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SUMMARIES!

JOURNEY PLANNERS CAN PROMOTE ACTIVE , HEALTHY AND SUSTAINABLE URBAN TRAVEL

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Journey planners can promote active, healthy and sustainable urban travel

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Summary

- Environmental exposure during commuting affects daily travel experience, health and wellbeing.
- People experience their surrounding environment through sounds, smells and scenery.
- Pedestrians and cyclist can reduce their exposure to pollution and improve travel experience with the help of dedicated journey planners.
- Green Paths routing tool promotes sustainable urban commuting by helping people to find
- pleasant routes while on bike or on foot.
- It is a proof-of-concept type open source development that makes suggestions on low-pollution active travel routes in Helsinki capital region.
- Land use and transport planning can benefit from the tool as it allows evaluating if access to healthy and pleasant urban travel is equally available in space.

Travel environment and environmental exposure

People usually make several trips and experience different travel environments every day. During commuting, people **sense surrounding environment with all their senses**: seeing the views, hearing the sounds or smelling the air. Some of the interaction is rather passive, routine and unconscious, and not even actively registered. However, passing through **heavily polluted areas** may cause disturbances and lead to severe physical and mental health problems such as respiratory or cardiovascular diseases, increased stress levels, insomnia or in worse cases even premature death [1, 2]. In fact, air and noise pollution are the top environmental threats to health in Europe [3].

On the other hand, commuting does not need to be considered as a burden. **Pleasant and calm commuting environments** may trigger travel satisfaction and bring health benefits such as increased cognitive performance and recovery from stress [4, 5]. This is particularly evident in case of urban greenery that forms the main restorative environment in urban areas [6, 7]. Urban greenery also helps to reduce harm from traffic pollution and excess heat, functioning thus as a substitute for nature.

Sensing the environment

Travel time environmental exposure is formed out of the numerous environmental encounters such as smells, sounds, views or temperatures that people experience while travelling. Harmful exposure from pollution may cause severe health problems or in worst cases even premature death. Exposure to urban greenery, on the other hand, can bring several health and wellbeing benefits.

The intensity of environmental exposure and its effects depend on travel mode. **Pedestrians and cyclists** are directly exposed to the ambient environment. The increased inhalation due to physical activity makes active travellers more vulnerable to pollution when compared to people travelling by public transit or personal vehicles [8]. At the same time, **physical activity** is associated with several health benefits in comparison to sedentary (travel) behaviour [9]. Despite these opposite effects and complex relations between environmental conditions and physical activity, **the benefits of active travel tend to overweigh the adverse effects caused by traffic pollution** [10, 11], particularly when healthy environments are available for travellers.

Environmentally sensitive journey planners

In order to improve the benefits of active travel, pedestrians and cyclists may have the possibility to choose more pleasant commuting routes in comparison to the faster and often heavily polluted main streets. This is where journey planners that take into consideration the quality of travel environment can be of help.

Journey planners are routing tools that assist people in finding **optimal routes from their origin to destination** based on spatial data and routing. Traditionally, these tools consider either distance or travel time when making route suggestions. The approach was developed already in 1950s when Edsger W. Dijkstra developed his well-known shortest paths algorithm [12].

Recently, several research groups have started to develop methods and tools for environmentally sensitive journey planning by combining **environmental information** to the equation. Namely, comparative research has demonstrated that the shortest routes are not necessarily the most beneficial for human health [13, 14].

If equipped with environmental data, journey planners enable to **prioritize healthier** and **more pleasant commuting routes**, help to achieve **more satisfying travel experience,** and thus support **active and climate-responsible travel choices**.

Novel examples of exposure-optimised routing methods and tools consider one or even several environmental variables in route optimisation. The core ambient environmental characteristics are:

- **air quality** [15, 16, 17, 18],
- **noise levels** [17, 19, 20],
- **heat exposure** [19, 21] and
- **greenery** [22].

Some other approaches consider also:

- **aesthetic, cultural and social qualities** such as the presence of landmarks [23, 24] or socio-semantic places [22, 25],
- **traffic safety** aspects such as street width or light conditions [23], or
- **the prevention of greenhouse gas emissions** [13, 26].

Several studies have shown that environmentally optimised routing that is distant from motorized traffic results in bigger drop in pollution exposure than the accompanied increase in travel time [13, 14, 26, 27]. Thus, route choices that help to avoid pollution or aim to support wellbeing are often accessible at a low additional time cost to pedestrians and cyclists.

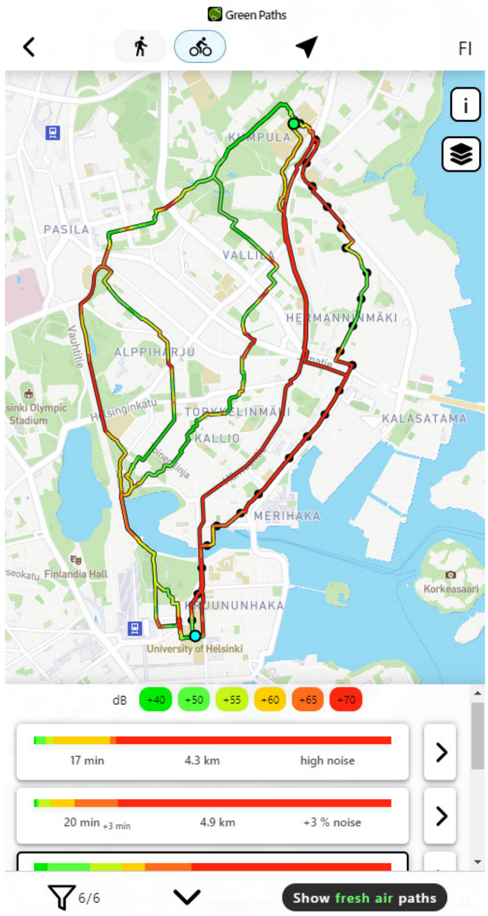
Green Paths routing tool

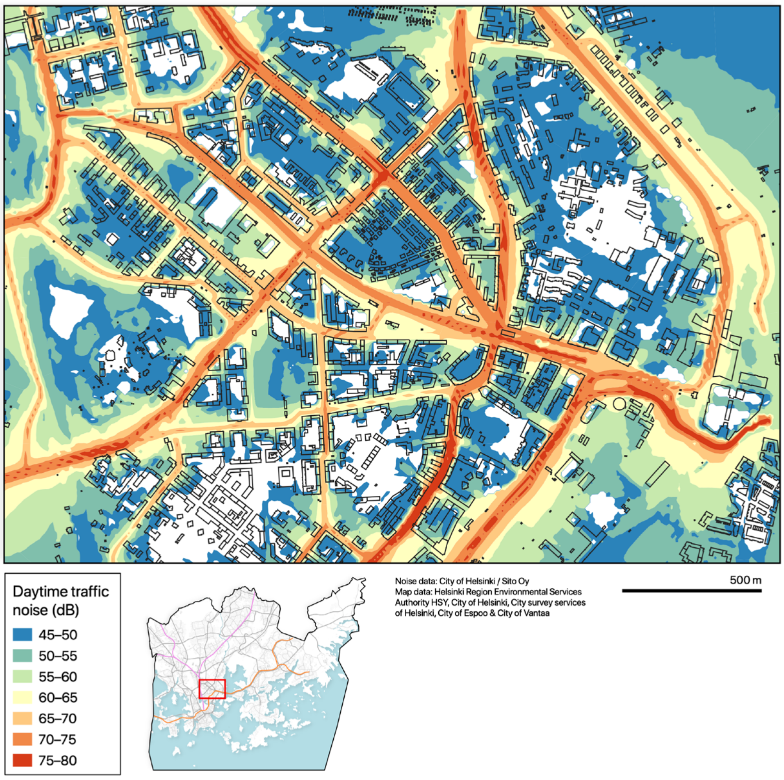
Inspired by the idea that pleasant routes improve travel experience by allowing positive interaction with the urban environment, we at the Digital Geography Lab, University of Helsinki, have developed a **Green Paths routing tool**. This proof-of-concept routing tool allows pedestrians and cyclists to choose routes with less air and noise pollution in Helsinki capital region. By suggesting **exposure-optimised alternatives for active travelling**, Green Paths routing tool also **promotes sustainable urban transport**: people are more likely to choose an active travel mode if the experience is positive. Furthermore, it highlights the need to consider health and wellbeing aspects in spatial and transport planning as these create the underlying opportunity structures for population to experience healthy routes.

Green Paths tool deploys open source environmental information. As a novel aspect, the tool applies real-time air quality information that is produced by the Finnish Meteorological Institute. We apply **Air Quality Index** in particular, which is an hourly composite data product of the ENFUSER modelling system [29]. For noise data, we use average **modelled noise levels** from road, rail and air traffic (Figure 2). The data is provided by the Finnish Environmental Institute and local municipalities, and is modelled in accordance with the EU Environmental Noise Directive in 2017 [30, 31].

For the underlying street and path network, we fetch data from OpenStreetMap, which is a collaborative open source geodata project [32]. We use separate networks for walking and cycling in Helsinki capital region. For now, the tool is developed as a proof of concept with advancing features and functionalities in time. It should be considered as a demonstration of environmentally sensitive routing based on spatially explicit and advancing open access data sets, and it is not guaranteed to work smoothly at all times.

Figure 1. The user interface of the Green Paths routing tool showing noise exposure for cycling routes between the central and Kumpula campus of the





As an end-user application, Green Paths routing tool is publicly available via a **mobile-friendly website** https://green-paths.web.app/, both in Finnish and English (Figure 1). It is an **open code development** [28] to ensure transparency and further development steps. By providing the open code, we aim to encourage other developers to consider environmental cost factors in their active travel oriented applications.

Figure 2. An example of the underlying traffic noise data set of the Green Paths routing tool [27].

Environmental exposure as a matter of environmental justice

Green Paths routing tool is a continuation to the master's thesis by Joose Helle [27] on developing a web application for quiet paths, and analysing **areal level variation in noise exposure of public transit commuting**. The latter serves as one of the first attempts to understand environmental equity structures behind daily commuting in Helsinki. The analysis shows that pedestrians' exposure to noise pollution on their way to local public transit stop has strong spatial variation (Figure 3), and that intensive noise exposure can be significantly reduced by using alternative, somewhat longer routes.

Environmental exposure is a matter of environmental justice. Research from many cities has documented that low-income or minority population groups are often disproportionately exposed to harmful living environments [33, 34]. However, much less scholarly attention has been paid to the **equal access of healthy commuting** environment for different socio-spatial population groups. The topic needs more attention considering how much people get exposed to the environment while being outdoors, and particularly during active travel. Ensuring equal access to health-benefitting environments is important when promoting active travel modes in urban transport [35]. It is also a global goal of sustainability [36].

Next, we aim to understand how the residents in Helsinki metropolitan region are exposed to both pollution as well as health-benefitting urban greenery during their commuting trips, and how equally accessible pleasant travel routes are for different socio-spatial population groups.

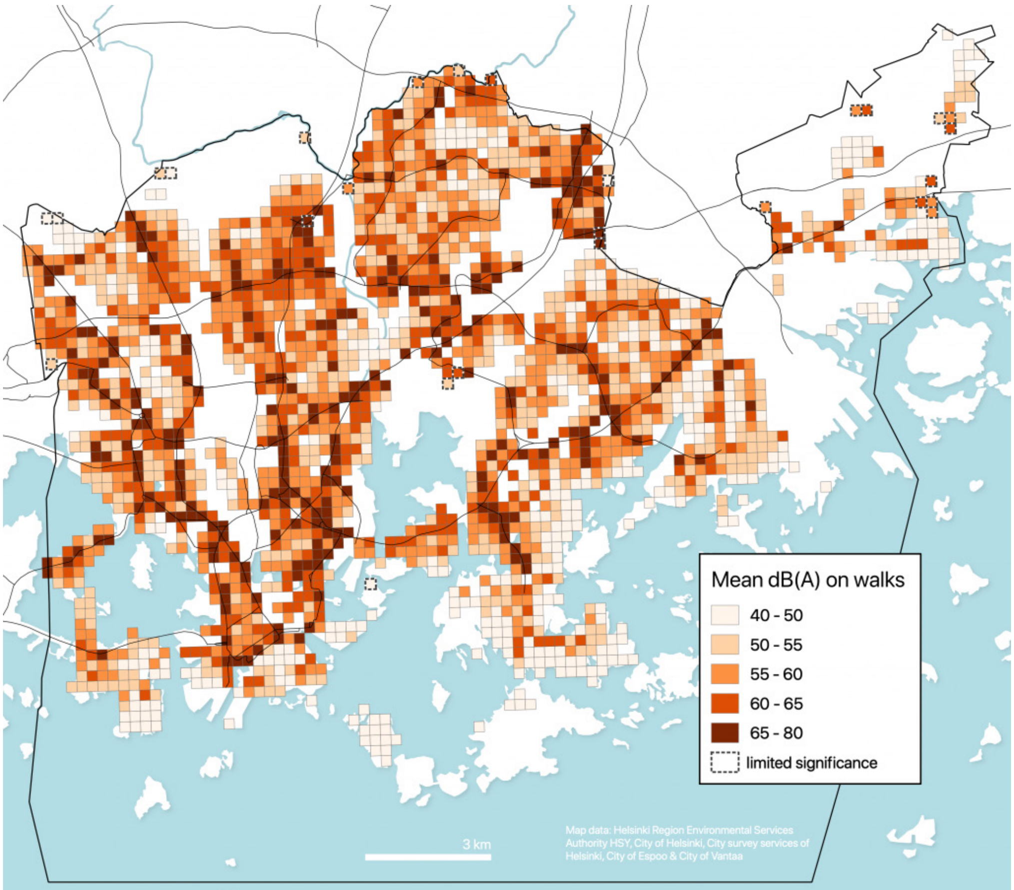


Figure 3. Mean traffic noise level (dB(A)) on walks from homes to the closest public transit stop [27]. The averages are weighted with the estimated utilization rates of the walks based on the total flow of commutes using each origin – public transit stop pair.

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