Weekly Report – 51

Xiufeng Liu

University of Waterloo, CA
xiufeng.liu@uwaterloo.ca

1 Introduction

2 Water Demand Forscasting Issues

2.1 Forcasting Models

2.2 Time Scales

2.3 Water Demand Patterns

3 Materials

3.1 Water Data and Customer Types

The water consumption data is from Abbotsford city, British Columnbia, Canada from September 1, 2012 to August 31, 2013. Daily and hourly time-series data were collected from 25,294 customers, distributed in six customer groups (see Figure ??). There are 2013 215,172,496 data points in total for the hourly time-seriels data, and 9,232,310 data points for the daily time-series data (roughly 10GB in total). The residential customers are discriminated according to the house types, which are single family residential (SFRES) and multifamily residential (MFRES). As shown, the single family residential has the biggest share (79.61%).

The climate data at the same period were downloaded from from Environment Canada (https://weather.gc.ca). The data contains the weather temperature at hourly resolution, and the rainfall at daily resolution.

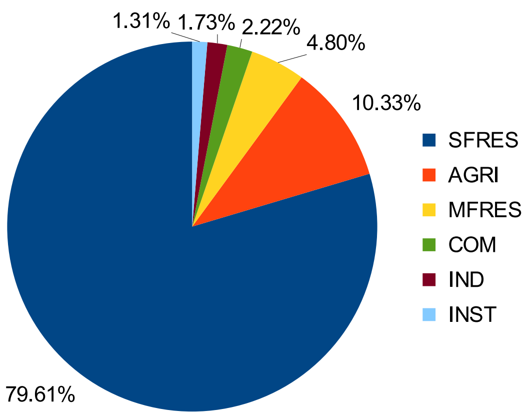

Fig. 1. Types of customers

file=images/watercustomergroups, scale=0.53
(a) 3-Line

file=images/waterconsumptiondist, scale=0.53
(b) Histogram

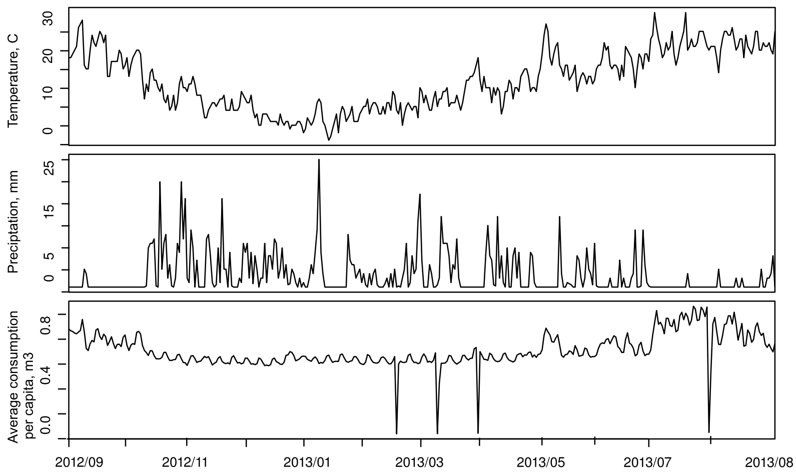

Fig. 2. The average weekly profile of residential water consumption

3.2 Exploratory analysis of the data

We show the daily time-series of the residential water usage in Figure **??**. we could observer that the water usage shows periodicity in the days of a week. From Monday–Friday, the consumptions are lower than the weekend, and the holidays, propably for the reason that in the weekend and holiday people stays more time at home, thus use more water. In addition, we could observer that in summer time (May - October) the consumption are higher than winter time (November–April) which is probably due to the temperature effect. For example, households grow the flowers in outdoors in summer, which need to water the flowers, wash the care, or fill the swimming pools. Another climate effect we might consider is the effect of rainfall. For example, due to the rainfall, the water consumption might be reduced, e.g., people can save the water for watering the flowers in outdoor.

4 The Water Consumption Model

We model the water consumption, W_i, into base load and seasonal load, which is as follows:

$$D_i = B_i + S_i \tag{1}$$

4.1 Base load

The base load represents the weather insensitive portion. 10% percentiled load at the hours of day, or the day of weeks.

4.2 Daily Seasonal Load

The seasonal load represents the weather sensitive portion of the total use, i.e., $S_i = D_i - B_i$. We use the use the periodic Auto-Regression with eXogenous variables (PARX) [**?**] (weather temperature and waterfall) to model the seasonal load. We use

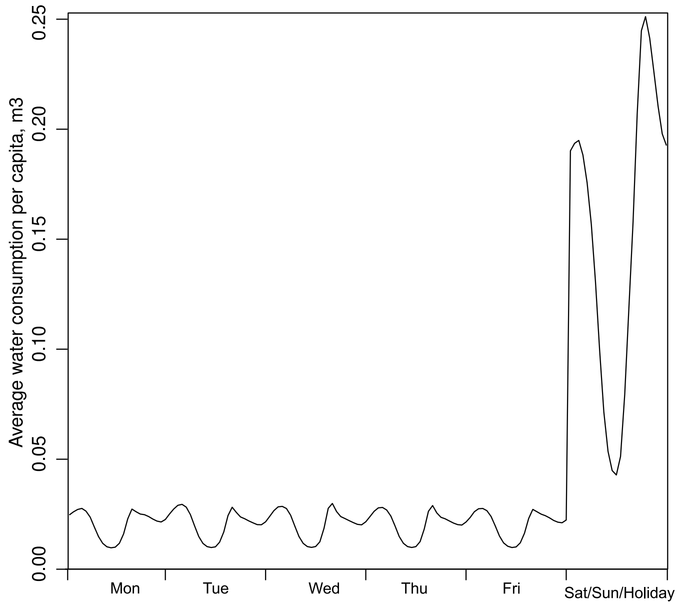

Fig. 3. The average weekly profile of residential water consumption

the week as the period, and the weekdays as the seasons. The water consumption can be modeled as:

$$S_t = \sum_{i=0}^{p} \phi_{s,i} S_{i-p} + \beta_s H(T_t) + \psi_s G(R_t) + \epsilon_s, \quad t \in s \tag{2}$$

where Y_t represents the water consumption at a particular day t in a week; t is the weekday whose values are $0, ..., 6$ representing Sunday, Monday, ..., Saturday; p is the order of auto-regression; s is the season index; $\phi_{s,i}, \beta_s, \psi_s$ are the coeffcients, and ϵ_s is the white noise; $H(T_t)$ and $G(R_t)$ are the functions of weather temperature and rainfall effects, and defined as:

$$H(T_t) = \begin{cases} T_t - \tau & T_t > \tau \\ 0 & \text{Otherwise} \end{cases}$$

$$G(R_t) = \begin{cases} \gamma & R_t > \gamma \\ R_t & \text{Otherwise} \end{cases}$$

where T_t is the temperature at the week day t, and τ the thredhold of temperature effect; R_t is the preciptation at the week day t, and γ is the thredhold.

4.3 Hourly Seasonal Load

– No hourly rainfall data

5 Results

5.1 Accuracy of the forcasting model

Evaluation. We now use daily single family residential (SFRES), and weather data to compute the coefficients. We set the temperature thredhold value τ as 20 celsius degree, and the thredhold value of rainfall γ as 1 mm preciptation.

References

1. Ten Million Meters Scalable to One Hundred Million Meters for Five Billion Daily Meter Readings. Sept. 2011.
2. Ardakanian, O., Koochakzadeh, N., Singh, R. P., Golab, L., and Keshav, S. (2014). Computing Electricity Consumption Profiles from Household Smart Meter Data. In EDBT/ICDT Workshops (pp. 140-147).