Assessing the hydrologic impacts of land use change in the Upper Paraná River Basin between 1985 and 2015

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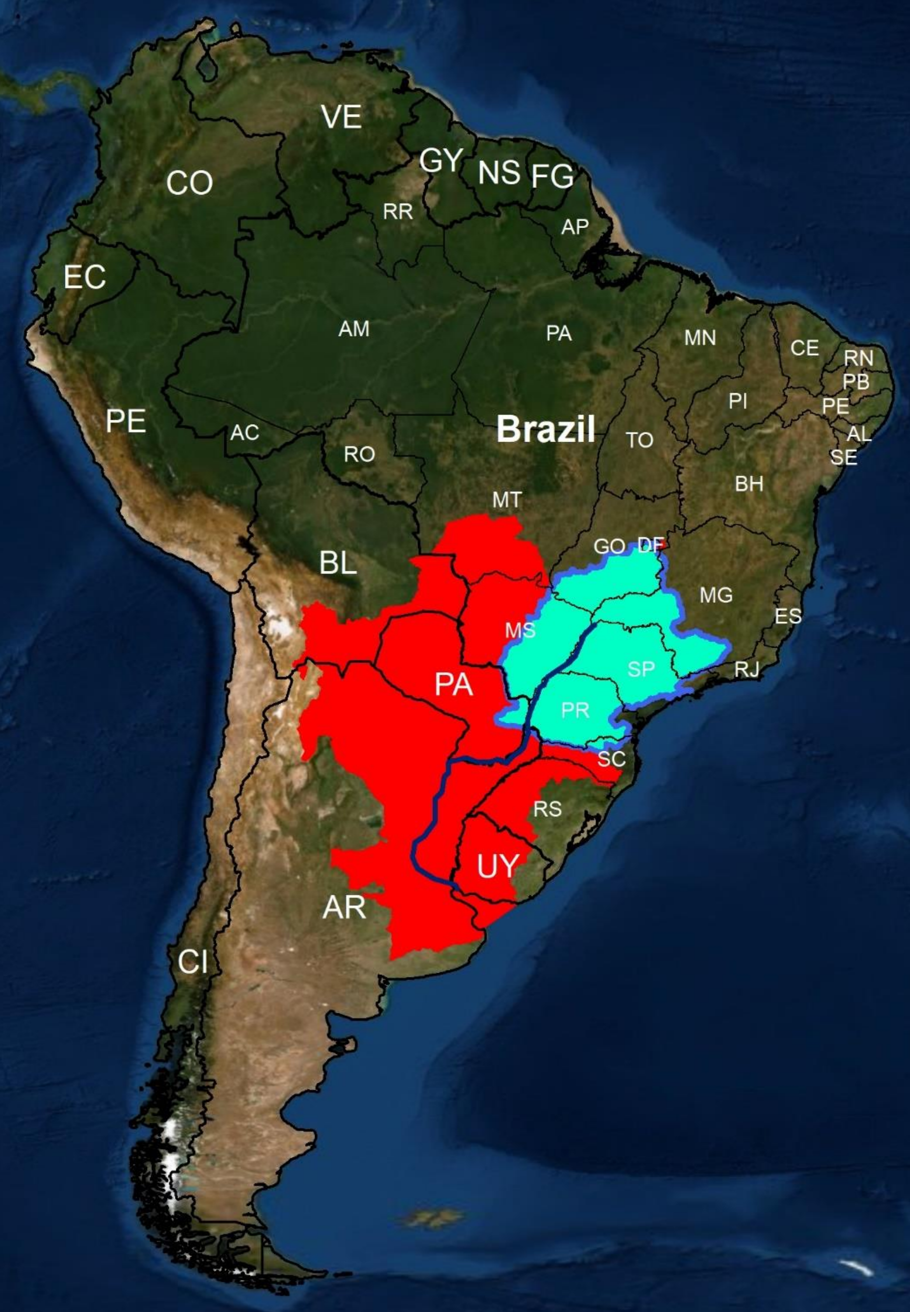
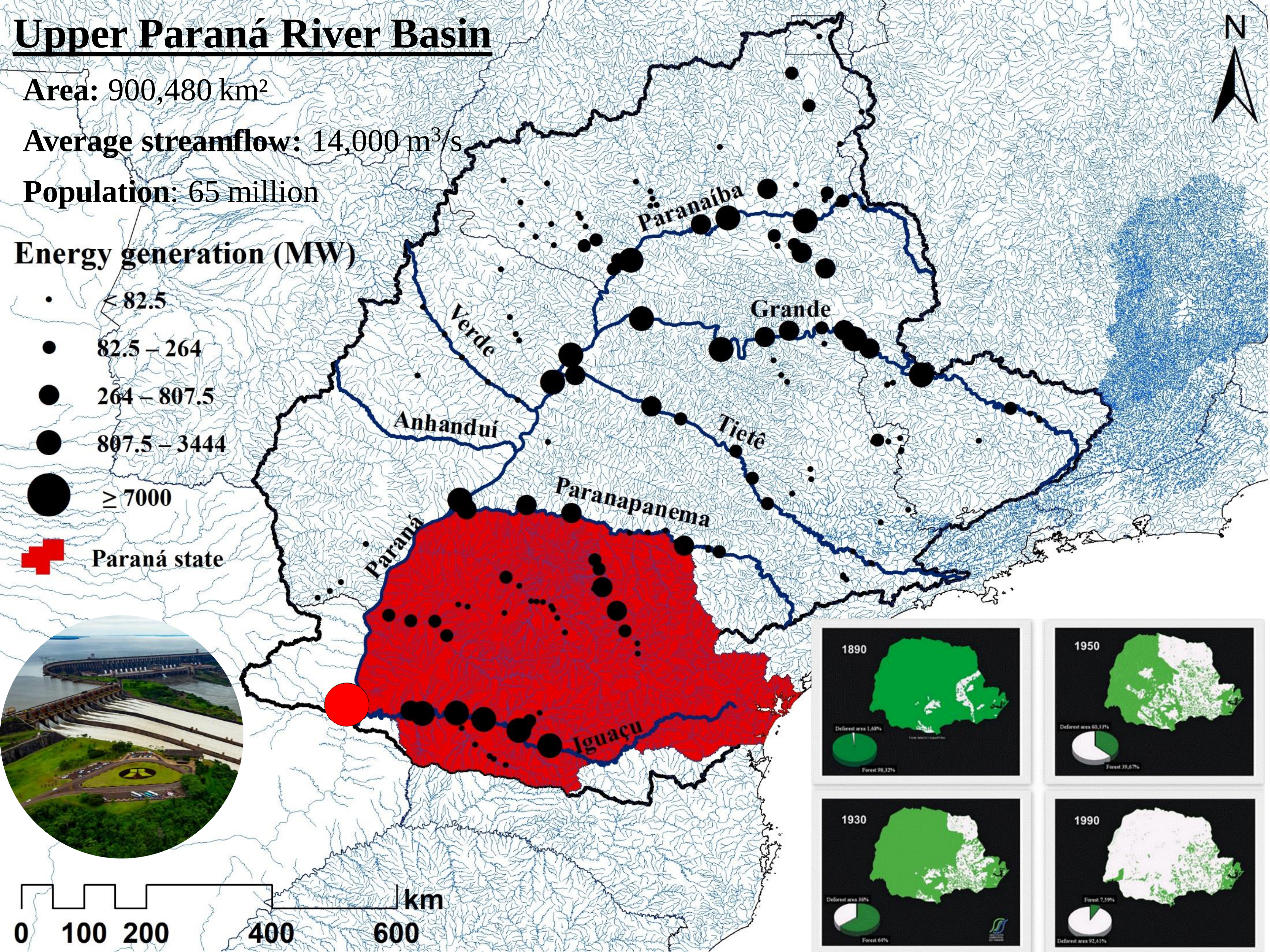
La Plata River Basin

Area: 3.1 million km²




Upper Paraná River Basin
Area: 900,480 km²
Average streamflow: 14,000 m³/s
Population: 65 million
Energy generation (MW)
< 82.5
82.5 – 264
264 – 807.5
807.5 – 3444
≥ 7000
Paraná state
Paranaíba
Verde
Grande
Anhanduí
Tietê
Paranapanema
Paraná
Iguaçu
1890
1950
1930
1990
N
0
100
200
400
600
km

Research Questions

What are the potential changes in the hydrological processes and discharge in the Upper Paraná River Basin between 1985 and 2015?

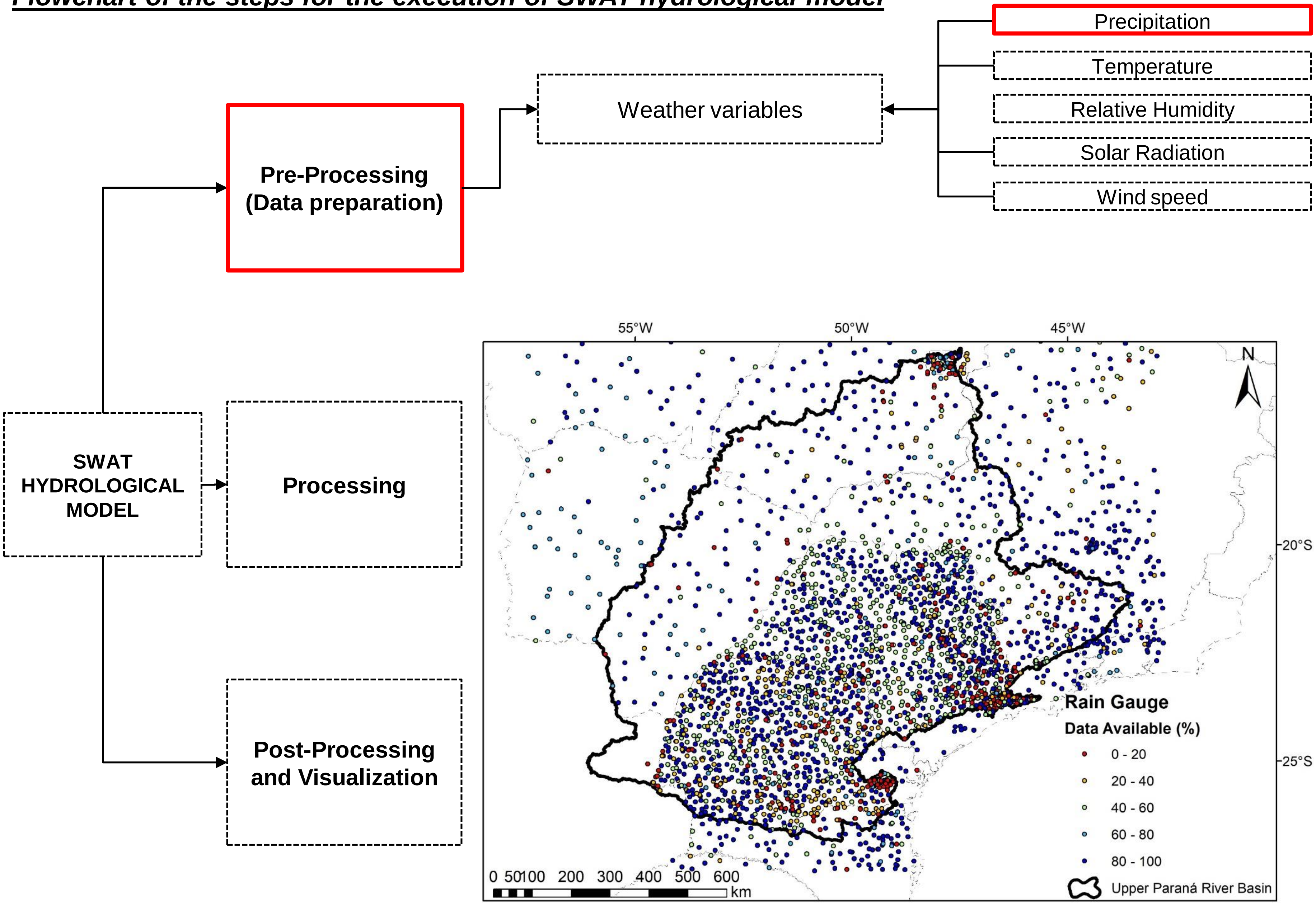
What extent they are associated with the observed past land use changes?

SWAT Hydrological Model

- Soil and Water Assessment Tool (SWAT, Arnold et al., 1998)

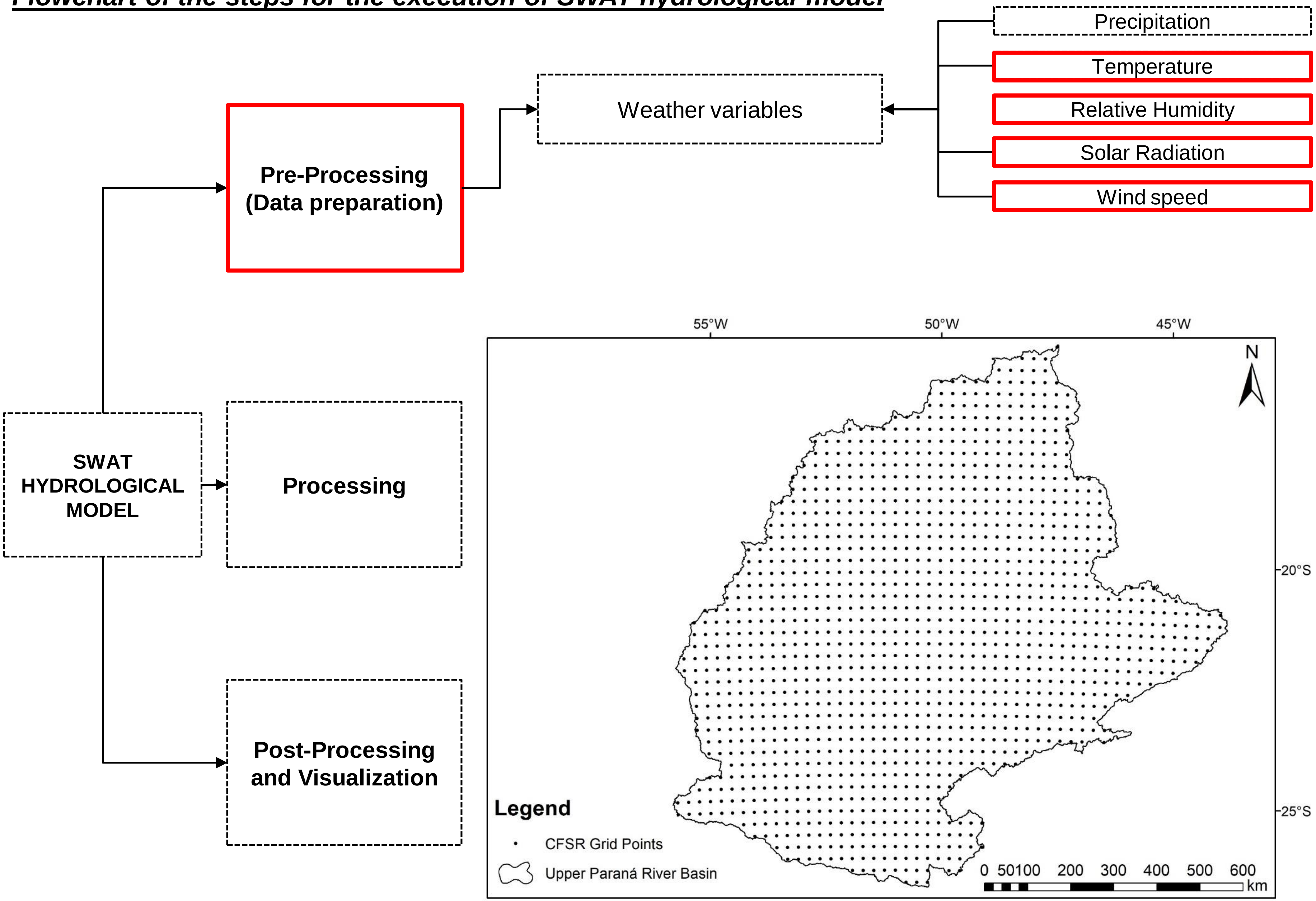
- **Simulation period:** 1979 – 2015
  - ✓ Warm-up: 1979 – 1983
  - ✓ Calibration: 1984 – 2004
  - ✓ Validation: 2005 – 2015

Flowchart of the steps for the execution of SWAT hydrological model



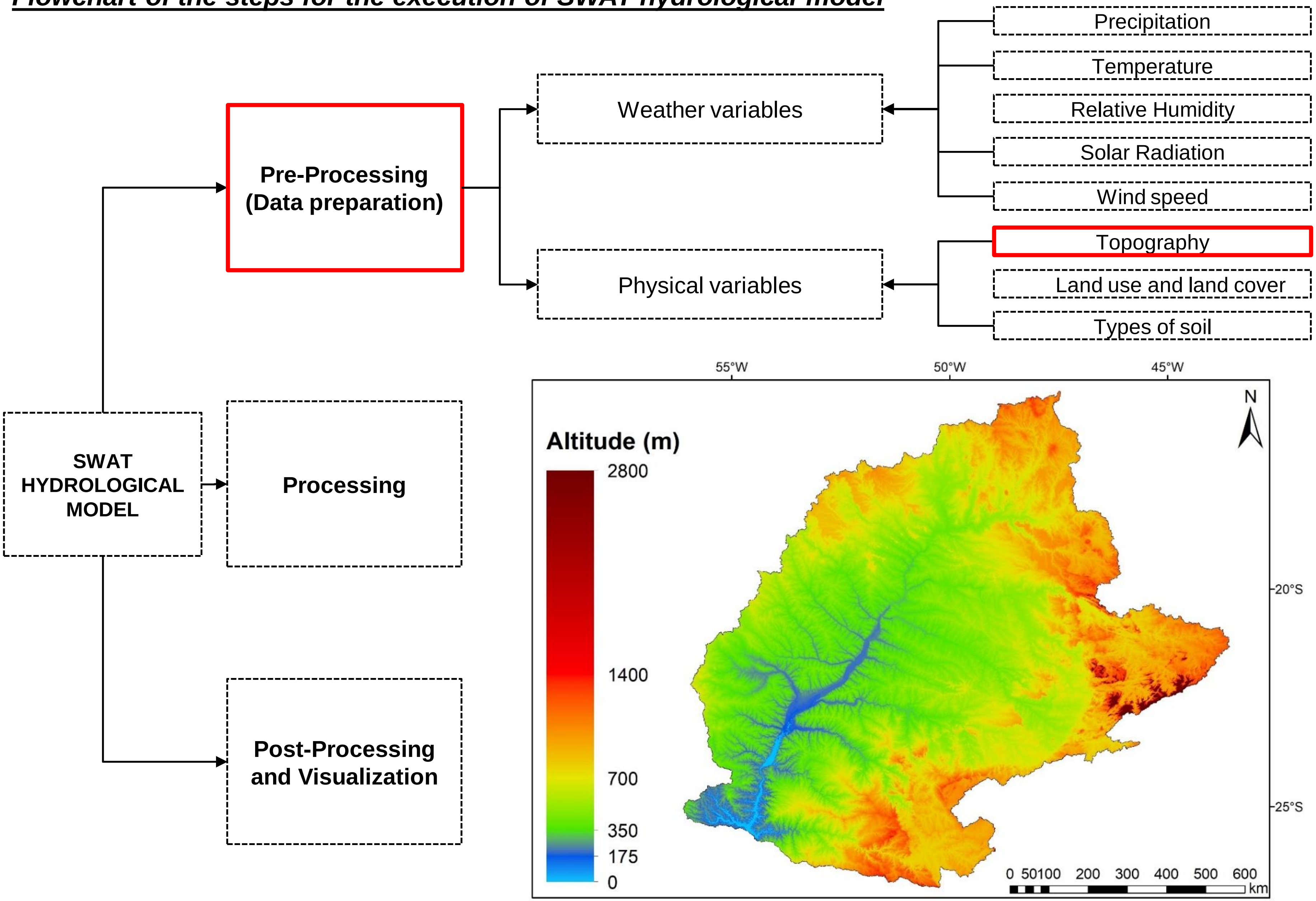
Source: National Water Agency (ANA).

Flowchart of the steps for the execution of SWAT hydrological model



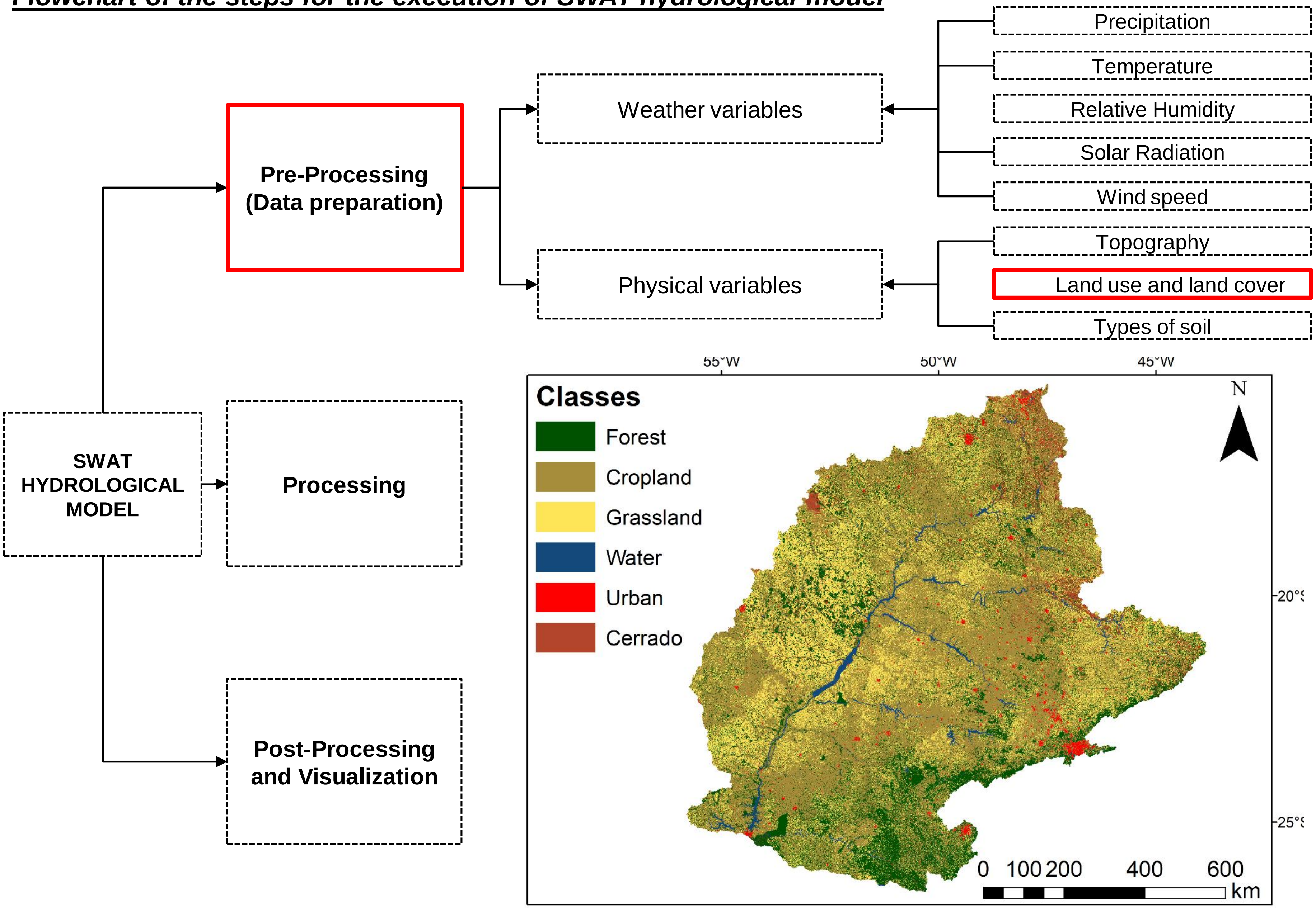
Source: Climate Forecast System Reanalysis (CFSR).

Flowchart of the steps for the execution of SWAT hydrological model



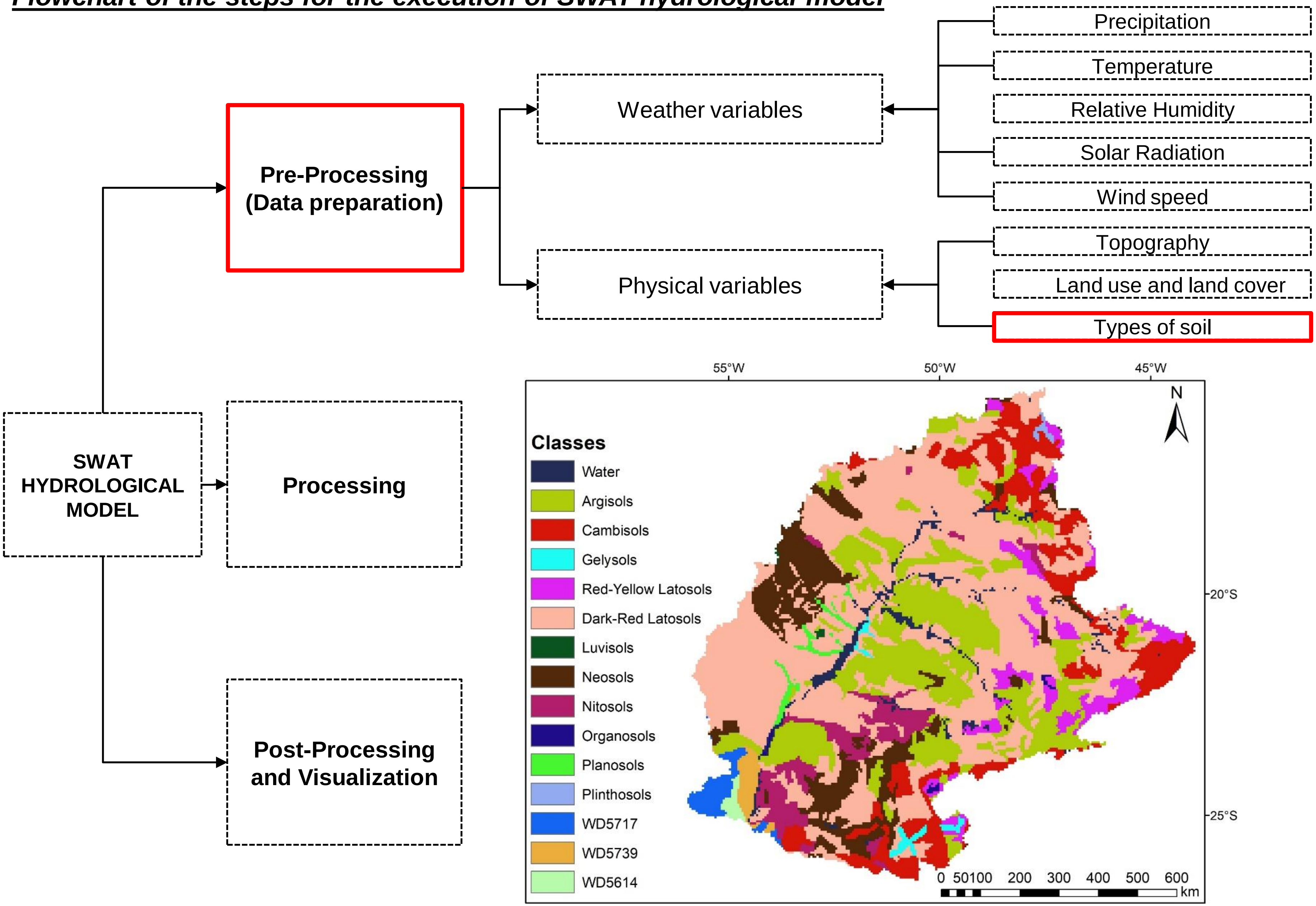
Source: Shuttle Radar Topography Mission (SRTM).

Flowchart of the steps for the execution of SWAT hydrological model



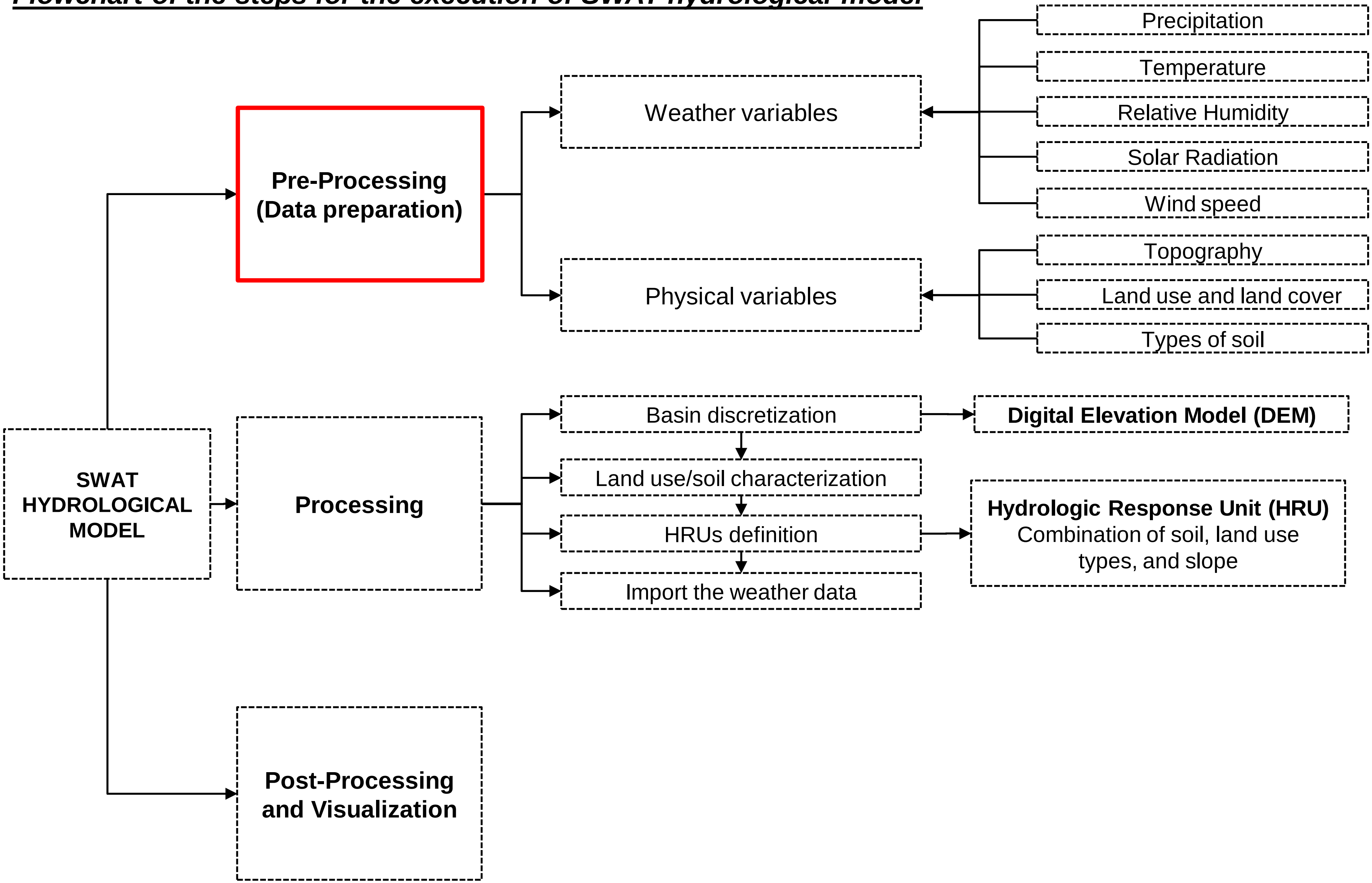
Source: Rudke (2018).

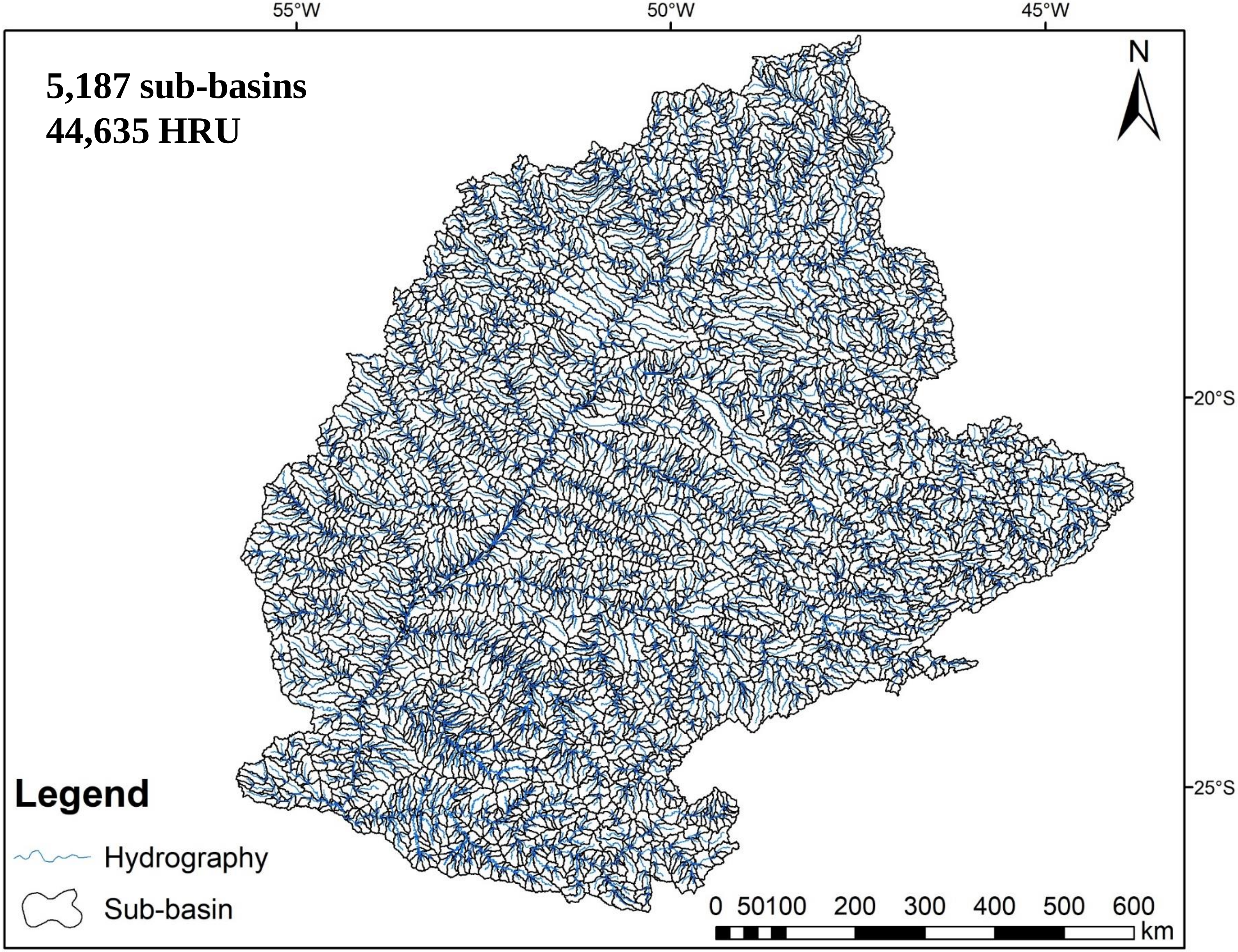
Flowchart of the steps for the execution of SWAT hydrological model



Source: Brazilian Agriculture Research Corporation (EMBRAPA); HWSD.

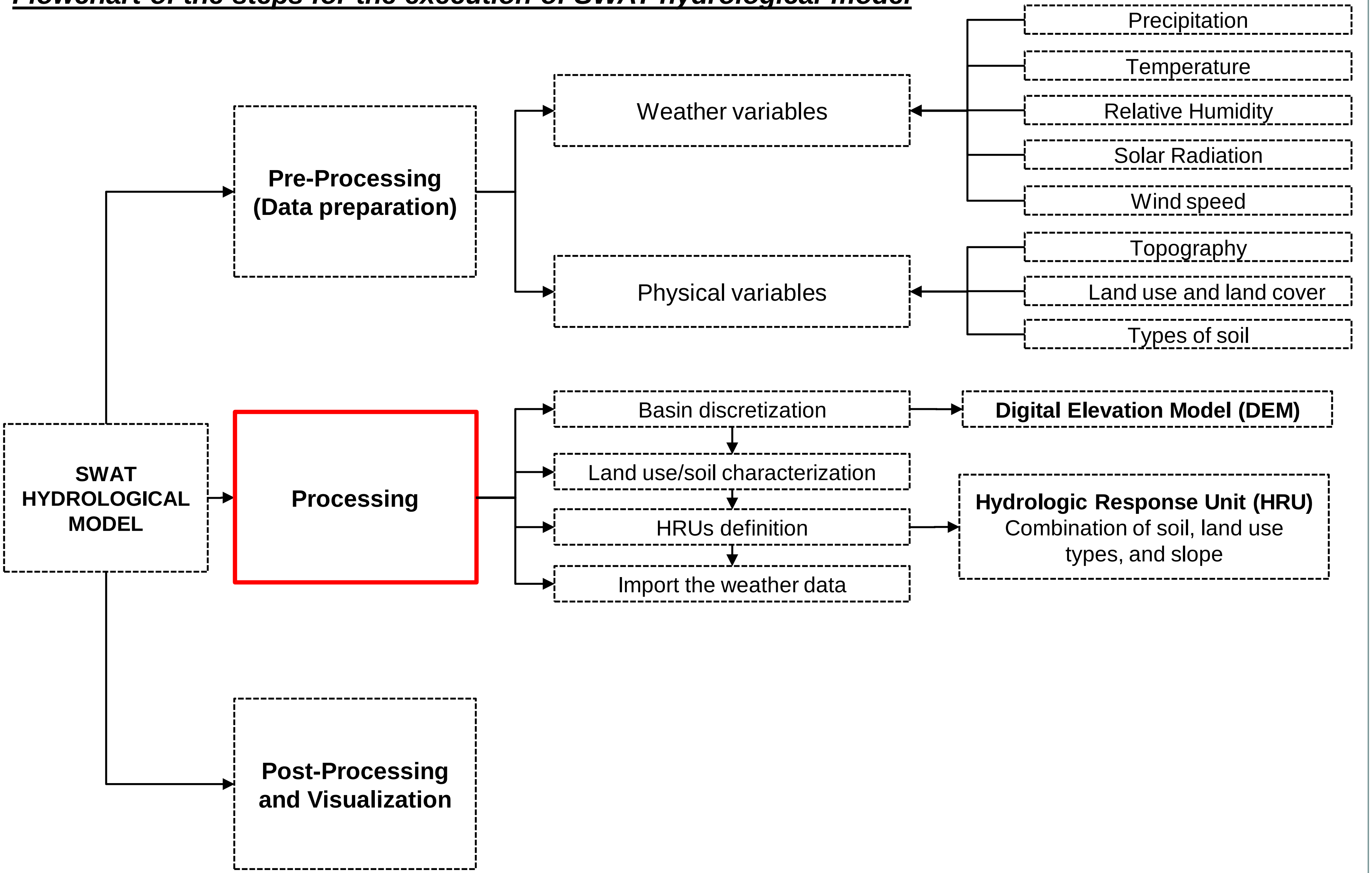
Flowchart of the steps for the execution of SWAT hydrological model





5,187 sub-basins
44,635 HRU
55°W
50°W
45°W
20°S
25°S
N
Legend
Hydrography
Sub-basin
0 50100 200 300 400 500 600
km

Flowchart of the steps for the execution of SWAT hydrological model



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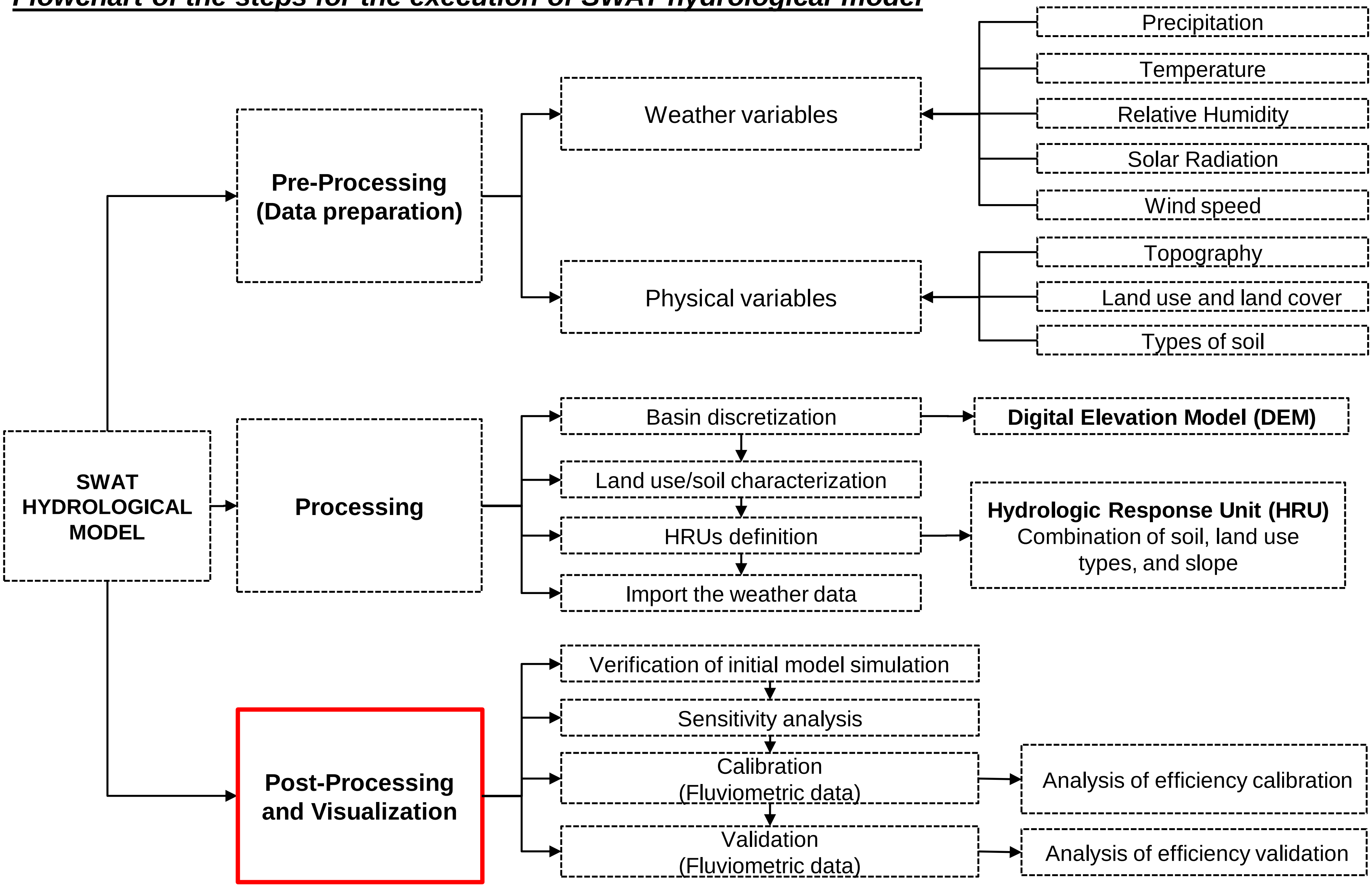
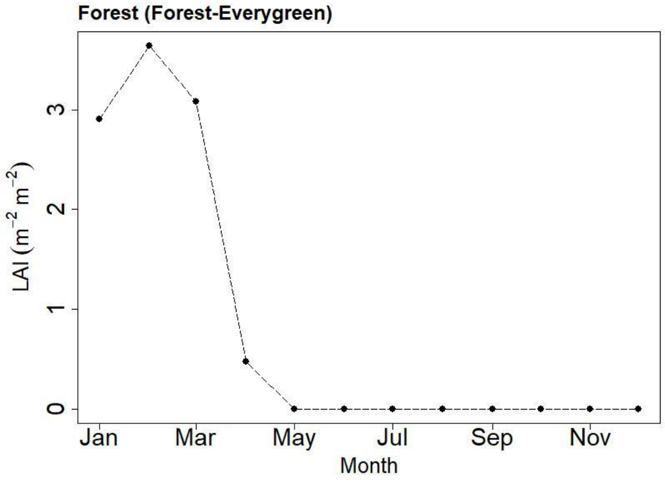


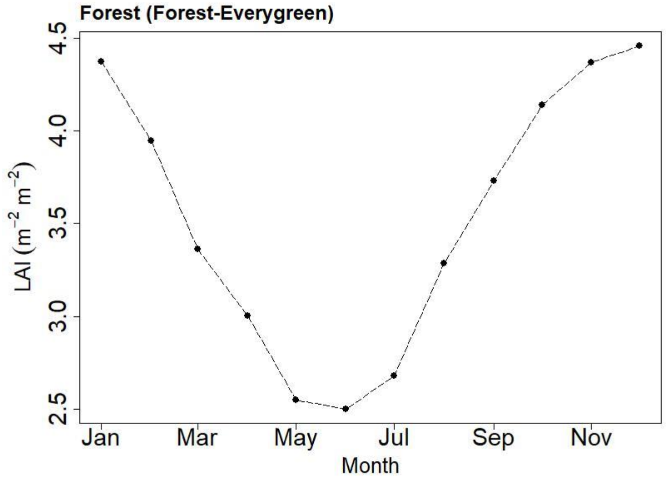
Leaf Area Index (LAI)

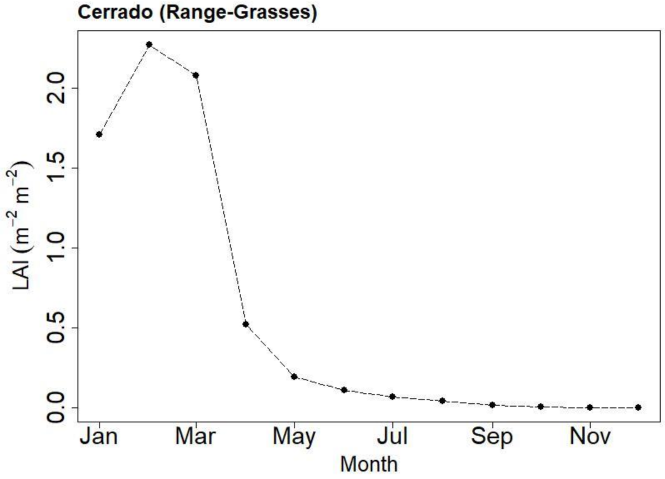
Default mode

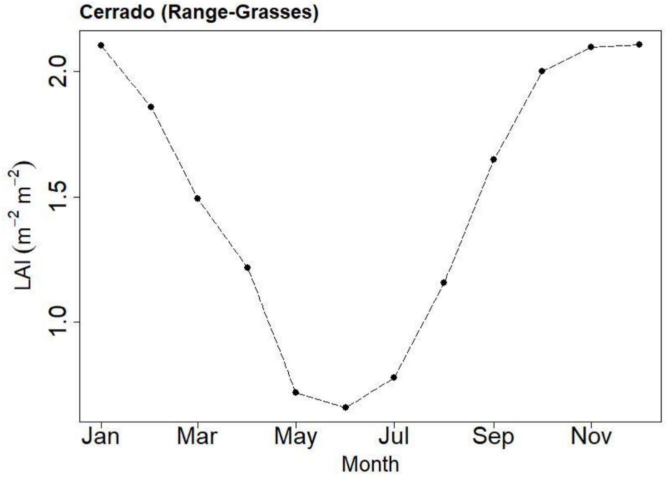
Modified plant growth module

Source: Strauch and Wolk (2013)

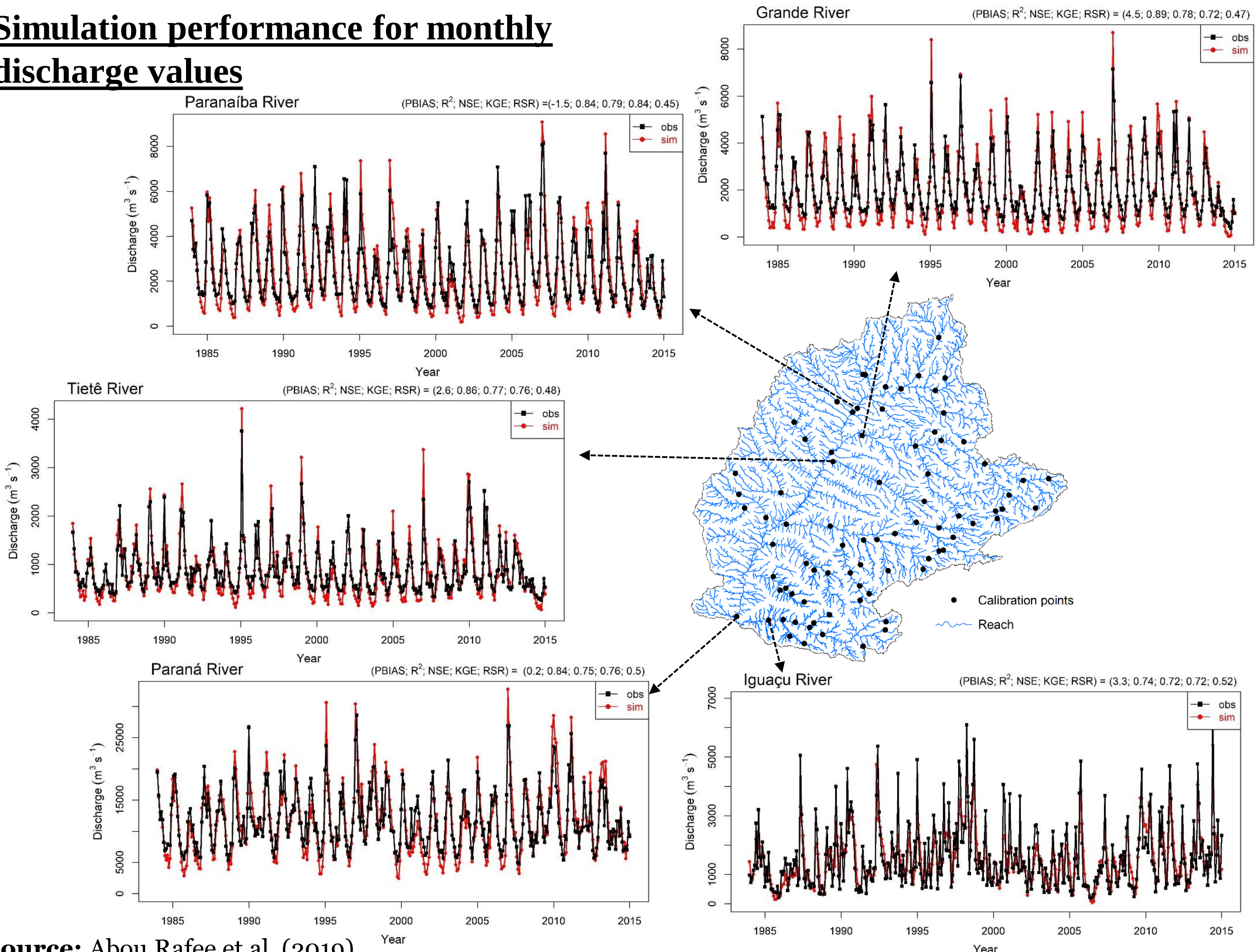






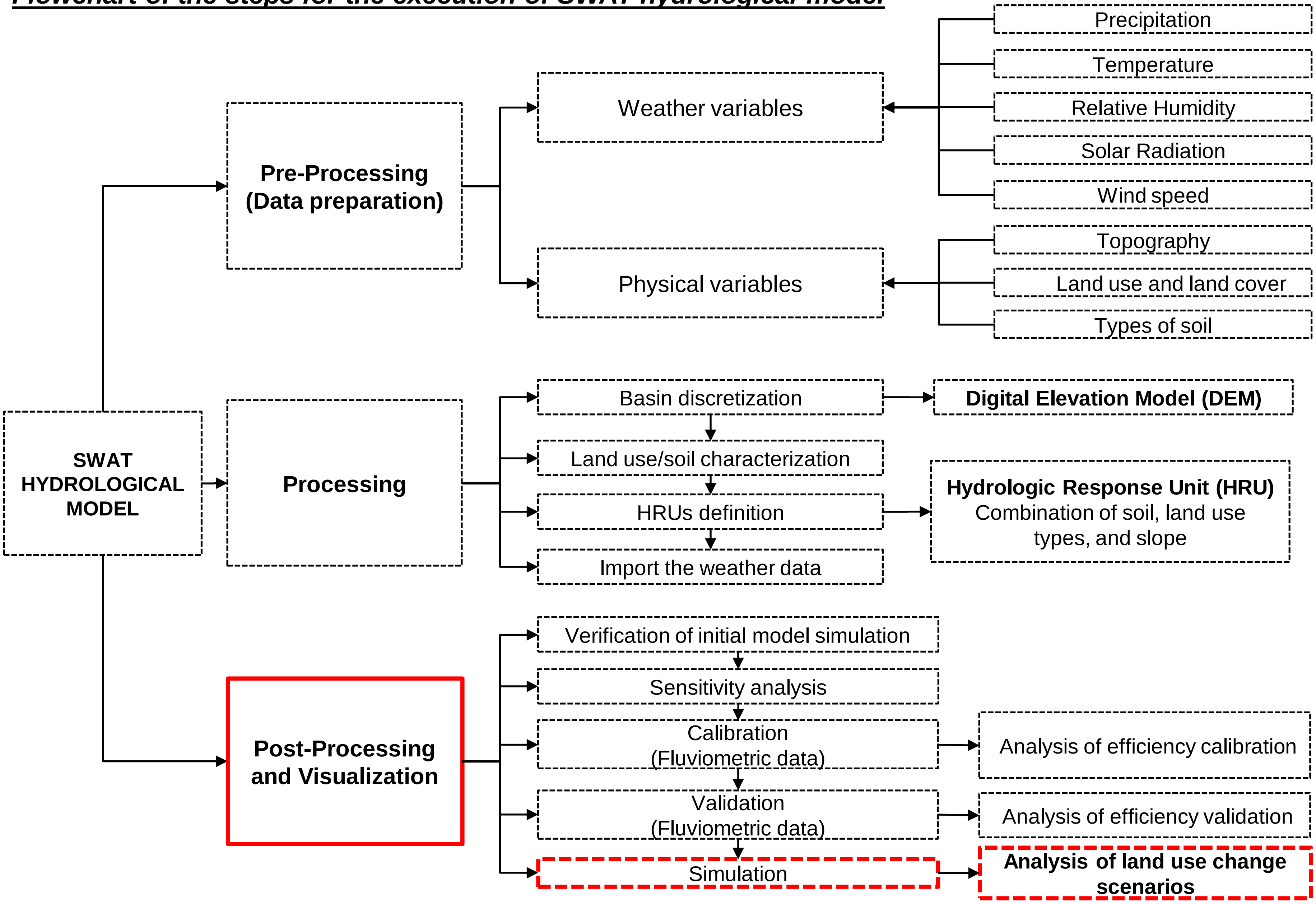


Simulation performance for monthly discharge values

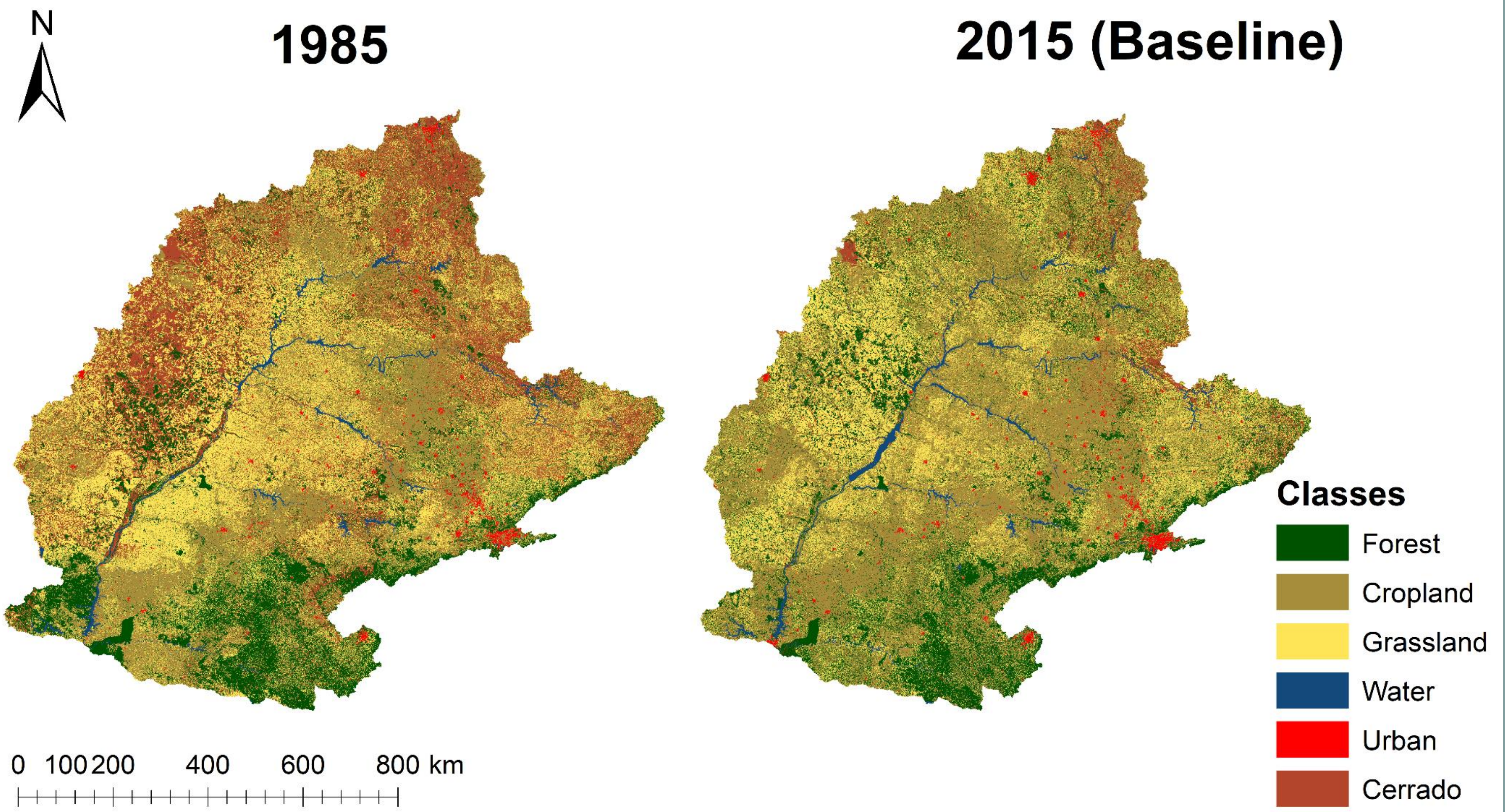


Source: Abou Rafee et al. (2019)

Flowchart of the steps for the execution of SWAT hydrological model



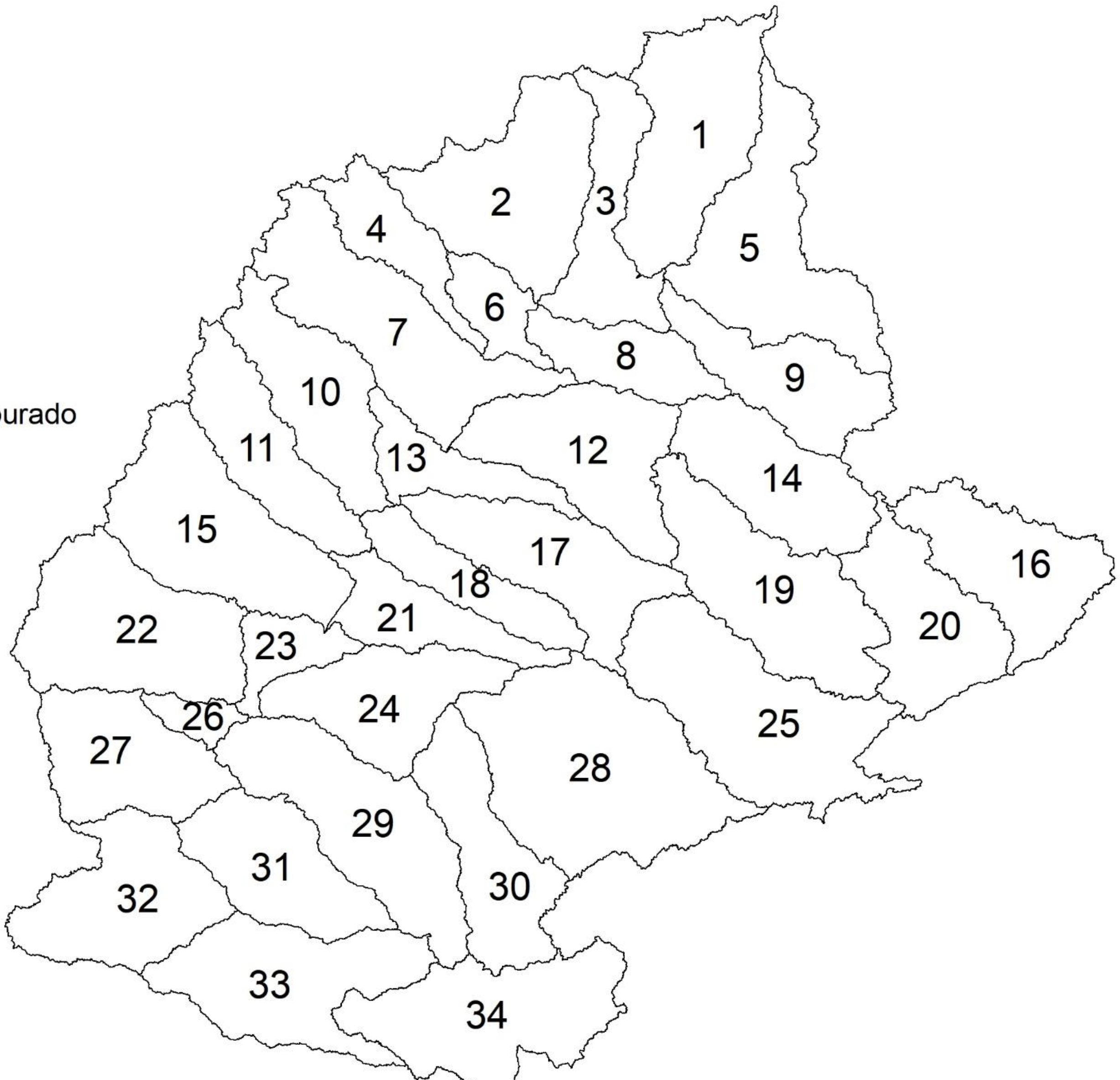
Scenarios



Source: Rudke (2018).

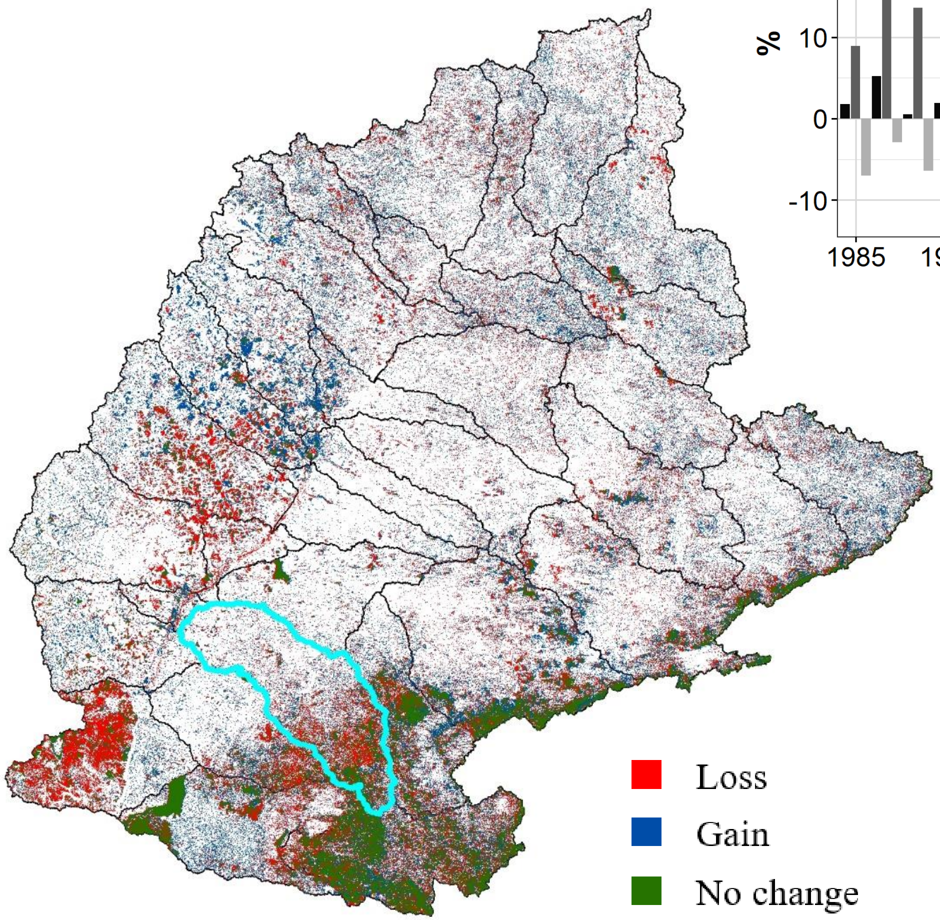
Subbasins

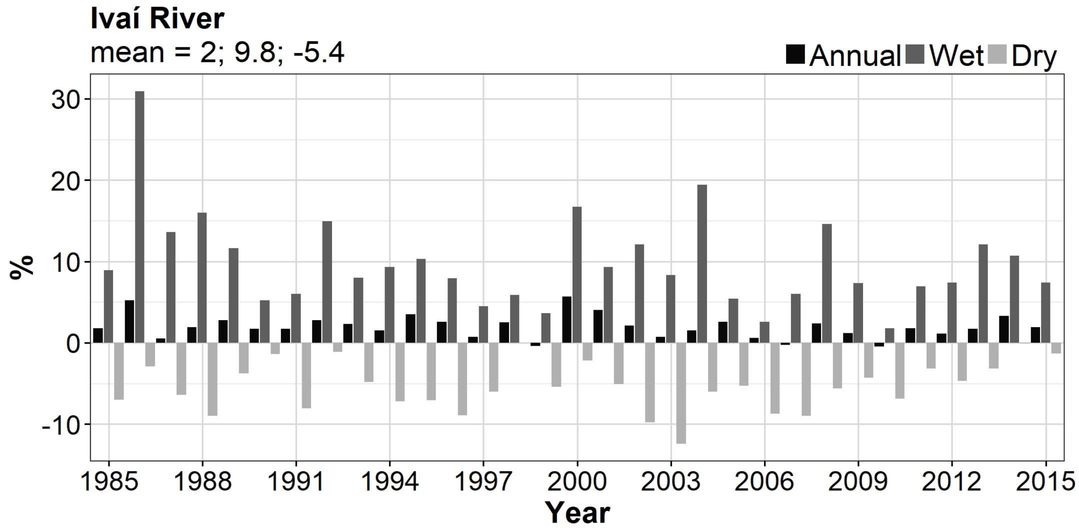
1. São Bartolomeu
2. Dos Bois
3. Paraná - Meia Ponte
4. Claro
5. Upper Paranaíba
6. Paraná - Preto
7. Paraná - Peixe, and others
8. Tijuco
9. Araguari
10. Sucuriú
11. Verde
12. Lower Grande
13. Paraná, Quitéria, and São José dos Dourado
14. Middle Grande
15. Pardo
16. Uppe Grande
17. Lower Tietê
18. Paraná - Feio or Aguapeí
19. Mogi-Guaçú
20. Sapucaí
21. Paraná, Peixe, and others
22. Invinheima
23. Paraná, Samambaia, and others
24. Lower Parapanema
25. Upper Tietê
26. Paraná, Laranjal, and outros
27. Paraná, Iguatemi, Maracaí, Amambaí
28. Upper Parapanema
29. Ivaí
30. Tibagi
31. Piquiri
32. Paraná, Guaçu, and others
33. Lower Iguaçu
34. Upper Iguaçu



Land use changes: Difference between scenarios 2015 and 1985

Forest



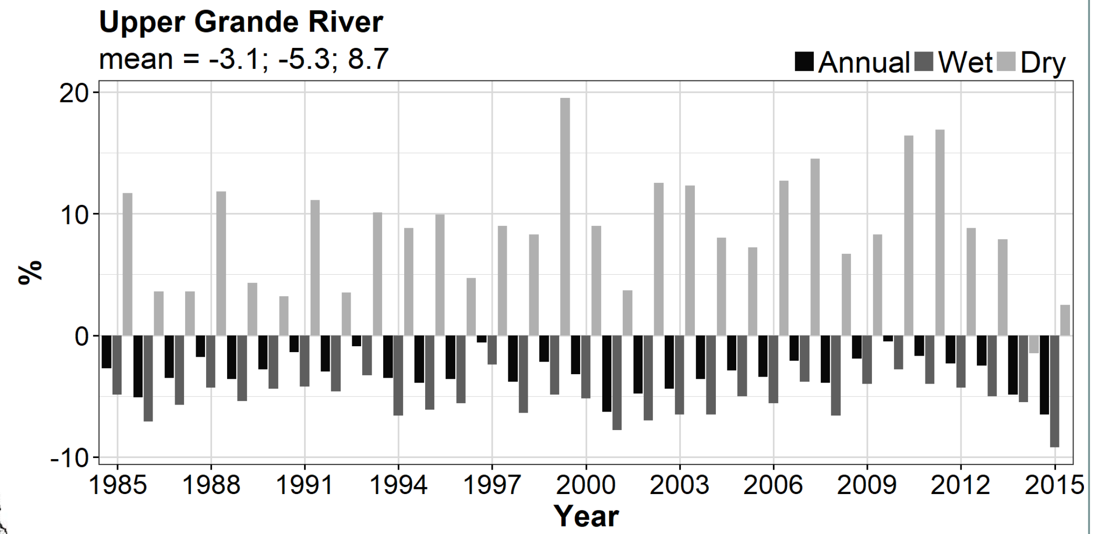


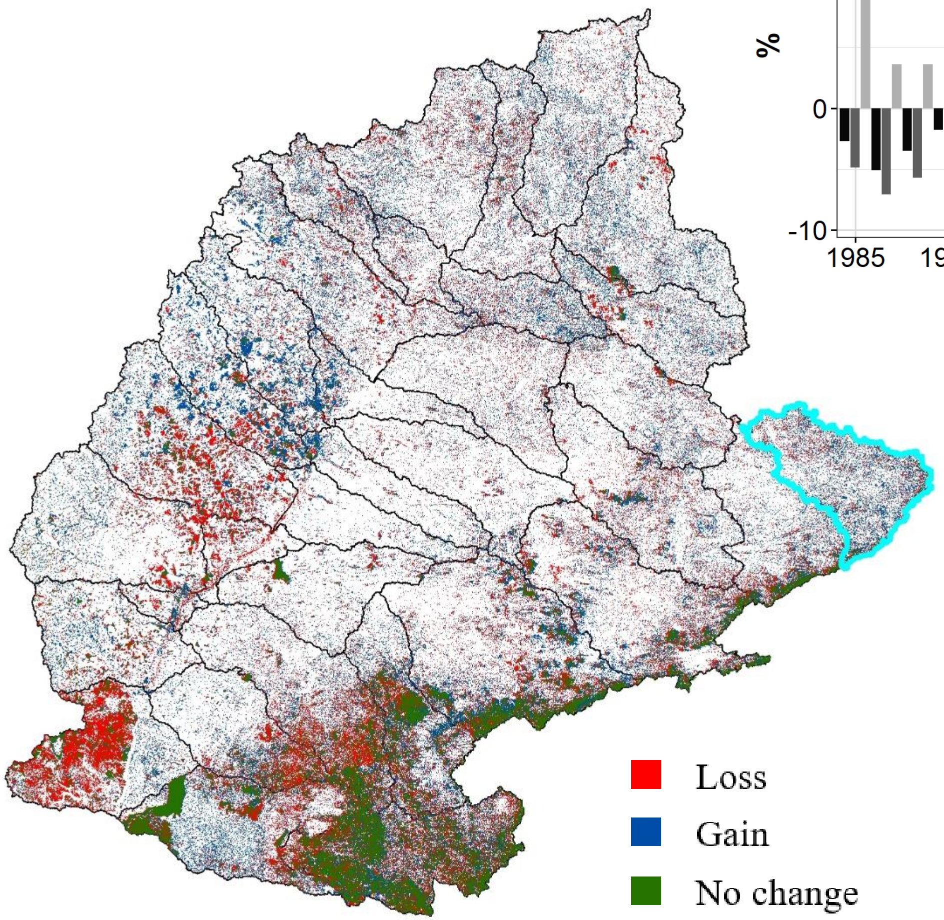
Wet season: October - March
Dry season: April - September

Total forest loss – Ivaí subbasin
1,937 km²

Land use changes: Difference between scenarios 2015 and 1985

Forest



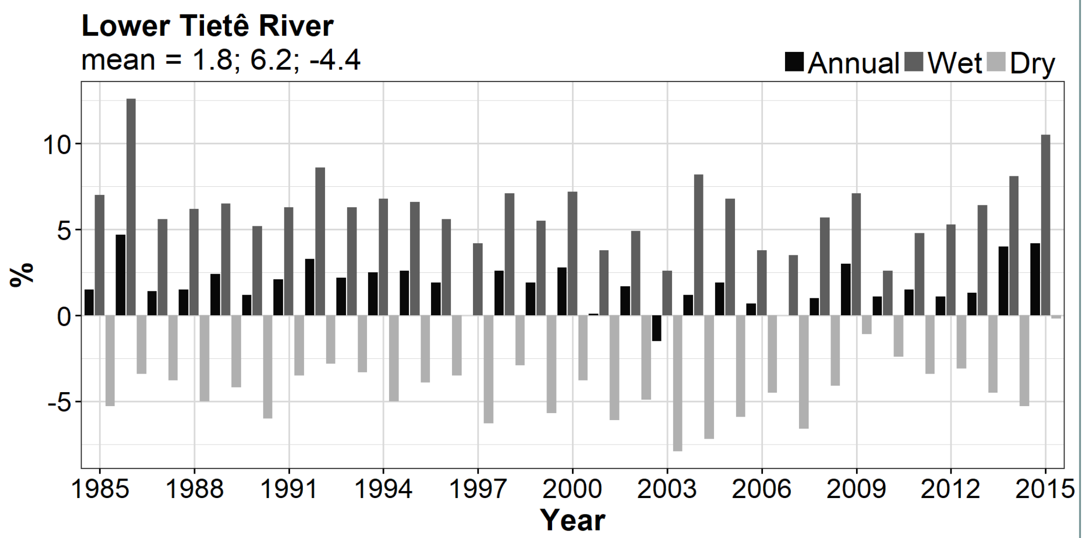


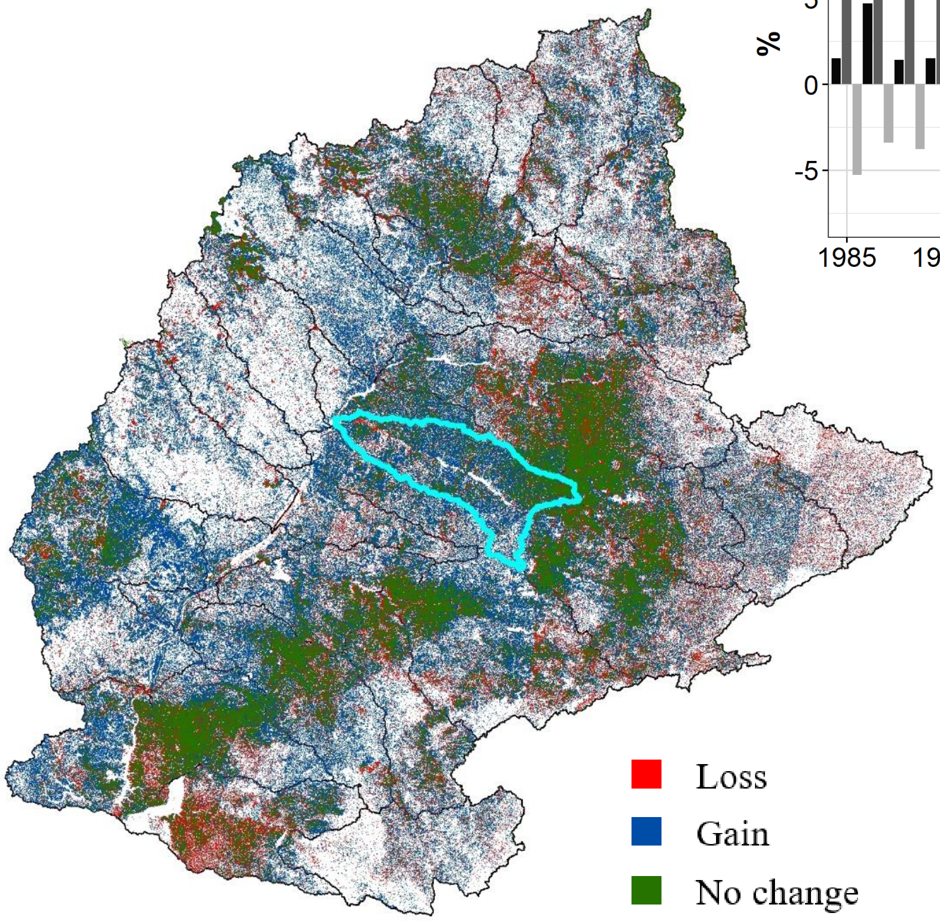
Total forest gain – Upper Grande subbasin

3,068 km^2

Land use changes: Difference between scenarios 2015 and 1985

Cropland

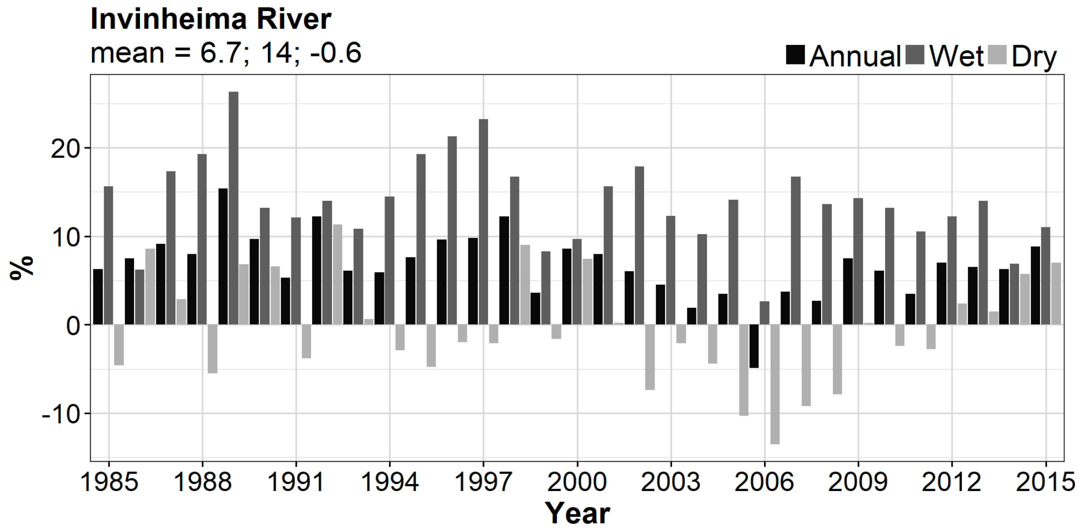


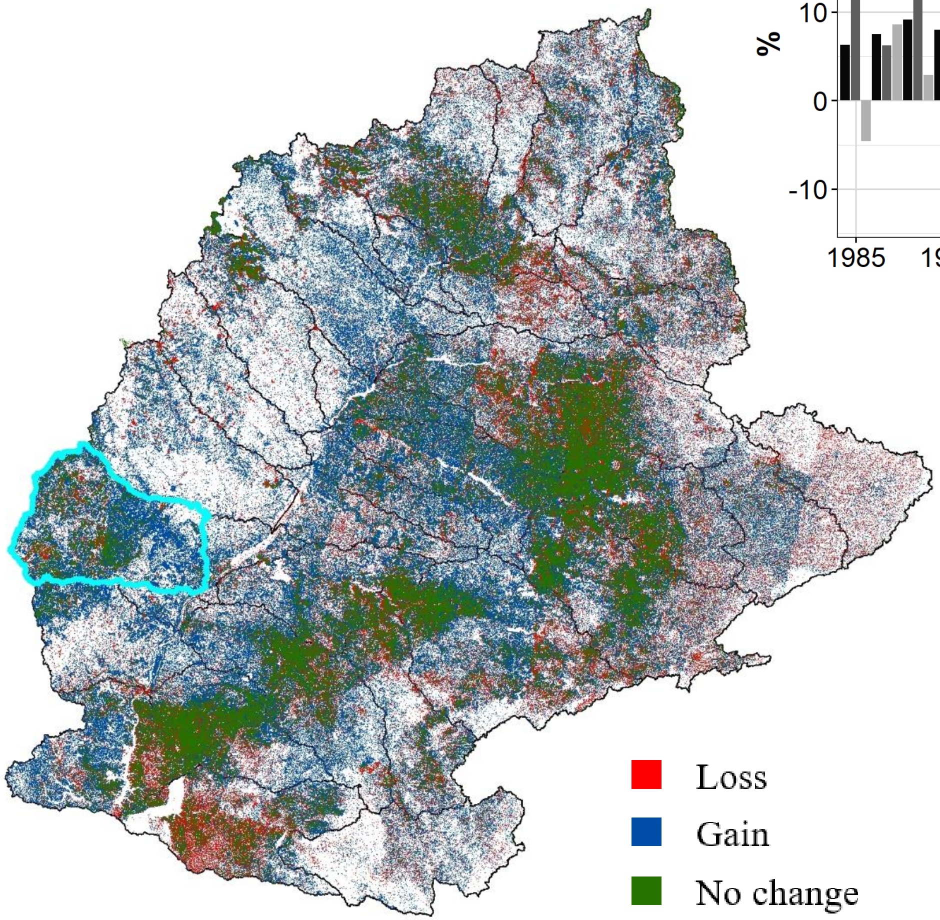


Total cropland gain – Lower Tietê subbasin
10,299 km^2

Land use changes: Difference between scenarios 2015 and 1985

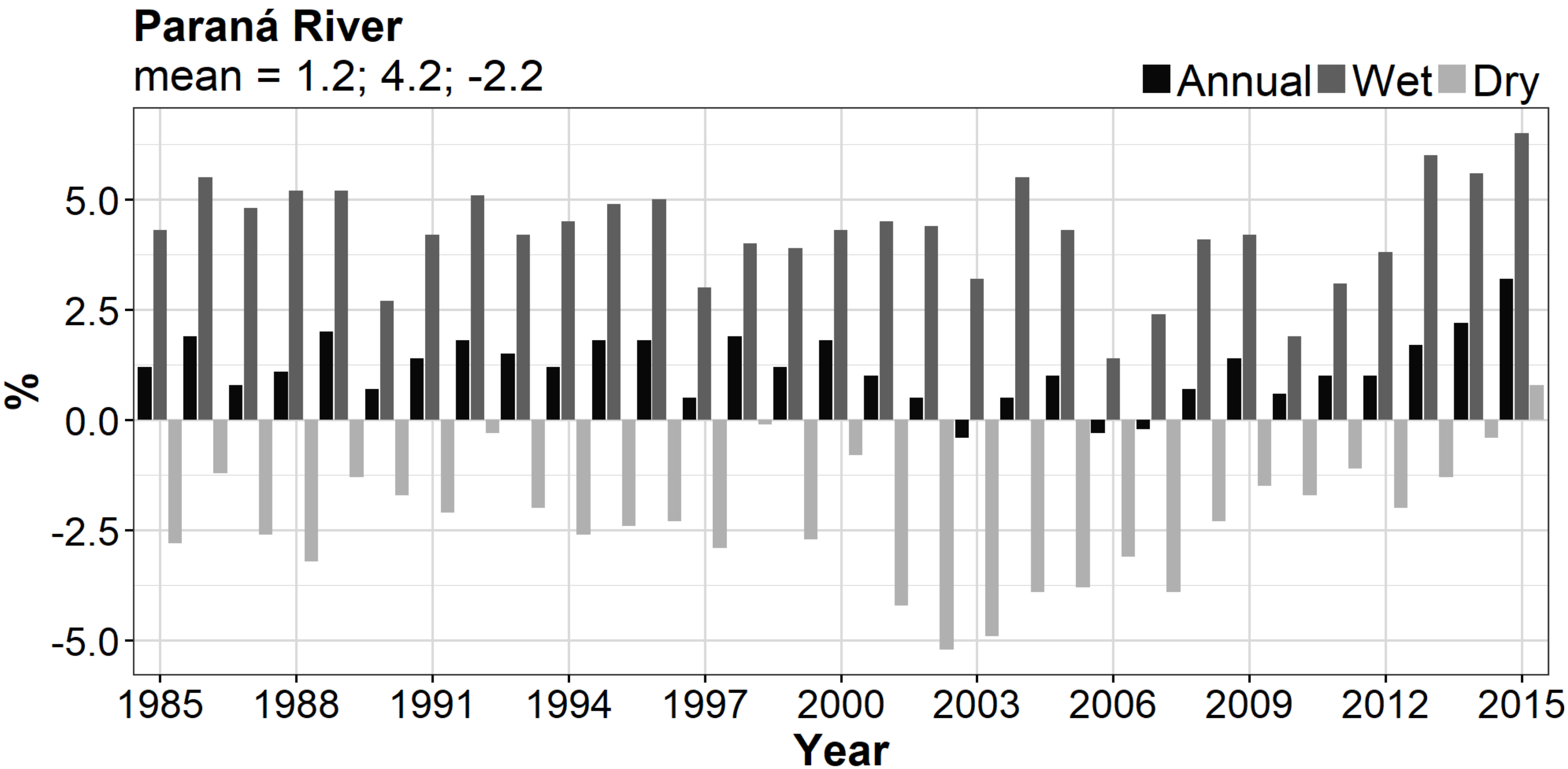
Cropland





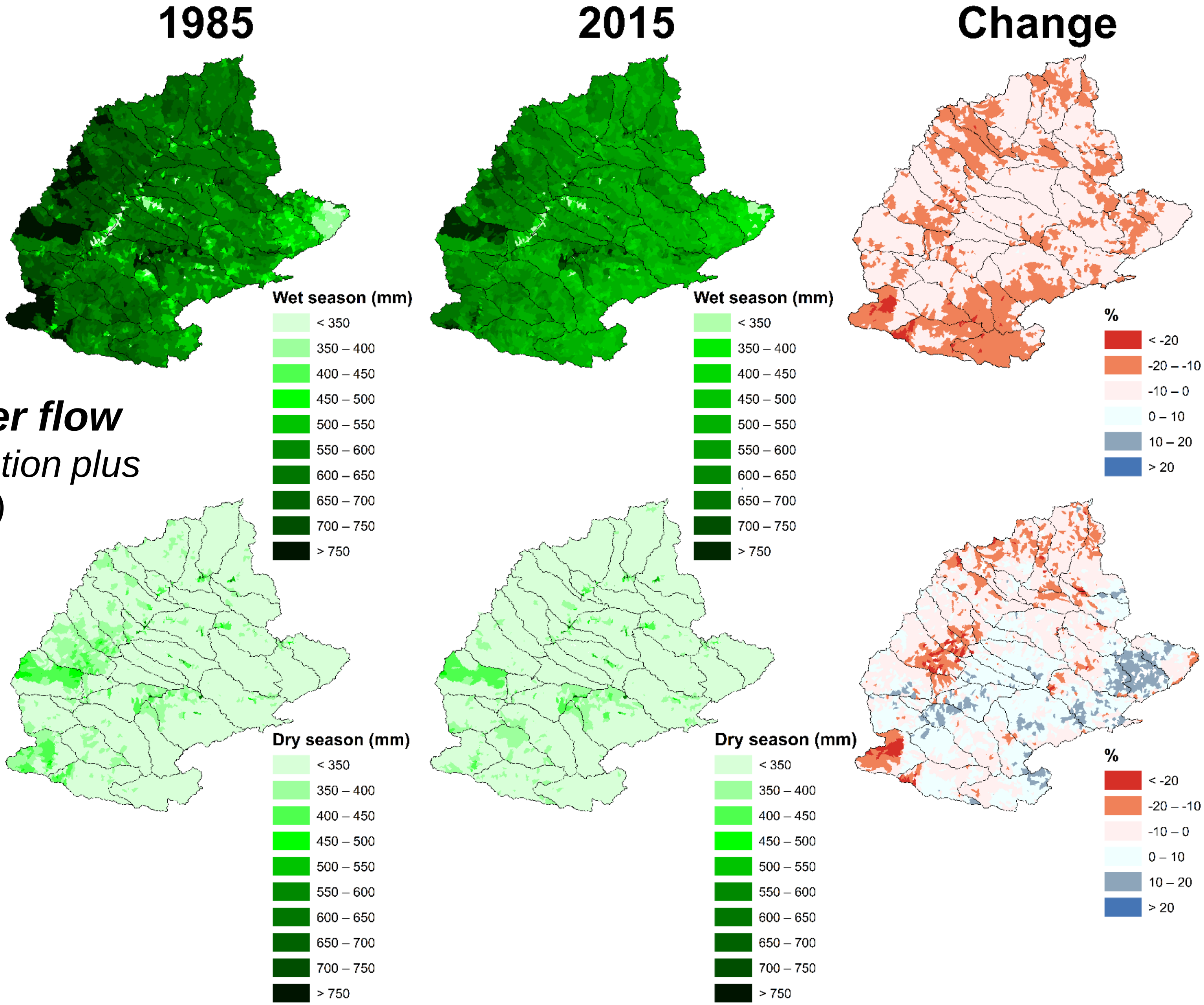
Total cropland gain – Invinheima subbasin
13,610 km^2

Percentage change in discharge for the year 2015 with respect to year 1985 at the final outlet of the basin



Green water flow

(soil evaporation plus transpiration)



Concluding Remarks

- **Deforestation (afforestation) mainly increases (decreases) the wet season discharge** along the main rivers of the Upper Paraná River Basin; the opposite happens in the dry season

- Land use changes between 1985 and 2015 affected **increases (decreases)** in the **wet (dry)** season discharge up to **7% (-6%)** at the final outlet of the basin

- Future land use changes may have potential impacts on the main economic activities developed in the basin such as hydropower generation, agricultural, and livestock

Thanks for your attention!

Iguazu Falls

(18 km before the Iguazu flows into the Paraná River)

Source: Guia Geográfico Paraná