Summer Chemical Engineering Research Internship at NUS

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INTRODUCTION

My project is a 8-week chemical engineering project at National University of Singapore. It was a great experience get to work in Singapore lab and got to know professors and scholars that hold interests in various professional fields. The topic I worked on was Water-Energy-Waste-Nexus with Julie Cui who is from Johns Hopkins University.

Water-Energy-Waste-Nexus was previously developed by Assistant Professor Xiaonan Wang and her team at National University of Singapore aiming to utilize a self-developed data model *Resilience.io* to help government and big corporation better organize their population and energy data and obtain the best decision with the allocated data through a series of optimizations in the model.

During those 8 weeks we first read massive papers about its methodology, analyzing how the previous case studies have been done, and how to better evaluate our new target area, which is Hunter Valley area, Australia. Then we started our data collection and data analysis process, and then we utilized the existing decision-making model to process the data and eventually to get the results of the optimal capital and energy distribution to let the water energy supply meet the demand for the next few years.

AIM

The aim of this 8 weeks project was to collect and gather population, household, company energy usage, pipeline data and so on for the Hunter Valley area, Australia. The data mentioned above is the input data for the model Resilience.io. The model resilience.io was previously served as a decision-making tool to help Ghana government to allocate water and energy resources and improve their wastewater treatment quality. Then the new goal for us is to do a new case study using resilience.io for Hunter Water Corporation, which is a state-owned corporation providing drinking water, wastewater and recycled water services to 500,000 people in the Lower Hunter Region in New South Wales, Australia The ultimate goal is to successfully run the model and get the output file as the decision-making suggestion for the Hunter Valley Corporation.

METHOD

After practicing and being familiarized with the model, we started our data collection process. The goal is to find all the data we need to put in the resilience model and the successfully run the model and get as accurate results as possible.

The data collection took quite a long time, because there were a lot of input data to collect. So, we first found the Australian Bureau Statistic website where they have detailed population data for every region in Hunter Valley. There are 37 regions in Hunter Valley in total, and three regions were selected to make sample input files, Dungog, Wallsend_Elermore_Vale, and Belmont_South_Blacksmiths. The birth rates, death rates, immigration rates, emigration rates, aging rate were collected for these three regions in order to make socio-demographic input file as in Figure 1.

In addition to socio-demographic input file, we also collected a large number of population data for Dungog, Wallsend_Elermore_Vale, and Belmont_South_Blacksmiths. A sample of population agent master table we have collected based on the data from Australian Bureau Statistic website as in Figure 2. The data collected for agent master table includes gender, age group, workforce, income, non-drinking access and drinking access.

Another important part is the distribution map generated in the model using the population data. However, we did not get the map part to run to generate the distribution image like below, because we did not have access to the codes for the model and in order to make it to run, some changes of the codes are required. A sample of this part is listed as Figure 3.

Figure 1. Socio-demographic input file

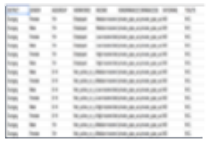

Figure 2. Agent master table

Figure 3. Distribution map in resilience.io

RESULTS

For the result, We managed to successfully obtain the solution text files where we have all the optimization data as output. Even though the data generated as output may not be accurate, since a lot of the input data we have collected is based on assumptions. It is a big step for this case study, and will be very helpful for the future team to further analyze this case study and provide the Australian team with the most accurate and detailed data and result. Below are our solution files generated from the *Resilience.io* model.

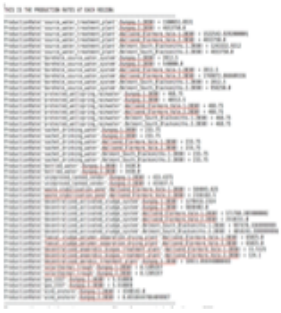

Figure 4. Output solution data

Figure 5. Output solution data 2

Appendix

Figure 6. Maps in Hunter Valley, Australia

CONCLUSIONS

throughout this research process, I have learned a lot about the Australian government wastewater treatment processes as well as optimization techniques.

References

1. Australian Bureau of Statistics web site http://stat.abs.gov.au/itt/r.jsp?databyregion (accessed Jul 12, 2018).
2. Wastewater Treatment Works https://www.hunterwater.com.au/Water-and-Sewer/Wastewater-Systems/Wastewater-Treatment-Works/Wastewater-Treatment-Works.aspx.
3. Triantafyllidis, C.; Koppelaar, R.; Wang, X.; Dam, K. V.; Shah, N. *Resilience.io user manual* **2016**, 1–22.

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