



## Sub-daily rainfall-runoff dynamics in tropical headwater catchments under different forest management: insights from Brazil

Presenter: : Nataly Foronda Ortega

Supervisor: Dr.<sup>a</sup> Larisa Tarasova

Co-supervisor: Prof. Dr. Silvio F. B. Ferraz



This presentation participates in OSPP



Outstanding Student & PhD candidate Presentation contest

Photo: Arthur Moreira



EGU26-13668

# How does forest management shape hydrological response?

*Native vegetation*

*Eucalyptus plantation*



Regeneration

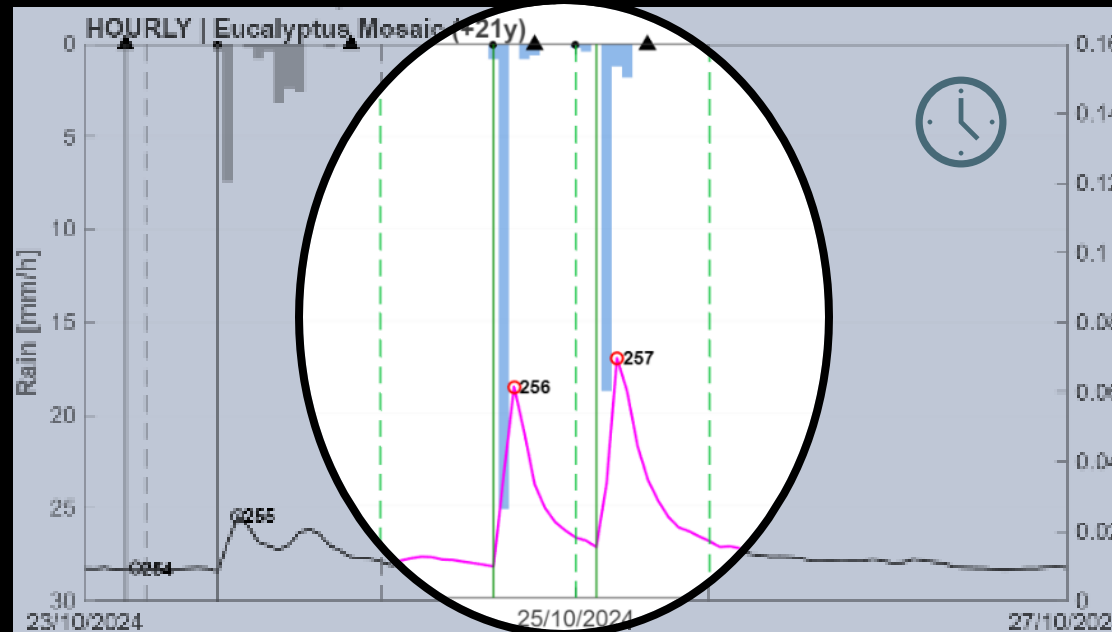
Restoration

Short cycle

Long cycle

Mosaic

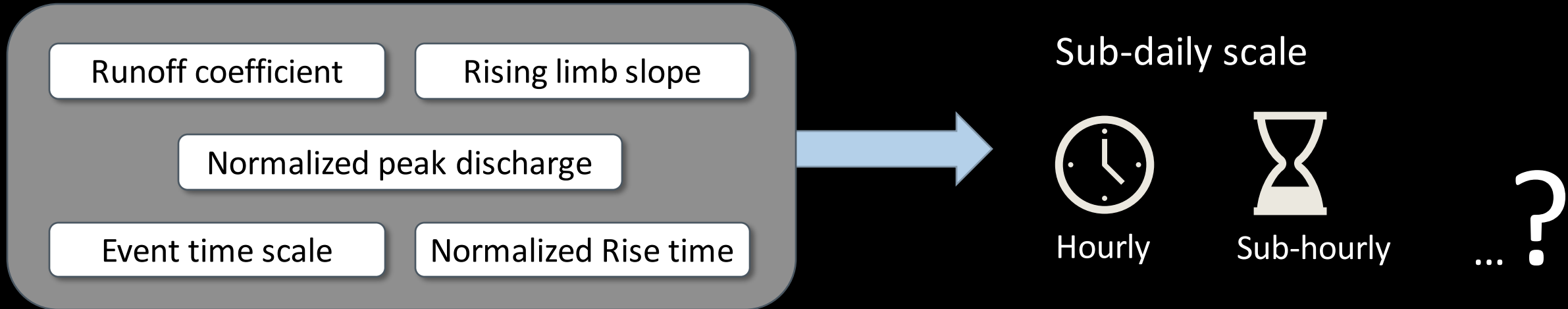
Five catchments




**We may be missing important information**

# Multi-Scale Rainfall–Runoff Event Identification

Using the *Detrending Moving-average Cross-correlation Analysis — Event Separation Routine* (DMCA-ESR) (Giani et al. 2022)



 Daily scale

Three of five event characteristics show no significant differences between most of catchments

**The full story is at Spot A.2**

**...Spoiler...  
It's not how much water — it's how fast and how high**

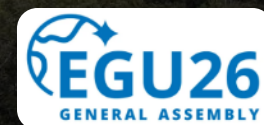


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Wood and cellulose



Ecological restoration



**Why understanding forest and water relationship matters?**

- Increase of forest projects
- Climate change – More extreme events

Carbon offset projects





# Multi-Scale Rainfall–Runoff Event Identification

Using the *Detrending Moving-average Cross-correlation Analysis — Event Separation Routine* (DMCA-ESR) (Giani et al. 2022)

## Native vegetation



Regeneration – 13y+



Restoration – 8y

## Eucalyptus plantation



Short cycle – 3y



Long cycle – 14y



Mosaic – 21y+



**5** Headwater forested catchments

Area: 0.6–1.8 km<sup>2</sup>

**3** Water years timeseries

2022-2025

**3** Temporal scales

- Daily
- Hourly
- Sub hourly: 30min

**5** Five event characteristics

- Runoff coefficient
- Normalized peak discharge
- Rising limb slope
- Normalized rise time
- Event time scale





# Multi-Scale Rainfall–Runoff Event Identification

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(Giani et al. 2022)

## Native vegetation



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Mosaic – 21y+

## Main questions

- 1) How does forest management affect rainfall–runoff event responses in tropical headwater catchments at fine temporal scales?
- 2) Does sub-daily analysis provide additional insight compared to daily data?



# Identified Rainfall–Runoff Event and their characteristics



Daily scale  
220 events

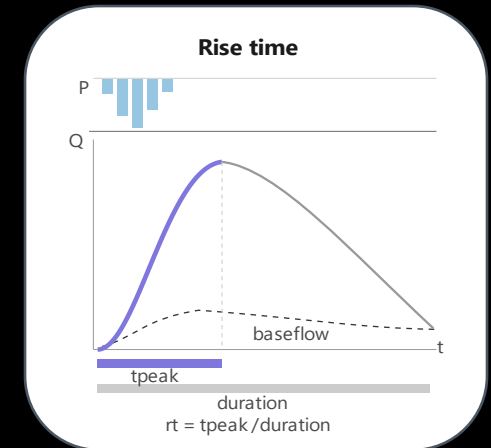
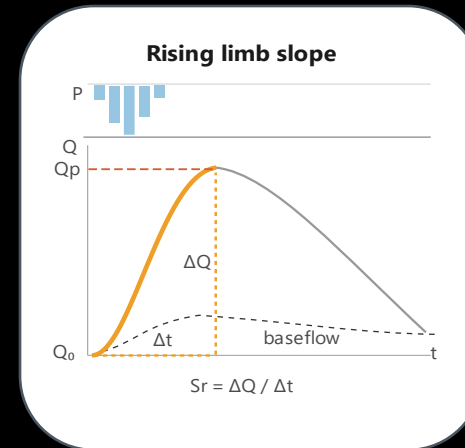
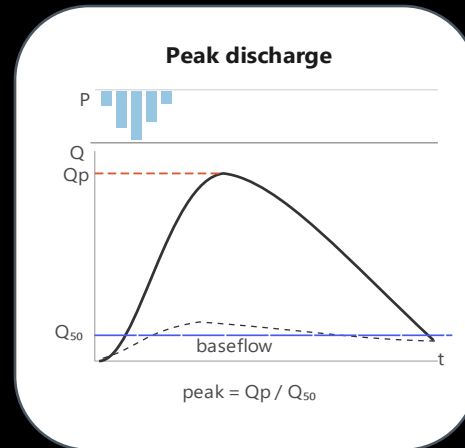
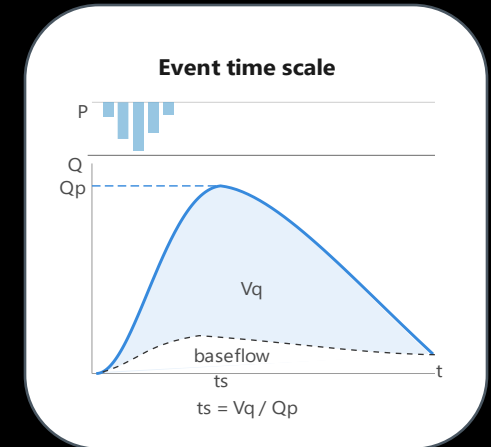
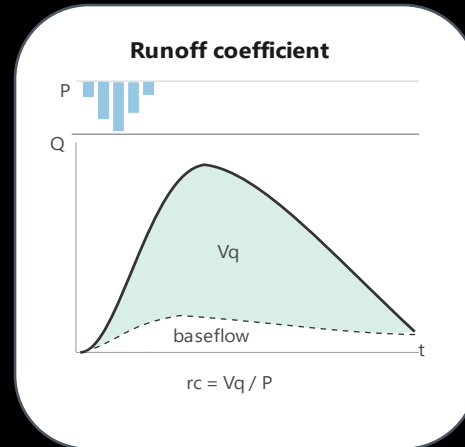


Hourly  
896 events



Sub-hourly  
694 events

### Five event characteristics





# Runoff coefficient

Decreasing forest management intensity



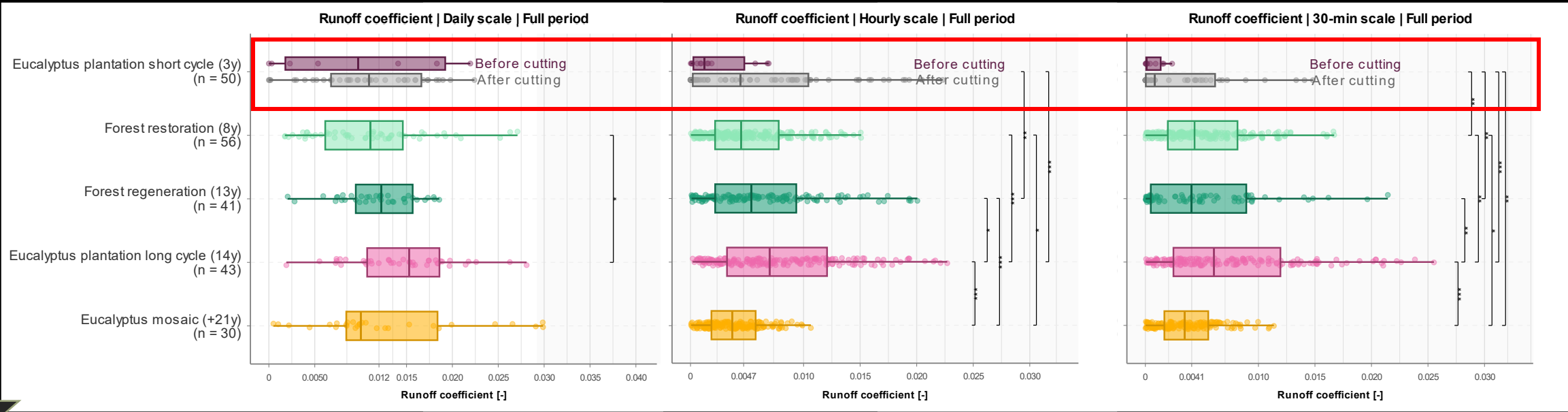
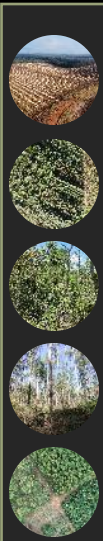
Daily scale



Hourly



Sub-hourly



At finer scales, significant differences emerge — but not along the expected management gradient:  
**Short-cycle Eucalyptus plantation** consistently shows the **lowest event runoff coefficient**





# Normalized peak discharge

Decreasing forest management intensity



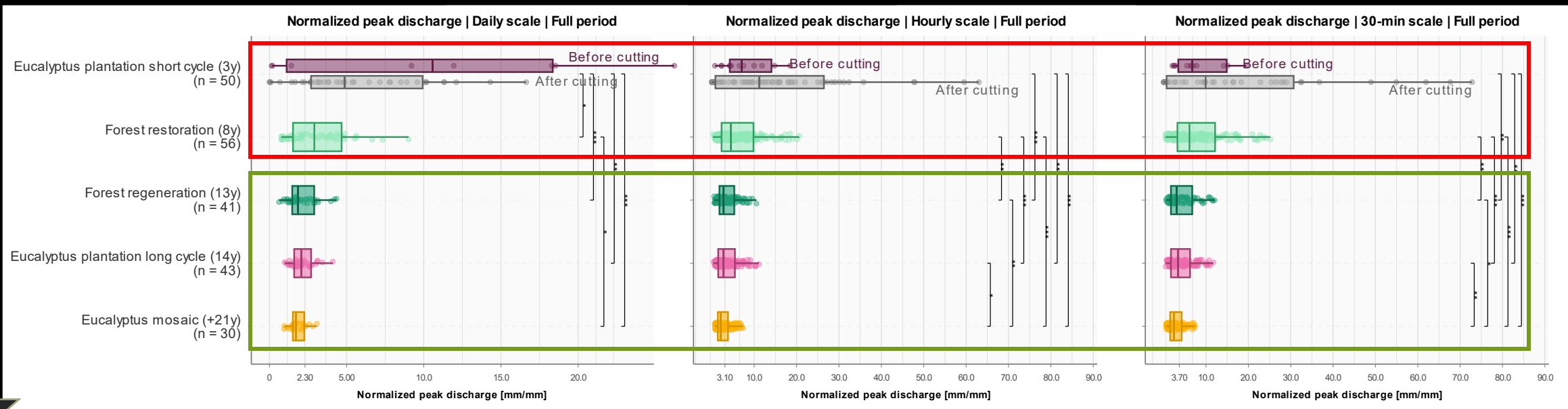
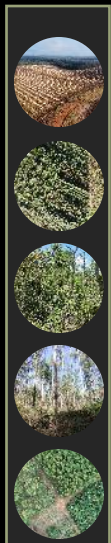
Daily scale



Hourly



Sub-hourly



- Short-cycle Eucalyptus plantation generates storm peaks up to 5× higher relative to its own baseline compared to the Eucalyptus mosaic.
- Two groups are visible: Younger forest and older.





# Rising limb slope

Decreasing forest management intensity



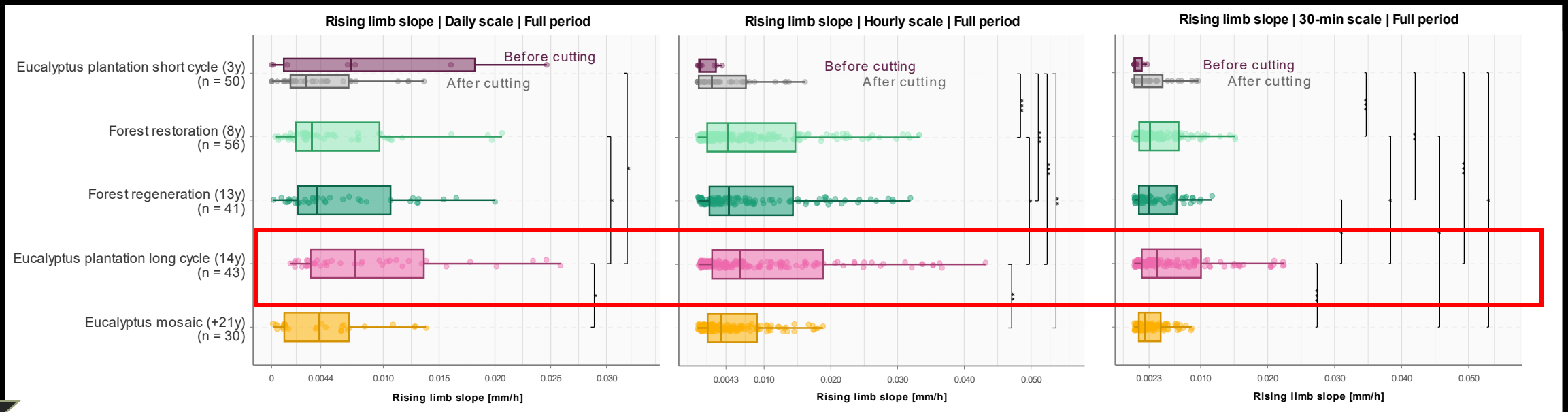
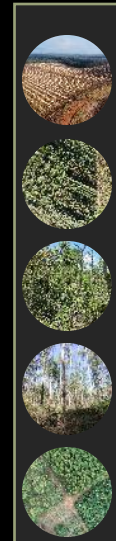
Daily scale



Hourly



Sub-hourly



- Short-cycle Eucalyptus plantation significantly different from all other catchments at sub-daily scale.
- Long-cycle Eucalyptus plantation rises fastest.





# Normalized rise time

Decreasing forest management intensity



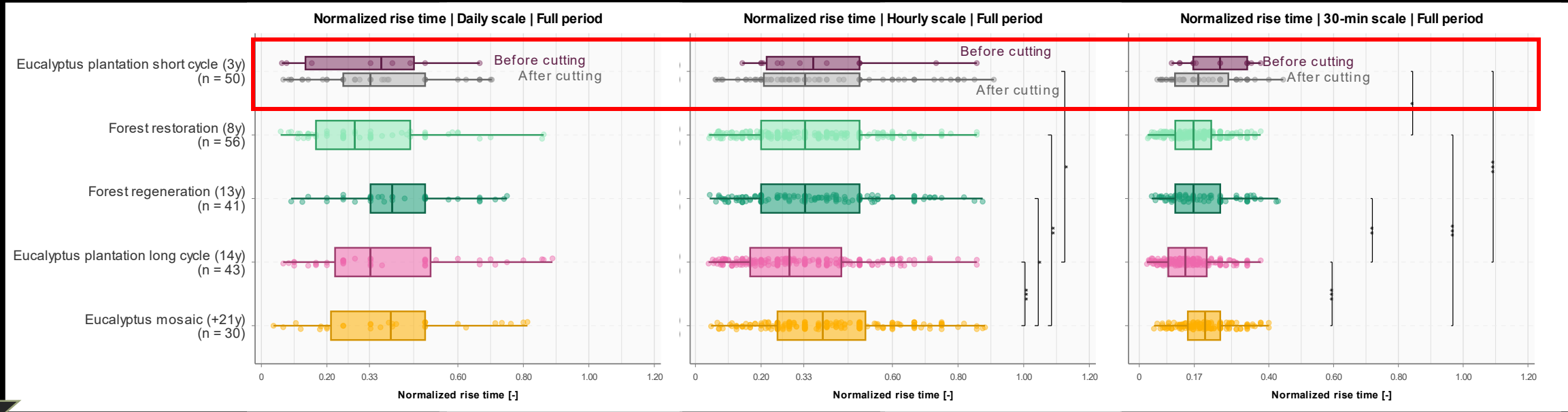
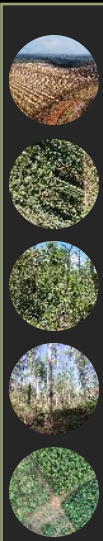
Daily scale



Hourly



Sub-hourly



- Rise time shows only isolated significant pairs at finer scales.
- It is not controlled by forest management





# Event time scale

Decreasing forest management intensity



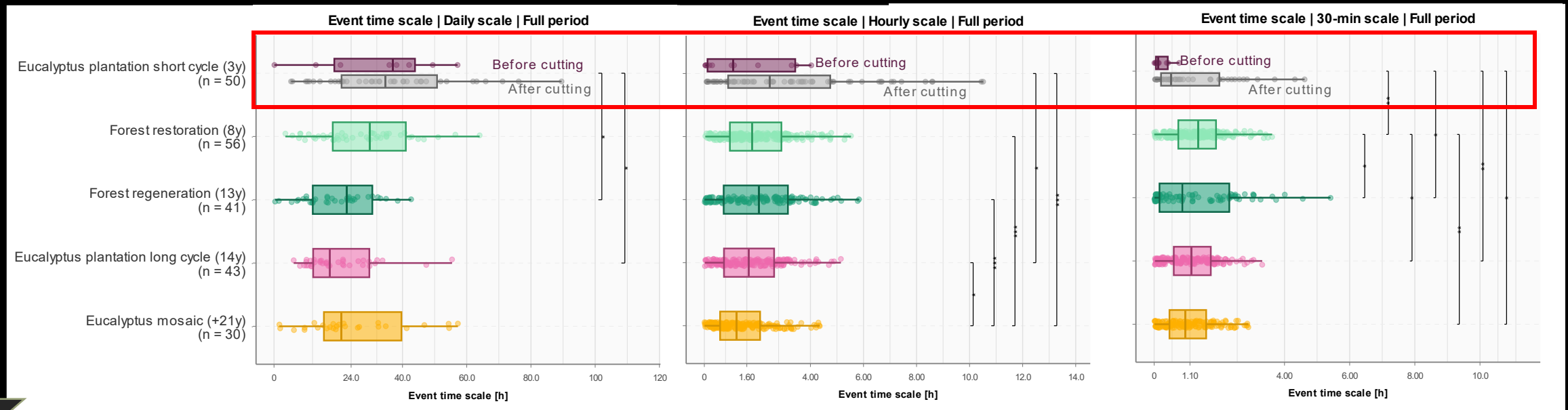
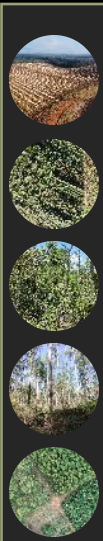
Daily scale



Hourly



Sub-hourly



- At the daily scale, the **Short-cycle Eucalyptus plantation** shows the broadest hydrographs but at the sub-hourly scale it shows the narrowest —Here **temporal scale** really matters.



## About the main questions

1) How does forest management affect rainfall–runoff event responses in tropical headwater catchments at fine temporal scales?

**Forest management primarily affects the shape and dynamics of the hydrograph rather than the volume of runoff generated per event.**

The response is not a simple gradient — two groups emerge: short-cycle plantation and forest restoration on one side, and regeneration, long-cycle plantation and mosaic on the other one.

2) Does sub-hourly analysis provide additional insight compared to hourly or daily data?

**Yes.** At the daily scale, only 3 of 5 variables show significant differences between catchments. At hourly and sub-hourly scales, 4 of 5 do.



**If we only look at daily data, we are missing the real hydrological differences**



# THANKS!



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