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Developing a strategy for adapting to climate change

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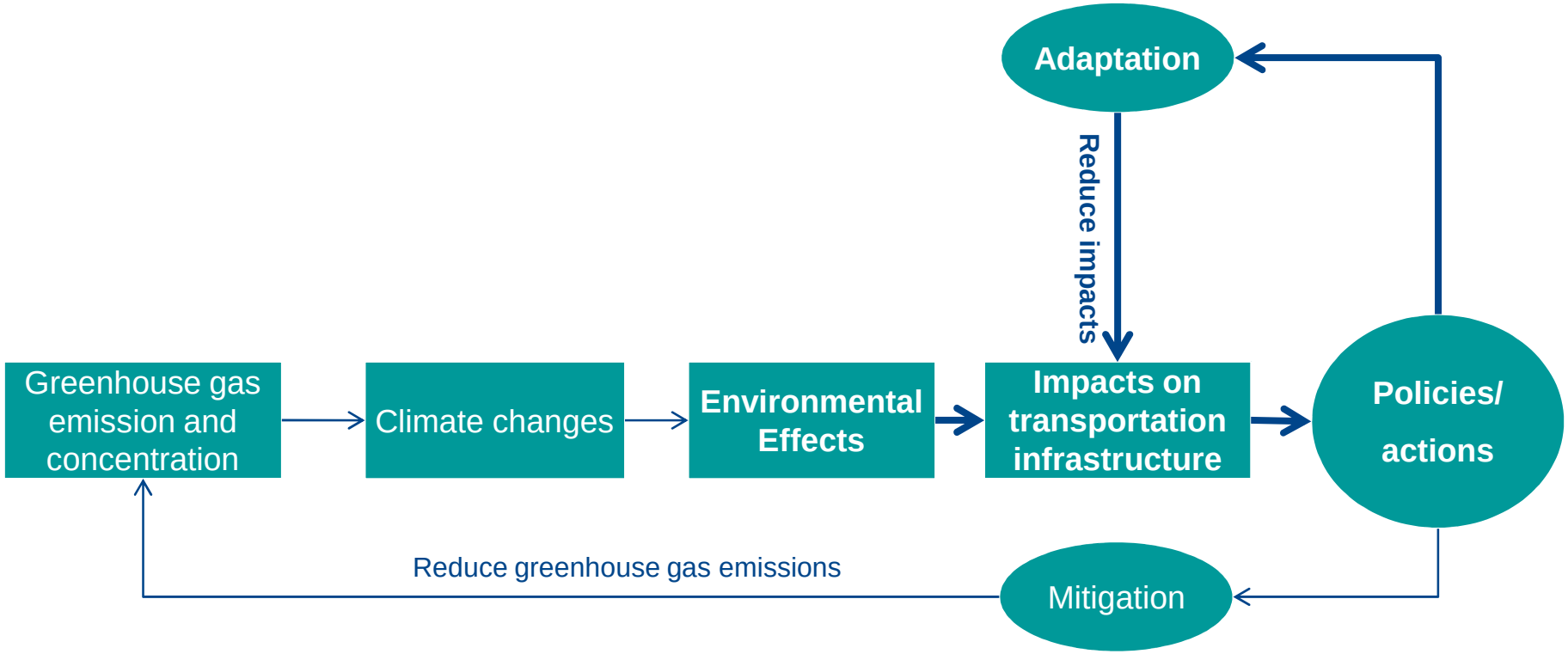
Outline

- Introduction
- A framework for adaptive decision/policy making
- Conclusions



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Impacts on operations and infrastructure

	Impact on	
Event	**Operations**	**Infrastructure**
Increase in the number of extremely hot days (heat waves)	Fewer working days	Thermal expansion on bridge expansion joints and road surfaces Pavement integrity, traffic related rutting, migration of fluid asphalt
Increase/decreases in arctic temperatures		Subsistence of road beds and bridge supports
Rising sea levels and storm surges	Interruptions to road services Emergency evacuations	Inundation of roads Flooding of tunnels and low lying infrastructure Erosion of road base and bridge supports Reduced clearances under bridges
Extreme precipitation (flooding)	Weather related travel delays Flooding of evacuation routes	Flooding of roads, road washouts Landslides and mudslides damaging roads and structures
Hurricanes	More frequent and intensive evacuations Debris on roads	Increased probability of infrastructure failure Larger threat to bridge decks

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Predict-and-act is insufficient for dealing with climate change challenges

- Long planning horizons (decades/centuries versus 5-50 years)
- Massive uncertainty (predict and act optimally, versus unexpected, unplanned events and system redundancy)
- Considerable resource requirements for dealing with long-term and lasting impacts
- Lack of relevant information for decision making

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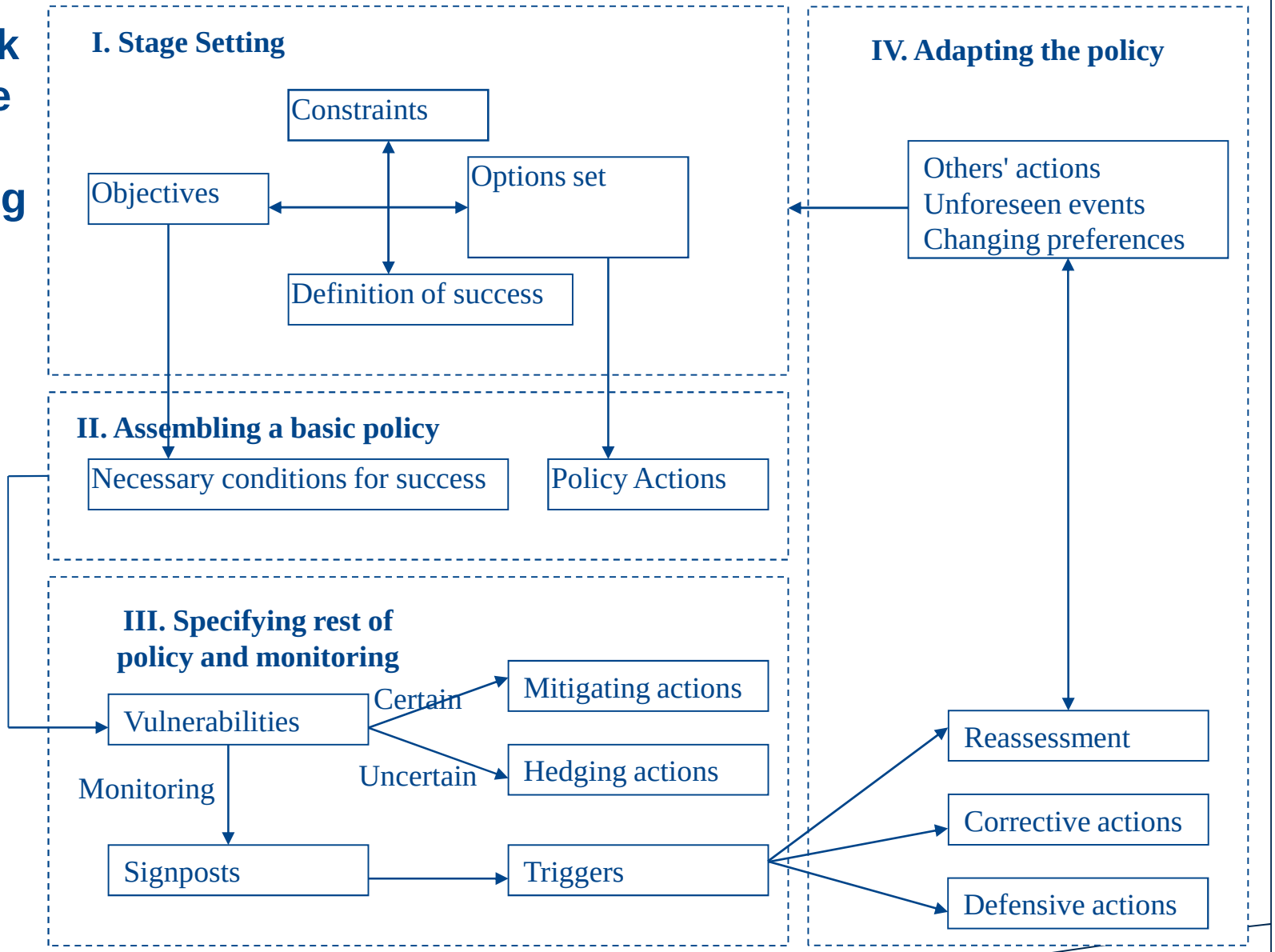
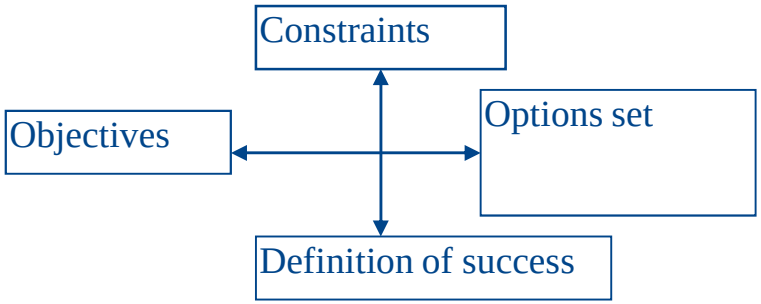
Questions to ask in developing an adaptation strategy

- Which changes are most relevant?
- What are the hazards (e.g., flooding, storm surge coupled with sea level rise)?
- Which assets may be affected?
- How severe must a hazard be before action is required? Can thresholds be identified?
- How likely is it that a hazard will exceed the threshold, when, and where?
- What level of much risk is acceptable, or in other words, what infrastructure performance level is tolerable?
- What level of investment (capital and operating) is needed to maintain different levels of service?
- Are there critical levels of service needed to protect health and safety?
- Who is empowered to make these judgments and decisions?
- What are the risks of adverse impacts or consequences if no action is taken?
- If action is necessary, how will investment priorities be determined?
- Who will make the necessary investments, and how will they be funded?

A framework for adaptive decision-policymaking



I. Stage Setting



Objectives:

Safeguard infrastructure assets

Maintain usability of assets

Prevent loss of life

Constraints:

Available resources

Technical performance characteristics of materials and designs

Definition of success:

No failure

No failure but damage

Option set:

Do-nothing

Retrofit

Redesign and relocate

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II. Assembling a basic policy

Necessary conditions for success | Policy Actions

Policy actions:

Develop inventory of assets

Estimate:

- **Exposure: Identify potential threats and risks**
- **Vulnerability: exposure, design, condition and age of asset**
- **Criticality:" network importance and redundancy requirements (evacuation routes)**
- **Impacts based on average daily traffic and detour length**

Identify assets that are in no-failure and no-failure but damage categories

Conduct Cost –benefit analysis to identify, for assets in each category actions to be taken:

- **Doing nothing**
- **Retrofitting**
- **Redesign and relocate**

Conditions for success:

Availability of up to date information for the risk assessment and cost-benefit analysis

Establishment of and agreement upon the definitions for:

- **Exposure**
- **Vulnerability**
- **Criticality**
- **No-failure and damage but no-failure**

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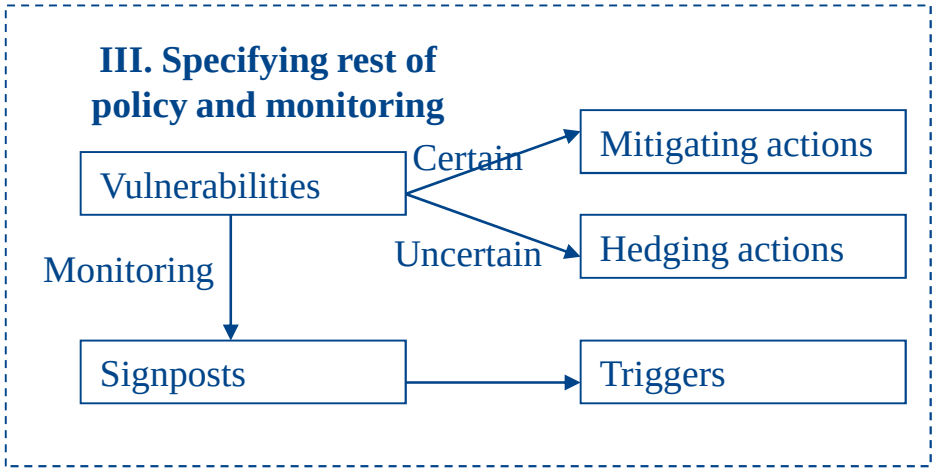

Vulnerabilities:

Changing weather patterns

Changes in use of infrastructure assets

Mitigating actions:

Stricter enforcement of land use and zoning regulations

Hedging actions:

Creation of a special contingency fund for emergency retrofitting/repairs to assets

Signposts:

Precipitation above a certain level in some given time period

Population density

Triggers

Threshold values for the signposts

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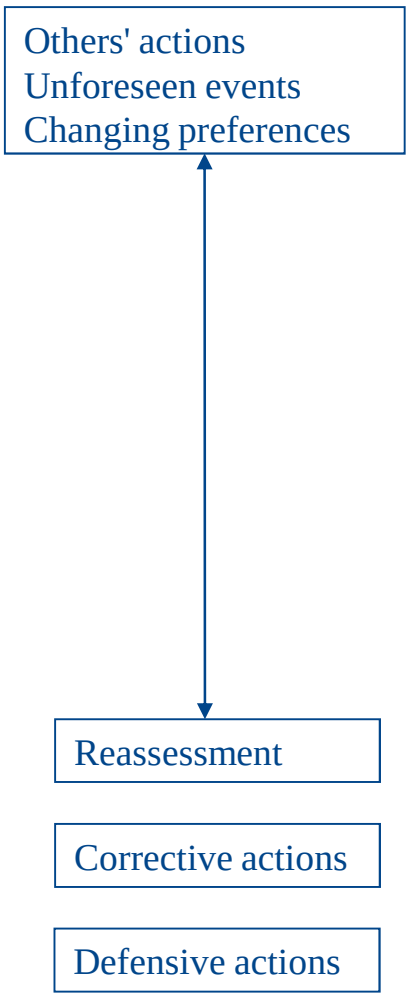
IV. Adapting the policy



Other actions, unforeseen events and changing preferences:

Implement a tolls on using specific assets

Reassessment:

Redefine no failure and damage but no-failure criteria

Redefine hazard, threat and vulnerability algorithms

Corrective actions:

Changing the category in which in an asset is placed

Defensive actions:

Divert traffic along specific routes

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Conclusions

- Climate change poses some special challenges for transport planners decision and policymakers
- These challenges cannot adequately be met using a predict and act approach
- New approaches are needed to meet these challenges, including:
  - Risk assessment
  - Options analysis
  - Monitoring
- In short, adaptation requires adaptive decision/policy making

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