Urban playgrounds as potential green infrastructure: The case of Thessaloniki

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Abstract. In Greek cities and towns, playgrounds, which represent a significant portion of open public space available in high density compact urban areas, fail to positively impact the sustainability of the urban environment, as they are made of artificial materials and generally lacking in natural elements. Designed around safety from accidents, a typical urban playground is equipped with prefabricated play structures, surrounded by an extensive area of rubber protective floor providing a surface safe from falls etc. This water-sealed surface does not absorb rainwater and has a very hazardous behaviour in hot temperature climates, such as Greece has. This “toxic turf,” a product of recycled elastic tires, contains chemicals suspect for cancer. In addition, trees and vegetation are usually insufficient or absent, thus worsening the overheating due to lack of shade. Although this model continues to prevail in Greece, around the world there is a significant shift towards natural playgrounds – play spaces that are designed to incorporate trees, shrubs, dirt, sand, grass, and play elements that are not industrially manufactured but constructed in situ, using stone, wood, reed, and other natural materials. From a pedagogical point of view, a stereotypical playground offers a rather dull and uninteresting environment for children to play, compared to the rich experience of a natural playground. Therefore, if designed as green infrastructure, playgrounds can considerably contribute to urban climate adaptation and a cooler microclimate and at the same time provide opportunities for urban children to come to contact with nature and benefit from free play. The scope of the paper is to present the multiple environmental benefits of natural playgrounds and to calculate the potential positive effects by the transformation of playgrounds into green spaces in a compact urban area. The field study examines the existing playgrounds in the municipality of Thessaloniki and their potential to become part of the city’s green infrastructure.

1. Introduction

Open spaces are arguably the most important assets of cities and towns. They serve a multitude of scopes and functions, as places for recreation and physical activity, contributing to wellbeing, and as gathering places and theatres of communal life, enhancing social inclusion. As parts of the urban ecosystem, they function as significant breaks in the built masses, providing landscapes that – if designed suitably – can host natural elements, regulate urban microclimate, reduce air pollution, promote biodiversity and serve as natural drainage systems. Therefore, open spaces play an important role in mitigating both the Urban Heat Island phenomenon and risks brought about by extreme weather (i.e. flooding due to rainstorms) caused by climate change. In parallel to the social and
environmental function of public spaces, economically, a well-designed, high-quality, connected public realm system can raise property values and enhance economic vitality [1]. This wide-ranging positive role of open spaces in all three aspects of sustainability (society, environment, economy) is also combined with a highly beneficial influence they have on an individual level, in terms of health and psychology of people – residents and visitors. Research shows that the affordance of urban green spaces helps reduce stress, lower blood pressure, while increased physical activity is related to a reduction of obesity and diabetes in city population [2].

Green Infrastructure (GI) is an overall term that refers to “the network of open spaces, waterways, gardens, woodlands, green corridors, street trees and open countryside that brings many social, economic and environmental benefits to local people and communities” [3: p. 1]. The emphasis is on network: size, affordances and physical attributes of open spaces contribute to the benefits mentioned above, but what is crucial in urban terms is how these spaces are distributed and whether they are connected. For example, in cities such as Minneapolis, the well-designed network of linked open spaces with different characters and functions gives its public space a much greater value than the individual components [1]. However, open spaces in densely built urban areas are often scarce, scattered and unevenly distributed. This is particularly true in compact cities as in the case of southern Mediterranean cities. To use the example of the city of Thessaloniki, unbuilt spaces hardly constitute a green network. Many of them are not accessible to the public, such as schoolyards, and thus underused, or they incorporate very little natural elements such as urban squares.

Urban playgrounds, despite their abundance and polycentric spatial dispersion, are not regarded as potential GI in planning and/or physical design terms. The typical playground in Greece is equipped with prefabricated play structures, placed upon protective floor tiles in order to provide a surface safe from falls etc. This water-sealed surface does not absorb rainwater and has a very hazardous behaviour in hot temperature climates, such as Greece’s. If playgrounds were designed as a network of open spaces, accommodating children’s play but also providing natural elements and porous surfaces, then they would benefit dense urban areas in terms of regulating microclimate and addressing the dangers of extreme weather events such as storms. As a field study, I examine the case of the network of playgrounds in the Municipality of Thessaloniki. For an evaluation of the potential benefits from “greening” these spaces, I consider three parameters: location, size, and service area of play spaces. The environmental positive outcomes are also combined with the physical and mental benefits for the users of these spaces, and, in addition to that, the overall greater quality of play that a natural playground offers to children.

2. The changing typology and morphology of playgrounds from their origins to our day

Playgrounds as a distinct category of urban open spaces have existed for more than a century. The first public playgrounds opened in the great North American metropolises of late nineteenth century, such as New York and Boston with the explicit aim to “keep children off the streets” due to the pervasiveness of accidents, wrongdoings and hazards children were facing [4]. In Europe, the housing complexes of Red Vienna, built from 1919 to 1933, were revolutionary in their design, which included a communal space in the central courtyard specially designated for children’s play [5]. In the interwar period playgrounds were often privately owned, as in the case of Amsterdam, where they operated under the care of community organisations and required an entrance or subscription fee [6]. After World War II, however, in most cities around the world, the playground as a freely accessible open space, constructed and maintained by municipal authorities, became the norm. In Amsterdam the famous architect Aldo Van Eyck designed almost 800 playgrounds, a “constellation” of public spaces for children [7], a physical expression of recognising children’s rights as citizens and caring for their needs for play and for socialising [8].

In the post-war period, the inclusion of playgrounds in urban plans became the norm, mainly for safety reasons, as car traffic in urban roads increased so much that playing in the streets became highly dangerous. Apart from the opportunities for physical activity they offer, playgrounds serve as a child’s first encounter with the public sphere, where he/she can meet with other children and adults, observe
and learn through others’ behaviours and socialise with peers. Despite their importance, however, playgrounds were regarded as of zero interest by the major stakeholders involved – authorities, municipal services and of course designers. In New York City, for example, until the 1970s the typical playground comprised of a cement floor surface and standard equipment such as a swing, a seesaw, a slide, a roundabout [9].

From the 1970s onwards a shift in playground design introduced safety standards for surfaces and for the design details of play equipment. New materials were introduced, such as elastic floor tiles, made of recycled tires and other petrochemicals to offer protection from falls, as play structures became more elaborate, and often included parts hanging too high from the ground to be safe. The dominant typology of playgrounds became that of a segregated space with a protective surface and colourful structures made of more “child-friendly” materials then steel, such as plastic and wood.

In the meanwhile, however, an increasing number of researchers from various fields – child psychology, children’s geographies, environmental psychology – have emphasised the decreasing value of play experience in such kind of spaces. Critics offered evidence of children’s disappointment over this typical model due to the lack of diverse opportunities that are part of a meaningful experience of play, such as the need of children to have control over their environment, to manipulate and alter it, to interact with diverse materials and shapes, to experiment in a multi-sensory way with their surroundings, for example with gravity, smells, textures etc. [10]. In response to these sceptics, in many countries, playground design has shifted to alternative models, incorporating “adventure” elements, natural features or flexible materials that children can use to construct their own spaces. Natural features in particular (trees, shrubs, rocks, earth etc.) allow for a wide range of learning opportunities not available in mainstream playgrounds. They offer challenges for the developing mind and body of the child that add to the pedagogical and developmental value of playing outdoors. In the last two decades or so, urban children are becoming increasingly disconnected from nature, therefore the incorporation of nature in playgrounds is imperative in reducing the “nature-deficit syndrome” [11] experienced by children all over the world.

3. Background and current situation of playgrounds in Greece
In this research, the focus is on Greek cities and on the model of playgrounds prevalent in this country. In the past century, the design of urban playgrounds in Greece has been on the margins of architecture and urban design canon [12] with rare examples of good practices such as Dimitris Pikionis’s, famous Children’s Garden in Filothei, Attica. From the 1950s until the early 2000s playgrounds in Greek cities were dull, poorly maintained and unsafe spaces. They were ubiquitously covered with sand, which was not replaced regularly, and thus suspect for infections, and featured metal standard structures which often were rusted and destroyed, and even vandalised.

The introduction of mandatory specifications for playgrounds in 2009 [13] was a clear win for the local playground movement. The 2009 law obliged Municipalities to redesign and reconstruct the playgrounds within their jurisdiction, incorporated new advances in playground equipment design and introduced the mandatory application of European Safety Standards related to surfacing (EN 1176) and play equipment (EN 1177). Today, most Municipalities have adopted these technical requirements, although, due to the high cost of reconstruction, a proportion of playgrounds were torn down but never rebuilt. The current typical playground is a fenced place equipped with colourful, mainly wooden, play structures, on a protective surface of rubber tiles or floor.

3.1. Problematic features of mainstream typology and morphology of playgrounds in Greece
The typical playground to be found in Greek cities and towns represents a significant step forward compared to the situation merely fifteen years ago. However, this mainstream typology of playground creates a completely artificial environment, mono-functional and segregated from other open space uses and activities. Many problematic features continue to exist, in terms of children’s health, pedagogical value and impact on urban sustainability.
3.1.1. Health concerns. Most playgrounds in Greece are covered by rubber surfaces, either in the form of tiles or “poured in place” (PIP), of the same kind used in athletic fields, also known as athletic turf. These human-made artificial surfaces on playgrounds have been used increasingly as they provide protection from falls and often come in many bright colours. However, research has shown that the raw materials used in the production of rubber surfaces, mainly recycled tires, are hazardous for children’s health. Apart from natural rubber, which comes from trees, they contain phthalates (chemicals that affect hormones), polycyclic aromatic hydrocarbons (PAHs), volatile organic compounds (VOCs) and other chemicals known or suspected to cause adverse health effects [14]. These hazardous elements can either be swallowed, if small rubber parts are loose, or inhaled by children, especially when the rubber surface is heated during hot days. In the case of PAHs, the EPA has concluded that while there are currently no human studies available to determine their effects at various levels, based on laboratory findings, “breathing PAHs and skin contact seem to be associated with cancer in humans” [15].

3.1.2. Pedagogical concerns. From the 1960s onwards, the standardization of play equipment and its factory production by specialised companies increased the complexity of its design – as well as its cost, to be covered by municipal budgets. As mentioned before, however, critics point out that pedagogically this fixed type of equipment, made of artificial materials and standardised in its details, fails to address children’s needs for a diverse and stimulating playscape [16]. Research on how children use outdoor play areas [10] reveals that playscapes with the highest level of security tend to represent areas with the lowest affordances and challenge. Natural places, on the contrary, offer a diversity of topography, in slope and in roughness, thus providing challenges and consequently opportunities for children to cultivate important motor skills. Children develop balance and coordination faster when they have woodland rather than just playgrounds to play in [1].

3.1.3. Environmental sustainability concerns. The dense compact city presents practical advantages such as proximity and short distances, however a common problematic feature in such cities is the scarcity of green open spaces. This shortcoming, combined with other characteristics of compact cities (such as high built-to-unbuilt ratio, narrow streets compared to height of buildings, sealed surfaces etc.) intensifies two major environmental problems of urban areas: the Urban Heat Island phenomenon and the impact of extreme weather (i.e. flooding due to rainstorms), both of which are expected to worsen as a result of climate change. Therefore, the environmental redesign of open spaces of multiple land use (mobility corridors, urban squares, schoolyards etc.) so as to include a greater proportion of porous surfaces and as much greenery as possible, becomes imperative. The impact of these interventions, which could also include private unbuilt spaces, such as interior of urban blocks or front yards [17], albeit small in scale, can be substantial if we consider how many such small spaces exist in the compact city.

Urban playgrounds are also spaces that are often small-scale but spread in the entirety of the urban grid. However, in the current typical typology, they do not contribute at all to the regulation of urban microclimate or to mitigating the negative effects of extreme weather events, as they seldom include porous surfaces or greenery. Artificial flooring, apart from the health hazards mentioned above, has a cement substructure, thus not allowing rainwater to enter. Trees and naturally landscaped areas are almost never part of playground design. A most valuable opportunity for a city to integrate natural solutions for such problems as raised temperatures and flooding is thus lost.

3.2. Research Questions
The typical playground model which is omnipresent in Greek cities today offers greater safety and better quality for children’s outdoor play than the one that was the norm before the 2009 law introducing mandatory safety standards. However, the current model presents substantial problematic aspects, in terms of health hazards due to toxic construction materials, in terms of reduced pedagogical value compared to what a more natural environment for play could offer and in terms of the “lost
opportunity” playgrounds as open spaces represent to act as part of a city’s green network. The main research questions are what a process of redesign of urban playgrounds as green infrastructure (GI) in a compact, high population density city would entail and what outcomes it would bring.

4. Materials and Methods
In the field study I focus on the Municipality of Thessaloniki as area of study. Hereby I present only the first part of the study, that is the general profile of the city and the existing data on the city’s playgrounds. For the demographic and spatial characteristics of the city, I based my calculations on the census data available on the Greek Statistical Service (ELSTAT) website and on the open data platform of the municipality of Thessaloniki. The data on playgrounds (location and surface) were taken from the GIS portal of the municipality, while the service radius of playgrounds was provided by the municipal Department of Urban Design (DUD). I examine three parameters related to the affordance of play spaces: quantity and ratio of residents to playgrounds, size (surface) of playgrounds, and service areas, in order to determine which parts of the city are void of playground amenities.

5. The potential of playgrounds as green infrastructure in compact cities: the case of Thessaloniki

5.1. Main characteristics of Thessaloniki
Thessaloniki, founded in 315 BC, is a typical example of a historic compact city of the European South. The Greater Metropolitan Area of Thessaloniki is the second largest, after that of Athens, with a population of about one million. The municipality of Thessaloniki, which includes the historic centre, a small area to the northwest of the centre and an extensive expansion to the southeast, is the second biggest city in Greece, with a population of 325,182 inhabitants, covering an area of about 2,040 hectares. Thessaloniki is divided in 6 Municipal Quarters and 24 neighbourhood units, with a median brutto population density of 159 residents per hectare. Central neighbourhoods, which were built in the 1950s and 1960s, with very high floor to surface rations, present very high densities, such as the Kamara neighbourhood, which has a brutto density of 423 residents per hectare. Open spaces are scarce and scattered; the ratio of open spaces per resident is 4.76 square meters (m²) per head population, including peri-urban forests.

The city has been losing population in the past thirty years, a phenomenon attributed both to a decline in births, which is a national trend, but also to an “exodus” of families towards the outskirts of the Greater Urban Area, in towns and suburbs with less density, more affordable housing and more open and green spaces. This demographic change is evident in the shrinking of the age group of 0 to 14 years: while in 1991 it represented 15.8% of the population of Thessaloniki, in 2001 it decreased to 12.48% and in 2011 to 10.37%. The problematic conditions created by traffic congestion, high density and scarcity of open spaces – such as air pollution, raised temperatures during hot days and lack of amenities for recreation – continue to exist, so the prognosis is that the upcoming census will show that the percentage of families with children has decreased even more since 2011. For the subject of this study, which is urban playgrounds, a strategic approach to provide more and better spaces for children could also affect positively a “return” of families to the Municipality.

5.2. Number, location, size and distribution of playgrounds in Thessaloniki
Today Thessaloniki has a total of 56 playgrounds, distributed in the six Municipal Quarters as shown in Table 1. Because of varying densities in different neighbourhoods, to evaluate the distribution of playgrounds, the table also includes the population of each Quarter. The ratio of residents per playground, is an index of the distribution of play spaces in the various districts of the Municipality. Distribution is far from even across Quarters. It ranges from one playground per 11,604 inhabitants in the historic centre (Municipal Quarter A), which fares the worst, to one playground per 3,770 residents in Municipal Quarter B. The median ratio for the entire Municipality is one play space per 5,915
inhabitants. For reasons of comparison, in Wellington, New Zealand (population 206,590) the number of playgrounds per head of population is approximately 1/1800 residents or 3.2/1000 children [18]. Further research is needed, mainly to compare the ratio of Thessaloniki to that of other compact European cities. Also, the absolute number of playgrounds has only relative meaning, because equally important is the size of a playground, in terms of its capacity to accommodate users.

Table 1. Number of playgrounds per Municipal Quarter in the city of Thessaloniki and residents per playground ratio.

| Municipal Quarter | Number of playgrounds | Population (2011) | Residents per 1 playground |
|-------------------|----------------------|-------------------|---------------------------|
| Municipal Quarter A | 4                    | 46,416            | 11,604                    |
| Municipal Quarter B | 8                    | 30,159            | 3,770                     |
| Municipal Quarter C | 5                    | 26,526            | 5,305                     |
| Municipal Quarter D | 13                   | 80,703            | 6,208                     |
| Municipal Quarter E | 22                   | 131,011           | 5,955                     |
| Municipal Quarter of Triandria | 4 | 16,435 | 4,109 |

Municipality of Thessaloniki

| Number of playgrounds | Population (2011) | Residents per 1 playground |
|-----------------------|-------------------|---------------------------|
| 56                    | 331,250           | 5,915                     |

Size, meaning the surface of playgrounds, needs to be calculated on a one-by-one basis because it is not part of the data available by the Municipality. At a preliminary level, I calculated the surface of the 8 playgrounds located in Municipal Quarter B. Table 2 shows that the surface area ranges from 116 m² to 1005 m², with a median of 409.62 m². If we use this median surface as an indicator of median size for the total of the playgrounds, in all Municipal Quarters, then the total surface of all 56 playgrounds amounts for 22,938.72 m² or approximately 2.3 hectares.

Table 2. Surface area of playgrounds located in Municipal Quarter B in the city of Thessaloniki.

| Playground                  | Surface area (in m²) |
|-----------------------------|----------------------|
| Vitsi – Chalkidos           | 181                  |
| Baloglou - Papathanasiou    | 116                  |
| Galopoulou Square           | 1005                 |
| Agion Panton - Koloniasi    | 184                  |
| Langada - Katsani           | 410                  |
| Agiou Nestoros - Langada    | 847                  |
| Klavdianou - Meropis        | 277                  |
| Peristerion Square          | 257                  |
| Median surface area         | 409.62               |
A third parameter to be examined is that of proximity, that is, which areas are served by playgrounds, within a service area of 400 meters, considered the maximum distance a child can travel on foot to visit a playground. According to the mapped data (see Figure 1) provided by the municipal DUD, several neighbourhood units (1, 4, 5, 9, 10, 11, 12, 15, 16, 17, 18, 21) include areas that are not served by playgrounds.

![Figure 1. The location and service area (in a radius of 400 meters) of Thessaloniki’s playgrounds. Source: Municipal Department of Urban Design.](image-url)

**6. Conclusions and future steps**

Urban playgrounds already constitute a substantial network of public spaces, at neighbourhood level, that could function as a part of a city’s green infrastructure, if redesigned properly. The function of a playground as a place where children play should not regarded as an obstacle for the redesign of playgrounds as green infrastructure. Children play much more creatively and meaningfully in natural settings than in the typical standard playground. Multifunctional landscapes are more desirable than monofunctional, single-purpose, ones, because natural systems provide various ecological services that are multifunctional and because they can save space – especially evident in high population density areas such as cities – and “exploit economies of synergy” [19].

Future steps of the study include a focus on a specific area within the Municipality to test the positive environmental impact on the urban microclimate and climate change resilience if playgrounds inside this specific area are redesigned as natural playgrounds, that is replacing sealed surfaces of artificial turf with porous surfaces and introducing green and blue features. A quantitative method will be used, using a model of assessing the impact of a “greening” of these spaces on urban microclimate. This will allow for evaluating the cumulative effect of a similar redesign would have for the sustainability and resilience of the entirety of the city.

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