# Hydrological regime and sediment transport in two Mediterranean intermittent rivers and ephemeral streams (IRESs)

**Ricci G.[1*], Fortesa J,[2,3], García-Comendador J.[2,3], Gentile F.[1], Estrany J.[2,3], Sauquet E.[4], Datry T.[4], De Girolamo A.M.[5]**

[1]Department of Agricultural and Environmental Sciences, University of Bari Aldo Moro, Bari, Italy

[2]Mediterranean Ecogeomorphological and Hydrological Connectivity Research Team, Department of Geography, University of the Balearic Islands, Palma, Spain

[3]Institute of Agro-Environmental and Water Economy Research –INAGEA, University of the Balearic Islands, Palma, Spain

[4] INRAE, UR RiverLy, Villeurbanne, France

[5]Water Research Institute, National Research Council, Bari, Italy

**[*]giovanni.ricci@uniba.it**

UNIVERSITÀ DEGLI STUDI DI BARI ALDO MORO | DIPARTIMENTO DI SCIENZE AGRO-AMBIENTALI E TERRITORIALI

MEDhyCON Mediterranean Ecogeomorphological and Hydrological Connectivity Research Team

INAGEA Instituto de Investigaciones Agroambientales y de Economía del Agua

IRSA CNR *Water Research Institute National Research Council*

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UIB Universitat de les Illes Balears

## Introduction

The hydrological regime strongly influences water quality, nutrient and sediment delivery in all river systems

The relevance of the flow regime has also been recognized by river ecologists, who pointed out that dynamic variability of streamflow is fundamental in sustaining the ecological integrity of the river ecosystem

The hydrological regime is the primary driving force controlling the sediment transfer from the upland to the lowland zone, therefore the river geomorphology

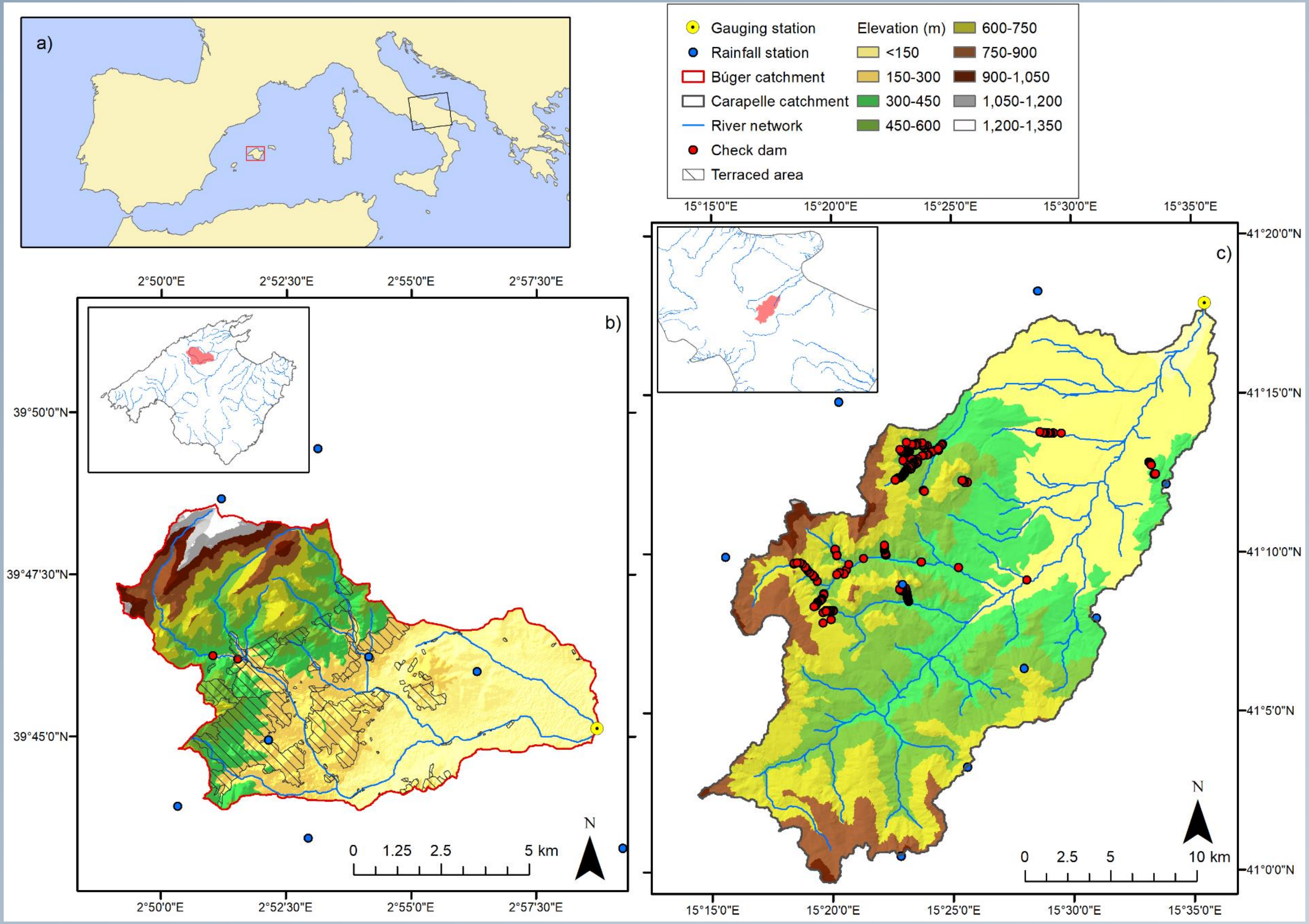
## Aims

To analyse the hydrological regime of two IRES

To analyse the temporal variability of suspended sediment transport

# Study areas

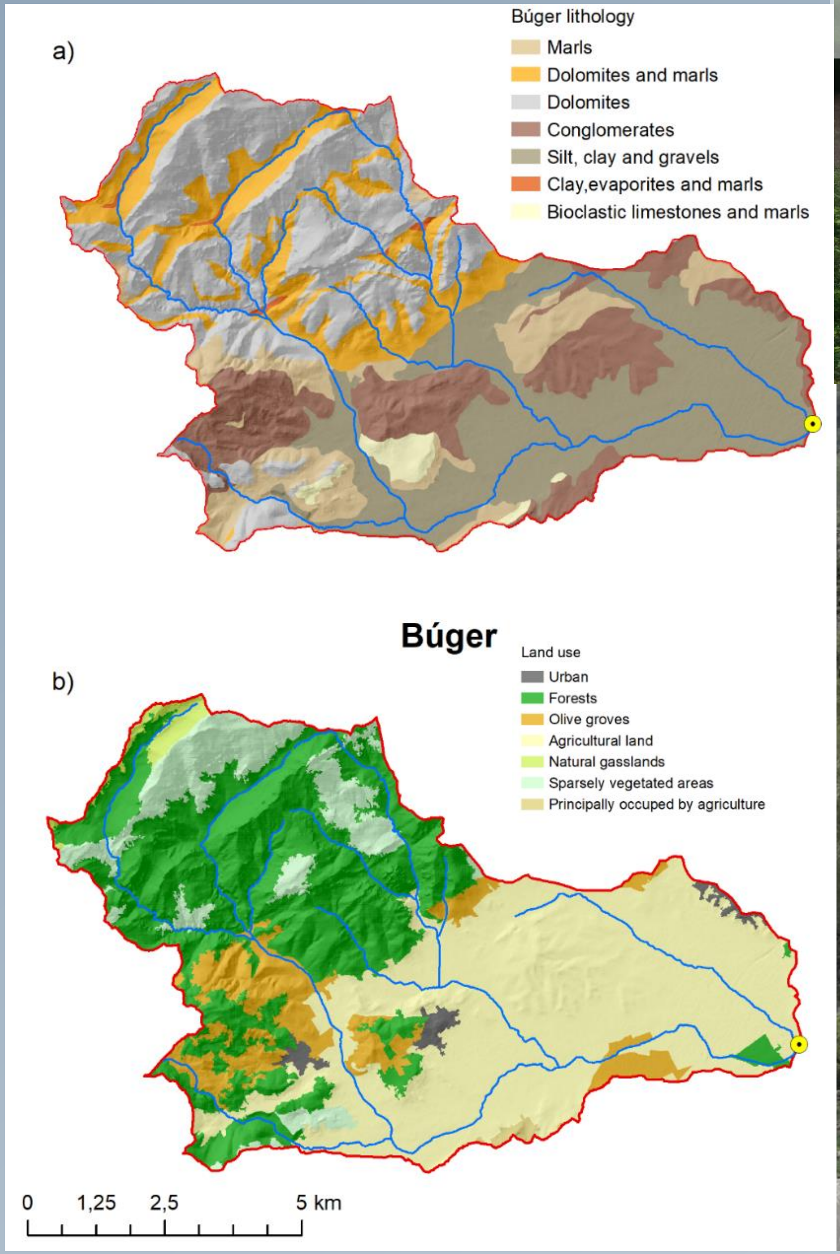
| Catchment characteristics | Búger | Carapelle |
|---|---|---|
| Area ($km^2$) | 68 | 506 |
| Elevation range (m.a.s.l) | 55 - 1360 | 120 - 1089 |
| Mean annual rainfall (mm) | 760 - 1201 | 531 - 779 |
| Mean catchment slope (%) | 31 | 16 |




Búger

Carapelle

# Study areas

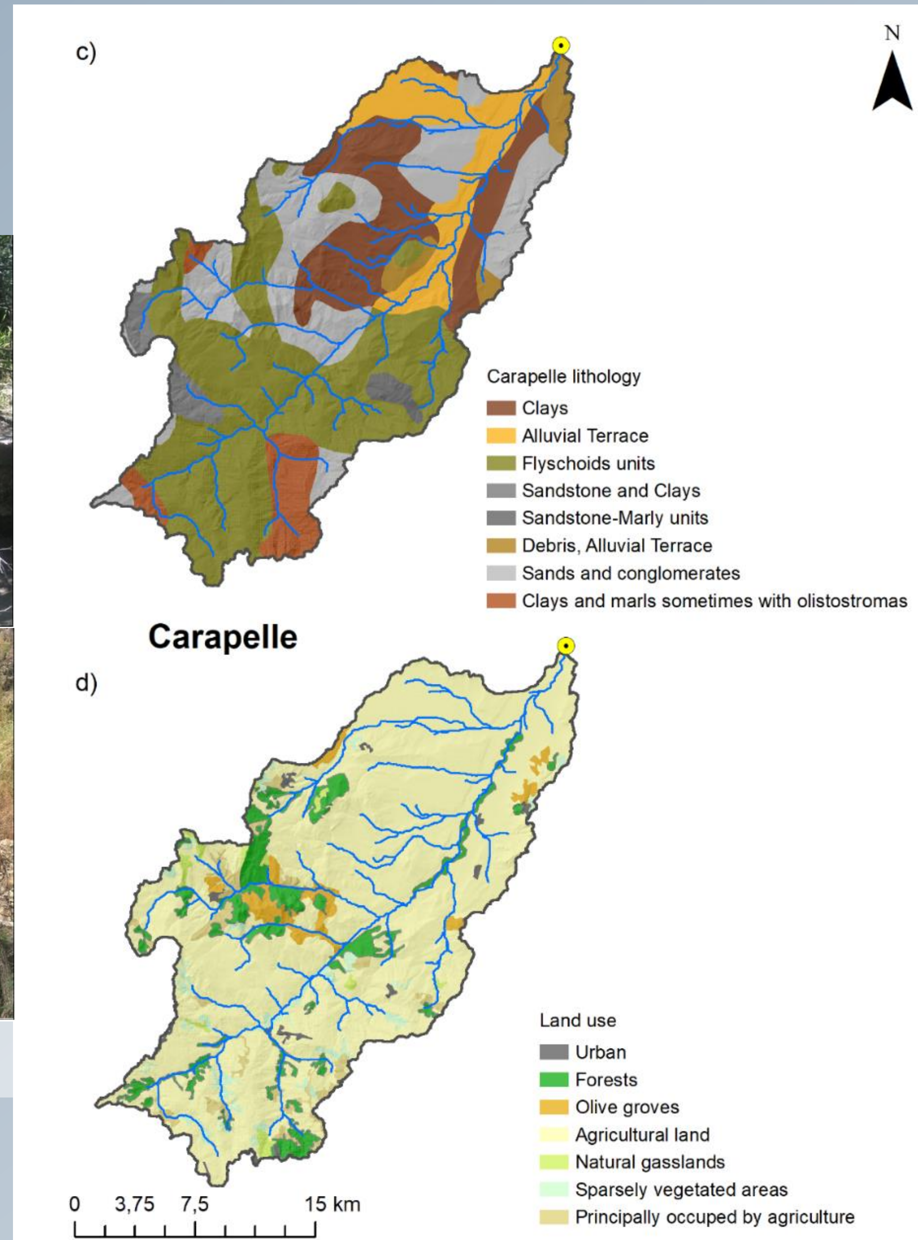

Búger lithology
a)
Marls
Dolomites and marls
Dolomites
Conglomerates
Silt, clay and gravels
Clay,evaporites and marls
Bioclastic limestones and marls
Búger
Land use
b)
Urban
Forests
Olive groves
Agricultural land
Natural gasslands
Sparsely vegetated areas
Principally occuped by agriculture
0
1,25
2,5
5 km


Check dam


Terraces

## Study areas

Check dams



## Methods

Monitoring and data acquisition of 5 years: rainfall, discharge and suspended sediment

Data computation:

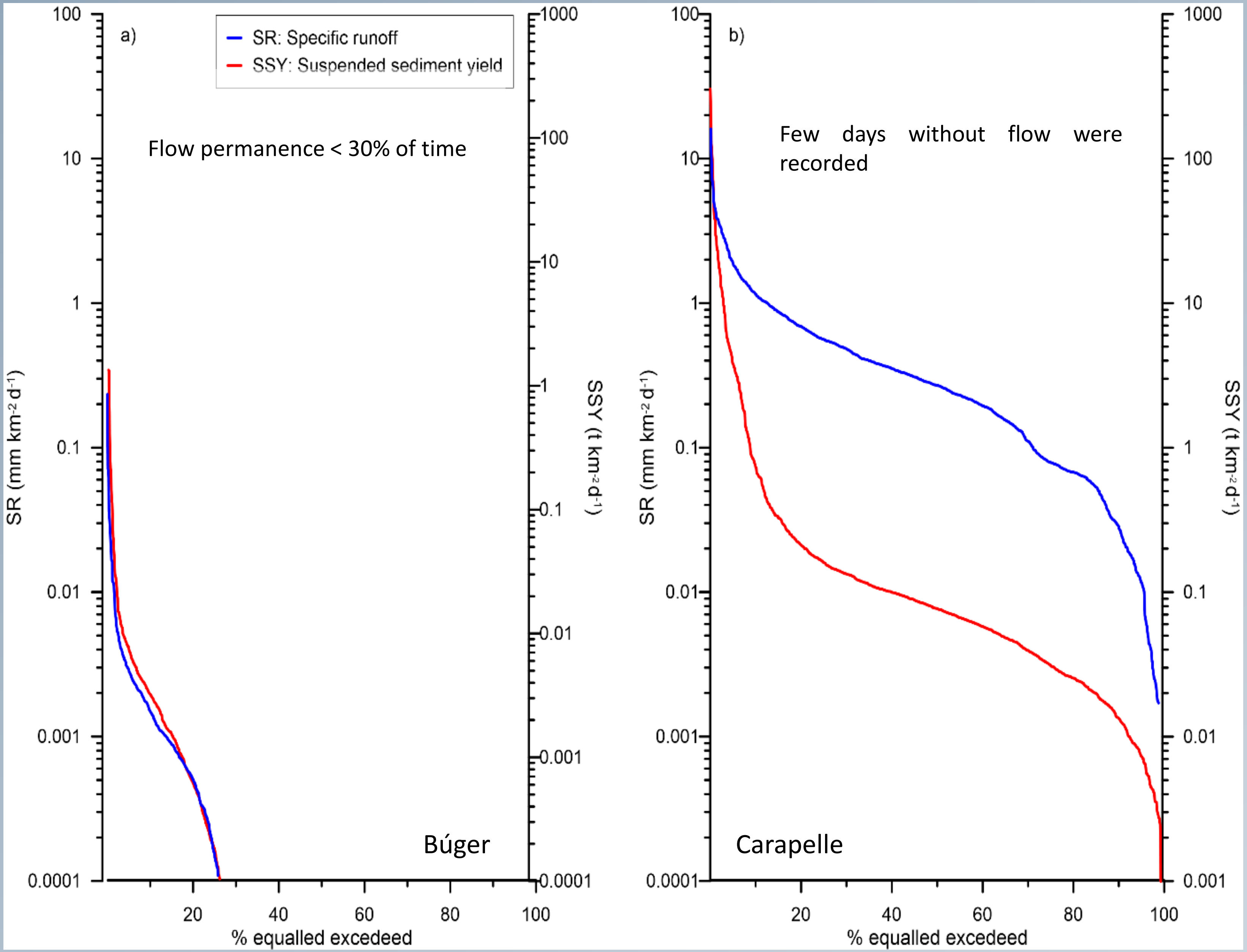
- Discharge and suspended sediment rating curves
- Runoff and sediment yields at annual, monthly and event scale
- Flow duration curves of daily runoff and sediment yield
- Event variables to identify main drivers of the hydrological response and sediment transport
- To identify sediment sources through discharge - suspended sediment hysteresis patterns

| | Rainfall variables | | Runoff variables | | Sediment variables |
|---|---|---|---|---|---|
| $P_{tot}$ | Total precipitation (mm) | $Q_{dur}$ | Flood duration (h) | $SSC_{max}$ | Max. susp. sed. conc. (g $l^{-1}$) |
| $IP_{max}30$ | Max. 30′ prec. intensity (mm h) | $Q_{max}$ | Max. discharge ($m^3$ $s^{-1}$) | SSY | Specific sediment yield (t $km^{-2}$) |
| AP1d | Antec. Prec. 1 day before (mm) | $Q_0$ | Discharge at time 0 ($m^3$ $s^{-1}$) | | |
| AP3d | Antec. Prec. 3 day before (mm) | $R_c$ | Runoff coefficient (%) | | |
| | | R | Runoff (mm) | | |

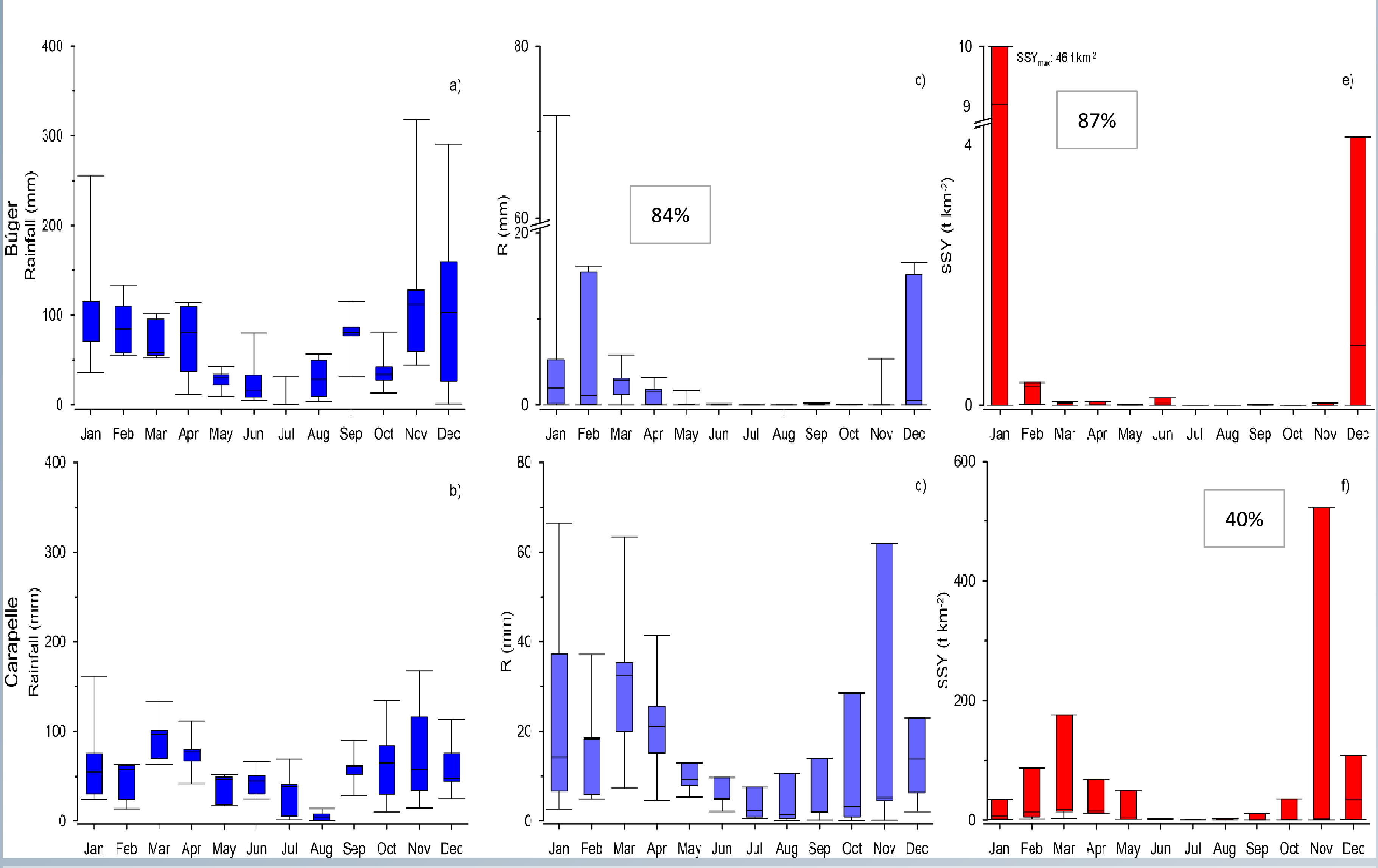
## Results: yields at annual scale

| Búger | | | | | |
|---|---|---|---|---|---|
| Year | Rainfall (mm) | Runoff (mm) | Runoff coeficient (%) | Zero day flow | SY (t km$^2$ yr$^{-1}$) |
| 2013 | 1019.4 | 26.86 | 3 | 204 | 0.79 |
| 2014 | 719.1 | 11.38 | 2 | 237 | 0.49 |
| 2015 | 606.3 | 25.38 | 4 | 212 | 1.51 |
| 2016 | 867.9 | 16.73 | 2 | 329 | 3.92 |
| 2017 | 835.4 | 91.11 | 11 | 250 | 45.97 |
| 2012-17 | 835.4 | 25.38 | 3 | 237 | 1.51 |
| **Carapelle** | | | | | |
| Year | Rainfall (mm) | Runoff (mm) | Runoff coeficient (%) | Zero day flow | SY (t km$^2$ yr$^{-1}$) |
| 2007 | 542.0 | 75.0 | 14 | 0 | 89.31 |
| 2008 | 546.0 | 93.5 | 17 | 54 | 123.70 |
| 2009* | 785.7 | - | - | - | - |
| 2010 | 889.0 | 307.8 | 35 | 4 | 745.40 |
| 2011 | 546.0 | 87.7 | 16 | 1 | 411.86 |
| 2007-11 | 546.0 | 90.6 | 16 | 2.5 | 267.78 |

# Results: flow and sediment duration curve



## Results: minimum, median and maximum monthly yields

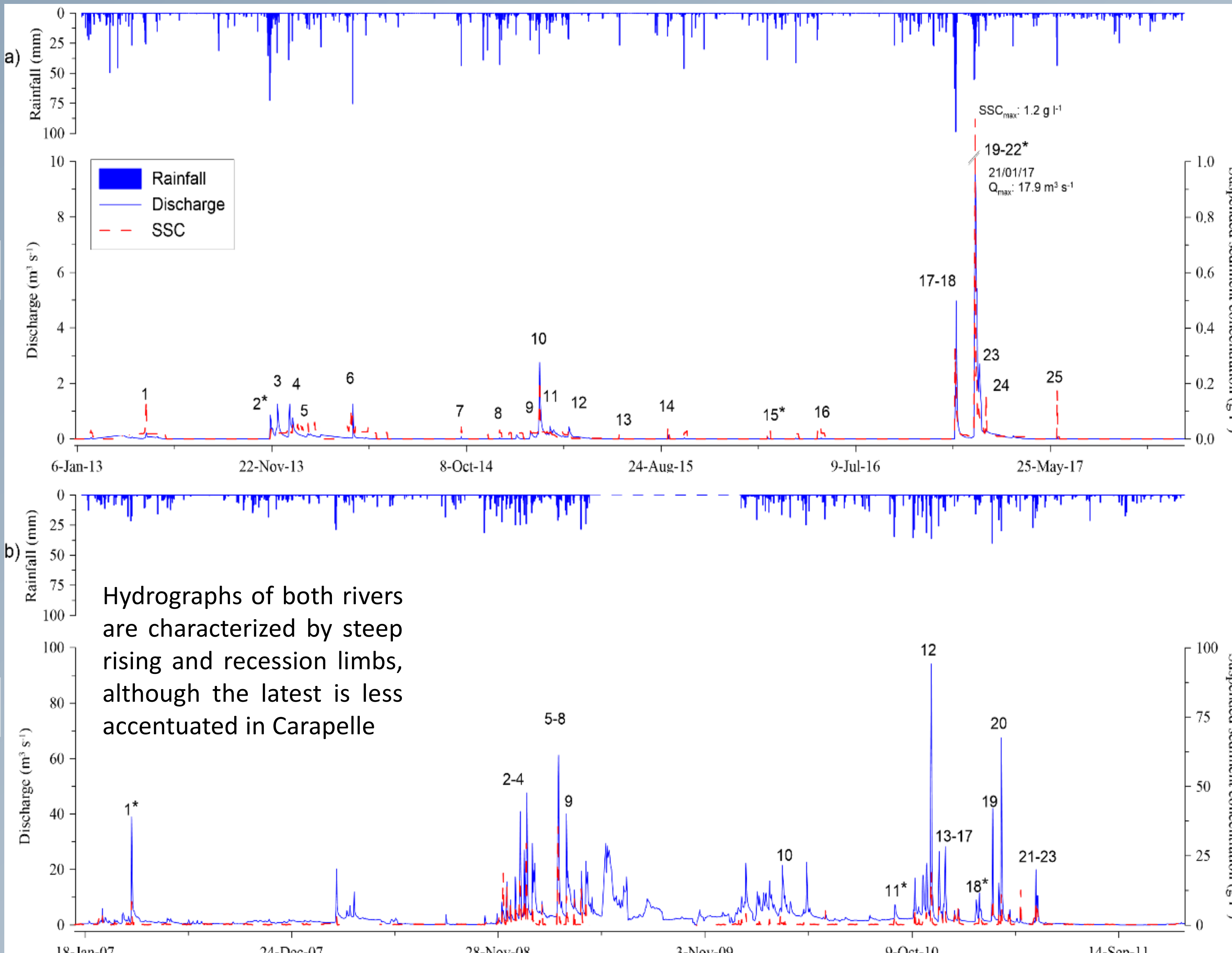



Rainfall, runoff and sediment yield values were more distributed along the year in Carapelle than Búger

# Results: daily discharge and suspended sediment concentration

Búger

Carapelle




Hydrographs of both rivers are characterized by steep rising and recession limbs, although the latest is less accentuated in Carapelle

## Results: drivers at event scale

### Búger

| | $P_{tot}$ | $IP_{max}30$ | AP1d | AP3d | $Q_{dur}$ | $Q_0$ | $Q_{max}$ | R | $R_c$ | $SSC_{max}$ | SY |
|---|---|---|---|---|---|---|---|---|---|---|---|
| $P_{tot}$ | 1 | 0.30 | 0.36 | **0.61** | 0.20 | -0.05 | 0.18 | 0.37 | 0.02 | 0.32 | 0.14 |
| $IP_{max}30$ | | 1 | -0.18 | -0.04 | *-0.51* | -0.29 | -0.14 | -0.18 | -0.35 | 0.02 | -0.11 |
| AP1d | | | 1 | **0.87** | *0.42* | **0.56** | **0.58** | **0.76** | **0.64** | *0.49* | **0.55** |
| AP3d | | | | 1 | 0.33 | **0.54** | **0.58** | **0.74** | **0.58** | **0.51** | **0.54** |
| $Q_{dur}$ | | | | | 1 | 0.01 | 0.01 | 0.29 | 0.20 | -0.12 | 0.00 |
| $Q_0$ | | | | | | 1 | **0.82** | **0.80** | **0.96** | **0.65** | **0.78** |
| $Q_{max}$ | | | | | | | 1 | **0.91** | **0.81** | **0.84** | **0.99** |
| R | | | | | | | | 1 | **0.87** | **0.76** | **0.88** |
| $R_c$ | | | | | | | | | 1 | **0.62** | **0.76** |
| $SSC_{max}$ | | | | | | | | | | 1 | **0.85** |
| SY | | | | | | | | | | | 1 |

**Significant correlation at 0.01 level**

*Significant correlation at 0.05 level*

Favorable moisture conditions and not rainfall intensities who promoted major runoff and sediment load contributions

### Carapelle

| | $P_{tot}$ | $IP_{max}30$ | AP1d | AP3d | $Q_{dur}$ | $Q_0$ | $Q_{max}$ | R | $R_c$ | $SSC_{max}$ | SY |
|---|---|---|---|---|---|---|---|---|---|---|---|
| $P_{tot}$ | 1 | **0.77** | 0.17 | -0.11 | **0.72** | 0.10 | **0.54** | **0.62** | *-0.42* | 0.29 | *0.50* |
| $IP_{max}30$ | | 1 | 0.36 | 0.10 | 0.28 | 0.24 | **0.77** | **0.60** | -0.40 | *0.52* | **0.60** |
| AP1d | | | 1 | *0.461** | -0.13 | 0.10 | 0.36 | 0.15 | -0.08 | 0.31 | 0.19 |
| AP3d | | | | 1 | -0.04 | 0.28 | 0.27 | 0.24 | 0.34 | 0.02 | 0.24 |
| $Q_{dur}$ | | | | | 1 | 0.23 | 0.30 | **0.66** | -0.21 | -0.09 | *0.46* |
| $Q_0$ | | | | | | 1 | *0.46* | **0.62** | 0.09 | 0.18 | *0.43* |
| $Q_{max}$ | | | | | | | 1 | **0.85** | -0.21 | *0.49* | **0.88** |
| R | | | | | | | | 1 | -0.15 | 0.37 | **0.91** |
| $R_c$ | | | | | | | | | 1 | -0.13 | -0.11 |
| $SSC_{max}$ | | | | | | | | | | 1 | **0.54** |
| SY | | | | | | | | | | | 1 |

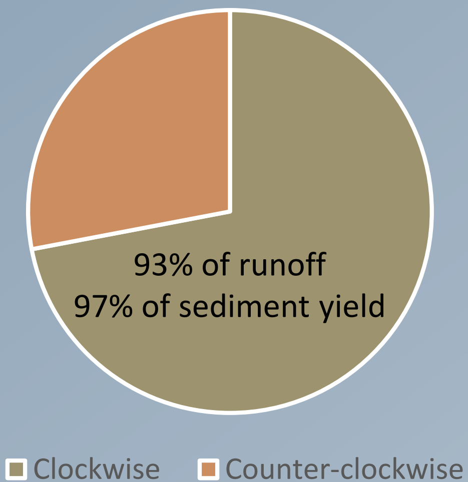
**Significant correlation at 0.01 level**

*Significant correlation at 0.05 level*

Runoff and sediment load contributions were controlled by rainfall amount and intensity

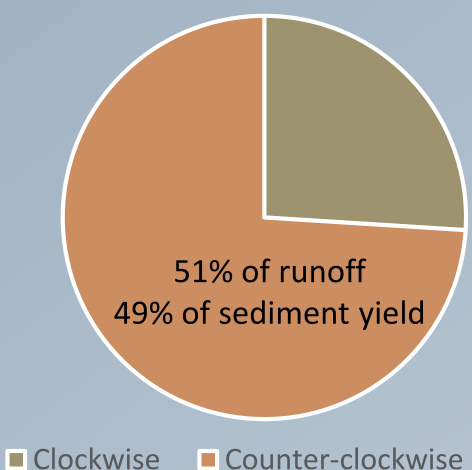
# Results: hysteresis patterns

## Búger




Low sediment availability in headwater (karst features) and higher in lowland agricultural areas

## Carapelle




Larger sediment availability due to agricultural fields

# Conclusions

Lithology resulted the most relevant driver controlling the hydrological regime

Runoff response can be due to different processes (i.e., saturation or infiltration excess)

Búger: SSY and $SSC_{max}$ were correlated with the runoff, peak discharge and antecedent rainfall
Carapelle: SSY and $SSC_{max}$ were correlated to the amount and intensity of rainfall

Land use and management practices were also relevant factors in SSY, determining the availability of SS material. A large number of terraces present in the Búger catchment contribute to retaining the sediment detachment

Hysteretic loops are greatly influenced by the size, shape, lithology and land uses of the basins

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MEDhyCON
Mediterranean Ecogeomorphological and Hydrological Connectivity Research Team

**Website**
http://medhycon.uib.cat
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