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Visualizing Planning Intentions: From Heterogeneous Information to Maps

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Abstract

The future development of urban regions is frequently envisioned through strategic spatial plans. The main objectives and means of spatial development contained in these documents, called planning intentions, can be fragmented and are commonly presented throughout the planning document in text, graphs, tables, diagrams, and maps. Presentation of the information rarely allows for clear visualization of each planning intention and of how the synthesis of all planning intentions builds an overall spatial development strategy. In this paper, we present a method to translate planning intentions into maps in order to better understand their spatiality. Focusing on the case study of Copenhagen, we conduct an analysis of the content of the urban region's latest strategic spatial plan (i.e., the Fingerplan 2013) in order to identify the main planning intentions. For each of these planning intentions, we systematically collect all information contained in the plan, such as details on location, extent, and fuzziness. We then transform the main planning intentions into pixel-based maps to visualize the planning intentions. Finally, a map of the composite planning intention is presented. This paper contributes to a better understanding of the spatiality of strategic planning.

Keywords Planning intention · Copenhagen Fingerplan · Spatiality · Visualization of planning

Introduction

Urban development is recognized as one of the key contemporary processes occurring around the world (Lambin and Geist 2008). Strategic spatial plans are often used as tools to envision the future development of urban regions. The main objectives and means of spatial development contained in these documents, hereafter called "planning intentions," form

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a complex system of divers superimposed intentions (Richter and Behnisch 2018). They are commonly represented in a heterogeneous way throughout the planning document with text, graphs, tables, diagrams, and maps (Grădinaru and Hersperger 2018). Information can be contained in one document, such as The London Plan 2015, or in many, such as in Copenhagen. These documents range from several dozen pages, such as the 37 pages long Edinburgh Strategic Development Plan, to several hundred pages, such as the approximately 400-page long London Plan. Description of planning intentions varies greatly from urban region to urban region. It can be mainly textual such as in Barcelona, textual, and accompanied by schematic maps such as in Helsinki or a mix of text, geographically accurate maps, diagrams, and tables such as in Copenhagen. The way planning intentions are described and illustrated is consciously chosen during the plan-making phase to serve specific purposes. The planning intentions are usually treated separately for a better understanding of the problems to be solved and of the goals to be achieved. The way planning intentions interact, in the sense of spatial overlap or potential conflict, is rarely addressed in the plans.

Research on the depiction of the main directions of spatial development has focused on (a) analyzing the presence and complexity of cartographic representations for showing the

planned territory (Dühr 2007; Dühr 2004), (b) assessing the capability of maps and words (i.e., spatial concepts) to promote certain strategic development directions or projects (van Duinen 2013), or (c) revealing the meaning and fuzziness of borders (Allmendinger and Haughton 2009; Paasi and Zimmerbauer 2015). These studies have paved the way for understanding the social dimension that is inherently embedded in strategic planning endeavors, but they offer little in terms of understanding how plans are expected to physically shape urban development.

Extracting spatial information from plans is a necessary task in many studies on Strategic Environmental Assessment or Land Change Modeling. Jones et al. (2005) showed that the highly general and variable content of spatial plans is a methodological and technical challenge often faced when applying a Strategic Environmental Assessment in spatial planning. Ambiguity of information, especially regarding spatiality of the content, is also an issue for integrating spatial planning information more deeply into land change models. Whereas land-use policies associated with accurate zones can easily be translated into suitability and exclusion layers, as described, for example, by Poelmans and Van Rompaey (2010), tools and methods to successfully implement strategic spatial planning in models need to be developed (Koomen et al. 2011). Furthermore, the visualization of planning intentions could also help planning research by facilitating comparisons of plan contents and even classifications, as proposed by McCosker and Searle (2016). However, little research has been conducted on how information can be extracted from plans and translated into data, which can in turn be visualized and incorporated into land change studies.

In this paper, we propose a three-step method for (a) extracting the main development intentions contained in strategic spatial plans, (b) visually representing them as individual pixel maps, and (c) aggregating the individual visualizations into a composite map. The composite map shows the overall development and conservation strategies, and it specifically identifies areas with conflicting or reinforcing planning intentions. The Fingerplan 2013 of the Copenhagen urban region was chosen for illustrating the developed method because it involves a limited number of planning intentions that are represented with a high degree of geographical accuracy. The potential value of this three-step method and methodological issues is then discussed.

Methods and Data

Case Study

The case study for this paper is the urban region of Copenhagen, Denmark, as delineated by the metropolitan plan, the so-called Fingerplan (Fig. 1). The metropolitan area of Copenhagen houses around 1.8 million inhabitants in 34 municipalities and comprises parts of two administrative regions, the Capital region (Region Hovedstaden) and the neighboring region of Sjælland. The provision and compliance of the plan are—for the time being—ensured by the national state.

The first regional plan for the greater Copenhagen area came into being in 1947 and was developed by the Secretariat for Regional Planning (Egnsplansekretariatet). It covered an area a little larger than what we would today name the "palm of the hand," i.e., the city center and inner suburbs. It was branded the "Fingerplan" after the star shaped, transit-oriented urban development structure and green "wedges" between the urban fingers. This spatial structure enabled easy transit from the suburbs to the city center and easy access to green spaces for everybody. The original Fingerplan was never formally adopted, but it had a considerable influence on later regional plans. The currently valid plan, which was mostly conceived by the Danish Nature Agency's planning department in 2007, took up the name Fingerplan to positively brand regional planning in the capital region, as all other regional planning was discontinued following an administrative reform in 2007 (Jørgensen et al. 2017).

The currently valid plan is built on three main principles: (1) an urban growth boundary that restricts urban development on land outside corridors along the public transit lines, (2) a strict protection of green spaces in the existing urban and suburban area, and (3) a "proximity to stations" policy. The specific planning is left to municipalities.[1] Urban transformation is encouraged, and a "relict" planning zone for a transport corridor designated in the Fingerplan 1973 crosses the fingers from south to north (Erhvervsstyrelsen 2017).

The aim of the plan is to further a compact city model and encourage use of public transit over cars. Nonetheless, cars account for 71% of person-kilometers, whereas public transport accounts for 21% and bikes only 7% of the region's transport (Tetraplan 2013). While accessibility—in an international context—seems to be approximately equal in different parts of the region and among fingers (Kaplan et al. 2014), the use of transit still varies among sub-areas.

Method

First, the strategic spatial plan is analyzed to extract the planning intentions (Fig. 2, step 1). The structure of the strategic spatial plan provides a filter to separate the information into several planning intentions. Most of the plans have sections specifically describing objectives and means to reach them. These sections generally correspond to planning intentions, either directly or indirectly (after merging or splitting).

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[1] More specific zoning provisions for selected themes, e.g., for particularly polluting industries, are given in the plan but are not fundamental to it. The plan also has a strong focus on regional bicycle networks.

Copenhagen urban region

Denmark

Region Hovedstaden

Copenhagen

Region Sjælland

Copenhagen urban region

Existing built-up areas

Limits of administrative regions

0   10   20 km

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Sources: Copenhagen FingerPlan 2013, Urban Atlas 2012, Eurostats NUTS 2013
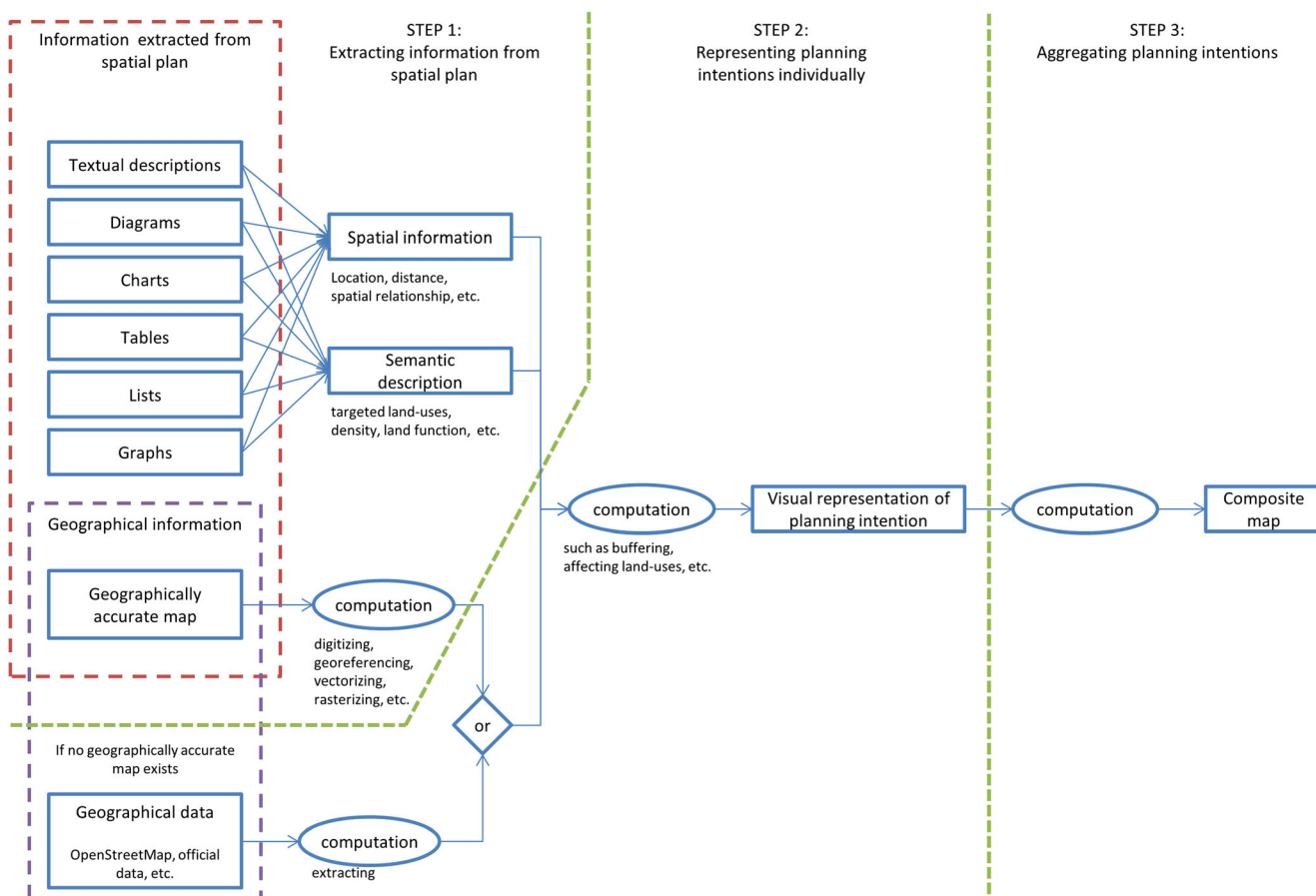
Fig. 1 Location of Copenhagen

Fig. 2 Flow chart of the three-step method developed in this study

The extracted information is heterogeneous in its presentation form (text, maps, diagrams, graphs, etc.), in its spatial precision (precise radius vs. notion of proximity; geographically accurate map vs. fuzzy communication map, etc.), and in its semantic precision (e.g., recreational function vs. dense housing). In practice, whatever its form, the extracted information integrates both spatial and semantic components. For example, a geographically accurate map includes the location and the extent of the planning intention, as well as some semantic attributes, such as the targeted land use or the land function. Likewise, text describes spatial relationships, for example "a circular area of 600 m radius," and semantic attributes, such as the minimum density of the targeted urban function.

In the case study of Copenhagen, information was extracted from four documents in PDF format: the Fingerplan 2013 and three complementary documents entitled Key messages, Planning decisions, and Statement and background. These documents include a total of 208 pages and nearly 80 visual representations (geographically accurate maps, schematic maps, thumbnails, and graphs). About half of these representations are unique, and about 15, mainly geographically accurate maps, were used to construct the visualizations of the planning intentions.

For each planning intention, the extracted information is assigned to one of two classes: spatial information, which describes the location and the spatial relationship of the planning intention and is used to create the geoprocessing chain; and a semantic description, which allows one to name the planning intention, define its type, specify the targeted land use, and summarize the nature of the information that describes the planning intention (Table 1).

In a second step, for each planning intention, a visual representation is created (Fig. 2, step 2). A preliminary raster layer of the urban area is produced. This layer defines the technical environment settings, such as extent, shape, and resolution that must be respected by the individual visualizations. By doing so, the visualizations of planning intentions do not exceed the perimeter of the urban region and are perfectly superimposed when the composite map is created.

For creating the visualizations, no generic method can be proposed because it varies strongly according to the available spatial and semantic information. Instead, we describe the three situations encountered with the Fingerplan 2013:

- Spatial information for PI1 "Transportation corridor" is given by a geographically accurate map in the document. This map was georeferenced, the outlined area was then vectorized as a

Table 1 Data for visualizing the planning intentions in the Copenhagen Fingerplan 2013

Number	Planning intention (PI)	Type of PI	Targeted land uses	Information present in the plan	
				Spatial	Semantic
PI1	Transport corridor	R	Transportation	Accurate geographical map Text linking semantic information with outlined area in the map	Text explaining if buildings can be constructed (temporary construction, construction required for agriculture or forestry)
PI2	Existing green wedges and green urban wedges	R	(Semi-)Natural (green and open spaces)	Accurate geographical map Text linking semantic information with outlined area in the map	Text describing allowed land functions and prohibited constructions
PI3	Core and peripheral finger development	F	Built-up (residential, service and industrial areas)	Accurate geographical map Text linking semantic information with outlined area in the map	Text describing preferred types of development (redevelopment of existing urban land before uptake of new (farm)land)
PI4	Station proximity	F	Built-up (residential and service areas)	Text and graph detailing the radius	List of targeted stations Description of priority urban functions (large office buildings, regional services, dense housing, etc.) Textual and numerical definition the of accepted density Description of the preferable location within the area Graph visualizing the location rules
PI5	New green wedges	R	(Semi-)Natural (green and open spaces)	Accurate geographical map Text linking semantic information with outlined area in the map	Textual description of the extent of the new green wedges
PI6	Revitalization areas	F	Built-up (residential, service and industrial areas)	Accurate geographical map Text linking semantic information with outlined area in the map	Text presenting general goals and rules for revitalization
PI7	Right business in the right place	F	Built-up (service and industrial areas)	Accurate geographical map Text linking semantic information with outlined area in the map	Description of the targeted activities in terms of, for example, accessibility to transportation infrastructure

R restrict built-up development, F foster built-up development in designated areas

polygon layer, and finally, this layer was rasterized using the settings of the preliminary layer (Fig. 3). The same processing method was used for PI5, PI6, and PI7.

- A geographically accurate map shows the "Existing green wedges and green urban wedges" (PI2) in the document. The map was georeferenced and reclassified to fit with the settings of the preliminary layer. A new raster layer containing the green wedges was then produced using map algebra (Fig. 4). The same processing method was used for PI3.
- PI4 "Station proximity" is characterized by the absence of a geographically accurate map. Based on the description in the document, we extracted all the public transportation stations from OpenStreetMap and selected the listed stations. A 1000-m or 1200-m radius buffer was created for each station according to its location (1000 m in the urban core area and 1200 m in the peripheral urban region). Finally, the buffer layer was rasterized using the settings of the preliminary layer (Fig. 6).

Finally, all planning intentions are combined into a composite map (Fig. 2, step 3). This map aims to highlight where the planning intentions are located in the territory and where they overlap. This map shows the areas of the urban region considered as strategic and the areas that could lead to conflicts of use (different land uses, i.e., natural land and built-up land; or the same land use but with different detailed uses, i.e., built-up for housing and built-up for economic activity). This map is constructed based on the three main land uses:

- Built-up areas intended for uses such as housing, commerce and services, industry, and mixed-use
- (Semi-)Natural areas such as forests, agricultural areas, recreational spaces, and water bodies
- Transportation infrastructures such as highways, roads, railways, train stations, airports, and ports.

Each land use corresponds to a value of the RGB triplet: R represents built-up areas, G represents (semi-)natural areas, and B represents transport infrastructure. Thus, when a pixel is only covered by a planning intention targeting a built-up land use, (semi-)natural land use, or
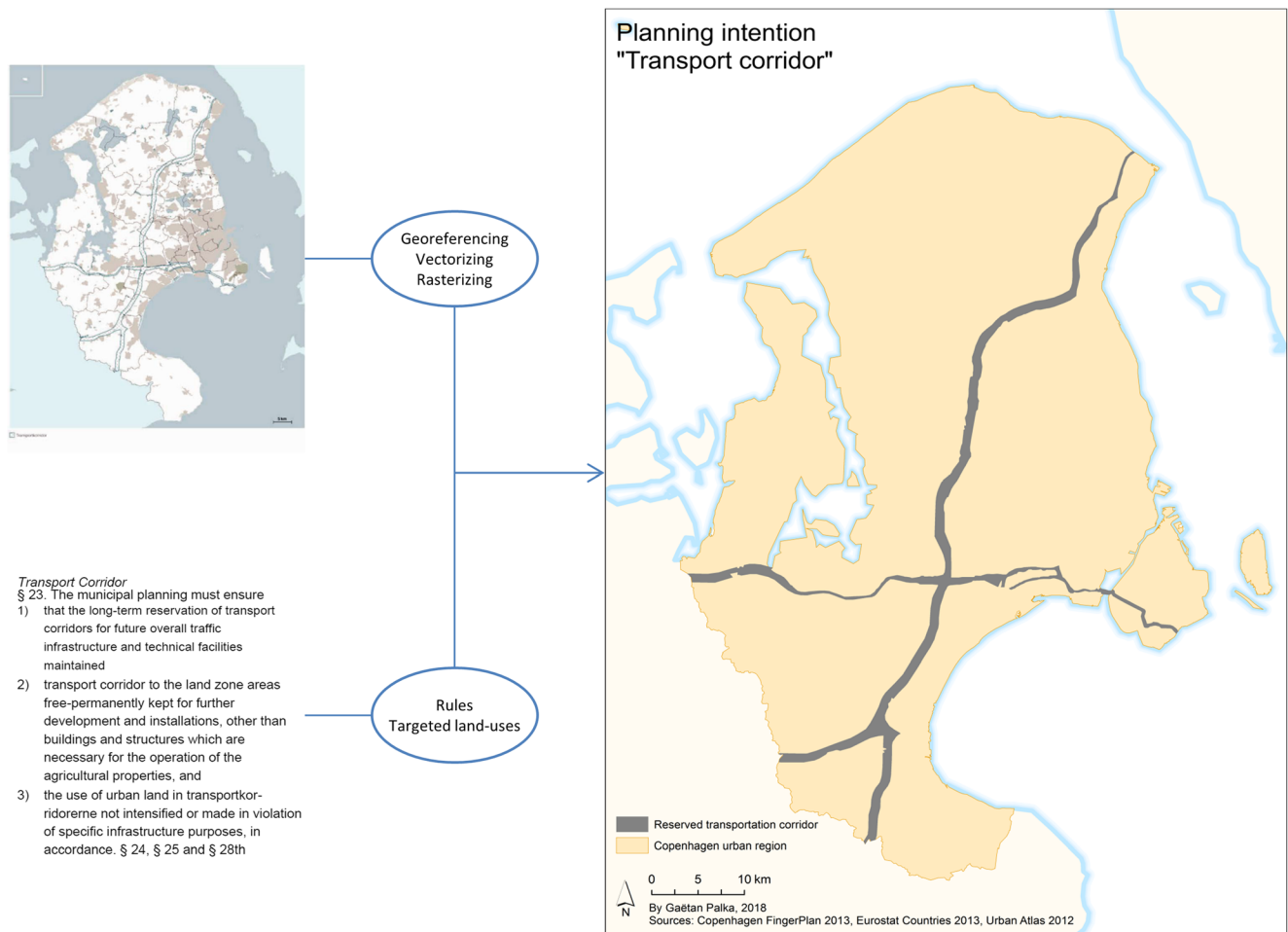

Fig. 3 Visualization of the planning intention "Transport corridor"

transportation land use, this pixel is red, green, or blue, respectively. If a pixel is covered by planning intentions targeting different land uses, the pixel has a complementary color: cyan, yellow, or purple. A pixel covered by planning intentions targeting the three land uses is white, and a pixel covered by no planning intention is black. At this stage of step 3, we do not take into account the number of planning intentions that overlap or give a weight to each planning intention. In addition, for each pixel, the more planning intentions that overlap, the darker the color is.

Four intermediate layers are created: three binary layers, one for each land use, to express the presence or absence of at least one planning intention targeting built-up areas (called Br), (semi-)natural areas (Bg) and transportation infrastructure (Bb), and a layer (called Ol) to count the number of overlapping planning intentions for each pixel. The maximum number of overlapping planning intentions (called max(Ol)) on the whole territory is also determined. In the Copenhagen urban region, this maximum is 3. The RGB triplet is computed

using the following formula to create the band composite raster:

$$R \ band : 153 \times Br + 102 \times \left(1 - \frac{Ol}{\max(Ol)}\right)$$

$$G \ band : 153 \times Bg + 102 \times \left(1 - \frac{Ol}{\max(Ol)}\right)$$

$$B \ band : 153 \times Bb + 102 \times \left(1 - \frac{Ol}{\max(Ol)}\right)$$

The numerical values 102 and 153 were determined by empirical tests to obtain an easily readable and comprehensible composite visualization. This corresponds to the superposition of a gray-gradient layer, ranging from white to black with a transparency of 60%, above a layer composed of RGB triplets of maximum values, such as (255, 0, 0) or (0, 255, 255). Thus, in an urban region where max(Ol) is 3, the RGB triplet for a pixel covered by a planning intention targeting built-up areas and a planning intention targeting (semi-)natural areas is (187, 187, 37).
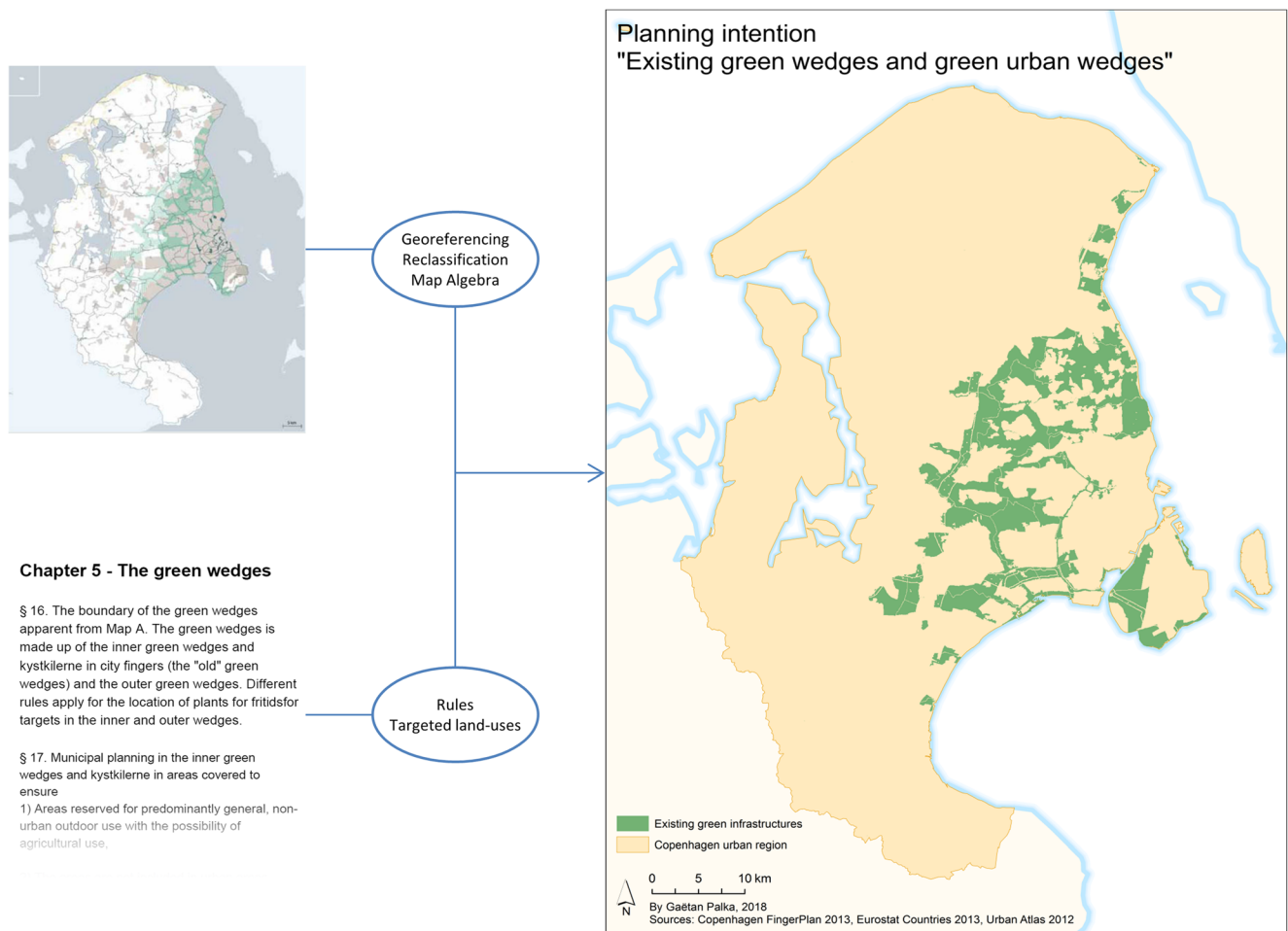

Fig. 4 Visualization of the planning intention "Existing green wedges and green urban wedges"

Results

Planning Intentions

Seven planning intentions were identified in the Fingerplan 2013 (Table 1), and a visualization was produced for each of them (Figs. 3, 4, 5, 6, 7, 8, and 9). Four of them target built-up land, two regulate natural land uses, and one targets transportation infrastructures. A brief description of each planning intention is provided in the next paragraphs.

Transport Corridor (PI1) This planning intention represents a long-term reservation of strip-shaped areas for potential future transport infrastructure of significance to the entire Greater Copenhagen area. Until the transportation infrastructure is realized, the area should remain free of any permanent constructions.

Existing Green Wedges and Green Urban Wedges (PI2) The finger city structure established in the Fingerplan determines that the existing green wedges and green urban wedges are areas that should remain exempt from the construction of

urban-related facilities. These areas should thus remain green and must be maintained for regional recreation purposes. The existing green wedges and green urban wedges consolidate the green infrastructure around and beyond the core area of the Copenhagen urban region.

Core and Peripheral Finger Development (PI3) This planning intention stipulates that urban development should generally take place in the urban core ("the palm of the hand") and in the peripheral urban core along the transportation infrastructure ("city fingers"). Thus, most new construction and the majority of the future growth in population and employment must occur in these two areas. This planning intention highlights the hierarchical structure of the urban development in three areas, from the most central—the urban core or the palm of the hand—to the most peripheral—the rural periphery or the last phalanx of the fingers. New urban zones may be developed within the "land" part inside the urban growth boundary of the peripheral fingers if they are in line with other planning principles and if other urban zones are already built up. The core and peripheral fingers encompass the city center of Copenhagen and other cities such as Høje Taastrup and Hillerød.
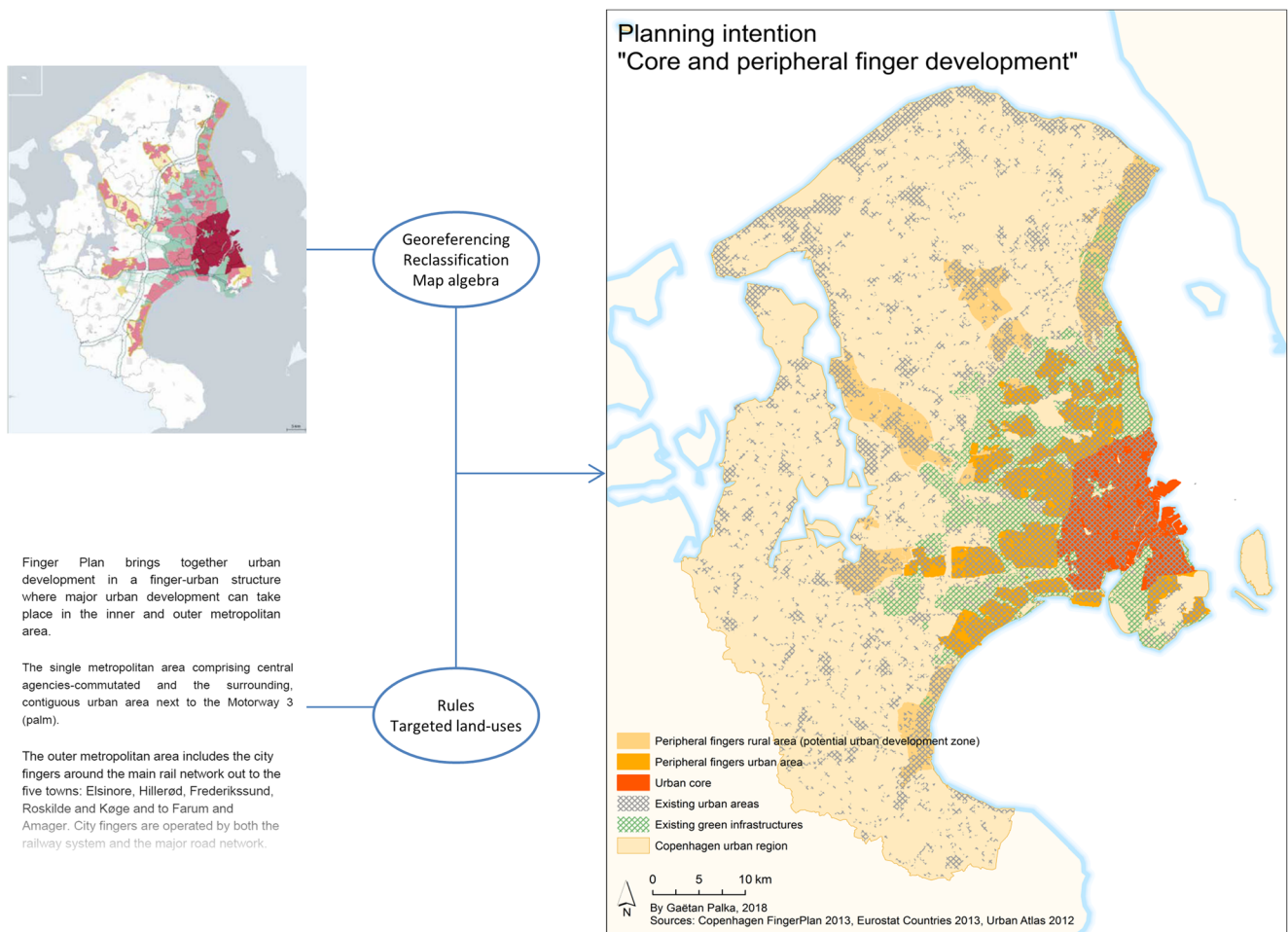

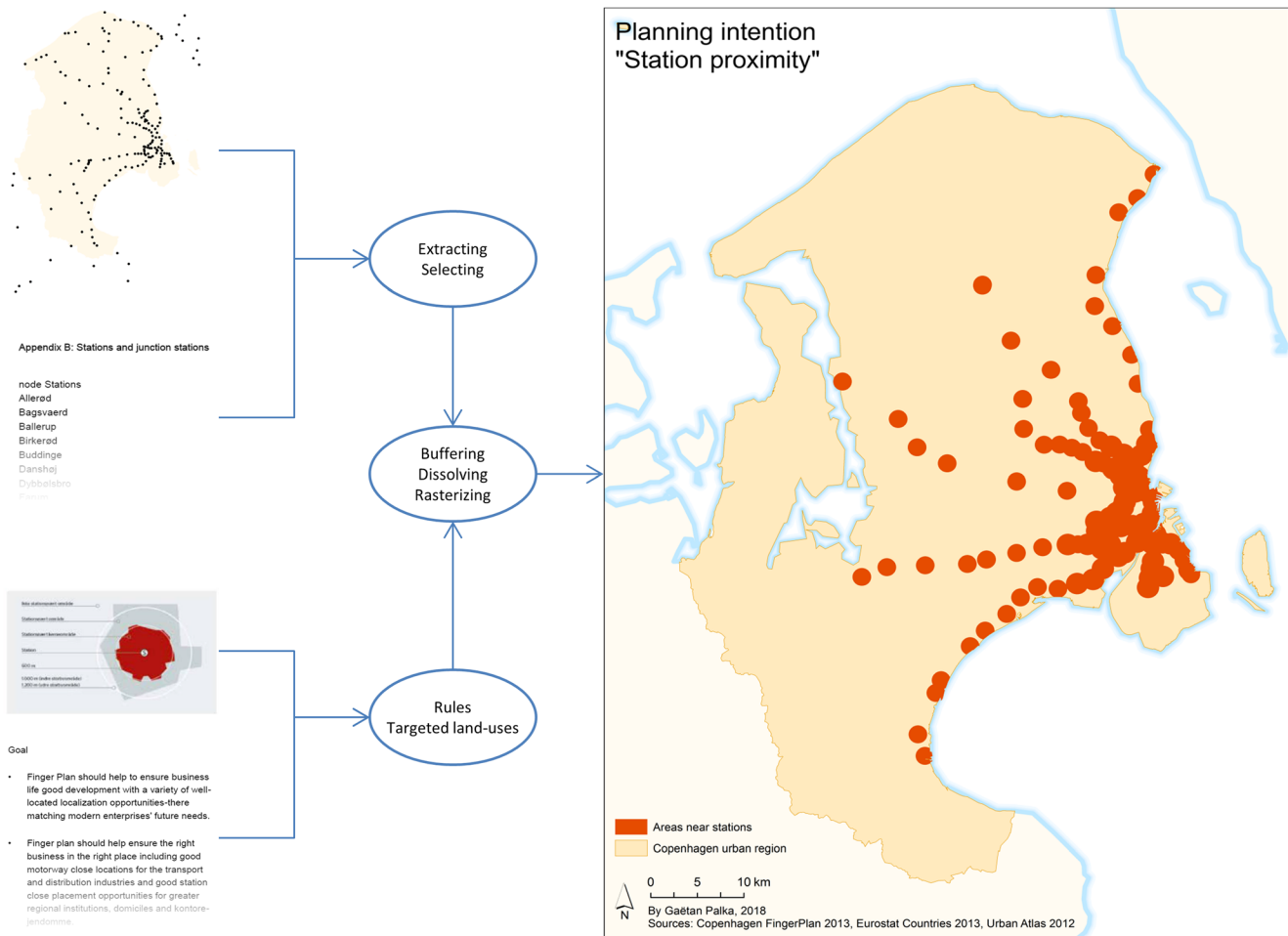Fig. 5 Visualization of the planning intention "Core and peripheral finger development"

Fig. 6 Visualization of the planning intention "Station proximity"

Station Proximity (PI4) This planning intention states that intensive urban uses in terms of land consumption, job density or visiting patterns, must be placed in areas near existing or approved stations of the rail and metro network. The plan defines two areas, i.e., core areas of stations and areas close to stations. Core areas are delineated on the basis of a radius of 600 m (representing a walking distance). In these core areas, municipalities must aim to maintain a high density of buildings for office and central services and at least 40 residences per hectare in residential areas. The areas close to stations are drawn on the basis of a radius of 1000 m in the core urban region and 1200 m in the peripheral urban region. In these areas, municipalities must aim to maintain a high density of buildings for office and central services and at least 25 residences per hectare in residential areas.

New Green Wedges (PI5) Some existing green areas are declared "new green wedges of regional importance." This designation increases their protection status. Similar to existing green wedges, the new green wedges should remain free from urban-related facilities.

Revitalization Areas (PI6) The plan designates a number of sub-urban areas around Copenhagen for revitalization, as part of the "LOOP City" project. Revitalization primarily targets improvements of built-up areas' quality, changes in the type of economic activities, and an increase in the density of built-up areas.

The Right Business in the Right Place (PI7) This planning intention envisions optimal locations for different types of businesses, particularly in relation to transportation infrastructure. This means, for example, that transportation and distribution businesses are located near motorways and major regional institutions, whereas headquarters and office buildings are located near stations. The latter is already described in the intention of station proximity, while this map shows areas designated for distribution businesses and/or polluting industries.

Composite Map

The composite map (Fig. 10) highlights the spatial distribution of the seven planning intentions included in the Fingerplan 2013. The planning intentions are concentrated in the south-
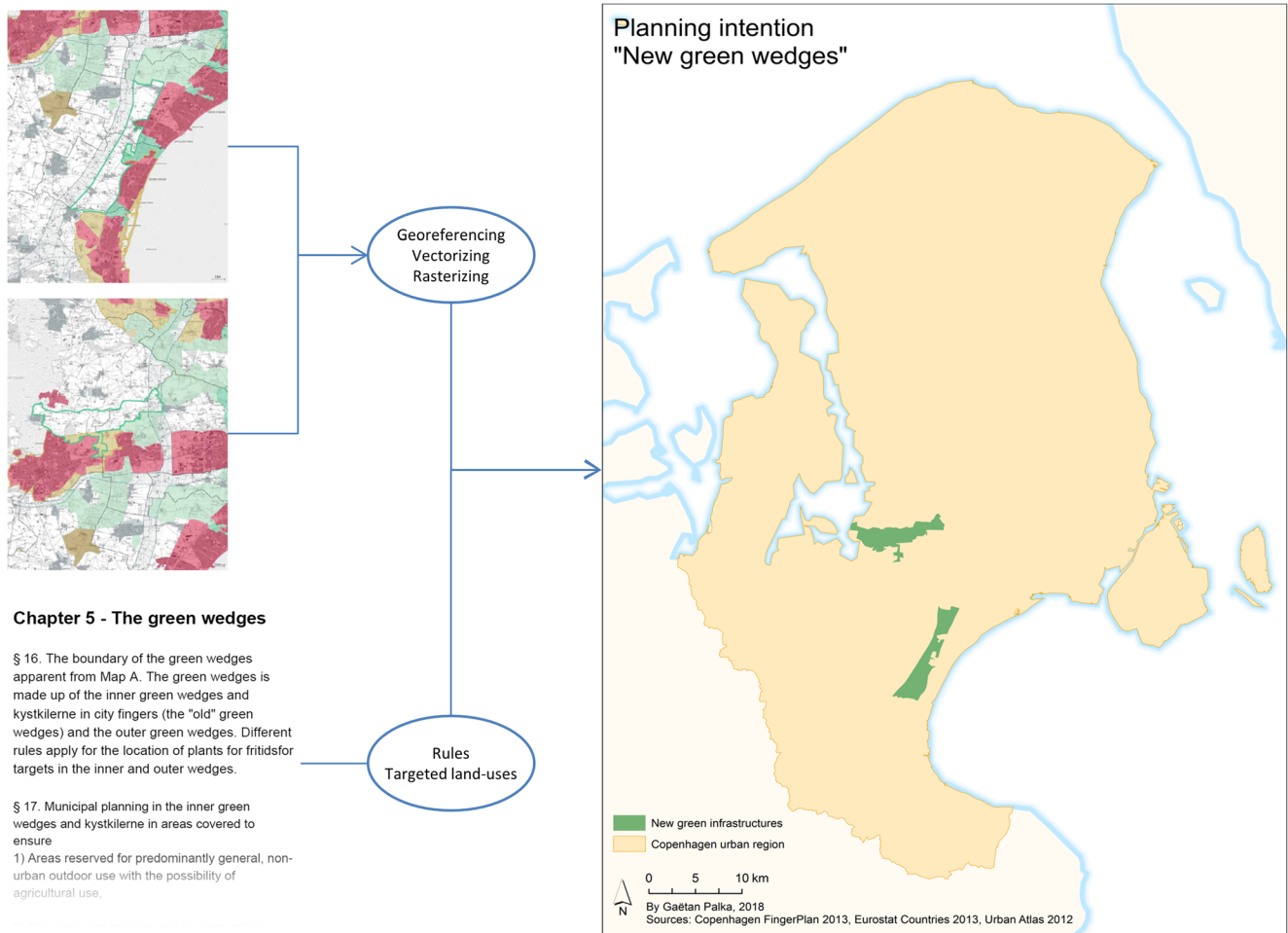
Fig. 7 Visualization of the planning intention "New green wedges"

east and center of the Copenhagen urban region, the most densely urbanized areas of the region, and continue the development patterns envisaged in the past.

In the urban core (city of Copenhagen) and in the center of the peripheral areas, two or three planning intentions targeting built-up land overlap. These planning intentions aim broadly in the same direction, as they all pursue densification of the built-up area. However, the planning intention "Revitalization areas" incorporates the notion of improving the quality of the built-up area. Although the overlap targeting built-up land does not tend to create conflict, these areas differ in their orientation. For example, an area covered by the planning intention Revitalization areas cannot be treated homogeneously if part of this area is covered by the planning intention Station Proximity.

In rural and urban peripheral fingers, some areas are covered by planning intentions targeting built-up development (PI 4 Station proximity and PI3 "Core and peripheral finger development") and planning intentions targeting (semi-)natural land (i.e., PI 2 and PI 5). These intentions can be conflicting and require further clarification. A first case involves the overlapping of PI2 or PI5, targeting green wedges, with PI4 Station proximity. We used generic construction rules to create PI4 Station proximity by selecting stations and creating a circular buffer with a radius specified in the Fingerplan 2013. This circular area covers areas dedicated to urban densification and areas within existing green wedges. Thus, this situation raises questions about potential conflicts. However, it can be resolved by detailed zoning of the circular area around stations in other land-use documents. A second more interesting case is visible in the eastern-most finger, where PI3 Core and peripheral finger development and PI2 Existing green wedges and green urban wedges overlap. This configuration highlights a long-term vision of densifying secondary urban centers to balance urban development between the urban core and peripheral areas. The future development might lead to a mixed land use (built-up and (semi-)natural) or might generate dense urban extension patches allowing and nature preservation patches.

In cases where PI1 "Transport corridor" overlaps with any other planning intention targeting (semi-)natural or built-up land, there is no conflict. Indeed, built-up development is prohibited in areas covered by the PI1 "Transport corridor," and this rule is binding over all others.
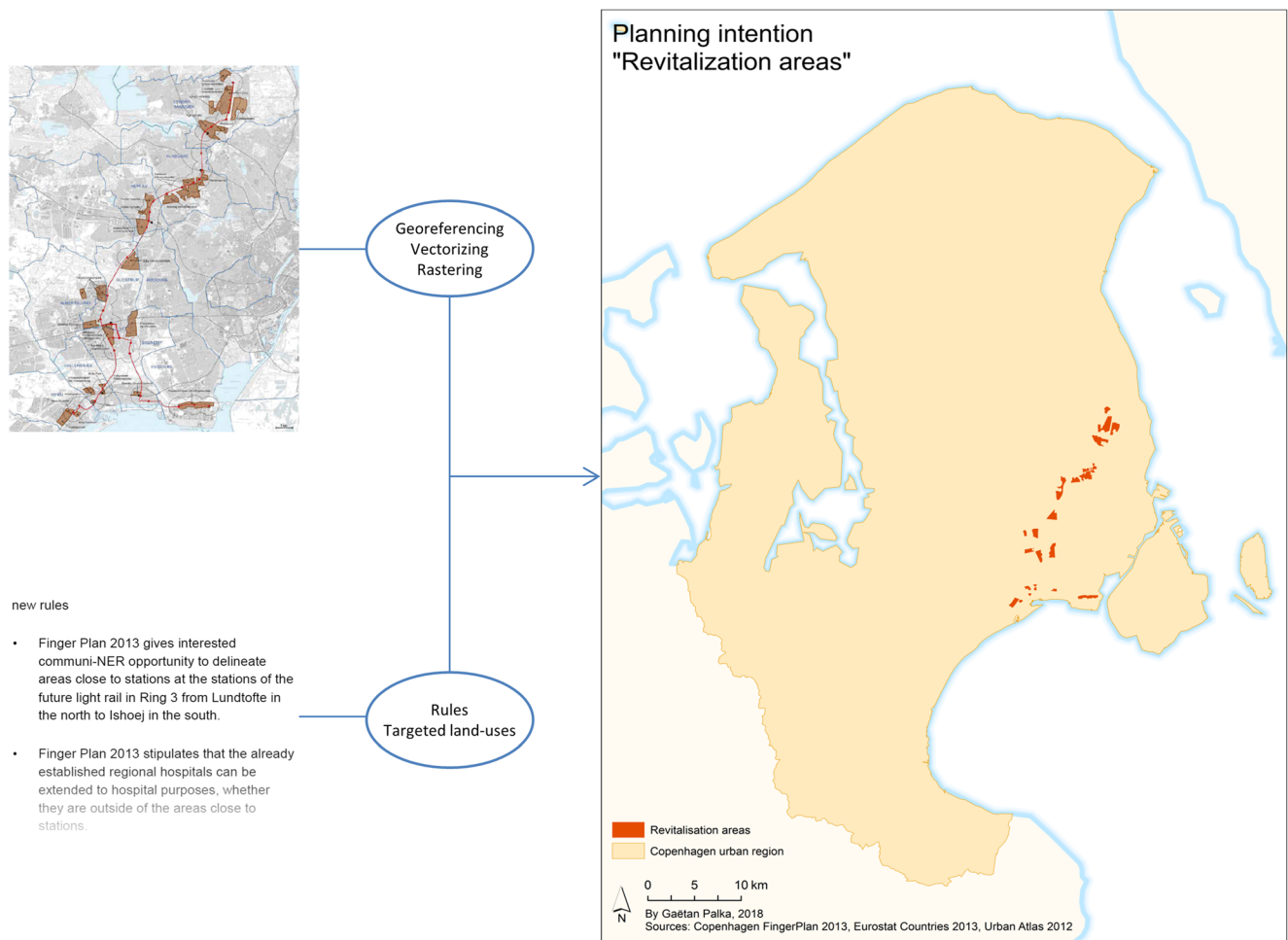
Fig. 8 Visualization of the planning intention "Revitalization areas"

Whereas some areas of the urban region are covered by several planning intentions, other areas are covered by no planning intention. This does not mean that there are no rules governing the transformation of these areas. Location constraints for development are stated in the Fingerplan 2013: Development must address a local need, limit urban sprawl, and not address a strategic need of the urban region.

Note that some of the potential urban development areas in the peripheral fingers (the land area within the urban growth boundary) may be subject to other planning intentions or restrictions, for example, nature, landscape, or forest protection designated within other legislations such as Natura 2000 and Important Bird Areas (IBA).

Discussion and Conclusion

In this paper, we have introduced a method that visualizes the focus of a strategic plan and highlights areas of potential conflict. We developed the method to be as generic as possible to enable applications to other urban regions. As shown by Dühr and Müller (2012), not all planning cultures rest on spatially precise strategic planning documents. However, the example of the Station proximity planning intention shows that heterogeneous information (e.g., text, list, diagram) can be combined to produce a spatially explicit output and that the absence of maps can be overcome by combining such information with geographical data from other sources such as OpenStreetMap. Additionally, a blur function could be applied to the edges of the planning intentions to take spatial uncertainty into account.

To conduct the analysis, we made use of geographic data extracted from the Fingerplan 2013 and open data freely available online. Despite the current trend to make planning information accessible to the public, with geographic information portals whose content can be exploited via web map services (WMS) and web feature services (WFS), such data do not exist for the Fingerplan 2013. A map portal (http://kort.plandata.dk/spatialmap) contains the planning information of the Fingerplan 2017, a continuation of the Fingerplan 2013. Thus, the planning intentions of the Fingerplan 2013, with the exception of PI6 Revitalization areas, can be extracted from this portal with little or no work required to match the planning intentions of the Fingerplan 2013. However, such a
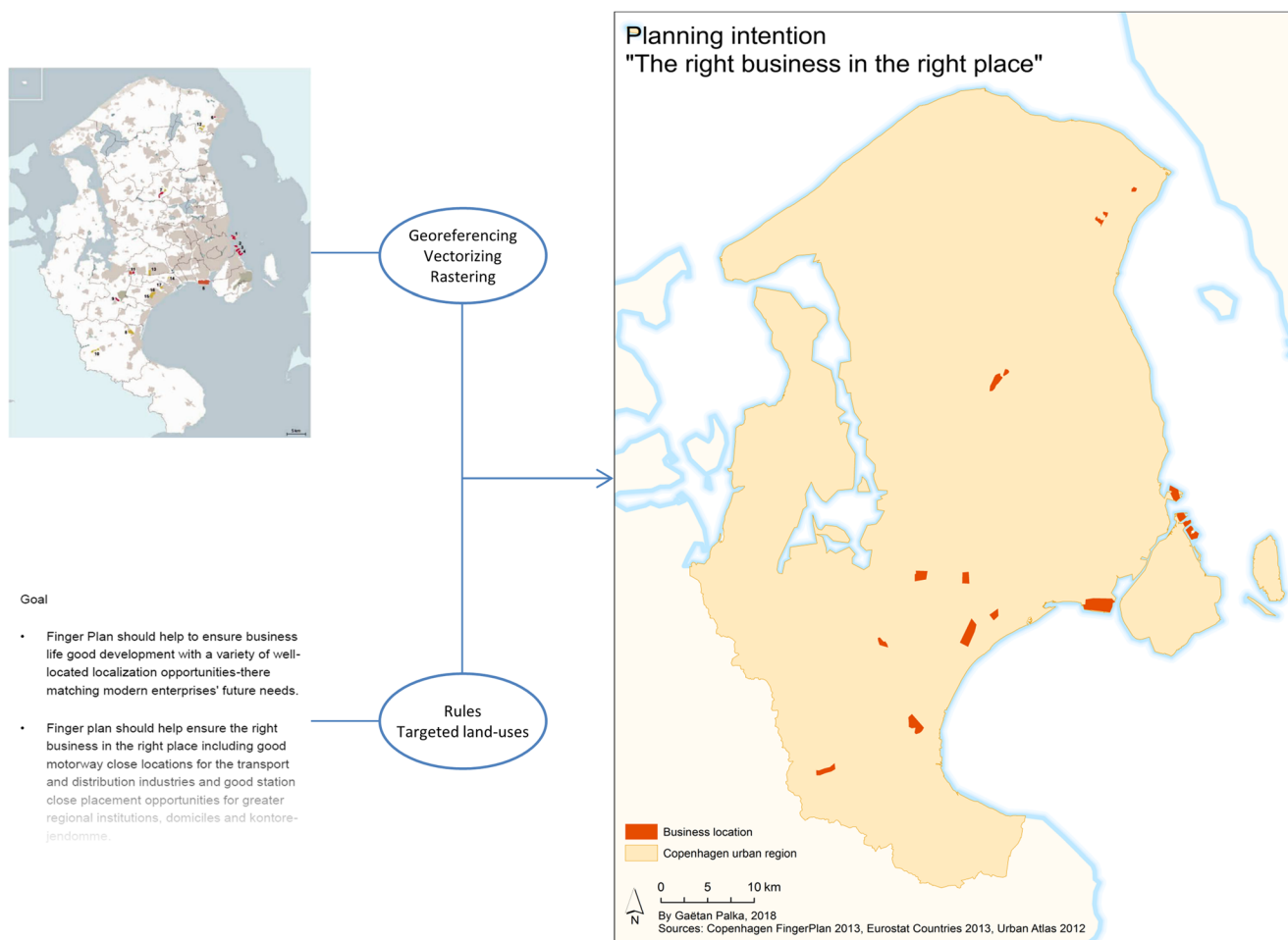
Fig. 9 Visualization of the planning intention "The right business in the right place"

solution was not used here because our method was developed to be as generic as possible and applicable to as many urban areas as possible around the world. The method described in this paper is applicable to any case study because of the versatility of the necessary data. Only a single datum is constrained: a strategic spatial plan of the studied urban region.

In our case study, data from Urban Atlas and OpenStreetMap were used. These data make it possible to work on two levels of detail—broad (transport, built-up, and natural) and detailed land-use classes (such as commerce and services, high density housing and low-density housing). These data can be replaced with data generated by local or official authorities or by land cover data derived from remote sensing imagery or CORINE Land Cover. This versatility makes it possible to work with similar data on several urban areas to facilitate comparison, or to work with data specific to a case study. When the data extracted from the strategic spatial plan allow it, planning intentions may be linked to a more precise land use, such as housing, industry, or commerce and services, and enable a visualization of the spatiality of these uses in the built-up area.

The rules for aggregation in the creation of the composite map need some consideration. In the Fingerplan example, an equal value was given to each planning intention. However, some planning intentions may have, in reality, more importance and thus more weight. Generally, in order to generate a composite map, one needs to determine if weight should be related to land use (and the same weight assigned to all planning intentions with the same targeted land use) or to planning intention (and a specific weight assigned to each planning intention), or if weight must take into account the location in the urban area (dividing each planning intention into subsets and assigning a weight to each subset according to its location). The issue of setting these weights can be seen in the context of plan making and plan implementation. Recent research shows that the performance of territorial governance and external forces are factors that explain the conversion of strategic spatial planning intentions into land-use changes (Oliveira and Hersperger 2018; Hersperger et al. 2018). In the case of the Fingerplan 2013, the weighting has little impact on the resulting visualizations because planning intentions are few in number, overlap little, and are geographically accurate. However, in urban areas where planning intentions are less geographically accurately
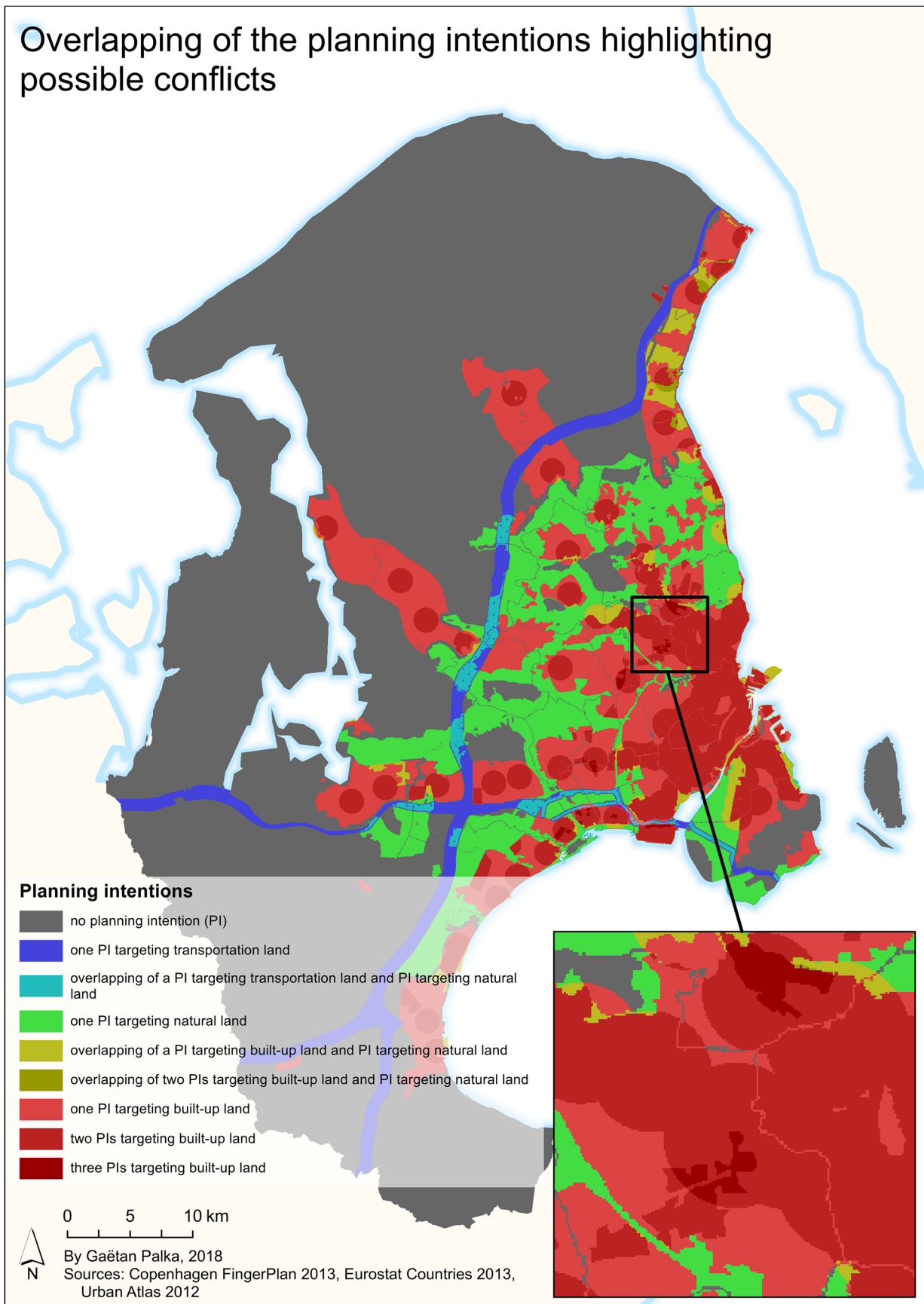
Overlapping of the planning intentions highlighting possible conflicts

Planning intentions

- ■ no planning intention (PI)
- ■ one PI targeting transportation land
- ■ overlapping of a PI targeting transportation land and PI targeting natural land
- ■ one PI targeting natural land
- ■ overlapping of a PI targeting built-up land and PI targeting natural land
- ■ overlapping of two PIs targeting built-up land and PI targeting natural land
- ■ one PI targeting built-up land
- ■ two PIs targeting built-up land
- ■ three PIs targeting built-up land

0   5   10 km

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Sources: Copenhagen FingerPlan 2013, Eurostat Countries 2013, Urban Atlas 2012

Fig. 10 Composite map: overlapping of the planning intentions highlighting possible conflicts

delineated and more numerous, weighting could change the values of pixels in the composite map.

Overlapping planning intentions raise questions. The overlap of PI4 "Stations Proximity" with PI2 and PI5 targeting green wedges (such areas in yellow on the left of the black square in Fig. 10) shows the importance of the link between strategic spatial planning and land-use planning. The former expresses the general concept of development around stations, and the latter details the rules with zoning. Planning at the municipality level needs to address potential conflicts emerging in the strategic vision.

The composite map does not show the overlapping of planning intentions with other regulations like Habitat2000 or other nature designations made at the national level. Although this potential overlapping does not fall within the scope of this research, it must be included in any broader analysis of spatial planning.

The method detailed in this paper could be of prime importance to modelers working on urban change. One of the major research challenges in land change modeling that includes urban areas is the lack of methods for extracting and converting information from planning documents (Koomen et al. 2011). The great heterogeneity and fuzziness of the content of these documents make the analysis and modeling exercise difficult, and the results are rarely detailed. As a result, many models include variables, such as slope, accessibility, and Natura2000, whose data construction methods are standardized, but they rarely include the main objectives and means of spatial development contained in these documents, called planning intentions in this paper. However, whether this information is considered has a strong impact on the results obtained with these models (Poelmans and Van Rompaey 2010).

Through visualization of the heterogeneous data found in strategic spatial plans, our proposed method provides a new link between the objectives and means of spatial planning and their spatiality. It also offers a novel way to reduce the gap between spatial planning and land change modeling by translating the heterogeneous information of spatial plans into exploitable data.

Compliance with Ethical Standards

This article respects the ethical standards of Springer.

Conflict of Interest The authors declare that they have no conflict of interest.

Ethical Approval This article does not contain any studies with human participants or with animals performed by any of the authors.

Informed Consent This article does not contain any studies with human participants performed by any of the authors.

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