EGU2020-4755
https://doi.org/10.5194/egusphere-egu2020-4755
EGU General Assembly 2020

Carbon Emissions and Sequestrations in Urban Landscapes and their Various and Changing Land and Water Covers

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In order to meet the dual challenges of providing for a growing global population and mitigating climate change effects, it is necessary to consider how urban areas can grow while achieving carbon neutrality, which is a complex and difficult task. It requires increased understanding of carbon dynamics in the coupled urban social-ecological systems, including process-level understanding and distinction of natural and human-perturbed carbon exchanges and their interactions. A better understanding of these complex systems and processes could, for example, facilitate enhanced use of nature-based solutions (NBS) to help mitigate and offset the greenhouse gas (GHG) emissions of urban regions. This paper addresses part of this challenge, aiming to further understanding of the complex interactions between urban growth and GHG emissions implied by associated land use changes, including the influence of water bodies within the urban region on the carbon source-sink dynamics.

The study involves a comprehensive analysis of the land-use related GHG emissions and removals (through carbon sequestration) in the urban region of Stockholm County in Sweden, which is currently experiencing large urban growth and rapid population growth. Stockholm County includes large urban areas, forested areas (both old and young preserved natural forests and managed forestry), farmlands, some wetlands, and a number of smaller towns and semi-urban areas. Geographically, much of the county is located on the Stockholm Archipelago – a series of islands in the Baltic Sea – and the remainder is dominated by many lakes, including Lake Mälaren, which is Sweden's third largest lake and the main water supply for the capital city Stockholm. The water coverage prevailing in the county allows for investigation of its effects in combination and relation to the variable and changing urban and other land cover distribution on the regional GHG emissions and sequestrations. These effects may be considerable and are addressed in this study.

Results include an inventory of existing and planned land uses in Stockholm County, and the GHG emissions or sequestration potentials associated with each of these. The land uses include urban and semi-urban areas, different types of natural and cultivated vegetation, agriculture, forestry, water bodies and wetlands. The study provides a map of Stockholm County's GHG emission and

sequestration potential, which is further analysed to advance our understanding of how future development in the county can be shaped to effectively minimize urban GHG emissions and maximize carbon sequestrations. The inclusion of water bodies in this GHG inventory proved to be particularly interesting; while lakes and other water bodies are often considered as 'blue' nature-based solutions (NBS) for maintaining and providing a number of ecosystem services in urban regions, our results indicate the lakes in Stockholm County as considerable sources of GHG emissions. The contribution of inland waters to the regional GHG emissions emphasizes the need and importance of improving rather than deteriorating the regional carbon sequestration potential in the urbanization process. This can be achieved by using and enhancing other types of NBS, such as rehabilitation of green areas like forests, in order to achieve carbon neutrality in this urban region.