Thresholding MEVD-Multiple Environmental Hazard

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SAMSI Talk
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Outline

Papua, New Guinea

Between 1994-1998: Volcano eruption in Rabaul, Cyclone Justin in the Milne Bay, and the El Nino-induced drought.

Outline

Events

Incidence Maps

- Floods
- Volcano
- Drought
- Earthquake
- GNP: 1990 Gross National Product in US dollars
- Population: Gridded population count (estimate) 1995

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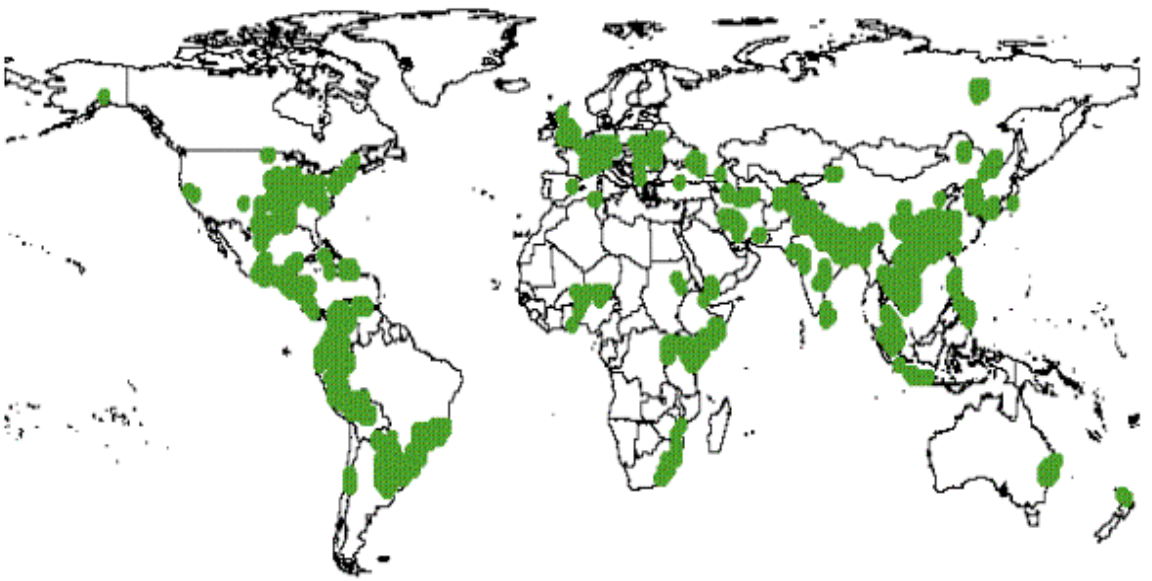
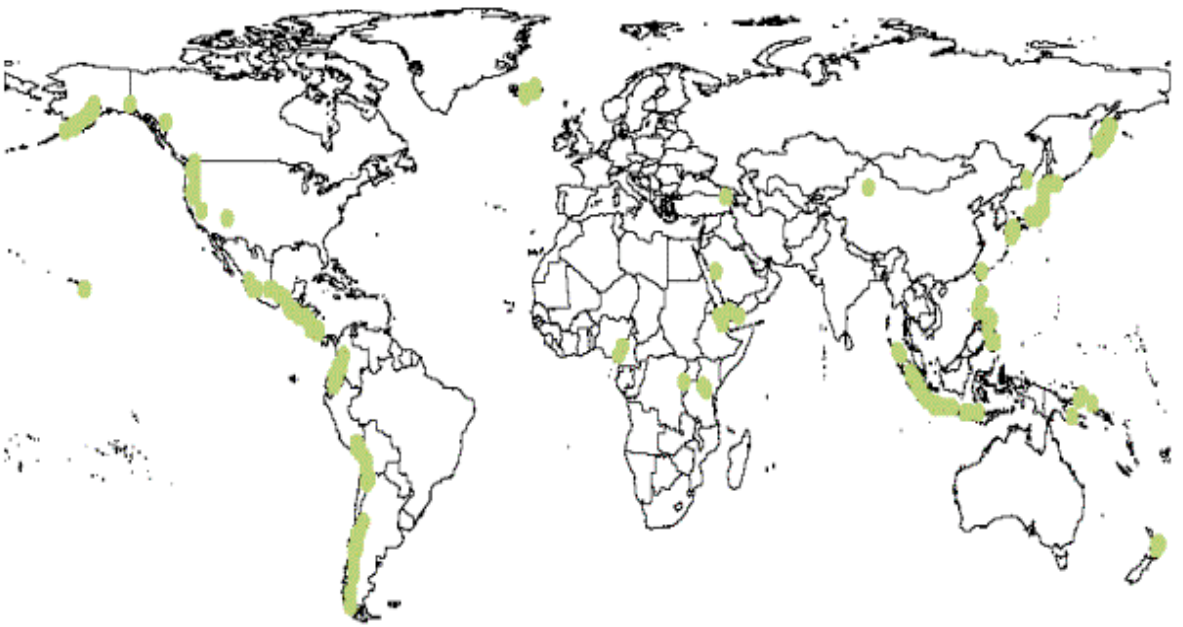
Floods

.9 ptile of Flood counts



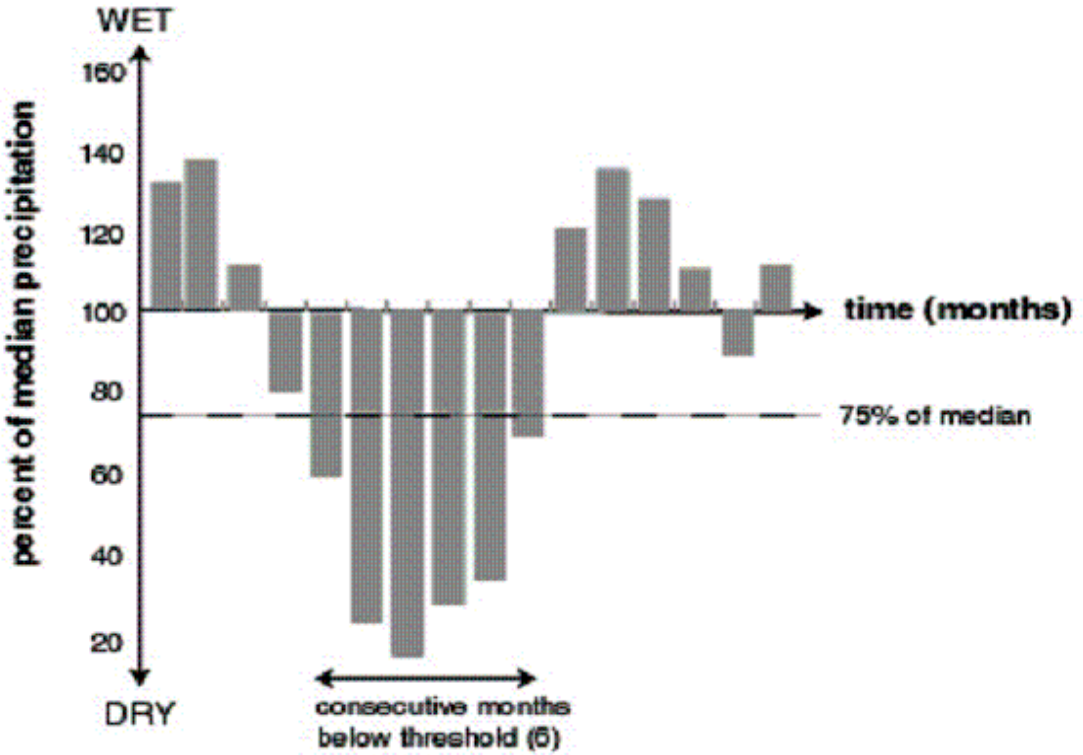
Volcanos

‘.9′ ptile of Volcano incidence



Droughts

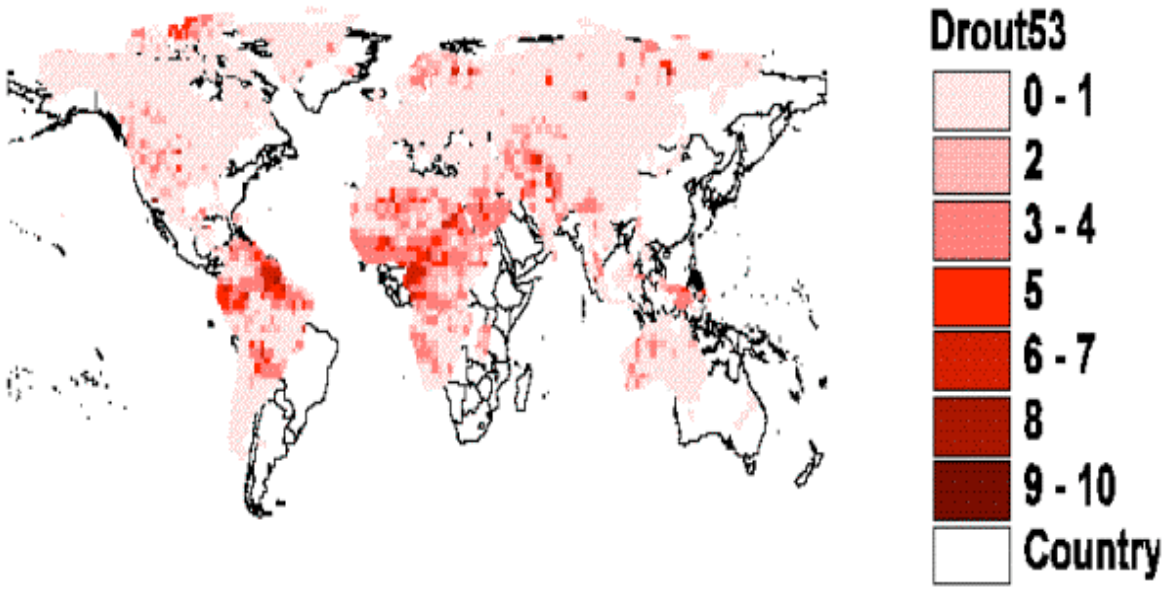
Droughts: Classifying a drought.



Example of a drought event defined by monthly precipitation being below a threshold of 75% of the long-term median value for at least 3 consecutive months. In this case, the duration of the event was 6 months.

Droughts

50 pct Weighted Anomaly Standardized Precipitation (WASP)



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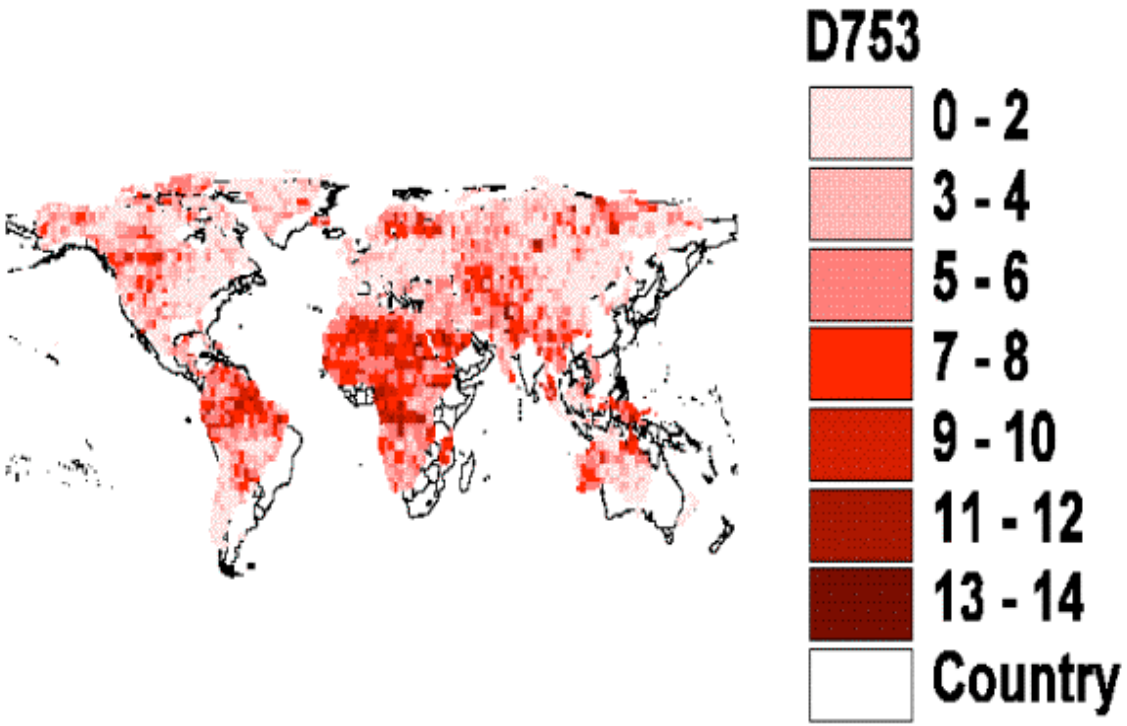
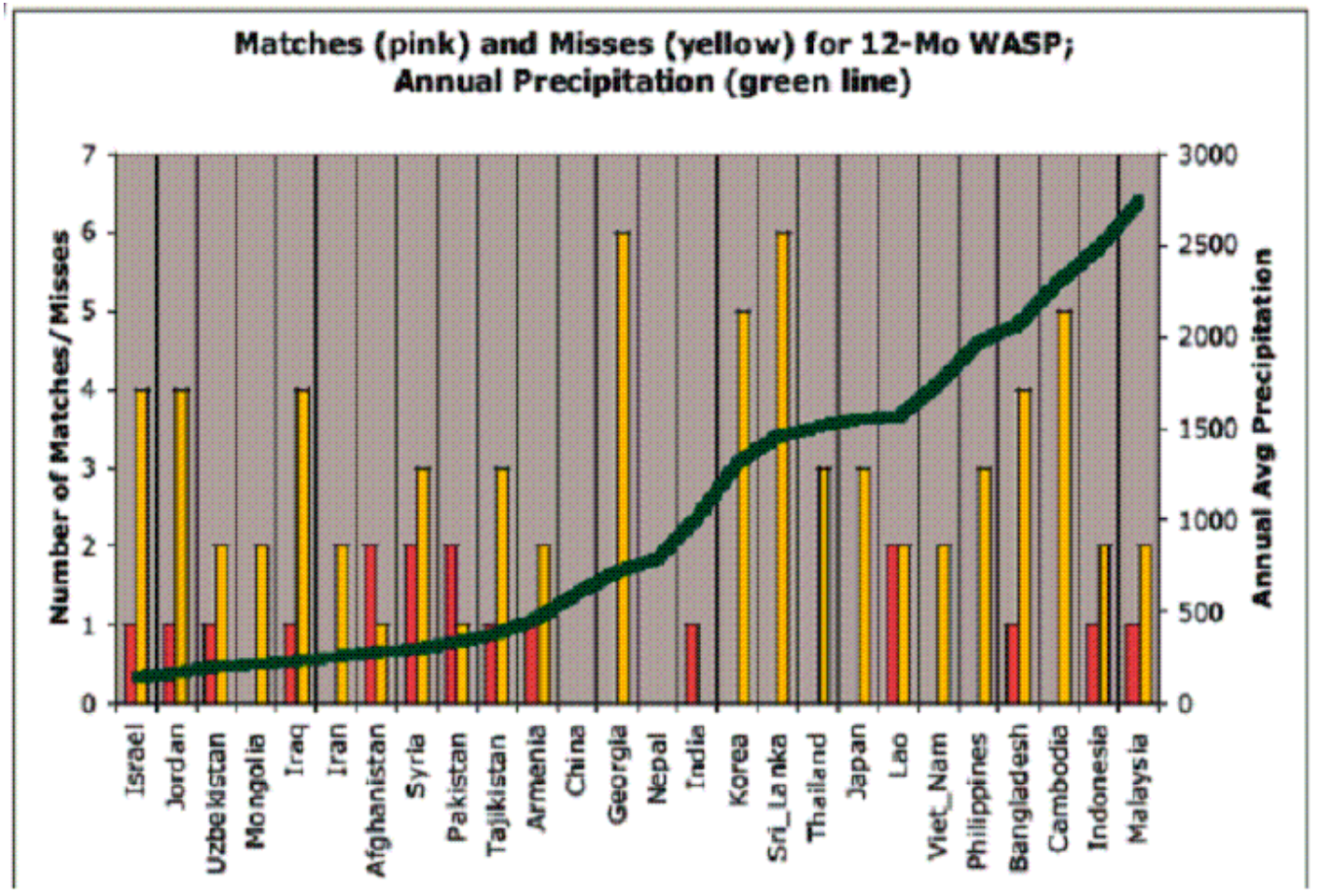


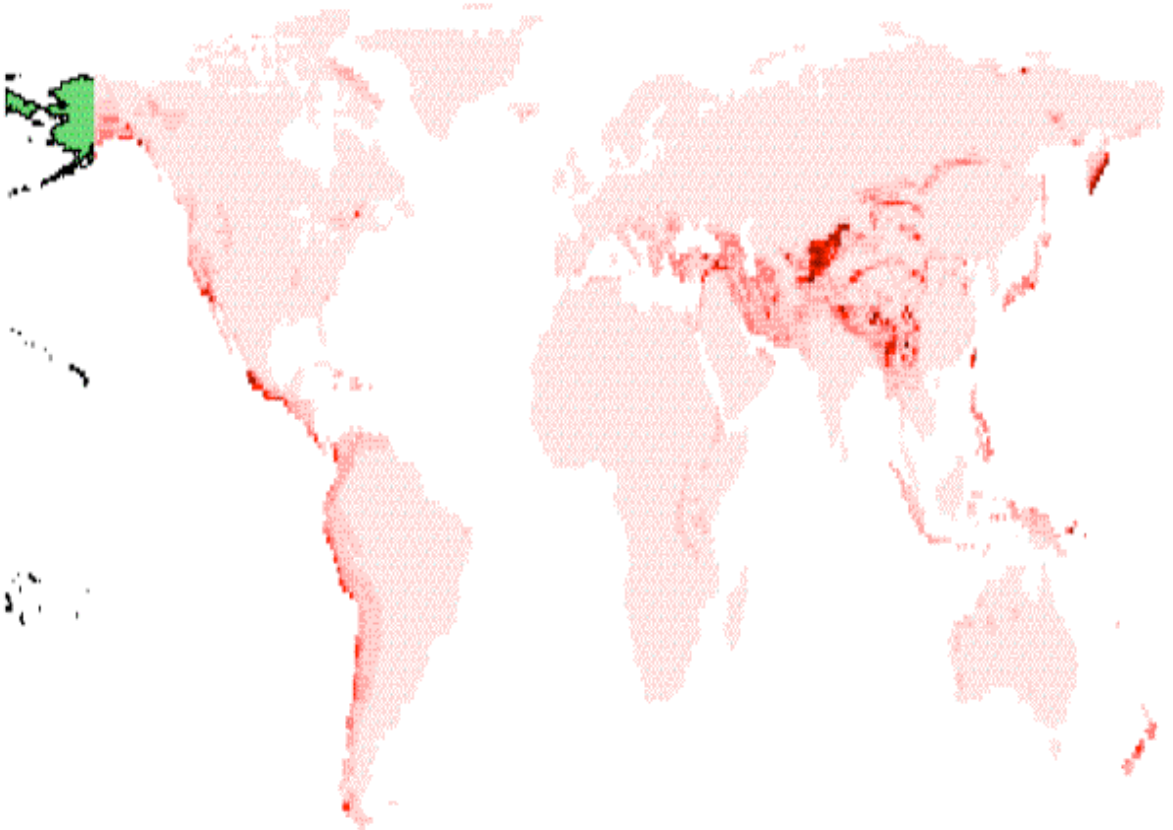
Droughts

Drought declaration vs. Drought classification



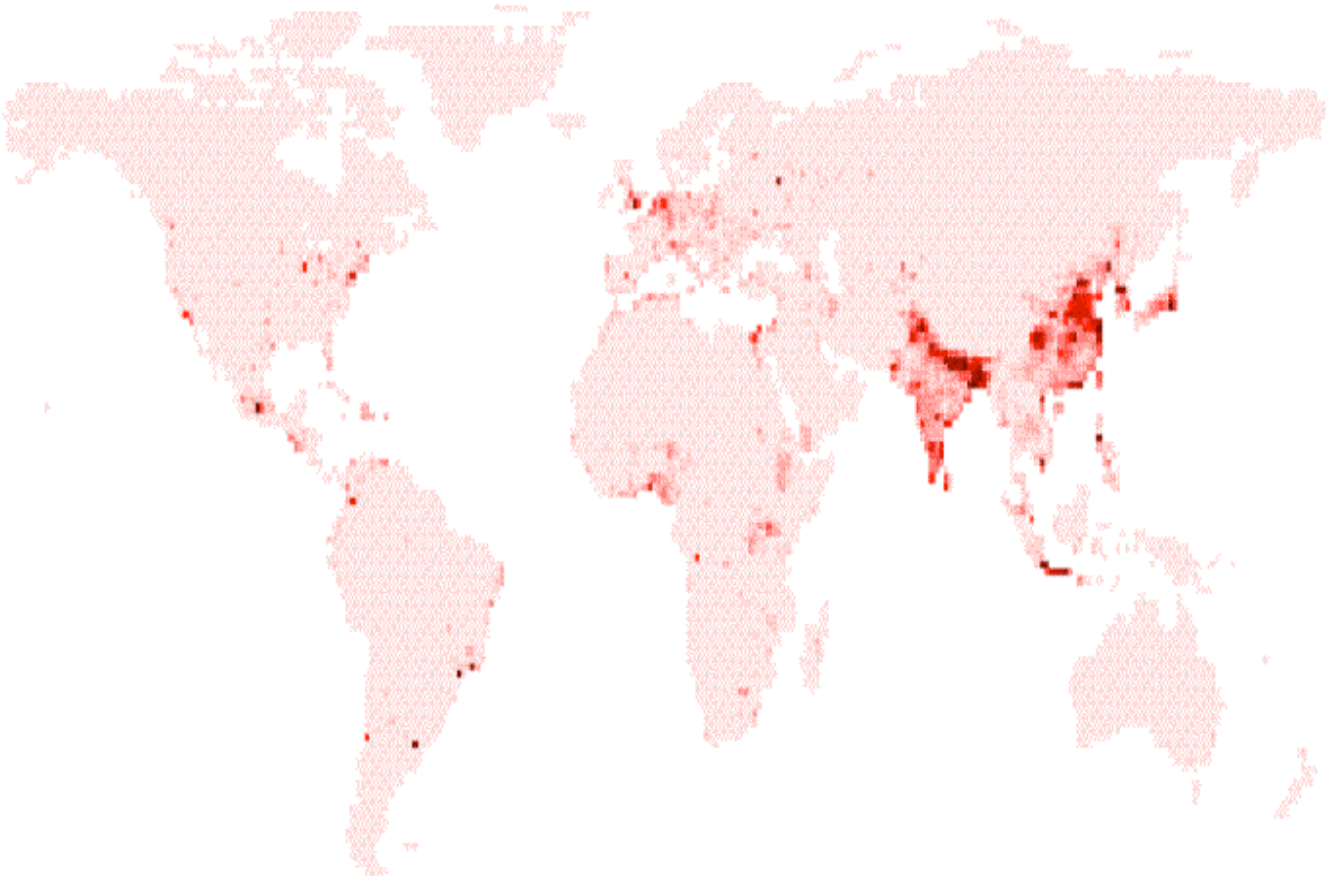
Quakes

Peak Ground Acceleration



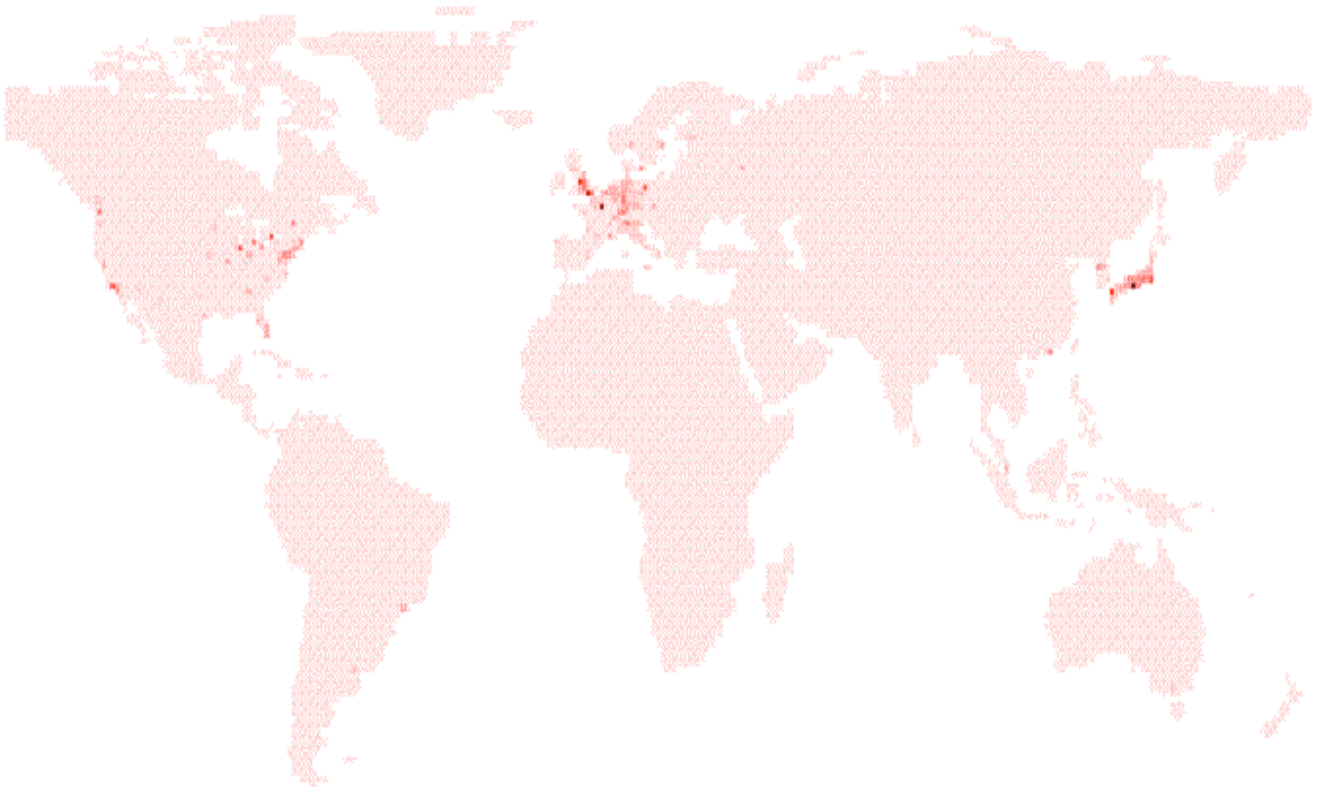
Population

Population Density



Income

GNP



Outline

MEVD (Logistic type) Model

For $i = 1, 2$

$$G(q_1, q_2) = \exp\{-(y_1{}^{\frac{1}{\alpha}} + y_2{}^{\frac{1}{\alpha}})^{\alpha}\} \tag{1}$$

where $\alpha \in [0, 1]$ is a dependency parameter and $y_i = [1 + \frac{\xi_i(q_i - \mu_i)}{\sigma_i}]^{-\xi_i}$ — with (μ_i, σ_i, ξ_i) the location, scale, and shape parameters of the ith univariate distribution. [Stephenson 2003].

Thresholding

Taking multivariate **q** we want to return the set $\mathcal{Q}$ such that

$$\mathcal{Q} = \{q | F(\mathbf{Q} > \mathbf{q}) > c\} \tag{2}$$

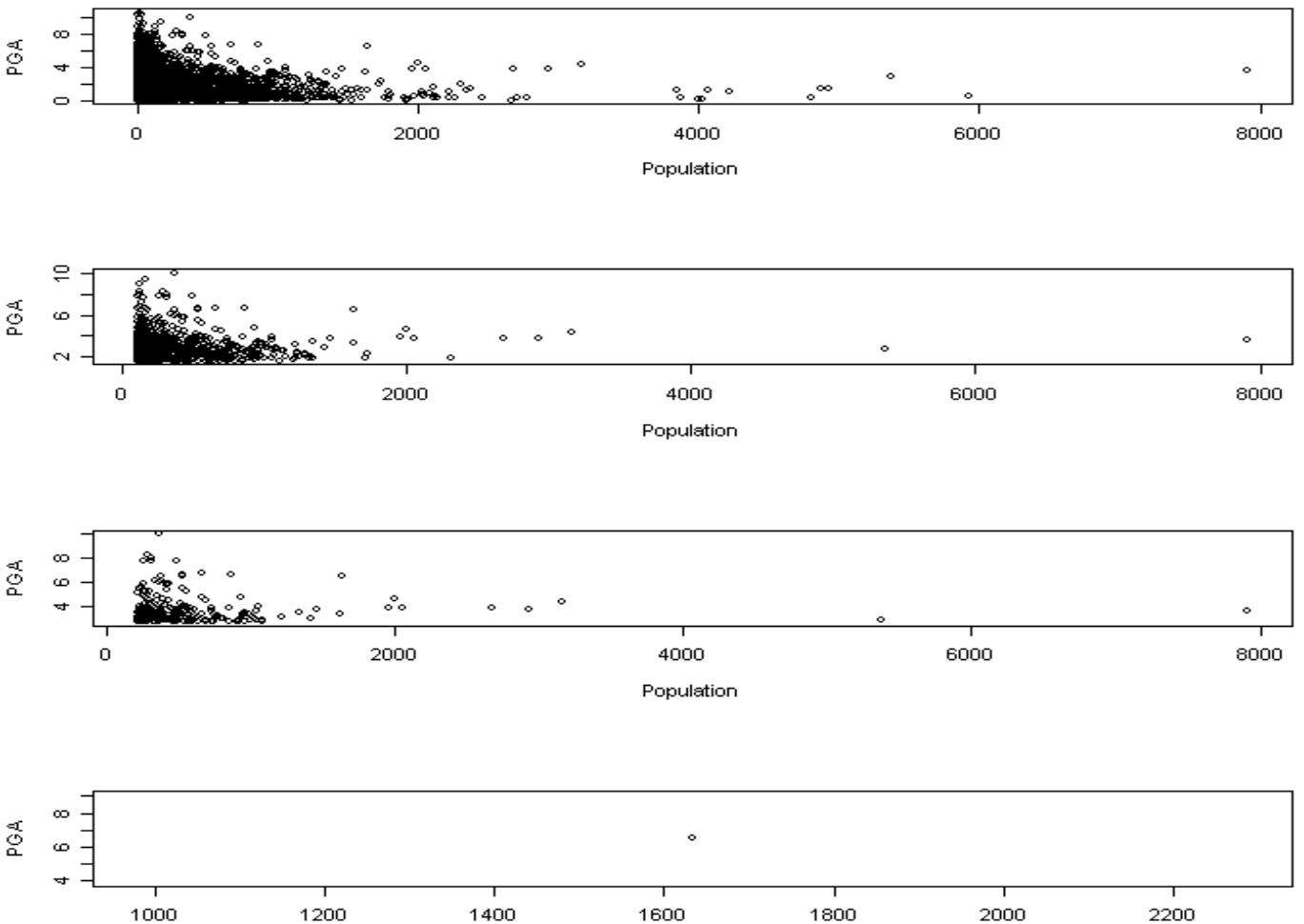
Censor the data:

$$\mathcal{Q} \supset \mathcal{Q}_* = \{\mathbf{q} \mid q_i > c, \forall i\} \tag{3}$$

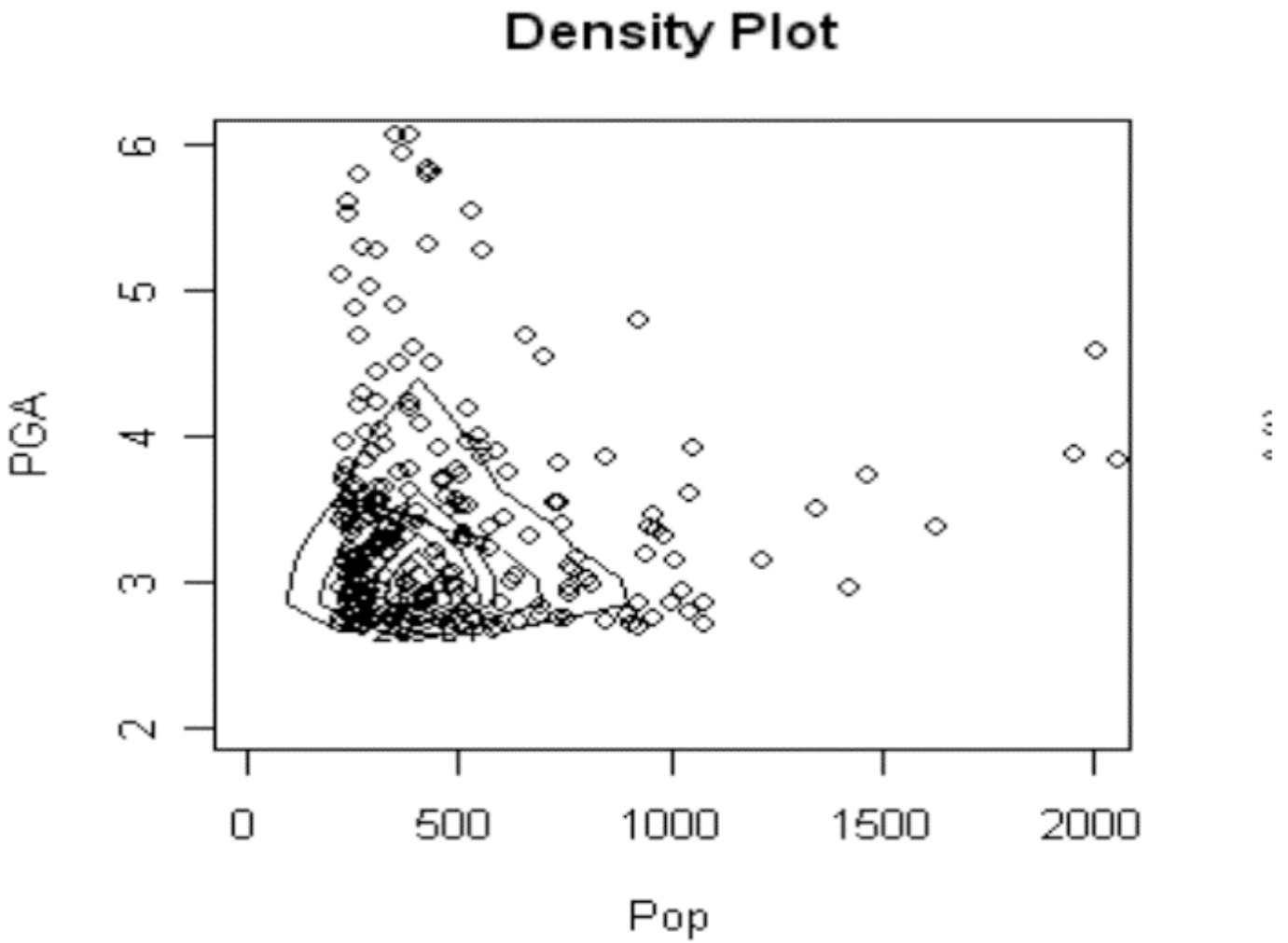
And the output is:F for $i = 1, 2$ is $F(\mathbf{Q} \leq \mathbf{q}_*) = F_1 + F_2 - F_1 F_2$ and $F_1 = Pr(\mathbf{Q} \leq \mathbf{q}_*)$; $F_2 = F_1 = Pr(\mathbf{Q} \leq \mathbf{q} \mid \mathbf{Q} > \mathbf{q}_*)$

Pop vs. PGA

Censored below 0, and .8, .9, .99 ptiles

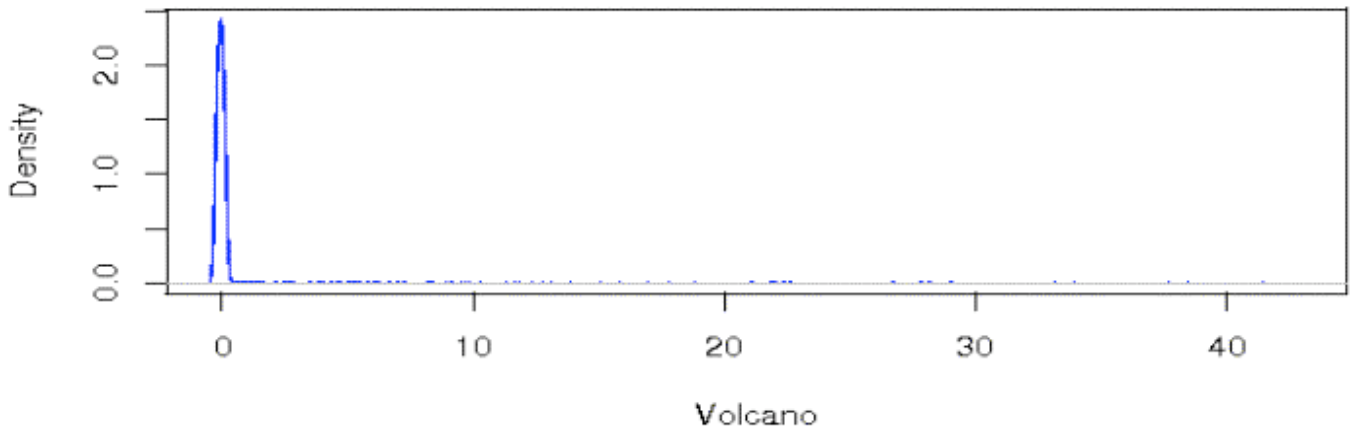


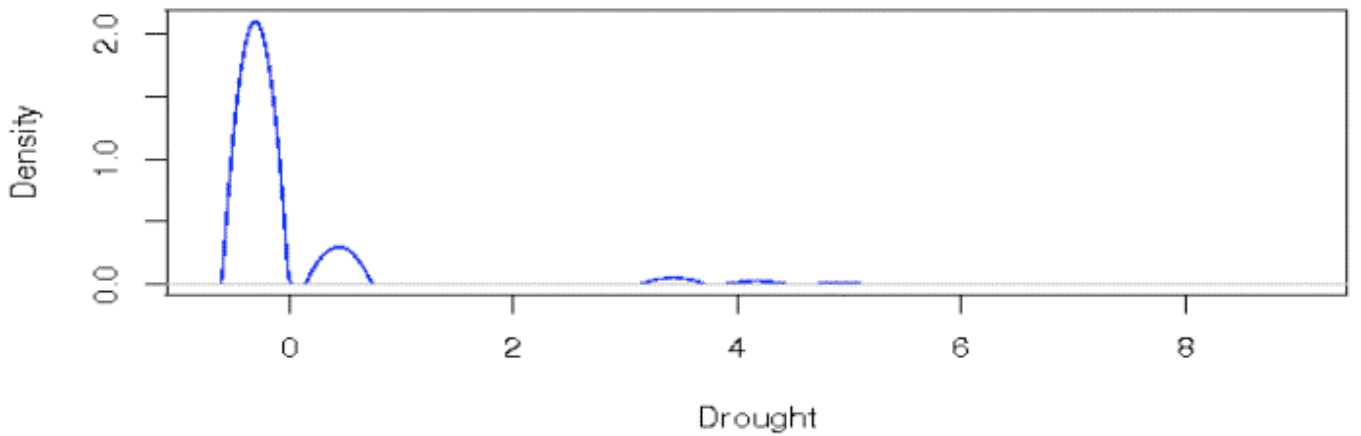
Pop vs. PGA



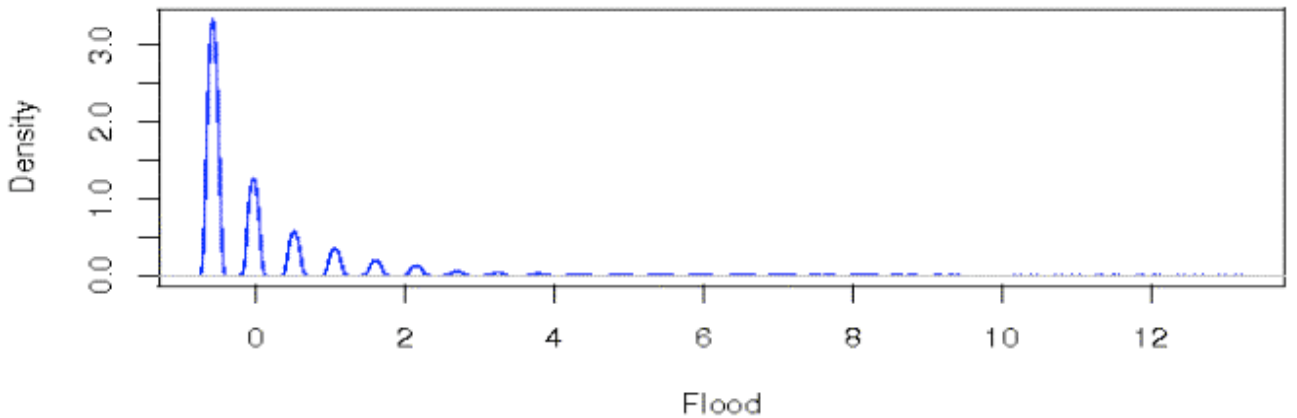
cm

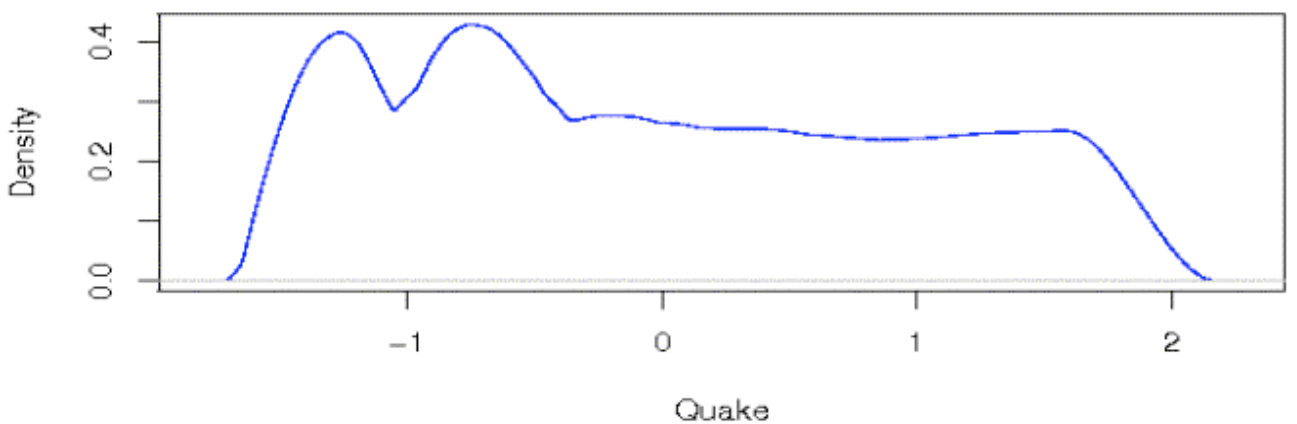
Volcano and Drought



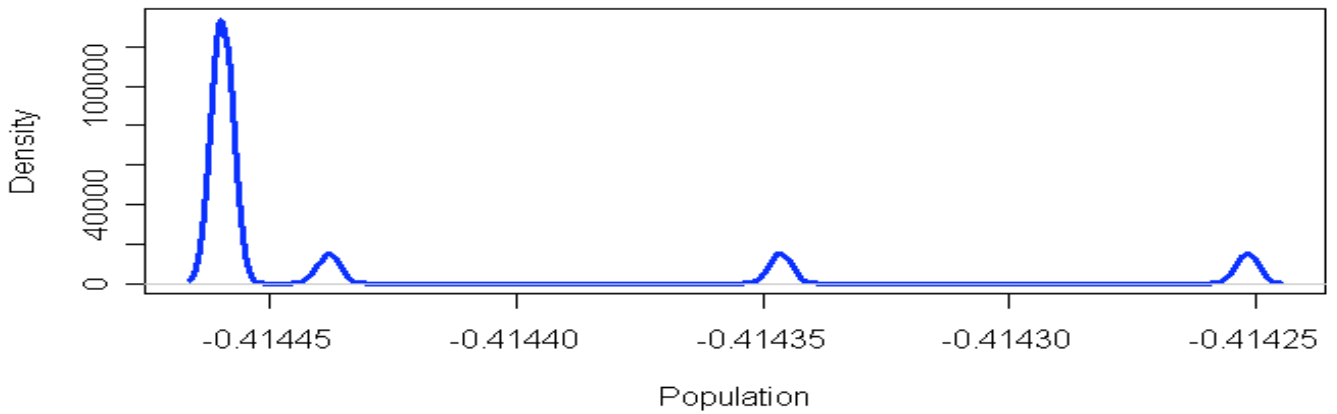


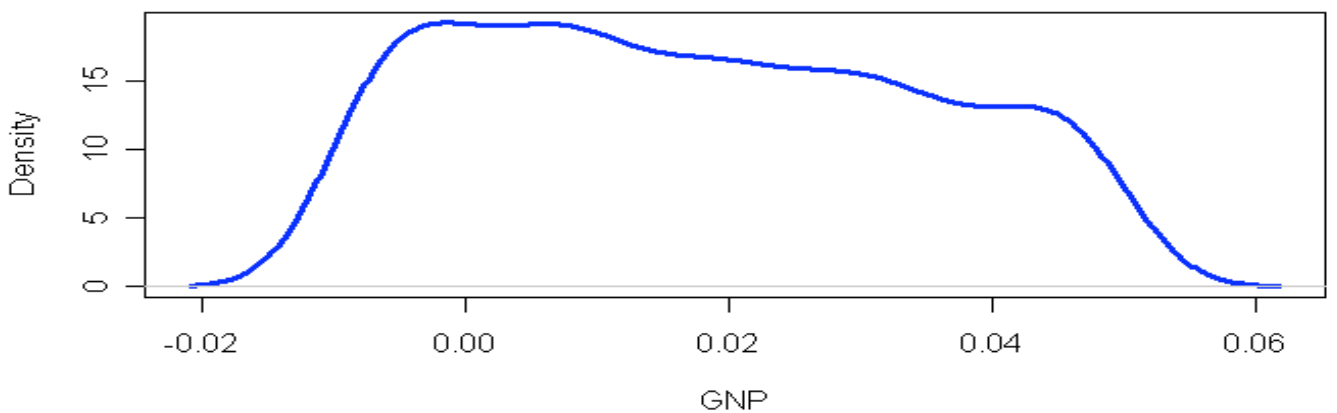
Flood and Quake





Pop and GNP


Density
0
40000
100000
-0.41445
-0.41440
-0.41435
-0.41430
-0.41425
Population


Density
0
5
10
15
-0.02
0.00
0.02
0.04
0.06
GNP

Pickands Type

Pickands suggesting minimizing KS distance

$$d_k = sup_{\mathbf{q}} |\hat{G}_n(\mathbf{q}) - \hat{G}_\theta(\mathbf{q})|$$

with $k = 1, 2, ...[n/4]$

Joe Type

Joe suggests computing measure of association and setting cutoff to maximize tail dependence

$$max_k\ \tau_{1-k/n} = max\ \tau(\mathbf{q}|\mathbf{q} > \mathbf{C}_k)$$
$$= max_k\ 4E[C_\theta(\mathbf{q}|\mathbf{q} > \mathbf{C}_k)] - 1$$

[Joe 1992]

Generalization of Joe Type

Maximum likelihood over minimum distance:

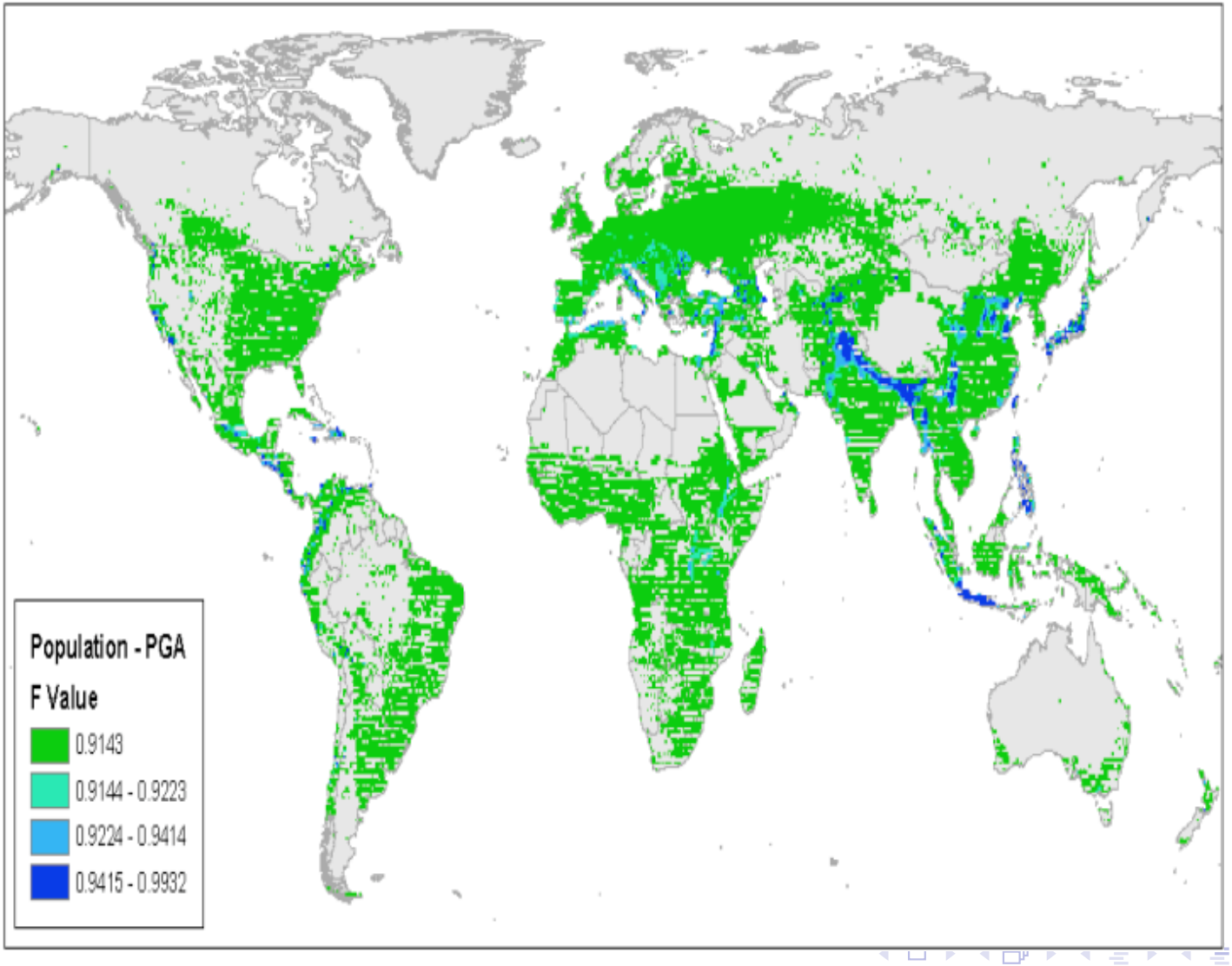
$$max_\theta \; min_k \; d_\theta(\mathbf{q}, \mathbf{C}_{k,\theta})$$

$$= max_\theta \; min_k \; E[ln(\frac{dG_\theta(\mathbf{q})}{dG_\theta(\mathbf{C}_k)})]$$

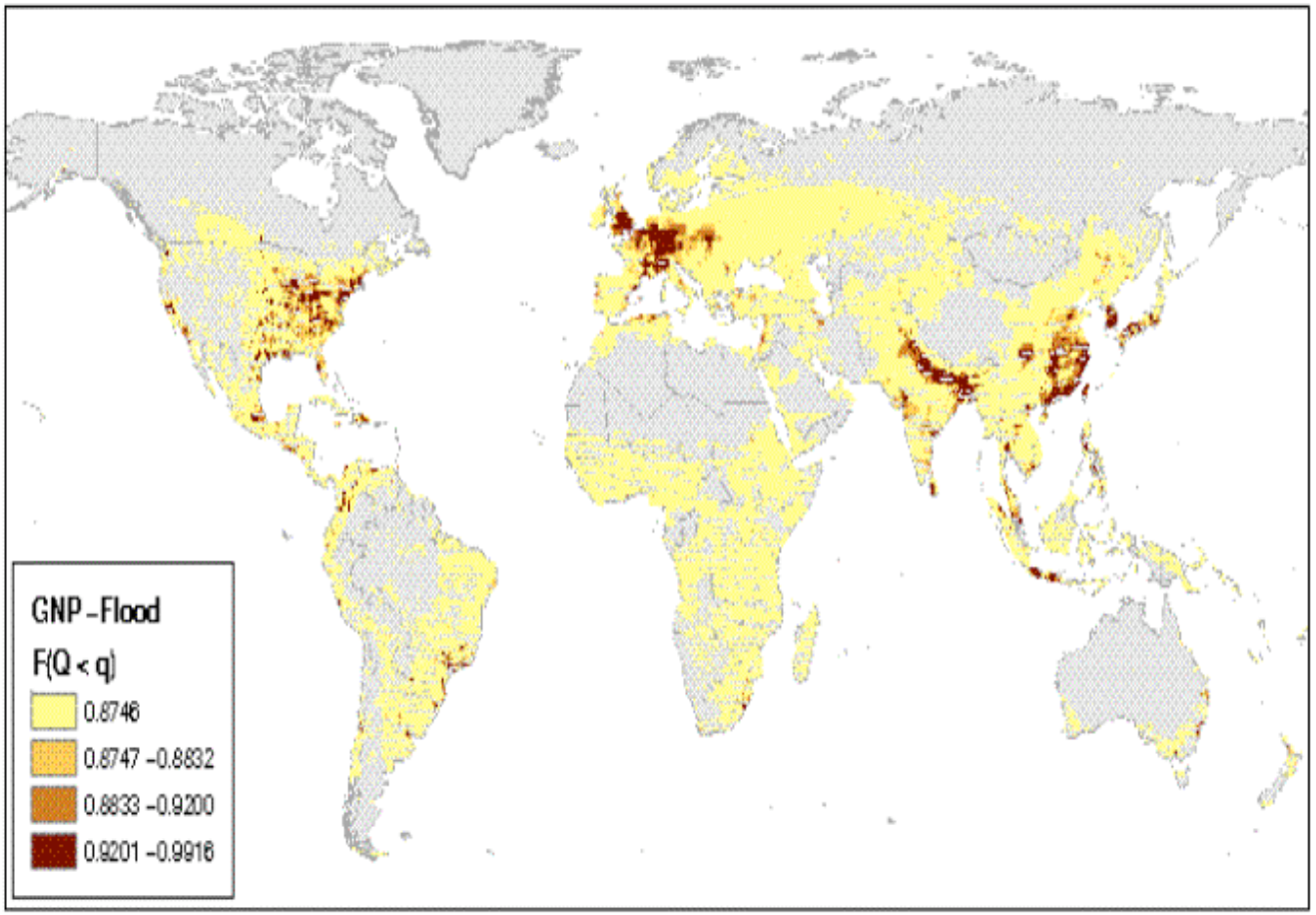
Kendall's Tau on tails

$\tau_{1-k/n}$	$\tau_{.9}$	$\tau_{.95}$	$\tau_{.99}$
Pop-Pga	.072	.186	.472
GNP-Flood	.113	.270	.326
GNP-Drought	.208	.290	.168

Pop-PGA


Population - PGA
F Value
0.9143
0.9144 - 0.9223
0.9224 - 0.9414
0.9415 - 0.9932

GNP-Flood



GNP-Drought