CPB Netherlands Bureau for Economic Policy Analysis

The economics of flood prevention

The Dutch experience

Frederik Huizinga

CPB Netherlands Bureau for Economic Policy Analysis

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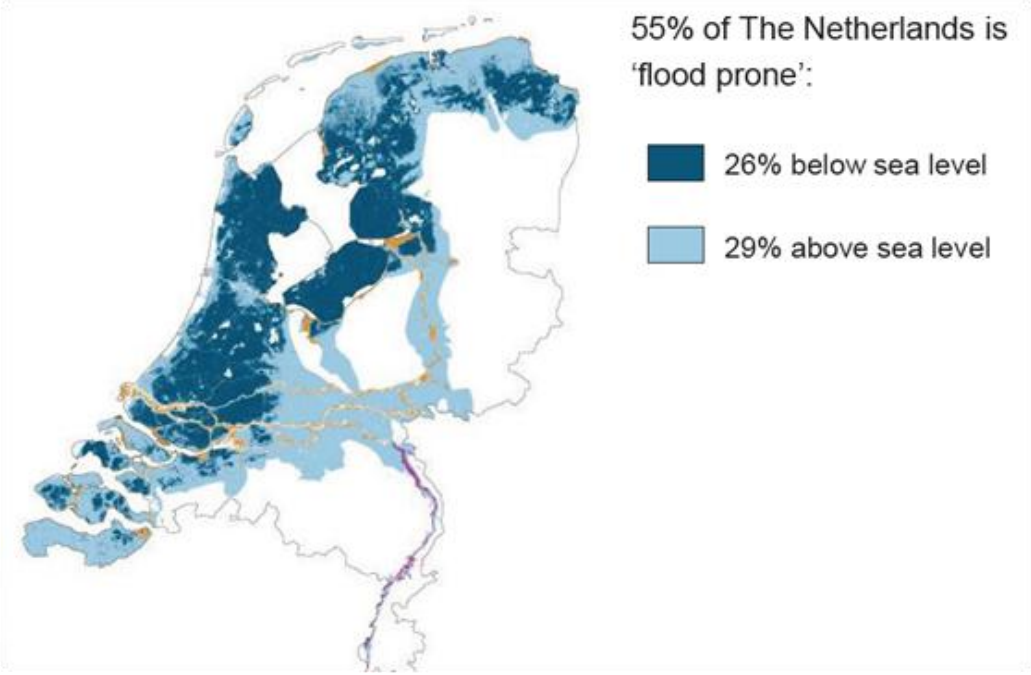
Geography of The Netherlands



55% of The Netherlands is 'flood prone':

- 26% below sea level
- 29% above sea level

Those include the most densely populated areas:

Flooded area after 1953 flood and deserted home

Legal protection standards by area

53 'dike ring areas'

<u>Legal</u> protection standards per dike ring area:

- Coastal areas:
  1/10.000 –1/4000 per year
- River areas:
  1/2000 – 1/1250 per year

The Netherlands is safe, for now, but...

- Further investment is needed.
  - Rising wealth
  - Subsiding land
  - Climate change
    - › rising sea levels
    - › more rainfall in winter
    - › drought

- Two challenges:
  - Finding and planning the best solution, by combining engineering, economics, climate change expertise.
  - How to get many stakeholders, many layers of government, and a rather tax averse public to agree on that solution.

Who is CPB?

- Independent, expert institute for very wide range of fiscal and policy issues. Tinbergen first director

- Analysis of parties' platforms before elections
  - better proposals
  - systematic overview of effects for public
  - common understanding of facts
    --> discussion about choices.

- "Best practice" according to IMF and OECD

Tinbergen

Cost benefit analysis

- Really started after big project became financial disaster.
- Ministry of transport commissioned CPB to head a research project to write guidelines for making CBA. Became official standard.
- By gov't ruling, for all big infrastructure projects CPB makes CBA or second opinion.
- Large impact
  - All major proposals with negative CPB judgments were cancelled or proposed (30 billion euros)
  - All project with neutral or positive judgments went ahead.
- Colleague in my division received very high royal honor last year.

Norms

- Legal standards only state probabilities: 1% per year in US. Difficult to conceptually for most people.

- An alternative way of stating the same thing:
  - Prob flood = .01 for any given year
  - Prob no flood = .99 for any given year
  - Prob no flood in two years = .99x.99 = .98
  - Prob no flood in 30 years = .99 to the power 30 = .74
  - Prob one or more floods in 30 years = 1 - .74 = .26 = 26%

- So:

  "If you buy a new home in a 1% flood area, probability that it will be flooded once or more before mortgage is paid off is 26%."

Probability tells only half of the story

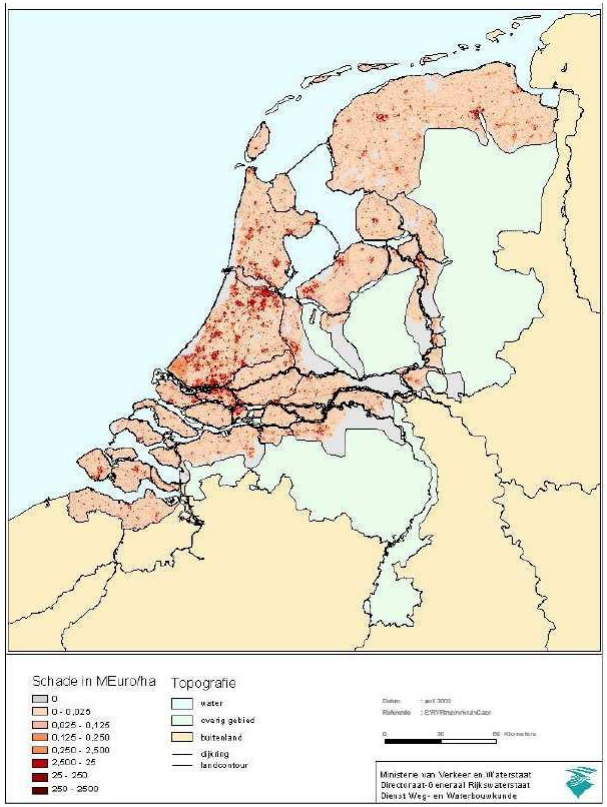
- Also need to know severity of flood if it occurs

- Risk = probability x damage
  = expected cost in dollars

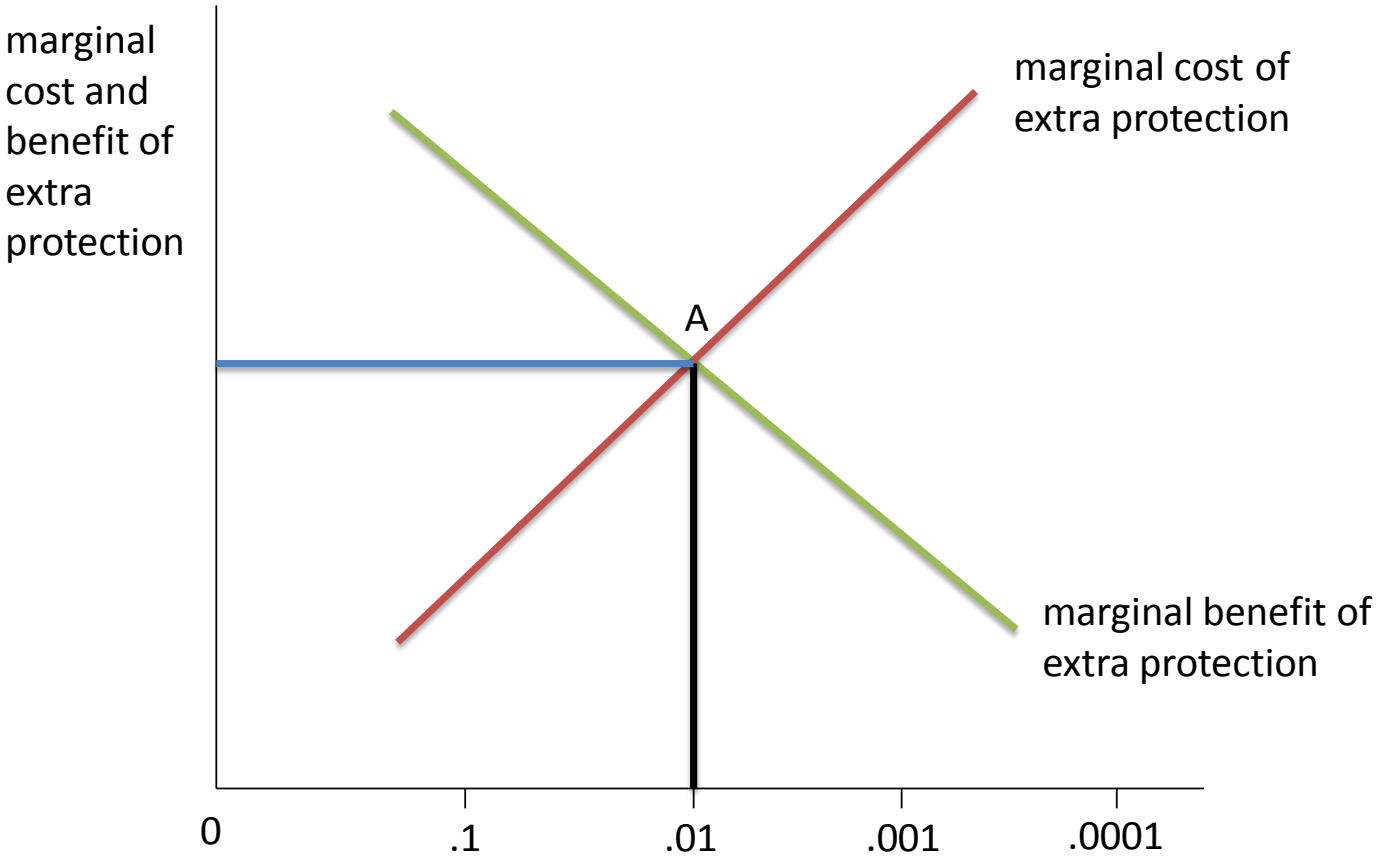
- Divide risk by number of people or by number of homes:
  "If you buy a new home in a 1% flood area, the flood risk per person or per home over course of a 30 year mortgage is ... dollars."

- My prediction: better understanding increases willingness to pay.

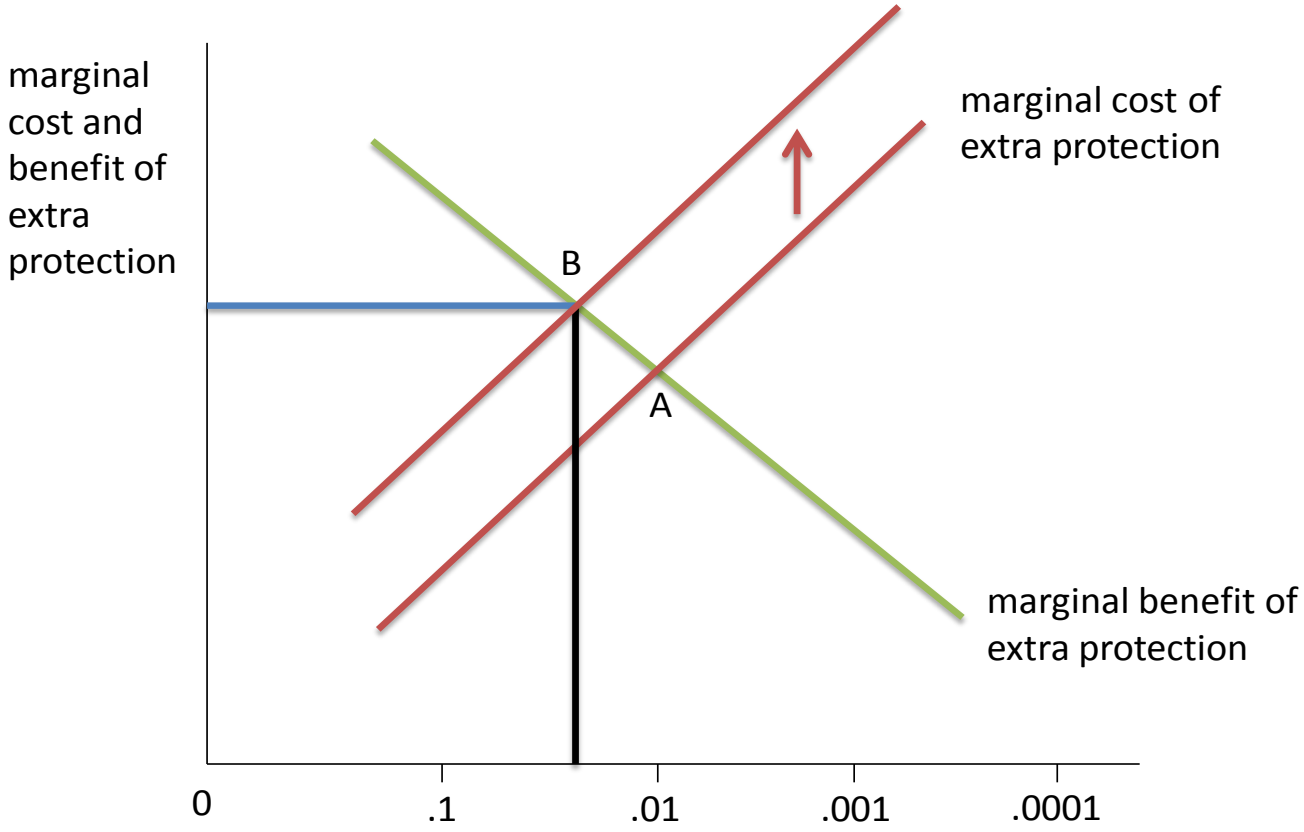
Water damage in millions of euros per hectare



Marginal benefit and cost of flood protection



Increase in the cost of protection, say due to worsening water conditions



Probability of flood in US is 1/100, in NL 1/10 000

- Risk aversion.
- Mindset: Dutch always fought the water.
- 2/3 of Dutch GDP produced in flood prone areas: national security issue.
- Big difference in weather conditions!

How to deal with residual risk?

- Private insurance does not work
  - similar risk
  - very infrequent, huge payouts

- Government
  - Has capacity to pay
  - Insures many types of other disasters
  - Solidarity

Cost benefit analysis

- Direct benefits
- Indirect benefits
- Non-monetary benefits

Ultimate goal: uniformly applied guidelines

Example of CBA: Deltawerken

- 2 CBA's
  - Tinbergen, 1961
  - Don & Stolwijk, 2003
- Both CBA's were positive.
- Tinbergen's estimated were correct as such,...
- but over course of 34 year project a lot can happen...

Movable barriers in the Oosterscheldekering

- Total cost turned out to be higher than Tinbergen thought by factor of 6!
- Due to environmental concerns: Oosterscheldekering

- Total benefits also turned out to be much higher, at least factor 6.
- Road propelled economic growth.

New road on the Oosterscheldekering

- Conclusion:

  - Tinbergen did the best possible job at the time, and CBA gave decision makers optimal information.

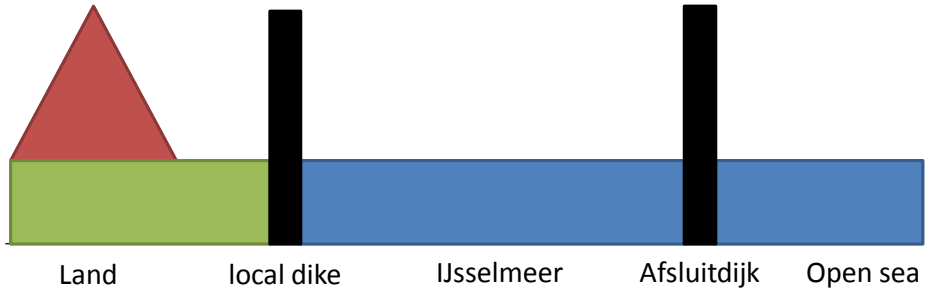
  - But CBA is not a fortune teller.

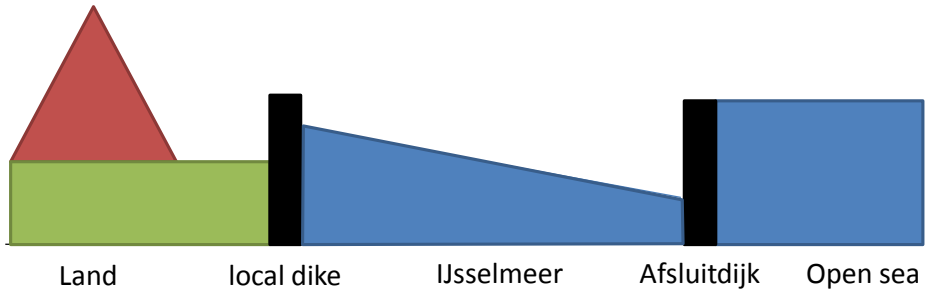
Alternatives protection measures

- Single dike may not be optimal.
- May work like a strung bow augmenting surges.
- Three alternatives currently being studied and implemented in The Netherlands.

Zuiderzee before the Aflsuitdijk and IJsselmeer with outer and inners dikes

How the Afsluitdijk works





- Optimal construction: inner dike at norm, outer dike can be far weaker.

Room for the river

- Make river bed deeper or wider, or create temporary relieve areas for water storage.
- Optimal solution depends on region, but concept is generally cost effective.

Multiple layers of defense

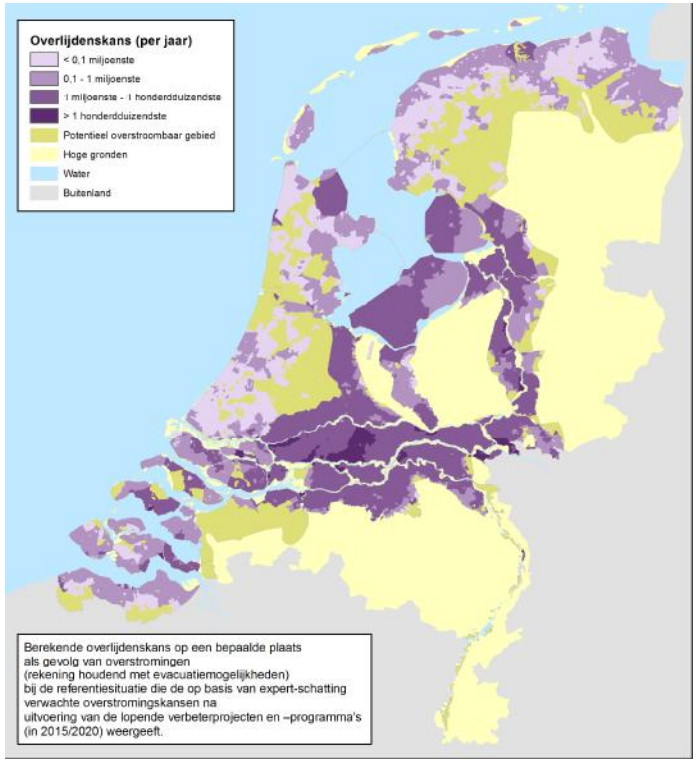
- Protection
- Spacial planning
- Prepare for emergency evacuation

Can we evacuate The Netherlands in case of a flood?

Optimal dike height: point A

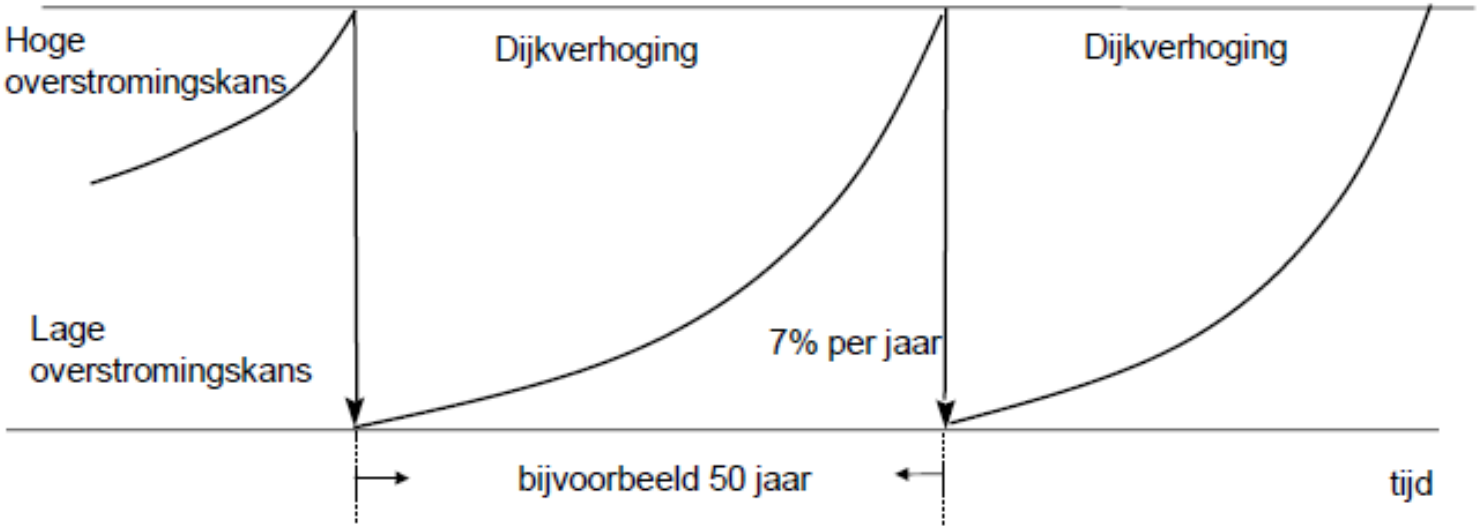
- Norms
- Timing
- Discounting

Expected death rates from flooding by region. The dark purple areas currently are the most dangerous.



- Concentrate on riverine areas: raise norms there.
- In addition: climate change
  - rising sea water
  - more rainfall
- Eventually, all dikes have to be raised by a lot,
  - but, when, and by how much at a time?

Climate change: Saw tooth safety levels over time



Discounting

- Discounting 100 dollar over 100 years
  - at 5,5%, 47 cents
  - at 3%, 5.2 dollars
  - at 1%, 37 dollars

  - 79 fold difference!

- New research sparked by climate debate

The way forward

- Flood prevention has a technological and economic side. Climate change makes it a common international issue

- So, let's cooperate:
  - technology and economics
  - internationally