water matters
THE IMPORTANCE OF GOOD STATUS OF WATER BODIES

Προσεγγίζοντας χωροχρονικά γεγονότα χωρίς ροή σε υδάτινους δρόμους

Addressing large scale patterns of no-flow events in rivers

Χριστίνα Παπαδάκη
Christina Papadaki

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Introduction

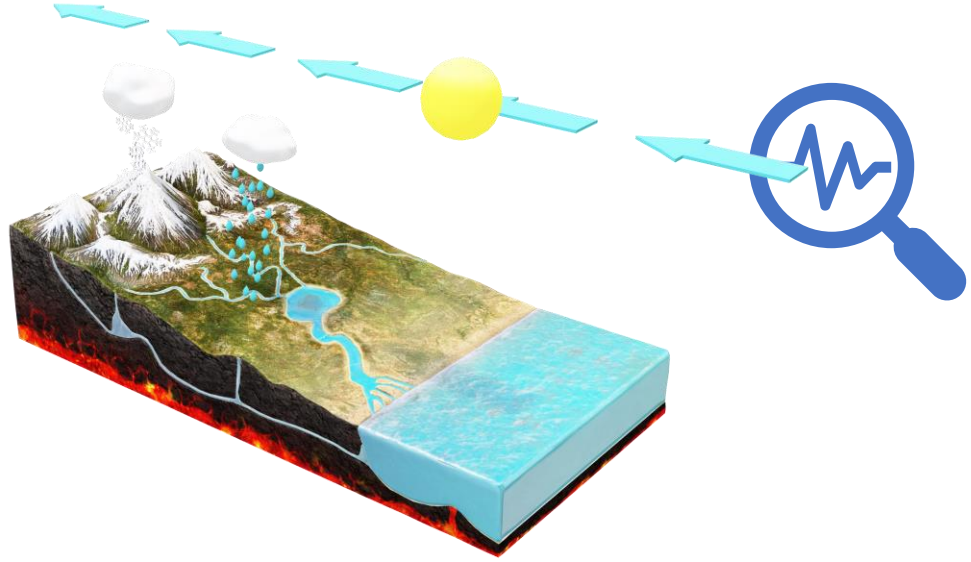
Regarding the way **water moves** and progresses from high to low altitudes, it is characterized by a **large diversity.**

The temporal pattern of water flow in rivers, and streams refers to with **periods of flowing water and the occurrence of periods when the flow of water ceases or becomes intermittent**, alternating with periods of flowing water.

A watercourse may dry up completely due to:

- seasonal variations in precipitation or hydrological conditions
- geomorphology
- anthropogenic pressures
- fluctuations in groundwater levels may also create transition zones
- climate change
- or even all or some of the above

Keep in mind….
Flow intermittency is dynamic. !!!



Several definitions have evolved through time trying to describe these phenomena/conditions
commonly referred to as:
Intermittent Rivers and **Ephemeral Streams** (IRES)
and
Non-Perennial Rivers and Streams (NPRS)

'episodic', 'seasonal', 'temporary', 'rain-dependent' 'ephemeral'

The definitions can vary in different regions and among different scientific studies, so **it's essential to consider the context in which these terms are used**.

Examples from representative studies:

- Cottet et al. 2023,
- Messager et al. 2021,
- Fovet et al. 2021,
- Zimmer et al. 2020,
- Busch et al. 2020,
- D'Ambrosio et al. 2017,
- Skoulikidis et. 2017,
- Kalogianni et al. 2017,

But they do not inherently distinguish natural from artificially intermittent rivers

According to Skoulikidis, et al. (2008, 2011, 2016, 2017):

- intermittent rivers/streams cease to flow seasonally (weeks to months),
- ephemeral rivers/streams flow only in response to precipitation or snowmelt events (days to weeks),
- and episodic streams maintain surface water only during very short periods (hours to days), primarily after heavy rainfall events

Within the WFD intercalibration technical report (Wouter van de Bund 2009) R-M5 are referred to as temporary rivers with higher natural variability.

How can we address all these matters?

An in-depth analysis with Achelous software.

Papadaki Ch., Mitropoulos P., Panagopoulos I. and Dimitriou E. **2023** **Addressing large scale patterns of no-flow events in rivers; An in-depth analysis with Achelous software** Journal of Hydrology (under review)

What do we mean by a 'no flow' event?

Case study
Greece

Methodology

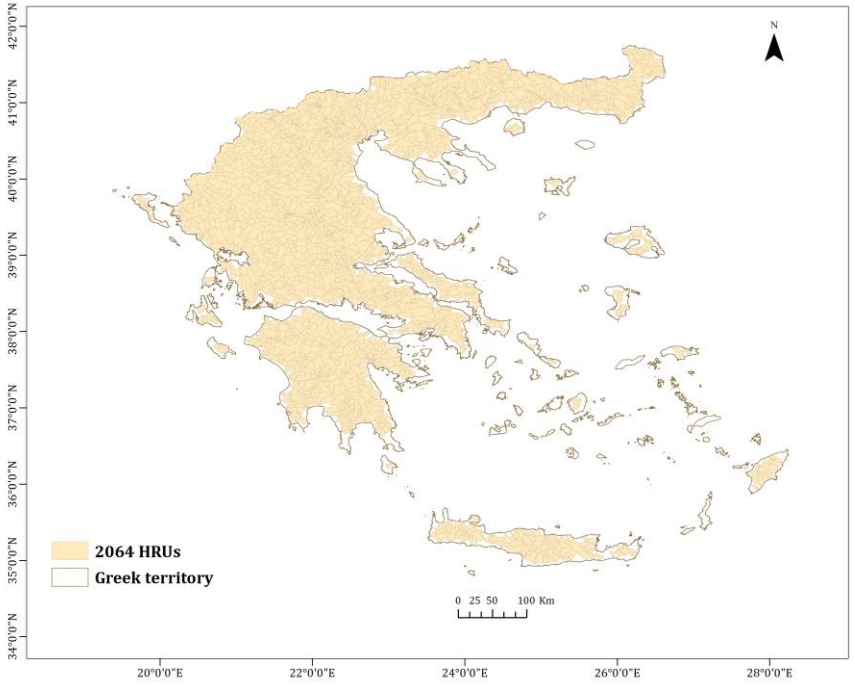
Critical threshold

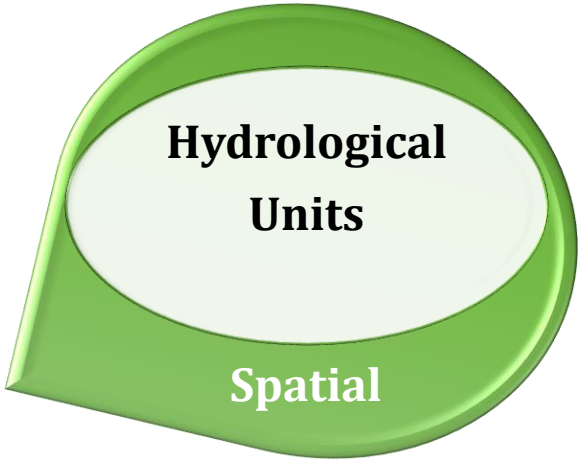
"no-flow event" = period of 5 consecutive days during which the daily flow remained less than or equal to the threshold of $0.005 m^3/s$

How can we distinguish between natural intermittency and other causes?

A hydrological model was utilized to provide naturalized flow regimes of HRUs

2064 subbasin-HRUs
(called simply HRUs from now on)



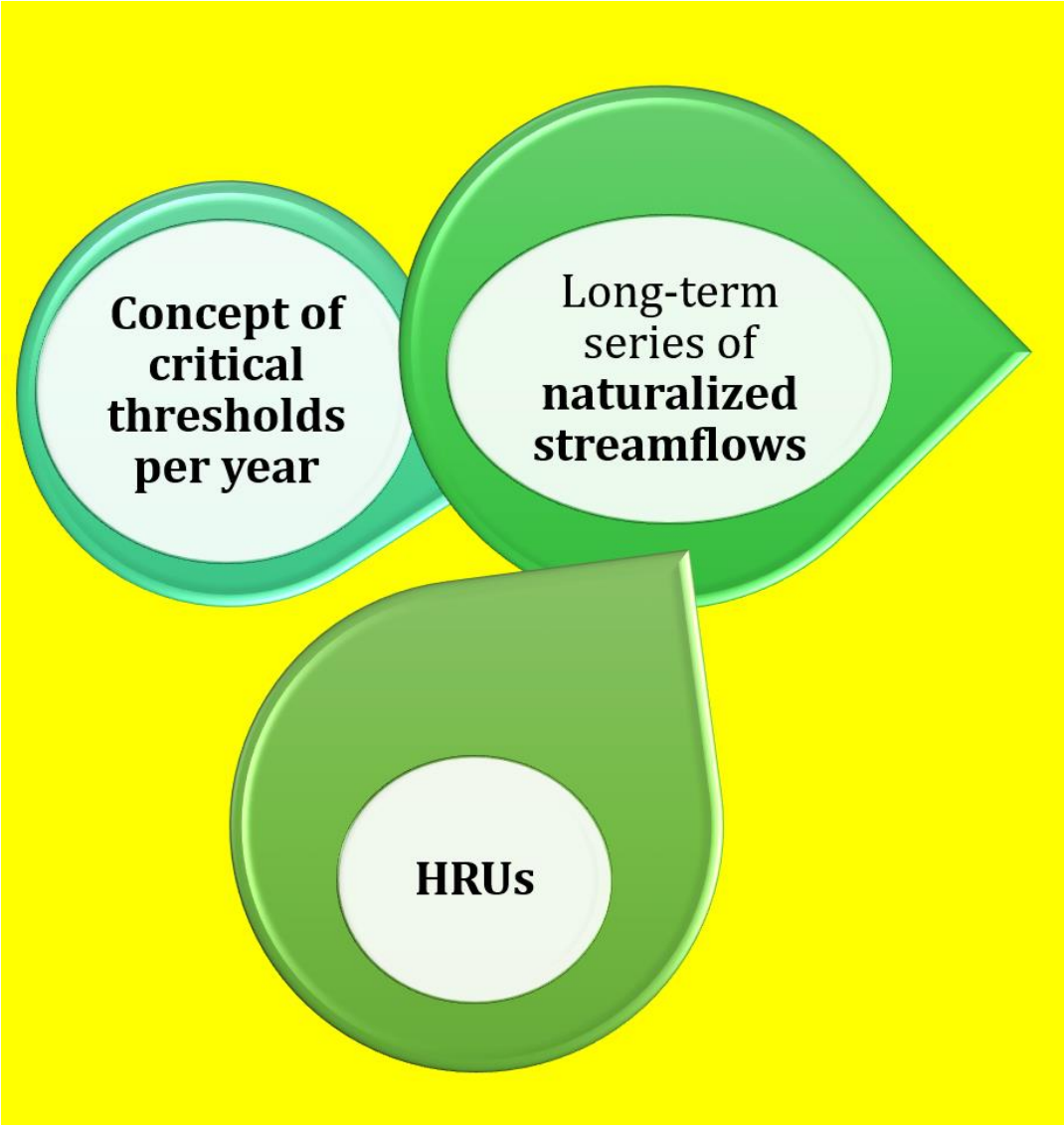


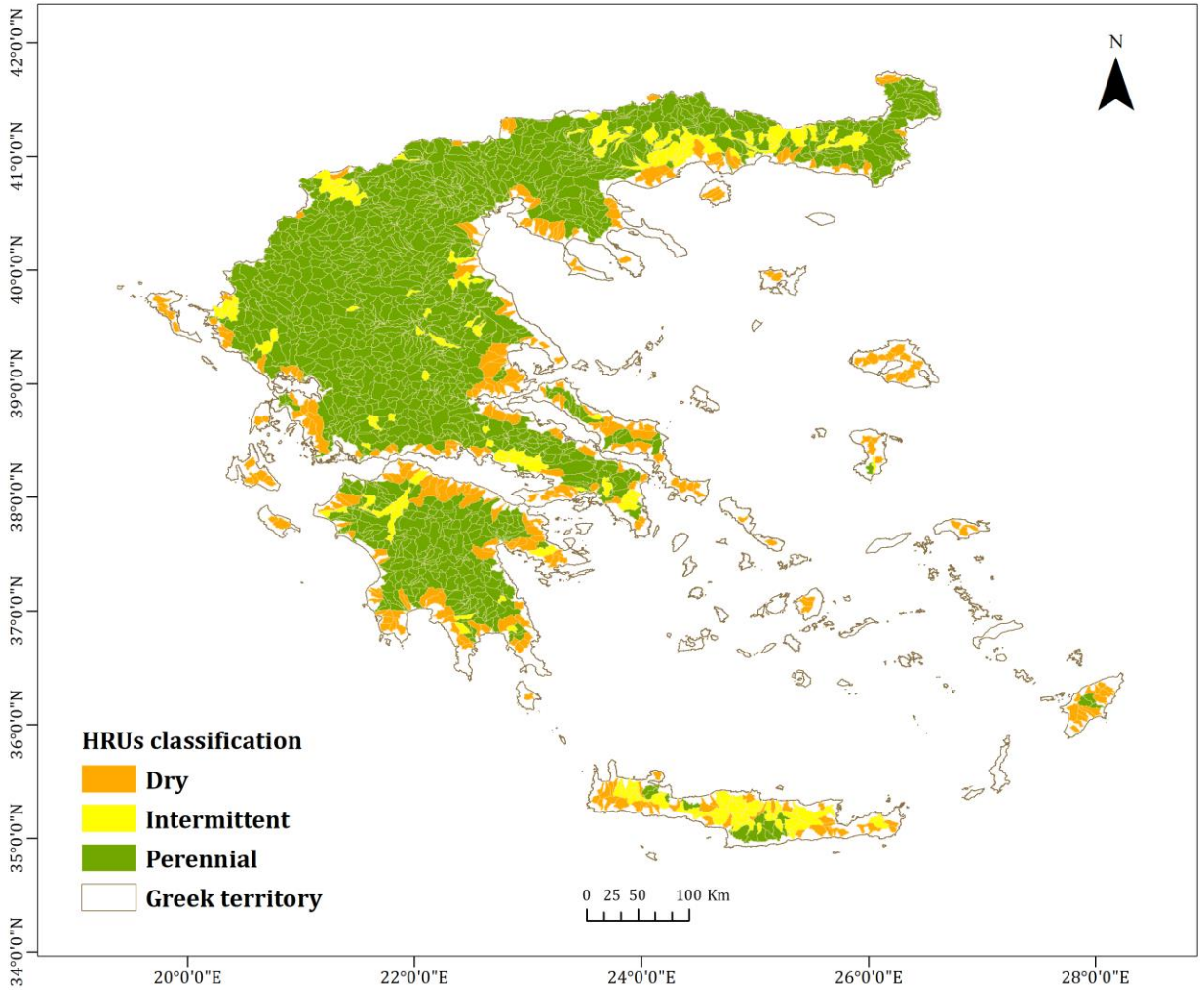
To facilitate the effective calculation of hydrological metrics for numerous and extensive time series, we have developed the **Achelous opensource software**

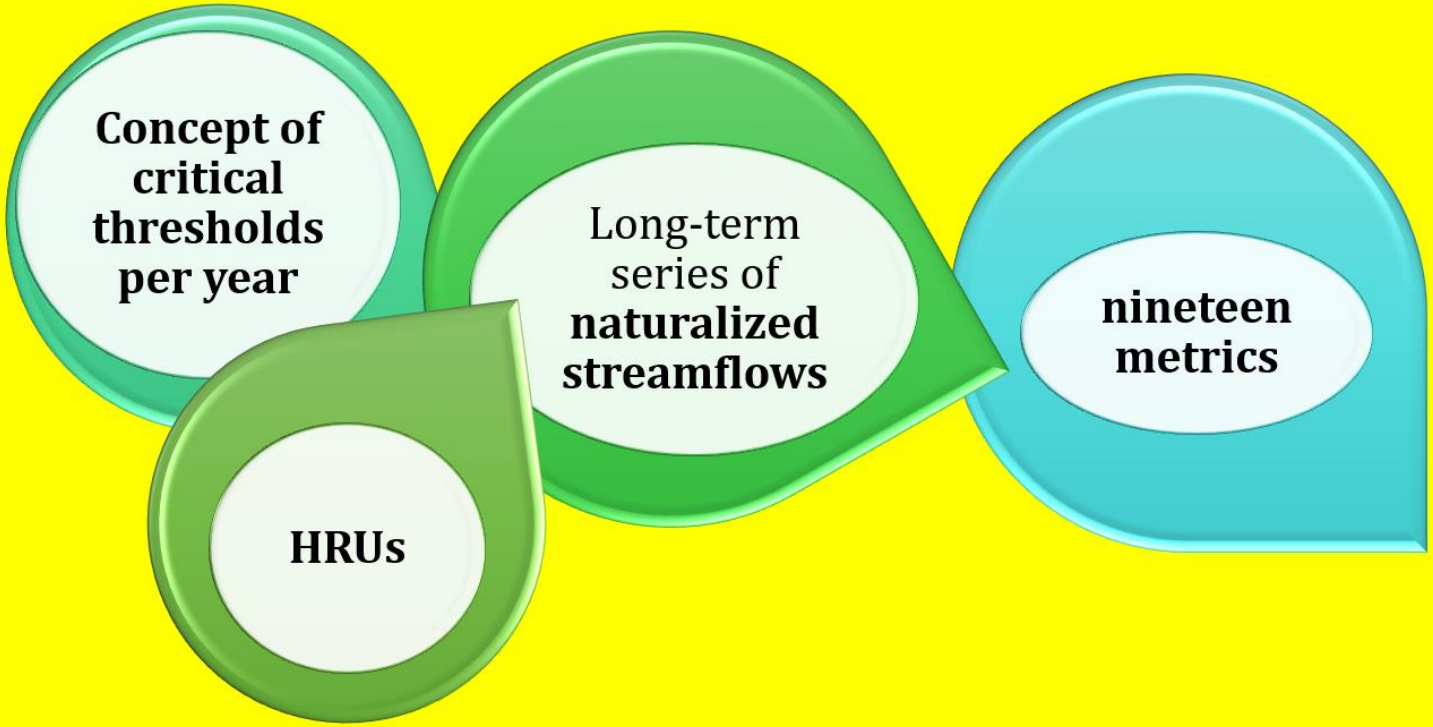
Achelous is a Python-based software that extends the capabilities of the popular library Pandas

https://papers.ssrn.com/sol3/papers.cfm?abstract_id=4737878

190 HRUs met the criterion of intermittency





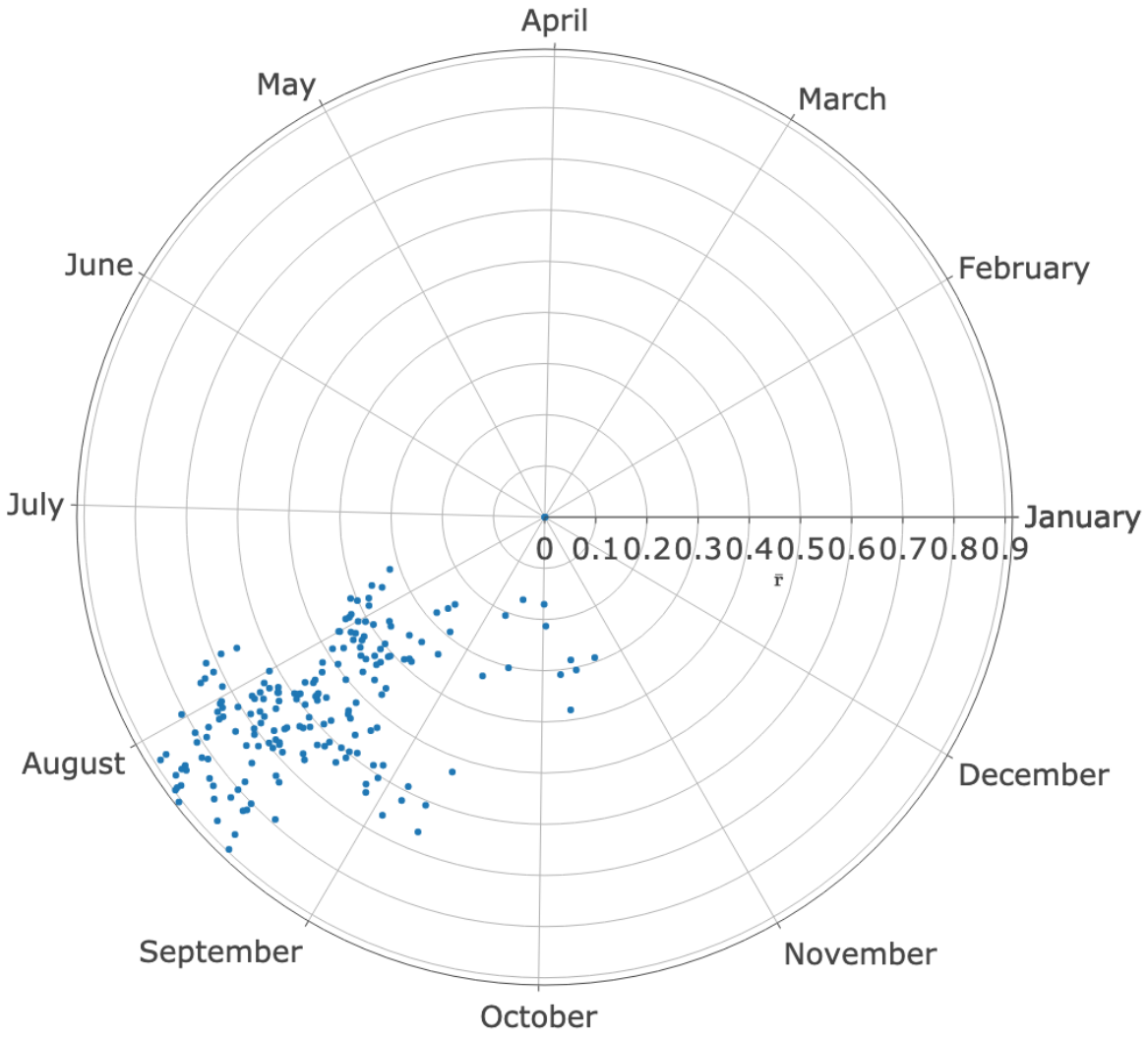

Concept of critical thresholds per year
Long-term series of naturalized streamflows
nineteen metrics
HRUs

To examine this in more detail, we constructed a radial plot, illustrating the seasonal distribution on **no-flow events.** It is evident from the plot that while some of these events show a year-to year variability, **they predominantly occur during August.**

The dynamic nature of intermittency has important implications for the ecology and functioning of these watercourses and the overall functioning of the associated ecosystems

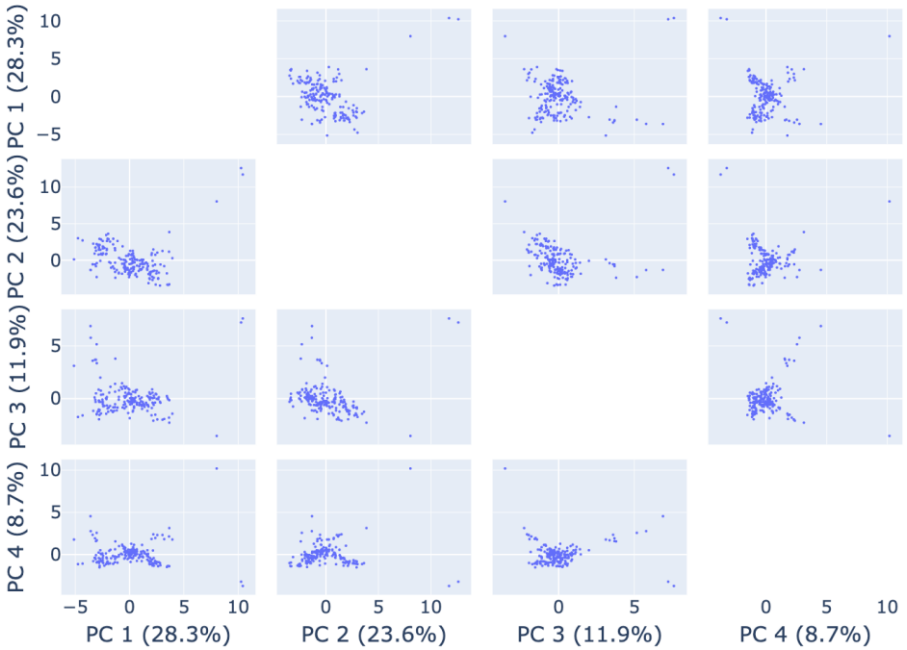
Intermittency can also shape the physical and chemical characteristics of the riverbed and affect the distribution and abundance of species.

It affects the availability of water resources for aquatic organisms, influencing their habitat suitability, and the overall population dynamics (Kalogianni et al. 2017).

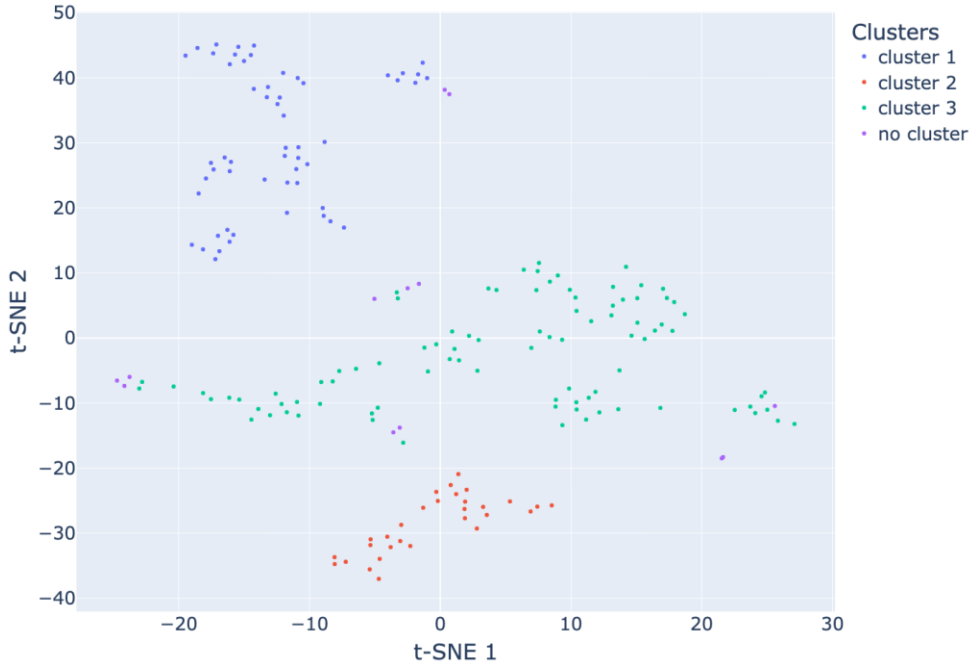


A commonly used and powerful technique for dimension reduction is Principal Components Analysis (PCA)

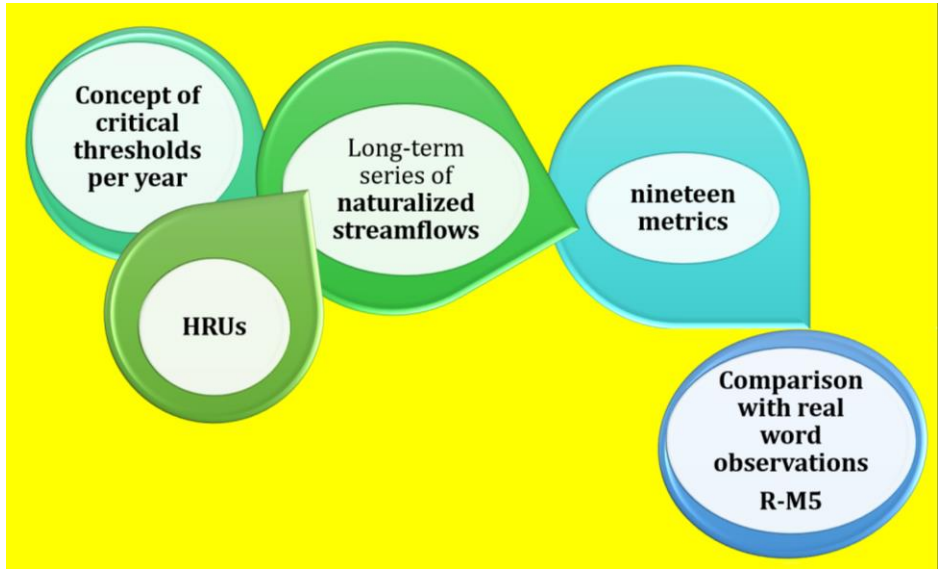
This step aimed to gain insights into the data and evaluate the interpretability of the resulting principal components

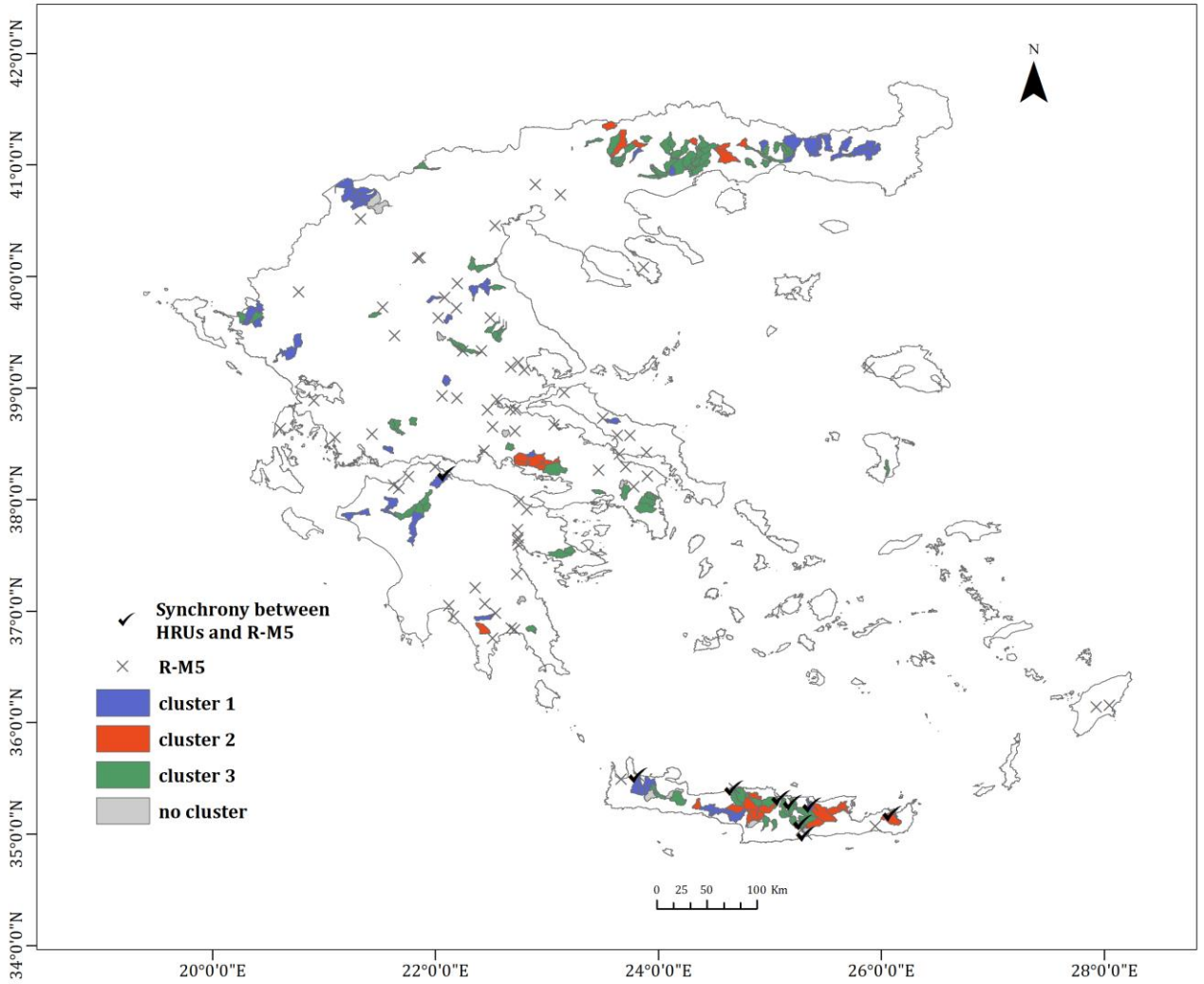


As a second step, we utilized the t-Distributed Stochastic Neighbor Embedding (t-SNE) method directly on the metric values, rather on the principal components to capture complex patterns, three main clusters were emerged



Recognizing naturally intermittent waterways





HRUs belonging to cluster 1 may be classified as seasonal and intermittent, and cluster 2 and 3 as intermittent

Hydrological model assessment and calibration for improving quantitatively and qualitatively the flow time series is of particular importance, this study did not focus on this objective; therefore, underestimation or misrepresentation of the no-flow events may happen.

This might also explain the limited agreement between the R-M5 available observations and the HRUs that fulfilled the criterion

Moreover, the characterization of RM-5, as based on observations, may potentially contain errors. This is particularly evident in the assessment of R-M5, which often proves challenging due to limitations such as insufficient water withdrawal data and a limited understanding of the hydrological conditions within the region

In addition, the fragmented knowledge of the natural/reference conditions and the evolution of a river/stream may contribute to ambiguity in distinguishing between naturally intermittent rivers and the deliberate human-induced desiccation of watercourses.

Nevertheless, **the utilization of the probabilistic t-Distributed Stochastic Neighbor Embedding (t-SNE) technique proved to be advantageous in capturing complex and non-linear patterns** enabling more accurate representation and analysis of the underlying structure.

These endeavors are **gradually shaping a more comprehensive framework to effectively manage and mitigate the impacts of intermittency on aquatic ecosystems and human water needs.**

As science and technology progressing, **these collective efforts pave the way for informed decision making and sustainable water management strategies.**

New approaches for setting an Environmental Flow regime in river systems is among the next challenges
For more information:

https://flowtech.hcmr.gr/

FlowTech

Thank you for your attention
Stay hydrated!!

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