Module III. Vulnerability and adaptation:
From theory to practice

Case study 1

From vulnerability assessments to decision-making: Natural disasters and climate change in Central America

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In collaboration with:

Overview:

1. Issues

2. Context - The clients and users

3. Method

4. Steps and tools for going from vulnerability assessments to adaptation strategies

5. Lessons learned

6. Conclusion

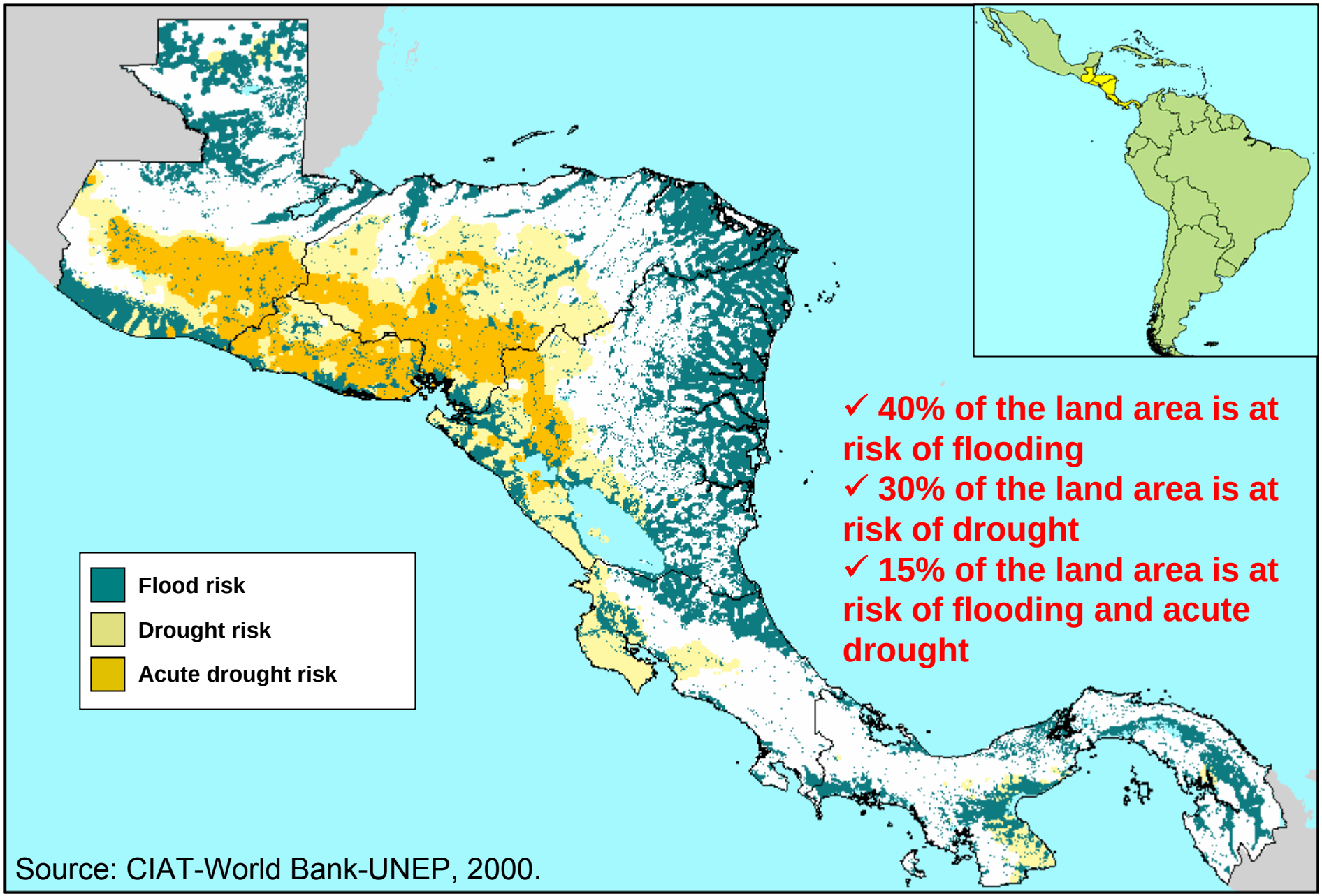
1. The issues…

There is much data on the risks, dangers and threats of climate disasters, climate variability and climate changes.

However, to give meaning to this data we must:

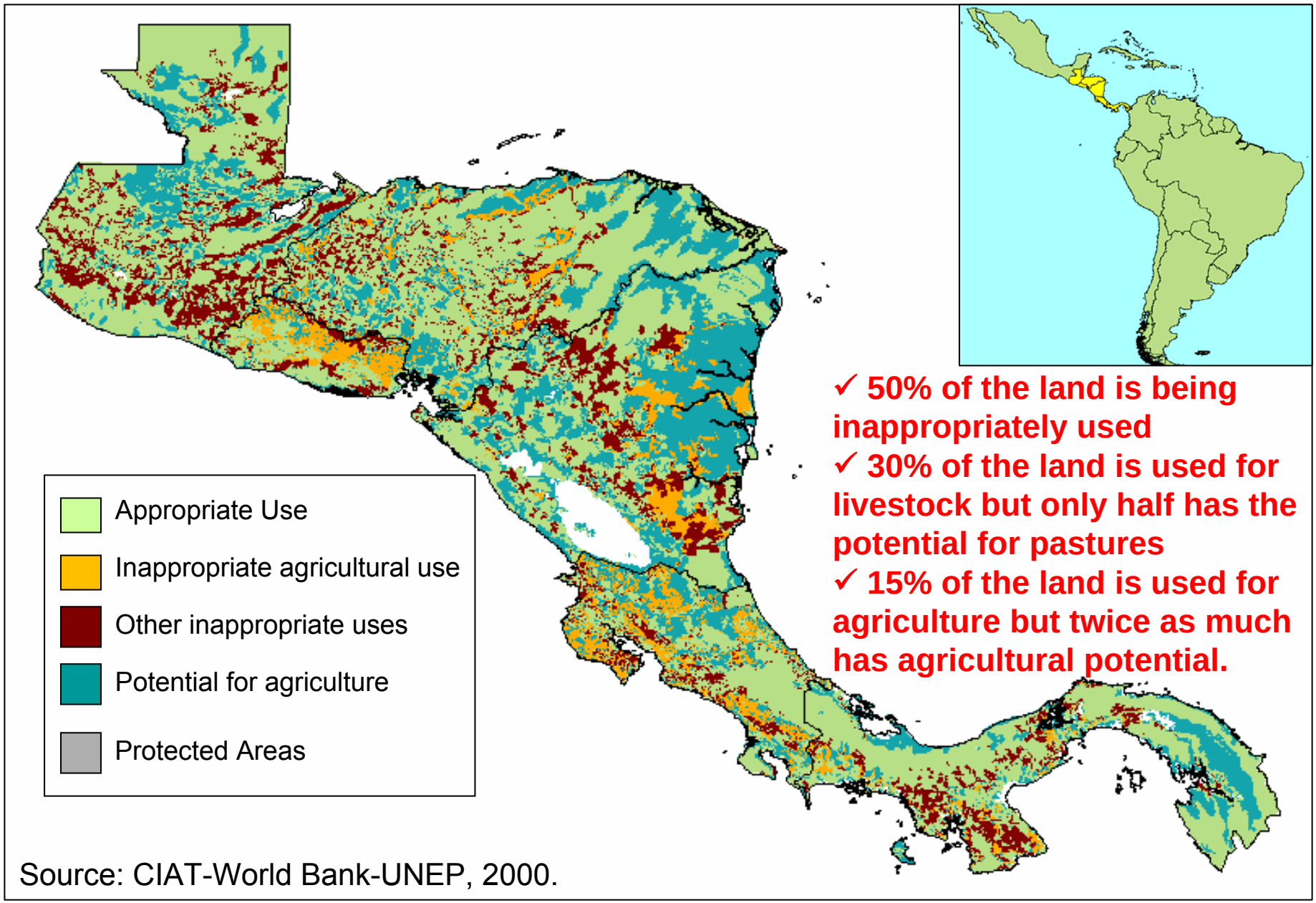
- ✓ **Translate the problems into information**
- ✓ **Turn the preoccupations into awareness**
- ✓ **Transform knowledge into action!**

The environmental issues:
Climatic risks in Central America



Source: CIAT-World Bank-UNEP, 2000.

The socio-environmental issues:
Land-use in Central America

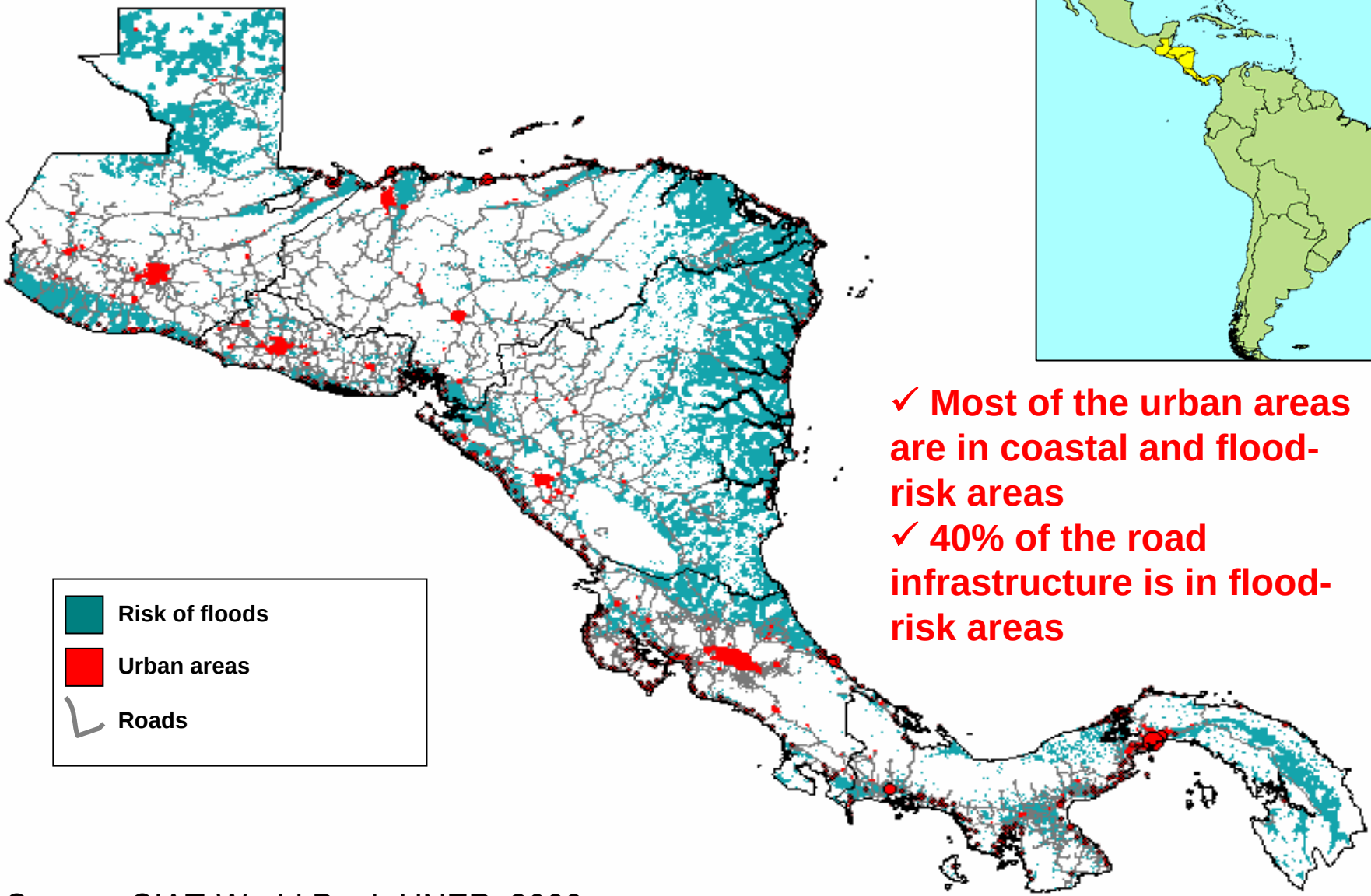


- ✓ 50% of the land is being inappropriately used
- ✓ 30% of the land is used for livestock but only half has the potential for pastures
- ✓ 15% of the land is used for agriculture but twice as much has agricultural potential.

Source: CIAT-World Bank-UNEP, 2000.

The socio-economic issues:

Infrastructure, urbanization and flood risk in Central America



✓ **Most of the urban areas are in coastal and flood-risk areas**

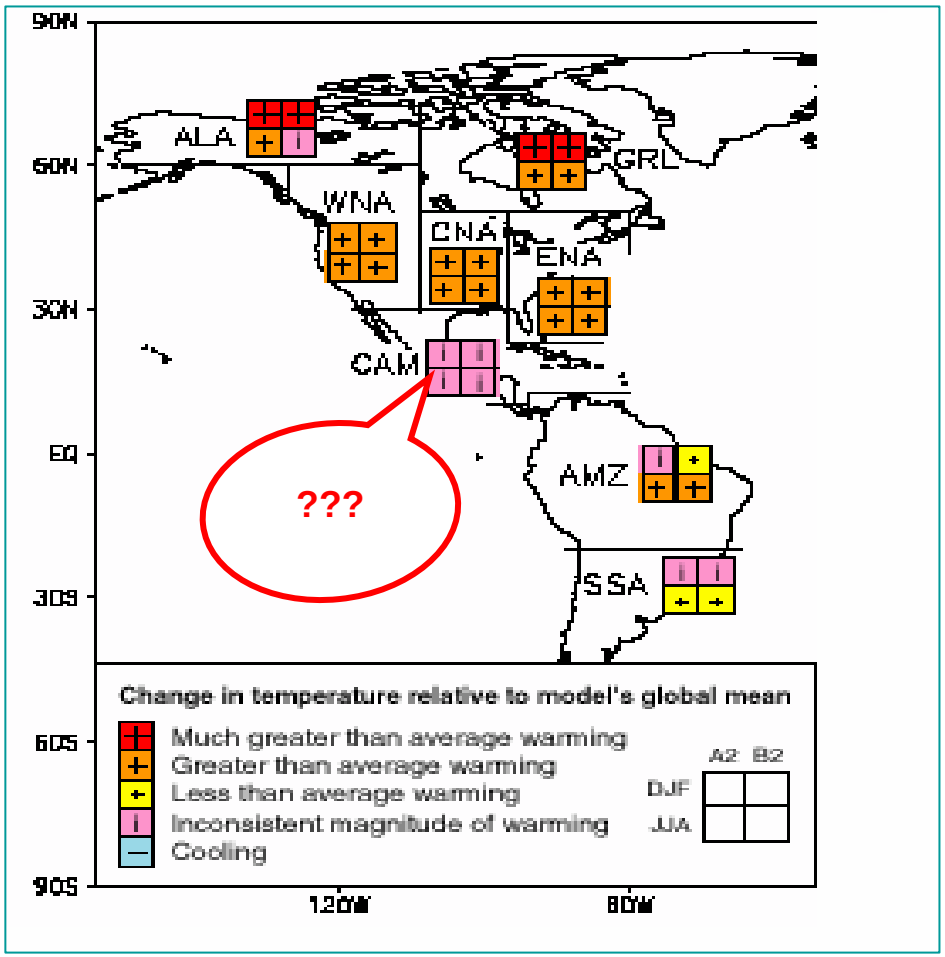
✓ **40% of the road infrastructure is in flood-risk areas**

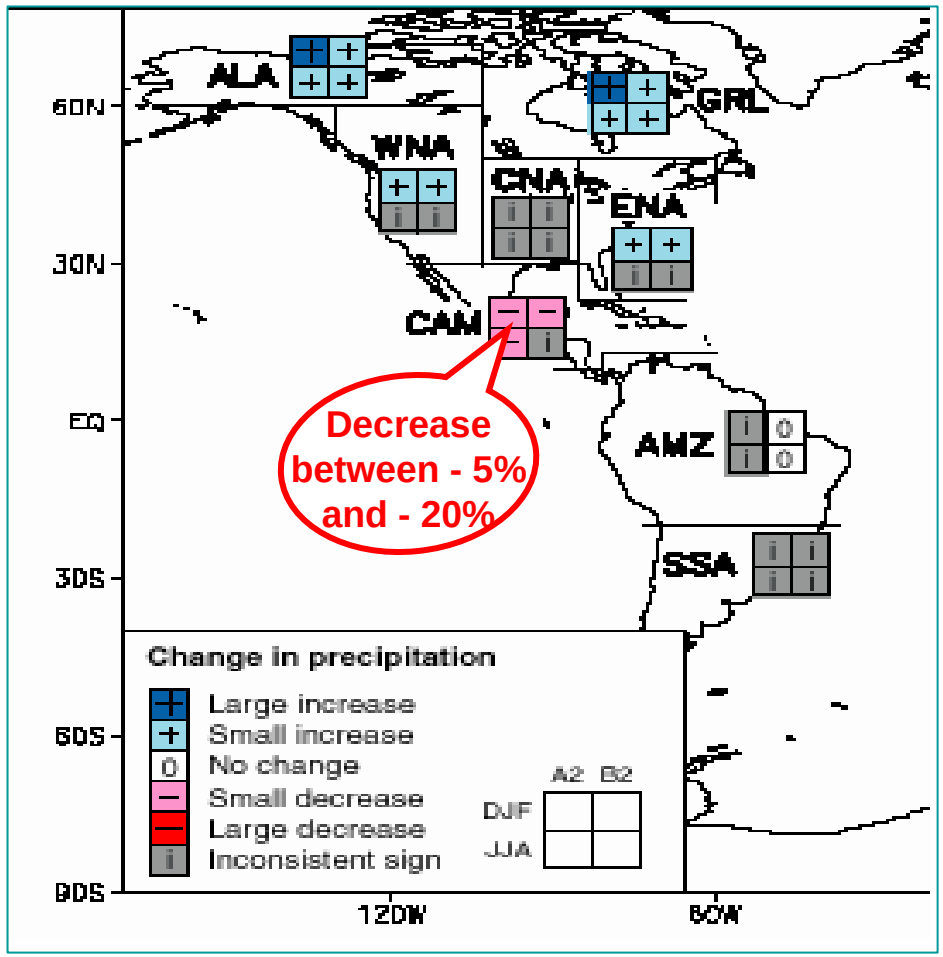
Source: CIAT-World Bank-UNEP, 2000.

The data and information issues:

Data uncertainty about climate change in Central America

Disagreement among models





2. Context - The clients and users…

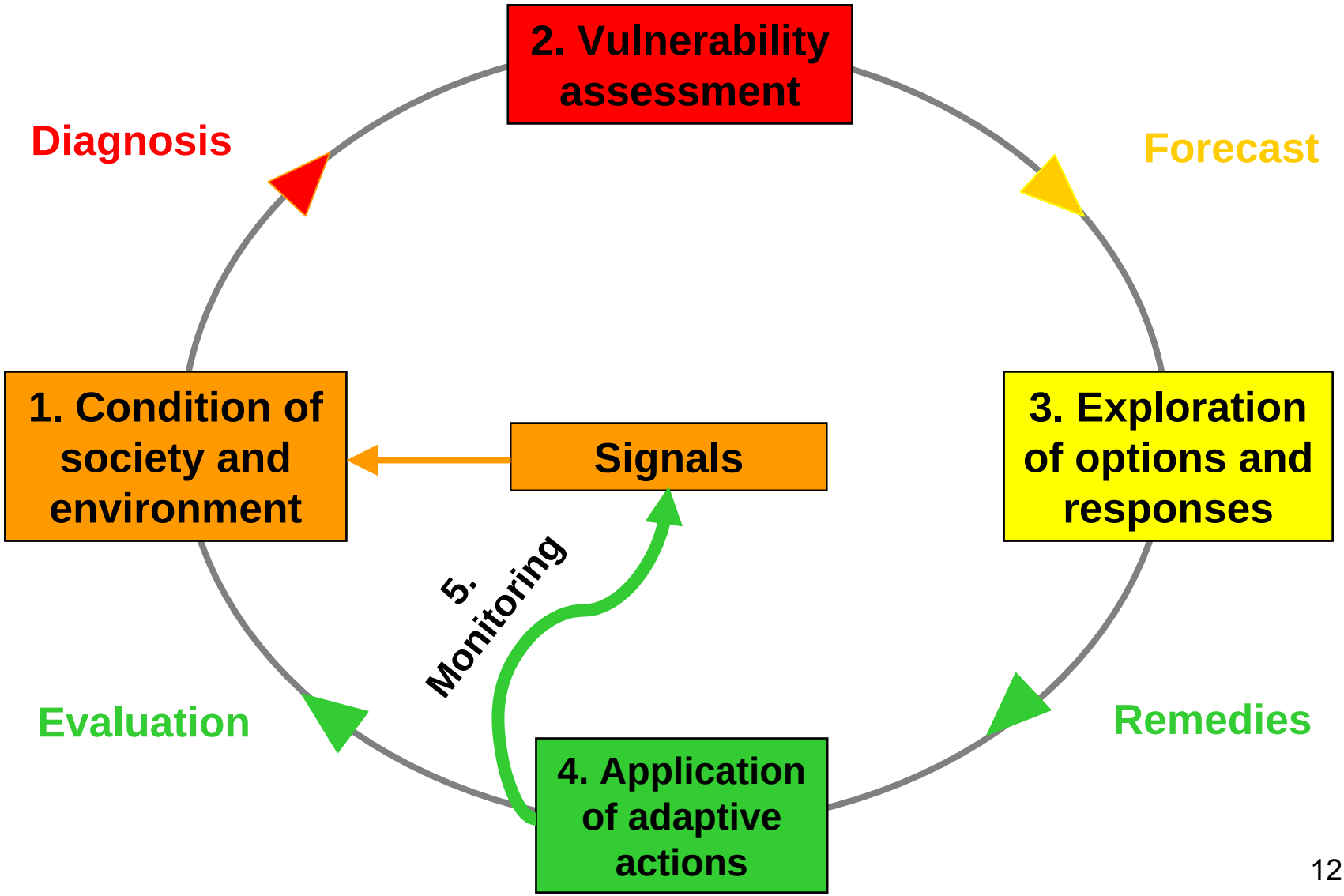
Clients and users:

Levels	Clients/Users	Information needs
International/ Regional	World Bank	Determine priorities
	CCAD	Define strategies
	CBM	Identify “hotspots”
	INFODEV	Produce information
National	World Bank	Determine reconstruction/ rehabilitation and mitigation priorities
	Governments of Honduras and Nicaragua	
	Ministries	Early warning
	Private sector	Insurance
Local	NGOs	Determine priorities
	Local authorities	Reconstruction/relocation
	Producer associations	Agricultural development
	Farmers	Agricultural diversification

3. The method…

The method:

Changing from dealing with the consequences to preventing the causes



Source: Winograd, 2004.

The tools:

Selection of tools for the present case study

Step / Tool	1	2	3	4-5	Main applications
1. Syndromes	X	X			Mapping and analysis of indicators for various groups, regions and sectors
2. Multi-attribute matrices	X	X			Attribute matrices
3. Institutional analysis	X	X	X	X	Identification of key players and interactions controlling how institutions work
4. Brainstorming	X	X	X	X	Constructing matrices and lists of ideas, knowledge and perceptions
5. Stakeholder consultation	X	X	X	X	Consultation of individuals and groups affected by the decisions and processes
6. Role playing	X	X	X	X	Participation to discover behaviour, trends and expectations
7. Oral history	X	X			Use of players' knowledge to build analogies of the strategies and future effects
8. Expert assessment	X	X	X	X	Field assessment techniques on specific problems
9. Macro-economic models and cost-benefit analyses	X	X	X	X	Economic and social costs of impacts, options and answers
10. Vulnerability indicators	X	X	X	X	Data compilation and mapping to build multi-scale/multi-level indicators

Sources: Downing and Ziervogel,2004; Winograd, 2004.

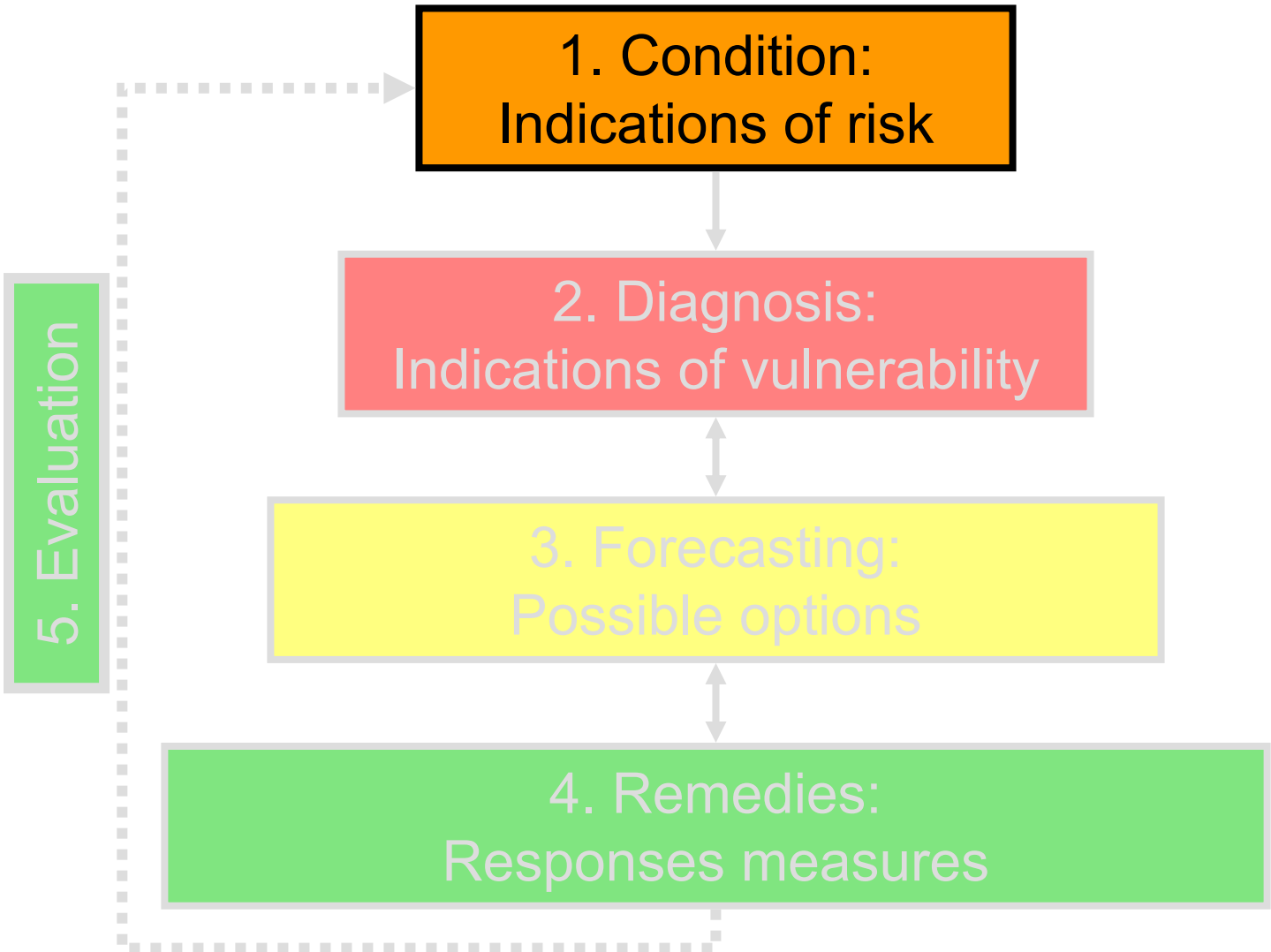
Selection of tools (continued)

Step / Tool	1	2	3	4-5	Main applications
11. Vulnerability profiles	X	X	X	X	Mapping and analysis of indicators for various groups, regions and sectors
12. Livelihood indicators	X	X			Analysis of vulnerable groups on the basis of development operations
13. Cognitive mapping	X	X	X	X	Mapping on the basis of players' knowledge
14. Scenario building and analysis			X	X	Insight into the implication of alternatives by varying key options
15. Bayesian analyses			X	X	Reassessment of the data in light of new information
16. Strategic environmental assessments	X	X	X	X	Understanding and analysing the environmental conditions and impacts before designating options and answers
17. Interactive/ participative GIS	X	X	X	X	Using GIS with the players to identify relations and critical hotspots
18. Risk analyses			X	X	Analysing uncertainties in decisions
19. Sensitivity analyses			X	X	Comparing risks and options to identify the most vulnerable sectors, resources and groups
20. Focus groups			X	X	Selected groups of players who analyse the options for certain problems

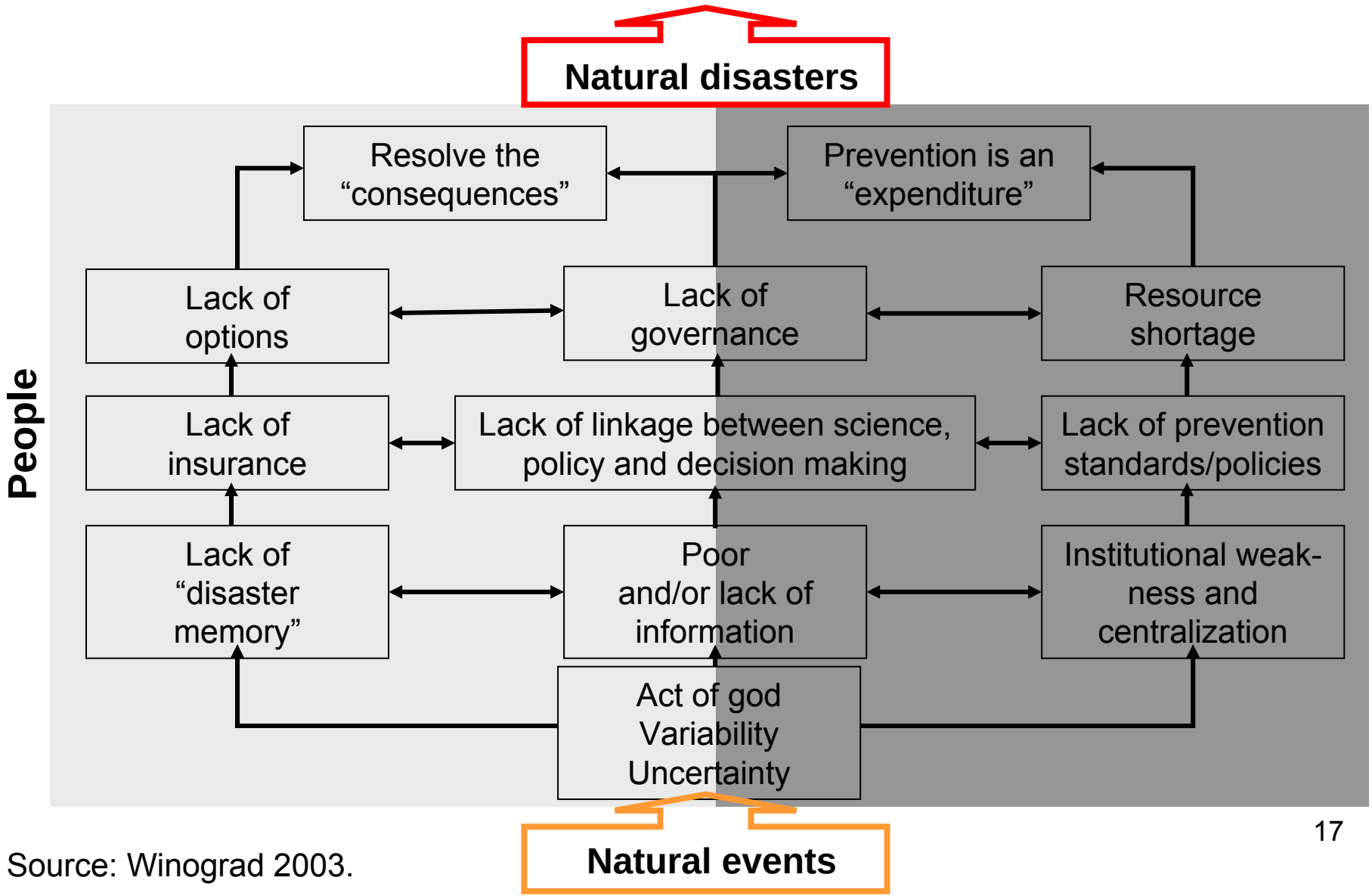
Sources: Downing and Ziervogel,2004; Winograd, 2004.

4. The steps and tools for going from vulnerability assessments to adaptation strategies…

Step 1: Tools for assessing the condition



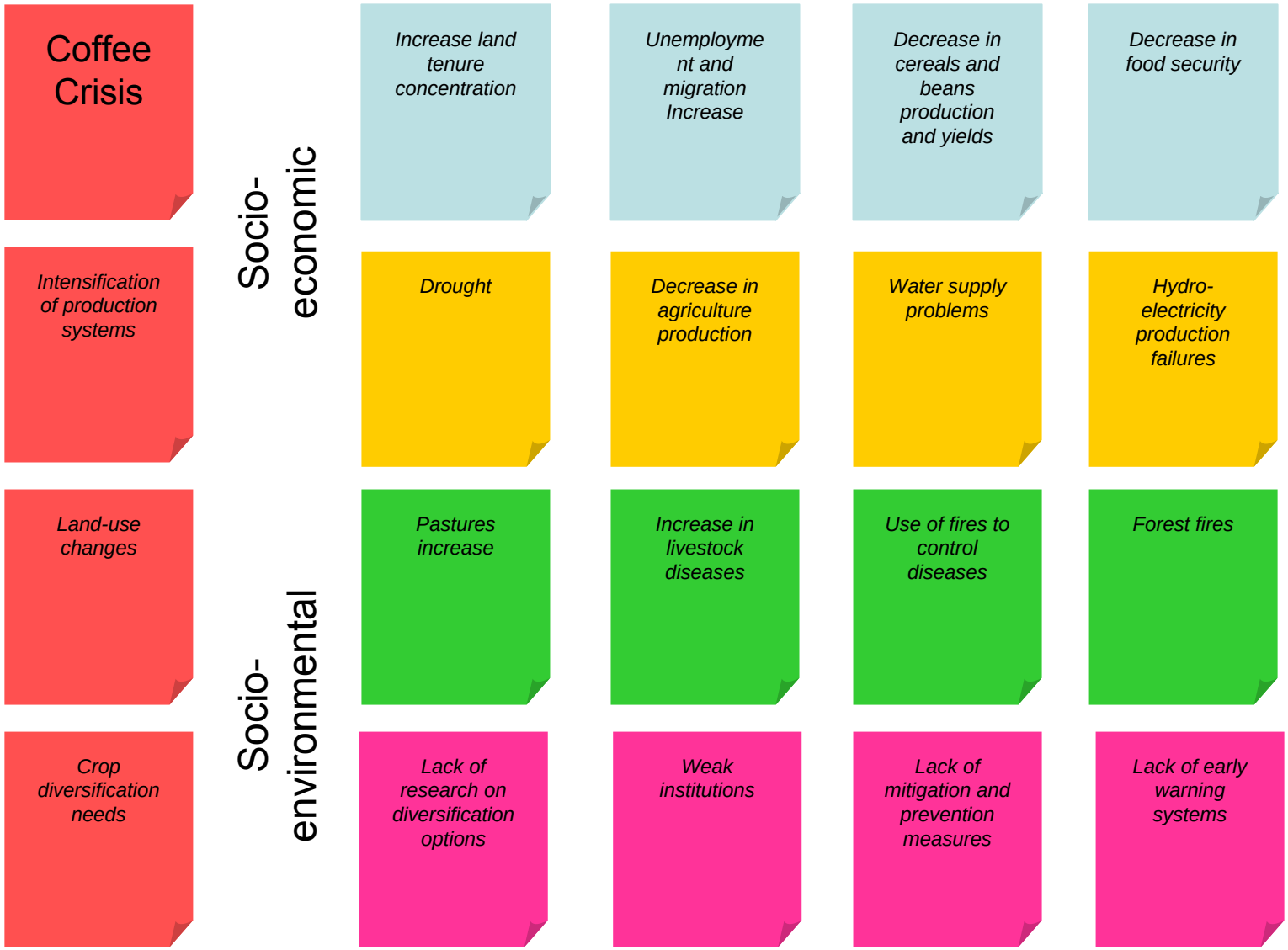
Tools: Syndromes/Integrated vulnerability models, Institutional analysis
Goal: Identify the institutional and social symptoms of natural disasters at national and local level (Honduras)



Source: Winograd 2003.

Tools: Brainstorming, stakeholder consultation

Goal: Analysis of the perceptions of actors of vulnerability at the regional/local level (Central America and Honduras, 1997 and 2001)

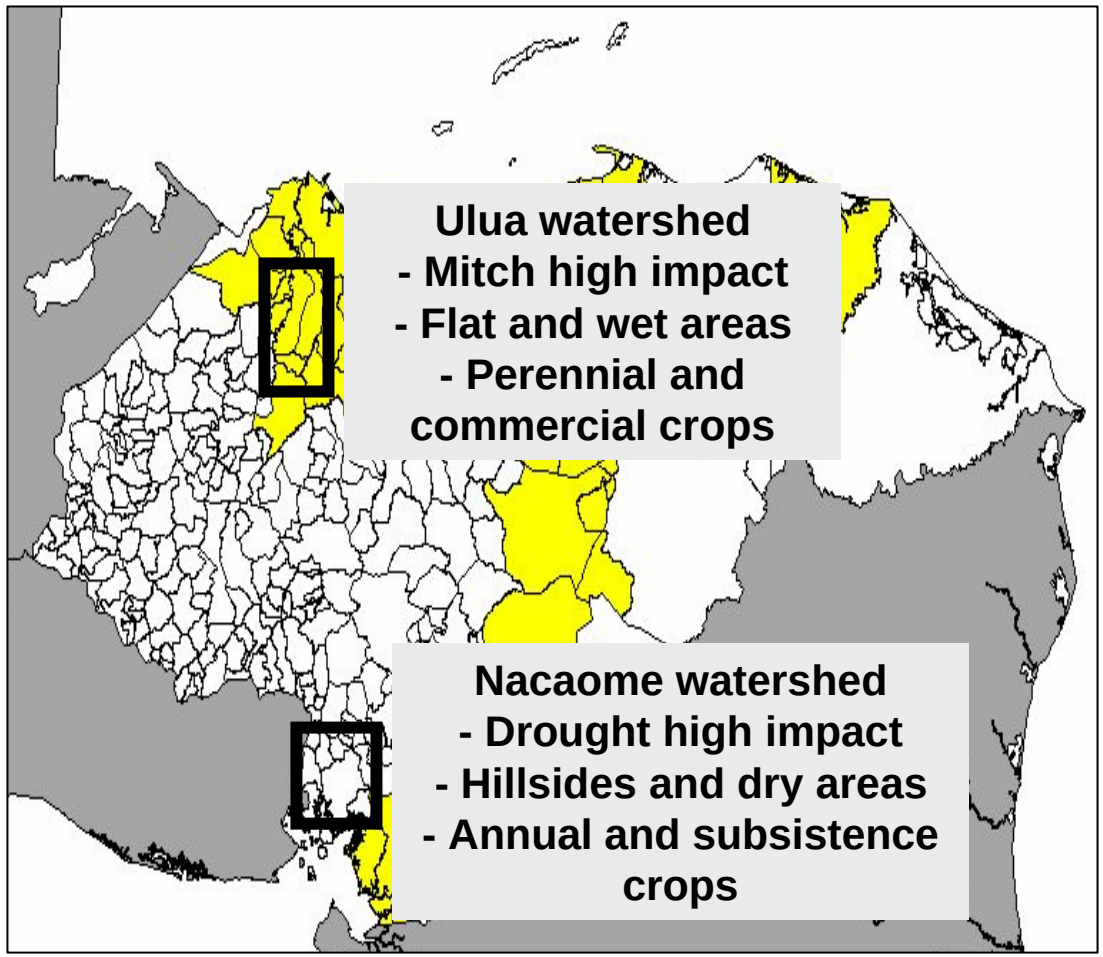


Source: CIAT survey, 1997; 2003.

Tools: Stakeholder consultation, Oral history

Goal: Analysis of the perceptions of actors at local level (Honduras)

Perception of problems by the communities 2003



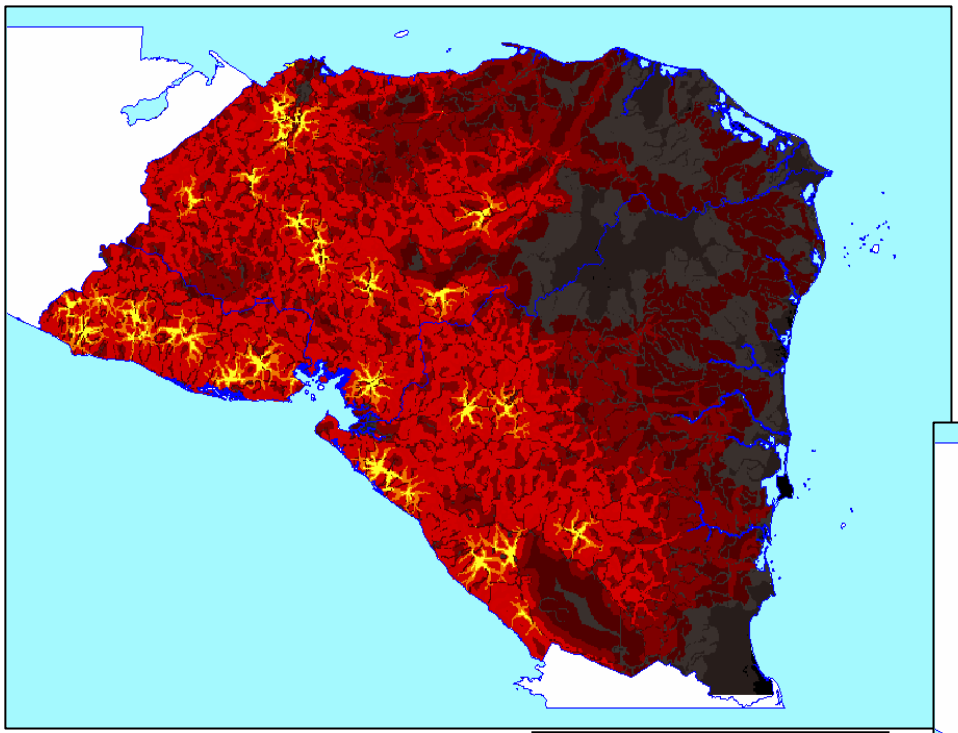
Nacaome	Ulua
Drinking water	Flood
Unemploy-ment	Health services and diseases
Electricity	Unemploy-ment
Housing	Drinking water
Famine	Electricity

Source: Rubiano, 2003; 2004.

Tools: Vulnerability indicators and mapping

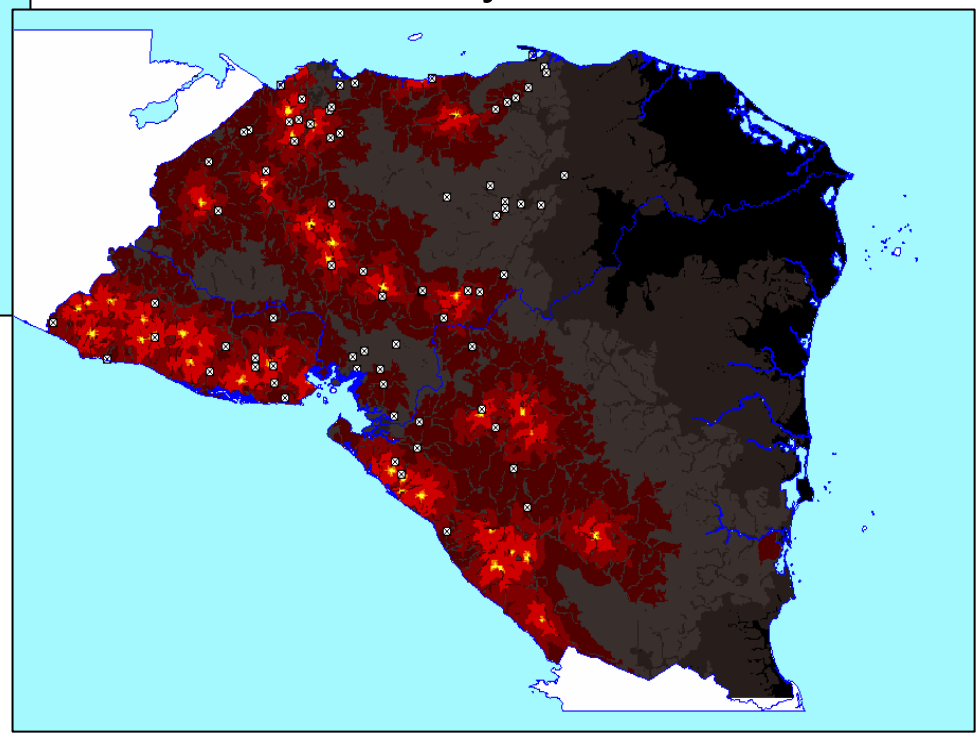
Goal: Analysis of the economic impact of Mitch (1998) on the accessibility to markets at the regional level (Central America)

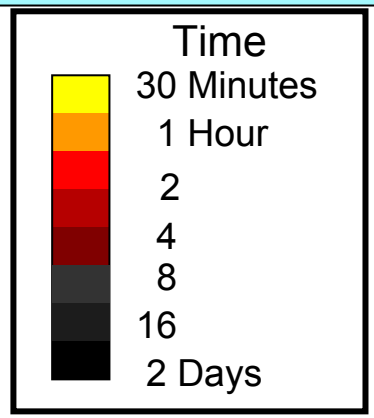
Accessibility before Mitch



- ✓ **80% of road infrastructure and access to markets affected**
- ✓ **The economic and social impact of cyclones and storms is 10-20 times higher than that of drought**

Accessibility after Mitch





Source: CIAT, 1999.

Tools: Expert assessment, Cost-benefit analyses

Goal: Analysis of economic losses from the 2001 drought at the regional level (Central America)

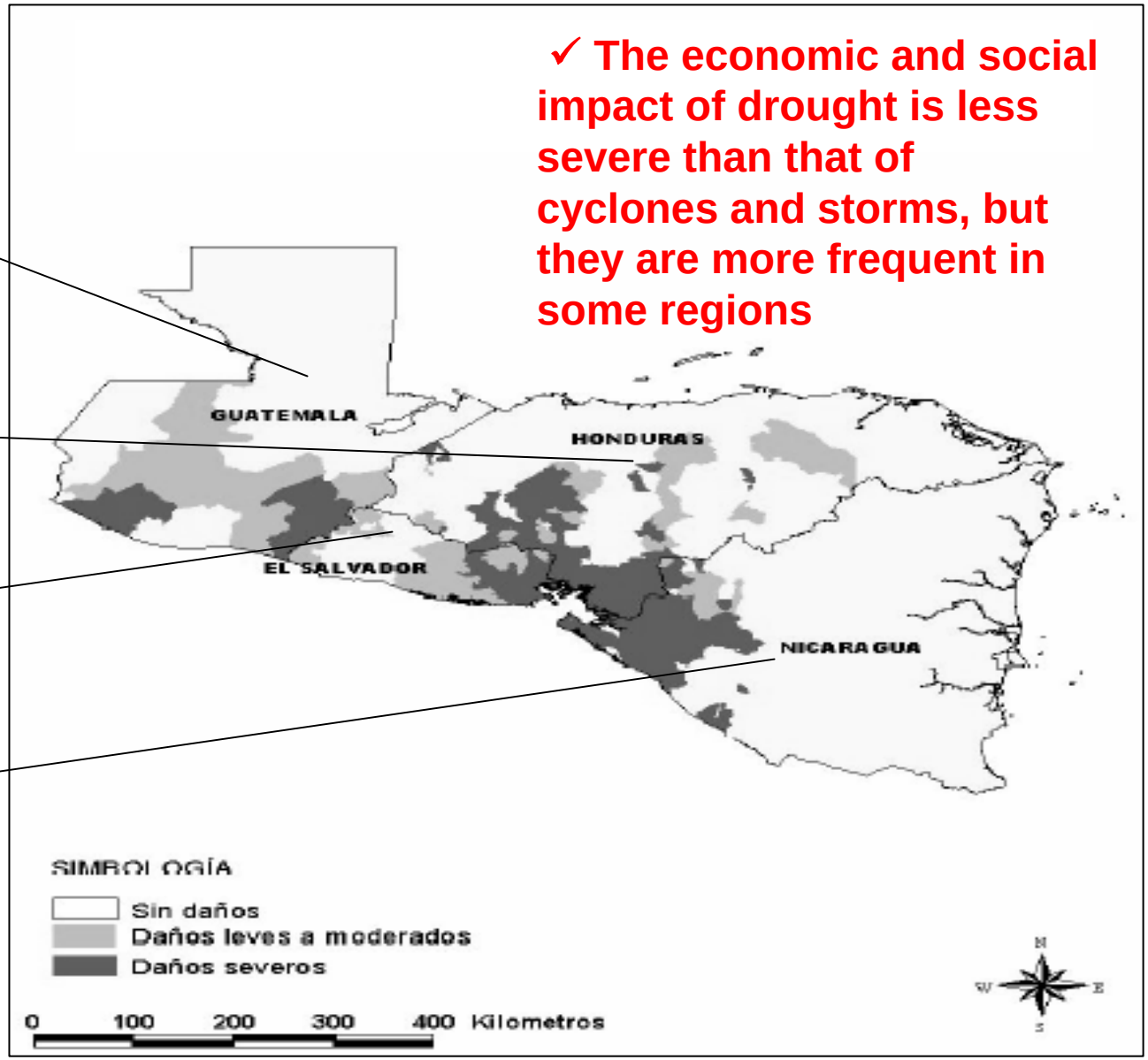
✓ **The economic and social impact of drought is less severe than that of cyclones and storms, but they are more frequent in some regions**

$22 million US

$52 million US

$32 million US

$50 million US

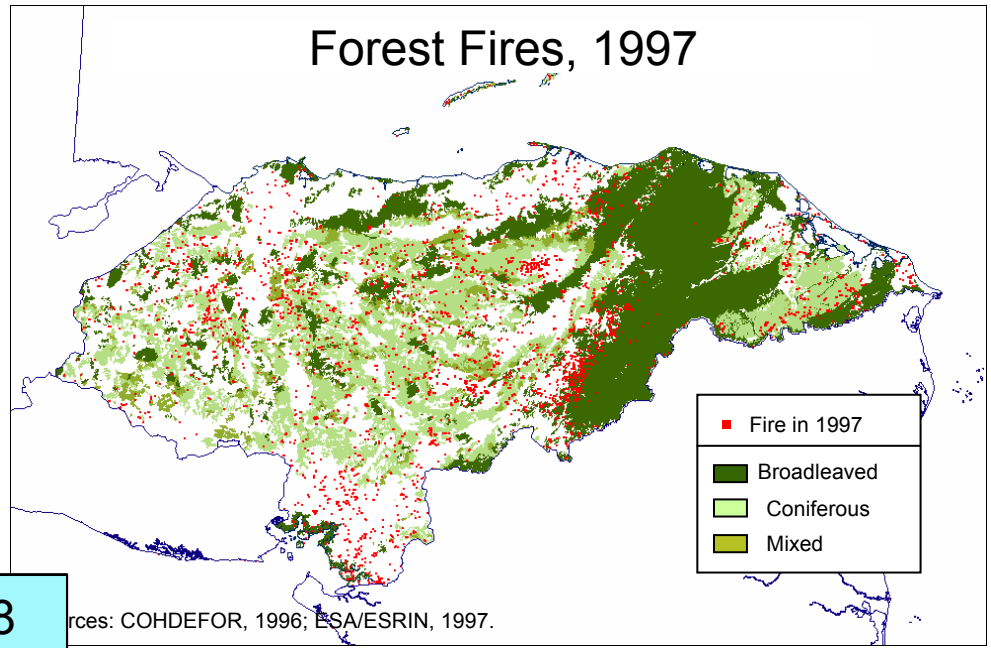


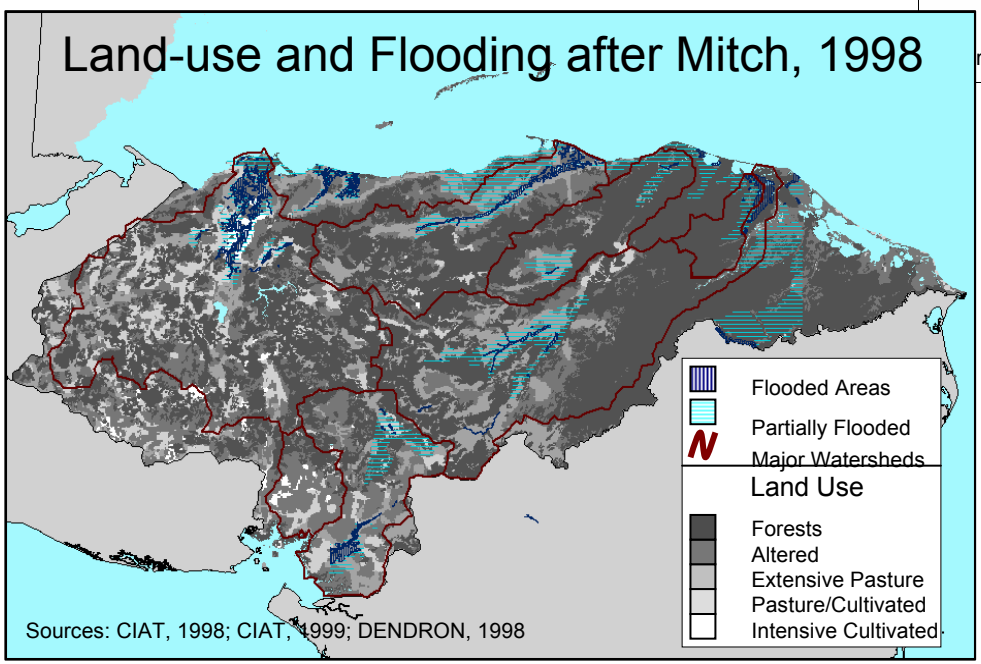
Source: ECLAC, 2002.

Tools: Vulnerability indicators and mapping

Goal: Analysis of the impact of climate variability and natural disasters on the environment in relation to land-use at the national level (Honduras)

✓ **70% of fires related to agriculture practices in agricultural areas**

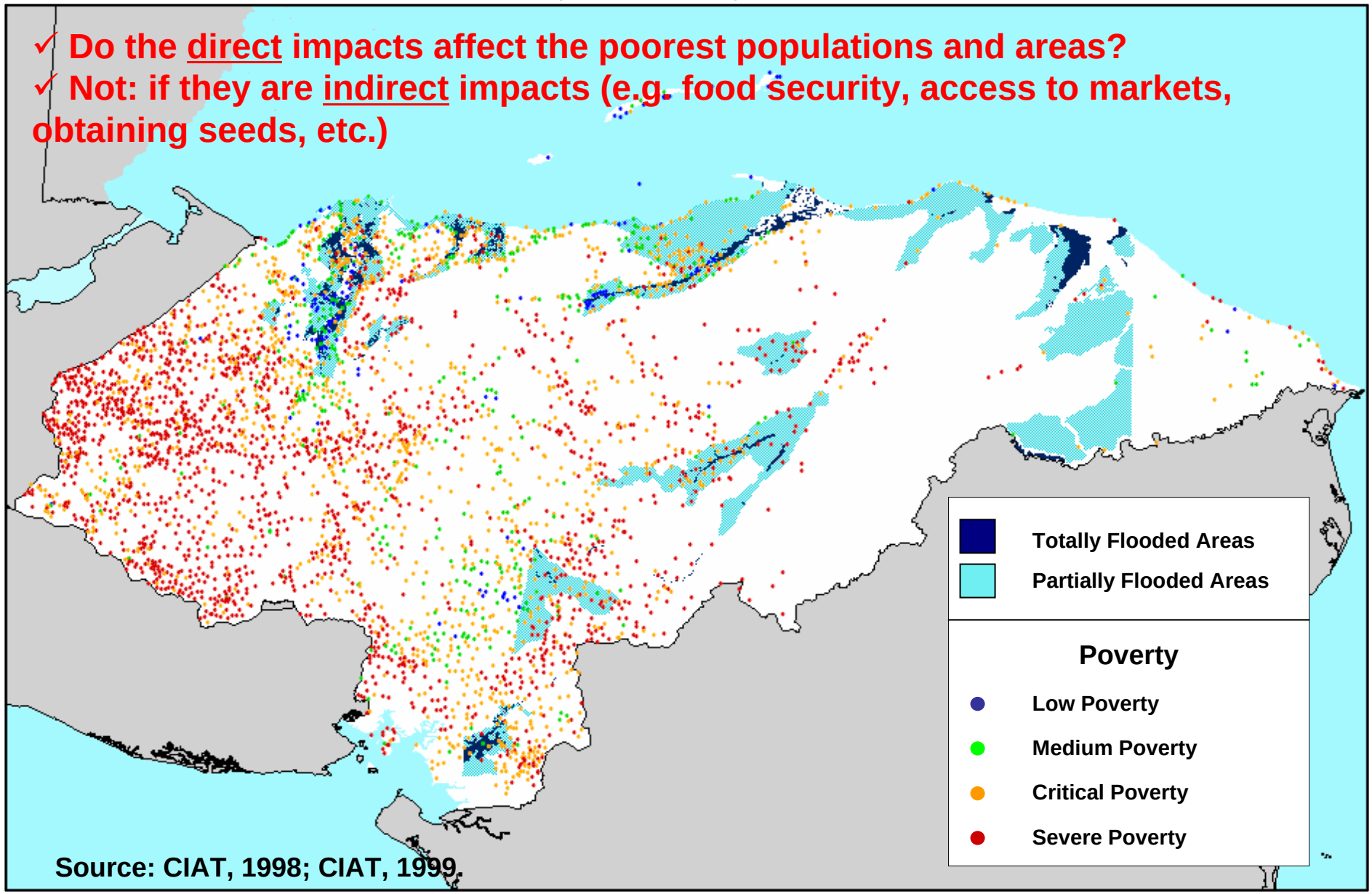




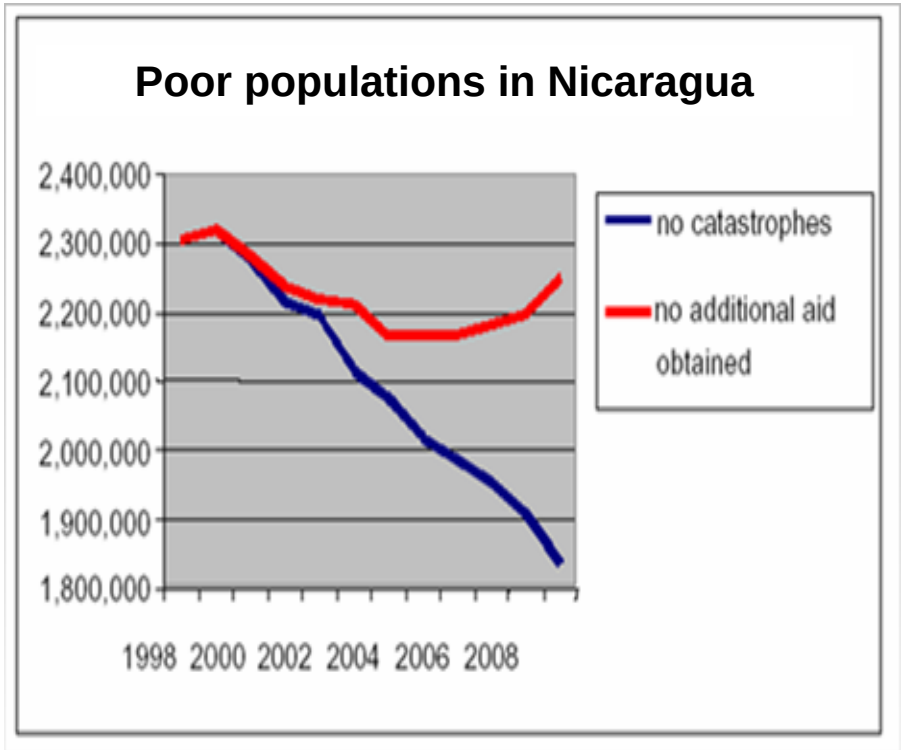
✓ **The areas most affected are those with intensive agriculture, grazing or annual crops in regions in the lower watershed areas without forest cover**

Tool: Vulnerability profiles

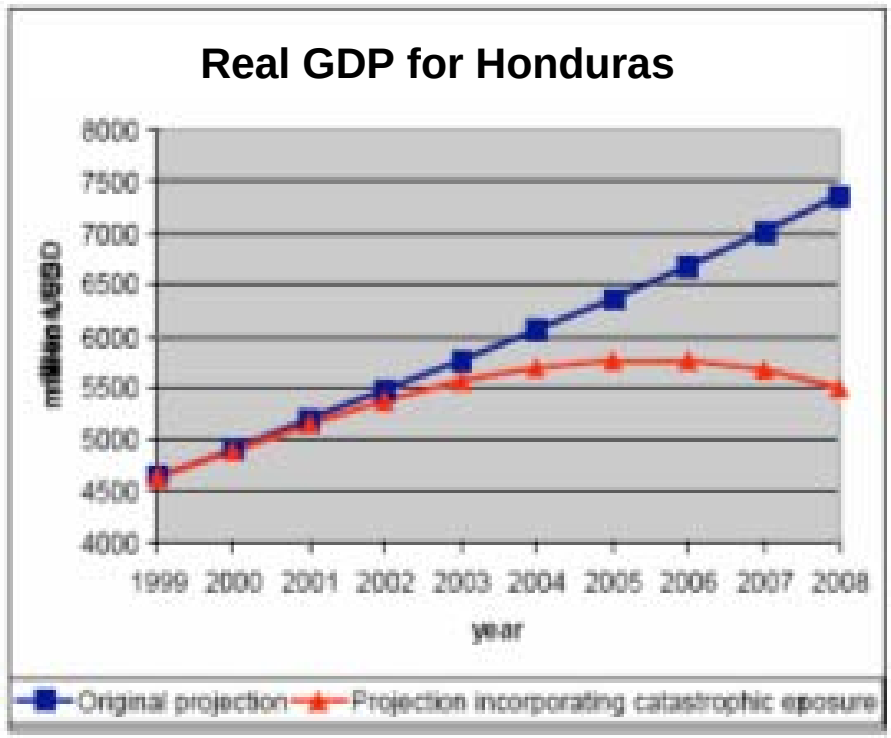
Goal: Analysis of the socio-environmental impact of Mitch (1998) on poor populations at the national level (Honduras)



Tools: Macro-economic models, Cost-benefit analyses
Goal: Analysis of the social and economic costs of natural disasters at the national level (Nicaragua and Honduras)



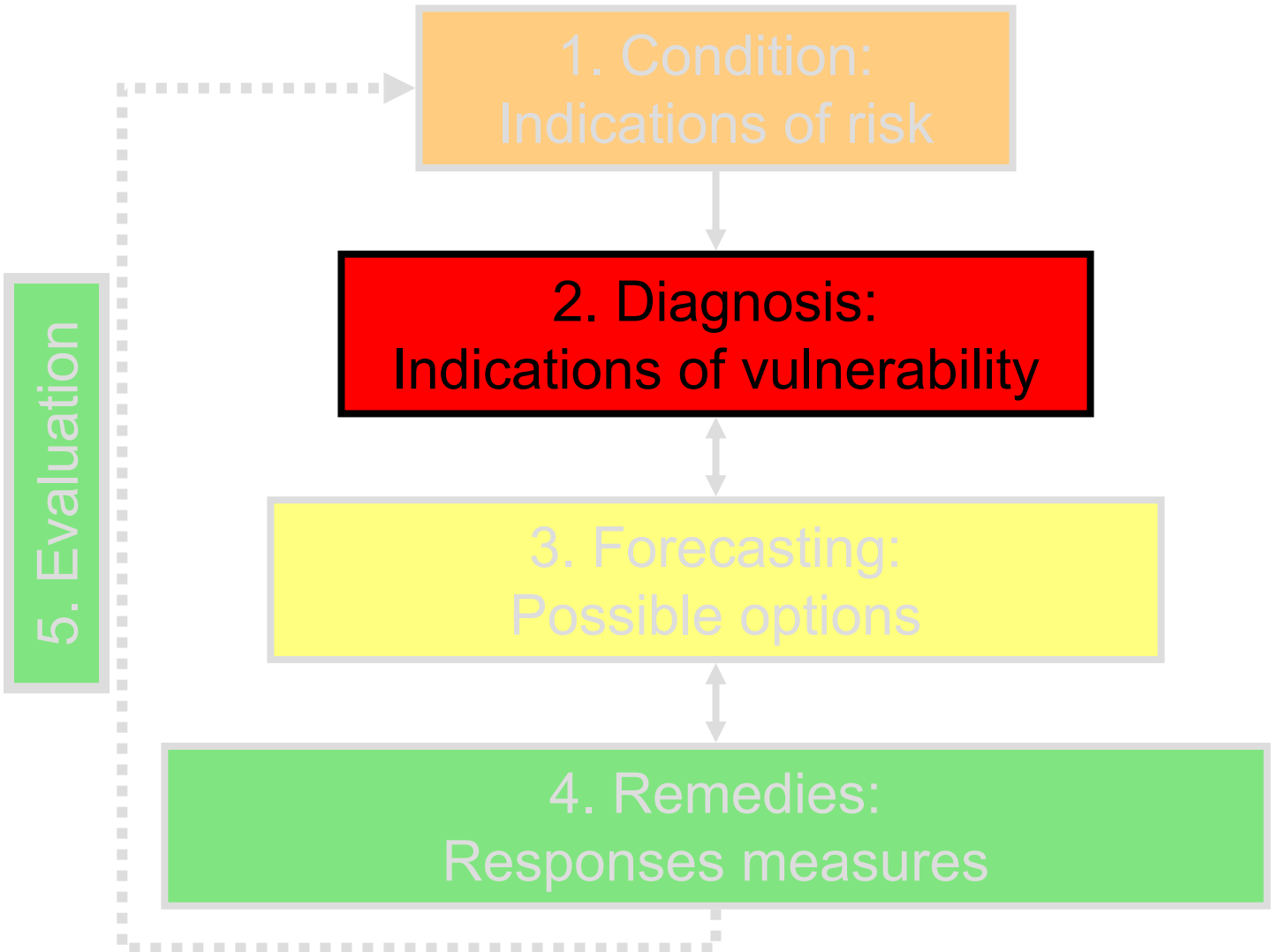
✓ **The socio-economic impacts of natural disasters related to climate variability and climate changes can be enormous**



✓ **Prevention and early warning are the surest and most profitable investments**

Source: Freeman *et al*.,2001.

Step 2: Tools for diagnosis

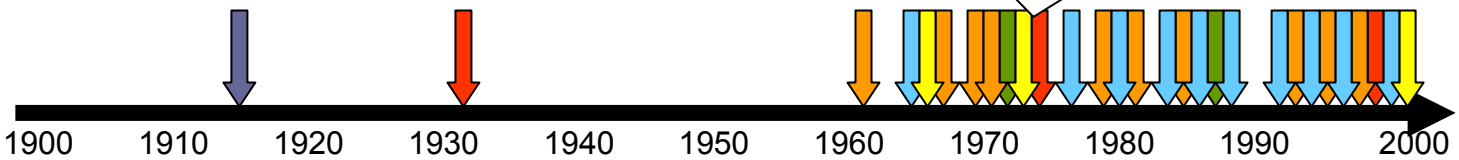


Tool: Vulnerability profile

Goal: To identify the probabilities and magnitudes of natural disasters at the national level (Honduras)


Inundation in Tegucigalpa,1906

Beware of statistics!!!...
Missing information!
Missing time series!
Inaccuracies!



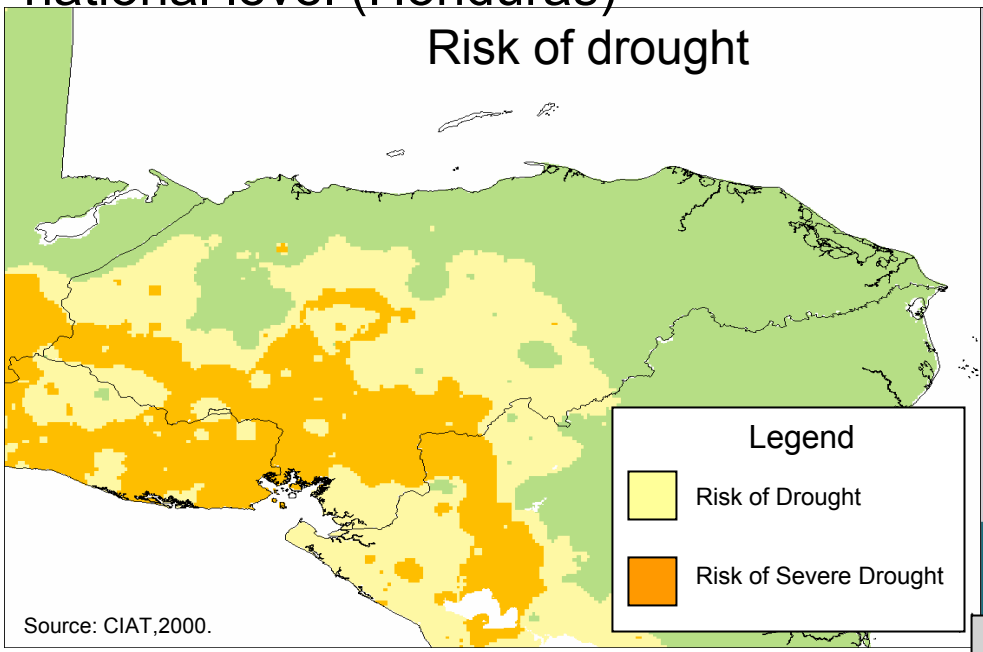
- Earthquakes = every 100/125 years
- Acute drought = every 25/30 years
- Hurricanes = every 25/30 years
- Landslides = every 10/20 years
- Storms = every 3/5 years
- Floods = every 2/4 years

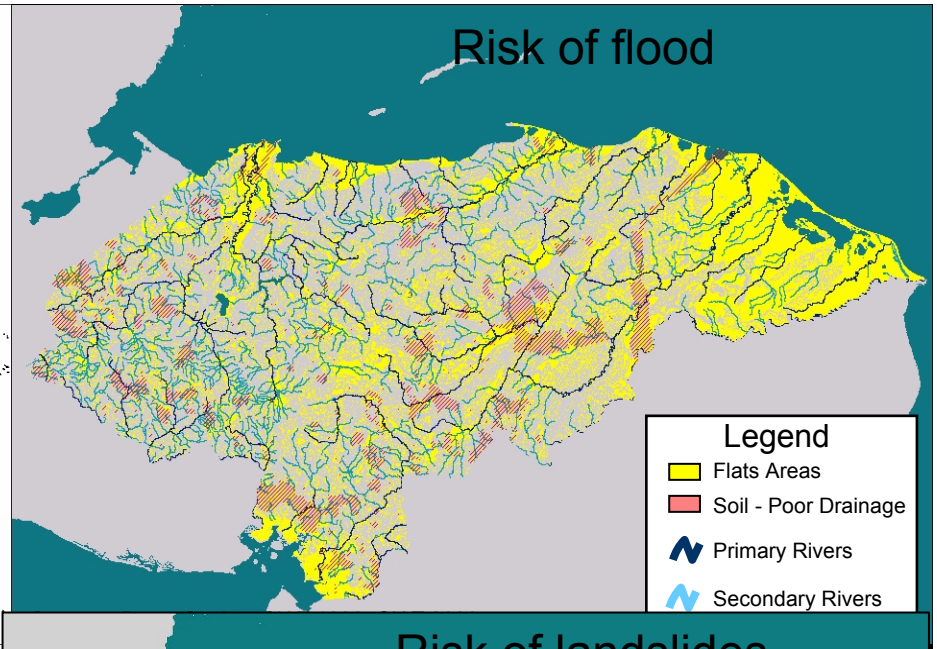

Landslides in 1998

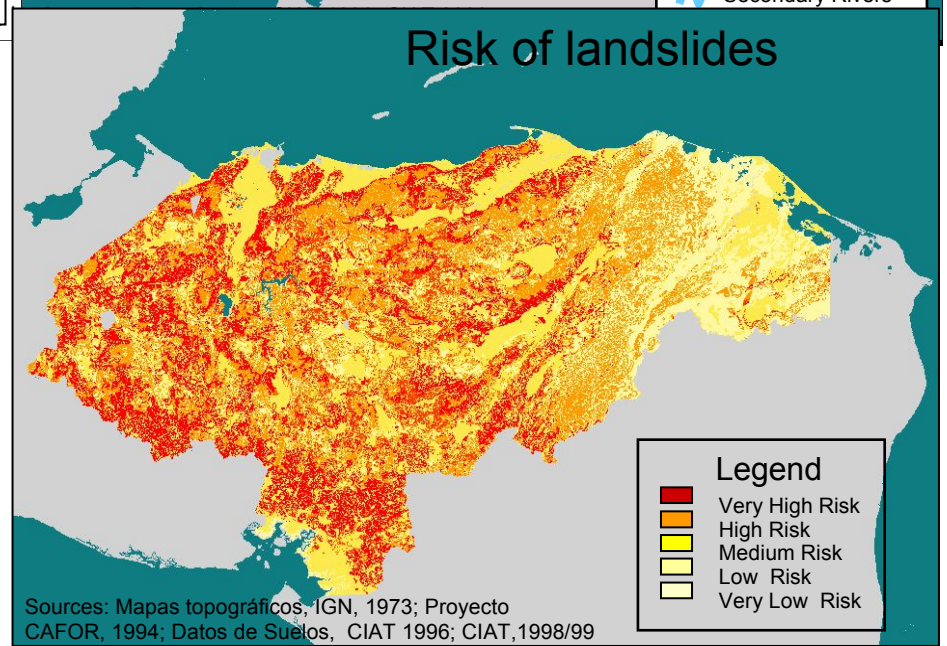
Source: Centre for Research on the Epidemiology of Disasters (CRED),2000.

Tool: Vulnerability profile

Goal: To identify the probability and magnitude of natural disasters at the national level (Honduras)







Acute drought = every 25/30 years

Major hurricanes = every 25/30 years

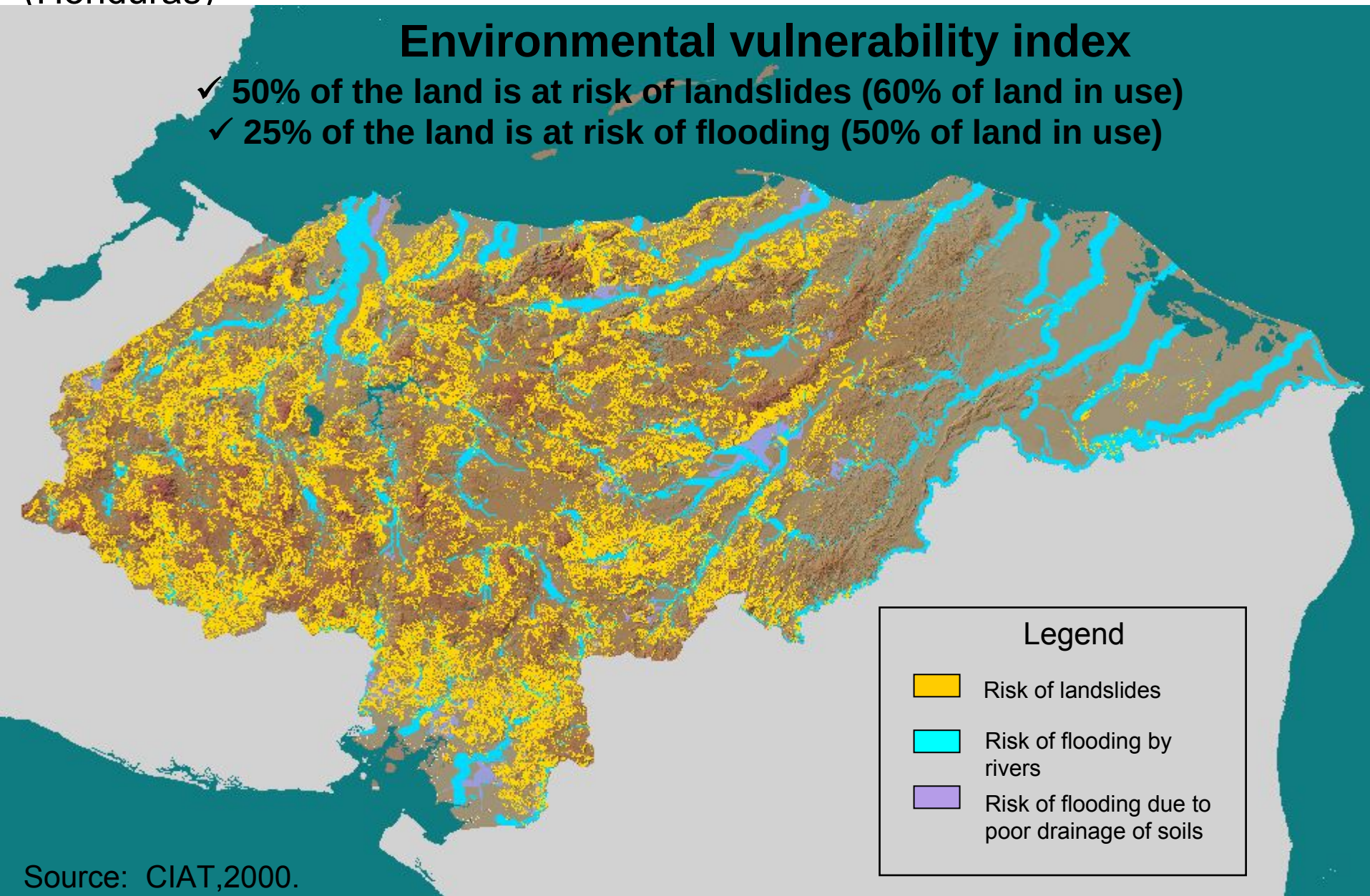
Landslides = every 10/20 years

Storms = every 3/5 years

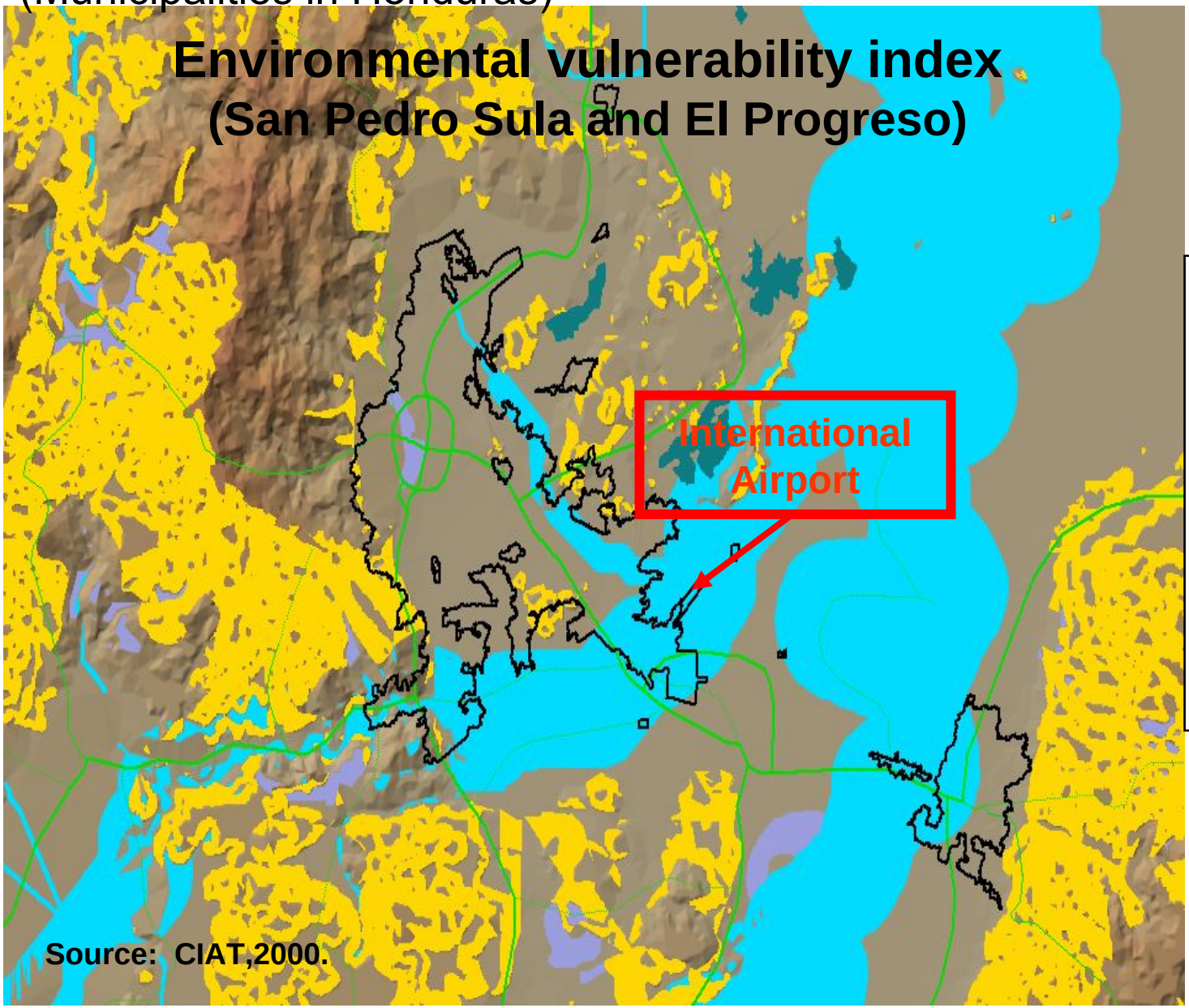
Floods = every 2/4 years

Drought = every 2/3 years

Tools: Vulnerability indicators and mapping, Vulnerability profiles
Goal: To assess the vulnerability to natural disasters at the national level (Honduras)

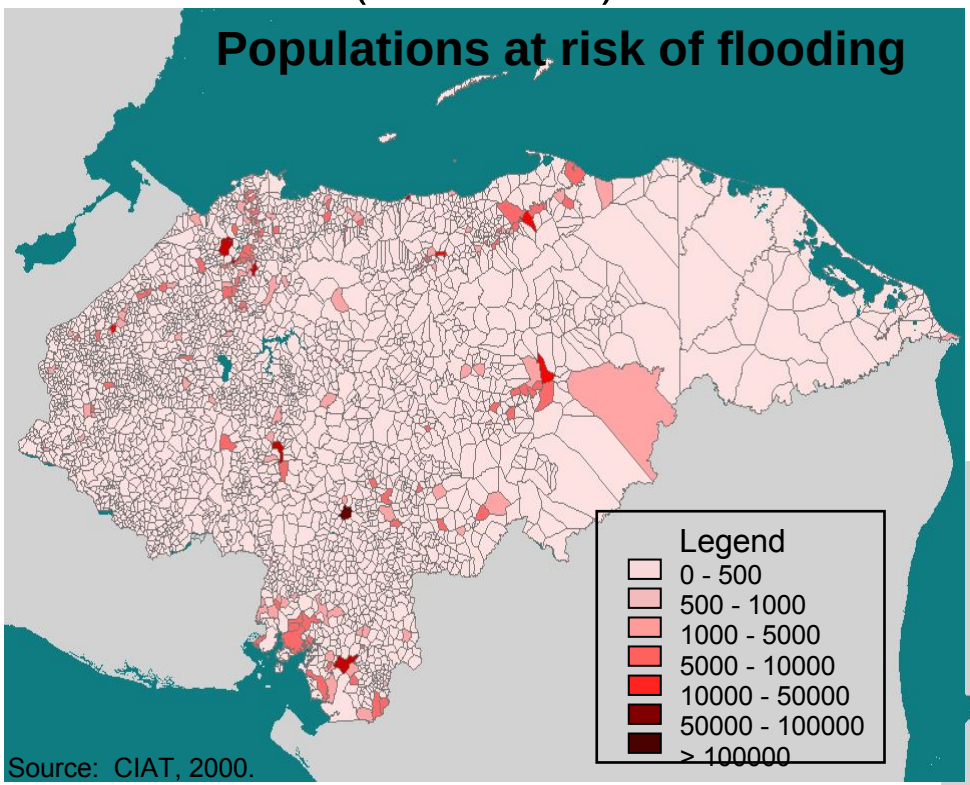


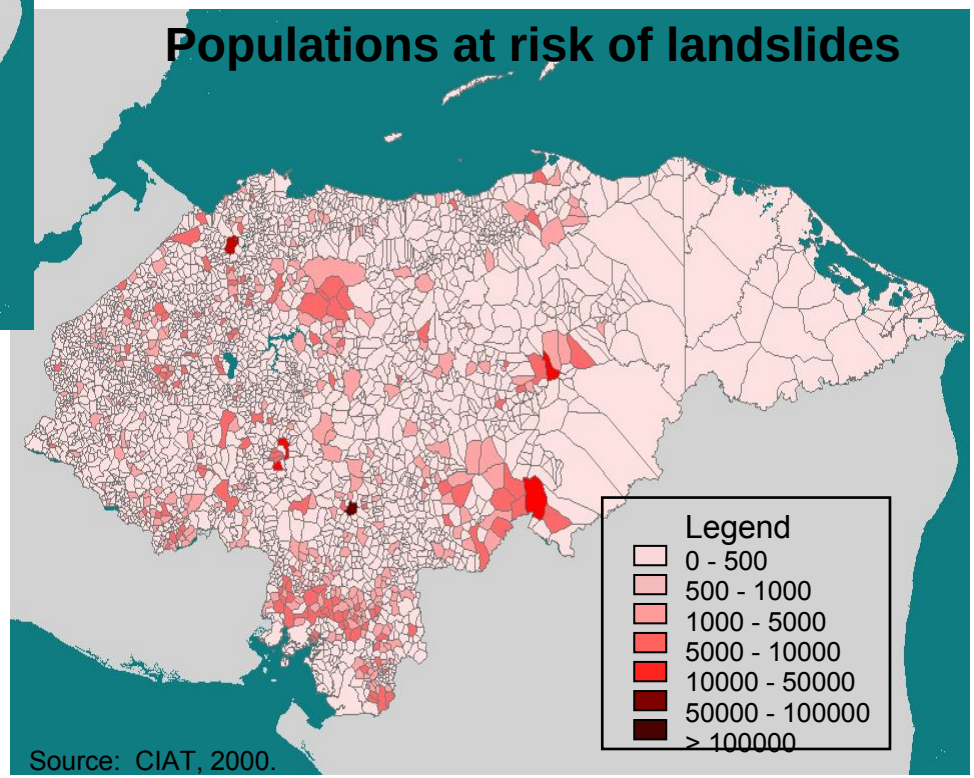
Tools: Vulnerability indicators and mapping, Vulnerability profiles
Goal: To assess the vulnerability to natural disasters at the national level (Municipalities in Honduras)



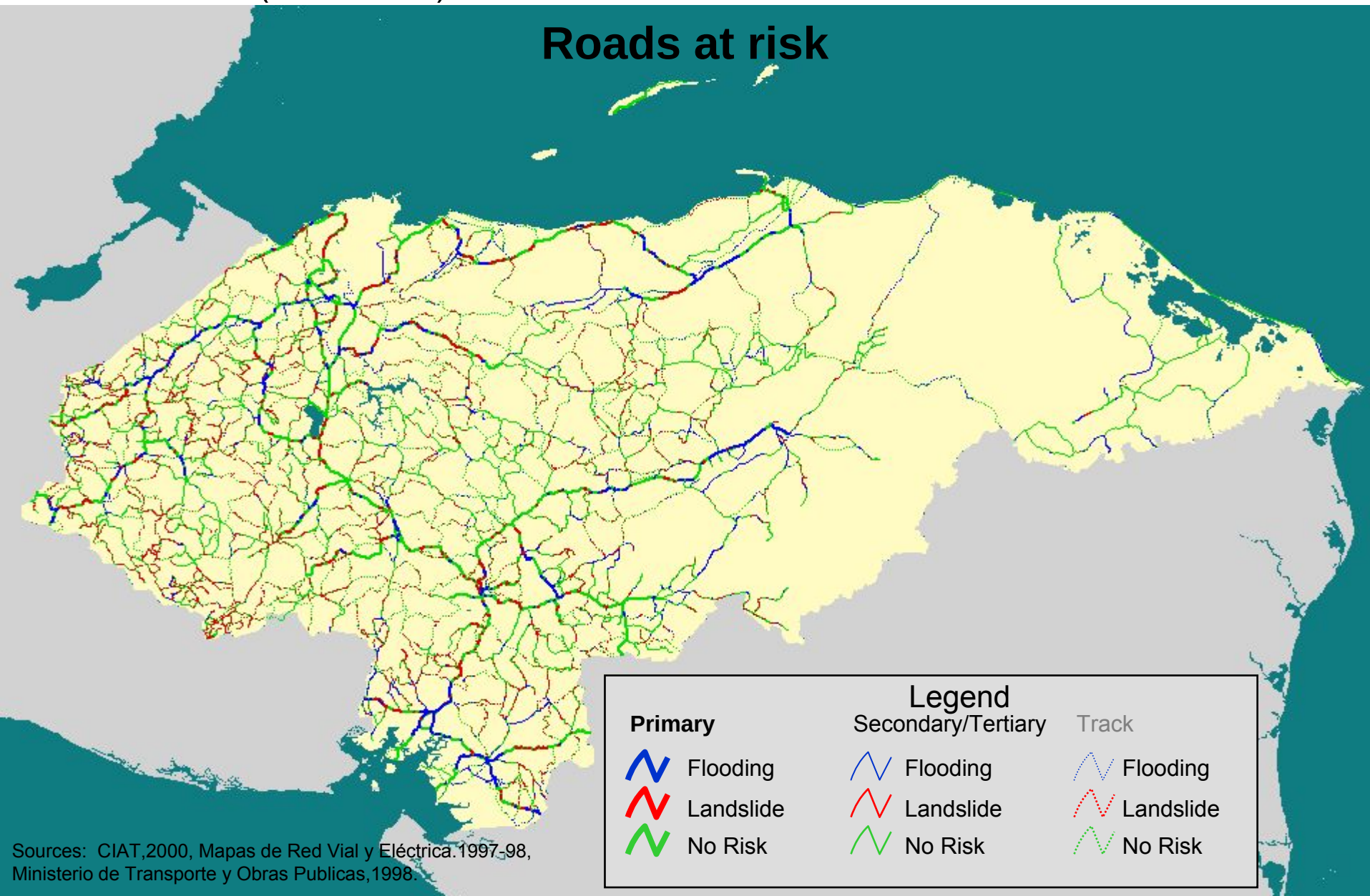
Tools: Vulnerability indicators and mapping, Vulnerability profiles

Goal: To assess the vulnerability to natural disasters of the population at the national level (Honduras)





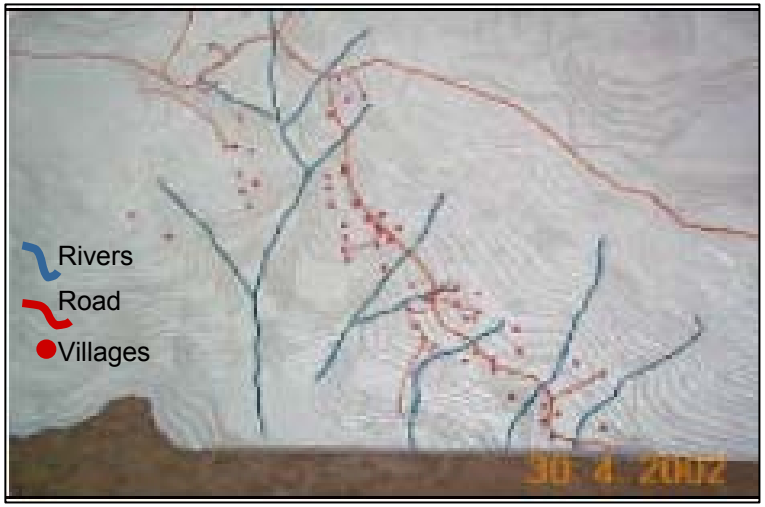
Tools: Vulnerability indicators and mapping, Vulnerability profiles
Goals: To assess the vulnerability to natural disasters of infrastructure at the national level (Honduras)



Tools: Cognitive mapping, interactive/participatory GIS

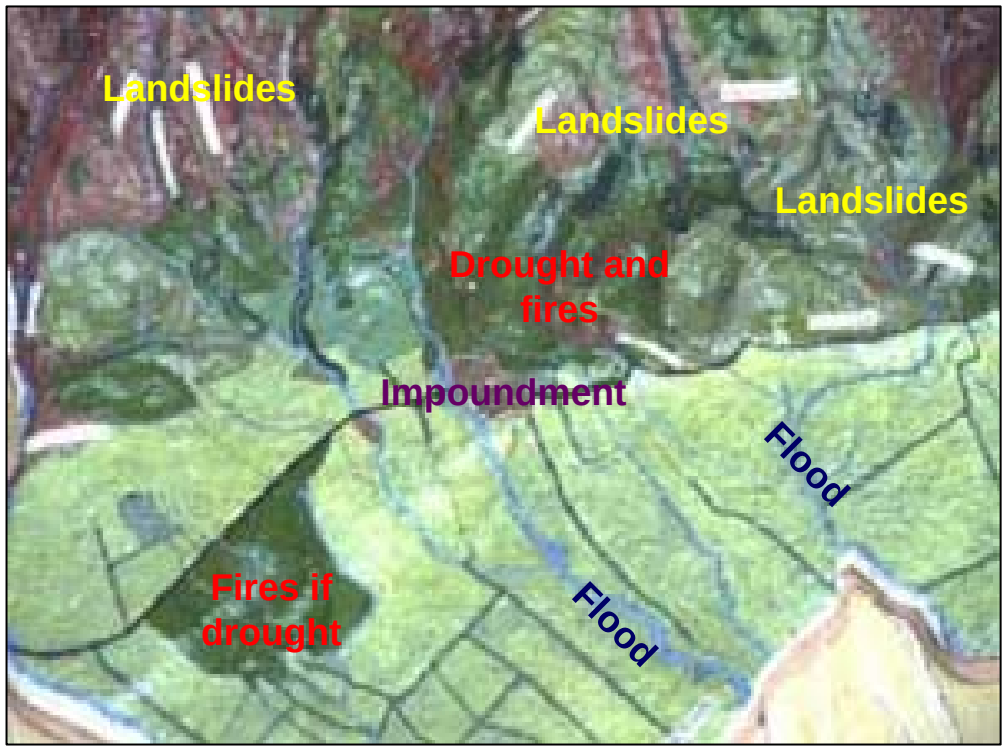
Goal: To assess the vulnerability to natural disasters at the local level (Municipalities in Honduras)

1. Data: Rivers, roads and villages



2. Information: 3D Model

3. Evaluation: Principal risks and dangers identified



Reminder:

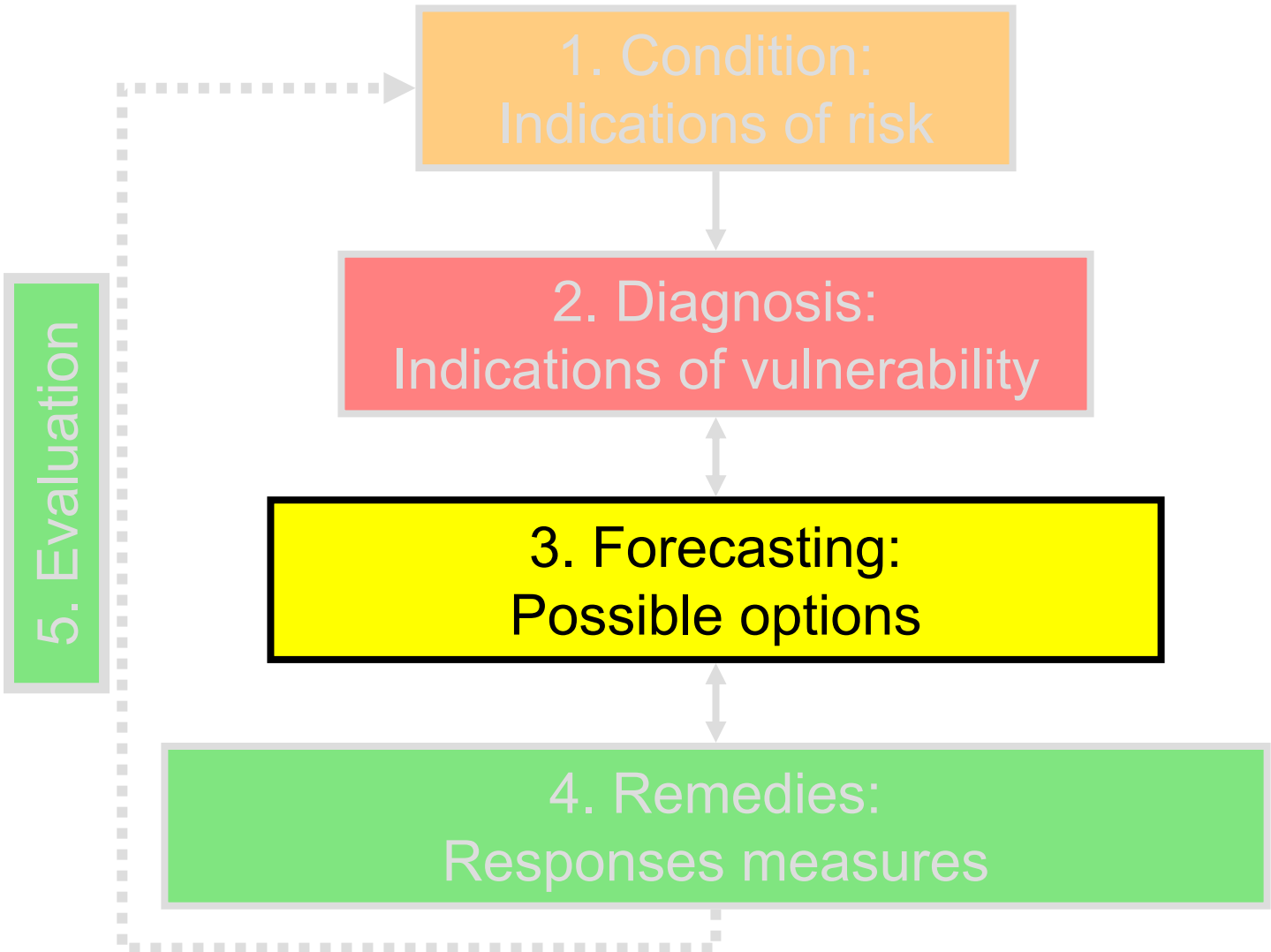
✓ 1. Collect the necessary data

✓ 2. Produce the relevant information that can be used by the actors

✓3. With the information, assess and identify the risks and dangers with the actors

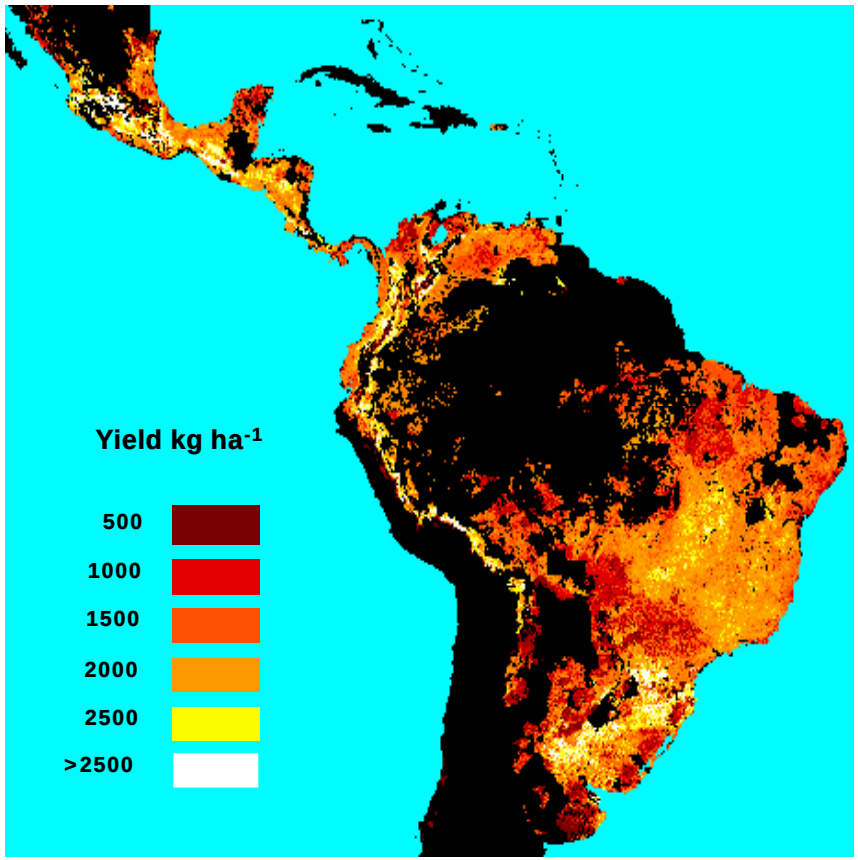
Source: Land-use Project, CIAT, 2004.

Step 3: Tools for forecasting

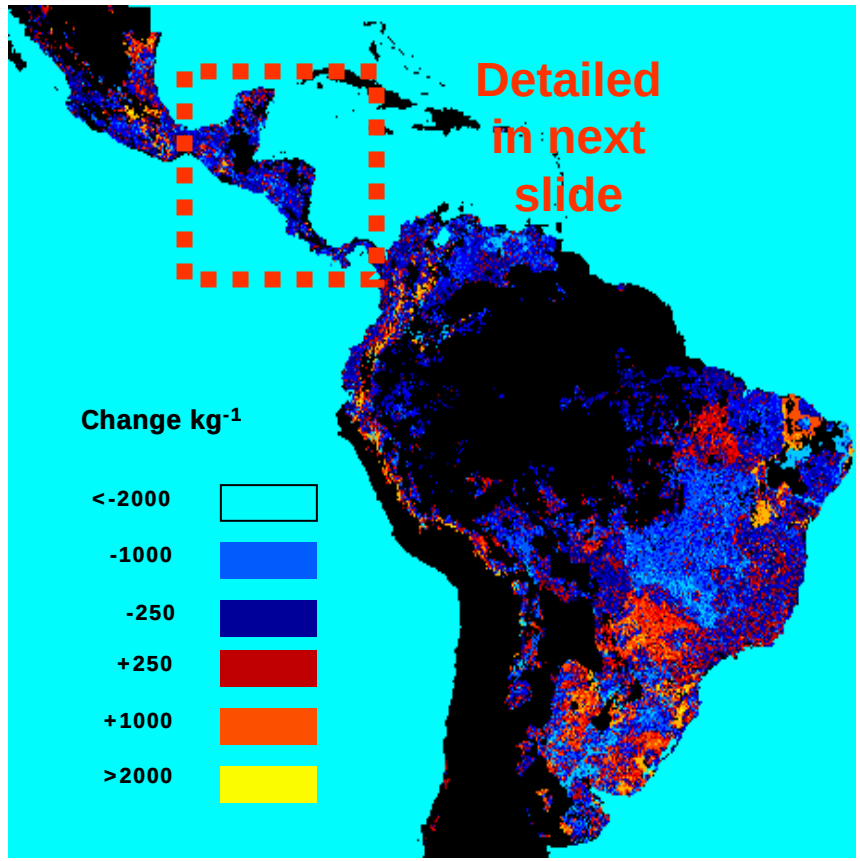


Tools: Analysis of scenarios, GIS

Goal: To explore the technological options for long-term adaptation at the regional level (Central America)



Maize yields
Actual climate

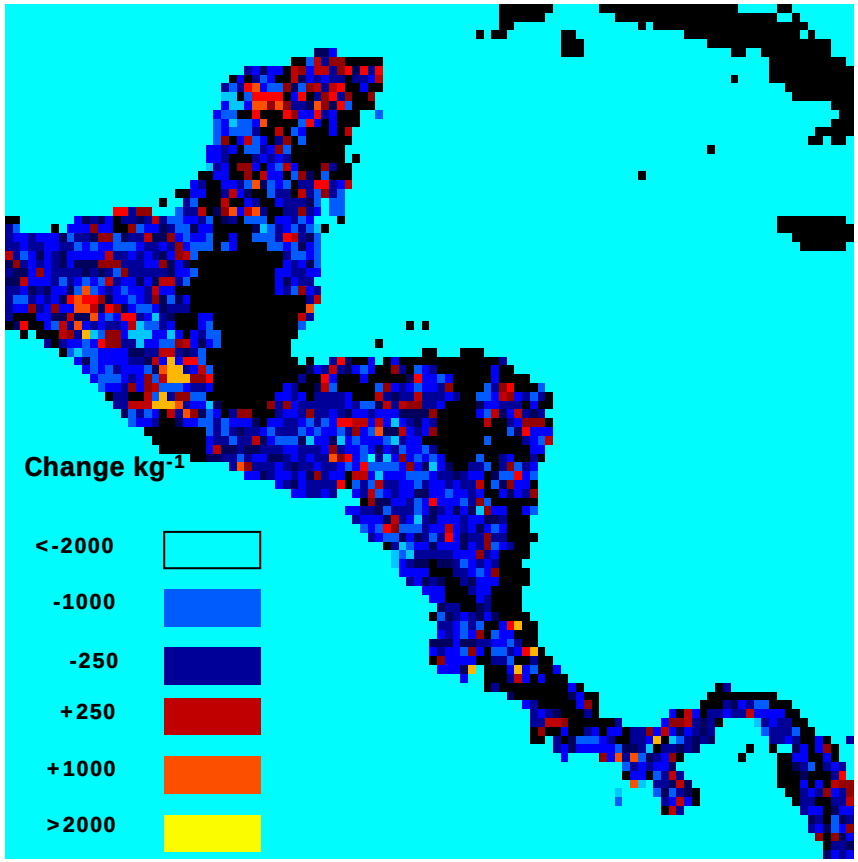


Changes in maize yields
Climate Scenario 2055

Source: P. Jones and P.K. Thornton, 2001.

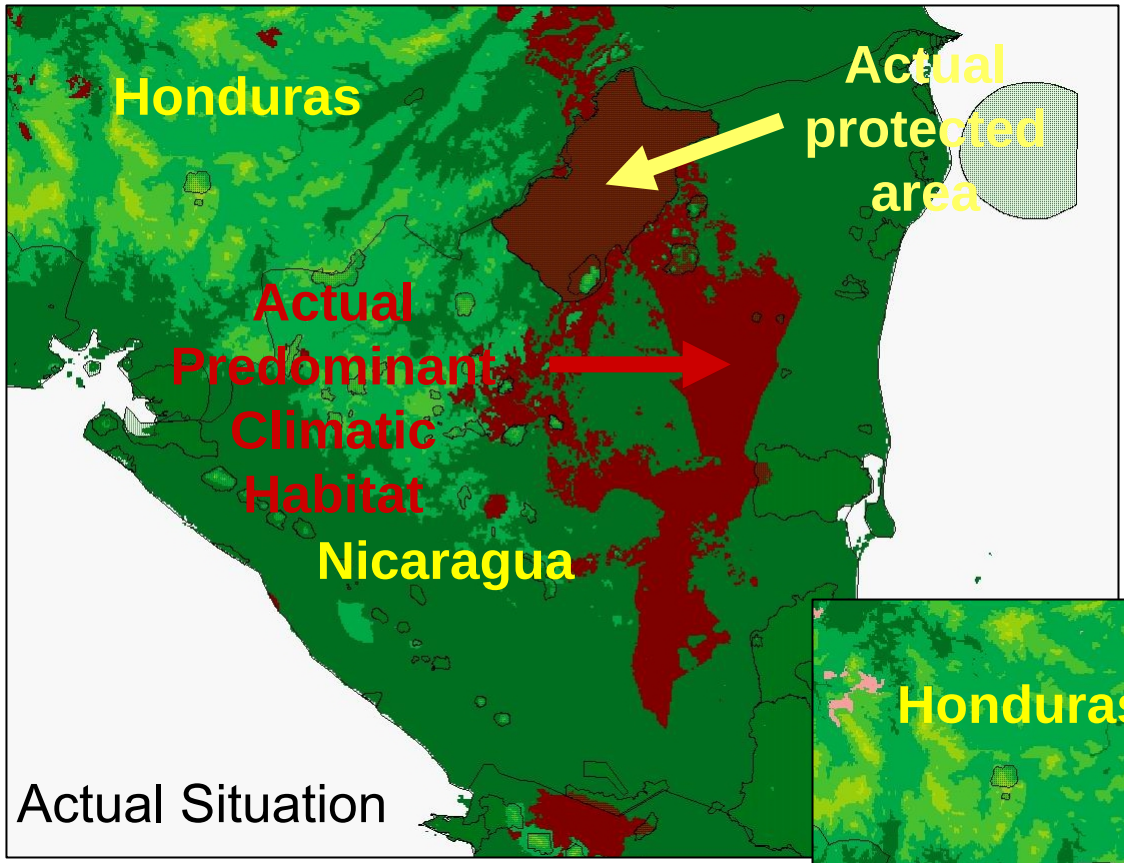
Continued. Exploring the technological options for long-term adaptation at the regional level (Central America)

✓ **80% of maize-growing areas in Central America suffer from losses of between 0.25 and 1 tonne/ha**



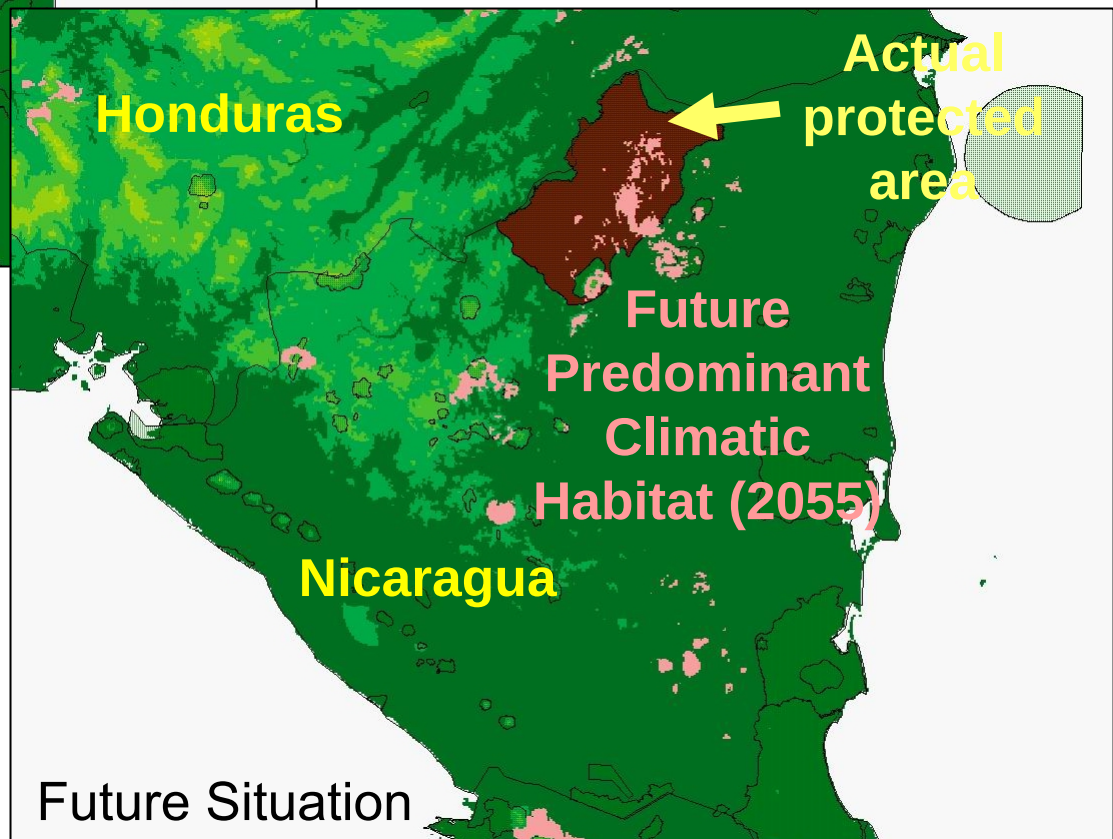
Changes in maize yields
Climate Scenario 2055

Source: P. Jones and P.K. Thornton, 2001.



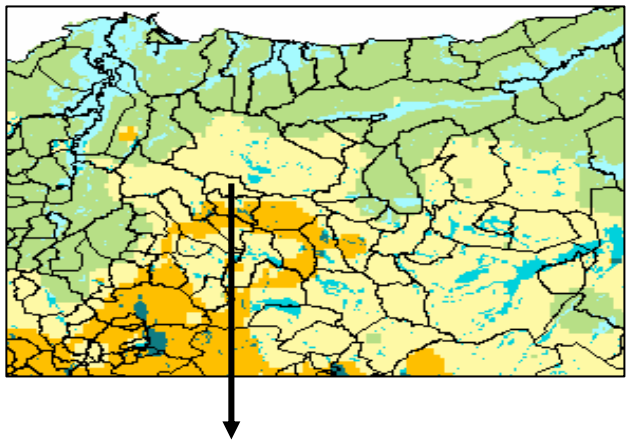
Tools: Analysis of scenarios, Strategic environmental assessments

Goal: To explore the policy options and long-term actions at the national level (Honduras, Ecological)



Source: Winograd, 2000.

Tools: Vulnerability profile, Bayesian analysis
Goal: To explore the short and medium-term technological options at the local level (Districts and Municipalities in Honduras)



Yorito, Honduras

1. The Yorito farmers are vulnerable to drought problems and must adapt.

2. They have options for livestock forage species, but they don't know which ones are most suitable for their environment.

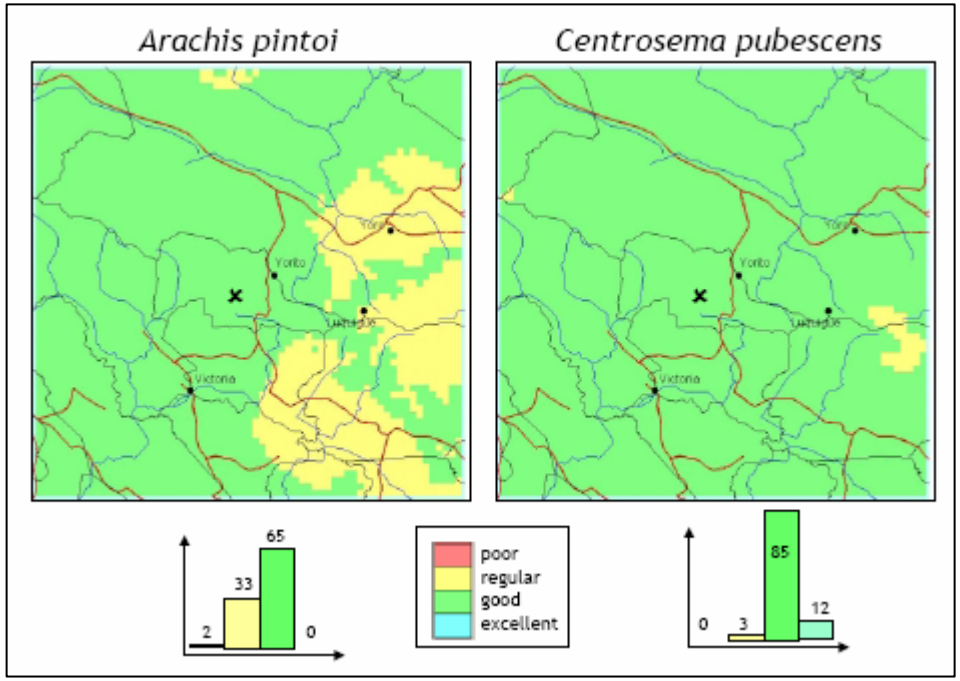
3. Where can they go to find specific solutions to their needs — to scientists, agricultural extension workers or their neighbours?

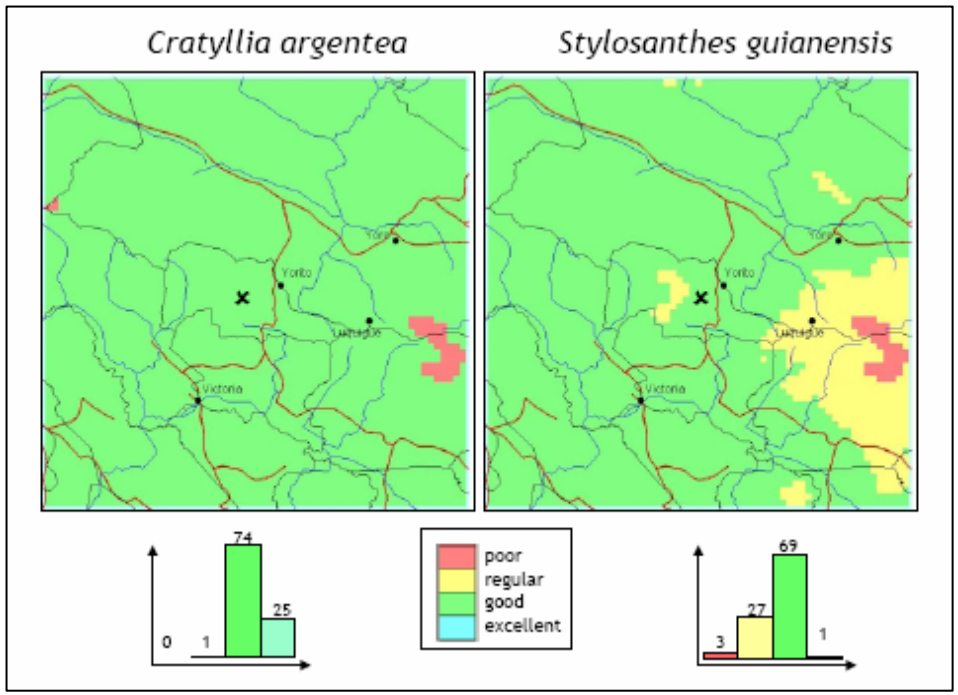
4. Existing data and knowledge for the various adaptation options are incomplete, inconsistent and partial.

5. How can these scraps of information be combined to produce fuzzy, but site-specific options?

Source: O'Brian, Peters, Cook and Corner, 2003.

The Bayesian modelling and techniques can be used to:
- Update the probabilities from data and knowledge
- Explore the conditions under which the options are most suitable
- Update the maps and probabilities on the basis of new data
-Explain the uncertainty related to partial data and knowledge



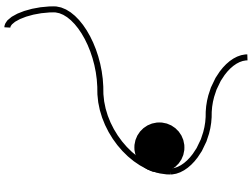


Source: O'Brian, Peters, Cook and Corner, 2003.

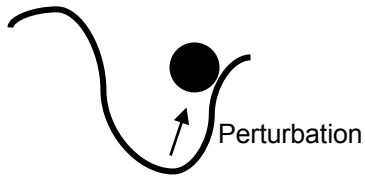
a. Mangrove, 1998
Roatan

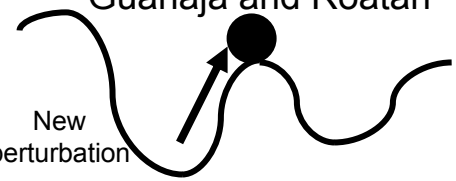
b. Deforestation, 1998
Guanaja

c. After Mitch, mangroves were buried by 1 m of sediment
Guanaja and Roatan



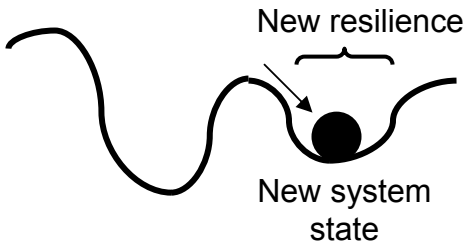
System state





d. Recovery Mangrove after Mitch, 2000, Roatan

e. Dead Mangrove and salt marshes, 2000, Guanaja



Tools: Vulnerability profile, Strategic environmental assessment

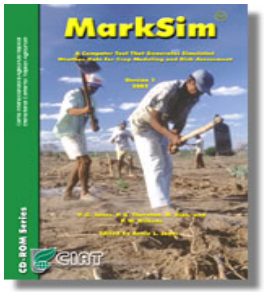
Goal: To explore the policy options and short-term actions at the local level (Islands and coastal areas in Honduras)

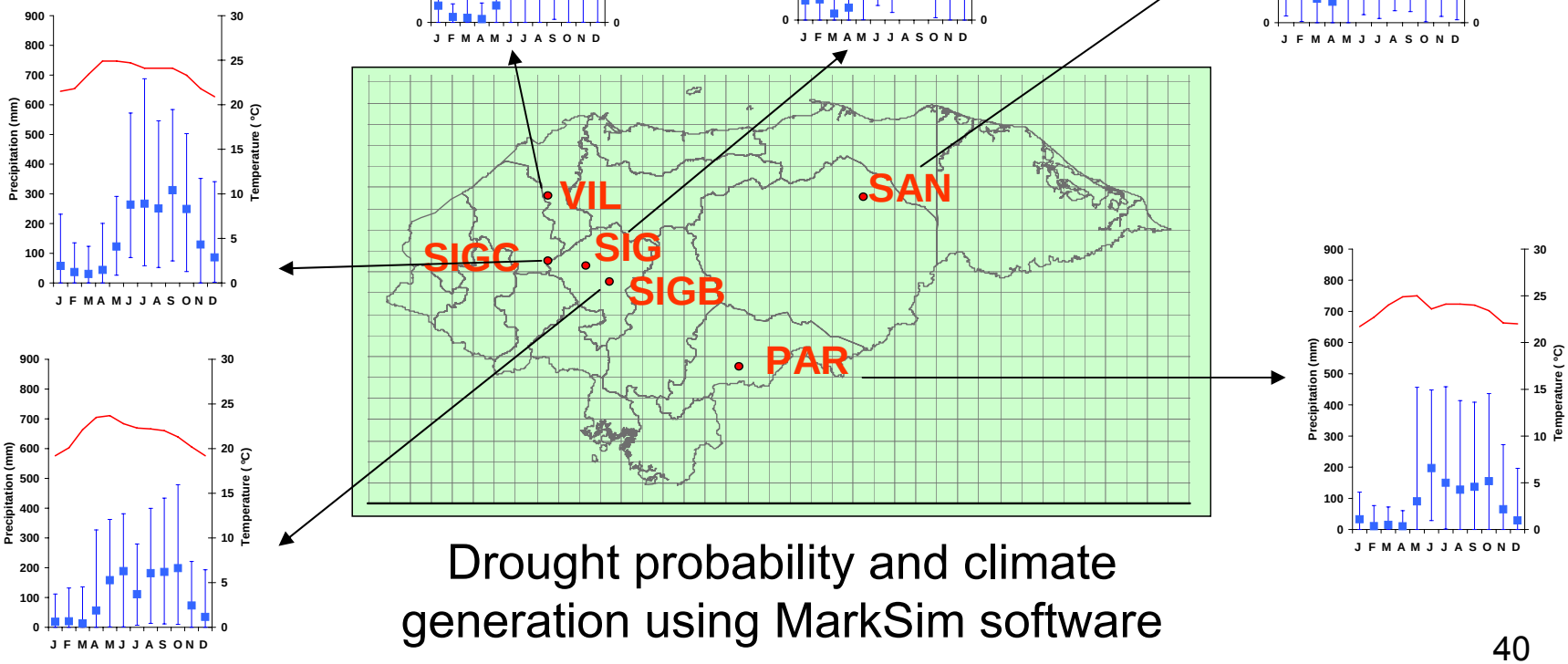
Source: Winograd, 2004.

Photo Source: USGS, 2001.

Tools: Vulnerability profiles, interactive GIS, risk analysis

Goal: To explore the short-term policy options and actions at the national/local level (Example of climate risk insurance for rural areas in Honduras)

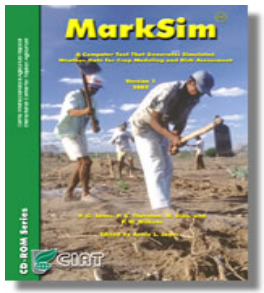




Drought probability and climate generation using MarkSim software

Source: Diaz-Nieto J., S. Cook, A. Gijsman, P. Jones, 2004.

Continued. To explore the short-term policy options and actions at the national/local level (Example of climate risk insurance for rural areas in Honduras)

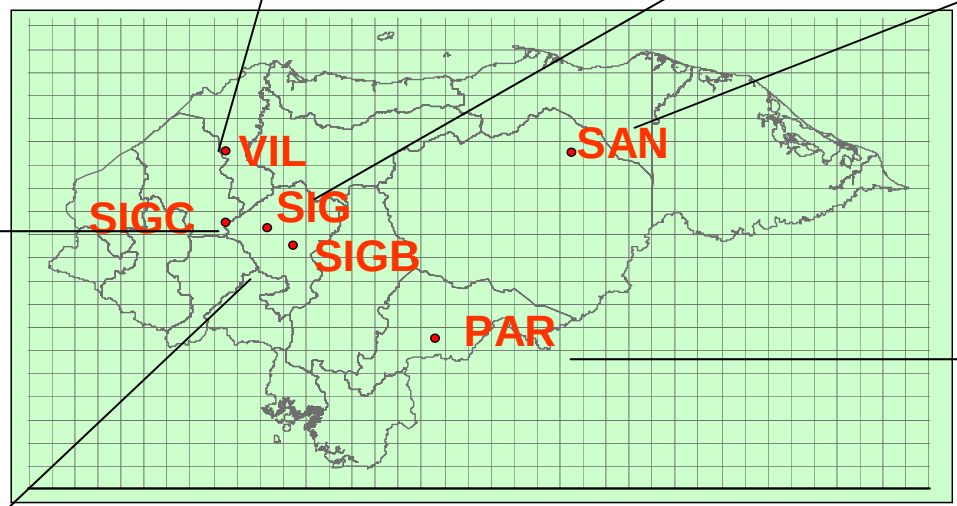


Villaparaiso
Prob' of drought
= *0.60*
Prime/ha
= *$30.30*

Siguatepeque 1
Prob' of drought
= *0.45*
Prime/ha
= *$22.73*

San Esteban
Prob' of drought
= *0.30*
Prime/ha
= *$14.6*

Siguatepeque 3
Prob' of drought
= *0.11*
Prime/ha
= *$14.65*



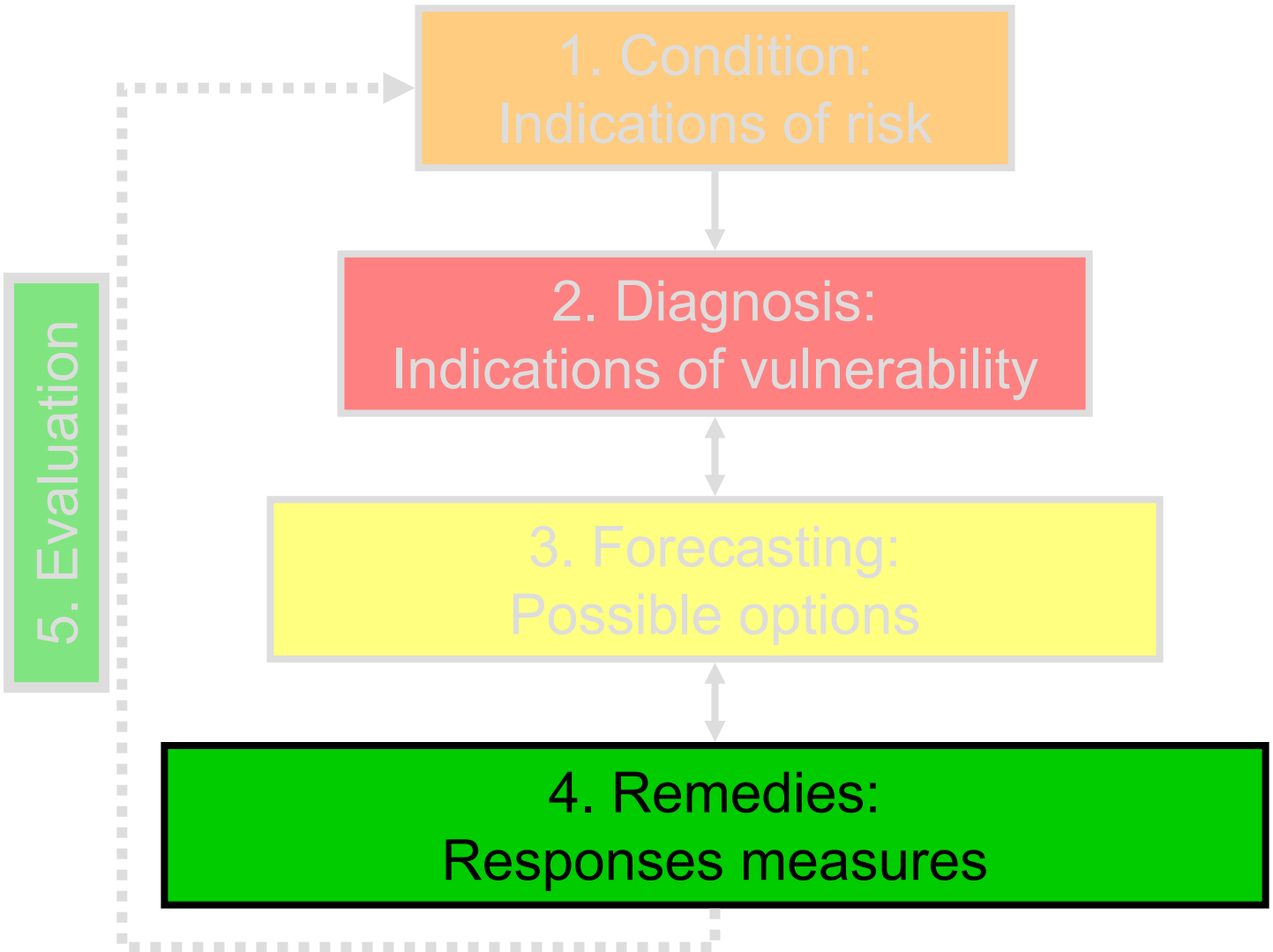
El Paraiso
Prob' of drought
= *0.48*
Prime/ha
= *$24.24*

Siguatepeque 2
Prob' of drought
= *0.07*
Prime/ha
= *$3.5*

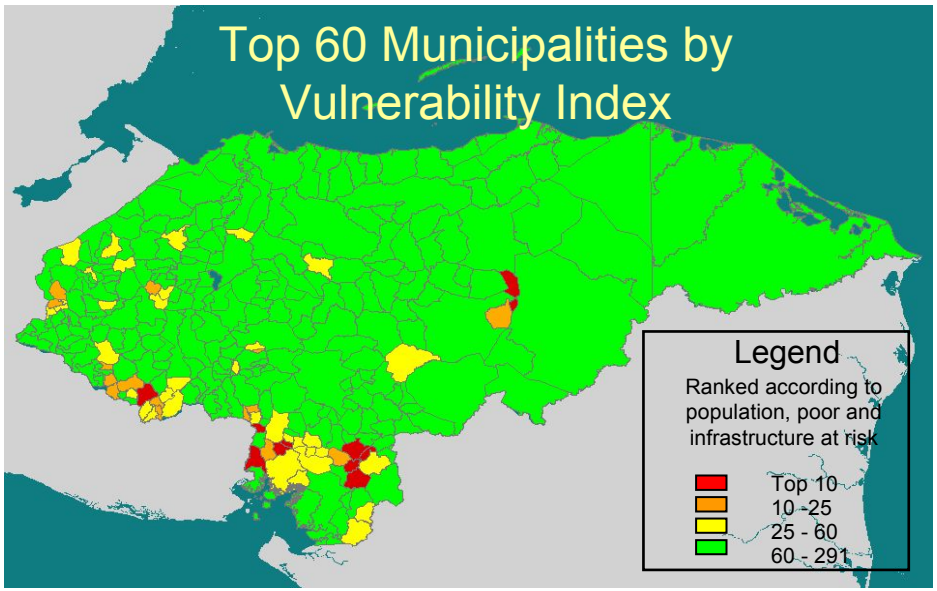
Generation of climate risk insurance premiums per hectare cultivated for each site in relation to drought probability

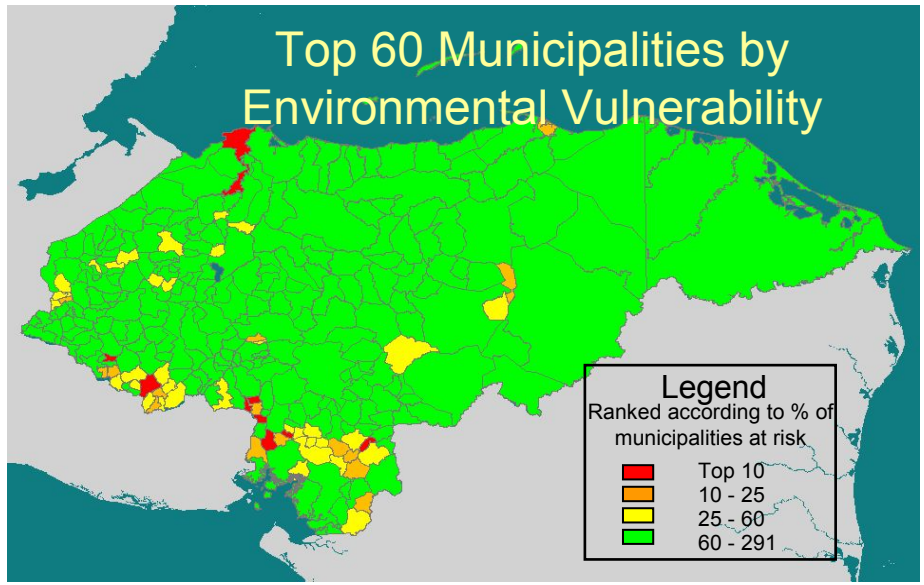
Source: Diaz-Nieto J., S. Cook, A. Gijsman, P. Jones, 2004.

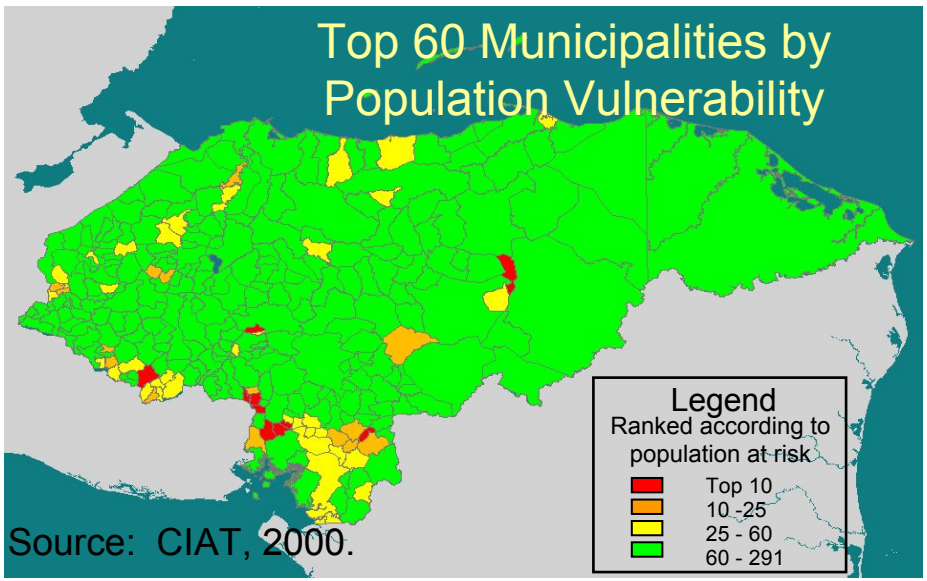
Step 4: Tools to assess responses

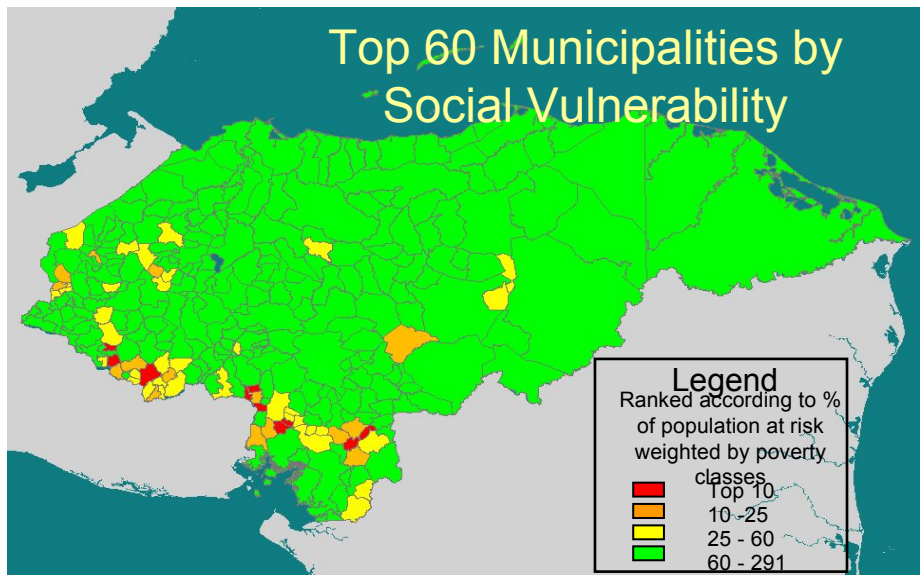


Tools: Vulnerability indicators, Vulnerability profiles, interactive GIS
Goal: To identify the priority groups and areas (hotspots) in relation to the various components of the vulnerability index at the national level





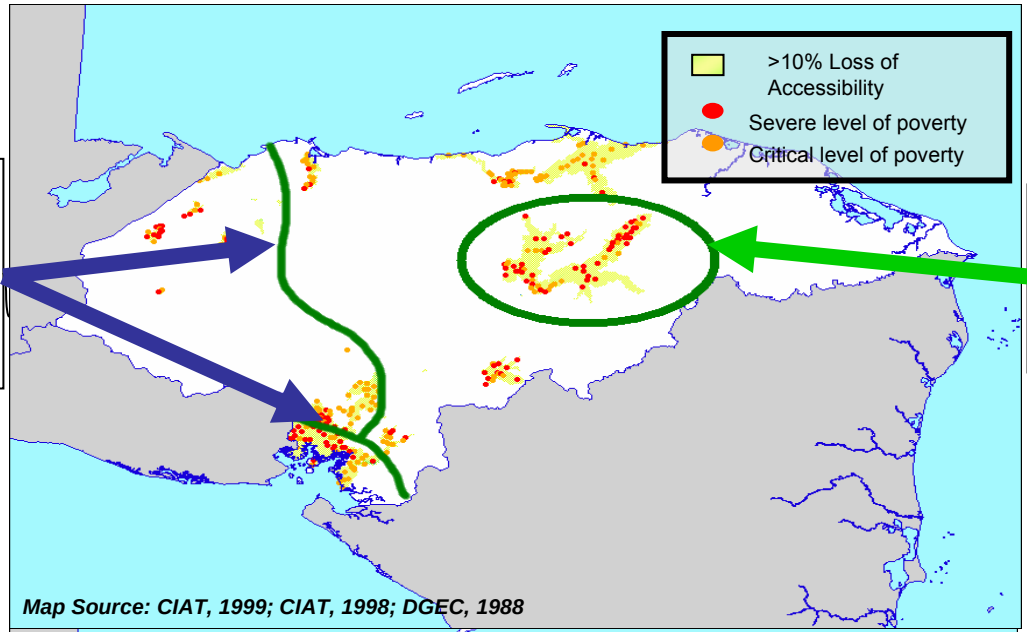




Tools: Macro-economic models and cost-benefit analyses, vulnerability profiles, interactive GIS, risk analysis

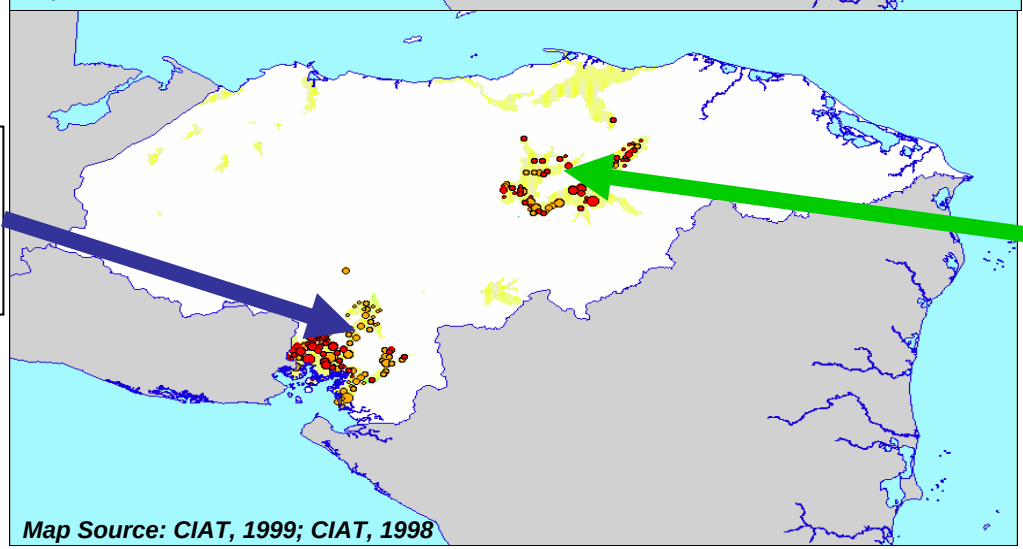
Goal: To analyse the short-term reconstruction and mitigation priority options at the national level (Hurricane Mitch in Honduras)

Option 1: Focus on Strategic Roads and Grouped Priority Municipalities



Option 2: Focus on 'Poor' Areas and Isolated Priority Municipalities

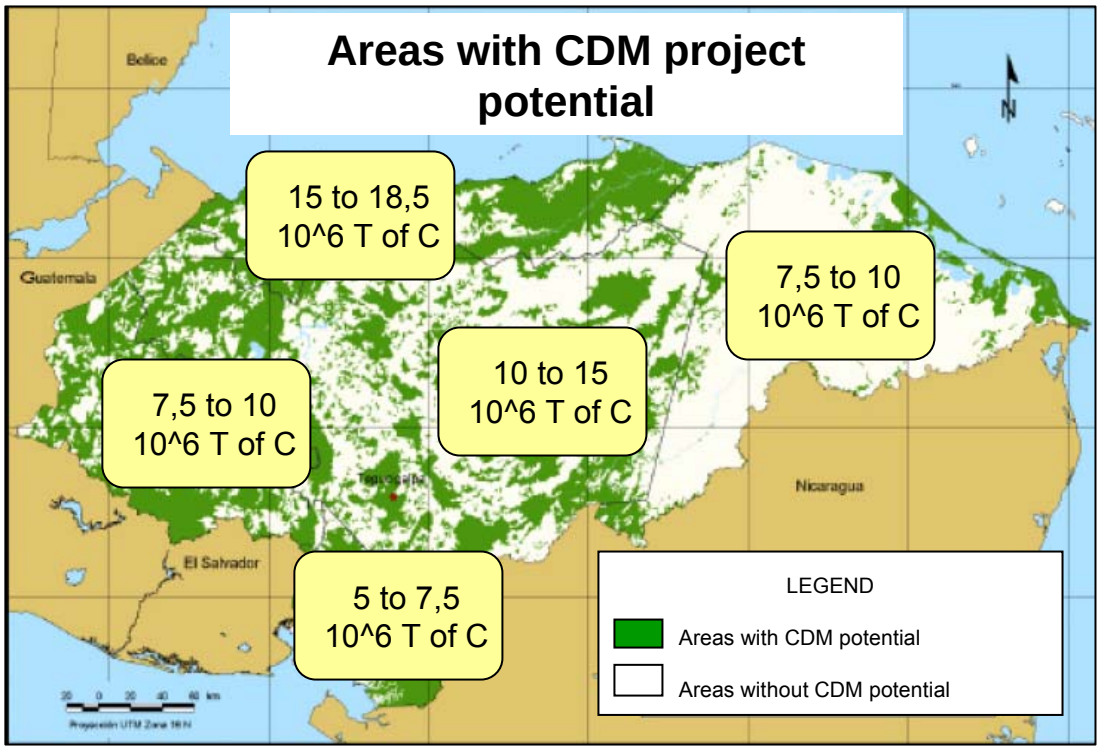
Option 1
Cost: $1 million
Impact: 161,000 people in poverty



Option 2
Cost: $1.4 million
Impact: 72,000 people in poverty

Tools: Strategic environmental assessments, Scenario analyses, Expert assessments, Interactive GIS

Goal: To analyze the priority long-term adaptation and mitigation actions at the national level (Honduras)



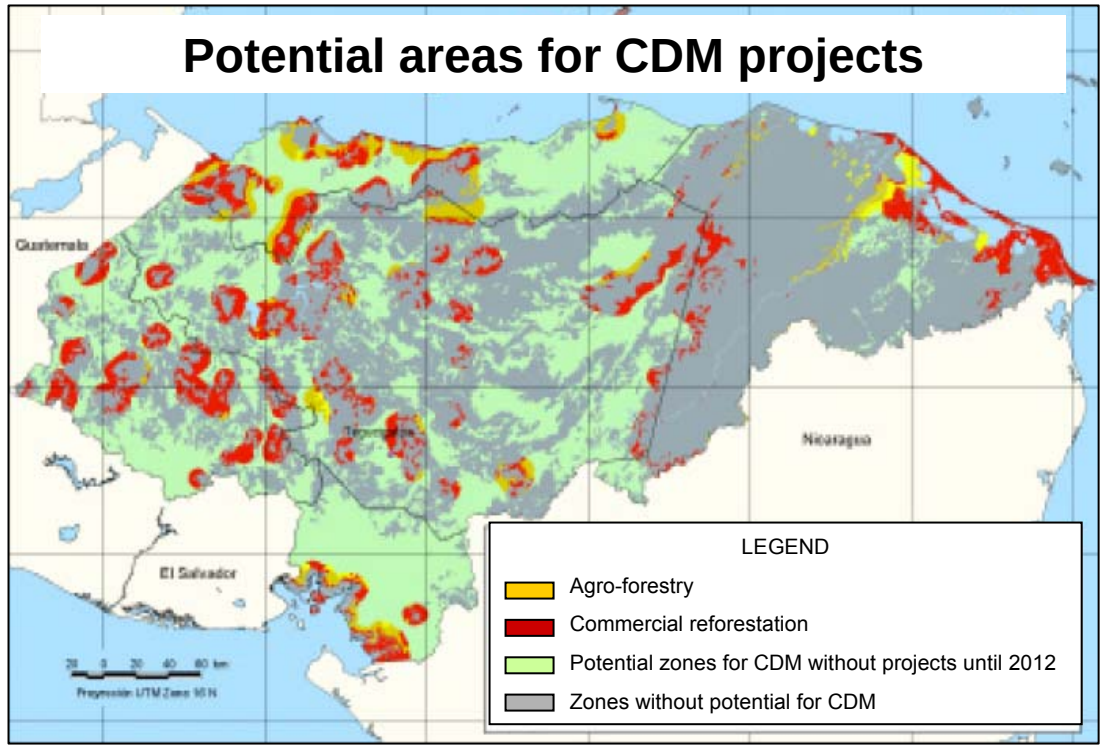
Potential of carbon storage

Land-use and potential for mitigating carbon emissions in the context of the Clean Development Mechanism (CDM)

Source: FAO-CCAD, 2003.

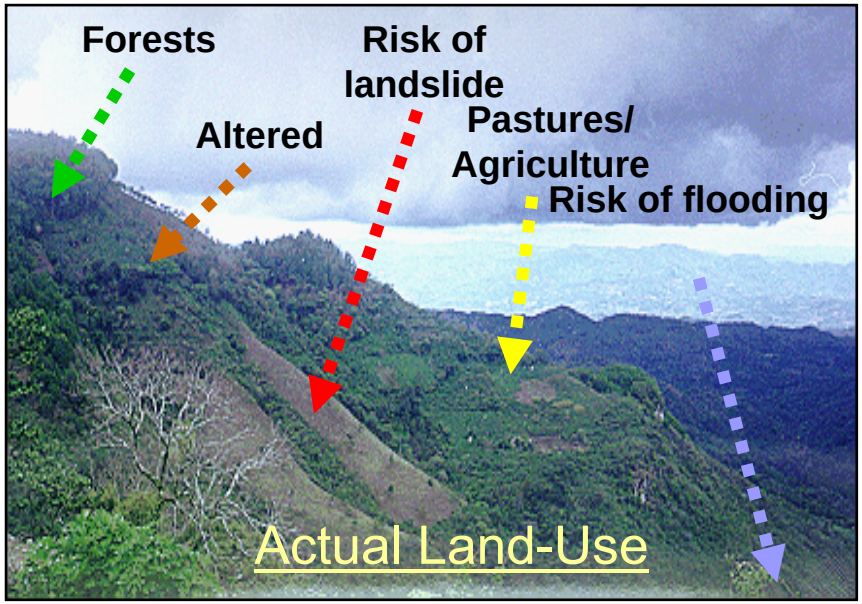
Continued. To analyze the priority long-term adaptation and mitigation actions at the national level (Honduras)

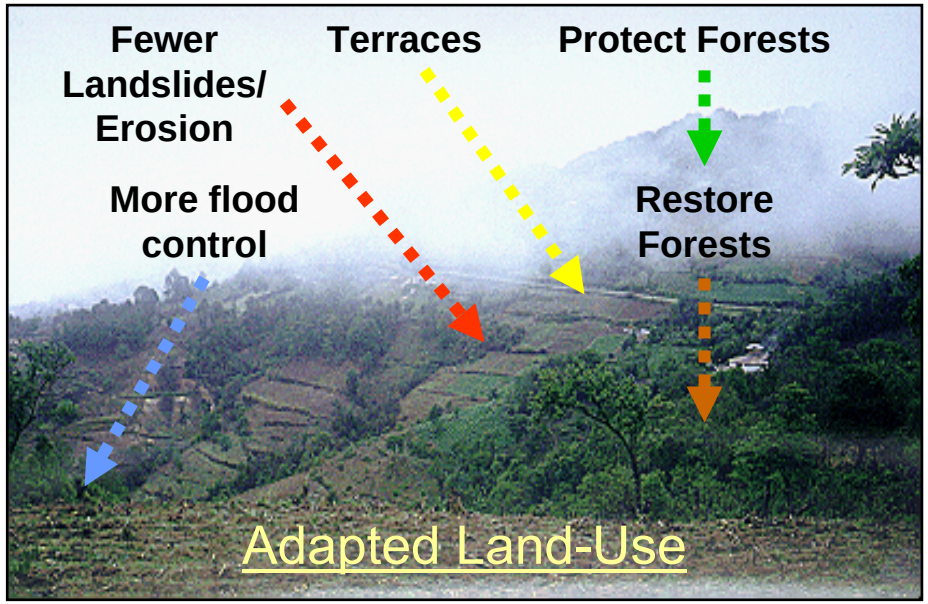
CDM mitigation potential in Honduras (tons of carbon): 1995-2012 scenario 126 million tons



Source: FAO-CCAD, 2003.

Tools: Cognitive mapping, Vulnerability profiles, Stakeholder consultation
Goal: To identify and analyse the options of land-use at the local level (villages and farms in Honduras)

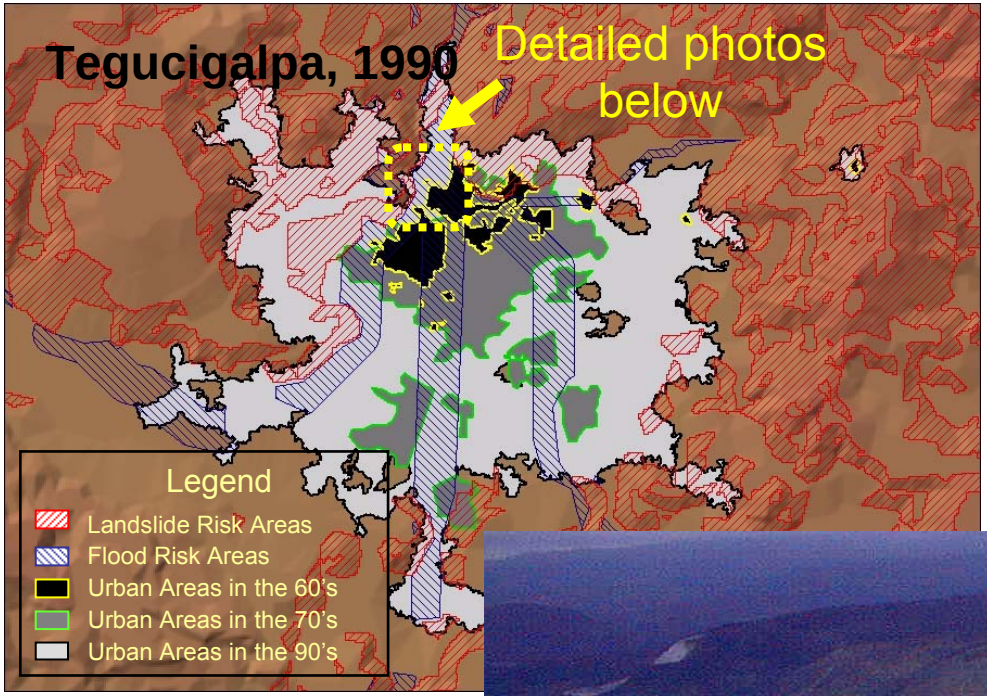




✓ **The current situation shows that land-use practices increase the risk of landslides and flooding**

✓ **In contrast the adapted situation shows land-uses that decrease the risk of landslides, erosion and flooding**

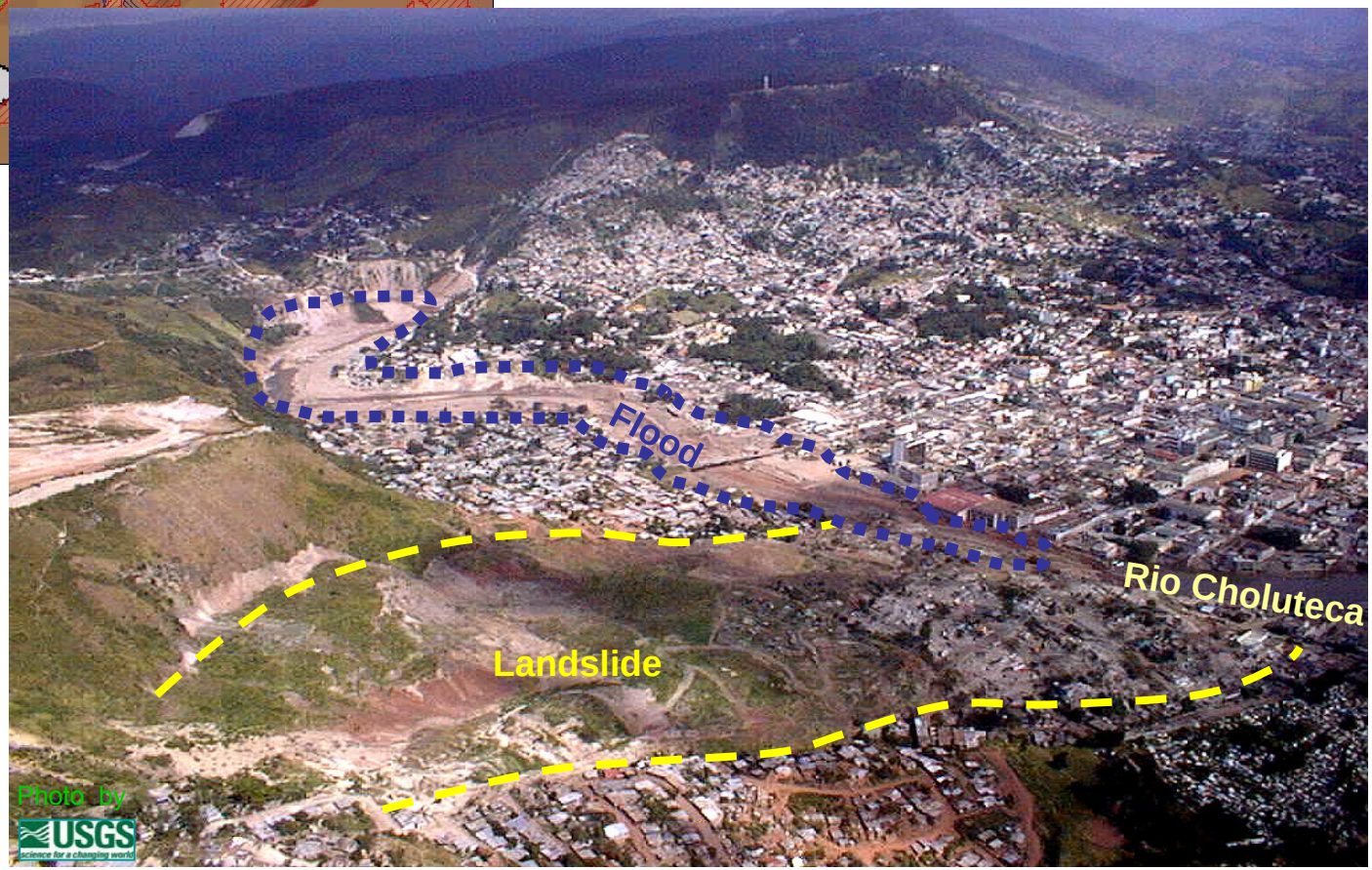
Source: CIAT, 2000.



Tools: Cognitive mapping, Vulnerability profiles, Stakeholder consultation

Goal: To identify and analyse the options for adaptation and mitigation in urban areas at the local level (Tegucigalpa town centre)

Impacts of Mitch (floods and landslides)

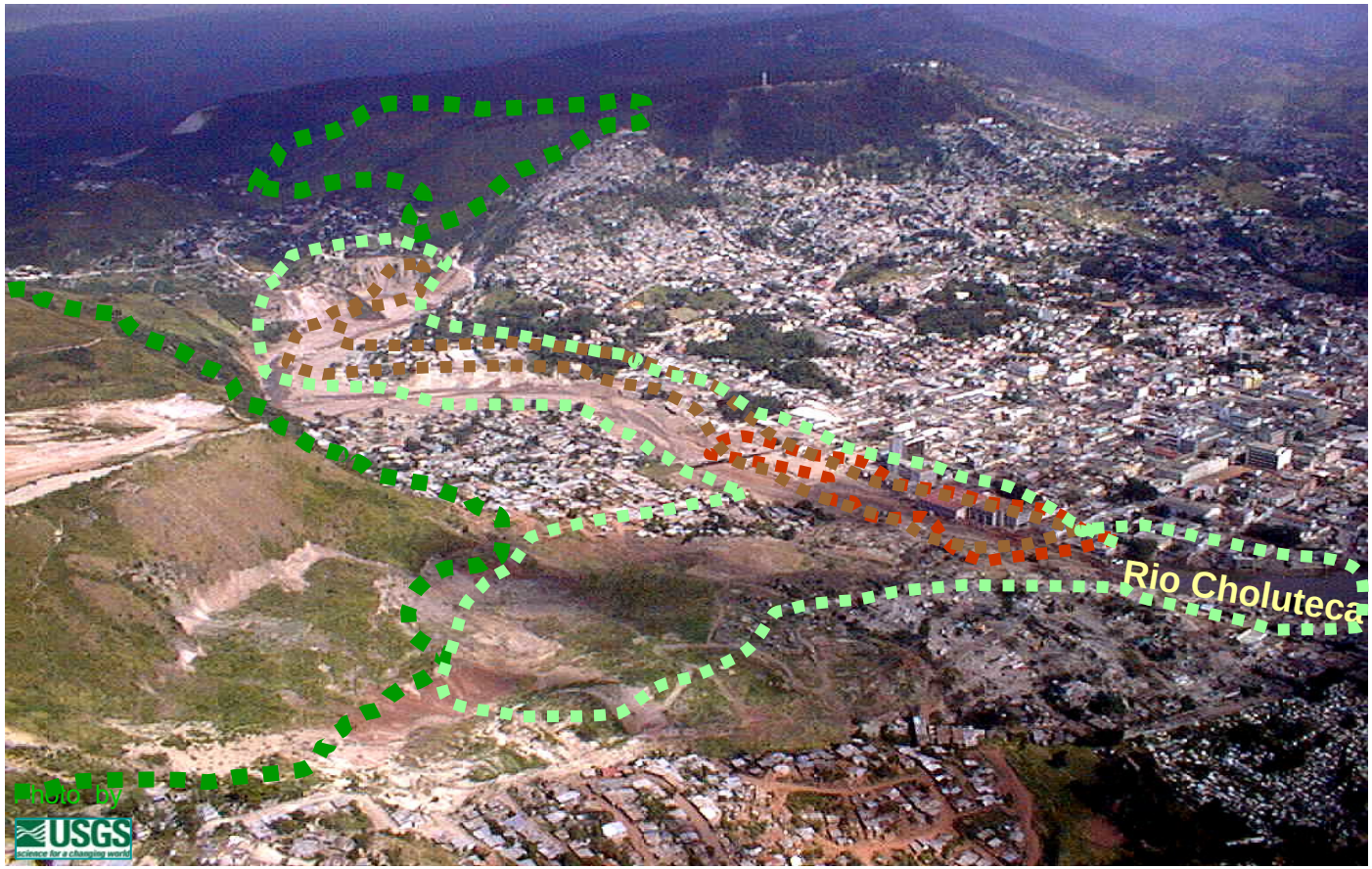


Source: CIAT, 2000.

Cont. To identify and analyse the options for adaptation and mitigation in urban areas at the local level (Tegucigalpa town centre)

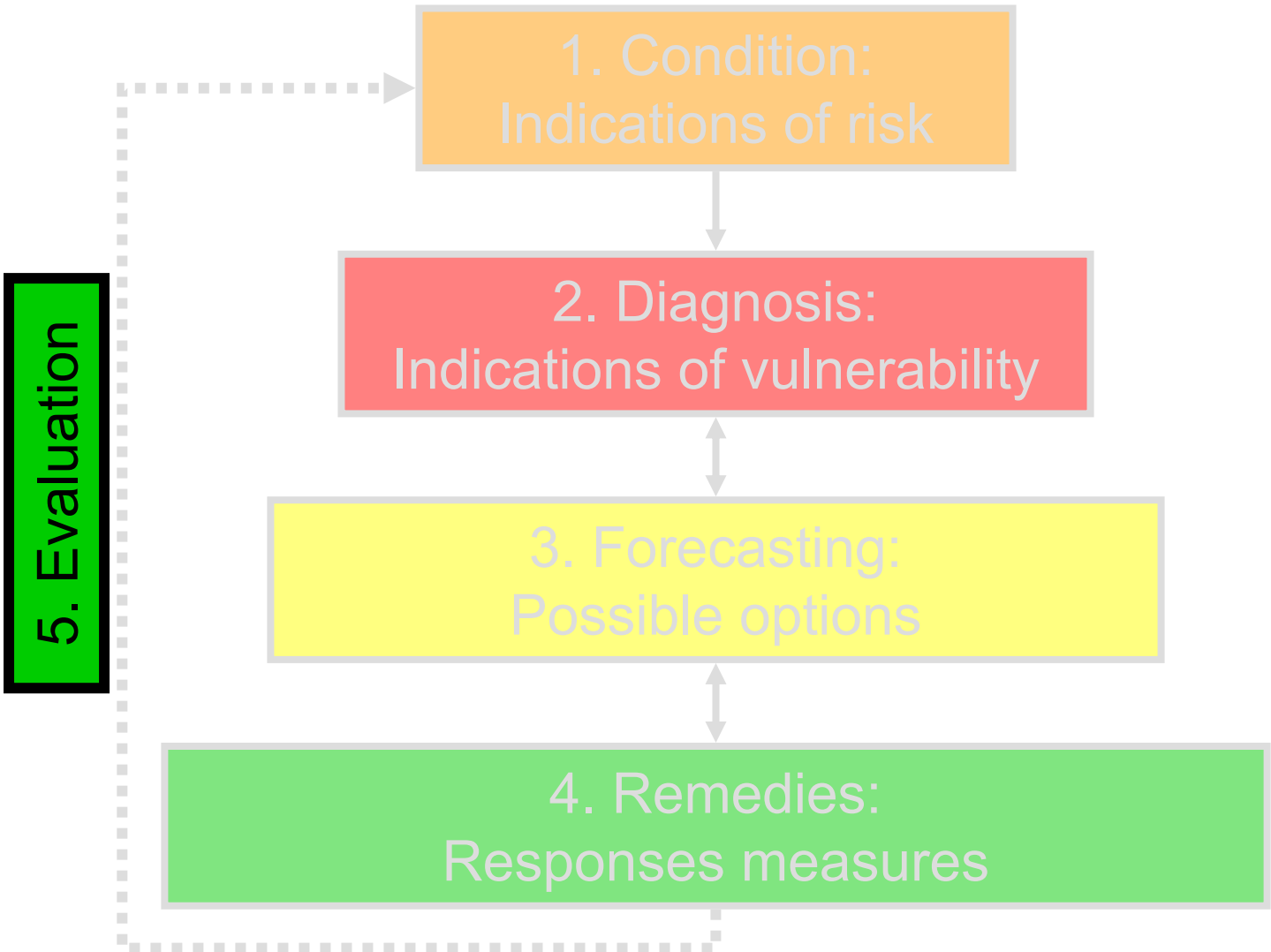
Mitigation Options/Actions

- Dredging
- Channeling
- Reforestation
- Rehabilitation



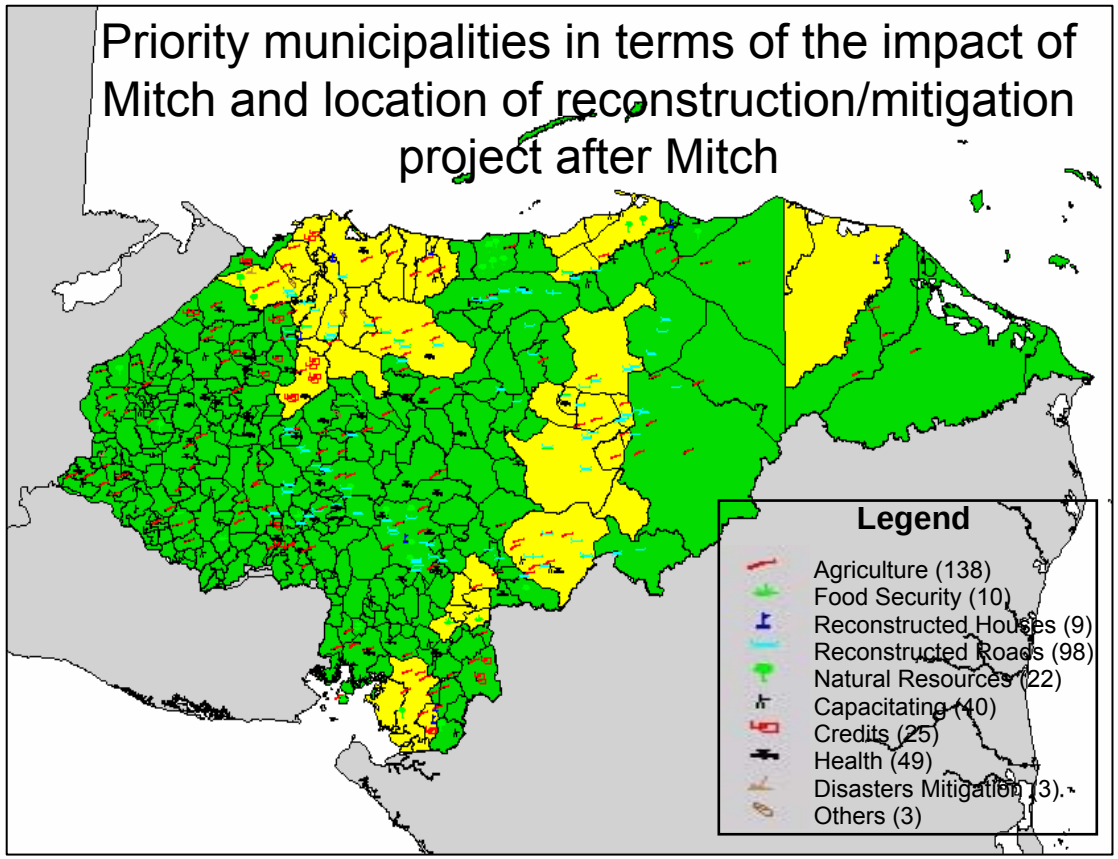
Source: CIAT, 2000.

Step 5: Tools for evaluation



Tools: Vulnerability profile, Stakeholder consultation, Focus groups, Expert assessment

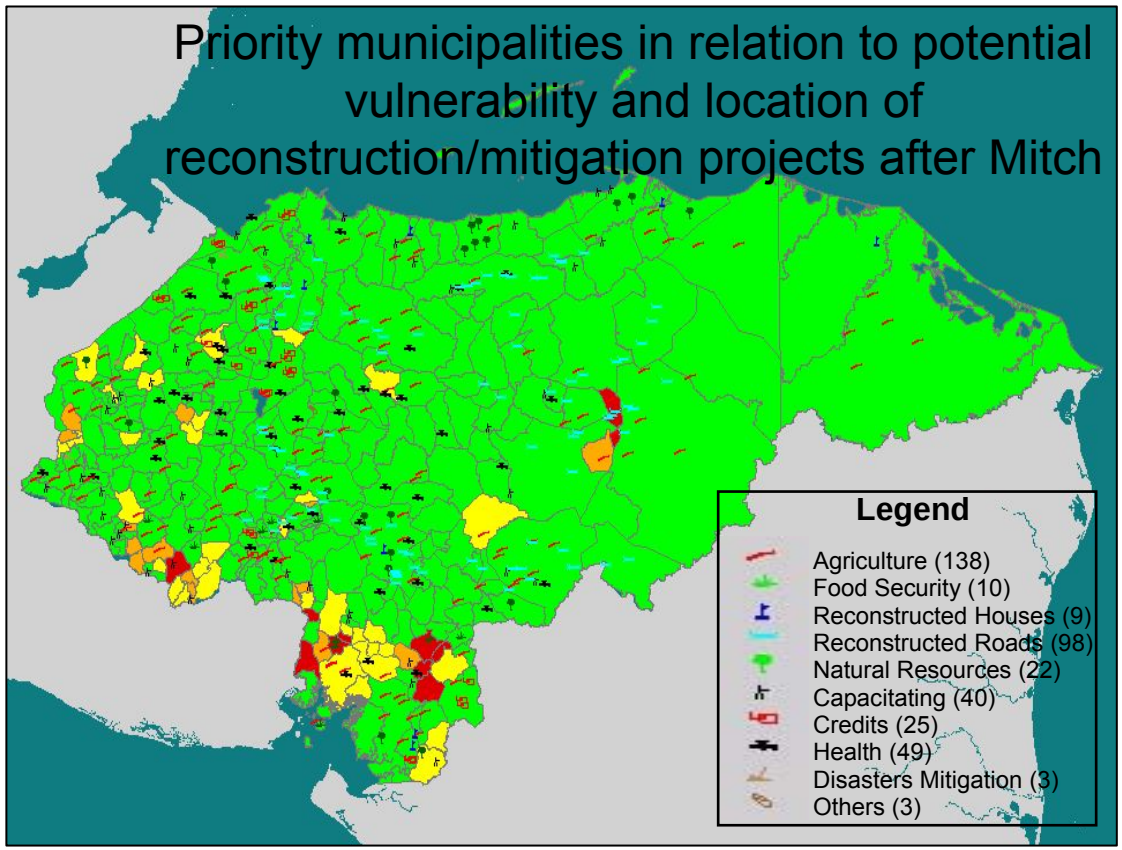
Goal: To assess the policies and actions for improving decision-making at the national level (Honduras)



✓ 40% of reconstruction and/or mitigation projects are situated in municipalities strongly affected by Mitch.

Source: CIAT, 2000.

Continued. To assess the policies and actions for improving decision-making at the national level (Honduras)



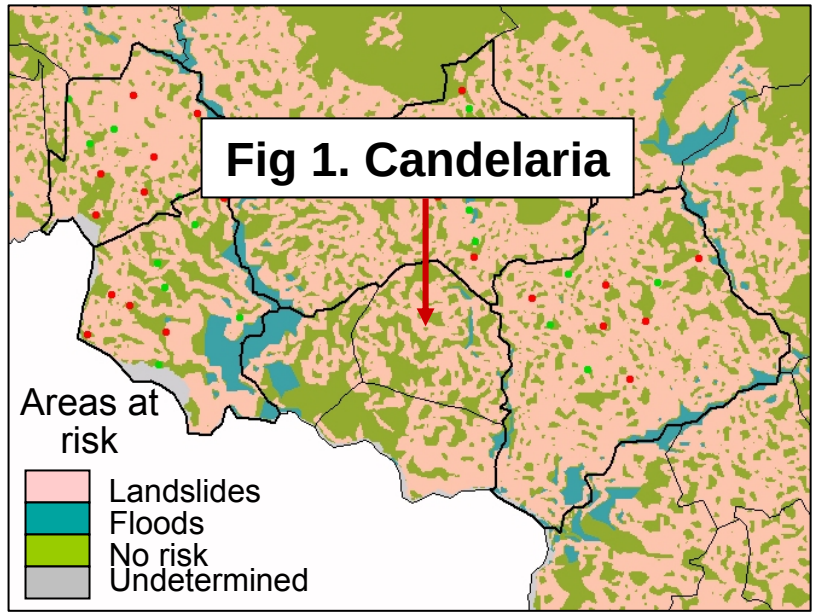
✓ 10% of reconstruction and/or mitigation projects are situated in highly vulnerable municipalities

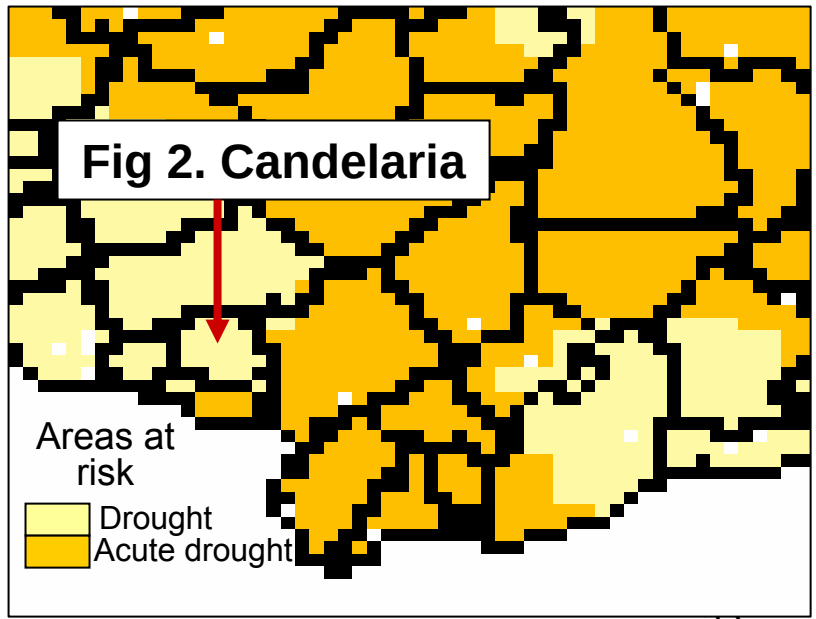
Source: CIAT, 2000.

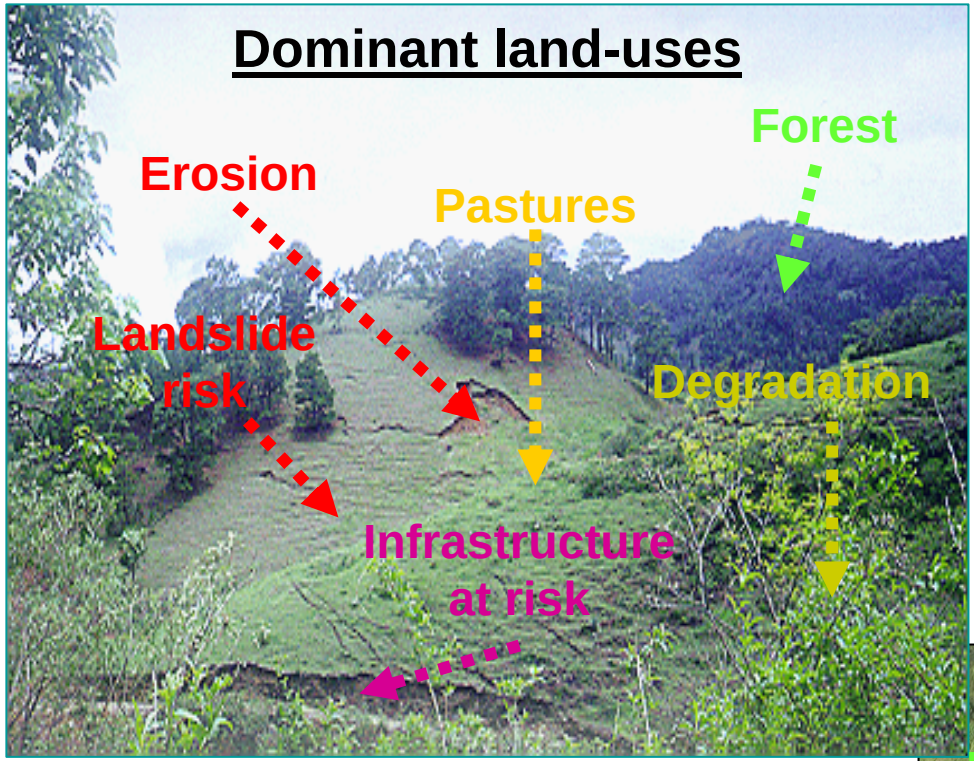
Tools: Vulnerability profiles, Stakeholder consultation, Focus groups, Expert assessment, Interactive GIS
Goal: To assess current and future vulnerability to improve adaptation options and decision-making at the local level (Municipalities, villages, farms in Honduras)

The village of Candelaria was affected by Mitch in1998 (Fig. 1) and by drought in 1997 and 2001 (Fig. 2).

Low impacts compared to other similar regions (subsistence farming on hillsides with high poverty indices)
Explanation = land-use system (Quesungual). With this system there was only a 10% crop loss after the drought and a cereal surplus after Mitch.



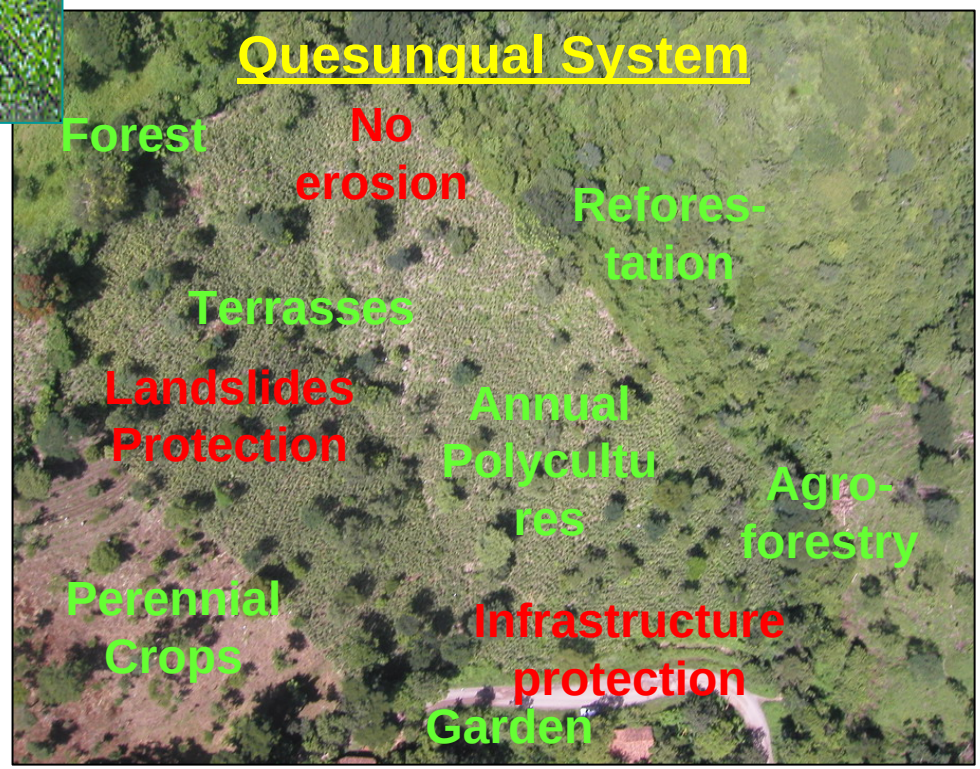




Continued. To assess the current and future vulnerability options to improve adaptation and decision-making at the local level

✓ **The dominant land-use, with grazing and degraded forests leads to a high risk of erosion, landslides and flooding**

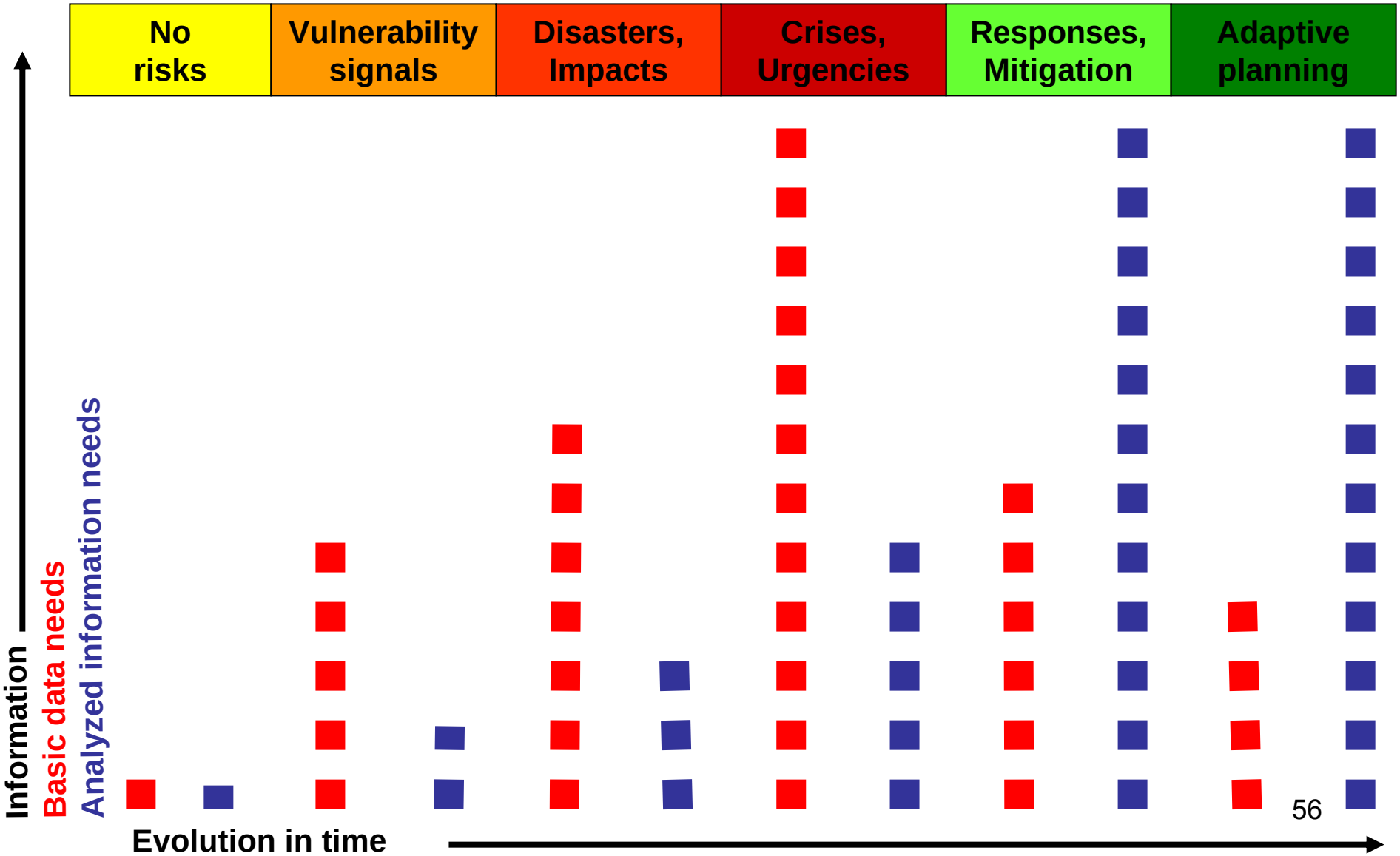
✓ **With the Quesungual land-use system (in green) the risks of erosion and landslides are reduced (in red)**



Sources: CIAT, 2000; CIAT, 2004; FAO,2001.

5. Lessons learned

Improve information production:
Meet the requirements for data and information



Improving the use of information:
Create communication links between actors

	Know	Don't know
Take Decisions	Decision-maker knows – decides Scientist knows – advises Media knows - informs Public knows – is aware 	Decision-maker ignorant – decides Scientist ignorant – advises Media ignorant - informs Public ignorant – is aware 
No Decisions	Decision-maker knows – no decision Scientist knows – no advice Media knows – does not inform Public knows – is unaware 	Decision-maker ignorant – no decision Scientist ignorant – no advice Media ignorant – does not inform Public ignorant – is unaware 

Source: Winograd, 2004.

Improving decision-making

From dealing with the consequences to preventing the causes

- Estimates show that the losses from hurricane Mitch reached 8.8 billion US$ in Central American countries.

- Multilateral institutions, international aid agencies and the governments of developed countries promised to donate 8.7 billion US$ to the countries of the region to help in reconstruction, mitigation and adaptation.

- By the end of 2004, six years after the disaster, less than 3 billion US$ had reached these countries.

- However, investments of from 0.35 to 0.5 billion US$ for mitigation, attenuation and adaptation measures (land-use and early warning systems) would have prevented and/or avoided 3.5 billion US$ of losses.

6. Conclusion

✓ Using appropriate information should enable us to define regional strategies, to draw-up national policies and to implement local actions.

✓ The set of information must be politically pertinent, socially acceptable and technologically appropriate to obtain clear signals and avoid questions on the basis of anecdotal evidence or issues in fashion at the time.

✓ The vulnerability assessments and indicators are not the final objective, but are tools for building processes. They assist in decision making, and in the selection and monitoring of the best strategies and adaptation options.

✓ Information on natural disasters must be used to explore and validate the possible impacts of climate change and can be used to reduce uncertainty, to plan the necessary responses, and to adapt to the new conditions.

✓ It is essential to move **from**

• Blaming “climate change” and the “unpredictability of natural phenomena or climate variability” for the high costs, the impacts and the consequences of “natural disasters” **to**

• Planning for the possible impacts, adapting to adverse consequences, preventing negative effects and mitigating the direct and indirect causes.