

Integrated assessment of green roofs in the Oslo Municipality

How can green roofs improve resilience, equity and provision of ecosystem services in cities without creating negative socio-ecological impacts?

Workshop report

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1. Summary

- The Municipality of Oslo is devoted to improving the environmental performance of the city in regard to stormwater management, energy consumption and reduction of green house gases: green roofs can help to achieve these goals.
- The Municipality of Oslo developed the *The Strategy for green roofs and facades*, an initiative devoted to providing guidelines for the construction of new green roofs.
- The present study aims to create an integrated evaluation framework for green roofs through a participatory and co-creative process, focusing on the dimensions of Vulnerability, Multifunctionality and Sustainability.
- A first workshop took place on November 5th 2021. Participants discussed the future scenarios regarding the amount of green roofs that will be existing in the city and the criteria to evaluate them.
- The four scenarios proposed were well received by the participants, who gave some insights to have into consideration, such as the fact that the green roofs demand has been increasing in the last couple of years, and that is more difficult to estimate the increase of intensive green roofs than extensive green roofs.
- Participants selected the criteria for the evaluation of green roofs under the dimensions of Vulnerability, Multifunctionality and Sustainability.

2. Introduction

Green roofs provide a good opportunity for **creating new green spaces** in urban dense areas and offer benefits such as stormwater runoff control, carbon dioxide sequestration, biodiversity enhancement, reduction of heat island effect, reduction of noise and reduction of particulate pollution.

The Municipality of Oslo is devoted to improving the environmental performance of the city by developing a better stormwater management (Oslo Kommune, 2016), reducing the city's total energy consumption in 2030 by 10 per cent compared with 2009 (Oslo Kommune, 2020) and reducing its greenhouse gas emissions in 2030 by 95 per cent compared with 2009 (Oslo Kommune, 2020). These objectives will require different simultaneous solutions, such as the creation of new green roofs in the city. In Oslo, green roofs has been growing in numbers: by 2013, 650 green roofs existed in the city, and 950 by 2017, and it is estimated that **in 2021 the number of green roofs reached 1000-1100 units** (Oslo Kommune, 2021). The Municipality of Oslo is promoting the creation of new green roofs in the city, intending to reach a total of 2030 green roofs by 2030 (Oslo Kommune, 2021).

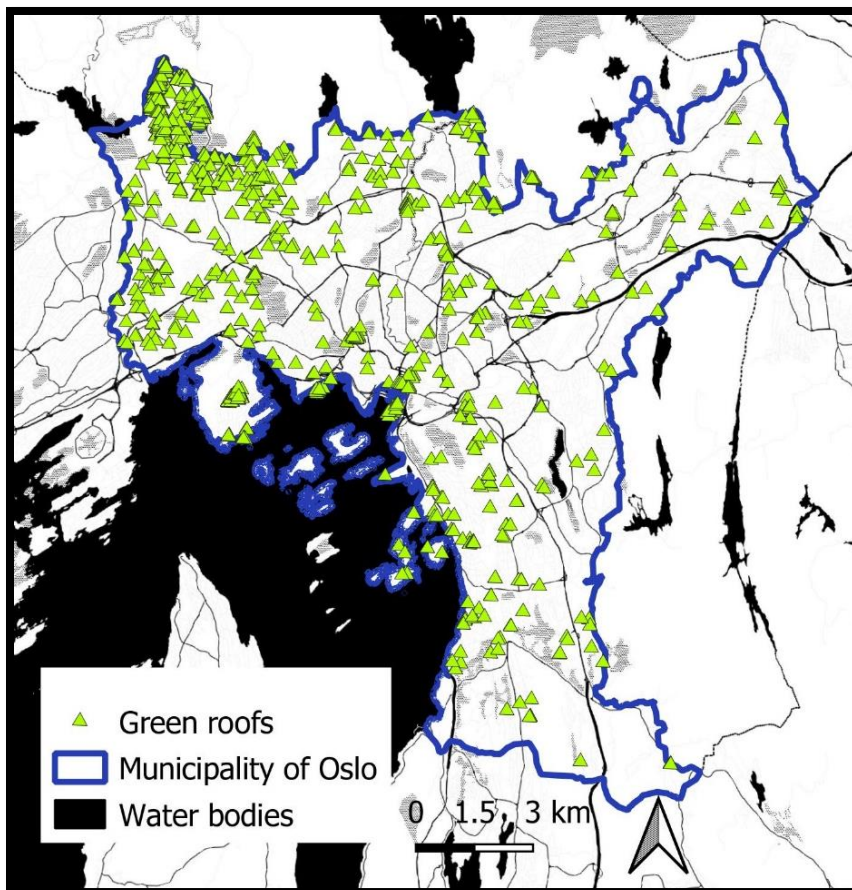


Figure 1. Locations of green roofs within the Oslo municipality for 2017 (Oslo Kommune, 2021)

The Strategy for Green Roofs and Facades by the Oslo municipality is an initiative devoted to providing guidelines for the construction of new green roofs and green facades in the city. These infrastructures will bring benefits such as developing the biodiversity in the construction zone, improving the climate-resilience of the city, reducing the energy consumption and strengthening the public health.

3. Evaluation of the Green roofs and participatory co-creation process.

URBAG is a research group of the Institute of Environmental Sciences and Technologies of the Autonomous University of Barcelona, whose objective is to examine how green infrastructures can provide the greatest number of benefits in urban spaces while making efficient use of resources. Under this premise, the group included Green Roofs as an object of study to apply and **develop its integrated assessment framework** (see Fig. 2) of green infrastructures on the dimensions of Vulnerability, Multifunctionality and Sustainability.

The study is based on a participatory process for the co-creation of the evaluation of the green roofs in the city, where policy makers, developers and students are taking part. The co-creation process focuses on **generating results based on the exchange of knowledge among participants**. To this end, it promotes dialogue between actors with different points of view with the intention of reaching a consensus on social and environmental issues. In this case, the process is divided in two stages: a first workshop focused on revising the most relevant criteria for the assessment and the green roofs configurations of the city for 2030, and a second workshop where the results of the evaluation is presented to the stakeholders. This report covers the first of the workshops, which took place in Oslo on November 5th, 2021.

Vulnerability: *exposure to social and environmental risks and the difficulty of individuals, groups or ecological systems to adapt to changes in the environment. The social aspect includes disadvantaged groups such as the elderly or people with motor disabilities.*

Multifunctionality: *the ability of green roofs to provide a variety of ecosystem services and benefits. These can be of different kinds, such as supporting, by providing natural habitats for animal species, provisioning of fruits and vegetables, regulating, such as runoff mitigation, and cultural, which refers to the ability to provide spaces for recreational or spiritual experiences.*

Sustainability: *ability to preserve the functionality of the infrastructure over time without compromising natural resources and biological ecosystems, while maintaining and promoting a good standard of living within society.*



Figure 2. *Integrated assessment of green roofs based on the dimensions of Vulnerability, Multifunctionality and Sustainability. Adapted diagram from (Langemeyer et al., 2021)*

4. Results

The workshop counted with 5 attendees of different backgrounds: landscape architecture, green roof planning, municipal environmental advisory and non-profit organization. The objective of the workshop was to present the ongoing research structure for the integrated evaluation of green roofs in Oslo and to seek the opinion of the participants on two aspects: the development scenarios that will be employed for the evaluation of green roofs in the city and the criteria under which these will be evaluated.

4.1. Scenarios

Four scenarios were discussed in the workshop, all of them related to the number of green roofs in the city and the capacity of green roofs for shaping it (**Table 1**).

Table 1. Proposed scenarios for the evaluation of green roofs in the Oslo municipality until 2030 and most relevant comments from participants

Scenario	Participant's perceptions
<i>Green roof strategy scenario</i> 98 new green roofs per year = 2,030 green roofs by 2030	<ul style="list-style-type: none">• The scenario was perceived as useful, as it represents the aims of the municipality (2030 green roofs by 2030)• Demand for green roofs in Norway has increased in the last couple of years, but is not yet clear which will be the trend in the next couple of years
<i>Ambitious strategy scenario</i> 200 new green roofs per year = 3,550 green roofs by 2030	<ul style="list-style-type: none">• The scenario was perceived as useful• The number could be backed up by the increasing demand for green roofs because of the necessity for stormwater management• The number may seem ambitious in the present, but may become less significant in the future as the market keeps growing
<i>Maximization scenario 1 (only extensive green roofs)</i> 8,000 green roofs by 2030	<ul style="list-style-type: none">• Since it is a reference scenario for understanding the maximum capacity of green roofs, there were no significant comments about it and the scenario was perceived as useful.
<i>Maximization scenario 2 (extensive & intensive green roofs)</i> 10,000 new green roofs by 2030	<ul style="list-style-type: none">• The scenario was perceived as useful• The fact that intensive green roofs required a lot more investment and more specific building characteristics, which make them less likely to implement them widely, was remarked by participants.

4.2. Criteria

A pre-selection of criteria was presented to the participants in order for them to discuss it during the workshop. The participants were asked to either add or discard criteria while also comment on their perception about these. Here is the final list of criteria that were selected by participants (**Table 2**):

Table 2. Criteria selected by stakeholders for the evaluation of green roofs in the municipality of Oslo until 2030

Urban vulnerabilities	Multifunctionality	Sustainability
Flood and runoff risks	Runoff and flood mitigation	Water depletion
Air pollution exposure	Air pollution reduction	Soil Pollution
Heat risks	Thermal regulation	Water pollution
Lack of habitat for biodiversity	Provision of habitat for biodiversity	Greenhouse gas emissions
Risk of social segregation / Social divide	Provision of environments for social cohesion / integration	Costs of implementation
Lack of opportunities for cultural and recreational experiences	Provision of environments for cultural and recreational experiences	Cost of maintenance
Neighborhood degradation	Landscape aesthetics	
Lack of opportunities for the involvement with natural environments	Provision of environments for biosphere reconnection, environmental education and stewardship	
	Reduction of energy use	
	Reduction of greenhouse gases	

5. References

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