reviewed paper

Analysing and Evaluating Gender+ Specific Requirements in Urban Space to Support Urban Planning

Ernst Gebetsroither-Geringer, Magdalena Bürbaumer, Theresa Fink

(Dr. Ernst Gebetsroither-Geringer, AIT Austrian Institute of Technology, Giefinggasse 4, 1210 Vienna, ernst.gebetsroither@ait.ac.at)
(Magdalena Bürbaumer BSc, AIT Austrian Institute of Technology, Giefinggasse 4, 1210 Vienna, magdalena.buerbaumer@ait.ac.at)
(Theresa Fink MSc, AIT Austrian Institute of Technology, Giefinggasse 4, 1210 Vienna, theresa.fink@ait.ac.at)

1 ABSTRACT

The research project called Smart Through Gender+ aims to support a gender+ appropriate urban planning and investigates on how new GIS based spatial planning tools can assist analysing the available data. In this context, gender groups are not only determined by sex, but by further factors which are considered to shape a person's urban routines.[1] Those groups are referred to as gender+ groups. For the case study area of Linz, a medium sized city in Austria, data from different sources like official statistics (Statistics Austria), Open Government Data (OGD), OpenStreetMap (OSM), Foursquare and TomTom have been evaluated. The focus is on data about infrastructure, services and facilities that are crucial for daily routines and the everyday life patterns of certain gender+ groups. The analysis is centred upon the principle residence of the citizens. This data is used to correlate supply and demand, deficits and potentials.

Based on the "city for all" approach, different gender+ groups and their specific spatial demands were identified in the course of the research project. This paper demonstrates the creation of gender+ specific supply and demand maps. For increased readability and comparability, a unique key performance indicator (KPI) was developed, which evaluates the appropriateness of the urban space to the needs of a specific gender+ group. This KPI set is a combination of spatial, infrastructural and demographic features, the classification is based on median values.

The resulting maps 1) express the current situation highlighting especially areas where the current infrastructure offer, and the available functions and facilities show need for improvement and 2) expel areas which possess the potential for an increased demand due to an already existing infrastructure for a specific gender+ group. Generally speaking, the resulting maps facilitate planning decisions within given spatial circumstances, which might range from easily adjustable services to fixed, immovable infrastructure.

The paper further discusses the different data sources and analysis methods, as well as the workflow of creating the maps of the current situation. The data basis as well as generalisation and simplification – both in terms of map creation and formation of gender+ groups – is critically reviewed. It finally concludes with the potential involvement of the demand and supply maps to display and validate future demographic development scenarios, as well as to support accompanying urban planning decisions. Decisively based on open data the developed tool shall be applicable to further Austrian cities, providing planners with a first overview of hotspot areas concerning gender+ appropriate design of a given city.

Keywords: Demographic Change, GIS Analyses, Urban planning tools, Open Data, Gender appropriate urban planning

2 INTRODUCTION

Cities are facing a fast change in their population, their needs and thus the requirements and demands. Social change processes and the global trend towards urbanization, as well as the current migration pressures on European cities are increasingly posing a major challenge to respond to the processes of change in urban planning. Although gender issues are considered important in some cities, they are often disregarded in planning practice due to the many other issues and the time and money spent on spatial research (especially in smaller and medium-sized cities). Cities always have been areas wherein different user groups, males, females, young and old, as well as different ethnic groups lived – and all of whom have different needs for urban functions. The current trend of migration even increases the requirement to cope with the different demands of citizens and to understand, which infrastructure and functions of a city have to be provided at which location. In this context, gender groups are not only determined by sex, but by further factors which are considered to shape a person's urban routines. Those groups are referred to as gender+ groups in this paper.

[1] such as age, household size, employment and country of origin

ISBN 978-3-9504173-8-8 (CD), 978-3-9504173-9-5 (print)
Editors: Manfred SCHRENK, Vasily V. POPOVICH, Peter ZEILE, Pietro ELISEI, Clemens BEYER, Judith RYSER, Christa REICHER, Canan ÇELIK

Furthermore, the role of urban planning and urban planners in shaping cities and regions changes increasingly as new data sources allow a more detailed insight in the spatial distribution of functions and forms of cities. Since the 1970s, an increasing consideration of gender-specific aspects in planning theory and practice has become apparent (Damyanovic and Zibell 2013). Since the gender mainstreaming strategy was anchored in the Amsterdam Treaty, there has also been an increased implementation of this strategy and thus of gender-specific aspects in urban planning. Some cities e.g. Berlin, Vienna have published guidelines on the integration of gender issues in urban planning and development (Stadt Wien, 2013). Only four of the 12 bigger cities in Austria refer to the gender mainstreaming strategy, use gender-disaggregated data or point out the different demands of women and men (Reinwald et al., 2016).

Digital tools for the analysis of socio-spatial structures and for the simulation of measures and their effects are increasingly used in urban planning. These tools though lack the integration of gender and group-specific aspects. Gender-sensitive urban planning is, as one of the basic principles, dependent on gender-specific disaggregated data.

3 SMTG+ PROJECT AND CASE STUDY LINZ

The project "SmartThroughGender+" (SMTG+) develops solutions for this, it investigates on how new GIS based spatial planning tools can assist analysing the available data. Traditional planning tools, such as local development concepts, have difficulty coping with the rapid changes and aligning goals and measures with long review periods. "SmartThroughGender+" aims in integrating gender+ aspects into a toolset to support urban planning. The overall objective of the project is a Proof of Concept if this toolset consisting of (quantitative) digital analysis and simulation tools as well as (qualitative) instruments from urban and landscape planning, taking into account gender+ specific requirements, enables to support gender+ sensitive urban planning. Thus, on the basis of a case study in the city of Linz (Austria), it examines based on commonly available data if and how indicators and characteristics can be developed to enable a (partially standardized) "rapid assessment" of social and spatial structures while taking the gender+ approach into account. SMTG+ develops quantitative tools on different spatial resolutions. One is developed at the overall level and a cell resolution of 250m*250m for the entire city to investigate “hot spots”, which possess an above average demand for gender+ sensitive urban planning. This quantitative tool is based on statistical data from the national statistic agency (Statistic Austria) and Open Government Data (OGD) and sources like OpenStreetMap (OSM), Foursquare and TomTom. The tool is implemented as a web application using R-Shiny. For a district, which was chosen based on the results of a GIS analysis and stakeholder judgement, a quantitative tool on the level of building blocks will be developed using Rhinoceros3D/Grasshopper and a parametric modelling concept. In order to validate, test and clarify the results at the overall level, a qualitative analysis is carried out at district level in which participatory statements are examined and proposals for measures are worked out (combination bottom-up and top-down). This qualitative analysis will also be combined on district level with the quantitative parametric design tool later. The project lasts till Mai 2021, thus in this paper we will focus on the already developed method for the GIS analyses at the overall (entire city) level and the first results and findings of the implementation into an interactive web application.

4 DATA SOURCES AND EVALUATION OF USE

In order to be able to carry out quantitative analyses at overall (entire city) level, different data sources were examined. The focus is on commonly available data to easily transfer the methodology to other cities. A good availability and standardised form of the data sets is essential for the automated processing and analysis of the data. In addition to the availability of the data covering a wide area, the relevance of the data and the implementation of updates is an essential requirement. Data sets which show the development in cities over a period of several years prove to be particularly helpful. In the presented project, demographic data and location data on selected uses were used for the analyses.

For the demographic information on the population the data of the national statistical agency (Statistics Austria) were used in a cell resolution of 250m*250m for the calculations. Here there is a wide range of different categories (family, household, population structure, ...), which represent the population structure on a grid available throughout Austria. In the analysis presented, data on age, gender, ethnicity, household size and marital status are examined. This information is available as bundled packages and can be purchased commercially on individually selected regions. The principle residence is used for the evaluation of population distribution and accessibility of the daily infrastructure. The availability of everyday facilities close to the workplace is therefore not represented. The data source Statistics Austria has proved to be very suitable according to the demographic data for the application in the project and the transfer of the tool to other Austrian cities.

Location data was used to check the availability and accessibility of daily local supply. The following data sources were tested for their usability: TomTom, OpenStreetMap [OSM] and Open Government Data [OGD]. Location data is available in different geometrical forms [points, polygons] and therefore the usability of data depends on the usage. The supply of daily infrastructure (e.g. shops, education, social infrastructure) can be expressed geographically by points of interest [POI]. However, the sufficient supply of green spaces requires the outlines (polygons, areas) to include the size of the parks in the calculation.

For the analysis of points of interest, comparisons were made between different data sources. The different classification schemes within the data sets form a challenge for counting and comparing characteristics (Hochmair and Zielstra 2013). For the project the TomTom data was bought as points (POIs) data set and the road network as lines for the overall city level. The POIs are available for the overall city of Linz in 2018 with 5571 points and in 2019 with 5667 points. The structure of the data is organized by PACKNAME, in by LABELNAME and by SUBNAME as a clear description of the point information. By applying filters, selected uses from POIs can be included in the evaluation. This means the data is described in the first level (Package) Eating & Drinking, in the second level (Labelname) Café or Pub which is on the third level (Subname) differentiated in Café, Coffee Shop, Pub or Empty.

PACKNAME	LABELNAME	SUBNAME	COUNT
Eating & Drinking	Café or Pub	Café	46
Eating & Drinking	Café or Pub	Coffee Shop	3
Eating & Drinking	Café or Pub	Pub	20
Eating & Drinking	Café or Pub	Empty	40

Table 1: Example on Structure of TomTom data

It was determined that not all POIs contain information in the SUBNAME, this affects that filtering POIs in the third level can cause a loss of data (POI). The percentage distribution of POIs on the PACKAGES also shows that the focus is on business (34.3%) and shopping (31.3%). The necessary basic health care is represented by 10.3% of the POIs and the food & drink category by 9.8%.

The advantage of the open source dataset of OpenStreetMap [OSM] is, a worldwide availability of data. However, the data is created by a user community in a different level of detail and is not validated by the providing company like TomTom. Hence the inclusion of this OSM POIs in the analyses can be beneficial in some applications.

The amount of pharmacies in Linz can be well compared among the different data sources. The lower Figure 1 shows the distribution of pharmacies in Open Government Data, OpenStreetMap and TomTom of the currently available datasets.

Pharmacies OGD [30] | Pharmacies OSM [40] | Pharmacies TomTom [41] | Combined Pharmacies

Included in all data sets
Included in 2 data sets

Fig. 1: Distribution of Pharmacies [POI] in Linz – Open Government Data, OpenStreetMap & TomTom © AIT

A comparison of the data sets showed that not only the location of the point data varies, but also the number of POIs in the urban area. For the general accessibility in a 250m raster the geographically exact location on

ISBN 978-3-9504173-8-8 (CD), 978-3-9504173-9-5 (print)
Editors: Manfred SCHRENK, Vasily V. POPOVICH, Peter ZEILE, Pietro ELISEI, Clemens BEYER, Judith RYSER, Christa REICHER, Canan ÇELIK

a few meters variance is negligible. However, the completeness of the data sets is an essential quality criterion. This insight raises the need for validation of the data within the research project which as a necessary step for a representative statement of the analyses. A detailed documentation of the processing and integration steps must be done in order to enable an optimized work when transferring the method.

The analysis of the polygons (e.g. green areas and open spaces) was based on the official zoning data by Open Government Data [OGD]. The dataset contains the polygons by function and therefore provides information about the area coverage of urban green areas for the population. For the calculation of the supply of open spaces, not only the distance but also the size, type and quality of the open spaces are relevant.

5 GENDER+ SPECIFIC SUPPLY AND DEMAND

The main idea is to combine the demand based on the spatial distribution of the different gender+ groups, with their needs regarding infrastructure as well as green and open spaces distribution. This means a combination of three factors so-called scores. A demographic score, an infrastructure score and a spatial score (green and open space score). All together -the combination of three single scores- was integrated to the so-called gender+ score, a unique key performance indicator (KPI) to investigate how the demand and supply matches Figure 2.

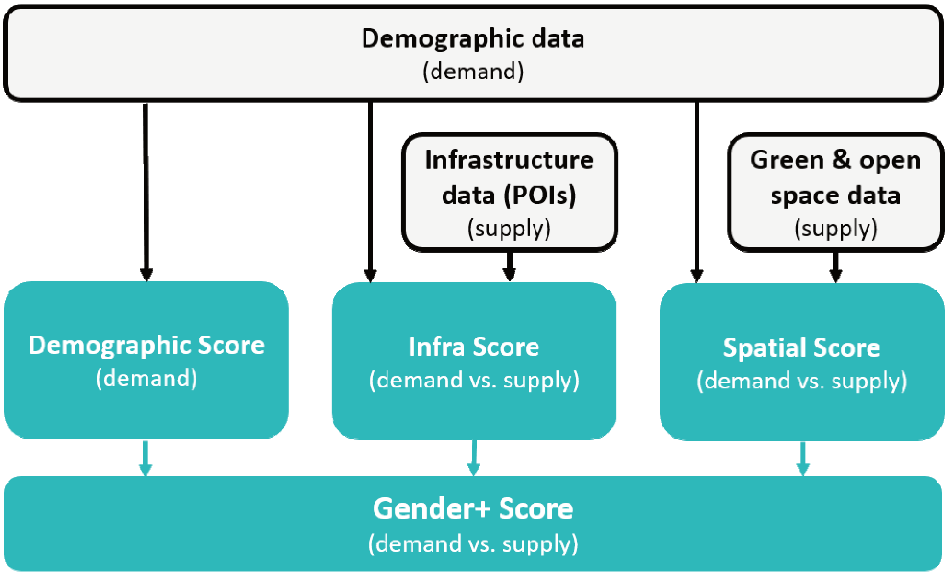

Fig. 2: Gender+ score schemata © AIT

First step to analyse gender+ specific supply and demand was to create the gender+ specific groups. This was established based on gender experience from the projects, desktop research and the available data. The following table shows the chosen gender+ groups for the analysis at the overall city level.

Gender+ Group Name	Sub-groups	Comments
Unemployed	male, female	Source: Statistik Austria
Persons 70+	male, female	Source: Statistik Austria
Childrens 0-9	male, female	Source: Statistik Austria, age groups available in 5-year steps (0-4, 5-9, 10-14, 15-19,…)
Non-German mother tongue	male, female	Source: Statistik Austria
One-parent families	parent-male, parent-female	Source: Statistik Austria
Households with more than 5 persons	-	Source: Statistik Austria,
Single households	-	Source: Statistik Austria, no male or females are available

Table 2: Investigated Gender+ groups

All these groups have their own set of requirements to fulfil their needs regarding all day infrastructure, mobility, security, health, leisure equipment etc. Which does not mean that there are no common needs for all, like open spaces or food shops, but with different weights in their daily life.

The second step was to explore these different needs for the gender+ groups regarding infrastructure and green and open space distribution. This step included searching for available spatial data to derive the single scores. The third step was to develop methods to derive the single scores and to combine them into a so-called Gender+ Score.

In this paper we focus exemplarily on one important group and show how this was done, namely for the gender+ group children females 0-9 years. The demographic data from statistic shows individual numbers of children which were classified into three quantiles visualized with lower case letters of "a", "b", "c", as can be seen in Figure 3.

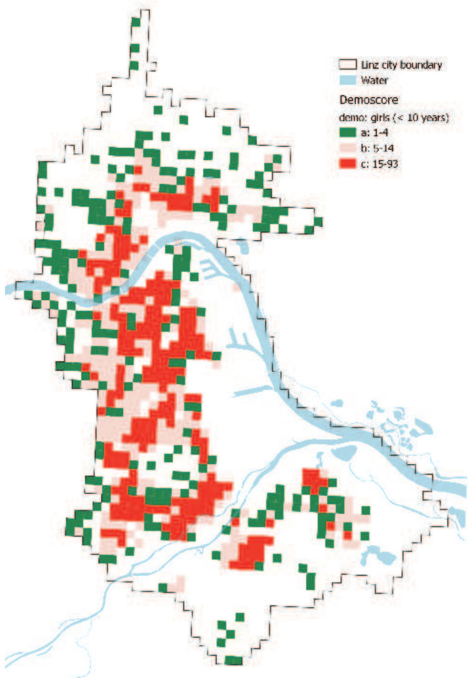

Fig. 3: Demographic score gender+ group female children 0-9 years © AIT

Regarding the infrastructure score a list of factors was found as important to be in close distance to the demand of the specific gender+ group. We used data from several sources mainly TomTom and OGD to calculate Euclidian distance maps to the individual factors called Points of Interests (POIs). First results have shown that due to the difference in the spatial distribution of some of the factors weights have to be used not to create biased maps. The following table shows the list of POIs as well as default weight factors chosen, to create the map depicted in Figure 5.

POI category	**weight factor**
Hort	0.7
Youth centre	0.3
Playground	0.8
Kindergarten	1
Park	0.8
Day sursery	0.5
Library	0.2
Music school	0.5
School	1

Table 3: Gender+ specific POIs and default weight factors, ©AIT

Similar as it was done for the demographic score where we categorised the euclidian distances to combined weighted infrastructure into three classes using quantiles. This time we used upper case letters "A", "B", "C". The following Figure 4 shows the resulting possible combinations of the demographic and infra scores.

ISBN 978-3-9504173-8-8 (CD), 978-3-9504173-9-5 (print)
Editors: Manfred SCHRENK, Vasily V. POPOVICH, Peter ZEILE, Pietro ELISEI, Clemens BEYER, Judith RYSER, Christa REICHER, Canan ÇELIK

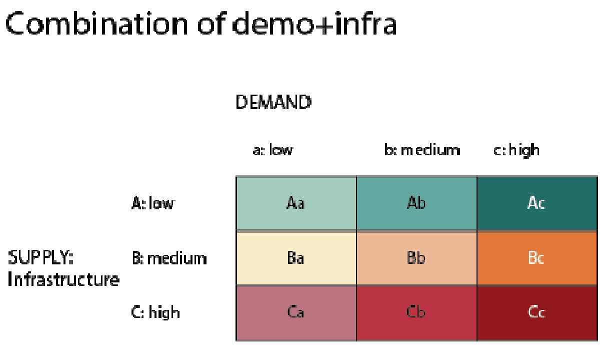

Fig. 4: Possible combinations of demographic and infrastructure score classes © AIT

This allows to understand for each class it's cause, e.g., "Ca" as low demand (few girls living in the given cell) and high supply of the relevant social infrastructure, as can be seen in Figure 5.

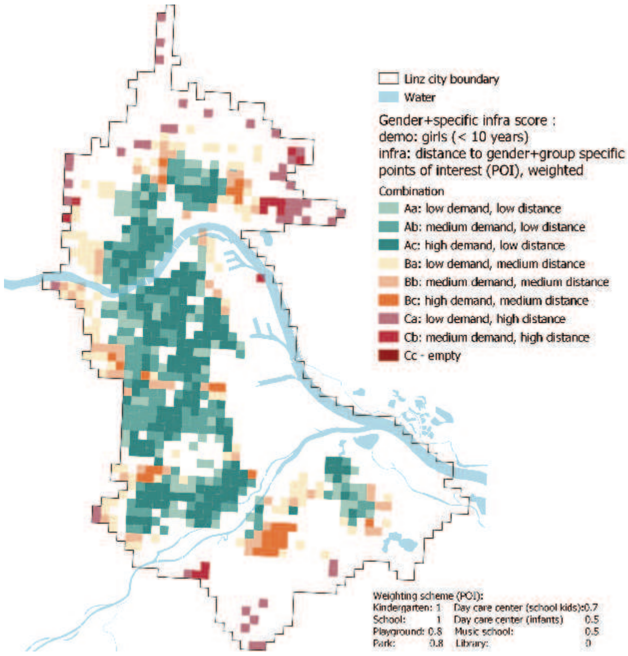

Fig. 5: Gender+ specific INFRASCORE (female children 0-9 years) © AIT

For the gender+ group childrens 0-9 also a spatial score (green and open space score) was calculated distinguishing between different sizes of green spaces. The categories were classified according to their size. For each category a distance was defined as the maximal acceptable distance based on expert judgement and former studies. The following table shows the chosen size and default maximal acceptable distance for the green space categories.

Green space category	Size	Maximal acceptable distances
Neighbourhood	<1 ha	250m
Residential area	1-3 ha	500m
District: small greenery	3-10 ha	1,000m
District: big greenery	10-50 ha	1,500m
City region	>50 ha	6,000m

Table 4: Gender+ specific POIs and default weight factors, (Wien and Magistratsabteilung 18 2015)

The calculated spatial score is thus a combination of the different green space categories and therefore a well supplied location would be one if all categories are reachable within the maximal acceptable distances. The first analyses showed that a simple counting does not achieve an informative result as for example the big green space in the case study area was accessible within all locations (250m*250m) raster cells in Linz. And furthermore, if for example a green space of 40ha would be in a distance of 1,750m it would be accounted as not acceptable (>1500m), but 250m is only a minor deviation compared to 1500m. Taking the same transgression into account for the smallest green space, the neighbourhood category, this green space would be twice as far away as it is aimed for. To avoid this a method has been developed named inaccessibility transgression. This method calculates for each green space category the percentage of inaccessibility compared to the maximal acceptable distance. Only transgressions are taken into account. If the closest green space of the given category is within the maximum acceptable distance, the percentage will be 0. The following Figure 6 shows a schematic representation of this method.

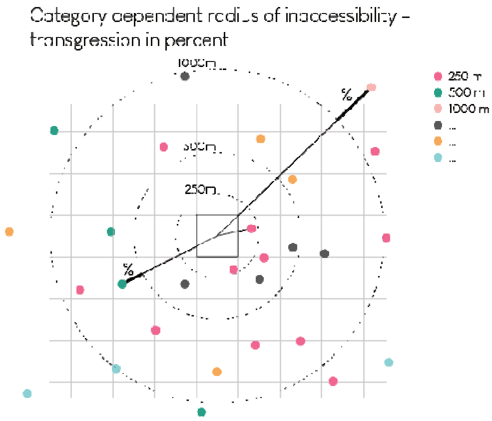

Fig. 6: Inaccessibility transgression © AIT

The calculated inaccessibility transgression was classified in the same way as the demo and infra scores using quantiles into three classes. To combine the demographic score with the spatial score the following combinations were used (Figure 7).

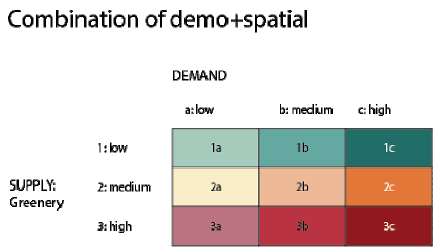

Fig.7: Possible combinations of demo and spatial score classes © AIT

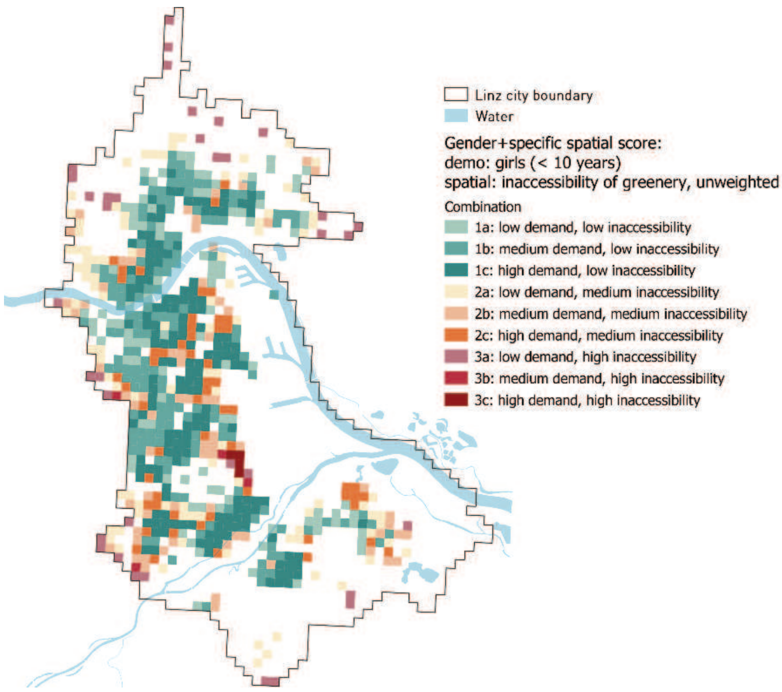

Fig. 8: Gender+ specific SPATIAL SCORE (female children 0-9 years) © AIT

ISBN 978-3-9504173-8-8 (CD), 978-3-9504173-9-5 (print)
Editors: Manfred SCHRENK, Vasily V. POPOVICH, Peter ZEILE, Pietro ELISEI, Clemens BEYER, Judith RYSER, Christa REICHER, Canan ÇELIK

The gender+ specific spatial score in Figure 7 shows areas with high demand and low inaccessibility, meaning well supplied areas but also with a high demand and thus bear no high potential to increase the specific gender+ group there. The map also enables to find areas currently not appropriately supplied with access to the green infrastructure (classes "3c"and "3b") as well as areas with a high potential for further increase of gender+ specific demand (i.e. in this case more females 0-9 year).

Last but not least, the above described scores have been combined to the Gender+ Score. The combination of the three criteria would give 27 different gender+ score classes, which would result in a very complex map (Figure 9 left). To simplify the visualisation and identify the "hot spots" we concentrated on the extreme values (Figure 9 middle). An additional category "0" was introduced as an indicator for areas with currently no demand (no specific gender+ population). This means the demand category exists of 4 categories "a", "b", "c", "0". So, the final possible combinations are 12 (Figure 9 right).

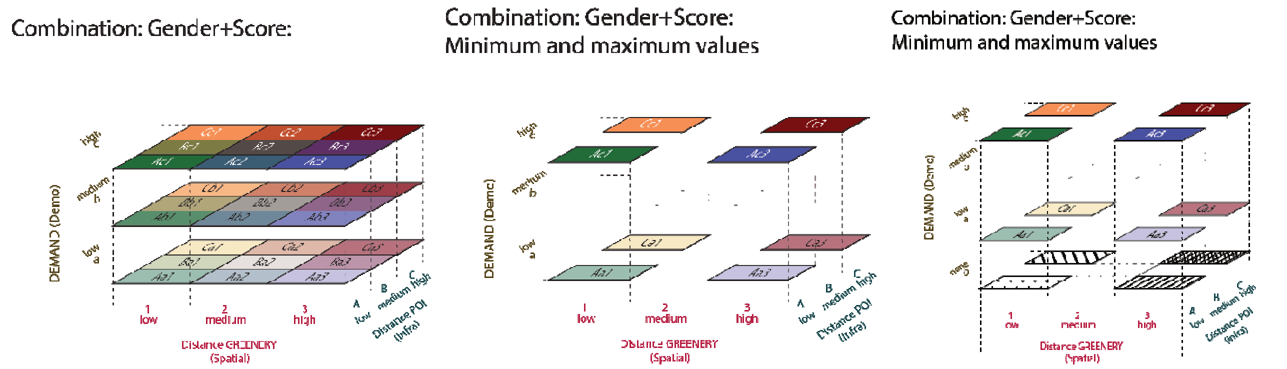

Fig. 9: Possible combinations GENDER+ SCORE (female children 0-9 years) © AIT

For the above chosen default values of the POI weights for the infrastructure score (Table 3) and green space types and maximal acceptable distances (Table 4) the following specific gender+ score map was calculated. This map (Figure 10) contains a lot of information depicting areas where demand and supply match "Ac1" (dark green), areas where a low demand but high supply indicate that a demand increase is easy to manage "Aa1" (light green). The same map can be used to find areas where new demand (females < 10yr) would find the infrastructure and green space they need "A01" (doted areas), and on the other hand areas where the current situation for these gender+ group seems to be very bad "C03".

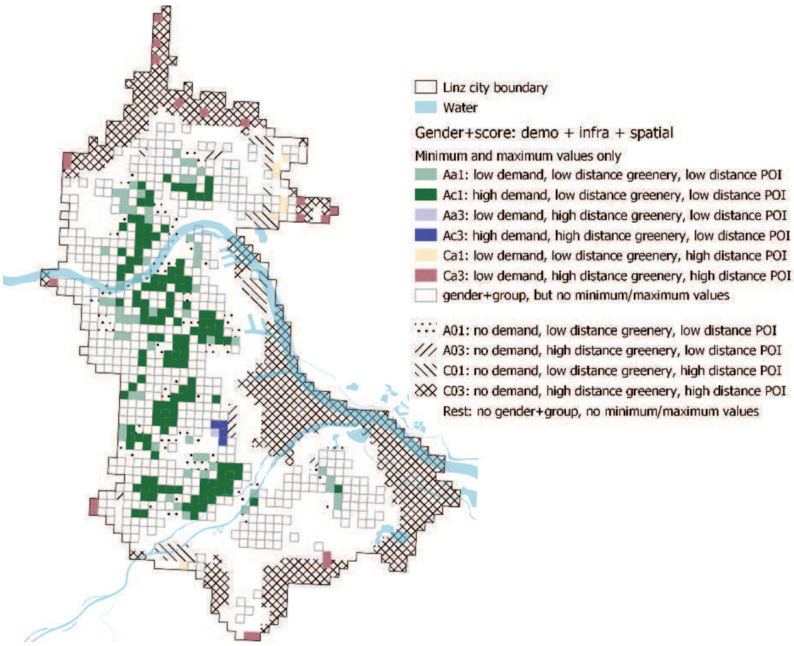

Fig. 10: Possible combinations GENDER+ SCORE (female children 0-9 years) © AIT

6 DEVELOPMENT OF A DECISSION SUPPORT PLANNING TOOL

The section 5 demonstrates that it is a high effort and a complex procedure to create these demand and supply maps and furthermore some parameters influence the results significantly as the weight and green space sizes etc. Additonaly, it is very difficult to define the “correct” values which shall be used. The aim of SMTG+ is to show as a proof of concept that an interactive simulations tool could help in several aspects. Firstly to reduce the effort to create this kind of maps, and secondly, to use them together with local experts from the city in co-creation workshops. The idea is to develop a decission support planning tool, which can perform the same or at least in a very similar way as GIS analysis tools and create the above discussed maps. As a first concept, we developed a web based application which uses the spatial data analysis capacity of R (Muenchow n.d.), (Lovelace et al., n.d.). To create the interactive web application Shiny was used, an R package that enables to build interactive web apps with less effort straight from R (R-Studio n.d.; Chang et al. 2017; Gebetsroither-Geringer, Stollnberger, and Peters-Anders 2018). The development of the interactive web application showed that the GIS analysis can be performed using R. The user interface (sliders in Figure 11 right image) enables to interactively choose the weights for the infrastructure (Table 3). The calculation of a new map needs less than half a minute using a standard notebook. This is a huge improvement compared to calculating all the necessary steps one by one in a starndard GIS program as QGIS.

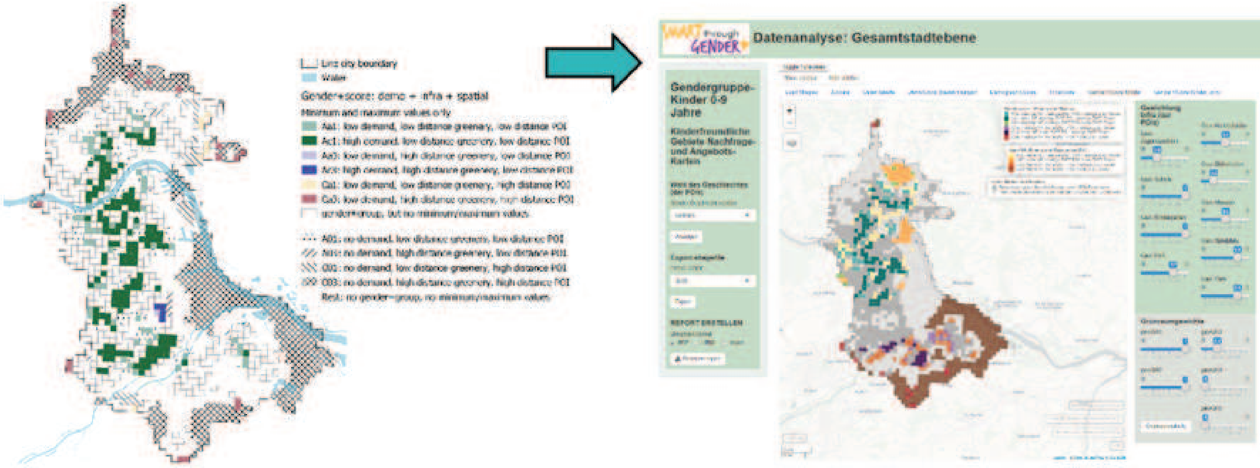

Fig. 11: Interactive web application - implementation of the Gender+ SCORE (female children 0-9 years) with R-Shiny © AIT

Furthermore, the developed application shows the single score maps at the same time, and zooming synchronously shows details on all maps.

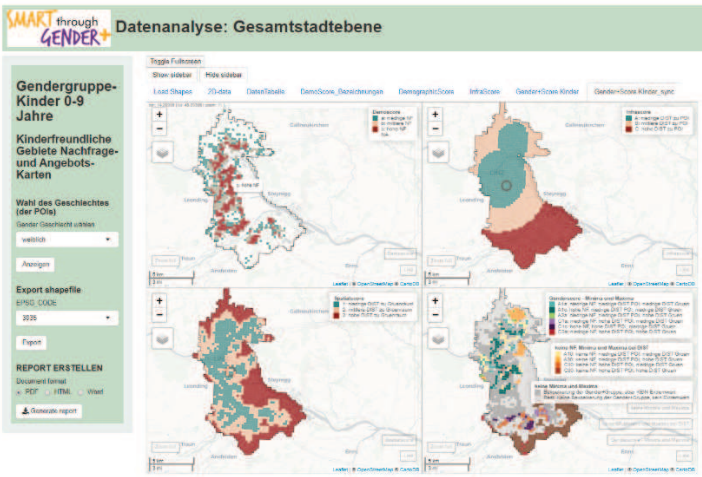

Fig. 12: Single synced maps - implementation of the Gender+ SCORE (female children 0-9 years) with R-Shiny © AIT

7 RESULTS DISCUSSION AND OUTLOOK

The result of the presented methodology is a proof of concept of a web application for the quantitative evaluation of the current situation regarding gender+ specific demand and supply on the overall (entire city) level. The dynamic evaluation and change of input data sets enables a flexible working mode, intended for planners in practice. This high flexibility is important, since it should be possible to create and evaluate different results depending on the input parameters as the weights, or discussed green space sizes. Furthermore, driven by the need to update the analysis with newer or more accurate data sets. This enables to

ISBN 978-3-9504173-8-8 (CD), 978-3-9504173-9-5 (print)
Editors: Manfred SCHRENK, Vasily V. POPOVICH, Peter ZEILE, Pietro ELISEI, Clemens BEYER, Judith RYSER, Christa REICHER, Canan ÇELIK

monitor the changes easily e.g., every 5 years with demand data from the statistic or new supply data from different sources. The application for other cities within Austria is possible without major adjustments by using standardized data sets. The application to other European cities is also considered possible through the use of open source data. While the development of a userfriendly web-application is considered as a possible next step in the future, it is this not covered by the project Smart Through Gender+ and its proof of concept analysis.

8 REFERENCES

Chang, Winston, Joe Cheng, J J Allaire, Yihui Xie, and Jonathan McPherson. 2017. Shiny. Web Application Framework for R. https://cran.r-project.org/package=shiny.

Damyanovic, Doris, and Barbara Zibell. 2013. 'Is There Still Gender on the Agenda for Spatial Planning Theories?: Attempt to an Integrative Approach to Generate Gender-Sensitive Planning Theories'. DisP - The Planning Review 49 (4): 25–36. https://doi.org/10.1080/02513625.2013.892784.

Gebetsroither-Geringer, E., R. Stollnberger, and J. Peters-Anders. 2018. 'INTERACTIVE SPATIAL WEB-APPLICATIONS AS NEW MEANS OF SUPPORT FOR URBAN DECISION-MAKING PROCESSES'. ISPRS Annals of Photogrammetry, Remote Sensing and Spatial Information Sciences IV-4/W7: 59–66. https://doi.org/10.5194/isprs-annals-IV-4-W7-59-2018.

Hochmair, Hartwig, and Dennis Zielstra. 2013. 'Development and Completeness of Points Of Interest in Free and Proprietary Data Sets: A Florida Case Study'. In GI_Forum 2013 – Creating the GISociety, 39–48. Salzburg: Austrian Academy of Sciences Press. https://doi.org/10.1553/giscience2013s39.

Lovelace, Robin, R Ac Lovelace@leeds, James Uk, and Rachel Cheshire. n.d. 'Introduction to Visualising Spatial Data in R'. https://cran.r-project.org/doc/contrib/intro-spatial-rl.pdf.

Muenchow, Robin Lovelace, Jakub Nowosad, Jannes. n.d. Geocomputation with R. Accessed 3 February 2020. https://geocompr.robinlovelace.net/.

R-Studio. n.d. 'Shiny'. Accessed 3 February 2020. https://shiny.rstudio.com/.

Wien, and Stadtentwicklung und Stadtplanung Magistratsabteilung 18. 2015. Fachkonzept Grün- und Freiraum: gemeinsam draußen. Wien: Magistrat der Stadt Wien, Magistratsabteilung 18 - Stadtentwicklung und Stadtplanung.

Reinwald, F, Wankiewicz, H, Damyanovic D.: Gender Planning in Austrian Cites and Urban Regions – What has been achieved, what is (still) missing? In: Engendering Habitat III - Facing the Global Challenges in Cites, Climate Change and Transport, 2016

9 ACKNOWLEDGEMENT

We would like to give our acknowledgements to the Federal Ministry Republic of Austria Climate Action, Environment, Energy, Mobility, Innovation and Technology for their financial support to the project Smart Through Gender+. We would also like to thank our project partners from the University of Natural Resources & Life Sciences, Vienna (BOKU), Planwind and Raumsinn who are responsible for the gender+ approach. Heidrun Wankiewicz and Lidewij Tummers will present another project paper: "Smart through Gender+ Werkstattbericht Kernthemen für eine inklusive Stadtplanung am Beispiel Linz" in Aachen.