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Role of Urban Planning Standards in Improving Lifestyle in a Sustainable System

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Abstract: The current study aims to propose urban planning standards and urban sustainability transitions to improve the living quality in a sustainable residential area. The planning of urban standards plays a vital role in improving the quality of living in any city. We present the intensity of land exploitation per inhabitant and the social infrastructure to determine a reasonable relationship between the housing development and the green spaces, type of services and indicators by considering the minimum requirement in establishing new sustainable systems and infrastructures. The research provides an in-depth analysis of urbanization developments through various indicators and addresses the exploitation of land use and the future of neighborhoods. New indicators have been developed, which include: the demographic indicators of demand for basic educational infrastructure depending on the current forecast; indicators to determine the exact space required for new infrastructure; academic indicators for each age group (i.e., nursery, preschool, junior and senior); and the minimum required urban green spaces (i.e., public parks, recreational areas and housing developments). The paper compares the proposed required areas and the standard area requirement according to the number of residents per hectare. It also considers the weighted average number of stories to the shared area in a plot. The research also develops a relationship between the proposed development intensity and the percentage share in the plot area, which provides the built-up area and the green area with leisure facilities. Then, we present the share in the plot area, calculated according to current indicators.

Keywords: urban sustainability transitions; urban planning standards; urban infrastructure synergies; planning practices; urban and regional planning

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1. Introduction

Over the past few decades, the non-use of urban planning in Saudi Arabia and the need and legitimacy of its application were negated. The environment of architects and urban planners unanimously admits that: "the lack of appropriate parameters defining spatial health and social minimums causes' abuse—construction of residential complexes without access to public transport, schools, kindergartens, greenery and sport" [1–3]. Residential houses are built under excessive constraints and often in harmful neighborhoods. Appropriate living conditions (i.e., both health and social) should be provided through the obligatory application of standards containing functional, cultural and ecological aspects [4–6].

Urban standards should contain principles and parameters of development which should follow the principles of sustainable development. They should be respected when formulating spatial policies, development strategies, land use and investment plans, as well as financial plans. A growing city poses new challenges for residents and urban planning. Densification and re-creation from living quarters, jobs and social infrastructure facilities form only a selection of tasks. The future of urban planning in growing cities must be dealt with [7–9].

Experience shows that urban growth processes demand tribute. Green and open spaces are proposed in new residential or industrial complexes. Undeveloped surfaces are experienced because of potential housing use without considering green spaces and urban planning. The uneven and unplanned designs create many issues, including low air quality, poor living standards and many health issues for the city dwellers. The resident population is expanding, which requires further development and urbanity. Improving the quality of life demands additional living standards, which is the main focus of the proposed research work. It can be achieved by establishing 50% of green areas within the city's development rather than making other unnecessary changes. Many studies have suggested open and green spaces in the city to enhance its development and improve air quality with good living standards [10–12].

Researchers partially or entirely plan the space in which we live. Space which is fully planned and designed is the city (urban space). Spatial planning concerns decision-making with regard to the shape and composition of space. Many research studies have been conducted over the centuries concerning the rules of architectural composition. Much attention has been paid to city planning, and model city models have subsequently been created (chessboard, geometric, centric). The third dimension, spatial composition, influences the experience of the participants most clearly within a designed space. The basis for designing a city composition should be multi-faceted knowledge of man, his perceptual and behavioral conditions and his mental predispositions. Thus, an architect shaping the spatial composition in the city, including the composition of greenery, should, through their decisions, consciously create opportunities for the implementation of needs and human goals [13–16].

Properly shaped and placed green plantings can emphasize the developed architecture. It provides a beautiful background for the local dwellers, which obtains the direct attention of visitors and residents. Undoubtedly, the development of such urban layouts can also be slightly expressive but interesting. Such layouts with proper green spaces/areas can emphasize the vicinity values and mitigate the effects of incorrect urban planning solutions [13,15]. With the help of varying forms of green areas, one can "repair" urban space, affect its perception and improve both the physical and psychological comfort of residing within it [17–23]. This research contributes well to developing the green areas within residential places by considering basic service indicators (i.e., public services, educational and care-upbringing). The following are the important points recommended in the proposed research:

- Developing standards for public services, educational and care-upbringing;
- Access to public green areas, leisure and sports;
- Percentage share of greenery in the residential investment area;
- Determination of optimal relations between the intensity of development (also related to population density) and the share of built-up and green areas.

2. Background

Metropolitan areas and rural neighborhoods are considered the forefront of sustainability [1,2]. They are considered to be the more crucial points over ecological, socio-economic, and urban standards, with novel ideas for sustainability evolutions [3]. In this regard, creating standards for improving the urban lifestyle is a good transition toward sustainability. Planning of such standards also improves the previous developments through novel ideas and techniques [4]. Accordingly, sustainable urban planning standards are decisive, universal, long-term, and vision-led alterations toward sustainability. They can be assumed as goal-oriented procedures designed to attain sustainable targets in a multifaceted set of urban planning, technologies, organizations, arcades, and establishments [2,5,6].

The major benefit of urban planning is improving the health and living standards of city dwellers. A model well-designed city increases the probability of attracting newcomers, making it easy to approach the necessities. It also impacts social well-being and enhances the country's economy [24–26]. Such standards include good exposure to nature, which

can improve the attention of residents and diminish the stress rate and disorder among children [10,15,27]. The other benefits of urban planning are that it provides good transit systems, footpaths, green areas and proper residences [28,29].

Although the concept of a structural housing unit in the theory of spatial planning is defined as to "separate the layout of the residential development with the corresponding program of basic service equipment, rest and communication located within walking distance of up to 500 m" [2], in practice, there are rarely complex projects of a similar spatial scale. Undoubtedly, the residents have the right to expect schools, kindergartens and other educational centers to operate near their residence, as well as health, commercial and service complexes and sports and recreational facilities. Designers of local zoning plans need such zoning elements to be included in the functional and spatial structure of residential areas. It may not be the case for discretionary but mandatory requirements.

2.1. Urban Standards in Residential Areas

Urban planning standards should, in particular, secure access to public service infrastructure, specifying the program indicators concerning the number of inhabitants and the rules for distributing service facilities [26–28]. The determination method is shown below as urban planning indicators for educational infrastructure, which are recommended for use in the near term. It is based on analyzing the demographic forecast for cities (Jeddah and Alkharj) until 2035 (see Table 1). On its basis, a percentage is given for the supposed educational age groups of the population. The forecast shows that in the next few years, the participation of children aged 0–2 years in the nursery will be at a level not exceeding 3%, preschool children (3–6 years old)—4%, younger school children (7–12 years old)—6%, and lower secondary school children (13–15 years old)—3%.

Table 1. City population forecast until 2035 by educational age groups.

	Population in City (Thousands)	**Number and Percentage of the Population of Individual Age Groups in the Range of 0–15 Years**								
		0–2 Years		**3–6 Years**		**7–12 Years**		**13–15 Years**		**0–15 Years**
		Number	**%**	**Number**	**%**	**Number**	**%**	**Number**	**%**	**%**
2009	23,200.4	6915	3	8253	3.6	12,235	5.3	7067	3.0	14.9
2010	23,145.5	7041	3	8501	3.7	12,001	5.2	6727	2.9	14.8
2015	22,897.7	7008	3.1	9438	4.1	12,519	5.5	5856	2.6	15.2
2020	22,649.7	6398	2.8	918	4.1	13,881	6.1	6274	2.8	15.8
2025	22,299.0	5568	2.5	8256	3.7	13,558	6.1	6932	3.1	15.4
2030	21,799.5	4941	2.3	7187	3.3	12,220	5.6	6696	3.1	14.2
2035	21,215.1	479	2.3	6524	3.1	10,658	5.0	5983	2.8	13.2

The next step is to consider the percentage of children from a given age group using care and educational services (Table 2, line 3). It is assumed that 10% will attend nurseries, 75% of 3–6 year olds will attend kindergartens, and all children aged 7–15 will be in primary and lower secondary schools. Indicators obtained with these assumptions (Table 2, line 4) justify the wording of the following recommendations:

- When preparing spatial development plans for residential areas, the following should be taken into account: nurseries for 0.3% of the number of residents, kindergartens for 3% of residents, primary schools for not less than 6% and junior high schools for not less than 3% of the population.
- At the same time, it is stipulated that the rate of demand for places in kindergartens will increase to 4%, if the care of upbringing and education of children aged 3–6 years old is given importance. It is worth noting that the currently recommended indicators of demand for care and educational services significantly differ from the values in the previous standard (Table 2, line 5) [28–31].

Table 2. Estimating the demand for care and educational services based on the analysis of demographic forecasts of the urban population by 2030.

		Type of Educational and Upbringing Services			
		Nursery	**Kindergarten**	**Primary School**	**Junior High School**
1	Age range	0–2 years	3–6 years	7–12 years	13–15 years
2	Age group share in the structure population	3%	4%	6%	3%
3	% of the age group of users from services	10%	75%	100%	100%
4	% of the number of inhabitants for whom places should be provided in facilities	0.3%	3%	6%	3%
5	Comparative data from urban planning [28–31]	0.75–1.5%	4.5%	12% (7–14 years)	

The table below shows that 1/3 of the services are lower than the population. This is the effect of demographic changes, generally referred to as the "aging of society", consisting of a decrease in the population's share of children and youth in the population and increased participation of older people. The immediate reasons for these changes are the decrease in growth, natural birth rate, reduction in family fertility and a longer duration of human life.

2.2. Urban Standards in Landscaped Green Areas, Sports and Recreation

Green spaces are an essential ingredient structure of the city and one of the main factors influencing the quality of the housing environment. It is about greenery's ecological, health and aesthetic value and its functional significance. These areas, recreation places, are increasingly appreciated in modern society. Proximity to public parks, leisure areas, and sports facilities affects the location's attractiveness and raises its market value of housing investments.

The urban planning standards presented very good grounds for securing an adequate area of green spaces. In the net areas of multi-family housing, it was necessary to provide an area of recreational greenery with playgrounds for the youngest children, at least 8 m^2 per one inhabitant. The total area designated for leisure and insulation greenery should not be less than 50% of the net area. In addition, within the gross area, the access radius should not exceed 300 m. A garden has to be provided for children with an area of 0.75–1.2 hectares (i.e., in justified cases near the school) and within a radius of access not greater than 500 m. Public recreation spaces with a calculated area according to the indicator of 5.5 m^2 per one inhabitant in the form of leisure gardens (4 m^2/inhabitant) and complexes of sports fields (1.5 m^2 per capita).

In addition, the normative stipulated that as part of a complex of structural housing units, secondary leisure facilities of 5 m^2 should be designed per inhabitant, of which 1.2 m^2 is intended for public sports facilities. Such a complex, available within a radius of 800 m, should include a recreational park with an area of 2 hectares, a complex of sports fields with an area of at least 2.5 hectares, a sports hall (0.3–0.5 hectares) and an indoor swimming pool (0.2–0.4 hectares). The given indicators did not include areas for qualified sports facilities and entertainment devices that were the subject of general arrangements. In total, it was at least 25–30 m^2 (i.e., depending on the type of development) of greenery and recreational areas per resident in the access isochrones which are not more than 800 m.

Although the literature is scarce with regard to the standards, the available literature in [27–29] receives much attention regarding arrangements for open areas. Unfortunately, it has not been fully exploited in practice with respect to created opportunities. In previous decades, when the housing estates were designed according to the given standards, the priority was the implementation of residential buildings, followed by schools, kindergartens and service and commercial centers. Properly arranging the areas intended for housing estate parks and sports complexes has always lacked funds. Therefore, the undeveloped land was often used for other commercial purposes.

Currently, no central regulations oblige designers of local plans to ensure generally accessible green and recreational spaces within housing estate structures (i.e., in Jeddah and Alkharj). The applicable law applies only to the area covered by the investment (i.e., can be defined as the net area), establishing that the minimum 25% of its area should be a biologically active surface unless the local spatial development plan provides a different percentage. Furthermore, not only is the native soil considered a biologically active surface, but also 50% of the green slabs above garages.

The consequence of such a legal state is a drastic reduction in the quality of the housing environment because only green spaces are being developed in a fragmented form near buildings, and their areas are limited to the necessary minimum. On the other hand, housing estates lack concentrated green, recreation and sports complexes, which have a much greater value in practical, ecological and health-promoting standards.

The view on the superiority of the concentration of these functions is not new. By the 90s, it was already believed that at least 50% of the greenery in an estate should be designed to form a compact surface of more than 1000 m^2, with a minimum width of 20 m. A similar opinion is held by the authors of [28–31], according to whom greenery in gross areas should be solved as a compact spatial area. The regulations of other countries sanction the need for larger recreational areas. Some standards predict in teams of larger than 50 family apartments, open areas of approximately 2 hectares per 1000 inhabitants (which provides 20 m^2/inhabitant). It was decided that it would be better to concentrate green spaces and leisure areas while maintaining the pedestrian access isochrones a maximum of 1/4 mile than distracting them. The following are surface indicators for green and recreational areas in most countries, depending on the number of apartments:

- A total of 30 m^2/1 apartment for a community garden;
- A total of 5 m^2/1 apartment for a playground for children from 0 to 5 years, with an area of 60–100 m^2;
- For the number of apartments greater than 50–5 m^2/1 apartment for a playground for children from 5 to 10 years, a minimum area of 250 m^2;
- For more than 75 apartments, an open recreational space with an area of 2 hectares/1000 inhabitants, including 5 m^2/1 apartment with an available sports area for adults.

Assuming that the average population is three residents per one apartment, applying the above indicators results in approximately 30 m^2 of green spaces and recreation per capita.

For comparison, indicators applicable to our neighbor—the Republic of Oman—can also be quoted (Table 3). The standard [32–34] differentiated depending on the size of cities and divided green spaces into general use (of regional and urban importance) and limited use, occurring as part of residential development (outside school plots, kindergartens and nurseries). They show that a minimum of approximately 30 m^2 should be secured in total greenery/one inhabitant. The larger the city, the more green areas are made public, while the indicator for residential areas decreases.

Table 3. Surface indicators for planning green and recreational areas in cities according to construction standards.

The Size of the City, the Number of Residents		Protection of Green Areas in m^2/Inhabitant		
		Built-in Housing	General Use	
			District Mean	Of Urban Significance
1	Over 1,000,000	9–10	8–10	9–11
2	250,000–1,000,000	10–11	7–9	8–10
3	100,000–250,000	11–15	6–8	8–10
4	20,000–100,000	15–20	3–5	6–8

The cited examples and proposed regulations, although utilizing different types of indicators, have some common features:

- Directly or indirectly take into account (referring to the number of apartments) the number of inhabitants and the required area of green, sports and recreational areas which depend on it;
- Give the minimum size of areas (e.g., housing estate parks, children's gardens) while striving to concentrate green areas and prevent their dispersion;
- Introduce hierarchy in the system of green areas associated with appropriate isochrones of pedestrian access;
- Adopt a similar summary requirements area—about 30 m^2/one inhabitant.

3. Materials and Methods

The present research was conducted in Jeddah and Alkharj cities of Saudi Arabia. The data were analyzed in the Department of Civil Engineering, College of Engineering, Prince Sattam bin Abdulaziz University, and Landscape Architecture Department, Faculty of Architecture and Planning, King Abdulaziz University, Saudi Arabia. The map of the investigation area is shown in Figure 1.

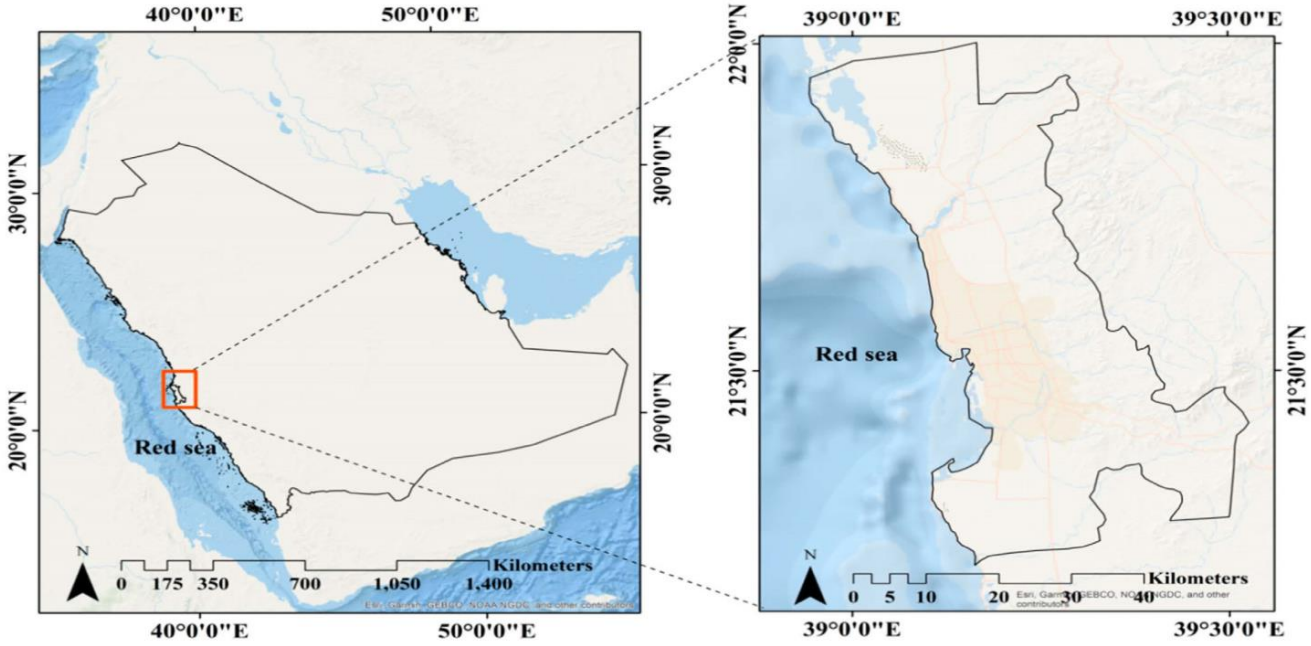

Figure 1. Map of the location of the research area.

The following are the proposed obligatory indicators and urban planning standards in the field of generally accessible (public) green areas, leisure and sports:

- In residential areas, planning is required for generally accessible greenery, recreational and sports areas with an area of no less than 2 hectares (ha). Areas with a basic program (greenery, playgrounds and sports fields for team games) should be within reach, with a pedestrian distance maximum of 500 m. Areas with a secondary program (sports and recreational complexes with a sports hall, indoor swimming pool, a complex of sports fields and a park) should be available within a radius of up to 1000 m.
- The area of generally accessible green areas (with playgrounds and sports games) should be estimated according to the minimum indicator of 8 m^2/inhabitant, and the area of common sports areas with a minimum of 4 m^2/inhabitant.

Proposed mandatory green indicators of housing estates on the area of a building plot for multi-family housing:

- The area of estate greenery (including playgrounds) cannot be smaller than the biologically active area required in the planning arrangements. It should be no less than 25% of the plot area.
- The area of estate greenery should be estimated according to the indicator of 8 m^2 per 1 inhabitant, which can be reduced by 50% in the downtown area.

3.1. Infrastructure Planning and Education Building: Urban Indicators and Standards

Recommended program and area metrics for basic infrastructure planning on education and upbringing are presented in Table 4. It considers the recommendations suggested by specialists: the capacity of the facility (line 2, in Table 4) and the plot size (line 3, in Table 4). Based on these data and the estimated demand for services, various urban indicators can be calculated: the number of inhabitants/facility or plot area of a given service/1 inhabitant (rows 4 and 5, in Table 4).

Table 4. Urban indicators and standards for social infrastructure in care-educational and educational services.

Type of Services / Type of Indicator		Nurseries	Preschool	Basic School	Gymnasiums
1	% of the number of residents using services	0.3%	3%	6%	3%
2	recommended absorbency of the facility	60 children	120 children	500–700 students	300–600 students
3	land area	0.3 hectare	0.4 hectare	1.2–2 hectares	1.2–2 hectares
4	number of inhabitants/1 facility	20,000	4000–5000	10,000	10,000–20,000
5	land area/1 inhabitant	0.15 m^2	0.9 m^2	1.8 m^2	1.0–1.5 m^2
6	recommended maximum pedestrian access radius	1000 m	500 m	500 m800 m *	500 m1000 m *
7	maximum radius of pedestrian access according to the given standards	500 m	500 m	500 m	. . .

* permissible values in areas with low development intensity.

It is very important to define the rules for the distribution of infrastructure in residential areas, depending on the pedestrian access isochrones. The 500 m operating radius required by the previous standard remains the desired, recommended standard. However, one must be aware that it may be impossible to obtain such standards in an area with low building intensity and population density, i.e., in the case of such institutions as primary schools and junior high schools, whose rationality of functioning (minimum number of students) is related to the "service" of over 10,000 inhabitants. In such cases, increasing pedestrian access to isochrones up to 800–1000 m is justified. In some countries, e.g., in the Republic of Belarus, current central regulations adopt the maximum radius of access to schools, 750 m, and kindergartens, 500 m.

The issue of access to isochrones is omitted altogether. The issues of securing access to social infrastructure are reduced to provide indicators of the minimum number of seats that will be provided as part of school services and kindergartens for another 2500 m^2 total area of apartments (Table 5).

Adopting the total area of apartments as a reference category is methodologically questionable, but assuming appropriate housing conditions, i.e., dwelling area per 1 inhabitant, can be used in estimates. A size of 2500 m^2 is most likely equivalent to 75–100 inhabitants (known to the author, it is assumed that the standard of multi-family housing is 25–35 m^2 total area/person). The draft correctly proposes two values of the indicator, but wrongly proposes this indicator, whereby the same group includes single-family and low-rise multi-family housing. There is no evidence that these buildings have a similar indicator for area

per 1 inhabitant. The division should be between single-family and multi-family housing because they have decidedly different standards of apartments. The statistical average of usable floor space of a dwelling in cities (i.e., multi-family houses) is approx. 60 m^2, and the home of a single-family is approx. 150 m^2. Using the same indicator will result in an underestimation of needs in terms of social infrastructure in areas with low-rise multi-family housing, which is the basic material for housing estates.

Table 5. Minimum number of locations for children and young people that will be provided as part of school services and kindergartens.

	Town Planning Regulation	**Multi-Family Housing Development**			**Single-Family Housing Development**
		High	**Medium–High**	**Short**	
1	primary schools and middle schools	6 areas on 2500 m^2 total area of apartments		4 areas on 2500 m^2 total area of apartments	
2	preschool	2 areas on 2500 m^2 total area of apartments		1 area on 2500 m^2 total area of apartments	

Table 6 presents a proposal of detailed surface indicators and isochrones access to various forms of green and recreational areas, recommended for use in designing the development of a building plot and in programming and planning the functional and spatial structure of residential areas.

Table 6. Recommended program and area indicators for green areas and home recreation and generally accessible greenery, leisure and sports complexes.

	Program	**Minimal Surface**	**Min. Indicator Surface**	**Max. Access Radius**
Backyard areas, on the plot construction (net)	playgrounds for children under 7 and older (above 50 apartments)	250 m^2 250 m^2	5 m^2	50 m 100 m
Basic public areas ofleisure and sports	housing estate gardens	2 hectares	4.0 m^2	500 m
	sports fields for team games		1.5 m^2	
Secondary recreational areas and sports	parks	2 hectares	4.0 m^2	1000 m
	indoor swimming pools sports halls		2.5 m^2	

3.2. Building Intensity Multi-Family Housing: Land Use Indicators

The intensity of development is one of the basic urban parameters. It expresses the ratio of the total area of buildings (P_{og}) (the sum of the areas of all residential stories counted in the outline of external walls) to the area (T_n). The indicator reveals little on the method used for the plot area and only additional information specifying the height of the building (weighted average number of stories) is presented. It allows us to calculate the share of built-up areas and determine which parts of the plot are open areas "between the buildings", which can be developed for communication services, recreation and housing estate greenery.

The relations between the development intensity $(\ln)$, the weighted average number of stories (k), and the built-up area (P_{zab}) is given by the following formulas:

$$\ln = \frac{P_{og}}{T_n} \tag{1}$$

$$P_{og} = P_{zab} \times k \tag{2}$$

From (1) and (2), we obtain:

$$\frac{P_{zab}}{T_n} = \frac{\ln}{k} \quad (3)$$

The right ranges of values for individual parameters should be determined so that it is possible to obtain an appropriate share of open areas, including biologically active ones, while meeting the general requirements that residential buildings and their respective locations should meet. Only correctly associated pointers can protect appropriate "spatial standards" and possibly the proper quality of development of residential areas. The standards in [28–31] precisely determined the relationship between the weighted average number of stories and the net development intensity, while considering the previously discussed requirements regarding backyard greenery (at least 50% of the areas net, minimum 8 m^2/inhabitant). The relationship between the building height, the recommended index and the net intensity is illustrated by the curve shown in Figure 2.

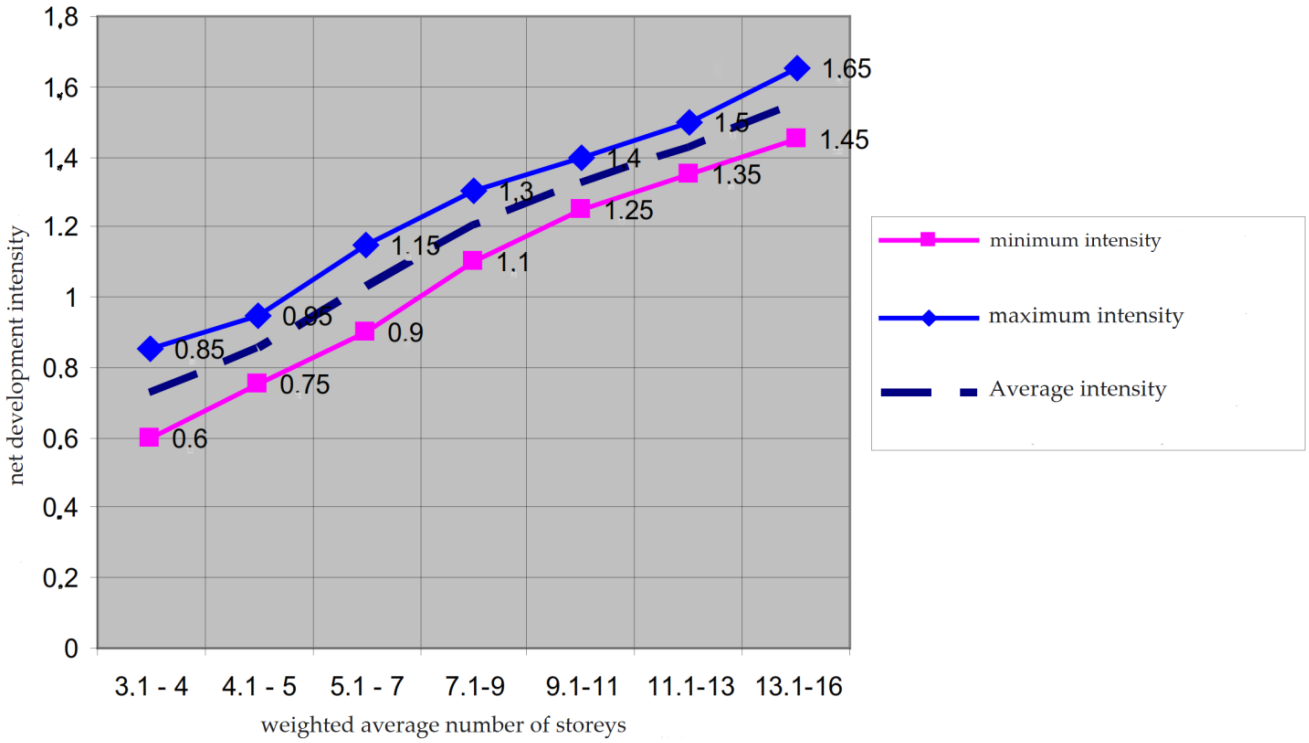

Figure 2. Relationship between the height of buildings and the intensity of development in the urban planning.

Table 7 shows the slightly modified urban planning and extends the currently applicable regulations in the biologically active areas and areas intended for housing estate greenery and recreation.

Table 7. Minimum percentage of land area intended for housing greenery and playgrounds for multi-family housing.

	Town Planning Regulation	All Types of Multi-Family Housing, Regardless of the Size of the City
1	Neighborhood greenery	20% of estate greenery concerning the plot area
2	Size and number of squares games for children	25% of the estate green area (as above) is intended for playgrounds for children, 25% for teenagers (aged 12–18), equipped playgrounds in the number of 1 square per 2500 m^2 of the total area of apartments, and for each another 2500 m^2

The regulations still apply only to the construction plot, specifying that at least 20% of its area should be occupied by housing estate greenery (i.e., greenery arranged with playgrounds). Duties to perform playgrounds: separately for children and teenagers (12–18 years) arises when the total area of apartments is greater than 2500 m^2, 1 square for each subsequent 2500 m^2. In principle, the above rules do not bring significant changes because the size of the green area is still a derivative of the plot's size and does not consider the number of potential users.

Considering the reality, i.e., legal conditions, the planning and operation investment standards, it is undeniable that the local authorities underestimate the importance of green spaces, sports and recreation. It is necessary to introduce normative regulations of an obligatory nature, relating separately to:

- The structure of residential areas, defined at the stage of drawing up local plans and zoning;
- The development of a building plot (area investments).

4. Results and Discussion

Figure 3 shows the relationship between development intensity and the percentage share of built-up and green areas. It shows that the higher the building intensity, the smaller the percentage of the area that must be intended for development. Thus, a greater percentage of undeveloped land is needed to provide green areas. From the results, it can also be seen that the curve representing the required percentage of green areas (estimated according to the indicator of 8 m^2 per inhabitant) has a higher upward trend (along with the increase in intensity) than the decreasing curve of the percentage share of built-up area.

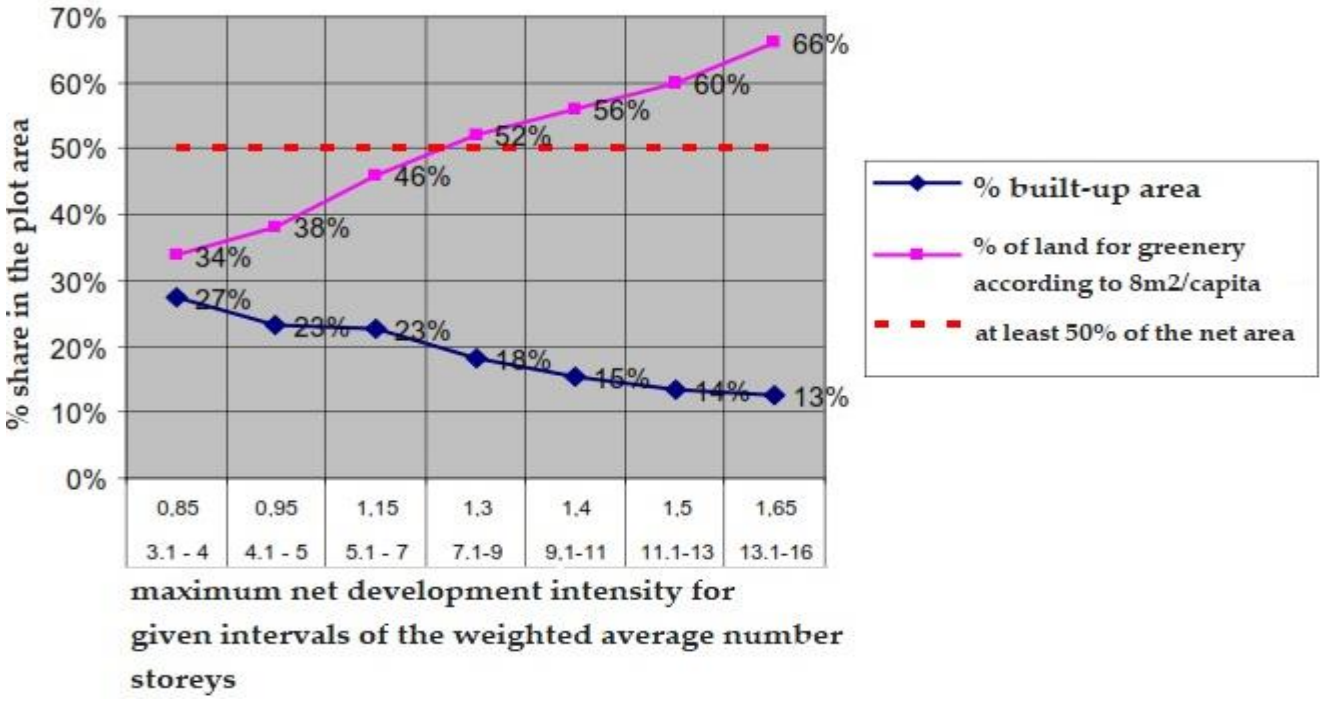

Figure 3. Relationship between development intensity and percentage share in the plot area: built-up and green areas with recreational facilities are calculated according to the indicators.

It means that with high development intensity, difficulties could arise in meeting all the requirements. Cities should be seeking non-conventional functional services solutions (access roads, car parks). After 1990, when the conditions for conducting housing investments changed, the prices of building land increased along with formal limitations; thus, the practice immediately transcended the old framework. The intensity of development

in the complexes under construction increased in a way that was not motivated by the increase in the height of the buildings (Table 8).

Table 8. Average statistical value of parameters: net development intensity and weighted average number of stories in multi-family housing built in cities.

Year	Net Development Intensity	Weighted Average Number of Stories
1970	1.1	6.2
1975	1.15	7.4
1980	0.95	5.5
1990	1.07	4.9
1992	1.16	4.3
1994	1.19	4.0

Figure 4 shows the averaged statistics (average index, ln, and weighted average number stories) for residential investments in 1970–1994. It can be seen that in the years 1970–1980, these data fit into the "intensity curve", consistent with the regulation. However, after 1990, a trend began, showing a significant increase in the intensity of new buildings with a decrease in the weighted average number of stories. It means that they were built more densely, increasing the share of built-up areas at the expense of open areas. It can be said that the "intensity curve" of development is gradually shifting, and the task for the present day is determining where it should be located and what its course should be.

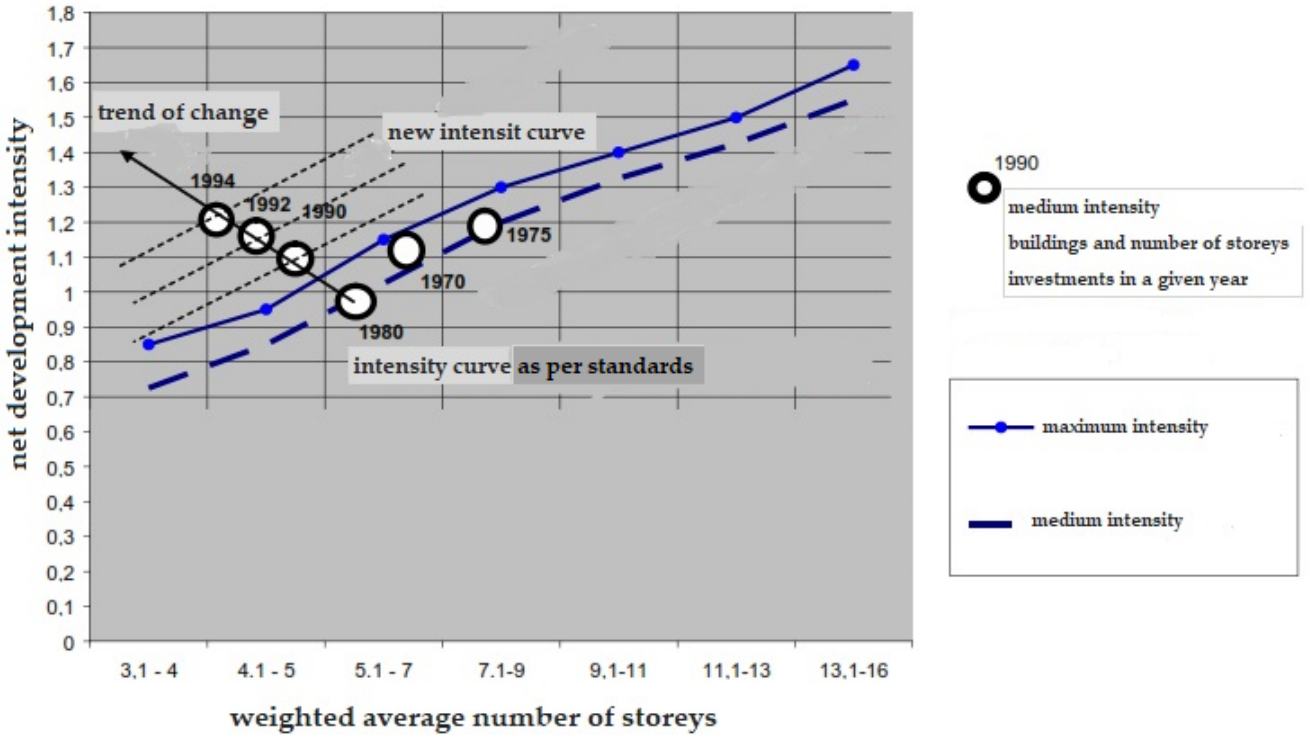

Figure 4. Trends in shaping the average development intensity based on all implementations in multi-family housing in 1970–1994.

Developing current indicators of the intensity of housing development in correlation with the height of buildings, i.e., looking for the optimal course mentioned curve, several new circumstances should be considered. First, the rules have changed distances between buildings and other elements of land development. They are much more liberal than in the '90s, allowing buildings to be located closer together and with greater density buildings.

Secondly, as has already been mentioned, the requirements that condition the size of the plot development elements (e.g., green areas) have been abandoned and redeveloped on the number of inhabitants. Third, important are the reasons for verifying the indicators' changes in the design of residential complexes. The problem of providing permanent parking spaces for cars is not solved only in land-intensive above-ground car parks, but more and more commonly in underground garages. Thanks to this, the area of land "freed up" can be used to increase the intensity of development, provided that spatial comfort and proper insolation are not impaired.

The impact of improvers also needs to be considered as housing standards to population density. The standard assumed an index of 20 m^2 P_{og} per one inhabitant, 30 m^2 is assumed for planning purposes per one inhabitant. For these reasons, the relationships between intensity indicators, buildings and population density are different today: at the same indicator, the population density will be lower by 33% (Table 9).

Table 9. Impact of changes in the standard of housing conditions (P_{og} /capita) on population density and on the percentage share of the plot area (area) that should be designated for greenery according to the indicator of 8 m^2/one inhabitant.

Mean Weighted Number Stories	Factor Intensity Buildings	According to the Standard 20 m^2 per Capita		Current Indicators 30 m^2 P_{og}	
		Number Inhabitants (ha)	% of Terrain Intended to Be Green According to the Indicator 8 m^2/Inhabitant	Number Inhabitants (ha)	% of Terrain Intended to Green According to the Indicator 8 m^2/Inhabitant
3.1–4	0.85	425	34%	283	23%
4.1–5	0.95	475	38%	317	25%
5.1–7	1.15	575	46%	383	31%
7.1–9	1.3	650	52%	433	35%
9.1–11	1.4	700	56%	467	37%
11.1–13	1.5	750	60%	500	40%
13.1–16	1.65	825	66%	550	44%

It means that it is estimated, according to the 8 m^2 indicator per inhabitant, that the areas of green areas would be 1/3 smaller. Therefore, there are no reasons to continue to omit this logical indicator in case it will make it difficult to obtain a rational development intensity. The conducted studies show that for a given weighted average number of stories, a much higher development intensity than required in previous standards—depending on the percentage of parking spaces—will be provided in the form of parking lots and underground garages.

Low-rise buildings have a minimum of 25%, and medium and high-rise buildings with a minimum of 50% of the permanent parking spaces will not be resolved on the ground surface. Maximum intensity indicators can be up to 30% higher than the previous standards (Table 10).

Figure 5 shows how the area demands individual forms of land use (expressed in percentage share of the area) at the maximum proposed intensity index for a given weighted average number of stories. The following indicators were used in the calculations: 30 m^2 P_{og}/capita, first place parking (20 m^2)/2.5 inhabitants, green areas and rest along with the necessary communication 8 m^2/1 inhabitant, and the area of access roads and walkways is 40% of the building area. The new "intensity curve", corresponding to the maximum values from Table 10, is presented in Figure 6 and is compared to the analogous standard curve. It is obvious that with other, more radical assumptions, e.g., 100% parking spaces below the surface, it is possible to obtain even higher rates of land use intensity, which is confirmed by numerous projects.

Table 10. Proposed development intensity depending on the weighted average number of stories.

The Weighted Average Number of Stories	Net Development Intensity	
	According to the Standards	Proposed
3.1–4	0.6–0.85	0.75–1.10
4.1–5	0.75–0.95	0.95–1.25
5.1–7	0.9–1.15	1.15–1.50
7.1–9	1.1–1.30	1.45–1.70
9.1–11	1.25–1.45	1.45–1.80
11.1–13	1.35–1.50	1.50–1.95
13.1–16	1.45–1.65	1.65–2.0

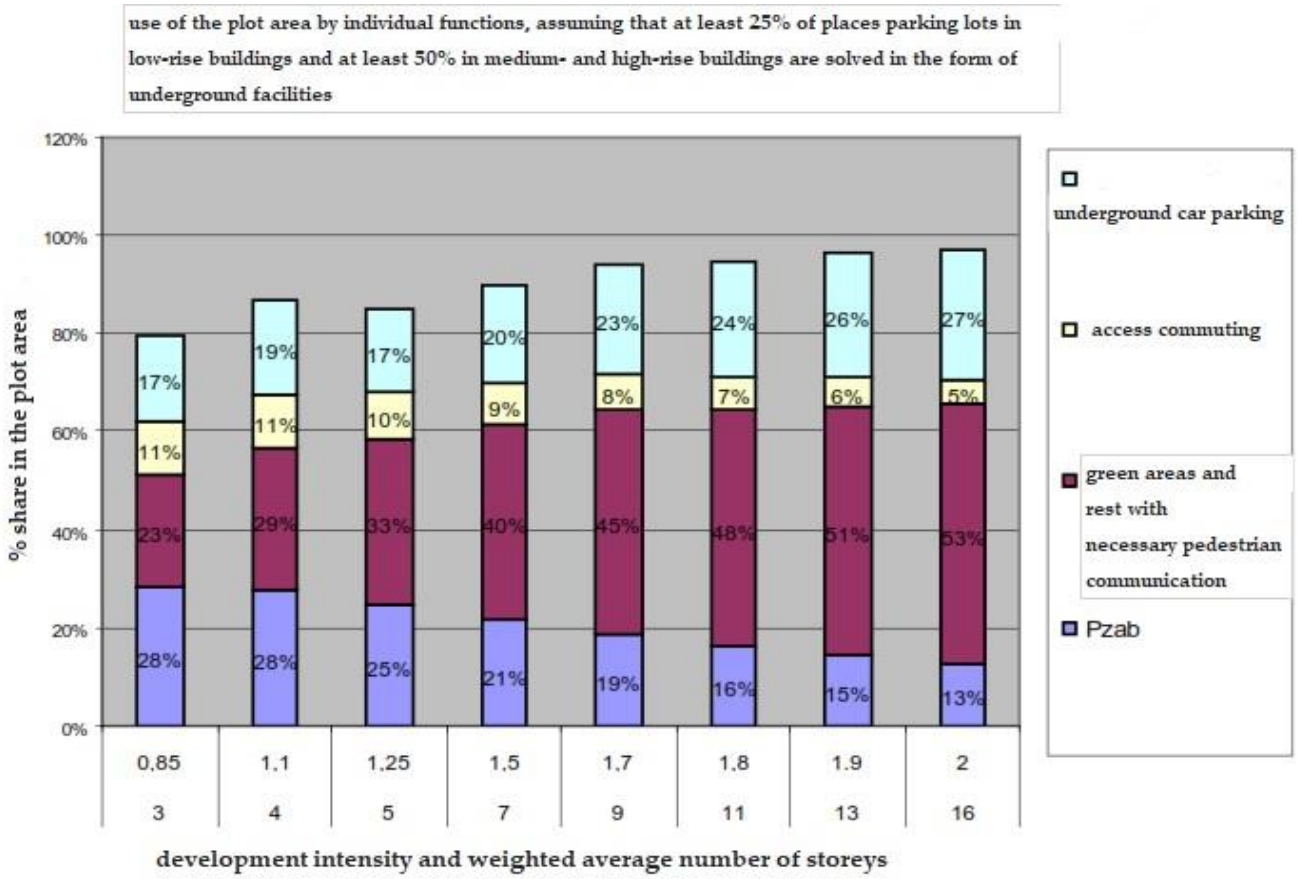

Figure 5. Use of the plot area by individual functions.

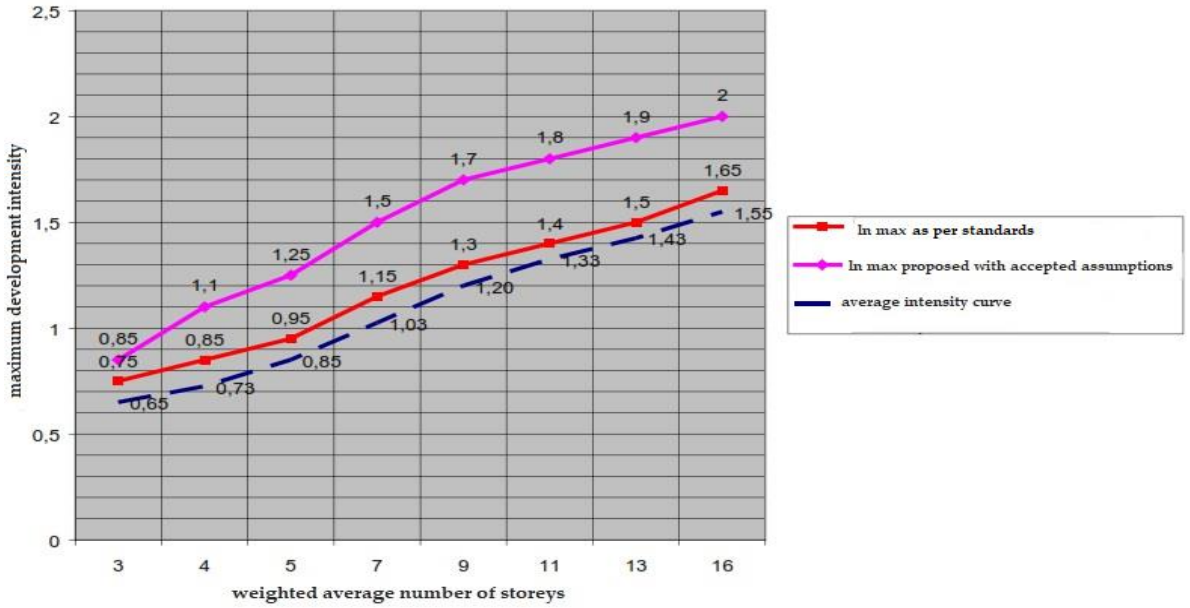

Figure 6. The course of the intensity curve depends on the weighted average number of stories adequate to current land design and use trends.

In the proposed method, it is important to consider the increased share of green areas (estimated according to the number of inhabitants) and prove that securing them under certain conditions with limiting indicators of development intensity is possible. Included in Figure 7 are the dependencies between basic urban parameters, defined in light of current conditions and considering the postulated quality indicators of the housing environment, which may be useful in practice planning.

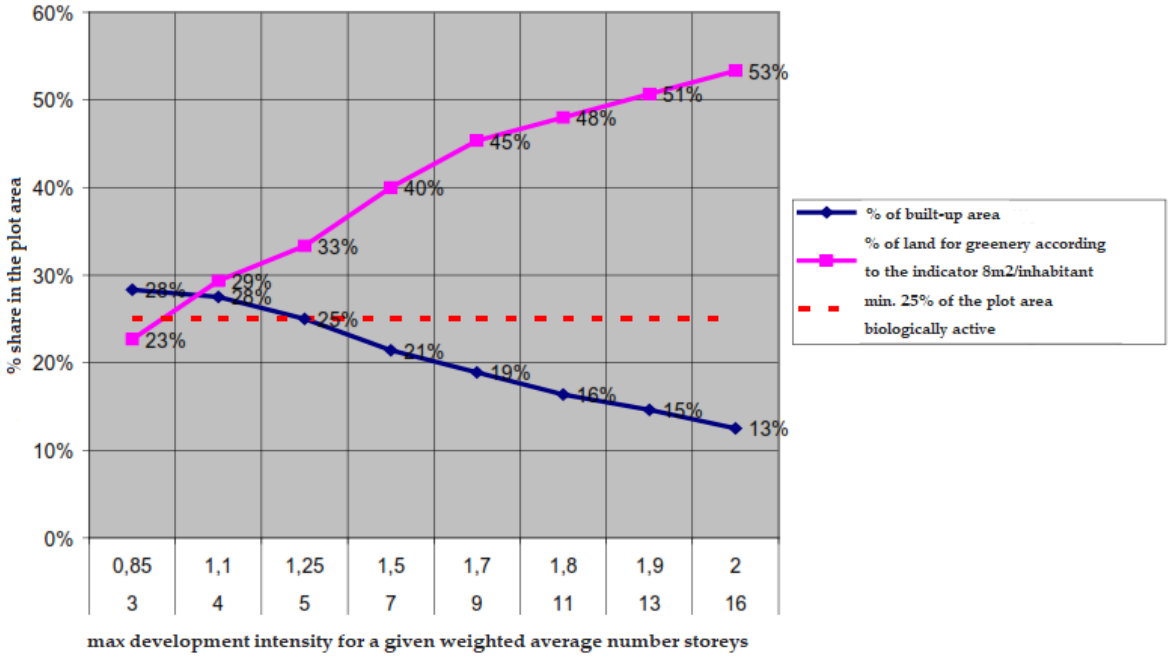

Figure 7. Relations between the proposed development intensity and the percentage share in the area of the plot: built-up area and green area with leisure facilities, percentage of share in the plot area calculated according to current indicators.

5. Conclusions

The article presents the results of previous work on urban standards to ensure appropriate quality housing environments in cities, especially in multi-family housing areas. They do not resolve all existing issues, but in many cases, they reveal the need for additional studies. This does not imply that the author has given up on questions with regard to his proposals, but sees the need to include them in a coherent and complete set adjustment. Continuation and elaboration studies on building intensity are required. Undoubtedly, this parameter should consider the city's scale and the area's location in the city structure. It is also worth considering the substitution of requirements, i.e., "something for something". It could be, for example, categories of biologically active surfaces: why do we include only horizontal surfaces but not completely vertical walls with vines?

Finally, based on standards, spatial planning with sustainable paradigm development is the most important issue. Pursuing a compact city must be undertaken in relation with a rational use of space and areas. However, at the same time, this city should offer an attractive housing environment to stop residents from escaping to a cottage near the city and the uncontrolled, uneconomic and harmful development of suburbs for the natural environment. It is why it is necessary—precisely through urban planning standards—to ensure competitive values: easy access to public services, arranged green areas, recreation and sports, and to create conditions of communing with nature near the apartment. In some countries, indicators/standards for green spaces are based on the population and do not concern the type or height of buildings. The present research showed a dire demand for normative regulations and obligatory urban standards.

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