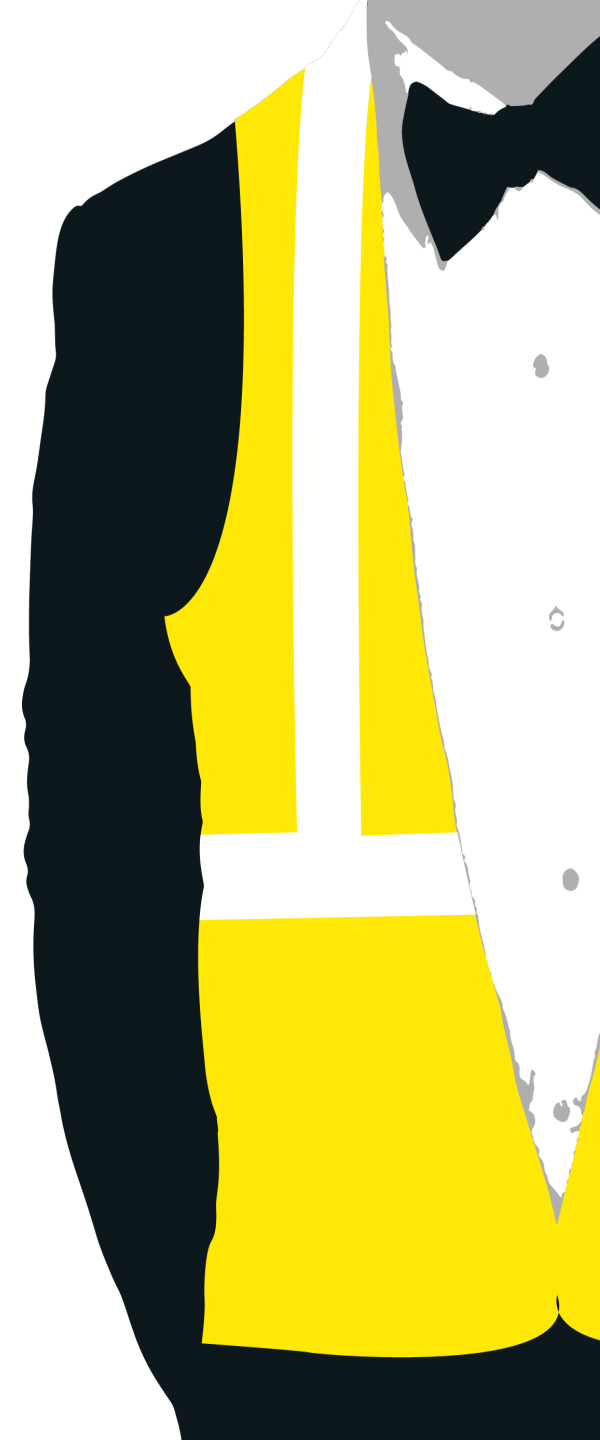


Webinar Corona

Pieter van Gelder

Safety and Security Science, TPM



Contents

- Introduction
- Statistical data on number of deaths
- Uncertainties
- Intervention options
- Decision making



Is a pandemic a black-swan?



5 Pandemic outbreaks since 1900

- Spanish flu (1918-1920), spread worldwide, causing 500 million sick and 20 to 100 million deaths.
- Asian flu (1957) with a million deaths.
- Hong Kong Flu (1968) with 700,000 deaths.
- Swine Flu (June 11, 2009 to August 2010) with at least 13,763 deaths.
- Corona pandemic. On March 11, 2020, the World Health Organization (WHO) officially determined that the outbreak of the SARS-CoV-2 virus has led to a pandemic.



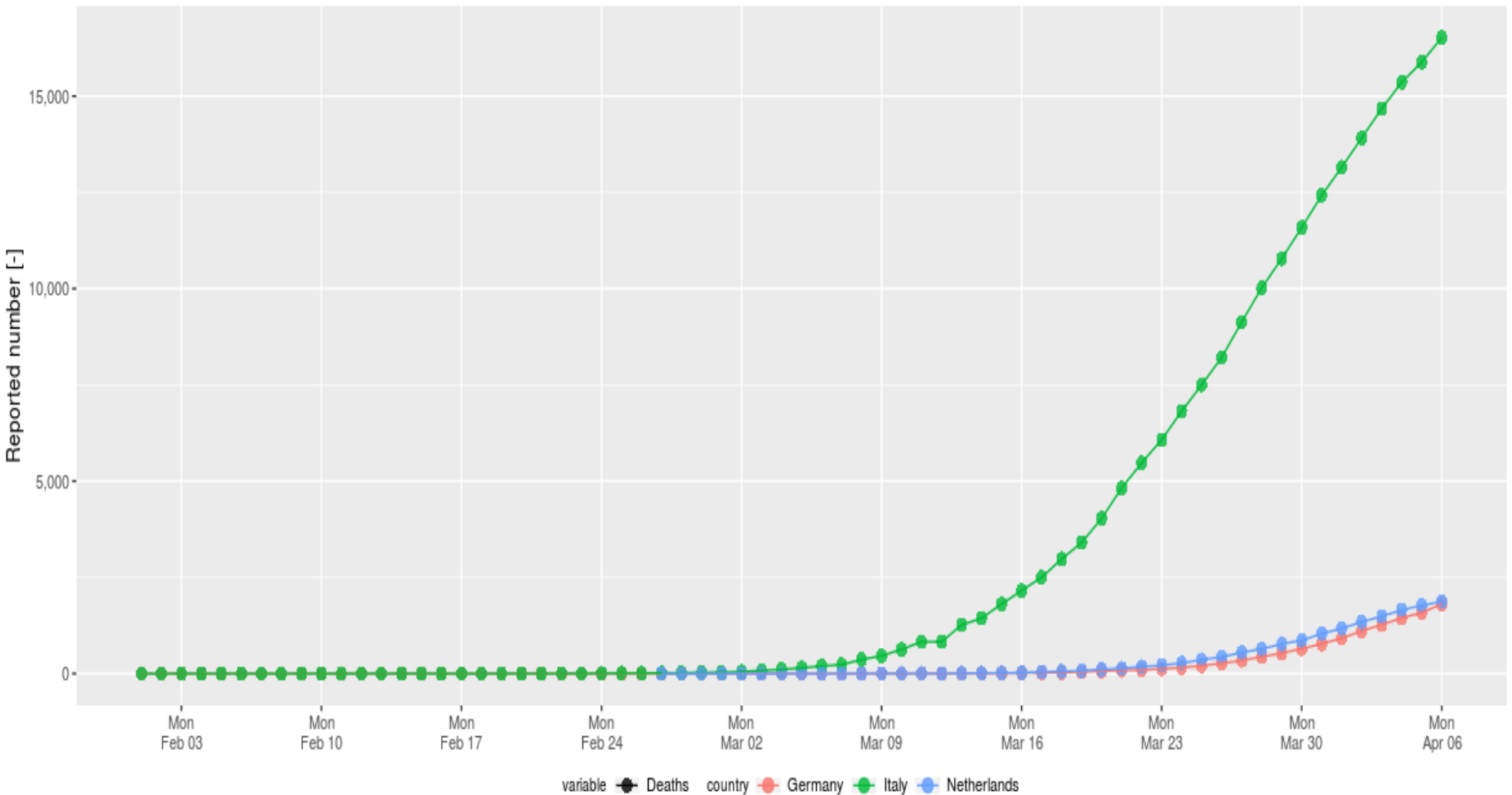


Nationaal Veiligheidsprofiel 2016

Een All Hazard overzicht van
potentiële rampen en dreigingen
die onze samenleving kunnen
ontwrichten

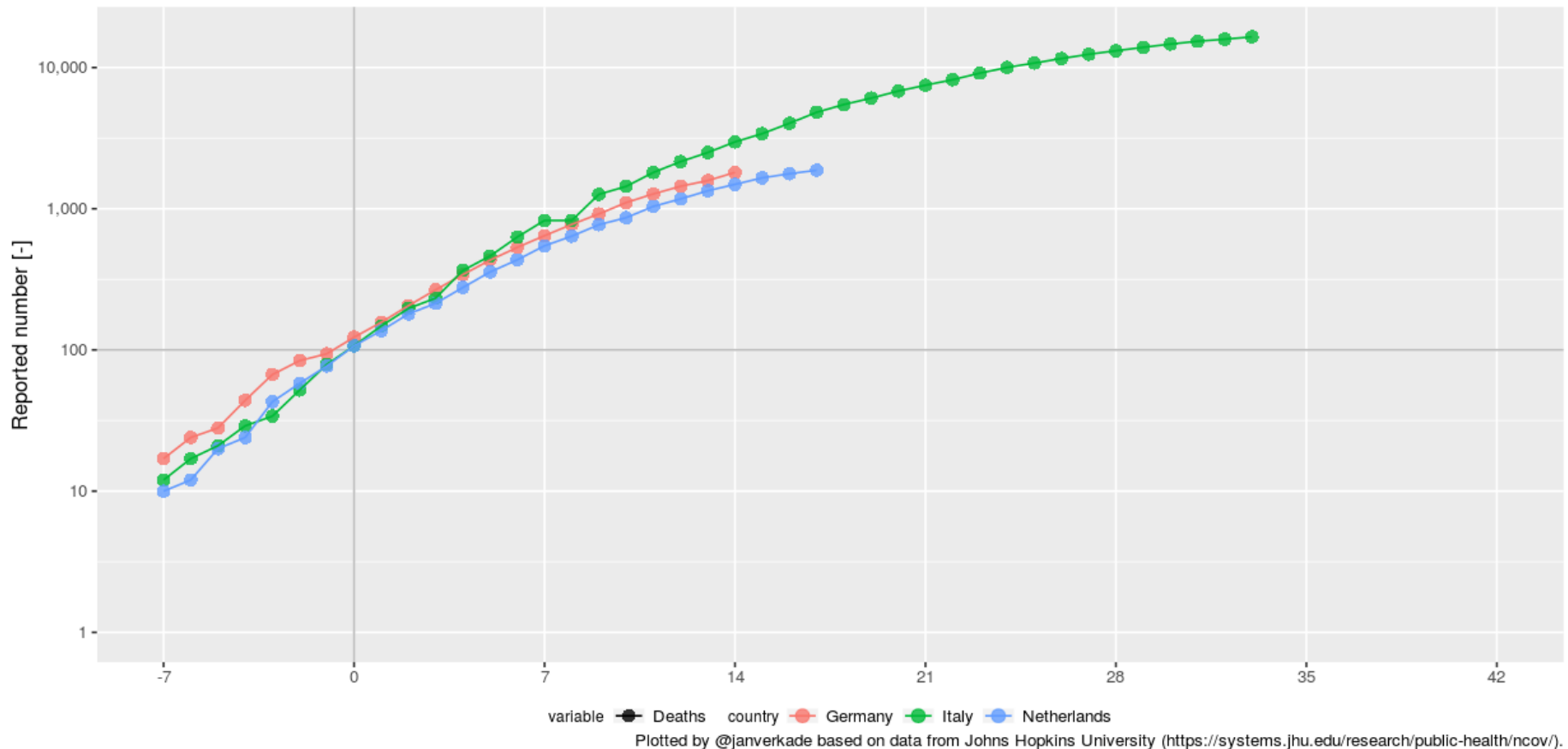


No. of death cases in 3 countries



Plotted by @janverkade based on data from Johns Hopkins University (<https://systems.jhu.edu/research/public-health/ncov/>).

Same figure on 10-log scale and normalized at 100

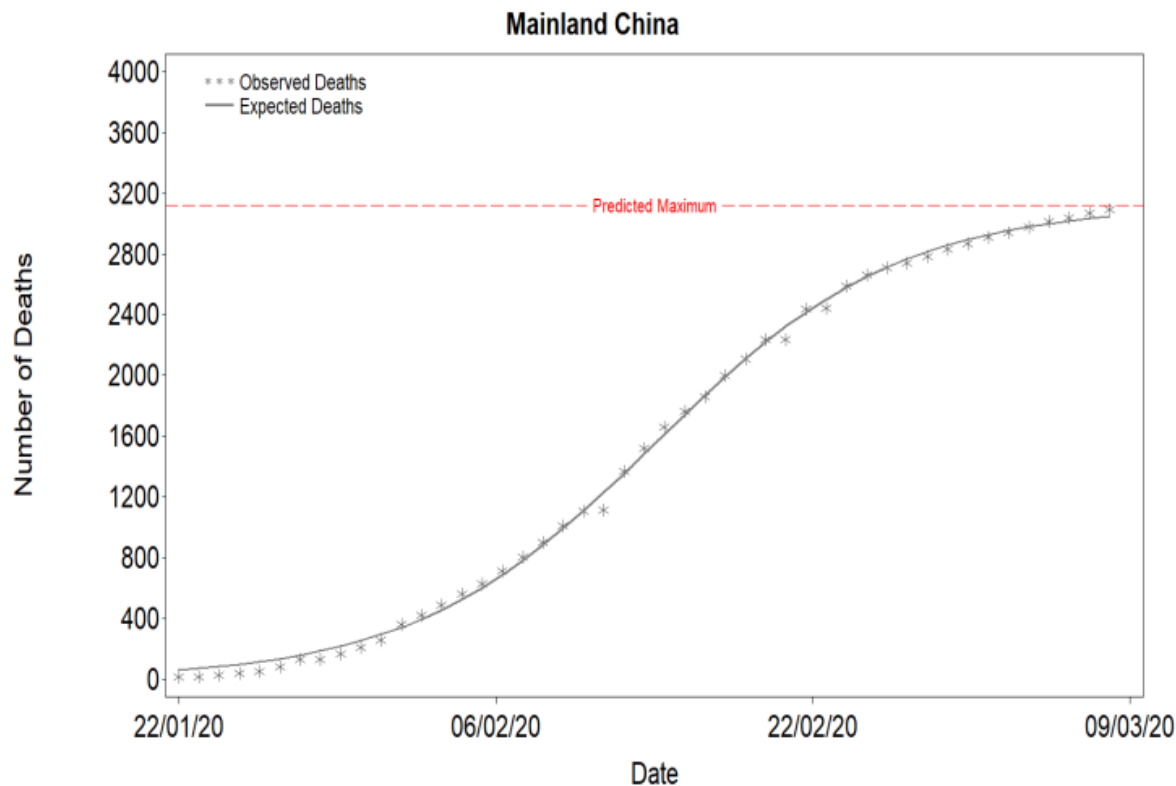


3-parameter Logistic function

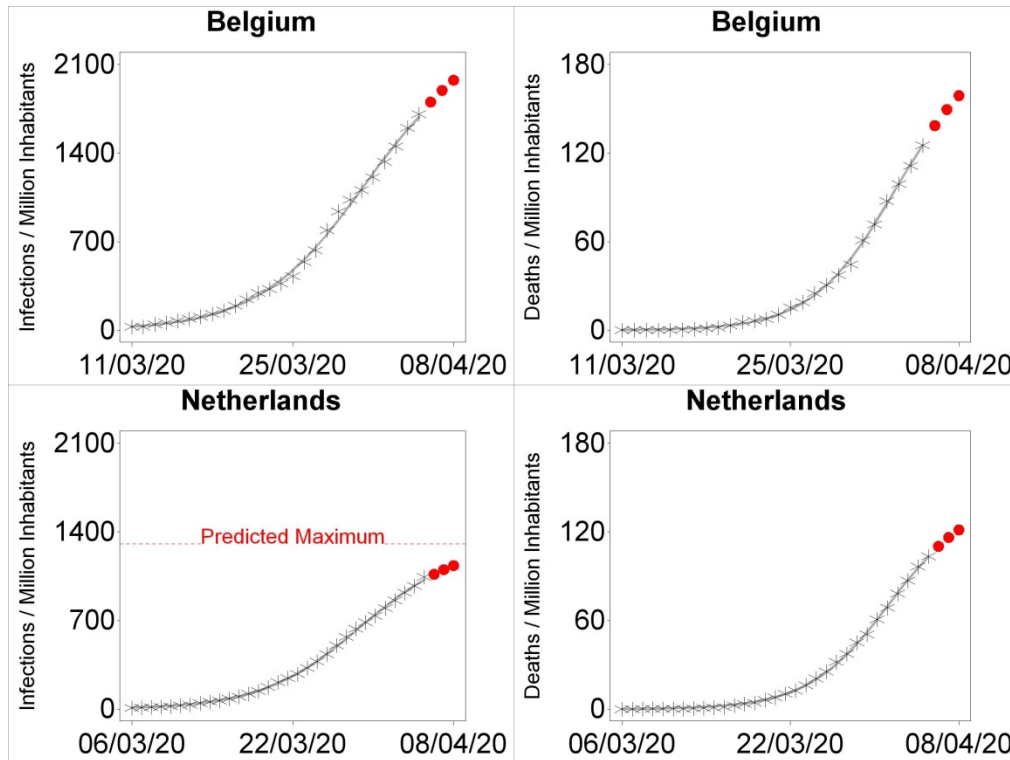
$$f(x) = \frac{L}{1 + e^{-k(x-x_0)}} ,$$



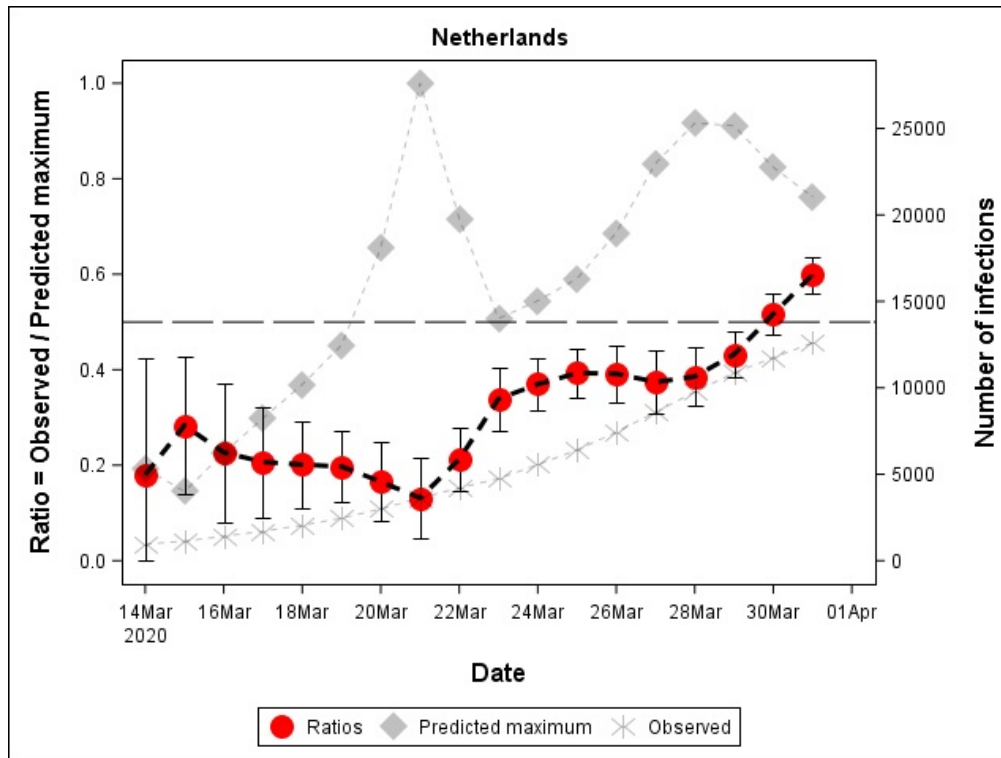
Quality of fit for Chinese data (Van den Heuvel, 2020)



Predicted maximum infections in NL: 23000 (Van den Heuvel et al., TUE)



Uncertainties in the extrapolation



(Van den Heuvel et al., TUE)

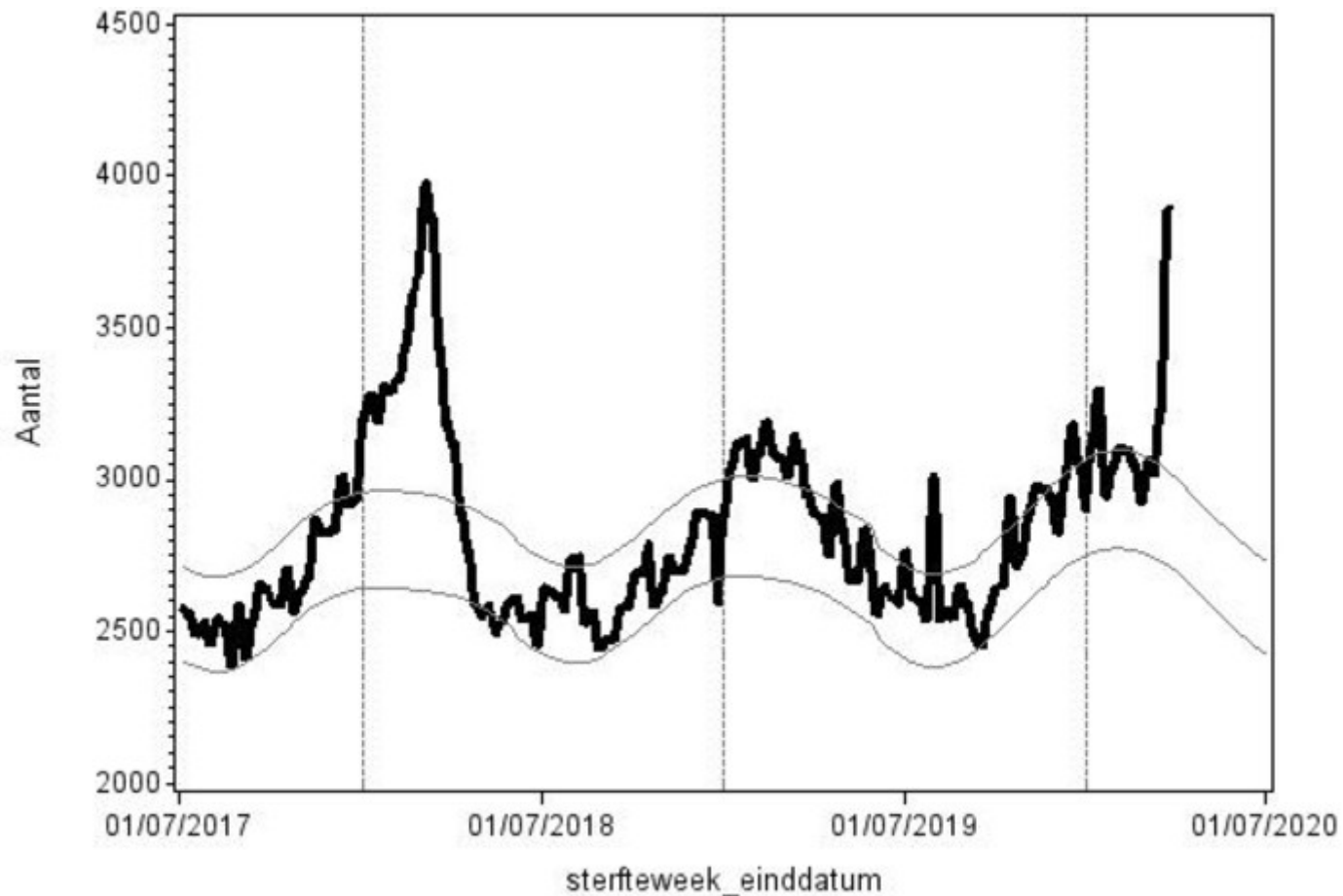


Uncertainties in the raw data

- No. of infections (many sick people are not being tested; many infected people don't show symptoms; test capacity is largely increased in recent days)
- No. of Corona deaths (many deaths are not being tested)



CBS data of weekly number of deaths in NL



- The Central Bureau of Statistics, which receives mortality rates from the municipalities, estimates that in the fourth week of March, approximately 4,300 people died. That is about 1,200 more than average in the first ten weeks of the year - while RIVM reported 713 corona deaths for that week.
- The actual number of Corona deaths could therefore be up to 50% - 100% higher than reported by RIVM.

Logistic modelling vs. epidemiological modelling

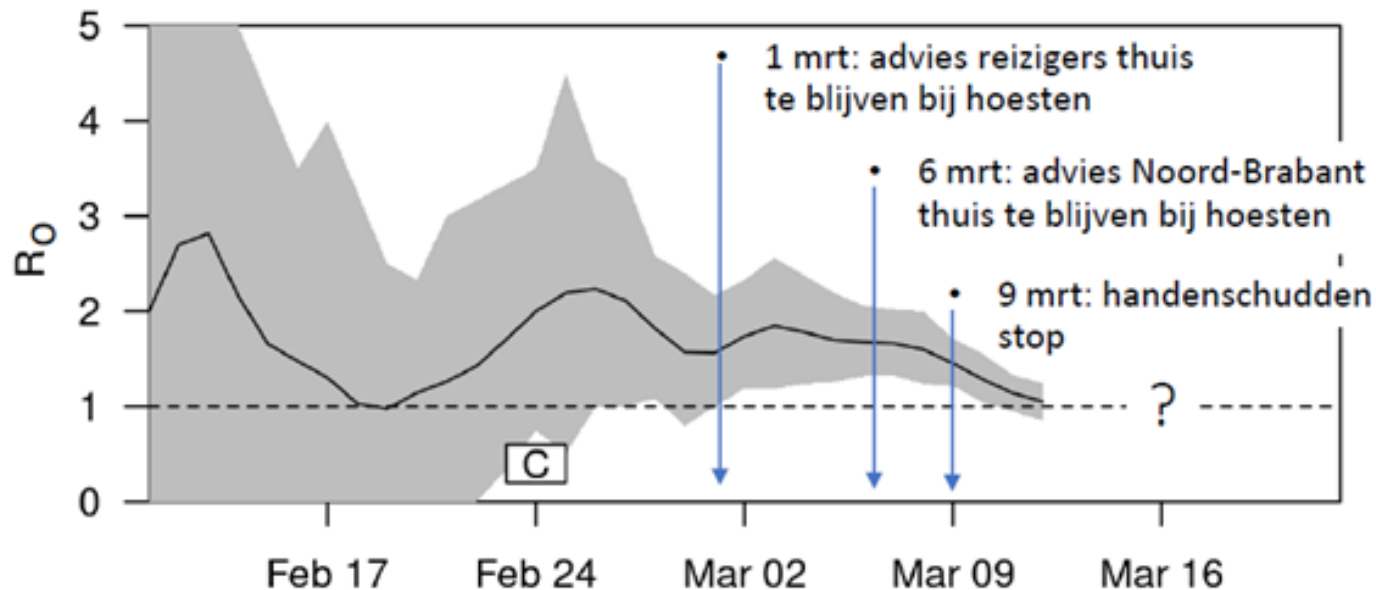
- Uncertainty in β : infection-producing contacts per unit time,
 - Uncertainty in the infectious period τ
 - Uncertainty in the incubation time
 - Uncertainty in the recovery / death rate
 - Uncertainty in the immunity
-
- Compare with the logistic model (or any AI model); focus is on the outcome metric; let the data 'speak for itself'



Uncertainty in the reproductive ratio

(Van Dissel, 2020)

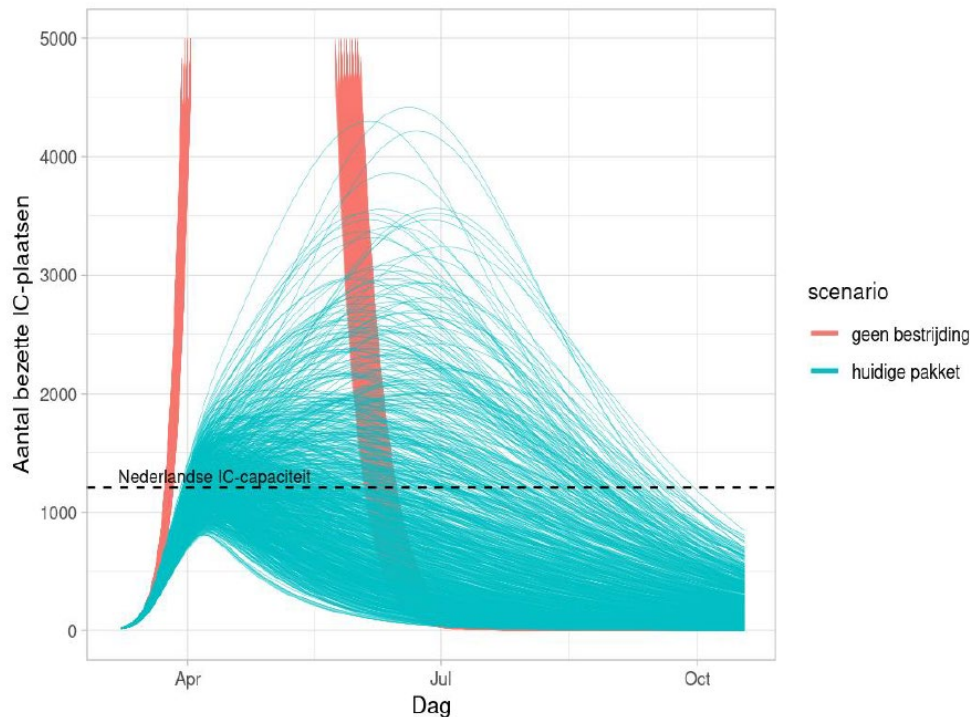
R_0 : number of cases directly generated by one case in a population



The above confidence bounds of the reproductive ratio seem symmetric. However, the distribution is fat-tailed due to individual 'superspreader' events. This should be incorporated in the epidemiological models.



Advantages of epidemiological model over full statistical-based model



Van Dissel, 2020



Putting the numbers in perspective

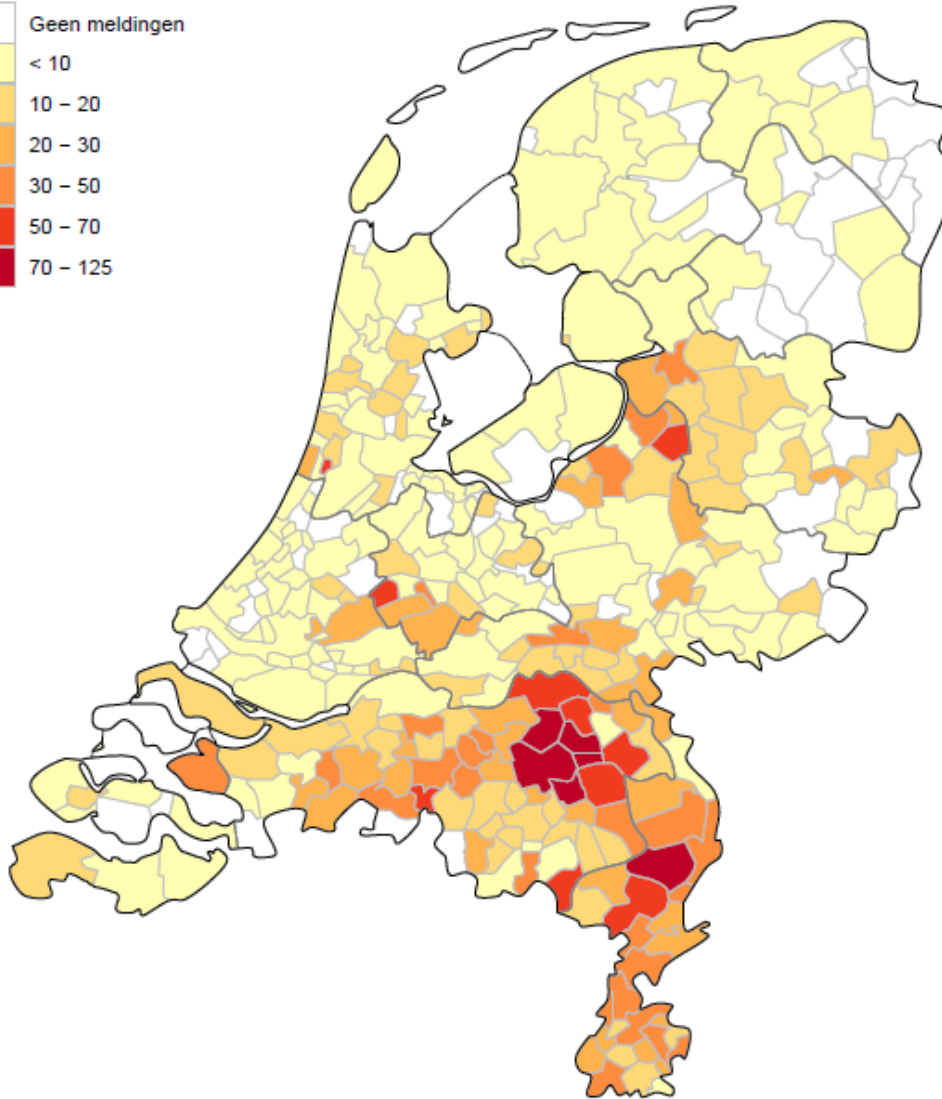
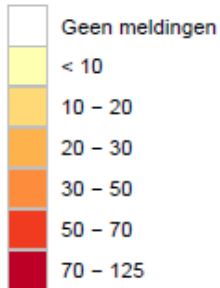
In the Netherlands there are about 150.000 deaths per year.

The overall probability of dying in the Netherlands is $8.3 \cdot 10^{-3}$ per year; in other words 830 out of 100.000 people.

The majority of these 830 people die of natural causes. Only 33 out of these 830 people die of non-natural causes. In total 6000 casualties per year.



Aantal per 100.000 inwoners



Number of deaths
per 100.000 people
Due to Corona
Since outbreak (6 weeks)

Compare to overall
830 deaths per
100.000 people (over full year)

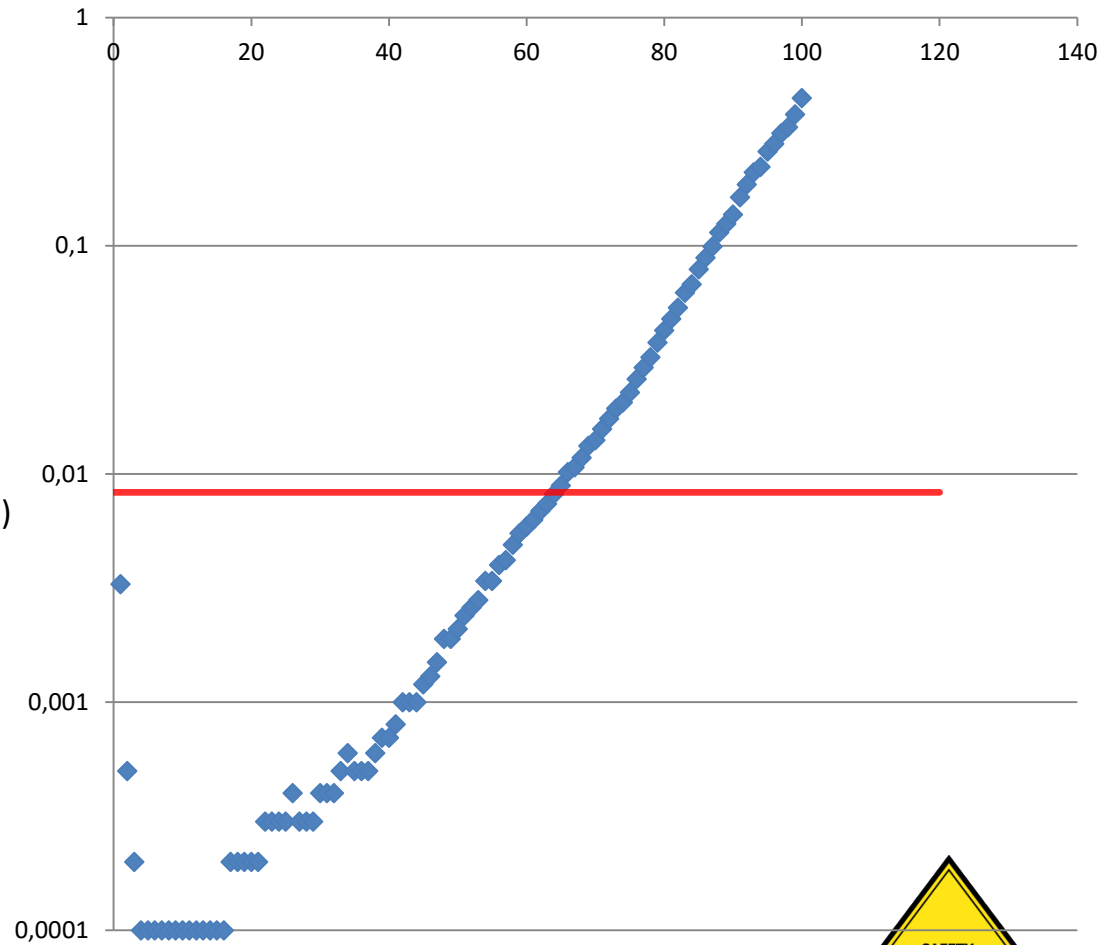
Apply multiplication factors
(2 for excess mortality and
8 for difference in period)



Temporal change

Probability of
decease as a
function of age

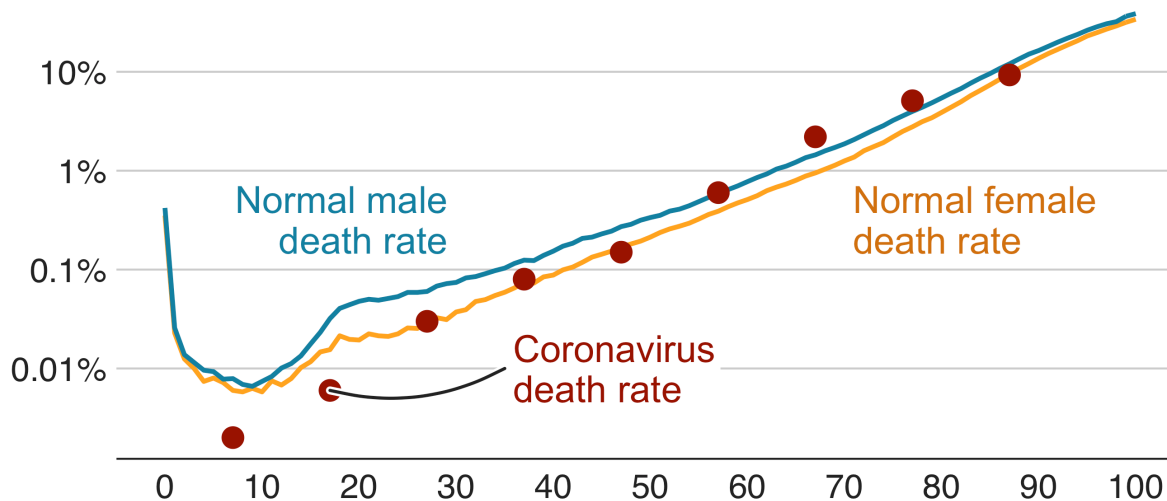
(Van Gelder,
Dies Natalis Lecture, 2013)



Death rate as a function of age

Chances of dying from coronavirus v normal annual risk

Risk of dying each year by age (GB)



Log scale used to see differences in rates at younger ages

Source: Prof. Sir David Spiegelhalter, ONS, Imperial College London

BBC



Reduction of life expectancy

Due to increase in exposed risk

	extra probability of decease in a year	expected age	decrease of the life span in years	decrease of the expected life span in days
	10^{-3}	74.97	3.16	1153
	10^{-4}	77.81	0.32	117
	10^{-5}	78.10	0.03	11
	10^{-6}	78.13	0.00	1
	10^{-7}	78.13	0.00	0



Overall death rate about 3.4% globally after infection (WHO, as of March 3, 2020)

- In China 3300 deaths over 82.000 confirmed infections (4%)
- In NL 2100 deaths of 20.000 confirmed infections (no. of confirmed infections is largely underestimated; no of deaths also underestimated)



Option1 (do nothing)

- Could result in 500.000 deaths
- Under the assumption that 90% of the population will be infected and a death rate of 3.4%

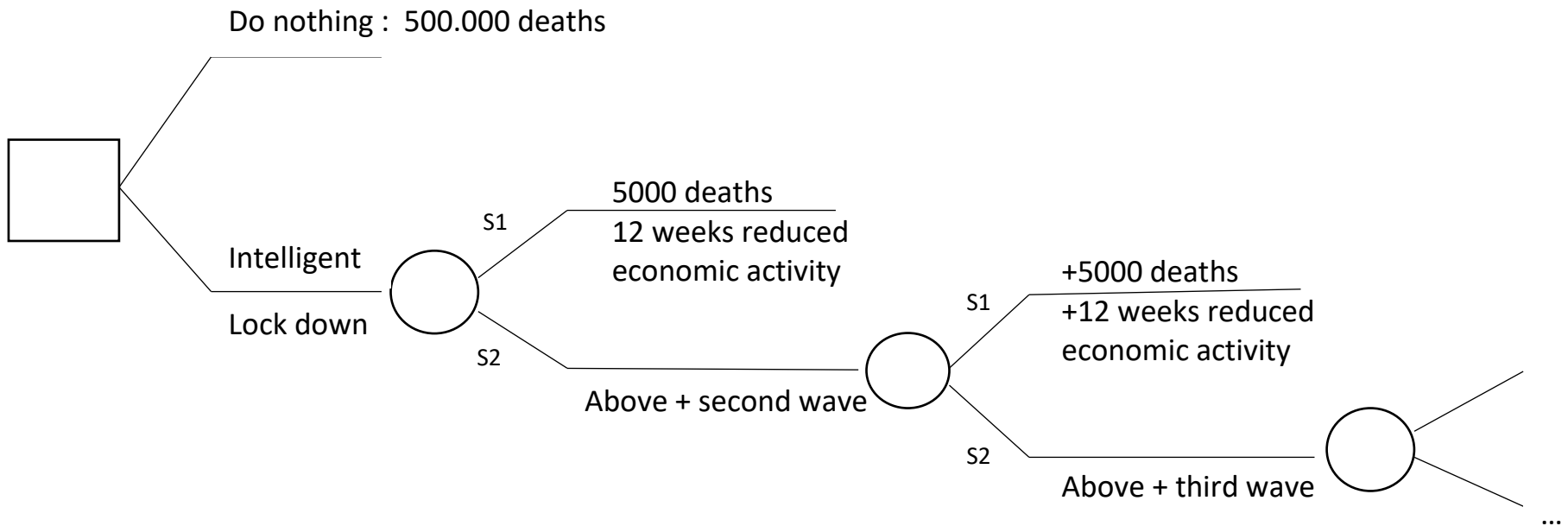


Option 2 (intelligent lock down; current NL policy)

- May lead to 5000 deaths (from logistic extrapolation x excess mortality factor)
- Highly uncertain what will happen after society will be (partly) opened again (with Covid certificate; with track- and trace software on the mobile telephone; with vaccin; with cocktail of medication; with only vulnerable people in isolation; etc); could it lead to a second wave?



Decision tree for the two policy options



Statistical value of a human life

- 60.000 Euro per lost life year
X 10 years (on average shorter life span)
= 600.000 Euro per human life
- Option 1 -> 300 billion Euro
- Option 2 -> 3 billion Euro + loss of economic activity x number of waves



Observation

- The intelligent lock down is the preferred option based on the assumption that we will be able to limit the number of future Corona waves recurring.

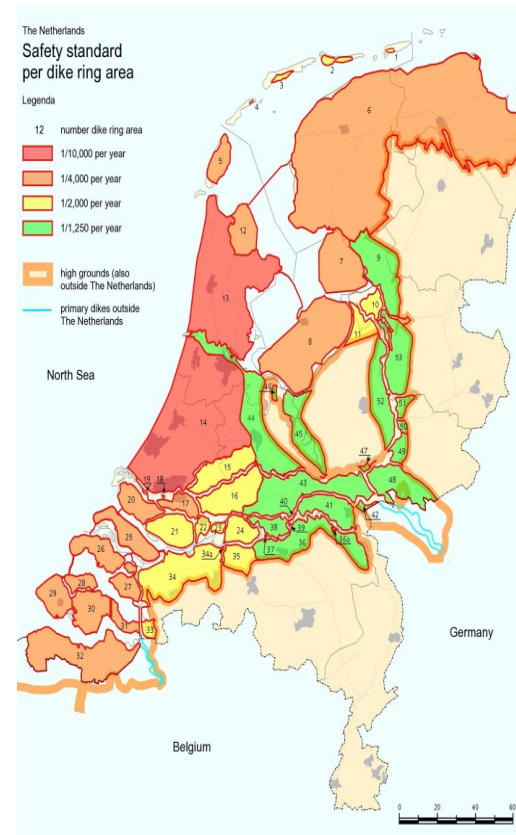
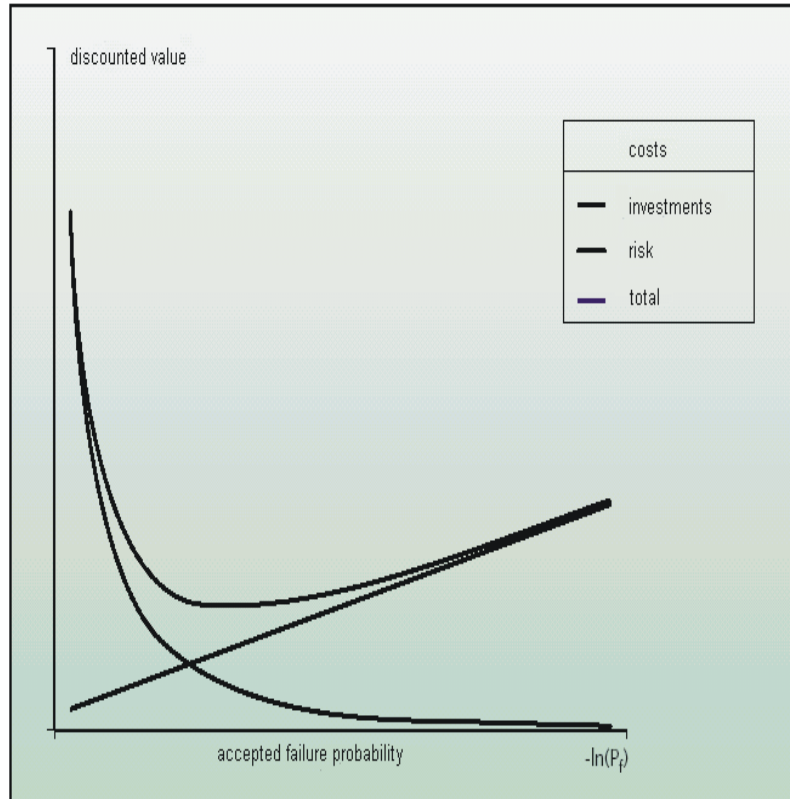


Nassim Taleb (2020)

- We are dealing with an extreme fat-tailed process owing to an increased connectivity, which increases the virus spreading in a nonlinear way
- Fat tailed processes have special attributes, making conventional risk-management approaches inadequate. Instead, apply precautionary principle.



Balance of safety and costs



Dantzig, D. van, 1960, The economic decision problem concerning the safety of the Netherlands against storm surges; Report of the Delta Commission, Contribution II.2, p 59-110.



Further steps

- We need to know from empirical data, lab studies, simulation models, what is the effectivity (mean values and confidence bounds) of measures such as:
 - Maintain social distancing to all (with / without mouth caps)
 - Maintain social distancing to vulnerable people only;
 - Use of (digital) Covid certificate;
 - Use of (cocktail of) medications.
- Effectivity referring here to reduced probability of death + effect on economic activity + effect on freedom, privacy breaches, etc.
- Then we can adopt multi-criteria decision-making techniques

