



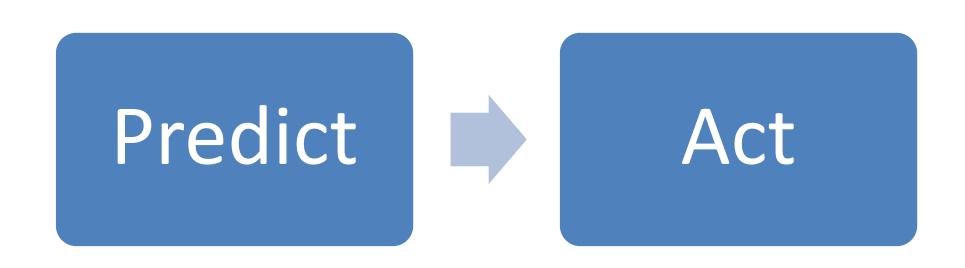


Decision making under uncertainty The case of climate change adaptation

Stéphane Hallegatte

many decisions have very long-term consequences and are climate dependent

The traditional way of making decisions



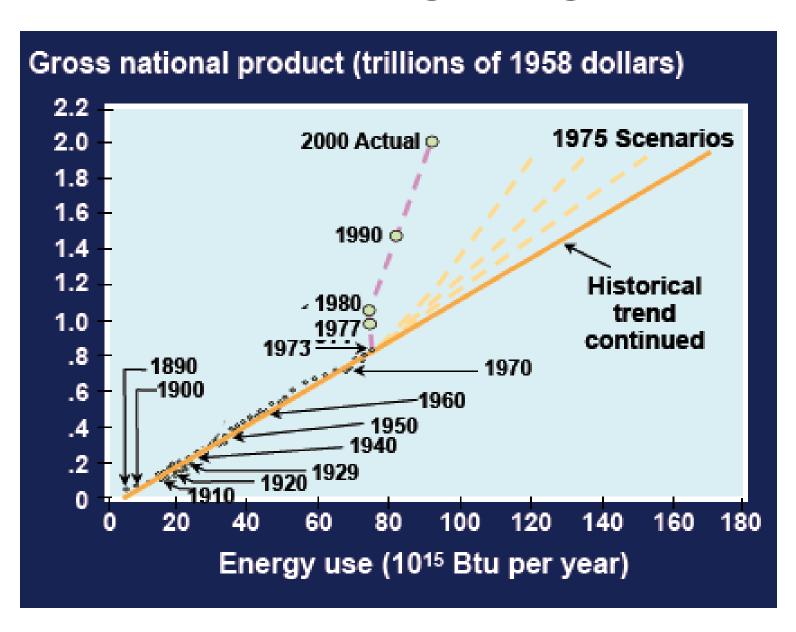
... and "prediction is very difficult, especially about the future" (N. Bohr)



Year 2000, seen from 1900...

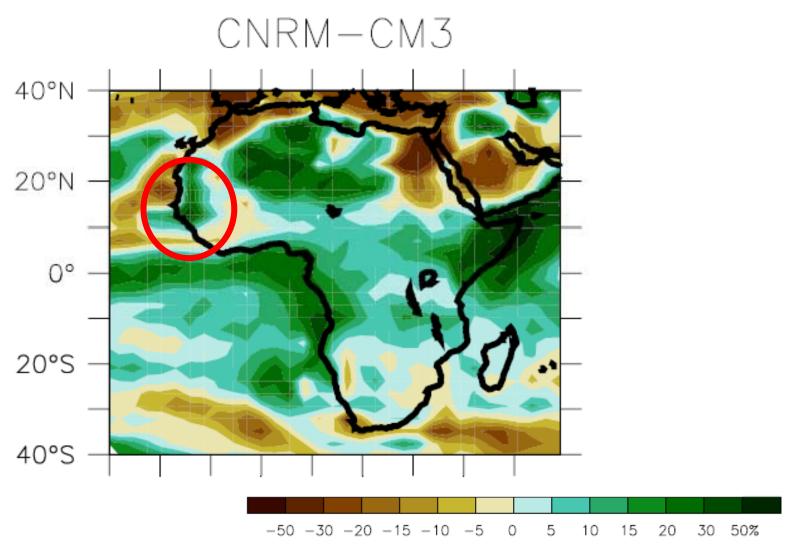
(From Hildebrands)

And we are not getting better...



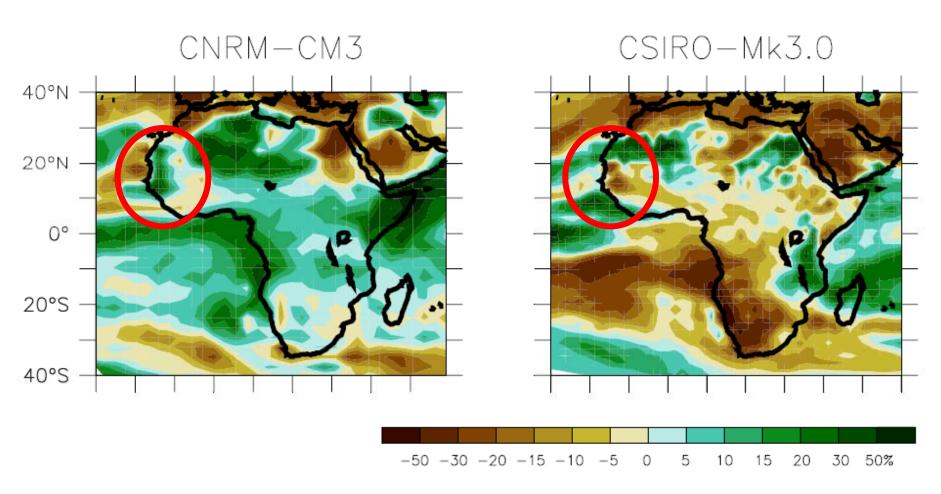
What will people want/like?
What technologies will we have?
What climate will we have?

Climate models try to guess that...



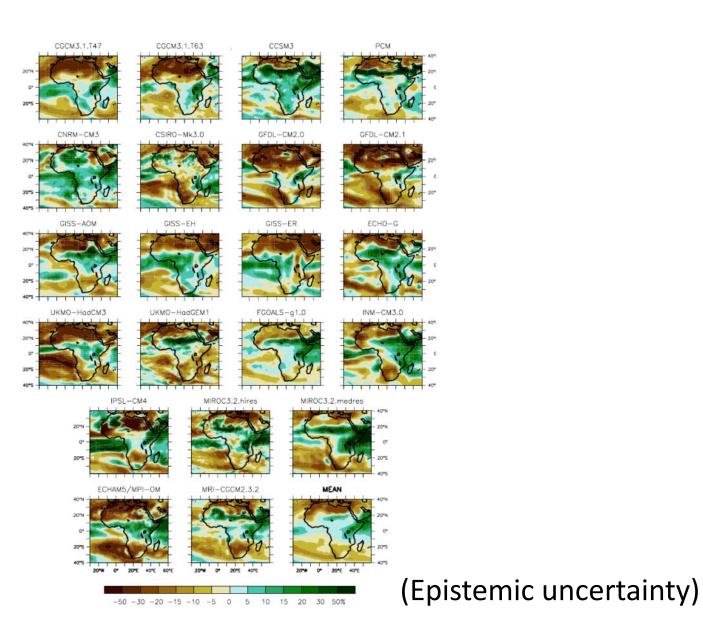
The Meteo-France model, from IPCC

But they disagree with each other



The Meteo-France and the Australian model, from IPCC

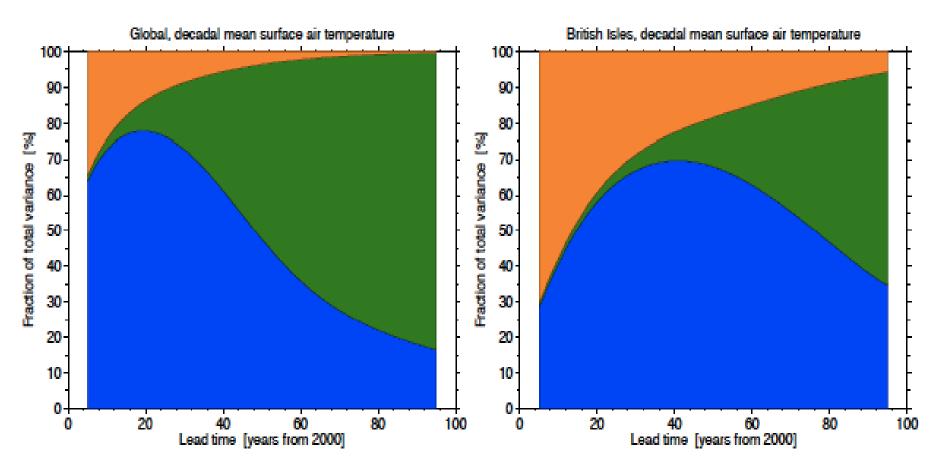
... and we have a lot of models...



... and future climates depend on future climate policies...



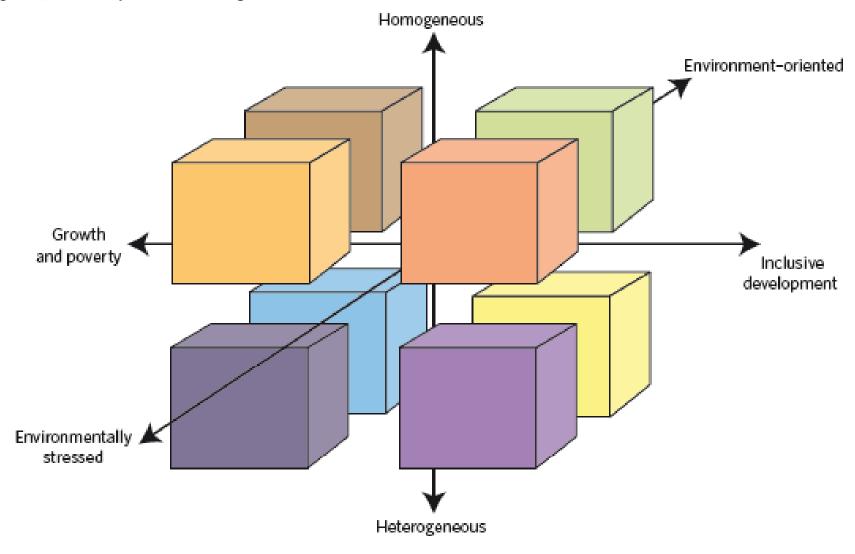
Plus some aleatory uncertainty...



The green is emission uncertainty, the orange is natural variability, and the blue is (climate) model uncertainty; the variable is temperature change. Source: Hawkins and Sutton, BAMS, 2009.

Building world narratives for climate change impact, adaptation and vulnerability analyses

Stephane Hallegatte^{1,2*}, Valentin Przyluski¹ and Adrien Vogt-Schilb¹



Socio-economic uncertainty is even worse at local scale. The case of Paris

18

16

14

1960

1980

2000

Emissions (GtCO2e)

Total transport-related emissions

Techno-economic scenario 1 Techno-economic scenario 2 Techno-economic scenario 3 Techno-economic scenario 4

2020

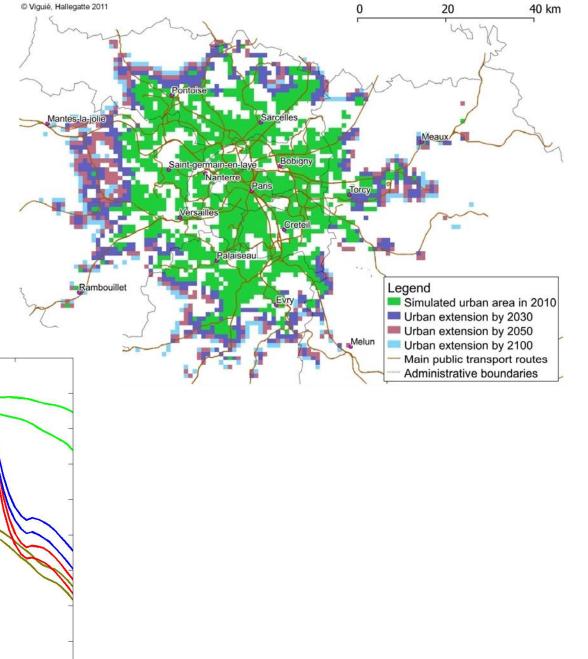
Year

2040

2060

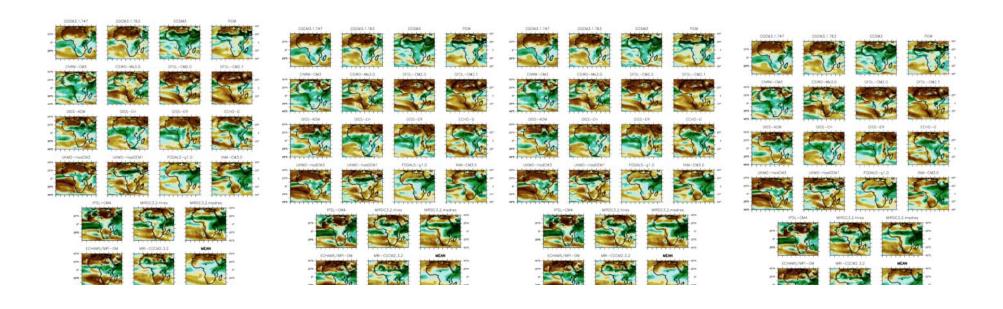
2080

2100

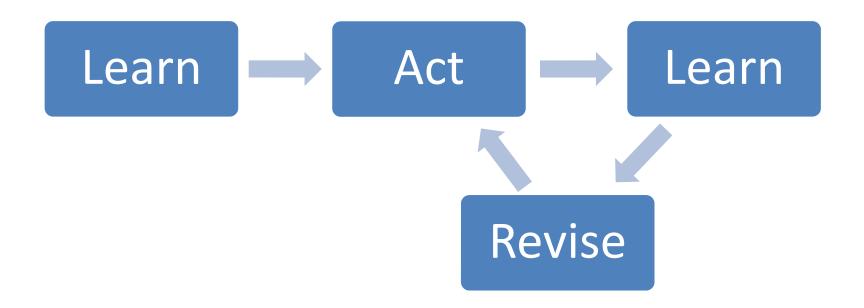


Is it hopeless?

Instead of optimizing in one most likely scenario, look for robustness to the many possible scenarios...



... and allow for revisions over time.



Methodologies

Cost-benefit analysis under uncertainty

- Different "states of the world" associated with different probabilities.
- The project is implemented when expected benefits exceed expected costs.
- Probabilities can be frequentist probabilities (especially when aleatory uncertainty)
- Probabilities can be subjective probabilities (when epistemic uncertainty)
- With concave "utility" (or basic needs), higher weight to worstcase scenarios.
- With concave "social and individual utility" (or basic needs), higher weight to the poorest.

Real option approach

 A context of increasing knowledge – and thus decreasing uncertainty.

 The decision on an investment project is not between "investing" and "not investing"

 It is between "investing now" and "investing later with more information."

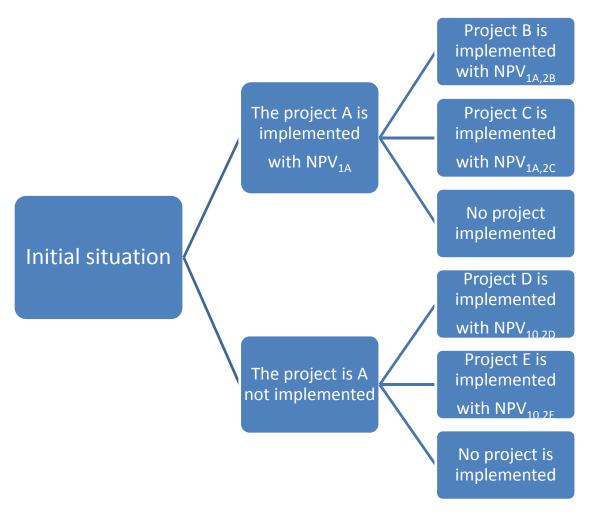
Real option approach

Initial situation

The project A is implemented with NPV_{1A}

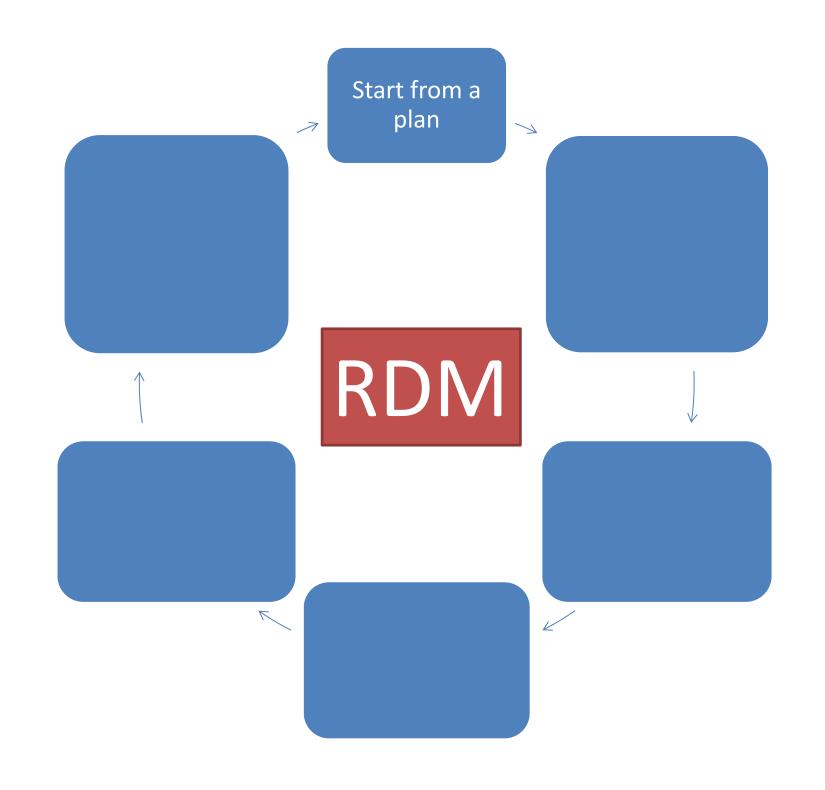
The project is A not implemented

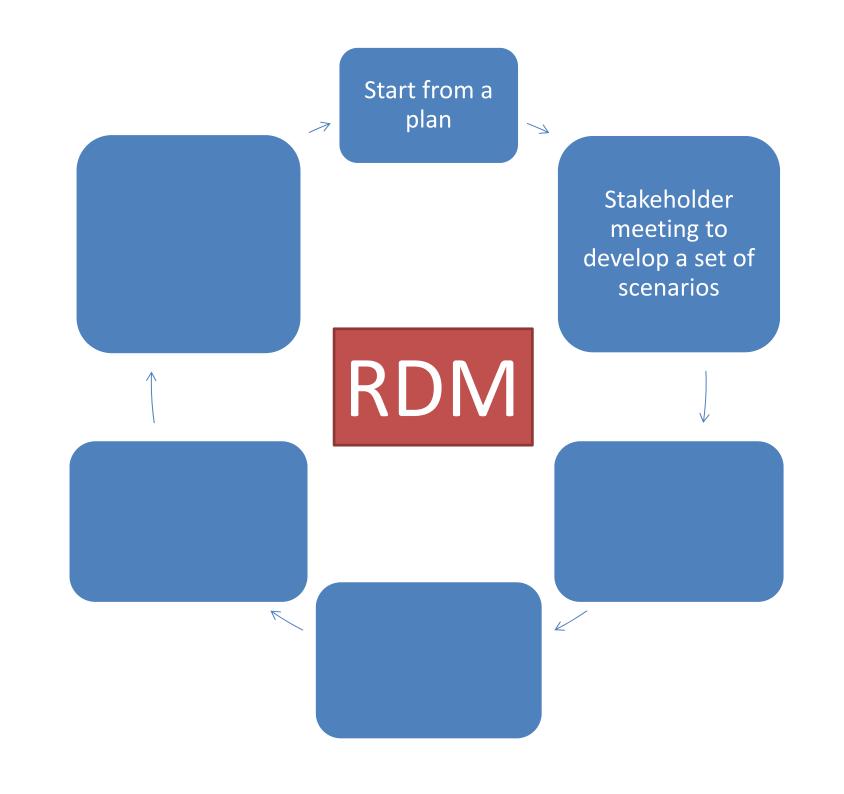
Real option approach

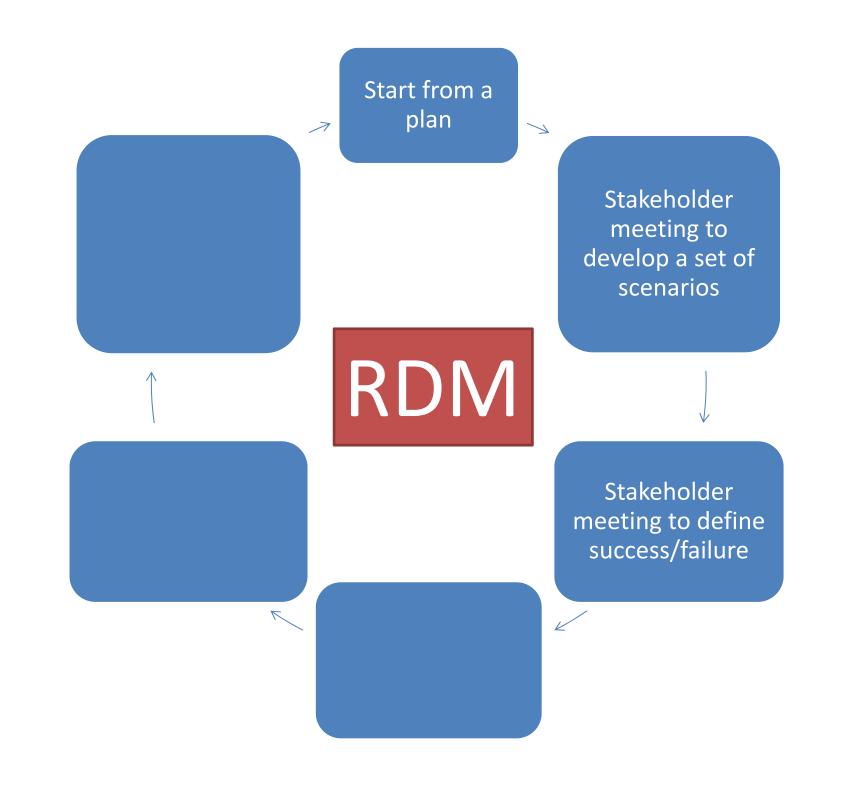


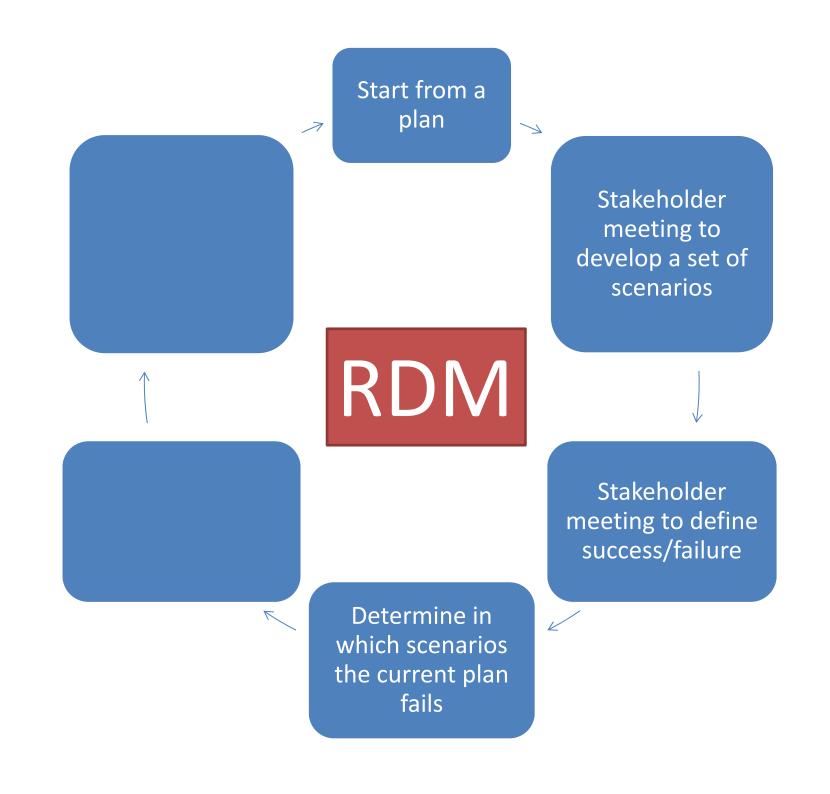
Complexity grow exponentially!
Real-world applicability is questioned...

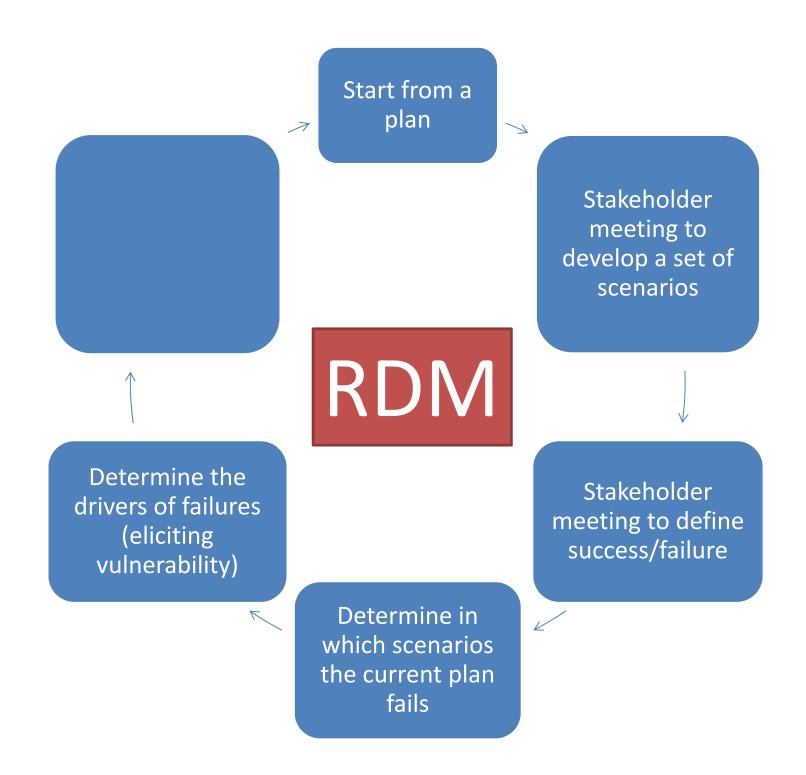
Robust decision-making











Start from a plan

Adjust the plan to cope with the vulnerabilities that have been identified

Stakeholder meeting to develop a set of scenarios

RDM

Stakeholder meeting to define success/failure

Determine the drivers of failures (eliciting vulnerability)

Determine in which scenarios the current plan fails

