



Quantitative Risk Assessment for climate change risks in the urban water system

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- **Introduction**
- **Case Study**
- **QRA Process**
- **Results**
- **Implications**



- **Presentation aim**
 - **Describe quantitative risk assessment (QRA) work of PREPARED**
 - **Highlight benefit of working with case-study partner**



- **Why QRA?**
 - **More robust decision-making**
 - **Trade-offs assessed**
 - **Address uncertainty**
 - **Aid planning decisions**
 - **Improve management**



- **Eindhoven, The Netherlands**





- **Urban development = greater risk to pluvial flooding**
- **Combined sewer system no longer suitable**
 - Very little capacity for rainfall events
 - Only 10-15% separated
- **CC impacts on rainfall events**



- **Impacts:**
 - **More properties affected**
 - **More frequent**
 - **‘New’ areas flooded**
 - **Increasing financial loss**

- **Potential solution:**
 - **Introduce ‘risk-reduction measures’**

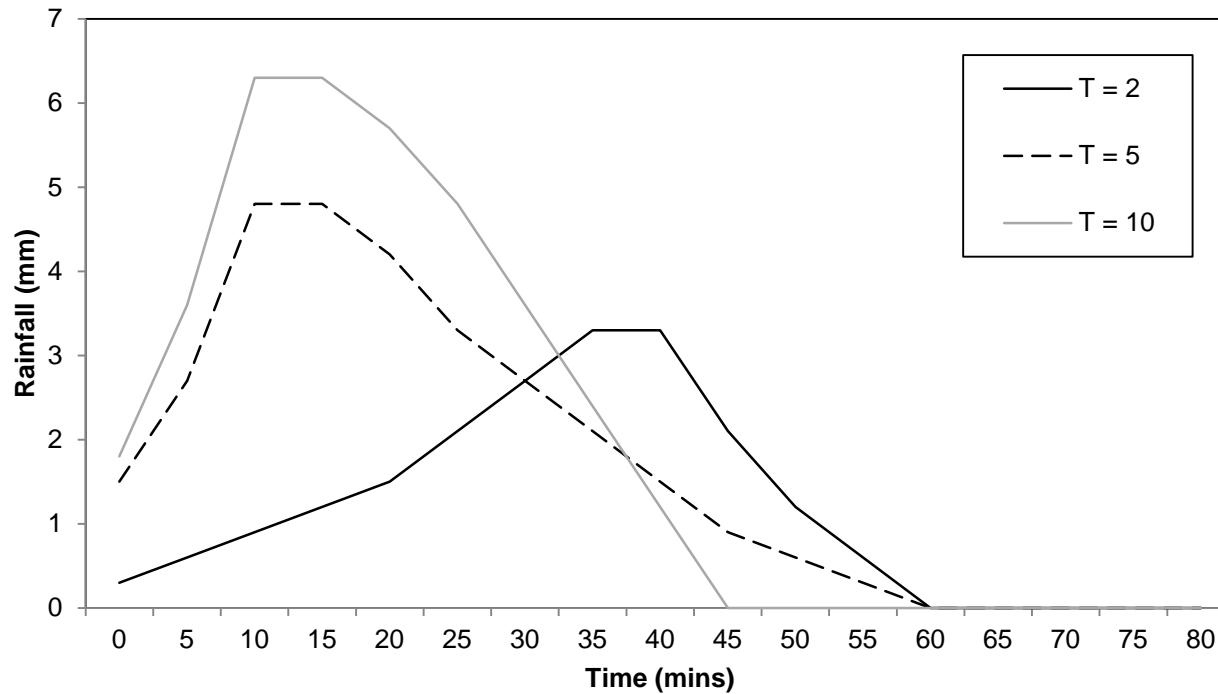


- **Assess potential effectiveness of two risk-reduction measures**

Rainfall return period	Risk-reduction
T = 2	Baseline
	Separate network
	Separation + reopen R. Gender
T = 5	Baseline
	Separate network
	Separation + reopen R. Gender
T = 10	Baseline
	Separate network
	Separation + reopen R. Gender



CASE STUDY

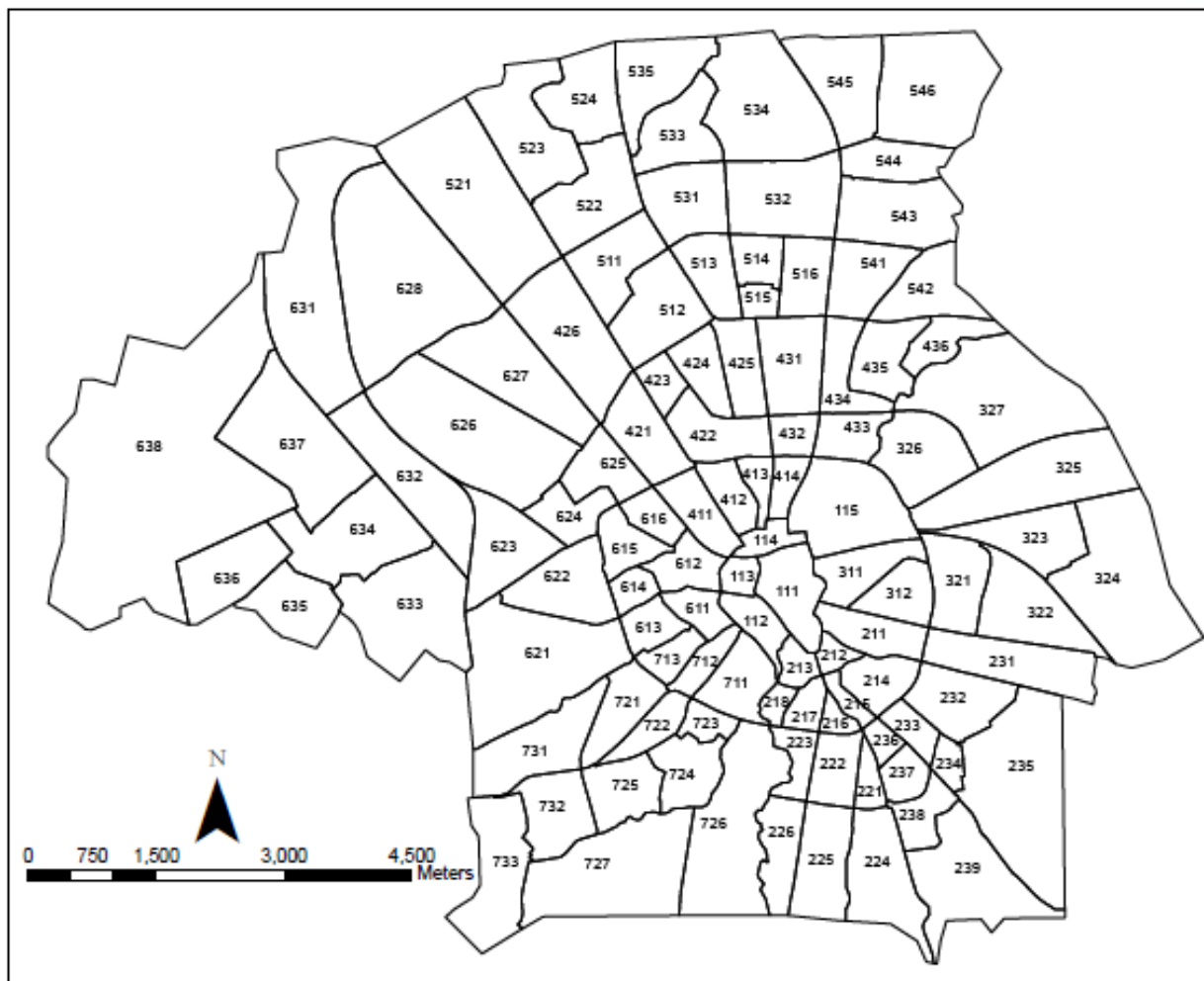




- **Stage 1: Hydraulic modelling**
 - **1D SOBEK model**
 - **Assessed pluvial flooding from the nine scenarios**
 - **Carried out by Eindhoven municipality staff**
 - **Results for 109 city zones**

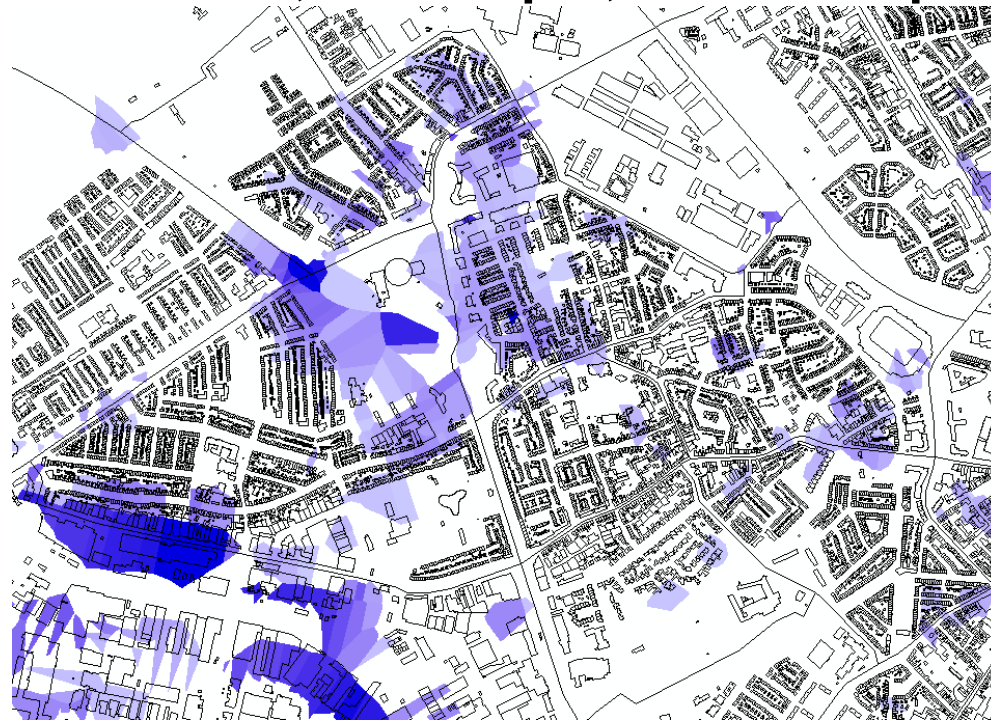


QRA PROCESS





- **Stage 2: GIS analysis**
 - **Total flooded area, max. depth, number of properties...**





- **Stage 2: GIS analysis**
 - Results form basis of QRA and CBA (next talk)
 - Deterministic (next talk) and probabilistic QRA



- **Stage 2: GIS analysis**

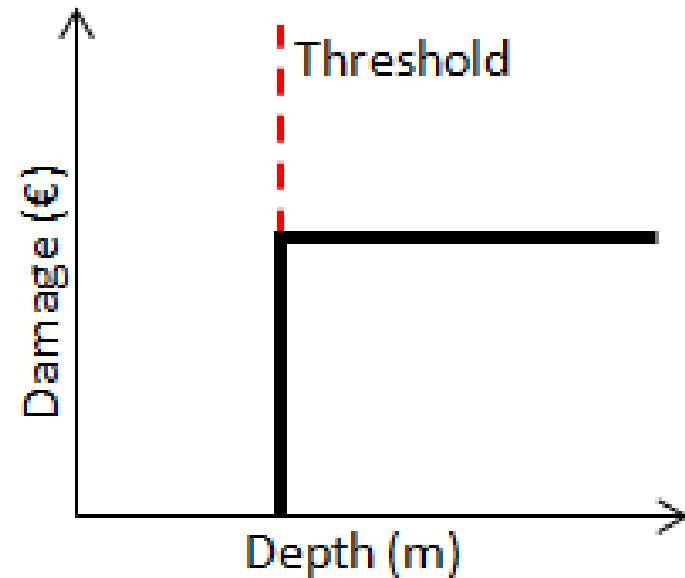
Zone No.	Zone area (km ²)	1a scenario		3a scenario		3b scenario	
		Average flooding depth (m)	% area flooded	Average flooding depth (m)	% area flooded	Average flooding depth (m)	% area flooded
111	0.666	0.04	4	0.14	34	0.14	32
112	0.345	0.05	10	0.17	68	0.17	66
113	0.184	0	0	0.07	6	1.59	6
114	0.223	0.09	4	0.39	9	0.38	9
115	1.246	0.02	3	0.16	28	0.17	27
611	0.303	0.05	9	0.11	52	0.11	48
612	0.420	0.06	12	0.14	53	0.11	29
613	0.331	0.01	4	0.08	61	0.08	61
614	0.219	0.03	8	0.18	77	0.17	77
615	0.402	0.07	49	0.26	90	0.25	75
616	0.298	0.17	2	0.17	35	0.17	30
711	0.599	0.06	0	0.14	44	0.14	44
712	0.273	0.04	13	0.21	73	0.21	72
713	0.271	0	0	0.08	59	0.08	53



- **Stage 3: QRA and CBA**
 - **Deterministic and probabilistic**
 - **Focus – financial loss in residential property sector**
 - **Better assessment of efficacy of risk-reduction measures**
 - **Increased detail for planners**



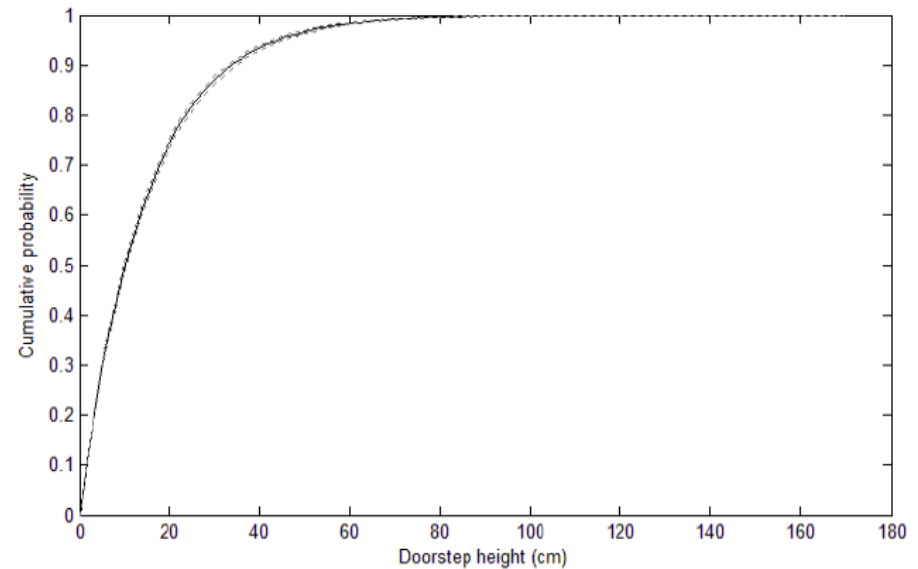
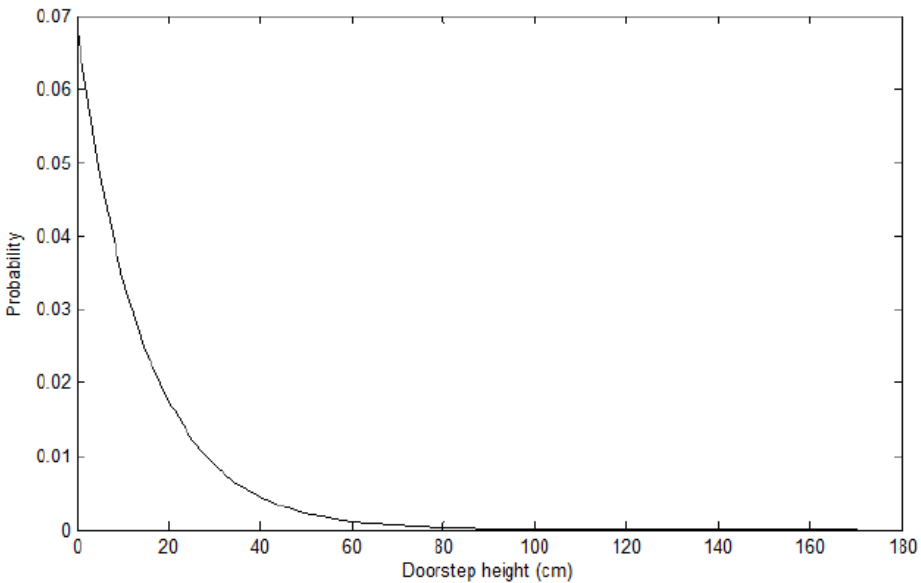
- **Deterministic**
 - Used ‘threshold method’
 - Details in next talk...
 - Focus here on probabilistic





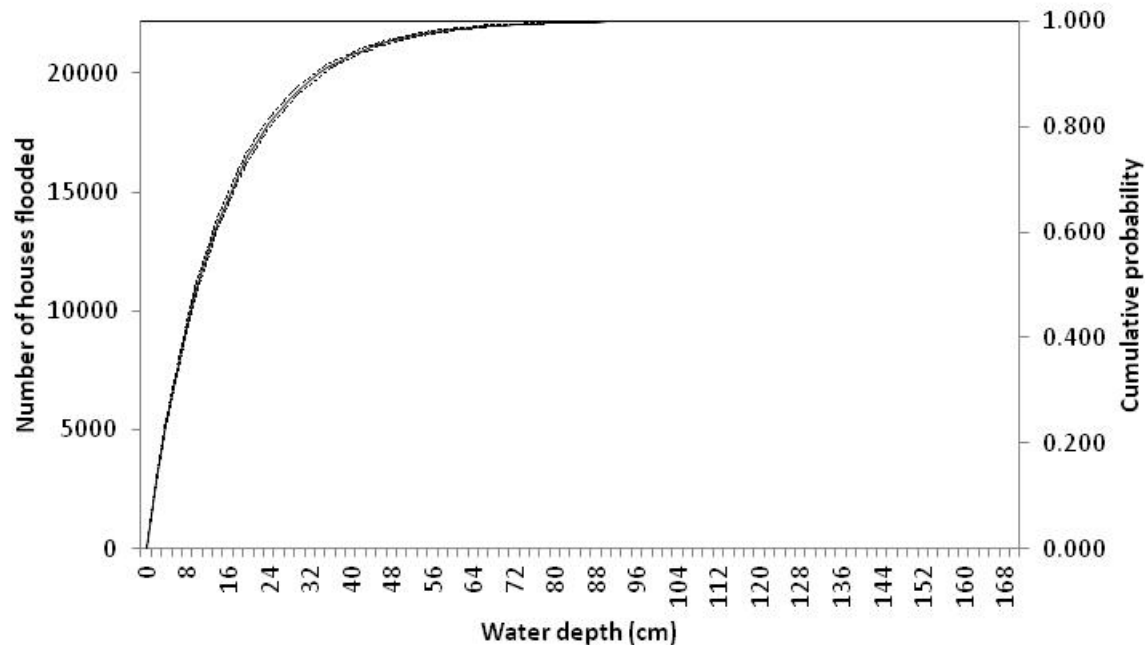
- **Probabilistic method**

- **Distribution of household doorstep levels**





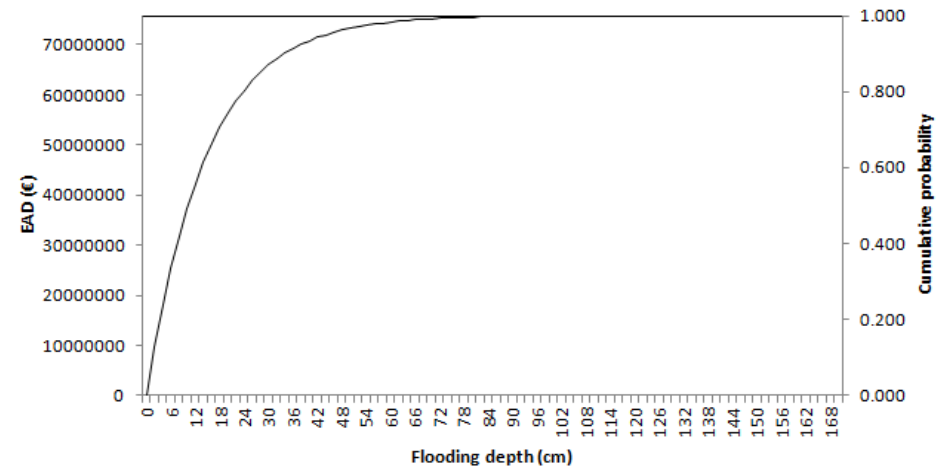
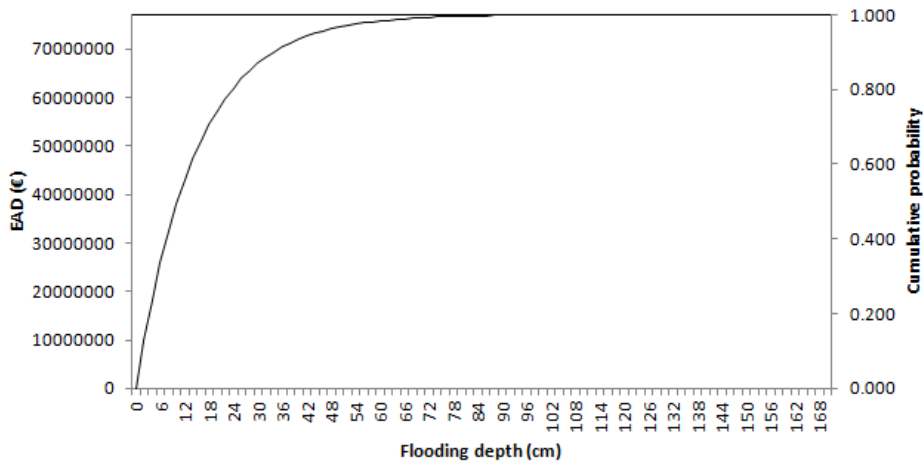
- **Probabilistic analysis**
 - **Number of properties**





- Probabilistic analysis

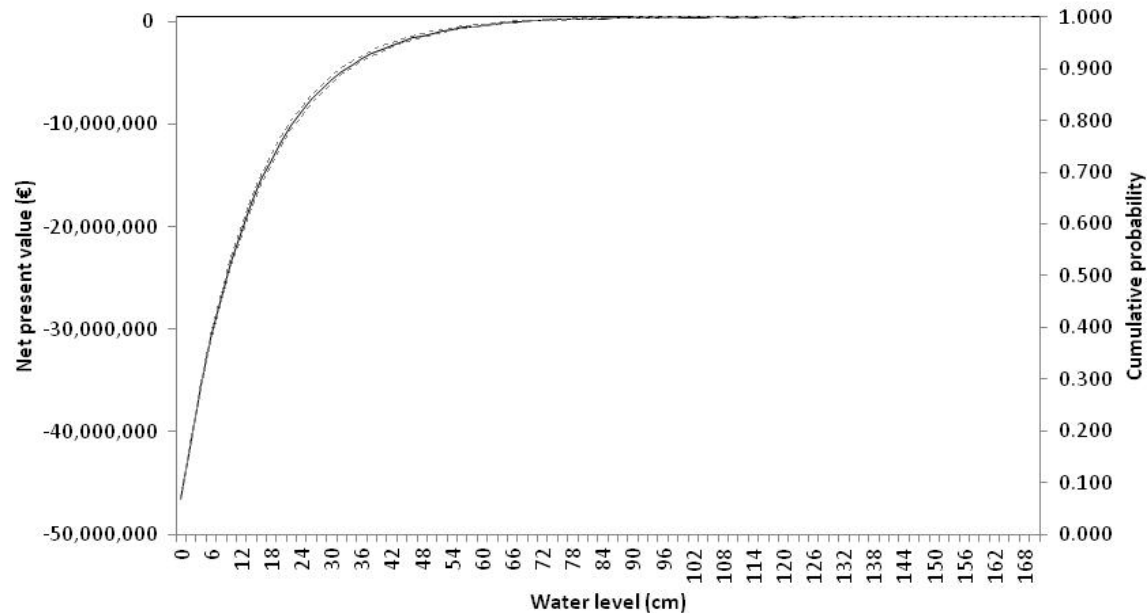
- Expected annual damage (EAD, next talk)





- **Probabilistic analysis**

- **Net present value of risk-reduction measures (details next talk)**





- **Quantitative estimations of damage to residential property in Eindhoven**
- **Assess some of the uncertainty**
- **Local planners have improved information**
- **General framework adaptable**
 - e.g. - easy to incorporate CC impacts on return period



- **Show that proposed measures are not cost-effective in long-term**
- **However, we neglect:**
 - **Other property types**
 - **Damage to streets, pavements, cars, etc.**
 - **Cost of lost working hours**
 - **Mental health costs**
 - **Damage to critical infrastructure**



- **Scope for further research**
- **Refined QRA and CBA for Eindhoven**
- **Lead to more effective resource targeting and management for robust risk reduction**



- **Read more:**
 - **Sušnik, J., Strehl, C., Postmes, L.A., Vamvakeridou-Lydroudia, L.S., Mälzer, H-J., Savić, D.A., Kapelan, Z. In Prep. Assessing financial loss due to pluvial flooding and the efficacy of risk-reduction measures in the domestic property sector in Eindhoven, The Netherlands.**