Assessing Urban Density
A Multidimensional Model

Thesis by
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Introduction

The worldwide urban population is currently estimated to be over 3 billion and is expected to reach 6 billion by 2030 (UN Population Division, 2009, 2). Considering this unprecedented demographic trend in combination to rising energy costs and decreasing governmental resources to pay for infrastructure calls urgently for more compact development. Densifying urban areas appears to be a priority for advanced industrial societies in order to create more sustainable, equitable and resilient metropolises. Cities seek to optimize and intensify land uses in neighborhoods already equipped with public facilities and infrastructures. The last decade saw a myriad of metropolises embracing a compact development agenda. From Seattle, Washington to Stockholm, Sweden, cities around the world set ambitious densification objectives and craft out innovative strategies to meet them.

However, urban compaction implies an increase in human activities within a limited area and necessarily makes the management of resulting nuisances more complicated. Densification proves to be a complex and multi-faceted process that has to be integrated into cities' heterogeneous development logics. A densification which would be limited to a sheer increase of people living in a given area will most probably not achieve the benefits it pursued. Improperly planned, densification can create undesirable urban environments and undermine residents' quality of life. Consequently, beyond the numerous political announcements in favor of density, it appears that compact development covers a broad range of realities and that "good" urban density has to be distinguished from "bad" urban density.

In this context, my thesis answers the following research questions:
What characterized suitable urban density? How can the suitability of urban density be assessed?

Approaching urban density in its broadest sense, I examine the different advantages generally conferred to compact development and the conditions of their achievement. Based on this initial investigation, I identify five performance indicators of suitable density and aggregate them into a composite index aiming to assess density holistically. I conclude my work by applying the created index to two particularly relevant density case studies: Portland (OR) Downtown Waterfront Urban Renewal Area and Amsterdam IJburg.

Background

Urban densification is a goal shared by a large number of cities across the western world and they are embracing it in very different fashions. In the following paragraphs, I give a glimpse of the diversity of responses to the challenges posed by urban densification.

Seattle, Washington

Seattle, Washington, whose population is above 600,000 (U.S. Census Bureau, 2010) in a region of more than 3.3 million (U.S. Census Bureau, 2009), has been attempting to reduce regional sprawl by encouraging more residential and commercial developments in the city. It is a major step in realizing the goals of Seattle's Comprehensive Plan of 1994 (City of Seattle, 1994, xii).

Fig 1: Downtown Seattle, aerial view

A major part of this effort was significant changes to Seattle's downtown zoning code, which covers three downtown neighborhoods. The area directly affected by the zoning change is 500 acres which is more than the half of the 950 acres in Seattle Downtown's area. Seattle's Downtown zoning change,

passed by Full Council on April 3rd 2006 (City of Seattle Legislative Information Service, 2006) concentrates on four major planning parameters:
1. Increased height limits: the most significant height change is inside the expanded boundaries of the downtown mixed commercial zones, up from the previous allowance of 125 to 240 feet, including 10 percent bonus height for certain design features.
2. Increased Floor/Area Ratio (FAR): the zoning code changes increase allowed FAR for commercial structures. The allowances in two sections of the downtown office core are raised from 5 to 14 or 6 to 20, depending on zones, from base to maximum bonus FAR. However any additional bonus FAR has still to be awarded through special provisions.
3. Office and Commercial Bonus Development: additional FAR, up to a maximum of 20 FAR in the DOC zone, is subject to bonus contributions directed at two categories of public benefits. The first is affordable housing and child care facilities (which can add up to 75 percent of bonus FAR) which have to be provided on site or on an adjacent property. The second is non-housing benefits (which can add up to 25 percent of bonus FAR). These include contributions to an array of civic and cultural projects, such as open space and landmarks theaters.
4. Residential Bonus Development: for residential projects, bonus height can be obtained in several ways. The maximum applicable height for residential use may be increased by 10 percent for rooftop features and residential amenity spaces. Another option to reach the applicable bonus height limits is to build affordable housing into the project or on an adjacent lot. Alternatively, a contribution can be made to an affordable housing fund administered by the city. Any residential bonus height requires a LEED Silver rating from the U.S. Green Building Council.

Interestingly, these various regulatory stimulations for more density are accompanied by a series of measures aiming to ensure a high quality urban environment in a more compact downtown:
1. Street-level requirements: special provisions in the code are intended to enliven the streetscape and contribute to the pedestrian realm. These provisions are requiring activated and continuous frontages and are restricting above-grade parking to minimize the negative impact of parking structures on the pedestrian environment.
2. Upper-level Development standards: to preserve light and views, the code distinguishes between a tower and a base in downtown buildings. The net effect of the upper-level development standards is that towers that do not exceed the base height limit have average residential gross floor plate area limits of 10,000 sqf with limits on tower width.
3. Common recreation space: zoning regulations require common recreational space for new residential developments, in an amount no less than 5 percent of the gross floor area in residential use. Contributing to abutting green streets will reduce the requirement by half.

4. Departures: a board appointed for the downtown area allows zoning code departures through a process of design reviews. Except for a narrow list of provisions, more flexibility is now possible through design review if the overall intentions of the code are served.

Fig 2: Downtown Seattle, streetscape

Seattle's Downtown rezoning appears to be successful in stimulating higher density. "Based upon economic indicators, the city is on a cusp of the most rapid development units in history within the boundaries of Downtown Seattle. [...] Judging by the presales that have already occurred, the market will rapidly absorb these units, and permit applications for thousands more can be expected before the end of the current plan period in 2024." (Urban Land Institute, 2008, 83).

San Diego, California

San Diego, California, covers 330 square miles and has a population of more than 1.3 million (City of San Diego, 2011). The city has seen explosive population growth for the past two decades, and

projections call for continued growth, albeit slower than in the past (County of San Diego, 2010, 2). San Diego adopted the "City of Villages" (COV) growth strategy in 2002 as part of its update to the city's General Plan with the intention of encouraging mixed-use neighborhoods close to transit and featuring pedestrian friendly environments. On February 10th 2004, "the City Council approved five innovative projects to become Pilot Village demonstration projects for the City of Villages strategy of smart growth in San Diego." (City of San Diego Planning Department, 2004, 1). The projects that were selected are dispersed throughout the city and represent a variety of approaches and styles that will demonstrate how Villages can revitalize existing neighborhoods while retaining their individual character. The five targeted areas are Mi Pueblo, North Park Village, The Paseo, Village Center ay Euclid and Market and The Boulevard Marketplace.

Fig 3: San Diego Downtown

To encourage development in the pilot villages, the San Diego City Council adopted a series of incentives in 2003 that included four major planning decisions (City of San Diego, 2003, 1-7):

1. Giving priority to pilot villages for infrastructure upgrades or replacements
2. Deferring collection of impact and capacity fees until prior to final inspection. Fee deferral allows applicants to finance a smaller portion of the project with construction loans that typically feature

3. Providing funding sources for items such as accessibility via a citywide handicapped access fund, rebates on property taxes, and revolving loan funds provided that the project fits in the COV overarching strategic goals
4. Providing assistance related to policies and regulations on the undergrounding of utilities, affordable housing, and Community Development Block Grants

Fig 4: San Diego, Paseo Courtyard rendering

The San Diego COV strategy was enacted through an innovative process. After the city council adopted the Strategic Framework in 2002, the city solicited proposals for pilot villages that would best demonstrate the goals and the vision of the COV strategy. Developers and community groups formed teams to submit proposals. The involvement of local community stakeholders as applicants for pilot villages encouraged community participation and ultimately acceptance of the plan.
Even Though "the implementation of the COV pilot villages has not proceeded as originally envisioned, [...] signs of new development and redevelopment in pilot villages are beginning to emerge." (Urban Land Institute, 2008, 99). This slowness in development is partly due to a lack of infrastructure funding mechanisms and organizational difficulties incurred by the multiplicity of actors involved in the projects. However, in North Park, for instance, the Historic Theatre has been restored and a new mixed-use condominium development is complete.

Vancouver, Canada

Known for its longstanding planning tradition, Vancouver, Canada, elevated density as an ultimate strategic goal for future planning policies in 2006. After two years of workshops, community meetings, and public forums and fairs, an EcoDensity Charter and a series of Initial Actions, were unanimously adopted by City Council in June 2008 (City of Vancouver, 2008, 3).

Fig 5: Vancouver high density area

The specificity of Vancouver's approach to densification lies in its emphasize on "density done well". The EcoDensity initiative acknowledges that not all density is the same and that density has primarily to be "designed to complement and enhance neighborhood character, to adapt over time with flexible form, and to contribute to walkable and interesting streets." It also recognizes that density "can take many forms, from the high rise towers of downtown and mid-rise buildings along commercial arterials to other, more character sensitive density types". (City of Vancouver, 2008, 13). Along those lines, the EcoDensity project develops counter-intuitive notions of density such as "gentle density" (density that includes housing types, such as rowhouses and infill that 'gently' fit into an established neighborhood in that they are a similar scale to single-family houses and are usually ground-oriented), hidden

density (density that includes housing types such as laneway houses that are hard to see from the street but change the nature of the lane), and invisible density (density that includes housing types such as secondary suites that can fit into an established neighborhood with minimal or no impact to built form. EcoDensity envisions making all new single-family homes suite-friendly, and enabling secondary suites in other building types, including multi-family apartment buildings). EcoDensity's conception of density is very broad, as it is seen as a means to achieve three major and interrelated challenges which go beyond the mere increase of the number of residents within the city's boundaries: environmental sustainability, livability, and affordability.

Fig 6/7: Laneway housing, examples

The City Council approved an array of "initial actions" which will act as a framework for future work and implementation of the EcoDensity commitments. The majority of actions require further work before getting final approval by the council. However four actions received priority (City of Vancouver, 2008, 2):

1. An interim EcoDensity Rezoning Policy
2. A report on issues and options for backyard/laneway housing
3. More options for secondary suites, including dealing with zoning barriers to creating basements in single-family houses; looking at requiring "suite ready" basements; and investigating options for suites in higher density housing
4. Removal of existing zoning or related barriers to green building approaches

Even though Vancouver's EcoDensity is too recent for its achievements to be assessable, it already seems to be a highly innovative and ambitious strategy for densification.

Stockholm, Sweden

In Sweden, Stockholm's Översiktsplan 1999 (City Plan 1999) sets forth strategies for infill development and revitalization in order to better utilize the existing urban landscape and preserve the natural elements of the city and region. The urban development strategy calls for "building the city inwards" by reusing brownfield land, turning old industrial areas into mixed-use neighborhoods, developing strategic nodes within the city boundaries and building in good locations for public transport (Stockholms Stad, 2010, 7).

Fig 8: Stockholm central city

The plan names twelve specific areas within central Stockholm that are prime for redevelopment, with strategies to create mixed-use communities. Those areas are given extra attention, as planners craft detailed development plans that mandate the type, form, and timing of development in that area. Then, as long as a development proposal meets the established plan's criteria, it is automatically approved. This densification strategy also recognizes the importance of saving valuable green spaces within the city, and stipulates that none of the 850,000 Stockholmers (SCB Statistics Sweden, 2011) should live further than a 5-10 minute walk from a park (Nelson, 2007, 5).

A great number of urban planning initiatives have taken place in the urban development areas that were highlighted in Översiktsplan 1999. The transformation of former industrial sites into dense, mixed-use neighborhoods in areas such as Hammarby Sjöstad (Sea City) has been appreciated by many Stockholmers and has attracted international interest. Hammarby Sjöstad was the first targeted redevelopment area in inner Stockholm. The site was originally industrial, but had become vacant and run down. In 2010, the area accommodated more than 20,000 workers and residents (Stockholms Stad, 2010) and had become a dense, mixed-use urban node. Public transportation connections, in the form of a light rail and ferry system, link Hammarby Sjostad with the center city and the regional metro network (Stockholm City Development Administration, 2006, 1-2).

Fig 9: Hammarby Sjostad, aerial view

Hammarby Sjostad incorporates a new neighborhood park, in addition to being connected to the regional park system. Översiktsplan 1999's density approach has also guided the planning of many smaller housing projects around the city and there are a whole host of good examples of land being used more efficiently. Generally speaking, all the new housing built since 1999 is well located for public transport. This has promoted sustainable travel, but has failed to ease capacity problems on certain sections of the metro during rush hour (Stockholms Stad, 2010, 7).

Bordeaux, France

Bordeaux's metropolitan region, 1,105,000 inhabitants (Institut National de la Statistique et des Etudes Economiques, 2009), is one of the fastest growing in France. Its population is expected to rise by 280,000 by 2030 (A'Urba Agence d'Urbanisme Bordeaux Aquitaine Métropole, 2011, part 0, 6). In order to absorb this growth in a sustainable and livable manner, the city launched a vast and innovative initiative called "Bordeaux 50,000" in 2009. Five international interdisciplinary teams were commissioned to develop a masterplan and operational processes allowing and managing the annual construction within the city's boundaries of 10,000 dwelling units over the next five years close to mass transit infrastructure. Each team gathered architects, landscape architects, urban planners, social scientists, transportation engineers, and environmental specialists. The strategy will seek ways to achieve density and accessibility for the new housing over a metropolitan territory of 550 square kilometers.

Fig 10: Bordeaux, central city

The competitive dialogue between the various teams took place between September 2010 and February 2011. It yielded three different types of conclusions. A first part of the analysis was led at a metropolitan scale. How can the construction of 50,000 housing units within central city boundaries challenge

and renew the vision for the metro region's future? (A'Urba Agence d'Urbanisme Bordeaux Aquitaine Métropole, 2011, part 1) The second level of investigation was carried out at the scale of the project. How can housing and transportation infrastructure projects be drivers for growth, especially in areas of the central city that are considered unsuitable for development today? What kind of new housing typologies and building forms would come out of such projects? (A'Urba Agence d'Urbanisme Bordeaux Aquitaine Métropole, 2011, part 2) The third and last level of conclusions, more operational, dealt with the various implementation options which would make the construction of 50,000 dwelling units within five years happen. How should the areas targeted for development be selected? Within which organizational framework should the multiple stakeholders be associated to work all together in a coordinated and efficient fashion? (A'Urba Agence d'Urbanisme Bordeaux Aquitaine Métropole, 2011, part 3)

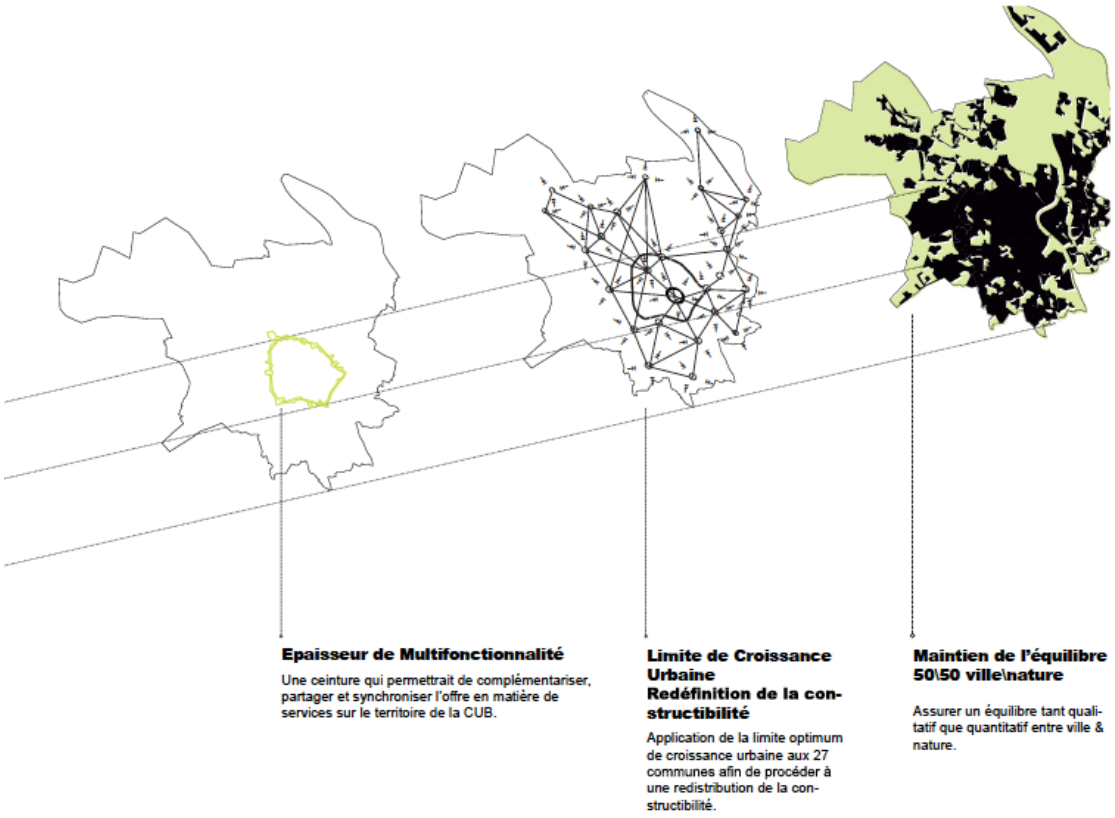

Fig 11: Bordeaux 50,000, diagram by OMA Team

Even if the plan is too recent for its outcomes to be gauged, Bordeaux's approach to densification is remarkable for several reasons. The Bordeaux 50,000 plan stands out by the broadness of the questions posed and the answers proposed in terms of geographic scale and diversity of parameters taken into

account in the analysis. It also features composite teams which are coming from different countries and professional backgrounds. It results in very different perspectives on densification that enriches the thought process. Beyond the question of densification, it is even more a definition of the new way to live in the city that is expected from such a consultation.

Although very incomplete, this list of examples of city planning strategies to generate denser urban environments demonstrates today's wide spread interest for compact development and the multiplicity of responses to the challenges it incurs. In the next part, I will examine the reasons which spur cities to densify.

Literature Review

Urban densification usually refers to "the process whereby residential densities (i.e. the number of dwelling units per hectare) are increased in a planned and meaningful way within the existing boundaries of a specific area." (Cape Metropolitan Council 2000: MSDF Handbook). Urban densification is often defined in opposition to urban sprawl which has been the prevalent pattern of growth over the past 60 years. Another notion directly related to the urban densification debate is the "compact city". As Anne Skrovbro writes, the general idea of the compact city strategy is "to locate future urban development within current urban boundaries. Thus, a large portion of future growth will take place through densification." (Urban and Regional Planning and Development, 2001, 99). Densification is seen as a means to contribute to the creation of good quality urban environments on five main aspects: sustainability, cost effectiveness, equity, health, and place-making.

The dominant argument calling for denser urban environments is sustainability. Firstly, higher density decreases the need for transportation and promotes more sustainable way of moving around the city. Simply put, the idea is that living in high-density urban areas and walking and biking are more environmentally friendly than living in a low-density suburb and driving everywhere. By enabling people to live closer to their work places, dense and mixed-use developments are likely to lessen car dependency and then curb non-renewable fuel consumption. Research demonstrates that potentials for savings are significant. According to Jerry Walters and Reid Ewing, the "evidence on land use and driving shows that compact development will reduce the need to drive by between 20% and 40%, as compared with development on the outer suburban edge with isolated homes, workplaces, and other destinations. A midrange estimate would be a 30% cut in VMT (Vehicle Miles Traveled) with compact development." (Walters and Ewing, 2009, 3-4). Another study, issued by the American National Academy of Sciences, supports these conclusions, claiming that, if 75 percent of all new and replacement housing in America were built at twice the density of current new developments, and those living in the newly constructed housing drove 25 percent less, CO2 emissions from personal travel would decline nationwide by 8 to 11 percent by 2050 (Transport Research Board, Driving and the Built Environment, The Effects of Compact Development on Motorized Travel, Energy Use, and CO2 Emissions, 2009, 165). Such an emission reduction is all the more important since transportation accounted for more than a third of CO2 emissions in the U.S. in 2006 (U.S. Environmental Protection Agency, 2008, 30). Meeting greenhouse gazes emission reduction goals will not be possible solely through the improvement of vehicle consumption efficiency and the reduction of the gasoline carbon content. Curbing the quantity of miles driven is critical to effectively reduce transportation-related CO2 emissions.

Research has also shown a close relationship between compactness and low energy consumption for space heating. A denser urban form supports efficient district heating systems (Owens, 1992, 100). Multi-story housing has lower energy consumption per square meter for heating than detached single family housing. Verlinden and Rooijers, for instance, developed scenarios for urbanization in the Netherlands over the period 2011-2030. They calculated that housing energy demand was almost 35% higher in a "dispersed" urbanization scenario than in a "compact" urbanization scenario (Jochem van der Walls, 1999, 115).

By encouraging building in urban areas, densification also decreases the consumption of other valuable, scarce, and non-renewable resources such as arable land and aquifer recharge areas (United States Environmental Protection Agency. Our Built and Natural Environments: A Technical Review of the Interactions between Land Use, Transportation, and Environmental Quality, 2001, 19). In other words, limiting urban sprawl, not only makes a more sustainable city, but benefits the countryside as well. Interestingly, some researchers involved with biodiversity issues are also counted among the supporters of a denser city. From a biodiversity point of view, large green areas outside the metropolitan region are more valuable than many small green spots within the city itself (Nyhuus and Thorén, 1997, 29).

Other arguments for more compacts urban environment are of an economic nature. Density is advocated on cost-effectiveness grounds. Urban sprawl is criticized for undermining the efficient provision of public services. John Carruthers and Gudmundur Ulfarsson found empirical evidence of the rising cost of providing public services in low density urban areas compared to more compact ones. "By far the most salient finding of the analysis is that the per capita cost of most services declines with density (after controlling for property value) and rises with the spatial extent of urbanized land area."(Carruthers et al., 2002, 518). On the contrary, higher densities accommodate increased population thresholds that creates a critical mass of consumers to generate economic opportunities, social facilities and services. This is especially true where there is excess service capacity or where increased thresholds are required to provide services and infrastructure. In that sense compact development supports the viability and provision of public transport options for mass and rapid transit by making them more cost-effective. By emphasizing development locations closer to urban centers, America is projected to save $4 billion in investment in local public services during the period 2000 to 2025, spending $139.2 billion annually in comparison to $143.2 billion in the traditional development scenario (Burchell and Mukherji, 2003, 1538).

Density can be a factor in economic attractiveness. For instance, having a corner store or cafe is considered a valuable asset for a neighborhood. In housing surveys, homebuyers regularly express a

preference for “shops within walking distance.” Retail businesses need residents to survive. “A neighborhood shopping center with local goods such as convenience items, videos, or dry cleaner needs a minimum of 3,000 people within a three-mile radius to be viable; a supermarket requires far more - 40,000 residents within three to six miles.” (Beyard Michael et al., 1999, 276). Such findings advocate for dense urban environments as they provide new economic opportunities.

Densification provides opportunities to increase the tax base of a jurisdiction by creating or renewing a property’s value. For instance, projections indicate during the period 2000 to 2025 a nationwide positive fiscal impact of $4.2 billion annually under the compact growth versus the traditional development scenario (Burchell and Mukherji, 2003, 1538).

It is interesting to observe how sprawl developments suffered some of the highest foreclosure rates during the vast mortgage meltdown over the past few years, creating pockets of higher poverty and crime (Chandler and Hopkins, 2007).

Of all the arguments for density, the claim that the compact city is more socially equitable is perhaps the one which is the least investigated. However, evidence supporting this statement can be found. Density has the potential to reduce the separation between home and work and thus the time and money spent on commuting. In a dense urban environment, not only are households closer to facilities but there are also likely to be a greater number of facilities per person as minimum densities of population are required for facilities such as retail to be economically viable. Proximity of multiple shopping options proves very advantageous as “car ownership is confirmed as the critical factor in determining whether a consumer makes use of the new off-centre shopping facilities or relies on the traditional centers” (Bromley et al., 1993, 232). This makes density especially beneficial to low-income households which don’t own a car and are consequently lacking shopping options in sprawled areas. By being more cost-effective, higher density settlements are more socially sustainable as local facilities and services can be maintained and therefore accessibility to goods and services is more equitably distributed.

The same reasoning can be applied regarding access to public transportation in a compact city. Public transportation systems work better in denser cities owing to the simple fact that a larger population lives within convenient access of a stopping-point. Newman and Kenworthy, in “Cities and Automobile Dependence”, concluded that higher-density cities are associated with a high use of public transport: public transport declines as density drops and falls away at around 20–30 people per hectare (Newman, 1992, 132). This promotes social equity because the disadvantaged, especially the car-less, tend to suffer disproportionately from accessibility problems in sprawled areas. Cass, in 1990, argued that living in

a region where access to necessary education and public sector services is limited, where suitable jobs are scarce, and the potential commute is long and expensive were conditions which may exacerbate and perpetuate social inequities (Cass, 1990, pp. 10-15). Interestingly, this description portrays many low-density urban areas where home and work are clearly separated and public facilities are expensive to maintain.

A mix of residential densities ensures diversification and choice of housing types and tenure options (Burton, 1999, 1987). That's why densifying urban areas in selected suitable locations, essentially those close to urban opportunities (services, facilities and jobs) and public transport, contribute to rationalize housing patterns in cities and offer more housing options for households from a wider range of sizes and social backgrounds. The compact city is also generally said to have the potential to reduce the cost of housing. Burke (Burke, 1990, p. 158) wrote that increasing the density of land use through medium-density housing "reduces the land value component of a dwelling and therefore the end cost to the consumer". However, certain types of high-density dwelling, such as condominiums and apartments, may be required to ensure that compaction policies lead to affordability benefits. This is all the more equitable since housing accounts for a major source of spending for unprivileged households.

Eventually, another series of arguments for urban density falls under the idea that it creates physically and socially healthier cities. Isolating people in car-oriented environments deprives them not only of the physicals benefits of walking but also of the natural human interactions typical of complete communities. This is particularly relevant to the growing number of aging residents who, when they can no longer drive, lose their independence. Children and young adults are also vulnerable to the negative physical consequences of car dependency as obesity is recognized as a major public health issue ("State Surgeon General Seal of Walkability", Promoting Health one step at a time, University of Miami School of Medicine, 2009).

Urban compactness is also claimed to have the potential to reduce crime. Even though the "fear of crime" is often cited as a spur for moving to low-density suburbs, those might not be the safest urban environments. Population decentralization often results in increased segregation which has been identified as a factor of higher crime rates. One of the most well-known planning principle taken from Jane Jacobs's book The Death and Life of Great American Cities is the importance of "eyes on the street" in a desirable and safe urban environment (Jacobs, 1961, 35). It relates directly to the notion of density. In densely populated areas, a higher number of people are watching the streets round-the-clock. This passive surveillance and mutual policing deter wrongdoings and promote personal safety in the public realm. What's more, densification that results in the development of housing in non-residential areas

and the conversion of empty spaces into stores might reduce fear of crime if not crime itself (Goodchild, 1998, 91).

In a dense city, communities are likely to be more mixed and low-income groups are less likely to suffer from disadvantages of being spatially isolated. This argument is based on the fact that decentralized urban growth and sprawl generate increased segregation. Concerns over the inequities of population due to decentralization rose as a result of the massive exodus of higher income households to the suburbs since World War II. For example, the Commission of European Communities' describes the inner-city decay and segregation problems resulting from urban or suburban sprawl (Commission of European Communities, 1990, 7). More recently, Putman wrote that "suburbanization means greater separation of workplace and residence and greater segregation by race and class" (Putnam, 2000, 208). Such segregation might exacerbate the disadvantages of the most vulnerable due to the resulting poor environment and facilities and worsen local social fragmentation.

Densification aligns with broad demographic trends as well. In 2000, 25 percent of all American households consisted of one person living alone, a significant increase over the 7.7 percent in 1940. This type of household increased each decade over the 60-year period from 1940 to 2000 (U.S. Census Bureau, 2011). In 2009, 181 million "empty nesters" were estimated to live in Europe and the U.S (Data Monitor, 2005, 2). These two structural demographic trends imply that an increasing demand exists for dense and vibrant places. In the book Getting Density Right, the Urban Land Use Institute argues that "convenience, amenities, and services provided by compact development can promote a lifestyle that is attractive to this demographic." (Urban Land Use Institute, 2008, 5). According to the Commission of European Communities, urban density acts as a cultural catalyzer. "The cultural dynamic: as in the social sphere of which it is a part, the city's cultural role depends on density, proximity and choice. These factors facilitate the "production" of culture as much as its "consumption"." (Commission of European Communities, 1990, 9). It adds that "The city's economic and social importance ultimately rests on the ease of communication offered by spatial density and the sheer variety of people and institutions which can exploit this opportunity. (...) The enemies of this source of creativity are, on the one hand undifferentiated suburban sprawl in quasi-rural settings which isolate the individual; and highly specialized land-use policies which create functional enclaves and social ghettos." (Commission of European Communities, 1990, 9). This document sets densification and the fight against urban sprawl as a priority for European urban policies.

Urban density also appears to be a condition for vitality, vibrancy, cultural activities and social interaction. If suitably designed (in terms of form, scale, height and orientation) and located, higher

densities can provide an opportunity for urban place-making and the creation of attractive and safer urban environments, especially those in proximity to public spaces (Jacobs, 1961, 208-221). In that senses compact and mixed-used developments are likely to create more vibrant communities as many generations with diverse incomes and backgrounds live and interact within them and provide opportunities to revitalize a neighborhood or downtown.

Misconceptions

These facts push density to the forefront of cities' environmental sustainability and position the question of urban densification a critical one for the 21st century. In many growing cities, the debate over whether to build compactly or not is over. The question is now where to increase density and how best to encourage, facilitate, plan, and design new compact development. However, the implementation of such densification policies is undermined by a widespread reluctance to embrace more compact development among the general public. Dense urban forms suffer from several misconceptions that fuel the fear of high-density neighborhoods. Urban density is generally associated with over-crowding. However there are fundamental differences between these two notions. As Julie Campoli and Alex S. MacLean wrote in their book Visualizing Density, "Density is the number of people in a given space, while crowding is the subjective perception that that number is too high." (Campoli et al., 2007, 11). As a result, some places may be very dense without being perceived as overcrowded and conversely some may be relatively less dense and perceived as overcrowded. Jane Jacobs describes the discrepancy between perceived and actual density comparing two neighborhoods of Manhattan: Greenwich Village and Stuyvesant Town. Surprisingly "The Stuyvesant Town Project has a density of 125 dwellings per net hectare, a density that would be on the low side for Greenwich Village" (Jacobs, 1961, 215). Yet the Stuyvesant Town Project urban environment, featuring massive social housing blocks surrounded by open space, seems way more crowded and oppressive than Greenwich Village's. This kind of comparison challenges the common view that high-rise buildings are the only answer to increasing urban density; it can be accommodated in very diverse urban forms. Another possible consequence of density is congestion. The idea that a dense city is necessarily over-crowded and constantly jammed up is widely shared, despite all the research showing that density tends to mitigate traffic congestion. This conception of the city stems directly from the traditional image of the 19th Century city as a city crowded, messy, congested, and insanitary.

Density is also generally said to be responsible for monotonous urban forms. This perception is primarily due to the "stack" approach to housing since the 1940s. The last 60 years saw a large scale standardization of construction technics and processes. It brought down the cost of construction and

made housing more affordable, but it also bred monotony. “When the same building form is repeated relentlessly across a broad area, it provokes a response that there are “too many” structures, regardless of the actual number. Density is perceived to be greater than it is.” (Campoli et al., 2007, 13). The risk of standardization was the only limit Jane Jacobs set to density arguing that “two hundred homes per acre are a “danger mark”. Once neighborhoods crossed that point they risk sterile standardization.” (Jacobs, 1961, 217). However, monotony has to be recognized as a consequence of poor design and planning, but not as a necessary consequence of densification. The widespread belief that density results in increased ghettoization stems also partially from the general perception of the monotonous developments built over the last 60 years. Mono-functional and repetitive, these buildings concentrated people from similar social backgrounds in car-oriented environments. This often resulted in hermetic pockets of blight and crime or of wealth. Once again, these urban failures are consequences of flawed plans and design and not of density itself.

Dense urban areas are said to lack open and recreational spaces. As a result, densification is held responsible for a decrease in quality of life. Yet the negative impact of density on the provision of open space is far from being proven. As Burton writes “overall, there are very few significant relationships suggesting that access to green space is related to compactness. The provision and accessibility of parks and public open spaces may be ad hoc—the result of topographical and environmental features, and historical and political decisions.” (Burton, 2000, 1982). Some even argue that, if properly planned and designed, a denser city allows a more efficient use of space and can provide more open space than some low-density areas. Comparing 10 study areas of different density levels in Sweden with the help of a GIS model, Stahle concluded that densification could even exist with increased access to open space. He claimed that “the structural inefficiency of the post-war areas could open up for qualitative infill and restructuring, which can mean a denser city but higher green space accessibility. This has also been indicated by contemporary urban design theorists like Dolores Hayden, Peter Calthorpe and Xaveer De Geyter.” (Stahle, 2010, 66).

Conclusion

The benefits of compact development and the negative consequences of low-density development may not be readily apparent to the public, which often mistakenly blames density for the consequences of a low-density development pattern. Acknowledging, understanding and trying to overcome these widespread misconceptions about density is critical for the success of any densification strategy. In Getting Density Right, the Urban Land Use Institute emphasizes the importance of communication with the general public and sets it as a prerequisite for compact development. “Without a complete

understanding of how land use affects the environment, a community may not attain the goal it is seeking. [...] Such misunderstandings of the benefits and consequences of land use decisions are unfortunately all too common. Addressing the many misconception about compact development is an important part of developing the community consensus required to create and enact policies and programs that support compact development. Overcoming these misconceptions is the first step toward creating solutions and enacting regulations that realistically address anticipated population and job growth and a dwindling of developable urban land." (Urban Land Use Institute, 2008, 4).

Yet, planners, urban designers, and policy makers have to be cautious when supporting urban density. "Although skepticism toward density is often based on fear and misconceptions, not all opposition is unjustified. There is no such a thing as "bad" density - that which is poorly planned and designed without an understanding or concern for human needs." (Campoli et al., 2007, 11). Likewise, Anne Skrovbro warns density advocates that "when it is claimed that the compact city will foster social and cultural diversity and activity, and provide a livelier, safer, and socially equitable environment, the counter-arguments are that higher densities lead to more crime, the disadvantaged will suffer more from resulting noise and pollution, and the compact city is not socially acceptable due to perceptions of overcrowding and loss of privacy. Thus, the critique has focused on the quality of the urban environment that a compact city strategy would produce and has questioned whether this urban environment will be seen from a local point of view as sustainable and desirable." (Urban and Regional Planning and Development, 2001, 101). In that context, it would be valuable to discuss how to strike a balance between the goal of densifying on a larger scale, while maintaining a desirable urban environment on a smaller scale. Such a discussion requires an understanding of the relationship between the compact city and the quality of the urban environment. Citizen support for policies aiming at shaping more compact development patterns is likely to rest heavily on how the outcome affects their quality of life.

Densification cannot be pursued solely in terms of population density for it to be supported by the community and to achieve the social, economic and environmental benefits presented above. A densification that is not producing a mix-used urban environment won't make people live closer to their workplaces and will consequently increase commuting time and cost, traffic and CO2 emissions. Likewise, a densification that is unaccompanied by a improved public transportation capacity will have negative consequences in terms of sustainability. A densification that does not seek to include people from a broad range of social backgrounds will lead to ghettoization creating pockets of blight and crime. A densification that does not incorporate a consistent strategy to provide a substantial amount of open space will shape an urban environment which will be perceived as overcrowded and held responsible for a lower quality of life by the community.

To contribute to the objective of more sustainable development, in its broadest sense, embracing social and economic sustainability as well as environmental concerns, a densification strategy has necessarily to aim at producing mix-used and transit-oriented developments along with population density. Differently put, population density cannot be thought of apart from land-use variety, social diversity, and mobility. Therefore densification might refer to the process of intensification and compaction of human activities within a certain spatial area.

Research Design

The previous part of this work made clear that a densification which would be limited to a sheer increase of people living in a given area would most probably not achieve the benefits it sought. Improperly planned, densification can create undesirable urban environments and undermine residents' quality of life. Consequently, "good" urban density has to be distinguished from "bad" urban density.

"Good" density is complex and multifaceted. It embraces social and economic issues as well as environmental concerns. It requires a densification strategy which aims at producing mix-used, transit-oriented, socially diverse developments along with increased population density. "Good" density creates a more desirable urban environment which enhances the quality of life for a large majority of citizens. "Bad" density solely pursues rising resident numbers within a definite perimeter. It results in monotonous and standardized building forms where people are crammed and it creates low-quality urban environments.

Another fundamental distinction made earlier in this work is between perceived density and actual density. In dense urban environments, spatial configuration has a great impact on perception. Some places may be very dense without being perceived as such and conversely some may be relatively less dense and perceived as overcrowded. The notion of perceived density is critical to the density debate, as opposition to compact development is generally fueled by misleading perceptions of density. According to Rapoport (Rapoport, 1983, 59), people usually see low perceived density as one of the characteristics of a high-quality environment.

Even though densification is a multifaceted process, it is generally uniquely assessed and communicated in terms of mere residential density. Density is expressed in residents per acres or hectares. Such a mono-dimensional measurement does nor account for the complexity of urban density. It leaves out many key aspects of densification. Likewise, residential or built-surface density alone cannot account for perceived density. As Dafna, Fisher-Gewirtzman, Burt, and Tzamir claim "A specific density measurement, in itself, cannot lead to a perceived density. [...] What matters for the building, the city block, or even for the neighborhood is the perceived density, and that cannot be represented adequately by the "unit per area" or "built area per land area" ratio." (Fisher-Gewirtzman et al., 2003, 1).

This knowledge prompts us to look for a more comprehensive measurement framework that could estimate density in a better way. As planners and policy makers struggle to show that both a high-density urban fabric and a high-quality urban life can be pursued together, a broader assessment method for density seems needed all the more.

A Composite Index

My work proposes a new framework to estimate urban density. It is an attempt to find a methodology which combines the different matters related to density with relatively simple indicators. It takes a holistic view on compact development and accounts for density in all its dimensions, including the perception of density. Ultimately, it aims to describe objectively and holistically cities' compactness in a composite index which could be used as an assessment method for densification strategies.

A composite index is a compilation of different quantifiable indicators. The way it is compounded is critical to its relevancy and significance. Depending on the variables taken into account, an index will come up with very different assessments of density. In other words, the concept of a composite indicator brings two subsequent questions: What is a good performance index for urban compactness? Which are the most relevant metrics to be included in a composite index aiming at assessing density?

The first elements of an answer to these questions can be found in literature about urban environment and morphology evaluation. According to van Eck and Koomen, the profile of a good indicator for urban morphology should relate to specific policy themes, be intuitive for policy-makers, and capture the differences between strategies (van Eck et al., 2007). What's more, Jaeger, Bertiller, Schwick, and Cavens wrote that indicators should be simplistic, mathematical, and have modest data input requirements (Jaeger et al., 2010, 428). I focus on these criteria in an attempt to tie several individual indicators relating to the urban compactness theme into one composite index aiming to answer the following question: To what extent is the density of a given development appropriate?

What are the different targets that must be pursued and hopefully reached in densification strategy for it to be successful? (1) First of all, even though it must not be considered the ultimate goal of such a process, densification has to make more people live in a given area. It has to result in a high residential density neighborhood. (2) Successful densification also makes people live closer to their work, shopping, and leisure places in order to cut down car use, commuting time and cost, and congestions. Densification has to create mixed-use environments. (3) Using the same sustainability rationale, well-planned densification provides residents with nearby public transportation options. (4) Densification must be inclusive and allow people from diverse social backgrounds to live together in order to avoid ghettoization and create complete communities. (5) Eventually, suitable densification offers a high-quality urban environment that is not perceived as over-crowded by citizens.

Keeping in mind these targets, I selected accordingly five performance indicators measuring each of these. These five key performance indicators make up my composite density assessment index.

1. Residential Density

Dense development aims to create high-residential-density neighborhoods. The first indicator compounding our index assesses residential density. Residential density is usually measured in number of residents per hectare or acre. It is a ratio equal to the number of people living in the area divided by the surface of the area. In this calculation, an individual is considered a resident, if his primary residence is within the study perimeter.

Even though it is a simple notion, resident density measurement causes problems since there are several ways to measure it. The main distinction lies between gross density and net density. Gross density is a units-per-acre density measurement that includes in the calculation land occupied by public rights-of-way, recreational, civic, commercial and other non-residential uses. On the contrary, net density is a units-per-acre density measurement that includes in the calculation only land occupied by residential uses. It does not include streets, parks or other uses. However, for the matter of this study, we are interested in population density for a neighborhood as a whole. Consequently, using gross density seems more relevant to our purpose.

As a result, our key indicator for residential density will be a gross density measure calculated by dividing the population of the considered area by the total surface of the area. Population data is generally included in census reports. Gross residential density is expected to be high in neighborhoods targeted for dense development.

2. Diversity of uses

Successful densification creates balanced and mixed-use urban environments. The second indicator included in our index measures the uses' diversity in a neighborhood. Several ratios account for the diversity of uses in an area. The "actual mix of uses" can be calculated, i.e. the number of square feet of office, commercial, and industrial built-surface divided by the number of square feet of housing built-surface; the closer to 1 the ratio is, the greater the land use mix. The "zoned mix of uses" is also measurable, i.e. number of acres of land zoned for commercial, office, industrial, and mixed land uses in the neighborhood divided by the number of acres zoned for residential use; the closer to 1 the ratio is, the greater the land use mix. The setting of a target value of 1 supposes that the most balanced mix of land uses integrates as much housing surface as non-housing surface. The choice of this target value is arbitrary. It appeared to be be the most straightforward definition of balanced land use mix.

Even though for the purpose of this work the "actual mix of uses" seems more relevant to be retained in the analysis, we will use the "zoned mix of uses" for practical reasons. Zoning data are public documents that are publicly available whereas construction data is most of the time either expensive or even nonexistent. The calculation of the land use mix ratio will be based on zoning maps which are held by cities' planning departments.

3. Provision of public transit options

Well-planned compact development comes with accessible mass transit options. The third indicator included in our composite index accounts for the provision of public transportation in a dense development project.

without a car. What's more, not only does high-capacity transportation have to be provided, but it also has to be oriented toward residents. In other words, public transit must be easily accessible to a vast majority in order to actually serve residents and cut car use.

As a result, the average distance of residents to the nearest transit option stopping point seems to be an appropriate metric for public transportation provision. Only subway, light-rail, and BRT stops will be considered in the calculation of this indicator. Such an indicator describes the level of provision of transportation as well as its spatial distribution relative to residents' location. The calculation of this indicator will be based on population data included in census reports and block maps. On a map, the distance from the center of each block to the nearest transit stopping point will be measured. Then, for each block, this distance will be multiplied by the number of residents it accommodates. Eventually, all the values obtained will be averaged by the total number of residents living in the area in order to get the average distance of residents to the nearest transit option stopping point.

$$\text{Transit Provision Indicator} = \frac{\Sigma\,[(\text{Dist Block}_1)\,(\text{Pop}_1) + \ldots + (\text{Dist Block}_n)\,(\text{Pop}_n)]}{\text{Pop}_1 + \ldots + \text{Pop}_n}$$

The lower the indicator, the more accessible is the public transportation.

4. Social Inclusiveness

Suitable compact development is socially inclusive. The fourth indicator compounding our index describes the equitability of a given dense development. The cost of housing is a major spending source for low income people. High housing costs are the main barriers for low income people to live in desirable areas. A development is socially inclusive if it enables a substantial portion of low-income people to find housing options at a reasonable cost.

Consequently, the proportion of affordable housing units seems to be a good metric in order to reflect one development social inclusiveness. This indicator is calculated as the number of affordable housing units divided by the total number of units in a given area. The higher the ratio, the greater the provision of affordable housing is. The calculation will be based on construction data which is generally held by cities' planning or construction departments.

5. Access to open space

Well planned and designed dense development creates desirable urban environments. The fifth and last indicator compounding our index accounts for the quality of the urban environment in a dense neighborhood. Low perceived density and crowding are key characteristics of high-quality urban environments. The amount of green spaces in a neighborhood has a huge impact on density perception. Densities being equals, a development that offers a greater amount of green spaces will be perceived as less dense. Green spaces also have to be accessible by most residents and perceived as such.

As a result, the average distance of residents to the nearest public park appears to be an appropriate indicator of urban environment quality. Such an indicator describes the level of provision of green space as well as its spatial distribution relative to residents' location. The calculation of this indicator will be based on population data included in census reports and block maps. On a map, the distance from the center of each block to the nearest park will be measured. Then, for each block, this distance will be multiplied by the number of residents it accommodates. Eventually, all the values obtained will be averaged by the total number of residents living in the area in order to get the average distance of residents to the nearest park.

$$\text{Open Space Provision Indicator} = \frac{\Sigma\,[(\text{Dist Block}_1)\,(\text{Pop}_1) + \ldots + (\text{Dist Block}_n)\,(\text{Pop}_n)]}{\text{Pop}_1 + \ldots + \text{Pop}_n}$$

The lower the indicator, the better the open space provision is and the higher the quality of the urban environment created is.

Compilation

The different indicators having been defined, they remain to be associated in our density composite index. To do so, they have to be harmonized in order to make the overall calculation of the index possible. For each of the five indicators a floor value and a ceiling value will be set. The floor value will be assigned the number 0 and the ceiling value the number 1. Then, each indicator's value will be reduced proportionally to a value comprised between 0 and 1. As a result, we will obtain five values comprised between 0 and 1. Floor and ceiling values will be set arbitrarily and are detailed below.

For the residential density indicator floor value will be 0 resident per acre and ceiling value 100 residents per acre. Ceiling value is set at 100 as it is about Manhattan's density and consequently a reference high density value. Proportional harmonization will be done applying the following equation:

$$\text{Residential Density Indicator Value} = \text{Residential Density} / 100$$

For the diversity of uses indicator, the floor value will be 0 and the ceiling value will be 1. However, this indicator's harmonization process is slightly more sophisticated than for the other metrics making up our composite index. Two cases are possible. In the first case, the residentially zoned surface is larger than the non-residentially zoned surface. The "zoned mix of uses" ratio will be lower than 1. The harmonized value of the indicator will be the actual value of the indicator. In the second case, the residentially zoned surface is smaller than the non-residentially zoned surface. The "zoned mix of uses" ratio will be greater than 1. The harmonized value of the indicator will be the inverse value of the indicator (Harmonized Indicator Value = 1/Actual Indicator Value). This process allows us to get a value that is necessarily comprised between 0 and 1 and that is closer to 1 when the land use mix is more balanced (i.e. when the residentially zoned surface and the non-residentially zoned surface are similar).

Either residentially zoned surface > non-residentially zoned surface =>
Harmonized Diversity of Uses Indicator Value = Initial Diversity of Uses Indicator Value

Or residentially zoned surface < non-residentially zoned surface =>
Harmonized Diversity of Uses Indicator Value = 1 / Initial Diversity of Uses Indicator Value

For the provision of public transit options indicator floor value will be 1,340 feet and ceiling value 0 foot. Floor value is set at 1,340 feet which equals 0.25 mile and is generally considered a maximum walking distance. Proportional harmonization will be done applying the following equation:

Harmonized Provision of Public Transit Value =
1 - (Initial Provision of Public Transit Indicator Value / 1340)

For the social inclusiveness indicator, floor value will be 0 percent and ceiling value will be 50 percent. The setting of this ceiling value supposes that 50 percent is a maximum provision of affordable housing that is unlikely to be passed. Proportional harmonization will be done applying the following equation:

Harmonized Social Inclusiveness Indicator Value =
Initial Social Inclusiveness Indicator Value / 50%

For the access to open space indicator floor value will be 1,340 feet and ceiling value 0 foot. Floor value is set at 1,340 feet which equals 0.25 mile and is generally considered a maximum walking distance. Proportional harmonization will be done applying the following equation:

Harmonized Provision of Open Space Indicator Value =
1 - (Initial Provision of Open Space Indicator Value / 1340)

The composite index value will be equal to the average value of the harmonized five indicators. It will be consequently necessarily comprised between 0 and 1. The closer to 1 the value of the composite index is, the "better" the density.

The composite index will also be visualized on the following diagram (Fig 12):

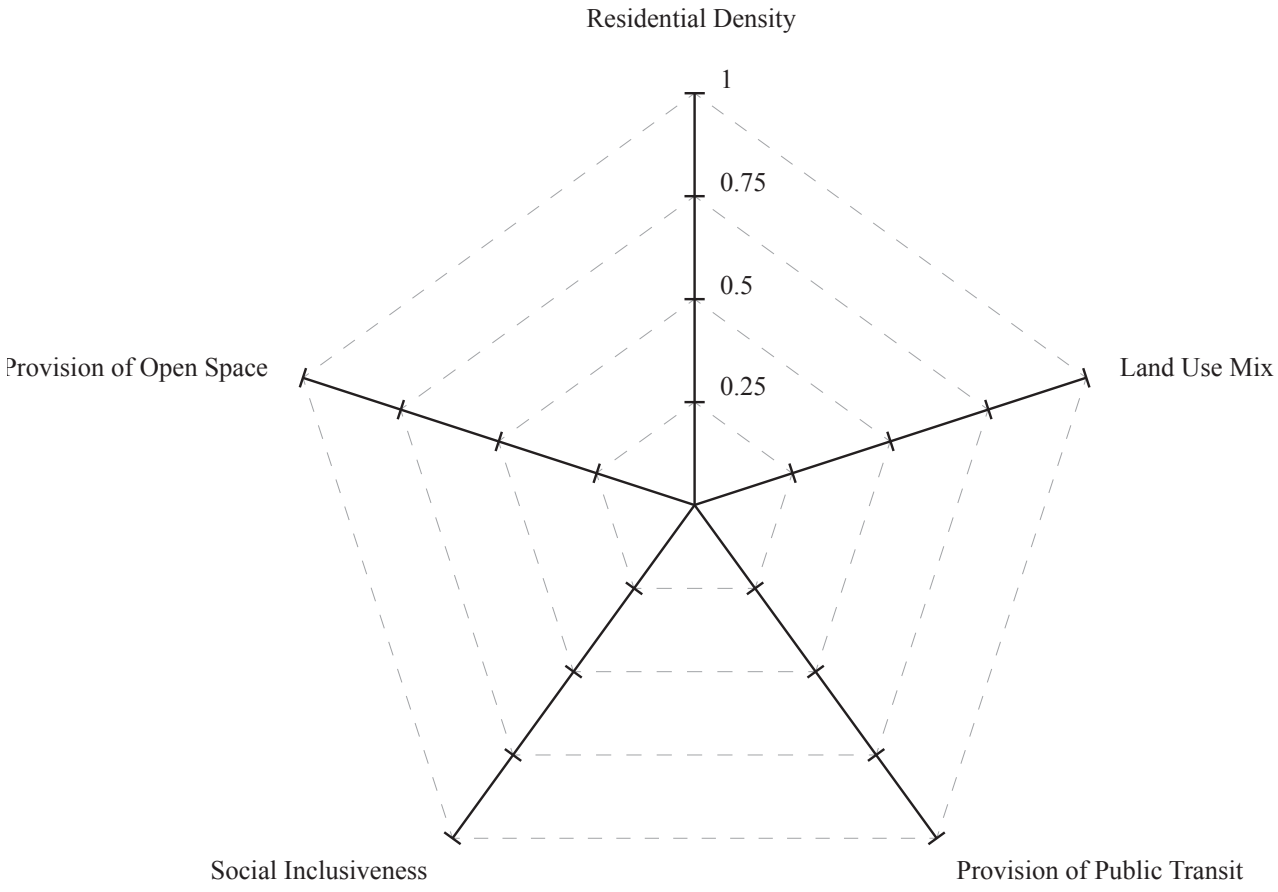

Fig 12: Composite Index Diagram

Application

Our composite density index is defined as the aggregation of the five indicators described above. Taking the work a step further, I intend to confront this modeled index to reality and to apply it to two case studies of dense development. Implementation is expected to provide us with a comprehensive assessment of the considered compact developments. Are they featuring "good" or "bad" density? Performing such an analysis is also aiming to capture differences between compact development strategies, the underlying idea being that differences in density index results are the sign of differently planned and designed dense developments.

To begin with implementation, I carried out extensive research in order to find relevant case studies. I was looking for cities that embraced an ambitious densification agenda over a sufficient period of time so that projects were built and tangible results are assessable. I was also seeking to find cities that implemented densification policies in very different planning contexts, surmising that different approaches to densification would lead to different results in terms of index. I picked two cases of cities that have implemented a city-wide densification strategy:

1. Portland, Oregon
2. Amsterdam, Netherlands

Those two cities appear to be particularly relevant case studies for several reasons. Both cities seem to be pioneers in terms of urban densification strategy. Oregon adopted growth management legislation in 1973 and Portland's Urban Growth Boundary was proposed in 1977 and approved by the state in 1980. The city and its region are well-known for innovative policy initiatives dealing with urban planning, regionalism, growth management, and community development and revitalization. The city-region is served by the only elected metropolitan government in the United States. That government, Metro, has authority to structure regional spatial planning and also administers the Urban Growth Boundary to maintain compact and efficient urban form. In Portland, densification issues are addressed at a metropolitan level through the Regional Framework Plan which was adopted in 1997 and amended in 2005. At a local level, each jurisdiction has to adopt an Urban Growth Management Functional Plan that complies with the Regional Framework Plan and deal with the actual implementation of the metropolitan densification strategy.

Urban growth management and planning have a long tradition in The Netherlands. For 30 years, national spatial planning policies were aimed at implementing denser urbanization in various forms as the compact city was elevated to a national planning strategy in The Netherlands in 1988 in the Fourth Report on Physical Planning. The objective was to protect valuable open space in the existing cities' surroundings and locate new development to minimize transport needs, through urban infill or, where greenfield urbanization was necessary, immediately adjacent to existing settlement areas. Amsterdam Metropolitan Region's planning is guided by the Amsterdam Structure Plan 2003-2010.

Furthermore, they are comparable in terms of size and wealth. Portland Metro Region has a population of 1,728,438 people in 2009 (Population inside Metro 1980-2009, Metro), while Amsterdam Metro Region's population is 2,158,592 (iamamsterdam.com, facts and figures). The two cities are situated in western developed countries featuring sensibly similar levels of wealth as Oregon GDP per capita

is $44,447 in 2010 (US Department of Commerce, Bureau of Economic Statistics) and Netherlands GDP per capita is $47,159 (World Bank, World Development Indicators).

Within each of the cities, I chose a study area on which to perform my density index analysis. I selected neighborhoods which were slated for accommodating dense developments. I was especially searching for areas which were densified over the last 10 to 20 years in a view to assess completed developments and to see how city-wide compaction strategies impacted local development projects. My research led me to pick the Portland Central Waterfront renewal and Amsterdam IJBurg projects as case studies.

Portland Central Waterfront Urban Renewal

Established in 1974, the Downtown Waterfront is Portland's oldest operational urban renewal area. From 1973 to 1979, when Neil Goldschmidt was Mayor, the city initiated or completed numerous planning and development projects that did much to define Portland's character around vibrant neighborhoods and a thriving downtown. Intertwined with this vision for the city, was a new view of urban renewal. The Downtown Waterfront Urban Renewal District encompasses more than 250 acres of the center city from Union Station to the Marquam Bridge (see Figure 13). Downtown's deteriorated conditions were described by Barbara Bennet, secretary at Centennial Mills, Inc. located along Front Avenue in 1964, "The pavement is in unbearable condition-my poor car-the approaches are almost impassable due to trains, there is a tremendous amount of traffic at commuting hours, and besides all of this, there is no bus service in case we can't drive." (Wollner et al., 2003, 18). Responding to congested traffic arteries and inadequate public transportation, urban renewal dollars funded projects and leveraged additional private and public dollars for an array of projects that addressed the coherent themes of turning the area in a strong downtown core.

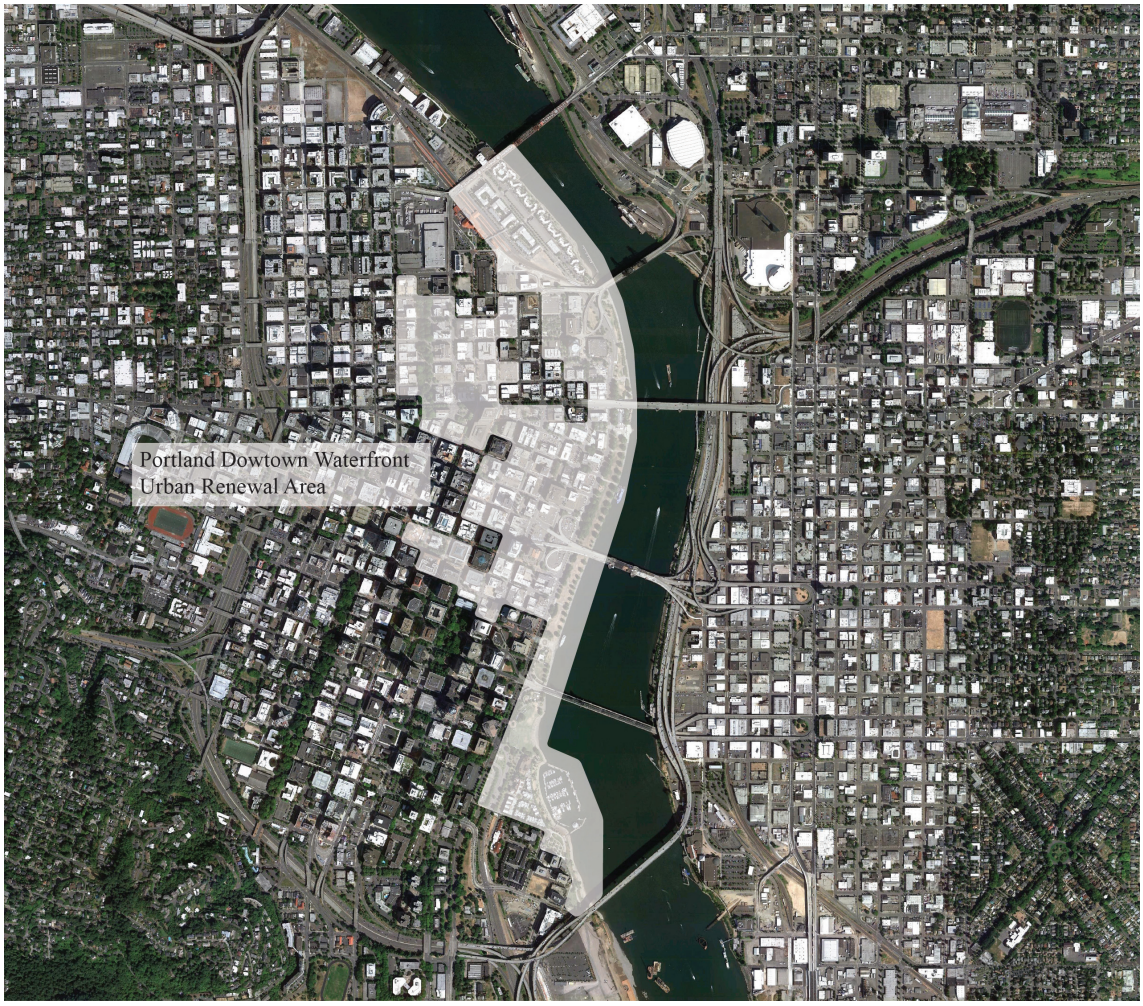

Fig 13: Portland Downtown Waterfront Urban Renewal Area, satellite view

The Downtown Waterfront Urban Renewal District's goals were multiple (Portland Development Commission, 2004, 4):

- Supporting development of a high-density retail/office core by providing pedestrian facilities and convenient short-term parking, thereby reducing traffic congestion.
- Helping ensure sufficient transportation facilities, including transit and street improvements, to maintain the Area's accessibility to the region and its ability to accommodate growth.
- Stimulate private conservation, rehabilitation and development both within and adjacent to the Area.
- Maintaining existing low-income housing and promote additional new housing serving mixed income groups.
- Eliminate blighted and deteriorated structures not suitable for rehabilitation.
- Develop Waterfront Park between the Marquam and Steel bridges as a major public open space and provide pedestrian connections to downtown.

The Portland Downtown Waterfront Urban Renewal approach to development appears to be holistic and, for that matter, is an interesting dense development case study.

Fig 14: Downtown Portland, aerial view

Over 30 years, more than 250 projects and programs were approved and implemented. Among many projects created in the district, urban renewal dollars supported new public open space in the construction of Pioneer Courthouse Square and development of the former Harbor Drive into the Governor Tom McCall Waterfront Park which allowed public access and family events along the west side of the Willamette River. Support also went to new development in the South Waterfront, called RiverPlace. The project included a mix of new housing, retail and office uses, a marina, hotel and fitness center and helped reclaim a former industrial area along the Willamette Riverfront. The Pioneer Place Project in the district is a significant example of PDC's focus on a strong downtown core. The project was designed to respond to a need to revitalize the downtown in a systemic way by creating a critical mass of customers in the area.

Businesses were reluctant to locate in the downtown because of the lack of services for customers and employees, and service businesses would not locate downtown because of a lack of customers. Other major projects included mass transit facilities, such as the expansion of the transit mall and improvements to Union Station. Additional money went into Historic Restoration Loans and Historic District improvements and Multi-Family Housing Rehabilitation and Downtown Housing Preservation for low-income and special needs housing. The district generated a $618 million increase in assessed value since its formation. (Wollner et al., 2003, 19)

Since its creation, urban renewal has leveraged investments which have strengthened Downtown Portland's role as the dense regional center for finance, trade, education, culture, retail, professional and governmental services. It is claimed to have contributed to maintain and improve a livable, economically viable, and well-planned Central City which is "critical to Portland's standing among elite mid-sized American cities." (Chair's Letter Central City Urban Renewal Review Committee, 2004, 1)

Fig 15: Downtown Portland waterfront and the Hawthorne Bridge

Amsterdam IJburg

East of Amsterdam, a new urban district has risen up on seven artificial islands of dredged sand in Amsterdam's IJmeer: IJburg. The creation of IJburg began more than a decade ago and its first wave of pioneering inhabitants has been living there for 11 years. In 1996, the city council gave its approval for the development of the area. The future archipelago was gradually constructed on the basis of an overall urban design scheme by the urban planners Palmboom & Van den Bout and should ultimately cover an area of more than 400 hectares (see Figure 16). In 2001, the first building was completed on Haveneiland West. In 2005, the IJ Tram came into service and in the summer of 2006 the bridge Nesciobrug, the new cycle and pedestrian bridge that connects IJburg with the district of Oost-Watergraafsmeer, was officially opened. It is now one of Amsterdam's most popular quarters, home to 12,800 people that represent no fewer than 102 nationalities (http://www.amsterdam.nl/@496686/pagina/, 2009).

The development of IJburg was divided into two phases. The first phase of IJburg included the construction of about 9,000 dwellings on the Haveneiland (Harbor Island), the Steigereiland (Jetty Island), and the Rieteilanden (Reed Islands). Today, these three islands are almost fully developed and cover and area of 195 hectares (482 hectares). Slightly delayed, the second phase started in 2011 and plans the construction of a further 9,000 dwellings on three different islands, Middeneiland (Middle Island), Strandeiland (Beach Island), and Buiteneiland (Outer Island). Eventually, all islands will intersect on Centrum island, which, as a 'neutral' pivot point, will link the first and second phases of the IJburg development. This island will also be the location for the link road from the A1 and A9 highways, the eastern access to the new district. In this way, the island will function as a central node for all of IJburg and will be the obvious location for the district's most important amenities. Ultimately, the development is to create in 18,000 homes and a total floor surface area of 213,000 m2 for functions and amenities.

IJburg plan's approach to compact development is comprehensive and, for that matter, appears to be an interesting dense development case study. First of all, high residential density is stipulated as a major goal for the development. "In the plan for IJburg, the street is the agent of urbanity, and density an indispensable ingredient.

Fig 16: Amsterdam IJburg, satellite view

With sixty dwellings per hectare the density will be twice that of the average new suburban development." (Ibelins, 2002, 114). Land resources for building new housing within the City of Amsterdam are limited. Urban planners tasked with meeting the increasing housing demand have found a solution in creating artificial islands close to the existing city center. Thus, IJburg can be considered an innovative densification process from a city-wide perspective, as it is increasing housing provision within Amsterdam's existing boundaries.

IJburg plan is a direct result of a country-wide compact development strategy. In the 1990s, a plan that had been drawn up in the 1980s for 'Nieuw Oost' ('New East') was turned into a scheme for a VINEX district in the IJburg area (http://www.ijburg.nl/english, 2012). The concept of IJburg is based on the so-called VINEX policy, which focuses on building dense and concentrated city extensions in the Randstad in order prevent sprawl and preserve the countryside The Netherlands has left. IJburg plan takes VINEX policy one step further. It aims to provide an abundance of different apartment and housing types, in contrast to the one-sided offering of single family housing in most VINEX locations. Interestingly, IJburg has been set-up as an independent city extension, with its own facilities for working, shopping and recreation. IJburg development comes with an important transportation scheme. A new tram line (route 26) was built especially to serve the new urban area. It opened in 2005 and connects IJburg to Amsterdam's central station in less than 15 minutes. It is the city's most modern tram line, and the only one to allow non-folding bicycles on board.

Fig 17: Haveneiland

Ijburg set ambitious goals for social inclusion. In addition to meeting the demand for market rate housing, Ijburg plan keeps aside 30% of the housing units for social housing (Van der Linden, 2004, 14)).

Fig 18: Rieteilanden

Planners mixed the social housing, rental units and homes for sale throughout the development. It's common to find all three types of housing in the same building, with little differentiation between them.

Findings

The last part of my work presents the results obtained by applying the density composite index defined earlier in our two selected study areas: Portland Downtown Waterfront Urban Renewal Area and Amsterdam IJburg.

Portland Downtown Waterfront Urban Renewal Area

1. Residential Density

Residential density is measured in residents per acre. Population counts used to calculate this indicator come from 2010 US Census data. Through a GIS analysis on the Portland Downtown Waterfront Urban Renewal Area, the overall population for the area is 4,464 inhabitants within a 252-acre area. Residential density in the Portland Downtown Waterfront Urban Renewal Area is 17.71 residents per acre.

2. Diversity of uses

The land uses' diversity in the area is assessed thanks to a land use mix ratio. Land use surfaces are calculated through a GIS analysis of Portland zoning maps. Portland Downtown Waterfront Urban Renewal Area is covered by two different types of zoning: RX Central Residential zoning and CX Central Commercial zoning.

The RX Central Residential zone is a "high density multi-dwelling zone which allows the highest density of dwelling units of the residential zones. Density is not regulated by a maximum number of units per acre." (Portland Bureau of Planning and Sustainability Zoning summaries, Multi-Dwelling Residential Zones). The size of buildings and intensity of use are regulated by floor area ratio (FAR) limits and other site development standards. Generally the density is 100 or more units per acre in these zones. Allowed housing developments are characterized by a very high percentage of building coverage. RX zones are located near the center of the city where transit is readily available and where commercial and employment opportunities are nearby. RX zones are usually applied in combination with the Central City plan district.

The CX Central Commercial zones are "intended to provide for commercial development within Portland's most urban and intense areas. A broad range of uses is allowed to reflect Portland's role as a commercial, cultural and governmental center." (Portland Bureau of Planning and Sustainability Zoning summaries, Commercial Zones). Development in these areas is intended to be very intense with high

building coverage, large buildings, and buildings placed close together. Development is also intended to be pedestrian-oriented with a strong emphasis on a safe and attractive streetscape.

Within Portland Downtown Waterfront Urban Renewal Area the aggregated RX Central Residential zoned surface is 16 acres and the aggregated CX Central Commercial zoned surface is 229 acres. As a result, the land use mix for the area is 17,43.

3. Provision of public transit options

The indicator accounting for the provision of public transport is the average distance of dwelling units to the nearest transit option stopping point. Four different Light Rail lines are running through and around the Portland Downtown Waterfront Urban Renewal Area: the Green line, the Yellow line, the Blue line, and the Red line. They connect the neighborhood to the rest of the metro region and to the airport (Red line). Portland streetcar line is not taken into account in the analysis because of its limited service area. The distance of each inhabited block located within our study area to the nearest light rail stop was found through a GIS analysis of Portland Census 2010 Block Map. The calculated average distance of dwellings units to the nearest transit option stopping point is 485 feet in the Portland Downtown Waterfront Urban Renewal Area.

Fig 19: Max Light Rail in Downtown Portland

4. Diversity of social backgrounds

For the purpose of our density composite index, social inclusiveness is measured as the proportion of affordable housing units located within the area. According to the 2008 Central City Inventory, in Portland Downtown District, 33.4% of the housing stock is affordable (Portland Development Commission, 2008, 11). Even though this figure is calculated for an area encompassing our study area, it is a good approximation of the affordable housing stock in the Downtown Waterfront Urban Renewal Area. All housing affordable to families earning at least 50% Median Family Income is considered affordable in the calculation of this ratio.

5. Access to open space

The indicator accounting for the provision of public transport is the average distance of dwelling units to the nearest public park. Eight different parks were identified within or close to the Portland Downtown Waterfront Urban Renewal Area: North Park Blocks, O'Bryant Square, Pioneer Courthouse Square, Terry Schrunk Plaza, Chapman Square, Ira Keller Fountain, and Governor Tom McCall Waterfront Park. The distance of each inhabited block located within our study area to the nearest of these eight parks was found through a GIS analysis of Portland Census 2010 Block Map.

Fig 20: Governor Tom McCall Waterfront Park

The calculated average distance of dwellings units to the nearest park is 623 feet in the Portland Downtown Waterfront Urban Renewal Area.

Amsterdam IJburg

1. Residential Density

Residential density is measured in residents per acre. Population counts used to calculate this indicator come from population per block data held by the City of Amsterdam Department of Research and Statistics (Gemeente Amsterdam Bureau Onderzoek en Statistiek). According to this data, the overall population for the considered area is 17,294 inhabitants within a 482-acre area. Residential density in IJburg is 35.88 residents per acre.

2. Diversity of uses

The land uses' diversity in the area is assessed thanks to a land use mix ratio. Land use at a block level is determined using Amsterdam zoning maps (plankaart) that are accessible online (http://www.ijburg.nl/main.php?obj_id=196754565) and surfaces are calculated through measures on a CAD file of IJburg held by the City of Amsterdam Department of Population and Geoinformation (Gemeente Amsterdam Dienst Persoons- en Geo-informatie). IJburg area is covered by a broad range of residential zonings (Wi, W2, W3a, W8, W28a, W38b, W39, W104, W108, and WW121) and non-residential zonings (M, M117, C5, B1 B101a). Within IJburg area the aggregated residentially zoned surface is 238,948 square meters and the aggregated non-residentially zoned surface is 115,622 square meters. As a result, the land use mix for the area is 0.48.

3. Provision of public transit options

The indicator accounting for the provision of public transport is the average distance of dwellings units to the nearest transit option stopping point. IJburg development is articulated around one central light rail line (Line 26) which connects the area to Amsterdam Central Station in 15 minutes. The distance of each inhabited block located within our study area to the nearest Line 26 stop was found through measures on a CAD file of IJburg held by the City of Amsterdam Department of Population and Geoinformation (Gemeente Amsterdam Dienst Persoons- en Geo-informatie). The calculated average distance of dwellings units to the nearest transit option stopping point is 748 feet in the considered area of IJburg.

Fig 21: Tram 26 on IJburglaan

4. Social Inclusiveness

For the purpose of our density composite index, social inclusiveness is measured as the proportion of affordable housing units located within the area. In IJburg, 30% of the housing stock is affordable (de Lange et al., 2009, 13).

5. Access to open space

The indicator accounting for the provision of public transport is the average distance of dwellings units to the nearest public park. Five different parks were identified within or close to the IJburg study area: Diemerpark, Brand Dirk Ochsepark, Ed Pelsterpark, Theo van Goghpark, and Steigerpark. The distance of each inhabited block located within our study area to the nearest of these five parks was found through measures on a CAD of IJburg file held by the City of Amsterdam Department of Population and Geoinformation (Gemeente Amsterdam Dienst Persoons- en Geo-informatie). The calculated average distance of dwellings units to the nearest park is 840 feet in the considered area of IJburg.

The different numbers calculated above are presented in the following table (Figure 22):

	Portland Downtown Waterfront URA	Amsterdam IJburg
Residential Density (residents per acre)	17.70	35.88
Land Use Mix	17.42	0.48
Access to Transit (feet)	485	748
Social Inclusiveness	33%	30%
Access to Open Space (feet)	623	840

Fig 22: Summary Table

The harmonized values of each indicator are shown in the following table (figure 23):

	Portland Downtown Waterfront URA	Amsterdam IJburg
Residential Density (residents per acre)	0.18	0.36
Land Use Mix	0.06	0.48
Access to Transit (feet)	0.64	0.44
Social Inclusiveness	0.66	0.60
Access to Open Space (feet)	0.53	0.37

Fig 23: Composite Index Table

Results are visualized on the following diagram (Fig 24):

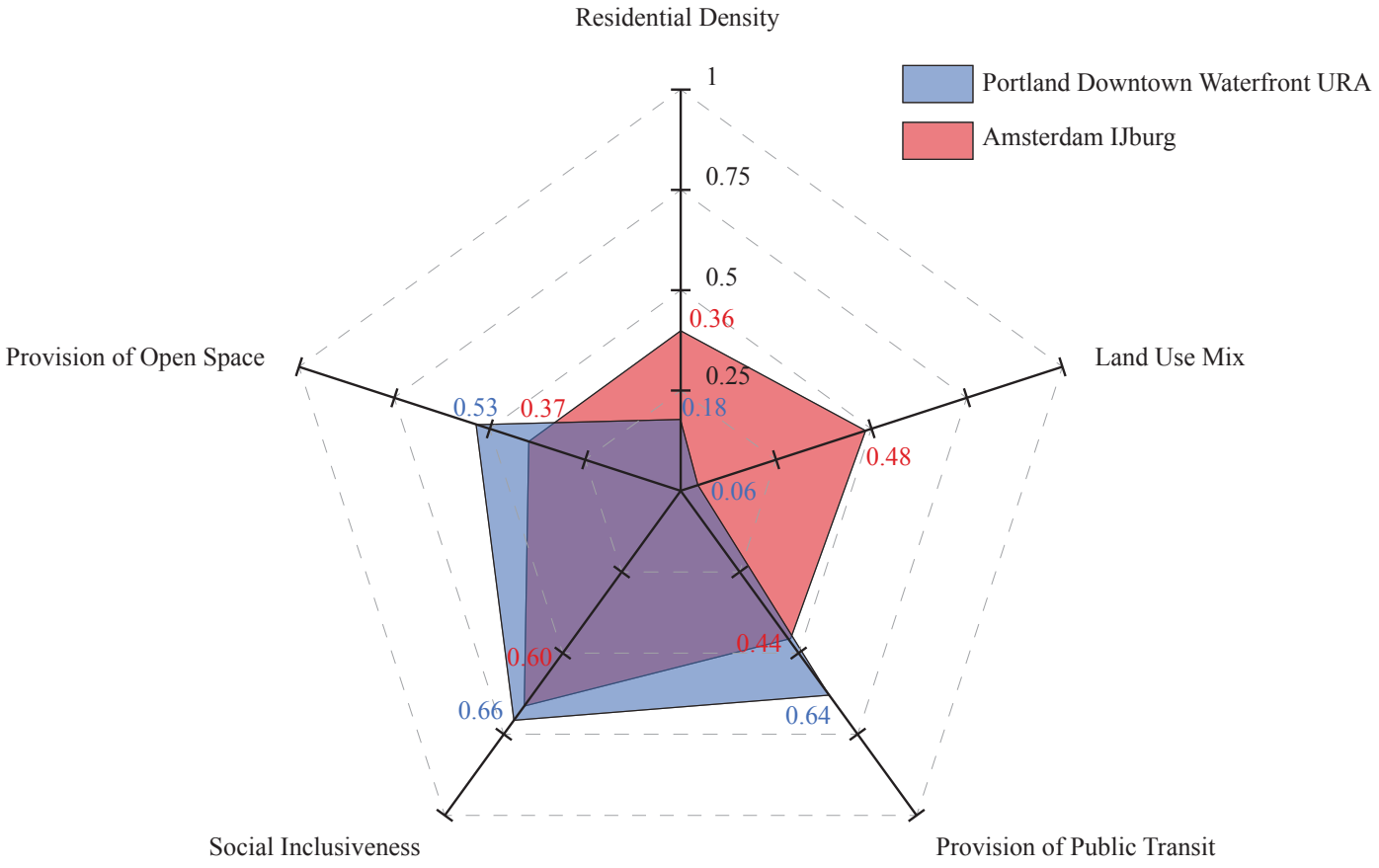

Fig 24: Amsterdam IJburg and Portland Dowtown Waterfront URA Composite Index Diagram

Conclusions & Recommendations

The first conclusion that can be drawn from this work is that the alleged economic, social, and environmental advantages of urban density can be effectively achieved only if integrated in a global approach to compact development. Suitable densification is a complex and multidimensinal process, It means a broad reinforcement of the urban offer, for a more diverse, active, and attractive city and not a sheer quantitative increase of residents or jobs in a limited area. Such an approach is especially important in a current context where density is simultaneously widely praised and feared. Planners and elected officials have to look at density holistically.

Secondly, this work proposes a comprehensive framework to assess density. It started with identifying five overarching goals pursued through dense development: environmental sustainability, cost-effectiveness, social equity, health, and place-making. Then, it made clear that urban density would achieve these goals only under a few conditions. Therefore five necessary components of successful urban density are defined: (1) residential density, (2) mix of use, (3) access to public transit, (4) social diversity, and (5) access to open space. For each goalof urban density, a set of necessary conditions is exposed (Fig 25).

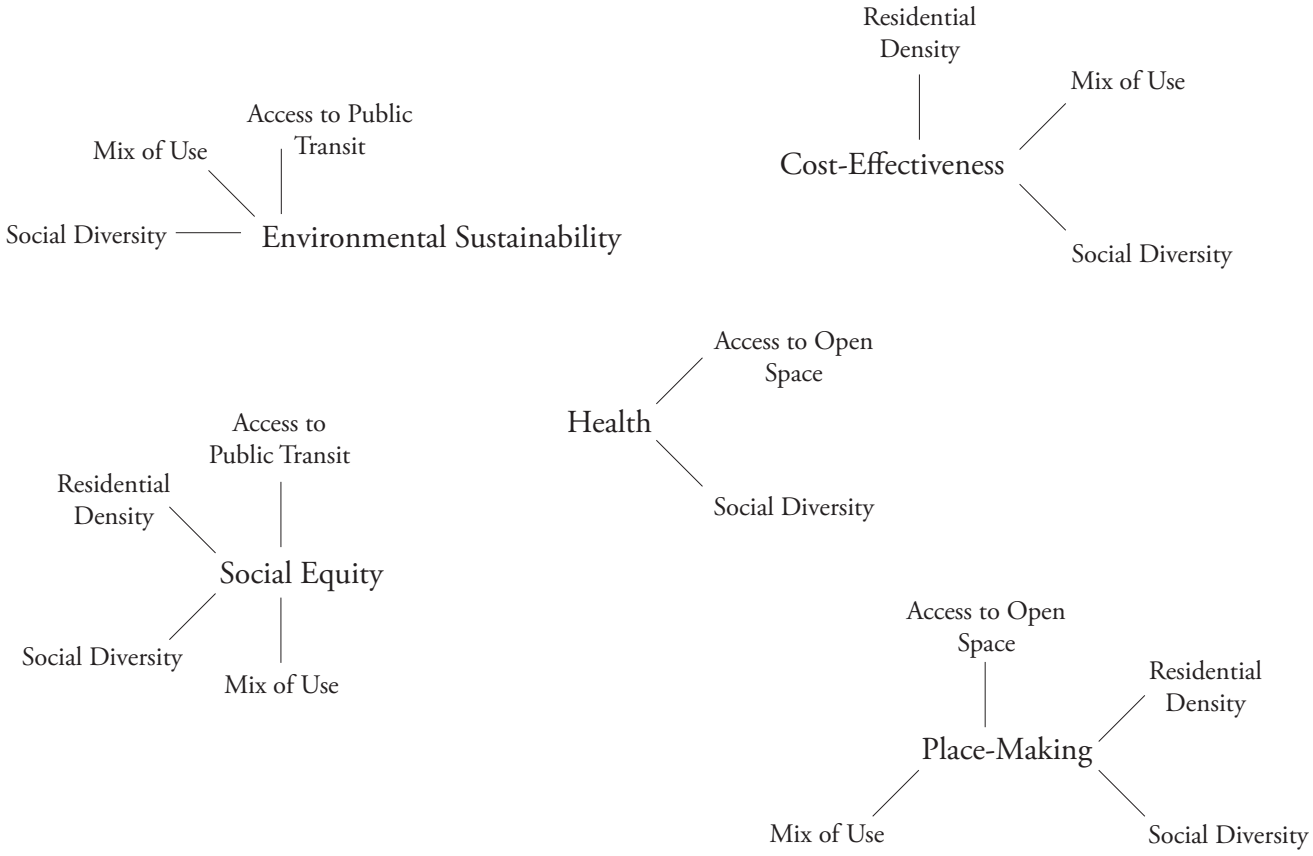

Fig 25: Goals pursued through dense development and their necessary conditions

For each of these components a key performance indicator is set: (1) gross density measure, (2) zoned mix of uses, (3) average distance of residents to the nearest transit option stopping point, (4) proportion of affordable housing units, and (5) average distance of residents to the nearest public park. It results in the creation of a balanced scorecard for urban density (Fig 26).

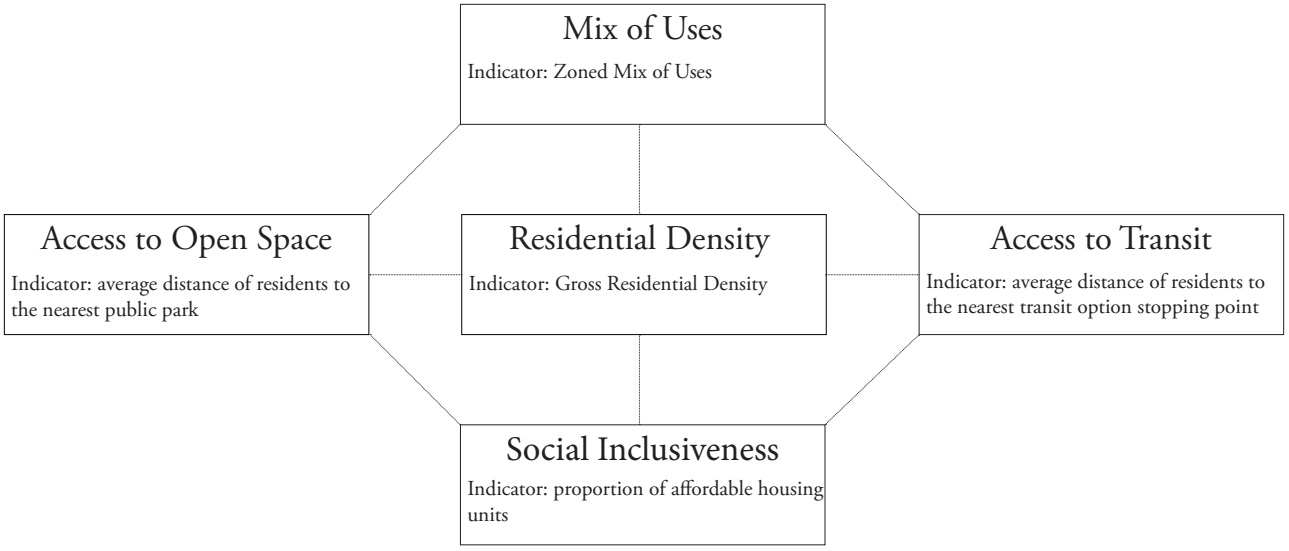

Fig 26: Urban density balanced scorecard

Those five indicators are eventually aggregated in a composite index describing the density quality of the studied area. Even though the choice of the indicators is debatable, such a methodology is interesting as it compiles in one figure different dimensions of urban density. If densification occurs while leaving out an essential aspect of urbanity, it is immediately reflected in a lower index score.

This methodology is an efficient tool to assess the suitability of past compact development projects as well as to set goals for future densification initiatives. In other words, it can help planners understand existing density and plan future densification. By comparing the evolution of the index score for a given area over time (Fig 27), it provides decision-makers with a simple indication whether or not planning urban policies are contributing to a complete urban intensification.

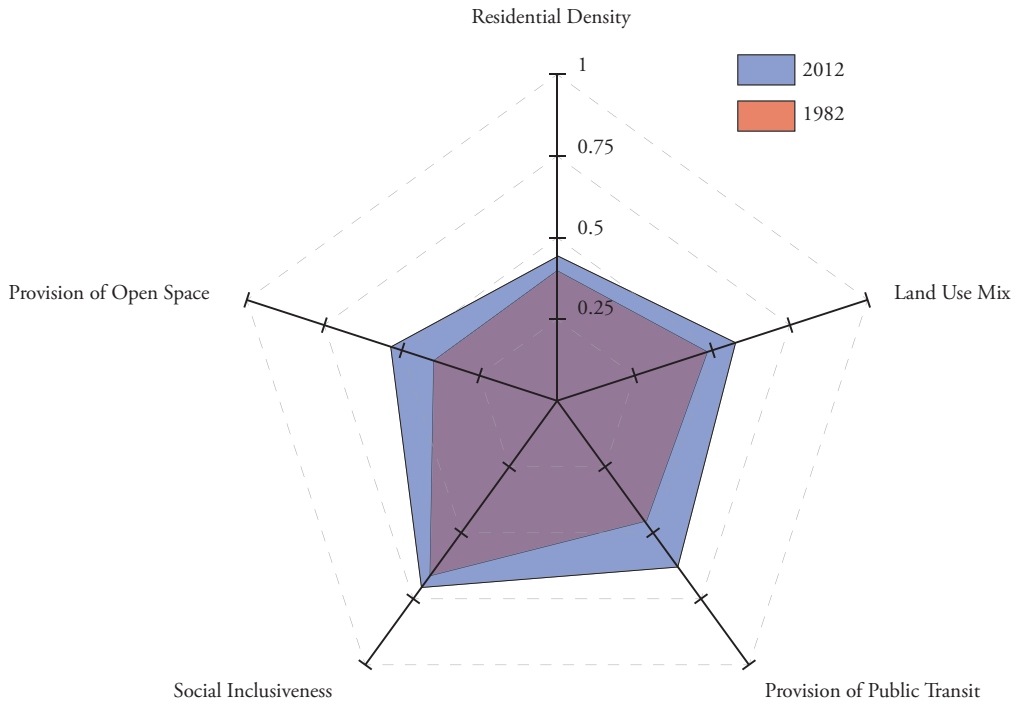

Fig 27: Composite index diagram used to assess density evolution in an area over time (example)

The interest of such a composite index also lies in the fact that it makes the comparison of density in several areas possible and straightforward. Through our calculation of the composite index for Portland Downtown Waterfront Urban Renewal Area and Amsterdam IJburg, significant differences between both areas appear immediately. Those differences describe the results of differing political and regulatory choices, especially regarding land use. Thanks to its systematic approach to density, the process is easily replicable to multiple areas. Applying our methodology to a large number of case studies would allow participating cities to understand where they stand on density before embracing densification (Fig 28).

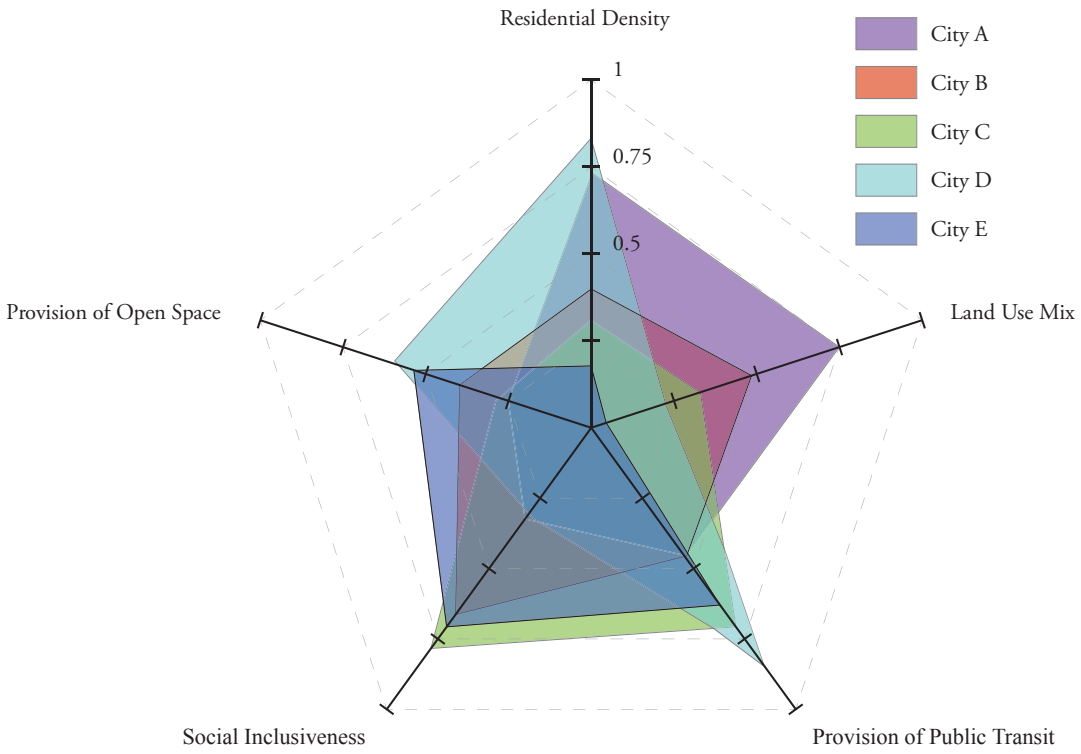

Fig 28: Composite index diagram used to assess density evolution in a larger number of cities (examples)

The proposed methodology is eventually interesting in terms of visual communication. A diagram representation of the composite index allows an immediate understanding of the strengths and weaknesses of a densification strategy. Such a representation could help planners communicating about this complex phenomenon. It seems that such visualization is missing in the way achievements of densification projects are communicated today. It is all the more needed that efficient visual communication is highly influential in overcoming misconceptions and enhancing acceptance of density by communities. The diagrammatic representation of the composite index makes apparent trade-offs that have been made in the planning of densification. For instance, a densification that prioritizes residential density, land use mix, and provision of public transit, leaving out social inclusiveness and provision of open space might achieve a good overall index score. However, such an imbalance will appear immediatly in the diagrammatic representation.

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