An urban metabolism approach to sustainability in the city of Östersund, Sweden

Introduction

Urban Metabolism (UM) is a metaphor that allows us to look at the city as a living organism. Just like an organism, the city requires food and water for its existence and turns them into wastes. Having information on how much of certain material is flowing in and out of the city can create a picture of its efficiency and sustainability. In 1965, Abel Wolman put up an urban metabolism model for a hypothetical North American city of 1 million people, evaluating some material in- and outflows [1].

As a start for UM research in the city of Östersund, located in the mountains of mid Sweden, a small literature review accompanied with a first assessment of the metabolism of the city were performed [2]. Two research questions were formulated:

- How has research on urban metabolism developed?

- What are the major material and energy flows in and out of the city of Östersund?

Literature review

The UM concept has been further developed since the first attempts done by Wolman and others. The literature review shows the development of different approaches to UM regarding 1) Internal and circular flows [3]; 2) consumption patterns, e.g. the ecological footprint approach [4]; 3) environmental impact, e.g. LCA [5]; 4) ecosystem approaches, based on an energy backbone, e.g. emergy accounting [6]; 5) spatial aspects addressed with GIS assessments [7]; 6) urban planning and design approaches [8]; 7) social-industrial ecology [9]; 8) urban ecology approaches [10]; 9) urban political ecology approaches [11] and hybrids [12]. It is also notable that there is not yet a standardized framework.

Method

The first estimation of the urban metabolism of Östersund city had an energy- and material flow approach. Three general methods were used to collect or produce data on material flows:

1) Local data was used as they were or recalculated to the population; 2) Regional data assumed to be representative also for the city of Östersund, often recalculated based on per capita or land use; 3) National data assumed to be representative also for the city of Östersund, often recalculated based on per capita or land use. A priority was given to local or regional data over national data.

First estimation

The results from our first estimation of some of the major material and energy flows in Östersund can be seen in Figure 1.

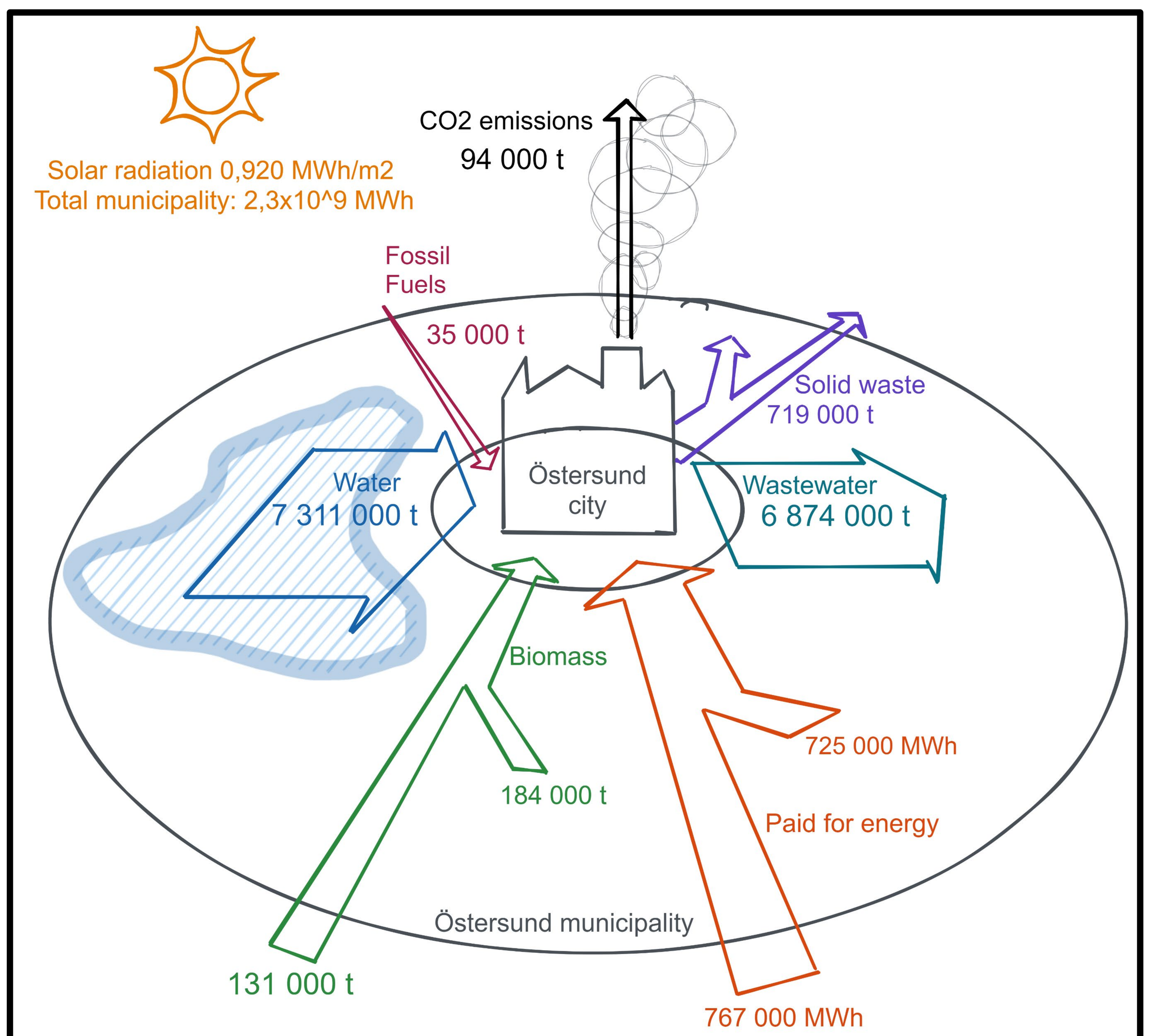

Figure 1. Annual major material flows (in tonnes) and energy flows (in MWh) used in Östersund city. A distinction is made between local production or treatment, and the import or export from and to outside of the municipality.

As can be seen from Figure 1, the flow of water is large compared to the other flows. Biomass and energy are both partially imported and partially produced locally to meet the rate of consumption.

Biomass

In Figure 2, local biomass production is specified. Most of the biomass weight produced comes from forestry while only a small part comes from agriculture. Within agriculture, most of the produced biomass is used to feed animals for meat, milk and eggs.

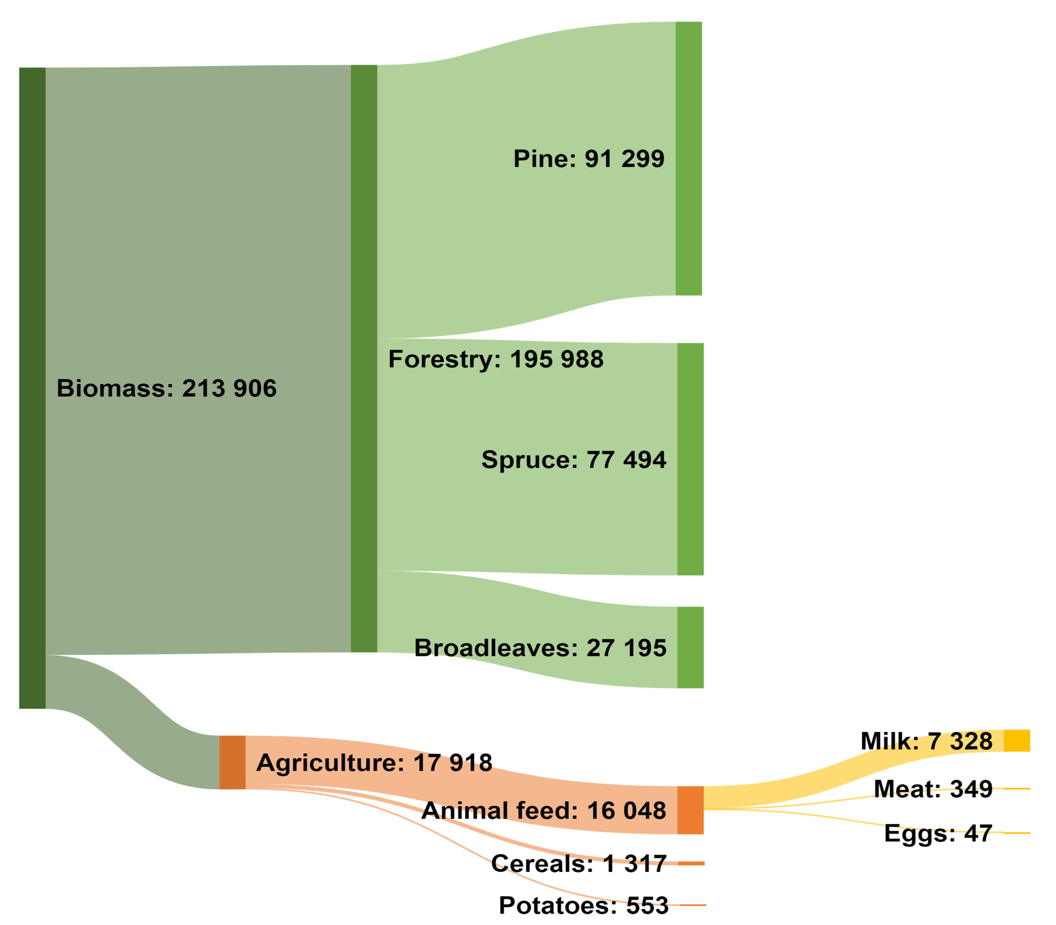

Figure 2. Yearly biomass production for consumption in the municipality of Östersund by industry and product, in tonnes

Energy

The distinction between the energy use in different sectors and different sources of energy is made in Figure 3. It shows how energy production in Östersund is dominated by renewable sources except when it comes to the transport sector.

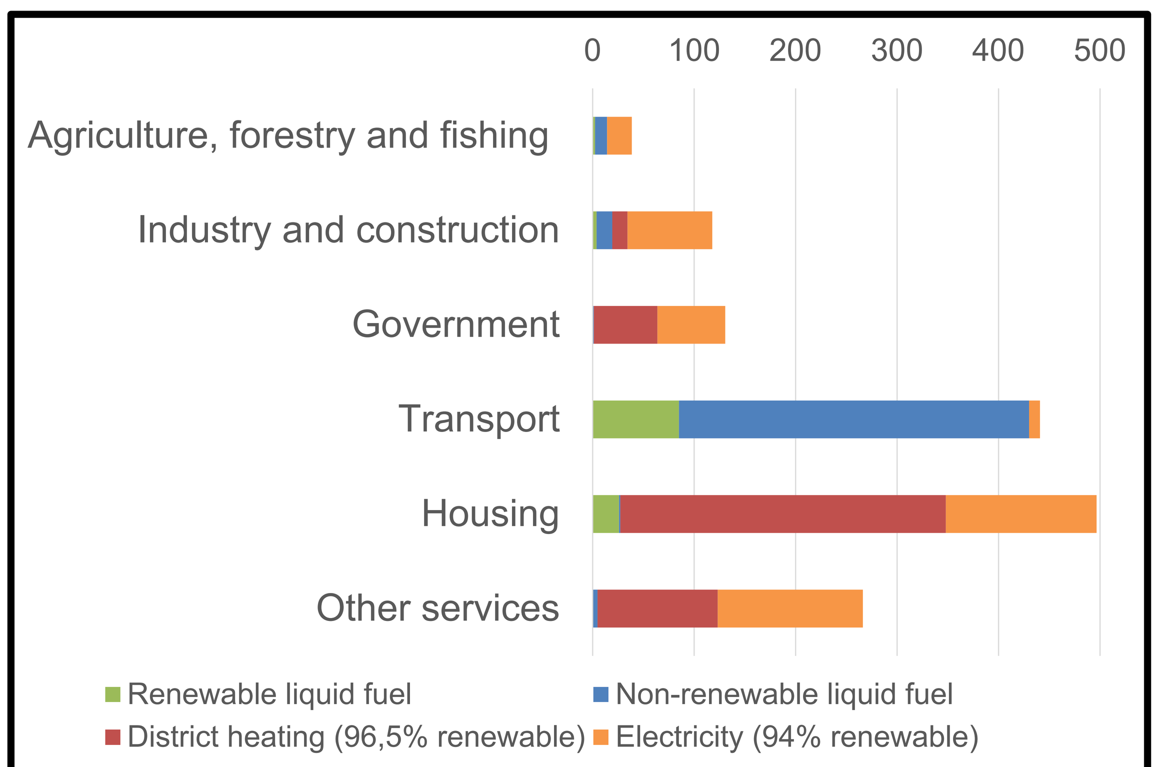

Figure 3. Energy use in the city of Östersund per sector and energy source in 2019, in GWh.

Discussion & conclusion

The material and energy flow analysis is a useful tool to better understand the major flows needed to maintain the city in its current state. This study starts to reveal the major flows of that type. The literature review shows that it can be used as the bigger picture, to which decisions in the different sectors of the city must relate, e.g. the impact of suggested circular flows, urban planning initiatives, or sustainable development policies and suggestions in general. Together, the large-scale assessment and the small-scale solutions can create a meaningful picture.

Reference list

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