Lecture 16
10 March 2025
Mid-sem exam-crib session

Lecture 17
13 March 2025
Concept of Adaptation, Coping range, Adaptive capacity etc.

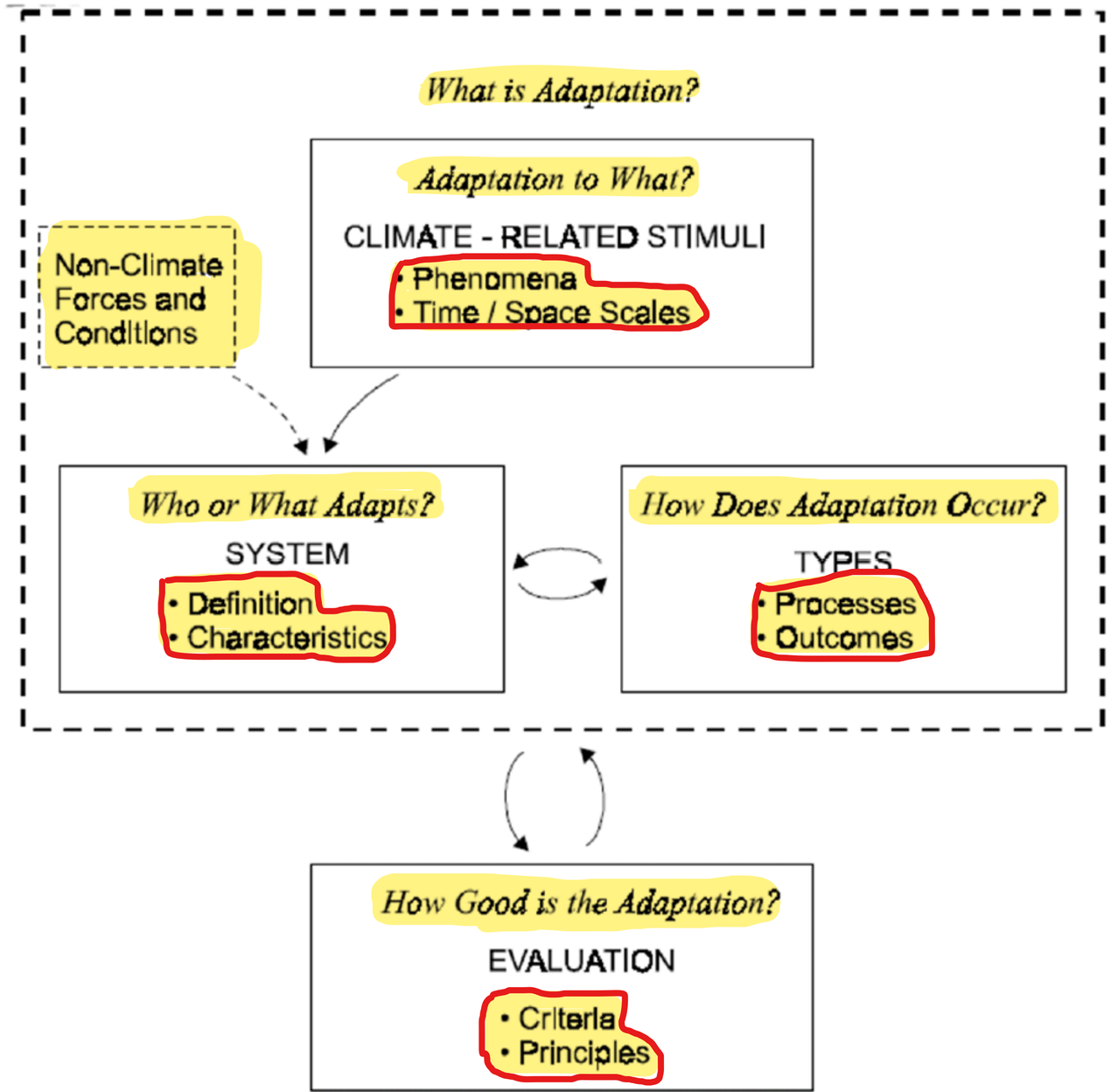
CM 615

Climate change Impacts & Adaptation

Climate change and adaptation

Angshuman Modak
Climate Studies, IIT Bombay

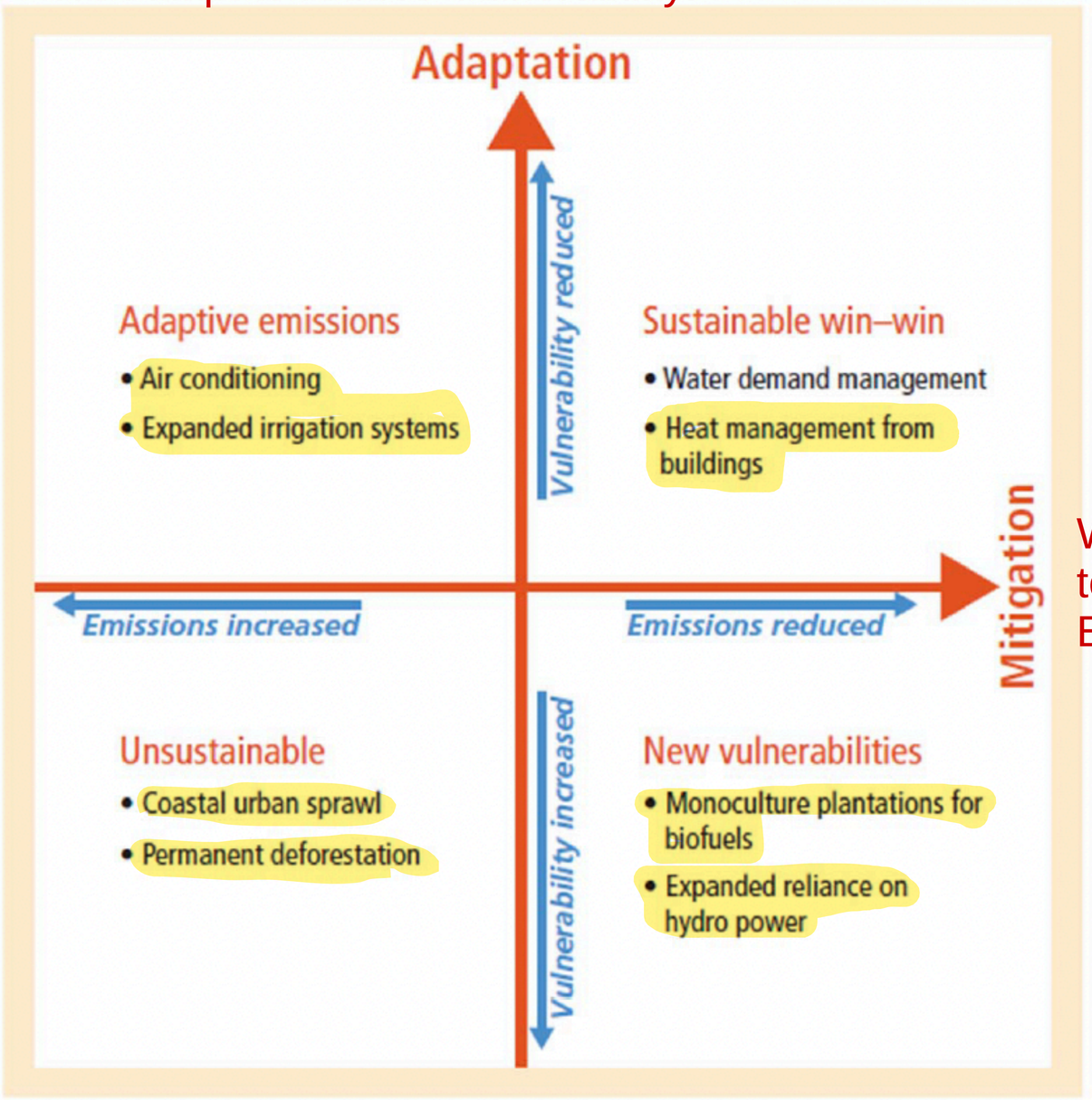
What is adaptation??



(Smit et al., 2000)

How do we link Adaptation Mitigation Sustainable development ??

We Adapt to reduce Vulnerability.



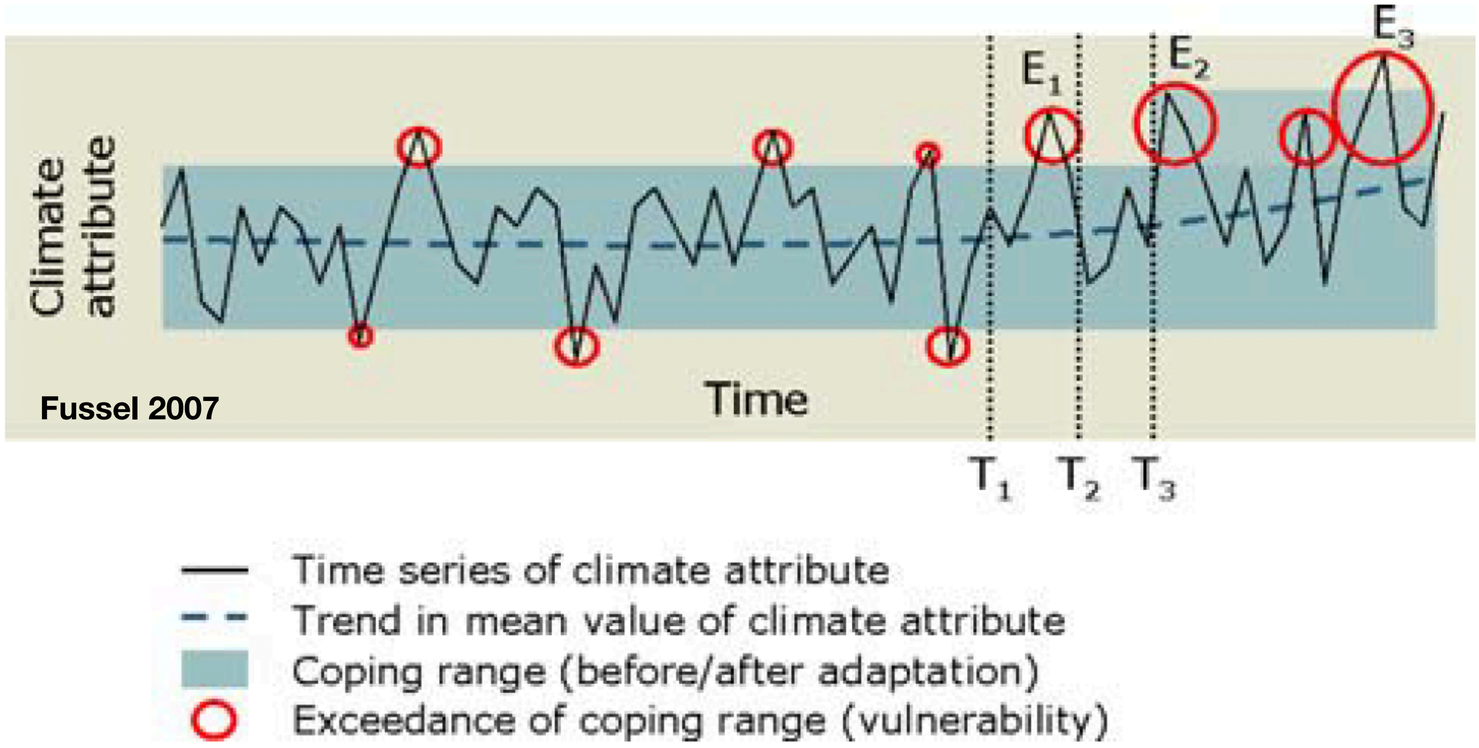
We Mitigate to reduce Emissions.

(Source: IPCC AR5, 2014)

When and how does adaptation occur?

A hypothetical time series of a climate attribute (for ex. seasonal precipitation)

Insufficient precipitation may cause crop damage whereas too much precipitation may cause river flooding.



Fussel 2007

- Let's say there is a community which is well adapted to a given range of a climate variable, denoted the "coping range", but it is vulnerable to climatic conditions outside this range
- In the time period up to T1, climate largely remains within the coping range, and the community is prepared to accept the minor damage caused by the occasional slight exceedance.
- After T1, the climate event E1 exceeds the coping range substantially, causing significant damage.
- In this hypothetical example extension of the coping range is assumed to be possible but costly.

When and how does adaptation occur?

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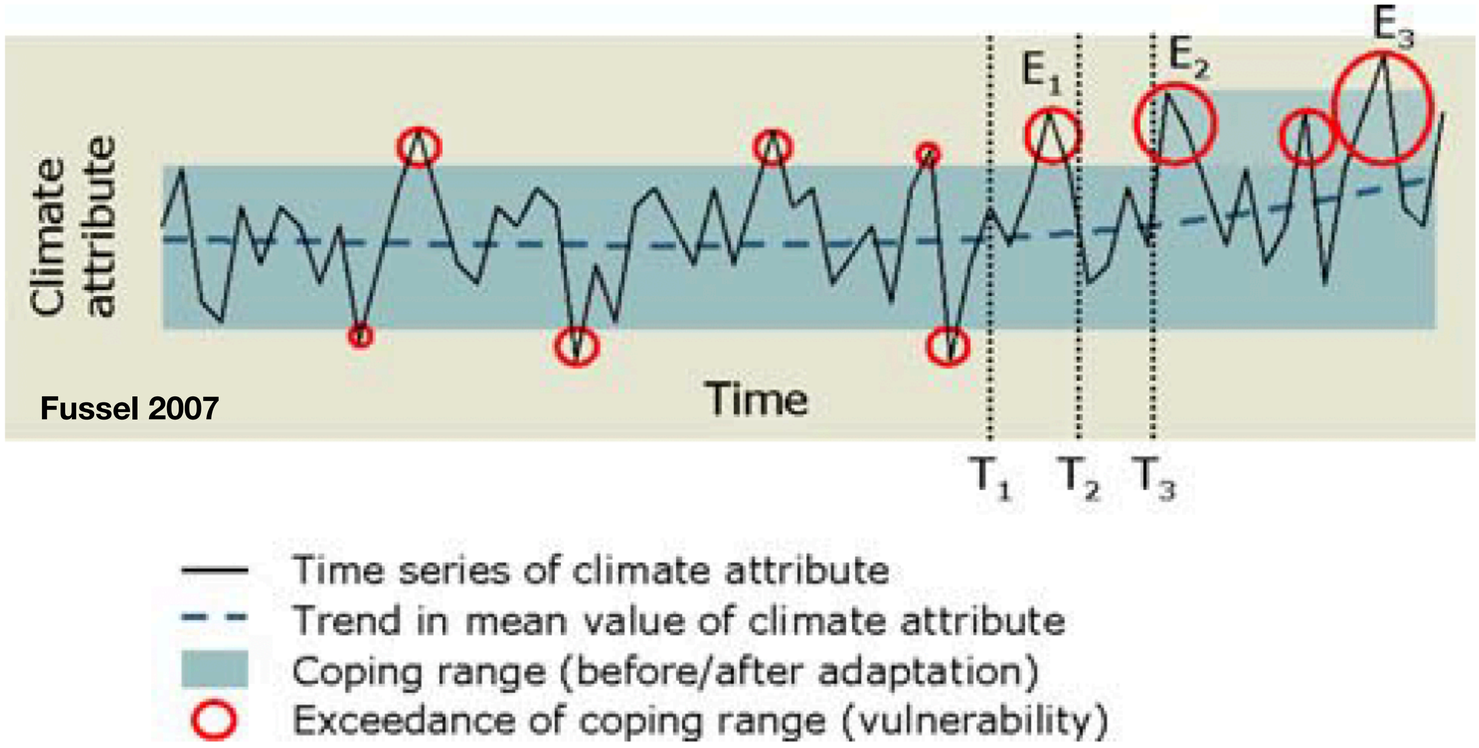
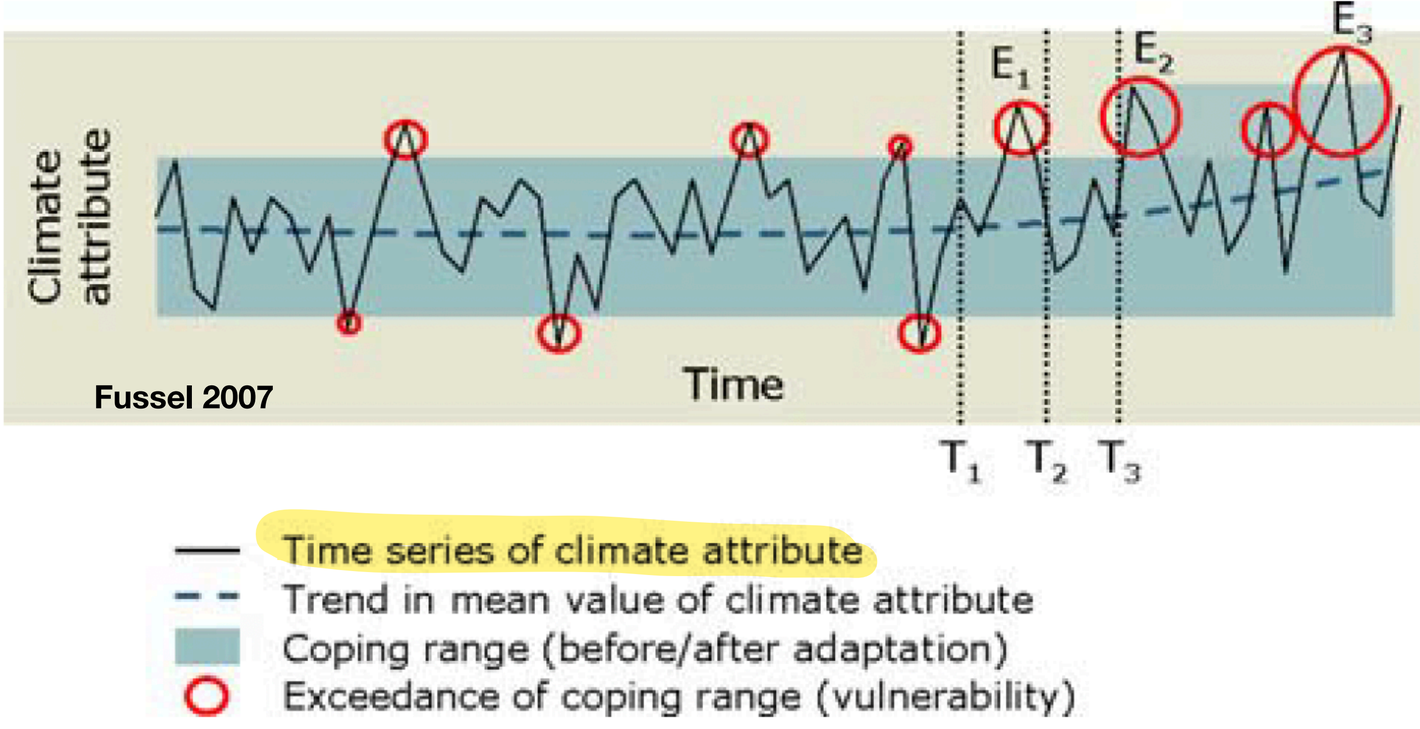


Fussel 2007

- The community wonders whether
  - E1 is still an expression of natural variability
  - or whether it is already a sign of more climate change to come.
  - If the first, then what would be the course of action??
  - If not then what??
  - Let's not worry much! the community would be willing to accept the damage because the return period of a similar event would be very long
  - The community would prepare for costly extension of their coping range because a previously "unusual" event like E1 would become increasingly "normal" in the future.

When and how does adaptation occur?

- But they know from model projections that the climate is changing due human induced GHG emissions and hence it is not natural variability and they should take some action.
- As a result, the community makes a decision at T2 to extend their coping range upwards (e.g. by building a new overflow reservoir).
- Soon after T3, another extreme event E2 occurs. This event is even stronger than E1 but still within the extended coping range.

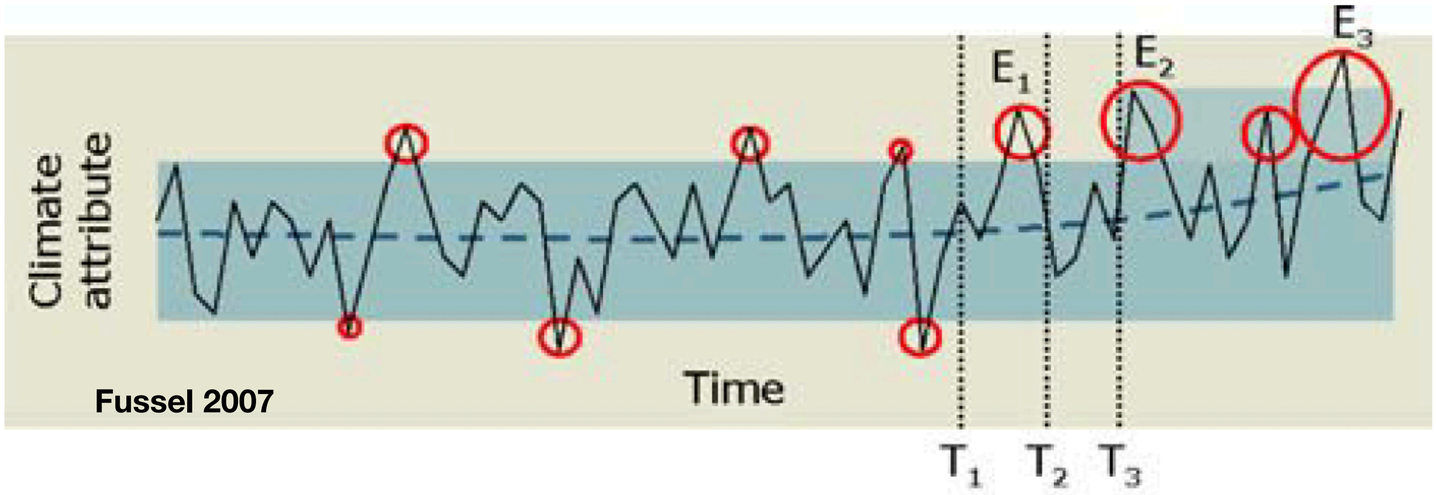


- Hence, adaptation has prevented substantial damage that would have occurred otherwise.
- As climate continues to change, an even more extreme event E3 occurs, which exceeds even the extended coping range, causing substantial damage despite previous adaptation.
- At this point, the community is faced with the question whether to accept the apparently increased risks or whether to undertake further costly adaptation.

Important lessons

1. adaptation needs arise often (but not always) from extreme events rather than from average climate conditions.

2. when vulnerability is linked to extreme events, natural climate variability and anthropogenic climate change need to be considered jointly, because risks arise from the combination of the two.



3. the distinction between reactive and proactive adaptation may be fuzzy in practice. Ex, the decision at T2 to adapt was triggered by the previous extreme event but it was largely made in anticipation of further risk changes in the future.

4. adaptation to climate change is a continuous process. Ex, adaptation was effective for some time, until E3 occurred. Accurate information about future climate change often reduces the total costs of adaptation. The community may have decided to increase the coping range even further (e.g. by building a larger reservoir).

What is planned adaptation to climate change?

Fussel 2007

- *Planned adaptation to climate change means the use of information about present and future climate change to review the suitability of current and planned practices, policies, and infrastructure.*

- *Adaptation planning involves addressing questions such as:*
  - *How will future climatic and non-climatic conditions differ from those of the past?* Past vs Present Scenarios
  - *Do the expected changes matter to current decisions?* Relevance of stimuli?
  - *What is a suitable balance between the risks of acting (too) early and those of acting (too) late?*

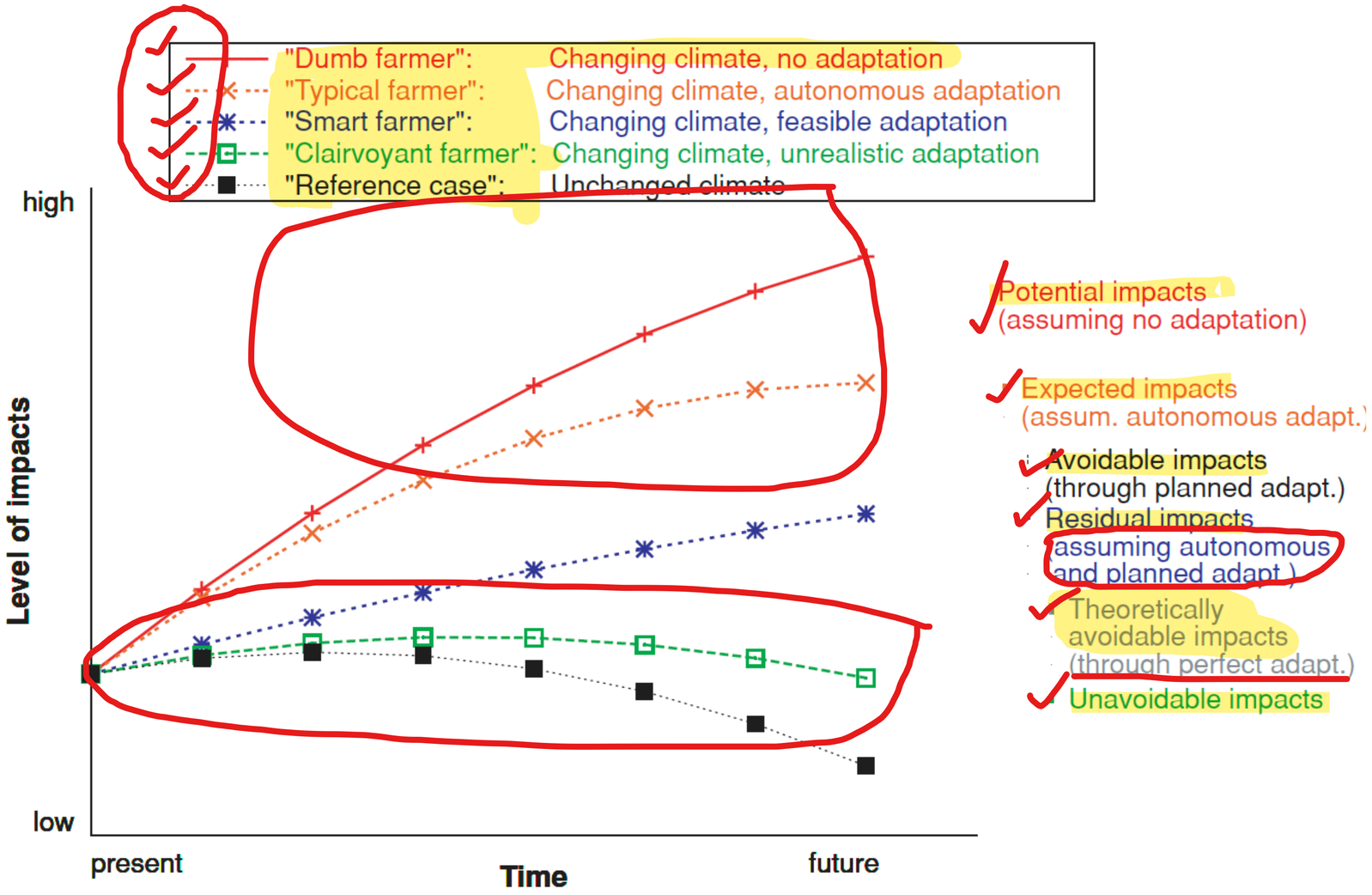
- *Eventually, adaptation planning is about making recommendations about who should do what more, less, or differently, and with what resources.*

What is the objective of planned adaptation ?

Fussel 2007

- Strategy to prevent all adverse impacts of current and future climate change.
- Such a goal implicitly assumes a world that is
  - ✓ perfectly adapted to current climate conditions,
  - ✓ that has perfect knowledge of future climate change,
  - ✓ and that has abundant resources for adaptation.
- Completely unrealistic!!
- Particularly for developing nations…

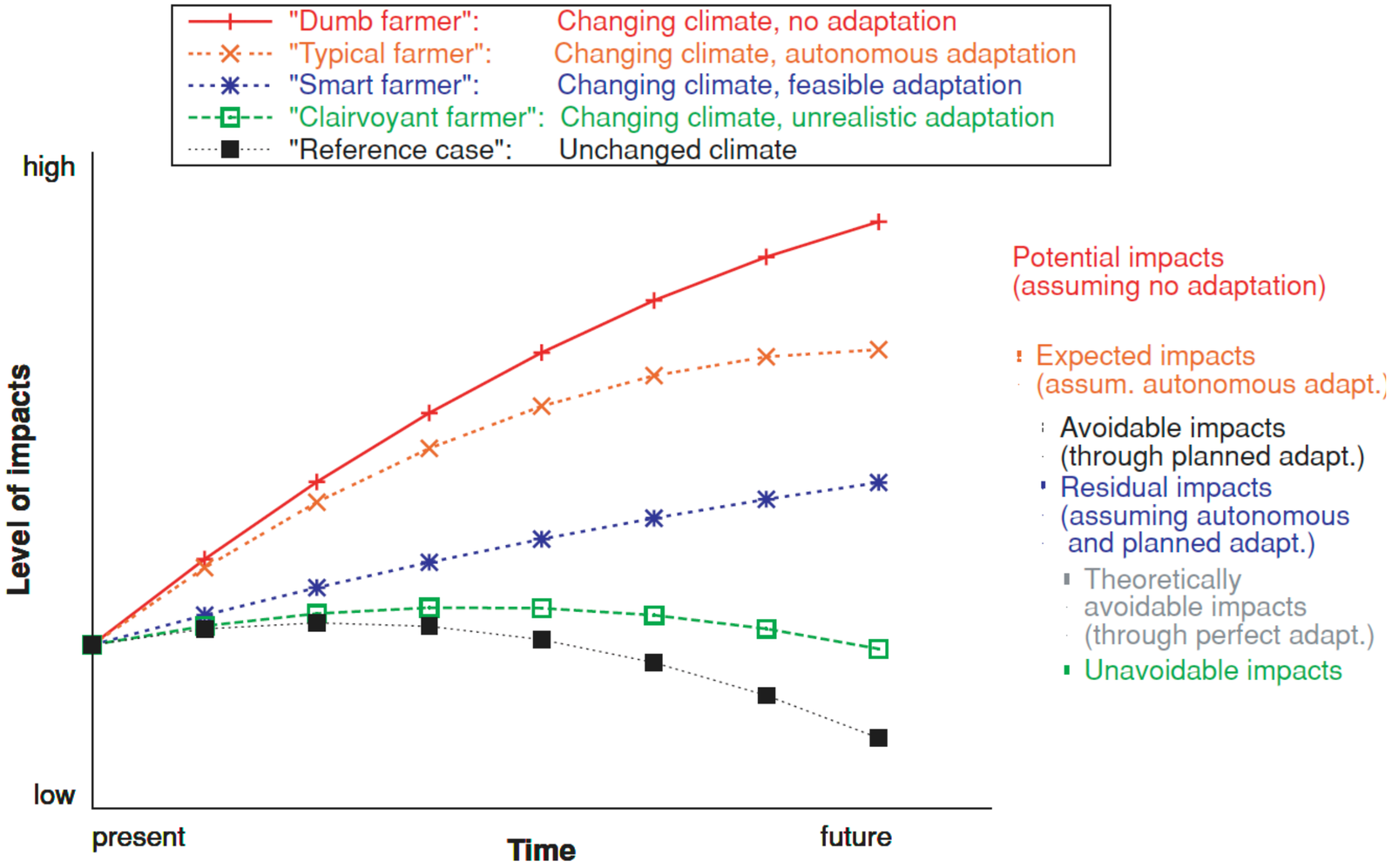
Different concepts of climate impacts and adaptation (Fussel and Klein 2006)



The diagram depicts hypothetical trajectories for the level of climate related impacts on a system because of both natural variability and anthropogenic climate change.

- The lowest trajectory denotes the (unrealistic) reference case of an undisturbed climate.
- Impacts are changing with time, because of economic growth, technological development, and demographic changes.
- The other trajectories depict the impacts associated with a changing climate for four different assumptions regarding adaptation.

Different concepts of climate impacts and adaptation (Fussel and Klein 2006)



The diagram depicts hypothetical trajectories for the level of climate related impacts on a system because of both natural variability and anthropogenic climate change.

In descending order of impacts:

"dumb farmer" - who does not react at all to changing climate conditions;

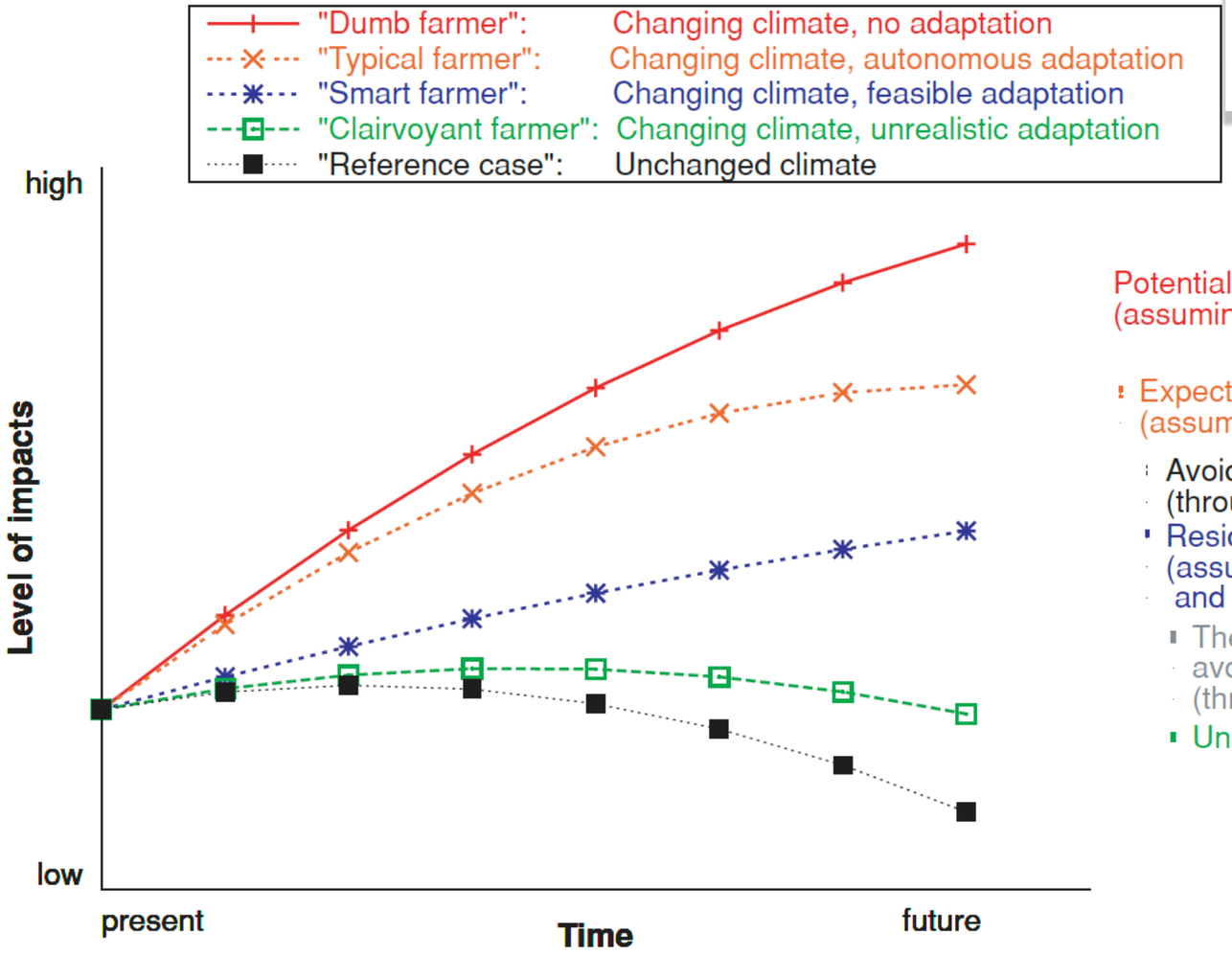
"typical farmer" - who adjusts his practice in reaction to persistent climate changes only;

"smart farmer" - who uses available information on expected climate conditions to adjust proactively;

"clairvoyant farmer" - who has perfect foresight of future climate conditions and faces no restrictions in implementing adaptation measures.

Different concepts of climate impacts and adaptation (Fussel and Klein 2006)

The benefits of planned adaptation thus correspond to the difference between expected and residual impacts rather than between potential and unavoidable impacts (or even zero).



Potential impacts (assuming no adaptation)

Expected impacts (assum. autonomous adapt.)

Avoidable impacts (through planned adapt.)

Residual impacts (assuming autonomous and planned adapt.)

Theoretically avoidable impacts (through perfect adapt.)

Unavoidable impacts

Potential impacts - show the level of impacts assuming no adaptation;

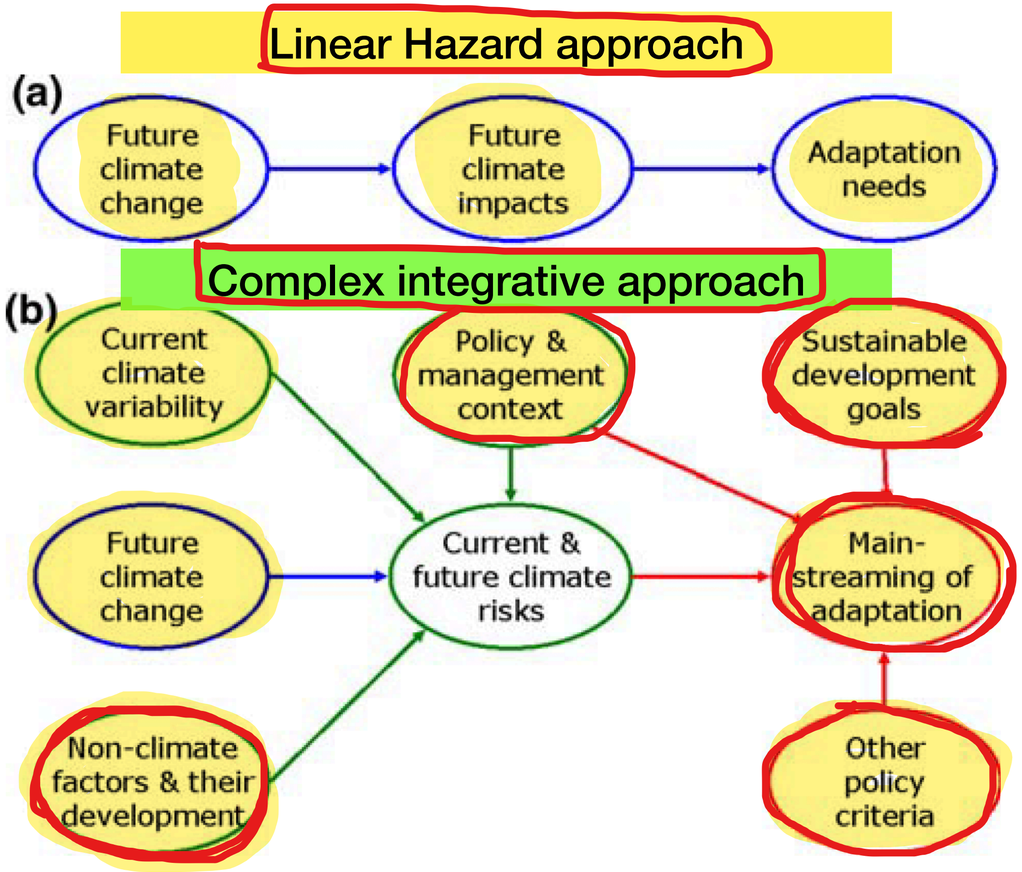
Expected impacts - assume only autonomous adaptation;

Residual impacts - assume autonomous adaptation and feasible planned adaptation;

Unavoidable impacts - refer to the level of climate impacts assuming perfect adaptation.

The diagram depicts hypothetical trajectories for the level of climate related impacts on a system because of both natural variability and anthropogenic climate change.

How are adaptation needs defined?



Evolution of approaches for determining adaptation needs

- *Climate scenarios are the basis for estimating future climate impacts, which then define adaptation needs.*
- *Adaptation to climate change is seen as largely separate from other social processes and activities, and adaptation needs are largely determined by scientific analysis.*

- *A more comprehensive description of climate-related risks now and in the future by considering future climate change together with current climate variability and non-climate factors.*
- *The risk assessment is further informed by experience from management of past climatic hazards.*
- *Recommendations for adaption are determined by their potential to reduce current and future climate risks but also by their synergy with other policy objectives, for example sustainable development goals.*

Fussel 2007

What are preconditions for effective planned adaptation?

Fussel 2007

- Awareness of the problem: Assessing and communicating vulnerability to climate change
- Availability of effective adaptation measures: Triggering research that may lead to the development of new adaptation options
- Information about these measures: Identifying and assessing effective adaptation measures (awareness among policy-makers and other stakeholders of the health risks associated)
- Availability of resources for implementing these measures: Evaluating co-benefits of adaptation (thus increasing perceived benefits); identifying ways for the most efficient use of resources, e.g. by mainstreaming adaptation in existing activity (thus reducing costs); and motivating the provision of additional resources, either domestically or internationally
- Cultural acceptability of these measures: Educating people about risks and response options to increase the acceptability of unfamiliar measures
- Incentives for implementing these measures: Identifying obstacles for implementation of effective measures and suggesting options to overcome them.

Practical limits to adaptation are usually a result of insufficient economic resources, technical skills, or political will.

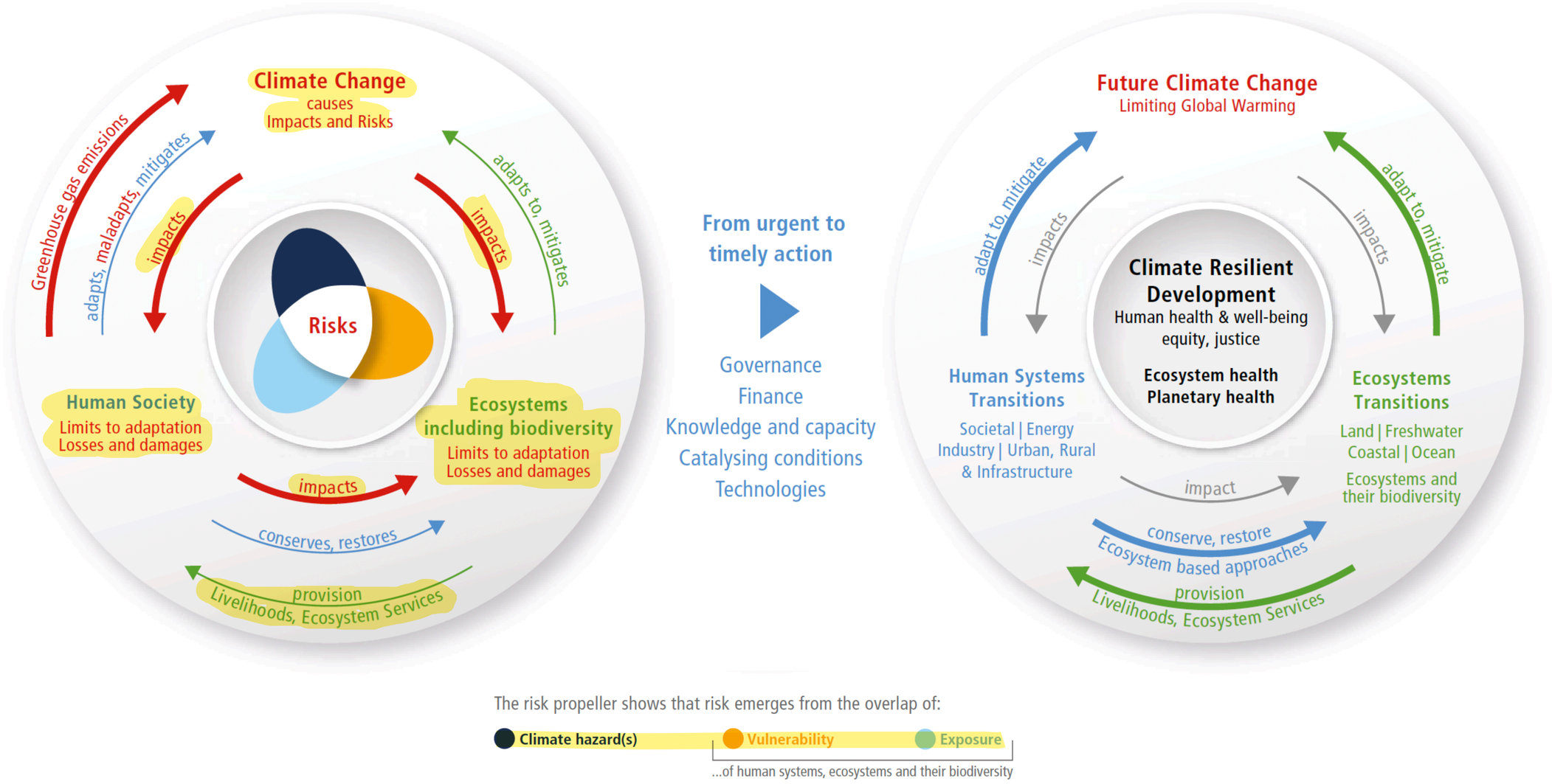
ADAPTATION

- Addresses the effects of the consequences;
- The IPCC defines adaptation as "process of adjustment in natural or human systems in response to actual or expected climatic stimuli or their effects, which moderate harm or exploits beneficial opportunities";
- A typical case of adaptation for aviation would be improvements in coastal area airports' defences against sea level rise and reinforce infrastructure and equipment in remote and exposed locations in case of air navigation service providers.

MITIGATION

- Addresses the causes of climate change and is the action taken to stabilize or reduce GHG concentrations;
- The IPCC defines mitigation as "an anthropogenic intervention to reduce the sources or enhance the sinks of greenhouse gases";
- An example of a typical mitigation measure for aviation would be optimizing the air traffic management systems to enable more direct routings and therefore reducing GHG emissions.

Inter-relationships



The risk propeller shows that risk emerges from the overlap of:

“Human society causes climate change. Climate change, through hazards, exposure and vulnerability generates impacts and risks that can surpass limits to adaptation and result in losses and damages. Human society can adapt to, maladapt and mitigate climate change, ecosystems can adapt and mitigate within limits. Ecosystems and their biodiversity provision livelihoods and ecosystem services. Human society impacts ecosystems and can restore and conserve them.”