Group 1: Designing Regional Industrial Symbiosis

Introduction

Industrial Symbiosis (IS) can be defined as interf-firm resources sharing, which include physical exchanges of materials, energy, water, and by-products among diversified clusters of firms. Industrial symbiosis became worldwide known when self-organized structure of Kalundborg was uncovered. Gothenburg Region is the most intense site considering industrial production in Sweden and boasts a wide range of industries from different sectors such as trading, shipping, agriculture, forestry and manufacturing industries.

Project approach and grading

Group work, 5 students. Grades will be 3, 4, 5, or failed. The project work is weighted 55% in relation to the other assignments.

Objective

The objective of this project is for you to learn some of the core aspects of the circular economy concept, and in particular the use of Industrial Symbiosis to foster the reuse of industrial wastes. The main objective is to enhance the emergence of industrial system relying on co-operation between the actors involved, in which exchanges of waste material and energy as resources occur, and minimize the input to the system of virgin materials and energy, as well as the output of wastes and emissions. You should propose and evaluate alterations to the existing industrial system in order to promote a more sustainable development, in particular in Gothenburg Region.

In this project, you will study all the industry operating in the region, understand the wastes that the industries generate, using a holistic approach. Furthermore, you will also have to propose and evaluate solutions for the wastes, as well as identify other industries that can reuse the wastes as raw-materials. You can as well identify potential policies or regulations that could be implemented that would foster industrial symbiosis partnerships.

Specific tasks:

1. Do a literature review on Industrial symbiosis.
2. Identify and quantify the types and quantities of wastes produced within a chosen region in Europe. You will have to account wastes using a developed method, that will be made available by teachers.
3. Identify and purpose potential reuse/recovery solutions for the wastes (based on literature review).
4. Try to identify and account benefits of reusing the wastes (can be environmental, economic, social, etc.).
5. Propose other alterations to the system, as for instance policies implementation.
6. Critically discuss the results obtained, for example missing data, made assumptions, suggestions for the method improvement etc.

Content and material presented in the final report

For the structure of the report, follow the instructions available in the course description. Apart from your findings regarding the tasks, the report should contain the following:

- General description of selected functions
- Data sources (including a description and reasoning)
- Methodology used to analyze the problem
- Discussion
    - Suitability of the method and suggestions for improvement
    - Results
    - Assumptions, problems, and weaknesses
    - References

Content and material presented in the Appendices to the final report

- Copies of literature used
- Excel spreadsheets with calculations

References

Employees number by sectors and region in Europe:
http://appsso.eurostat.ec.europa.eu/nui/show.do?dataset=sbs_r_nuts06_r2&lang=en

Other important information:

The waste generated by each sector has been showed to be corelated to the number of employees that sector has. The table below shows the equations that should be used to account for industrial waste by sector, using the number of employees as estimator.

Calculation on the quantities of generated waste per employee

Industrial Sectors	**Waste generation equation (x=number of employees, y=waste in tons)**
Agriculture, forestry and fishing	$y = 3{,}3733x^{0{,}7701}$
Mining and quarrying	$y = 3{,}6854x^{0{,}9906}$
Manufacture of food products	$y = 2{,}095x^{1{,}1935}$
Manufacture of textiles	$y = 1{,}1831x^{0{,}8422}$
Manufacture of wood	$y = 4{,}7547x^{1{,}17}$
Manufacture of paper	$y = 4{,}0424x^{1{,}302}$
Manufacture of coke	$y = 5{,}7524x^{1{,}3727}$
Manufacture of chemical	$y = 1{,}0237x^{1{,}2667}$
Manufacture of other non-metallic mineral	$y = 3{,}1975x^{1{,}0191}$
Manufacture of basic metals	$y = 2{,}1393x^{1{,}3062}$
Manufacture of computer, electronic	$y = 0{,}9434x^{1{,}1137}$
Manufacture of furniture	$y = 1{,}1575x^{0{,}9883}$

INDUSTRIAL SYMBIOSIS

Supervisor: João Patrício

Group Project – ACE 155

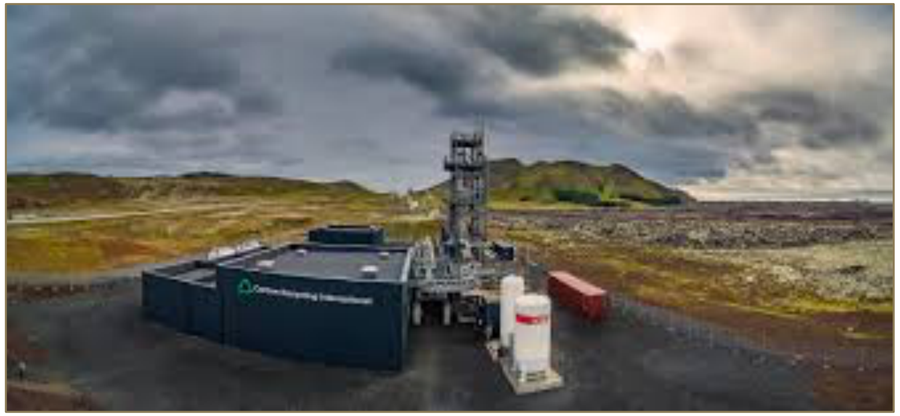
INDUSTRIAL SYMBIOSIS

"**inter-firm sharing**, which include physical exchanges of wastes, energy, water and by-products, or infrastructure and services sharing."

Source: "Uncovering" Industrial Symbiosis, Chertow 2007

Geothermal Plant

Carbon Dioxide

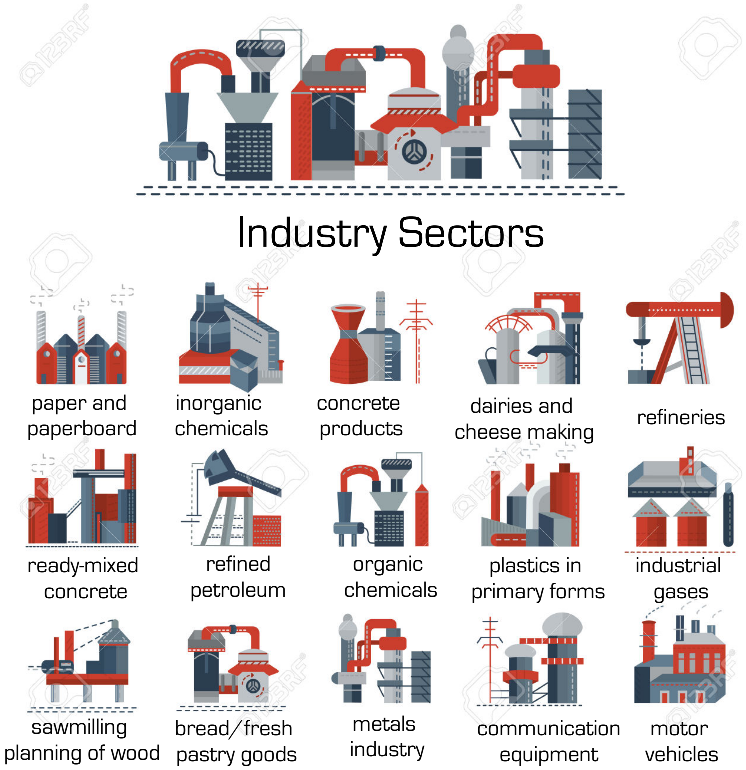


Methanol Plant

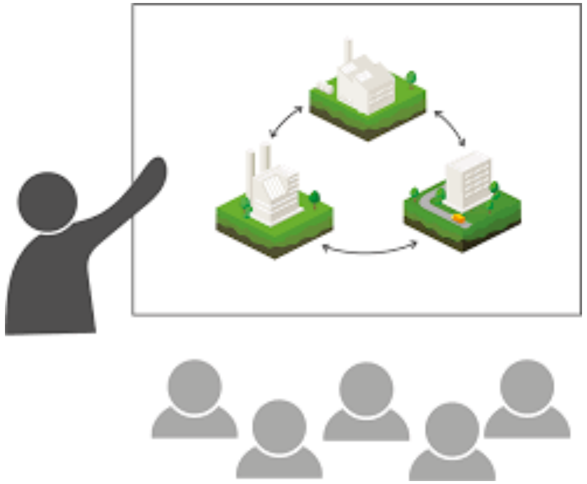
PROJECT OUTLINE

- **Minimize the input** to the system of virgin materials and energy, as well as the output of wastes and emissions;
- Use **industrial symbiosis** concept;
- Foster the reuse of industrial wastes in a **chosen region in Europe**;
- Develop strategies to improve the **resource efficiency** in urban areas;

ACCOUNT FOR INDUSTRIAL WASTES USING A GIVEN METHOD



PROPOSE AND EVALUATE ALTERATIONS TO THE EXISTING INDUSTRIAL SYSTEM IN ORDER TO PROMOTE A MORE SUSTAINABLE SYSTEM



Specific Industrial Symbiosis Partnerships

New Policies or Procedures

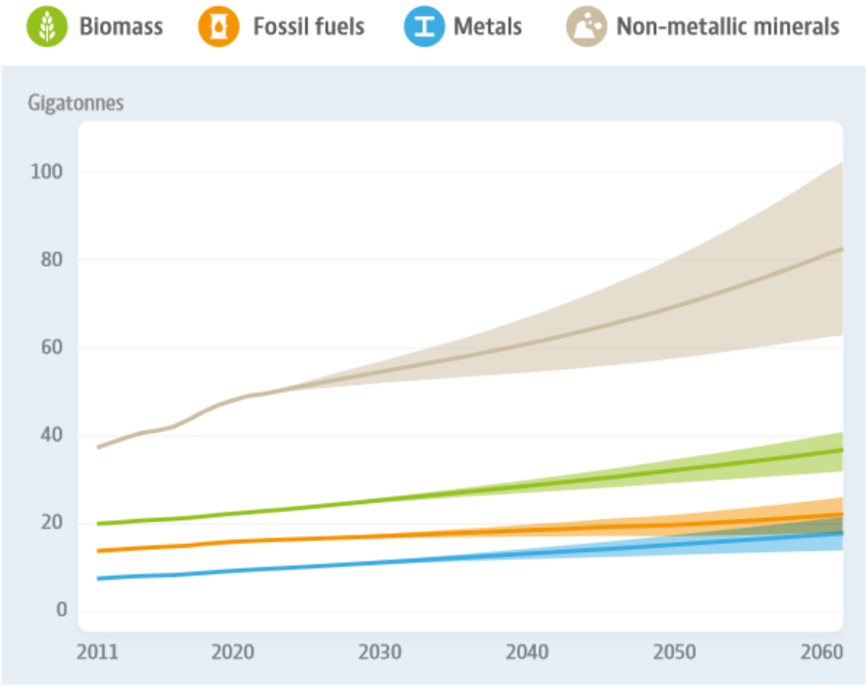
REGIONAL RESOURCE USE REDUCTION

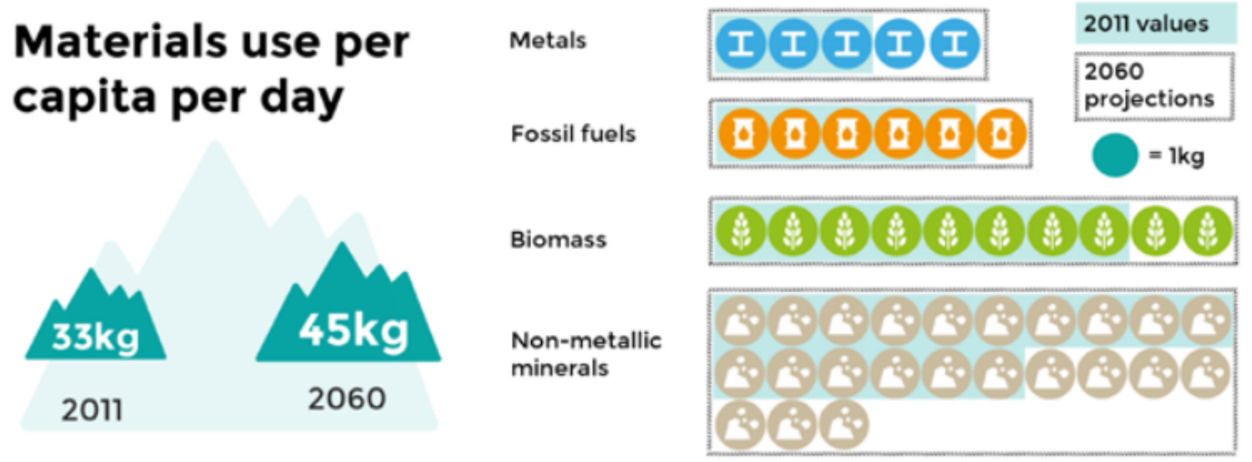
Supervisors: Alexandra Lavers Westin & Leonardo Rosado

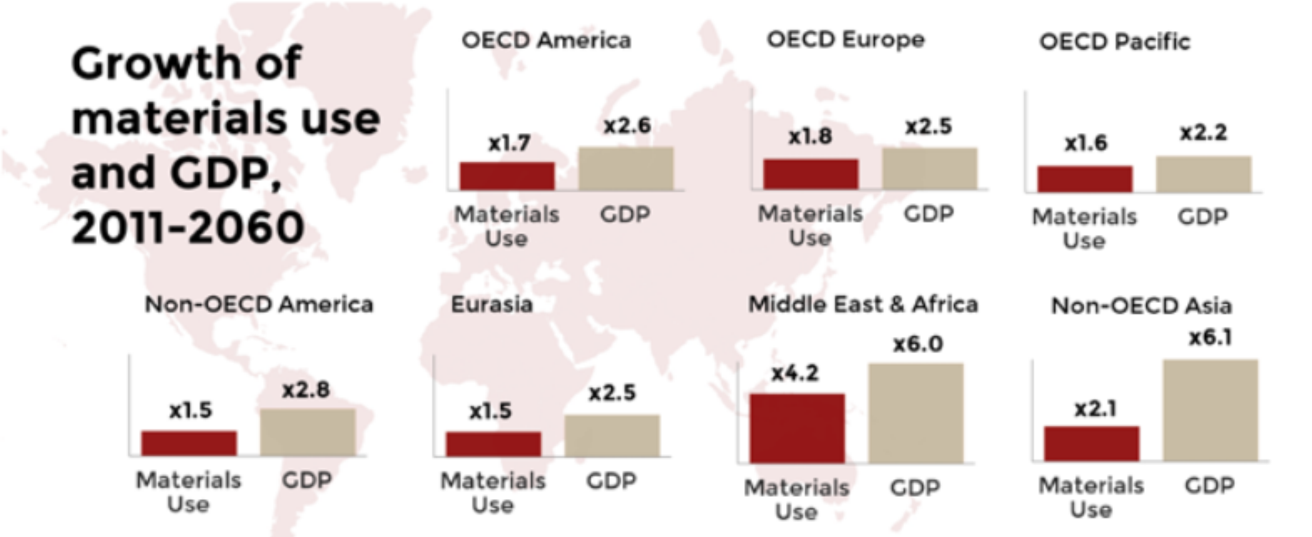
Group Project – ACE155

BACKGROUND

Figure 6. **Growth in materials use depends on population and economic growth assumptions**







https://www.oecd.org/environment/waste/highlights-global-material-resources-outlook-to-2060.pdf

EUROPEAN REGIONS

- Example: Västra Götaland
- Population of 1.719.000
- Increasing consumption
- Increasing population

https://stadsutveckling.goteborg.se/en/

PROJECT OUTLINE:

- Select a European region
- Identify the top three sectors with respect to various indicators (consumption-based, production-based), also identify top three product groups.
- Investigate a realistic reduction in some kind of material/product (e.g., a policy) in the product groups that are high consumption. Provide concrete examples.
- Analyze results and assess the strengths/weaknesses of the model, if the reductions are likely and/or possible, etc.

CHALMERS
UNIVERSITY OF TECHNOLOGY

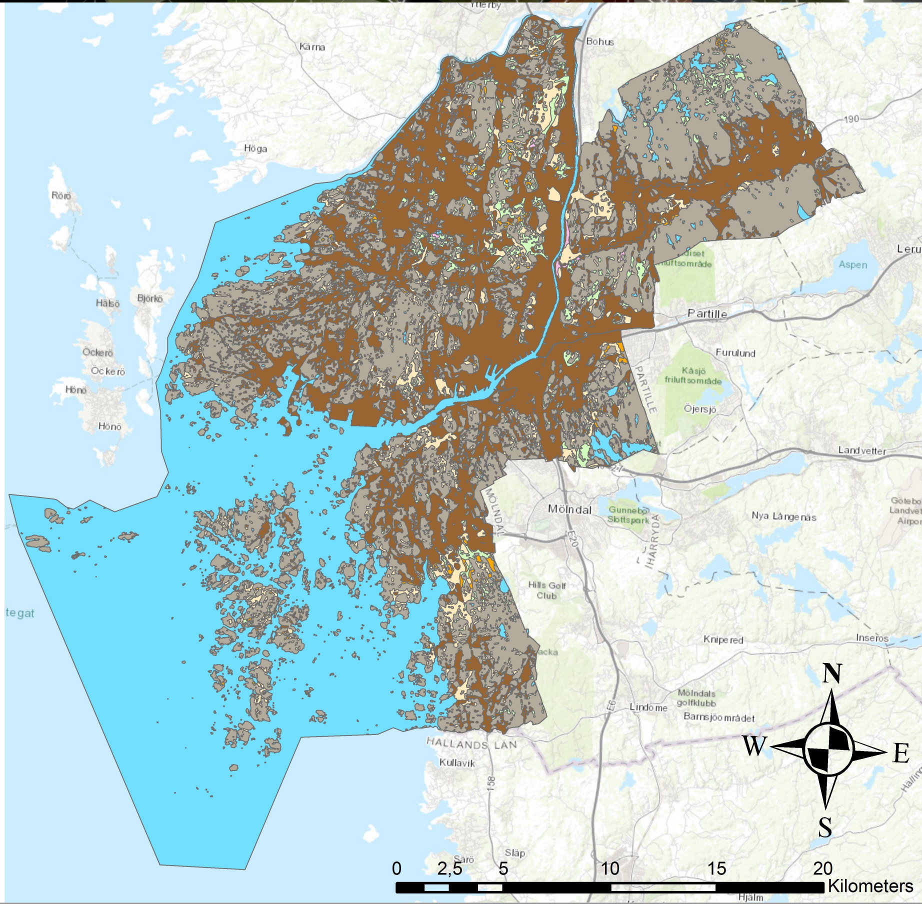
Dynamic Stock Modelling of road infrastructure

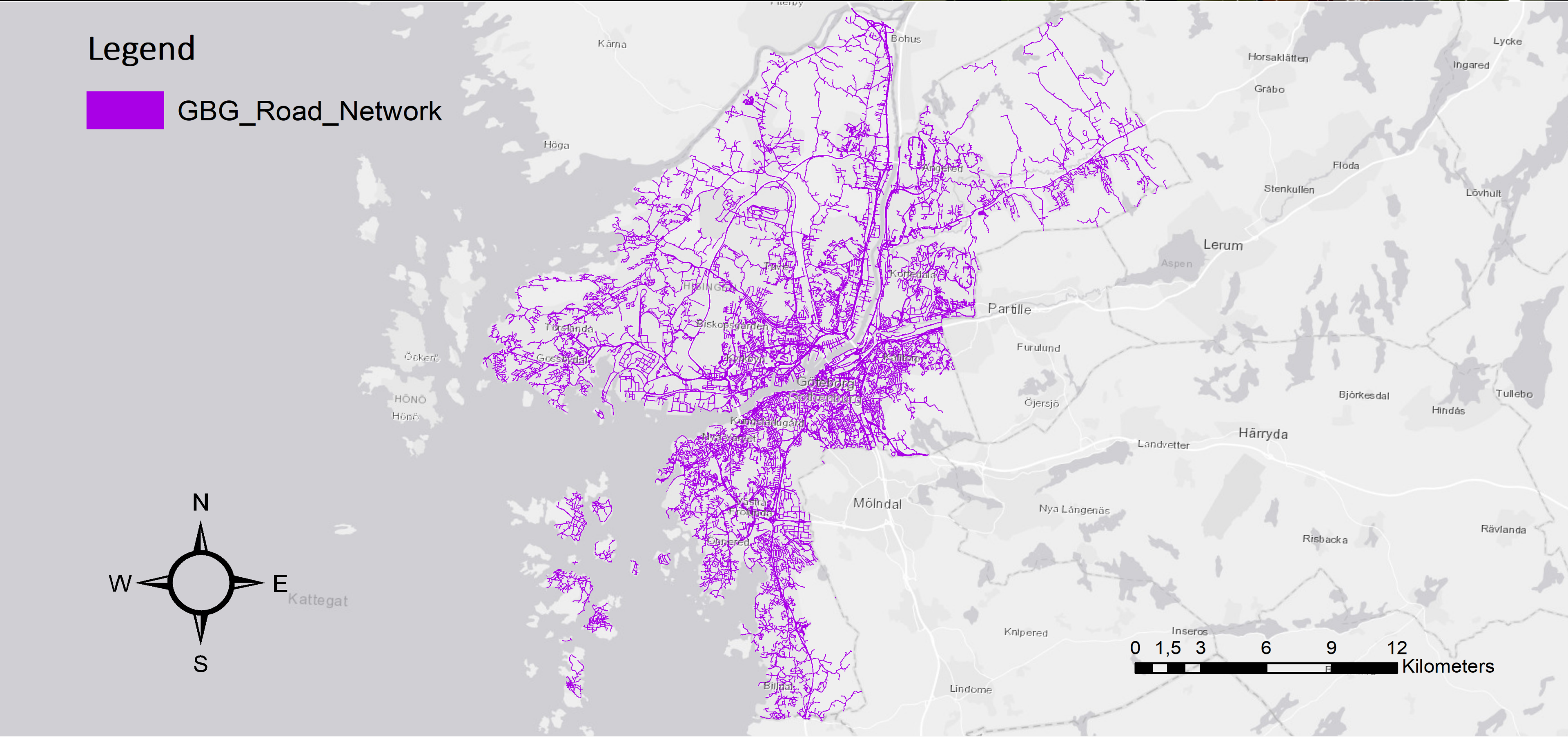
Group Project

Supervisor:
Babak Ebrahimi (babake@chalmers.se)

Project Outline

- Perform a bottom-up stock modelling of road infrastructure in the municipality of Gothenburg
  - One group focuses on <u>road aggregate</u>
  - While the other group focuses on <u>road binder</u>




Legend
GBG_Road_Network
N
W
E
S
Kattegat
0 1,5 3 6 9 12
Kilometers
Kärna
Höga
Bohus
Horsaklätten
Gråbo
Lycke
Ingared
Floda
Stenkullen
Lövhult
Lerum
Aspen
Partille
Furulund
Öjersjö
Björkesdal
Hindås
Tullebo
Härryda
Landvetter
Mölndal
Nya Långenäs
Risbacka
Rävlanda
Knipered
Inseros
Lindome
Öckerö
HÖNÖ
Hönö
Torslanda
Göteborg

Dynamic MFA of road aggregate

Task description

- **Dimensioning of pavement structures**
- **Quantitation of the present stocks of road aggregate**
- **Prediction of future flows of road aggregate with respect to the potential upcoming road maintenance activities**
- **Evaluation of findings and comparing with prior studies**

Dynamic MFA of road binder

Task description

- **Dimensioning of pavement structures**
- **Quantitation of the present stocks of road binder**
- **Prediction of future flows of road binder with respect to the potential upcoming road maintenance activities**
- **Evaluation of findings and comparing with prior studies**

URBAN WATER AND CLIMATE RESILIENCE

Supervisor: Yuliya Kalmykova

Group Project – ACE155

https://youtu.be/bVNMuFTfpUE

SEK 7 billion in damage in 2 hours (150mm rain)

CLIMATE CHANGE BRINGS MORE WATER INTO THE CITY

- Increased rainfall (+30 % in volume)
- Frequent extreme events ('100-year' rain may become a '10-year')
- Rising sea
- Increased water flows
- Rising groundwater

CITIES NEED TO ADAPT

PROJECT OUTLINE:

- Identify climate adaptation techniques developed to protect function of the vital urban infrastructures, such as energy and transportation networks
- Choose a future or an ongoing infrastructure project in Sweden
- use model SCALGO-Live to project flood risks within the project area
- select resilience measures from your literature study
- simulate application of these measures at the site with SCALGO-Live/own calculations