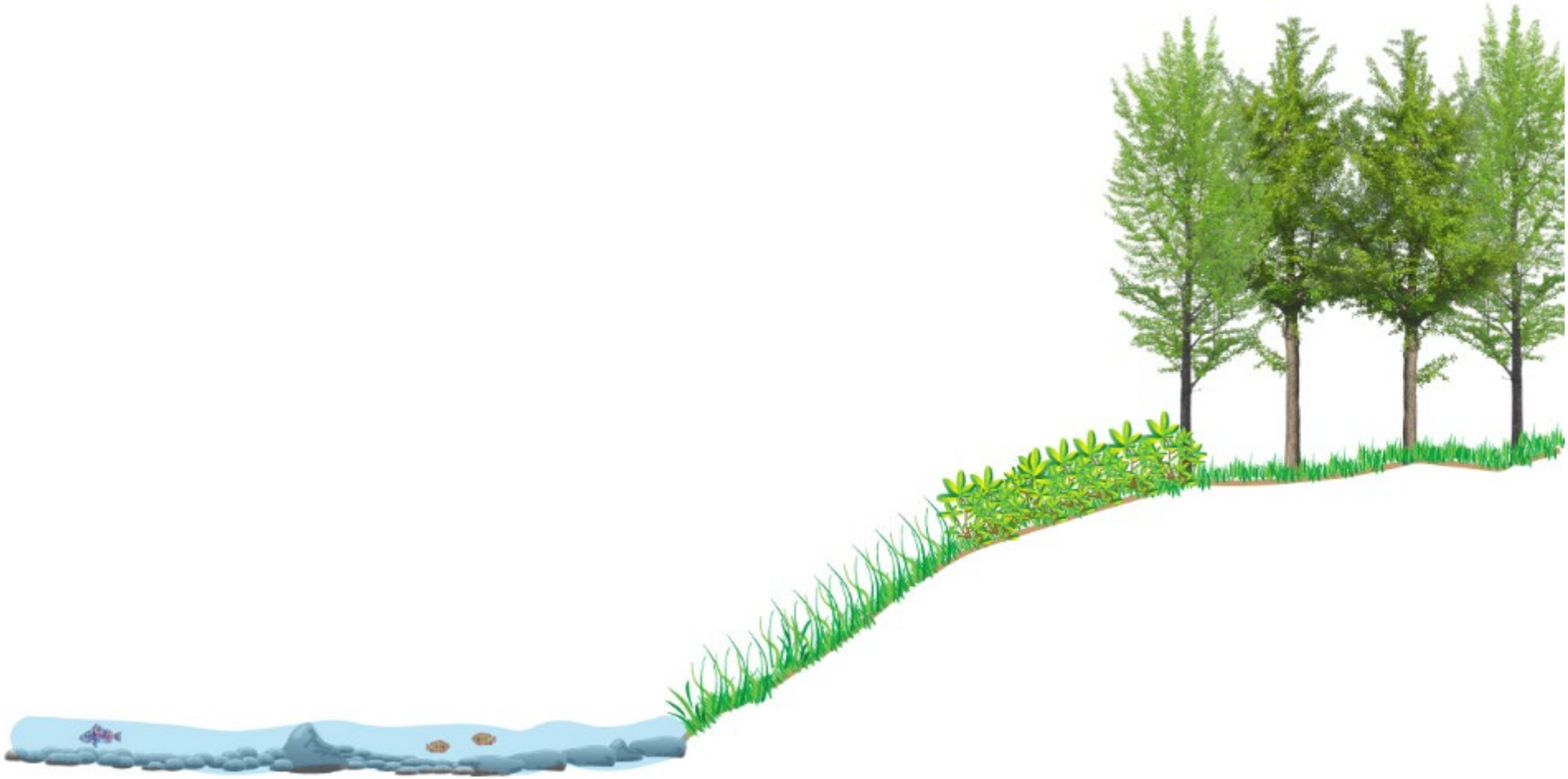
Changes in floodplains after serial damming of the Tocantins River in the eastern Amazon

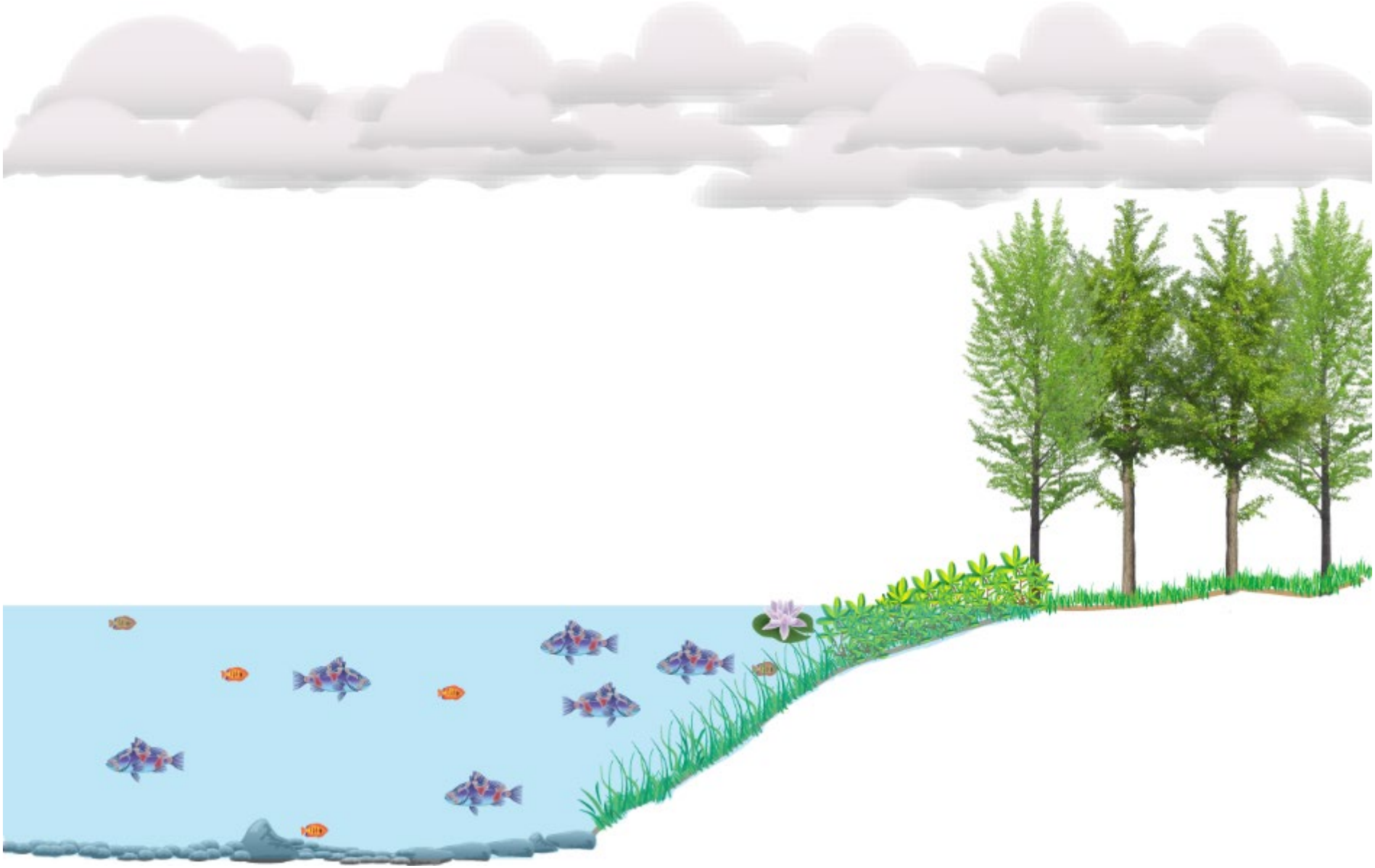
A. C. Swanson, S. Bohlman, & D. Kaplan
Water Institute
School of Forest Resources and Conservation
University of Florida

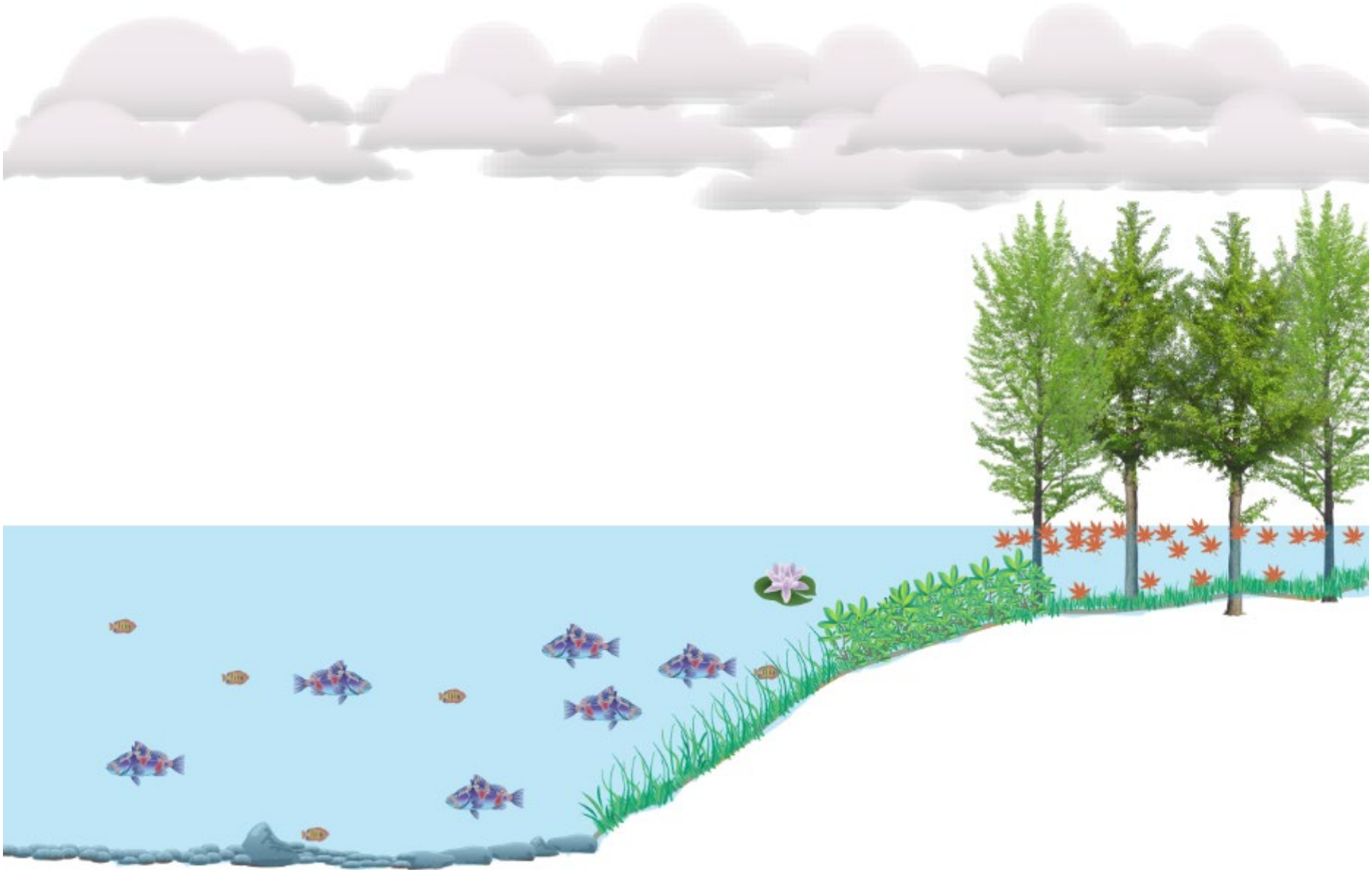
The flood pulse concept:

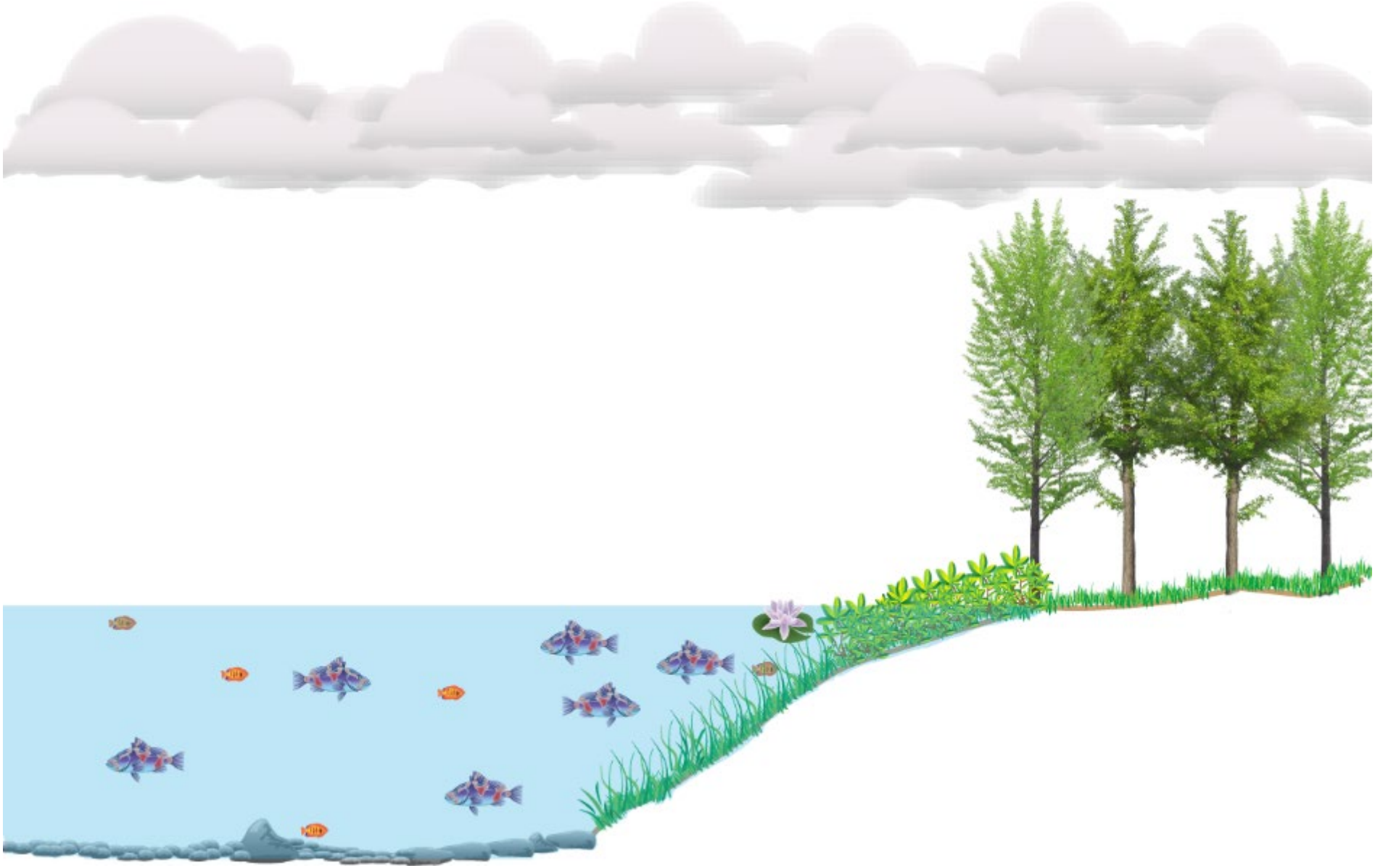
Regular flood regimes drive the ecology of floodplains and allow different species to flourish

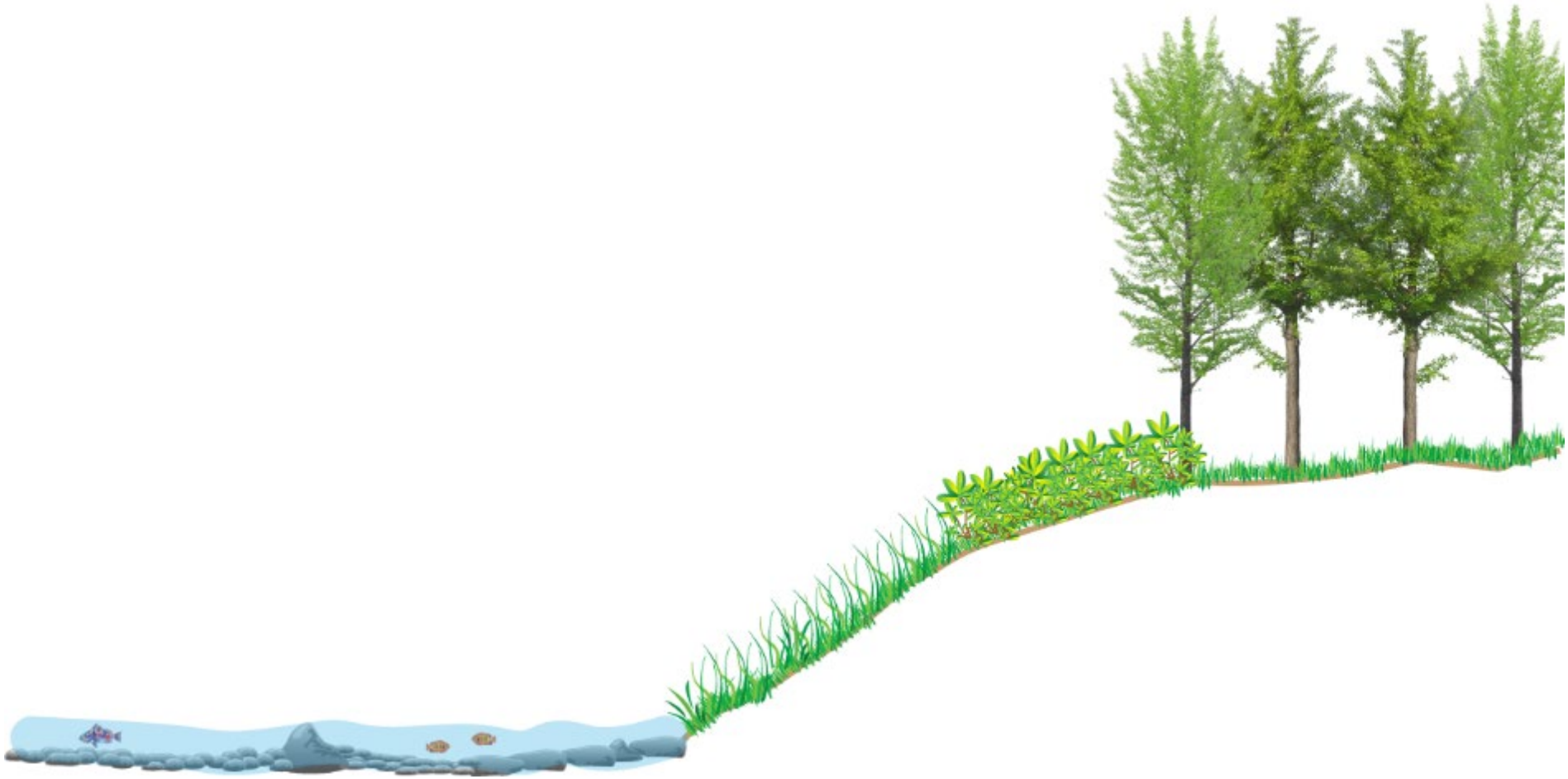
Junk et al. 1989. The flood pulse concept in river-floodplain systems.



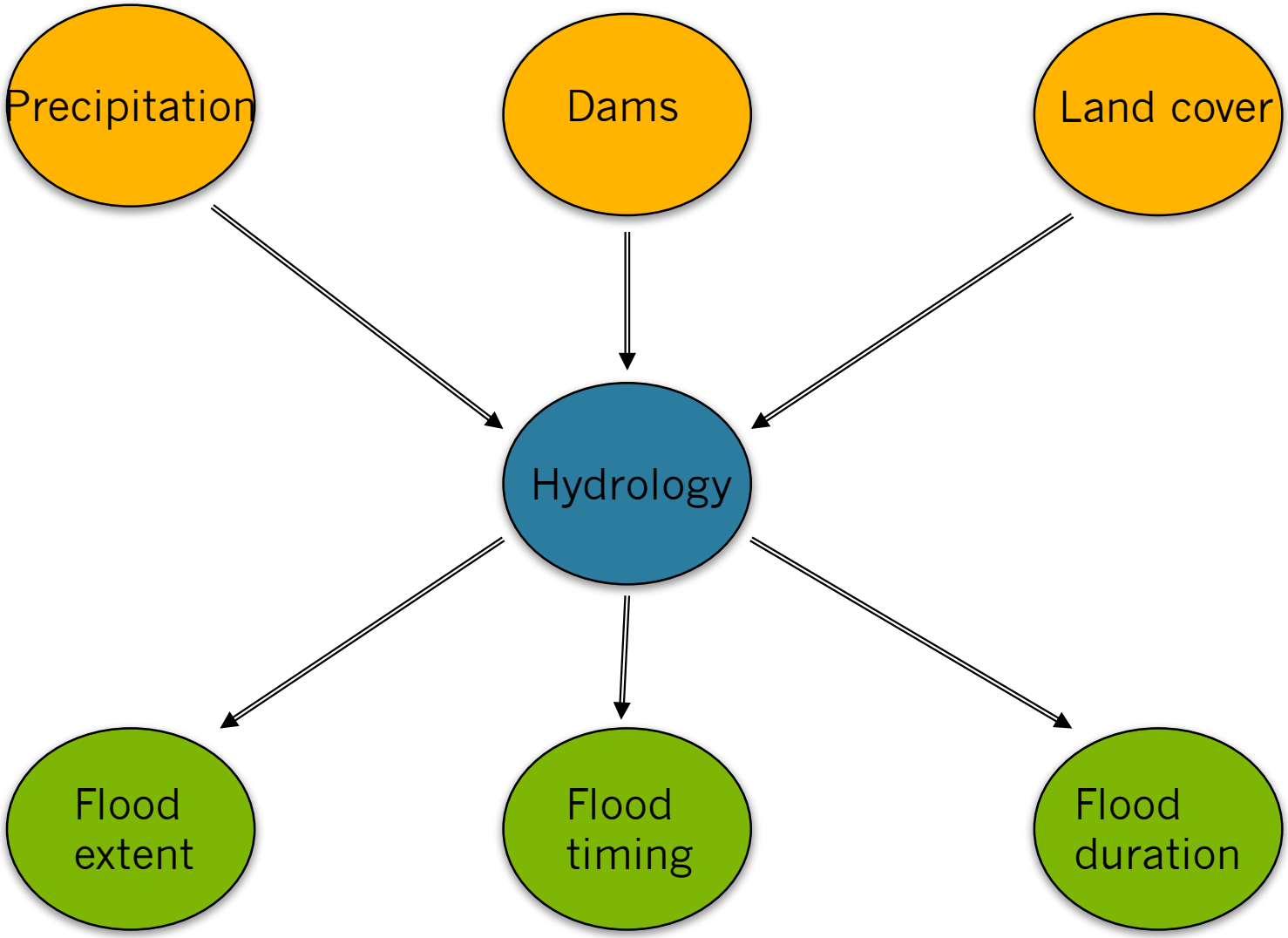


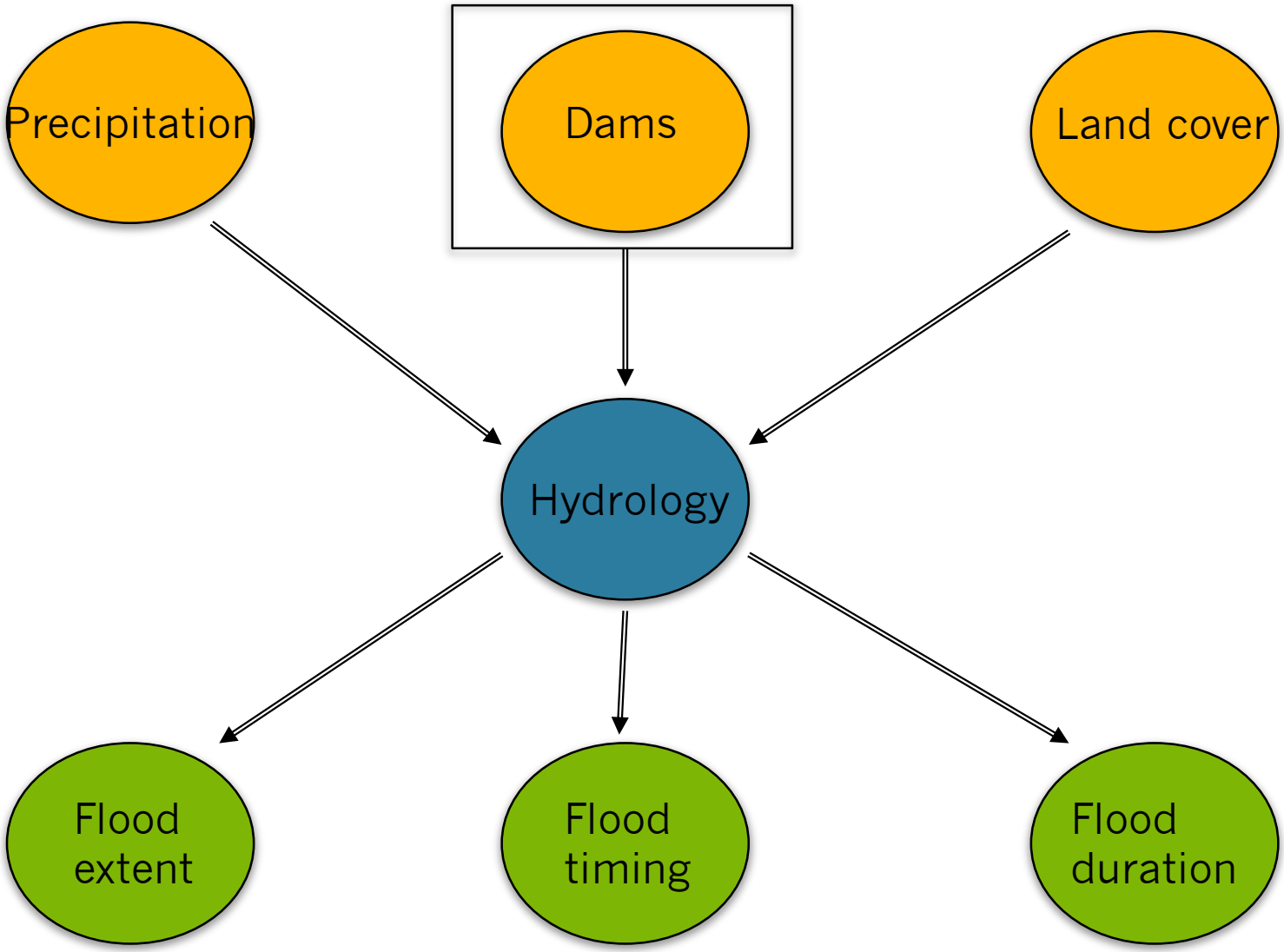


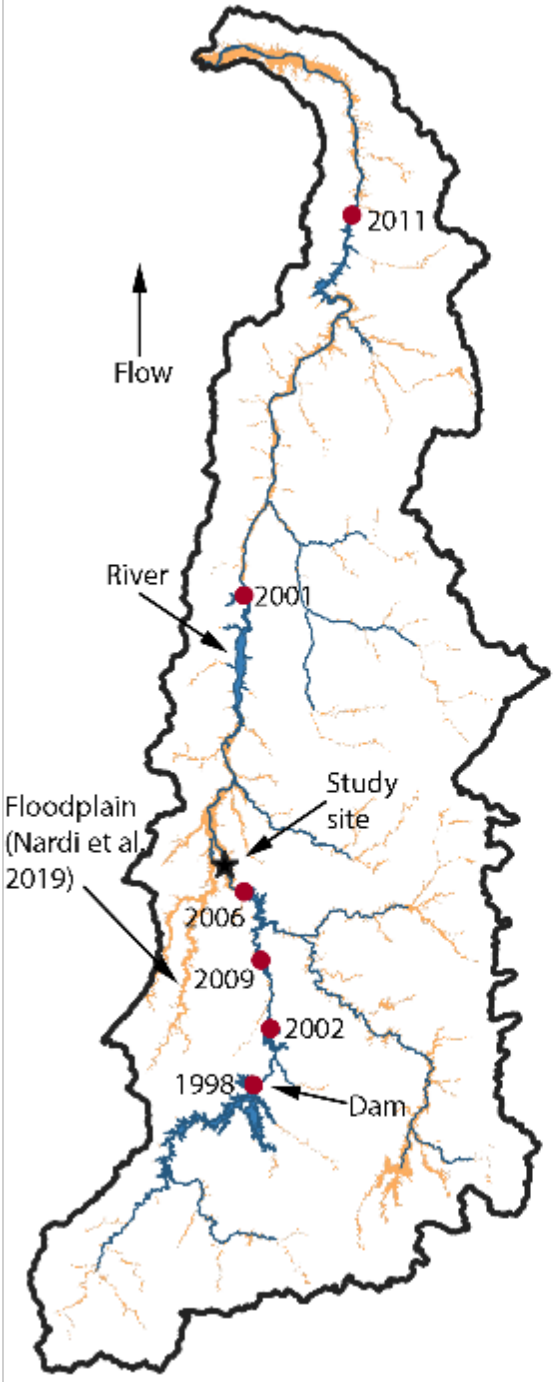


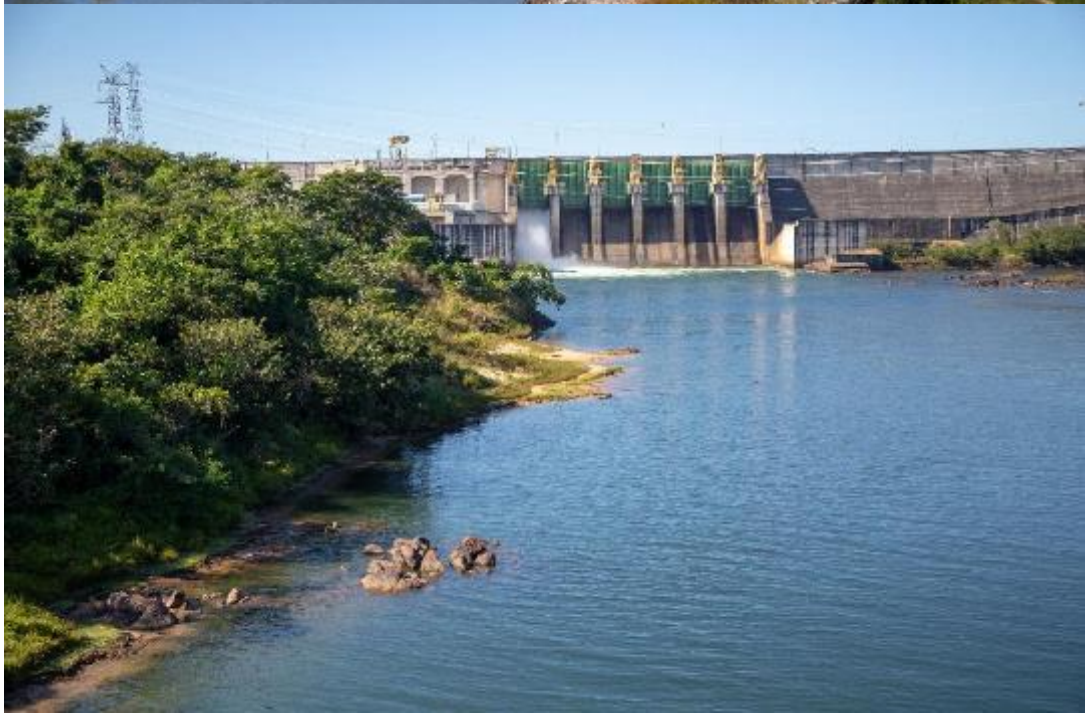


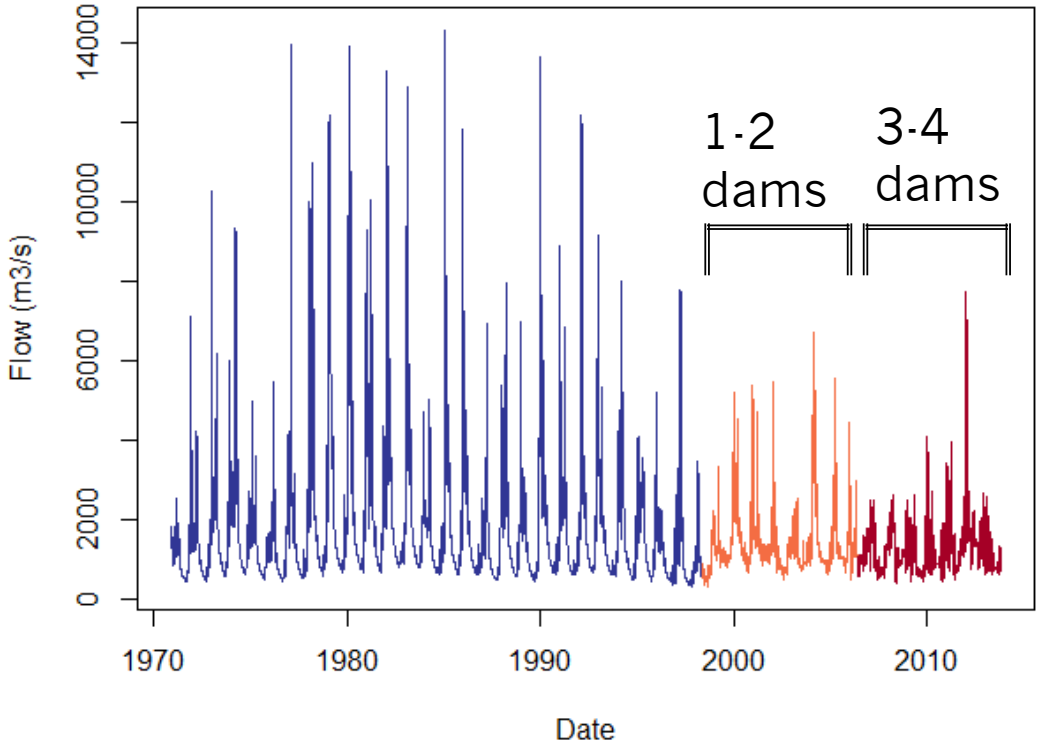
How does changing a river's hydrologic regime affect floodplain extent, flood timing, and flood duration?

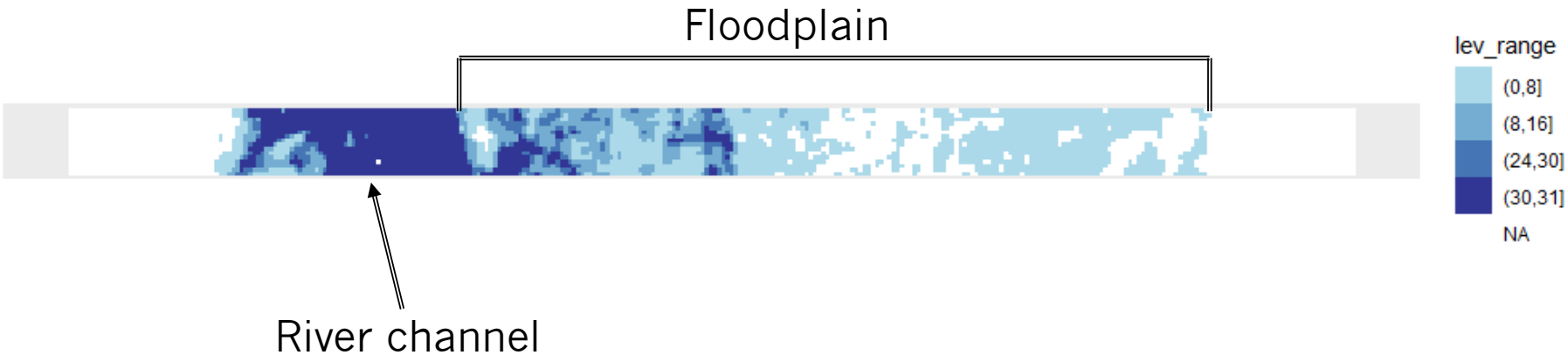

Precipitation
Dams
Land cover
Hydrology
Flood extent
Flood timing
Flood duration


Precipitation
Dams
Land cover
Hydrology
Flood extent
Flood timing
Flood duration


2011
Flow
River
2001
Study
site
Floodplain
(Nardi et al.
2019)
2006
2009
2002
1998
Dam

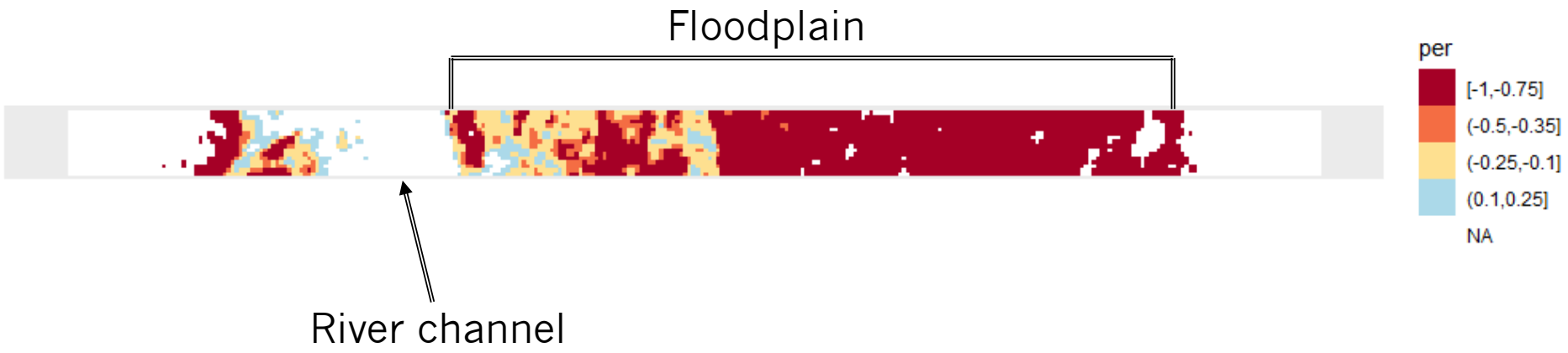



Flow (m3/s)
0
2000
6000
10000
14000
1970
1980
1990
2000
2010
Date
1-2 dams
3-4 dams

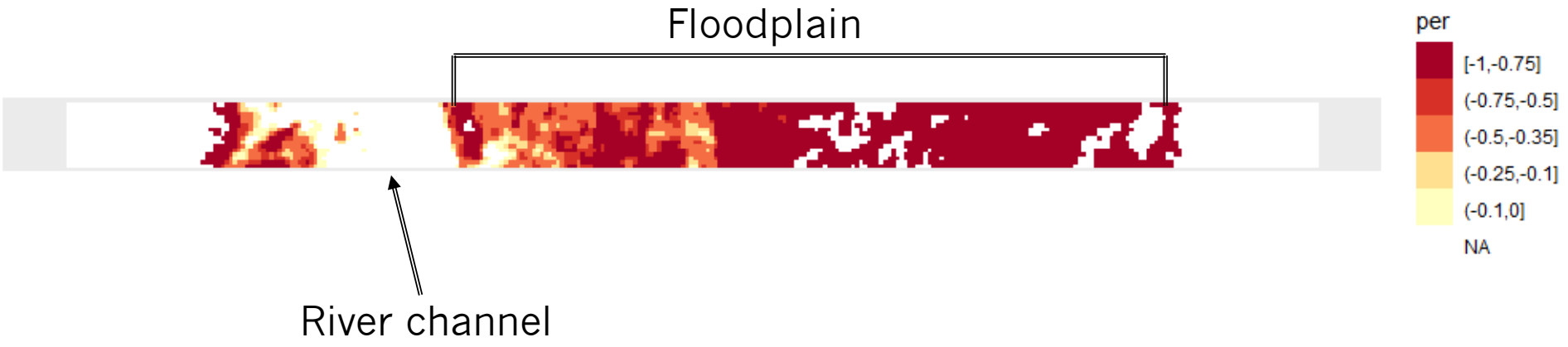

Floodplain
River channel
lev_range
(0,8]
(8,16]
(24,30]
(30,31]
NA

- Difference between post- and pre-dam floodplains

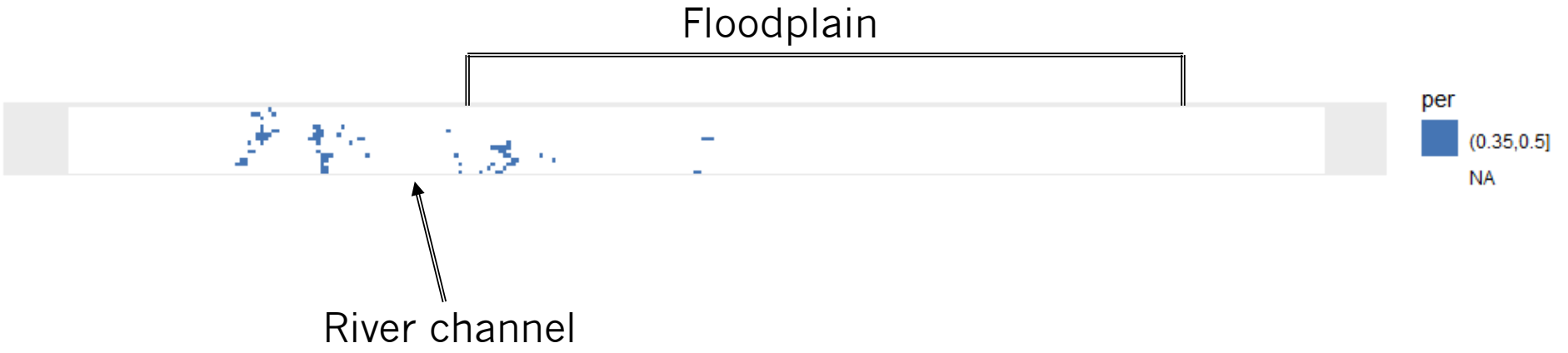
- Warm colors indicate a loss in hydroperiod
- Cool colors indicate a gain in hydroperiod

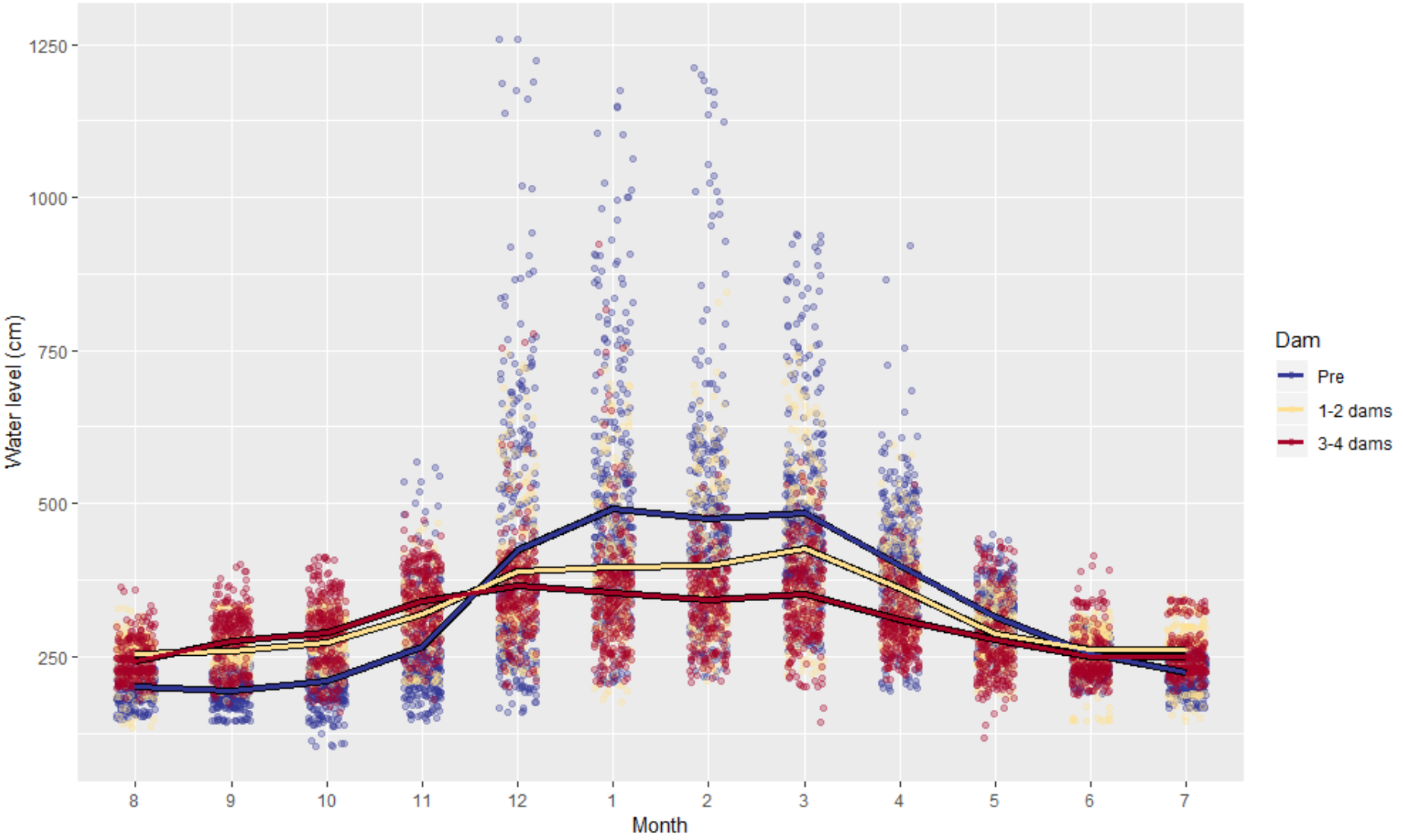


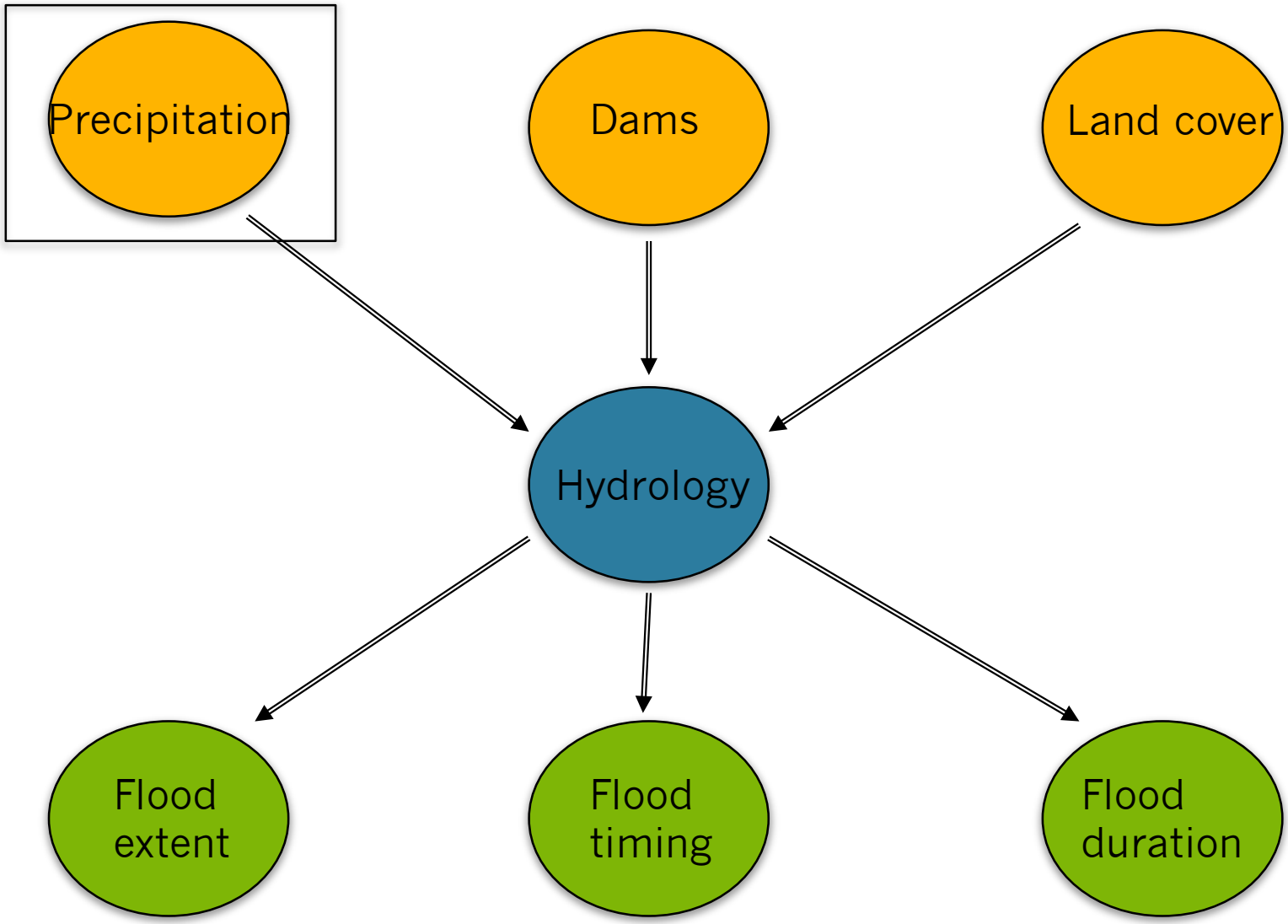
- During the wet season, the post-dam floodplain has a shorter hydroperiod and less area is inundated

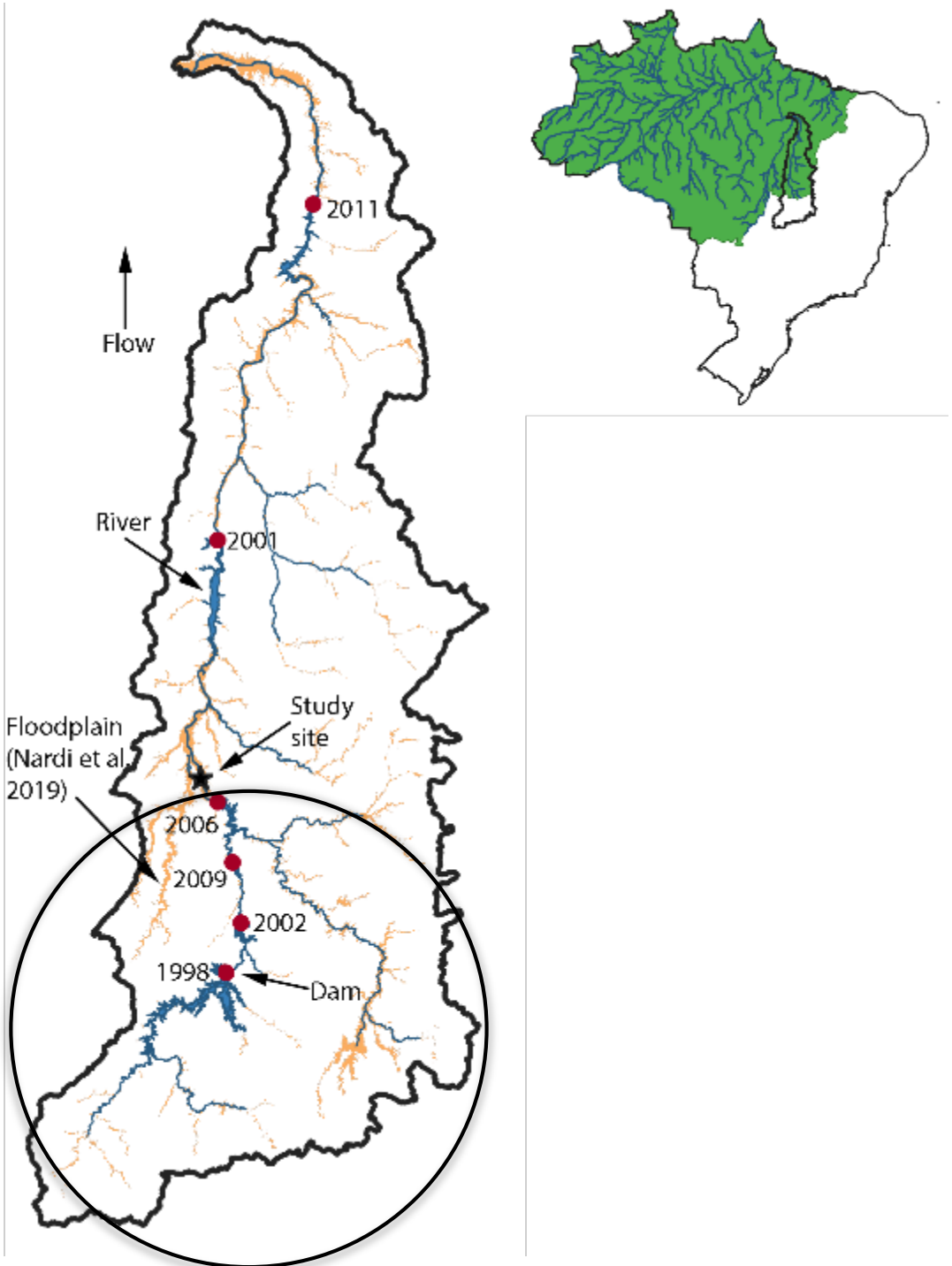


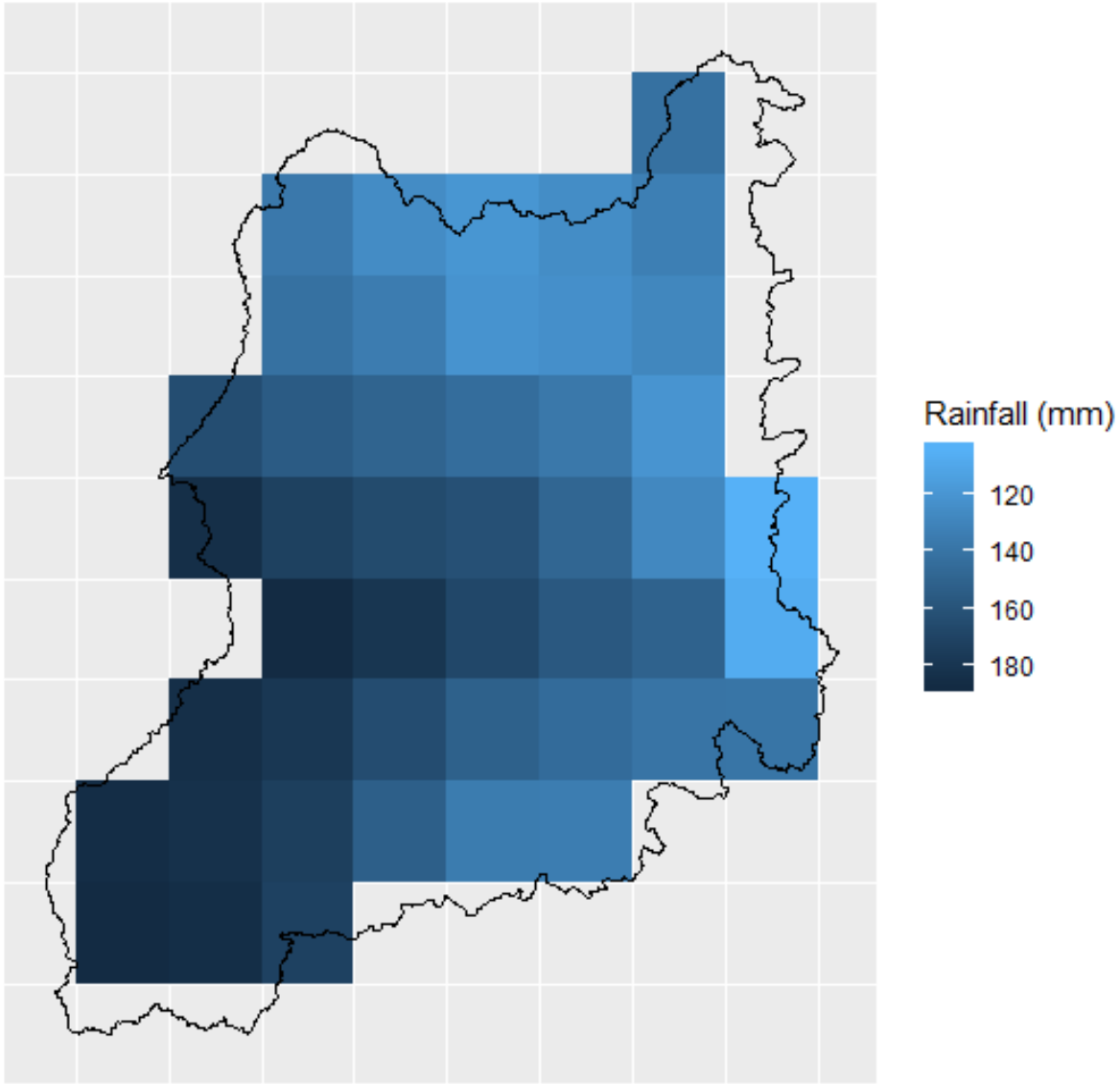
- But in the dry season, the post-dam floodplain becomes inundated for a longer amount of time



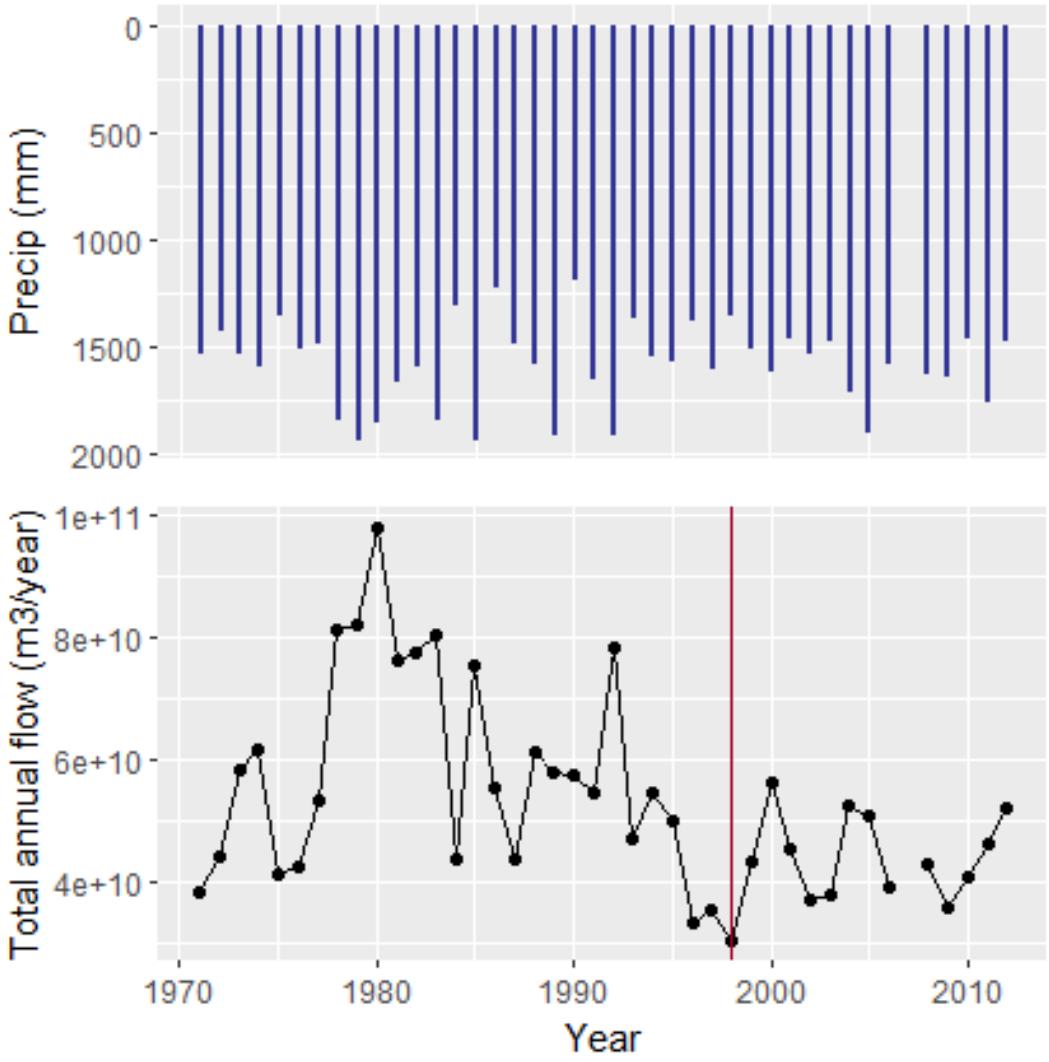

Water level (cm)
1250
1000
750
500
250
8
9
10
11
12
1
2
3
4
5
6
7
Month
Dam
Pre
1-2 dams
3-4 dams

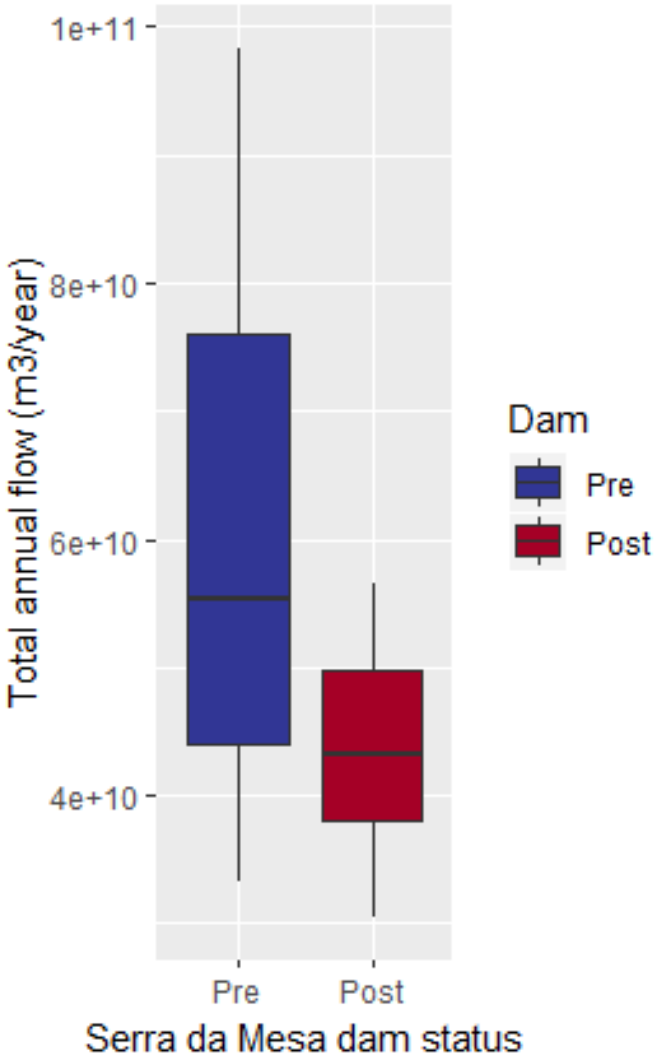

Precipitation
Dams
Land cover
Hydrology
Flood extent
Flood timing
Flood duration

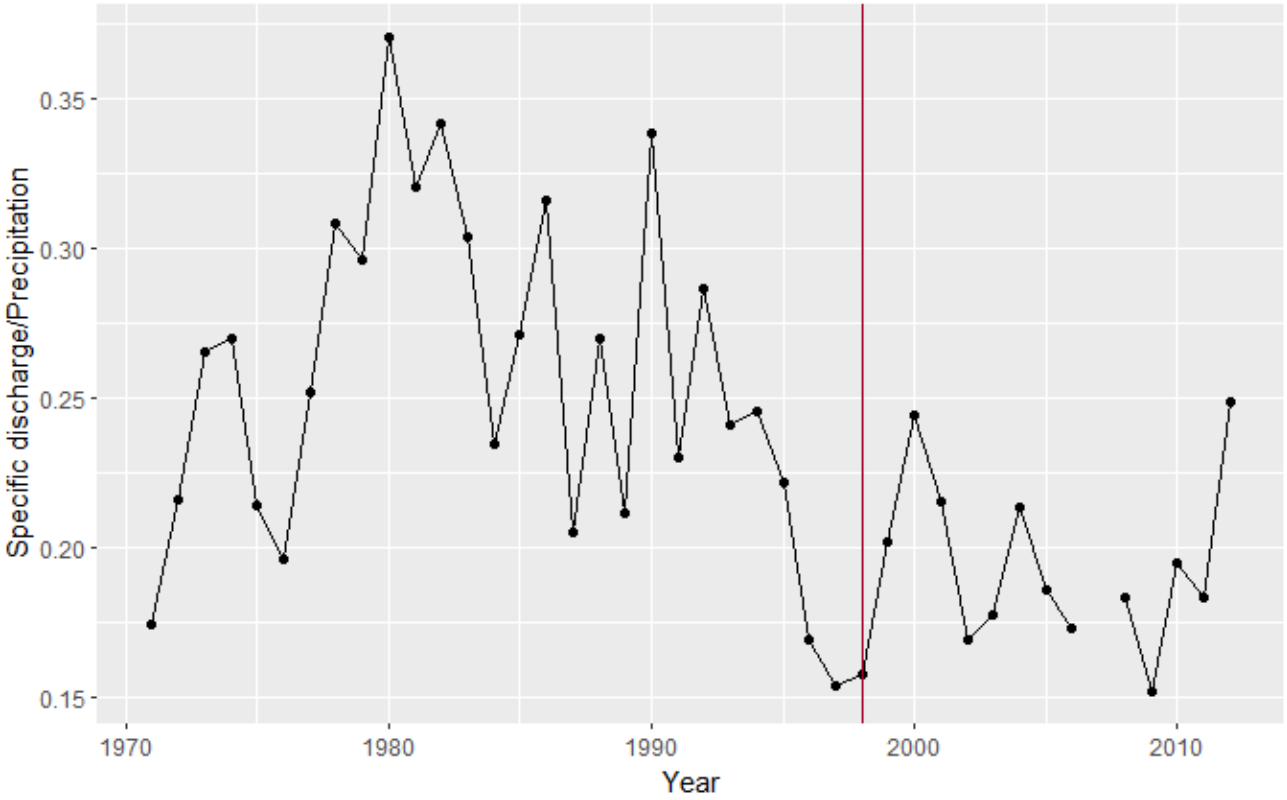

2011
Flow
River
2001
Floodplain
(Nardi et al.
2019)
Study
site
2006
2009
2002
1998
Dam

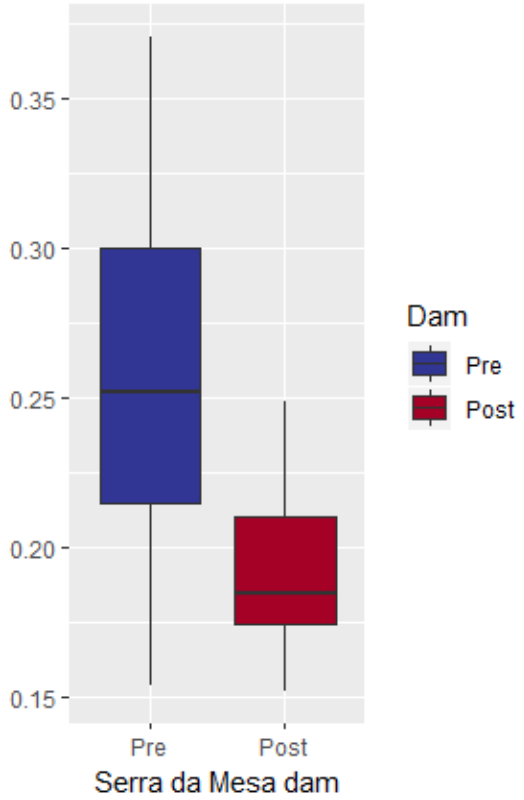


- Annual precipitation data from the Climate Research Unit
- Similar analysis as Costa et al. (2003)


Precip (mm)
0
500
1000
1500
2000
Total annual flow (m3/year)
1e+11
8e+10
6e+10
4e+10
1970
1980
1990
2000
2010
Year

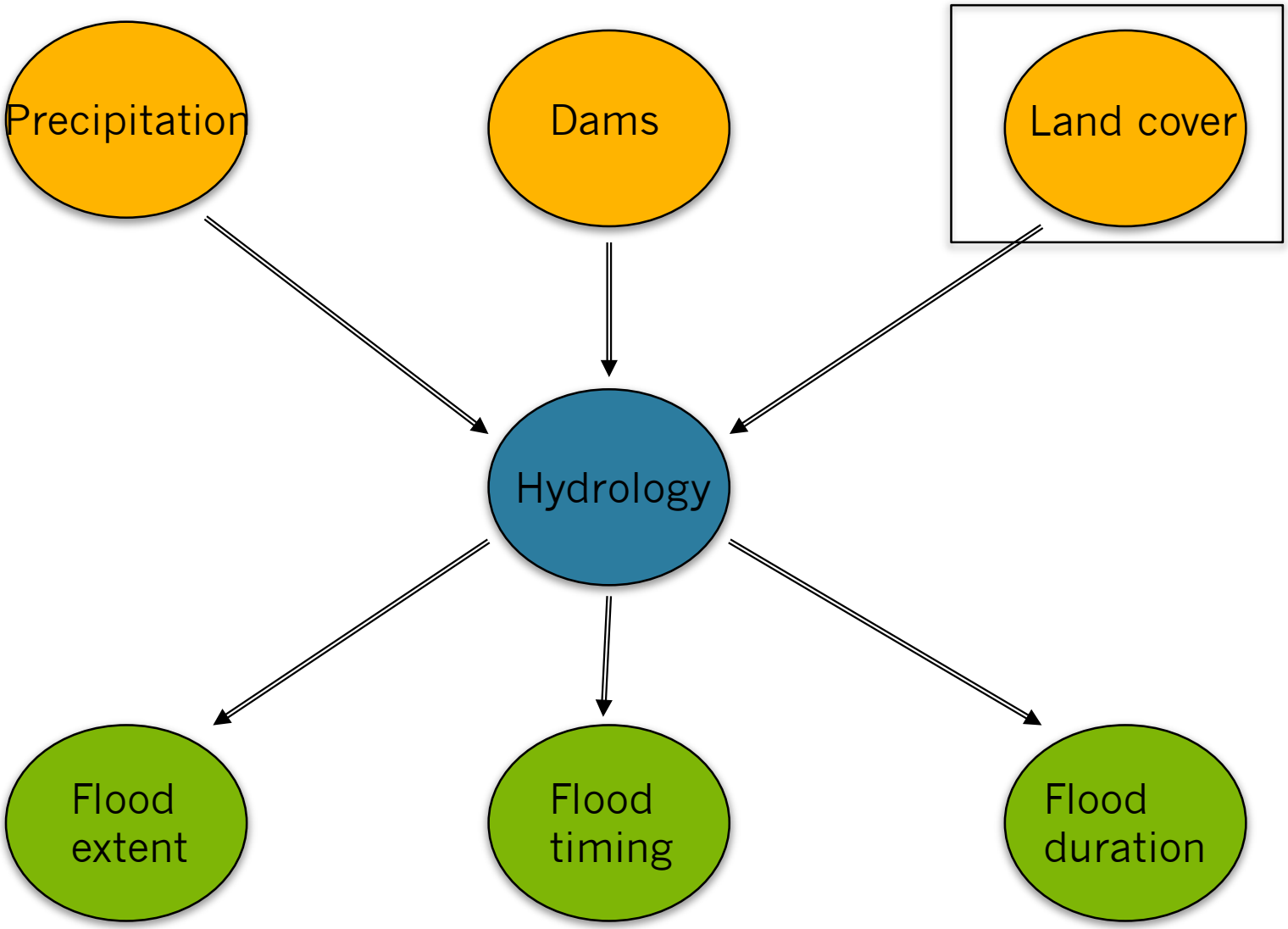

Total annual flow (m3/year)
1e+11
8e+10
6e+10
4e+10
Pre
Post
Serra da Mesa dam status
Dam
Pre
Post

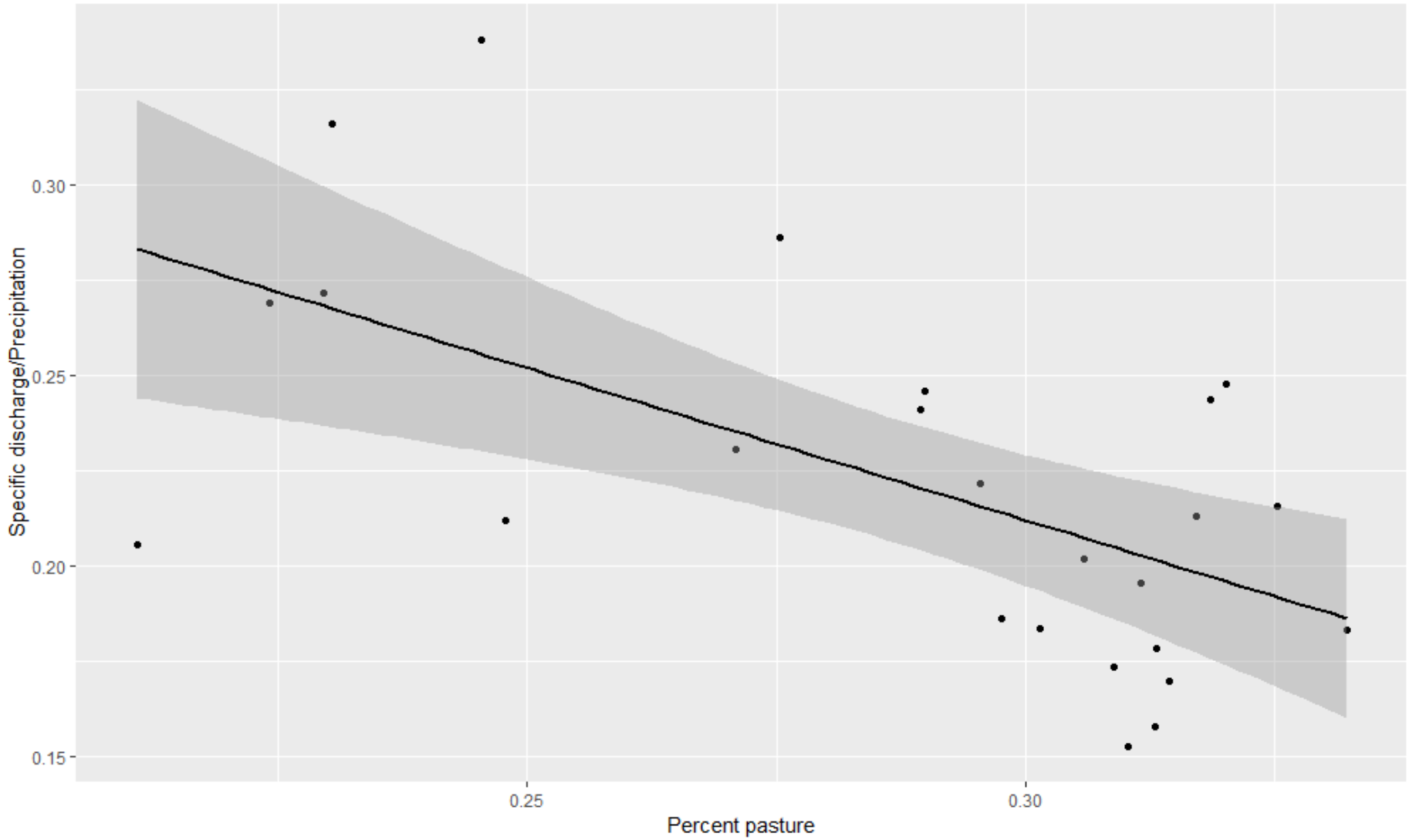




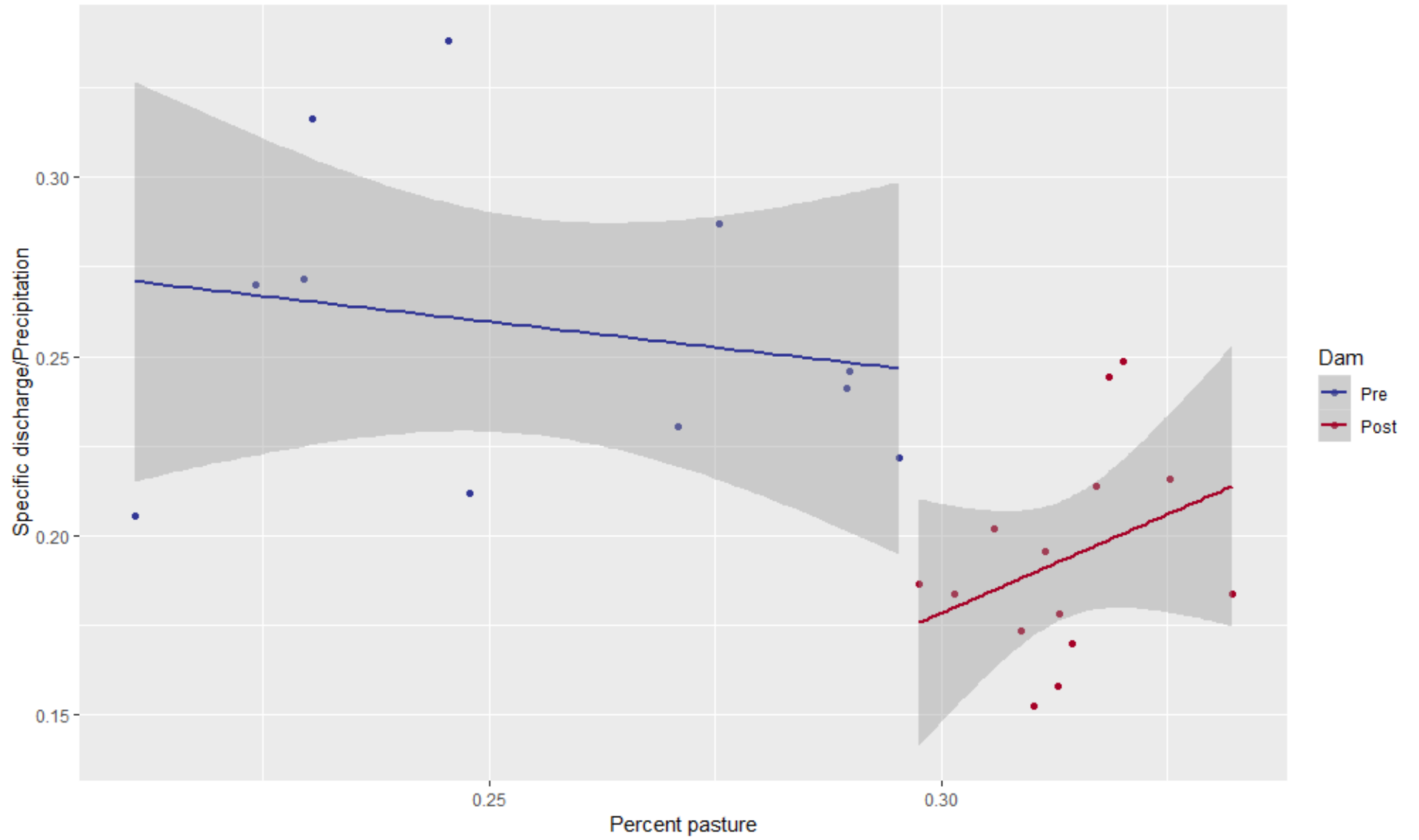
- Specific discharge = total discharge/total area

- Graph represents the % precipitation that goes to the river as runoff


Precipitation
Dams
Land cover
Hydrology
Flood extent
Flood timing
Flood duration

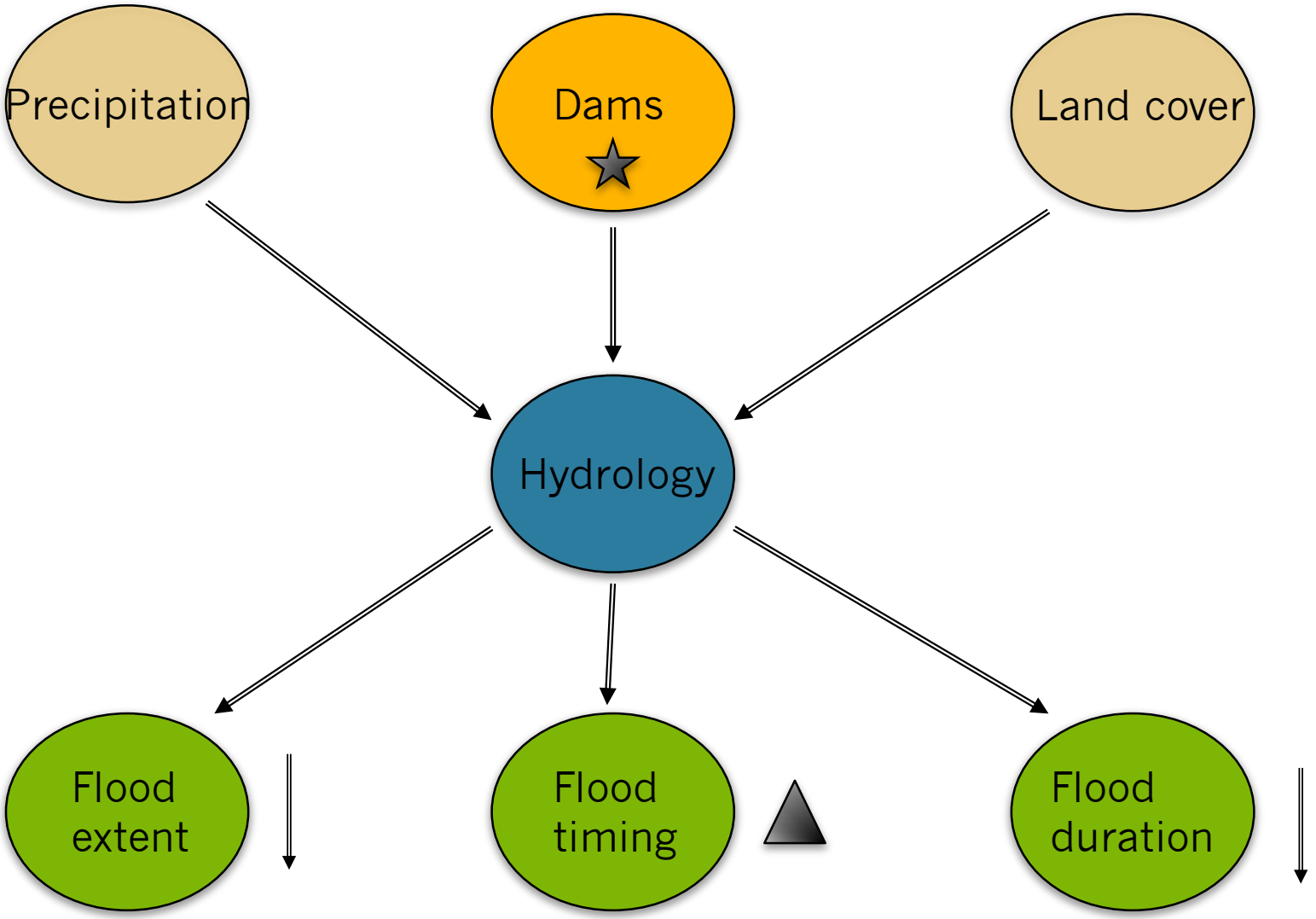

Specific discharge/Precipitation
0.30
0.25
0.20
0.15
0.25
0.30
Percent pasture

Time


Specific discharge/Precipitation
0.30
0.25
0.20
0.15
0.25
0.30
Percent pasture
Dam
Pre
Post

Time

Conclusions



Next Steps

- Add sites throughout the watershed to determine effects with additional dams
- Relate changes in the floodplains to changes in forest phenology

Acknowledgments

Funding sources

UF | Water Institute
UNIVERSITY of FLORIDA

UF | Informatics Institute
UNIVERSITY of FLORIDA

SFRC School of FOREST RESOURCES & CONSERVATION

NASA

Collaborators

Elineide Marques
Cristhyano Borges


Questions?