FUNDAMENTAL APPROACH FROM IPCC:

> **VULNERABILITY IS A FUNCTION OF EXPOSURE AND SENSITIVITY, AND BOTH CAN BE MODIFIED BY EXERCISING ADAPTIVE CAPACITY**
>
> (TAR, WGII, 2001)

TODAY WE WILL ADD SOME DETAIL TO THIS EXPLOITING THE TEMPLATE OF THE ADAPTATION POLICY FRAMEWORK OF THE UNDP AND THE DETERMINANTS OF ADAPTIVE CAPACITY.

THE POINT WILL BE TO OFFER SOME GUIDANCE FOR THOSE TRYING TO UNDERSTAND THE VULNERABILITY OF SOME SYSTEM OR COMMUNITY TO CLIMATE STRESS *IN THE CONTEXT OF ADAPTATIONS THAT CAN BE ANTICIPATED OR IMPLEMENTED.*

The Adaptation Policy Framework (the APF) builds on this and emphasizes five principles:

- ***Adaptation policy and measures are best assessed in a developmental context.***

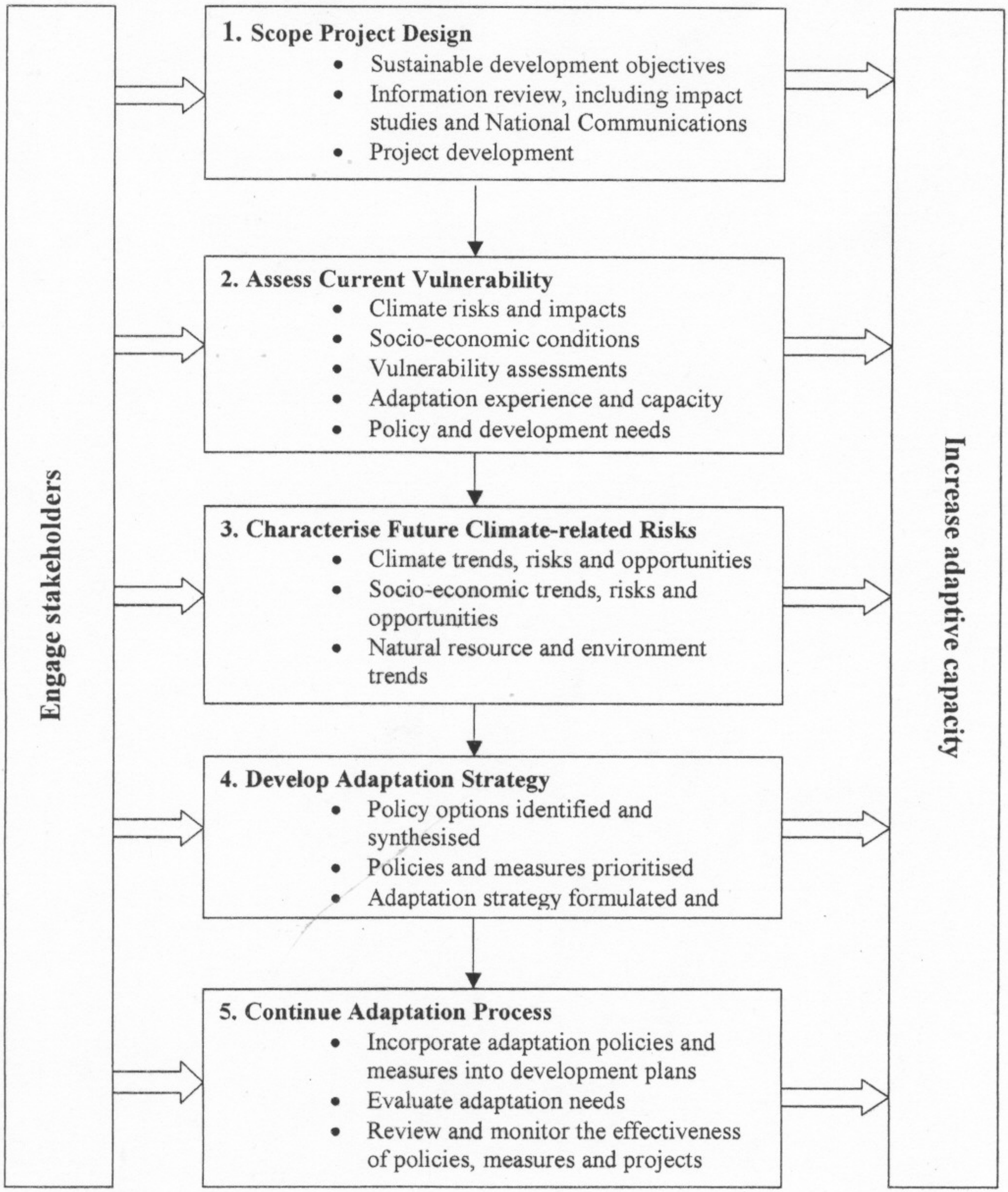
- ***Adaptation to short-term climate variability and extreme events are explicitly included as a step toward reducing vulnerability to longer-term climate change.***

- ***Adaptation occurs at different levels in society, including the local level.***

- ***The adaptation strategy and the process by which it is implemented are equally important, and include review, evaluate, and monitor adaptation. They are instrumental in driving each stage of the process.***

- ***Building adaptive capacity to current climate is one way of preparing society to cope better with future climate.***

Figure 9.1: Schematic of an Adaptation Policy Framework



Working the Adaptation Policy Framework from Design to Evaluation

Eakin's (2000) examination of the vulnerability of smallholder maize production in Mexico to climate risk provides a perfect context within which to illustrate how the APF can lead to a monitoring and evaluation phase. This example will work through the first four steps of the APF before applying M&E fundamentals to two adaptation strategies – the Plan Puebla introduction of a draught resistant hybrid through demonstration projects in the 1970s and ENSO based seasonal forecasts in the 1990s.

1. Project Design:

   Objectives: To reduce the vulnerability of small, traditional farming communities to climate vulnerability and to increase their maize yields so that they can participate in commercial markets.

   Information Review: Castaneda (1981) reported that Mexico's climate has never been particularly suited for agricultural production. Grazing and irrigated farming should be preferred over the 46% of the land that is classified as arid; but poor soils, limited water, and complex topography can frequently support only rain-fed agriculture.

   Project Development: Mexico has initiated a series of economic and land tenure reforms over the past several decades; they have promoted modest technological change, freer product markets, and general integration into the North Atlantic Free Trade Agreement in addition to sporadic input subsidies and preferential structures for small loans.

2. Current Vulnerability (specifically for Tlaxcala – the location of the Eakin analysis):

Climate Risks: Early frosts in the fall and late frosts in the spring so that the probability of a frost is less than 50% for only 187 days per year (on average); extremely variable precipitation (400mm to 1200mm per year), particularly in July {see Figure 9.3}.

Socio-economic Conditions: Maize agriculture dominates production for more than 50% of the households. Yields are extremely variable {see Figure 9.4}. Recently, fertilizer costs have risen significantly, sources of financial credit have dwindled and price guarantees have evaporated to the point where socio-economic uncertainty dwarfs climate uncertainty.

Vulnerability: Households suffer extreme hardships when yields fall below 2000kg/ha. This threshold defines a coping range whose boundary was crossed 30% of the time between 1967 and 1989. It was generally determined by precipitation in July, particularly when warming climate scenarios reduced the threat of early and/or late frost.

Figure 1. **Percent of planted area lost to hazards, summer 1970. Data are from Liverman (1989).**

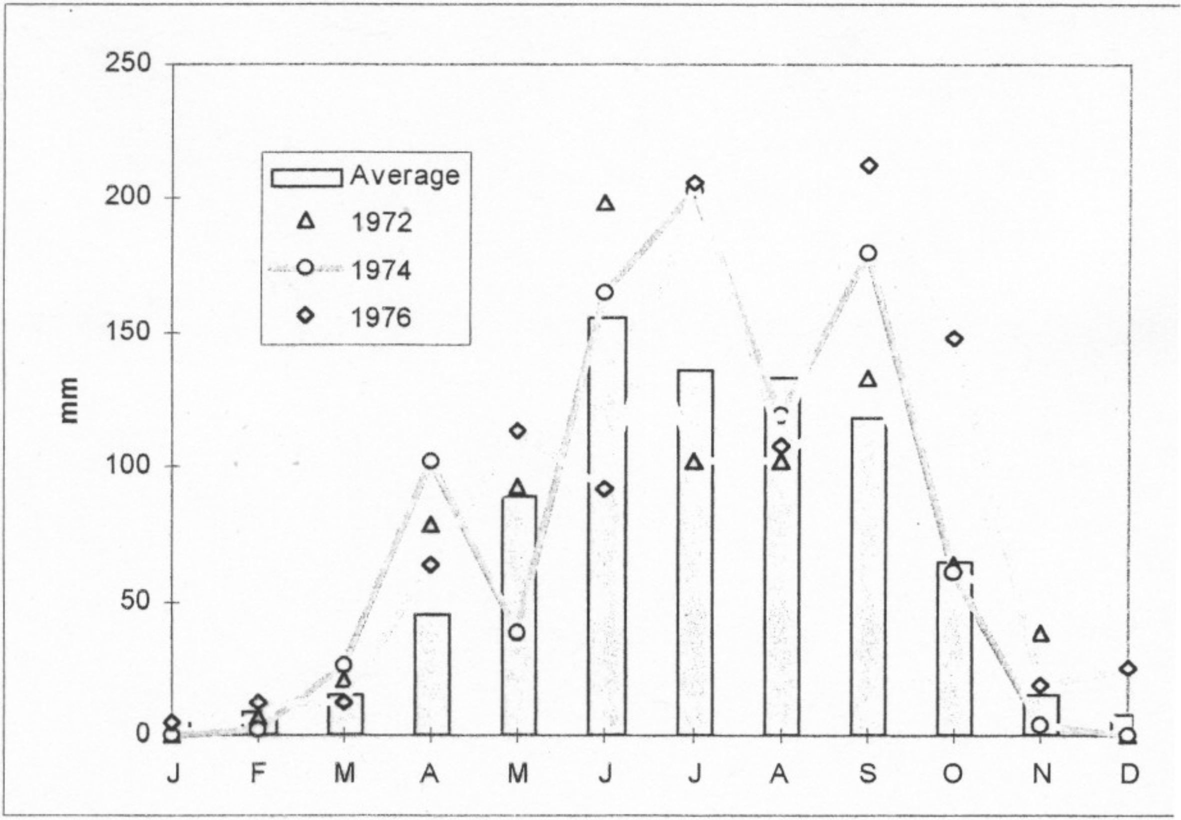


Figure 9.3. Average monthly rainfall in Apizaco, Tlaxacala from 1961 through 1990 contrasted with rainfall in three specific years. Rainfall in July is most significant in predicting annual yields. Source: Figure 5 in Eakin (2000).

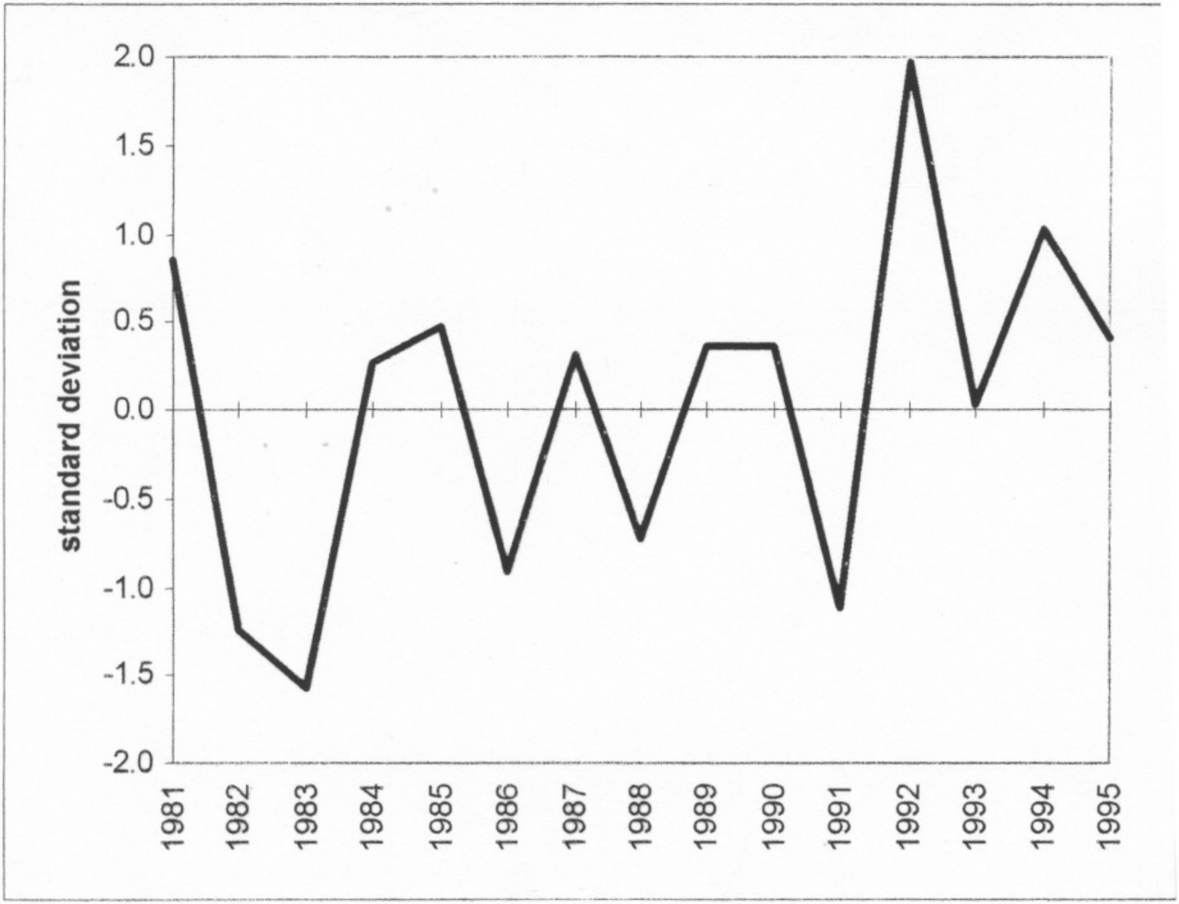


Figure 9.4. Variability in Tlaxcalecan maize yields from 1981 thorugh 1995. Data are from INEGI, *Annuario Estadistico de Estado de Tlaxcala*, vol. 1989-1995. Source: Figure 4 in Eakin (2000).

Adaptations: Households routinely adopt a range of risk-averse adjustments depending on their experienced-based expectations of climate for the growing season. These include: planting shorter, fast maturing maize varieties (with corresponding lower yields), changing planting dates, rescheduling labor-intensive tasks, building terraces and small scale irrigation projects, diversifying crops across locations, etc… Under extreme conditions, farmers must sell livestock and/or farm equipment for cash to support themselves and their families; and they rely on family and social community networks for assistance.

Policy Needs: Interventions designed to reduce vulnerability to climate variability and uncertain economic conditions in the short-run and to reduce vulnerability to climate change and socio-economic trends over the longer term.

3. Future Climate-related Risks:

Climate Trends: Figure 9.5a displays a representative range of not-implausible scenarios of July precipitation in Mexico drawn by COSMIC (1999) from 14 different global circulation models and multiple climate sensitivities and emissions trajectories {from Yohe, et. al (1999). Figure 9.5b depicts the corresponding sustainability indices for each scenario – likelihoods (inferred from fitting a gamma distribution to historical July precipitation records) that rainfall in July will be high enough to sustain yields in excess of 2000 kg/ha along each trajectory.

Socio-economic Trends: Continued emphasis on globalization, commercialization, liberalization of even domestic markets, and strong urbanization.

Figure 9.5a. Trajectories of July precipitation for eight representative climate scenarios.

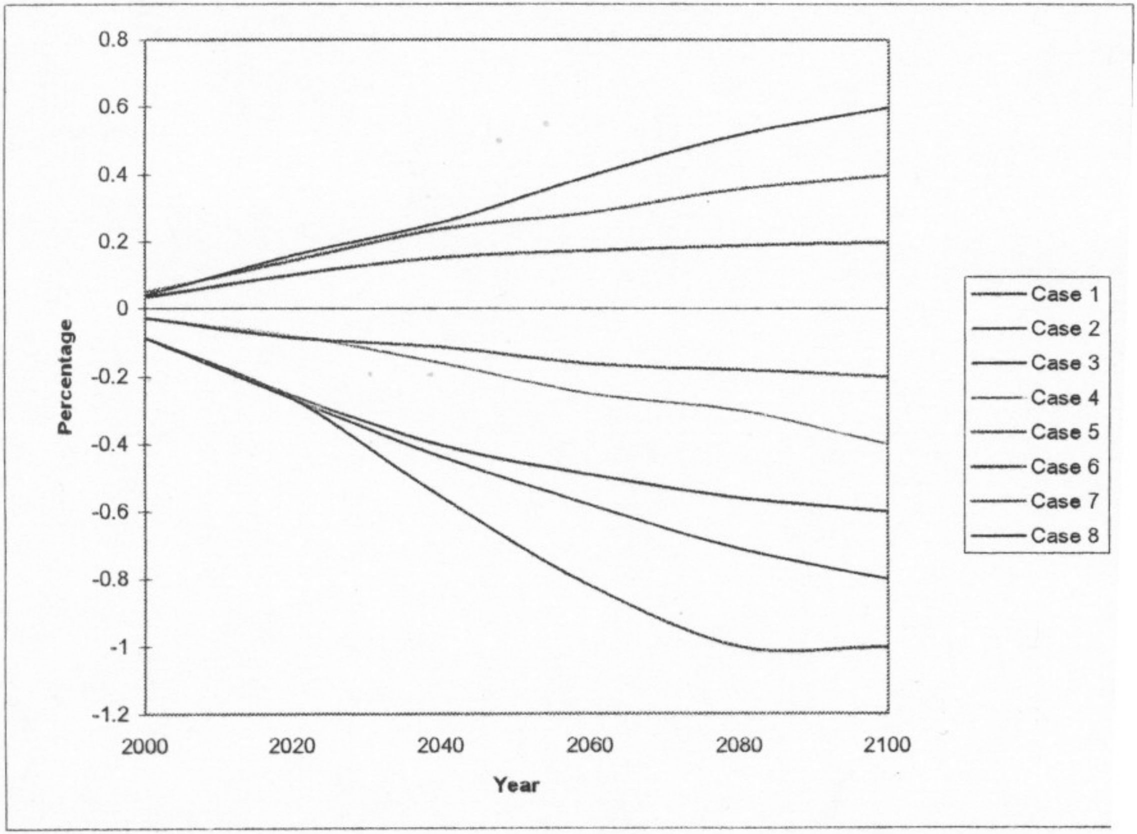
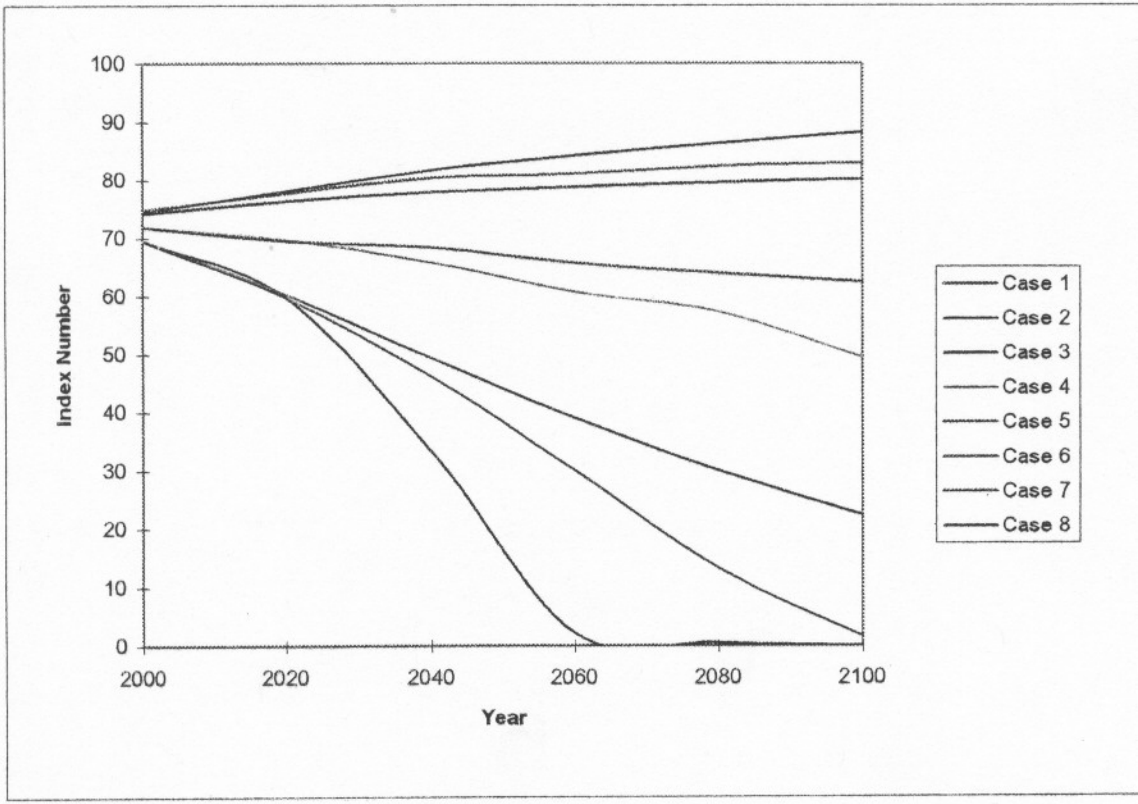


Figure 9.5b. Corresponding sustainability index trajectories for traditional maize agriculture along the representative scenarios. The sustainability index is the likelihood that July precipitation will be above a critical threshold in any given year.



4. Adaptation Strategies:

The government develops draught resistant hybrid varieties of maize: Redclift (1983) reports on this plan as well as the success of the Plan Puebla demonstration farms in the 1970s. The government continues to promote commercial hybrid varieties – the hope is that they will be more resistant to variable climate and they will integrate small-scale farmers into the market economy.

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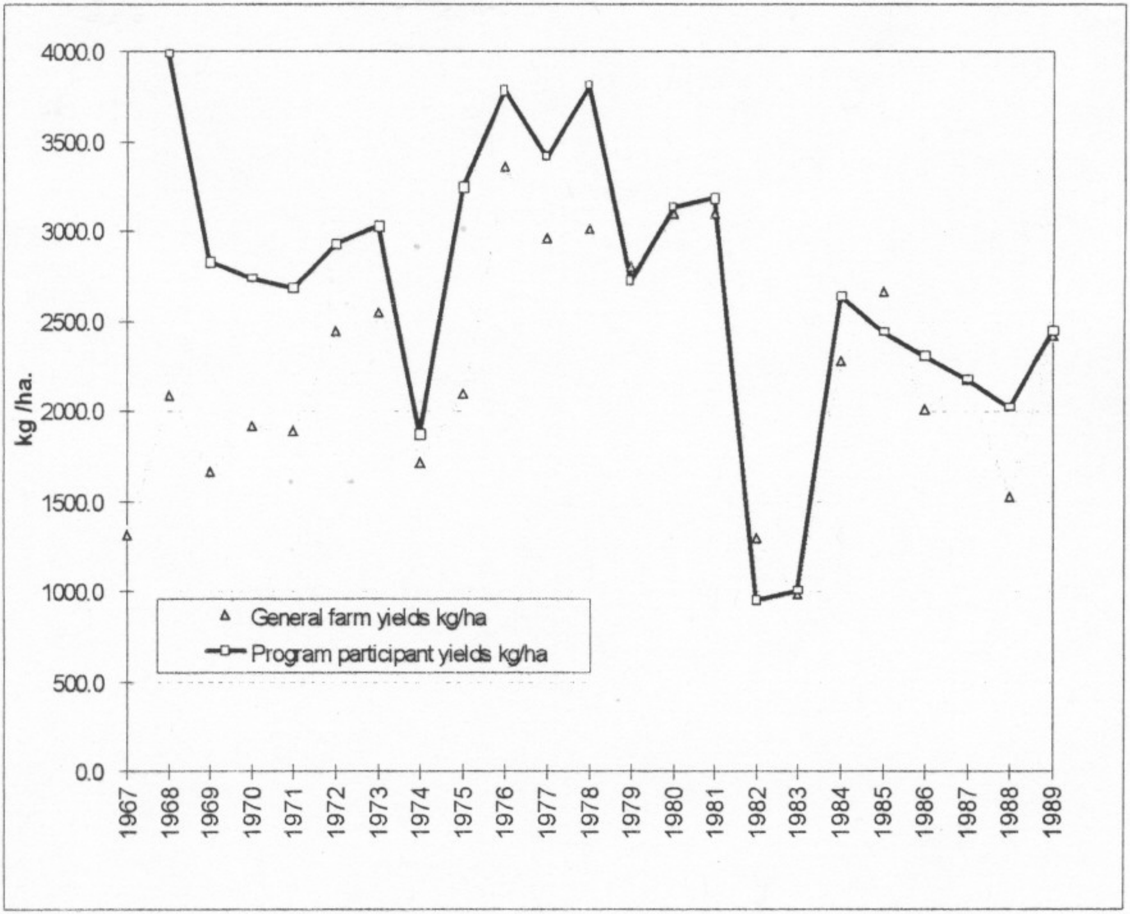


Figure 9.6a. Average yields within the Plan Puebla in contrast to general farm yeilds. Source: Figure 2 in Eakin (2000).

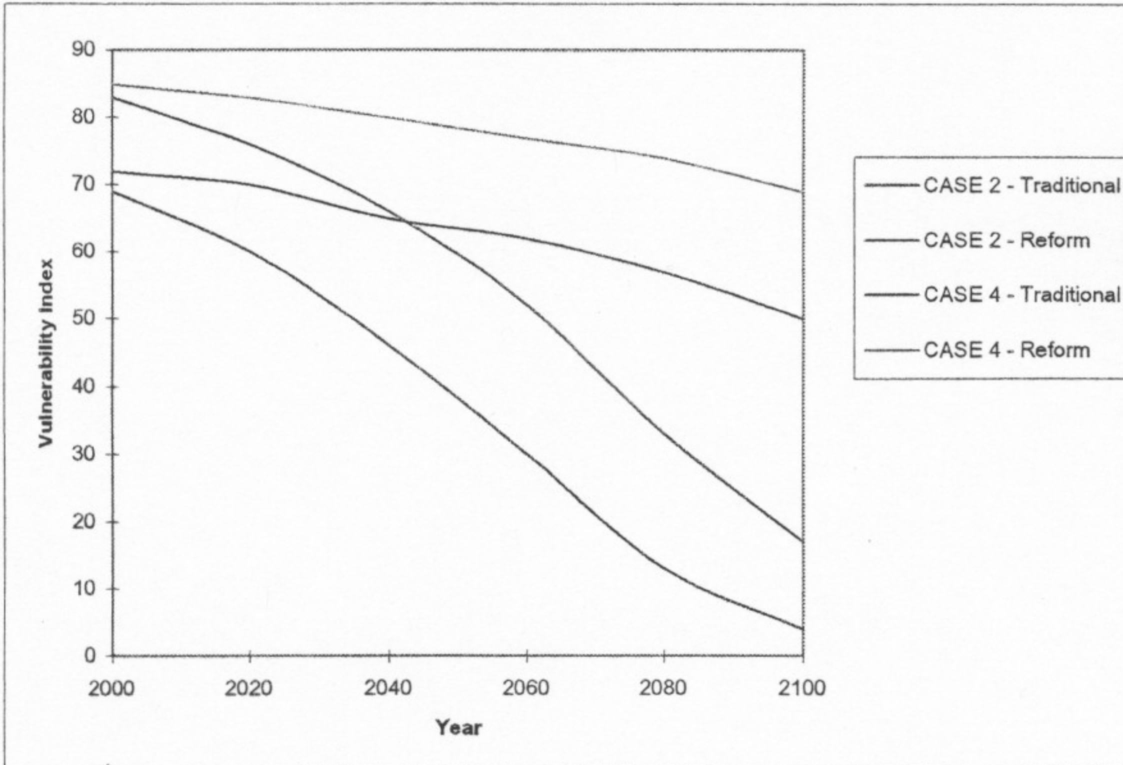
. Continue the Adaptation Process:

Incorporation: Both initiatives have been implemented, so they are perfect subjects for applying M&E fundamentals.

Monitor and Evaluate – the hybrid varieties: USDA data (from Cisneros, 1994) show that the hybrids produced higher yields in good years but did not perform noticeably better in bad years; see Figure 9.6 for data from general farm yields and the demonstration project farms located in the same areas. Reliance on chemical inputs and irrigation increased economic vulnerability (through higher debt). The hybrids did not, however, cross the critical 2000 kg/ha as frequently, so the sustainability indices are higher for any future climate scenario; see Figure 9.7.

Issue ENSO-based seasonal forecasts: Magana Rueda (1997) reported that climatologists saw ENSO playing a significant but nonetheless small role in determining Tlaxcaltecan weather patterns. Even if the role were larger and the forecasts were incorporated into broader policy initiatives that would bring them more effectively to the small-scale farmer. Eakin (2000) reports the results of stakeholder engagement. Most farmers are skeptical. The most enthusiastic farmers could see how the information might add them in their investment and timing decisions. The majority thought that the geographic variability of the region made it impossible to provide anything useful. Conditions had changed over recent years to the point where farmers had lost their experiential basis for making judgments; and so they were not excited about adding another source of uncertainty into their decision-making context.

Figure 9.6b. Sustainability indices for traditional and hybrid maize along two representative climate scenarios.



DETERMINANTS OF ADAPTIVE CAPACITY:

1. The range of available technological options,

2. The availability of resources and their distribution across the population,

3. The structure of critical institutions, the allocation of decision-making authority, and the decision criteria that would be employed,

4. The stock of human capital,

5. The stock of social capital,

6. **Access to risk spreading processes,**

7. **The ability of decision-makers to manage information and to determine which information is credible; the credibility of the decision-makers, themselves, and**

8. **The public's perceived attribution of the source of stress and the significance of exposure to its local manifestations.**

THESE DETERMINANTS CAN BE USED TO CONSTRUCT INDICATORS OF VULNERABILITY – UNITLESS METRICS THAT RECOGNIZE ADAPTIVE CAPACITY IN JUDGING RELATIVE VULNERABILITY

An Indicator for Coping Capacity from the Determinants of Adaptive Capacity.

A feasibility factor denoted FF_j can be assigned to all of the determinants for each adaptation option (denoted by the subscript j) according to:

$$\mathbf{FF_j \equiv min\{ff_j\,(2), \ldots\ ff_j\,(8)\}.}$$

The ff_i are subjective judgments of the strength of each determinant – from 0 to 5, for example.

An efficacy factor (denoted EF_j) can be judged for each adaptation - *a subjective index number of likely success assigned from a range running from 0 to 1.*

The potential contribution of any adaptation to a system's coping capacity can finally be defined as the product of its overall feasibility factor and its efficacy factor; i.e.,

$$\mathbf{PCC_j \equiv \{EF_j\}\{FF_j\}.}$$

Figure 1a
Static Environment

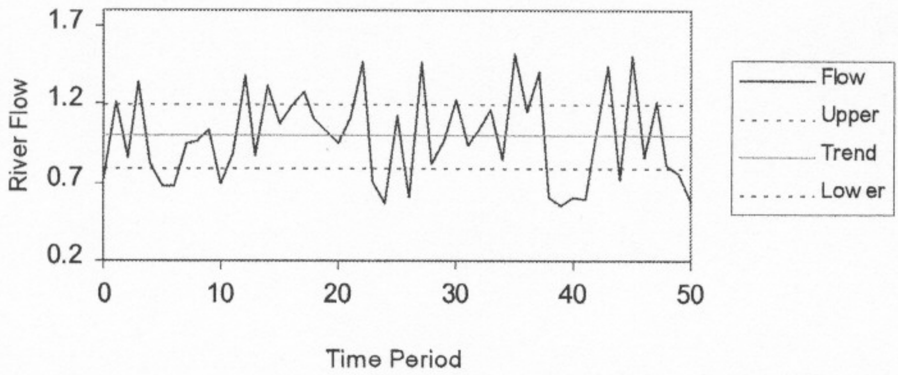


Figure 1b
Gradual Change in the Mean

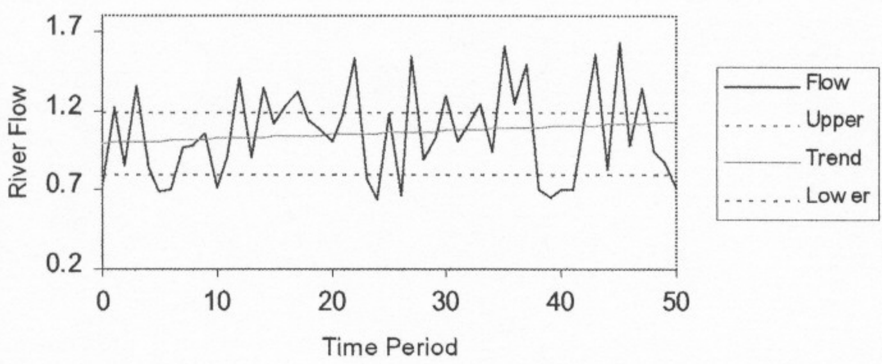


Figure 1c
Gradual Change with Enlarged Variance

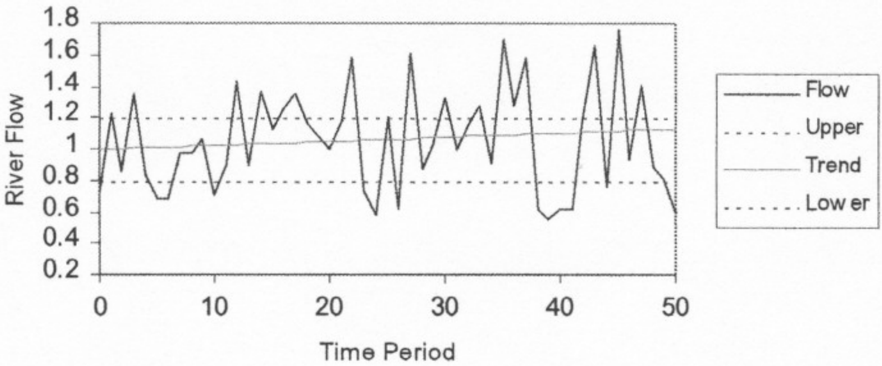


Figure 2
Building Flood Protection in the Fifth Period

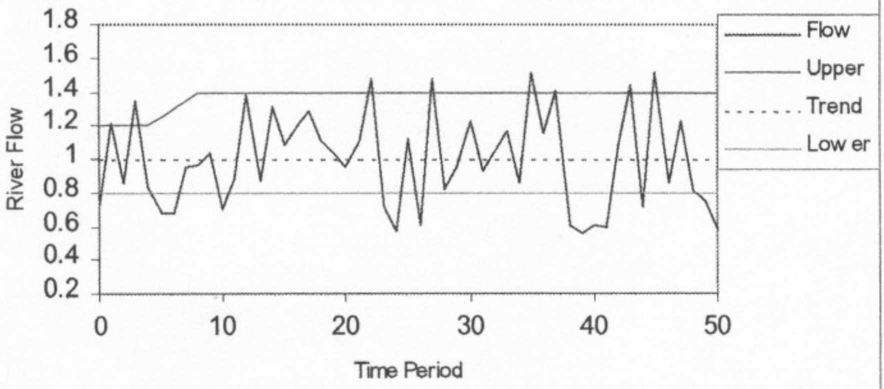


Figure 3
Smoothing Variation with an Upstream Dam

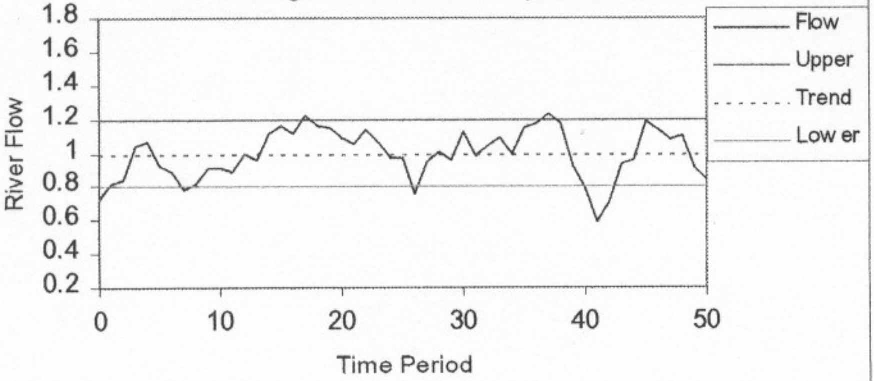
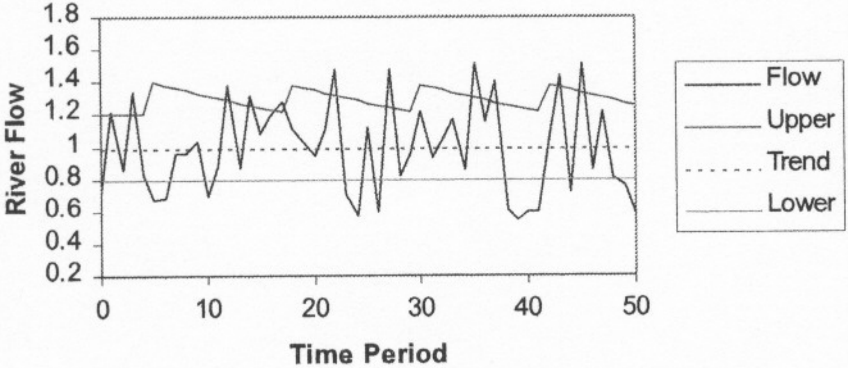


Figure 4
Reducing Flood Threat by Dredging



Tol *et al.* (2001) reports on an assessment of adaptation against increased risk of flooding in the Rhine Delta. Six options were identified for the Netherlands:

1. Store excess water in Germany.

2. Accept more frequent floods.

3. Build higher dikes.

4. Deepen and widen the river bed.

5. Dig a fourth river mouth.

6. Dig a bypass and create a northerly diversion.

Quantifying the Details of Adaptation Options for the Lower Rhine Delta

	Options					
Determinant	**Store water**	**Accept floods**	**Higher dikes**	**River bed**	**4th Mouth**	**Bypass**
2. Resources						
Total costs	3	5	4	4	1	2
Distribution[a]	1	3	4	5	1	1
3. Institutions						
Structure[b]	1	4	5	4	2	3
Participation[c]	2	2	3	5	1	2
Criteria[d]	2	1	5	4	3	2
4. Human capital	1	2	5	4	4	3
5. Social capital	1	3	4	5	2	2
6. Risk spreading	2	1	5	4	4	3
7. Information						
Management	1	3	5	4	2	2
Credibility	1	2	4	5	3	3
8. Awareness	3	3	5	5	3	3
Feasibility Factor (FF) [e]	1	1	3	4	1	1
Efficacy Factor (EF)	0.8	1.0	1.0	0.6	0.8	0.6
Coping Index (PCC)	0.8	1.0	3	2.4	0.8	0.6

Notes:

a The distribution of the costs and benefits of implementing an option.
b The degree to which the current mandates of bureaucracies are inadequate for the problem, essentially, hov
integration of land use and water management is needed for successful implementation.
c The degree to which the decision making process is likely to be hindered by "not in my backyard" phenom
d The degree to which the option fits in with current decision making criteria.
e Ranking (minimum of the weighted scores).