

An operational method for the ecohydrological classification of temporary rivers and streams

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Outline

Why do we need an “ecohydrological” classification of temporary rivers?

Is this one more hydrological classification or really a new one?

Which information do we need?

How can we obtain the necessary information?

How can we visualize the results?

Which classes can we define?

Which is the future for this classification?



Why do we need an “ecohydrological” classification of temporary rivers?

- ✓ The best way to assess water quality in a water course is to assess the quality of its aquatic life.
- ✓ But the quality of aquatic life also depends on the temporal patterns of presence and connectivity of mesohabitats, which are controlled by the hydrological regime.
- ✓ The results of a biological sampling depend on the mesohabitats that occur at the time of the sampling and those that existed in recent weeks, controlled by the hydrological regime.

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So, we need an “ecohydrological” classification of temporary rivers to:

- ✓ Compare the regimes of different temporary rivers from the point of view of the life they can host.
- ✓ Look for low-impacted rivers that have regimes of different classes, to define the biological communities of reference that serve to assess the quality of temporary rivers.
- ✓ These metrics and classifications are essential to assess the degree of hydrological alteration from an ecological point of view.

Is this one more hydrological classification or really a new one?

Usual regime classifications

Data

Flow records
(where extant)
Hydrological models

Classification

Permanent,
Intermittent,
Ephemeral...

Ecological significance



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TREHS regime classification

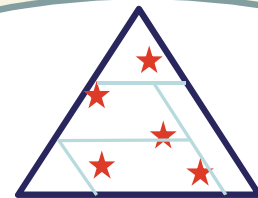
Ecologically relevant features

Temporal patterns
of mesohabitats

Data

Flow records
direct observations
air/ground photographs
interviews

Classification



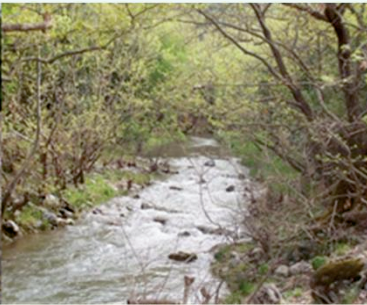
Which information do we need?

We need an assessment of the temporal patterns of aquatic mesohabitats.

6 'Aquatic States' were defined in Gallart et al. (2012); as *transient sets of aquatic mesohabitats that occur in a river reach and moment, driven by the hydrological conditions.*



Hyperrheic



Eurheic



Oligorheic



Arheic



Hyporheic

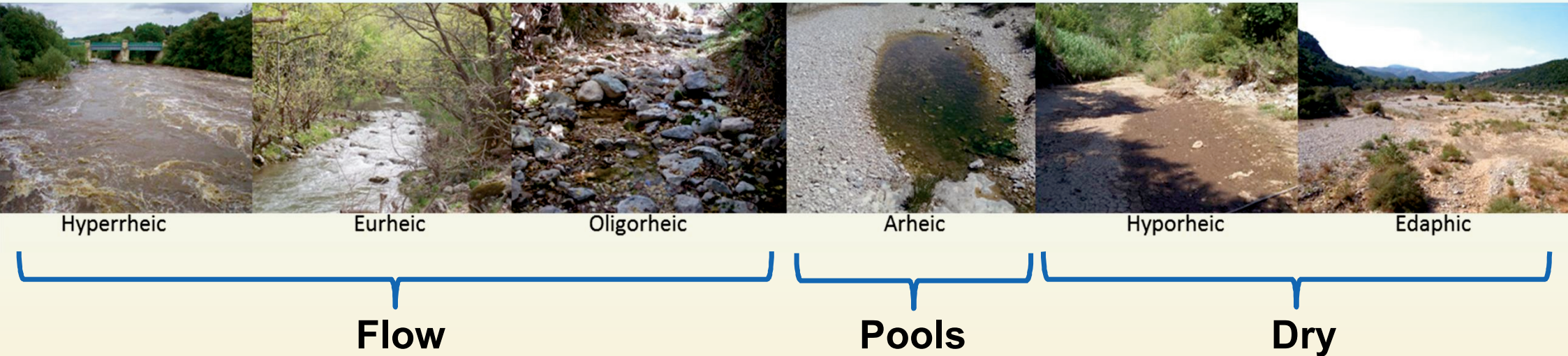


Edaphic

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But for operational reasons these 6 'states' were simplified to 3 'phases', easier to identify and frequently used in the literature: flow – disconnected pools – dry stream bed

How can we obtain the necessary information?

As we need qualitative rather than quantitative information, we have experimented several ways to obtain it.

The uncertainty associated with some of these sources is compensated by its availability in the ungauged reaches.

Aerial photographs



Flow



Pools



Dry

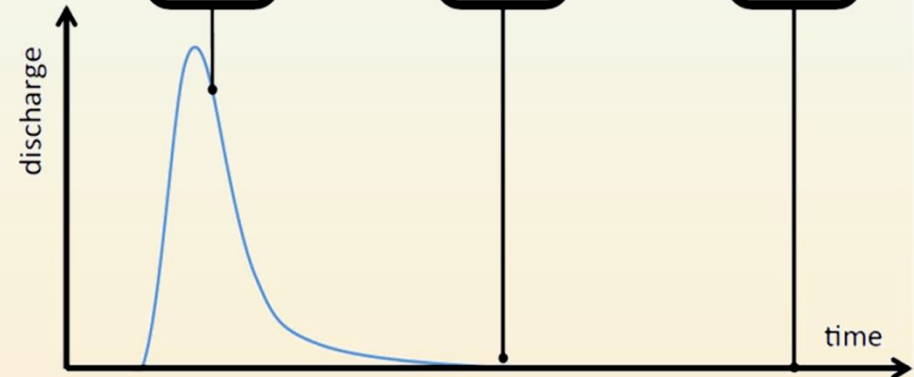
Interviews

☒ Flow
☐ Pools
☐ Dry

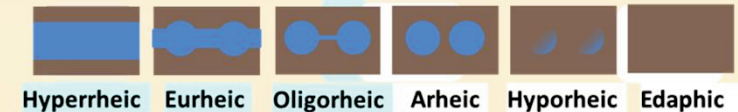
☐ Flow
☒ Pools
☐ Dry

☐ Flow
☐ Pools
☒ Dry

Hydrographs



Direct observations



How can we visualize the results?

From this information we obtain the three main complementary metrics that allow the analysis and visualization of the regime..

Mf: Flow permanence: relative number of months per year with flow, at the long term (0-1)

Mp: Pools permanence: relative number of months per year with pools, at the long term (0-1)

Md: Dry permanence: $Md = 1 - (Mf + Mp)$

How can we visualize the results?

Other six metrics are also calculated to assess the seasonality of the regime, but these metrics are not used for the main classification.

Sd_6 : seasonal predictability of the no-flow period (semester):

$$Sd_6 = 1 - \left(\sum_1^6 Fd_i / \sum_1^6 Fd_j \right)$$

where Fdi represents the frequencies of the no-flow months during the wettest 6 contiguous months and Fdj represents the frequencies of the no-flow months during the remaining 6 contiguous months (0 – 1).

SWs: Summer – Winter seasonality: relative difference between the periods without flow in summer minus those in winter (0-1)

SEs: Solstices – Equinoxes seasonality: relative difference between the periods without flow in the solstices minus those in the equinoxes (0-1)

How can we visualize the results?

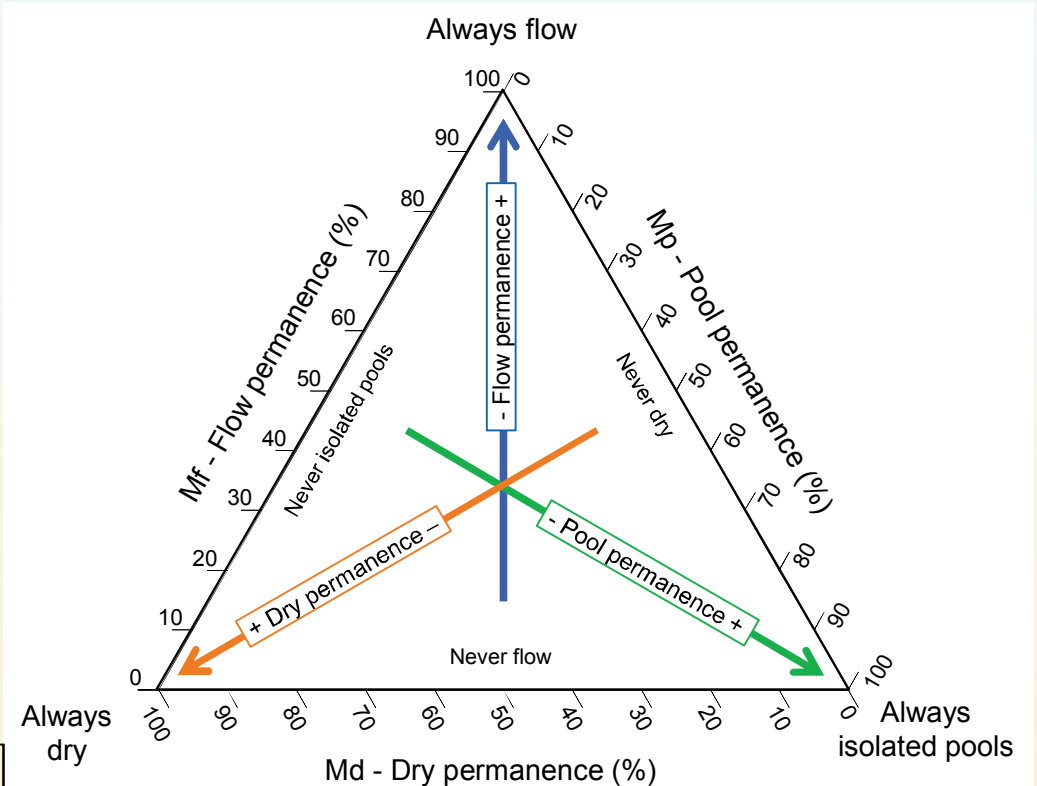
FPD (Flow – Pools – Dry) graph

Shows the relationship between three complementary metrics:

Flow permanence - Pools permanence - Dry permanence

The upper vertex represents perennial rivers, the left vertex represents permanent pools and the left vertex, terrestrial systems.

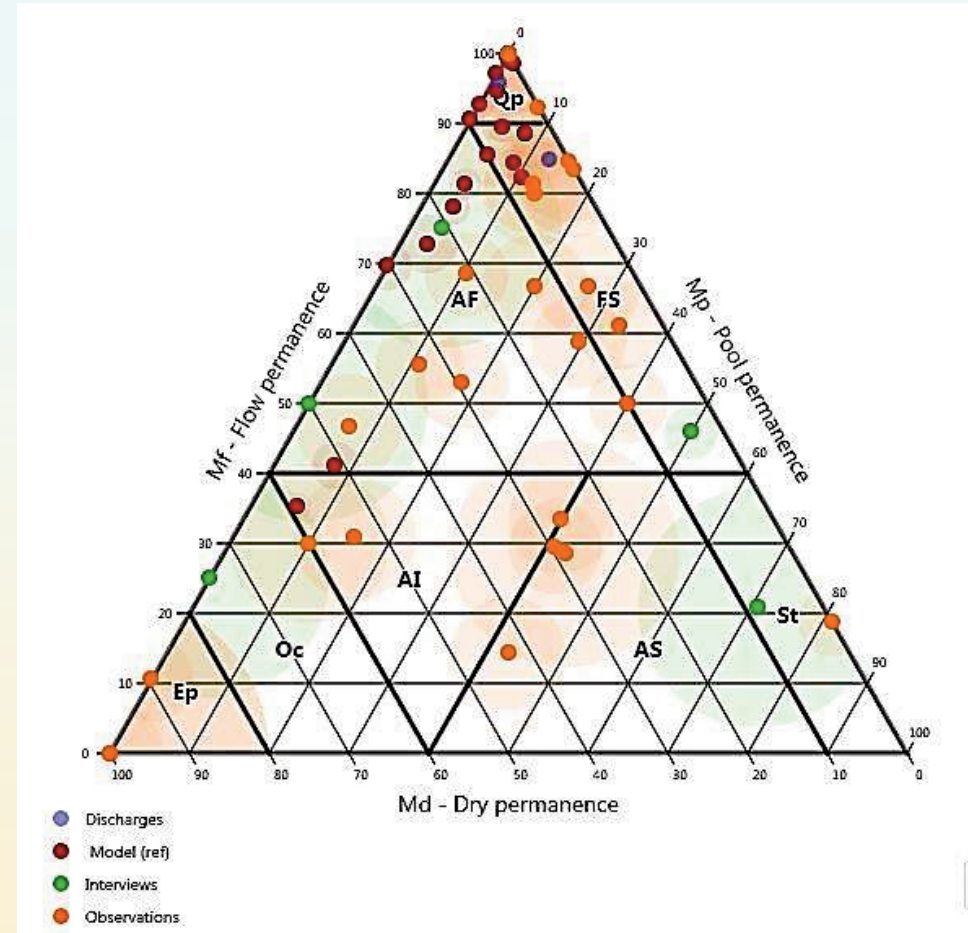
Gallart et al. 2017



How can we visualize the results?

Every stream reach is represented with a dot in the graph.
Different colours represent the origin of the information and coloured circles represent the uncertainty of the metrics.

Gallart et al. 2017



Which classes can we define?

From expert criteria we defined 9 regime classes of assumed ecological significance.

Descriptive class names were selected avoiding confusion with the current classifications

These classes can be easily updated when more information is available.

Fluent: usually flowing

Alternate: rotates between the three aquatic phases

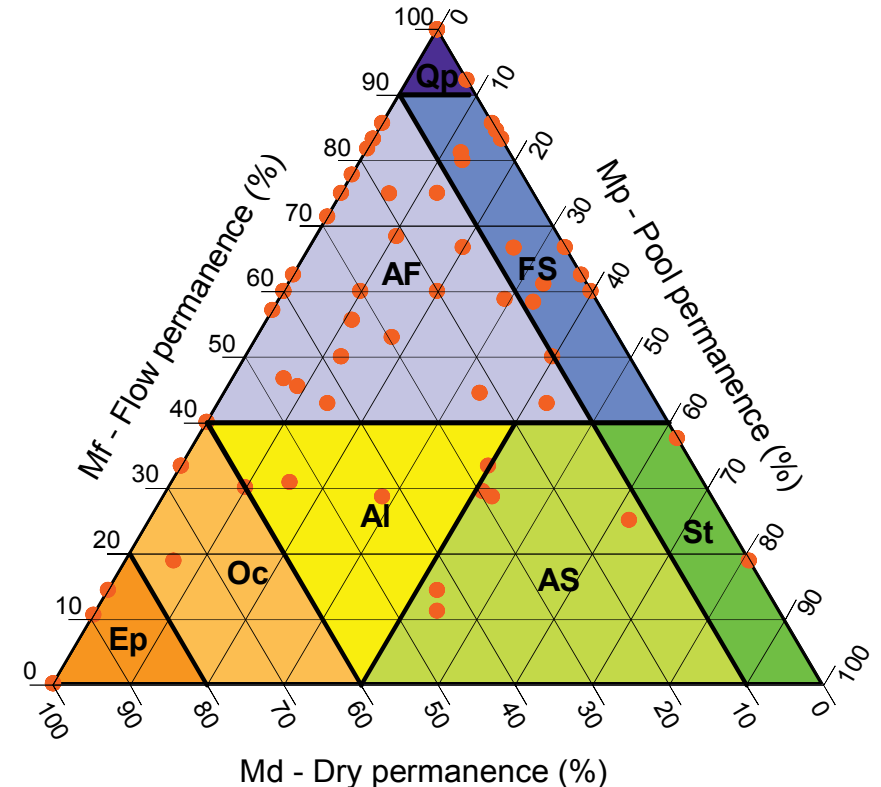
Stagnant: usually takes the form of disconnected pools

Occasional: usually dry, seldom with flowing or stagnant water

Episodic: always dry, except at irregular and infrequent intervals

Quasi perennial (Qp)
Alternate – Fluent (AF)
Fluent – Stagnant (FS)
Stagnant (St)
Alternate – Stagnant (AS)
Alternate (Al)
Occasional (Oc)
Episodic (Ep)

Gallart et al. 2017



Which is the future for this classification?

This classification and the TREHS free software where it is embedded was developed within the LIFE Trivers project for its operational use for the implementation of the European Water Framework.

It is already used in several countries like Spain, Portugal Cyprus and Greece.



References

- Gallart, F., Prat, N., García-Roger, E.M., Latron, J., Rieradevall, M., Llorens, P., Barberá, G.G., Brito, D., de Girolamo, A.M., lo Porto, A., Buffagni, A., Erba, S., Neves, R., Nikolaidis, N.P., Perrin, J.L., Querner, E.P., Quiñonero, J.M., Tournoud, M.G., Tzoraki, O., Skoulikidis, N., Gamez, R., Gomez, R., Froebrich, J.. A novel approach to analysing the regimes of temporary streams in relation to their controls on the composition and structure of aquatic biota. **Hydrol. Earth Syst. Sci. (2012)**: 16, 3165–3182. doi:10.5194/hess-16-3165-2012
- Gallart, F., Llorens, P., Latron, J., Cid, N., Rieradevall, M., Prat, N. Validating alternative methodologies to estimate the regime of temporary rivers when flow data are unavailable. **Sci. Total Environ. (2016)**:565, 1001–1010
- Gallart, F., Cid, N., Latron, J. Llorens, P., Bonada, N., Jeuffroy, J., Jiménez-Argudo, SM., Vega, RM., Solà, C., Soria, M., Bardina, M., Hernández-Casahuga, AJ., Fidalgo, A., Estrela, T., Munné, A., Prat, N. TREHS: an open-access software tool for investigating and evaluating temporary river regimes as a first step for their ecological status assessment. **Sci. Total Environ. 607 (2017): 519-540**. doi:10.1016/j.scitotenv.2017.06.209.

Free software:

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