World Meteorological Organization

Weather • Climate • Water

WMO, Second Meeting of the RA VI Hydrology forum,
24 - 26 September 2014, Warsaw

Inventory of monitoring needs; network optimization and strategic planning

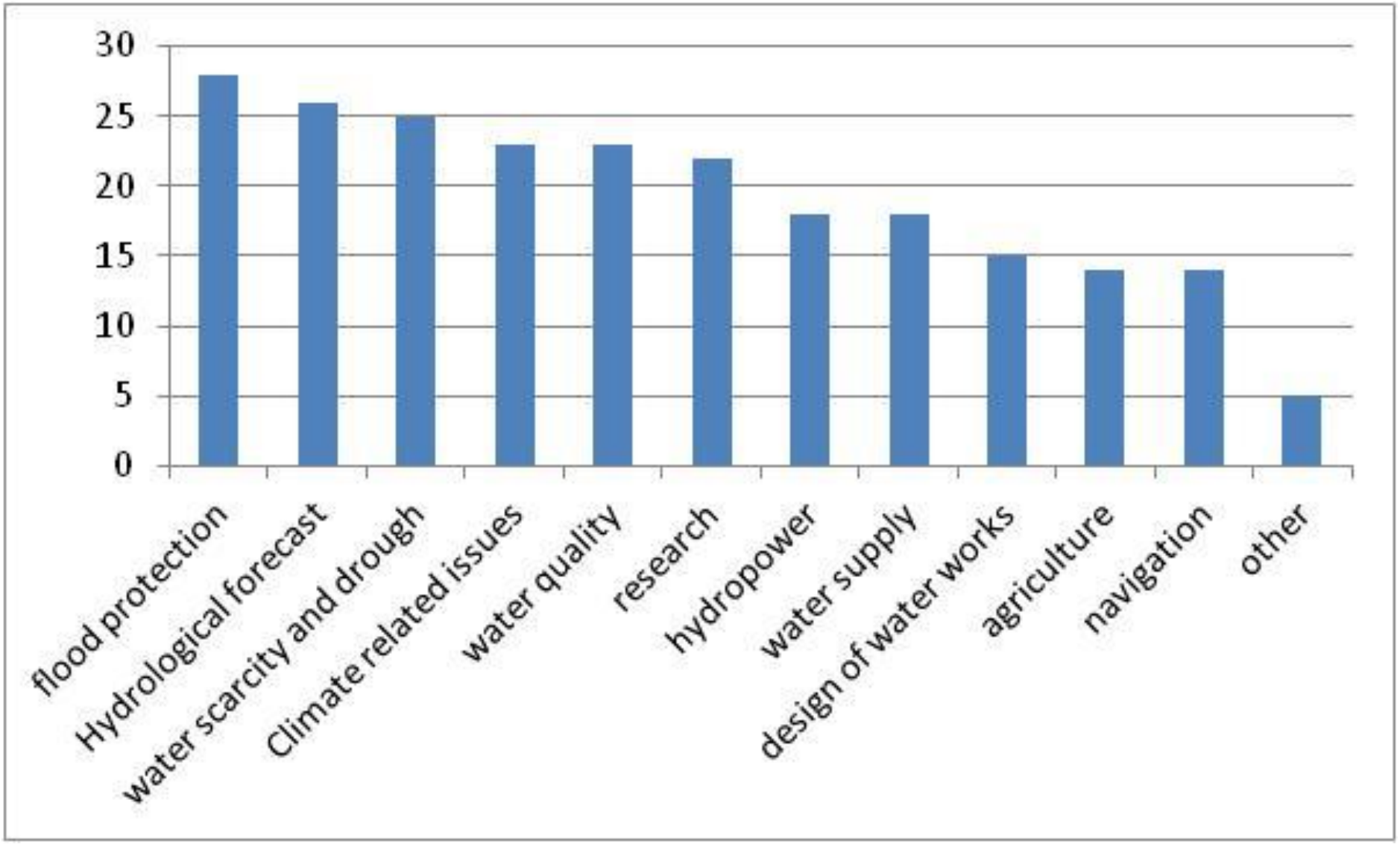
Dominique Bérod

Challenges

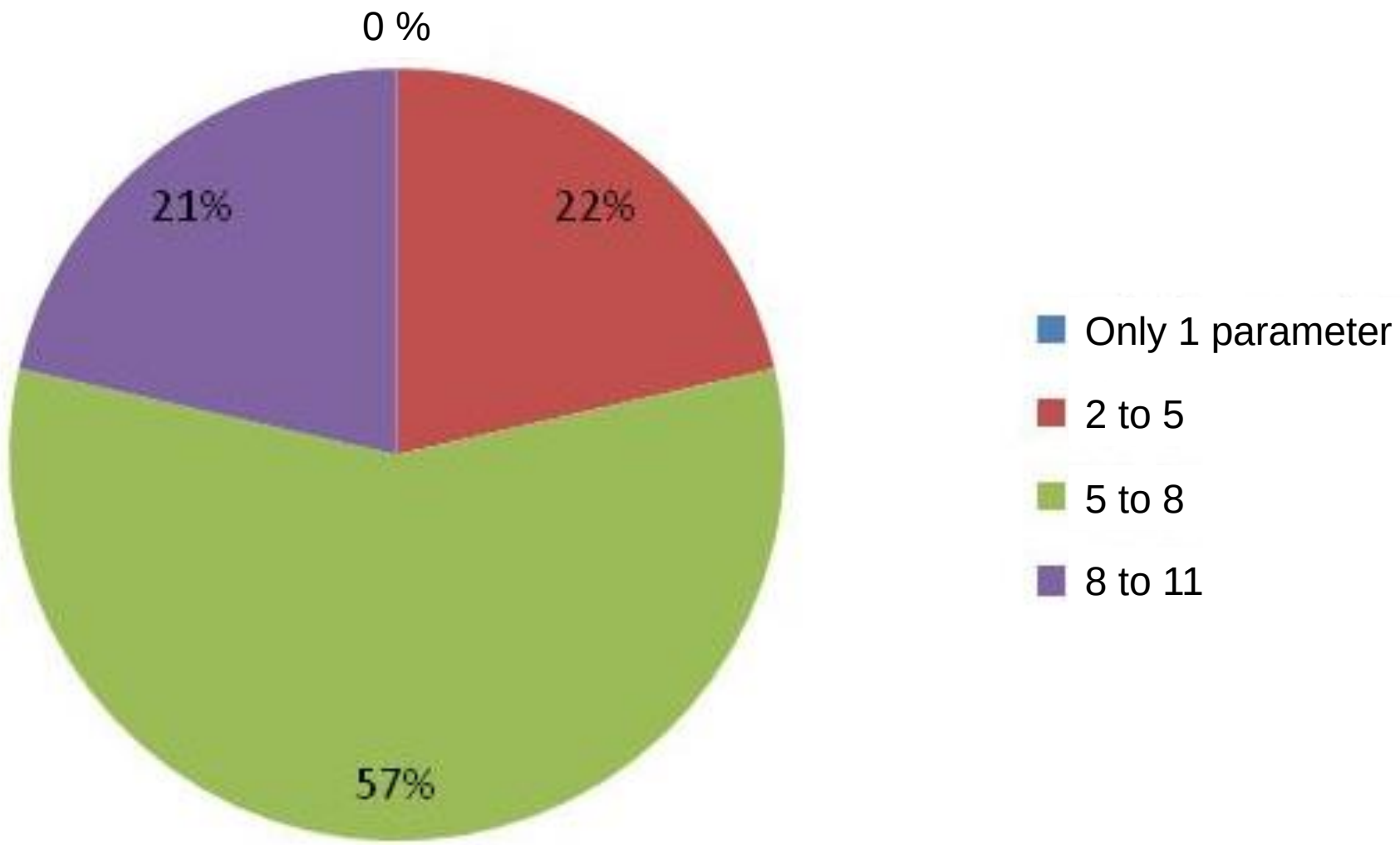
1. **Topical**
   - Increasing and very diverse need for new parameters and new products
   - Long term series, real time data
   - Natural and anthropic changes in catchments and regimes

2. **Financial and political**
   - Financial and personal resources are shrinking
   - Lack of visibility of NHS

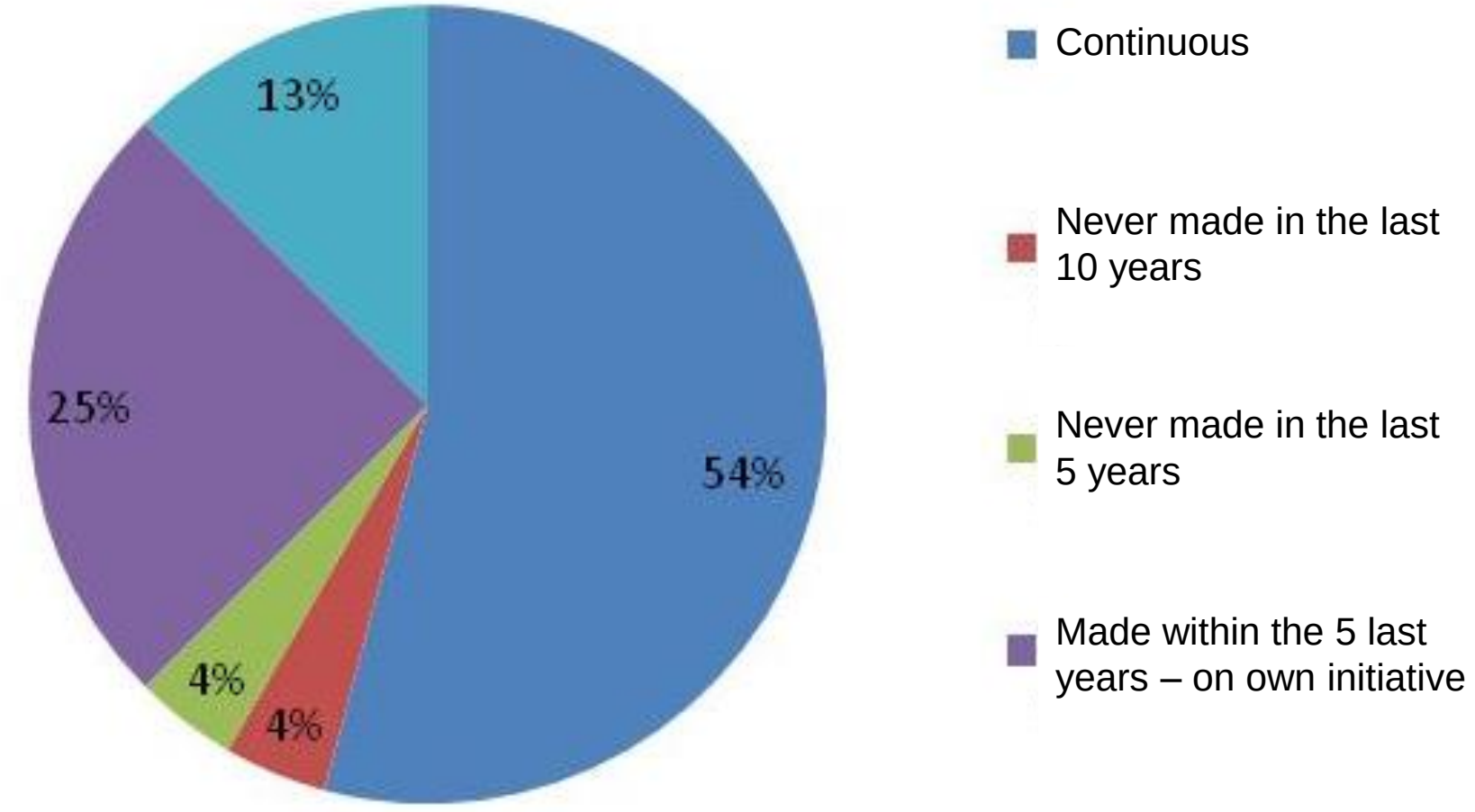
RA VI survey 2011: network objectives



RA VI survey 2011: parameters



RA VI survey 2011: network optimisations

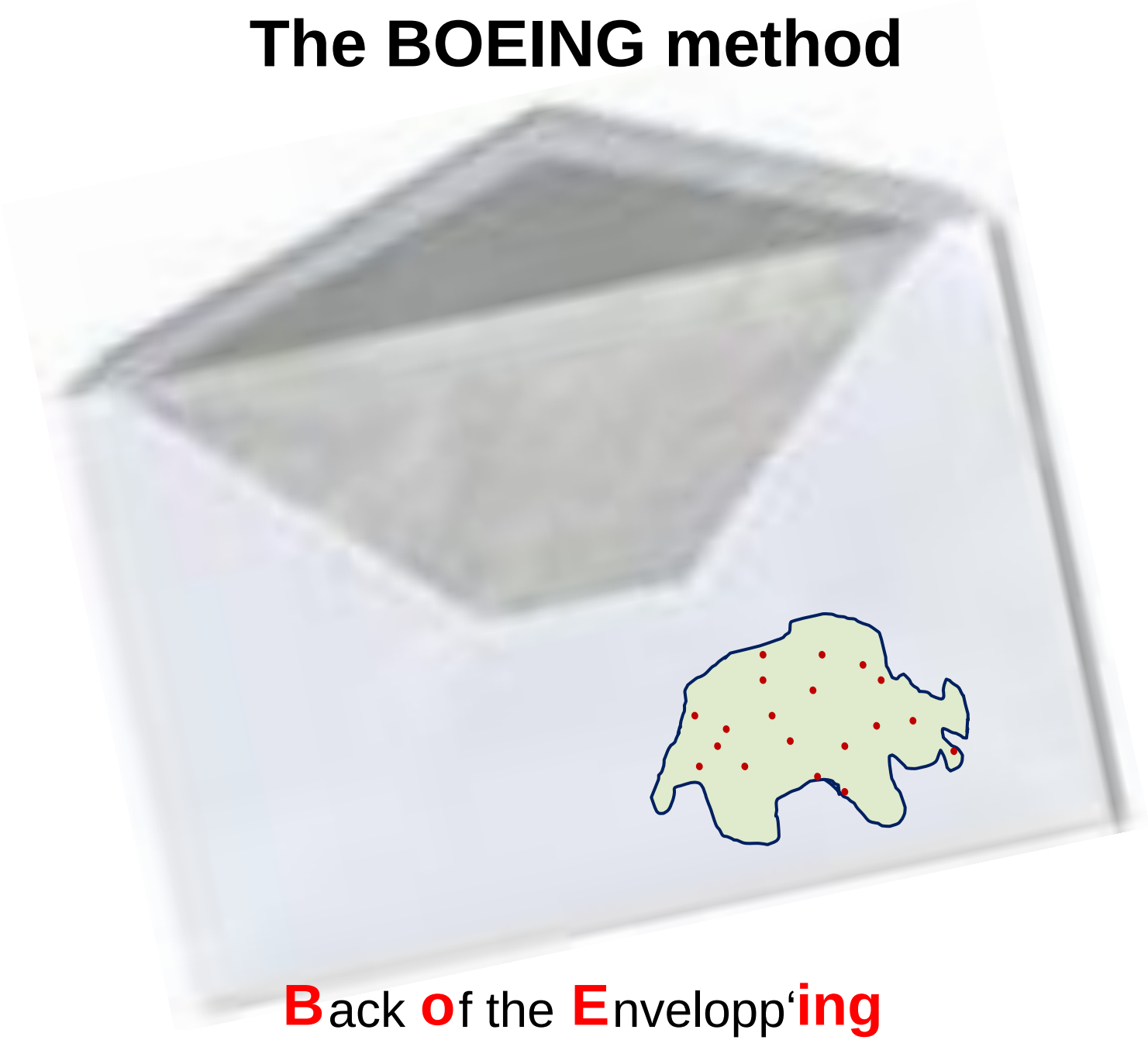


Optimization mainly based on experience and local characteristics

Optimisation methods

1. BOEING
2. Recommendations of WMO
3. Scientific approaches
4. Pragmatic approaches

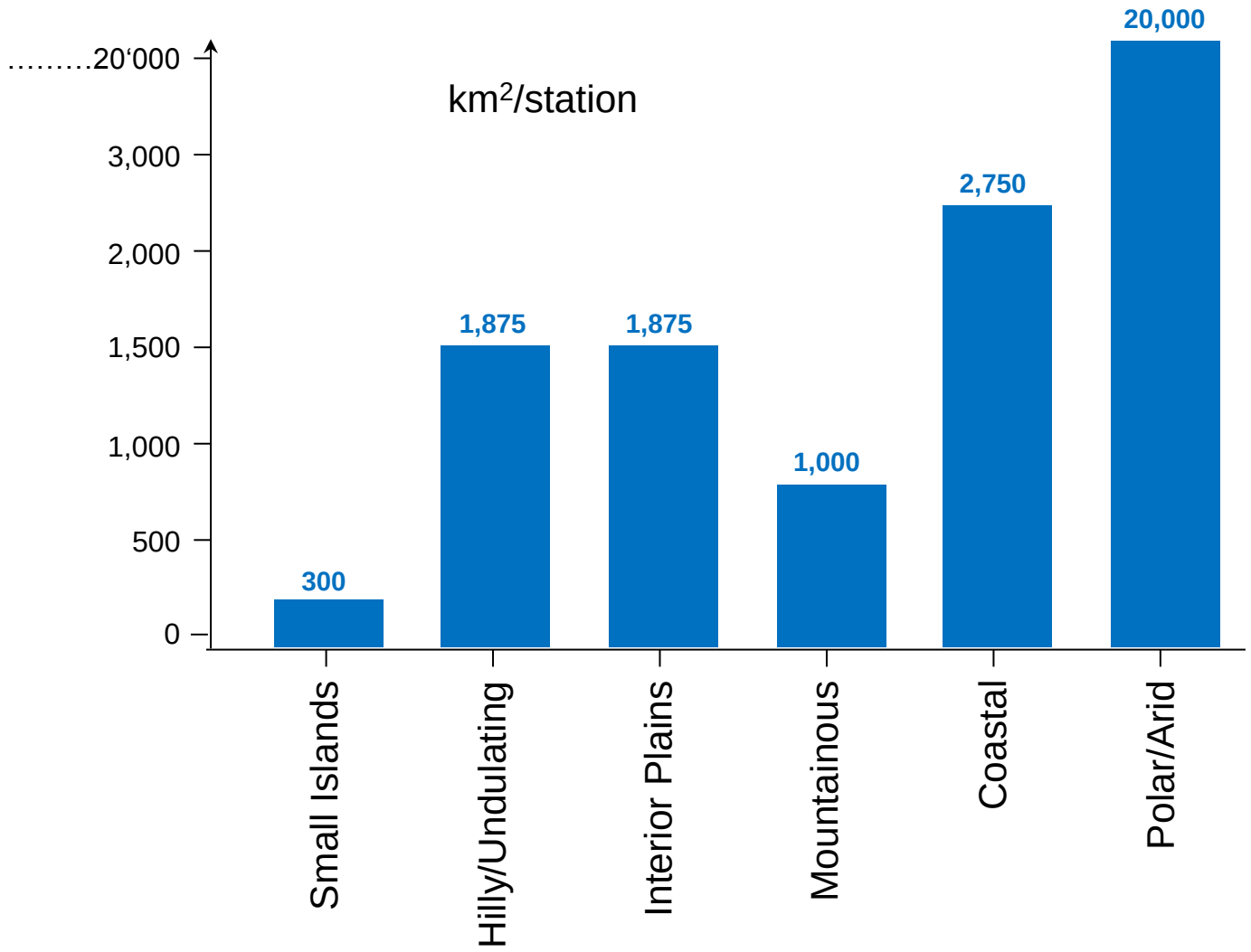
The BOEING method



Back **o**f the **E**nvelopp‘**ing**

Recommendations of the WMO

WMO Guide to Hydrological Practices recommends the following station densities:



Scientific approach

- Information theory
- Sampling strategies
- Entropy
- Total correlation
- Mean squares
- Baysian approaches

  - Adequate for special purposes such as definition of minimal number of stations for catchment model calibration
  - Should be used only in combination with hydrologic considerations

Scientific-pragmatic approach (example)

$$N = 22.9\ A^{0.26}\ P^{0.22}\ R^{0.21}\ W^{0.11}\ I^{0.05}$$

N: number of gauging-stations
A: area in 1'000 mi^2
P: population in millions
R: relief (difference between highest and lowest altitudes) in 1'000 ft;
W: surface-water withdrawals in 1960 for all uses except waterpower, in thousands of acrefeet;
I: irrigated acreage in 1,000 acres, in 1959

Pragmatic approach

Report to be readen:

Review and Analysis of Stream Gauge Networks for the Ontario Stream Gauge Rehabilitation Project March 2004 (revised from May 2003)

WSC Report No. 01-2004

Richard S. Pyrce

Pragmatic approach

1. Policy framework
2. Define objectives, combine them
3. Define partners and users
4. Define homogeneous catchments and river reach
5. Define financial frame
6. Define acceptable risk
7. Analyse representativity of stations, information gained, possible interpolations
8. Base, continuous stations and secondary for shorter periods (5-10 Y)
9. Priority stations with higher security including redundancy, etc.

Hydrometric network concept of Switzerland

(only water level and discharges)

- Objectives of the network:
  - Water management
  - Flood survey
  - Assessment of surface water quality, incl. sediment, temperature, etc.
  - Lake monitoring
  - System understanding (catchment and river processes, flow regimes, climate changes, …)

Pragmatic approach, Site selection

Site selection affects the following outcomes:

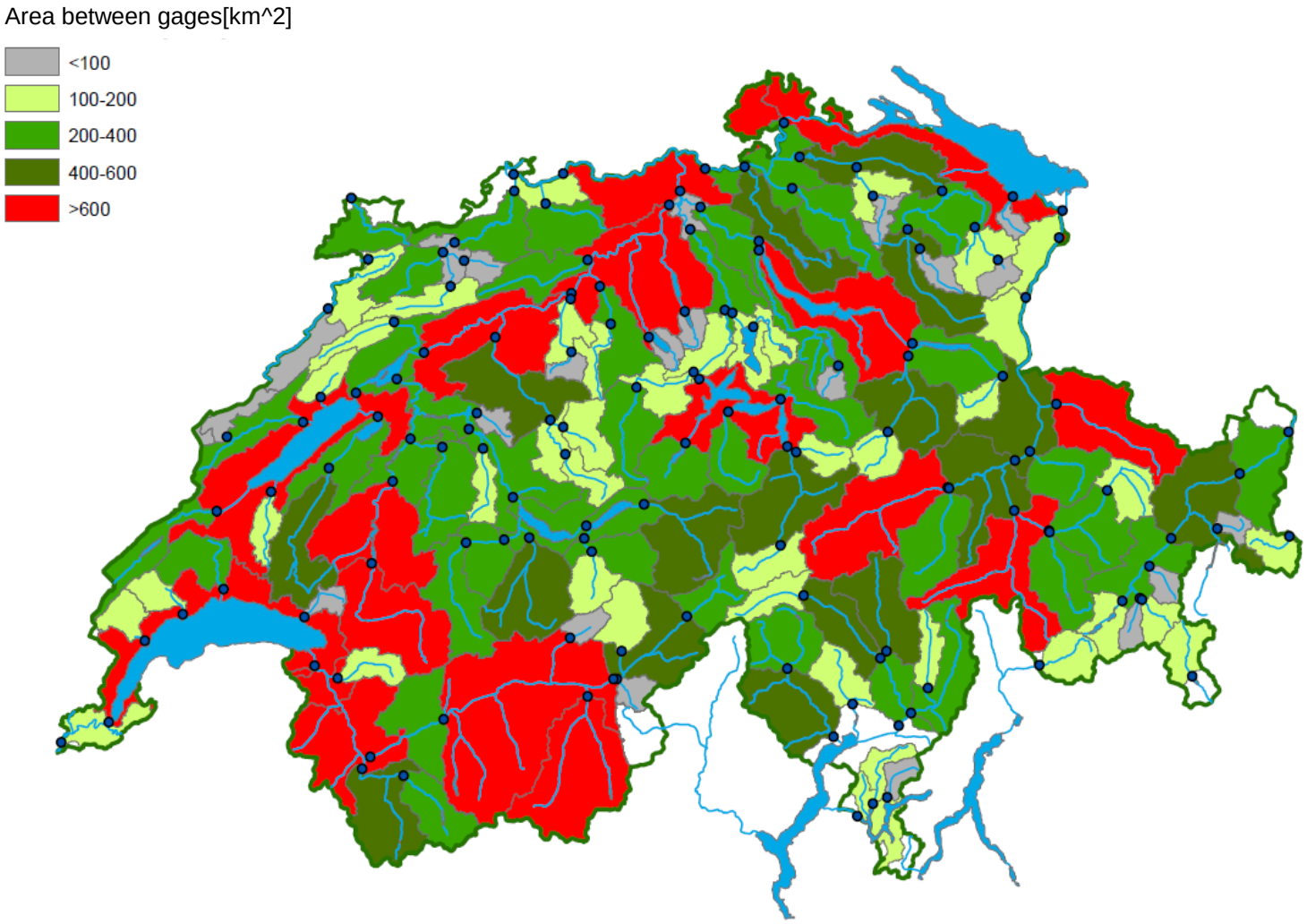
- Data persistence (i.e. a well selected location should produce data for generations to come),
- Data quality (e.g. conformance with underlying assumptions),
- Data representativeness (i.e. relevance to ungauged locations),
- Operational costs (e.g. site access),
- Liability risks (i.e. occupational and/or public safety),
- Selection of methods (e.g. use of rating curve vs. index velocity method), and
- Reliability risks (e.g. exposure to vandalism).

Criteria for water management

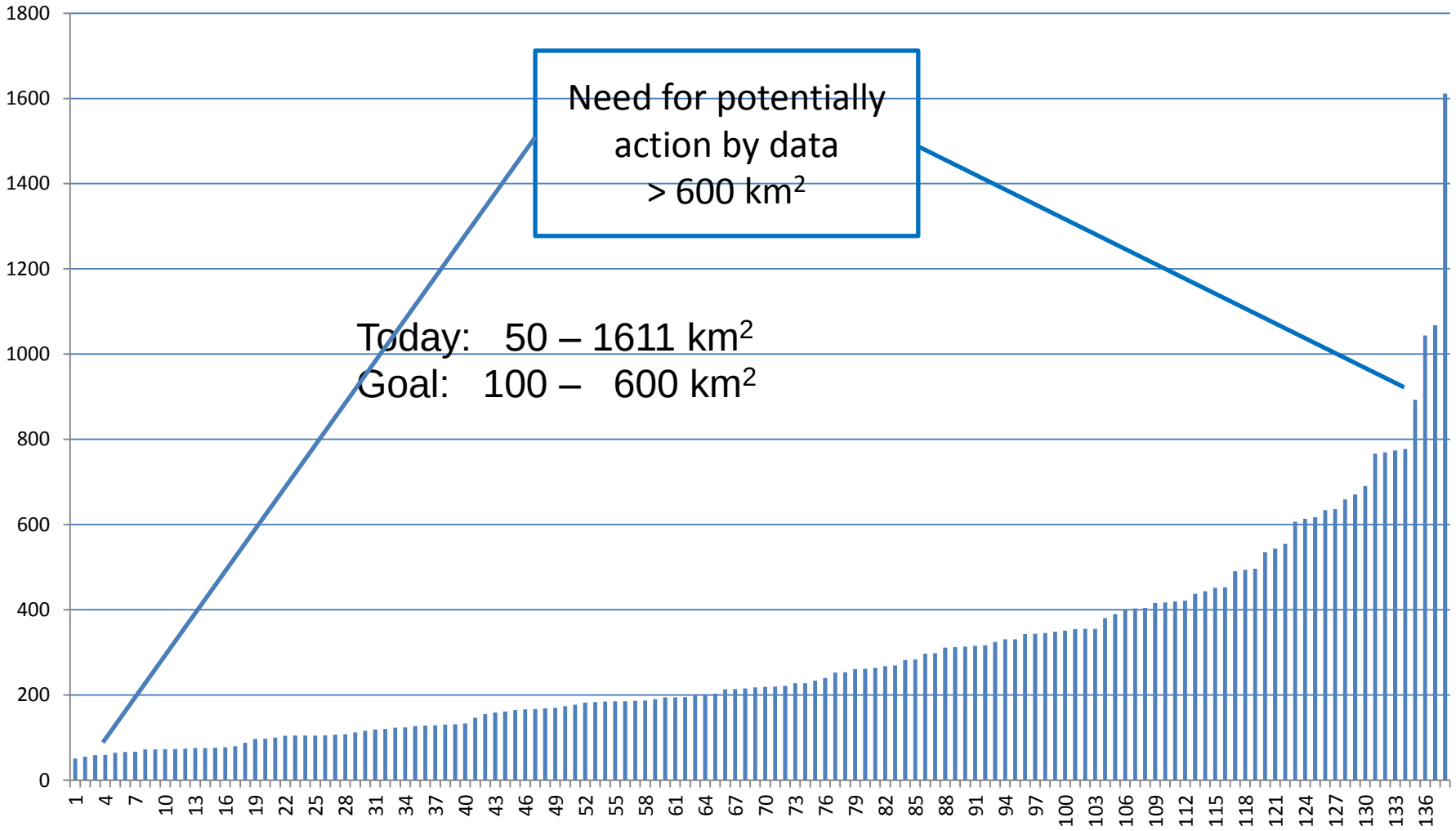
- Objective:
  - Long term series covering the whole Switzerland

- Density:
  - Hydrologic, geomorphologic and geologic analyses: 300 km^2/station on average: 138 stations

Current situation



Current situation

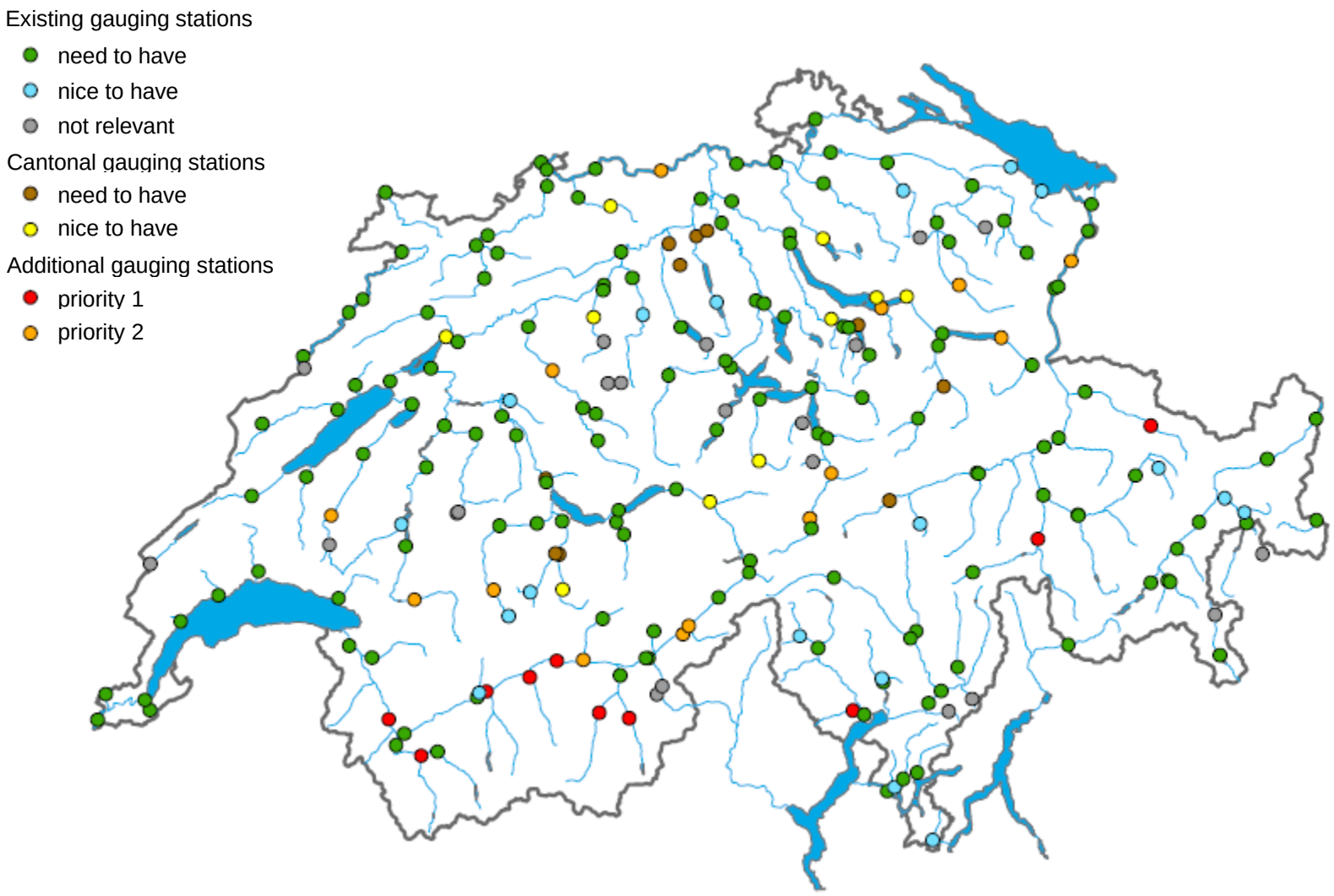


Criteria for Flood survey

- Objective:
  - Survey, nowcasting and input for forecasting for river of national interest

- Currently:
  - 183 existing stations
  - 145 NEED: priority, with redundancy
  - 18 „nice to have“
  - 20 not relevant

Criteria for Flood survey



Need for 10 additional stations

Criteria for research catchment

- Objective:
  - Long term series on representative, uninfluenced catchments for hydrological system understanding.

- Density: 49 stations

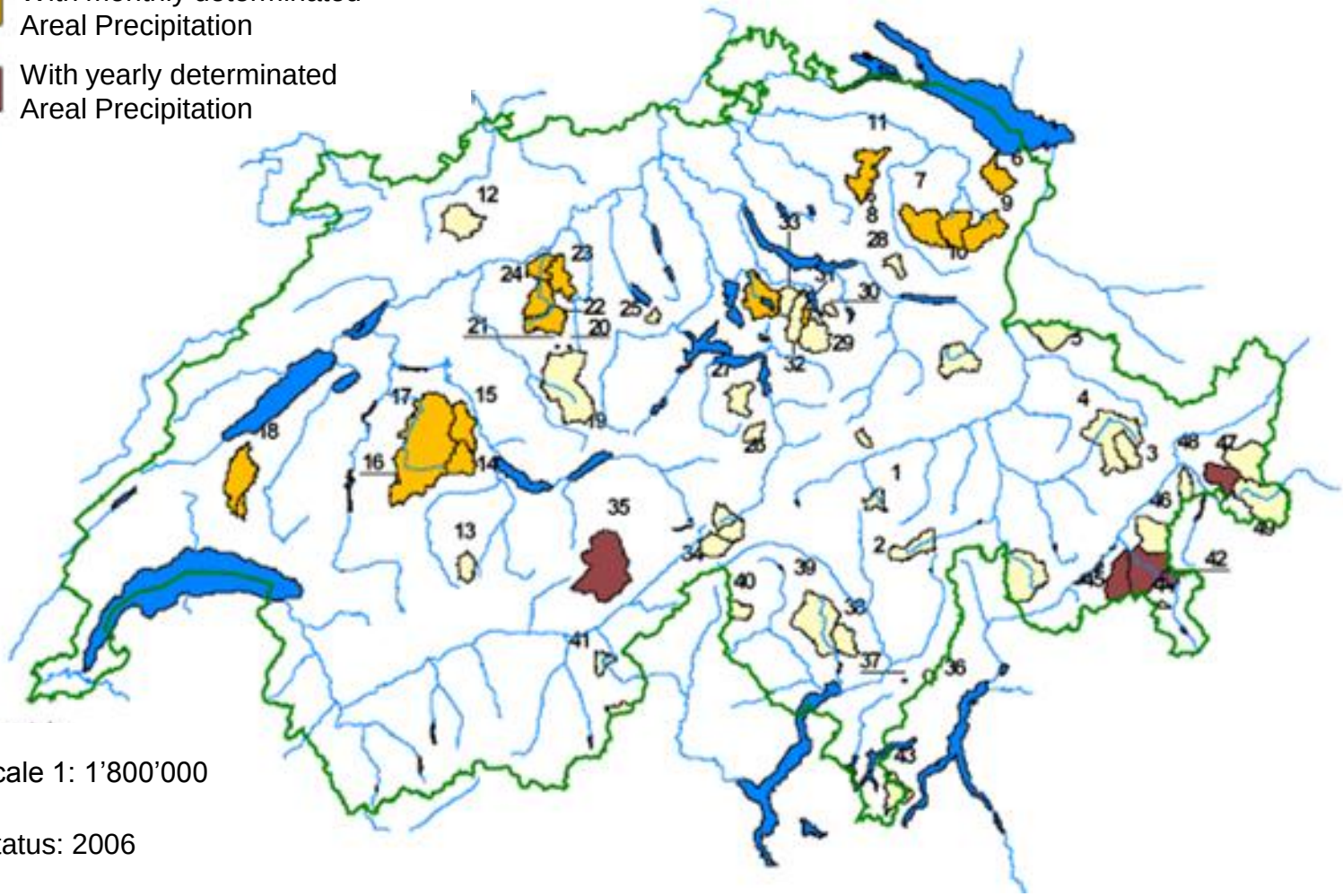
Criteria for research catchment

Swiss Hydrological Research Basins

Hydrological Research Basins

With monthly determinated
Areal Precipitation

With yearly determinated
Areal Precipitation



Scale 1: 1’800’000

Status: 2006

Conclusions

1. Network optimisation is requested for improving efficiency and for arguing with politics
2. There is neither simple nor universal method
3. A pragmatic approach is requested for defining the network density, based on clear objectives and financial possibilities.
4. Additionally, a scientific approach can help the refine the number of stations as well as their location.
5. Objectives should be combined and stations should be multipurpose
6. There must be several classes of stations: base, long term stations and temporary stations. They also have to be priorized.
7. A key factor is the dialog with partners: users, decision makers, other data provider.