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Leibniz-Institut für
Agrartechnik und Bioökonomie

# Impact assessment of livestock production on water scarcity in a watershed located in southern Brazil

Authors:
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Association

# • Introducing myself

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Bachelor's degree in Environmental Engineering (University of Caxias do Sul, Brazil)

Master's degree in Engineering and Environmental Science (University of Caxias do Sul, Brazil)

Doctoral researcher at the ATB and Humboldt Universität zu Berlin (since October/2019)

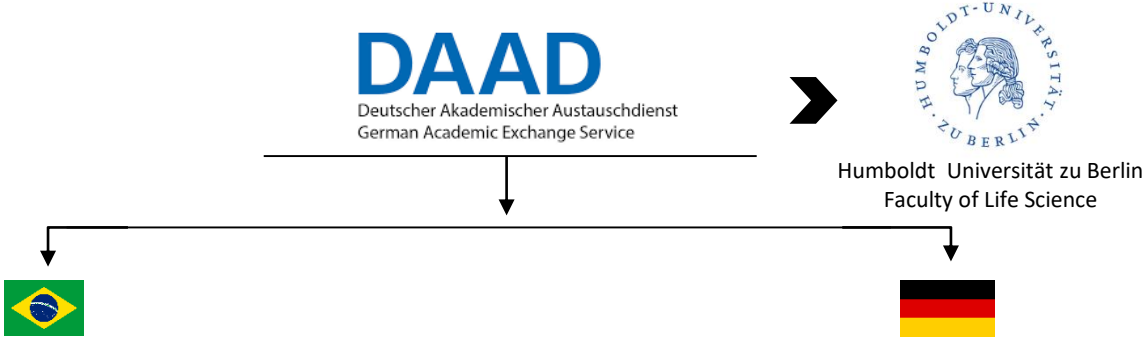
Department 2: Technology Assessment and Substance Cycles

Supervisor: PD Dr. Katrin Drastig

Research Program 1 "Precision Farming in Crop and Livestock Production"

Working Group "Water Productivity in Agriculture (AgroHyd)"

# Evaluation of Water Productivity of Plant and Livestock Production in an Experimental Watershed Located in Southern Brazil




UCS UNIVERSIDADE DE CAXIAS DO SUL | isamo

Dr. Vania Elisabete Schneider
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PD Dr. Katrin Drastig

EMATER/RS ASCAR

*Rural extension service*
Engineer Leandro Ebert

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# • PhD project

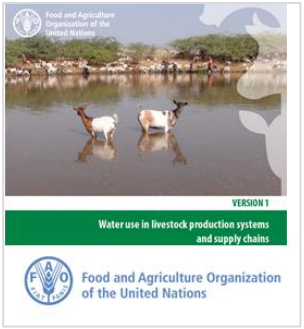
Water productivity assessment on 115 farms
Pig, poultry and dairy milk production

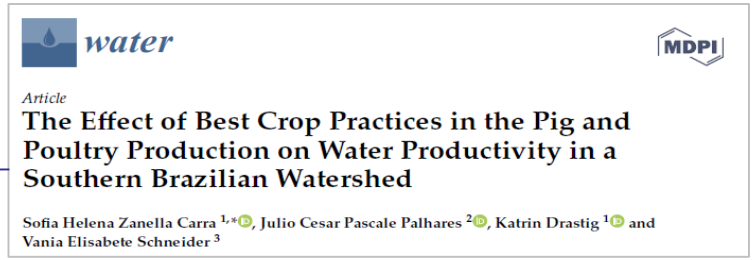
1st and 2nd articles

Water scarcity footprint assessment in the watershed

3rd article (in progress)

Reporting back of key findings on the application of LEAP Water TAG guidelines to the LEAP Partnership Secretariat of the FAO





water

MDPI

Article

The Effect of Best Crop Practices in the Pig and Poultry Production on Water Productivity in a Southern Brazilian Watershed

Sofia Helena Zanella Carra [1,*], Julio Cesar Pascale Palhares [2], Katrin Drastig [1] and Vania Elisabete Schneider [3]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Water productivity of milk produced in three different dairy production systems in Southern Brazil

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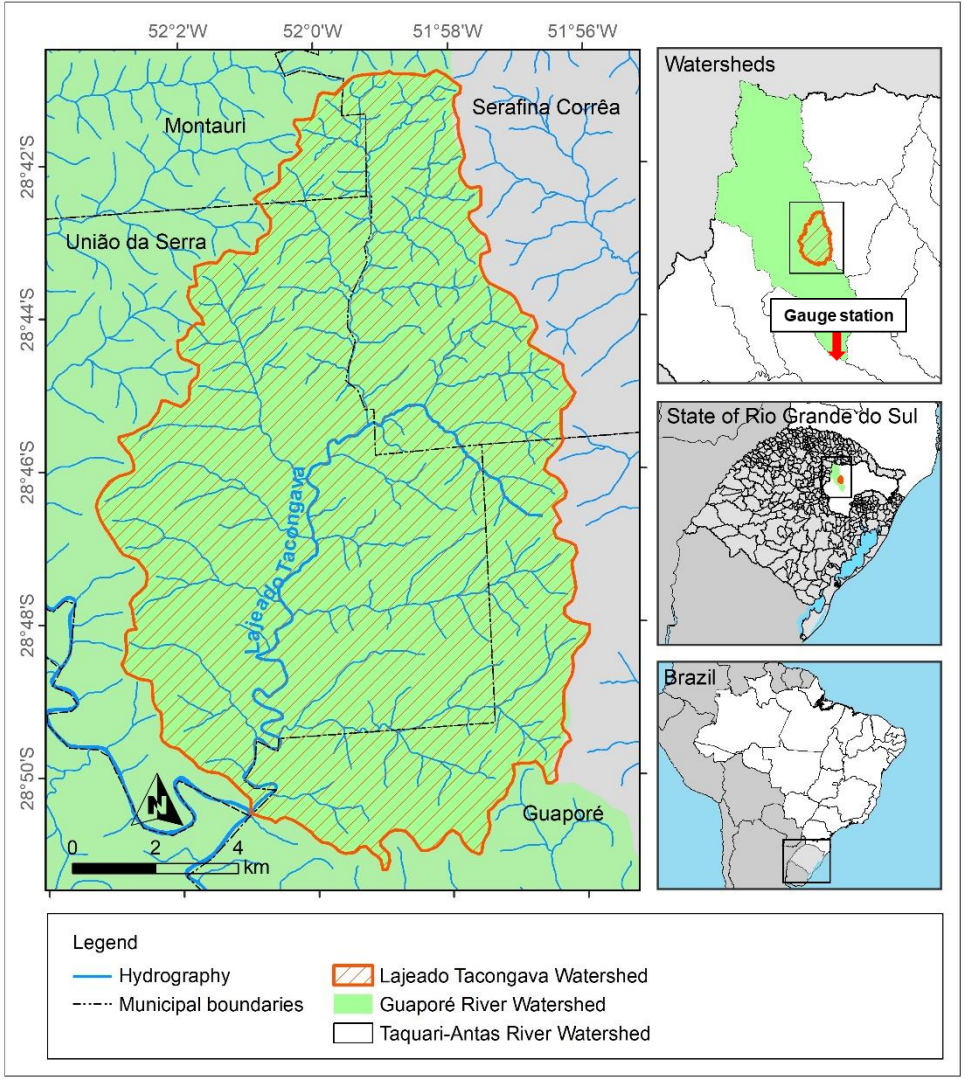
- **Study area**

Lajeado Tacongava Watershed
(150 km2)

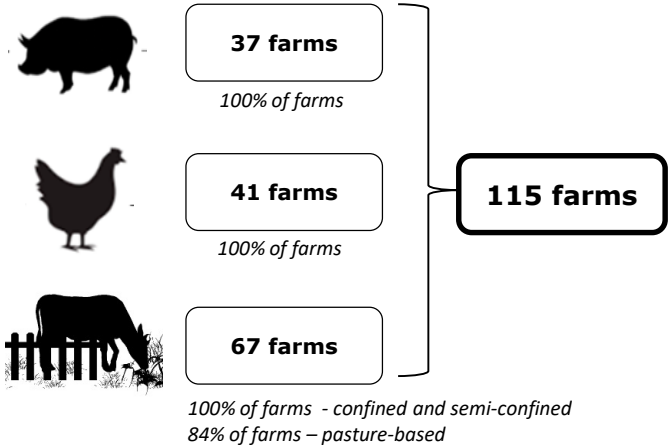
*Sub-watershed*

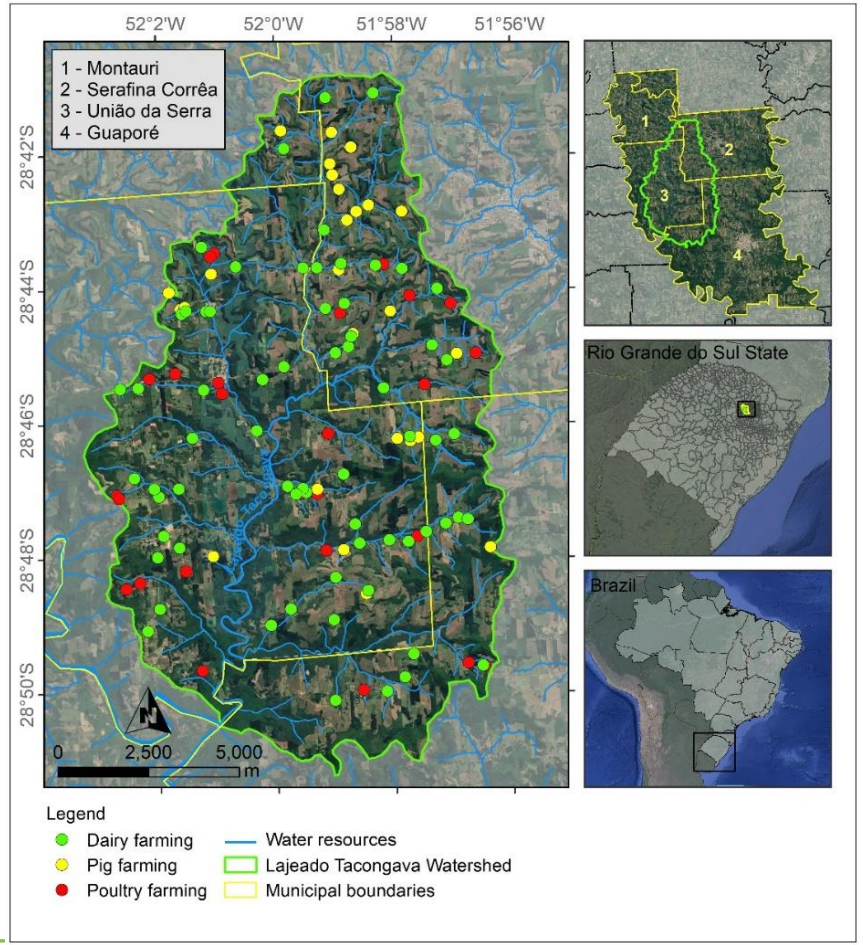
Taquari-Antas Hydrographic Basin
(26,430 km²)



# • Study area

- Primary data collected on farms (study year: 2018)




- Pasture-based system (dairy cattle stay in the grassland): **57 farms**
- Semi-confined system (dairy cattle stay inside the barn up to 6 hours day-1): **7 farms**
- Confined system (dairy cattle stay inside the barn): **3 farms**

# • Methodology – Water Productivity

Food and Agriculture Organization of the United Nations

*Livestock Environmental Assessment and Performance (LEAP)*

*FAO LEAP Guidelines (2019)*

*"Water use in livestock production systems and supply chain"*

***Water Productivity*** » *Ratio of the net benefits to the amount of water consumed to produce those benefits*

$$\mathbf{WP_{Feed}} = \frac{\text{kg FM [kg FM*]}}{\text{water input (Q}_{ind}\text{) [m3]}}$$

**FM: fresh matter*

Indirect water

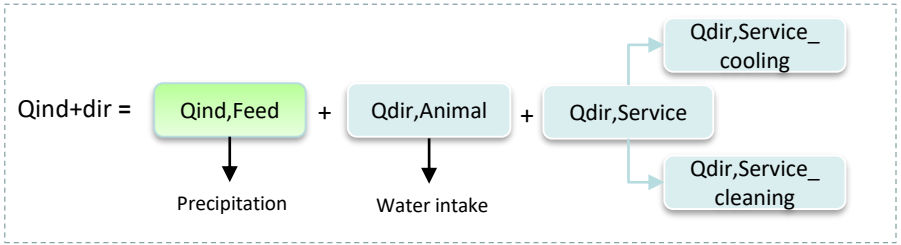
Actual evapotranspiration (ET)

Modelling software AgroHyd Farmmodel

$$\mathbf{WP_{Mass}} = \frac{\text{kg CW* or FPCM**}}{\text{water input (Q}_{ind+dir}\text{) [m3]}}$$

**CW: carcass weight (poultry and pig) ; **FPCM: fat protein corrected milk*

*Water use inventory*




*Q: water consumption*

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# • Methodology – Water Scarcity Footprint

- FAO LEAP Guidelines (2019) recommend to apply at least two methods:

*Available Water Remaining* **(AWARE)**

(Boulay et al, 2018)

$$AMDi = \frac{WA - HWC - EWR}{Area}$$

$$CF\ AWARE = \frac{AMD\ world.avg}{AMDi}$$

*Blue Water Scarcity Index* **(BWSI)**

(Hoekstra et al, 2012)

$$BWSI = \frac{HWC}{WA - EWR}$$

CF: characterization factor

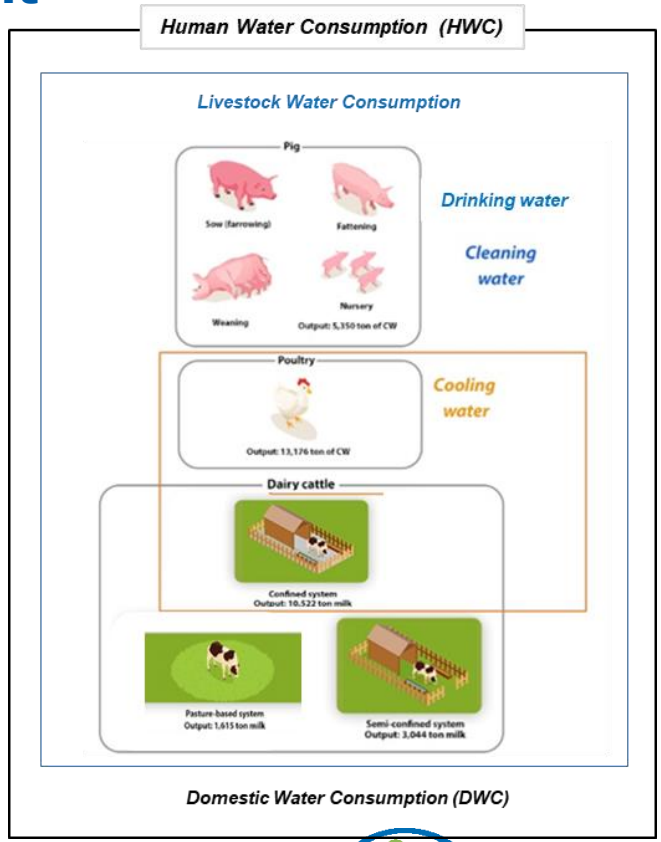
$CF_{AWARE} = 0.1$ (min. WS); $CF_{AWARE} = 100$ (max. WS)

AMD world.avg = 0.0136 m3/m2·month

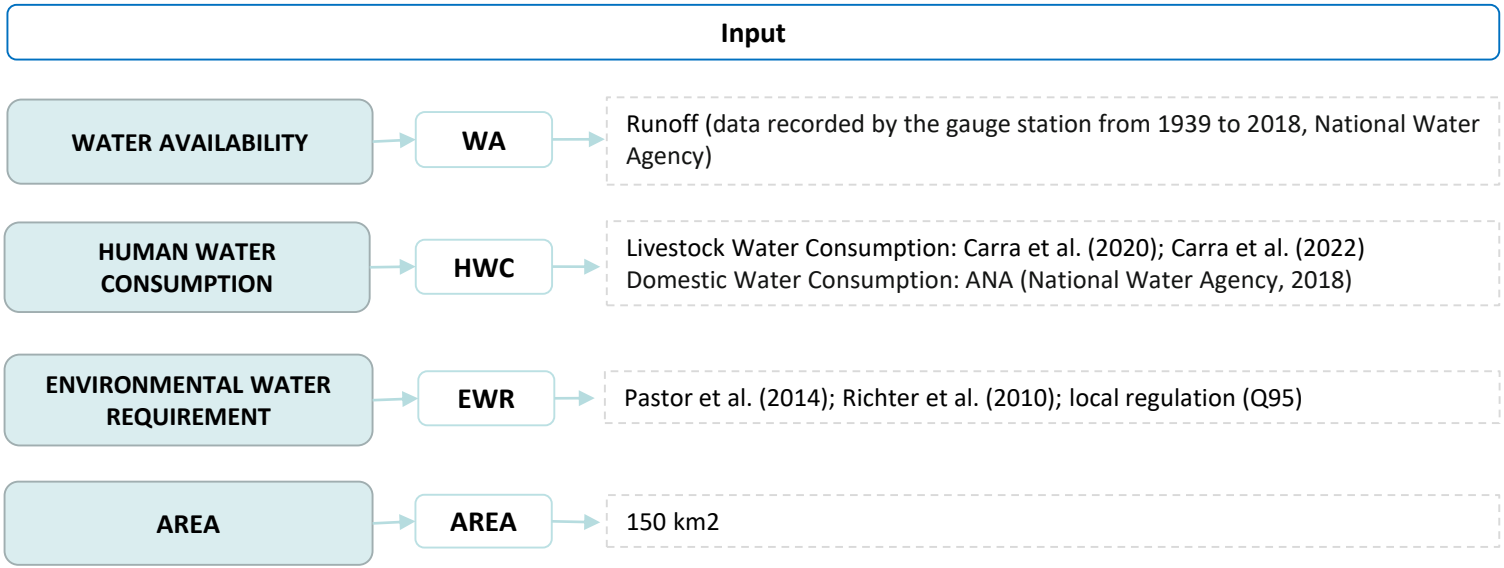
BWSI > 1 (max. water scarcity)

BWSI < 1 (min. water scarcity)

**Water scarcity footprint: $CF_{AWARE}$ * LWC**



# Data input


Input
WATER AVAILABILITY
WA
Runoff (data recorded by the gauge station from 1939 to 2018, National Water Agency)
HUMAN WATER CONSUMPTION
HWC
Livestock Water Consumption: Carra et al. (2020); Carra et al. (2022)
Domestic Water Consumption: ANA (National Water Agency, 2018)
ENVIRONMENTAL WATER REQUIREMENT
EWR
Pastor et al. (2014); Richter et al. (2010); local regulation (Q95)
AREA
AREA
150 km2

# Scenarios assessed – Water Scarcity footprinting

| Scenarios | Runoff | WA: Q95 | WA: Q90 | WA: Q80 | HWC: Water consumption | Local regulations in Brazil (national, state): Q95 | Local regulations in Brazil (national, state): 50% Q95 | EWR: Pastor et al. (2014) | EWR: Richter et al. (2010) |
|---|---|---|---|---|---|---|---|---|---|
| SC.1_AWARE | x | | | | x | | | x | |
| SC.2_AWARE | x | | | | x | x | | | |
| SC.3_AWARE | | | x | | x | x | | | |
| SC.4_AWARE | | | | x | x | x | | | |
| SC.5_AWARE | | x | | | x | | x | | |
| SC.1_BWSI | x | | | | x | | | | x |
| SC.2_BWSI | x | | | | x | x | | | |
| SC.3_BWSI | | | x | | x | x | | | |
| SC.4_BWSI | | | | x | x | x | | | |
| SC.5_BWSI | | x | | | x | | x | | |

Recommended by both methods

Statistical water flow (drier flow condition)

Local regulations in Brazil (national, state)

Recommended by Boulay et al. (2018)

Recommended by Hoekstra et al. (2012)

# • Results – Water consumption

| *Water input* | *Pig* | | *Poultry* | | *Dairy* | |
|---|---|---|---|---|---|---|
| | % of Q input | m3 | % of Q input | m3 | % of Q input | m3 |
| Feed (indirect) | 99.6 | 10,418,691.8 | 99.4 | 17,215,578.3 | 97.3 | 9,542,402.0 |
| Drinking (direct) | 0.4 | 37,012.2 | 0.3 | 54,647.5 | 1.6 | 157,930.1 |
| Cleaning (direct) | 0.4 | 45,508.9 | <0,01 | 17.1 | 0.5 | 53,464.1 |
| Cooling (direct) | | | 0.3 | 49,271.6 | 0.6 | 57,121.6 |
| **Total water consumption** (direct water) *(livestock water consumption)* | 0.8% | 82,521.1 | 0.6% | 103,936.2 | 2.7% | 268,515.8 |

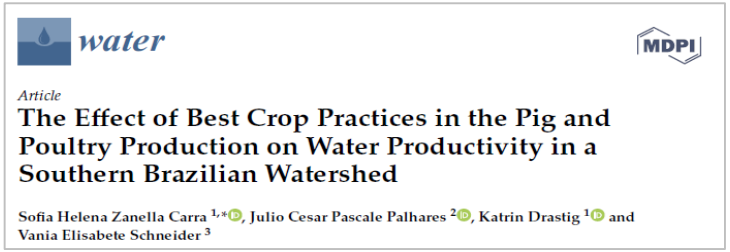
***Groundwater: 73% (fractured aquifer)***
***Surface water: 27%***

# • Results – Water productivity

| | |
|---|---|
| WPpig [kgCW $m^{-3}$] | 0.51 (0.8%/99.2%) |
| WPpoultry [kgCW m-3] | 0.76 (0.6%/99.4%) |
| WPmilk_pasture-based [kgCW m-3] | 1.01 (1.0% / 99.0%) ± 0.22 SD |
| WPmilk_semi-confined [kgCW m-3] | 0.95 (0.7% / 99.3%) ± 0.19 SD |
| WPmilk_confined [kgCW m-3] | 0.96 (0.8% / 99.2%) ± 0.11 SD |

*(% blue water / % green water)*

**CW: carcass weight (poultry and pig) ; **FPCM: fat protein corrected milk*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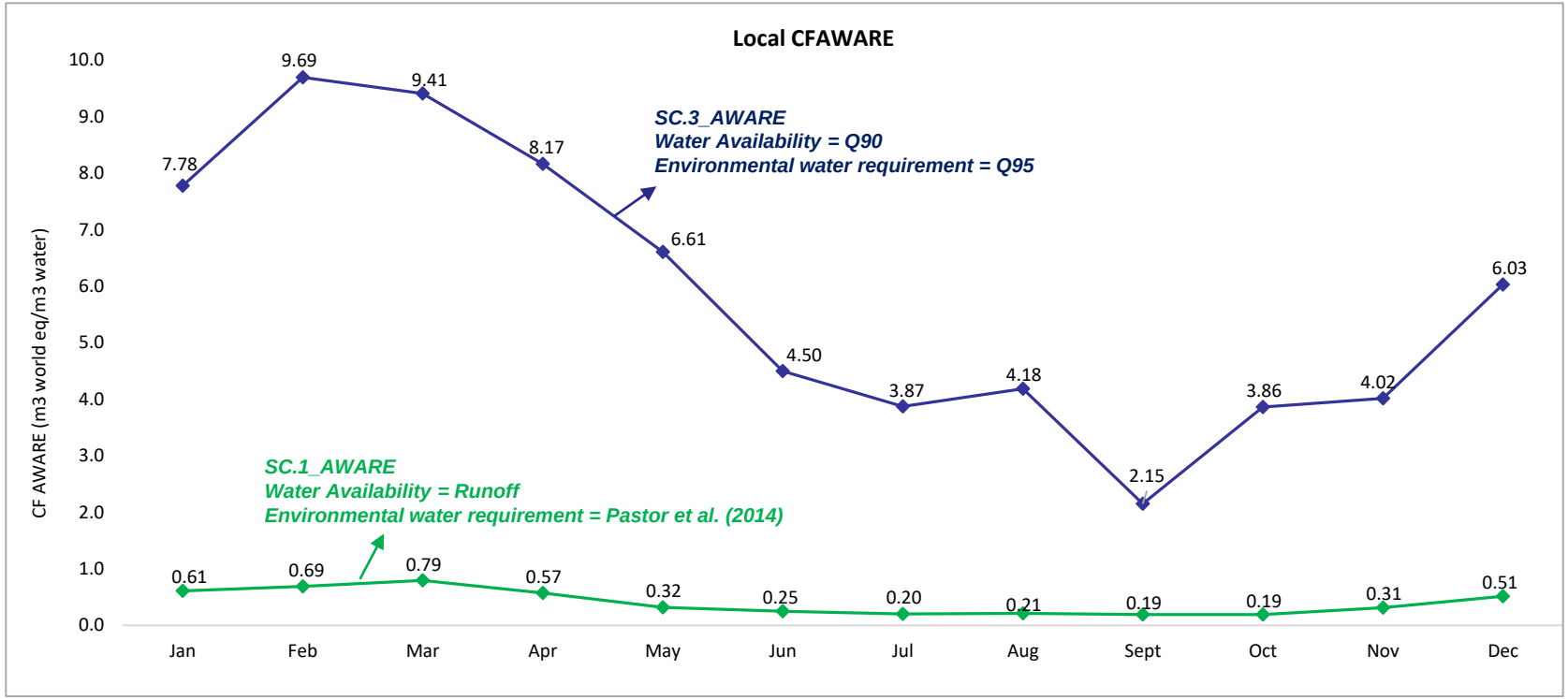
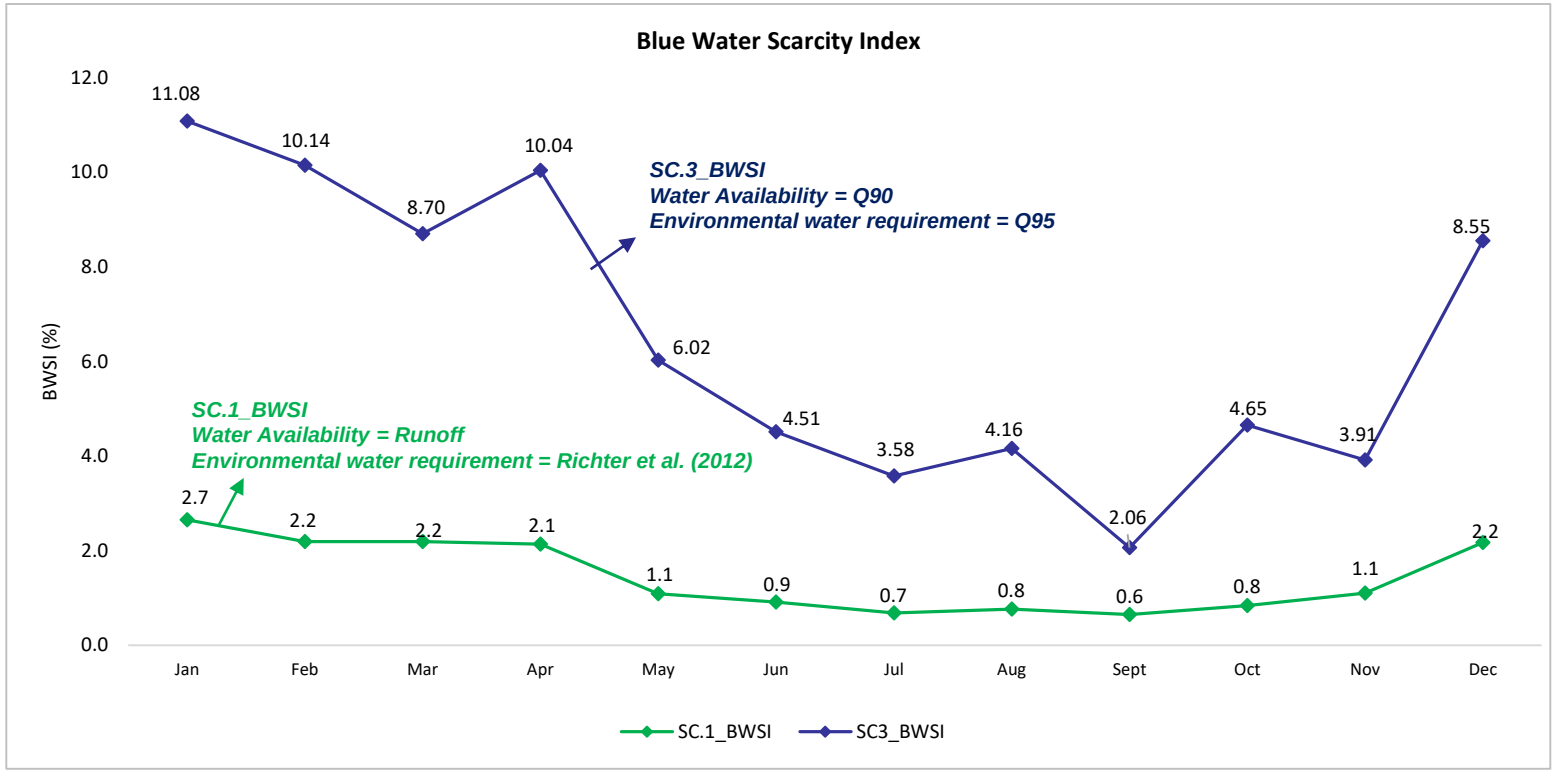
# • Results – Water scarcity - CF AWARE (SC.1; SC.3)

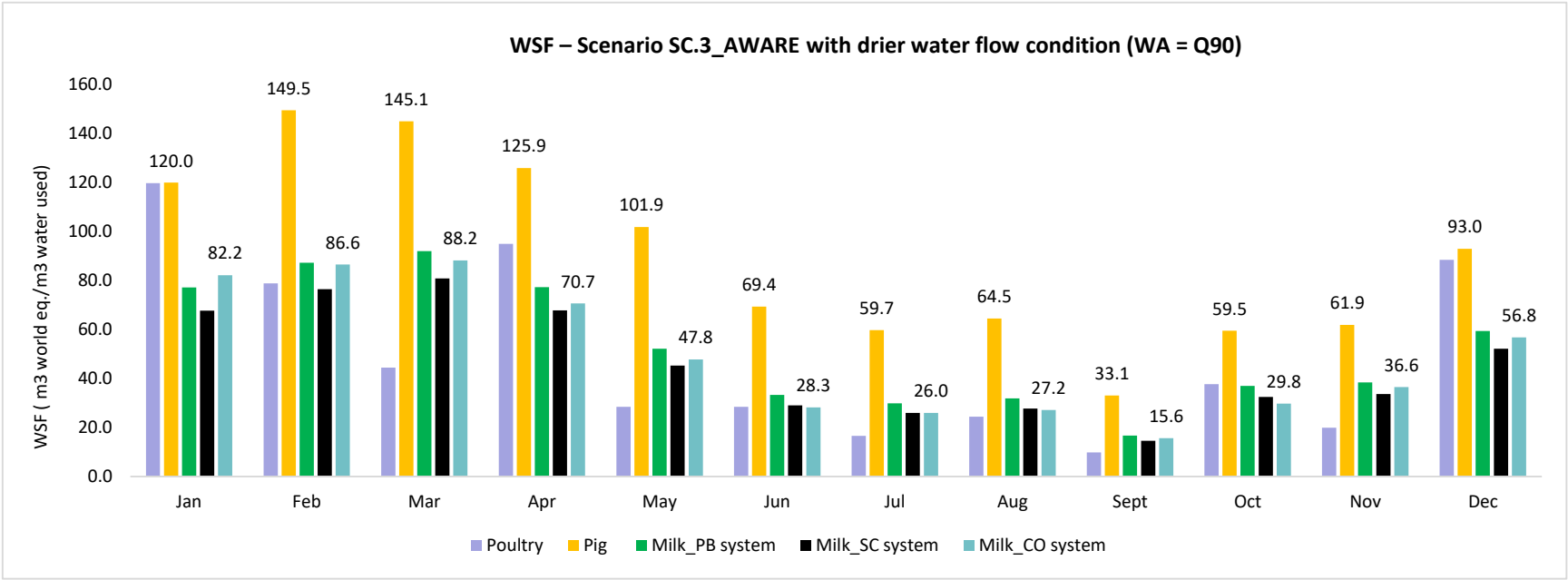


# • Results – Water scarcity – BWSI (SC.1; SC.3)




***Low blue water scarcity*** *in all scenarios and throughout all months assessed.*

# • Results – Water scarcity impact assessment




***BWSI = binary (0 or 1)***

BWSI > 1 (max. water scarcity)

BWSI < 1 (min. water scarcity)

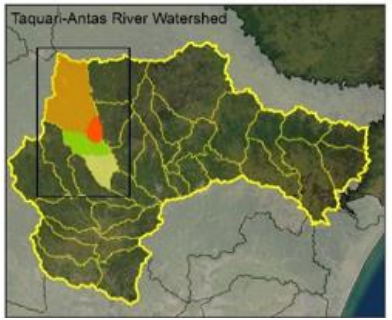
# • Results – Water scarcity impact assessment

*Andrade et al. (2019)*

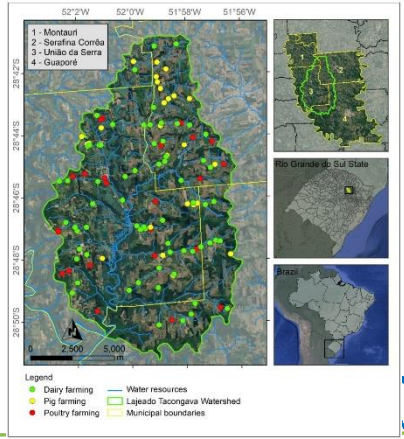
WSF results using different CFAWARE

| | local CFAWARE SC.1_AWARE | CFAWARE (monthly) Taquari-Antas | Difference between the WSF (%) |
|---|---|---|---|
| | m3 world eq./m3 water used | m3 world eq./m3 water used | |
| Poultry | 3.5 | 6.3 | 44.6 |
| Pig | 6.2 | 11.3 | 44.6 |
| Milk_PB system | 3.7 | 6.6 | 44.4 |
| Milk_SC system | 3.2 | 5.8 | 44.4 |
| Milk_CO system | 3.5 | 6.3 | 44.2 |

Taquari-Antas hydrographic basin (26,430 km²)




Watershed - study area (150 km2)



# • Results – Water scarcity impact assessment

*Andrade et al. (2019)*

WSF results using different CFAWARE

| | local CFAWARE SC.1_AWARE<br>m3 world eq./m3 water used | **CF Non-Agri Taquari-Antas**<br>m3 world eq./m3 water used | Difference between the WSF (%) |
|---|---|---|---|
| Poultry | 3.5 | 5.5 | 36.3 |
| Pig | 6.2 | 10.8 | 42.3 |
| Milk_PB system | 3.7 | 6.2 | 40.1 |
| Milk_SC system | 3.2 | 5.4 | 40.0 |
| Milk_CO system | 3.5 | 5.7 | 38.5 |

- Boulay et al. (2018) recommend the **aggregation of CFAWARE** for irrigation (**CF agri**) and for other sectors (**CF non-agri**) to country or watershed level.
- It is calculated based on the water consumption-weighted averages at the monthly and watershed levels.
- They should be used on regions with a lack of water flow data.

*Industry, domestic,* ***LIVESTOCK***

| | Jan | Feb | Mar | Apr | May | Jun | Jul | Aug | Sep | Oct | Nov | Dec | CF Agri | **CF Non-Agri** | CF Default |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Taquari-Antas | 1.1 | 0.9 | 1.2 | 1.0 | 0.7 | 0.5 | 0.4 | 0.4 | 0.4 | 0.4 | 0.7 | 1.0 | 1.0 | **0.7** | 0.9 |
| Brazil | 32.0 | 33.7 | 21.8 | 13.5 | 14.6 | 16.6 | 22.2 | 29.2 | 30.8 | 30.7 | 30.2 | 28.6 | 31.5 | **22.8** | 26.1 |

*Andrade et al. (2019)*

# Conclusion - WSF

- Low water scarcity observed in the study area in all scenarios assessed;
- Different definitions of WA and EWR depending on the country/state;
- Lack of data to integrate groundwater in the WSF assessment;
- Aggregated CFAWARE: livestock water consumption is integrated in a factor with other water users (CF non-agri);
- Results reinforce the importance of regionalized water scarcity assessment to achieve more accurate WSF results;
- Description of WSF assessement could be more clear in the LEAP Guidelines, bringing some examples;
- The LEAP Guidelines application could allow the comparison among studies, define benchmarks and provide more reliable data.

- **Acknowledgement**

DAAD
Deutscher Akademischer Austauschdienst
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União da Serra

Prefeitura de
Montauri

Prefeitura de
Guaporé

# Thank you!

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