Ecological approaches to wise use of wetlands, Trebon, 5-9 June 2007

Ecohydrological monitoring of water bodies

in the context of the EU Water Framework Directive

National aspects

Josef K. Fuksa

T.G.M. Water Research Institute, Prague, CZ

josef_fuksa@vuv.cz

What controls the communities of organisms in a river/stream?

- Is it a good question??
- What is a stream ?
  Something between the source and the sea.
- SO, try to study something more specified:
  a river stretch > site > biotop > habitat.
- The SCALE / SCALING is basic.

Scaling solutions :

Concepts (models) of rivers:

Systems to describe and understand structures and functions along the river course. Scientific, educative.

WFD concept:

Water bodies. Sufficient for the WFd level, open to both science and policy/economy.

What controls the communities of organisms in a river/stream?

- Physics – Hydromorphological conditions.
- Regional distribution of organisms (ecoregions etc.).
- Sources of energy or food: Sun + nutrients, particulate organic carbon, (+ temperature).
- Quality of water – inorganic carbon, oxygen, pollution.

First ecological description of communities along the river course. Forgotten, again invented:

- Frič, A.,1872:

  Vertebrata of the Bohemia. Archiv pro přírodovědný výzkum Čech.
- Fish zones: Trout, greyling, barbel, bream.
- Controlled by „physics“ and channel morphology.

The Zonal Concept:

- Frič, and certainly others. Reinvented and more specified.
- 1954 Huet.
- 1963 Illies a Bontosaneanu:

  Krenon – epi/meta/hypo …

  Ritron.

  Potamon.
- Controlling factors: Temperature, stream velocity, state of the channel (HABITAT).
- ATTENTION:

  This system is the basis of the WFD (Ecological status, Ecoregions, see Annex V and XI).

Downstream change – general:

- River growths downstream (why?).
- Small tributaries posses a limited influence on the main stream (not always !).
- Small polluters posses a limited influence on the main stream (some can !).
- Possibilities of river use change (upstream mills and drinking water, downstream transport, etc.)
- **People of the basin (both up- and downstream) have equal and common rights and duties.**
- Solution TODAY: Water Framework Directive.
- The State of Water Body upstream controls the State of WB downstream.

River as a Whole – the Concepts:

DOWNSTREAM:

Increase: Discharge (Q), thermal stability, width, depth, relative importance of transport from upstream …

Decrease: Slope, velocity, diversity of habitats (?), effect of riparian zone, grain size of bottom material, …..

- Change of hydromorphology.
- Change of organisms / communities.
- Hierarchisation of the river network – Strahler.
- Structural and functional chracteristics.
- The **SCALE**.

River Continuum Concept (RCC)

1980, Vannote et al.

- Continual gradient and development downstream.
- The state in the „profile“ is controlled by hydro morphological conditions – shape, slope, hydraulics, energy of\the stream.
- Organisms: Energy budget (feeding, movement, reproduction) should respect the habitat.
- Source\ of Corg – PP UPSTREAM (terrestric), downstream only CPOM>>FPOM.
- Arguments: Judgement, ecological groups of benthos, P/R ratio instream.

RCC :
Downstream profile and sources of C-org.

- PP upstream
- Transformation
  CPOM>FPOM
- Feeding groups
- P/R instream
- Lenght (SIZE)
  = Stream Order
- River is a line !

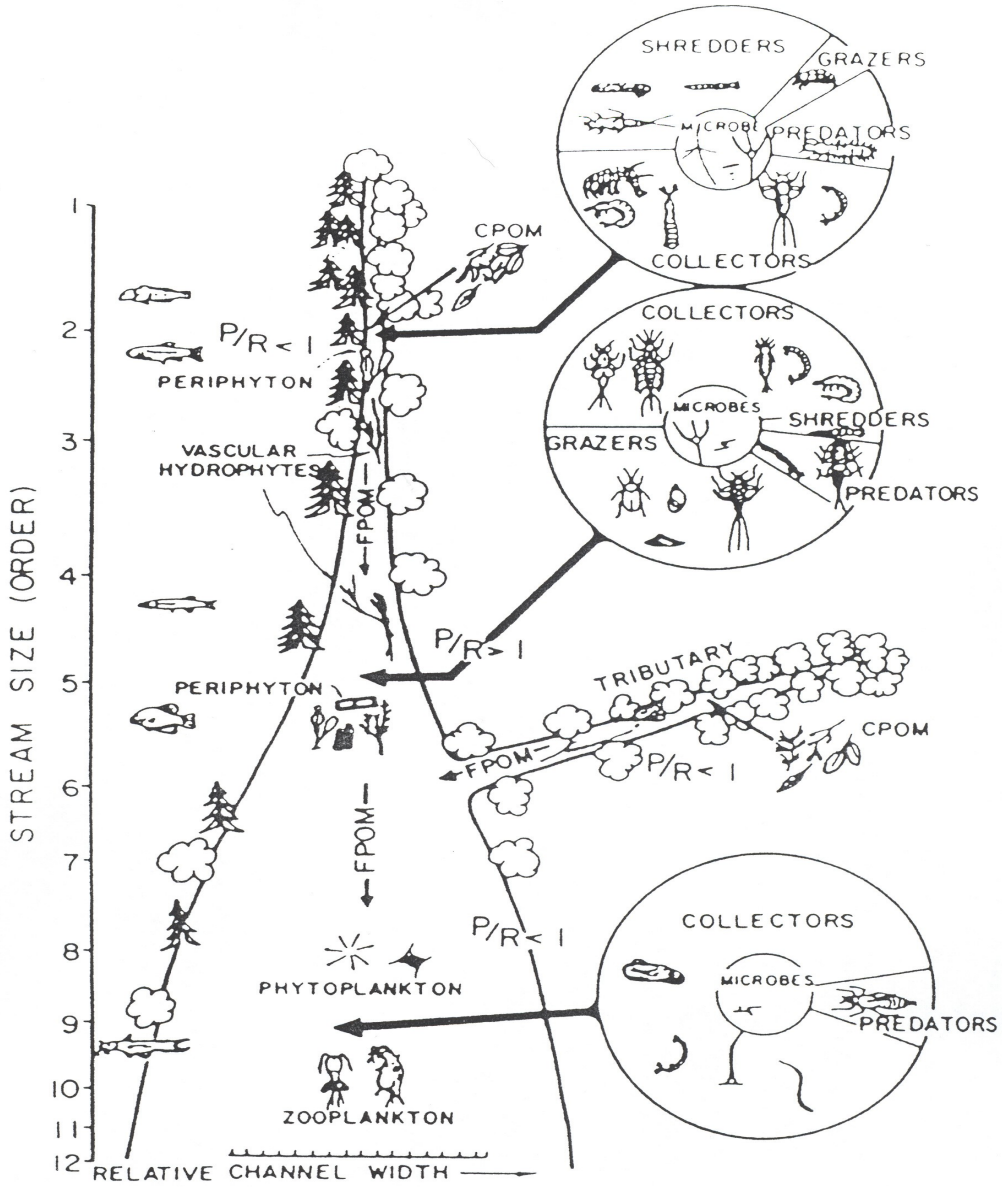


FIG. 1. A proposed relationship between stream size and the progressive shift in structural and functional attributes of lotic communities. See text for fuller explanation.

Serial Discontinuity Concept – SDC
1983, Ward a Stanford.

- Reaction on the RCC: The continuum is a theory, the stream development is a series of discontinuities.
- Discontinuity shifts the „state of continuum“ downstream or upstream.
- The impoundment (reservoir) – shift downstream.
- Under the dam (cold water) – shift upstream.
- Control: Localisation, size, lenght of the discontinuity.
- In the case of species composition the continuity could be effective also upstream !!

Flood Pulse Concept - FPC 1989, Junk et al.

Something quite new to RCC:

The 3D system operating in the year cycle (4D).

- The stream is not a steady state system.
- Influence of the riparian zone does not decrease downstream.
- Transport of C-org from upstream is not stable and not sufficient.
- There is no channel without an interacting floodplain.
- Significance of the lateral connectivity.

Flood Pulse Concept – FPC:

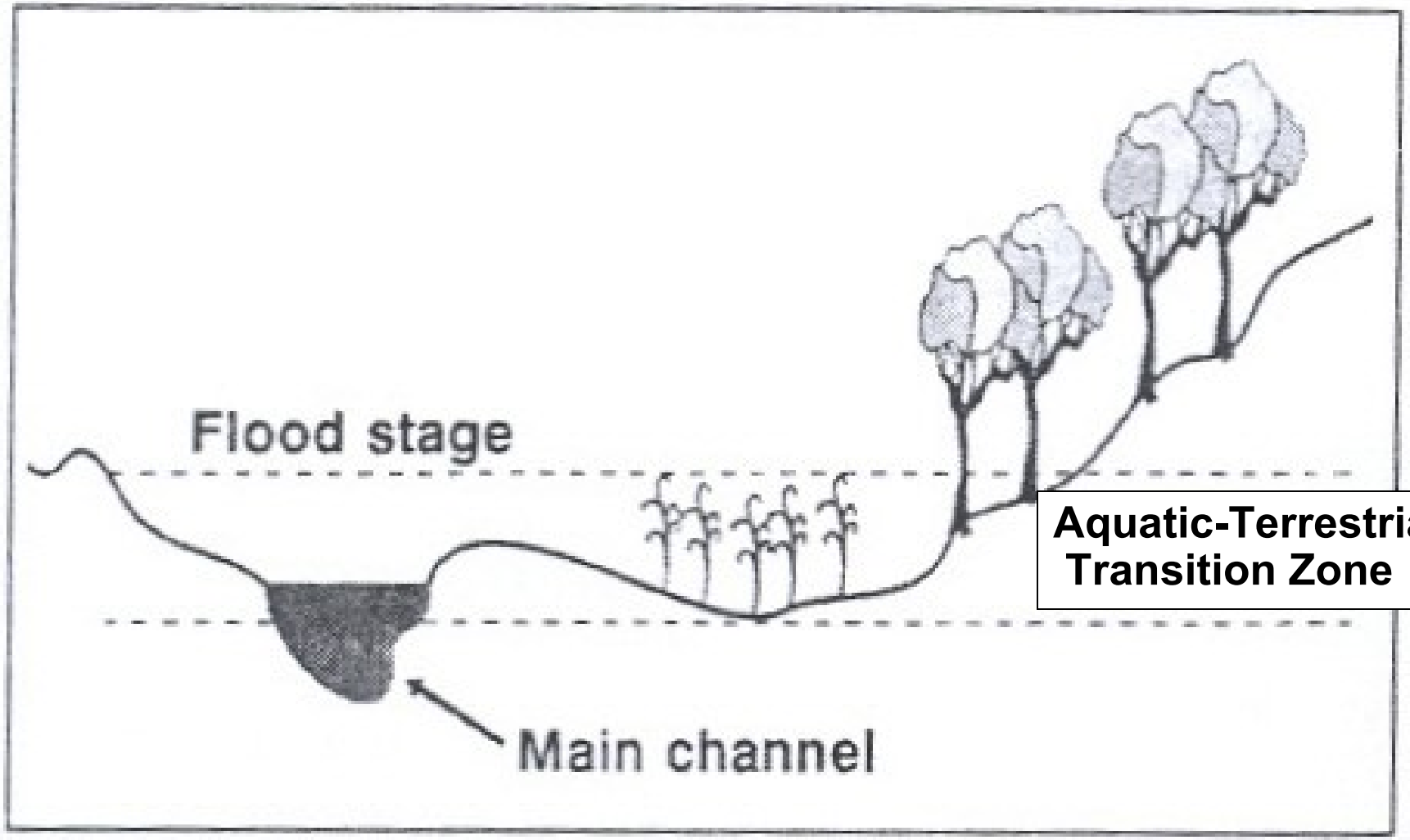
- Floods / flood pulses are a part of the function of river system.
- The channel works in various way during the season – empty, bankfull, out of the channel, flood.
- The flood controls production in the floodplain.
- The floodplain production returns stepwise to the channel.
- Production of C-org in the stream is distributed during the year cycle and is connected with production in the floodplain.

Flood Pulse Concept - FPC

Many people do not like FPC, because the FPC does not like channelized rivercourses. BUT:

- Floodplain absorbs harmfull effects of floods. Channel + retention space is a cheap (?) flood protection system.
- „Common“ pulses increase fish production, diversity in the landscape etc.
- Retention in the floodplain attenuates input of nutrients into the channel (buffer strips, ecotones).
- A political problem – change of land use and estate management.
- FPC covers also the „soft“ flood protection.

Flood Pulse Concept - FPC



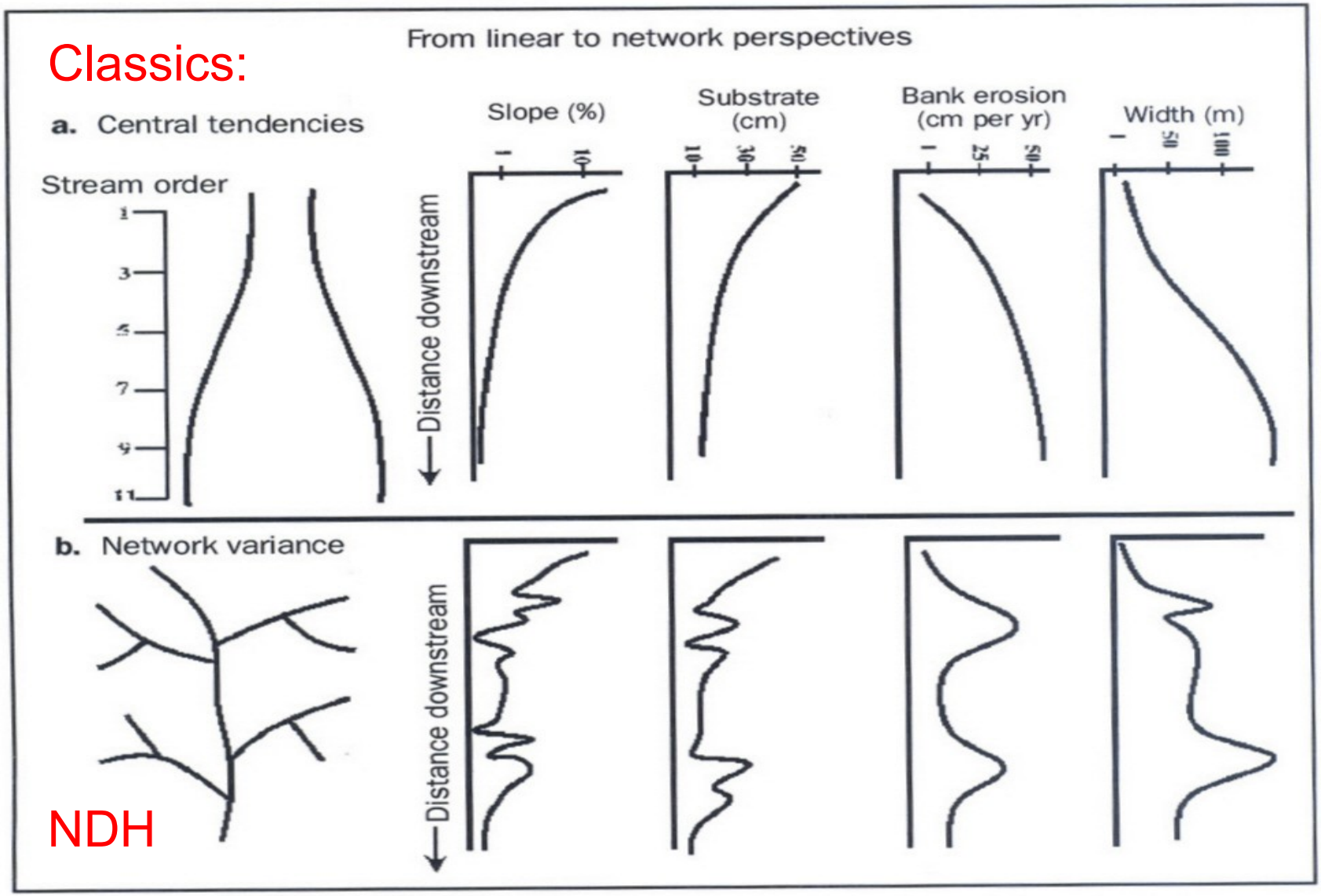
Riverine Productivity Model – RPC(M)

1994, Thorp a Delong:

Something new to RCC: the system works more as 2D, in time

- Reaction to the RCC: Production upstream cannot feed the system downstream.
- Calculations of RCC are not correct (methodology etc.)
- **Input of C-org from riparian zone and instream production are significant also downstream.**
- Models like to transplant knowledge from upstream parts to downstream rivers
  – a frequent mistake.

Network Dynamics Hypothesis (Lee Benda, 2004):



Hierarchical Patch Dynamics view (Poole, 2002)
How to employ an order, a hierarchy?

Why it works?

Patches are not closed.

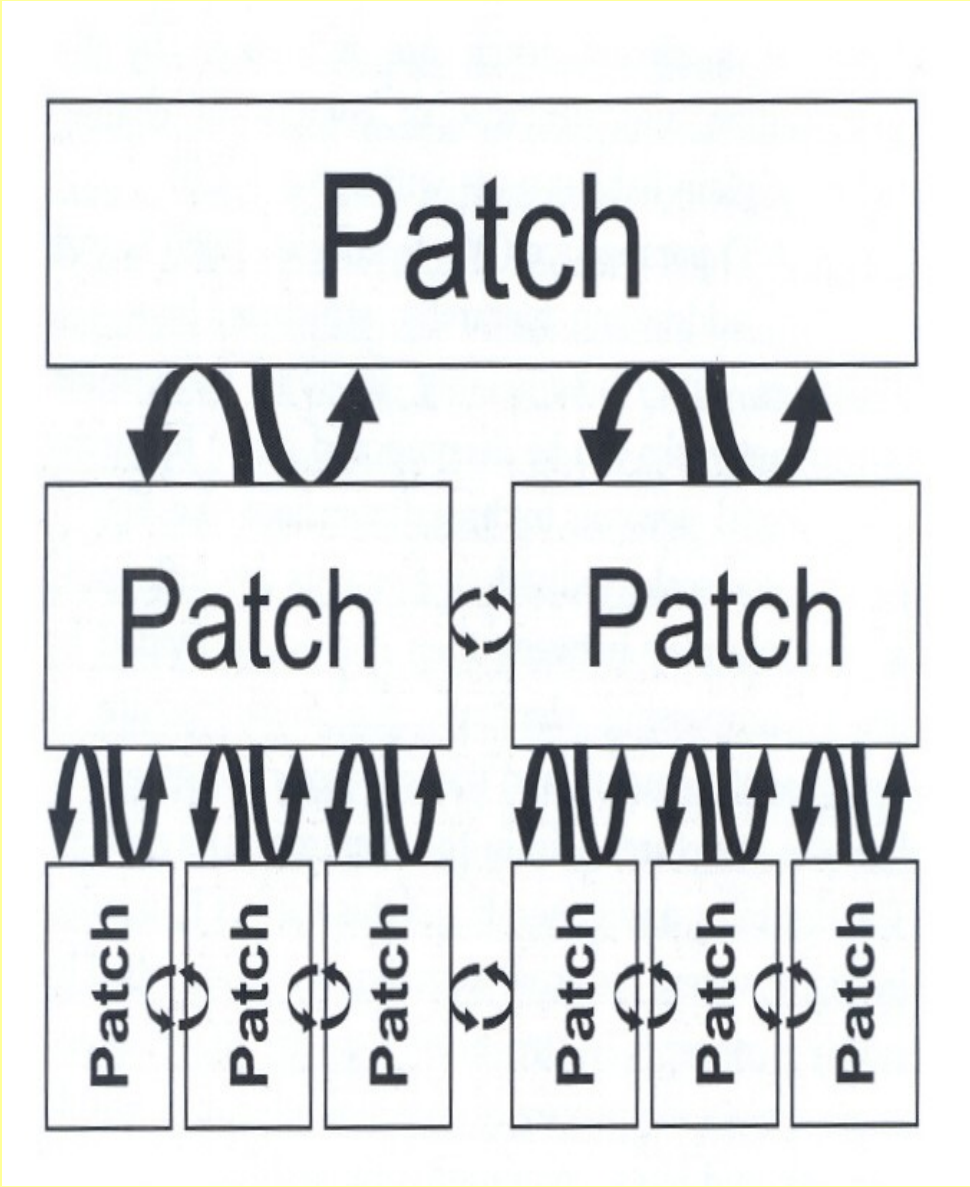
Water connects them.

Scale:

- River network
- Stretch
- Habitat

Physical processes act downstream.

Transformtion and control of processes and communities acts also upstream.



Lesson of the Concepts / Models:

The PURPOSE and the SCALE determine the effect.

One can characterise only a stretch (site, profile) or a patch.

One cannot simply compare two sites on one river as such, but „pairs“:

- Reference vs. influenced.
- Upstream and downstream an „object“.
- Disturbed vs. undisturbed.

CURRENT SITUATION – **what controls the structure of riverine communities now:**

Pollution had decreased,

so the hydromorphology remains.

Objectives of the WFD (surface waters)

Prevent deterioration of status of all WBs.

2015:

- Good Ecological status + Chemical status .
- HMWB and AWB:

  Good Ecological potential + Good Chemical status.

***Wetlands in the WFD*:** Article 1 - dependence on aquatic ecosystems, part of the channel/flooodplain, Protected Area, dependence on ground water systems/WBs.

The assessment:

Quality+Pollution and Hydromorphology

Pollution: It is relatively simple – quality of water, sediments, biofilms, biota etc. could be sampled on some selected sites, analyzed etc. Most activities covered by ISO EN standards, wide network of intercalibration. Discharges and threats are covered by GIS.

Hydromorphology: One should study the whole basin, not only selected sites. Methodology of field work and assessment is loose. You should use the EN ISO 14614.

WFD solution:

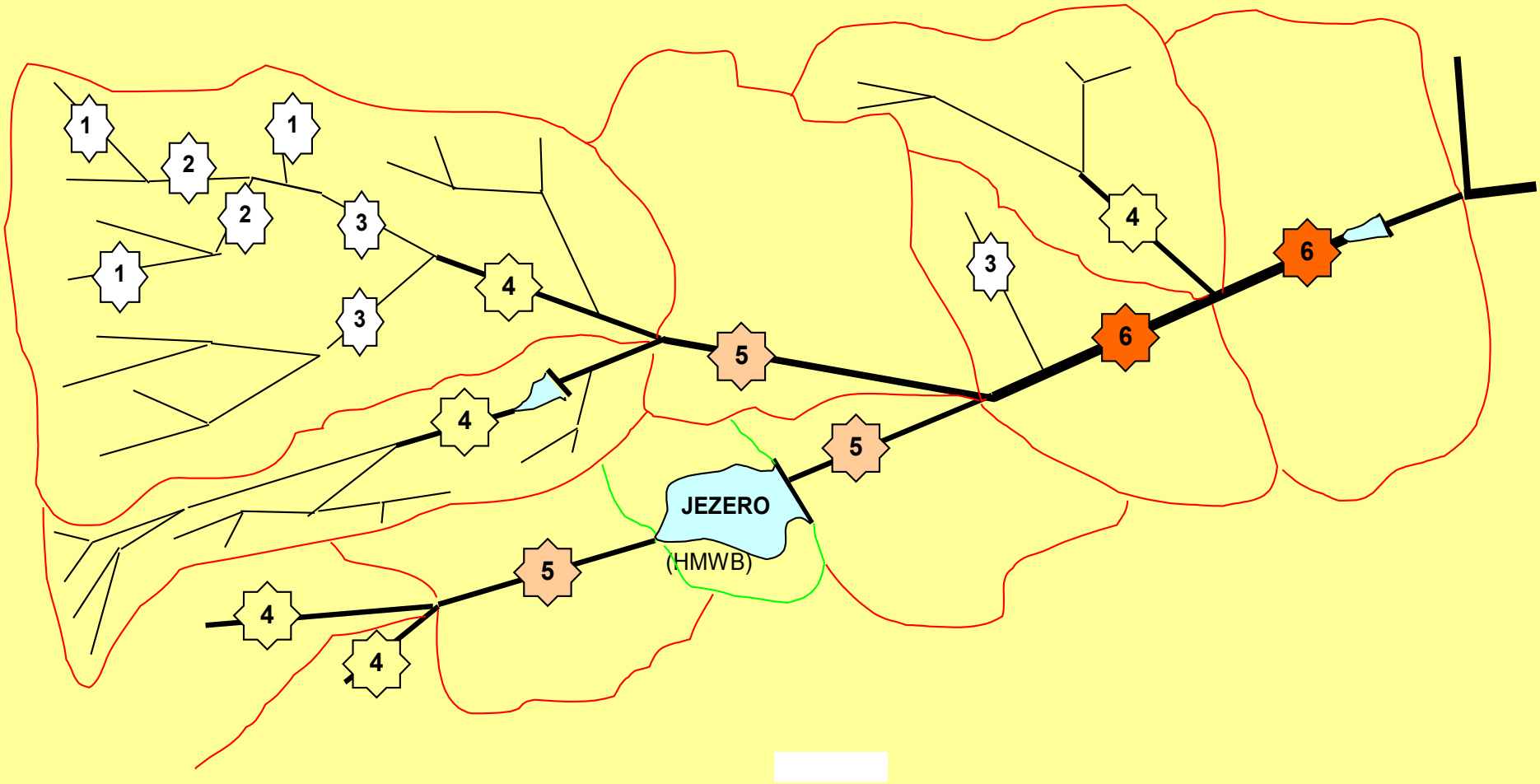
Water body (WB) as an unit in the River Basin District (its national part).

Ecological status of WB – deviation from the reference conditions defined for all WB types:

- Biological elements: Flora, benthos, fish, calculation of EQR (1 – 0).
- Supporting Hydromorphological elements.
- Supporting Chemical and Physicochemical elements.

Chemical status of WB.

Water bodies – designation (2004 – 5) :



What controls the species composition of river communities (Ecological status) ?

- **HISTORY** – Pollution: Discharge of urban and industrial sewage waters – massive pollution, oxygen depletion, ammonia, toxic substances.
- Pollution now: Specific pollutants, no obvious effect on community **structure**.

  Effect on **functions** ? We do not know (see endocrine disruptors).
- **PRESENCE**: Habitats control presence of species and community structure.
- **WFD: Proper species to proper habitats.**

WFD Programme:

- **Restore water quality.**
- **Restore habitats.**
- Define reference conditions and **GOOD** status.
- Delineate water bodies.
- Designate HMWB and „less stringent objective“.
- Designate WBs „at risk“.
- Elaborate and start the
  River Basin Management Plans.
- Monitor, observe, assess the ecological status,
  „wait for the improvement“ = use tools.

Ecological Status

Deviation from **Reference Conditions**, expressed as **EQR** calculated for **BIOLOGICAL ELEMENTS**:

- Species composition and abundance of aquatic plants, macrozoobenthos and fish (+age structure).

HYDROMORPHOLOGICAL ELEMENTS supporting biological elements:

Hydrology:

- quantity and dynamics of water flow,
- connection to ground water bodies.

River continuity.

Morphological conditions:

- depth and width variation,
- structure and substrate of river bed,
- structure of the riparian zone.

Hydromorphological elements:

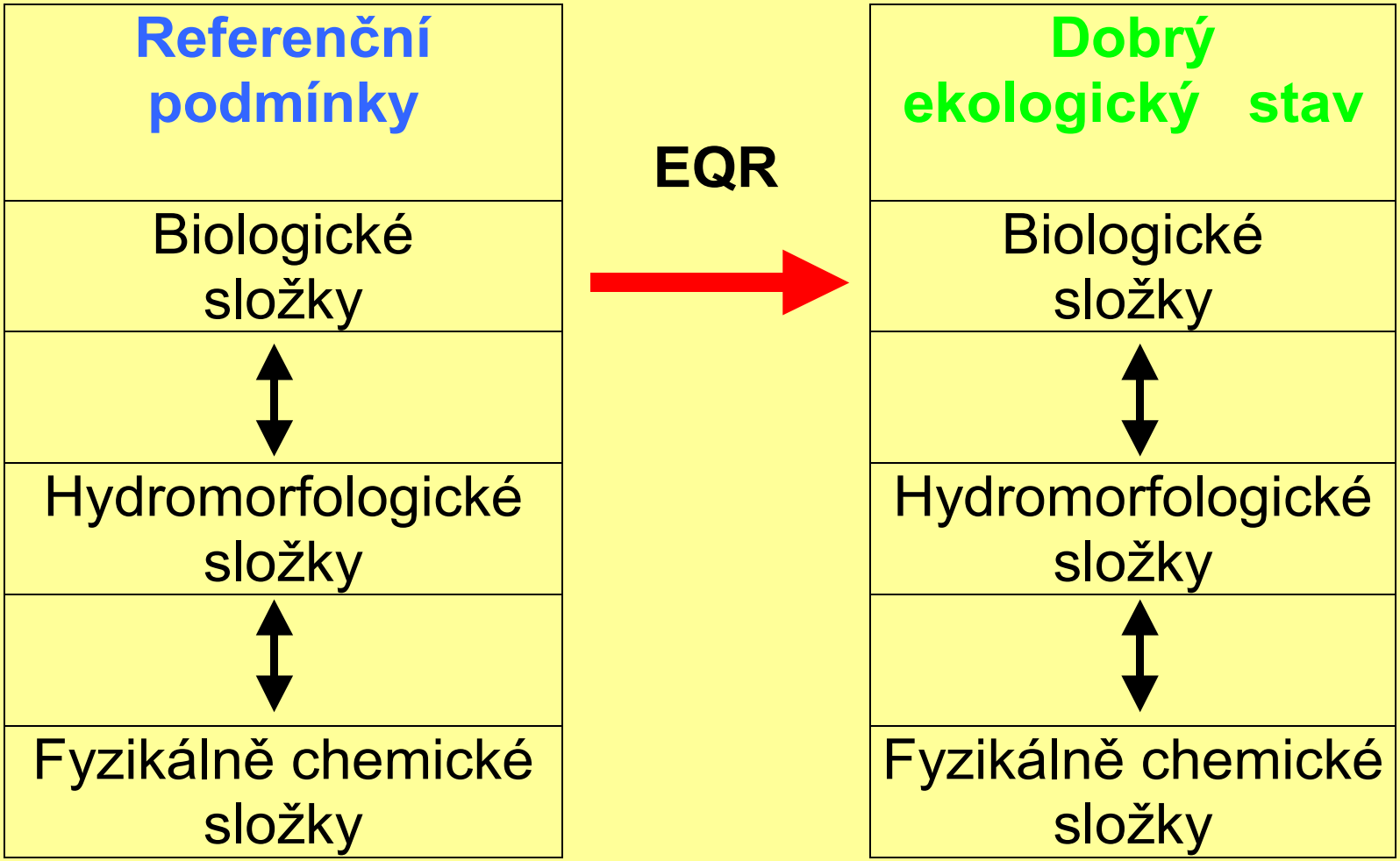
How to get data:

- Sources: Archive materials and field mapping.
- Assessment: Decision „natural/anthropogenic“ could be a part of data aquisition.

Relation to water bodies:

- Selection of rivercourses (according to Strahler order).
- Setting the mapping sections – fixed or variable lenght.
- Weighing and scoring the data.
- Decision on the „deviation“.
- Elaboration of maps.

Reference Conditions - what is the standard?




Natural hydromorphology?
Nature in 21st century?

Hydromorphological elements:

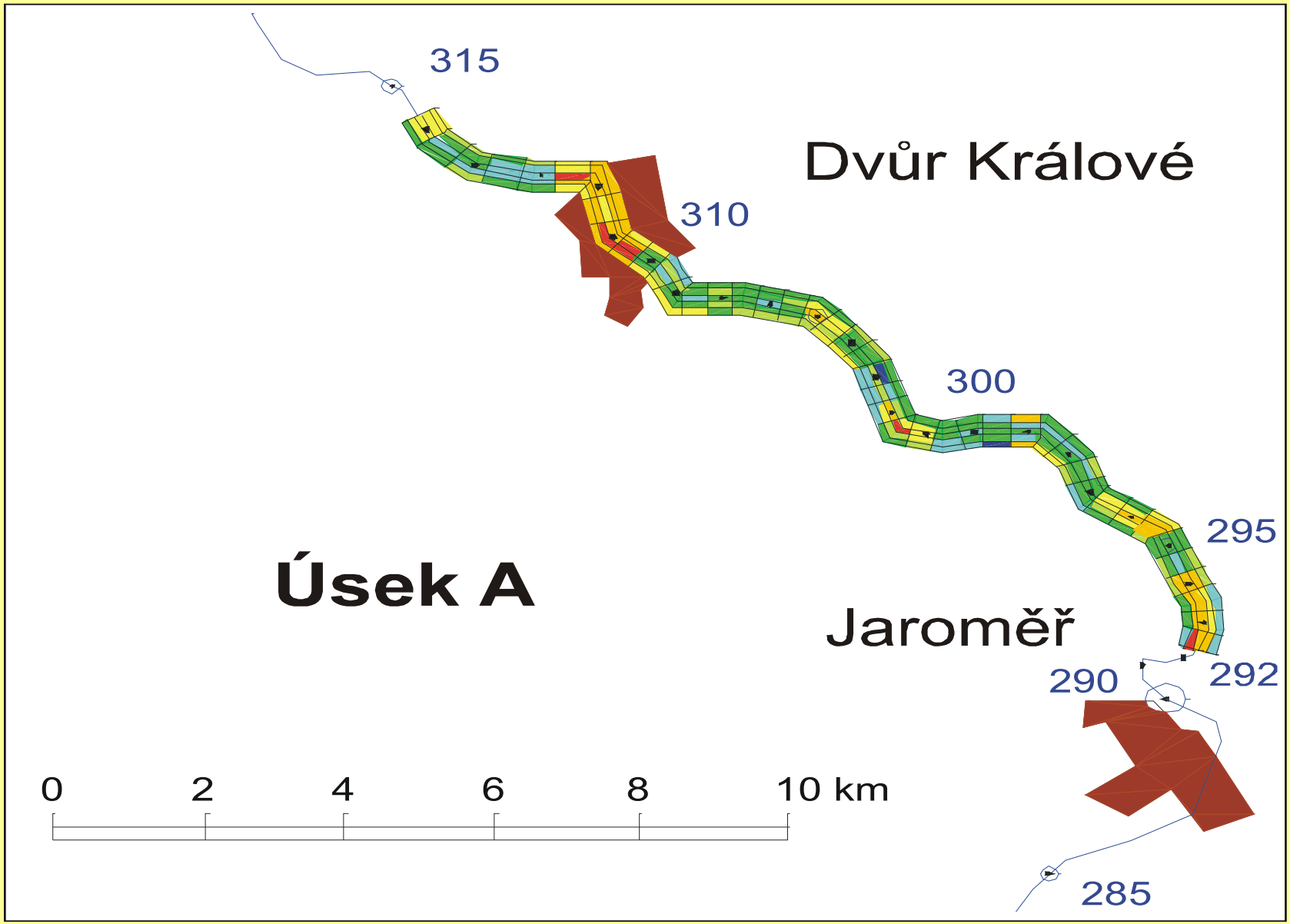
Three factors (five lines) :

- **Channel** (sinuosity, bottom, depths and flow).
- **Shore** line (width, shape, structure). R/L.
- **Vicinity** (riparian zone, connection to floodplain). R/L.
- *(Flow – direct data from hydrology.)*
- *(Diversity of habitats – synthesis.)*

Connection to ground water bodies:

- Quaternary aquifers.
- Deep aquifers.

Mapping – fixed lenght stretches:



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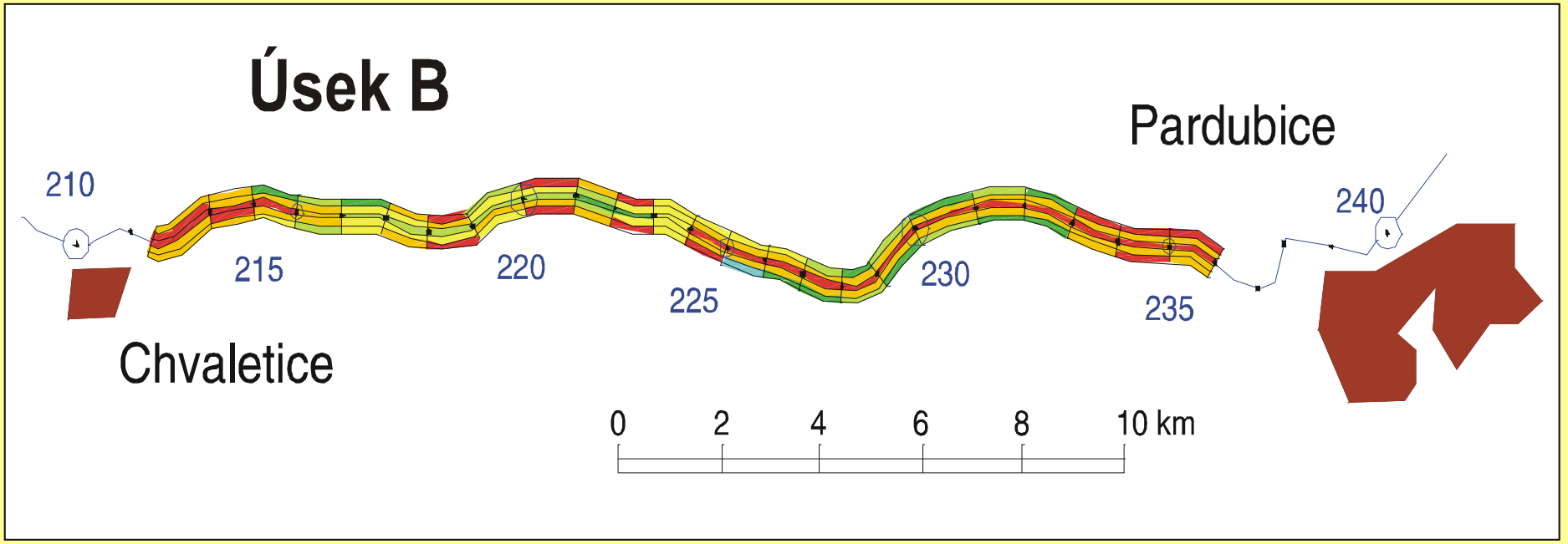

Fixed lenght vs. variable lenght stretches?

- Low order streams – variable lenght more effective.
- When differences R/L are significant, fixed lenght is a solution.

Present state of Hy-Mo monitoring

- Water bodies (1:10000) and typology.
- HMWB designation in run (2nd stage).
- Surveillance monitoring in run.
- Selection and monitoring of reference sites in run.
- Assessment of Hy-Mo conditions – choice of general methodology.

Final solutions are coming from Ispra:
EQR calculation, intercalibration, etc.