**Introduction**

* What is the scope of the problem?
  + Improving the modeling of the walkable environment / service connecting area for urban green spaces (UGS) in European cities based on a proximity approach
  + Provide solutions for easy-to-handle / understandable indicators based on publicly available data and software
  + Develop an approach to combine high-resolution data with a comparative approach
* What do we know about the problem?

ES = Important

* + Ecosystems supply ecosystem services (ES) which are critical to human well being (Fisher et al. 2019).
  + Living in proximity of urban green spaces (UGS) was found to have positive effects on mental health and physical activity as well as reduce mortality (Kabisch 2017?).
  + Thus, having access to UGS can enhance inhabitants’ quality of life (EU 2018).
  + In the Sustainable Development Goal (SDG) 11.7, the United Nations have agreed to provide universal access to public green spaces by 2030.

(Global) urban pop growing = relevance of ES in cities

* + Urban population is growing worldwide. 55% of the global population were living in cities by 2018 and 68% are projected to do so in 2050 (UN, 2019).
  + In Europe, 74% of the population are living in cities (UN, 2019).

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European challenges = narrowing down

* + Due to various influences, in Europe there are regions with growing and regions with shrinking cities (Kabisch et al. 2012).
  + These dynamics pose varying challenges and opportunities for the development of UGS (Kabisch, Haase 2012).

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SPA vs SBA

* Since ES are rarely consumed by humans at the same place where they are produced by the ecosystem, we distinguish service production areas (SPA) and service benefiting areas (SBA) (Fisher et al. 2009, Syrbe and Walz, 2012).
* Service production areas (SPA) represent the supplying side, the spatial unit where the ES are generated.
* Service benefiting areas (SBA) embody the demand side, the target of an ES flow (Syrbe and Walz 2012).
* In the case of UGS in and urban environment, the UGS are the SPA and the residential areas or buildings are the SBA.

Accessibility of UGS vs availability of UGS:

* + The availability of UGS can be defined by the “amount of green area in a defined distance to where urban residents live” (Kabisch et al. 2016).
  + Having actual access to UGS might be limited by additional factors though.
  + The physical accessibility, for example, can be limited by fences, or opening hours of an UGS.
  + Additionally, accessibility may be limited by perceived overcrowding effects through population pressure (Kabisch et al 2016, Wollf et al. 2020).
  + The population pressure might be amplified by the compact city paradigm, which is popular among European city planners: A more compact city can result in shorter traveling distances but also in more overcrowding effects (Commission of European Communities, 1990; Burton, 2003 <https://doi.org/10.4324/9780203362372>).
  + As use intensity can influence ES, it can create a mismatch between supply and demand (Syrbe & Grunewald, 2017).

SCA = modeling space between SPA and SBA

* + In order to account for physical and perceived barriers to green space access, it is beneficial to take a look at the space between SPA and SBA (Syrbe & Walz 2012).
  + As stated above, the space *in between*, also called the service connecting area (SCA), may affect the quality of ES and, thus, the accessibility of UGS (Syrbe & Walz 2012).
  + Therefore it is necessary to model the walkable environment of a city.

Proximity = Modeling green space proximity in cities important (SCA for green space and population in cities)

* + Three perspectives have been used in past studies to tackle model the availability and accessibility of UGS:
  + The provision perspective looks at the flow from green area to buildings, thus, focusing on UGS provision (area / person).
  + Secondly, the pressure perspective describes the flow from residential buildings (i.e. the population) to the UGS.
  + The focus here lies on the pressure on UGS or the demand for green areas (person / area).
  + Lastly, the proximity perspective takes into account the space between supply and demand. (minimum or average distance). A proximity perspective is necessary to account for barriers and network characteristics like overcrowding effects. (Wolff, 2021).

State of the art:

* + Availability and accessibility of UGS in Europe have been analyzed and compared in multiple studies.
  + In their 2016 paper, Kabisch et al. carried out an assessment of green space availability in 299 EU cities.
  + They used a population grid of 1 km² and land use data (urban atlas) to calculate the population within a buffer distance of UGS.
  + In 2016, the Joint Research Center (JRC) of the European Union developed an indicator for areas that are served by UGS in European cities.
  + In their analysis, the authors used a 10 m² resolution land use data grid and a 100 m² population mosaic and a network based approach.
  + In another analysis from 2018, the JRC used urban atlas data and a street network to assess the area that can be reached in a walking distance of 10 minutes (JRC, 2018).
  + Their analysis also results in an area per population measure on a city level.
  + In a 2021 paper, Wolff tried to couple the provision, pressure and proximity perspectives by applying network characteristics.
  + In his analysis, he found two promising indicators, the Detour Index (DI) and the Local Significance (LS).
  + The DI is a measure of the efficiency of the paths people take to their next UGS.
  + This way barriers that people have to overcome on their way can be modeled.
  + The LS is a simple measure to describe the relevance of different edges (Esch 2014).
  + Wolff used the LS to model use-intensity of UGS.
  + As a consequence LS might serve as a spatial indicator for overuse of UGS.
* What do we not know about the problem?

Research gaps (of previously mentioned studies):

* + The previously mentioned studies have mostly used fixed distances for their analysis, leading to binary results of ‘having or not having access to UGS’.
  + We also saw mostly one perspective being used to assess green space accessibility (provision, pressure or proximity).
  + Accordingly, previous research did neither account for the mutual dependencies of supply and demand, nor did it put the focus on SCA – the walkable environment.
  + In addition to the precious points, the mentioned studies, if on a larger scale, were carried out on a coarse resolution.
  + A fine resolution can reveal spatial patterns at a finer scale enabling targeted intervention.
  + A finer resolution will also reduce the uncertainty that is introduced if e.g. a grid or a city block aggregation is used as in urban atlas data.

Conclusion:

* + All things considered, knowledge about green space accessibility is important for planning and decision making.
  + A combination of provision, pressure and proximity aspects of green space accessibility might prove promising to detect a mismatch between supply and demand.
  + No comparable studies using e.g. a building-based approach on a European scale
* What is the purpose of this paper?
  + Modeling the *walkable environment* of European cities by including the three perspectives mentioned above and using a network characteristics approach.
  + We want to answer the questions:

What does a modeling approach look like that estimates the walkability between green space supply and demand in cities?

(How to incorporate publicly accessible data and open source software in order to allow i.) a reproduction over time (e.g. with more recent data), ii.) assessments in data-scare regions, and iii.) comparative approaches covering a larger sample of cities)

* + - How can easily understandable and applicable indicators be used in order to support urban planning in detecting mismatches between demand and supply?
  + Our objectives are i.) to develop modeling approach that applies the aforementioned walkability indices, ii.) to compare the results on a European scale and to iii.) implement the indices by showing possible use cases for city planners.
  + Objective 1: From concept to workflow (based on service-connecting area/proximity approach)

What does a modeling approach look like that estimates the walkability between green space supply and demand in cities?

Modeling service connecting areas:

Description of indices

* + - * + Combine buffer distance and network distance (Detour index)
        + Combine population, GBS size network distance (Local significance)

local significance for streets / detour index for buildings

Objective 2: Develop and apply indicators, display/interpret/compare them

* + - How can easily understandable and applicable indicators be used in order to support urban planning in detecting mismatches between demand and supply
      * Create Network characteristics for European cities
      * Comparison across Europe
        + Clustering / aggregation
      * City scenarios
        + Three scenarios