Karlsruhe Institute of Technology

MuDak-WRM

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Project Results

GRoW
GLOBALE RESSOURCE WASSER

PD Dr. Stephan Fuchs
Dr. Nils Wolf

FONA
Research for Sustainable Development
BMBF

Berlin, Oct. 2020

EFTAS
UNIVERSITÄT KOBLENZ · LANDAU
WUPPERVERBAND
für Wasser, Mensch und Umwelt
KIT
Karlsruher Institut für Technologie
52north
exploring horizons
HYDRON
UMWELT und WASSERWIRTSCHAFT
TriOS
Optical Sensors

ANA
AGÊNCIA NACIONAL DE ÁGUAS
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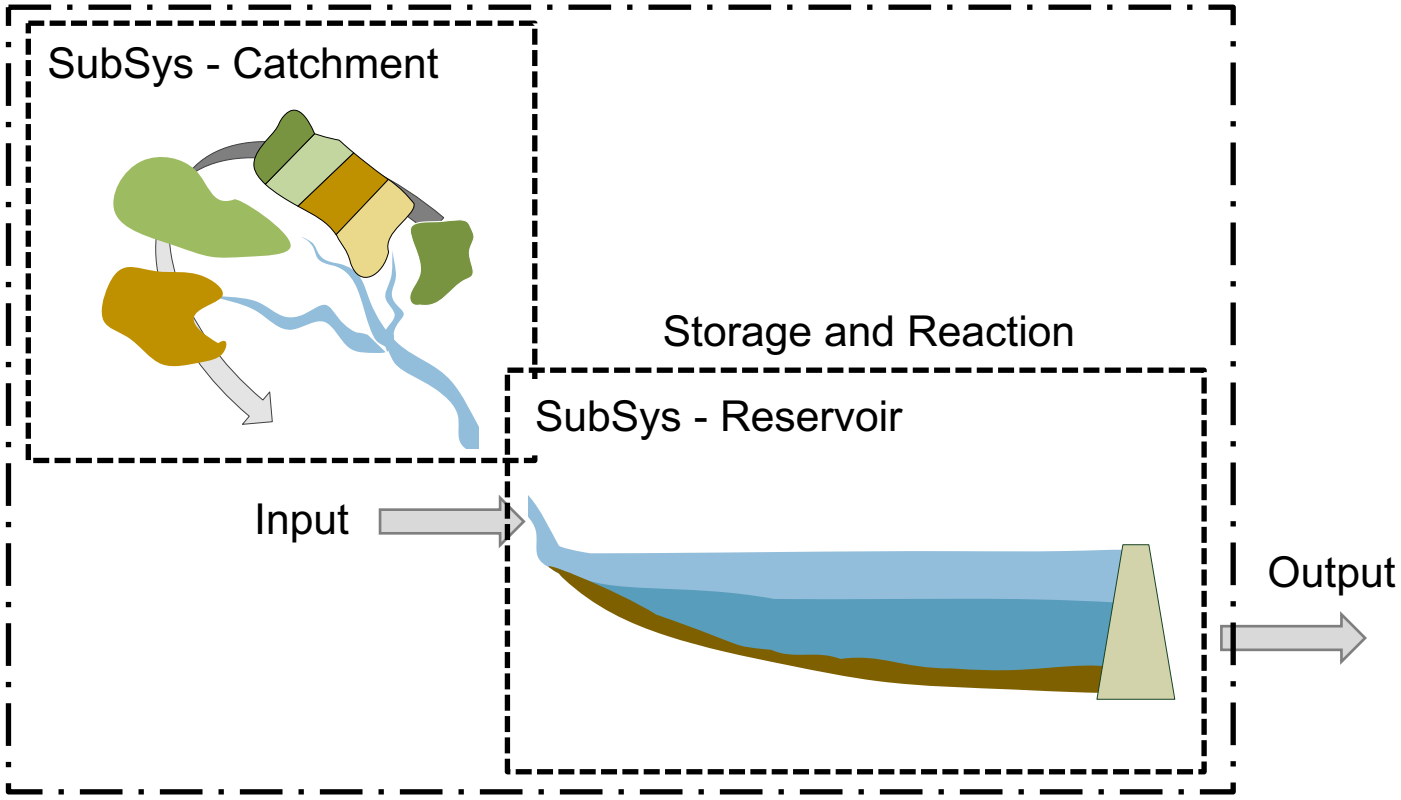
SANEPAR
AGUASPARANÁ
Instituto das Águas do Paraná
UFPR
UNIVERSIDADE FEDERAL DO PARANÁ
UNIVERSIDADE POSITIVO
EMATER
INSTITUTO PARANAENSE DE ASSISTÊNCIA TÉCNICA E EXTENSÃO RURAL
CAPES
AGUASPARANÁ
Instituto das Águas do Paraná
The Nature Conservancy

Initial Situation, Approach & Objectives

- Most environmental models are too complex and data demanding
- Adaptation to specific questions is often complicated
- Availability of input and validation data is generally limited

- Minimum monitoring strategies
  - Catchment, river, reservoir
  - Appropriate resolution

- Reduced complexity models
  - Catchment - MoRE
  - Water balance - LARSIM
  - Water quality - Delft-3D



$$V \cdot \frac{dC}{dt} + C \cdot \frac{dV}{dt} = Q_{in} \cdot C_{in} - Q_{out} \cdot C_{out} - k \cdot V \cdot C$$

Storage | Transport | Reaction

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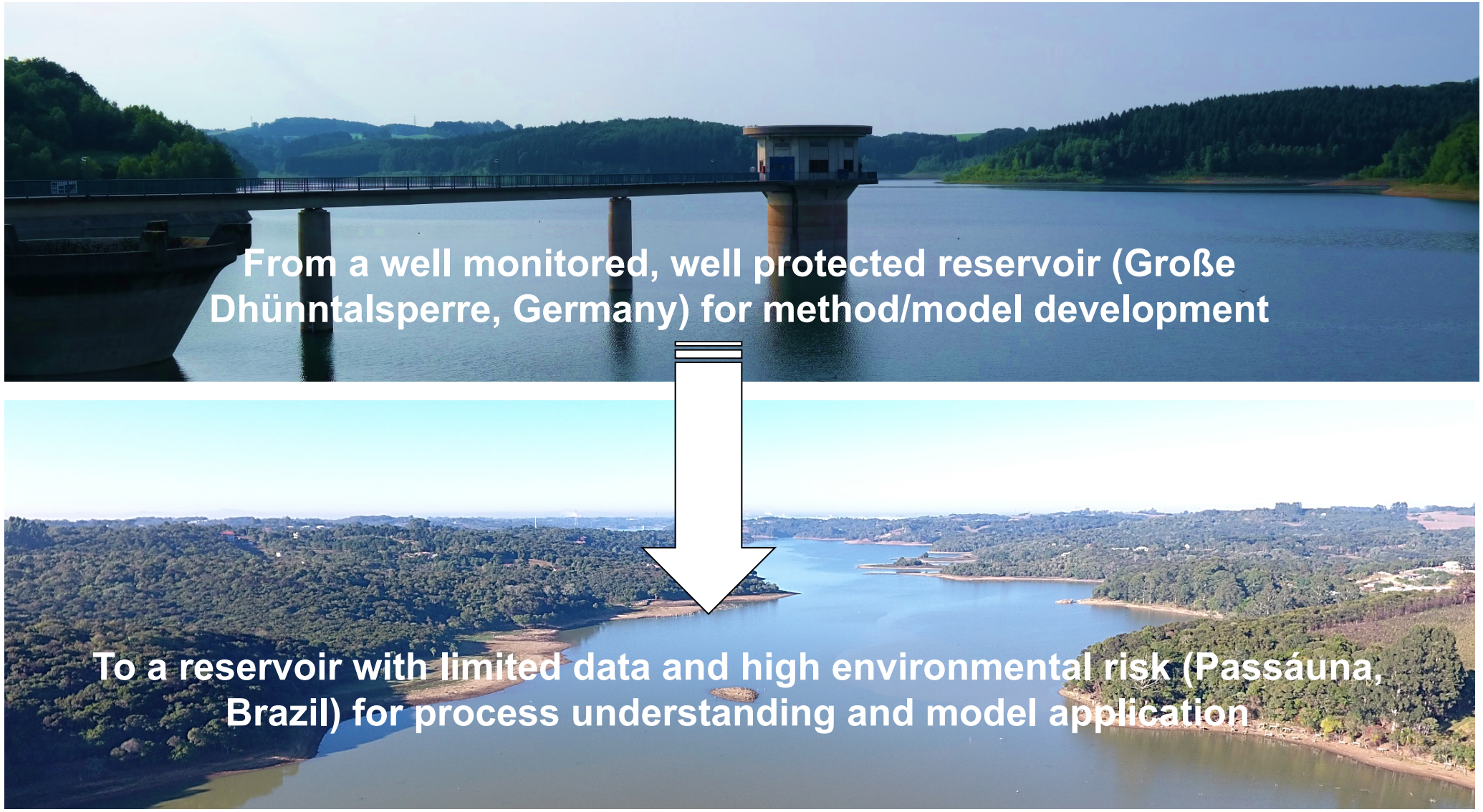
Project Roadmap



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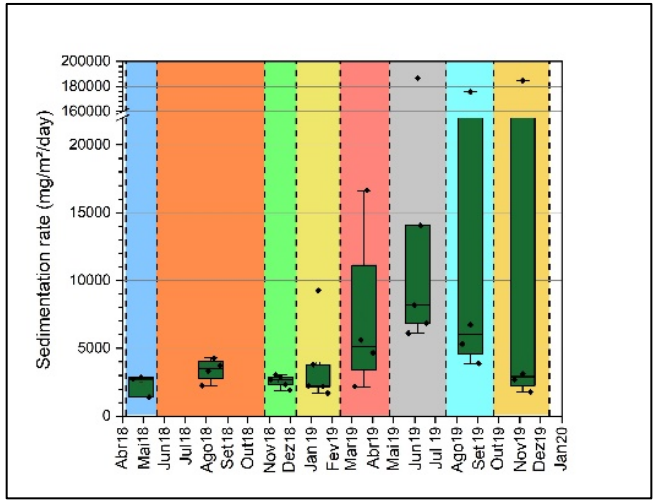
Results

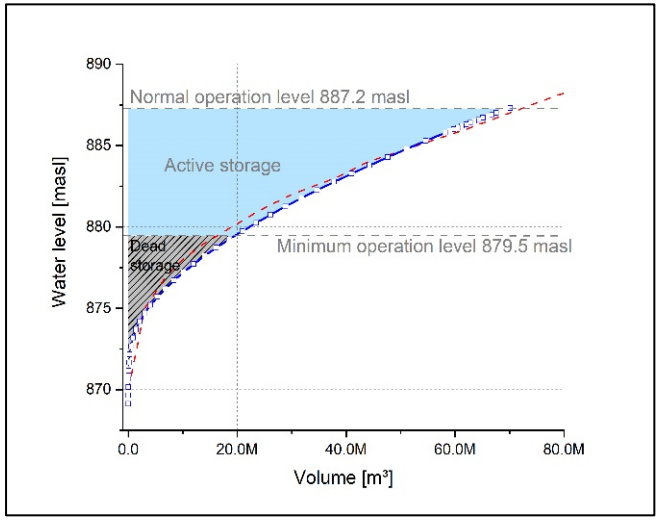
Science

- Method development
- Process understanding
- Simplification
- Model application
- Scenario calculation
- Creating „Hard facts“

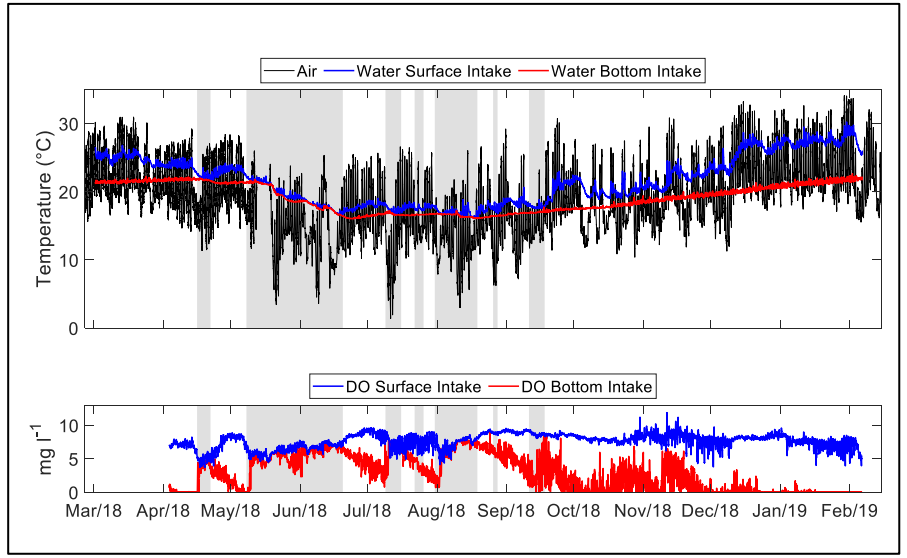
A: Sedimentation rate



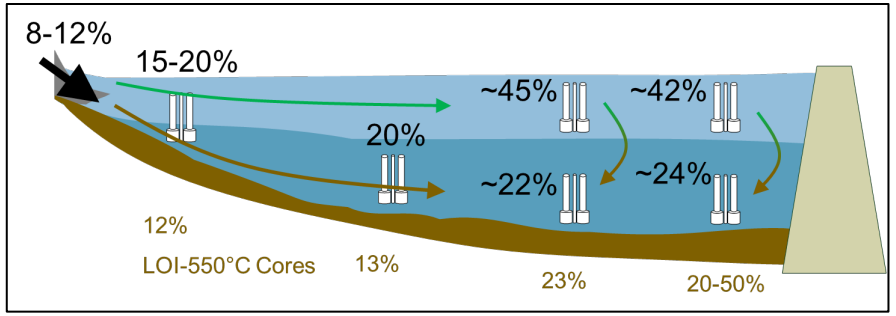
D: Lifetime assessment



B: Oxygen concentration and stratification



C: Organic matter transport - hydrodynamics



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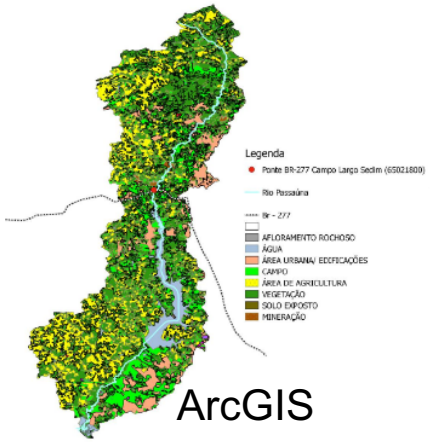
Results

Sensor Web



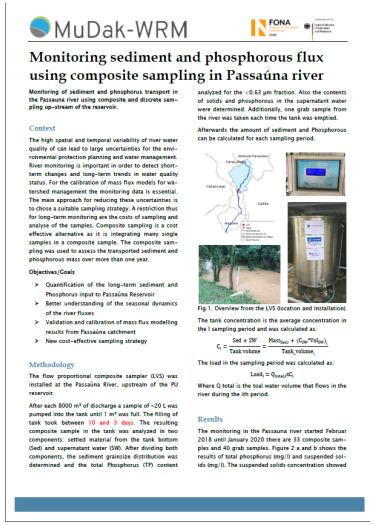
ArcGIS

MoRE
Modelling of Regionalized Emissions

Practice

- Turning the essence of the results into company knowledge
- Transfer of scientific results into useful products
- Development of monitoring guidelines
- Support during implementation

17 Product Flyer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Monitoring sediment and phosphorous flux using composite sampling in Passaúna river

Monitoring of sediment and phosphorus transport in the Passauna river using composite and discrete sampling up-stream of the reservoir.

Context

The high spatial and temporal variability of river water quality of can lead to large uncertainties for the environmental protection planning and water management. River monitoring is important in order to detect short-term changes and long-term trends in water quality status. For the calibration of mass flux models for watershed management the monitoring data is essential. The main approach for reducing these uncertainties is to chose a suitable sampling strategy. A restriction thus for long-term monitoring are the costs of sampling and analyse of the samples. Composite sampling is a cost effective alternative as it is integrating many single samples in a composite sample. The composite sampling was used to assess the transported sediment and phosphorous mass over more than one year.

Objectives/Goals

- Quantification of the long-term sediment and Phosphorus input to Passaúna Reservoir
- Better understanding of the seasonal dynamics of the river fluxes
- Validation and calibration of mass flux modelling results from Passaúna catchment
- New cost-effective sampling strategy

Methodology

The flow proportional composite sampler (LVS) was installed at the Passaúna River, upstream of the PU reservoir.

After each 8000 m³ of discharge a sample of ~20 L was pumped into the tank until 1 m³ was full. The filling of tank took between 10 and 3 days. The resulting composite sample in the tank was analyzed in two components: settled material from the tank bottom (Sed) and supernatant water (SW). After dividing both components, the sediment grainsize distribution was determined and the total Phosphorus (TP) content analyzed for the <0.63 µm fraction. Also the contents of solids and phosphorous in the supernatant water were determined. Additionally, one grab sample from the river was taken each time the tank was emptied.

Afterwards the amount of sediment and Phosphorous can be calculated for each sampling period.

Fig 1: Overview from the LVS location and installation

The tank concentration is the average concentration in the i sampling period and was calculated as:

$$C_i = \frac{Sed + SW}{Tank\,volume} = \frac{Mass_{Sed,i} + (C_{SW} * V_{SW})_i}{Tank\_volume_i}$$

The load in the sampling period was calculated as:

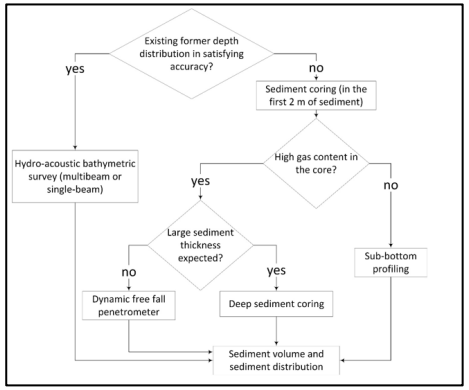
$$Load_i = Q_{total,i} * C_i$$

Where Q total is the toal water volume that flows in the river during the ith period.

Results

The monitoring in the Passauna river started Februar 2018 until January 2020 there are 33 composite samples and 40 grab samples. Figure 2 a and b shows the results of total phosphorus (mg/l) and suspended solids (mg/l). The suspended solids concentration showed

Monitoring Guidelines



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Results

Science

- Method development
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Practice

- Turning the essence of the results into company knowledge
- Transfer of scientific results into useful products
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Regulation

- Adaptations of strategies for monitoring, management and measures
- Rising awareness of ecological problems (siltation, nutrient accumulation)

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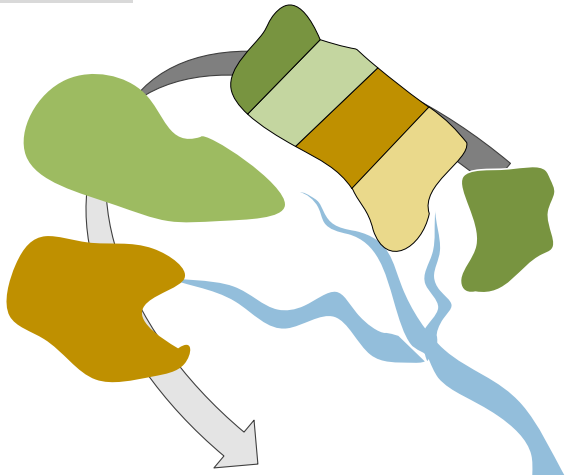
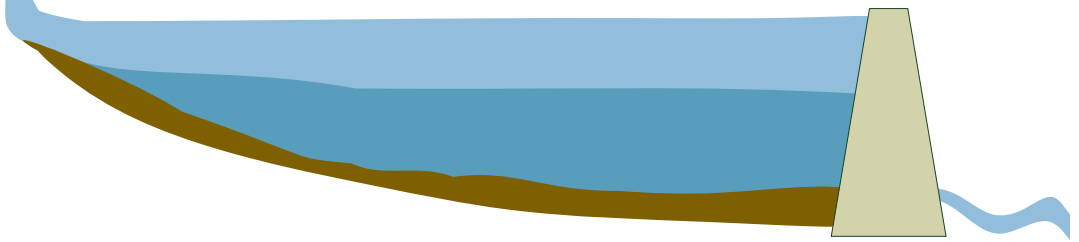
Immediate Outputs

- Automatization of satellite data integration

- Appropriated sediment and phosphorus input model



- Quantification of sediment and phosphorus stock
- Reservoir lifetime assessment
- P-stock and eutrophication potential



- Long-term river input monitoring

- Assessment of trophic state and eutrophication risk by innovative continuous monitoring.

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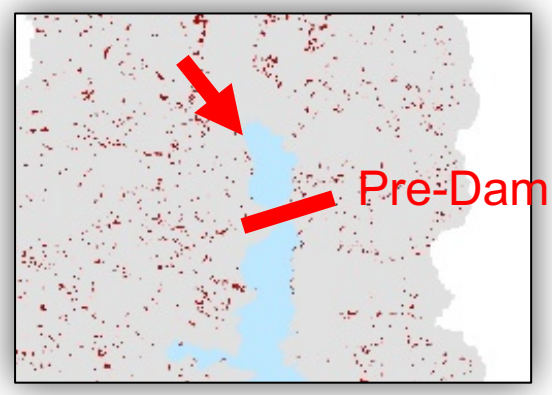
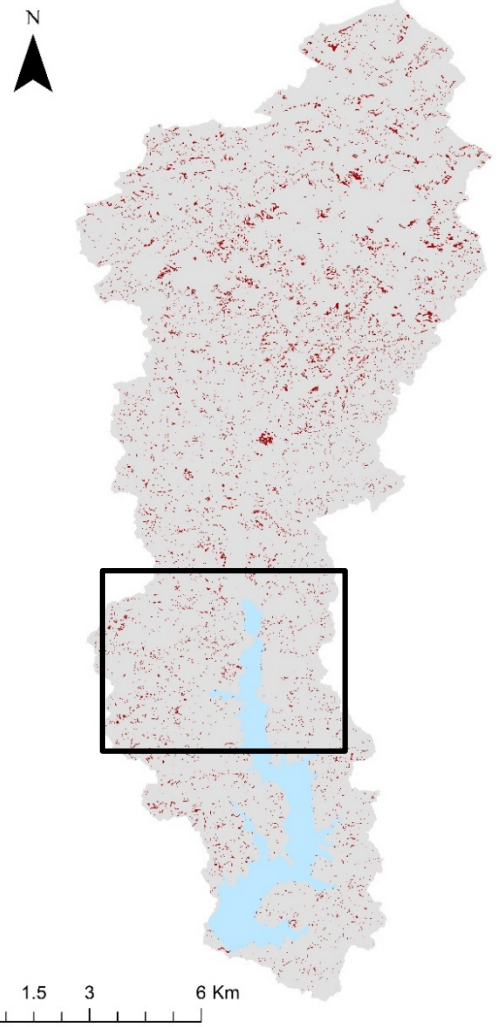
Knowledge-based Measures

- Aimed Reforestation
  - Very severe erosion areas were identified (>250 t/ha/a)
  - Equaling 3% of the catchment area
  - Reforestation of these areas can lead to up to 26% reduction of sediment input to the reservoir

- Construction of a Pre-Dam in Passaúna Reservoir
  - Conditions are good for the construction (existing „Buffer area“ upstream a bridge)
  - A dam with 4m height will retain up to 82% of particle bound Phosphorous and sediment
  - The main reservoir will receive 2/3 less phosphorous input.
  - Future water quality deterioration will be significantly reduced.





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Long-term Outputs

- Until now 23 publications, many in process and 2 in review
- 12 PhDs and 16 Msc. Thesis
- 17 “Product Flyer” summarizing technical and scientific results (see MuDaK booth)

- Transfer of the catchment model MoRE to a new project funded by the National Water Authority for a catchment the size of Germany

- The TriOS sensor platform in Passaúna continues to deliver real-time water quality data for Sanepar

- The Sensor Web is included in the permanent reservoir observation at Wupperverband as a guiding example for innovative data management (see stakeholder forum)

- The Satellite catchment assessment was brought to market maturity by EFTAS

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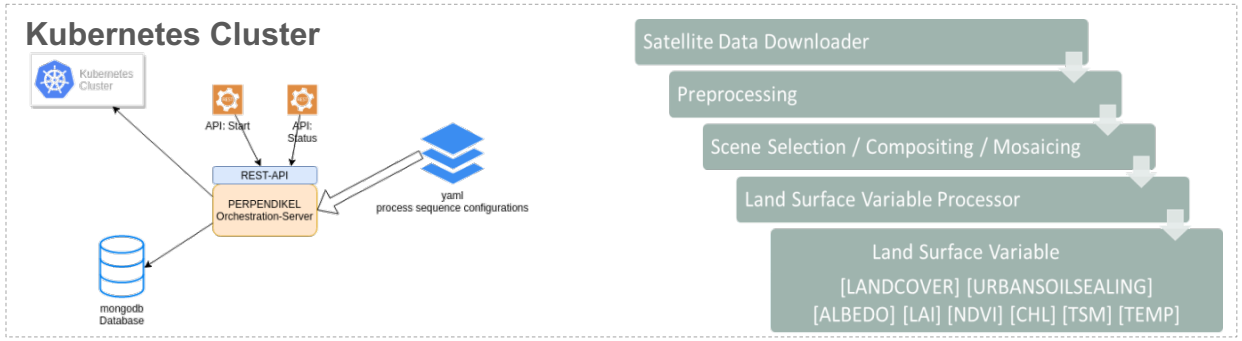
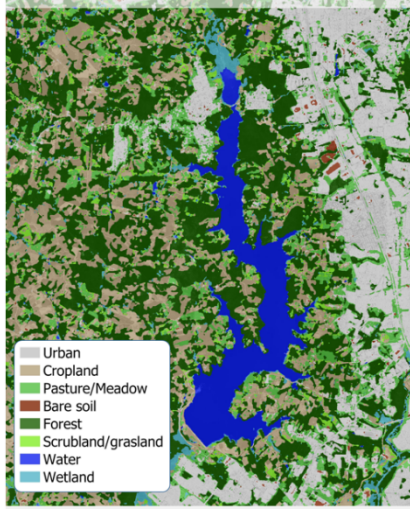
Earth Observation-based Catchment Assessment

Automatic processing chains

for the ad-hoc provision of spatial-temporal datasets on the status and change of catchment and water quality parameters



Landcover



Spatial resolution: 10 m
Temporal resolution: yearly

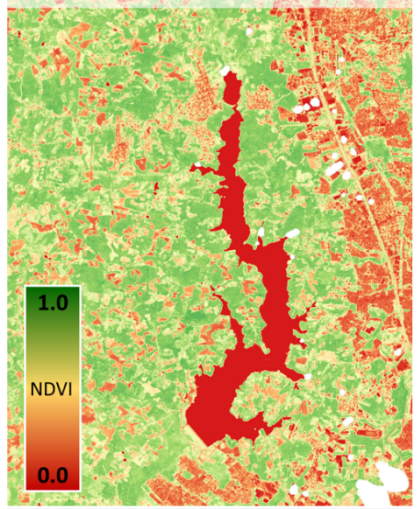
Summary: Describes the physical or biological coverage of the Earth's surface. It can be linked to (human) land use and associated pollutant emissions. Moreover, it is the basis for erosion modeling.

Urban Soil Sealing

Spatial resolution: 10 m
Temporal resolution: yearly

Summary: Provides detailed information on the permeability of settlement areas, which impact surface runoff and substance transport as well as microclimatic processes.

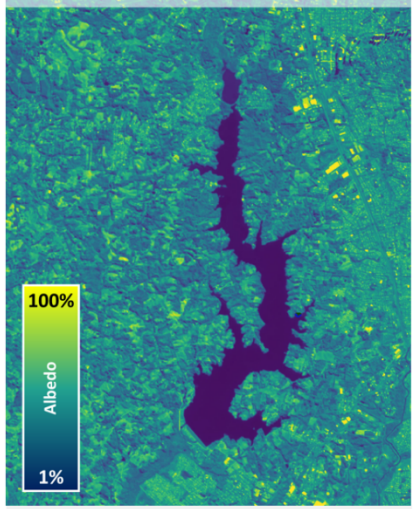
NDVI



Spatial resolution: 10 m
Temporal resolution: 5 days

Summary: The Normalized Difference Vegetation Index (NDVI) provides proxy information on biomass and vitality of vegetation. It supports erosion modeling with vegetation periods information.

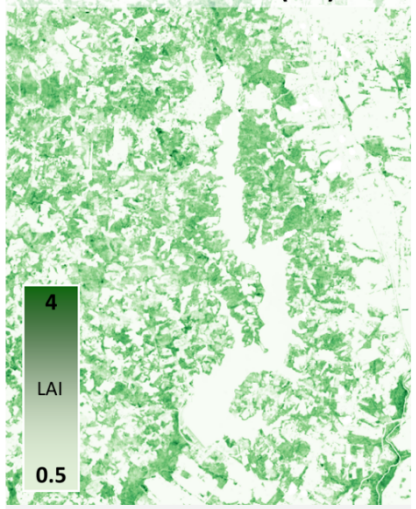
Surface Albedo



Spatial resolution: 20 m
Temporal resolution: monthly

Summary: Describes the 'reflectivity' of the Earth's surface. It is an essential input parameter for energy balance calculations, including the estimation of evaporation rates.

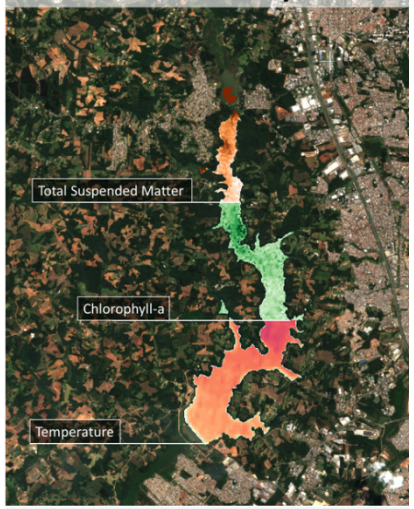
Leaf Area Index (LAI)



Spatial resolution: 20 m
Temporal resolution: monthly

Summary: Quantifies the one-sided green leaf area per unit ground surface area, thereby characterizing plant canopies. It is an essential parameter for the estimation of evapotranspiration.

Water Quality



Spatial resolution: 10 m
Temporal resolution: 5-16 days

Summary: Chlorophyll-a, Total Suspended Matter and Temperature are obtained from water surfaces to monitor and model water quality on a large scale.

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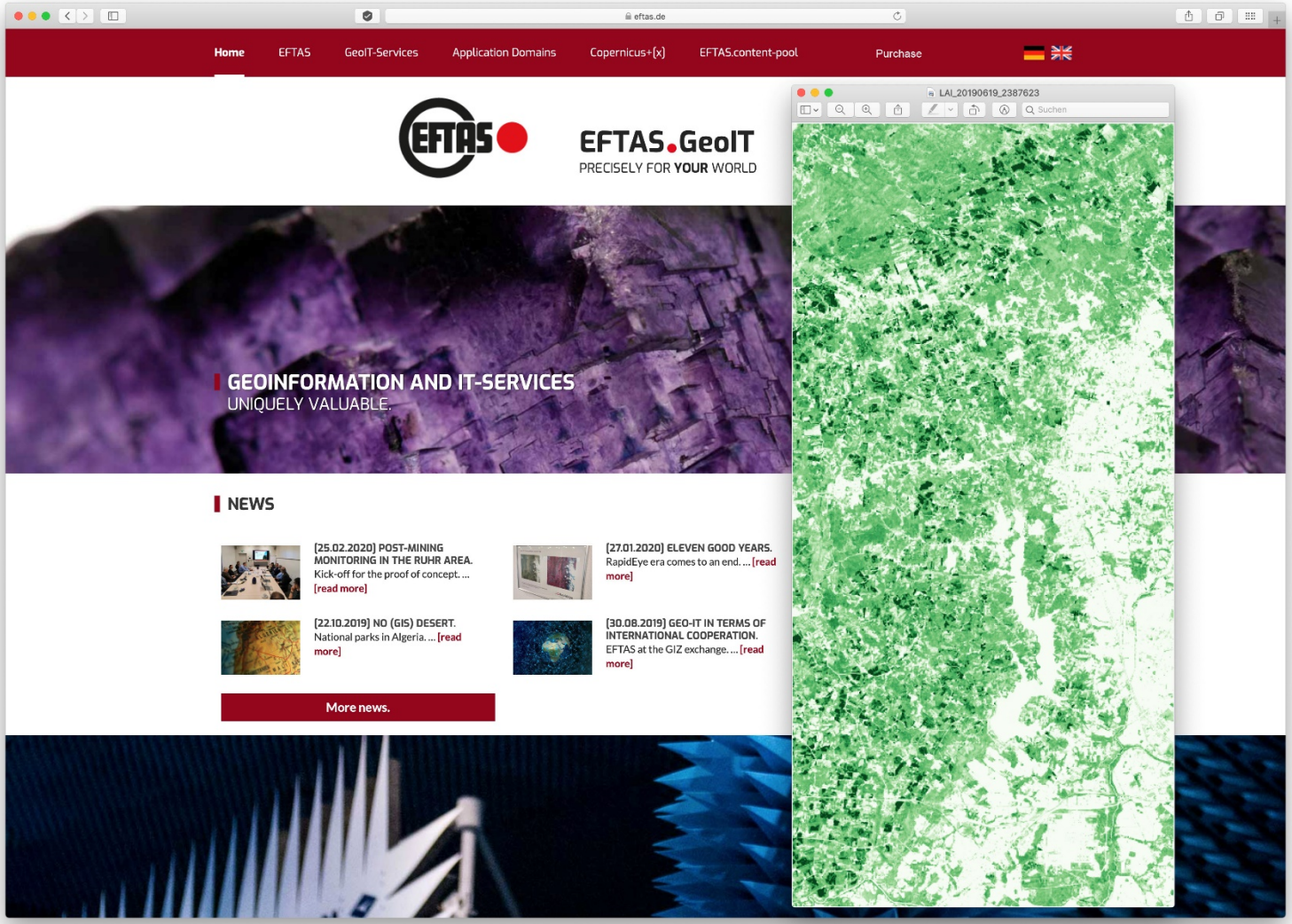
On-demand Processing and Web-based Access



..available soon online!

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Thank you for your attention!

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Passaùna Reservoir during the water crisis 2020
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