CT4491

Lecture. IDF and Design Storms for urban drainage systems design

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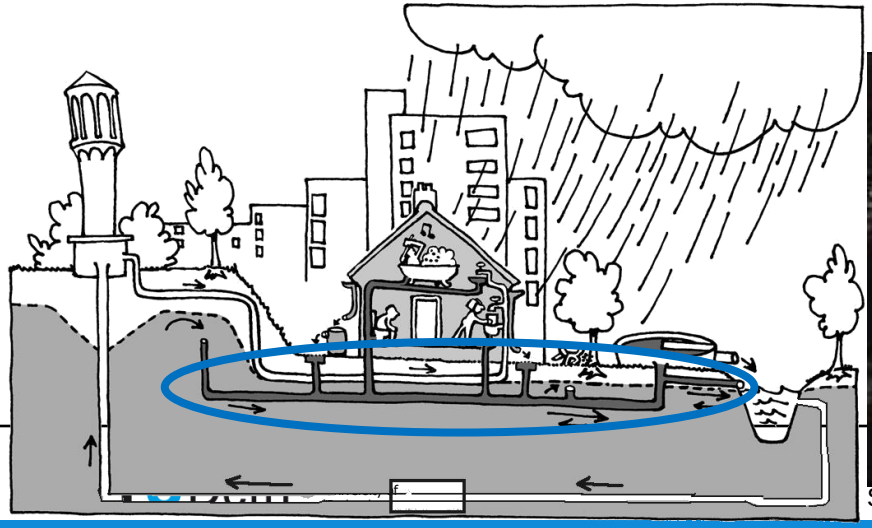


Source: news.bbc.co.uk

Source: www.nu.nl

Use of rainfall data in urban drainage system design and analysis

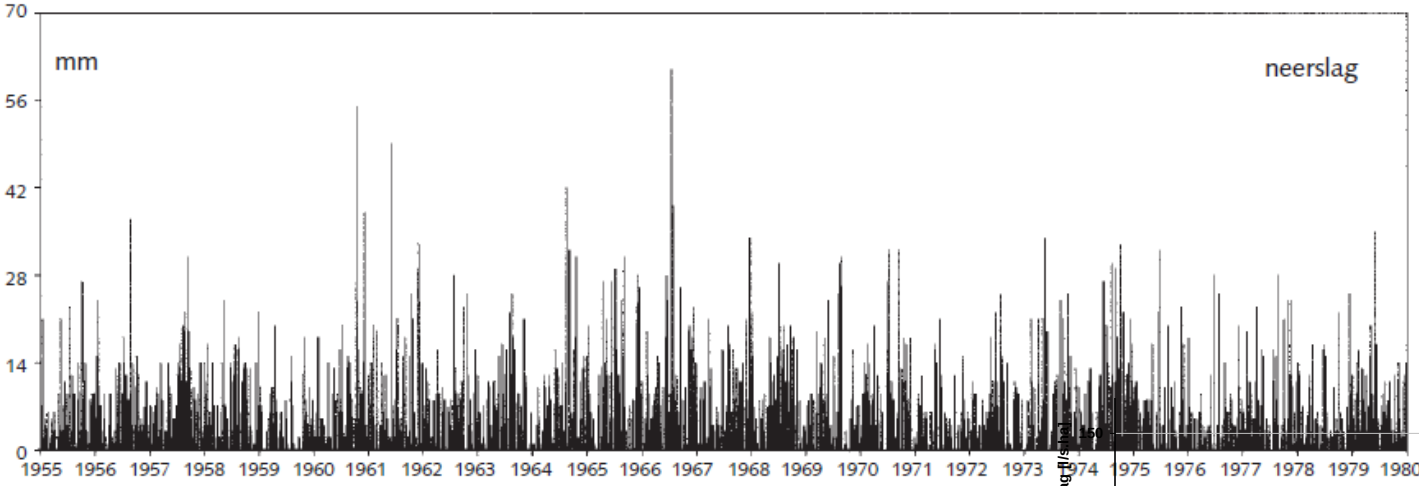
Two approaches:

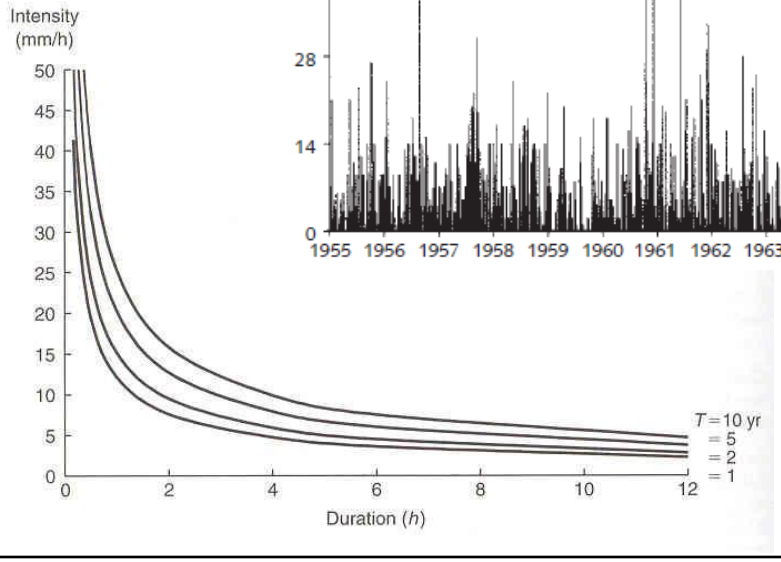
- Stationary/steady state analysis:
  constant rainfall intensity, stationary flow

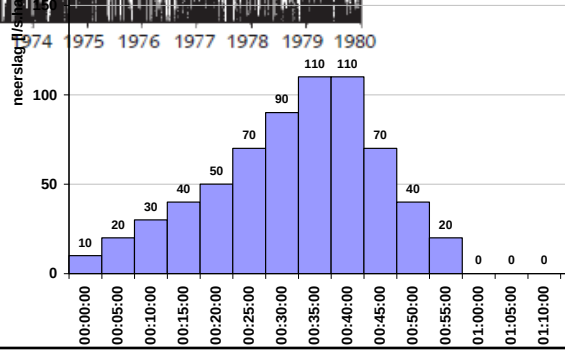
- Dynamic analysis:
  variable rainfall intensity, non-stationary flow

Rainfall data in urban drainage system design and analysis

How to compose or choose a representative rainfall intensity/event from rainfall time-series?







Rainfall data in urban drainage system design and analysis

- for Design:

  How to choose rainfall characteristics, representative of a pre-defined protection level, over a system's lifetime?

Rainfall data in urban drainage system design and analysis

- for Analysis:

  How to find rainfall intensities characteristic of the conditions we want to check performance for?

Stationary rainfall intensity for stormwater design, IDF-curves

Storm water system design and analysis

- What method (stationary/dynamic) to apply when?
- What rainfall intensity/intensities to use for analysis?

Storm water system design and analysis

Examples of design/analysis situations:	Stationary .. Or..	.. Dynamic?
Design of small sewer system in Delft		
Design of small sewer system in Jakarta		
Analysis of small, existing sewer system		
Analysis of large, complex existing sewer system		
Design of large sewer system in Jakarta		

Storm water system design and analysis

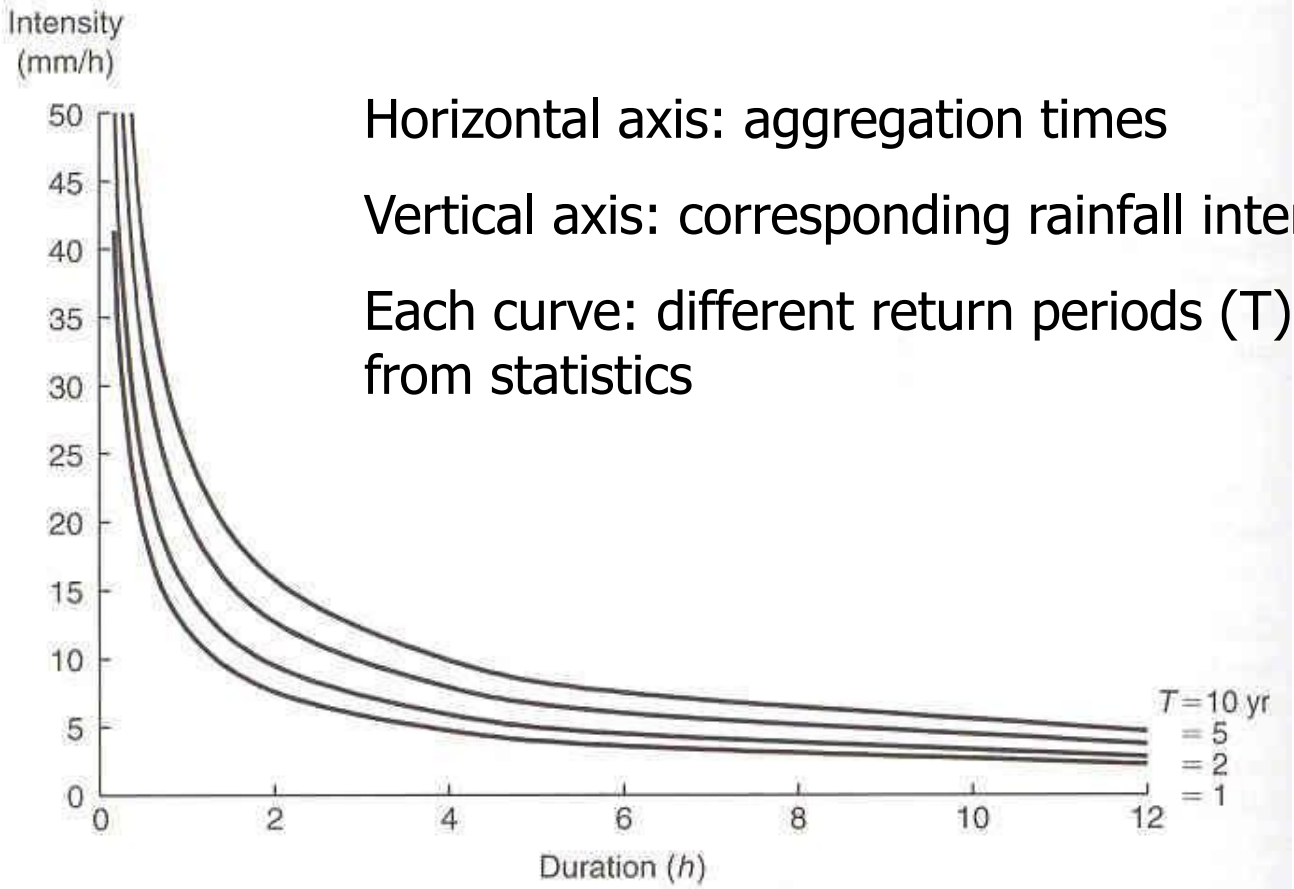
Examples of design/analysis situations:	Stationary .. Or..	.. Dynamic?
NB:		
Complexity of flow network		
Comparison to real-life situation		
Computer resources		
Spatial rainfall variability		

Storm water system design and analysis

Design assignment, part 1: stationary conditions

- Application of Rational Method

Finding a representative IDF curve



Horizontal axis: aggregation times

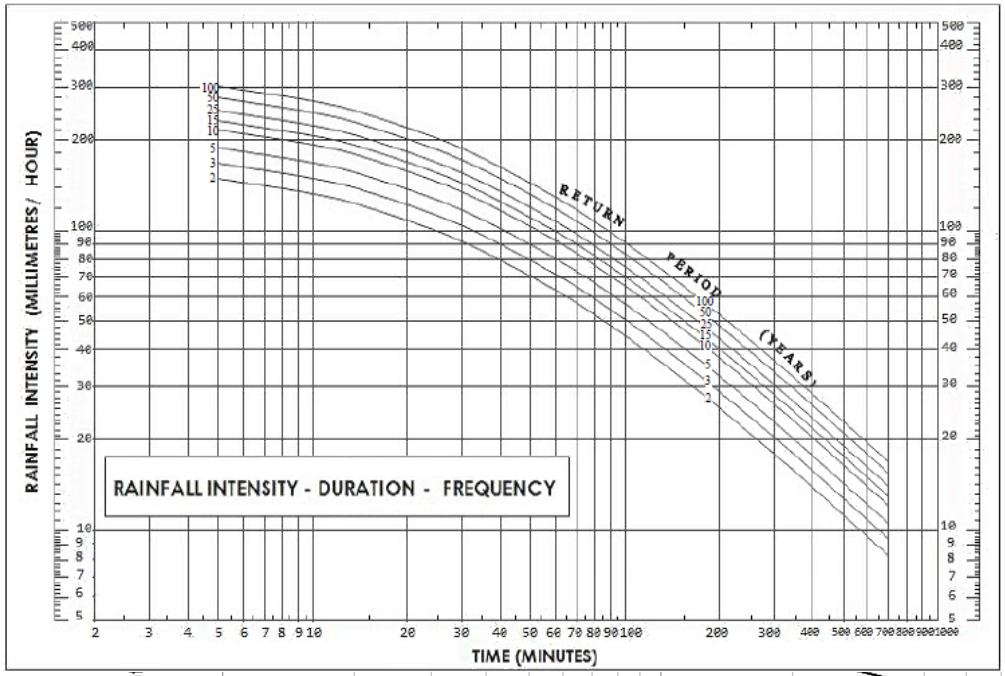
Vertical axis: corresponding rainfall intensities

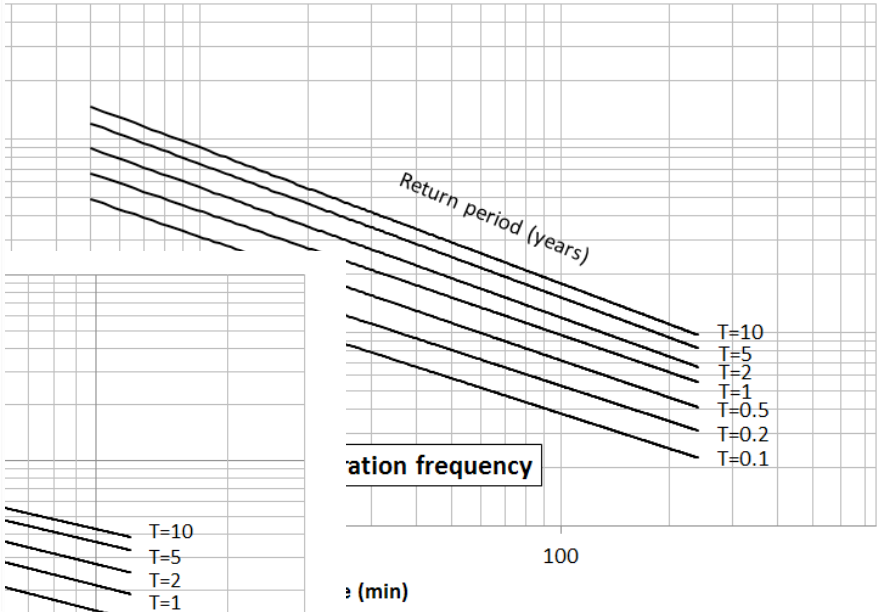
Each curve: different return periods (T), derived from statistics

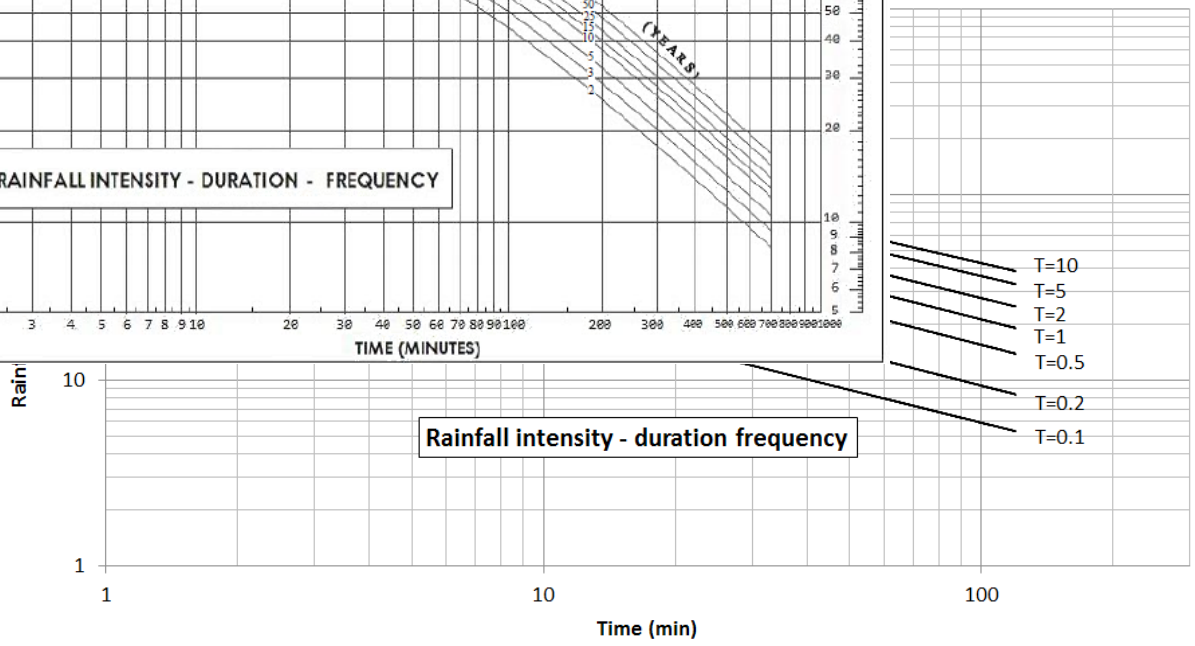
Example of Intensity-Duration-Frequency curves

Finding a representative IDF-curve

Design assignment: 3 IDF-curves provided for 3 different climates: NW-Europe, Mediterranean, Tropics







Finding a representative IDF-curve

Design assignment: 3 IDF-curves provided for 3 different climates: NW-Europe, Mediterranean, Tropics

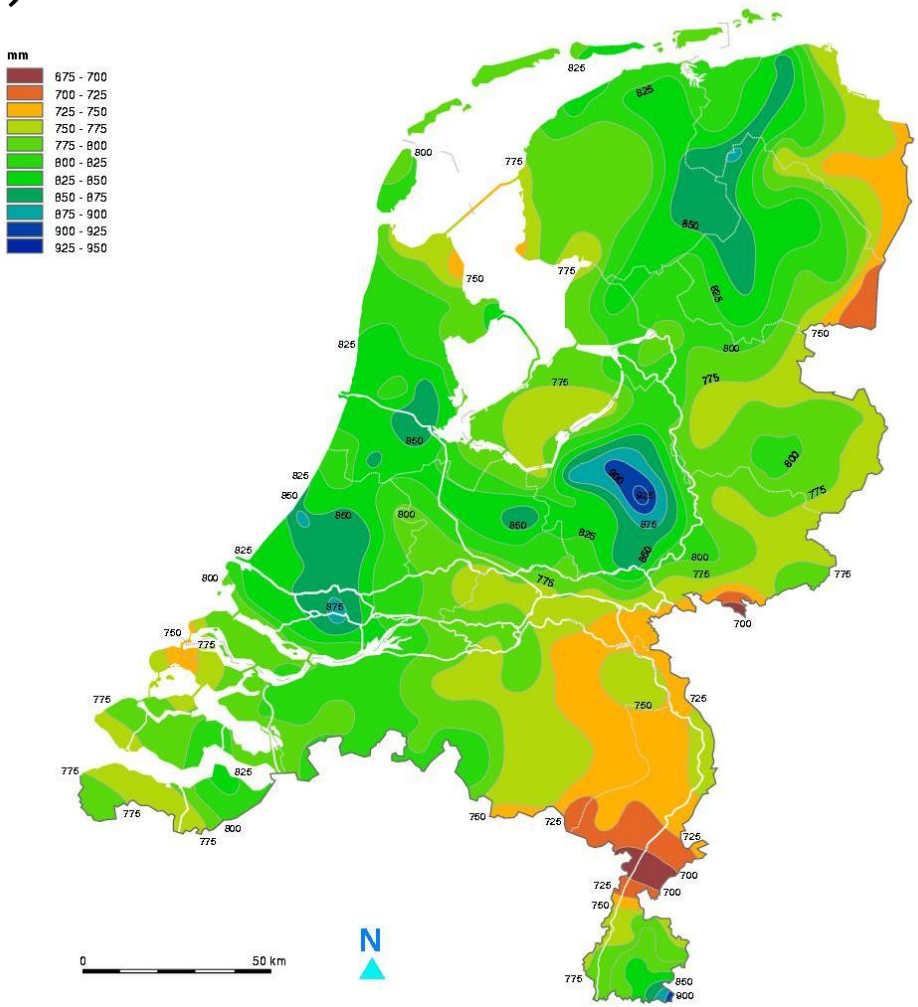
Make a motivated choice for 1 of the curves to use in your design:

- Identify and report which curves stands for which climate
- Choose and motivate use of 1 curve (think for instance of climate change)

Spatial variation, annual rainfall

Average annual
rainfall depth
in the Netherlands
1971-2000

min: 700 mm/yr;
max: 950 mm/yr



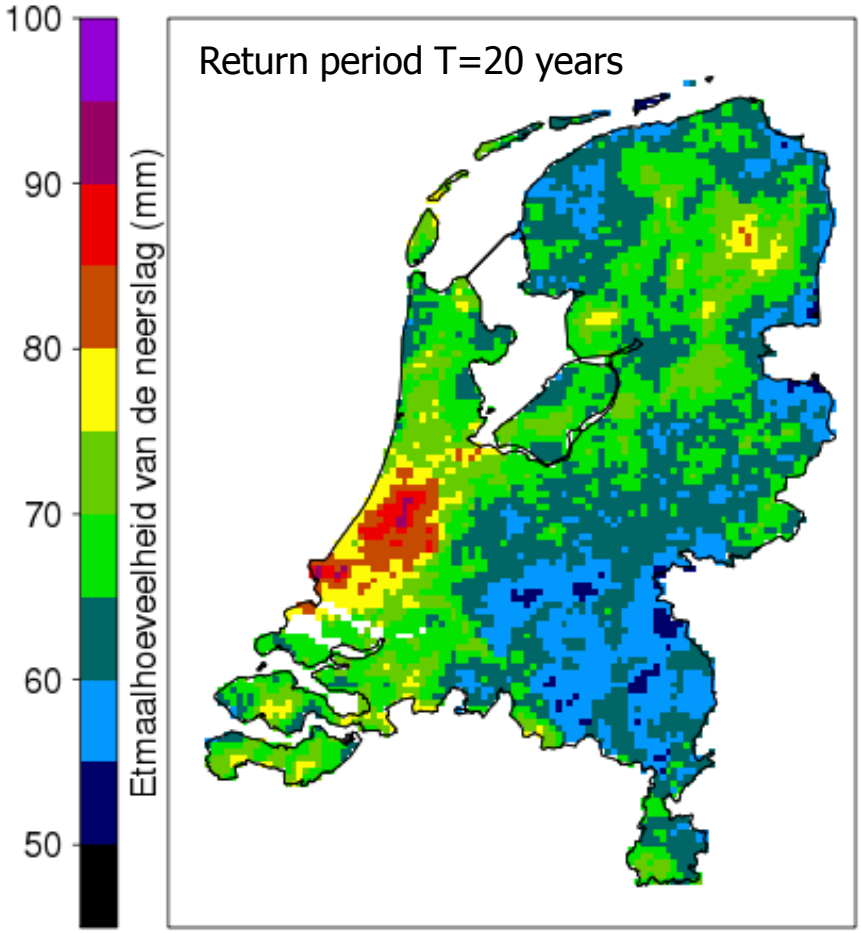
Interpolated rain gauge data, period 1971-2000, Courtesy: KNMI

Spatial variation daily rainfall

Daily rainfall depth in the Netherlands for T=20 yrs

max: 100 mm/day

- Yearly rainfall sums and daily extremes - different spatial pattern



Radar data, period 1998-2008

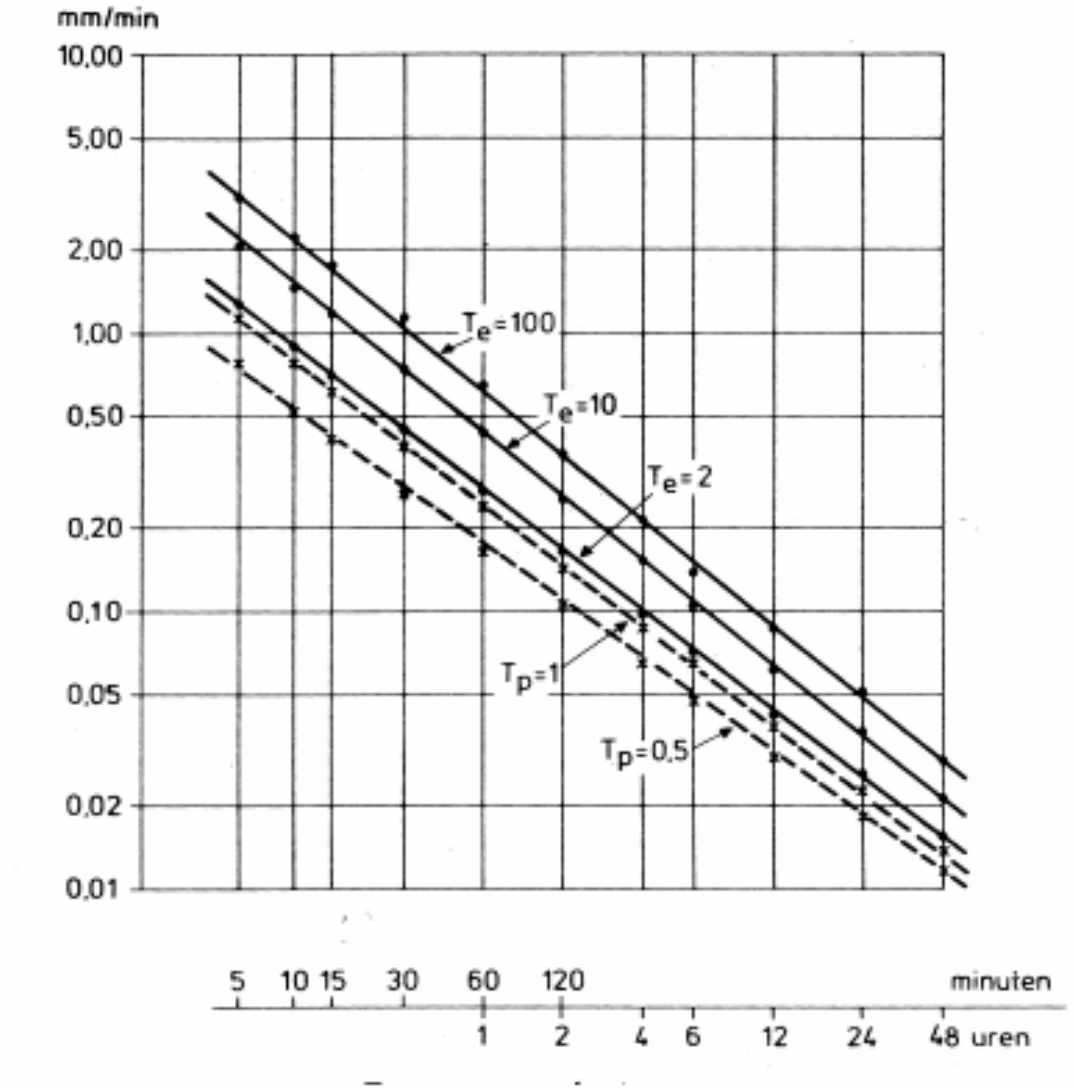
Rainfall curves used in the Netherlands

Statistical curves:

- Braak (1933)
  Rainfall data of different stations during 1899 t/m 1931: 33 years
- Van de Herik en Kooistra (1973)
  Time series based on 5-minute rainfall data collected over 12 years: 1928, 1933 and 1951 – 1960
- Buishand en Velds (1988)
  Time series of rainfall data collected over 1906 - 1977: 72 jaar

Example:
Buishand and Velds
(KNMI report 1980)

Curves are being
updated for climate
change effects
(KNMI, 2004 a.o.)



Extreme neerslagintensiteiten voor De Bilt (1906-1977) voor duren van 5 minuten tot 48 uren. De herhalingstijden T_p en T_e zijn uitgedrukt in jaren.

bron:
KNMI, klimaat van Nederland, Neerslag en verdamping
TA Buishand, CA Velds fig 8.8

Rainfall data in storm water system design and analysis

Stationary conditions: representative of real-life conditions?

Why use stationary conditions and IDF-curves?

- Quickscan required dimensions new system
- Quickscan capacity limits of existing system
- Manual design: where there is no computer

Rainfall data in storm water system design and analysis

Stationary conditions: representative of real-life conditions?

Why use stationary conditions and IDF-curves?

- Manual design: where there is no computer
- Some areas of the world
- 19th and 20th century, up to ±1990

Rainfall data in storm water system design and analysis

Stationary conditions: representative of real-life conditions?

Why use stationary conditions and IDF-curves?

- Manual design: where there is no computer
- where there is a lack of data to build a proper model (many areas worldwide, incl Europe!)

Dynamic rainfall intensity for stormwater design, design storms

Rainfall data in urban drainage design and analysis

- If dynamic calculation is reasonable: use dynamic rainfall conditions

What rainfall characteristics to choose?

- Maximum intensity of a rain event (mm/h)
- Total volume of a rain event (mm)
- Duration of a rain event (h)
- Variation in intensities, high versus low

- What is critical for the system we want to design/analyse?

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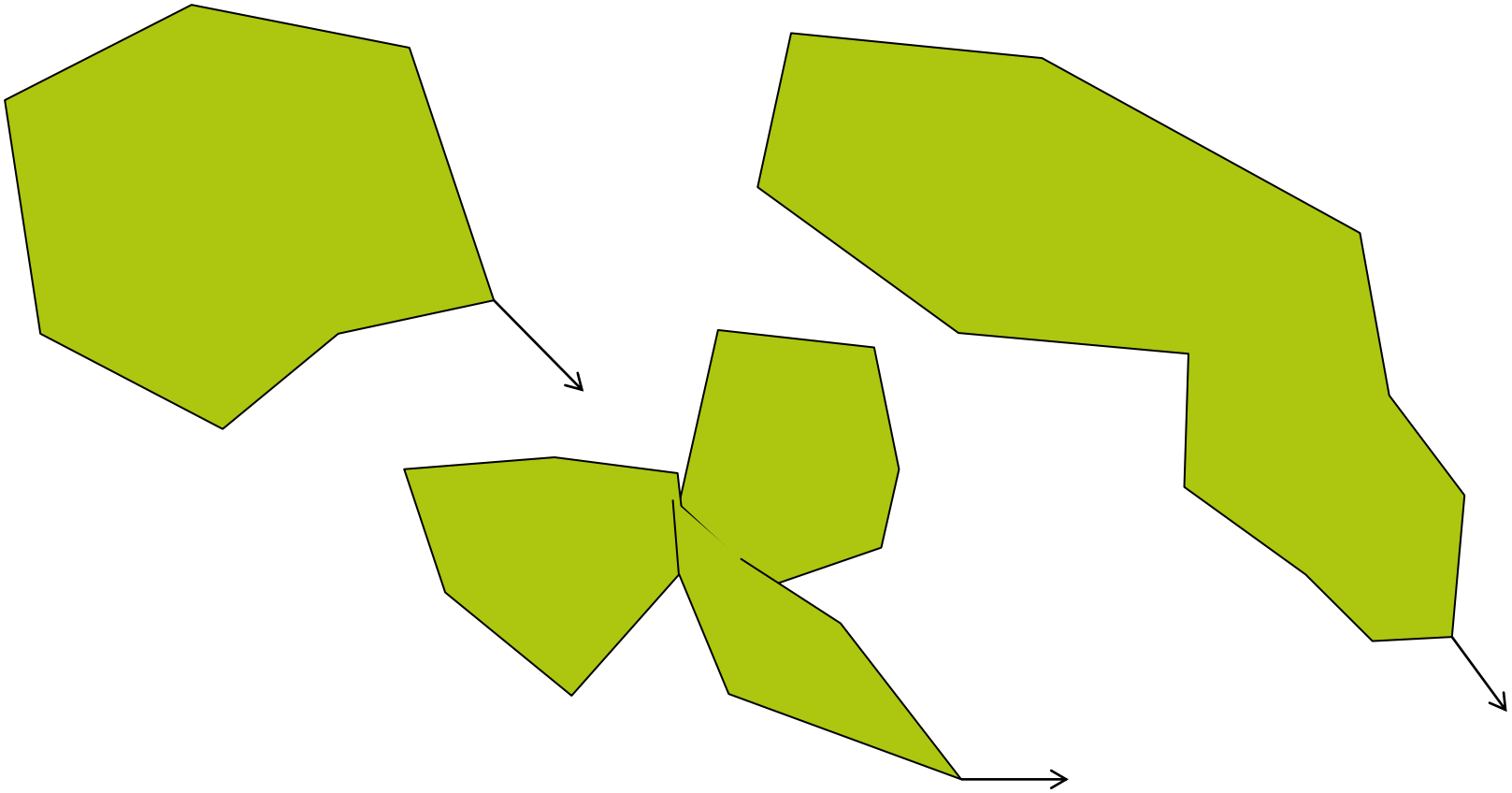
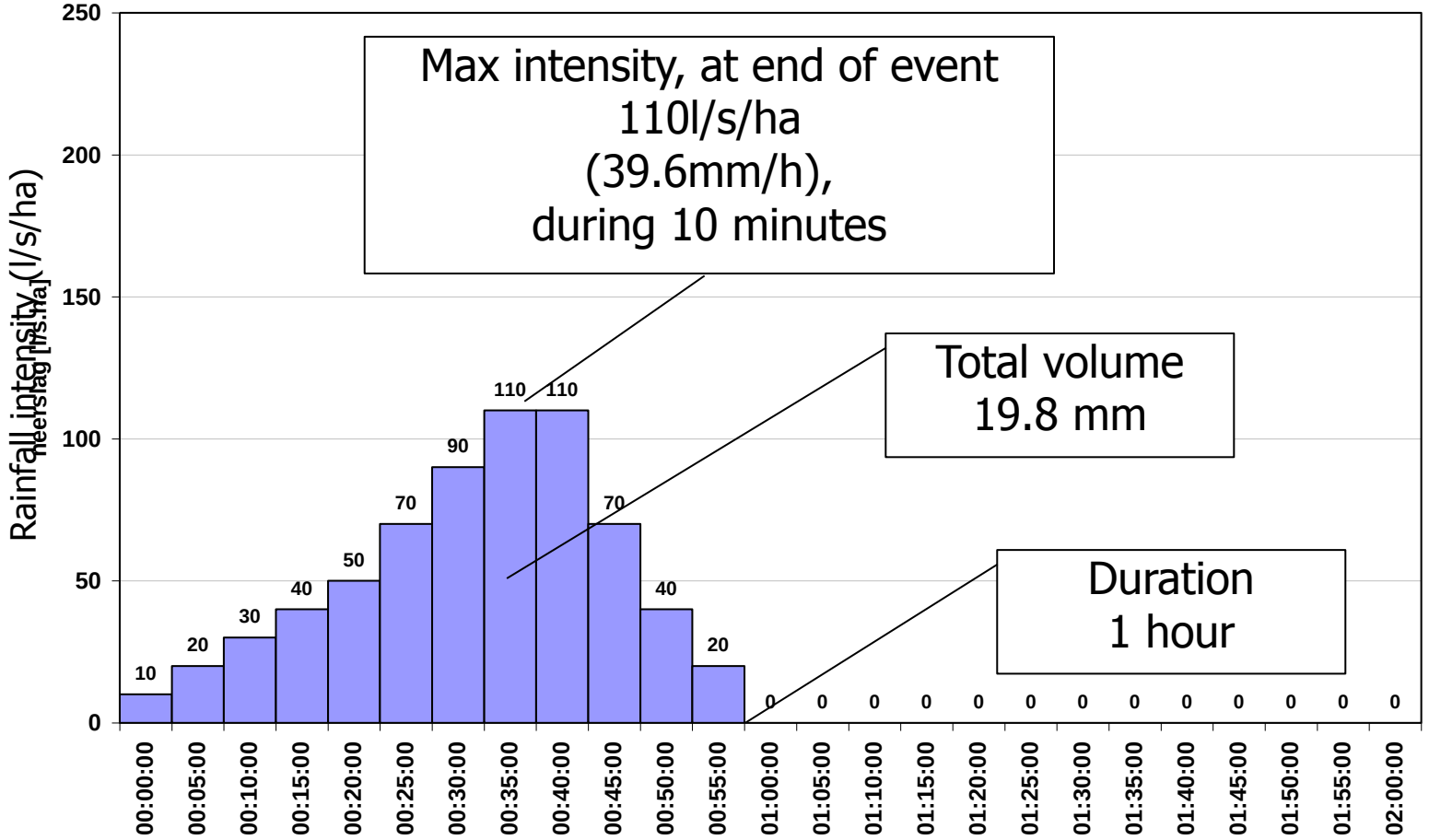
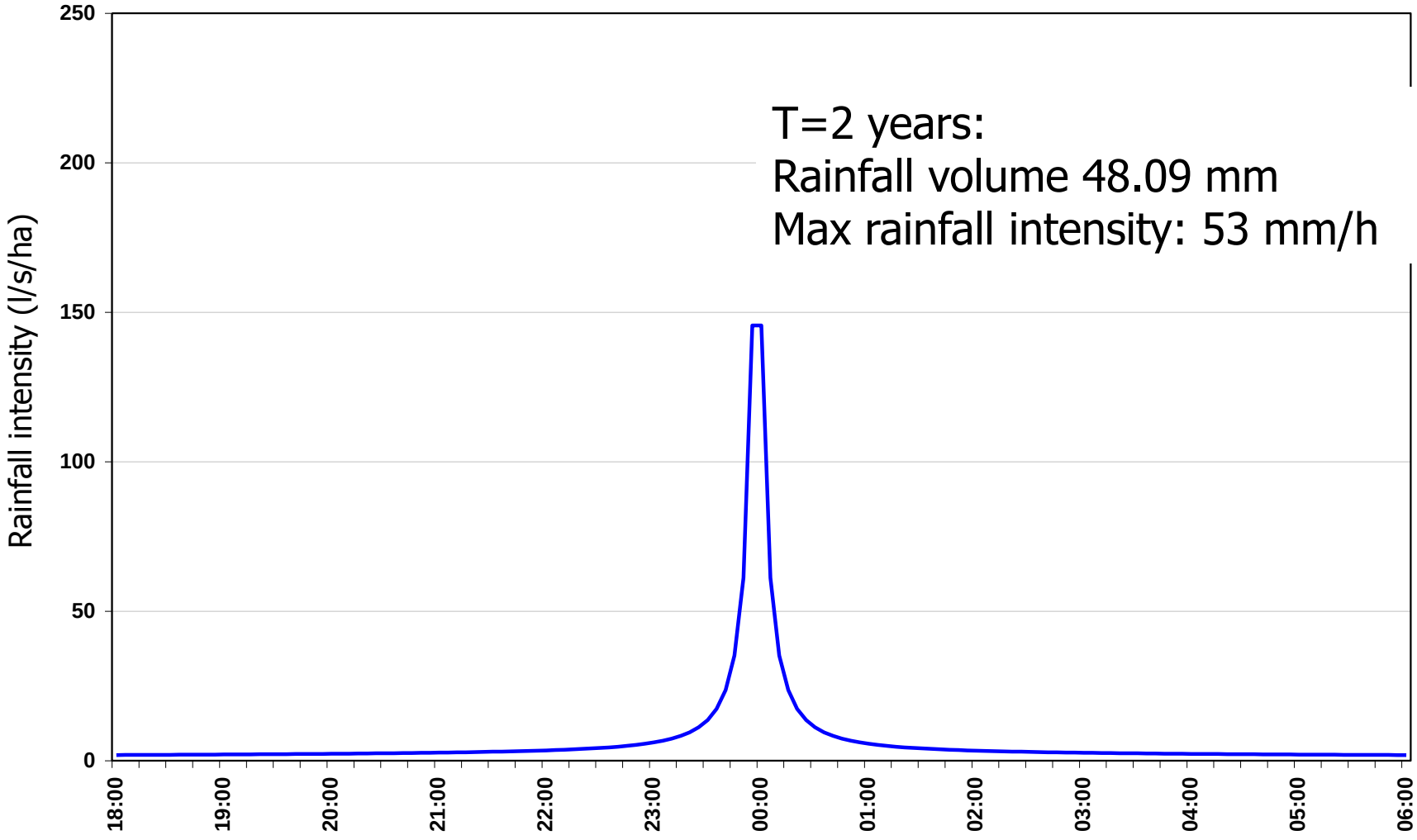


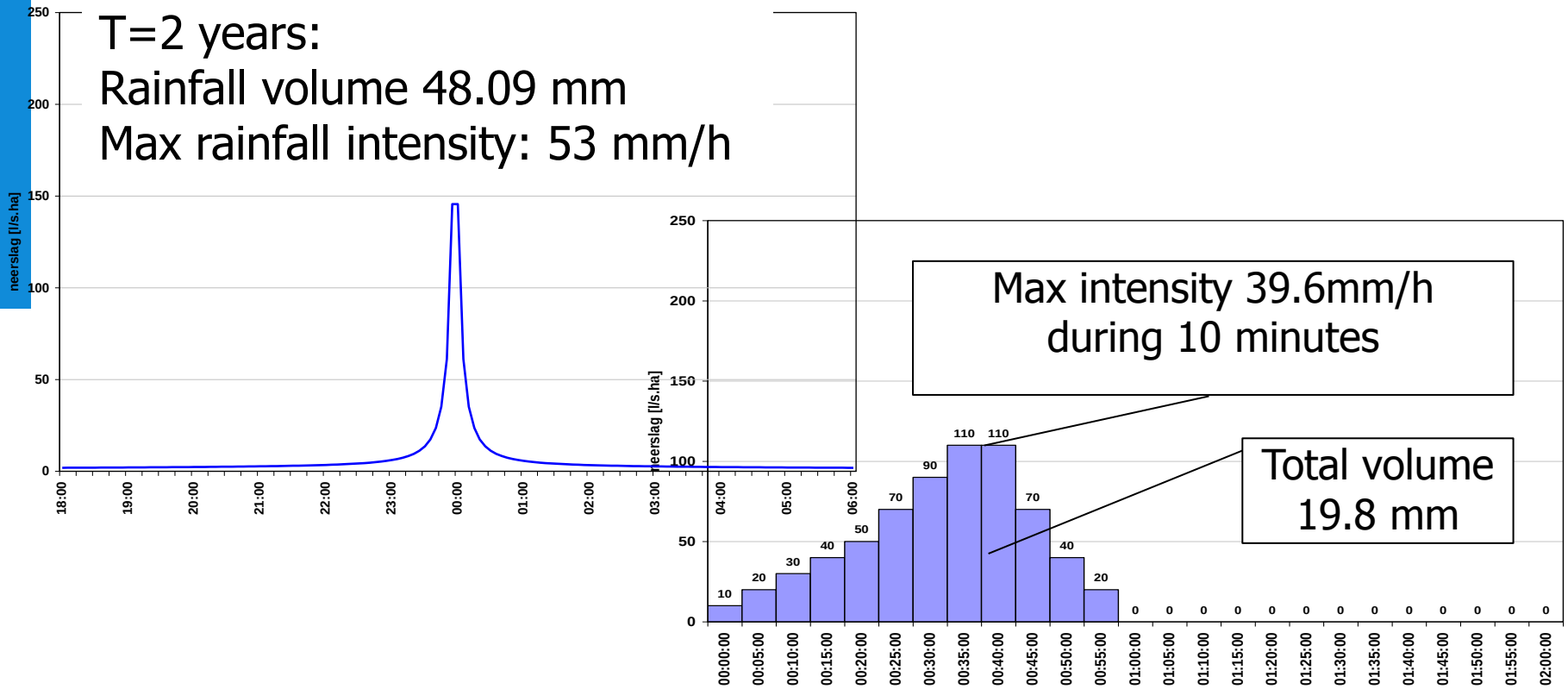
- Depends on characteristics of the catchment: dimensions, imperviousness, slope

Example synthetic standard design storm T=2 years (NL: “Bui 08”)



Synthetic storm T=2 jaar (e.g Belgium)





- Can you explain why different design storms have been chosen for BE and NL?

- What do you expect to find when you apply the BE T=2yr design storm to a system designed according to NL T=2yr storm ?

Use of rainfall data in urban drainage design

Multiple event:

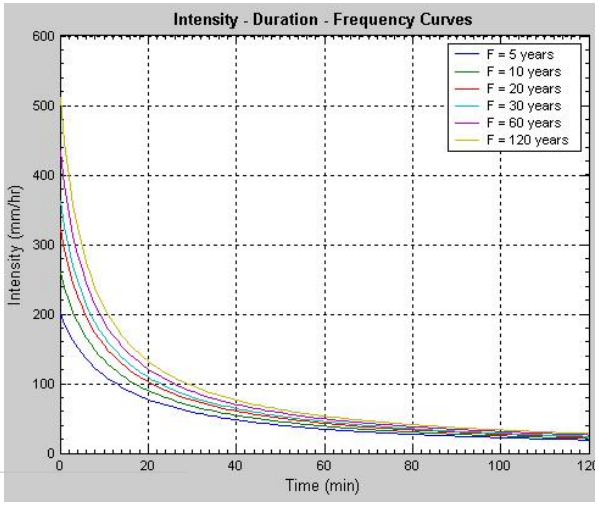
- Historical: rainfall measurements
  e.g. in the Netherlands: time series of KNMI De Bilt,
  15 minute time step:
  - 10 year series: 1955-1964
  - 25 year series: 1955-1979

→ Mainly used for analysis of annual pollution from cso's

→ **Because (why not for flooding analysis?):**

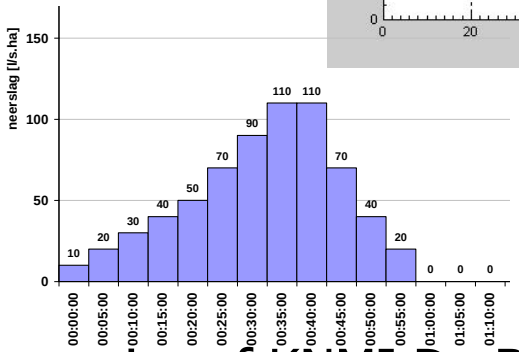
- Synthetic rainfall series

Rainfall input for urban drainage design



To summarise:

- Stationary design
  - IDF curves, fixed design rainfall intensity
- Dynamic design, single event:
  - Design storm



- Multiple event/rainfall series
  - Historical series
    e.g. in the Netherlands: time series of KNMI De Bilt, 10 or 25 yrs
  - Synthetic rainfall series