

Restorative potential of green spaces in noise-polluted environments (RESTORE)



Urban areas experience a continuous increase of population and mobility, and infill development (densification) is a frequent strategy to limit urban expansion. These processes go along with increased noise exposure of the residents (causing, among others, noise annoyance and stress) and a decline of green spaces, although the latter are important for restoration from (individual and/or environmental) stress. To date knowledge on the role of green spaces and their required characteristics to reduce noise annoyance and promote stress recovery is still scarce.

Therefore, the project's objective is to assess the effects of green spaces as facilitators and noise as impediment to recover from stress. We will address the following research questions:

- RQ1: How are perceived and physiological stress associated with noise annoyance and noise exposure?
- RQ2: What is the effect of visiting green spaces with different audio-visual characteristics on the recovery from short-term perceived and physiological stress?
- RQ3: What is the effect of green spaces in the neighbourhood on long-term noise annoyance, perceived and physiological stress of people exposed to noise at the place of residence?
- RQ4: Which audio-visual requirements do green spaces have to meet to enable noise-exposed people to recover from stress?

The project is structured in 4 work packages: **WP1 Laboratory experiments** to explore the pathways from noise to annoyance and stress, and the audio-visual requirements on green spaces to facilitate recovery from stress; **WP2 Field experiments** in urban and suburban areas of varying acoustic and visual settings, to investigate the effect of walks through different green spaces on the recovery from

stress; **WP3 Extended field study** to assess the influence of green spaces in the neighbourhood on people's long-term wellbeing; and **WP4 Swiss-wide survey** and remote sensing green space assessment to determine the subjectively perceived restorative potential compared to the physical characteristics of green spaces in the urban and suburban regions of Switzerland.

The work packages use various methods and approaches such as questionnaires, cortisol measurements, skin conductance measurements, and quantitative landscape and soundscape descriptions. They are closely linked to each other with joint research approaches: identical standard sets of questions in all work packages to assess noise sensitivity, noise annoyance, perceived stress and wellbeing; measurements of physiological stress (salivary cortisol and skin conductance in WP1 and WP2; hair cortisol in WP3); real-world urban green spaces selected as test sites in WP2 and WP3, based on a categorisation in WP4, and of which video scenes will be taken for WP1; sound measurements and acoustical characterisation of the green spaces and the adjacent residential areas for WP2 and WP3; and finally establishing the link between perceived and physiological stress (reduction) for acute (WP1 and WP2) as well as long-term exposure (WP3) and different green space settings (WP4).

The project will provide new insights in the pathways of perceived and physiological stress build-up as evoked by noise exposure, and recovery as promoted by green spaces. These pathways will be explored for acute and long-term situations as well as on different scales, using laboratory and real-world situations representative to limited small scales up to national scale. The project will further identify the visual and acoustic prerequisites of restorative green spaces, including aerial extent, visibility from residents' home, accessibility, vegetation composition and volume, as well as soundscape (with mixes of anthropogenic vs. natural sounds). Based on these results, the restorative potential of green spaces will be mapped and classified on a national scale in the Swiss neighbourhoods, which will reveal areas with sufficient restorative green spaces as well as areas where improvements are advisable. In addition, the consequences of varying leisure behaviour on the restorative potential of green spaces will be studied to assess which part of the population benefits to which extent. Methodologically, as a result of the joint research approaches, the project will assess the transferability of results from laboratory and field experiments to larger parts of the population. This project is thus unique in its comprehensiveness and addresses a highly relevant and much-discussed topic that concerns three quarters of the population in industrialised countries. It will provide important information for spatial planning and noise abatement and will have an impact on the Swiss noise legislation and the implementation of the revised spatial planning act.

Project team

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Funding: SNF Sinergia grant CRSII5_193847/1