Supporting investment decisions under uncertainty by exploring and evaluating adaptation pathways

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Deltares
Enabling Delta Life

Given that climate is changing in an undesired direction, but yet we do not know how fast and how much, how do we start to adapt?

Given that infrastructure and institutions investments are being made now how should decisions be modified to cope with a changing conditions?

Source picture: http://www.ideachampions.com

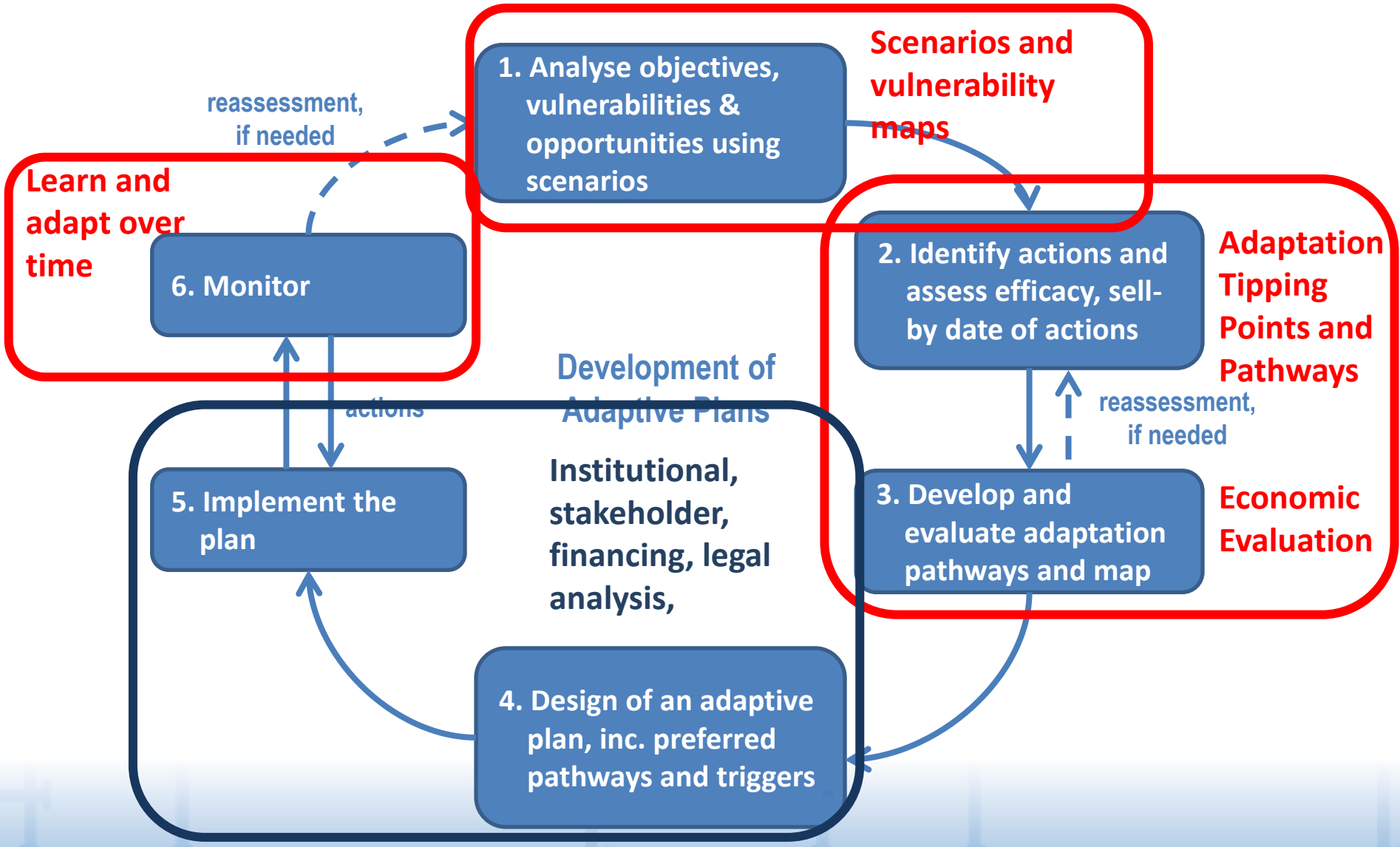
Adaptation pathways describe a **sequence of policy actions or investments** in institutions and infrastructure over time to achieve a set of pre-specified **objectives** under uncertain changing conditions,

and are part of a **policy** and planning **framework** (e.g. DAPP*) that ensures **evaluation** of costs and benefits and **monitoring** to track both implementation and changing conditions.

*Haasnoot et al. (2013) Glob. Env. Change. 10.1016/j.gloenvcha.2012.12.006

Planning Framework: Dynamic Adaptive Policy Pathways

And contributing tools



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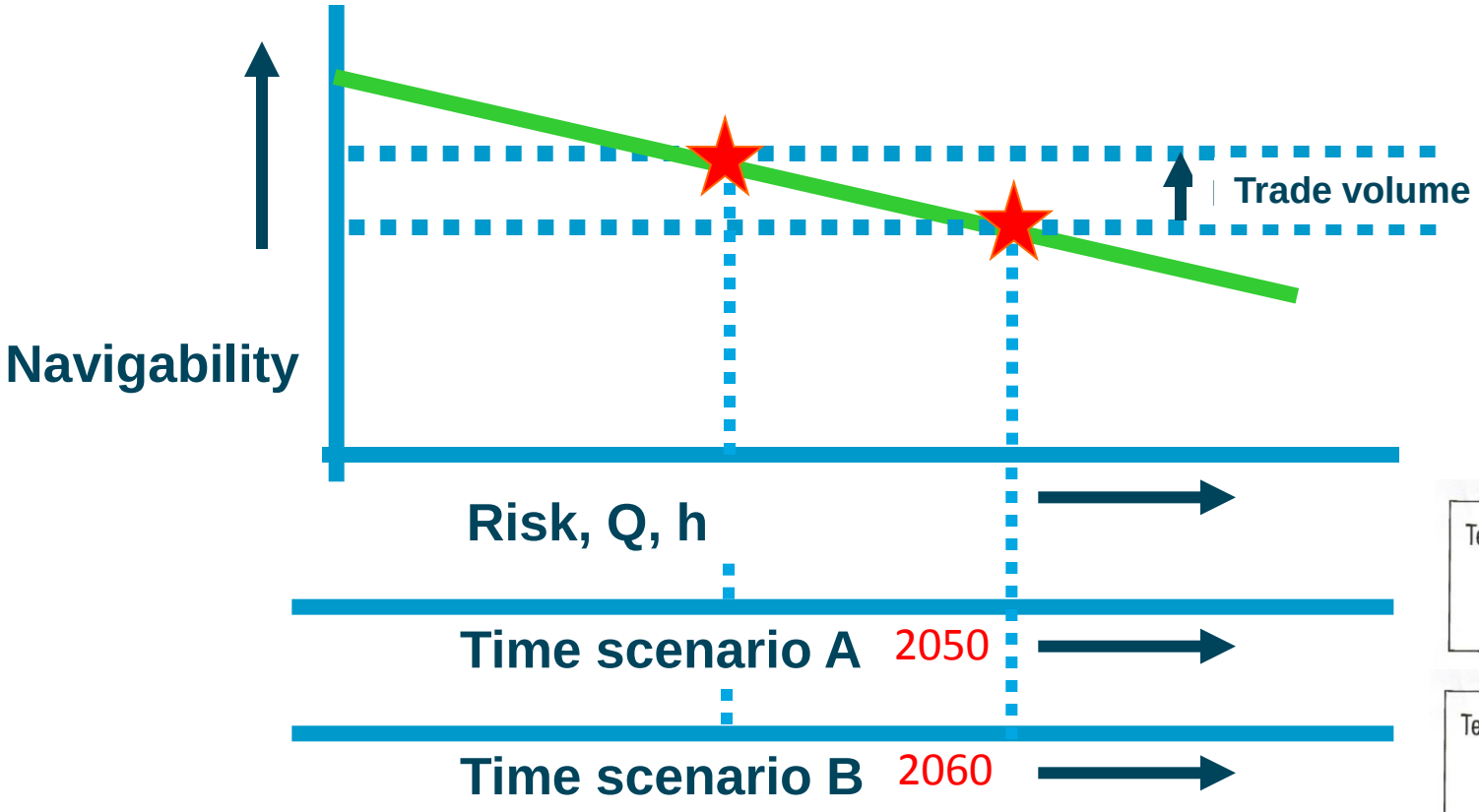
Adaptation Tipping Point & Use by date of policy action

A stress test: How much (climate) change can we cope with?
When do start to achieve missing our objectives?



Model based, participatory and/or with expert judgement

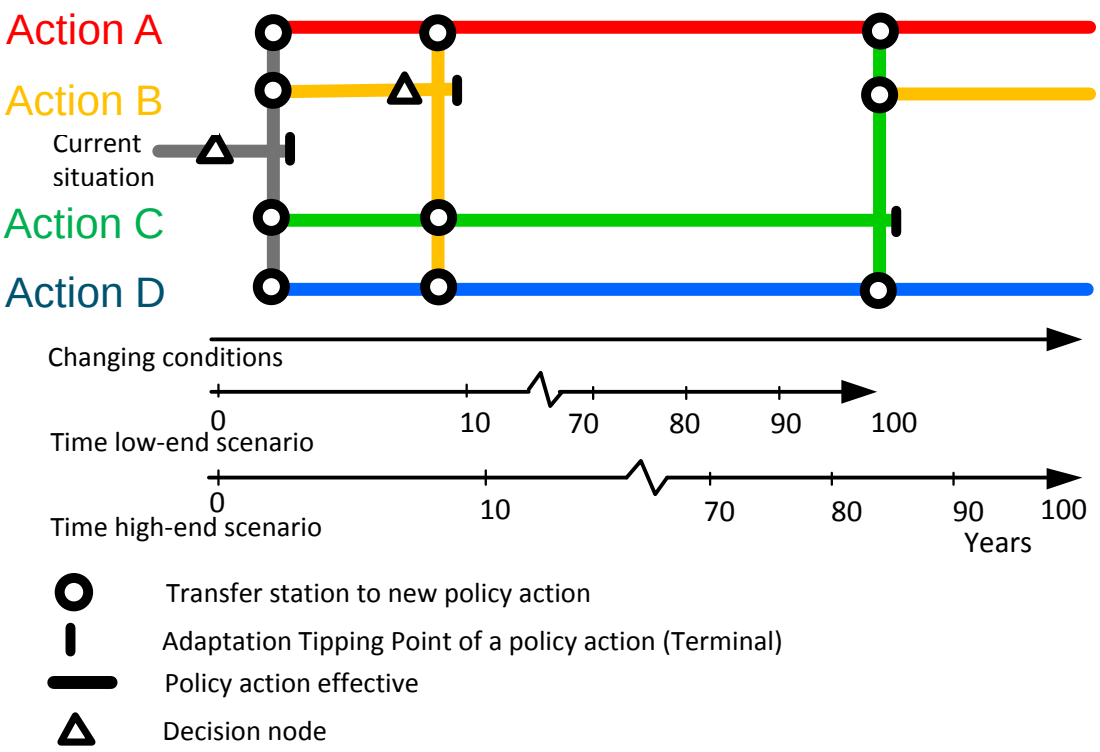
Kwadijk, J.C.J. et al 2010 WIRES Climate Change DOI: 10.1002/wcc.64, Haasnoot et al 2012 Climatic Change

Adaptation Pathways

What are robust and flexible policy options/pathways?

An adaptation pathways map shows **different possible sequences of investment decisions**. A scorecard helps to evaluate the decisions.

Adaptation Pathways Map



Costs and benefits of pathways

Time horizon 20 years

Time horizon 50 years

Time horizon 100 years

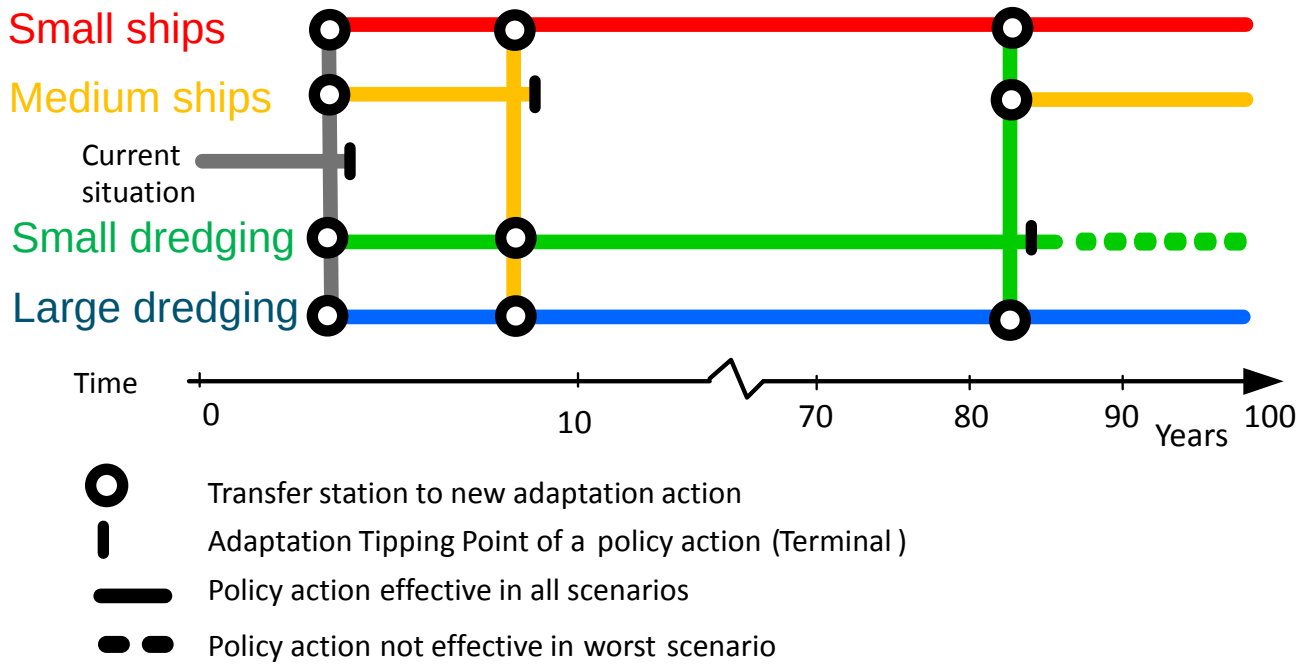
Pathway	Costs	Benefits	Co-benefits
1	+++	+	0
2	+++++	0	0
3	+++	0	0
4	+++	0	0
5	0	0	-
6	++++	0	-
7	+++	0	-
8	+	+	- - -
9	++	+	- - -

Pathways that are not necessary in low-end scenario

Haasnoot et al. (2012). Clim. Change.; Haasnoot et al. (2013) Glob. Env. Change. 10.1016/j.gloenvcha.2012.12.006

Example: Adaptation Pathways

How to keep a river navigable in a changing environment that may result in lower water levels in the river?



Scorecard for Pathways

	Path actions	Costs	Target effects	Side effects
1		+++	+	0
2		+++++	0	0
3		+++	0	0
4		+++	0	0
5		0	0	-
6		++++	0	-
7		+++	0	-
8		+	+	- - -
9		++	+	- - -

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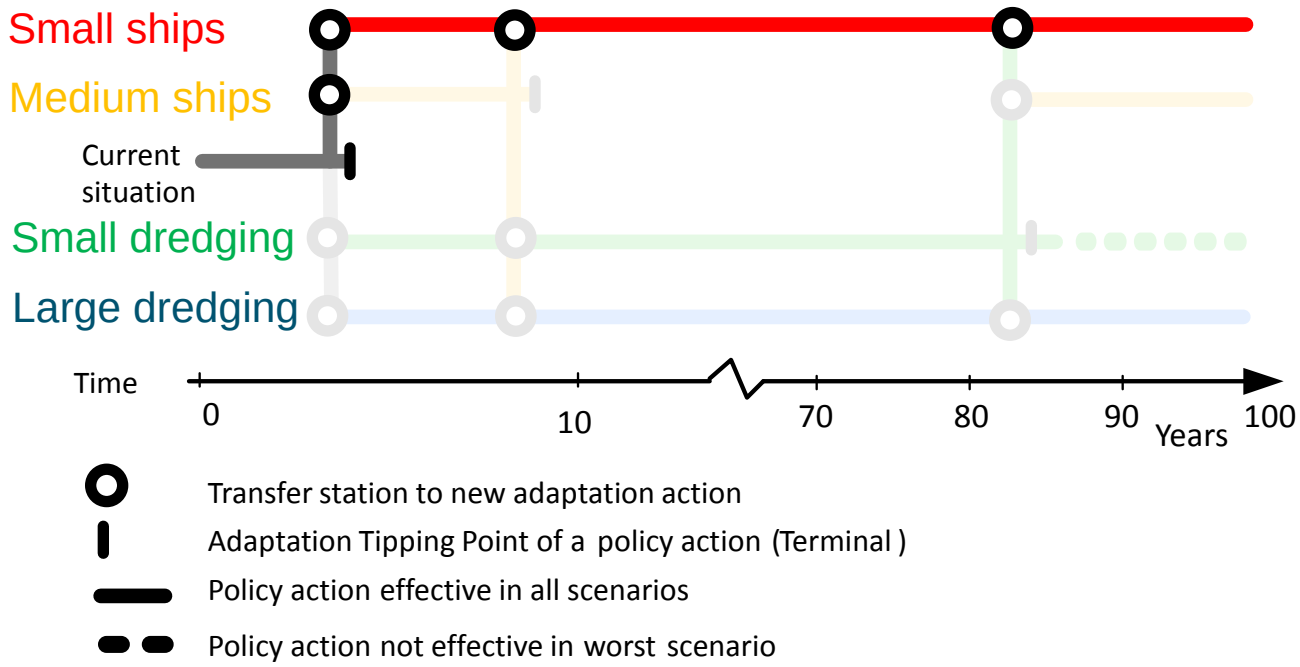

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6		++++	0	-
7		+++	0	-
8		+	+	- - -
9		++	+	- - -

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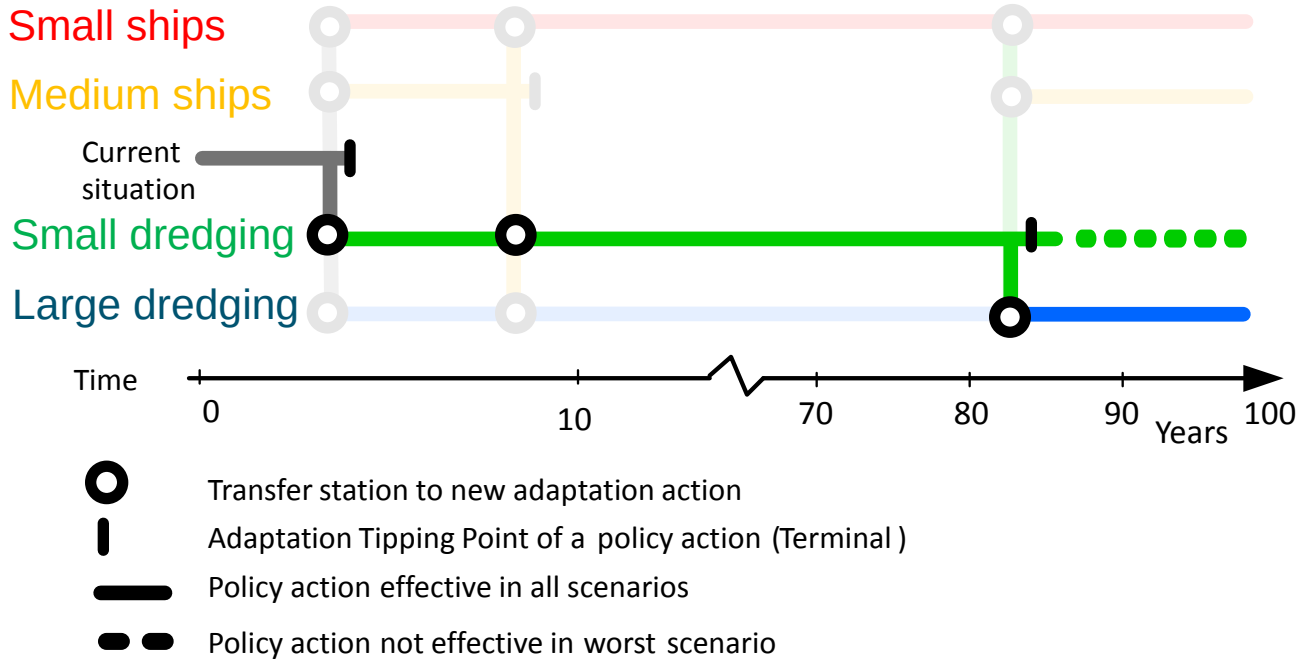

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7		+++	0	-
8		+	+	- - -
9		++	+	- - -

Adaptive Plan: small dredging and switch to large scale dredging.
Implement corrective actions to mitigate negative side effects.
Monitor river discharges and transport developments.

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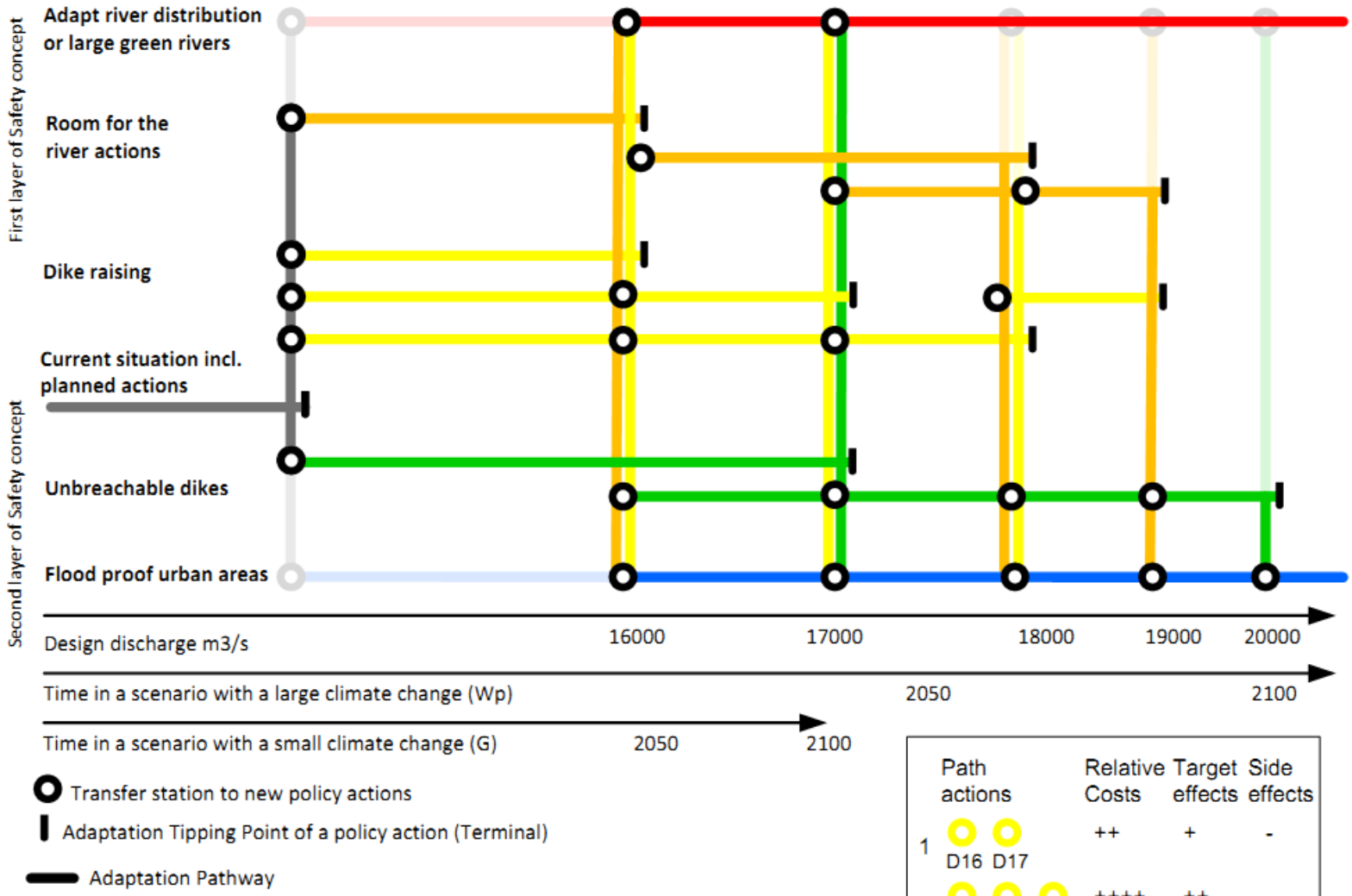

	Path actions	Relative Costs	Target effects	Side effects
1	D16 D17	++	+	-
2	D16 D17 D18	++++	++	- -
3	D16 Rfr	+++	++	++
4	D16 D17 Rfr	++++	+++	++
5	D16 Cdike	+++++	++	0
6	D16 Rfr Cdike	+++++	+++	+

Pathways for river flood risk management in NL (river Waal)

Some (additional) evaluation criteria for sustainable investment decisions under uncertainty *(make sure that it is not a waste of money even if conditions change)*:

Robustness: a robust action performs acceptably over a range possible futures.

Flexibility: flexible actions can be adapted (e.g. intensification of the action), abandoned (switch to a different action) or extended (add an action) at low cost or having small societal impact. Flexible actions do not result in lock-ins and have little influence on potential future options (i.o. have less **path-dependencies**).

Path-dependency: e.g. society gets used to certain conditions**,** low flexibility because of societal response

Preparatory actions: help to keep options open

Corrective actions: help to stay on track

Enabling policies: set of decisions agreement enabling pathway realisation

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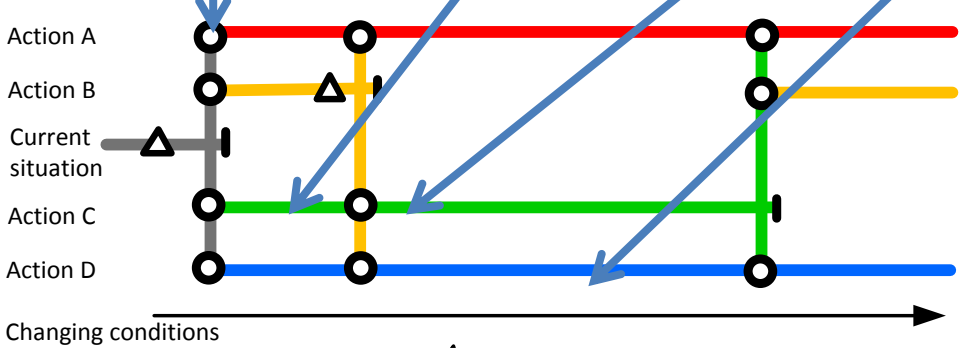
Elements in economic evaluations of adaptation pathways

Economic Evaluation of Adaptation Pathways

Net present value (pathway$_8$)

Expected costs | **Expected benefits** (avoided damages, co-benefits)

Initial investment$_{ActionC}$ ($t=1$) + Costs$_{ActionC}$ ($t_1 \ldots t_x$) + Transfer cost (t_x) + Costs$_{ActionD}$ ($t_x \ldots T$) + Benefits$_{ActionC}$ ($t_1 \ldots t_x$) + Benefits$_{ActionD}$ ($t_1 \ldots t_x$)



t=1 Time T

t=x

Time horizon

Time horizon

Time horizon

Time horizon 20 years

Time horizon 50 years

Time horizon 100 years

Pathway	Costs	Benefits	Co-benefits
1	+++	+	0
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8	+	+	- - -
9	++	+	- - -

Pathways that are not necessary in low-end scenario

Example FIRST RESULTS economic evaluation of adaptation pathways

- 30 climate scenarios
- 3 discount rates

Multi-Criteria analysis

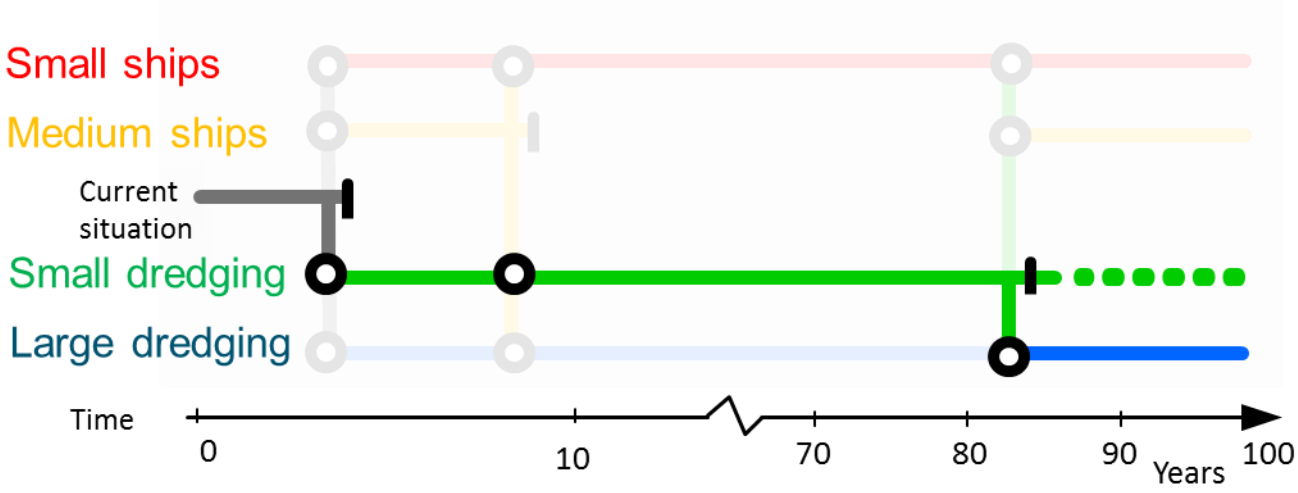
Cost-Benefit analysis

Cost-effectiveness analysis

Investment costs	M&O costs	Transfer costs	Damage costs	Ecological side effects
Investment costs of ships, discounted, including uncertainties	M&O costs of ships and dredging, discounted, including uncertainties	Transfer costs of shifting to ships and/or dredging Indicator of **flexibility** of pathways	Damage costs due to % of non-navigable time, discounted	In -,0,+, included in MCA

Economic effectiveness of pathways

Pathway 3



TP year scenario mean

4 8 84

Economic costs & damages
r: 2.5%,€ mln

Mean value of scenarios

Pathway 3 → **47** — **59** — **124** — **155**

Time horizon evaluation	**10**	**20**	**50**	**100**

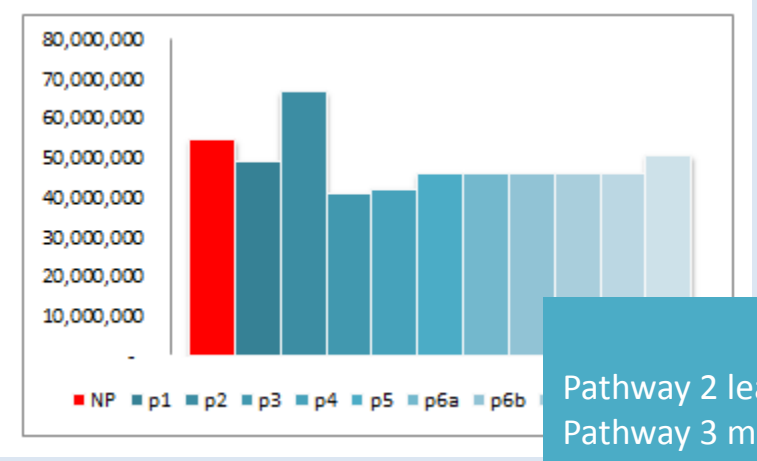
Economic effectiveness of pathways

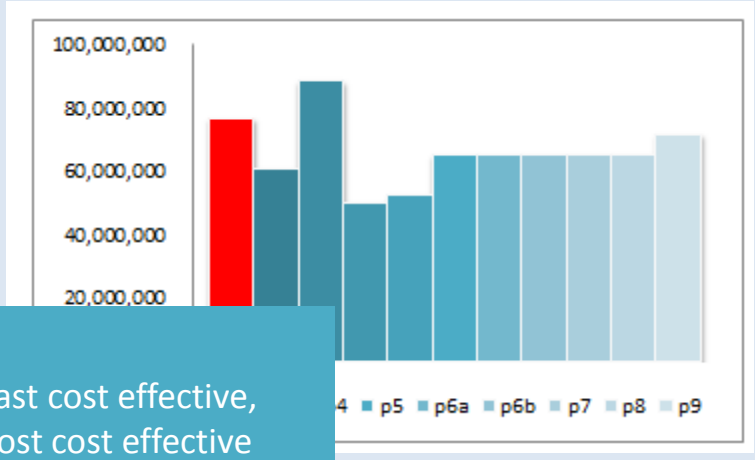
Time horizon

Costs incl damage, discount rate: 5.5%

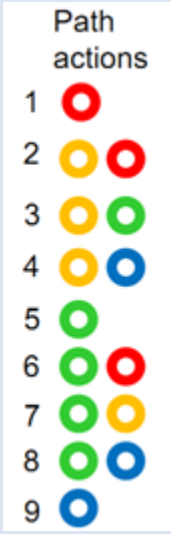
Costs incl damage, 1% discount rate

0-10 years

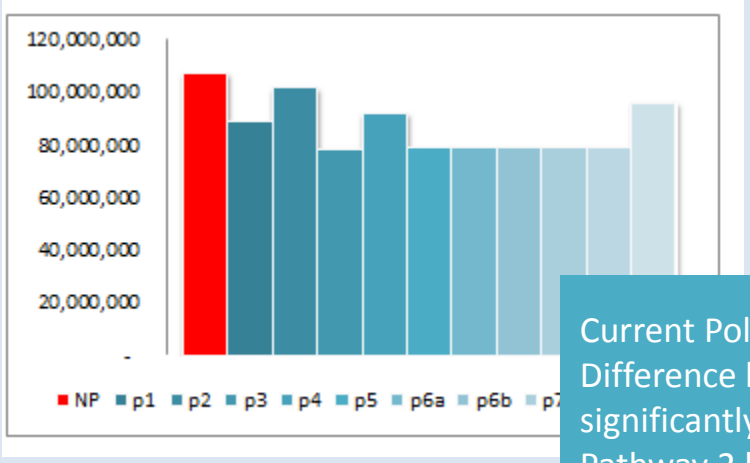


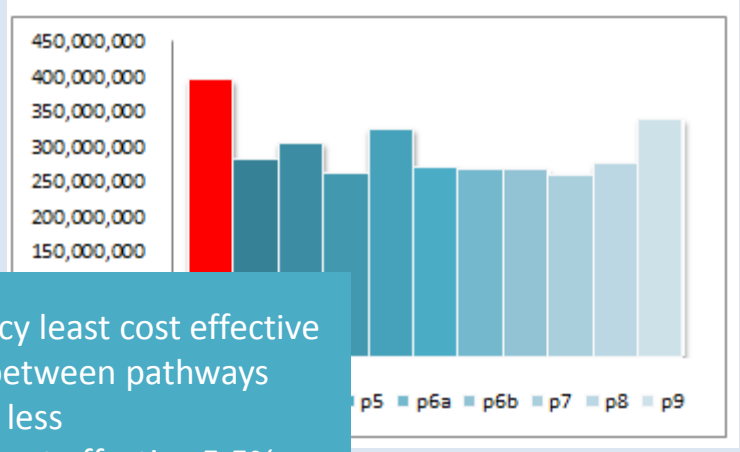


Pathway 2 least cost effective,
Pathway 3 most cost effective



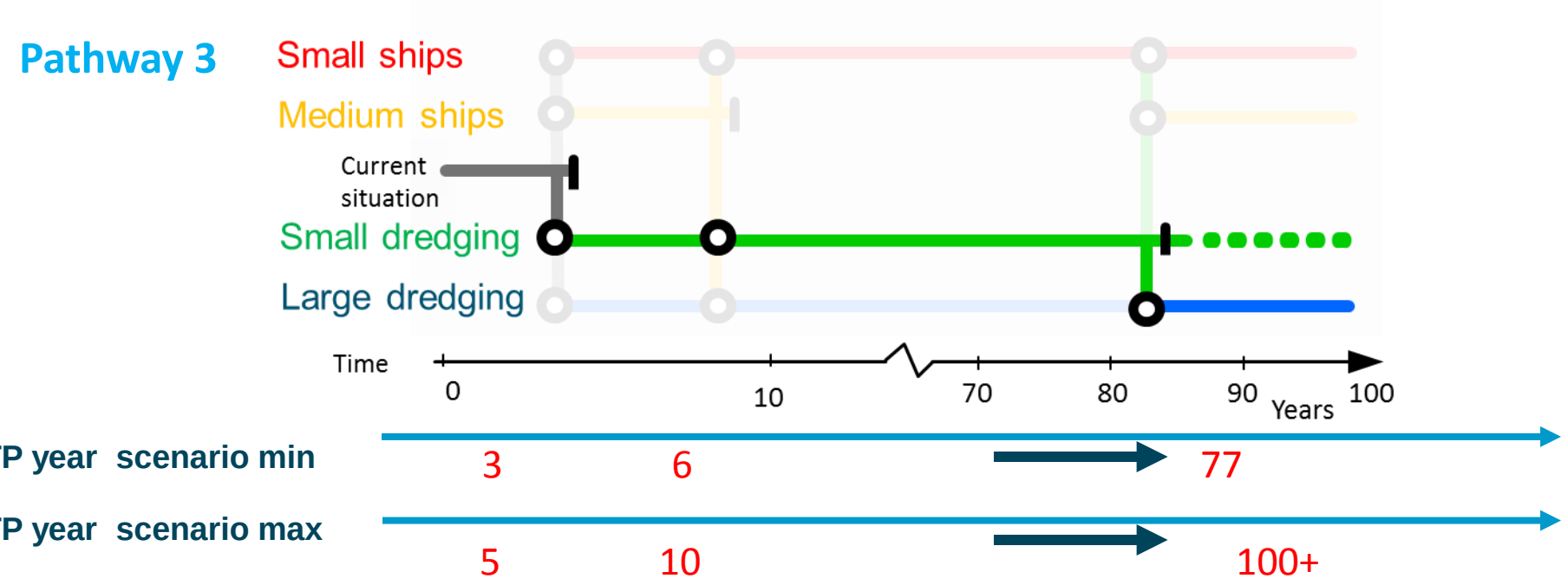
0-100 years



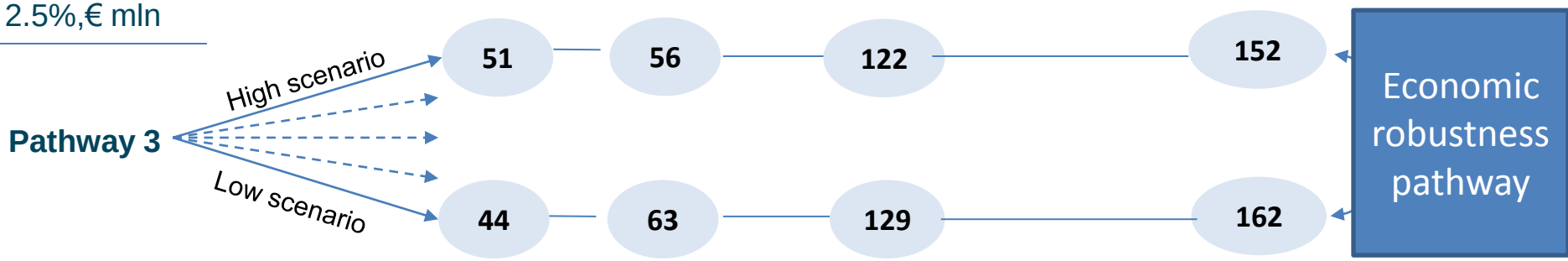


Current Policy least cost effective
Difference between pathways significantly less
Pathway 2 least effective 5.5%
Pathway 4 least effective 1%

From policy actions to economic robustness of pathways



Economic costs
r: 2.5%,€ mln

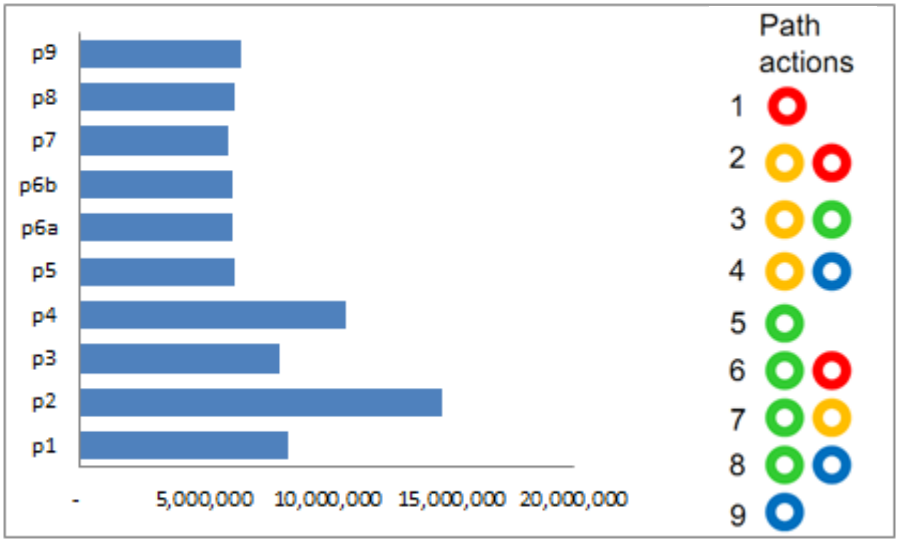


years	10	20	50	100

Draft: economic robustness of pathways

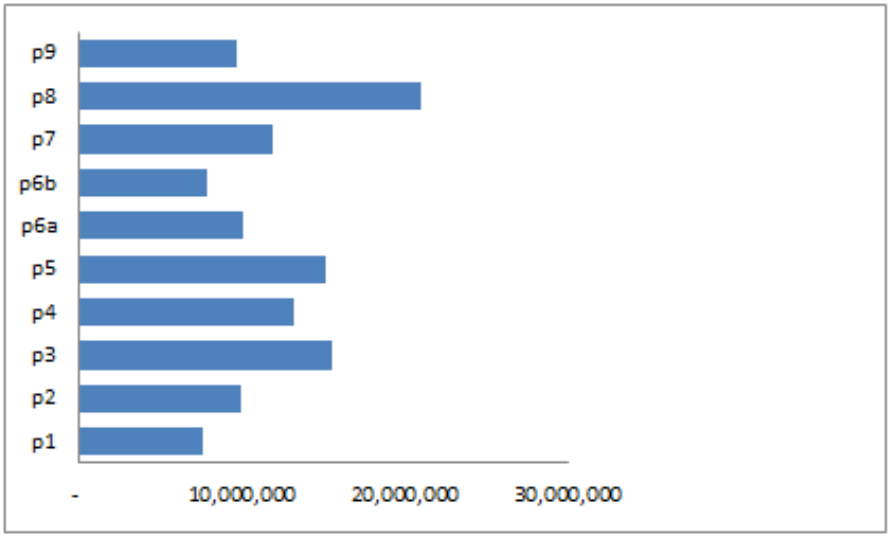
What is the range of costs and benefits under different scenarios. Minimum performance needs to be included.

Discount rate 5.5% 0-100 y



With a high discount rate (5.5%) pathway 2 and 4 are least economically robust

Discount rate 1% 0-100 y



With 1% discount rate, pathway 8 is least economically robust

Reflection economic evaluation…

- **Transfer costs** are a proxy of **flexibility** of a strategy. Transfer costs are costs for switching from one policy action to another policy actions or for adding actions
- **Economic robustness**: acceptable cost and benefits and the range of possible outcomes for different scenarios
- **Ranking of pathways** differs significantly when using different discount rates

Reflection on the Tools

DAPP supports decision making under uncertain change. **"invest not too little nor too much, and not too early nor too late"**.

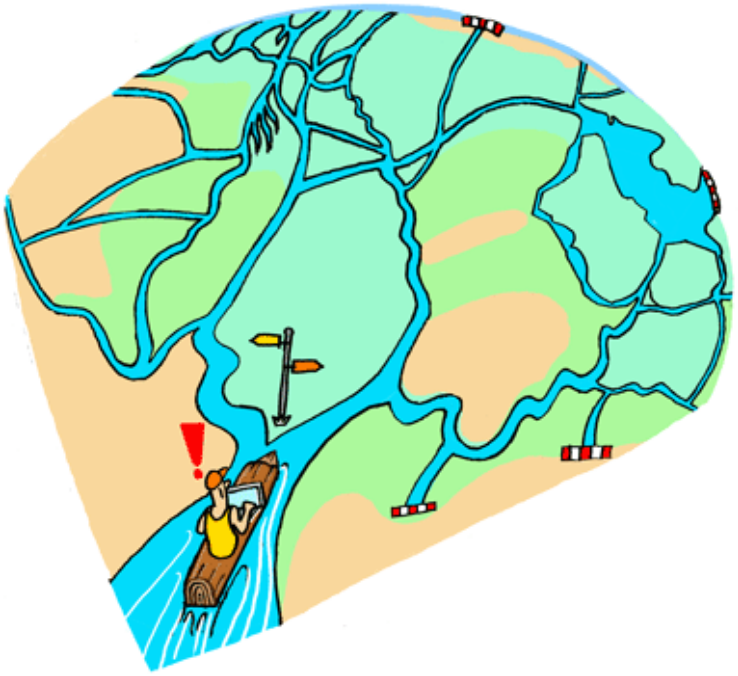
Vulnerability and Risk MAPPING TOOLS combined with Climate and Socio-economic **SCENARIOS** support where to take action

Adaptation PATHWAYS can support the identification of **policy options**, and **short term actions** to mitigate adverse impacts and seize opportunities, and **keep options open** to adapt.
www.youtube.com/watch?v=IEuXkm77bn4

Adaptation TIPPING POINTS help in identifying if and **when** to take actions at earliest or at latest.

Sustainable DELTA GAME helps to get familiar With adaptive planning approach.
http://www.deltares.nl/en/product/1518666/sustainable-delta-game

Experience: Dutch adaptation program, Vietnam, Colombia, Bangladesh, EU, New Zealand.



Thank you!

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