

Security Diagrams: Assessing the Risk of Extreme Climate Events on Society

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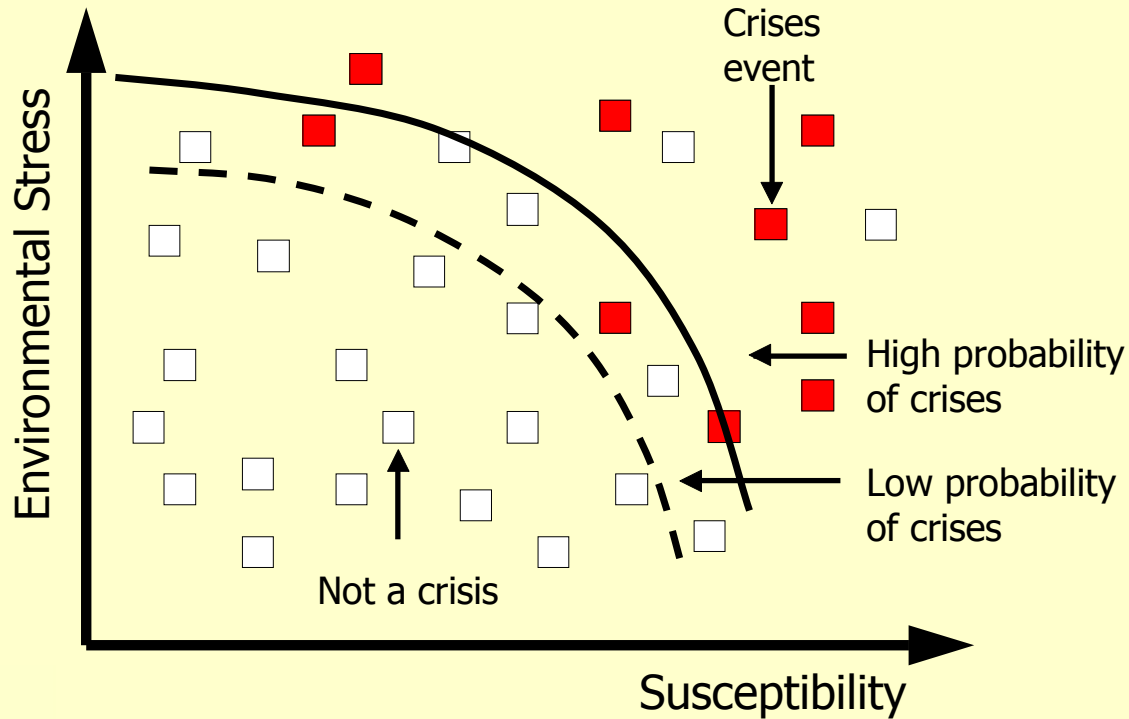
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Framework for Quantifying Vulnerability: Security Diagram

Security



Focus on droughts



Specific Research Questions

- *Crisis* – How can crisis events be identified?
- *Environmental Stress* – What measures of environmental stress best reflect society's vulnerability to drought?
- *Susceptibility* – How can susceptibility of society to drought be quantified, and how is it defined by different disciplinary perspectives?



Case Studies

**Algarve + Alentejo
Portugal**



**Volgograd + Saratov
Russia**



**Andhra Pradesh
India**



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Crisis: Serious disruption of the functioning of societies causing widespread **human or material losses** as well as **socio-cultural impacts** requiring political and social responses .



Identifying Drought Crisis Events

Media analysis -- “Factiva” media data base
(8000 media sources, local/regional/national)

- Establish classes of “attributes” of crisis
- Identify reliable local media
- Tabulate recurrent (> 2 per month) reports of attributes



Results of Media Analysis

Example – Southern Portugal, 1983

<i>Attributes of crisis</i>				
Agriculture	Energy & Industry	Political	Social	<u>Sum</u>
(0.25)	(0.25)	(0.25)	(0.25)	1.0
Irrigation strongly reduced	Reservoirs empty towards end of year Hydroelectric production severely curtailed.	Announcement of „emergency“ for Alentejo	Mandatory electricity-saving measures	



First Estimate – Drought Crisis Events

Year 19	80	81	82	83	84	85	86	87	88	89	90	91	92	93	94	95
A. Pradesh					0,75		0,25	1,0						0,5		
S. Portugal		1,0		1,0									1,0	1,0		1,0
Volga Region					0,5		0,5		0,25							0,75

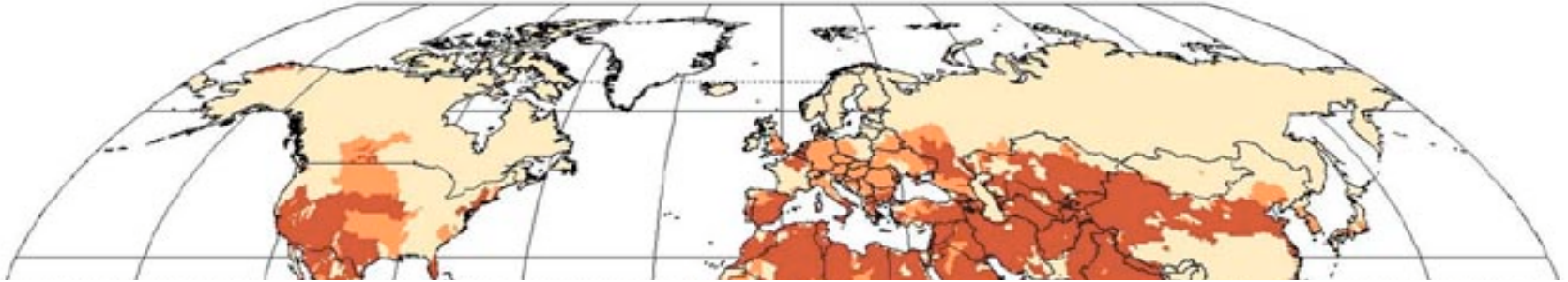


Specific Research Questions

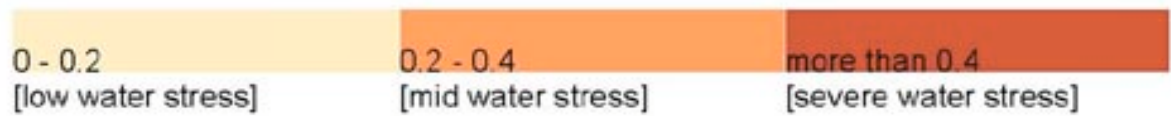
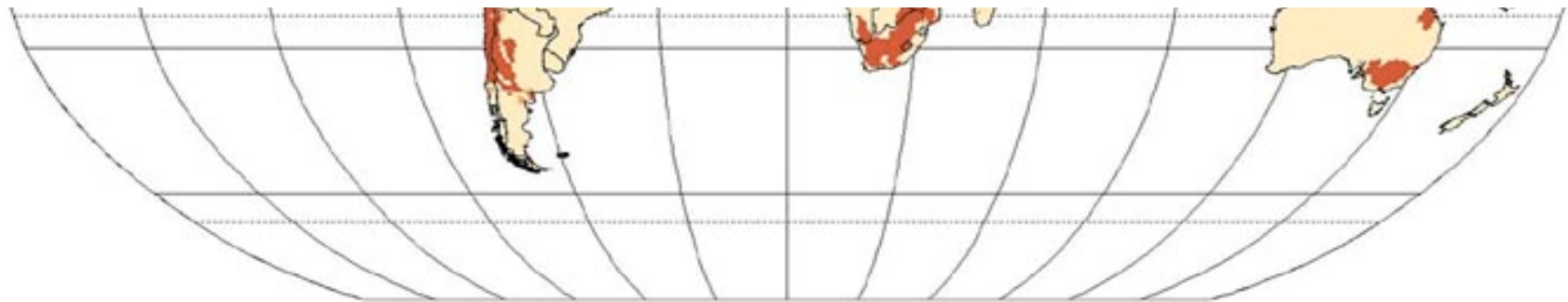
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Water Stress: Withdrawal to Availability ratio 1995



Environmental stress: the intensity of environmental change that is (i) an undesirable departure, (ii) short duration.



(c) Center for Environmental Systems Research, University of Kassel, August 2003 - Water GAP 2.1D
no data

Water Stress Indicators

-- Test against occurrence of crisis events --
Statistical significance, t test (0.05)

Statistically significant indicators

Water withdrawal to availability ratio

Deviation of groundwater recharge from long time average

Deviation of water availability from long time average

Runoff deficit index

Deviation of evapotranspiration from long time average

MaxIndex

Maximum function [*withdrawal to availability ratio, deviation of water availability from long term average, and percentage of area with high water stress*]

Not statistically significant indicators

Water withdrawal to internal availability ratio

Annual groundwater recharge in mm

Groundwater discharge per capita

Water availability per capita

Internal renewable water availability per capita

Percentage of area under stress (defined as withdrawal to availability ratio of 0.4 or more)

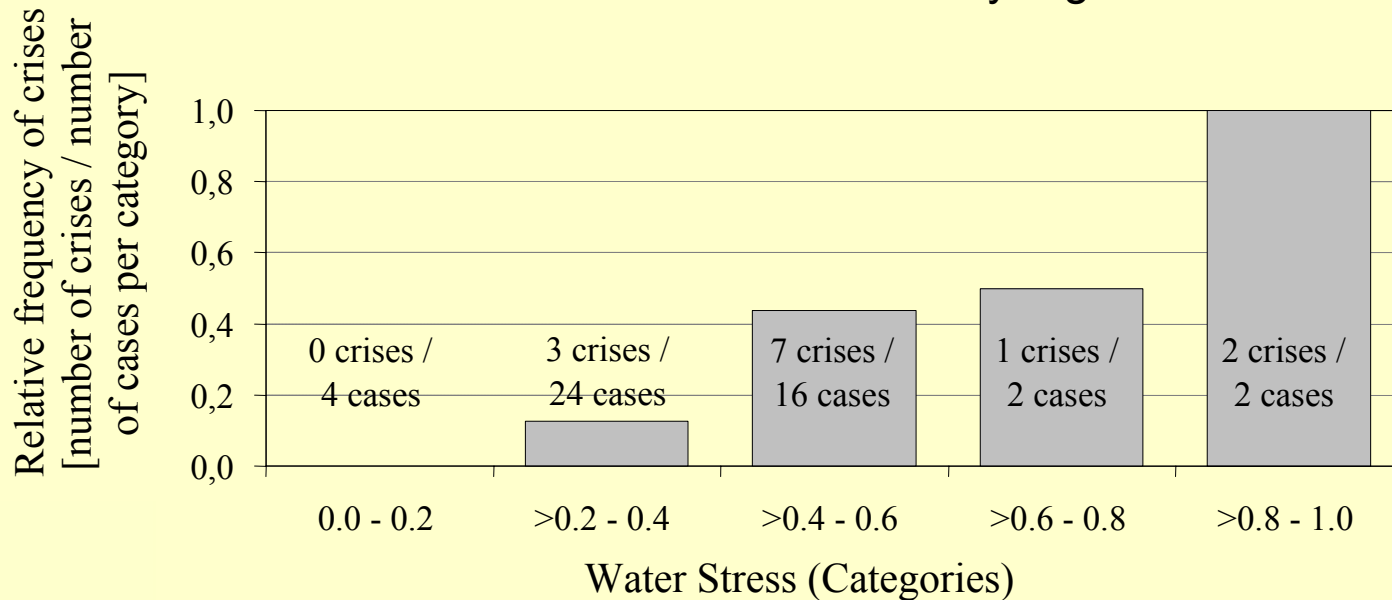
Percentage of population under stress

Deviation of precipitation from long time average



Testing Water Stress

Water stress (“MaxIndex”) vs.
crisis data from three case study regions



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Susceptibility: the capability of an individual, community or state to resist, adapt and/or recover from environmental stress.



Procedure to Assess Susceptibility

- Develop inference models: Adapt theory, select variables, specify relationships between variables, select indicators for variables.
2. Quantify the models based on fuzzy set theory
- Collect data for indicators: (top-down and bottom-up from case study regions: Southern Portugal, Volga region, Andhra Pradesh)
4. Input data to model and compute susceptibility



Conceptual Overview

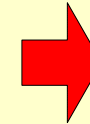
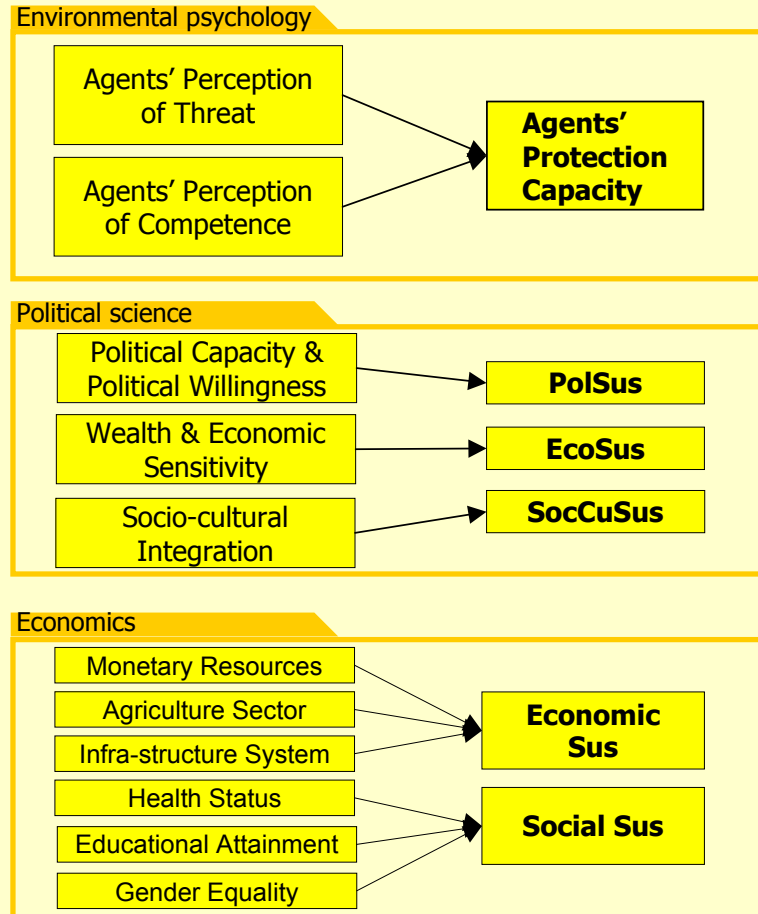
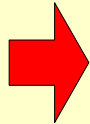
Exposure

Susceptibility

Disaster/Crises

Security

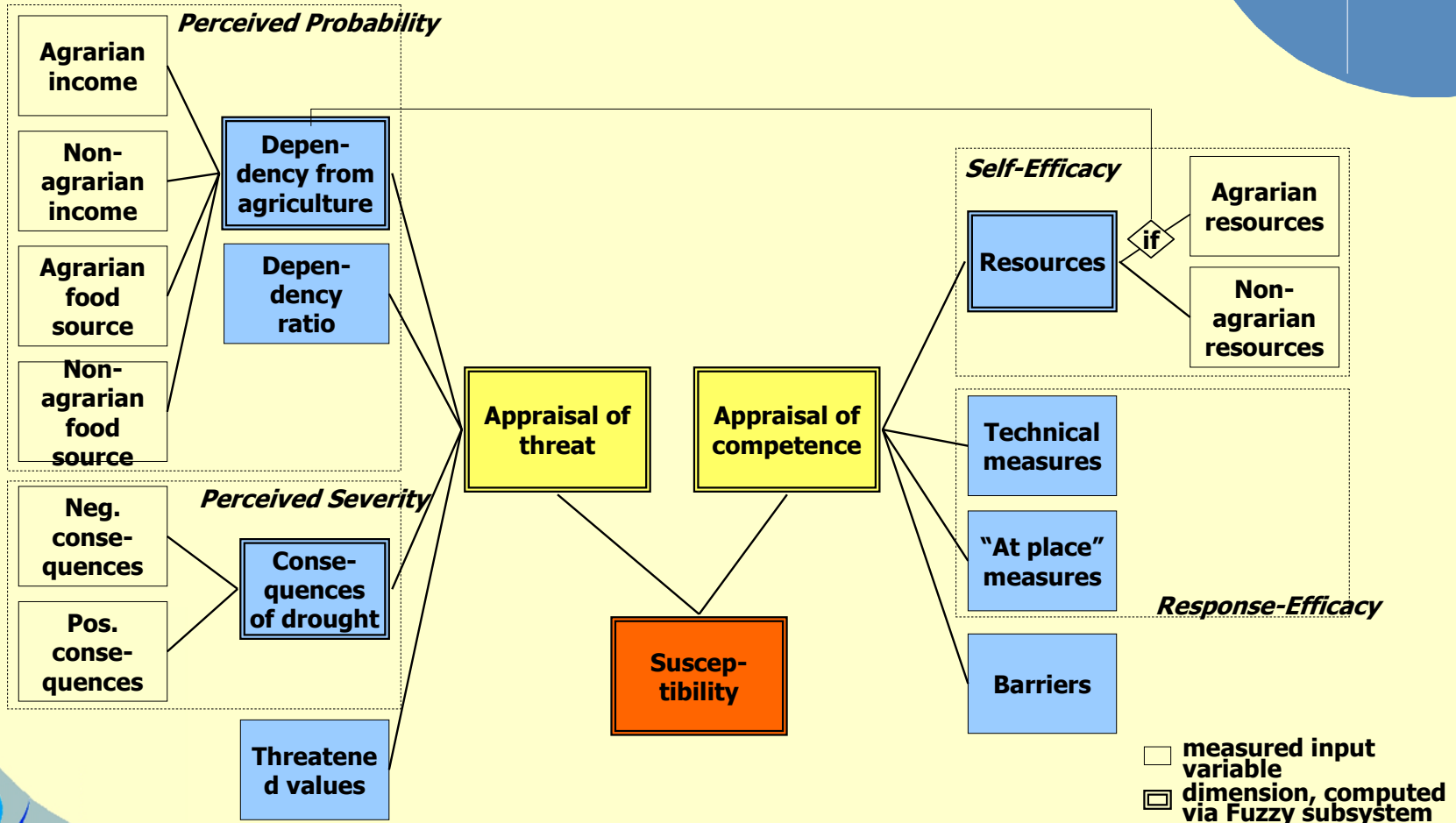
Environmental stress



Degree of being susceptible

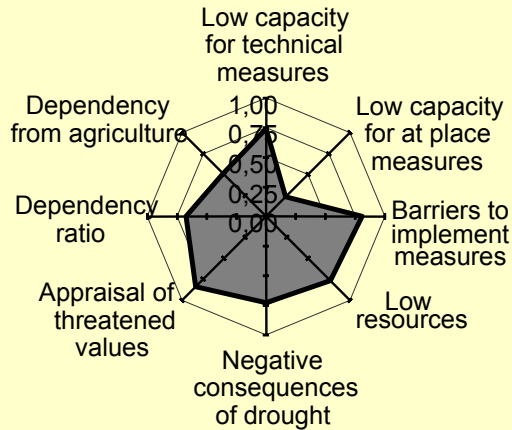


Model of Psychological Perspective



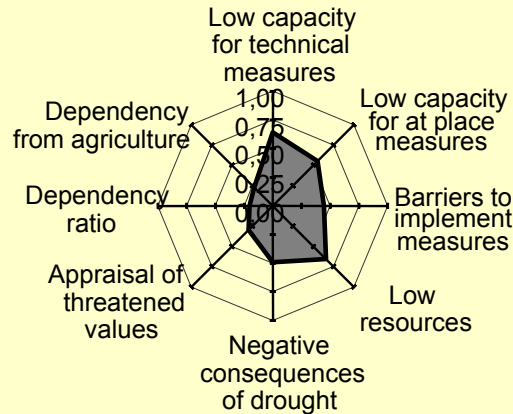
Results for Psychological Perspective

Andhra Pradesh, India 2001



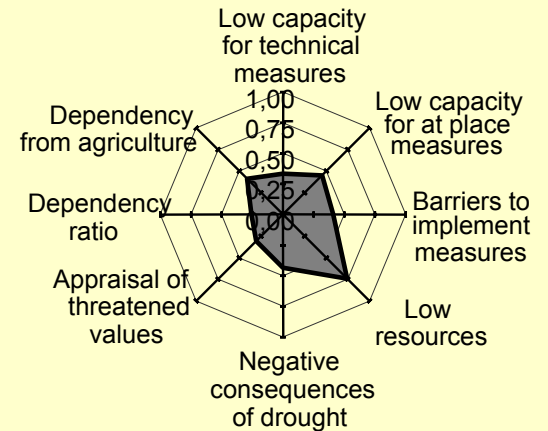
high

Algarve + Alentejo, Portugal 2001



low

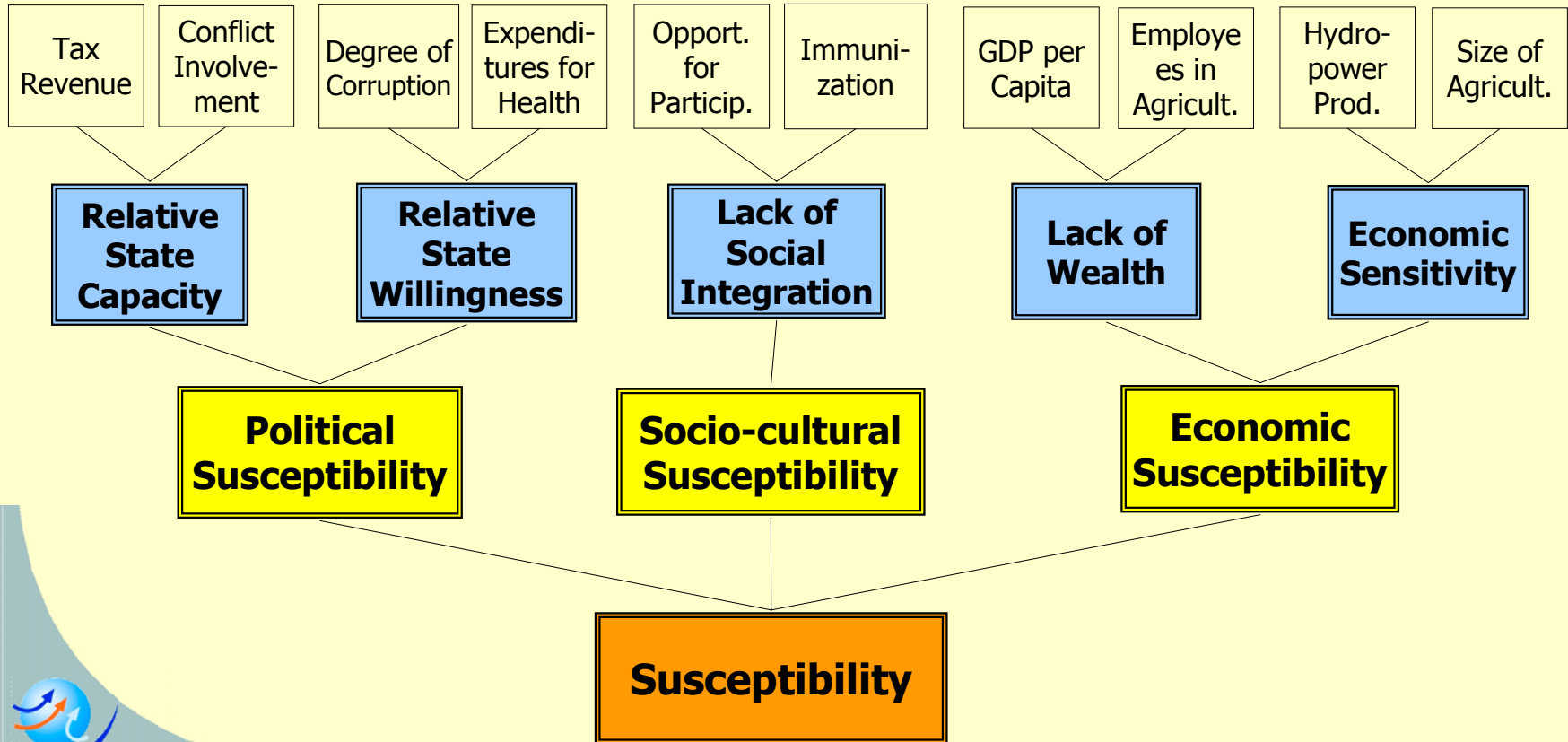
Volgograd + Saratov, Russia 2001



low

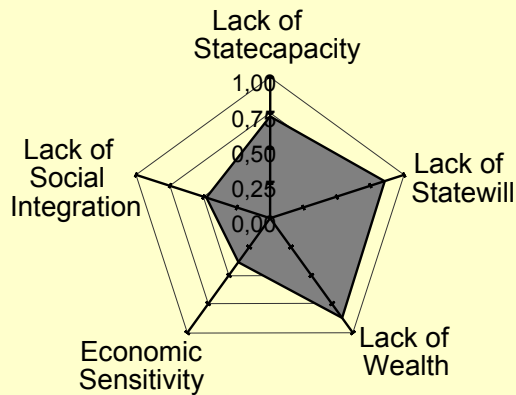


Model of Political Perspective



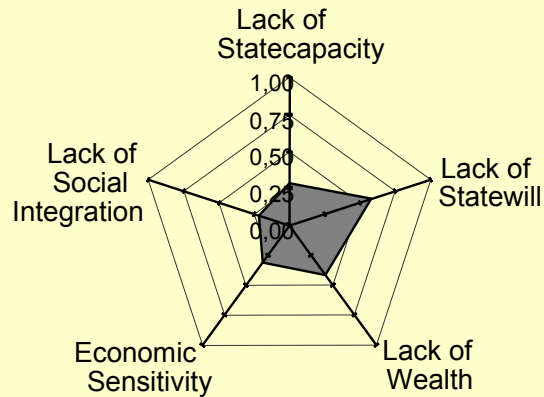
Results for Political Perspective

**Andhra Pradesh,
India 1991-1995**



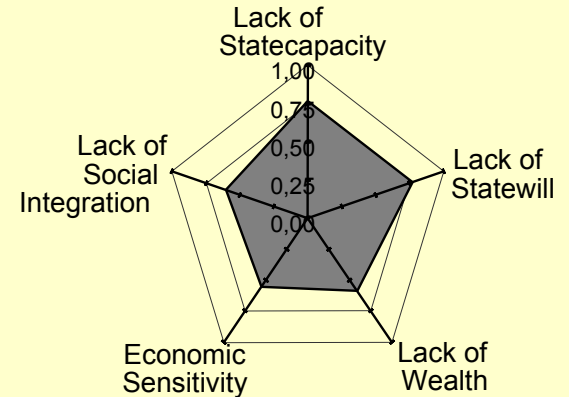
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**Algarve + Alentejo,
Portugal 1991- 1995**



low

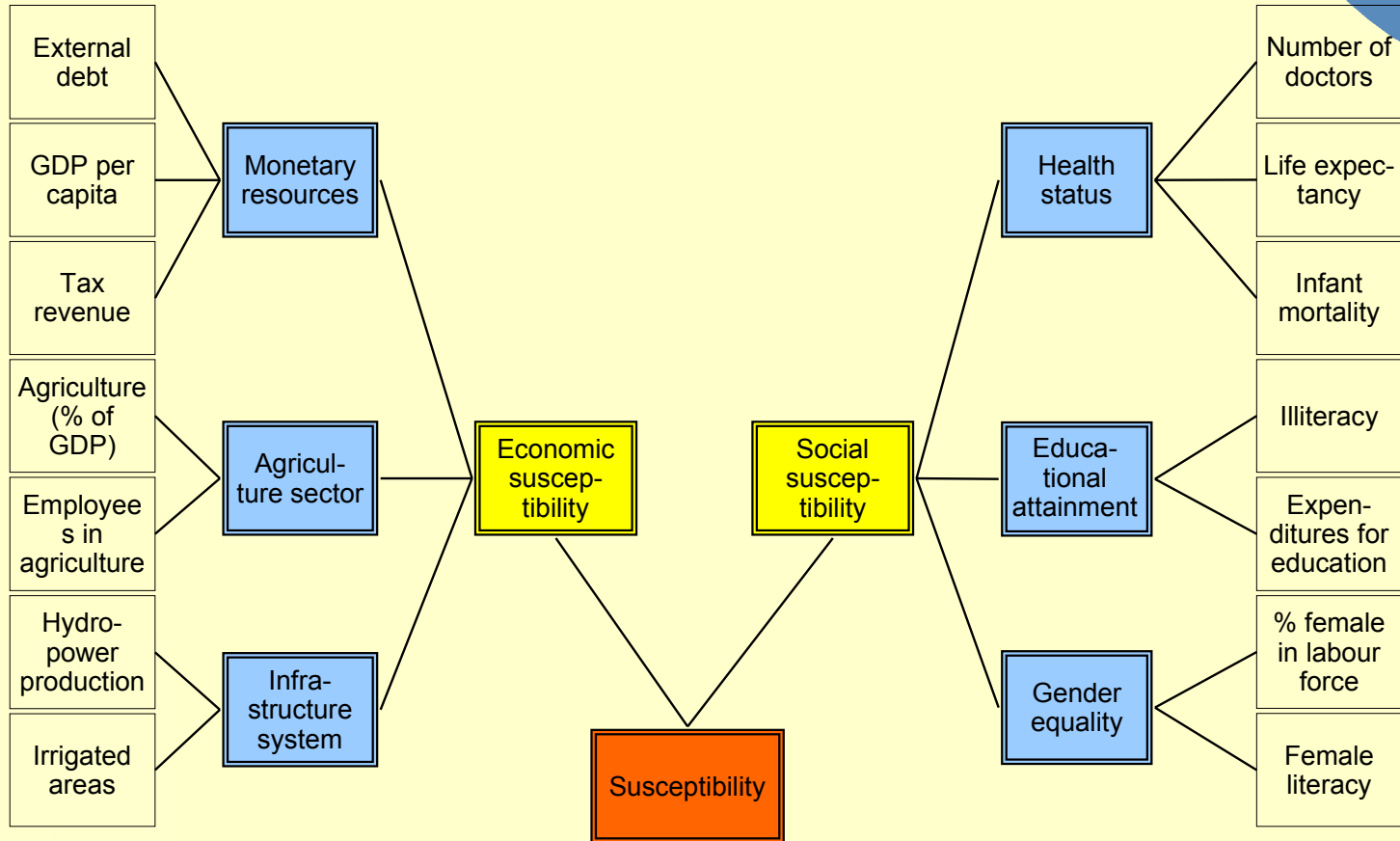
**Volgograd + Saratov,
Russia 1991-1995**



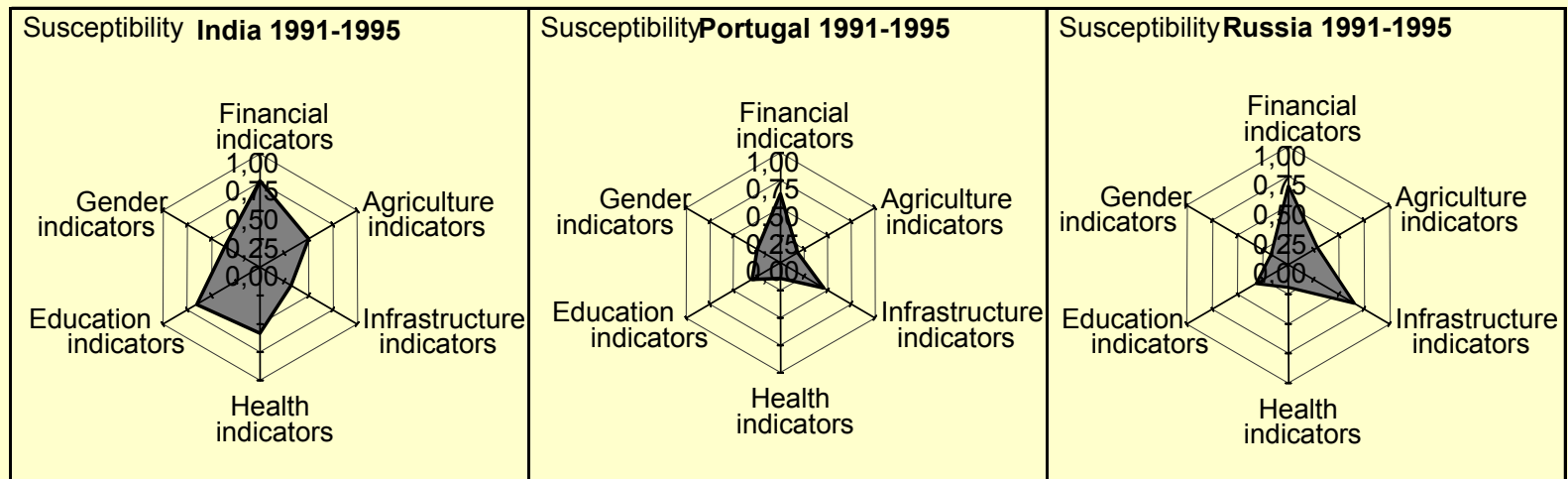
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Model of Economic Perspective



Results for Economic Perspective



crucial

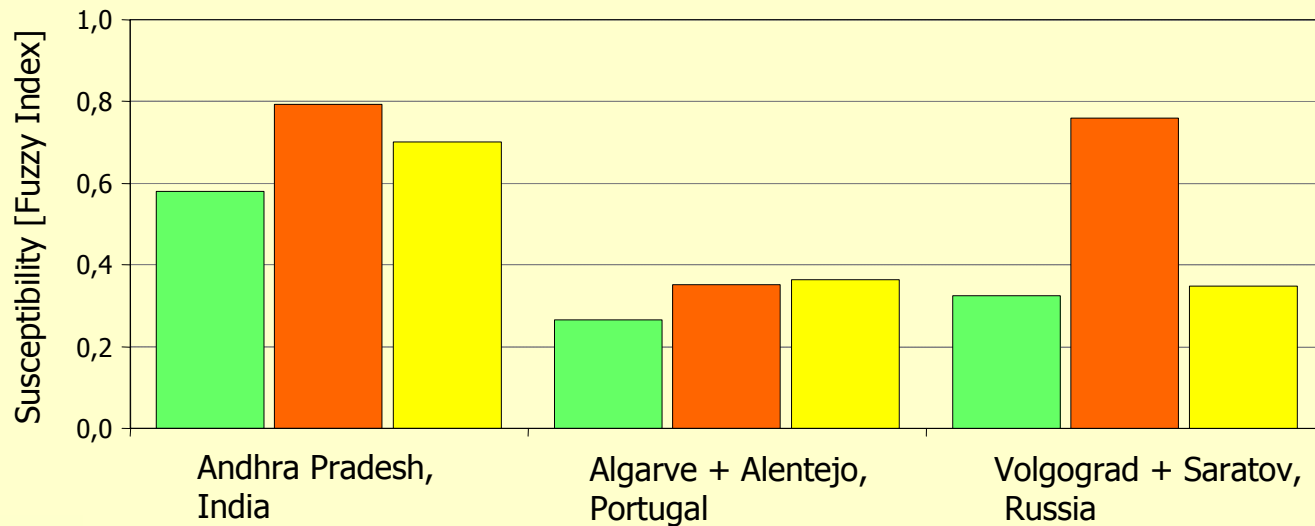
low

low



Results Overview

Comparison of Disciplines



■ Economics perspective ■ Political perspective ■ Psychological perspective



Summing up

- Refinement of the concepts of susceptibility, environmental stress, crisis
- Integrated Assessment – Coupling between approaches from the social and natural sciences
- Development of methodology to assess susceptibility
- Comprehensive and comparative approach to susceptibility
- First steps towards integrated approach to study the internal side of vulnerability
- Quantification of susceptibility
- Consideration of qualitative information

- However, more effort needed to validate findings
- Consider participative involvement of relevant stakeholder



Conclusions

- Methodology offers diverse degrees of informational resolution
- Depending on stakeholders' interest different foci can be chosen
- Makes clear that a single action will not be sufficient

