TOWARDS BETTER UNDERSTANDING OF SUSTAINABLE LIVING IN SPARSELY POPULATED AREAS – A CASE STUDY OF NORDERÖN ISLAND

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ABSTRACT

Much effort presently goes into research regarding 'sustainable cities'. This is reasonable in light of the globally rapidly increasing population in urban areas. Much less research is directed to understand how to achieve a more sustainable situation in rural areas, but a substantial number of the world population will live in sparsely populated areas also in future. This study contributes to the understanding of environmental impacts and sustainability issues in sparsely populated areas. The island of Norderön in Jämtland, Sweden, is used as a geographically well-defined case study object. Activities on the island has been screened and green house gas emissions from these activities been estimated using LCA methodology. Special interest was given transportation, since it is often argued that this is a significant sustainability issues in rural areas. It is concluded that solutions adapted to each location are needed to develop sparsely populated or rural areas in a more sustainable direction. Solutions developed for urban areas will often not be applicable or efficient if directly transferred to sparsely populated areas.

KEYWORDS

Rural areas, screening life cycle assessment, transportation, green house gases.

1 INTRODUCTION

Much effort presently goes into research regarding 'sustainable cities' (1) (2). This is reasonable in light of the rapidly increasing population in urban areas globally. Much less research is directed to understand how to achieve a more sustainable situation in rural areas, but a substantial number of the world population will live in sparsely populated areas also in future, which is prospected to be one third of world's population in 2050 (3). This study contributes to the understanding of environmental impacts and sustainability issues in sparsely populated areas. The island of Norderön in Jämtland, Sweden, is used as a geographically well-defined case study object. Activities on the island has been screened and green house gas emissions from these activities been estimated using LCA methodology (4). Special interest was given transportation, since it is often argued that this is a significant sustainability issues in rural areas. Rural communities are characterized by dispersed population, low public transportation demand per area, long distances, low accessibility, and high dependence on fossil-fuelled automobile transportation (5) (6) (7).

2 NORDERÖN – THE CASE STUDY AREA

Storsjöbygden, the area surrounding Lake Storsjön and including the island of Norderön, is well suited for agriculture and has hosted the majority of the population of Jämtland County through history. The island, see Figure 1, is classified as area of national interest for culture conservation. Norderön measures approximately 773 hectares and had in 2011 a population of 117 people (8). Administratively the island is part of the municipality of Östersund and is located about 20 kilometers west of the city. The island has 70-80 permanent households, and 16 summer houses hosting about 100 temporary residents during the summer. To the west of Norderön one finds the Håkansta ferry port and the island of Verkön that is owned by three Norderön islanders but has no permanent residents. To the east of Norderön one finds the island of Isön with its ferry port. There is no public transportation servicing Norderön, except for school busses. The closest bus stop is located about two kilometers from the Isö ferry port on the mainland side. Norderön has a long tradition of agriculture and today one dairy farm (9), one organic grain farm and two potato farms are in operation.

Figure 1: The region of Storsjöbygden. The two ferry routes are marked by red dotted lines, the city of Östersund is marked by grey color and the islands of Norderön and Verkön by dark blue.

Several visitor attractions are located on the island:

• Tivarsgård Dairy and Restaurant: 7,600 visitors, opened in summer of 2011
• Norderö church: one of the oldest in the province
• Norderö golf course: 2,500 visitors per year
• EFS Church's Wilhelmsberg conference centre: 2,000 guest nights per year
• Verkö slott hotel and conference centre: 3,000 visitors ferried by shuttle boat from Norderön, shut down in late 2011

3 GOAL AND SCOPE

3.1 Goal

The goal of this study is to contribute to the understanding of environmental issues in the context of sparsely populated or rural areas, using the community of Norderön as a case study object.

3.2 Functional unit

The functional unit is activities on the Norderön island and activities related to inhabitants of the island during one year.

3.3 Scope

This study investigates the environmental impacts from the community on Norderön, within the municipality of Östersund, Sweden, during one year, using attributional life cycle assessment methodology. The year of study is 2011. The study differs in scope from many LCA studies, since our main interest is studying activities based in a geographic area and relates this to persons living in this area basically for benchmarking purposes to be able to better understand the findings. This means, for example, that we have not made any system expansion for milk or potatoes produced on the island but transported off the island for consumption elsewhere. Since this is an initial screening study we have focused only on global warming potential (GWP_{100}). Emissions included are carbon dioxide (CO_2), methane (CH_4) and nitrous oxide (N_2O). A special focus is put on a better understanding of rural transport and mobility needs.

3.4 System Boundaries

The calculations are made for the year 2011. The geographical boundary includes the island and the ferry routes (shown in Figure 1). There nearby island Verkön has no permanent population but goods to and waste from Verkön is passing through Norderön. Other activities on Verkön are excluded in this study. The church, the golf course, Midgården and Wilhelmsberg have been included regarding their heating demand and electricity use. An overview of activities considered in the screening is presented in Figure 2.

Annual transport work and diesel consumption are the only parameters regarding the ferry routes that was included. For example the energy use for ice breaking to keep the Isö ferry route open during winter has been excluded. Regarding fuels for heating and vehicle fuels, both use (combustion) and production are included. However, such things as car production

and maintenance are excluded, as well as building construction, reconstruction (restoration) and maintenance.

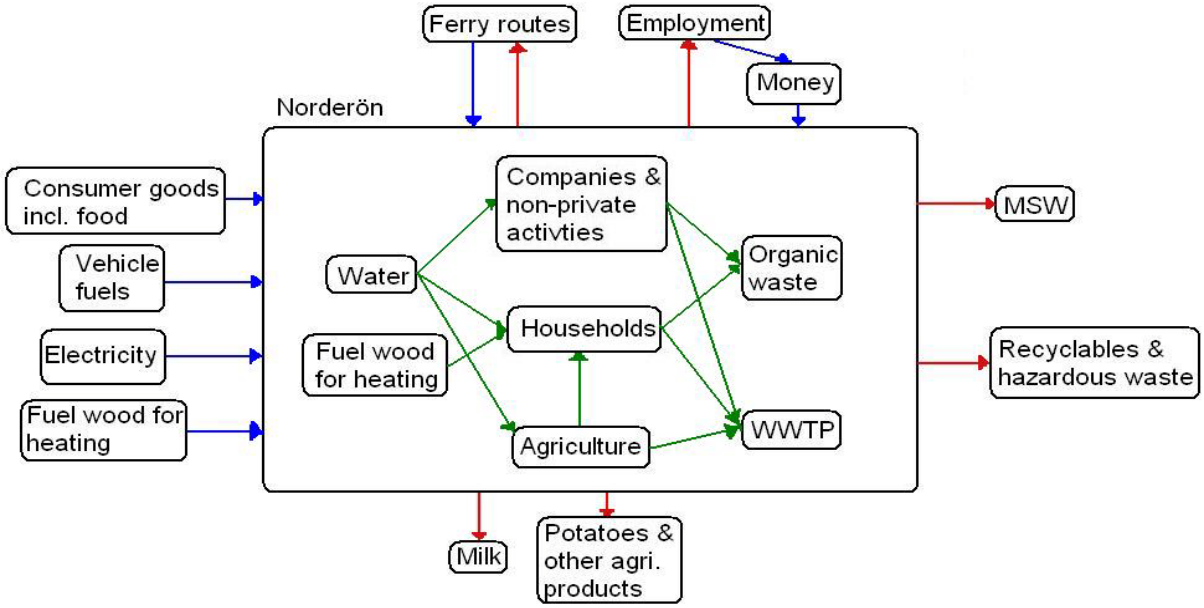

Figure 2: Overview of activities discussed in this study of the Island of Norderön.

3.5 Data collection

The main primary information where gathered by interviewing inhabitants of the island and from companies and authorities. For upstream and downstream activities, generic LCI data from the ELCD database from the Joint Research Center of the European Commission (10) was used. Additional datasets were collected from Probas (11), run by the German Federal Environmental Agency.

The consumptions of households were assumed to be similar to Swedish average consumption. For this screening study we have also assumed that all vehicles run on petrol and that the electricity used on the island is Swedish electricity mix.

Most data used in this study is newer than 2000.

4 INVENTORY

4.1 Electricity

The island of Norderön is supplied with electricity by one cable from the mainland. According to the local power company owning the cable, Jämtkraft AB, and energy balance calculations, the electricity consumption on the island was found to be 1,7 GWh in the year 2011 (12). The electricity used is described as Swedish average electricity mix (45 % hydro power and 45 % nuclear power) plants, causing 55 g CO_2eq. per kWh (13).

4.2 Heating

There are about 80 houses that are heated all year. The houses were built during several hundreds of years, but in average they were built around the beginning of the 20th century (14). The most common heating systems are heat pumps (air or geothermal, using electricity) and fuel wood heating by stoves and boilers. Based on interviews, it was estimated that 54 houses on the island are heated using electricity (covered by the electricity use described above) and 26 houses are heated with different kinds of locally produced wood fuels (fuel wood, wood chips etc.).

The average heating consumption of a Swedish one family house is about 20 MWh/year (15) and this figure has been used for estimate wood fuel consumption. Wood burning was assumed to have an efficiency of 70% using pinewood with 70% dry content and heating value of 3,44 kWh per kg. To heat 26 houses 216 tonnes of wood are needed per year. Assuming the carbon dioxide balance between tree growth and combustion is zero, because the wood binds as much carbon dioxide as it emits. The fuel wood production is based on a study producing reforested pine wood with a water content of 44% (10). This gives a per capita emission of 12 kg carbon dioxide per year for wood fuelled heating. The rest of the emission due to heating is covered by the electricity delivered to the island.

4.3 Transportation and fuels for vehicles, ferries etc

Transport demand on the island can be roughly divided into three key groups: islanders, visitors and through traffic. A large quantity of the through traffic on Norderön is skiers going to Bydalsfjällen ski resort. Personal cars, tractors, snowmobiles motorcycles and other fuel based transportation units are the types covered by this study. The amounts and use of different vehicles are based on a study by Lanker (16). Long distance vacation travel is not included in the study. Two different methods were used to estimate transport fuel use on Norderön: one based the data on the traffic on the ferries and the other based it on the questionnaire and oral sources, leading to similar results. It is assumed that all vehicles run on petrol except the tractors. Regarding fuel both use (combustion) and production are included.

Only the fuel used by the people living on the island and visitors is seen as emissions allocated to the functional unit. Emissions caused by through traffic are excluded. The amount of diesel used to run the ferry is included.

The consumption of diesel and petrol fuel from personal cars, tractors and heavy machinery, snowmobiles and similar equipment and the ferries is based on the inventory described in the thesis by Lanker (16). The amount of fuel consumed on the island is 17 TJ (473 m^3) of diesel and 3,6 TJ (109 m^3) of petrol, respectively. The emissions from diesel and petrol production are based on data sets in the Probas database for European production in the year 2010 (11). Only CO_2 is included regarding the combustion of the fuels.

4.5 Agriculture

Agriculture is rather prominent on the island: two farmers are working together with milk farming, two farmers are having potatoes, one farmer is utilizing low-intensive farming with different animals and one farmer has small-scale meat production with Highland cattle and sheep. A number of households are leasing out fields for grazing to the active farmers (14).

The report considers the milk and the potato farms, but not impacts from other minor farming or private gardening activities (except as a generic deduction in amount of store bought food per person compared to the Swedish average, see below).

Tivarsgård milk farm is the largest farming activity on the island. The farm has 140 ha crop fields and pastures. The crew is 135-140 cows, including recruitment. During one year 580 m^3 milk is produced (9). A LCA study on milk farms in Northern Sweden (17) was assumed to sufficiently describe the Norderön milk farming activities resulting in 600 tonnes CO_2 eq. per year. Similarly, potato farming producing 175 tonnes of potatoes annually was described using data on potatoes from the Probas data base (11) resulting in 16 tonnes CO_2 eq. per year.

4.5 Consumer goods and food

The consumption of consumer goods and food was assumed to be similar to Swedish average. A discounting factor of 5% was introduced for the GHG emissions caused by food consumption, to take food production on the island into account. In 2003 the Swedish average emissions caused by private consumption of food was about 2,3 tonnes per capita and year and for consumer goods about 1,3 tonnes (18).

4.6 Municipal solid waste

The islanders generate approximately 208 m^3 (36,4 tonnes) of municipal solid waste (MSW) and 20 m^3 organic waste every year (19). Most of the municipal solid waste is transported via Gräftåsen waste disposal plant in Östersund to Korstaverket waste incineration plant in Sundsvall, located 200 km from Östersund. The organic waste is separated from the MSW at collection and treated locally, without transportation off the island. The reason for the local treatment is to prevent transport to the mainland. This practice started in 2010 (20). Recyclable materials and hazardous waste was disregarded in this screening study.

The emissions caused by the transportation of the waste are included in the diesel consumption. The GHG emissions from waste incineration in Sundsvall are based on emission data in the ELCD database (10). As a result, 12 tonnes of carbon dioxide equivalent or 0,1 tons per capita and year were emitted.

4.7 Wastewater

Wastewater treatment is done on the island by wet composting (9). Impacts included in this study were caused by transportations needed and electricity used by the facility and are included in the vehicle fuels and electricity estimates.

5 RESULTS

This report only considers global warming potential.

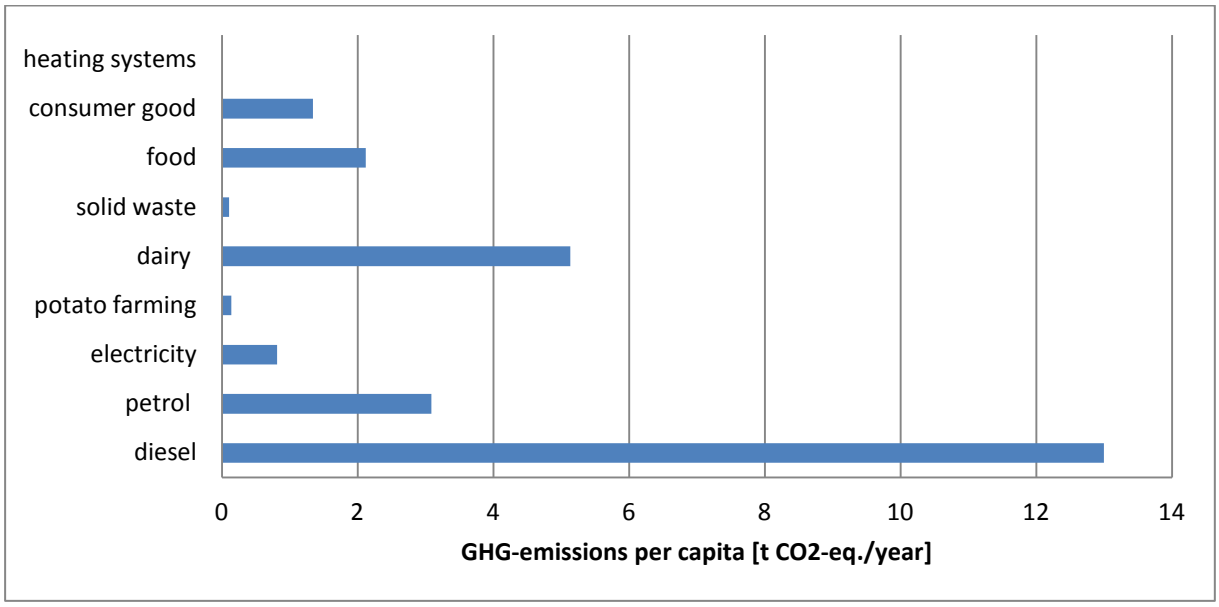

Figure 3: GHG emissions from different source.

Total emission of green house gases from activities connectd to Norderön in 2011 was estimated to 3011 tonnes of carbon dioxode equivalents. In Figure 3 the shares from diffrent sources reported per capita of the 117 inahbitants can be seen. The two largest sources of climate impacts are the vehicle fuels used (diesel and petrol) and the milk farming activites sector with 70% of the total carbon dioxide emission on Norderön. The running of the ferries result in about 70% of the consumption of vehicle fuels and and their connected environmental impacts.

In Figure 4 the Norderön results are benchmarked to Swedish average, when including and excluding the dairy and ferry.

6 DISCUSSION

A large part of the green house gas emissions are as expected connected to transportation activities, but it is also obvious that the magnitude of such emissions can be related to very local situations. The emissions caused by the Norderön related activities per capita are almost three times the Swedish average for the private consumption according to the Swedish EPA of about 9 tonnes per capita and year (18).

The two ferries and the dairy farming activities give significant contributions. If the ferries and the dairy farming activities are excluded, the carbon dioxide emissions are around 10 tons per capita and year, which is slightly higher than the Swedish average.

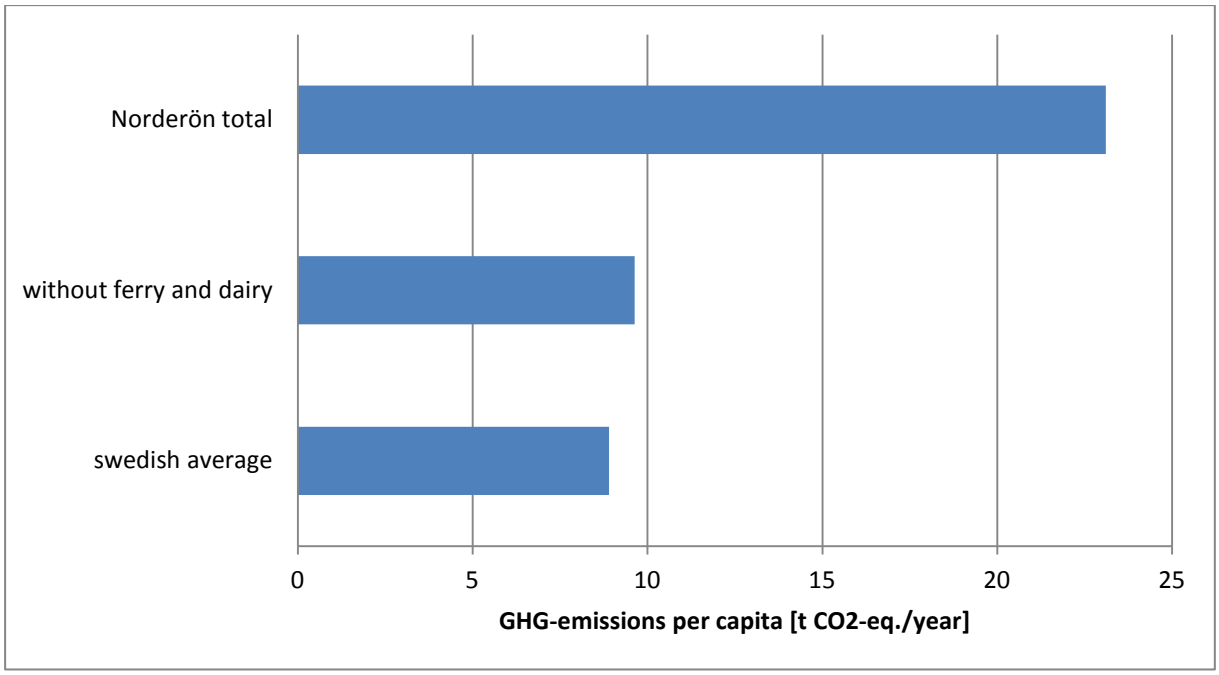

Figure 4: Emissions of Green house gases from the studied activities on Norderön Island benchmarked toward total carbon dioxide equivalents of Swedish average consumption.

In a narrow interpretation of LCA type results, this can be seen as an indication that the ferries should e.g. be replaced by a bridge. However, it should be kept in mind that such solutions are in themselves not without environmental impacts or consequences (e.g. concrete use, increased traffic). These types of interpretation also raise the question if we should have people living in rural areas at all. In a more holistic type interpretation, the same result could be seen as an indication that we will need a multitude of approaches adapted to each local situation, and that proposed solutions based in the idea of many people sharing the use of an artifact will not be applicable to less densely populated or rural areas. Another example could be the idea that transportation emissions should be curbed by public transportation. This is often feasible in a city, and the question then becomes how to get enough people to use it, but seldom in rural areas, where the density of people to utilize the public transportation is so low that it becomes an exceedingly expensive solution.

The second large contributor to total green house gas emissions in the geographical area Norderön is the agricultural activities. This highlights a problematic side of the ‘simple solution’ that we to curb green house gas emissions should just concentrate all population to large cities. However, since food production, as well as other area demanding activities like e.g. hydro power or forestry will still be needed in future, we will still be needing ideas for how people working with such activities should be able to live with good quality of life in a sustainable manner in rural areas where such production will take place. To have social sustainability in rural areas in general the population cannot be too low, e.g. because different services cannot be supported with a too low population (like schools, health care etc.) and vitality in general might diminish.

Fossil fuels are not only used for transportation of people but also for tractors, working machines etc. in agriculture and forestry, and for snowmobiles et c. Such fuel use is even less likely to be reduced by 'public' solutions than transportation of people, and is also less easy to change by switching from liquid fuels into electricity. These areas have so far not gained as much interest regarding R&D as fossil free private car solutions. Further discussion on issues regarding more sustainable transportation in sparsely populated areas, with Norderön as a specific case study, can be found in Lanker 2012 (16).

More research is needed in the field of solutions for how to increase sustainability in sparsely populated and rural areas. We can see this regarding the developed world from this case study, but it is also obvious that we urgently need sustainable solutions for better lives for millions of poor people in rural areas in developing countries.

7 CONCLUSION

To develop sparsely populated or rural areas in a more sustainable direction, solutions adapted to each location are needed. Solutions developed for urban areas will often be not applicable or efficient if directly transferred to sparsely populated areas. More research is needed in the field of solutions for how to increase sustainability in sparsely populated and rural areas.

8 ACKNOWLEDGMENTS

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