Regional estimates of water scarcity and river habitats for southern Europe

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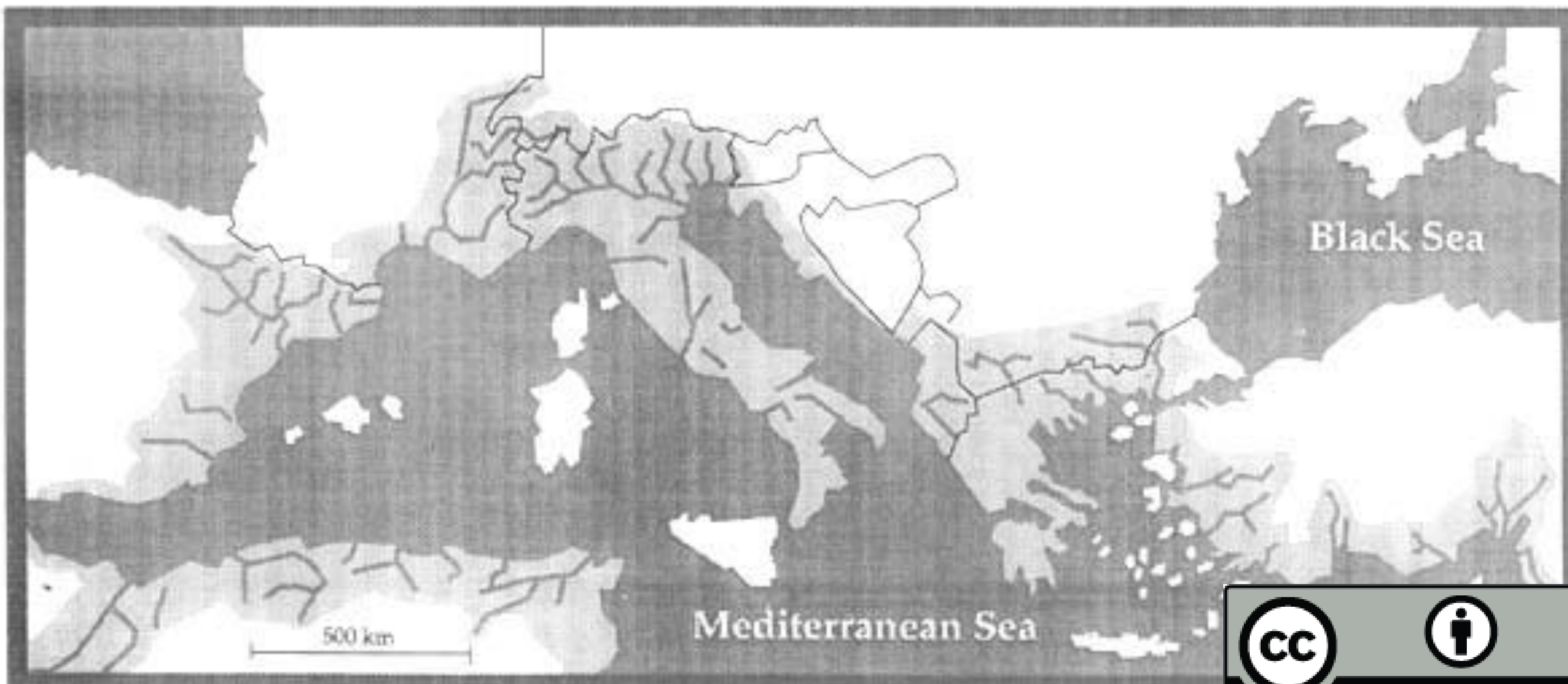
MIRAGE

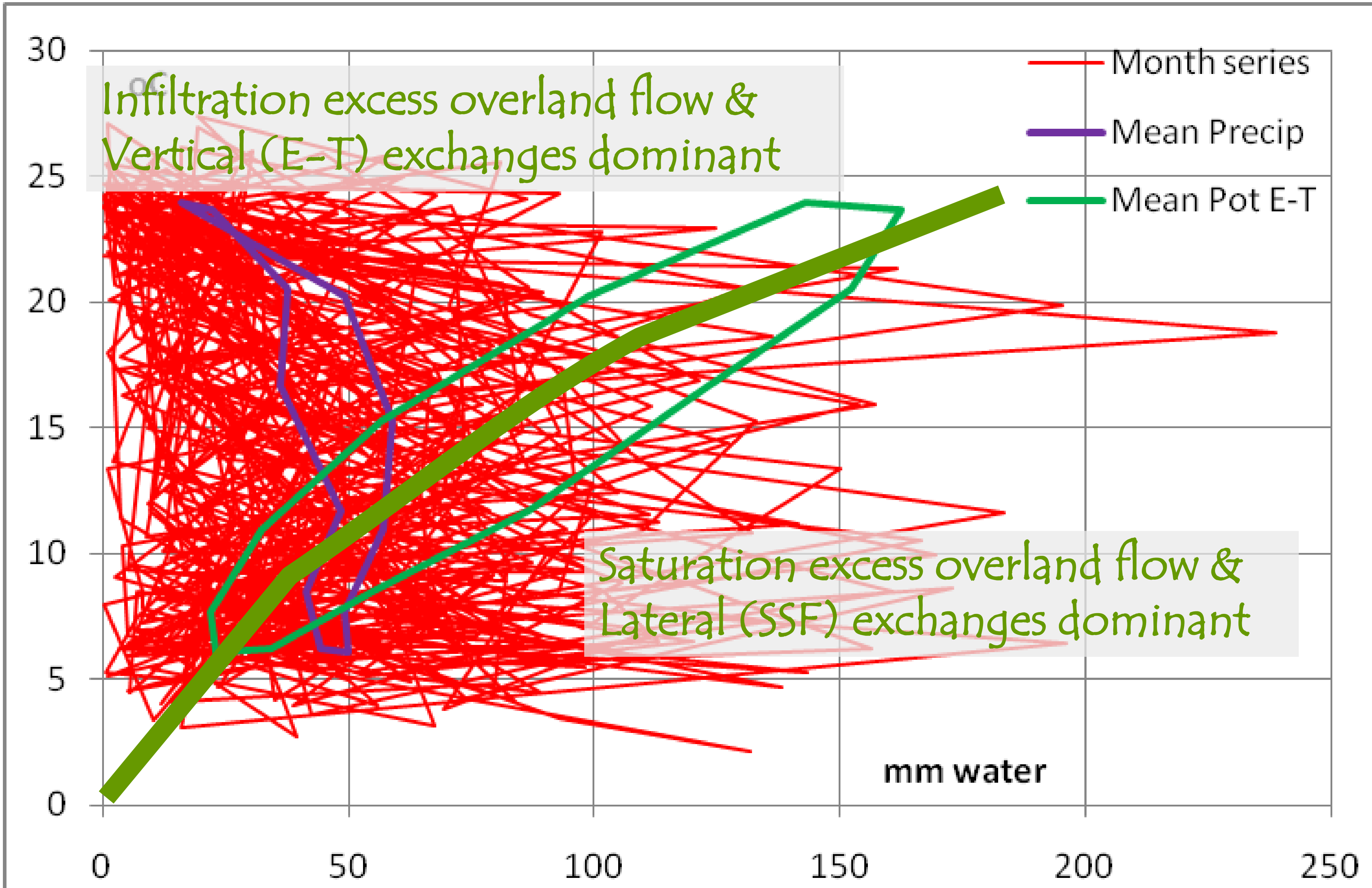
Mediterranean Intermittent River ManAGEment

Rivers draining to the Mediterranean

[Excluding the River Nile]
The Ebro, Rhone and Po together provide
c. 45% of the total flow to the Mediterranean
from c. 12% of the total area drained (c. 500 mm annual runoff)
The remaining 88% of the area averages c. 60 mm annual runoff



Example of a 50-year synthetic climate realisation for the Celone catchment, near Foggia.



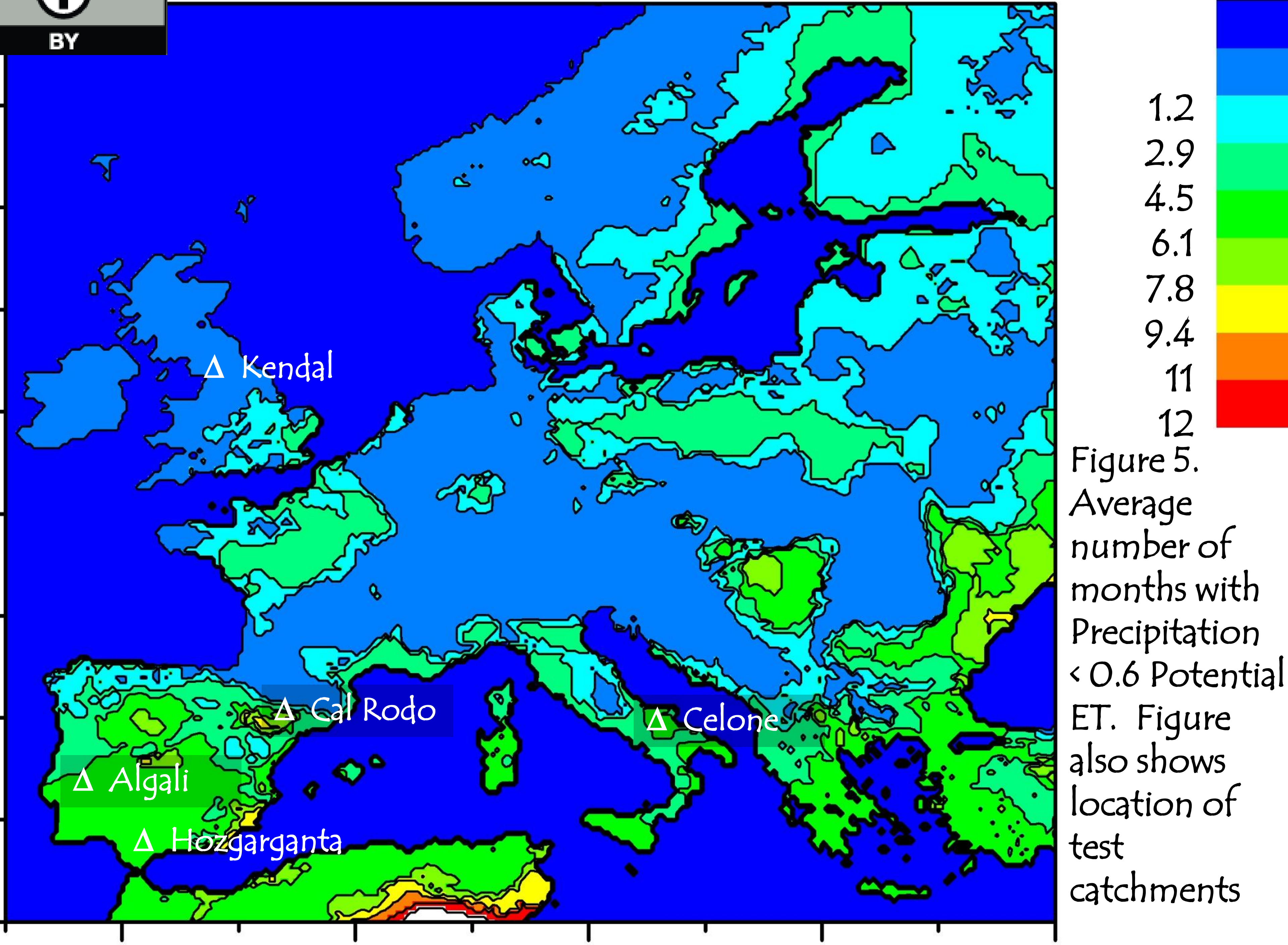


Figure 5. Average number of months with Precipitation < 0.6 Potential ET. Figure also shows location of test catchments

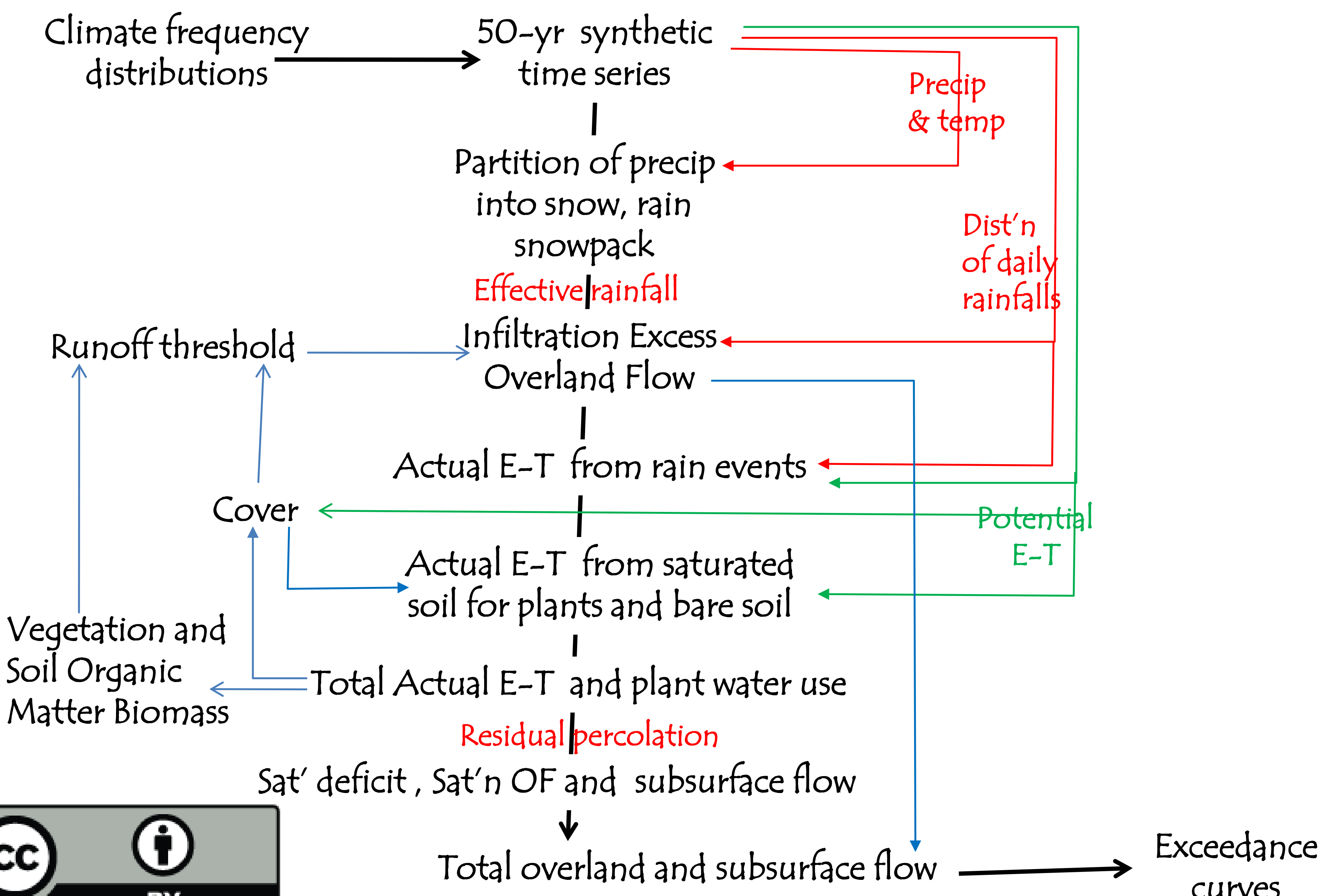
Extending the Water Framework Directive (WFD) to temporary rivers

- Temporary rivers drain most of the catchment area draining to the Mediterranean, and provide about half of the total runoff to it.
- WFD aims to maintain or restore good ecological status, that depends on species (usually focussing on arthropods) that can survive the critical dry-season conditions
  - Water breathing (e.g. fish)
  - Water breeding (e.g. frogs, mosquitoes)
  - Water drinking (e.g. deer, cattle)
- Here we try to use flow duration curves to indicate the frequency of these critical 'pool' conditions, and how this varies regionally, with climate.

Steps in the analysis

- Given limited flow measurement data for semi-arid rivers, we generate flow duration curves from climate data, using synthetic 50-year sequences.
  - Comparing alternatives, we focus on monthly flows and duration curves, which seem most consistent, and most sensitive to climate rather than local catchment conditions
- From duration curves we identify
  1. "Bank-full" conditions based on a fixed recurrence interval for high flows. This defines a flow level.
  2. "Pool" conditions, from the geometry of a typical bank-full X-section, as a fixed ratio of pool-flow to bank-full flow (taken as 0.1%). This gives frequency of "pool" conditions

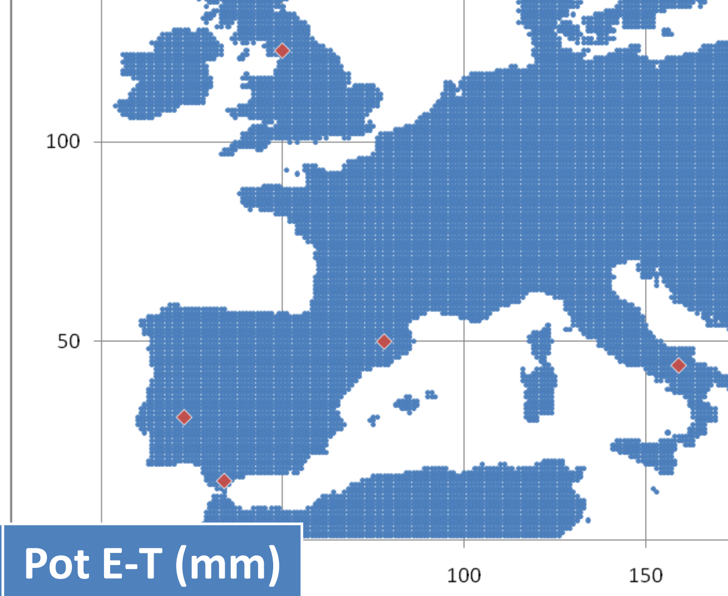
Schematic for monthly hydrological model



Model behaviour

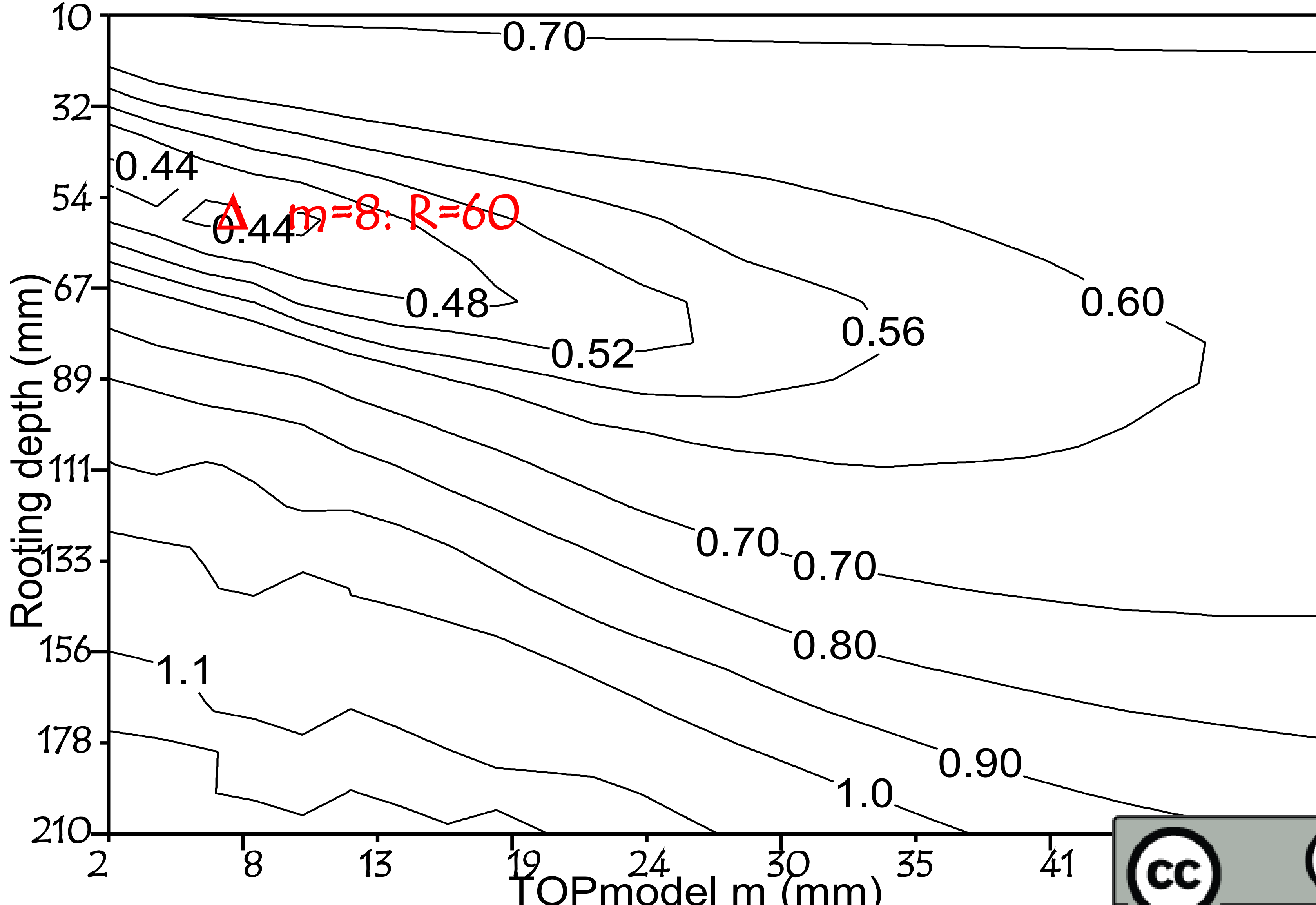
- Model response dominated by two parameters, which represent
  1. Rooting depth, R, from which plants can recover soil water
  2. Drainage depth, m, which determines rate at which soil drains
- Extreme cases
  - R>>m: All water goes to evapo-transpiration
  - R<<m: All water goes to drainage
- Fitting to flow data, best fits always lie between these extremes, so that both drainage and E-T interact (often with seasonal dominance)

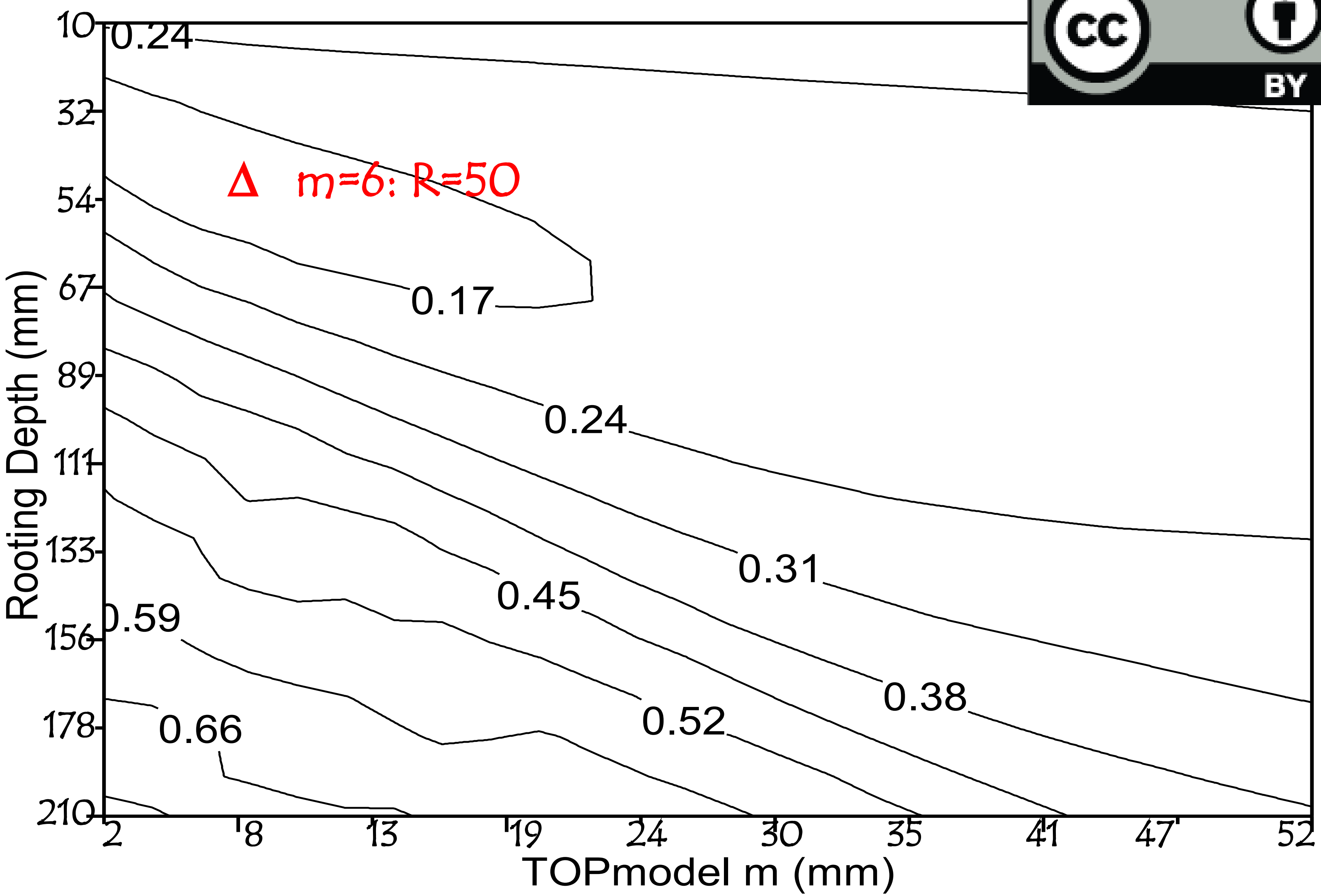
Summary characteristics of catchments studied



Name	Latitude (N)	Longitude (E)	Precip'n (mm)	Pot E-T (mm)
Hozgarganta, Spain	36.4	-5.4	699	1053
Cal Rodo, Spain	42.2	1.9	989	776
Algali, Portugal	39.1	-7.2	640	1170
Kendal, UK	54.4	-2.7	2064	577
Celone, San Vincenzo, Italy	41.3	15.5	465	991

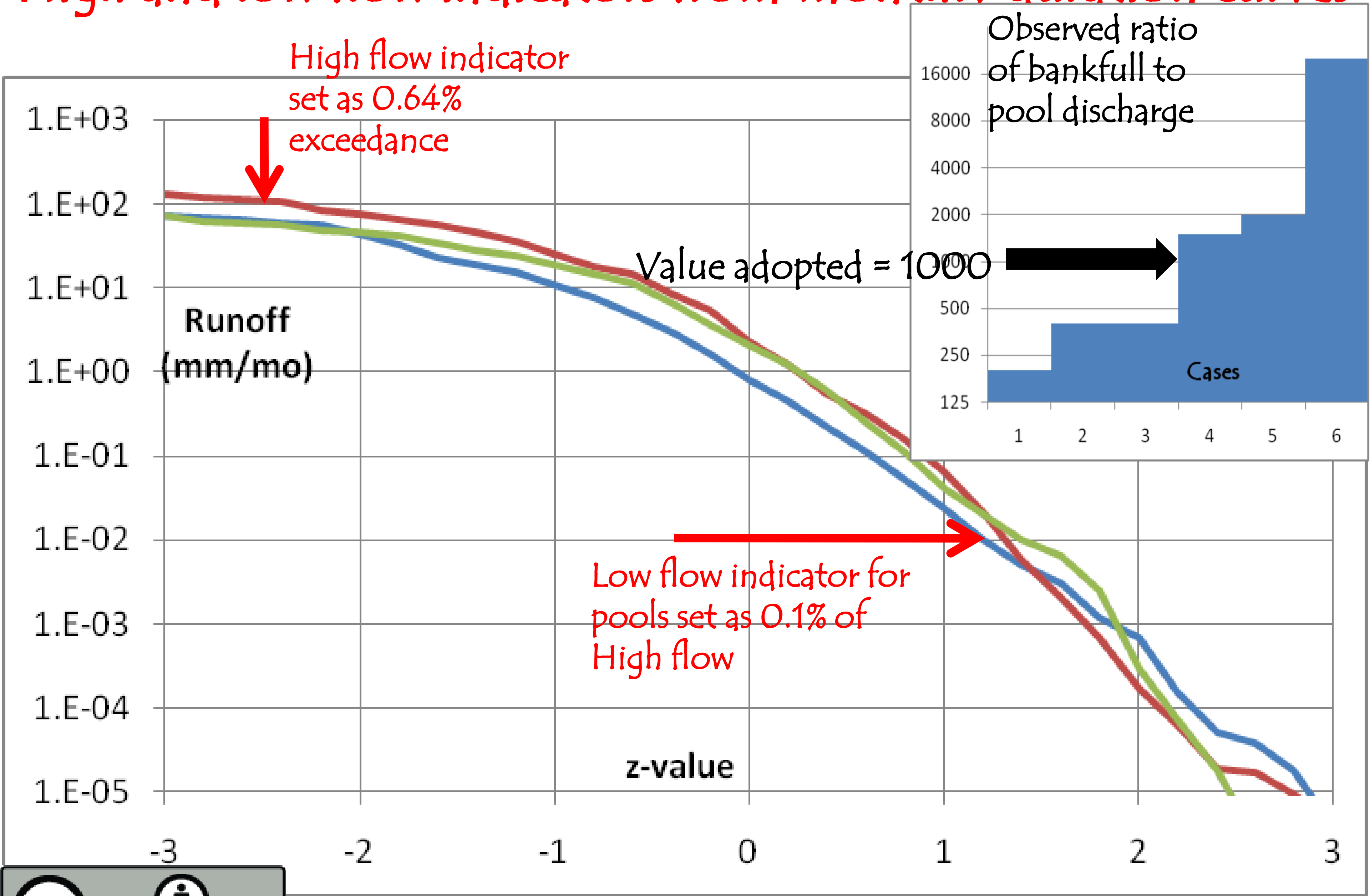
RMS mean difference between observed and simulated exceedance curves for R. Hozgarganta, S. Spain. Δ shows catchment optimum

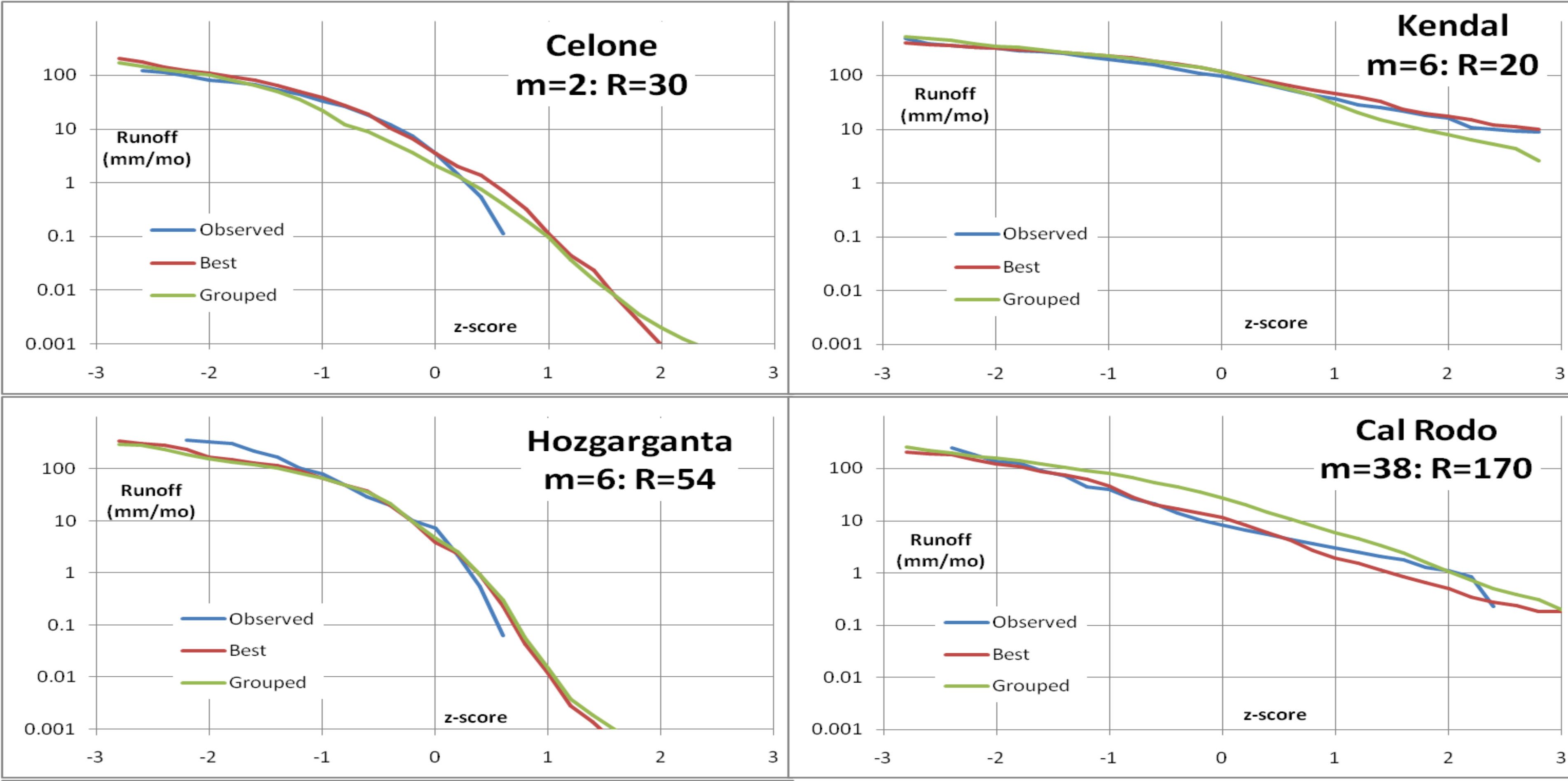


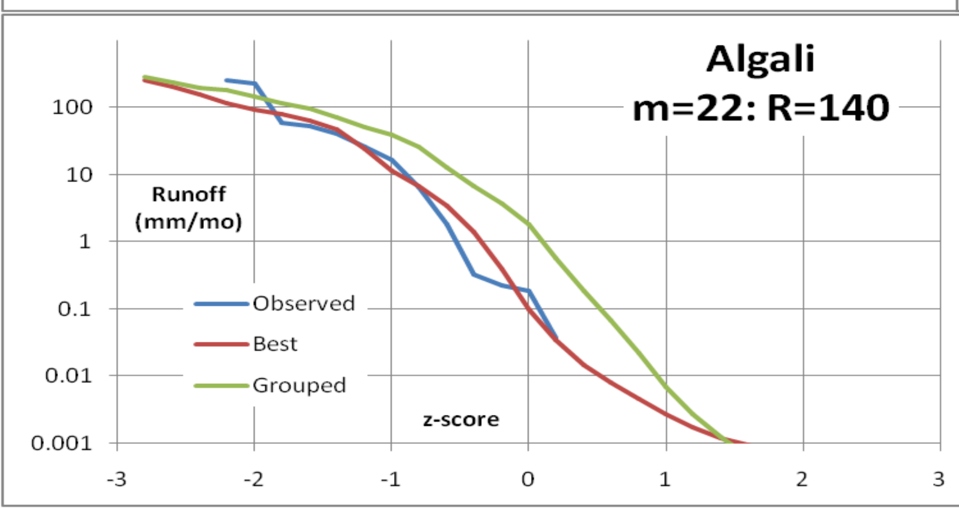


Average normalised departure summed across five test catchments from their individual RMS errors. Δ shows global optimum

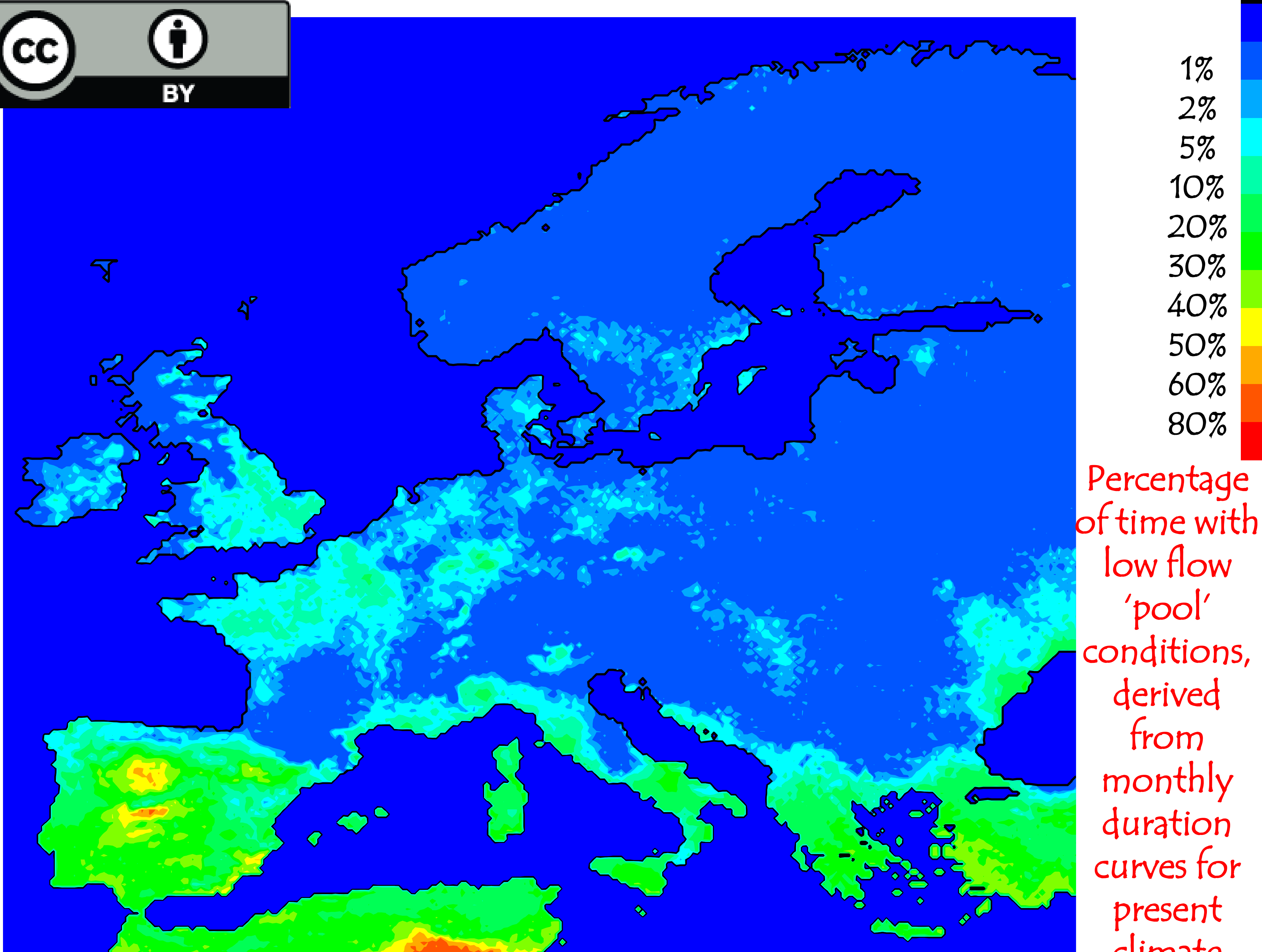
High and low flow indicators from monthly duration curves



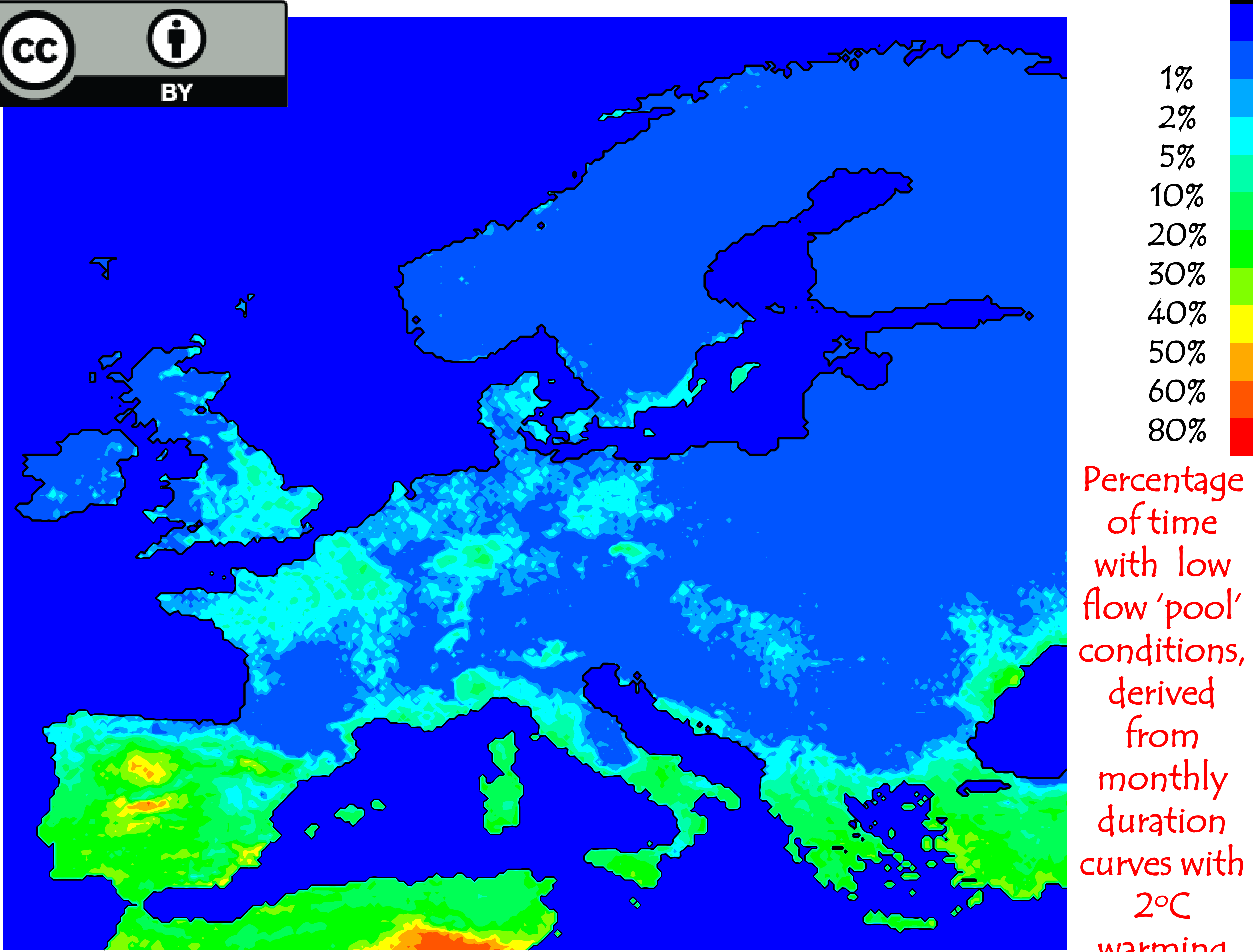




Exceedance curves for the five test catchments. Each graph shows the observed data, the individual best fit model and the global best fit model.



Percentage of time with low flow 'pool' conditions, derived from monthly duration curves for present climate


1%
2%
5%
10%
20%
30%
40%
50%
60%
80%
Percentage of time with low flow 'pool' conditions, derived from monthly duration curves with 2°C warming

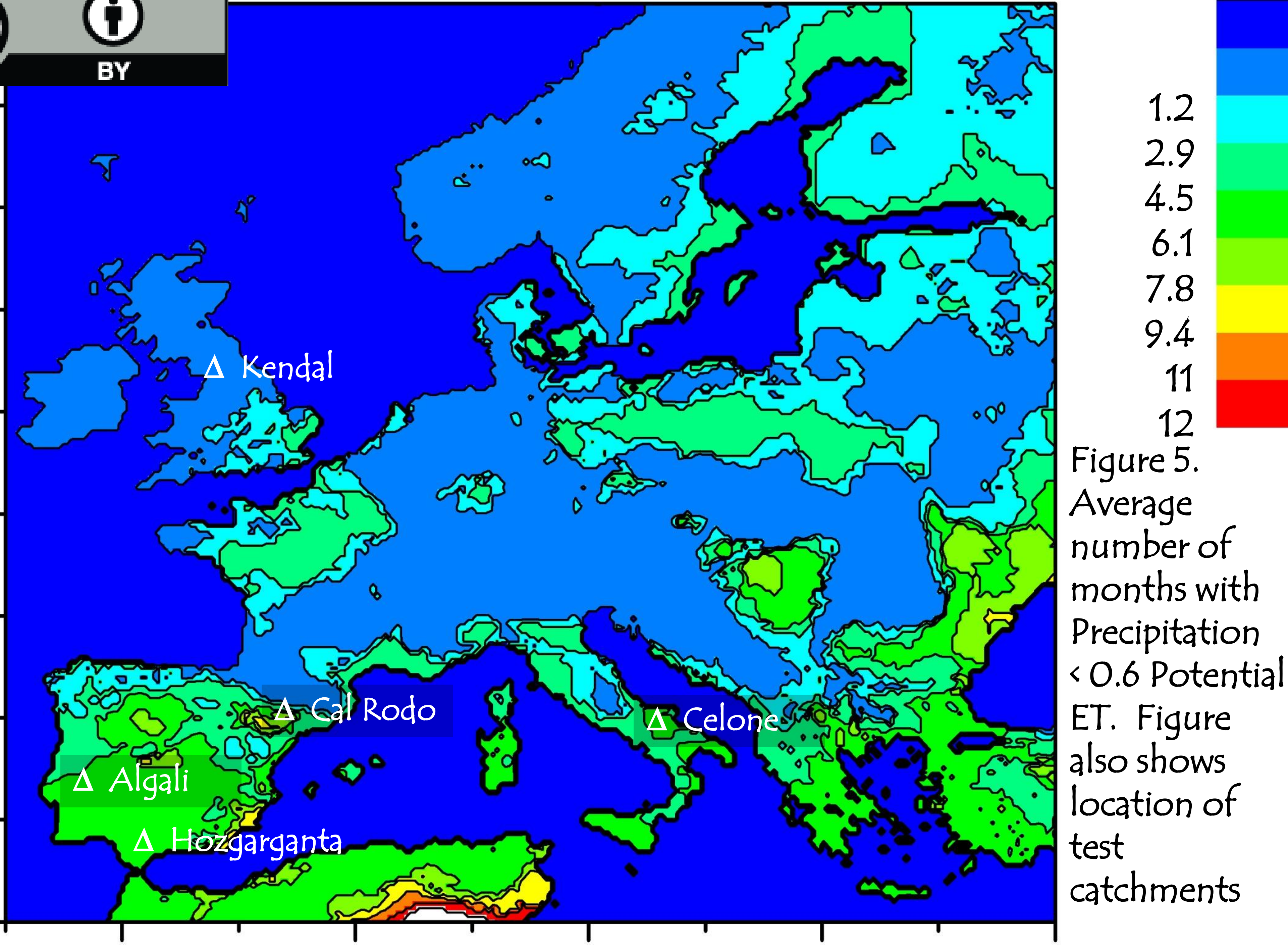
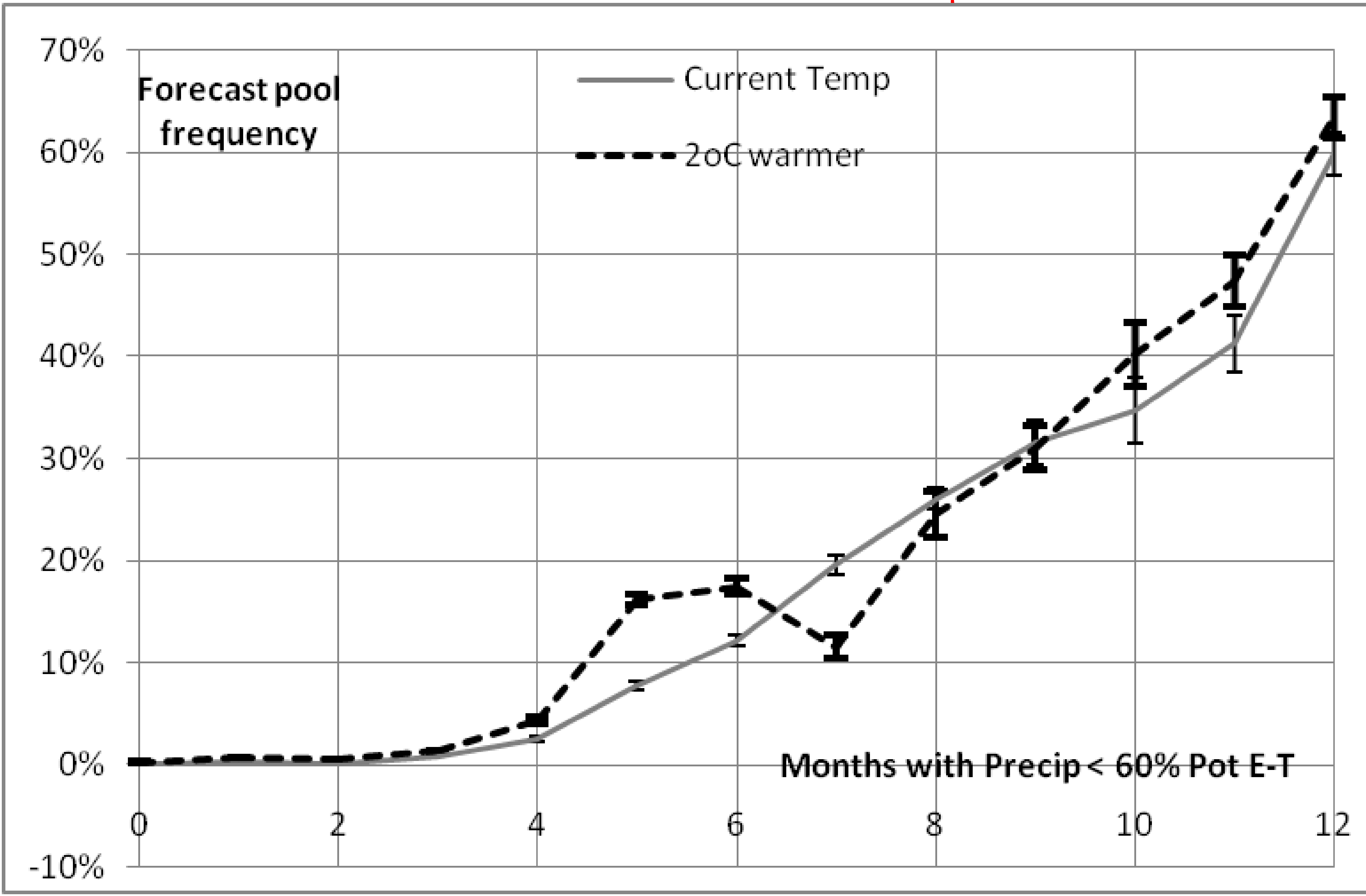


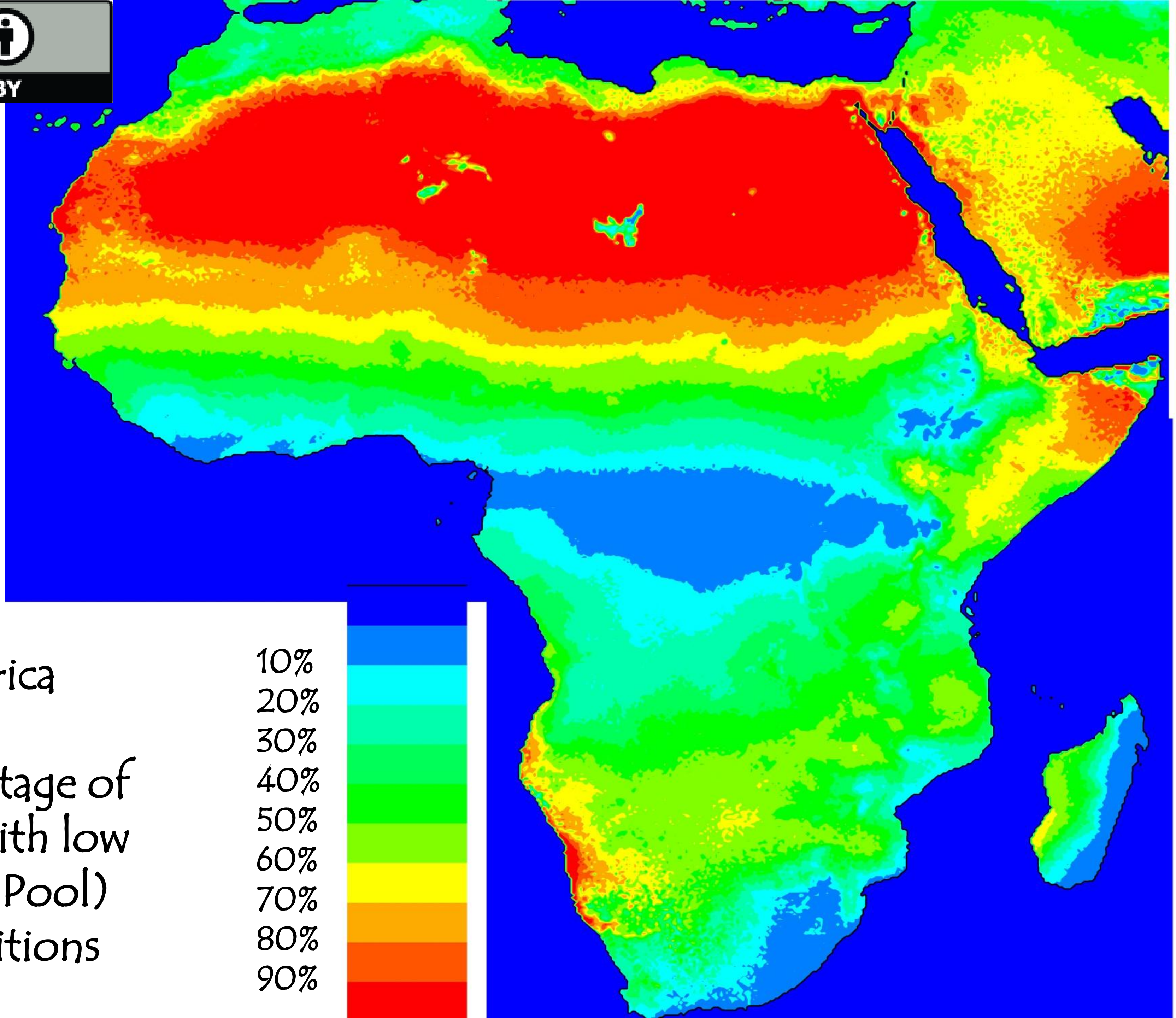
Figure 5. Average number of months with Precipitation < 0.6 Potential ET. Figure also shows location of test catchments

Empirical relationship between forecast pool frequency and the average number of dry months (Precip < 0.6 Pot E-T) for current climate and with a 2°C temperature rise



Africa

Percentage of time with low flow (Pool) conditions



Conclusions

- Provides a methodology that can readily be applied at regional scale to map the climatic signal in pool frequency.
- A basis for classifying ecological conditions for species survival and comparing status.
- Real distributions is affected by a number of additional factors
  - Abstraction & return of waste water etc
  - Interaction with karst and other aquifers
  - Detailed catchment morphology.