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Analysis of ecosystem services in water supply infrastructure in Southeastern Brazil

Mariana Abreu [1], Wilson Sousa Junior [1], Demerval Gonçalves [2], Angélica Giarolla[2]

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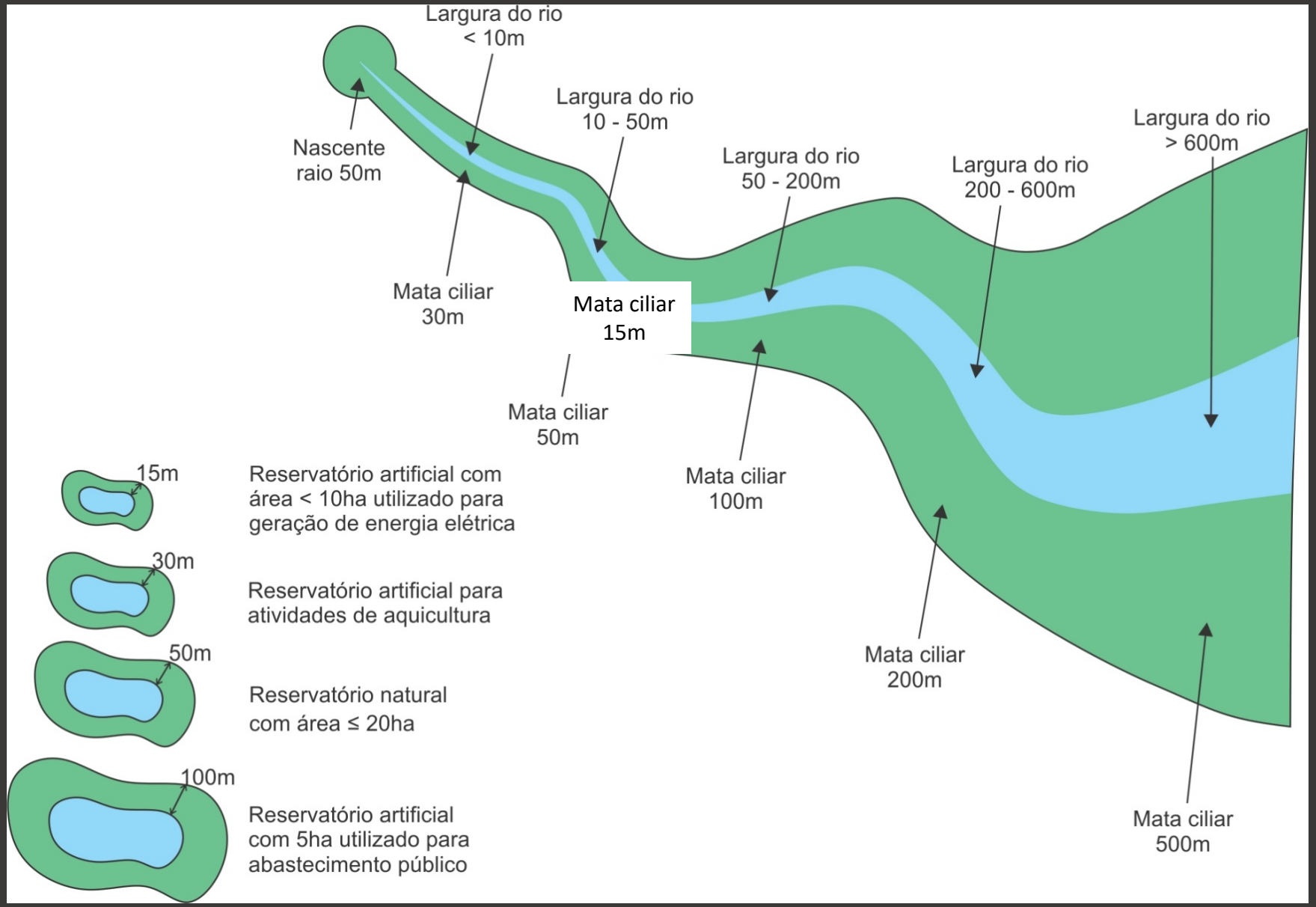
Context

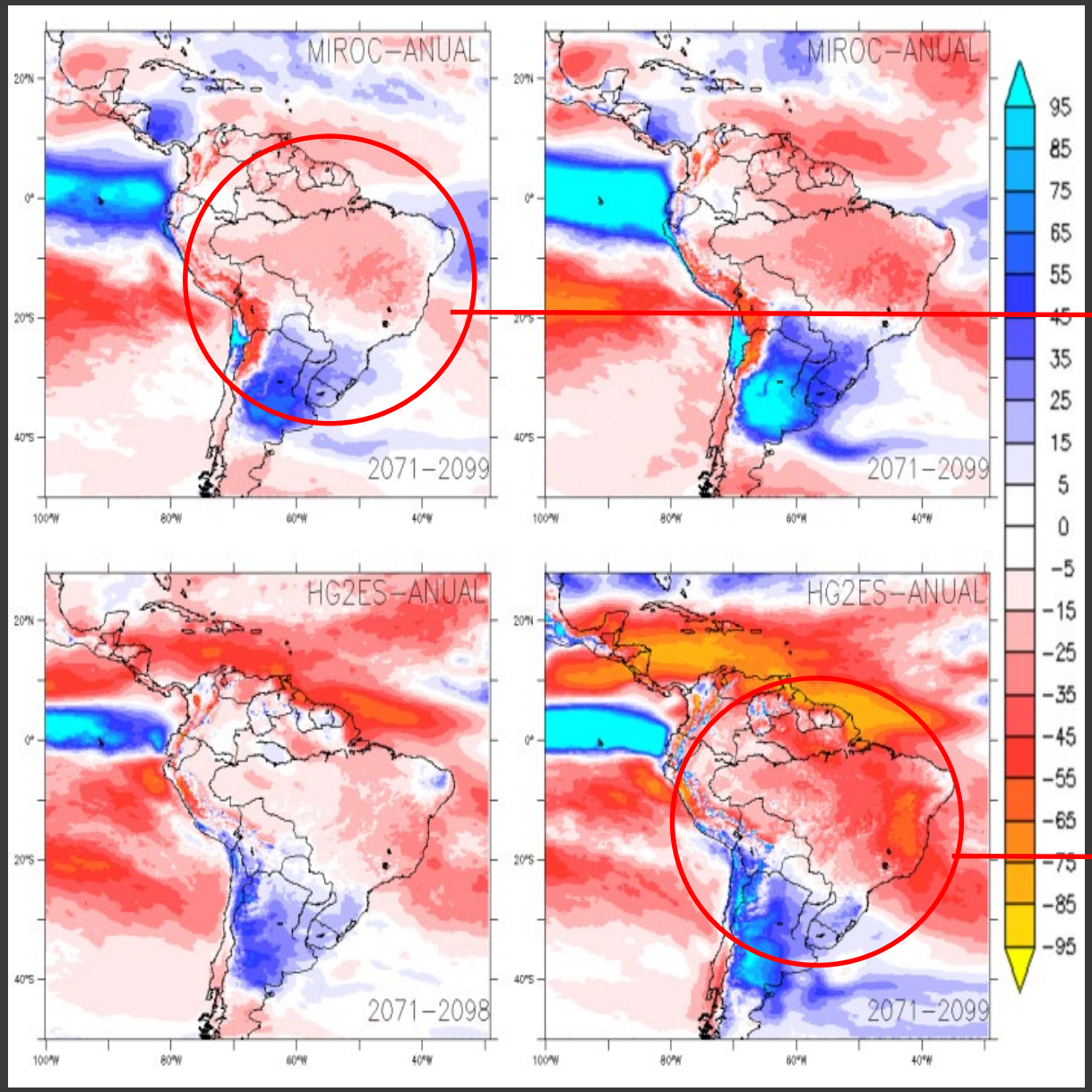
Forest Act 12651/2012: Permanent Protected Areas (APP)



Before: APP – native forest

Now: APP – native **or** agroforestry

Context



Global changes

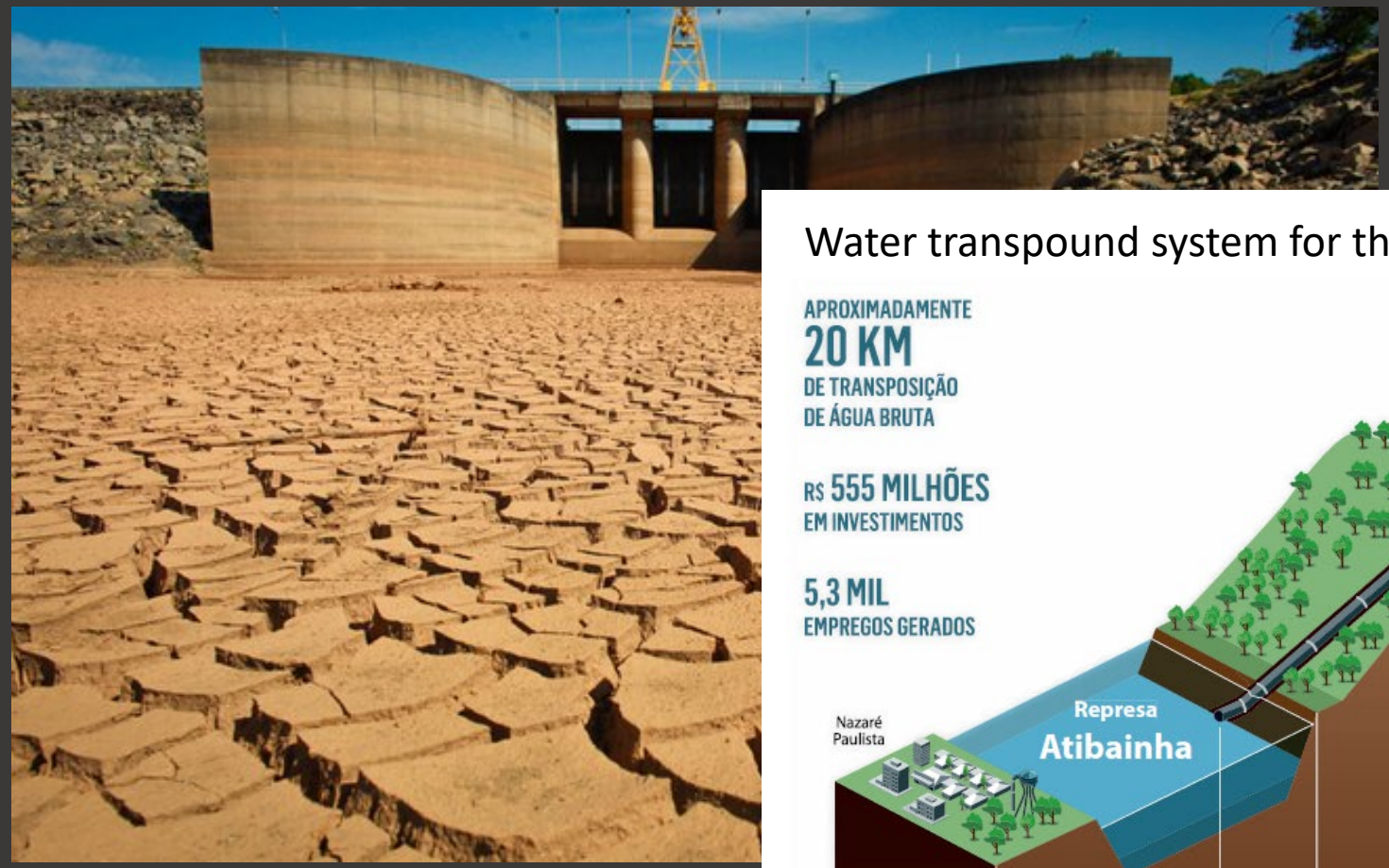
"optimistic" scenario

Precipitation in Brazil:
2071 a 2099
Climate models predictions

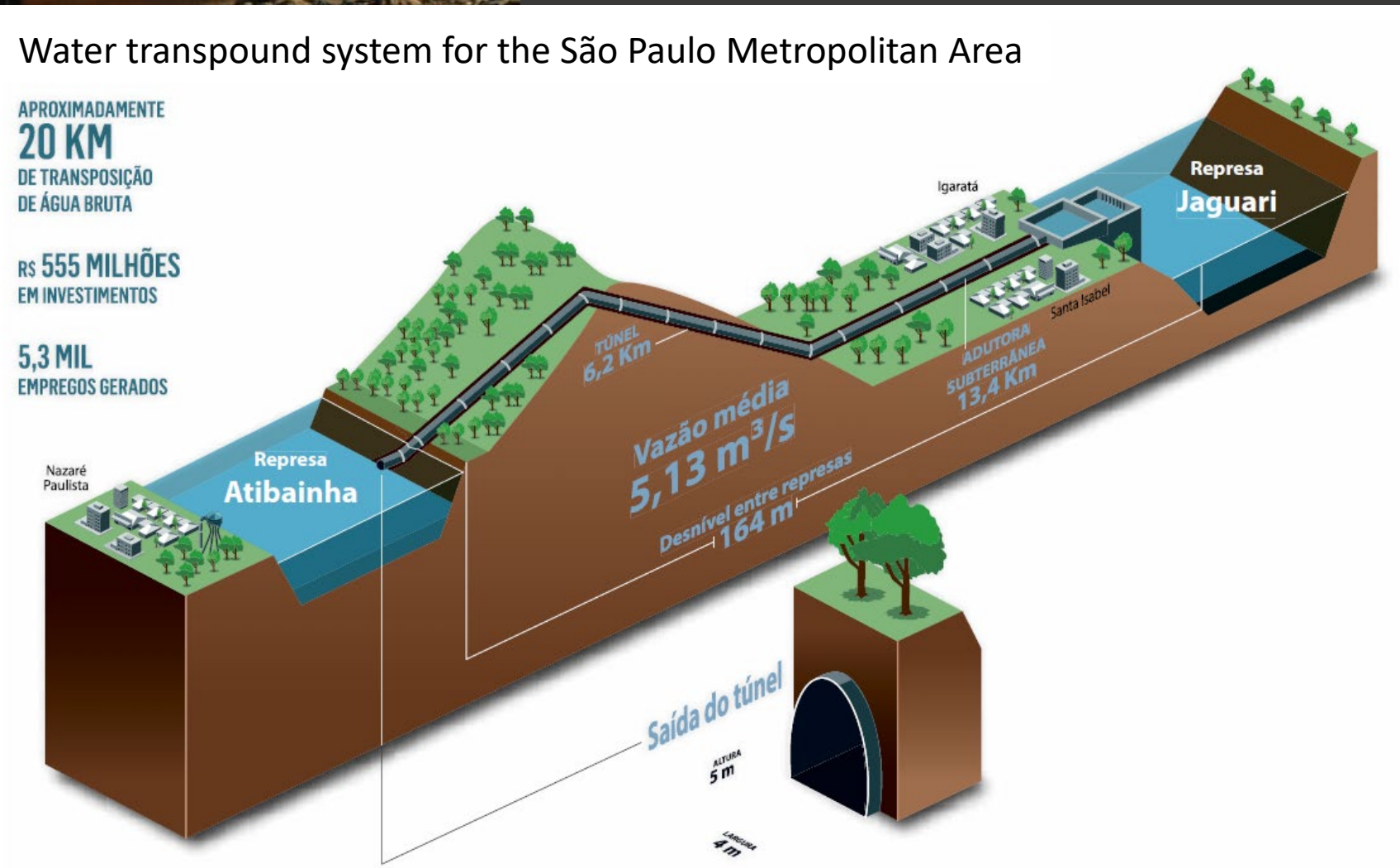
"pessimist" scenario

Source: SAE/INPE (2015)

Context

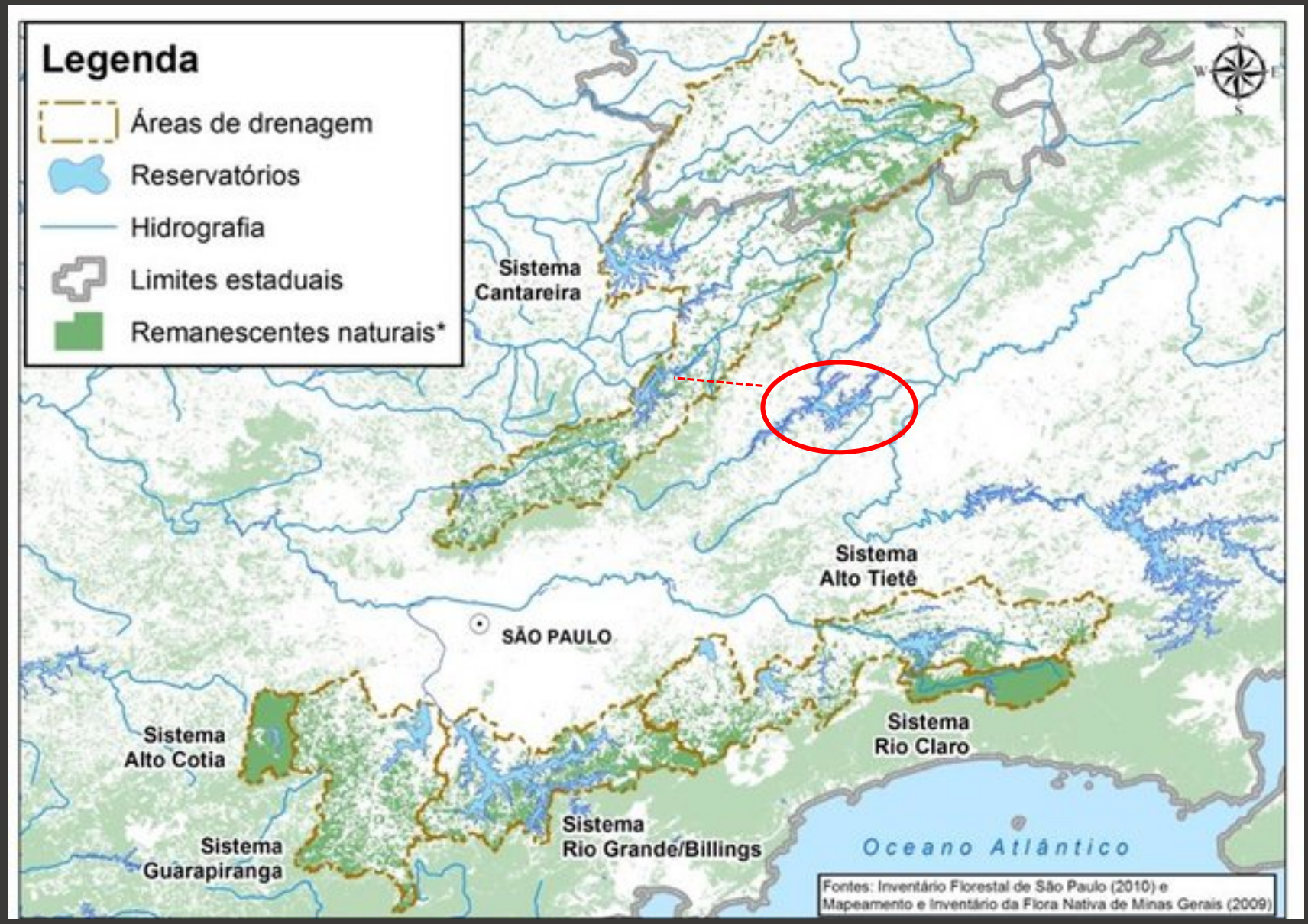


Water transpound system for the São Paulo Metropolitan Area



Context

São Paulo Metropolitan Area – Water Suply System



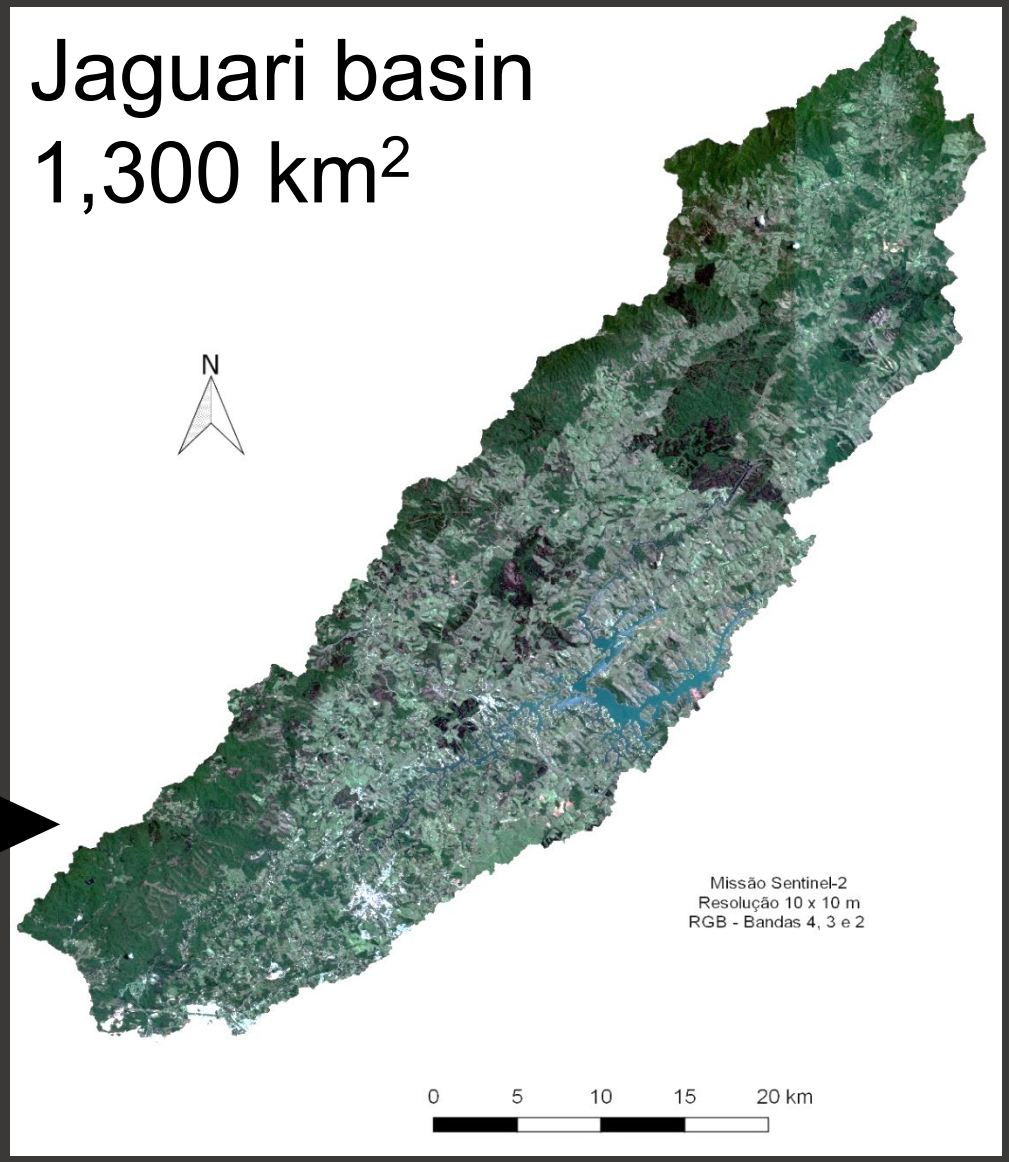
Introduction

The objective of this study is to analyse the hydrological balance of Jaguari Watershed, regarding ecosystem services of native forests and agroforestry under their contributions for maintenance of baseflow in critic periods (dry season).

Study area

Recently connected to the Cantareira System, that supplies 9 mi inhabitants of Greater SP

State of São Paulo



Introduction

Analysed Scenarios:

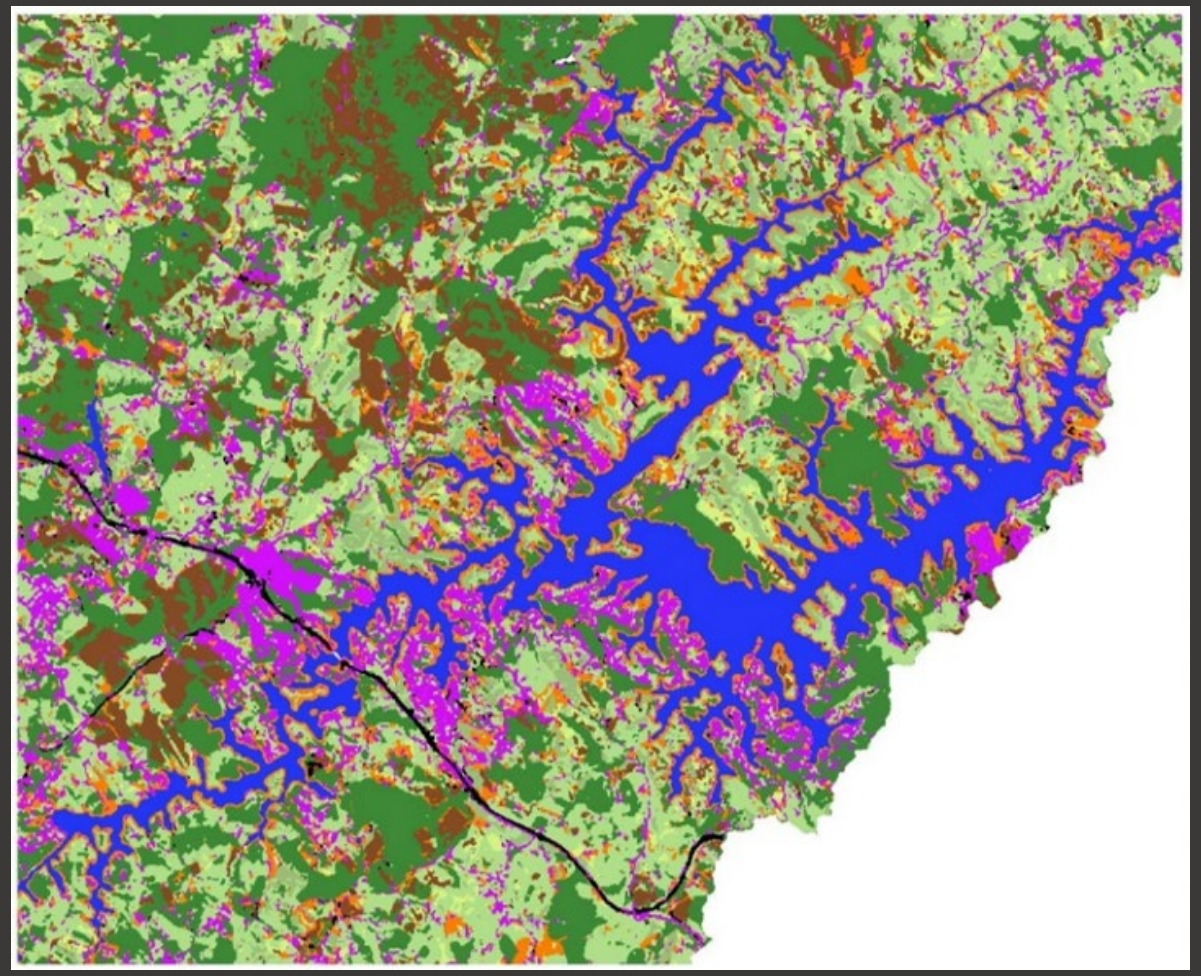
1. Current status

2. All PPA covered by native forest

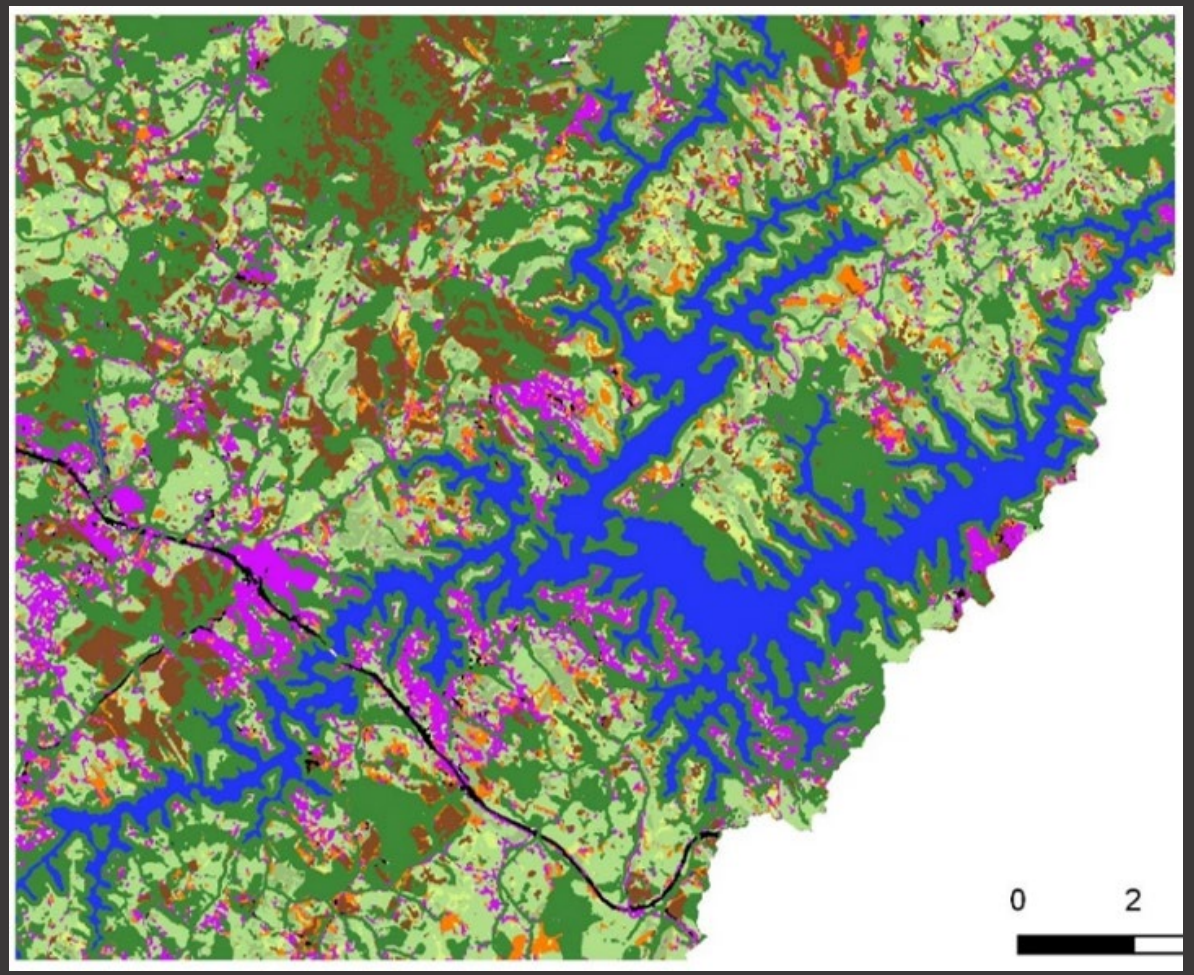
3. All PPA covered by agroforestry

Introduction

Today



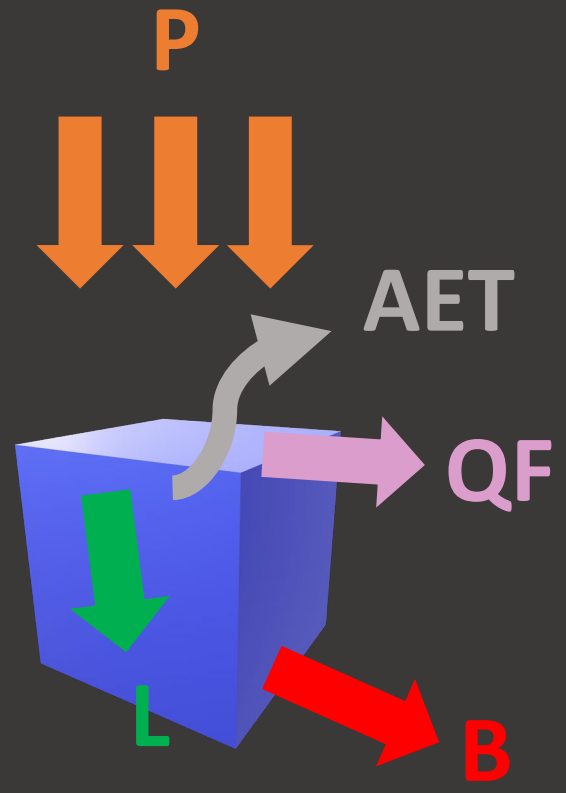
PPA reforested



Methods

Seasonal Water Yield

Provides information regarding the contribution of land parcels to the generation of both baseflow and quick flow.



InVEST
integrated valuation of ecosystem services and tradeoffs

- ✓ Quickflow
- ✓ Local recharge
- ✓ Baseflow

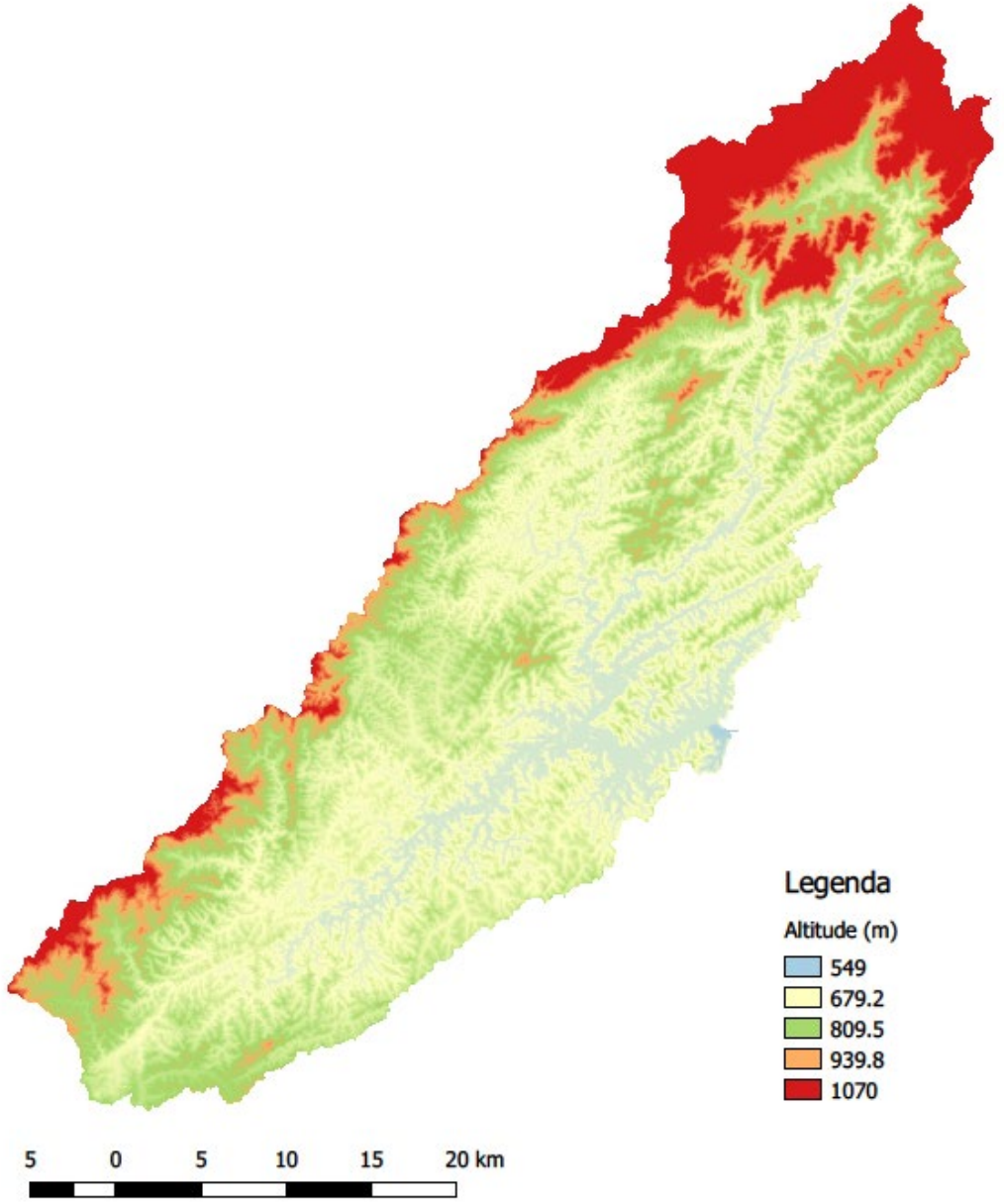
Datasets

DEM

obtained from the
Alos Palsar - Global Radar
Imagery dataset (2011)

Resolution: 12,5 m x 12,5 m

Digital Elevation Model



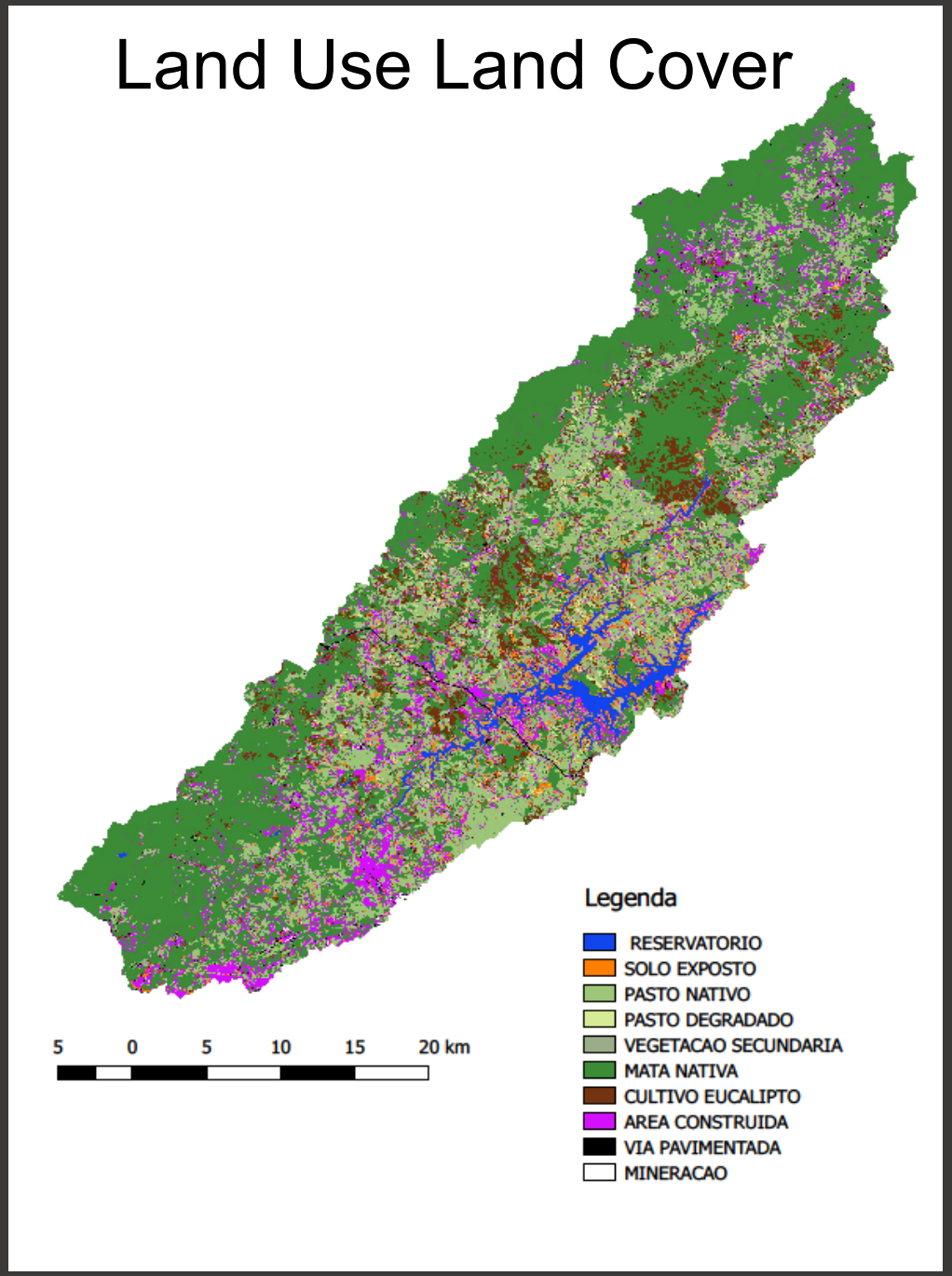
Datasets

LULC

Generated in QGIS 2.18.19. (Semi-automatic Classification Plugin)

Images from Sentinel-2 mission (European Space Agency) 2017

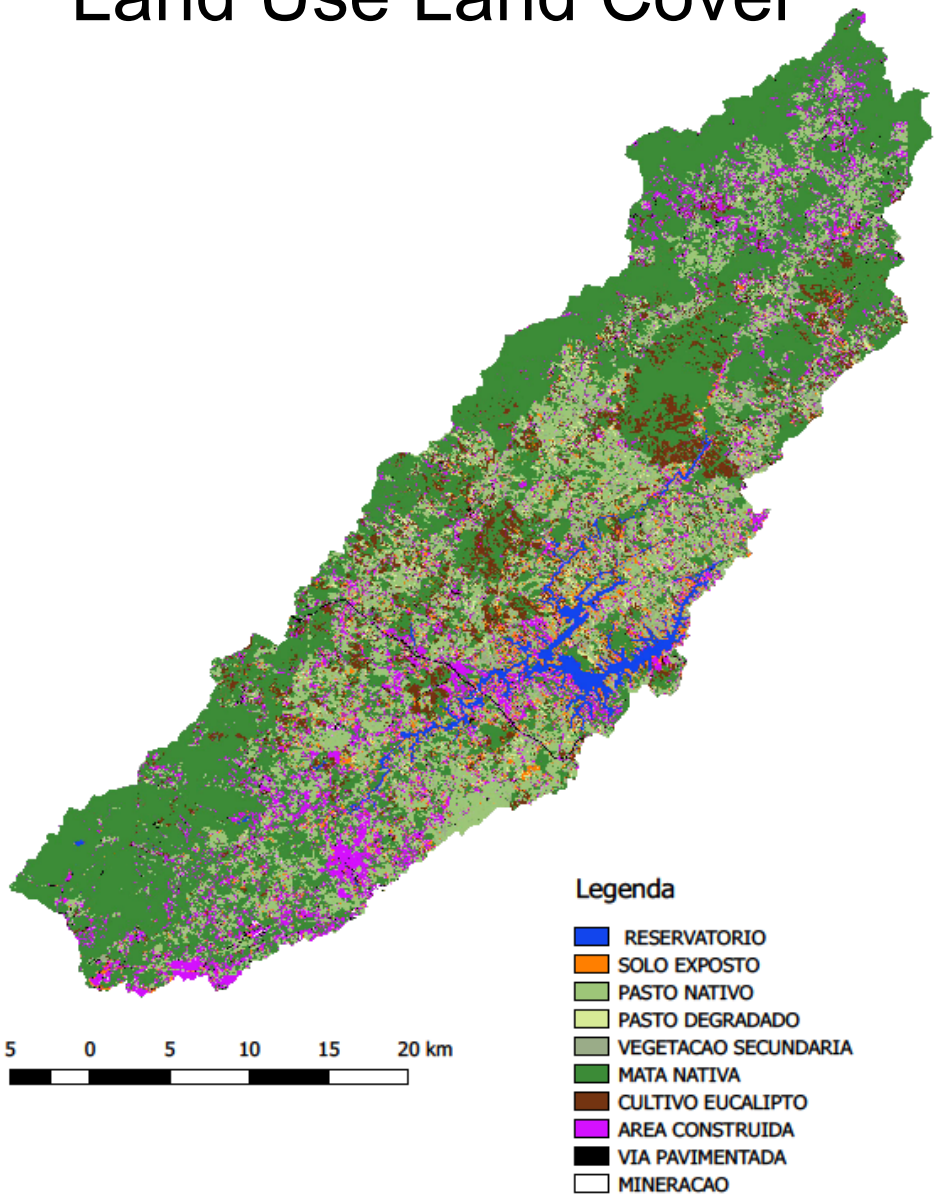
Resolution: 10 m x 10 m



Datasets

LULC	AREA (%)
Native forest	50,0%
Pasture, rotated grazing	21,4%
Built area	9,9%
Eucalyptus crop	6,1%
Uncovered soil	4,0%
Secondary vegetation	3,8%
Water bodies	2,7%
Pasture, extensive grazing	1,4%
Roads	0,7%
Mining area	0,1%

Land Use Land Cover

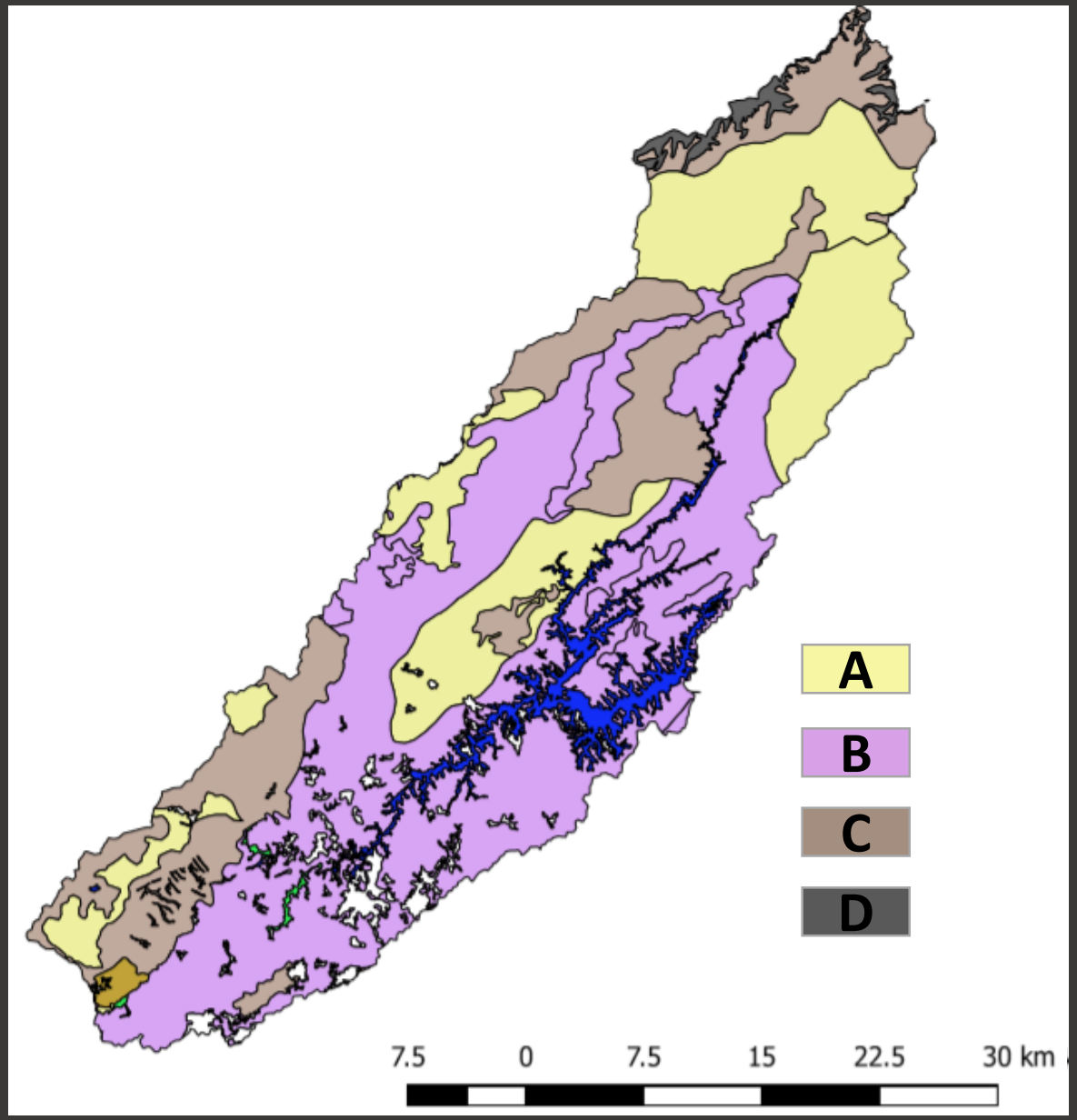


48% of PPA are not preserved

Datasets

SOIL GROUP

Pedological Map of the State of São Paulo: Revised and Expanded (Rossi, 2017)



Datasets

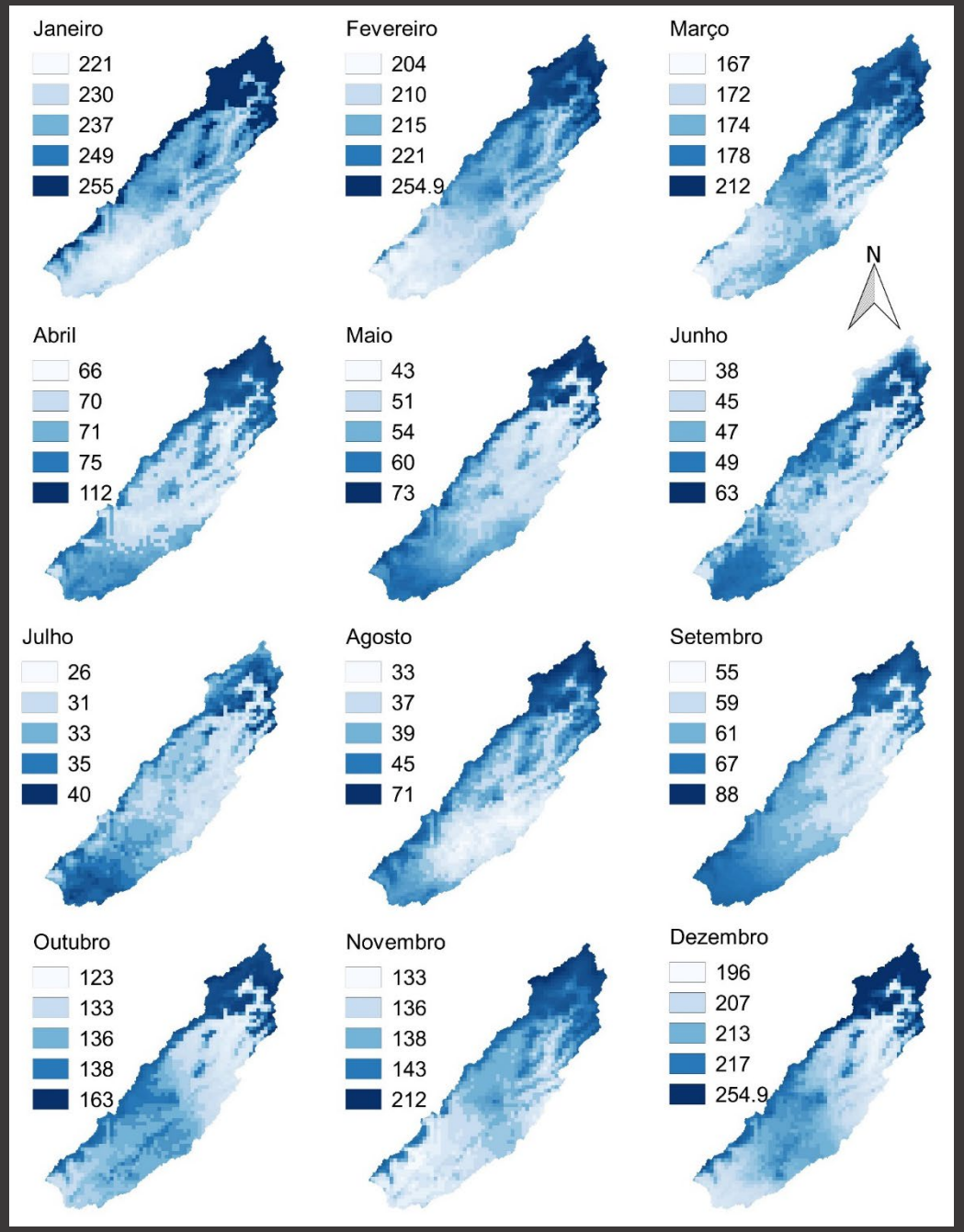
MONTHLY PRECIPITATION

obtained from the WorldClim dataset

1970 to 2000

Resolution: about 1 km^2

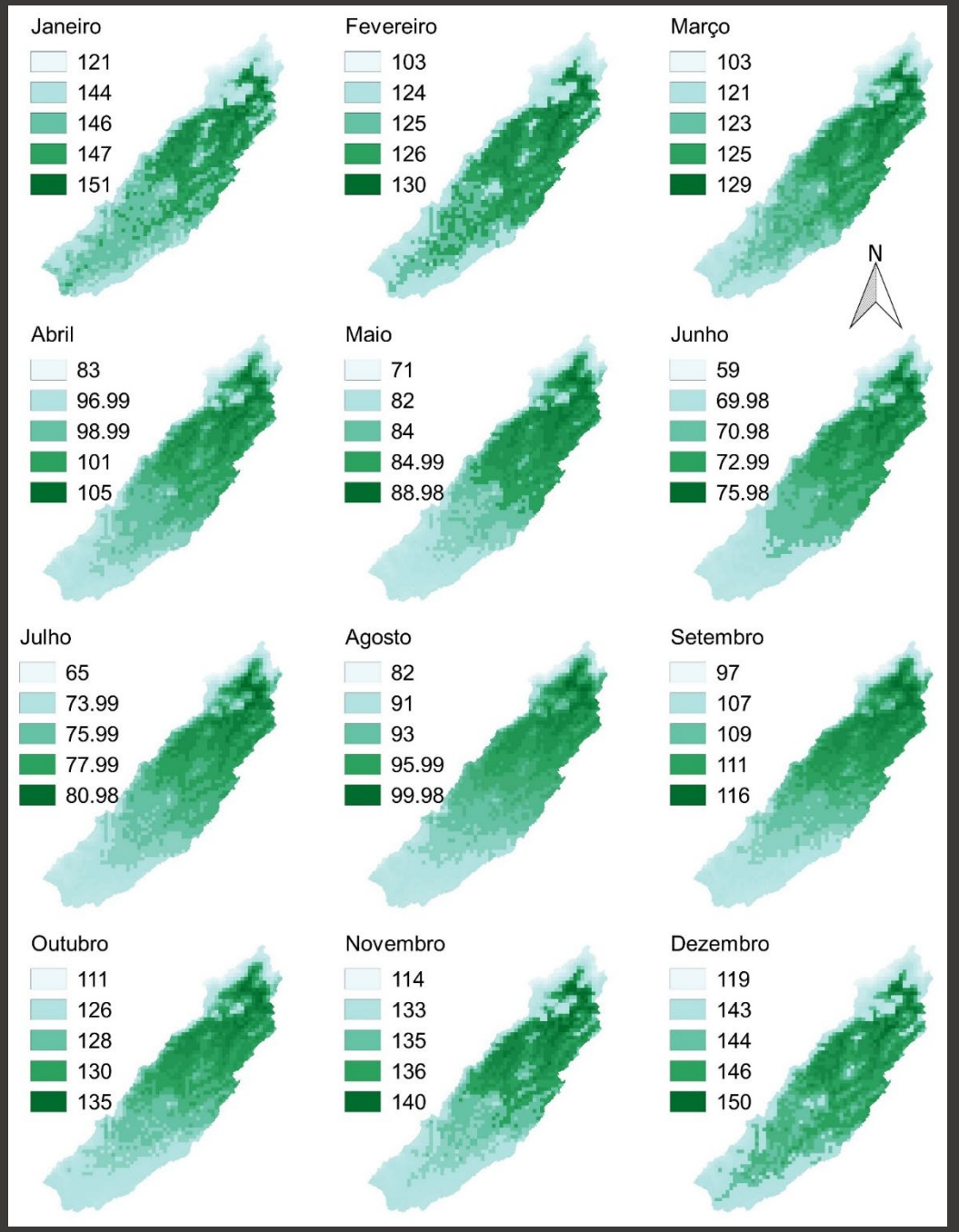
P_mean: 1451 mm
standard deviation: 98,2 mm



Datasets

REFERENCE EVAPOTRANSPIRATION – ET_0

obtained from the CGIAR CSI dataset (based on WorldClim data)



Datasets

Curve-number (CN) and Crop coeficiente (Kc)

	Soil Group			
LULC	A	B	C	D
Uncovered soil	83	86	91	94
Pasture, rotative grazing	49	69	79	84
Pasture, extensive grazing	68	79	86	89
Secondary vegetation	30	48	65	73
Native forest	20	40	49	52
Eucalyptus crop	61	71	78	81
Built area	72	82	87	89
Roads	72	82	87	89
Mining area	72	82	87	89
Water bodies	99	99	99	99

Adapted from (Sartori et al.,2004).

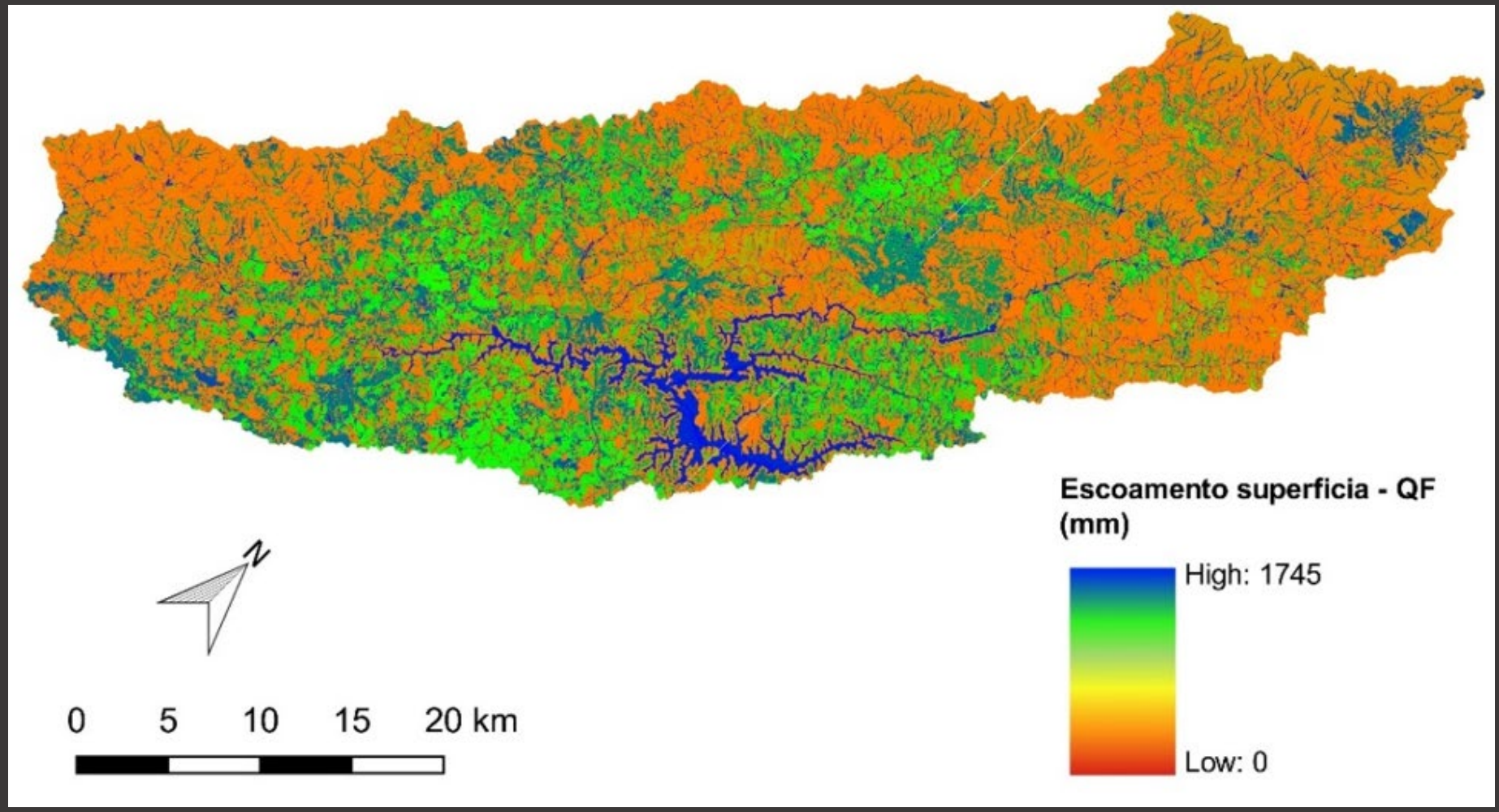
LULC	Jan	Fev	Mar	Abr	Mai	Jun	Jul	Ago	Set	Out	Nov	Dez
Uncovered soil	0,25	0,25	0,25	0,25	0,25	0,25	0,25	0,25	0,25	0,25	0,25	0,25
Pasture, rotated graz.	0,95	0,85	0,85	0,85	0,85	0,4	0,4	0,4	0,4	0,95	0,95	0,95
Pasture, extensive graz.	0,75	0,75	0,75	0,75	0,75	0,3	0,3	0,3	0,3	0,75	0,75	0,75
Secondary vegetation	0,92	0,85	0,85	0,85	0,85	0,9	0,9	0,9	0,9	0,92	0,92	0,92
Native forest	1,1	1,1	1,1	1,1	1,1	1,1	1,1	1,1	1,1	1,1	1,1	1,1
Eucalyptus crop	1,1	1,1	1,1	1,1	1,1	1,1	1,1	1,1	1,1	1,1	1,1	1,1
Built area	0,2	0,2	0,2	0,2	0,2	0,2	0,2	0,2	0,2	0,2	0,2	0,2
Roads	0,2	0,2	0,2	0,2	0,2	0,2	0,2	0,2	0,2	0,2	0,2	0,2
Mining area	0,2	0,2	0,2	0,2	0,2	0,2	0,2	0,2	0,2	0,2	0,2	0,2
Water bodies	1,05	1,05	1,05	1,05	1,05	1,05	1,05	1,05	1,05	1,05	1,05	1,05

Adapted from (Allen et al.,1998).

Results

QF
- PPAs covered with native forest: reduction of 3.0%
- PPAs covered with agroforestry: reduction of 2.6%

3.8 mi m^3 available to the baseflow



Results

- ✓ Considering the capacity of generating baseflow, the agroforestry areas, in spite of its density (70% of the native coverage), **their contribution for the baseflow is around 86%** of a native area, in the studied case.
- ✓ Sensitivity analysis showed higher influence of Evapotranspiration, CN and Kc on the results.

Next steps

- ✓ Improve the accuracy of Evapotranspiration, CN and K c;
- ✓ Include predictions of water scarcity and temperature increasing (climate changes), which would affect the parameters of baseflow generation – like evapotranspiration of forests;
- ✓ Calculate the area to be reforested in the whole watershed to generate the baseflow of 8 cubic meters per second in the dry season – the goal of the water transpound.

Thanks for your attention!

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