Executive Summary

This report aims to capture. The trends in the water demand in the industrial sector of the free state of Thuringia. The annual water consumption of the industrial sector of Thuringia has been increased over time for the observed years (2004 – 2019) ranging from 48264000 m3 in 2004 to 71836000 m3 in 2019 with a peak of 72075000 m3 in 2016 (figure 1). Considering this, trend, it is important to delve deeper into the insights of what factors drive these industrial water demand overtime. To do that, we investigated the factors that affect this industrial water demand at the Kreis level.

A graph with a line going up

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Introduction

Write a short introduction about the industrial sector of Thuringia  
No of companies as of 2019/2022 (if 2022 values are used). The industry sectors that are currently in the Thuringia state, the total GVA of Thuringia

A little info about the no of Kreis and their respective contributions to the GDP (GVA at the Kreis, highest Kreis, lowest etc.)

We assumed the water withdrawals for industrial use (water demand) may be correlated with factors such as Gross value added, mean temperature, and technological change factor (TC).

TC Calculation

In order to calculate TC we assumed that the reduction in water intensity is a positive factor of Technological change as it is a sign of increase in water use efficiency. Also we considered the multiple and circular use of water in industrial processes which also indicate a reduction in water withdrawals resulting in increase in water use efficiency over time.

##

New TC method as discussed with Simon;

analyze water use and circular use trends, derive the growth function, calculate Technological Change (TC)

A graph of water use

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A graph with colorful lines and numbers

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A graph with a line going up

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In this method,

We aggregated the circular water use over all Kreis to calculate the proxy for TC. The reasons behind this aggregation to state level is;

1. Focusing on a state-level TC where a single TC proxy derived from aggregated circular use captures the general trend of technological progress for the whole state which can be applied directly in our water demand model
2. To avoid noise in the data caused due to inconsistencies, which made it easier to capture a clear growth trend.

Initially two growth trends were analyzed (linear and exponential), the growth functions for the two trends are given as follows:

Linear growth function: circular\_use= β0​+βl​(year)+ϵ

Exponential growth function: n(circular\_use) = β0​+βe​(year)+ϵ

The gradients of the above functions were calculated as follows

1. βl​: 507.6
2. βe : 0.075

For the linear function βl​ (gradient of the linear function) can be directly taken as the growth rate and for the exponential function, it has to be transformed using the exponential transformation;

Growth Rate (%)=eβe​−1

And after its application we can get the exponential growth rate of circular water use as 0.0778 or 7.78%.

Since the aggregated circular water use from 2004 – 2019 follows a strong linear trend, we assume the best proxy for TC is the linear growth trend which is 507.6 units per year.

**Water demand model**

IWW​=β0​+β1​⋅GVA+β2​⋅T+β4​⋅TC+ϵ

Here;

IWW = Industrial water withdrawals

GVA = Gross value added

T = temperature

TC = Technological change factor.

We fitted the TC into the water demand model assuming TC is a constant factor across all Kreis for the whole considered time period where TC = 507.6

\*According to the study conducted by Shang et al., 2017, there should be a negative relationship between TC and IWW. In order to see this, based on the logic we used,

Which is: increase in circular water use means it is an increase in more water saving technologies. So that means, circular water use (circ) should be inversely proportional to water withdrawals (wa).

But the regression between wa ~ circ suggest otherwise and it is statistically significant at the 0.05 CI

Call:

plm(formula = wa ~ circ, data = inddata, model = "within", index = c("Kreis",

"year"))

Balanced Panel: n = 23, T = 6, N = 138

Residuals:

Min. 1st Qu. Median 3rd Qu. Max.

-5541.4726 -148.9070 -2.7719 138.8532 6959.1166

Coefficients:

Estimate Std. Error t-value Pr(>|t|)

circ 0.62047 0.27750 2.236 0.0273 \*

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Signif. codes: 0 ‘\*\*\*’ 0.001 ‘\*\*’ 0.01 ‘\*’ 0.05 ‘.’ 0.1 ‘ ’ 1

Total Sum of Squares: 204650000

Residual Sum of Squares: 196060000

R-Squared: 0.042013

Adj. R-Squared: -0.15127

F-statistic: 4.99949 on 1 and 114 DF, p-value: 0.027302