



How Did the COVID-Pandemic Impact Water Usage in Long Beach, CA?

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Status Qua

- Water usage by 80k accounts
- Water usage by 6 type of customers within three years (2017 - 2020)
- Water Department
 - Find effective ways to provide reliable water supply
- Customers
 - Mange their usage and save on water bills
- Government
 - Effectively allocate budget to provide the required Facilities

Residential



Commercial



Irrigation



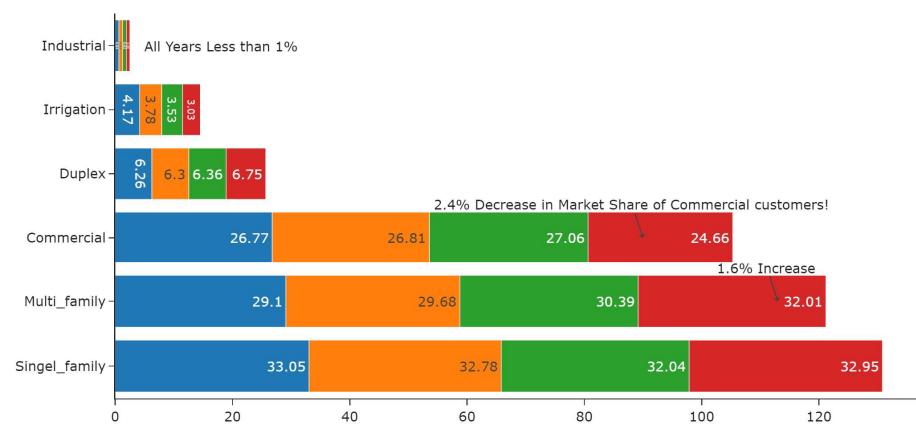
Problem



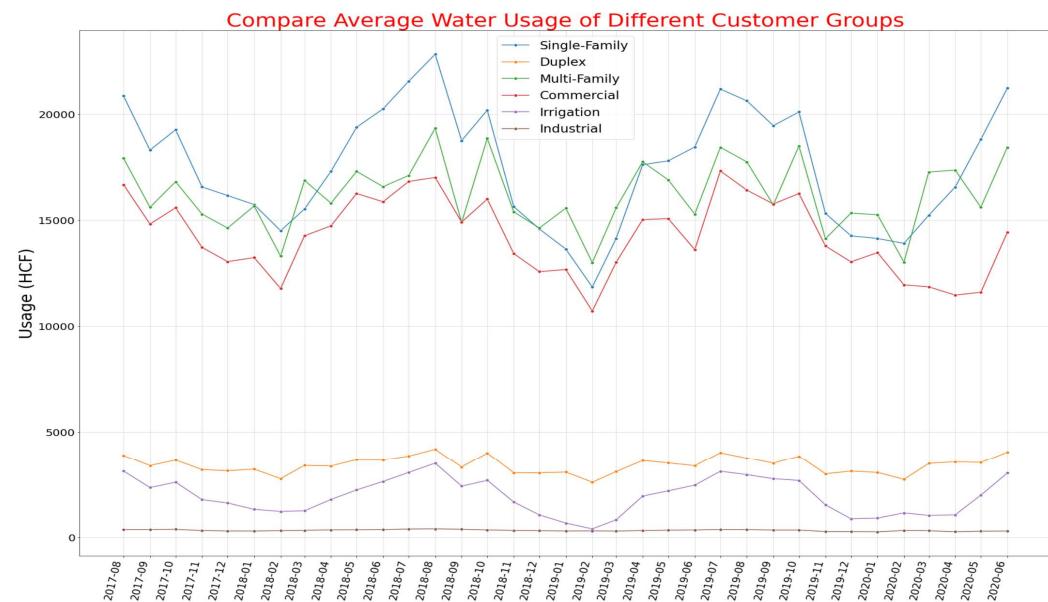
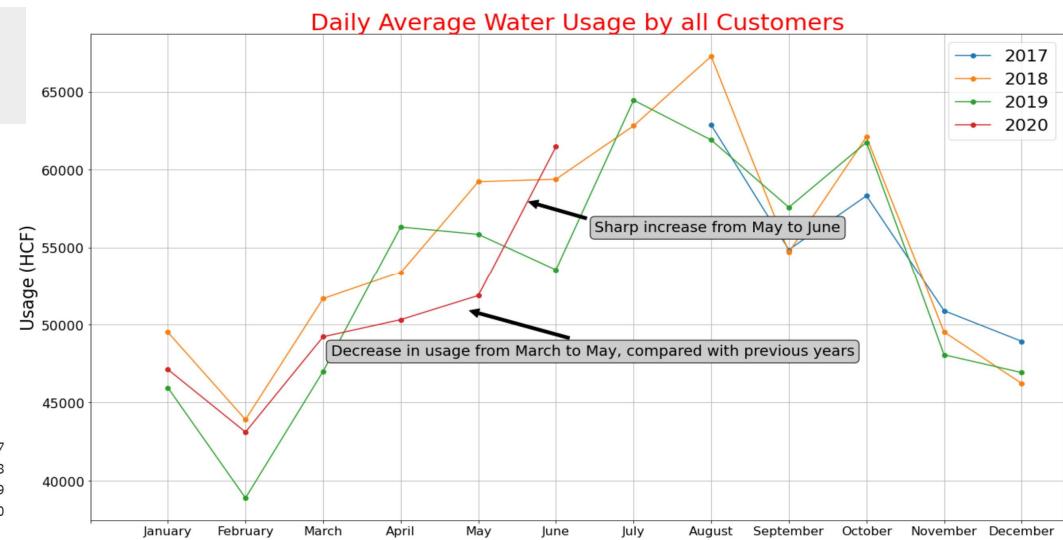
- Did COVID-Pandemic affect water usage?
- Which models better explain and predict water usage by different groups of customers?

Key Findings

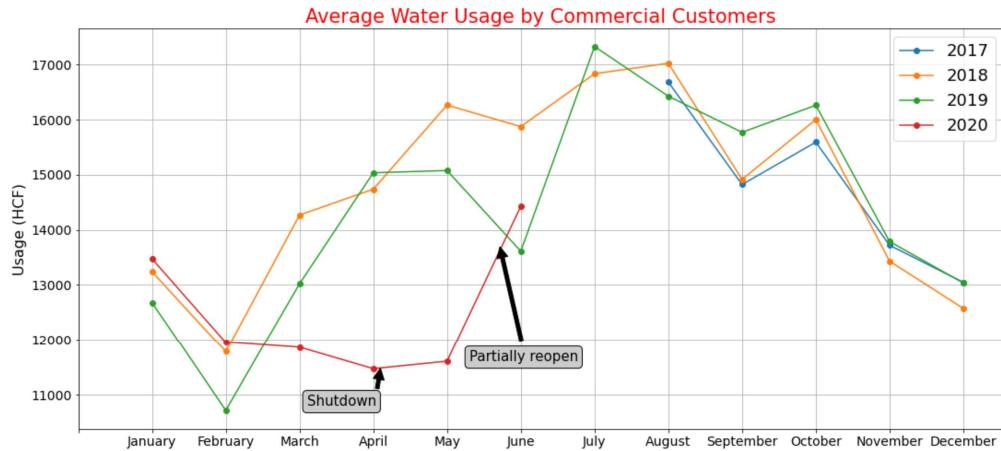
Market Share of Water Usage



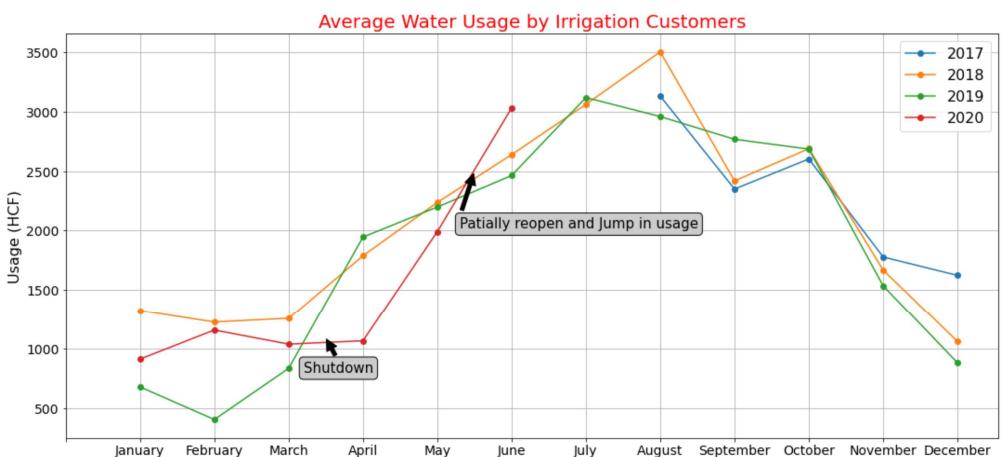
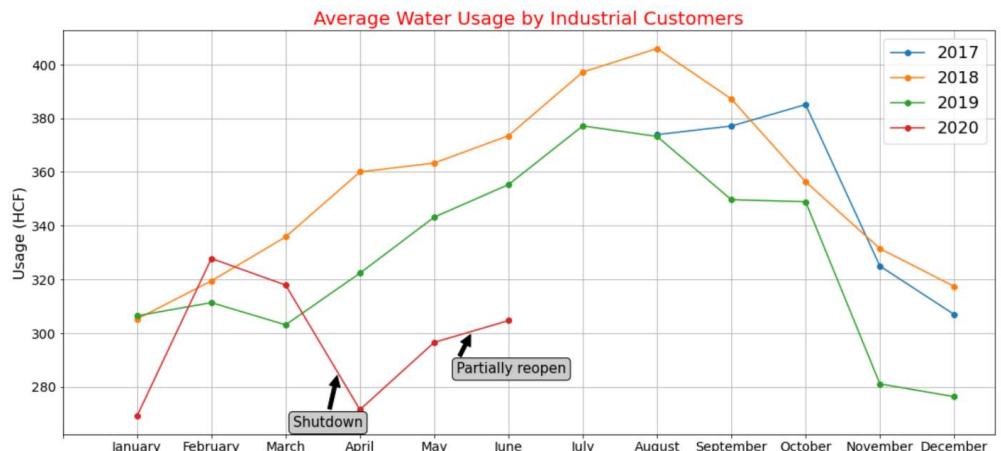
Approximately 80,000 customers



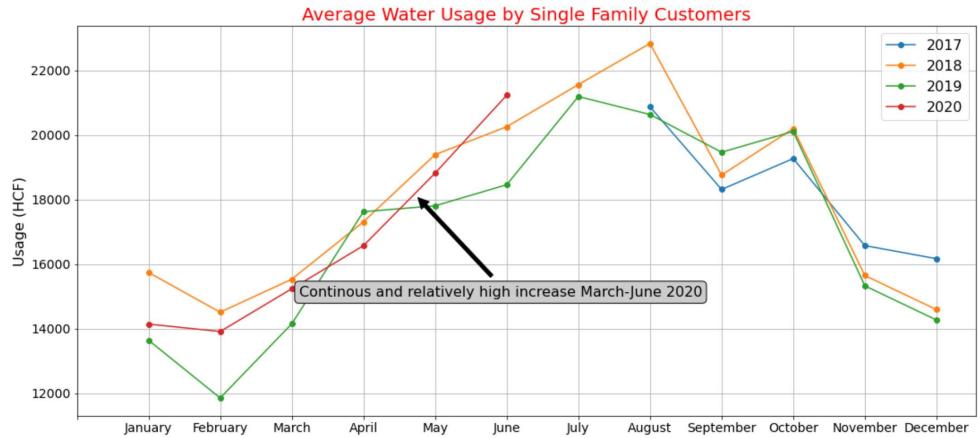
Key Findings on Non-Residential Customers



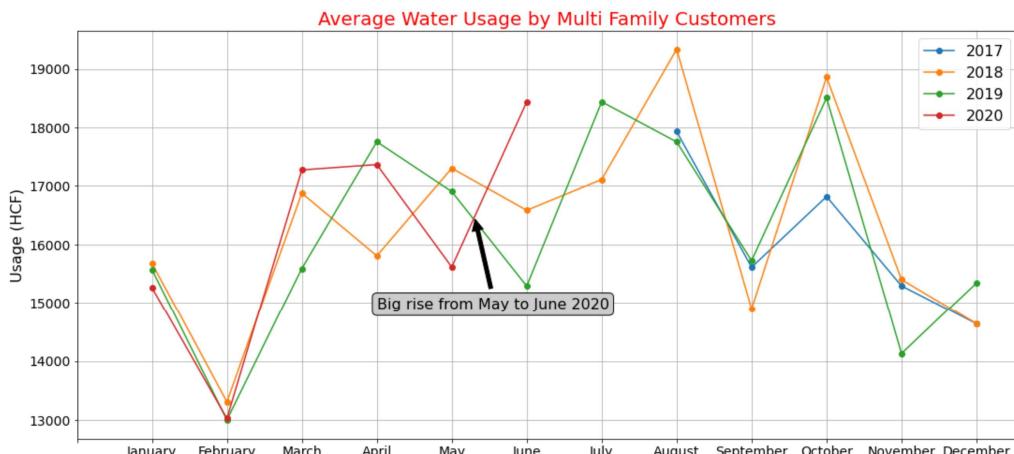
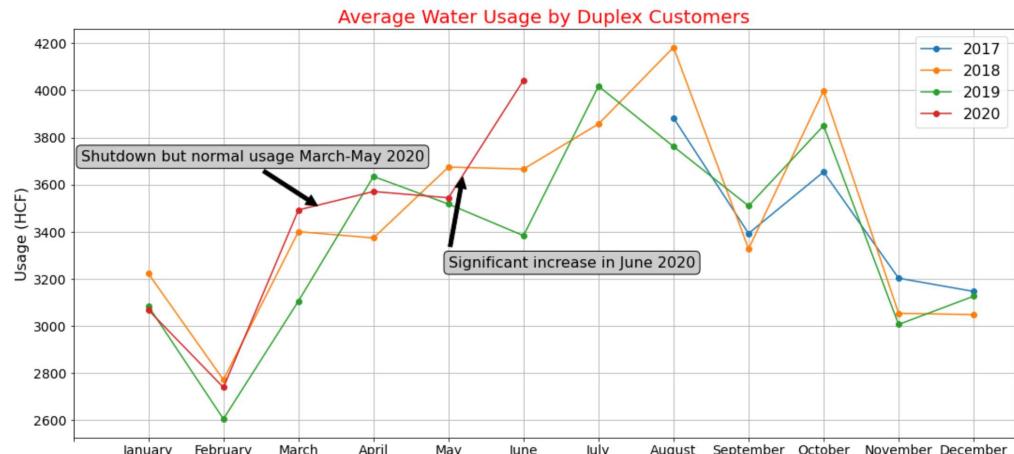
- Shutdown and sharp drop in April and May
- Reopen and usage jump in June

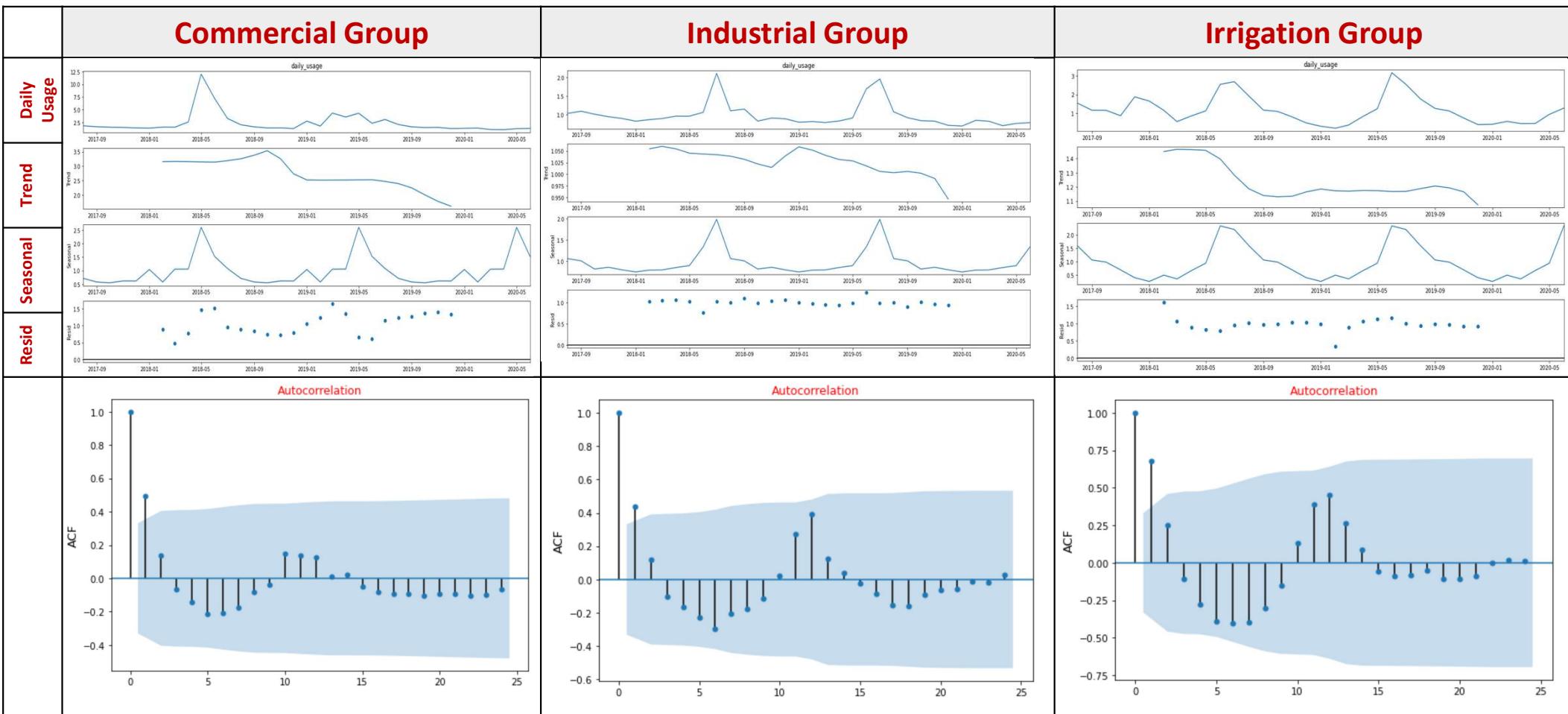


Key Findings on Residential Customers

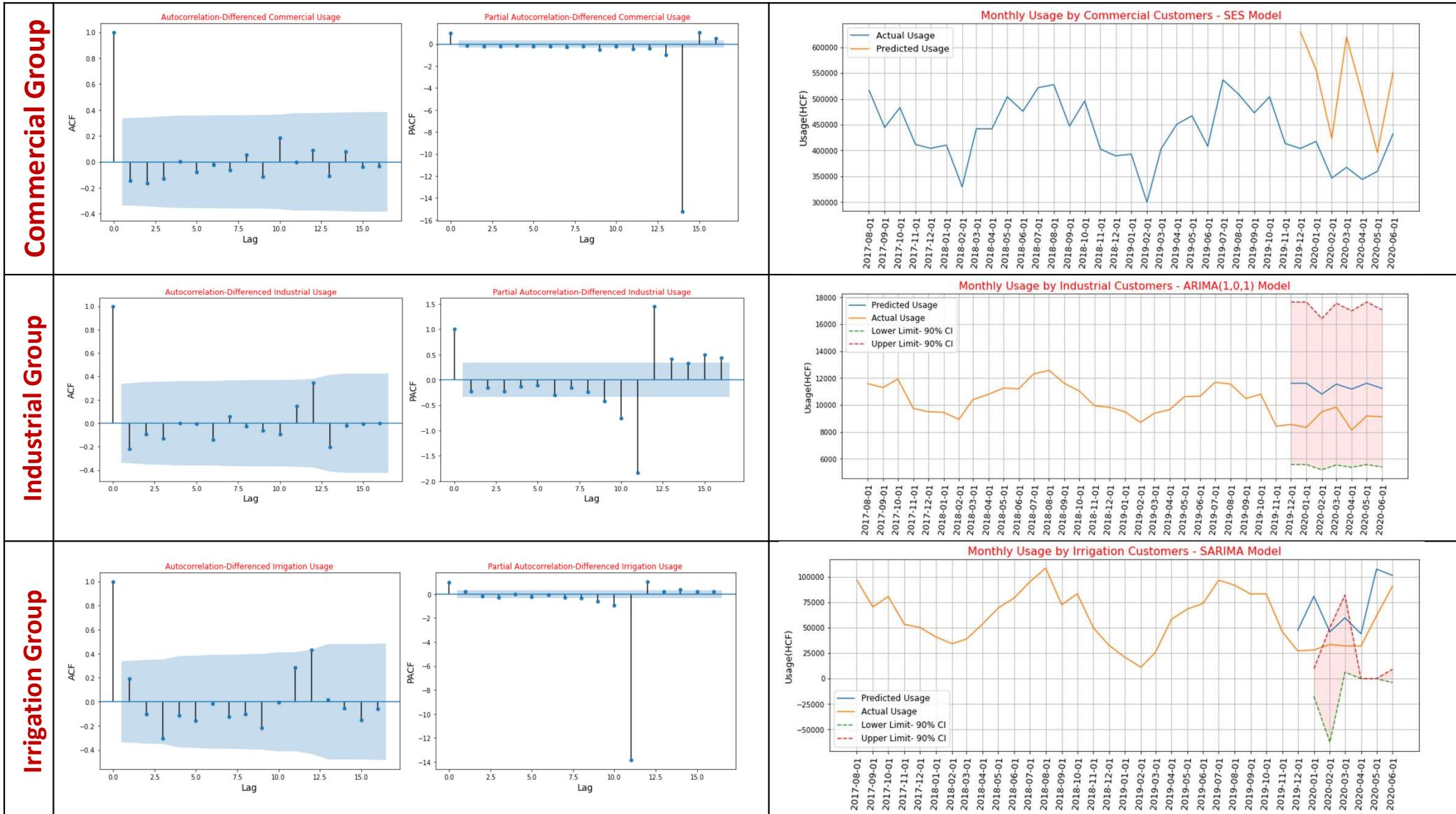


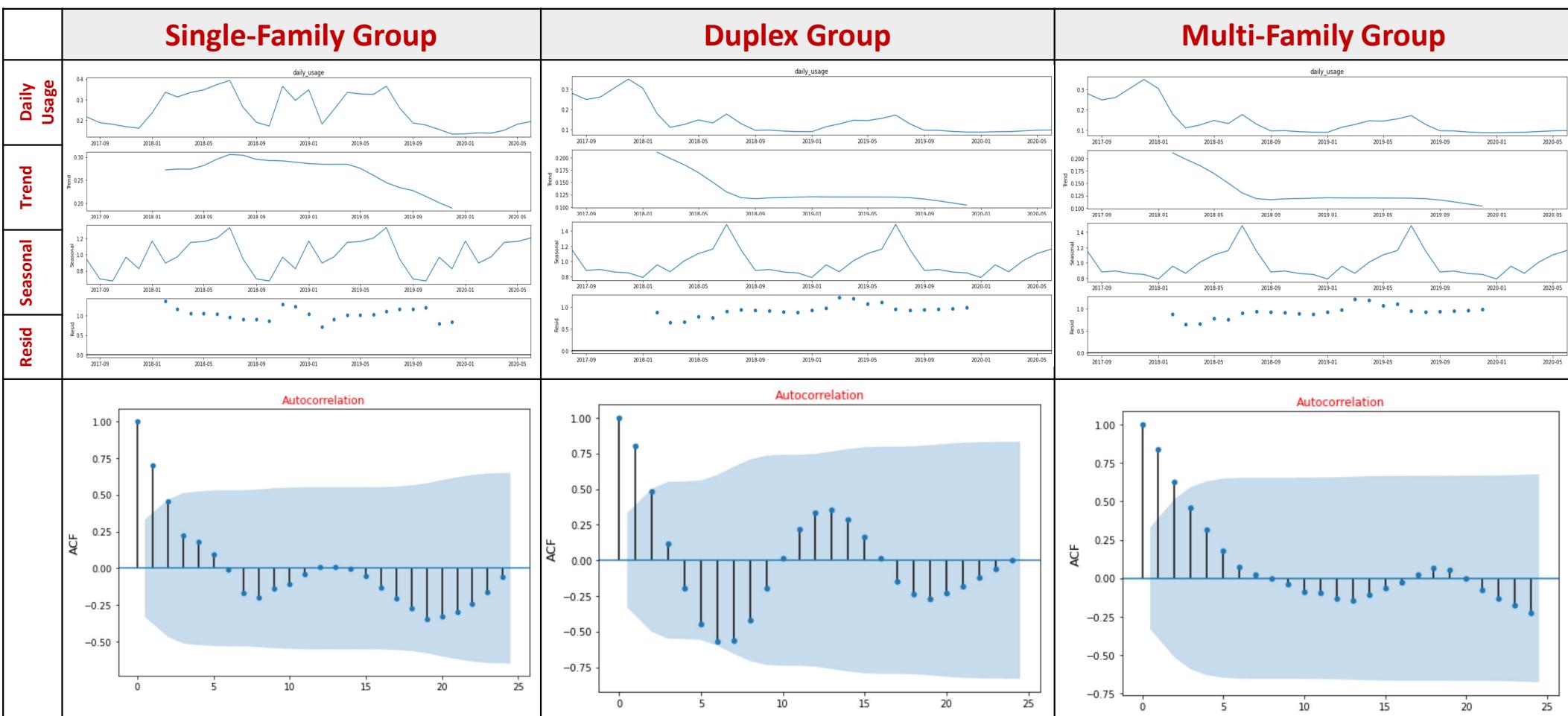
- Single family kept its trend
- Multi family and duplex:
 - Normal increase from March to May
 - Decrease in May
 - Grow in June



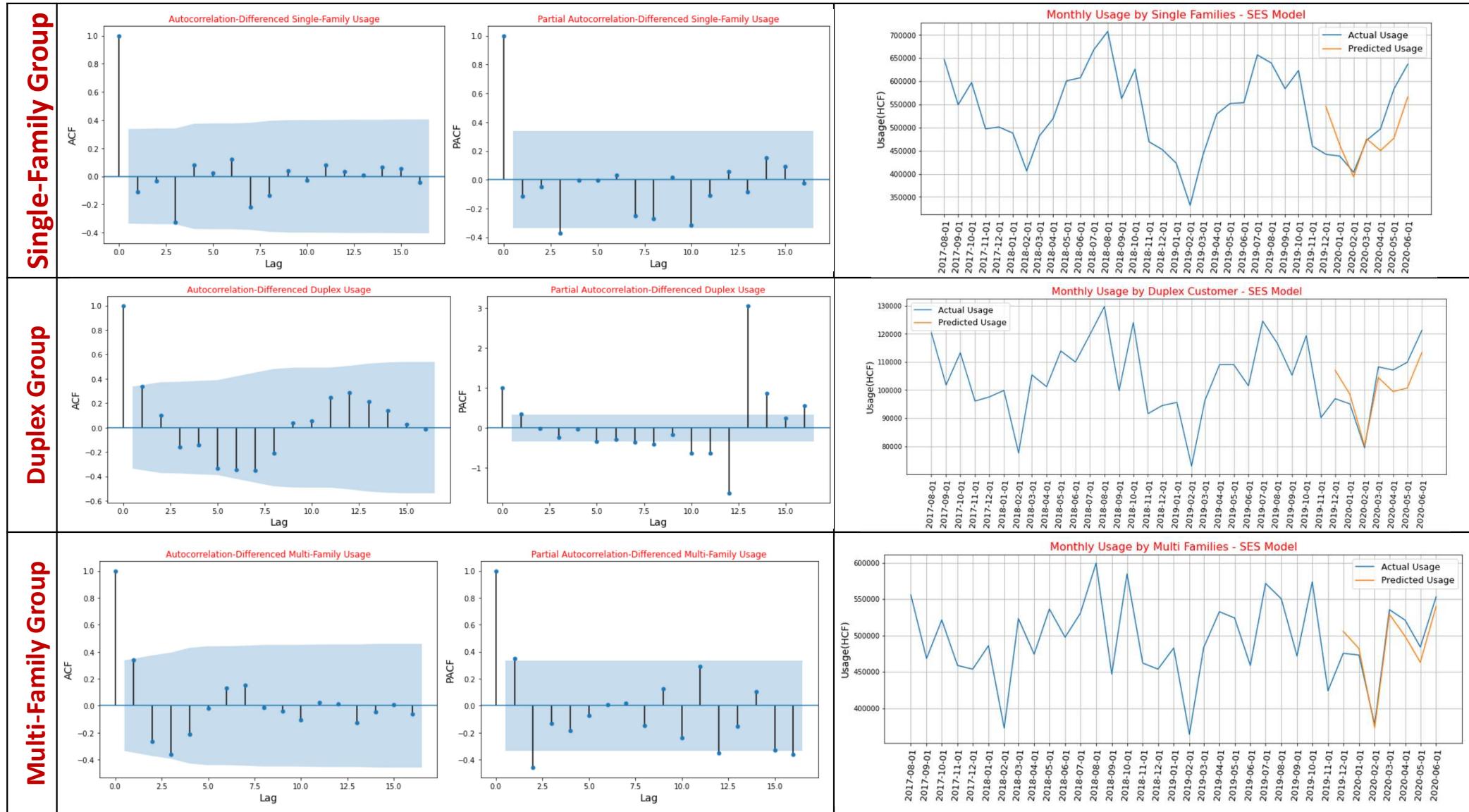


Not a white noise, but non-stationary time series

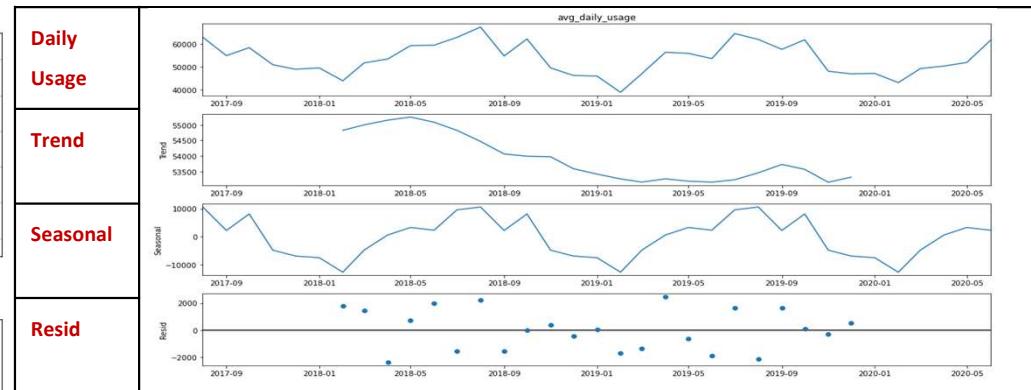
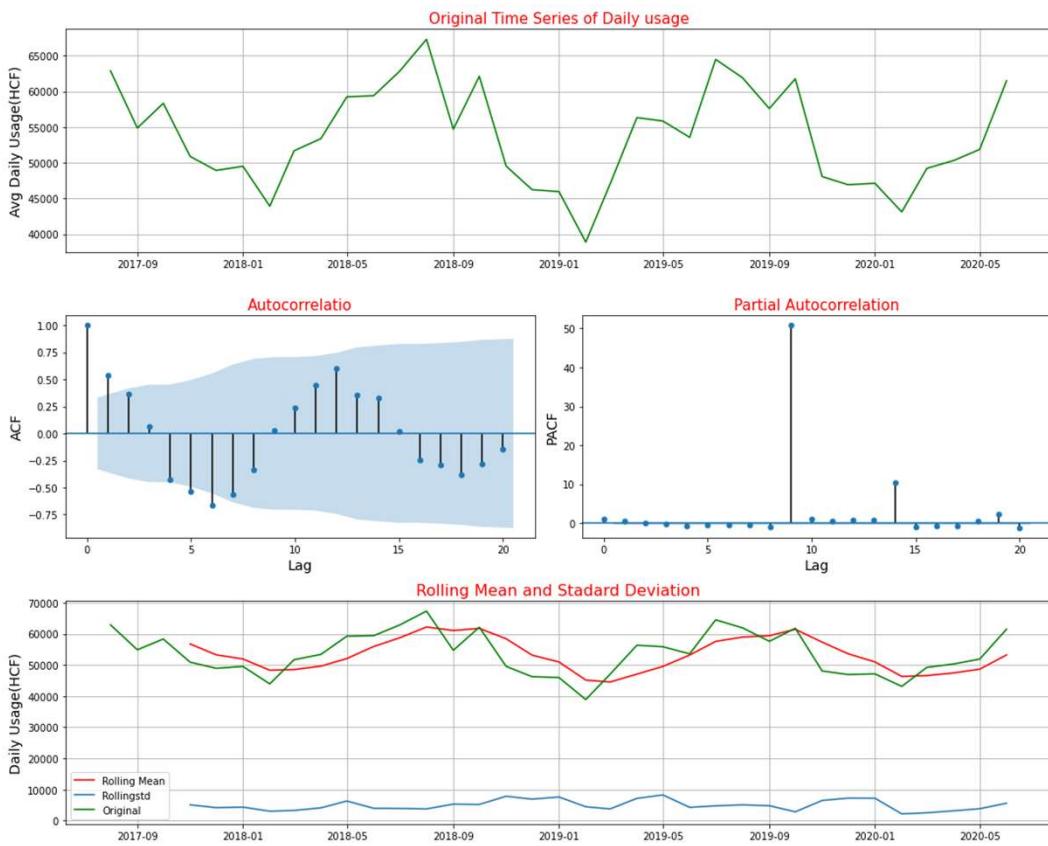




Not a white noise, but non-stationary time series



Key Findings on Daily Usage by All Customers

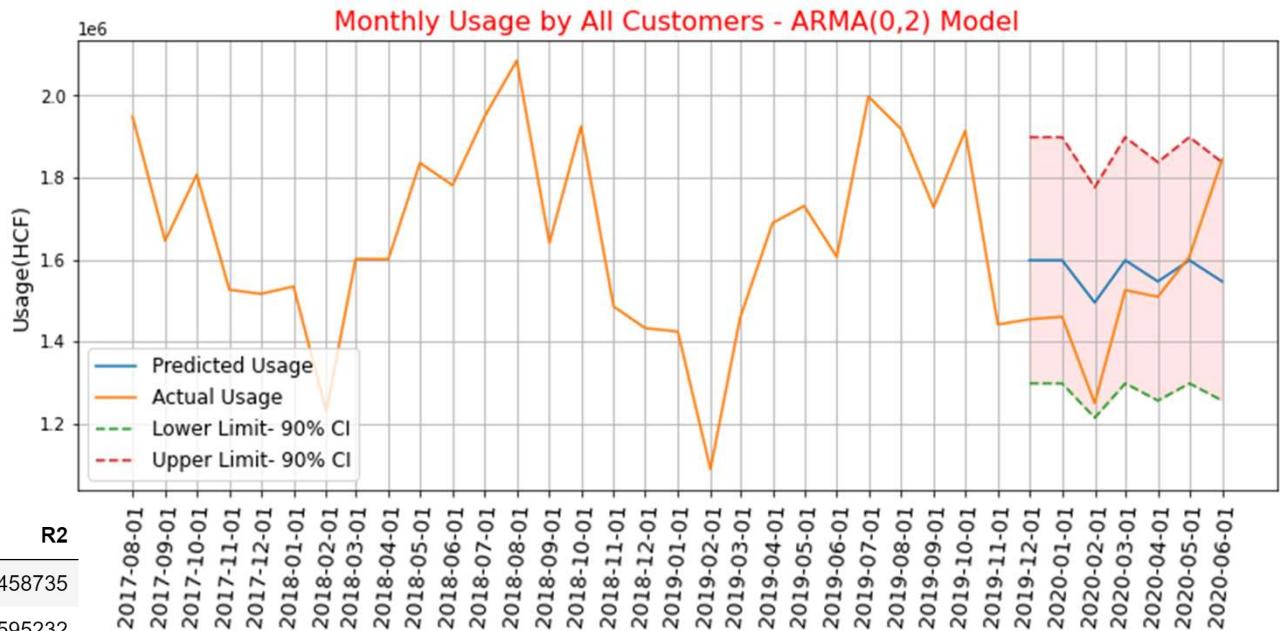


Stationary Time Series

Results of Dickey-Fuller Test:

test statistic	-5.068553
p-value	0.000016
# Lags Used	5.000000
# Observation Used	29.000000
Critical Value 1%	-3.679060
Critical Value 5%	-2.967882
Critical Value 10%	-2.623158
dtype:	float64

Prediction of Usage by all Customers



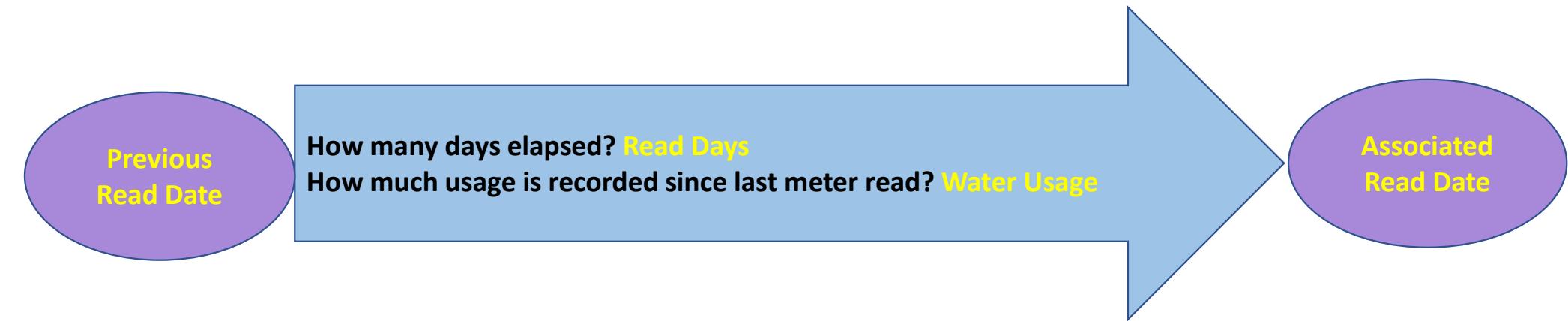
Next Step

- Fitting and building predictive linear models to measure the importance of customer groups on the amount of usage
- Building ensemble models like Random Forest Regression to measure importance of month of year in usage

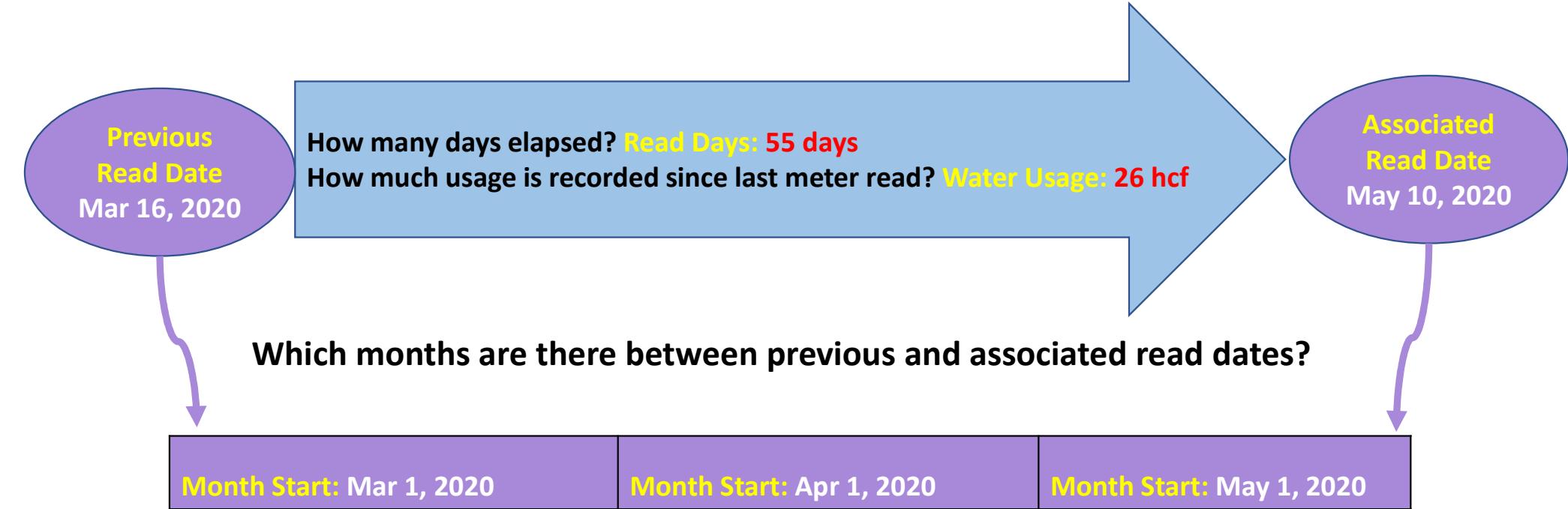
Data Wrangling

How Much Water Used in each Month?

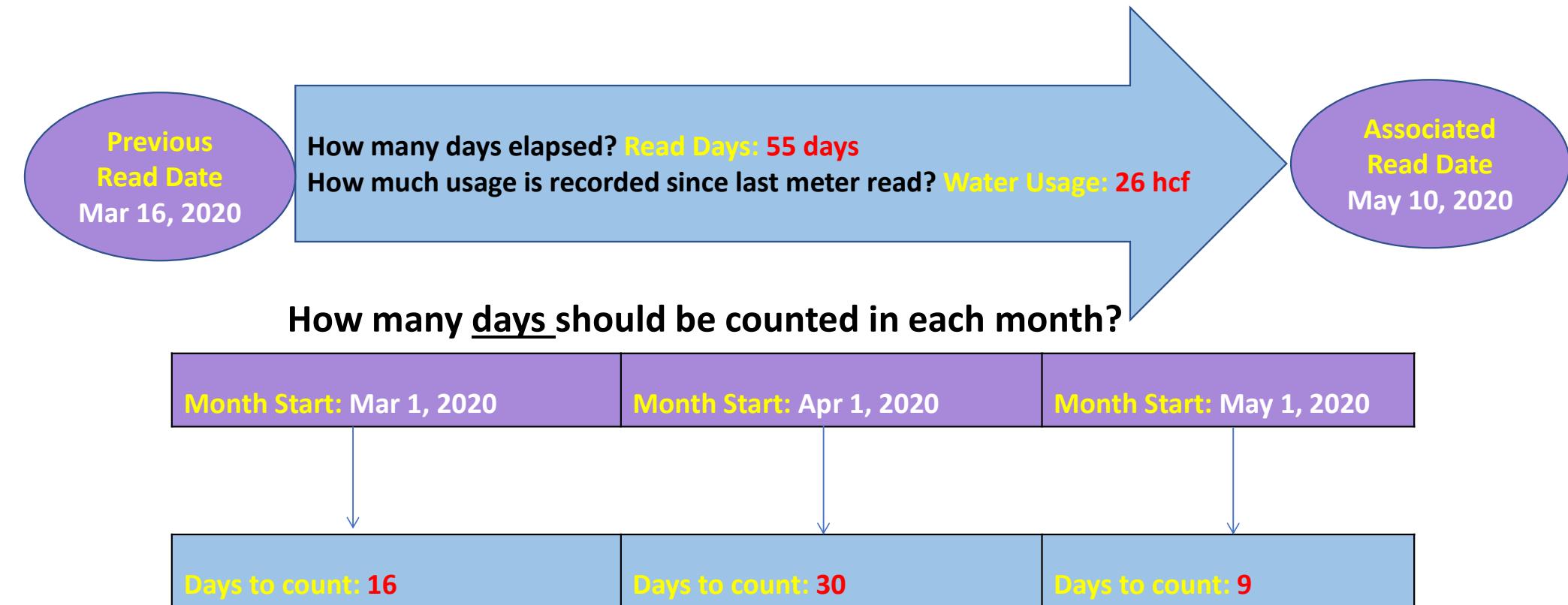
(based on the Records of Water Meter)



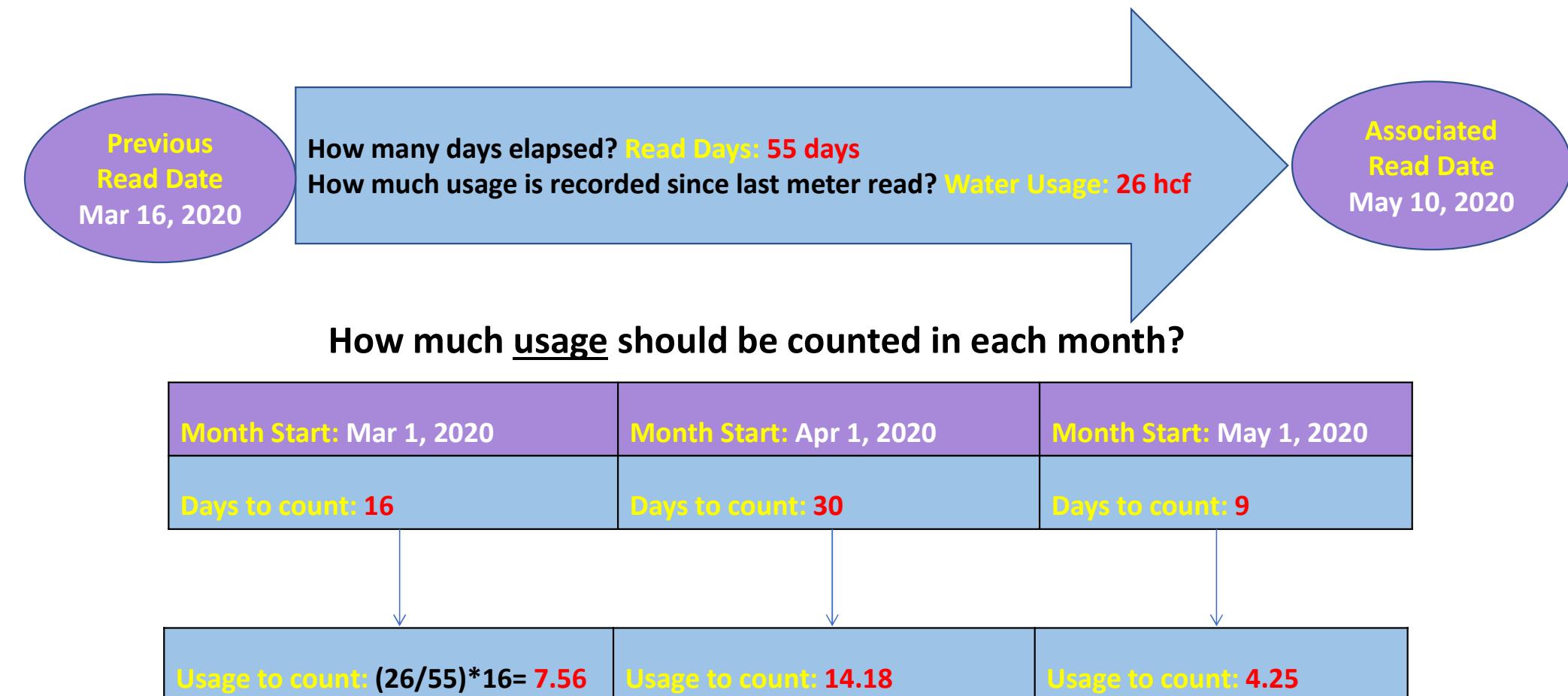
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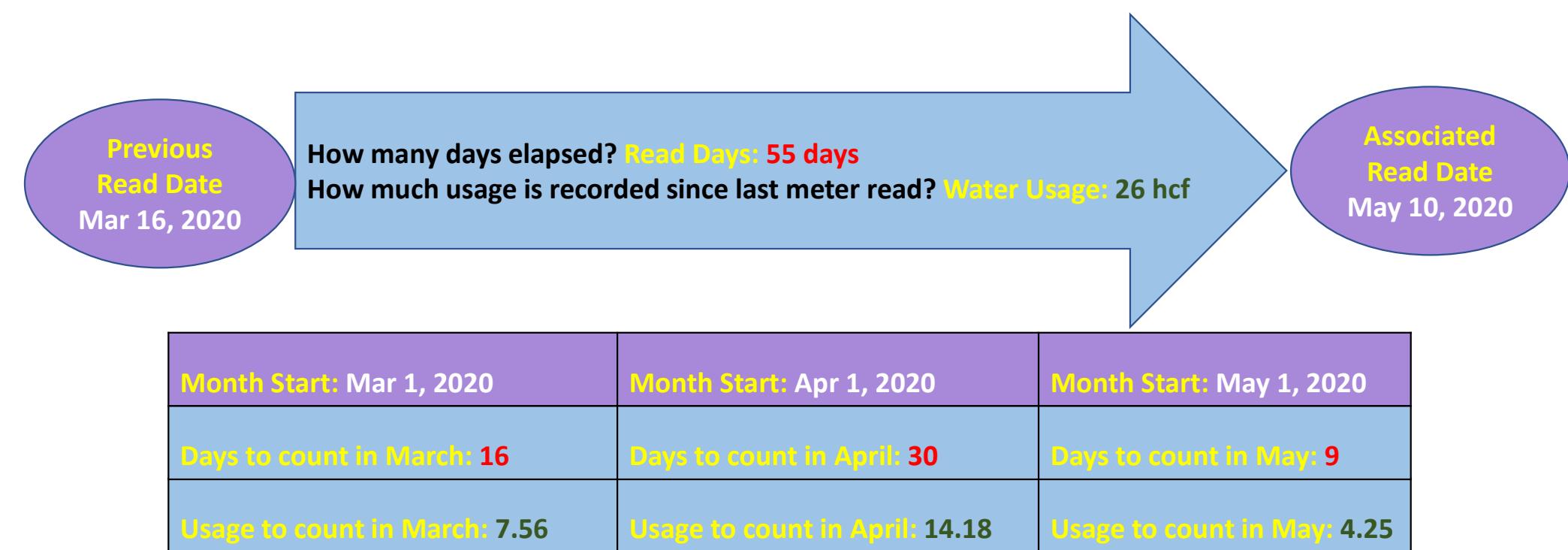
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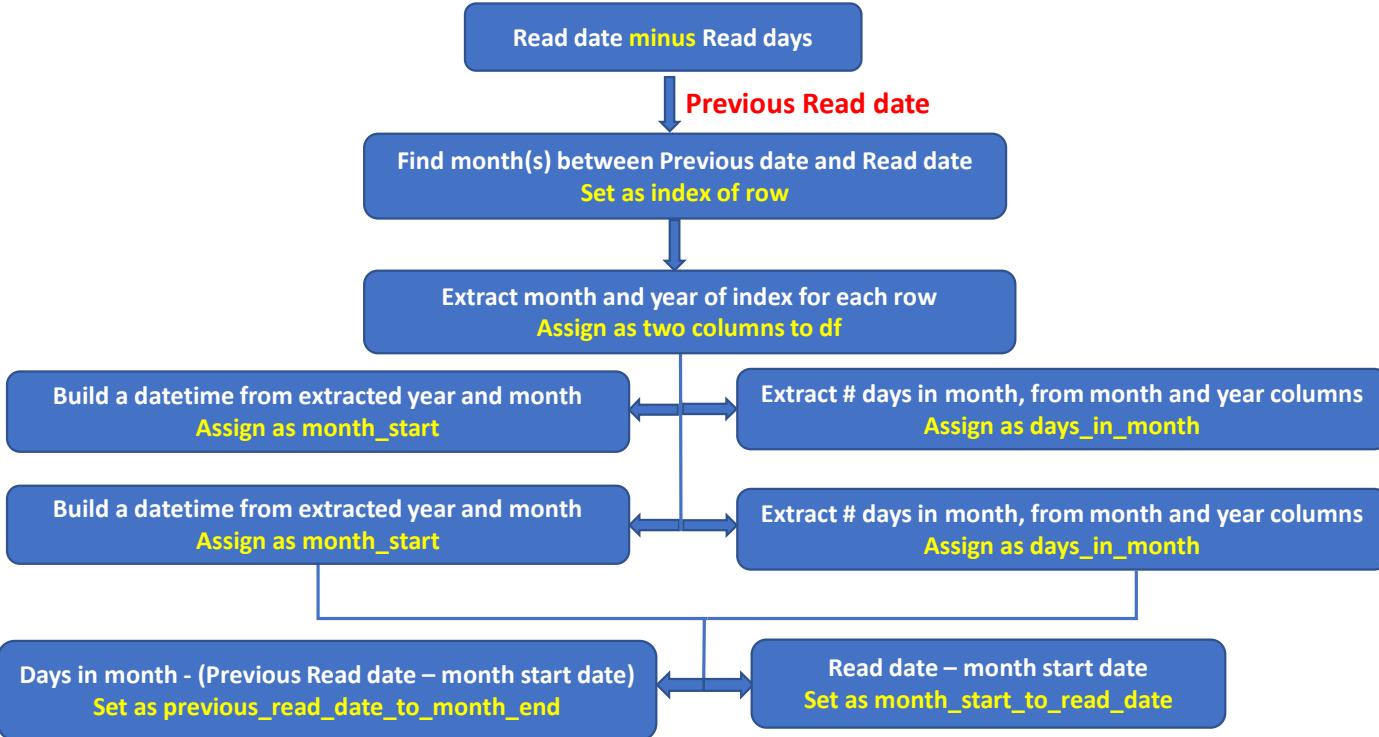
How Much Water Used in each Month?



How Much Water Used in each Month?



Algorithm



Days in month			
Month Start	Previous Read Date	Month End	Read Date
	<code>previous_read_date_to_month_end</code>		
	<code>read_date_to_month_start</code>		
	<code>days_to_count_in_period</code>		

IF	Then 'days_to_count_in_period' will be
previous_read_date_to_month_end <= days in month	previous_read_date_to_month_end
previous_read_date_to_month_end > days in month & read_date_to_month_start >= days in month	Days in month
previous_read_date_to_month_end > days in month & read_date_to_month_start < days in month	read_date_to_month_start

Examples of the algorithm application

Days in March = 31			
Month Start Mar 1, 2020	Previous Read Date <u>March 16, 2020</u>	Month End	Read Date May 10, 2020
previous_read_date_to_month_end 16 days			
read_date_to_month_start 70			

previous_read_date_to_month_end <= days in month (16 <= 31)

Month Start	days_to_count_in_period
2020-03-01	16

Days in April = 30			
Month Start April 1, 2020	Previous Read Date <u>March 16, 2020</u>	Month End	Read Date May 10, 2020
previous_read_date_to_month_end 30-(-16) = 46 days			
read_date_to_month_start 39			

previous_read_date_to_month_end > days in month (46 > 30)
& read_date_to_month_start >= days in month (39 >= 30)

Month Start	days_to_count_in_period
2020-04-01	30

Days in May = 31			
Month Start May 1, 2020	Previous Read Date <u>March 16, 2020</u>	Month End	Read Date May 10, 2020
previous_read_date_to_month_end 31-(-46) = 77 days			
Read_date_to_month_start 9 days			

previous_read_date_to_month_end < days in month (77 > 31)
& read_date_to_month_start < days in month (9 < 30)

Month Start	days_to_count_in_period
2020-05-01	9

Days in March = 31			
Month Start Mar 1, 2020	Previous Read Date <u>March 16, 2020</u>	Month End	Read Date May 1, 2020
previous_read_date_to_month_end 16 days			
read_date_to_month_start 56			
previous_read_date_to_month_end <= days in month then (16 <= 56)			

Month Start	days_to_count_in_period
2020-03-01	16

Days in April = 30			
Month Start April 1, 2020	Previous Read Date <u>March 16, 2020</u>	Month End	Read Date May 1, 2020
previous_read_date_to_month_end 30 - (-16) = 46 days			
read_date_to_month_start 30			
previous_read_date_to_month_end > days in month (46 > 30) & read_date_to_month_start >= days in month (30 >= 30)			

Month Start	days_to_count_in_period
2020-04-01	30

Days in May = 31			
Month Start May 1, 2020	Previous Read Date <u>March 16, 2020</u>	Month End	Read Date May 1, 2020
previous_read_date_to_month_end 31 - (-46) = 77 days			
Read_date_to_month_start 0 days			
previous_read_date_to_month_end < days in month (77 > 31) & read_date_to_month_start < days in month (0 < 30)			

Month Start	days_to_count_in_period
2020-05-01	0