

An exploration of water use intensity in the non-domestic sector in Singapore

Singapore International Water Week

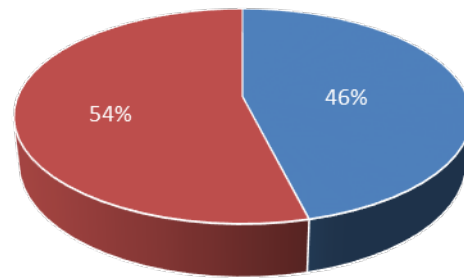
20 April 2022



Background

- The non-domestic sector accounts for a significant share of water consumption in most places

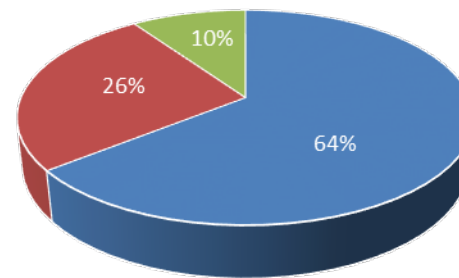
Singapore, 2019



■ Domestic ■ Non-Domestic

Source: singstat.gov.sg

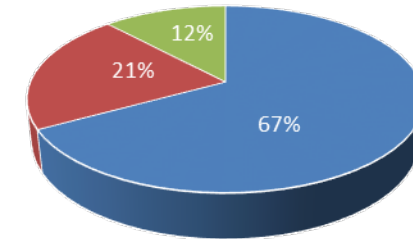
San Francisco Bay Area, 2019-2020



■ Residential ■ Non-residential ■ Irrigation

Source: bawasca.org/water/use/customer

Sydney, 2020-2021



■ Metered residential ■ Metered non-residential
■ Non-metered & losses

Source: sydneywater.com.au

- However, non-domestic urban water demand is much less studied than water demand by households:
 - Large diversity, high variability in water use
 - More difficult to get data, different metering practices

Exploration of water consumption data

- Large dataset with water consumption from PUB:
 - From monthly billing data from January 2011 to December 2019
 - For all, close to 260,000 unique non-domestic user accounts
 - Anonymised and de-sensitised, but with Singapore Standard Industrial Classification (SSIC) code
- Use of data analytics methods to obtain a better understanding of the characteristics of non-domestic water demand
- This presentation focuses on water use intensity: differences between sectors, development over time, and if it has been affected by conservation efforts
- Additional SingStat data used:
 - Quarterly, seasonally adjusted gross domestic product (GDP) by SSIC section
 - Monthly index of industrial production by SSIC division

Water demand management policies

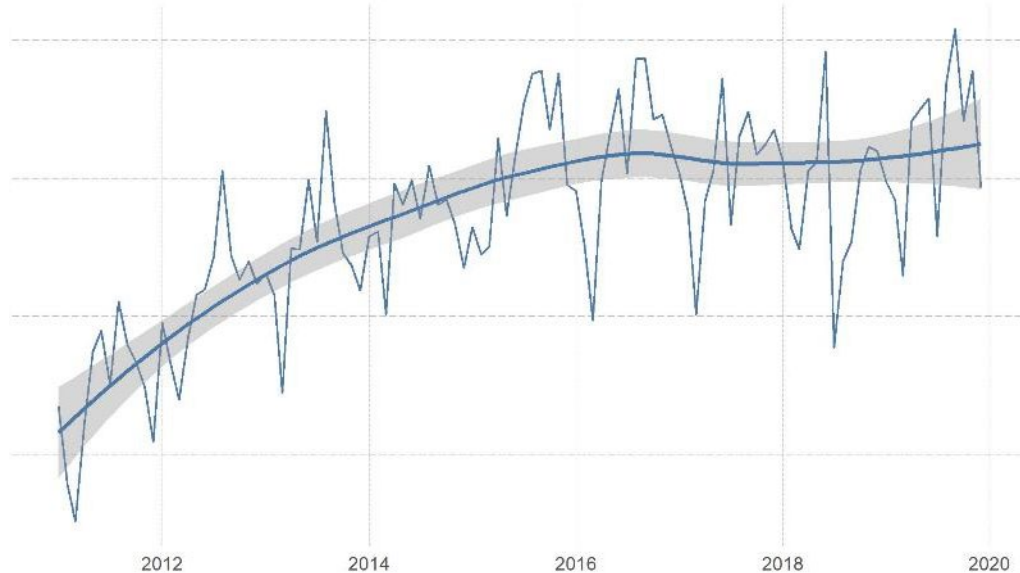
Non-domestic water demand management policies in Singapore in the period 2011-2019:

- Water tariff increases: from S\$1.52 to S\$1.82 in two steps in 2017 and 2018 for potable water and introduction of 10% water conservation tax for NEWater in 2017. Also the waterborne fee for wastewater was restructured and increased.
- Mandatory submission of Water Efficiency Management Plans for large users consuming $\geq 60,000\text{m}^3$ per year
 - Requirement came into effect in January 2015
- Several schemes to support development and implementation of water conservation technologies in industries
- Awards and certifications for water efficiency

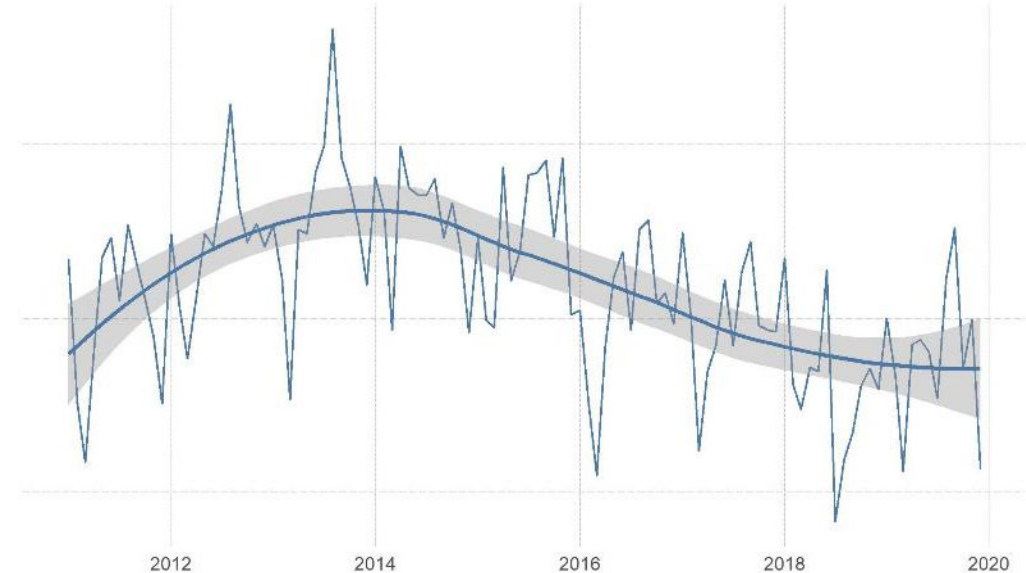
Aggregate and average water consumption

- Water consumption varies over time
- Aggregate demand increased up to about 2016
- Average demand per account declined since about 2014

Aggregated non-domestic water consumption trend



Average non-domestic water consumption trend



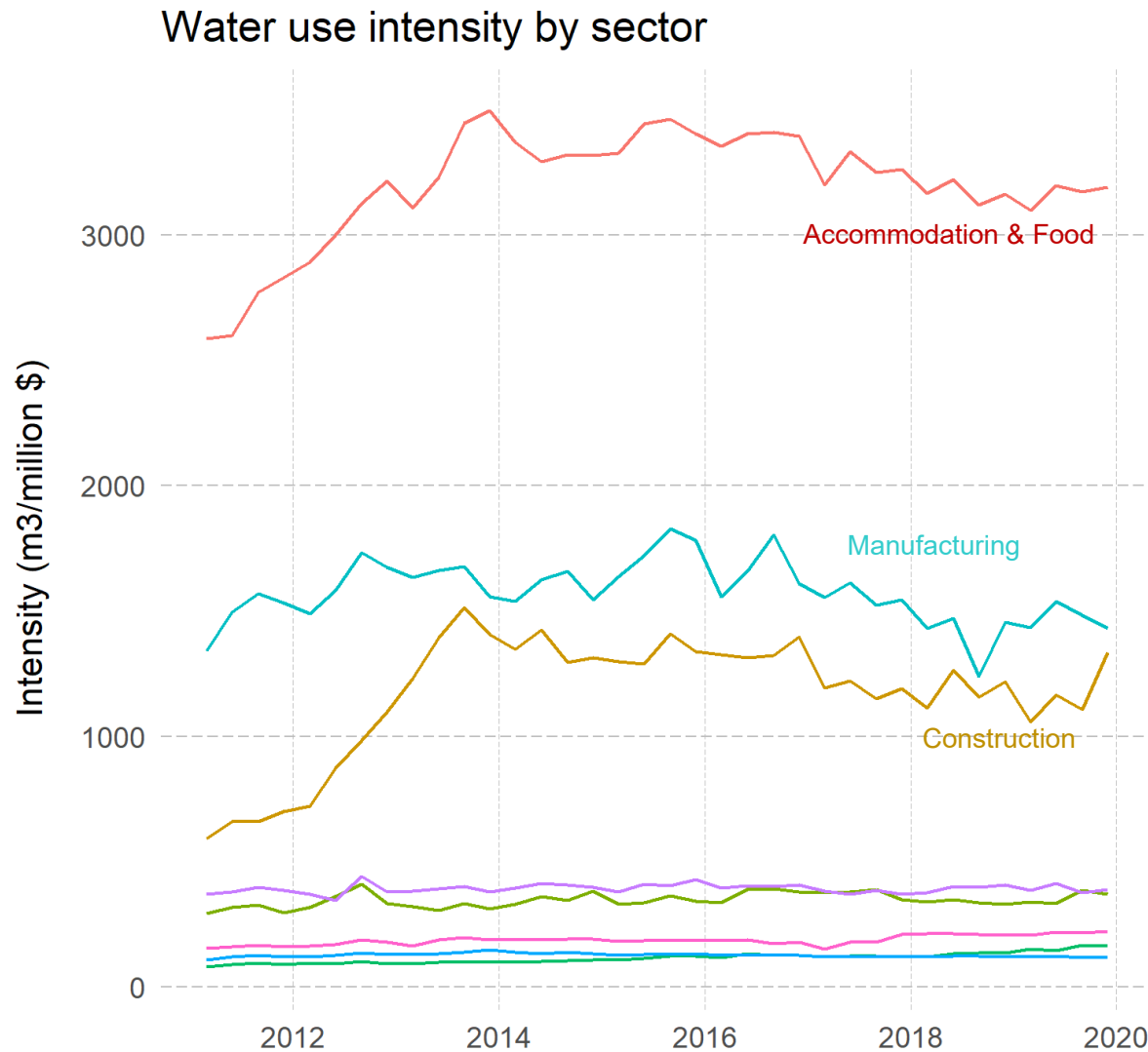
Water use intensity

$$\text{Water use intensity} = \frac{\text{Water consumption}}{\text{Value of production}}$$

- Provides insight into how much water is used for a dollar of production
- Countries which are water-stressed could get most value out of their water resources by focussing on industries that have a low water use intensity, and hence produce more with less water
- Insights in development of water use intensity could support non-domestic water management

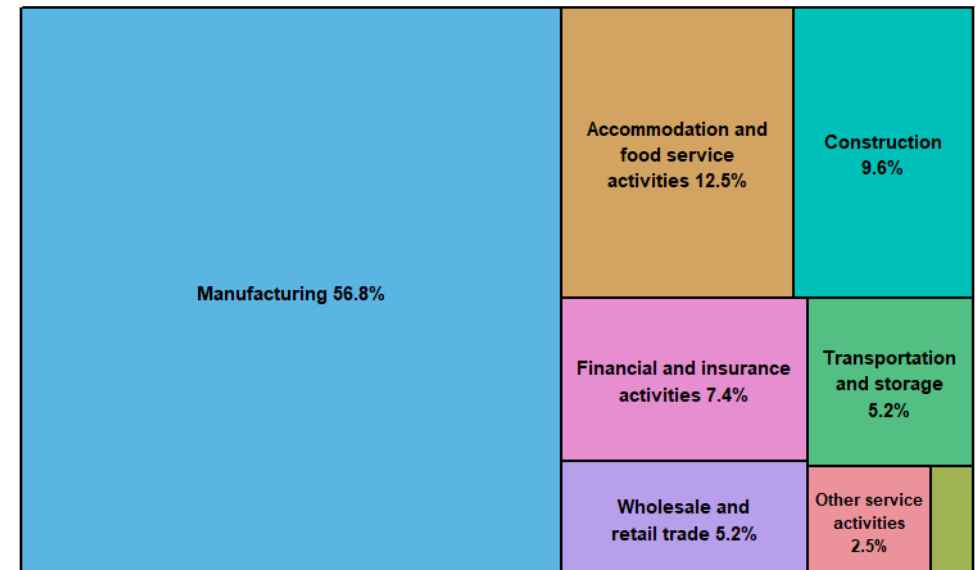
Water use intensity by economic sector

There is large variation in water use intensity among economic sectors



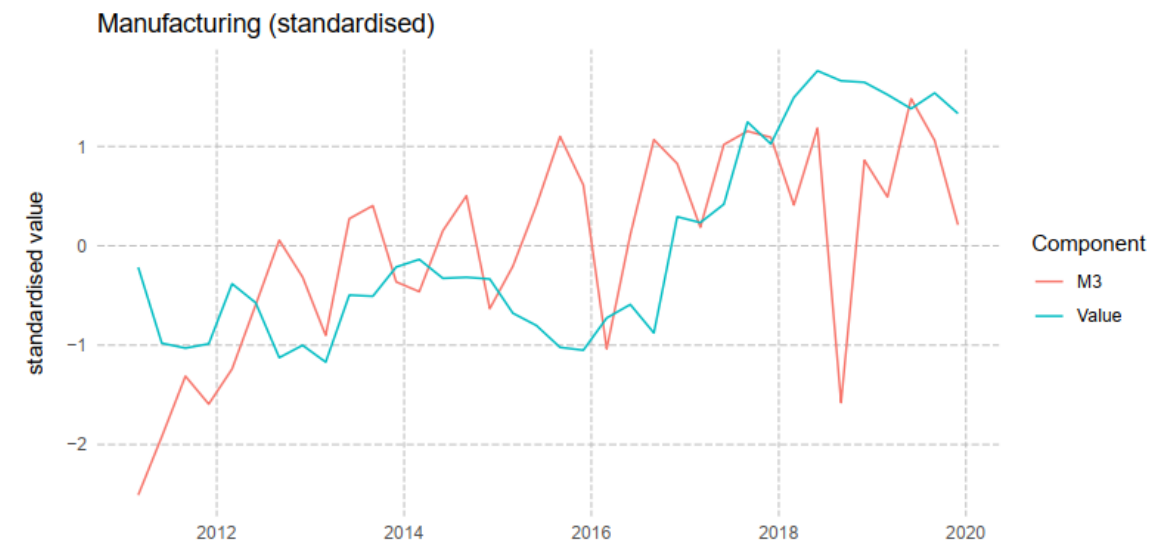
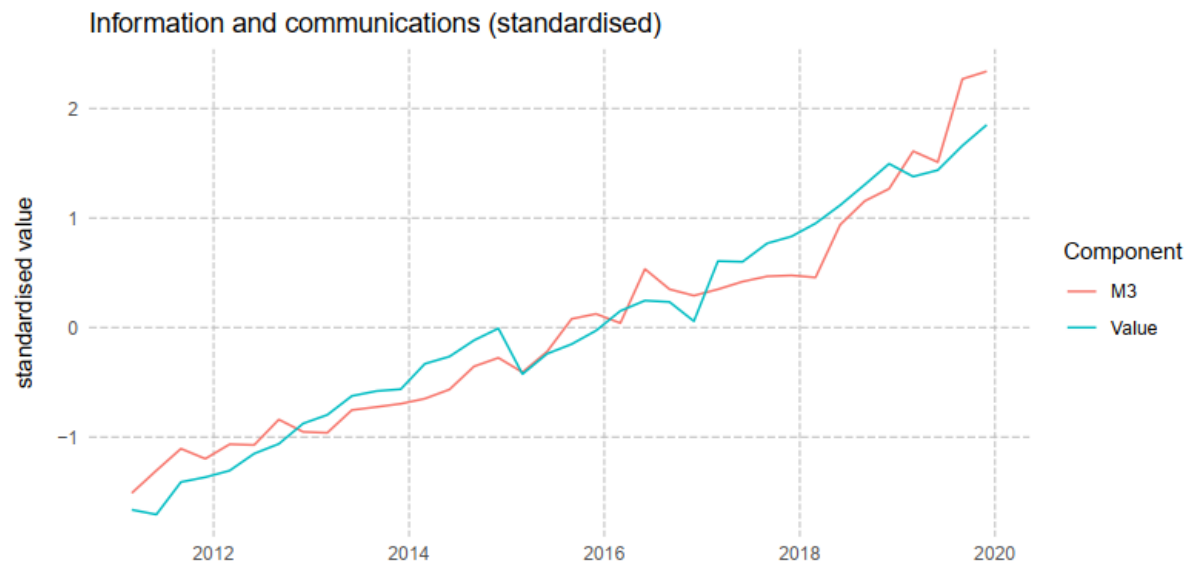
- Section name
- Accommodation and food service activities
 - Construction
 - Financial and insurance activities
 - Information and communications
 - Manufacturing
 - Other service activities
 - Transportation and storage
 - Wholesale and retail trade

Total water use

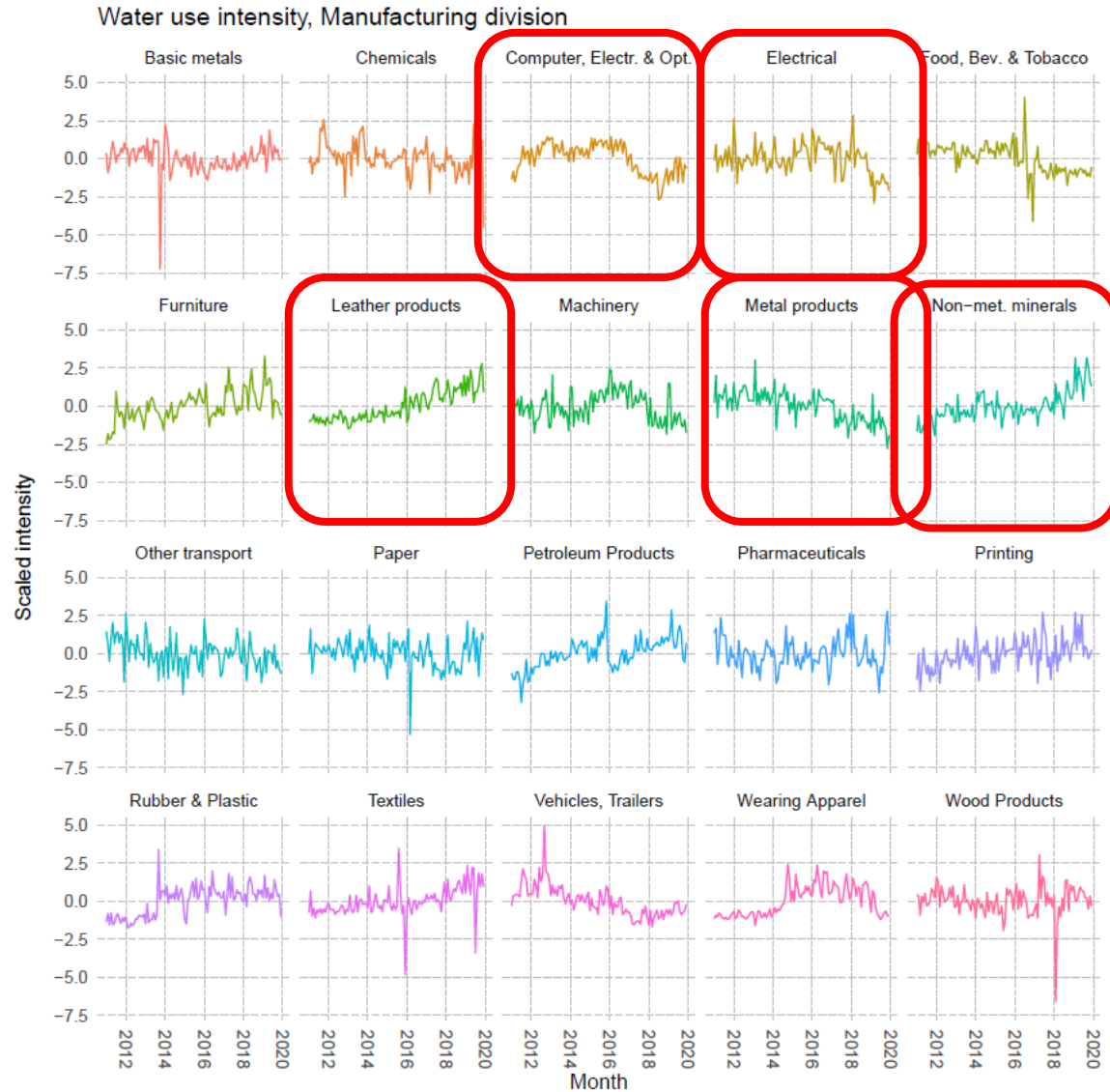


Variation between sectors

- Most sectors have strong correlation between water use and output (correlation coefficients 0.85 and higher) → rather constant water intensity
- Manufacturing has lowest correlation coefficient (0.42) → more variable water intensity



Water use intensity in manufacturing



- Water use intensity in m^3 water use per index-point of production
- Different manufacturing divisions show different patterns over time

Breaking down water use intensity

- The water use intensity of a sector could change as the result of:
 1. Individual users becoming more efficient, e.g. by adopting water saving technologies
 2. Changes in composition of a sector towards companies that use more or less water per dollar of production, e.g. shift from oil refinery to battery production in the energy sector
- These two effects have different implications for water demand management

Divisia Index

- The Divisia index can be used to decompose changes in water consumption into:
 - sectoral intensity effect (techniques)
 - product mix effect (composition)

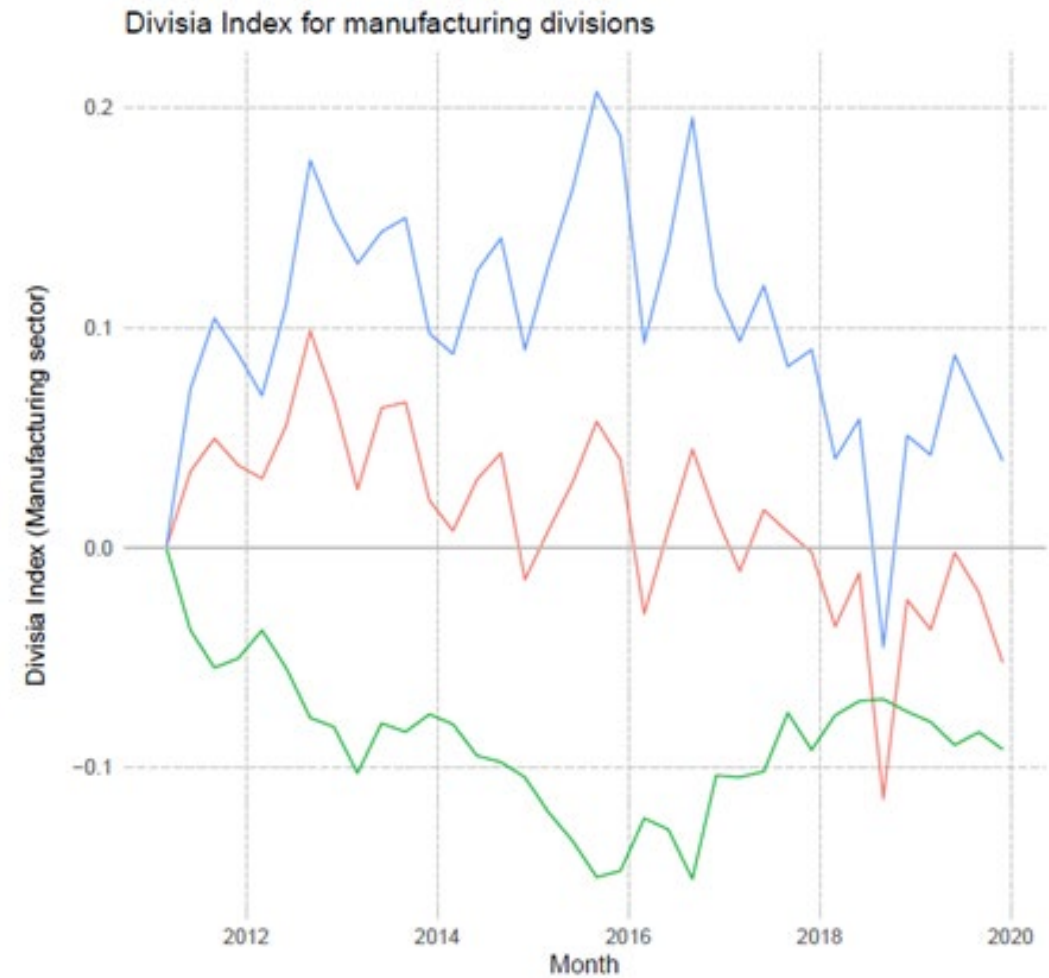
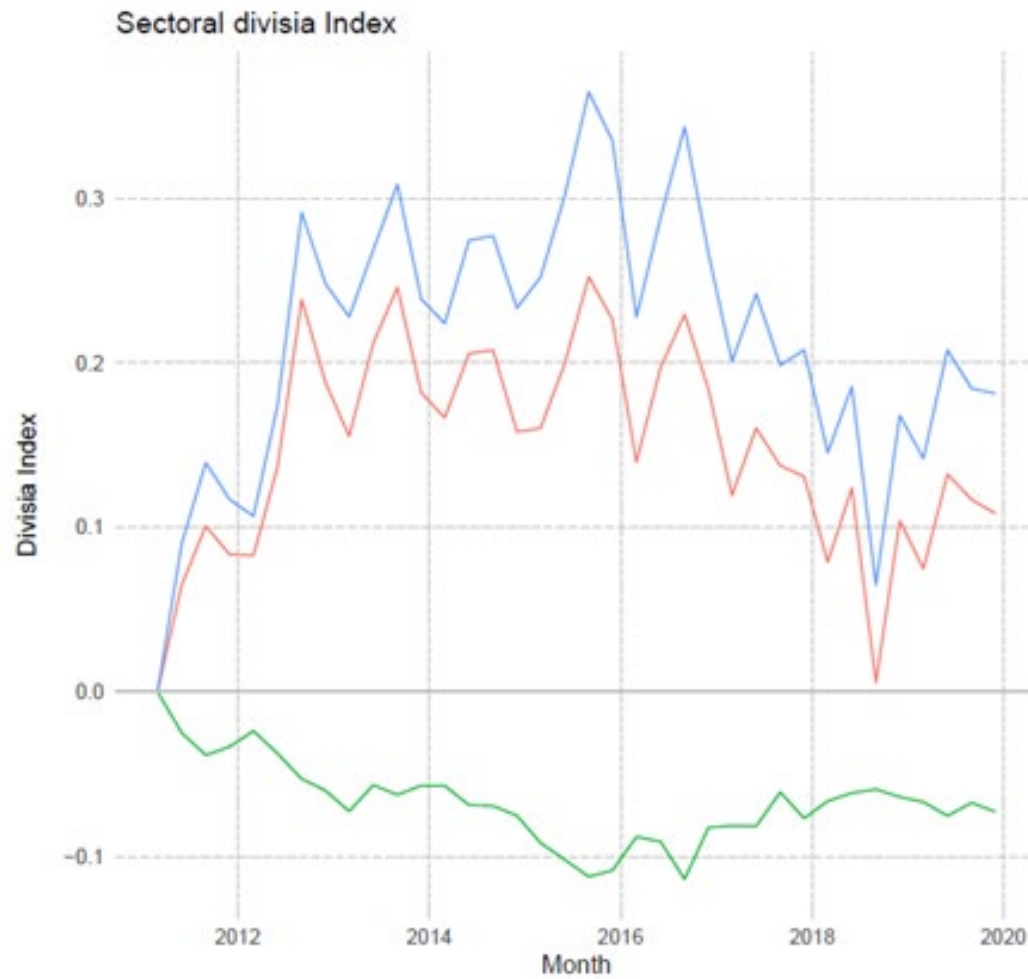
$$I_t = \frac{Q_t}{Y_t} = \sum_{k=1}^n \frac{Q_t^k}{Y_t^k} \frac{Y_t^k}{Y_t} = \sum_{k=1}^n I_t^k S_t^k$$

Q water use
 Y production
 t time period
 k sector
 I_t^k sectoral water use intensity
 S_t^k share of the sector in total production

- Changes can be calculated with the following equation:

$$\frac{I_t}{I_0} - 1 = \frac{1}{I_0} \sum_{k=1}^n \frac{L(I_t^k S_t^k, I_0^k S_0^k)}{L(I_t^k, I_0^k)} (I_t^k - I_0^k) + \frac{1}{I_0} \sum_{k=1}^n \frac{L(I_t^k S_t^k, I_0^k S_0^k)}{L(S_t^k, S_0^k)} (S_t^k - S_0^k)$$

Changes in water use intensity over time



— aggregate intensity — Product mix (composition) — Sectoral intensity (techniques)

Conclusions

- There are large differences in water use intensity between different sectors in Singapore, with Accommodation and food services, Manufacturing, and Construction being most water intensive
- Sectoral intensity trend is decreasing after 2016, which could suggest there is an impact of PUB's efforts to stimulate water conservation in the non-domestic sector