



Risk Assessment of Infrastructure

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20

25

ProRail



Rijkswaterstaat
Ministry of Infrastructure
and Water Management

Beavers in embankments

- A beaver hole through a regional dike (Zijkade near Vianen, the Netherlands)



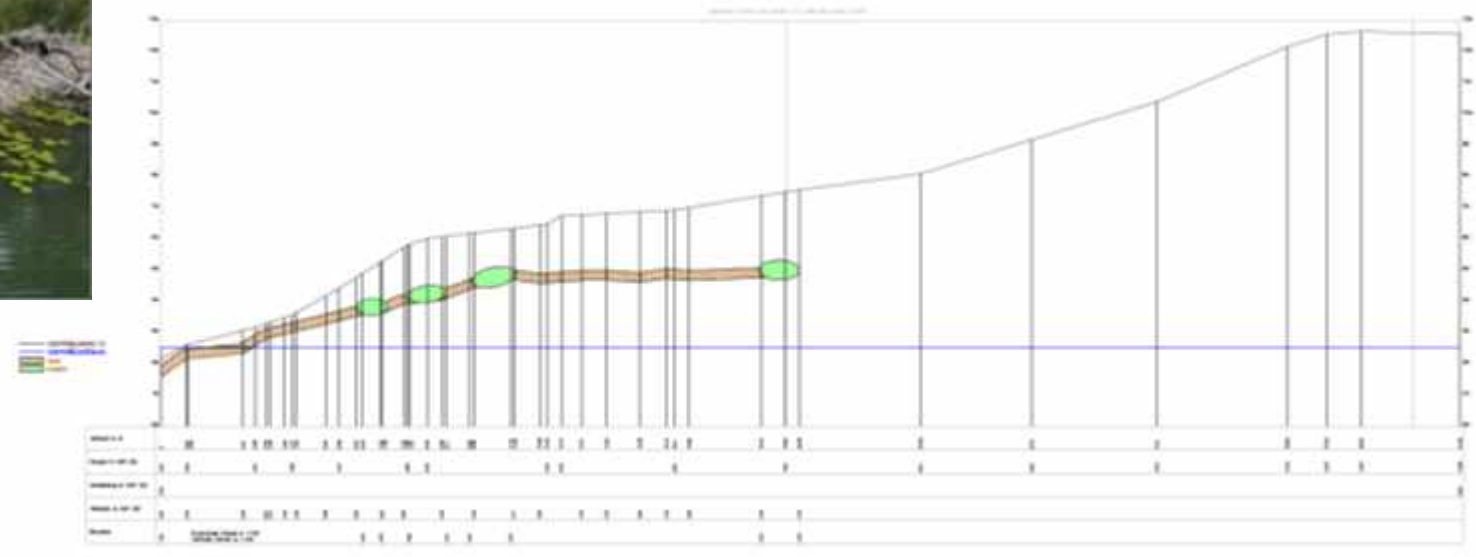
Beaver causing piping through a hole in the cover



Scenario:

- Burrow attract water in stead of drain
- Fluidization of landside toe
- Slope instability
- Failure remaining profile
- Emergency measures fail

Wamel (NL)
Summer 2022



Beavers in other infrastructure



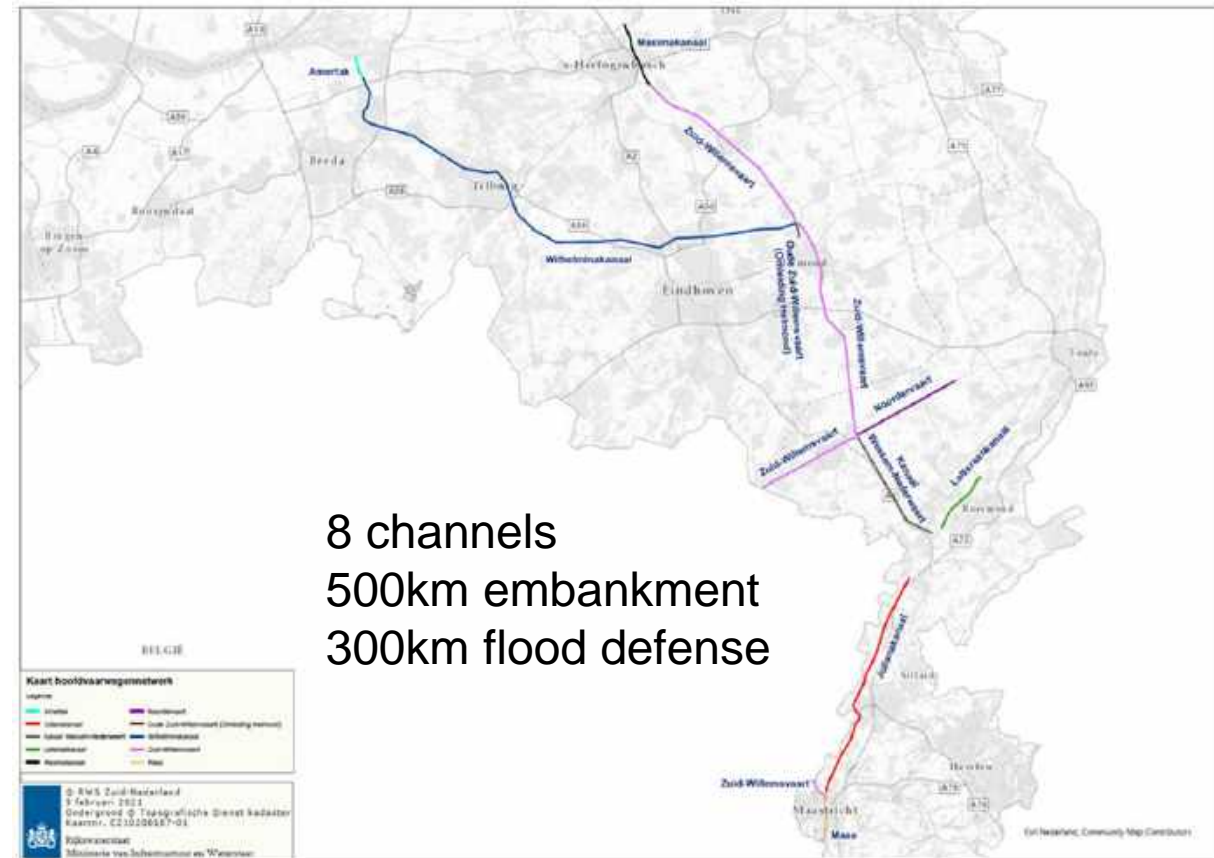
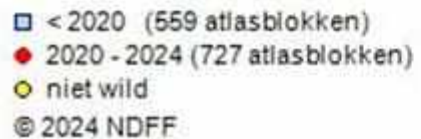
Operational health and safety



Where will this beaver family go to?

Aerealphoto's: Tom Hessels





8 channels
500km embankment
300km flood defense

Risk definition

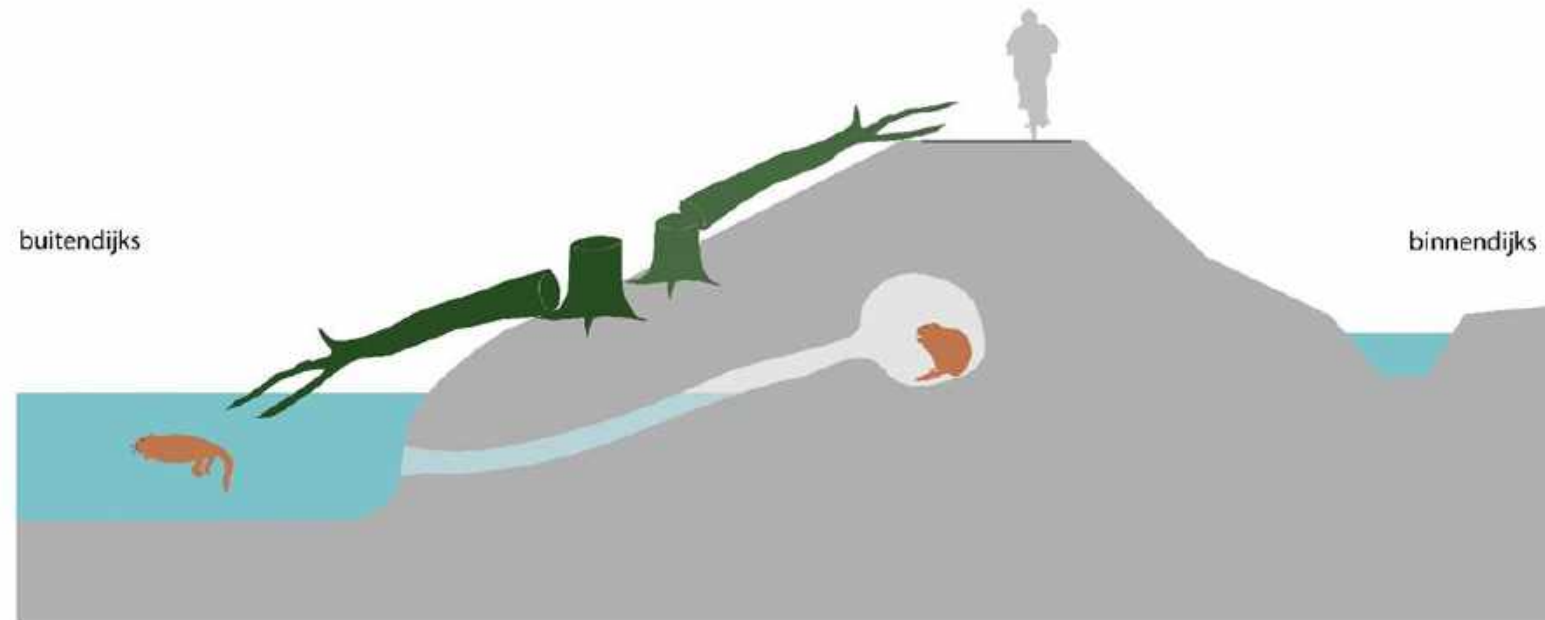
chance x effect = risk

		Effects			
Chance		small	average	serious	extreme
	frequent	medium	high	high	very high
	regularly	low	medium	high	high
	little	negligible	low	medium	high

Chance of beaver entering the embankment

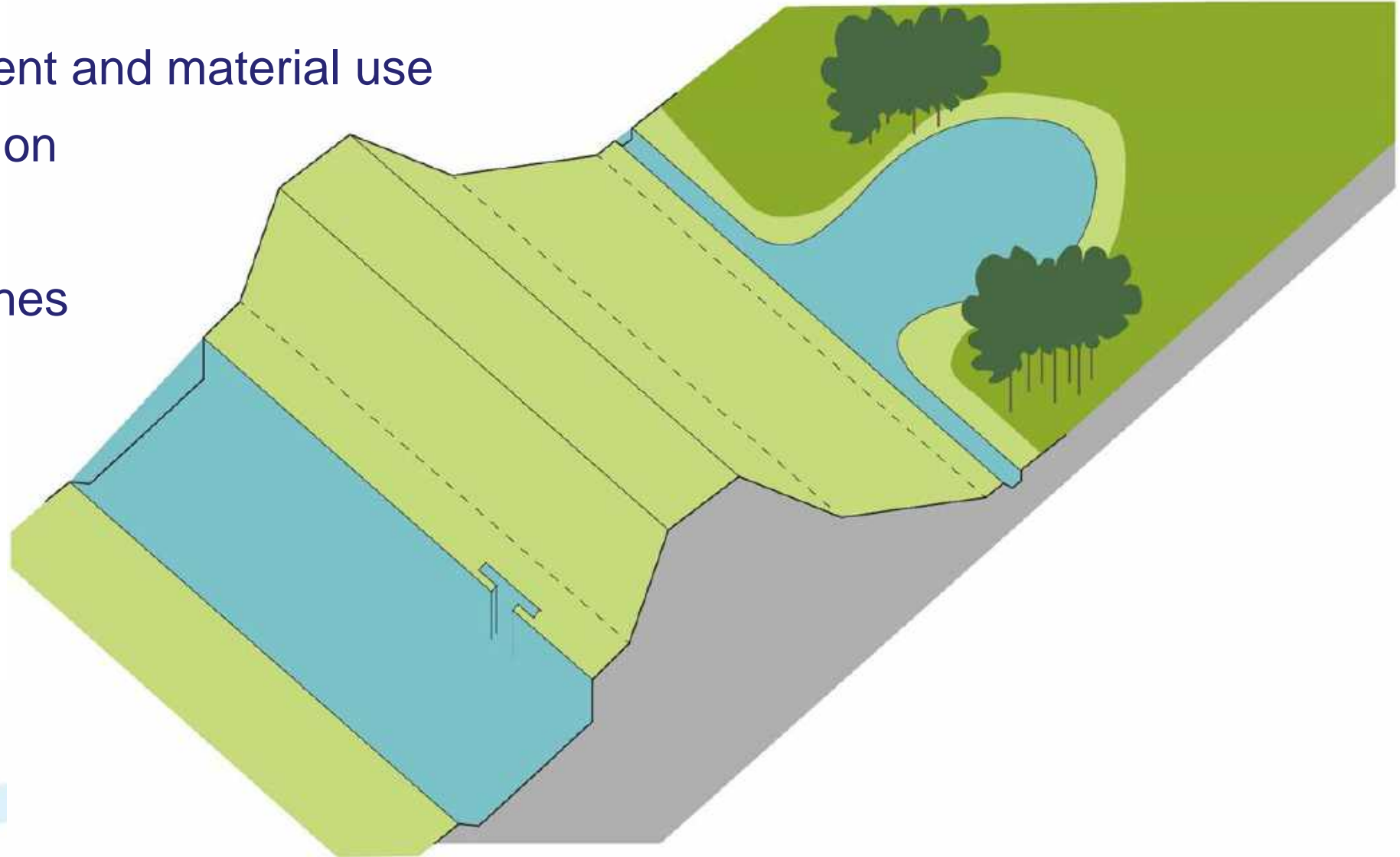
Effect of damage

Risk for an asset

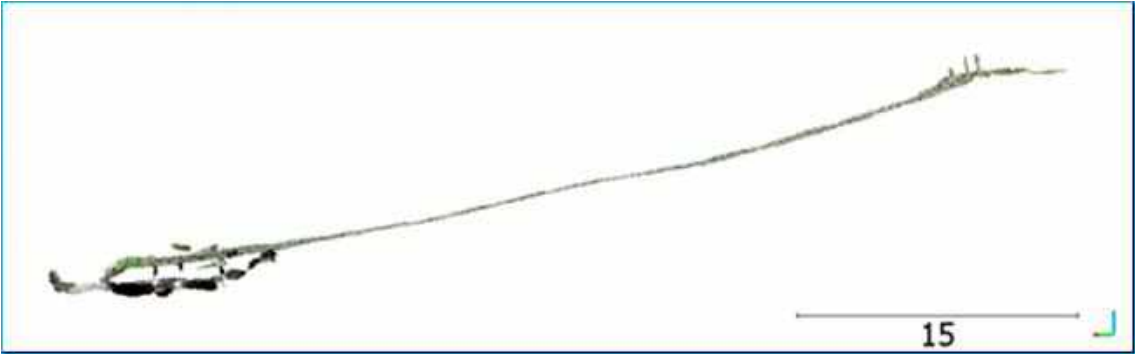


Spatial analysis of the chance

- type of embankment and material use
- trees and vegetation
- soil
- drainage and ditches



Analysis of effect



Flood damage, shipping damage, road damage, green/nature damage, traffic damage



M€

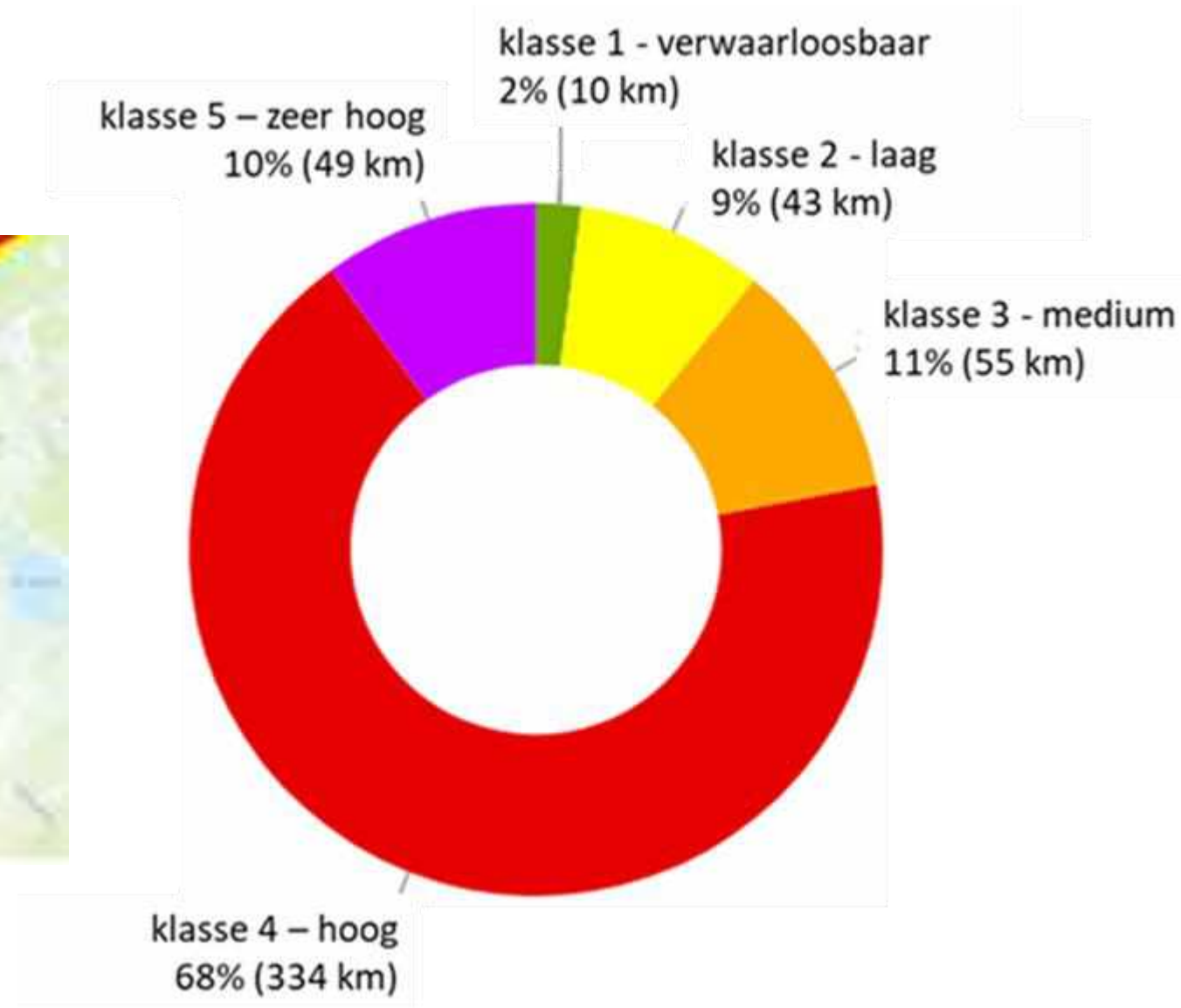
overstromingsschade		scheepvaartschade		wegschade		omgevingsschade natuur		wegverkeersschade	
IPO schadebedragen	klasse	scheepvaart schade bedrag	klasse	wegtypes	klasse	afstand water tot houtige begroeiing	klasse	afstand bomen tot aan type weg	klasse
<8	1	<1	1	geen	0	>20 m	0	geen bomen <15 m van weg	0
tussen 8 en 25	2	1-2,5	2	voet- en fietspaden	1	10-20 m	1	boom <15 m van voet- en fietspaden	1
tussen 25 en 80	10	2,5- 16	5	lokale wegen	2	0-10 m	2	boom <15 m van lokale wegen	2
tussen 80-250	20			N-wegen	5			boom <15 m van N-wegen	3
				rijks- en spoorwegen	10			boom <15 m van rijks- en spoorwegen	4




Risk overview

500 km channel, every 100m

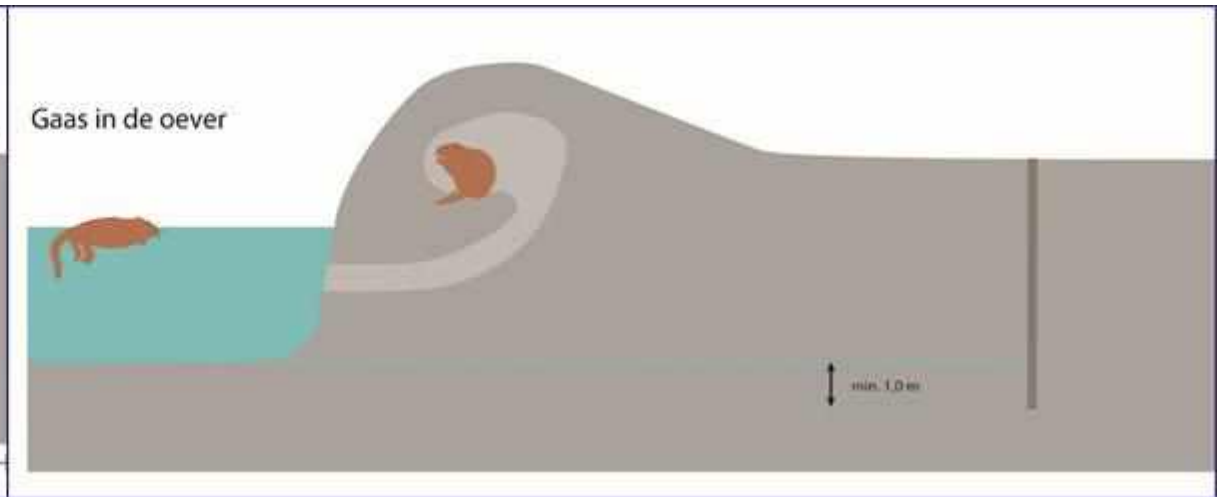
Missing data results in chance "frequent"



Verwijderen wilg, populier
(eik, es, veldesdoorn)

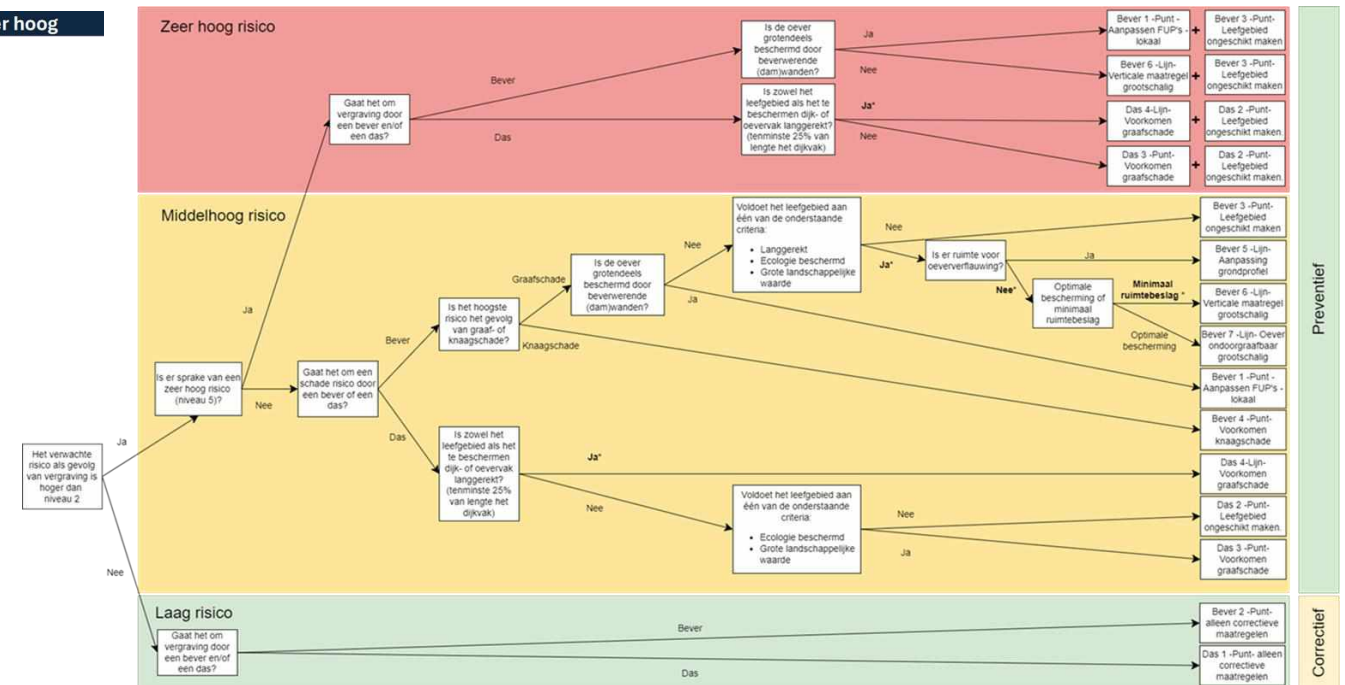


20 tot 30 meter



Netwerkschakel	Kosten excl. btw	Risicoklasse – zeer hoog
Maximakanaal	€ 3.146.000	
Zuid-Willemsvaart (Helmond Zuid - Nederweert) - kanaal Wessem Nederweert	€ 6.100.000	
Zuid-Willemsvaart sluis 6 – Hintham	€ 4.526.000	
Zuid-Willemsvaart tak Lozen	€ 1.672.000	
Zuid-Willemsvaart Maastricht	€ 1.361.000	
Grote Pand (Wilhelminakanaal (Tilburg Loven – Beek en Donk) en Zuid-Willemsvaart (Helmond Zuid – Beek en Donk))	€ 4.598.000	
Noordervaart	€ 4.139.000	
Maasplassen (Lateraalkanaal)	€ 3.371.000	
Julianakanaal	€ 10.619.000	
Wilhelminakanaal sluis I-IV	€ 7.093.000	
Amertak buitenpand Wilhelminakanaal	€ 1.357.000	

Total costs **€50M** for risk class "very high"



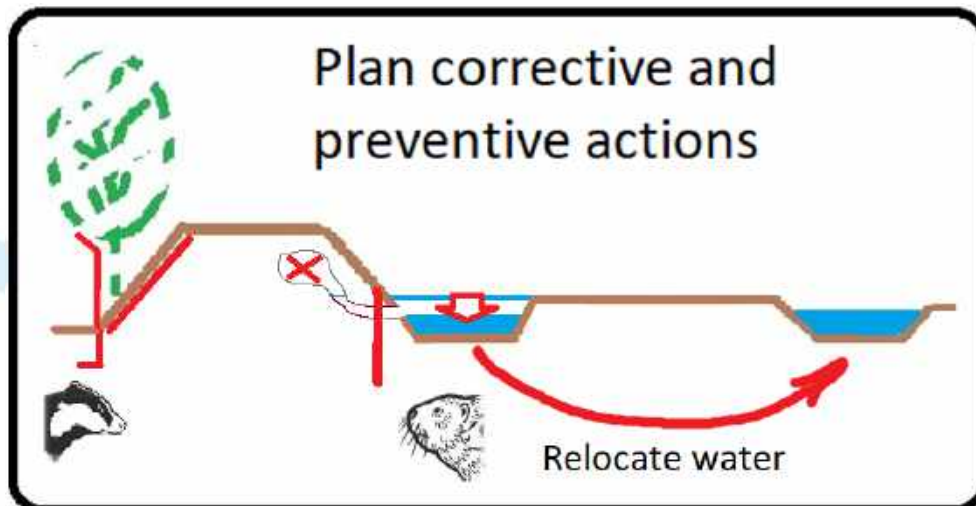
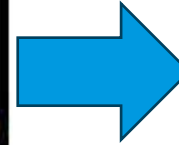
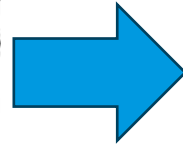
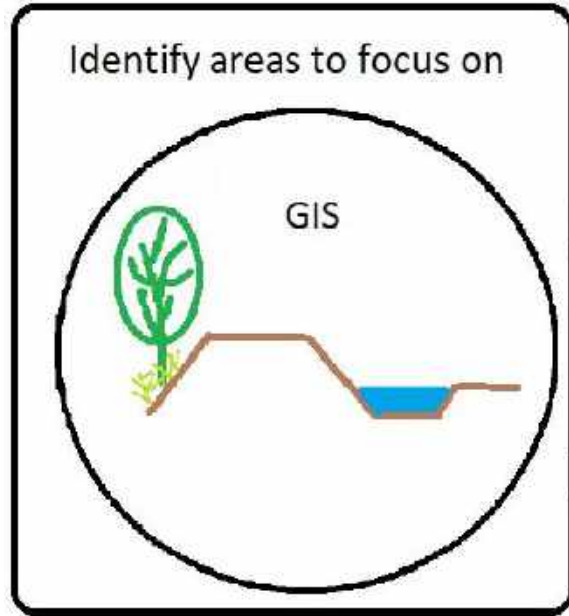


Reasons for analyses ProRail



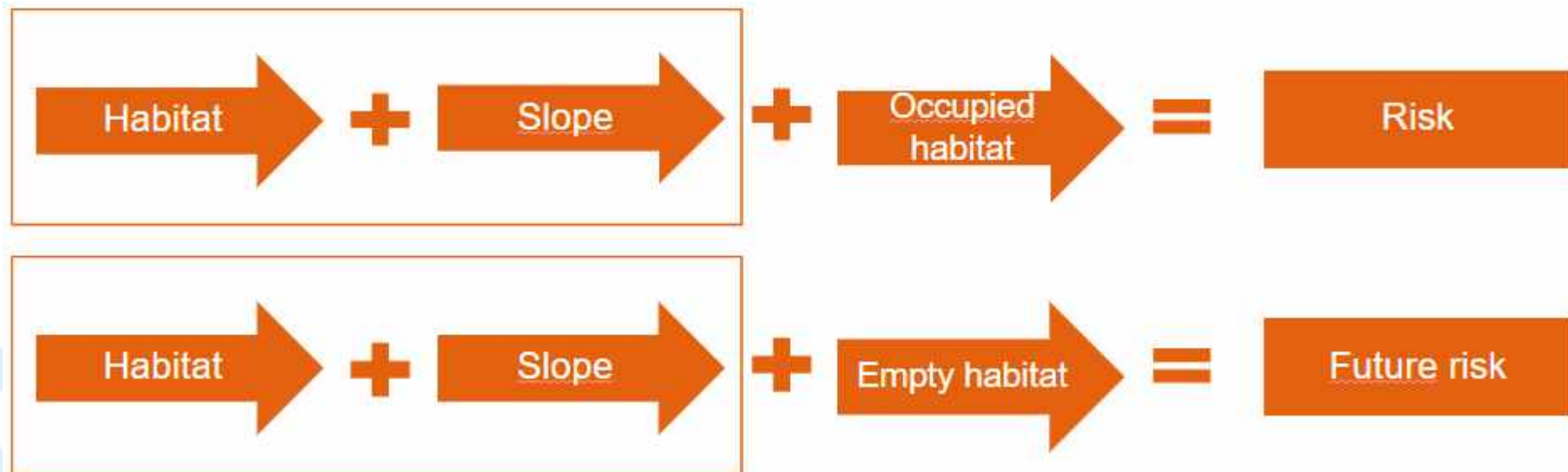
Approach of analyses ProRail

stowa



GIS approach ProRail

1. Select nationally available GIS data sources.
2. Determine the length of suitable habitat per 100 meters of railway.
3. Identify the presence and height of slopes.
4. Determine the presence of known occupied habitat.



Risk assessment ProRail (corrected version)

Risk based on the combination of the presence or absence of water and foraging areas (beaver habitat) determined per 100 meters.

Features	m/100m	Features	m/100m	Features	m/100m	Risk category
optimal foraging area	< 10 m	subopt. foraging area	< 20 m	no water/ no foraging area		none
optimal foraging area	< 10 m	subopt. foraging area	> 20 m	water	< 20 m	low
water/ optimal foraging area	< 10 m	water/ subopt. foraging area	> 20 m	water	> 20 m	average
water/ optimal foraging area	> 10 m	water/ subopt. foraging area	> 20 m			high

Embankment attractiveness		
Height of slope:	< 0,5 m	> 0,5 m
Risk:	Low	High
	Risk category	
none	none	none
low	low	low
average	low	average
high	average	high

Occupied habitat beaver		
Occupied?	NO	YES
Risk:	Low	High
	Risk category	
none	none	none
low	Future low	low
average	Future average	average
high	Future high	high

GIS result ProRail Risk assessment Badger & Beaver

The first results of 1000 km field survey are expected summer 2025.



National approach (legislation)

Waarneming beveractiviteit	Mate van schade en risico's openbare veiligheid	Trede 1: geen vergunning nodig	Trede 2: vergunning aantasten functionele omgeving	Trede 3: vergunning aantasten voortplantings- of rustplaats	Tussenafweging (acceptatie / preventie mogelijk?) ¹	Trede 4: vergunning doden bever
Boom in of op infra	Mate van schade en risico's openbare veiligheid →	Acceptabel: niets doen				
		Onacceptabel: boom verwijderen				
Dam in waterloop	Mate van schade en risico's openbare veiligheid →	Acceptabel: niets doen			Herhalende dambouw acceptabel of preventieve maatr.? →	Geen trede 4, wel monitoren
		Onacceptabel: 1) techn. maatregelen 2) dam verwijderen		Onacceptabel: 1) passief verplaatsen 2) techn. maatregelen 3) verwijderen ² →	Herhalende dambouw onacceptabel en preventieve maatr. geen oplossing? →	Doden bever
Hol- of burcht in oever, waterkering, onder (spoor)weg of kunstwerk	Mate van schade en risico's openbare veiligheid →	Acceptabel: niets doen			Herhaaldelijke graverij acceptabel of preventieve maatr.? →	Geen trede 4, wel monitoren
				Onacceptabel: 1) passief verplaatsen 2) techn. maatregelen 3) verwijderen ² →	Herhaaldelijke graverij onacceptabel en preventieve maatr. geen oplossing? →	Doden bever
	Acute ernstige risico's openbare veiligheid ³ - - - - -			Verwijderen - - - - -		Doden bever

Ernst van de schade en strijdigheid