Quantifying the impact of blanket-peat re-vegetation & gully-blocking in terms of their NFM potential

NATURAL FLOOD MANAGEMENT RESEARCH PROGRAMME

Webinar Series

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MANCHESTER 1824 The University of Manchester

NERC SCIENCE OF THE ENVIRONMENT

Newcastle University

Content

- **Before-After-Control-Intervention (BACI) experiment**
- **Findings of the BACI experiment**
- **Motivations of the numerical work**
- **Brief introduction of numerical procedure**
- **Numerical experiment #1: Impact of restorations, and their variation with storm size**
- **Numerical experiment #2: Underlying processes, and their variation with storm size**
- **Does NFM always work?**
- **Conclusions & Future Work**

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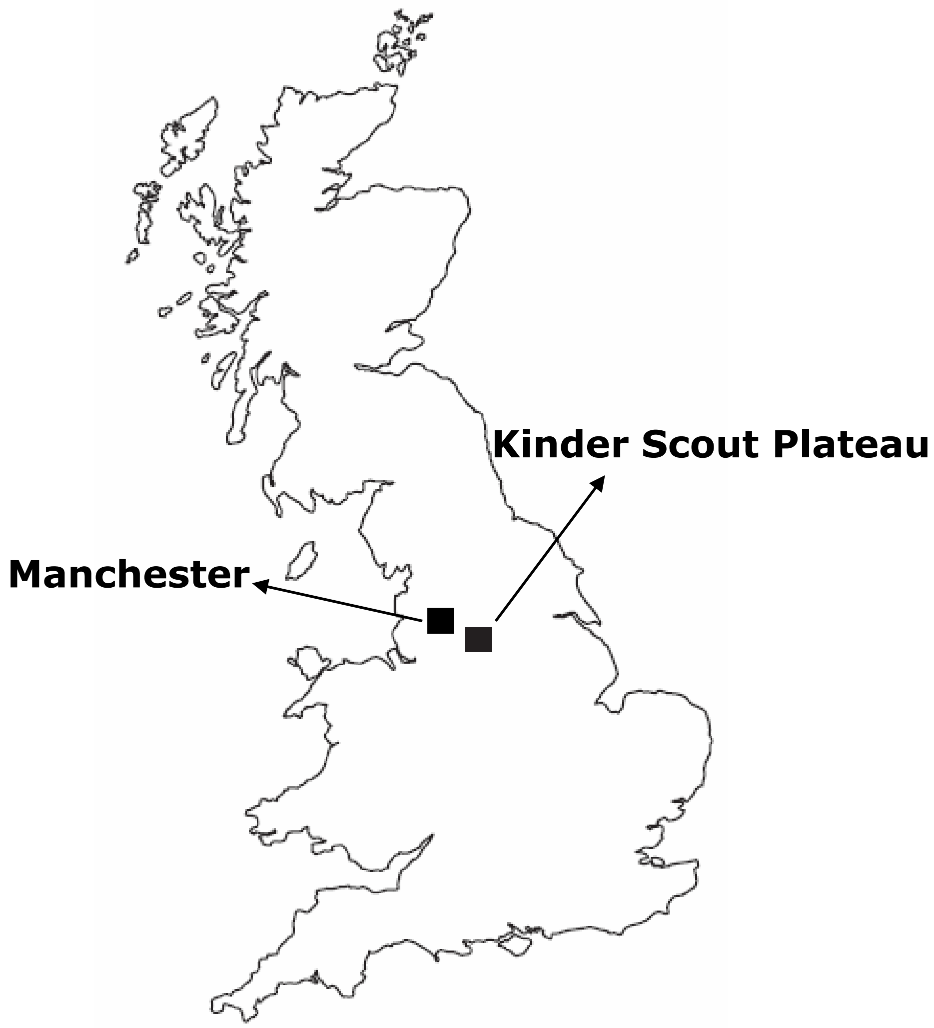
Location of study sites

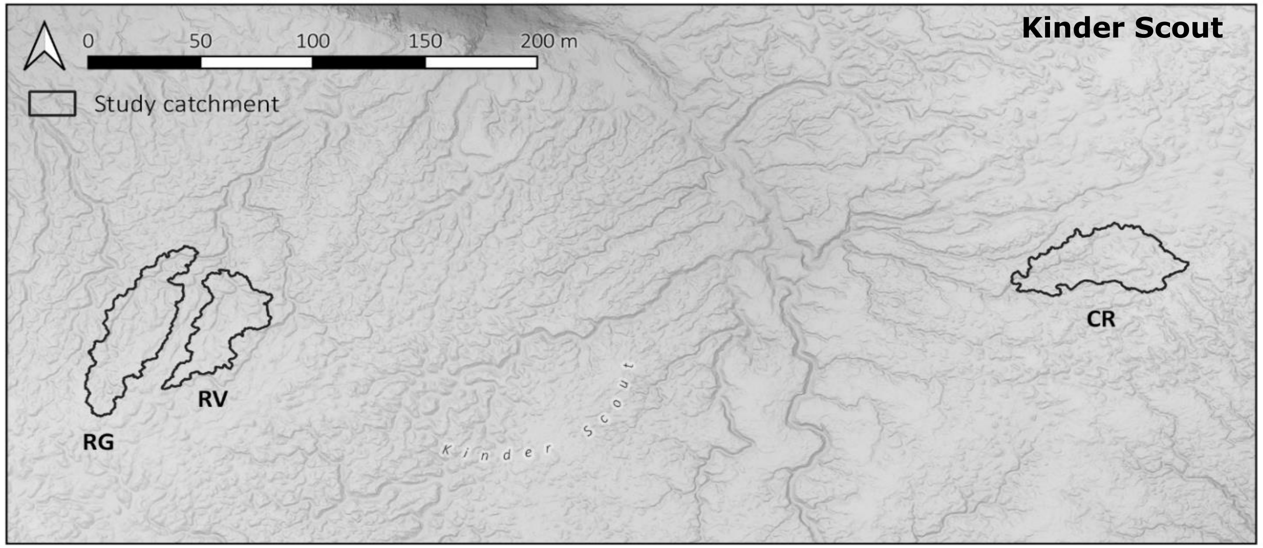


Bare peat

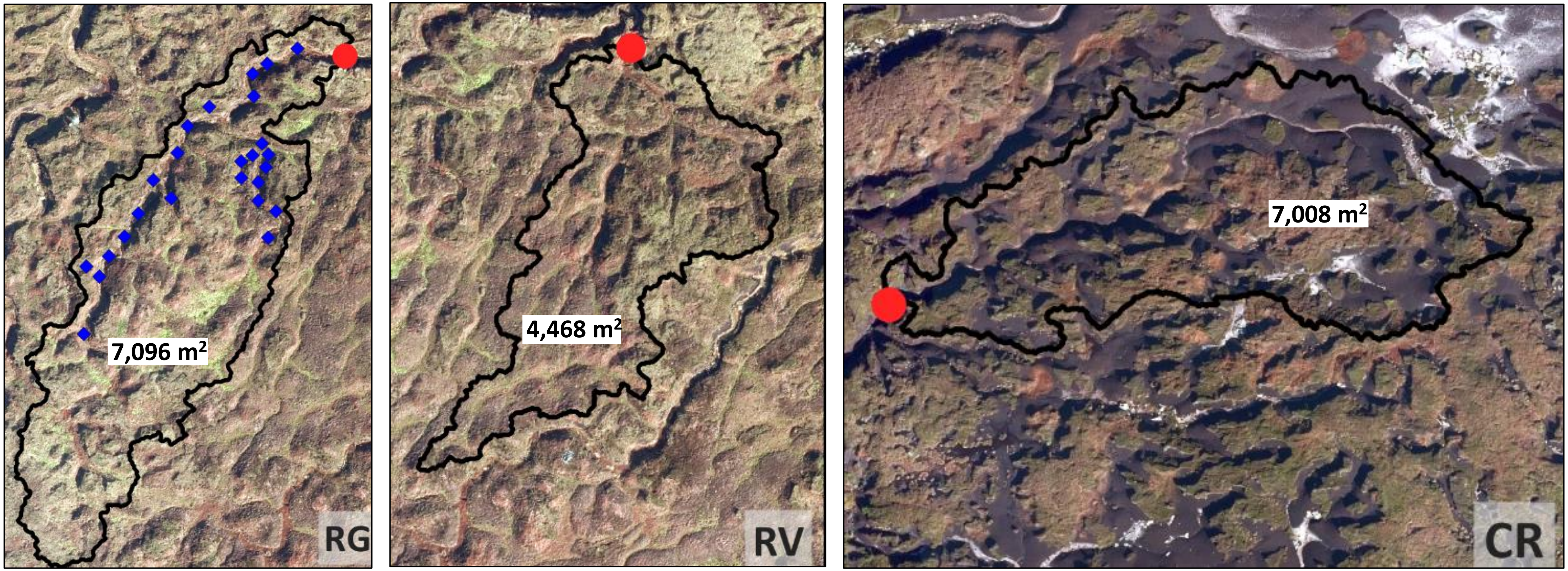
Deep gully

BACI Experiment

CR: control site
RV: re-vegetated site
RG: re-veg. & gully-blocked site
outlet
block location



*For comparison: a standard football pitch is 7,140 m^2



*all satellite images are recent (2020)

Rapid restoration success

re-vegetation

stone dams

re-vegetation
&
gully-blocking

timber dams

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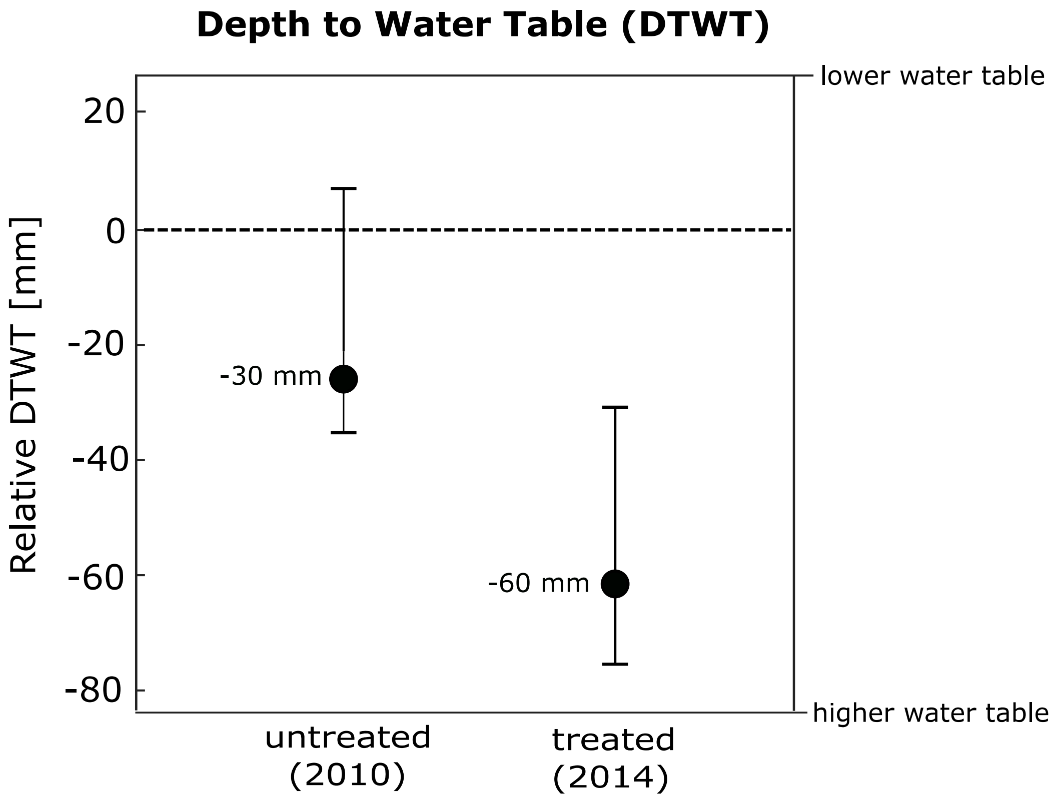
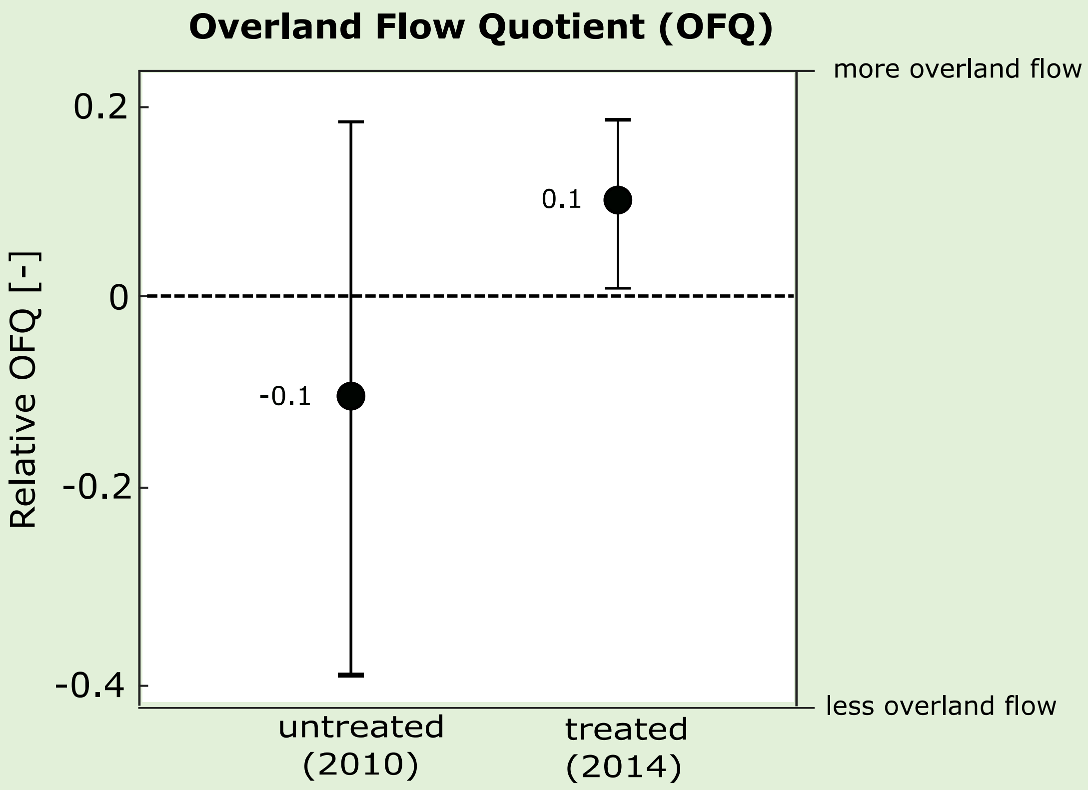
BACI Observations



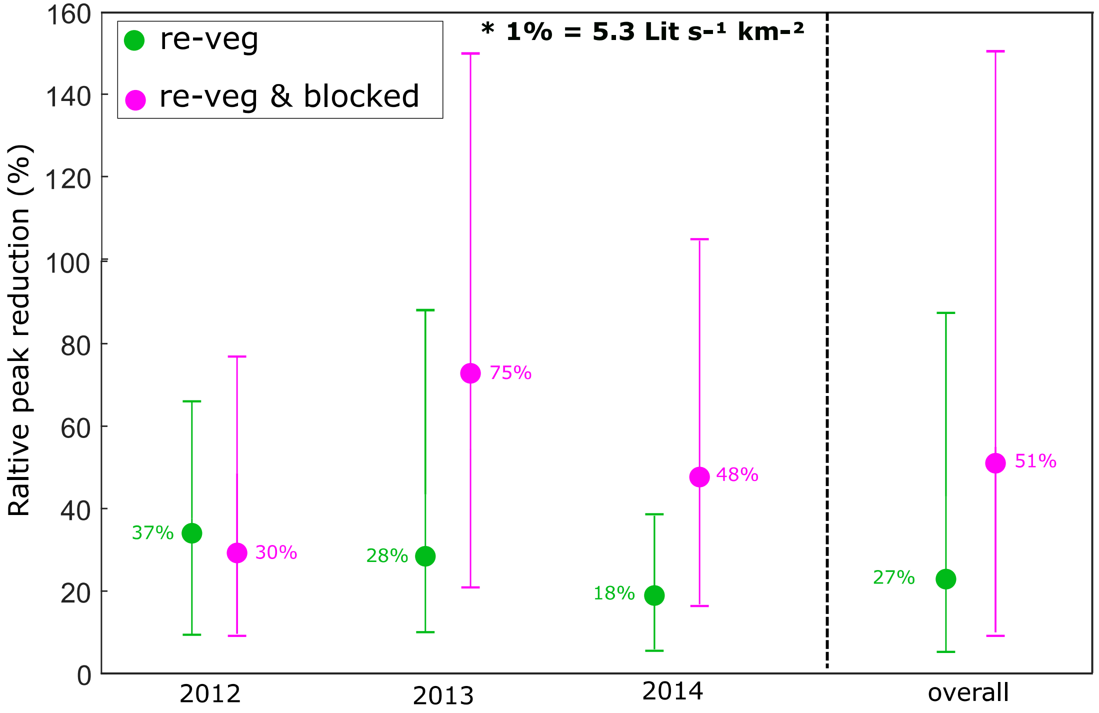


Relative OFQ = portion of dipwell tubes recording overland flow, relative to control site

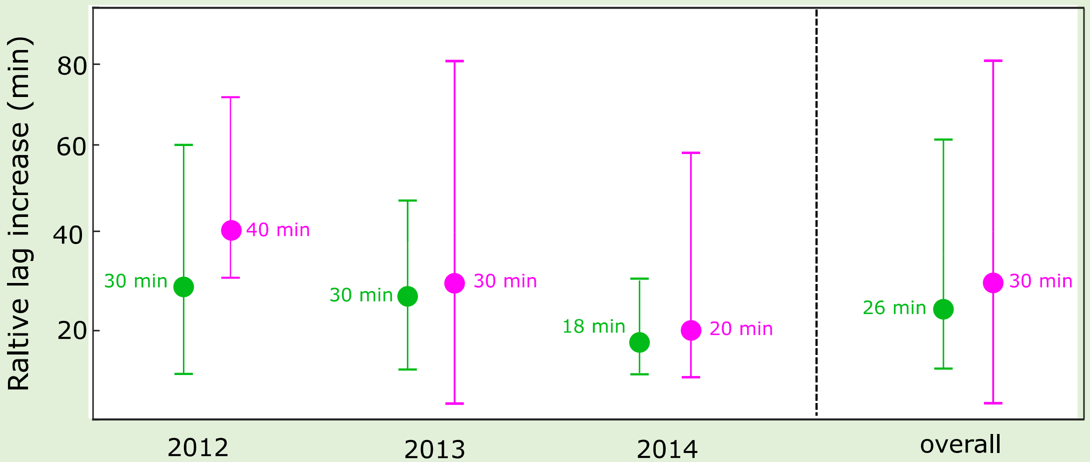
***Data extracted from Shuttleworth et al. (2019)**
****all values relative to control site**

BACI Observations

Relative peaks post treatment ➡



Relative lags post treatment ➡



****Data extracted from Shuttleworth et al. (2019)**
*****all values relative to control site**

Surface Storage

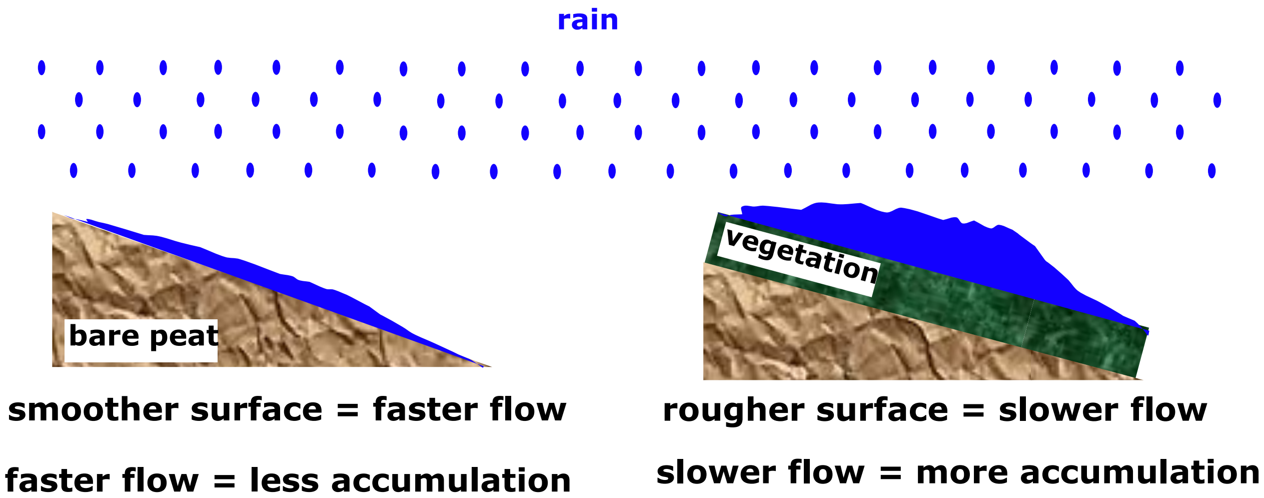
Static (immobile) surface storage

Dynamic (mobile) surface storage

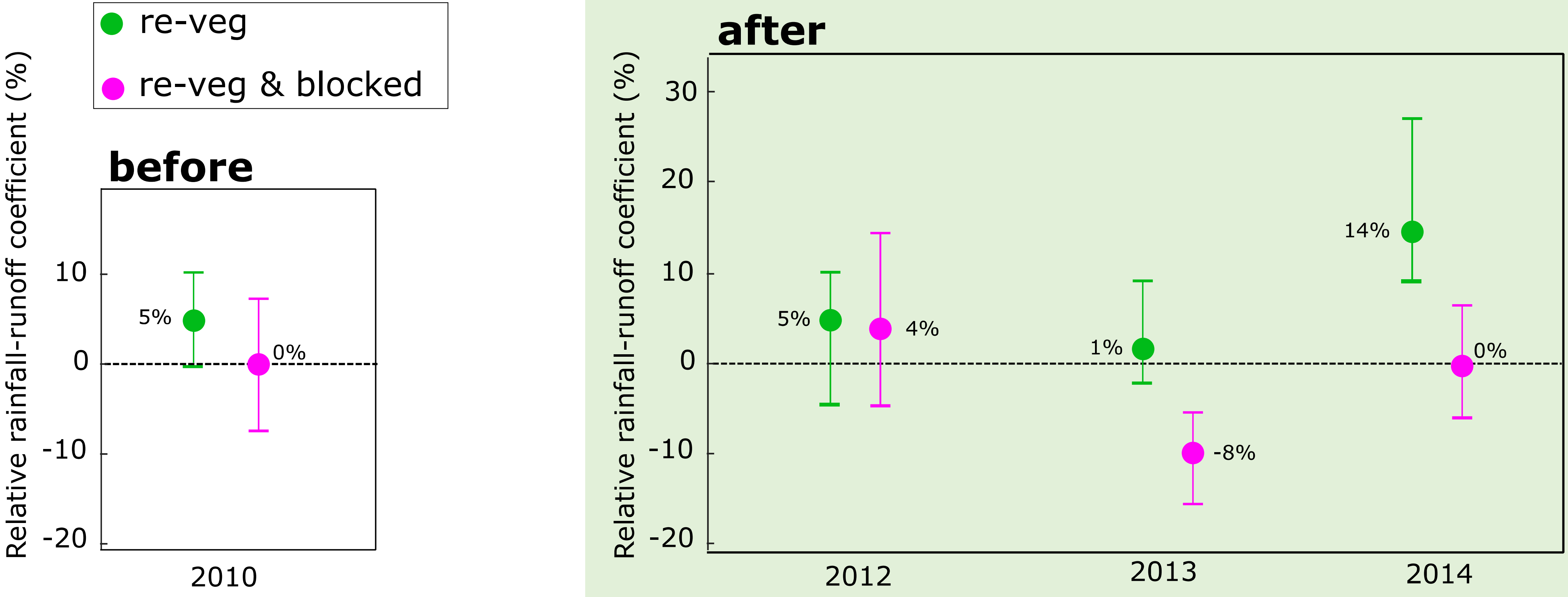
Interception storage

Block storage

"flow storage"



BACI Observations



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Summary of knowns

- **Water tables rise**
- **Hillslope storage is reduced**
- **Overland flow production is enhanced**
- **Lags increase and peaks reduce**
- **Dynamic storage is more important**
- **Roughness is more important**
- **Gully-blocking impact is significant**

Questions to answer

- **Is dynamic storage always more important?**
- **How much more important is dynamic storage?**
- **What about evapotranspiration?**
- **Do these findings hold for all storm sizes?**
- **Potential importance of different sources of uncertainty: rainfall, topography**
- **Are there situations where NFM won’t work?**

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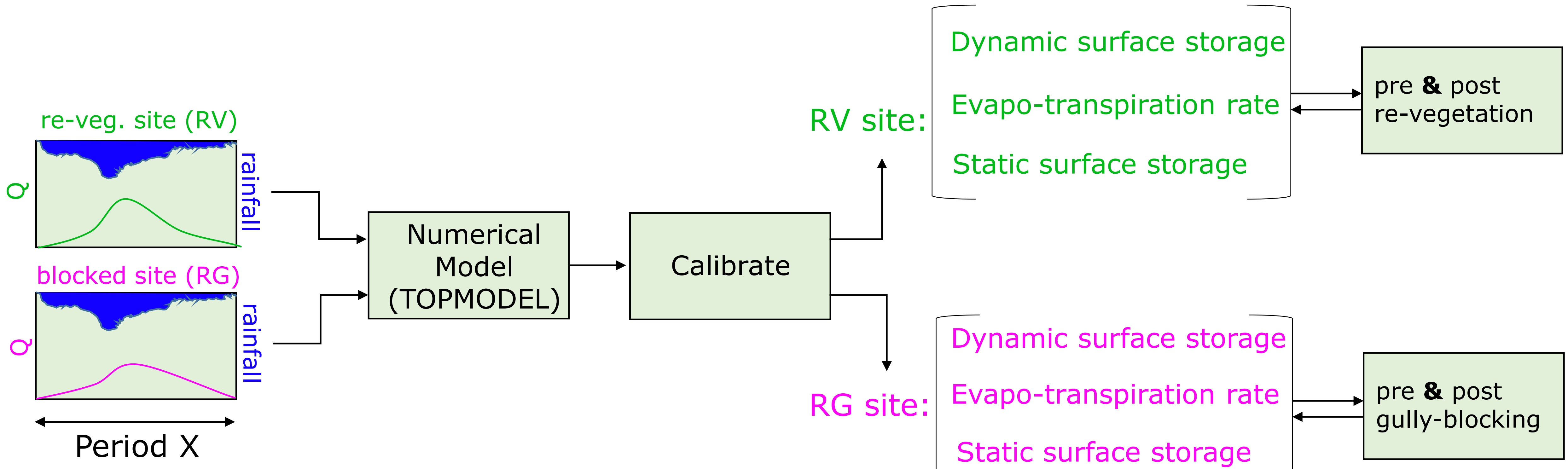
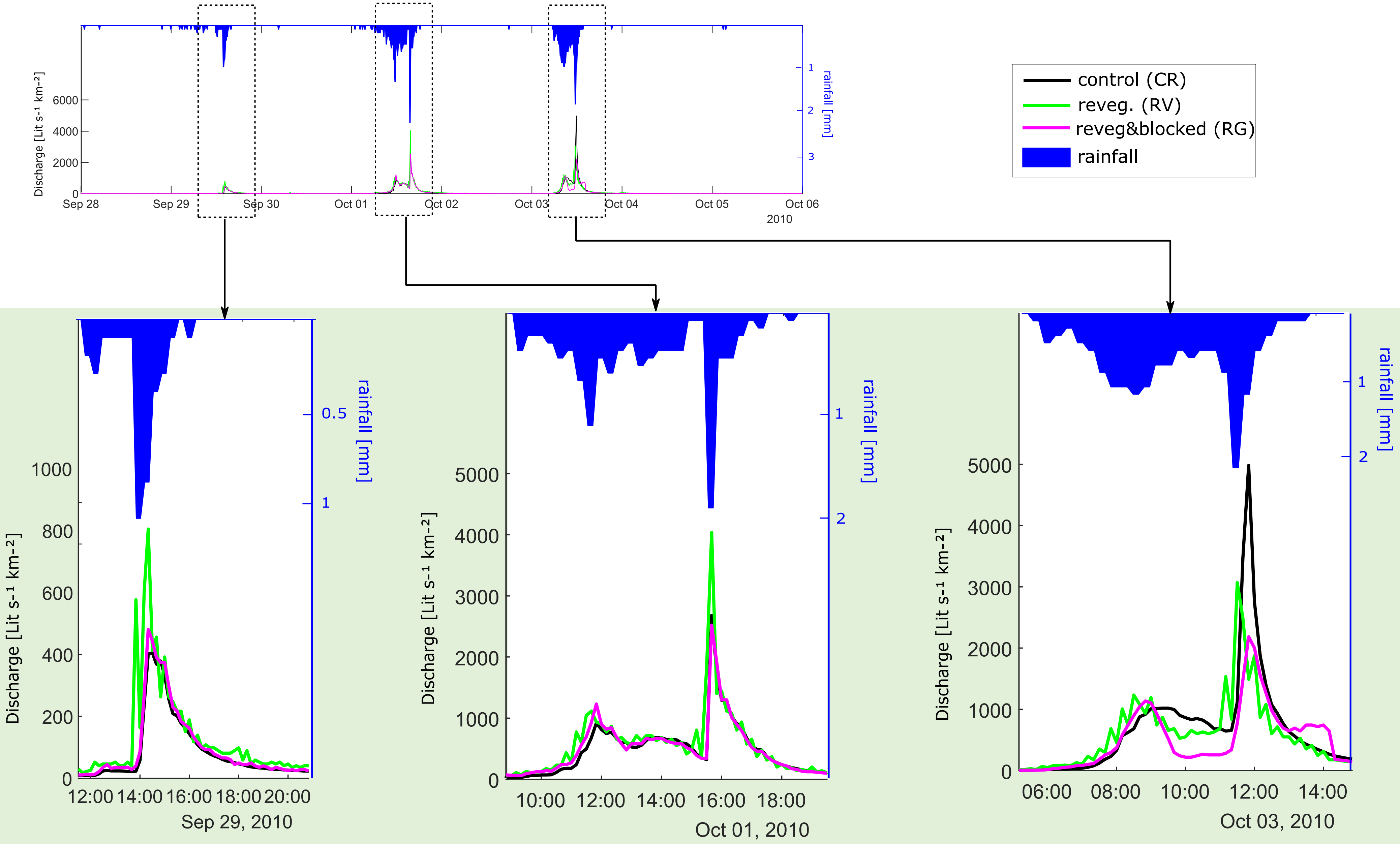
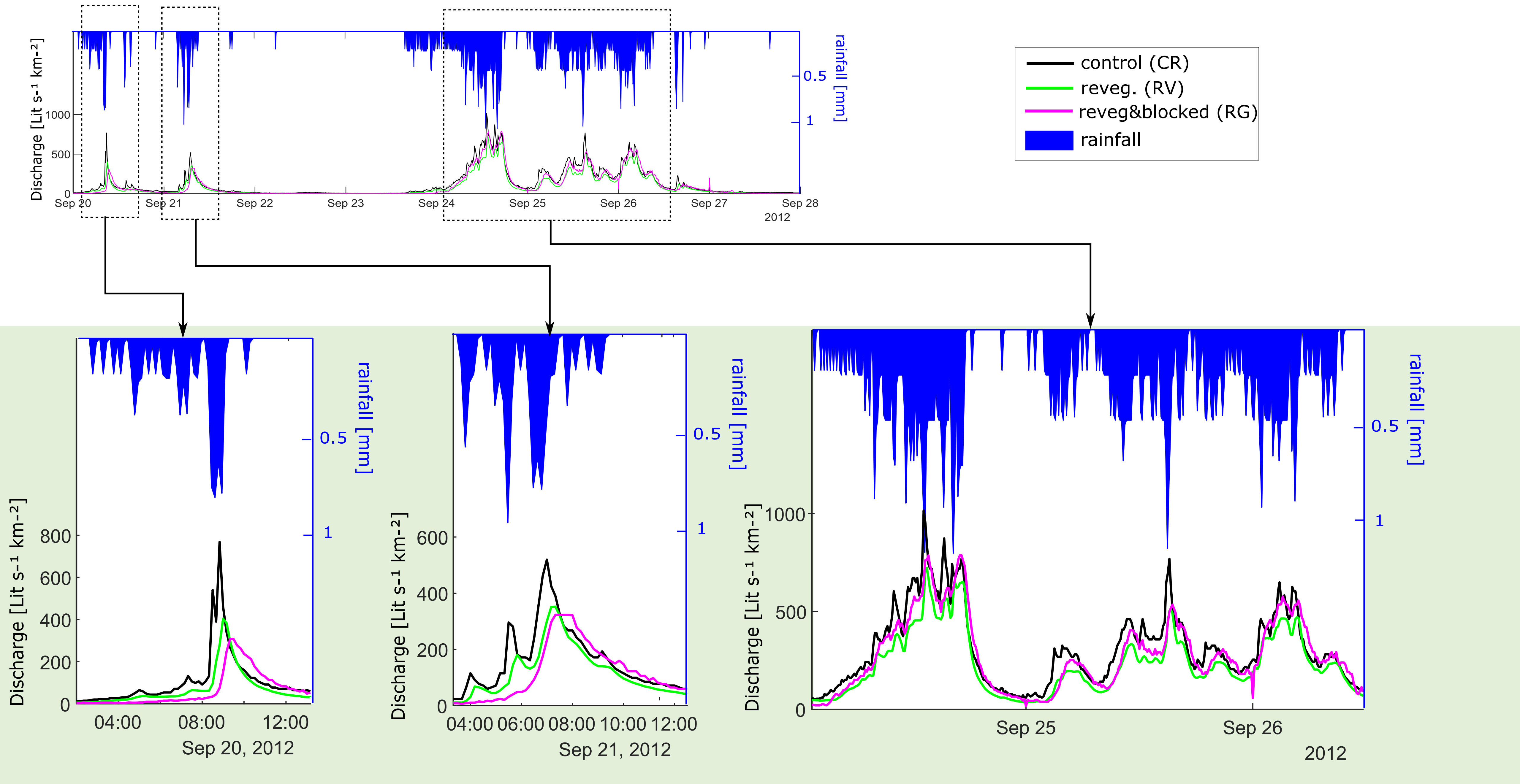
Schematic of the numerical procedure



Pre-intervention period (2010)



Post-intervention period (2012)



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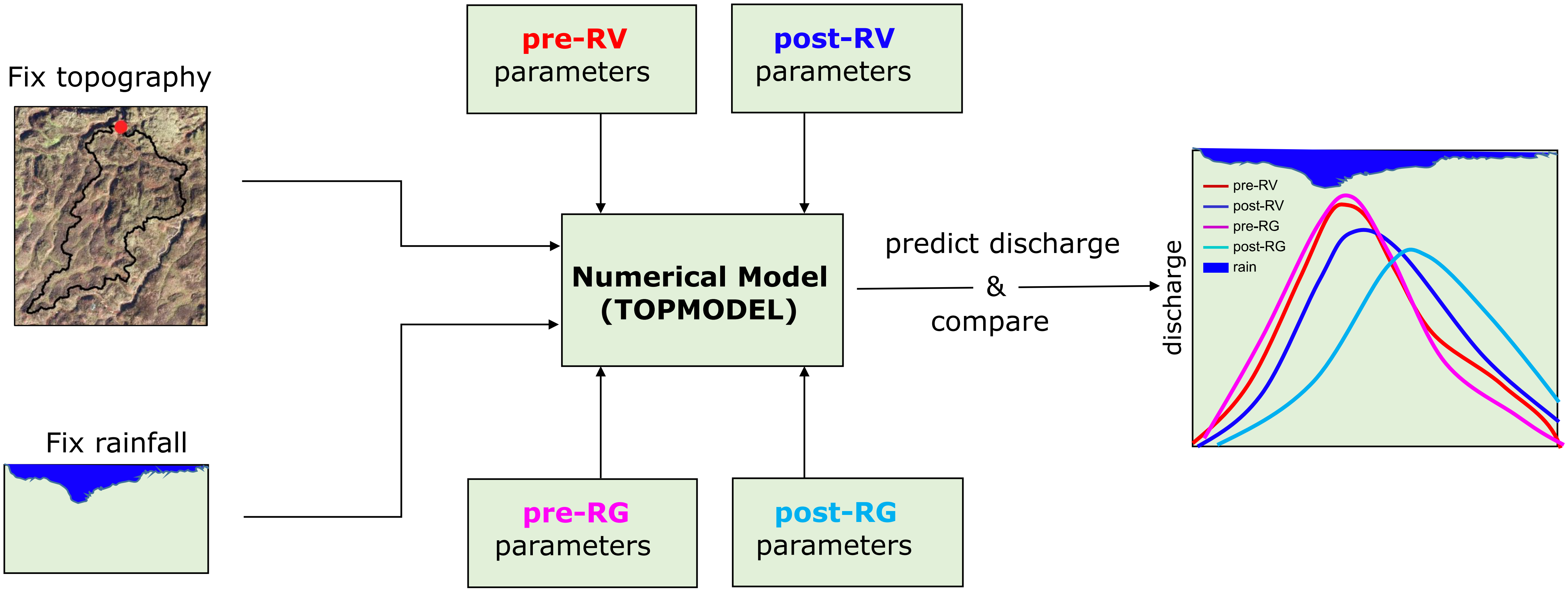
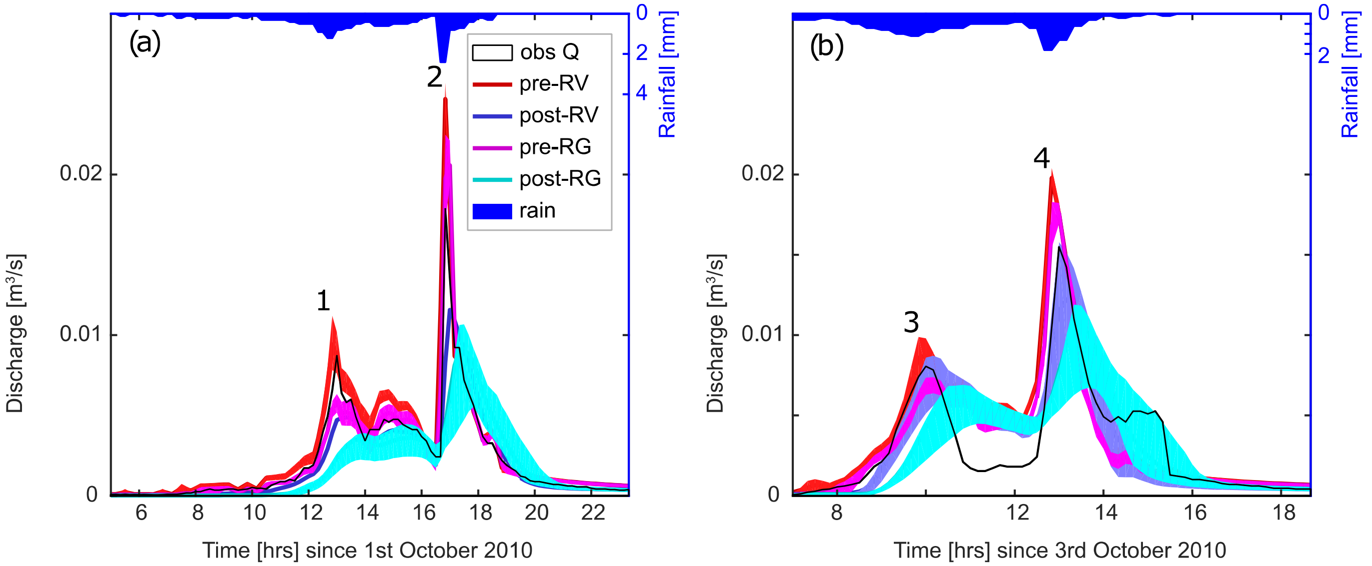
Numerical experiment #1: “Virtual Twin”

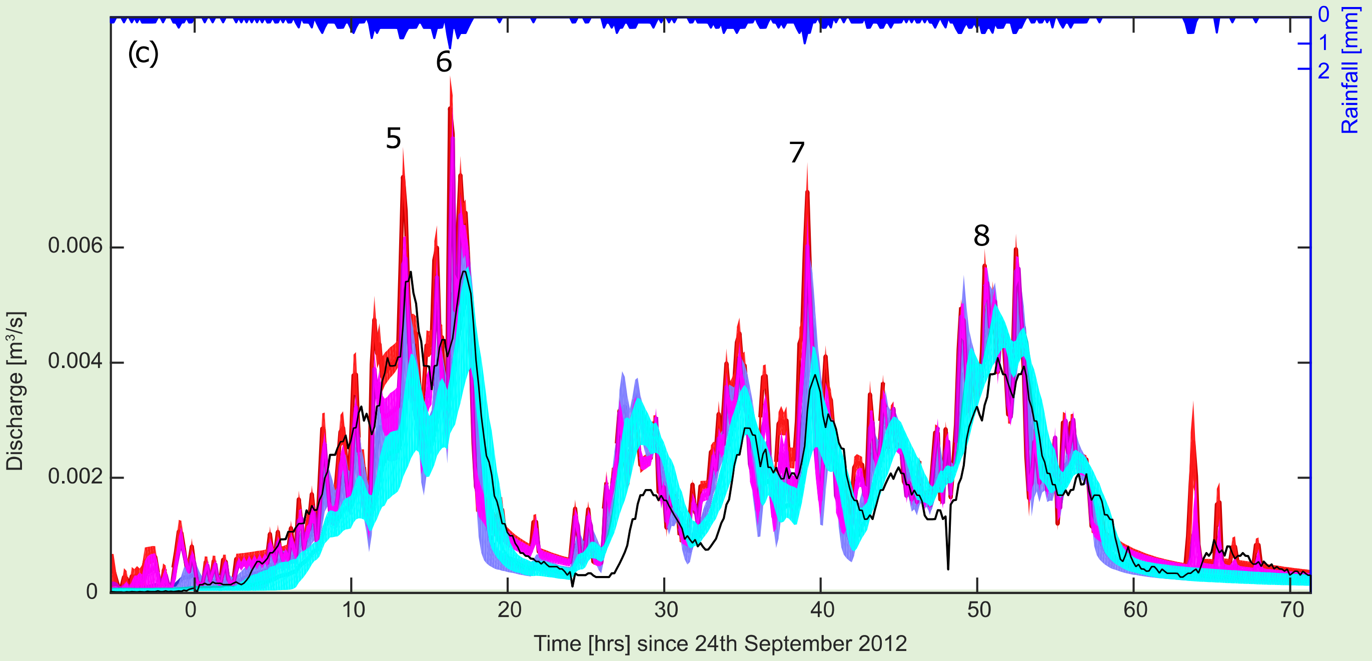


Numerical experiment #1: “Virtual Twin”

Largest storms ➡

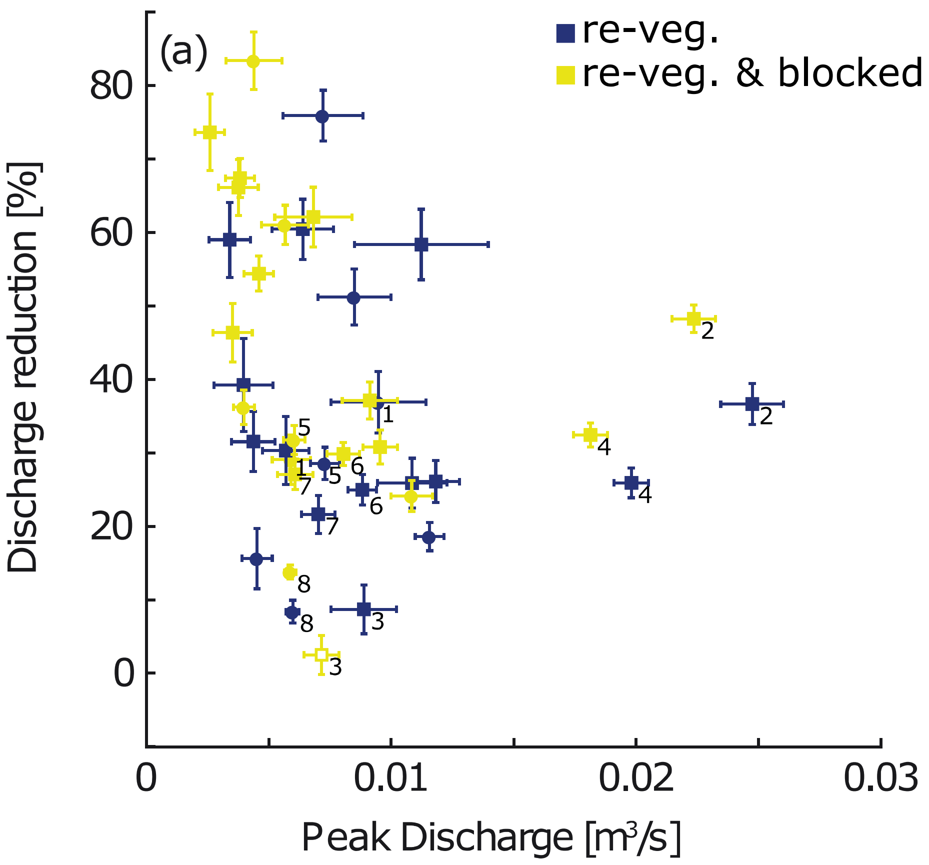


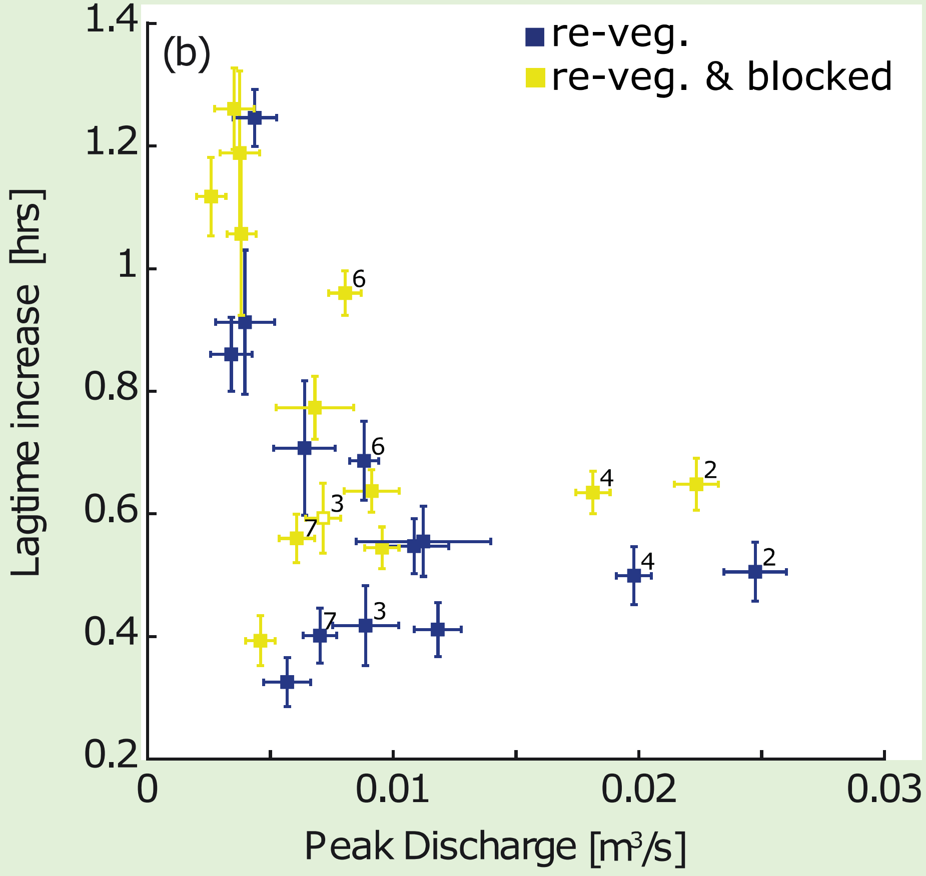
Most complex storm ➡



RV: re-vegetated site
RG: re-veg. & gully-blocked

Variation with storm size





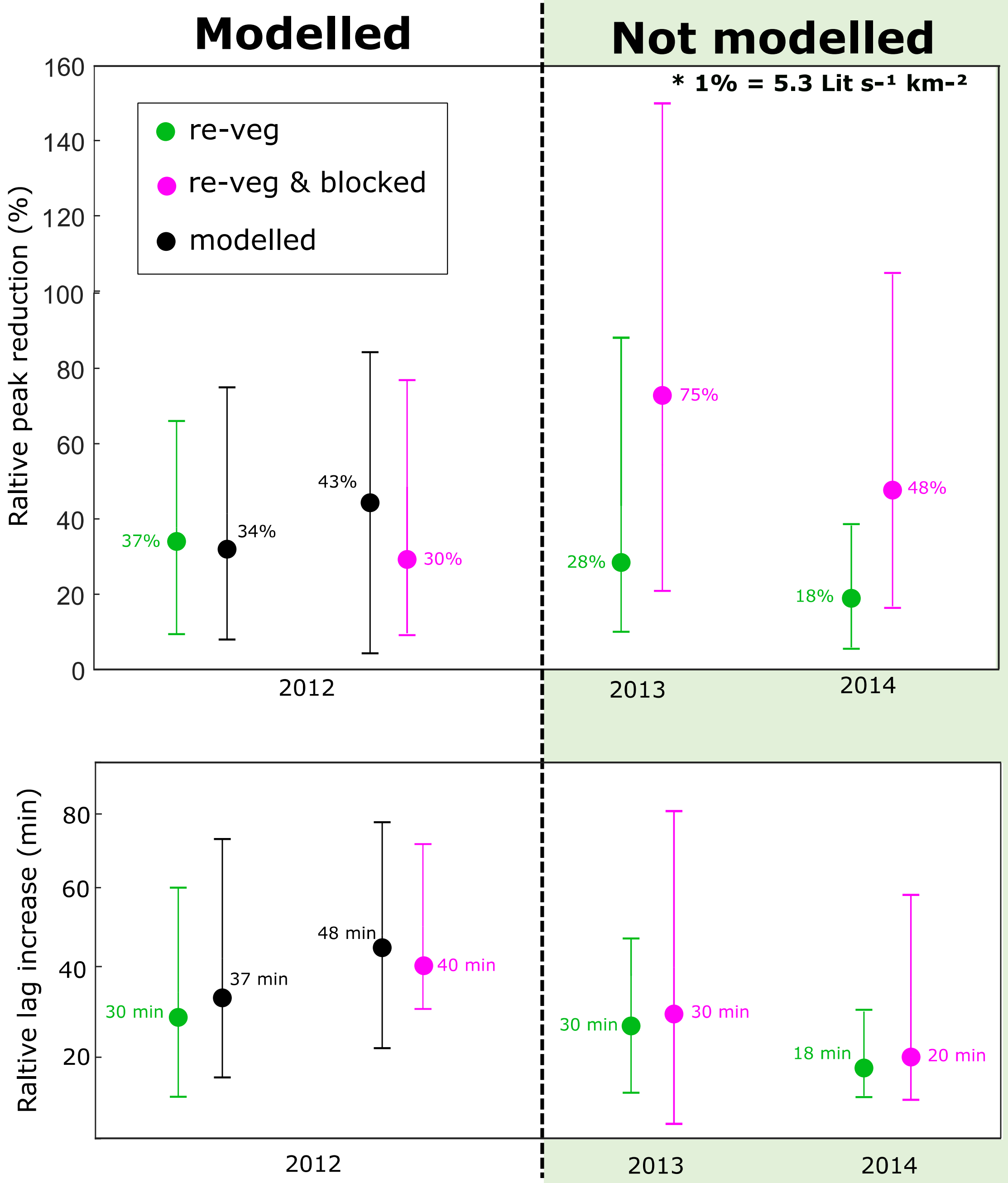
Across all 20 peaks, mean discharge reduction due to:

-revegetation was **34%**
-revegetation & gully blocking was **43%**

Across all 20 peaks, mean of lag-time increase due to:

-revegetation was **0.62 hr**
-revegetation & gully blocking was **0.8 hr**

Comparison with observations



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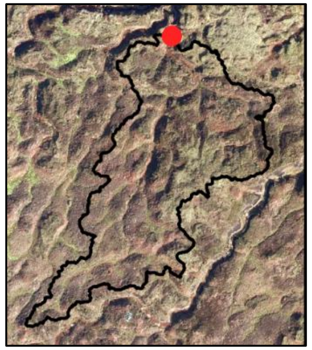
Numerical experiment #2: “Parameter Switch”

Fix topography



Fix rainfall

re-vegetated site (RV)

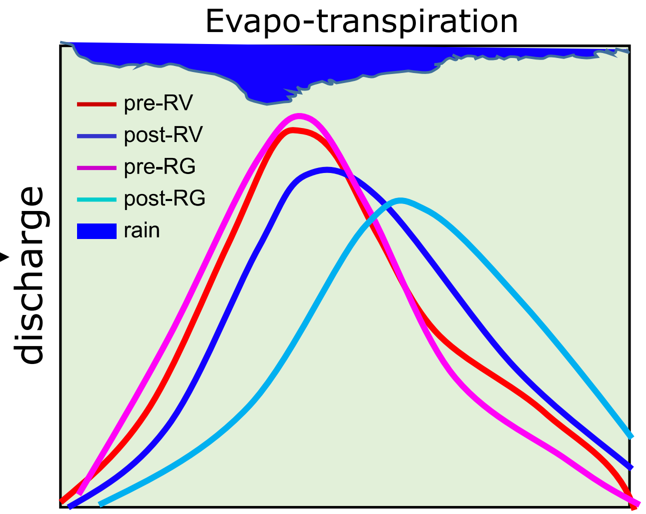
all parameters, except one, at pre-treatment value

Numerical Model (TOPMODEL)

all parameters, except one, at pre-treatment value

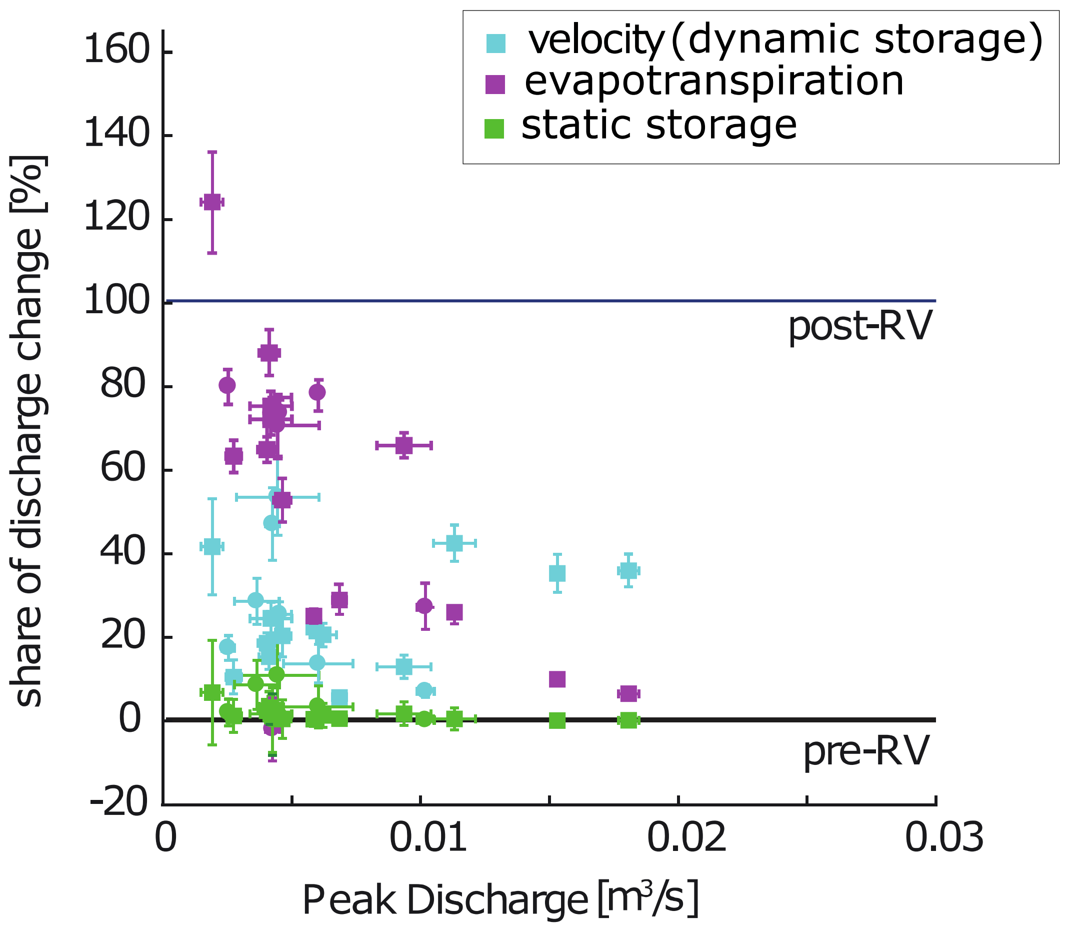
re-veg. & blocked site (RG)

predict discharge & compare

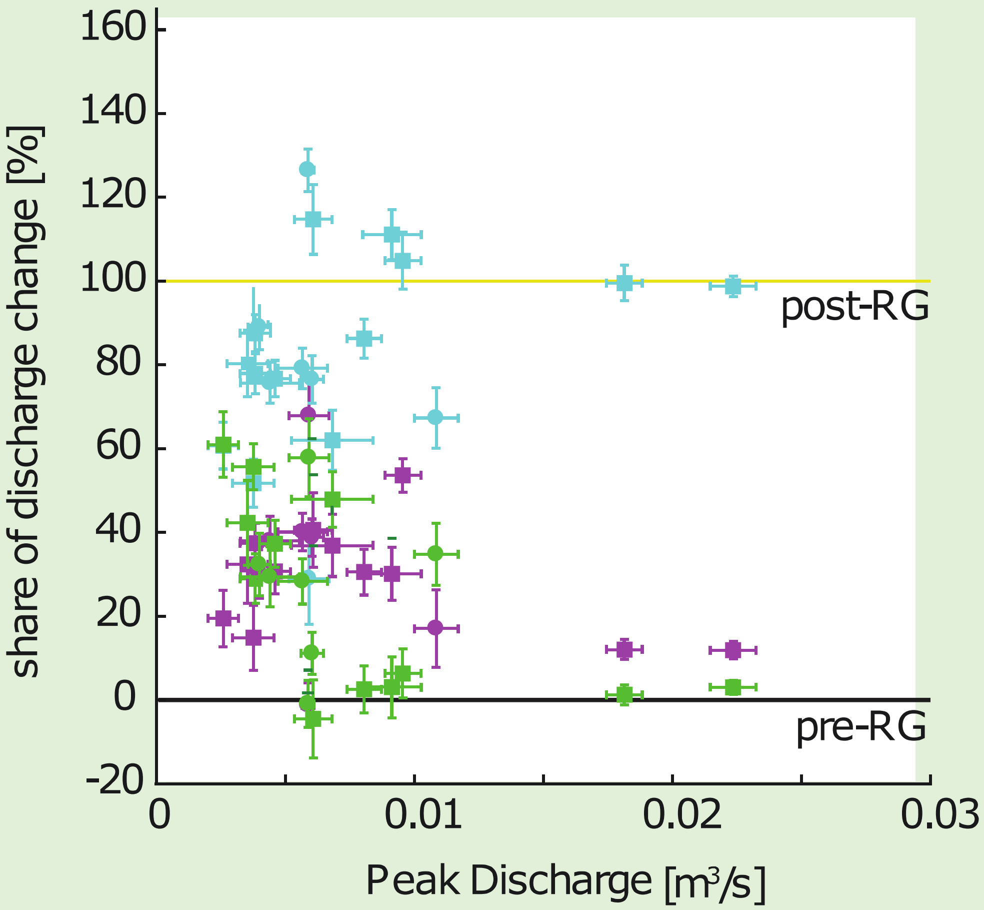


Parameter shares in peak reduction

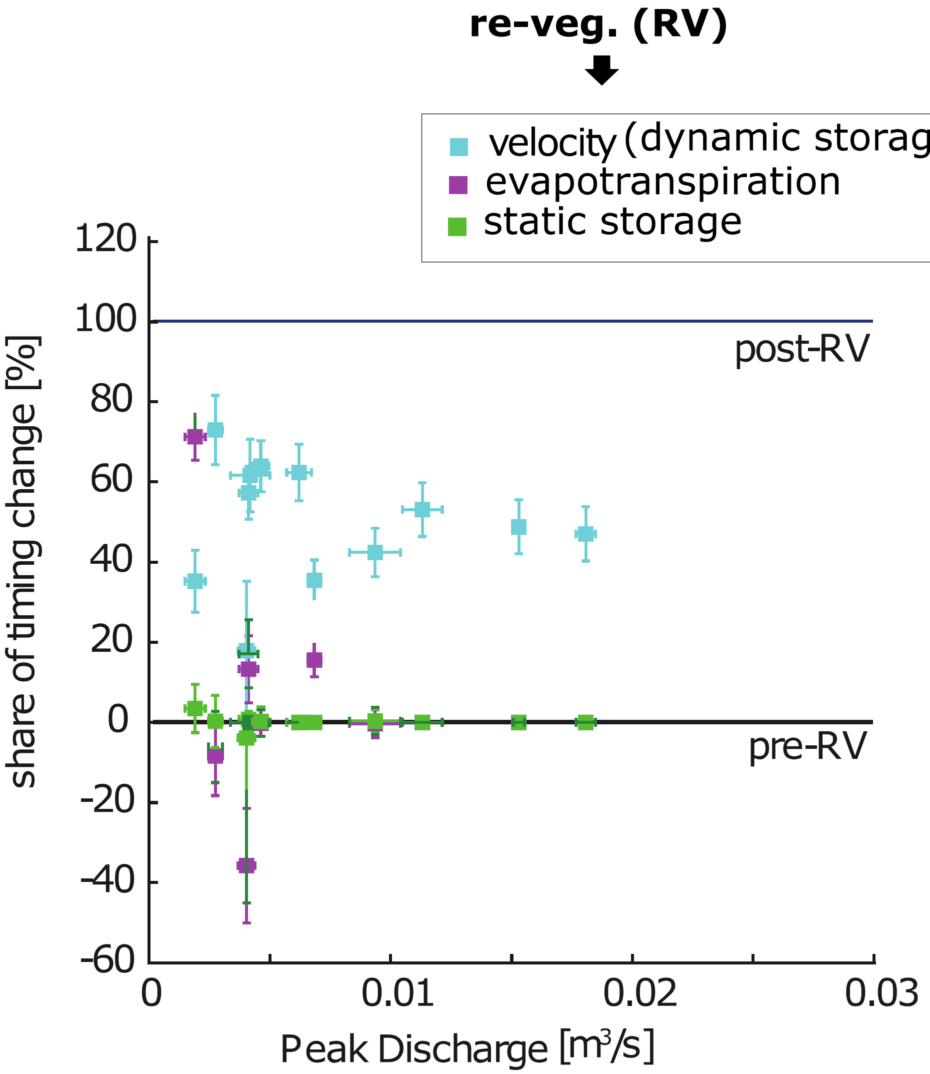
re-veg. (RV)

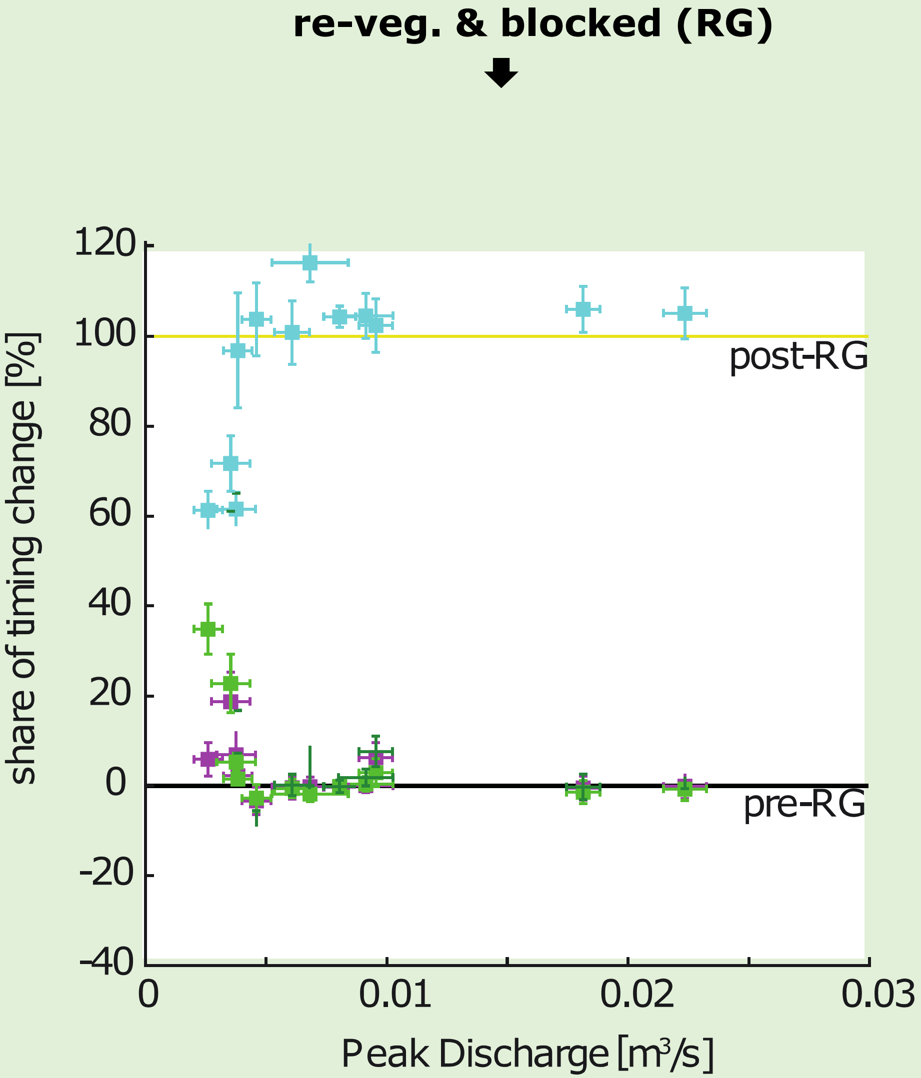


re-veg. & blocked (RG)



Parameter shares in lag increase





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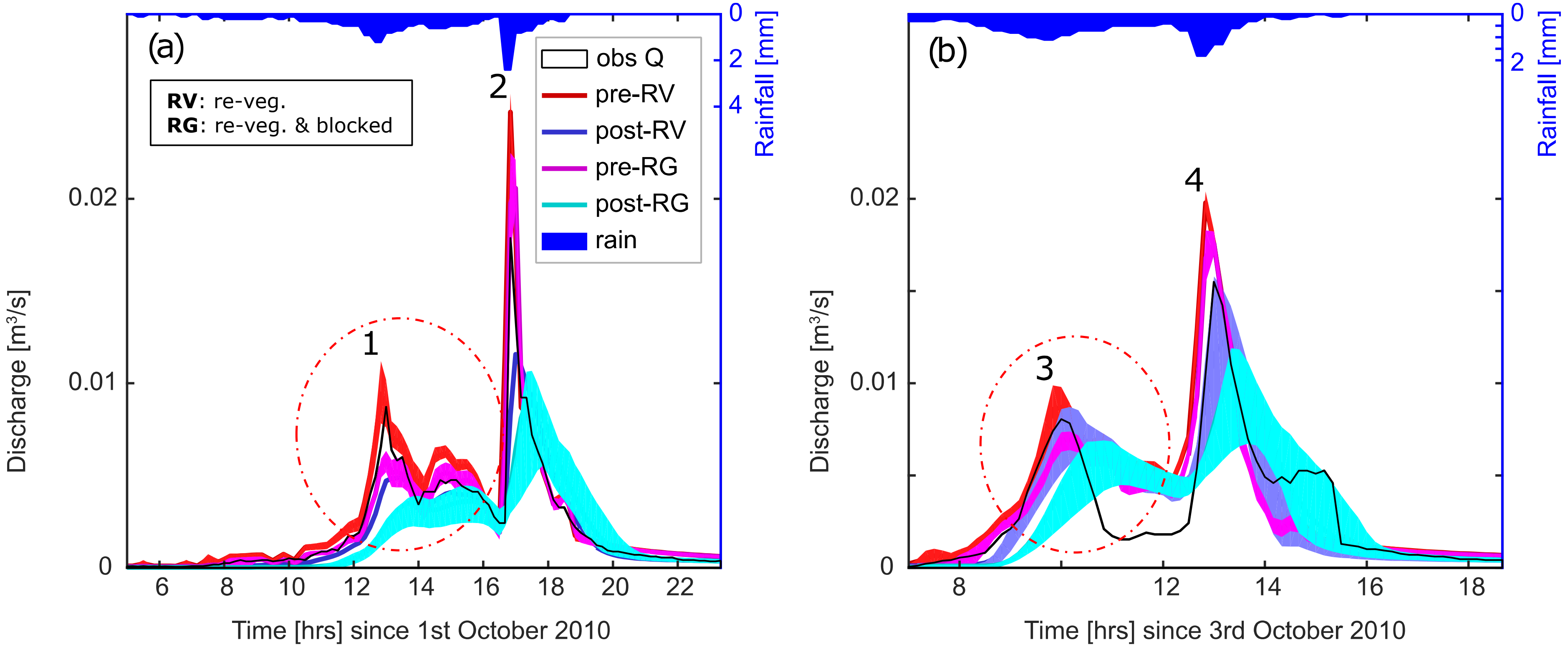
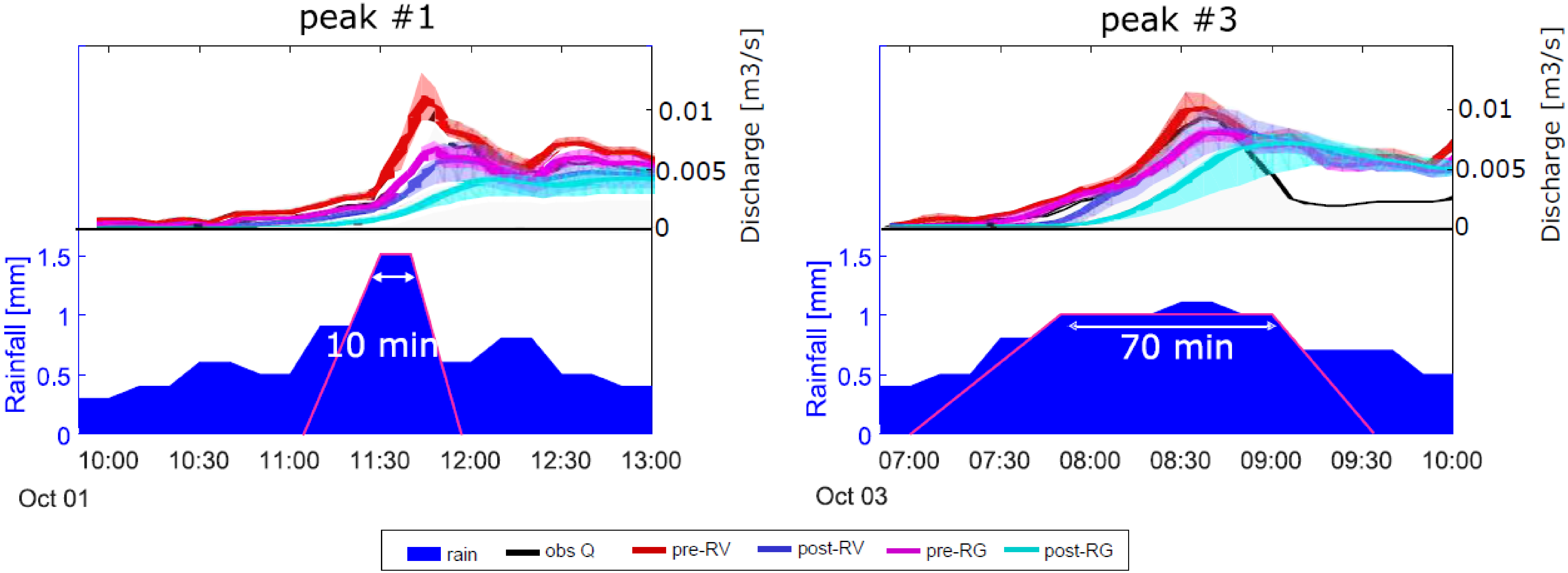
Does NFM always work?



Duration of peak rainfall intensity



Conclusions

- Modelling supports the BACI findings that peaks are reduced and lags increased by re-vegetation and gully-blocking
- Roughness, both due to re-vegetation and gully-blocking, introduces dynamic (mobile) surface storage that is:
  (1) the most important delivery mechanism for the observed intervention impacts
  (2) independent of storm size
- Storm properties can strongly alter the discharge reduction of interventions, although not their lag increase

Future work

-Depth dependent surface velocity

-What happens when you scale up?

-How do the intervention effects change over time?