A decision-support model for time-dependent investments in flood defences

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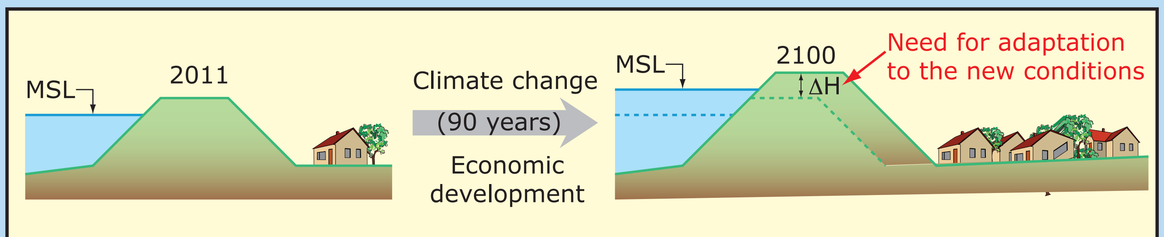
This poster presents the framework of a decision support model for time-dependent investments in structural flood risk mitigation measures. The model development is currently in progress; hence the presented framework is critically evaluated and eventually new research questions are generated, which need to be answered in order to have the model finalized. The analysis is presented through an elaborated example of investments in one measure, the improvement of a dike cross-section.

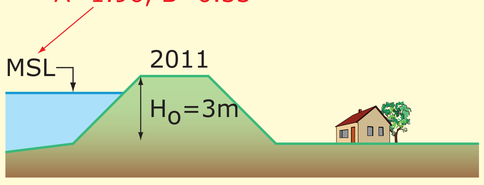
Decision problem



Given a time horizon T_h=*90 years:*
- *How much should the crest level of the dike be increased; ΔH=?*
- In how many intervals should this heightening be applied; Δt=?

Case description

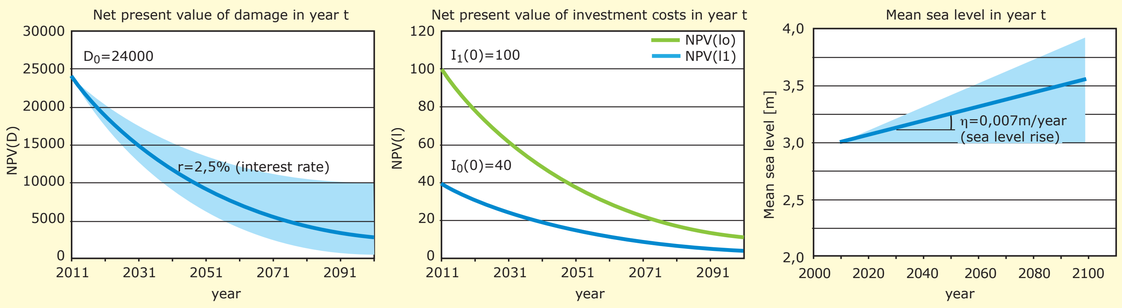
Exponentially distributed
A=1.96, B=0.33



- Single dike section
- Failure mechanism: ***overflow***
  Water level > Crest level

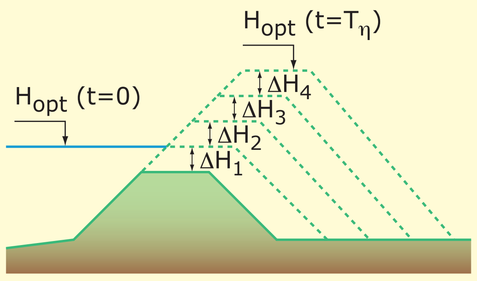
  ⇕

  Flooding



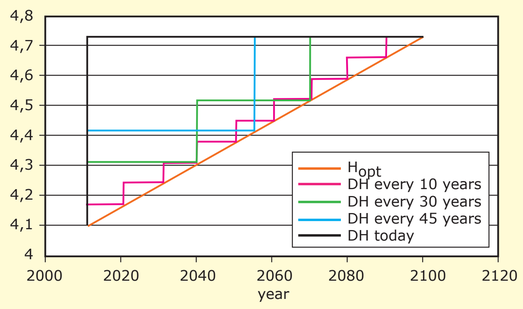
Model objectives

1. Determine the economically *optimal crest level* over the time horizon (H_{opt} at time t)



ΔH_1=f (A,B)
ΔH_2=f (r)
ΔH_3=f (η)
ΔH_4=f (ε) ⇒ other uncertainties

2. Develop alternative *investment strategies* that comply with the optimal crest level;



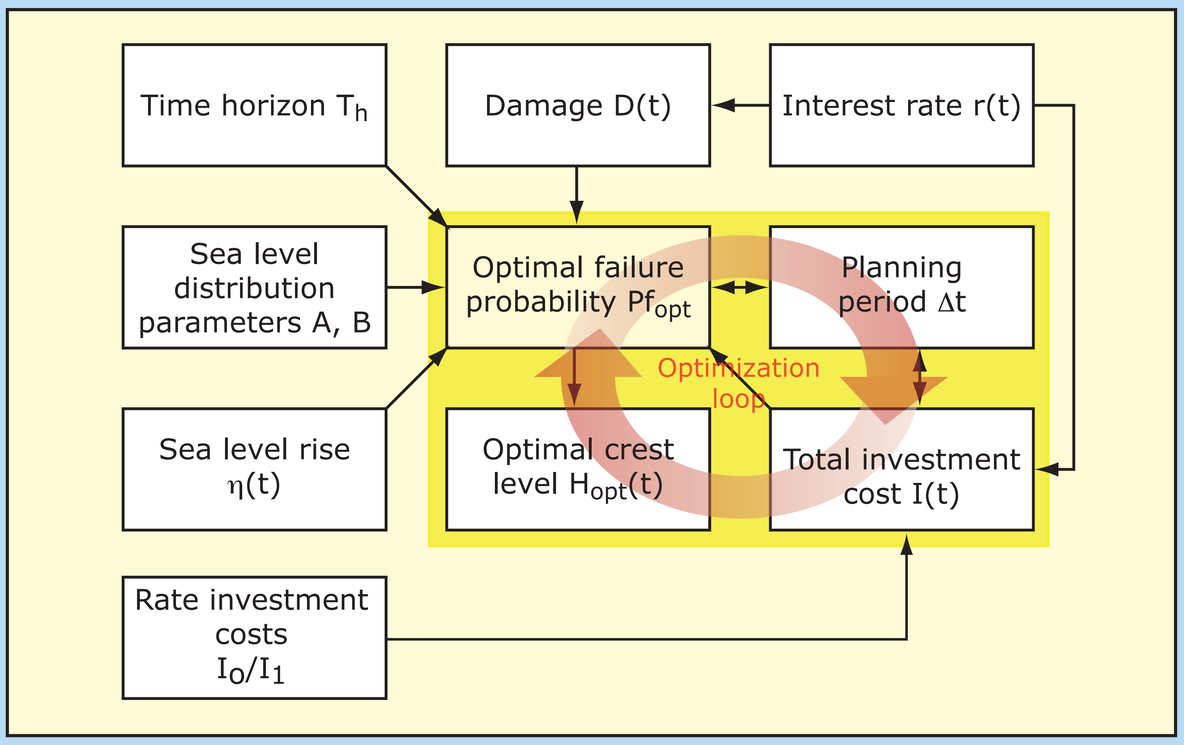
Starting from t=0,
raise the dike to $H_{opt}(t)$,
planning for *equal intervals* ΔH_i, Δt_i.

$\Delta H_{total}=\Delta H_{opt}(T_h)=n\Delta H_i$

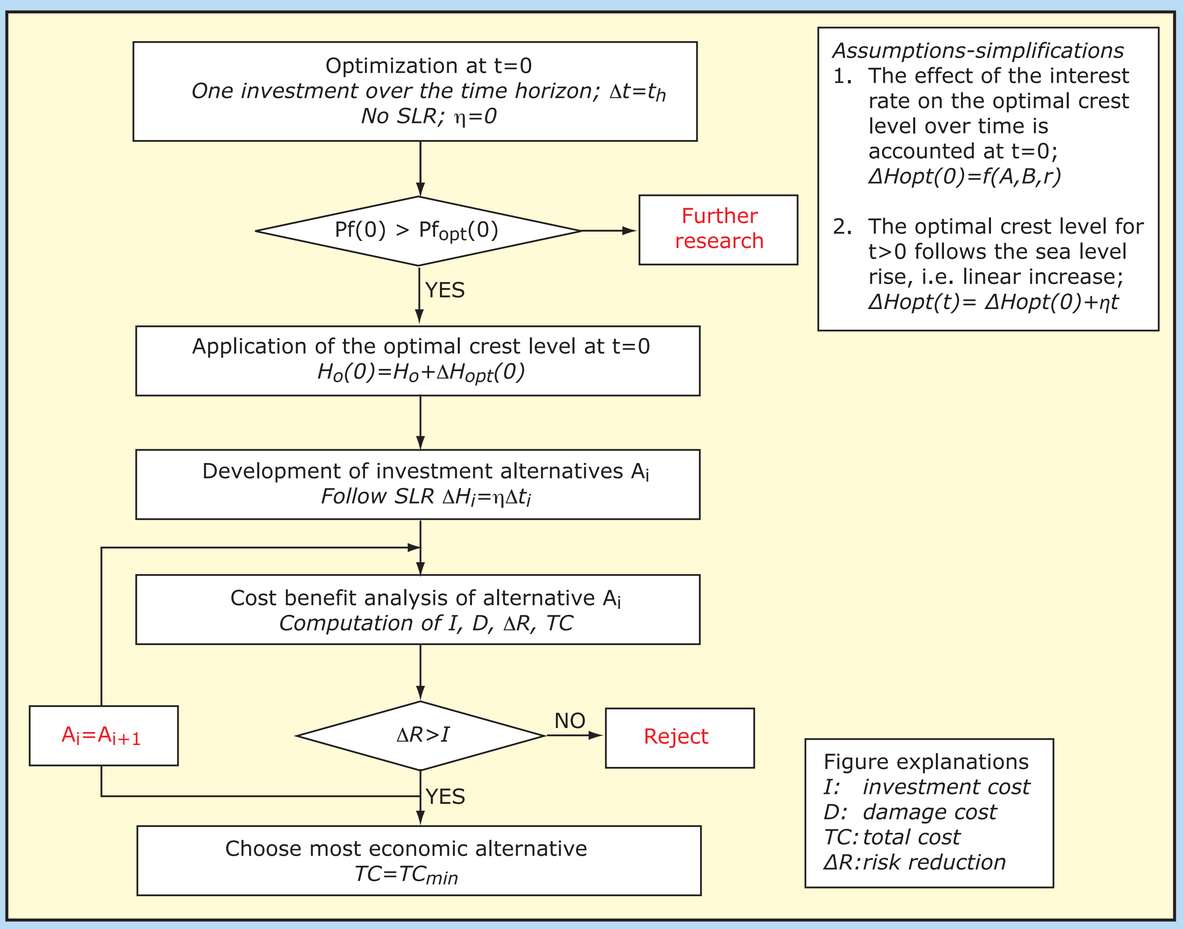
$\Delta t_{itotal}= T_h=n\,\Delta t_i$

3. Assess the alternative strategies by means of *cost-benefit analysis*.

Interaction of problem parameters



Model functions



Assumptions-simplifications
1. The effect of the interest rate on the optimal crest level over time is accounted at t=0; *ΔHopt(0)=f(A,B,r)*
2. The optimal crest level for t>0 follows the sea level rise, i.e. linear increase; *ΔHopt(t)= ΔHopt(0)+ηt*

Figure explanations
I: investment cost
D: damage cost
TC: total cost
ΔR: risk reduction

Application - Results

		Decision criteria	
	I_0/I_1	**$TC=TC_{min}$**	**$I=I_{min}$**
Flexible measure	0,002	ΔH_i only today	ΔH_i every 10 years
Base case	0,4	ΔH_i only today	ΔH_i every 45 years
Robust measure	20	ΔH_i only today	ΔH_i only today

!!! *$TC=TC_{min}$ is not a suitable criterion for choice of investment strategy due to compliance with **optimal safety** and not **safety standard***

Conclusions - Recommendations

1. The *time-dependence* implies complicated interactions in the problem parameters. There is *no straightforward solution* to the decision problem. *Advanced modeling* is necessary;
2. The compliance with the optimal safety calls for a *risk-free decision criterion*, i.e. minimization of the investment cost;
3. Further research is necessary on the *development of the optimal safety over time*;
4. *Uncertainties* need to be incorporated. Need for a *fully probabilistic model*.

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