Interim Report
EE5500

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Introduction

Today it is natural that clean water is available whenever it is needed. Water is not only used for drinking, it is also used for cleaning, cooking, washing or many other things in daily life. Besides for individuals it is important for whole industries like agriculture industry, catering industry, food industry and many more. It is one of the most important basics in today's life that clean water is accessible for everyone with a certain quality and quantity. To make sure that clean water is present all the time, there are industrial processes, which use water and wastewater treatment plants to make use of natural water resources and sewage to produce clean water which can be used by consumers. The following picture shows the process for natural water resources:

Figure 1 - water treatment [1]

The purpose of this report is to give an initial overview about the master dissertation project, which topic is water resource planing in the UK with the help of modern web technologies. This project will be done in cooperation with another student, so this report will briefly describe the background of the project and will then focus on the part which is relevant for this dissertation. After the information about the backgound of the project, there will be a part which describes the initial survey done. Furthermore, this report gives information about the aims and objectives of the dissertation and the expected outcomes as well as the time plan for the project.

Background to the project

"Customers' top priority for water services is a safe, reliable supply of water at a price they can afford" [2]. Because of different factors the risk of droughts in the UK increases steadily and there have also been some droughts during the last 40 years which were worse than those that had been used as the basis of planning. [2] One factor which is responsible for the increased risk of a drought is the climate change as well as the resulting increased evaporation during the warm months of the year. Another factor is the population growth, which is estimated to be between 6,6 million and 16 million by 2040 for England and Wales. Especially regions with the least resilience regarding water resources are subject to most population growth and climate change. [2]
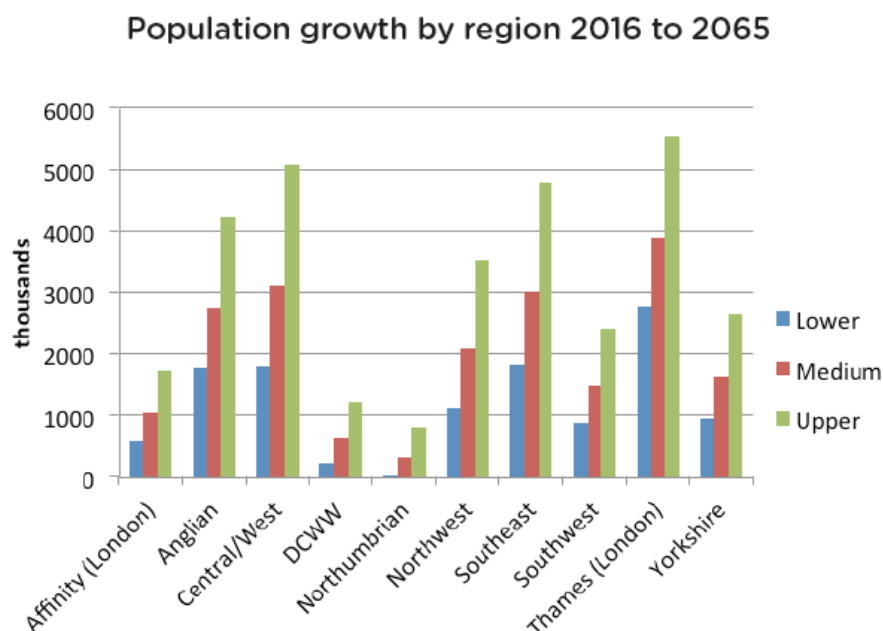

Figure 2 – Population Growth [2]

To protect customers as well as the industry from the consequences of serious droughts and to enable an economical and environmental efficient use of water resources, politics and the water industry have to make strategical long-term and short-term decisions regarding water infrastructure to be able to gain resilience.

The problem is that in water industry there is no technology which provides information about the overall state of the current water resources, neither for consumers nor for providers or political decision-makers. Because of this missing knowledge, there is a lack of efficiency regarding different aspects, e.g. energy consumption or cost. It is not possible to achieve an efficient water resource planning without information about important key indicators and predictions.

Initial survey

The basis of this project is the data acquired by modern sensors of water and wastewater treatment plants. This data is categorized in the industry's key performance indicators. Those indicators are Carbon Footprint, Energy Consumption & Generation, the yield of the By-Products and the Productivity, which means the performance of the Equipment and Reliability. It has to be dealt with the real-time data as well as with historical data. As already mentioned, the acquisition, harmonization and provision of the data from different water providers is done by the partner dissertation. This dissertation focuses on the data analysis and data representation. That's why it has to be analyzed which stakeholders there are to create a concept how the data analysis has to be done and which factors has to be considered. A source for this kind of knowledge is Water UK:

"Water UK is a membership organisation which represents and works with the major water and wastewater service providers in England, Scotland, Wales and Northern Ireland". [3]

Water UK provides all kind of information about water supply, wastewater and regulations regarding those processes. Focusing on the regulators, Water UK makes the following statement:

"A wide range of organisations work with water companies to ensure customers get the best services for the best possible price, and that the environment is protected." [4] The mentioned organisations are categorized in governmental organisations, regulators, consumer watchdogs and water companies. These categories will be relevant for the concept of the data visualization:

Governmental organisations:

Defra (Department for Environment, Food & Rural Affairs, Environment Agency):
UK government department responsible for looking after natural environment. Defra sets the overall rules for water services in England and is responsible for water quality and orders regarding droughts.

Welsh Government: devolved Government for Wales which works to help improve the lives of people in Wales and make the nation a better place in which to live and work. The Welsh Government sets the overall rules for water services in Wales. [4]

Regulators:

Drinking Water Inspectorate: the DWI was formed in 1990 and provides independent reassurance that water supplies in England and Wales are safe and drinking water quality is acceptable to consumers. [5]

Environment Agency: non-departmental public body which is responsible for regulating industry waste, as well as water quality and resources in England. They are also responsible for managing the risk of flooding from rivers, reservoirs, estuaries and the sea. [4]

Natural England: the government's adviser for the natural environment in England, helping to protect England's nature and landscapes for people to enjoy and for the services they provide.

Natural Resources Wales: works to ensure that the environment and natural resources of Wales are sustainably maintained, enhanced and used, both now and into the future.

Ofwat: the economic regulator for the water and sewerage sectors in England and Wales. It works in the interest of customers by setting price limits, ensuring companies run efficiently and encouraging resilience. [4]

Consumer Watchdog:

CCWater: The Consumer Council for Water promotes consumers' interests to governments, regulators and water companies. They also provide a free advice and complaint handling service for consumers, research their views on key topics, and keep them informed on the issues that affect their services. [4]

All these stakeholders have different kind of interests in the data, which has to be considered when doing a data analysis with a visualized result. What exactly these interests are must be researched beforehand which is one of the first steps during the project.

External factors

The data analysis which has to be done is based on two data sources. On the one hand it is the data which is collected on the plant level. This means real-time and historical data about the productivity, the energy consumption or the water quality measured by the sensors of the water treatment plants. On the other hand there are external data sources which will be required to perform fitting analyses. So it is important to identify which external factors are relevant for the water resource planning and what's the impact of these factors.

Maybe the most important external factor is the weather situation. It has impact on the total availablity of water, on the demand for water by the people and on the water quality. The Met Office[1] states [6]: "With climate change predicted to increase, the likelihood of significant weather events from extreme rainfall to heatwaves, will have a significant impact on the water industry." Extreme weather conditions may have a serious impact on water quality e.g. too

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[1] National meterologic service of the UK

much rain can cause sewers to flood and overflow into water course. Heatwaves with few rain may lead to droughts which could result in a reduction of availability of water as well as a higher demand of the consumers. If less water is available then the overall cost of delivering water to the end consumer may increase for the industry. With the knowledge of upcoming extreme weather conditions, actions could be taken early by regulators or consumers.

As mentioned before the cost of the whole process is also interesting for the stakeholders. Ofwat sets price limits for customers, so that the providers have to work efficiently and look after resilience to avoid sudden increase of cost. The following image shows how the price for water is set by a specific water provider (south east water):
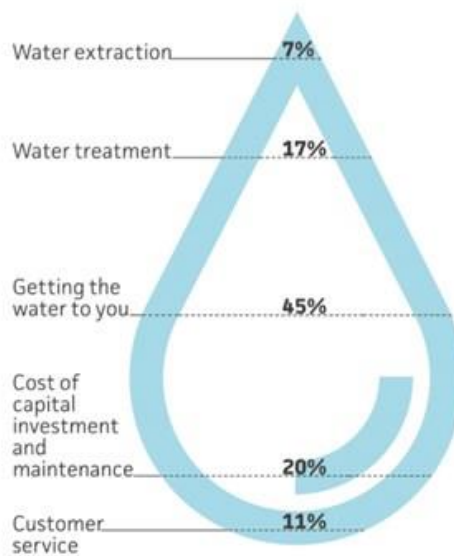

Figure 3 - how the price is set [7]

Almost 20% of the price is related to the water treatment process. So the absolute cost of the treatment process will influence the overall cost for whole process. This information could be very useful for water companies and may lead to strategic decisions depending on the current situation. From 2016 to 2017 the average household water and sewage bill in England and Wales was about £389. [9] The prices increased by £2, which is part of a 5-year-plan confirmed by Ofwat. This plan enables companies to invest £44 billion over 5 years in better services, greater resilience and environmental improvements. [9]

Aims and Objectives

The main objective of this project is to develop a central platform which analyzes and visualizes data for water resource planning for different stakeholders. This data should picture different abstraction levels:

- stratetic level: level which enables users to create strategies (e.g. price shouldn't go over x)
- operational level: engineering level combined with external factors (e.g. weather)
- engineering level: lowest level/plant level

 For example an end consumer wants to see different kind of data than a representative of a water provider company or a politican which aims towards developing a strategy for water resource management. This should be achieved by analyzing real-time data and/or historical data combined with different external factors like weather conditions. It is necessary to have a fitting security concept to guarantee that every user role can only see information which it should be allowed to see. For example a member of a water provider company shouldn't be able to see sensitive data from another provider company (of course a consumer shouldn't also be able to see sensitive copmany data).
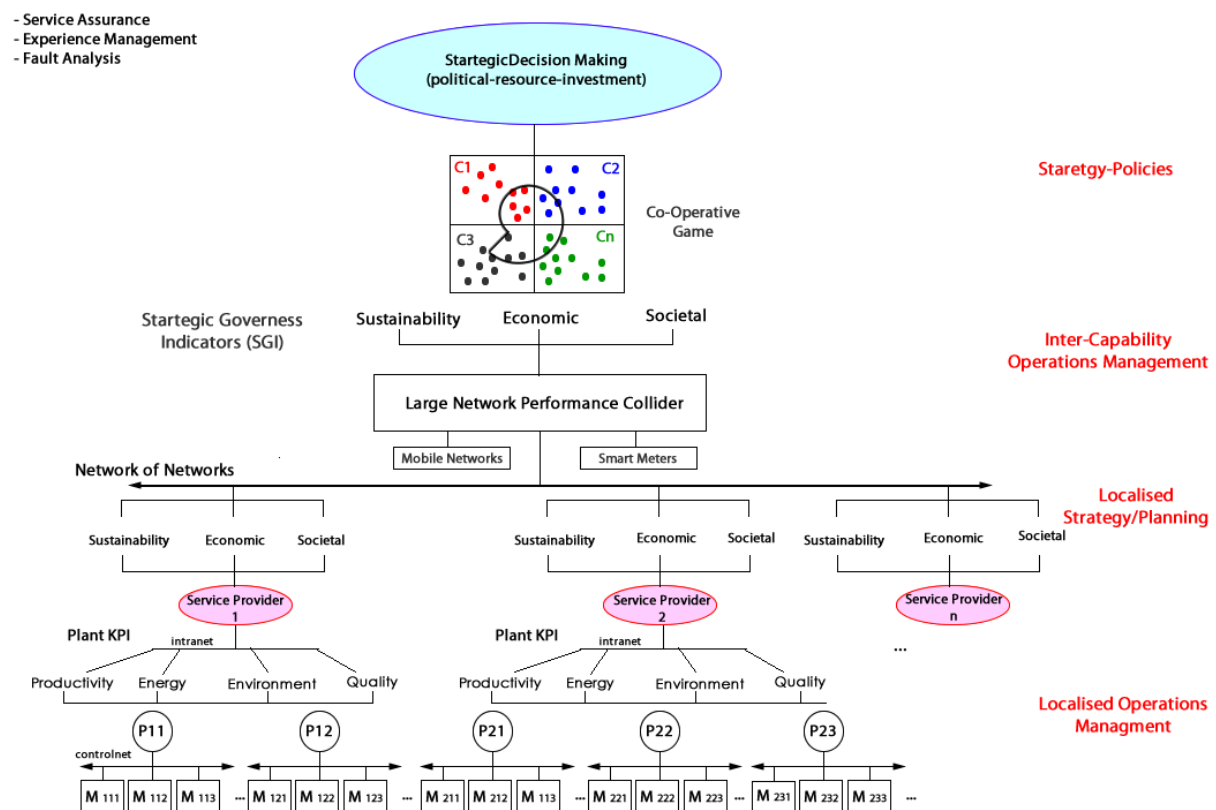

Figure 4 - system overview [8]

The illustration (reference) shows that the water and wastewater treatment plants of different water providers are equiped with different kinds of modern sensors, measuring data regarding several key indicators like Carbon Footprint, Energy Consumption & Generation, the yield of the By-Products of the processes, and the Overall Performance of the Equipment and Reliability (Productivity). This sensor data from different plants is collected and will be migrated to a common data model.

Each service provider categorizes the data from its plants in different indicators. The Large Network Performance Collider collects this data and converts it into a common model. This collected data is the basic information for the data analysis which has to be done to create the representation for stakeholders to enable strategic decision making.

Experimental/investigative methods to be adopted

It has to be analyzed which cloud technologies will be used to create a fitting representation of the current situation considering external factors and/or historical data. Furthermore a strategy has to be developed how to analyze the harmonized data from the different plants and create meaningful results, depending on the users' request. It must also be evaluated which external data sources must be used to produce useful information. Another important task will be the role concept for the application. A fitting security strategy has to be developed to ensure that every user is only allowed to see what he/she should see. Critical data has to be secured from unauthorized access to avoid the misuse of information.

Due to the fact, the project partner works on the problem of the data aqcuisition and data harmonization of differen data sources (different providers), there is a need for "simulated" data which can easily replaced by the real data when it is available.

For the visualization of the results, a fitting user interface must be developed. It has to be researched which user will be interesed in which kind of information and after that the user interface has to be designed by using Mock-ups.

Time-plan

The dissertation project should be finished until March 2018. To ensure that this project will be finished until then, an initial time plan is created which contains the key activities that have to be done with a time estimation. This time plan can be used as a tracking mechanism to detect possible delays early and take actions against it early:

Vorgang	Anfang	Ende
Research technologies to be used	09.10.17	11.10.17
Research external sources	13.10.17	18.10.17
Verify access to external API's	19.10.17	25.10.17
Determine security concept	26.10.17	01.11.17
Create role concept	02.11.17	08.11.17
Create data models for representation	09.11.17	17.11.17
Develop GUI concept	06.11.17	14.11.17
Implement GUI prototype	15.11.17	04.12.17
Create mocked data	05.12.17	11.12.17
Integrate security concept	09.11.17	15.11.17
Implement businness logic for data analysis	12.12.17	08.01.18
Integrate backend from partner project	09.01.18	05.02.18
Write Report	25.09.17	09.03.18

Screenshot 5 - Time Plan

Of course it is not guaranteed that all the tasks are found on creating the initial plan. It is likely that further tasks emerge during the research and the development. Nevertheless the initial time plan gives a good orientation which will help during the work process.

Deliverables or specific outcomes

The expected outcome of this dissertation is a working prototype of a cloud application which visualizes data regarding water resource planing considering real-time data, external factors and historical data. This prototype should use a fitting security and role concept. The overview should help stakeholders to get an idea of the current state in their area of interest and make them able to make strategic decisions to achieve a certain change. Besides the representation a data analysis has to be done by using the acquired data of the partner dissertation. Along with the technical deliverable in form of a web application there should also be documentation about how the presented data is created and categorized and which indicators are used for evaluation.

References

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[9] „Water UK," [Online]. Available: https://www.water.org.uk/news-water-uk/latest-news/household-water-and-sewerage-bills-2016-17. [Accessed: 27 September 2017].