Hazard, Risk and Prediction Figures

Stefan Hergarten
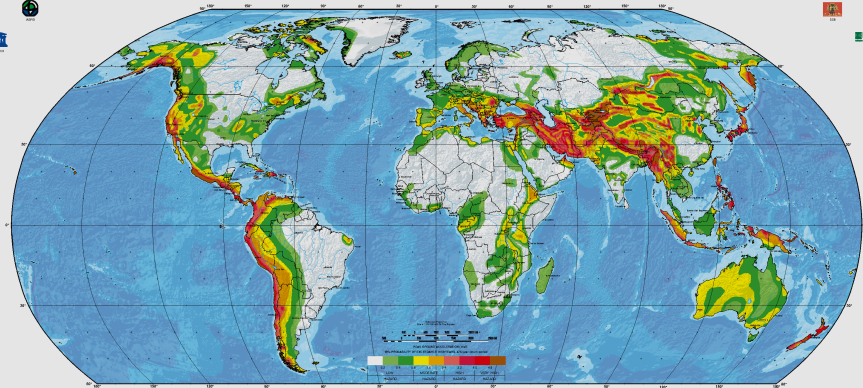
Institut für Geo- und Umweltnaturwissenschaften
Albert-Ludwigs-Universität Freiburg

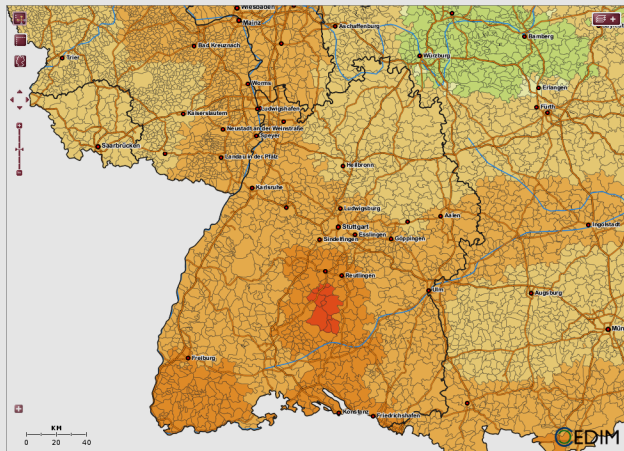## Worldwide Earthquake Hazard

Source: Global Seismic Hazard Assessment Program

Regional Earthquake Hazard

Source: CEDIM Risk Explorer (KIT / GFZ Potsdam)

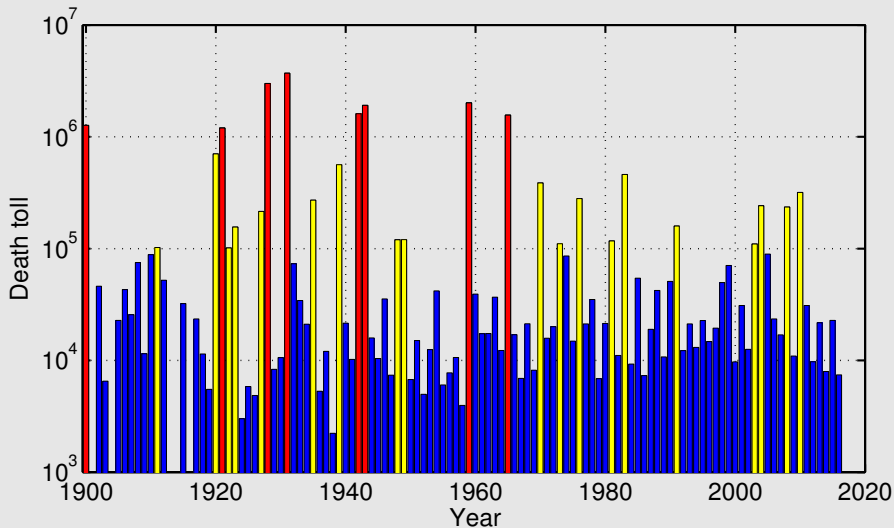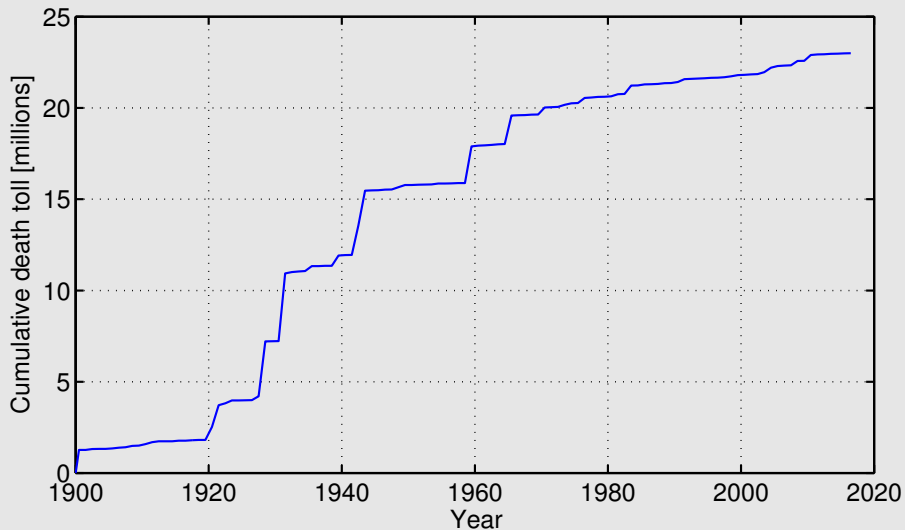# Hazard and Risk

Regional Earthquake Risk
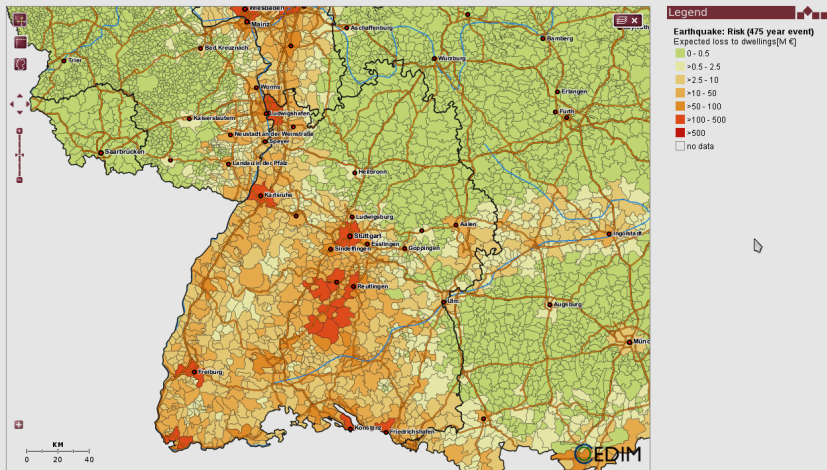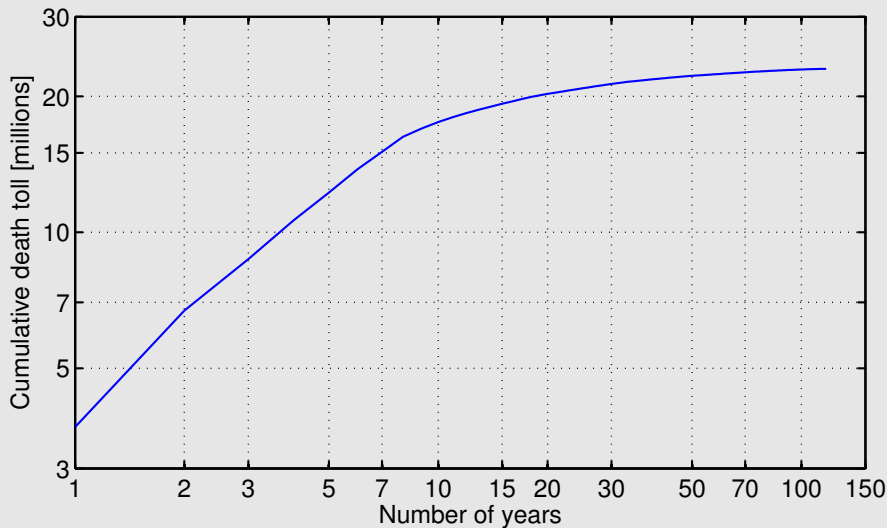

Source: CEDIM Risk Explorer (KIT / GFZ Potsdam)

Worldwide Death Toll of all Geohazards since 1900

Hazard and Risk
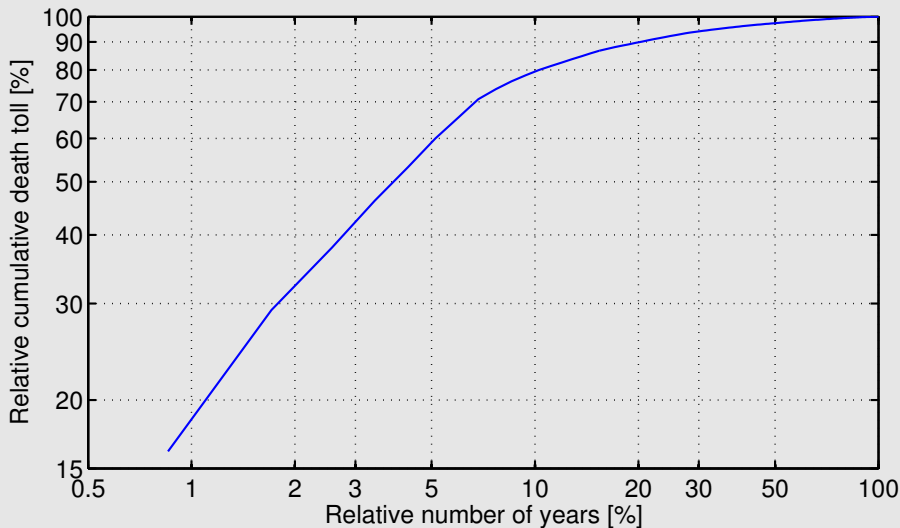
Worldwide Death Toll of all Geohazards Since 1900

Hazard and Risk

Pareto Diagram of all Geohazards Since 1900

Hazard and Risk

Pareto Diagram of all Geohazards Since 1900

Frequency-Magnitude Relations

Binning

Frequency-Magnitude Relations

Cumulative Distribution

Frequency-Magnitude Relations

Cumulative Distribution

Frequency-Magnitude Relations
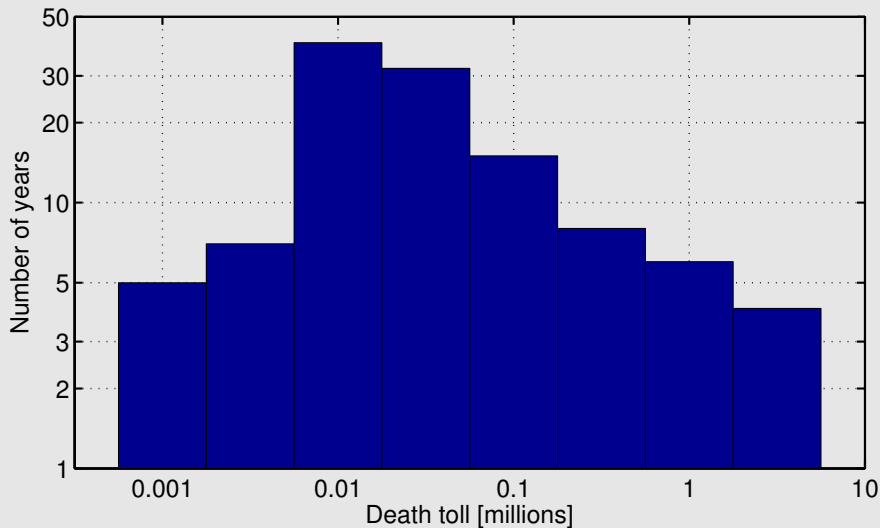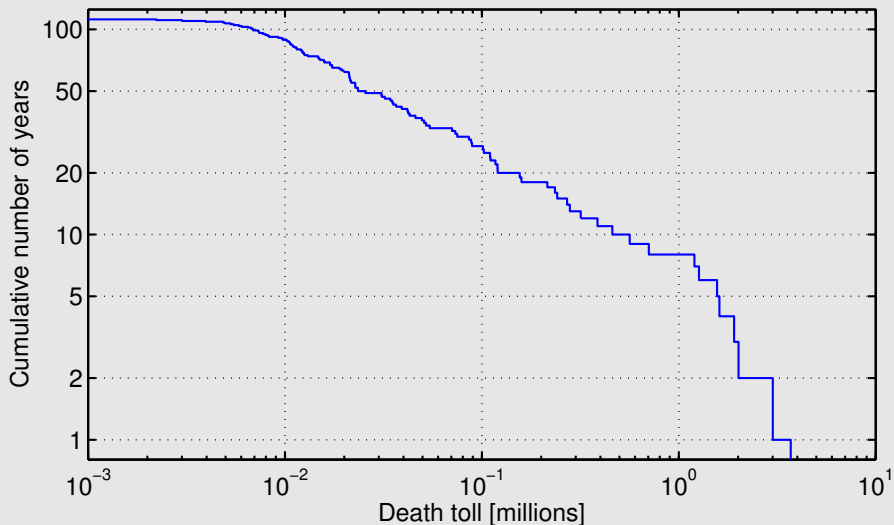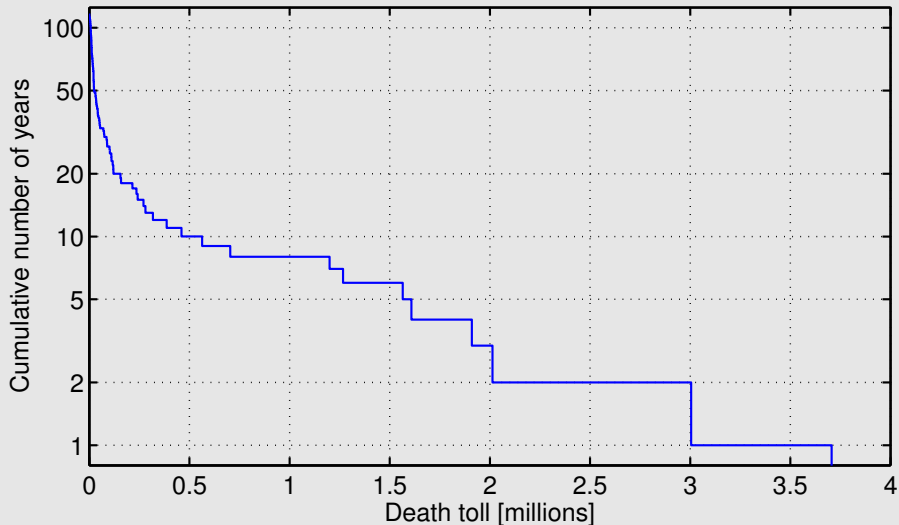
Cumulative Frequency

$$F(s) = \text{expected number of events with sizes} \geq s$$

- Can be either considered for a given region (or worldwide) or per domain size (area).
- Can be either considered for a given time interval or per time.
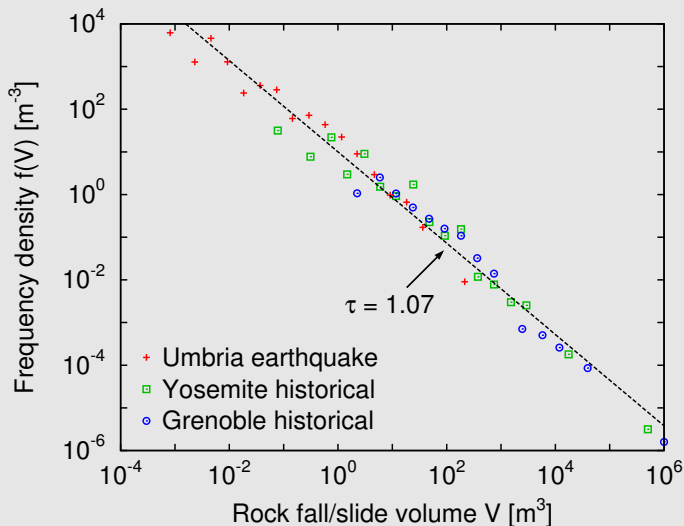- Often called frequency-magnitude relation.
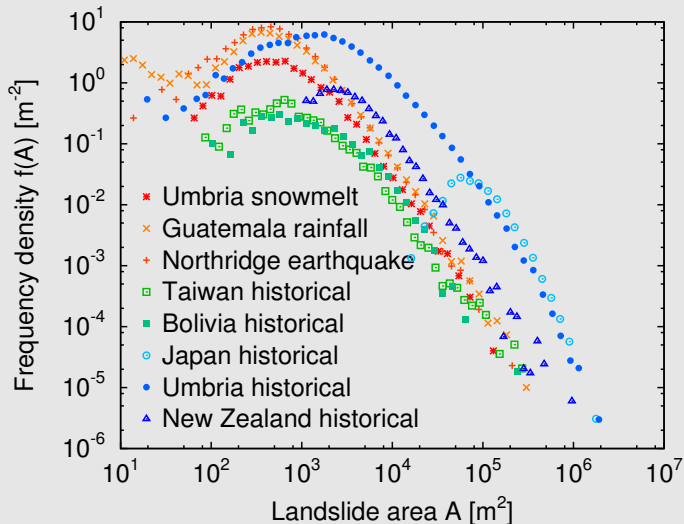
Frequency Density

$$f(s) \;=\; -F'(s)$$

so that

$$\int_{s_1}^{s_2} f(s)\, ds \;=\; F(s_1) - F(s_2)$$

is the expected number of events with sizes between s_1 and s_2.

Frequency-Magnitude Relations

Frequency Density of Rockfalls

Frequency-Magnitude Relations

Frequency Density of Regolith Landslides

Cumulative Probability

$$P(s) \;=\; \frac{F(s)}{F(s_0)}$$

(s_0 = smallest possible event size) is the probability that the size of a randomly picked event is $\geq s$.

- Often $s_0 = 0$ or $s_0 = -\infty$
- In mathematics defined as the probability that a value drawn from a random distribution is $\leq s$.

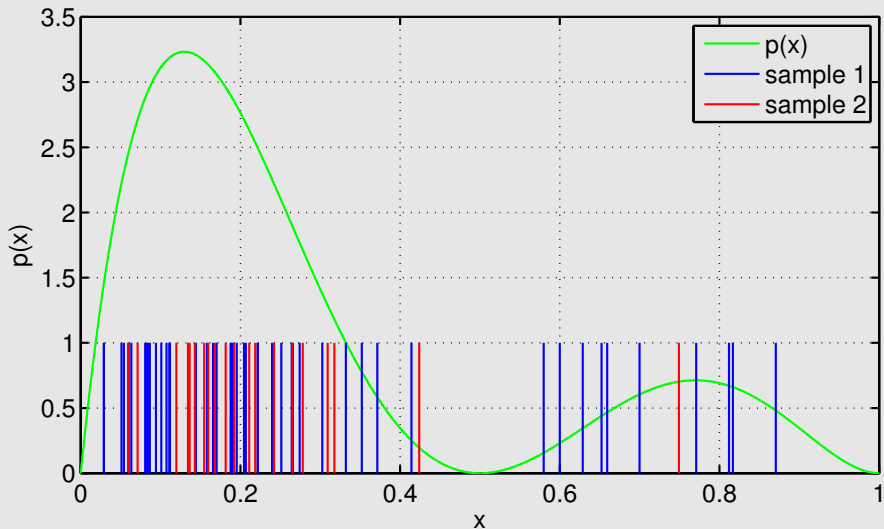# Frequency-Magnitude Relations

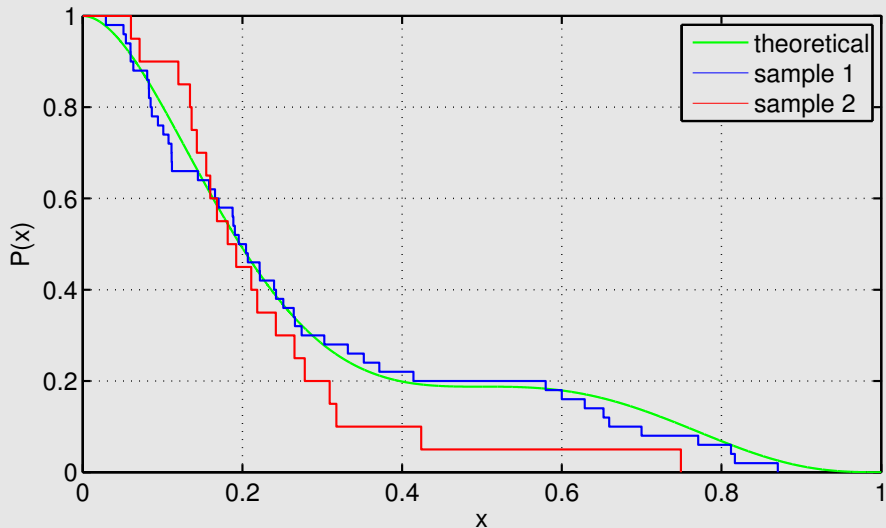## Probaility Density

$$p(s) = -P'(s)$$

so that

$$\int_{s_1}^{s_2} p(s)\, ds = P(s_1) - P(s_2)$$

the is the probability that the size of a randomly picked event is between s_1 and s_2.
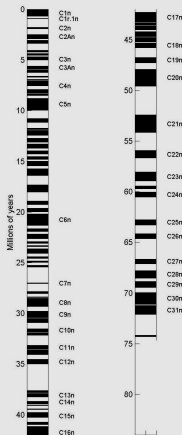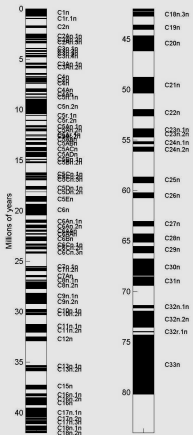
Kolmogorov-Smirnov Test

Statistical Tests

Kolmogorov-Smirnov Test

Waiting Time Distributions
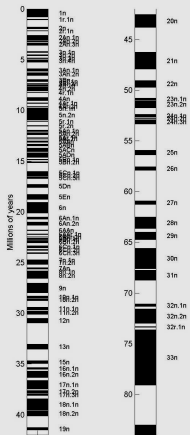
Magnetic Field Reversals
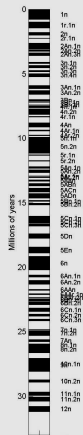
Quelle: Woods Hole Oceanographic Institution

Waiting Time Distributions

Magnetic Field Reversals

Assessment of Predictions
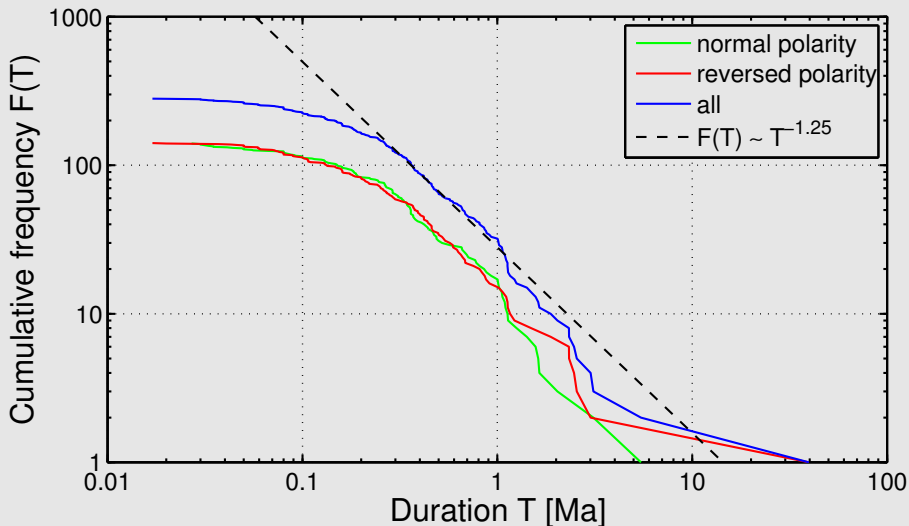
Receiver Operating Characteristic Curves
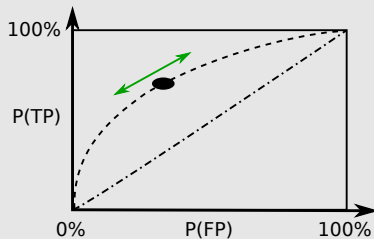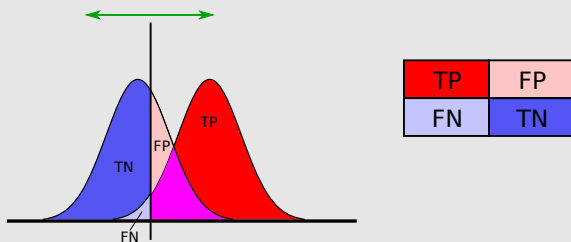
Source: Wikipedia, ©Sharpr

Self-organized Criticality
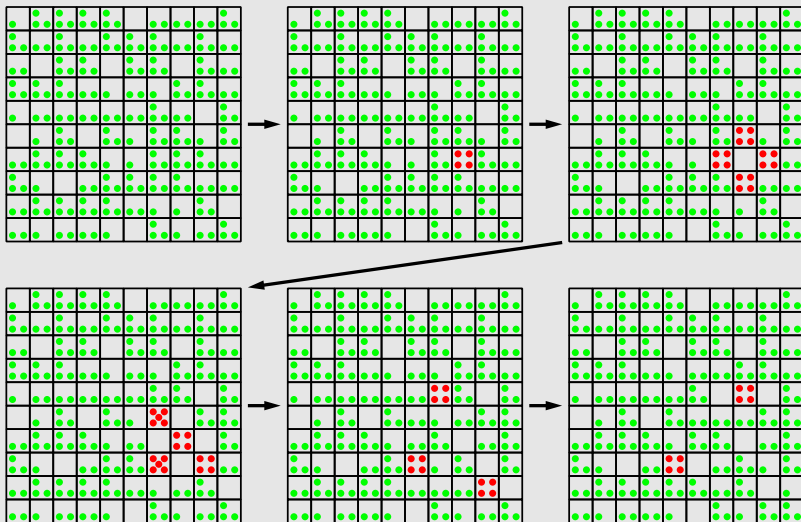
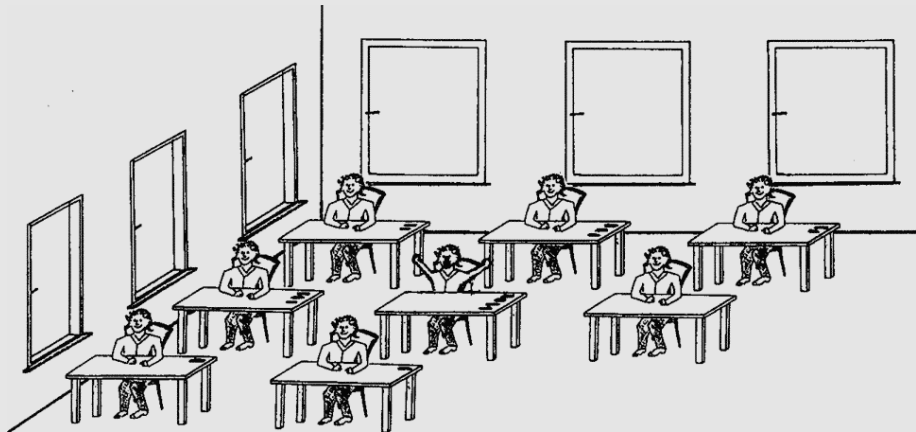## The Bak-Tang-Wiesenfeld (BTW) Model
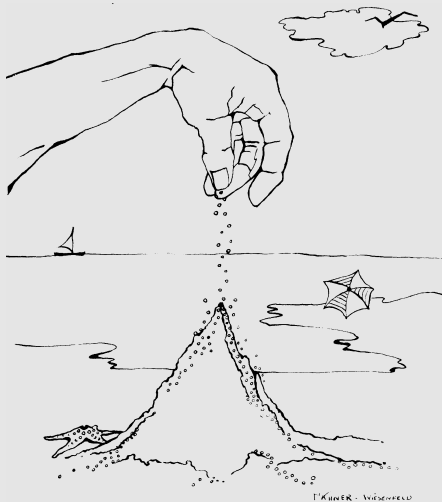
Source: Bak, How Nature Works

The Bak-Tang-Wiesenfeld (BTW) model

The Bak-Tang-Wiesenfeld (BTW) Model

Source: Bak, How Nature Works

The Olami-Feder-Christensen (OFC) Model