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CLIMATE CHANGE IMPACT ON HYDROLOGICAL EXTREMES

LILLEHAMMER 2015

Session 3: From modelling to decisions

Complex analysis of flow and duration of floods and droughts in the context of climate change and simple presentation of its results.

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NVE

- **The project aims to estimate the influence of climate changes on extreme river flows (low and high) and evaluate the impact on the frequency of occurrence and magnitude of hydrological extremes.**
- **Eight catchments in Poland and Norway serves as case studies.**

- We address:

(i) the statistical analysis of observed hydrological extreme events time series,
(ii) the development and application of methods for flood and drought frequency analysis in a non-stationary framework,
(iii) the development of hydrological projections for likely changes in extremes and assessment of the projections' uncertainty, and
(iv) recommendations for an adaptation strategy for managing the impact of climate change on hydrological extremes in the context of the European Flood Directive.

Analysis of annual maxima and minima is not enough

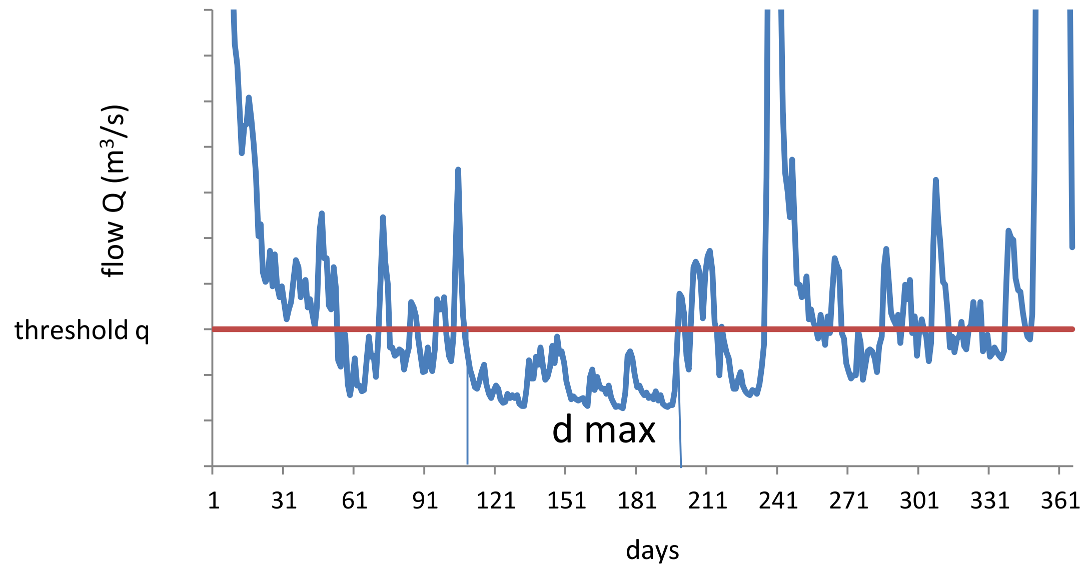
↓

Duration of extreme events is needed

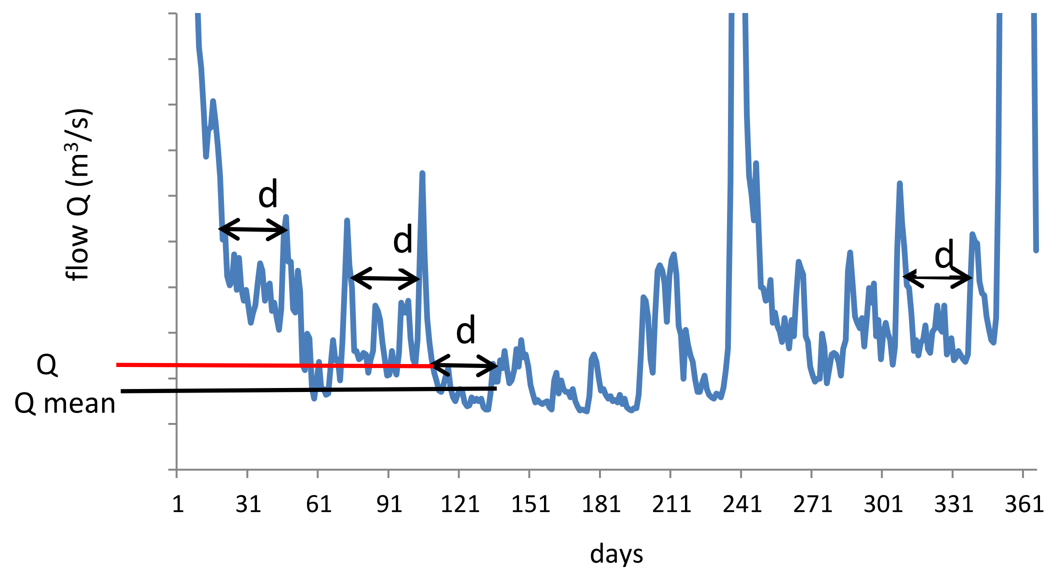
Duration-flow-frequency	Flow-duration-frequency
DqF	**QdF**
q – fixed value	d – fixed value
D – random variable	Q – random variable

Low flows

DqF approach

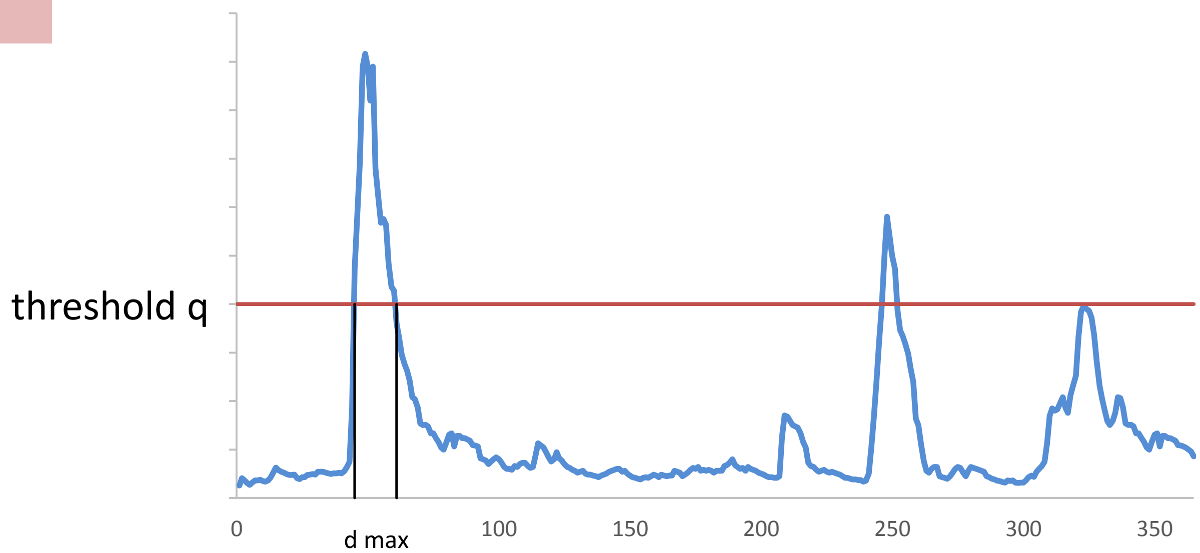


QdF approach

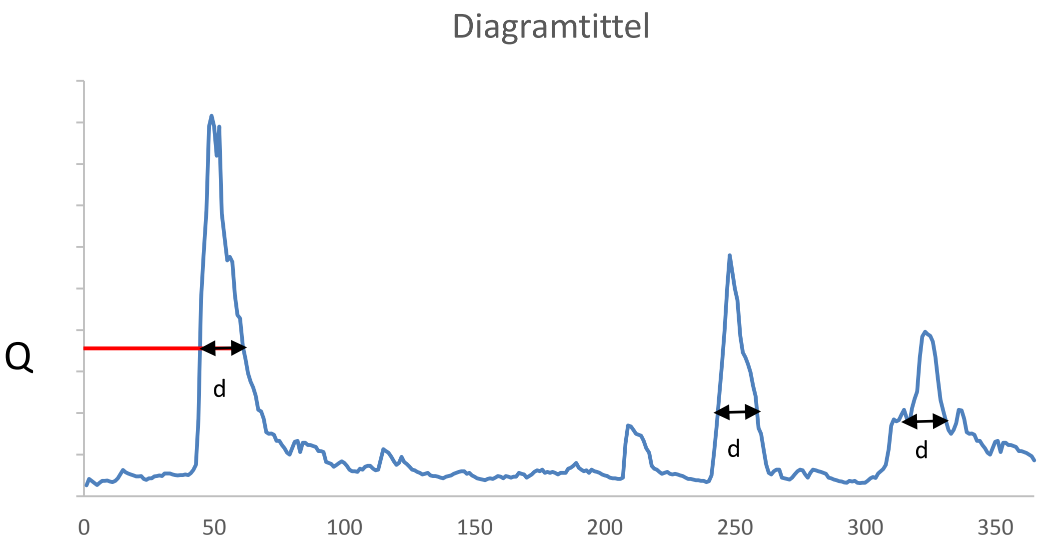


High flows

DqF approach



QdF approach



DqF models

The distribution of D is mixed with PDF and CDF:

$$f(d) = \beta \cdot \delta(d) + (1-\beta) \cdot g(d|D>0;\boldsymbol{\varphi})$$

$$F(d) = \beta \cdot \mathbf{1}_{[0,\infty)}(d) + (1-\beta) \cdot G(d;\boldsymbol{\varphi})$$

where β=P(D=0)

We have focused on:

Low flows	$\beta = \beta_{min}$, $1 - \beta_{min} = P(D>0)$
High flows	$\beta = \beta_{max}$, $1 - \beta_{max} = P(D>0)$

QdF models

Low flows

Quantile function :

$$Q(d,F) = Q(0,F) \cdot \left(1 + \frac{d}{D_{min}}\right)$$

Distribution of minimum flow non-exceeded in d days
or minimum mean d-day flow

Annual minima distribution

D_{min} parameter of low flows dynamics

High flows

Quantile function :

$$Q(d,F) = Q(0,F) / \left(1 + \frac{d}{D_{max}}\right)$$

Distribution of maximum flow exceeded in d days
or maximum mean d-day flow

Annual maxima distribution

D_{max} parameter of high flows dynamics

CHIHE Polish catchments

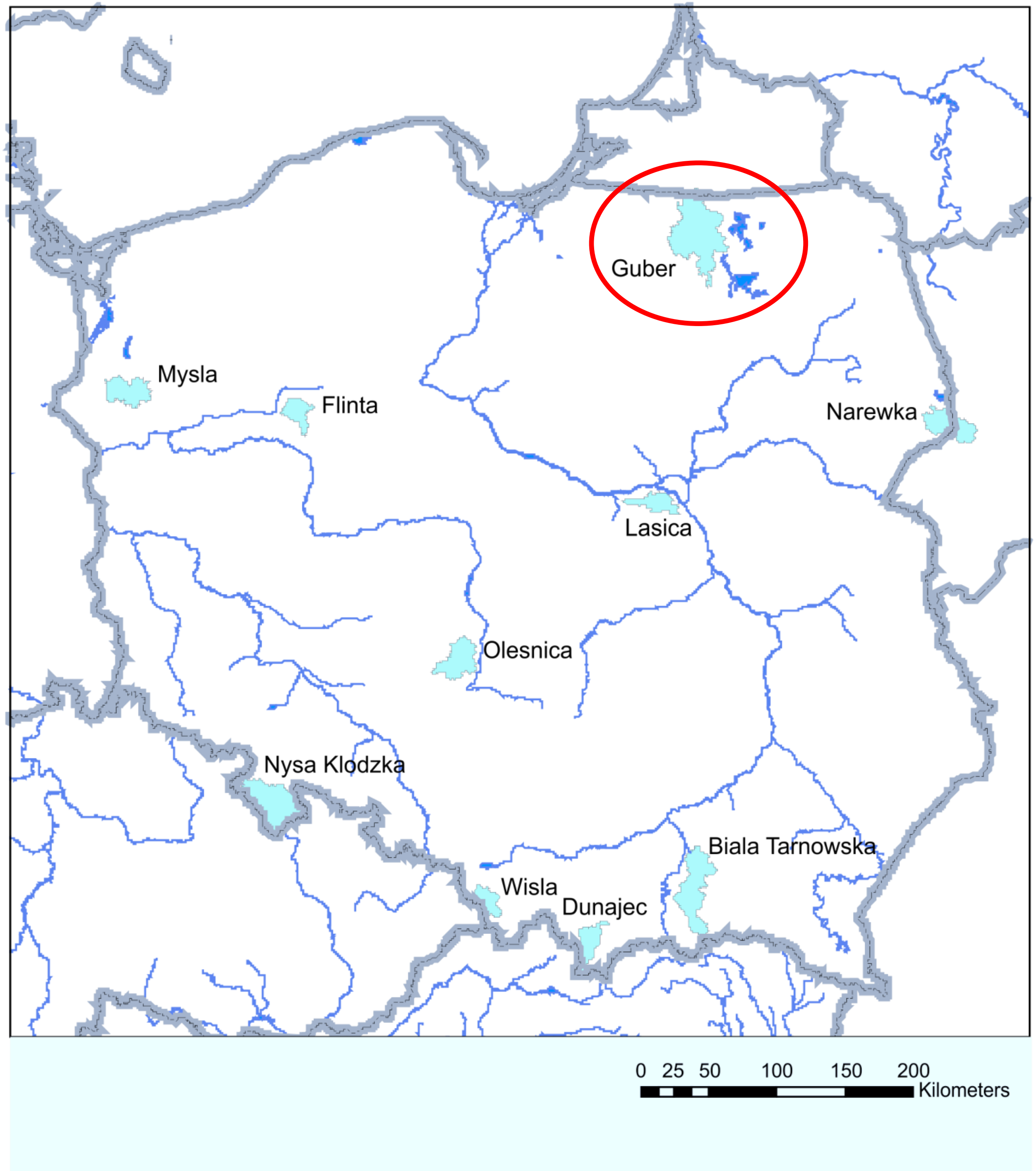
…with natural or quasi-natural water regime.

Chosen reference period 1971-2000.

River: Guber

Station: Prosna

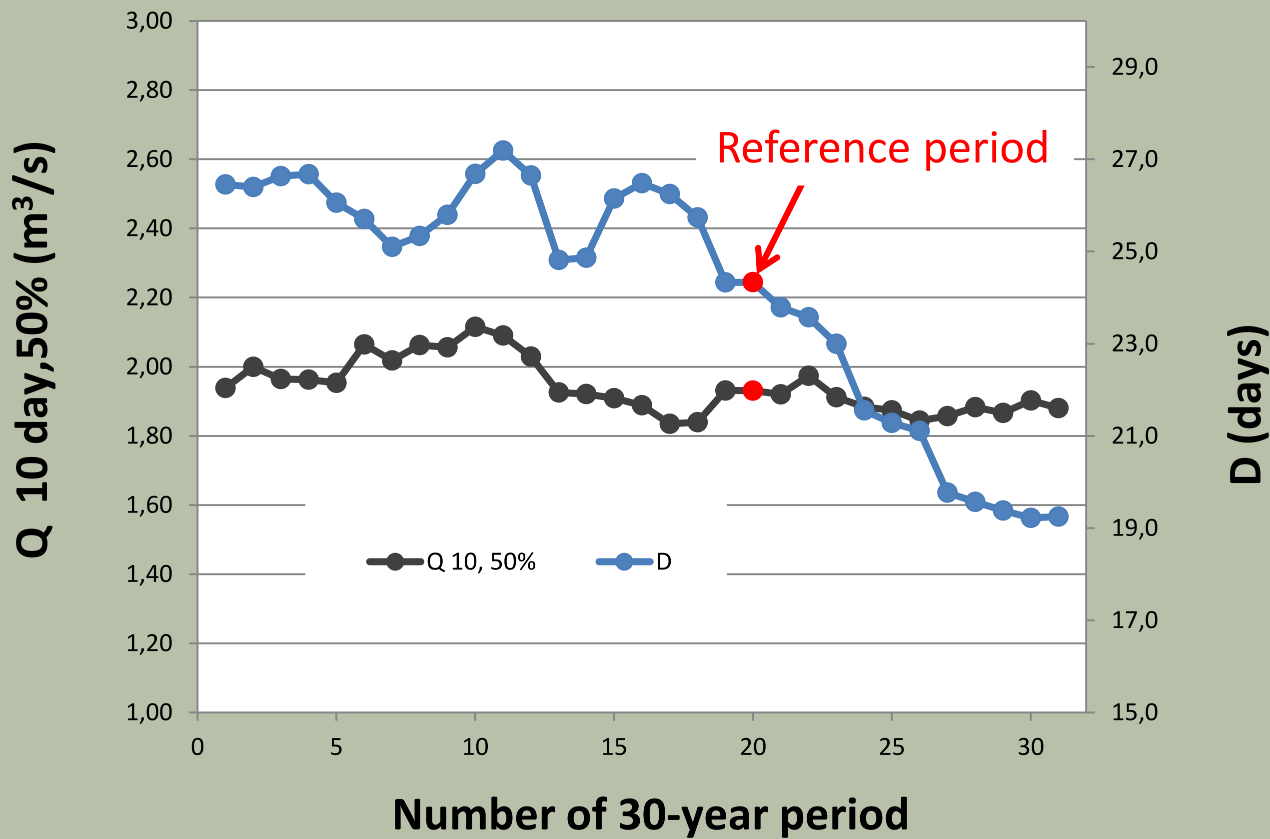
$A=1567{,}8\ km^2$

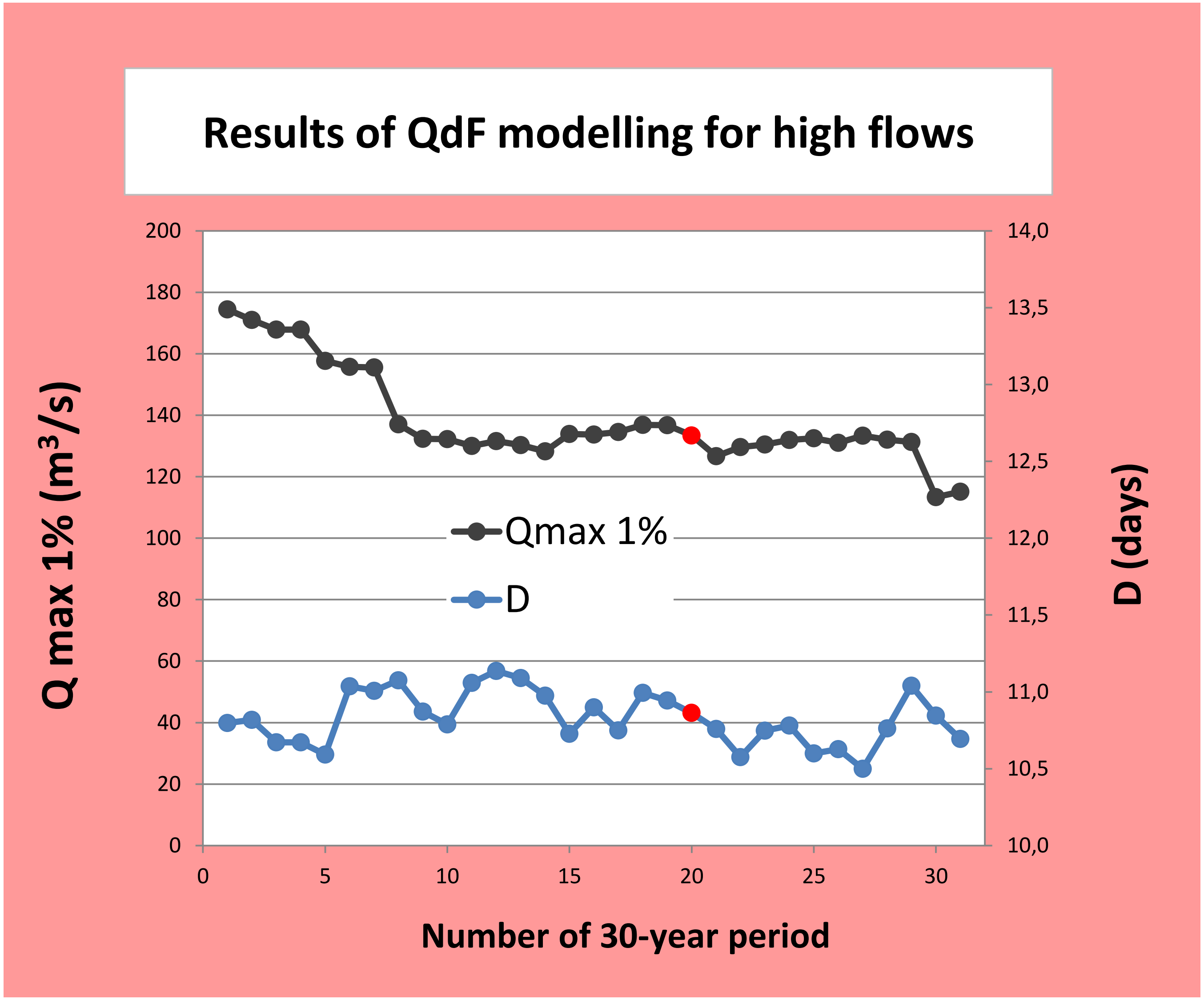


The Guber River near Prosna

Both models DqF and QdF have been estimated for 30-year periods: 1951-1980, 1952-1981, 1953-1982,…

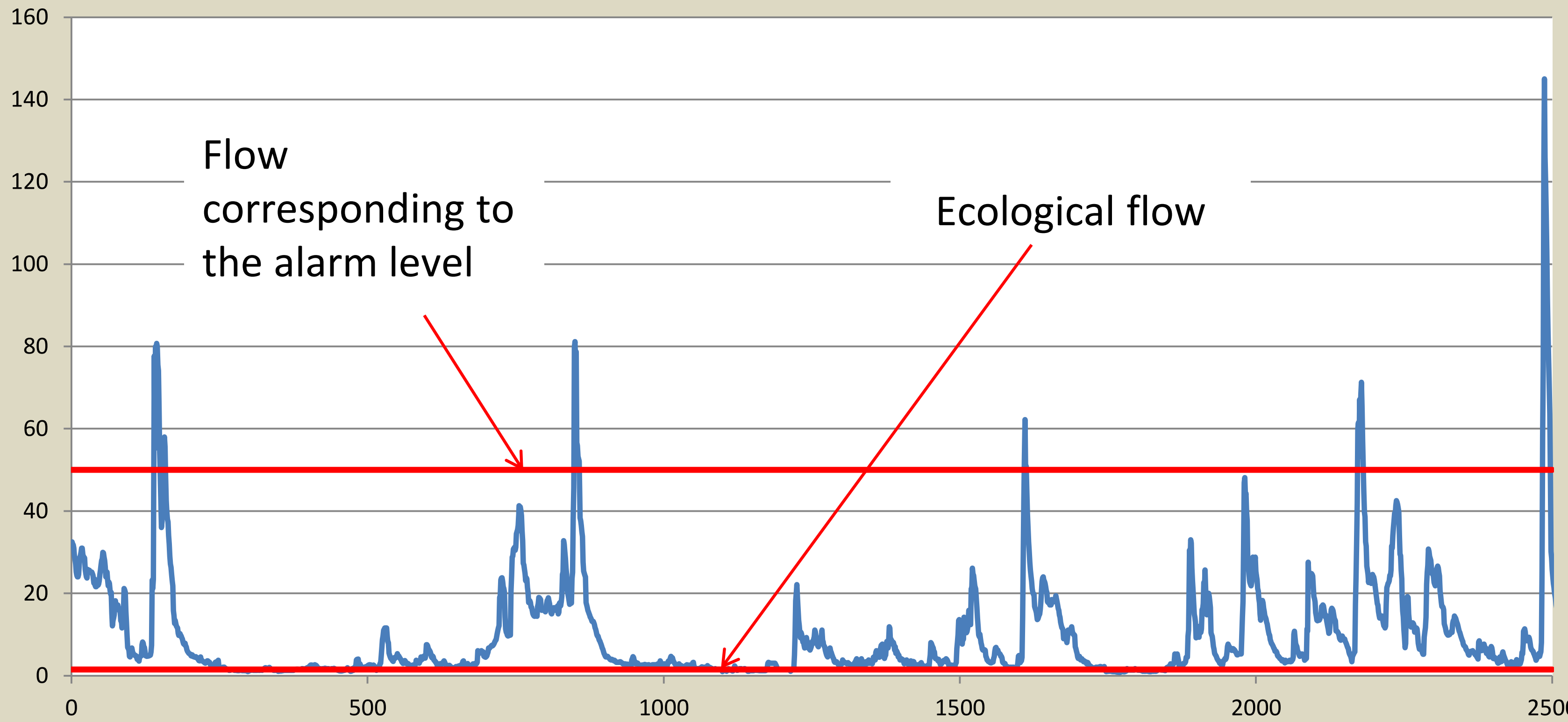
Results of QdF modelling for low flows

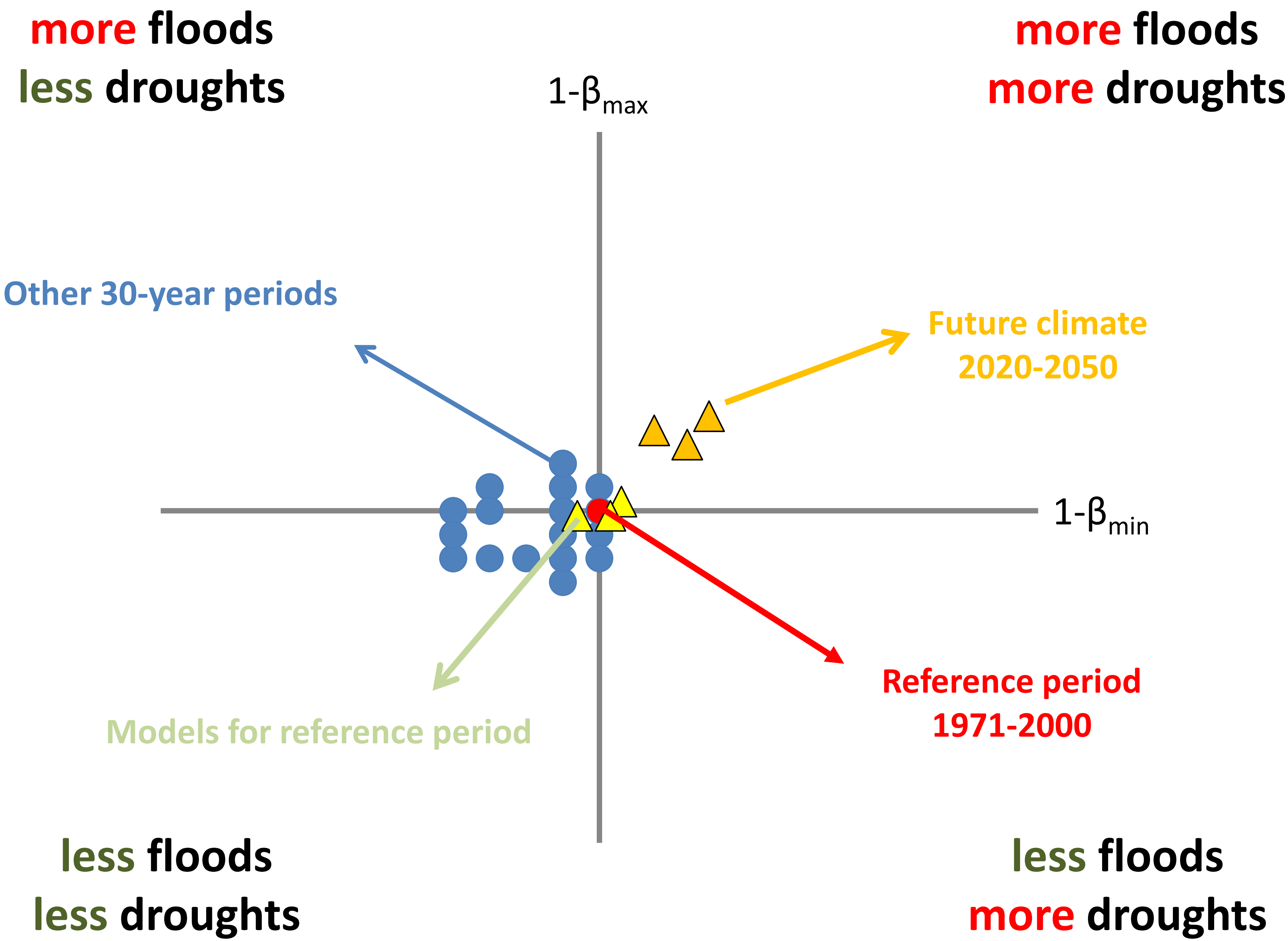


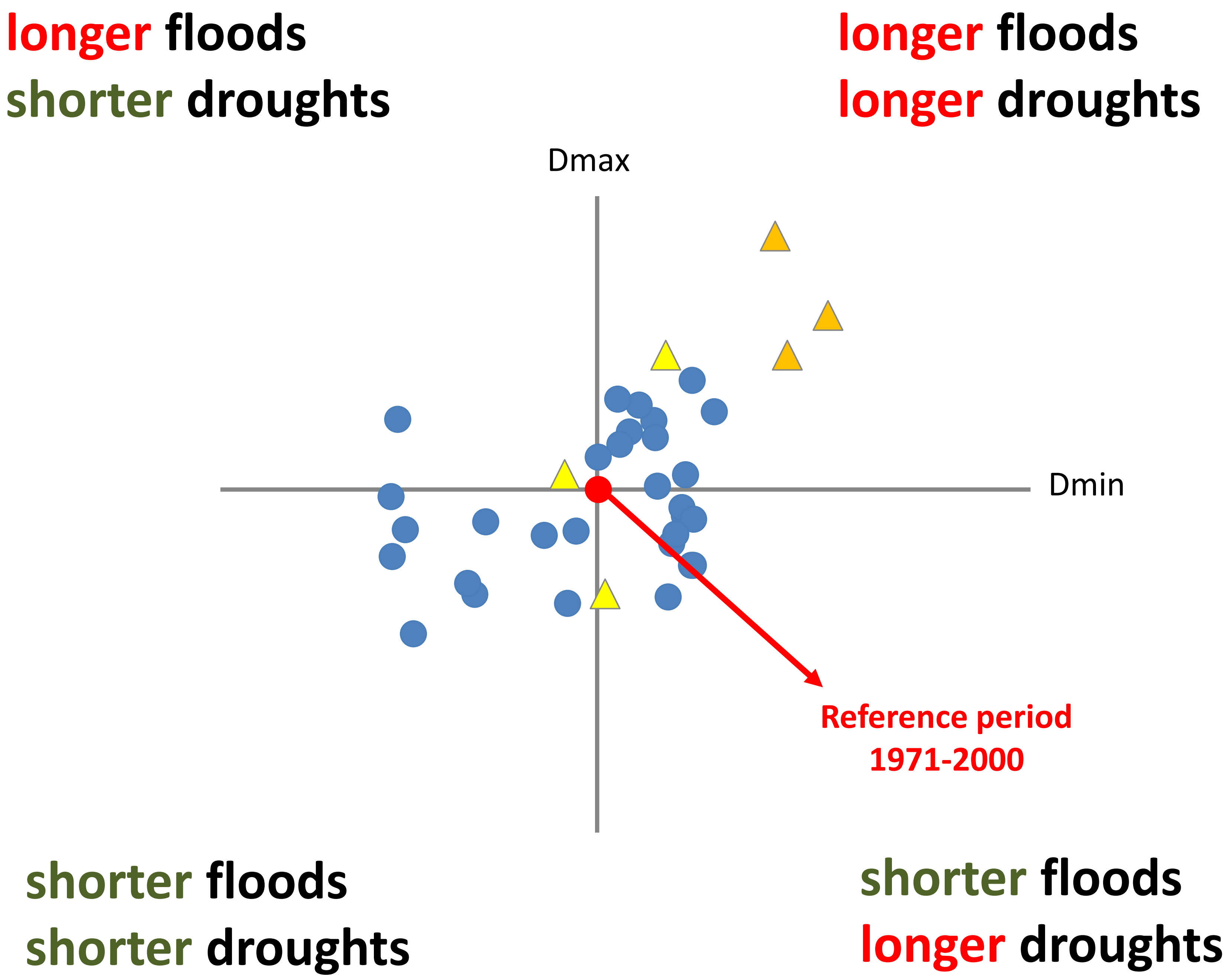

Results of QdF modelling for high flows
Q max 1% (m3/s)
D (days)
Qmax 1%
D
200
180
160
140
120
100
80
60
40
20
0
14,0
13,5
13,0
12,5
12,0
11,5
11,0
10,5
10,0
0
5
10
15
20
25
30
Number of 30-year period

DqF

In most cases we are interested in two threshold values….




more floods
less droughts
more floods
more droughts
$1-\beta_{max}$
Other 30-year periods
Future climate
2020-2050
$1-\beta_{min}$
Reference period
1971-2000
Models for reference period
less floods
less droughts
less floods
more droughts


longer floods
shorter droughts
longer floods
longer droughts
Dmax
Dmin
Reference period
1971-2000
shorter floods
shorter droughts
shorter floods
longer droughts

Thank you for your attention.