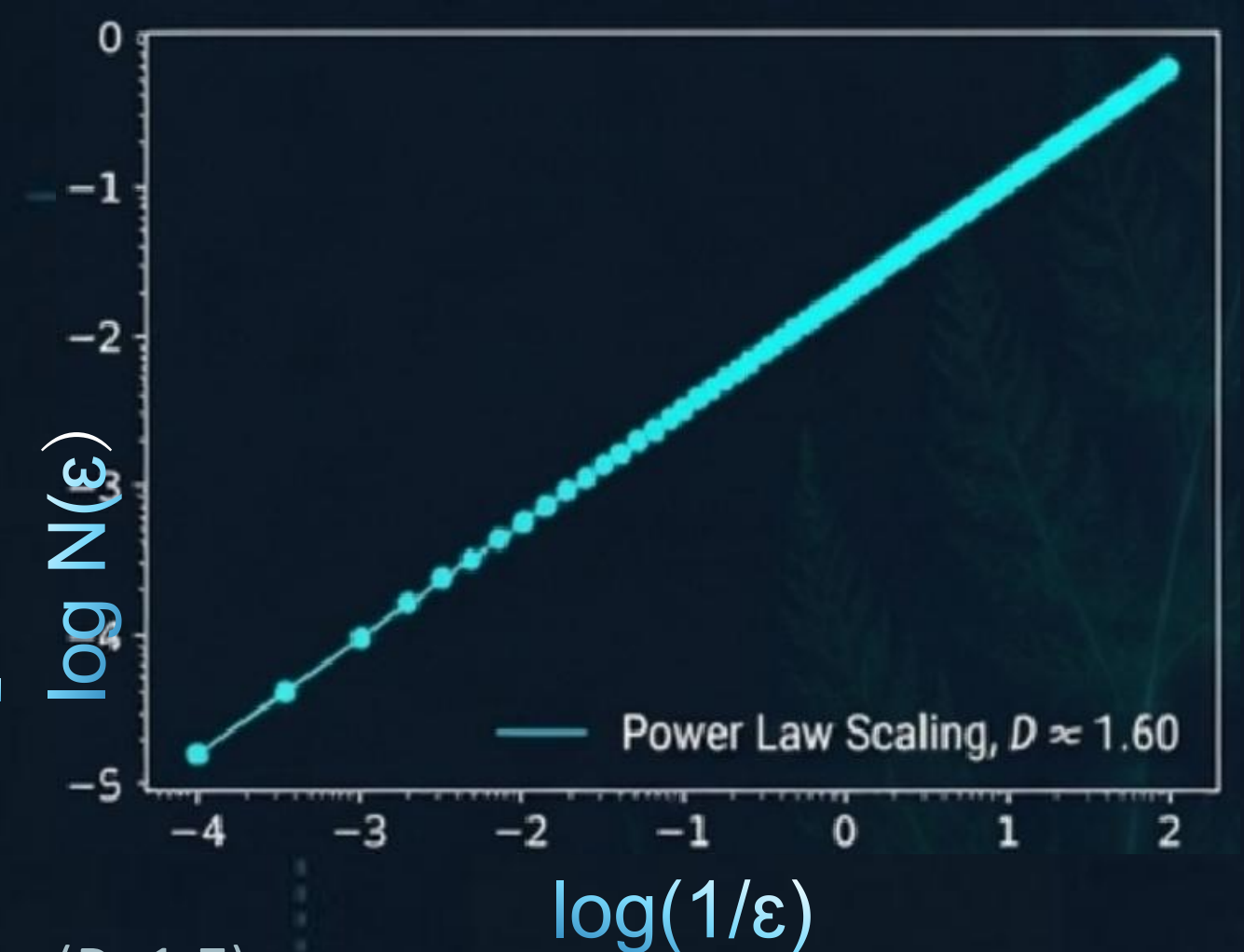


Evidence

• $R^2 = 0.997$
(Mean powerlaw scaling fit)

• ANOVA p
= 7.28×10^{-10}

(Confirming extreme regional heterogeneity)
High fractal dimension ($D > 1.7$)
encodes **systemic fragility**.



The path out of poverty might be written in the same mathematical language as a coastline or a fern.

$$D = 1.658 \pm 0.123.1$$

To our knowledge, first empirical proof that global poverty is a self-affine fractal.

