



Re-Connecting Children to Nature in Cities: The Role of Urban Green Infrastructure Smouha Neighborhood, Alexandria, Egypt Case.

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KEYWORDS:

Sustainability, Children, Green infrastructure, Nature, Smouha, Alexandria.

Abstract—Sustainability, by its definition, is an investment in the future. This interprets the importance of linking sustainability studies to children as they are 'the future'. Achieving and practicing sustainability is more than a rigid roadmap to be followed, it is rather beliefs and faiths that have to be deeply rooted and considered truthful. So, embedding environmentally conscious attitudes and right behaviors about nature and its norms is crucial to children.

This paper investigates the potential that the green infrastructure could present to reconnect children to the natural environment in cities. It develops a model that correlates all the spatial aspects: Space definition and configurations; Activities practiced in space; Experiencing space; Safety and security and the three types of green urban infrastructure: linear elements, nodal points, and networks. This is presented within the outlines of planning and management aspects of the successful green infrastructure to move the child from just being "In Nature" to being "With Nature" to finally being "For Nature".

It examines the applicability of this model by analyzing Smouha -a new residential suburbia located in the southern part of Alexandria city- originally planned after the principles of the 'Garden City'. In its final part the paper concludes that while local streets and parks present real potential for connecting children to nature, lack of connectivity on the design scale and applicability on the management scale limits children's experiences to be developed in reaching the desired 'with nature' or 'For Nature' states

I. INTRODUCTION

A REPORT published by the International Union for the Conservation of Nature, the Children and Nature Network entitled "Home to Us All: How Connecting with Nature Helps Us Care for Ourselves and the Earth", shows the importance of connecting children to nature and the positive impacts of this connectedness over time [1]. This is based on evidence that early experiences are stored in the limbic brain and recalled at the latter stages of human life

[2]. This goes in parallel with deep investigations about long-term sustainability applications. After years of practice, it is time-honored that believing in sustainability is guaranteed its applicability over time. Cultivating this culture in children is the best way to achieve this goal.

While it seems of great benefit to have strong connections between children and the natural environment in the early stages of their life, studies have shown a dark side to this relationship due to the environmental global changes. According to [3], a great feeling of disappointment was clear in interviews with adolescents as wild places they were attached

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to in their cities were removed. They expressed their anger and sadness as the natural green spaces are swept and replaced by new developments with high-built densities and intensified urban features. This has become a prototype urban development feature as built upon mere economic criteria. However, this was a predominant feature until the emergence of New York's Staten Island Bluebelt project. Although it was just a problem-solving solution and wasn't described as green

infrastructure at the time of its creation, it is now marked as a milestone in investigating the potential for applying green infrastructure with multi-dimensional benefits. This project comes as an extension to the concepts of Ian McHarg's: 'Design with Nature' and Frederick Law Olmsted's plans for Nicolas parks which created a new pattern of urban development that preserves nature and integrates it with human development in parallel [4].

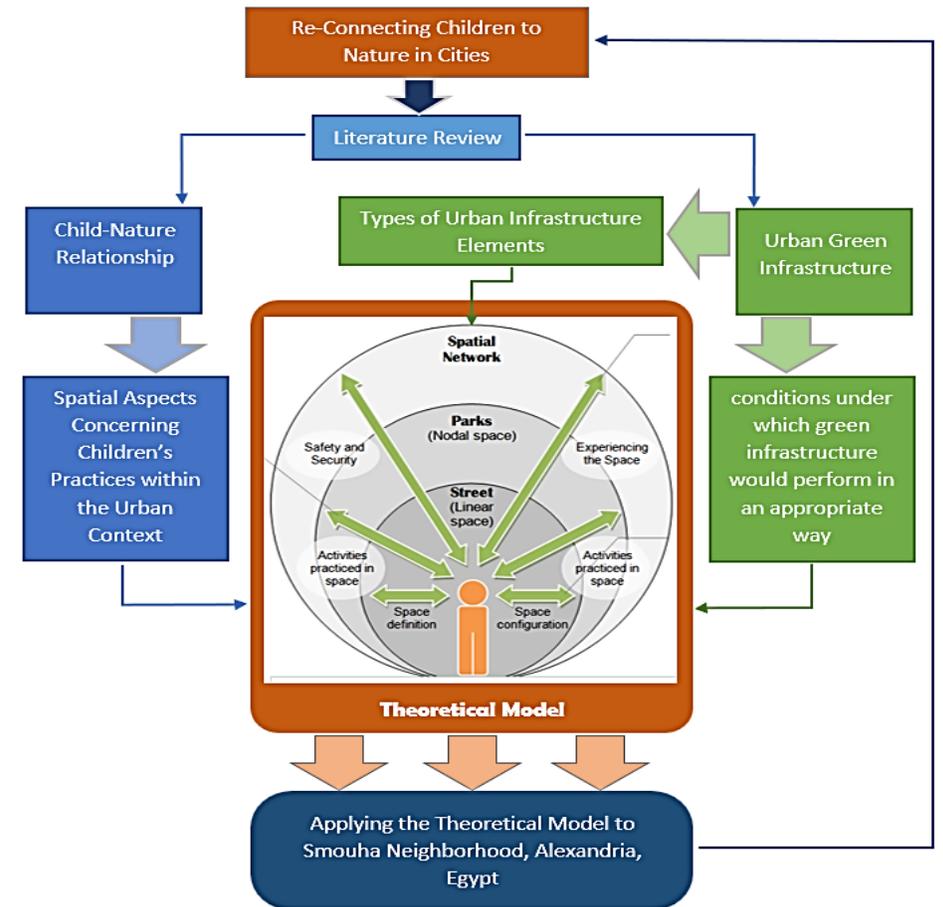


Fig. 1. Paper's structure. Source: the author.

The emergence of green infrastructure was the first to optimize landscaping performance (President's Council on Sustainable Development, 1999). This was before the term 'Green Infrastructure (GI) itself appears (the term is first mentioned by Benedict and McMahon in a paper entitled "Green infrastructure: Smart conservation for the 21st century") (2002). Starting from its early beginning, the concept of green infrastructure has witnessed three milestones till now. The first is exploration, the second is the expansion and from 2010 onwards it witnesses a consolidation stage [5]. This involves a greater realization of the benefits -economic, ecological, and social- that could be offered to urban life when green infrastructure is appropriately integrated into its ongoing systems [6]. This paper builds on the increasing awareness of

the potential that green infrastructure can offer to overcome the deficiencies of children-nature connectedness in modern cities. This would be of special interest within the Egyptian context as the percentage of children is about 40% of the total population (the number of Egyptian residences scored about 101.48 million inhabitants by 2021) [7, 8, 9].

This paper tackles a critical point for the fourth-coming Egyptian generations. Due to the accelerating increase in densities in cities, being detached from nature is growing as a norm. This would have immediate great negative impacts on our children and accordingly will lead to generations without a deep faith in the importance of environmental-related issues. However, reconsidering the role of urban open spaces as the main provider of nature in the urban overwhelming context

could be a potential. This paper raises questions about the dual role that green infrastructure can play in an understanding of the spatial structures of our cities. It is based on a hypothesis that this role could be better played if the spatial configurations and their associated natural processes are comprehensively managed.

To come up with a model that correlates all the related aspects, the structure of this paper (as shown in Figure1) is divided into two main parts the first scans literature about both child-nature relationships and the benefits that he/she would realize out of this relation in urban life and the conditions under which green infrastructure would perform in an appropriate way. This part ends with a theoretical model that links, on one hand, spatial aspects related to children's practices within urban context (space physical definition and configurations; activities practiced by children in outdoor spaces; the way they perceive and experience the space; and finally factors affecting children safety and security in outdoor spaces), and on the other hand, types of urban infrastructure elements based on their spatial morphological configurations (linear, nodal, and networks).

The second part is an empirical analytical study. It scans the spatial structure of Smouha -a neighborhood located in the southern extension of Alexandria, originally planned after the 'Garden City' principles-, to investigate the applicability of the developed theoretical model. Two matrixes are used to show the results of this analytical study. The first correlates the spatial aspects related to children's practices within the Smouha context to its spatial morphological configurations: linear spaces (minor arterials, collectors, local streets); nodal spaces (circulation nodes, and parks); and finally spatial networks (Connection pattern). The second correlates these morphological configurations to design and management aspects that shape the principles for a successful green infrastructure.

II. CHILDREN-NATURE RELATIONSHIP

The 'Affordance Theory' proposed by Gibson [10] is widely used to interpret the connection between children and nature [11]. Since the initiation of this theory the list of affordances has been extended over many studies to include both social and emotional affordances in addition to the functional ones as prerequisites. These affordances are the core of many studies as detected by [2] in his article entitled "Childhood nature connection and constructive hope". In this review, he presents a wide scan for studies to determine the dimensions of nature connection concerning both children's and their parents' points of view.

While the dimensions addressed in these included studies are wide and comprehensive, some classifications can make the trends behind these dimensions clear and give more in-depth insights. These dimensions could be addressed in a hierarchical way as parallel to the way connections between children and

their natural surroundings are initiated and developed. Five stages of connectedness could be addressed starting from just enjoying being in nature as the lowest degree of attachment to feeling a sense of oneness with nature as the highest degree.

The first step is a prerequisite to all the further steps of connectedness. It encompasses all the spontaneous reactions children perform while first being in nature. These dimensions include finding the beauty of nature [12], enjoying the sensory aspects of it [13], and wanting to be in it [12]. The second step moves further beyond just nature-relatedness to being aware of nature. This starts with feeling freedom in nature [14] as a prologue to initiating a sense of curiosity about the surroundings [13] which leads to creating awareness about the ecological routines [15].

The second part of the ladder of dimensions encompasses a higher degree of reactions towards nature and its phenomena. The first step of this part represents sensitive reactions concerning nature and its plants and animals. It witnesses a rapport with natural features leading to different kinds of children and nature affinity; cognitive affinity, eco-affinity, and attitudinal affinity [16] [15]. The second step of this part is to feel a responsibility towards nature [17]. This represents a higher degree of attachment to the surrounding environment and leads to more respect when dealing with it [12]. The highest degree of children-nature connectedness is feeling part of it (sense of oneness) [18]. This perspective has many consequences as it affects positively the child belonging to and kinship with the natural community. Moreover, it affects the children's perception of themselves as a fundamental constituent of the natural scene [19]. And finally, create an implicit connectedness with nature [20].

A later interpretation of the 'Affordance Theory' is presented by [21]. They have initiated an 'embodied ecosystem' concept which gives clear links between a child's perception of his/her surrounding environment and his/her behavior. This concept gives a dynamic vision to the overwhelming ecosystem consisting of intra-relationships between body, mind, culture, and the encompassing environment. According to [16] this could be used to address simultaneously the multimodal dimensions of child/nature connections.

Based on these understandings, ref. [16] develops a framework for investigating the connectedness between children and their surrounding natural environment as relies on three well-stated aspects; identifying the qualities of life experiences that connect children to nature, the abilities of children's human-nature connection, and finally the relation between these two aspects (qualities and abilities) over time. Using the Delphi technique, the study performed by [16] identifies 16 qualities (as the most important regarding the consensus of 275 experts) classified under six categories as shown in (Table I). Many other studies also have emphasized the importance of these qualities [22] - [28].

TABLE I
QUALITIES OF LIFE EXPERIENCES THAT CONNECT CHILDREN TO NATURE

Category	Qualities
- <i>Entertaining</i> [22]	- Entertainment
- <i>Environmental Epiphanies</i> [23]	- Thought-provocation
	- Awe
	- Surprise
- <i>Restorative Experiences</i> [24]	- Intimacy
	- Mindfulness
	- Self-restoration
	- Creative expression
- <i>Nature Free Play</i> [25], [26]	- Physical activity
	- Challenge
	- Engagement of senses
	- Child-driven
	- Involvement of mentors
	- Structure /Instructions
	- Social/cultural endorsement
- <i>Nature School</i> [27]	- Involvement of animals
- <i>Animals Engagement</i> [28]	- Involvement of animals

Source: the author after [16], [22] – [28]

However, this framework is built upon three levels of children-nature connectedness as mentioned in many references [22], [29] - [32]. They are classified into three categories to best describe the relationship between children and their surrounding environment either: being in nature, being with nature, and finally being for nature. Table II shows abilities for children-nature connections as classified under these three categories. In this regard, children-nature connectedness is seen as a cluster of abilities built in the limbic brain to connect all of mind, body, culture, and environment [19]. These abilities are developed over time to move from just being “In Nature” (feeling comfortable in natural spaces, and being curious about nature), to being “With Nature” (reading natural spaces, acting in natural spaces, feeling attached to natural spaces, knowing about nature, and finally recalling memories with nature), to at the end being “For Nature” (taking care of nature, caring about nature, and finally being one with nature) [22], [29] - [32].

TABLE II
ABILITIES OF LIFE EXPERIENCES THAT CONNECT CHILDREN TO NATURE

Category	Abilities
- Being IN nature	- Feeling comfortable in natural spaces
	- Being curious about nature
- Being WITH nature	- Reading natural spaces
	- Acting in natural spaces
	- Feeling attached to natural spaces
	- Knowing about nature
	- Recalling memories with nature
- Being FOR nature	- Taking care of nature
	- Caring about nature
	- Being one with nature

Source: the author after [16], [22], [29] – [32].

III. TYPES OF GREEN INFRASTRUCTURE

Despite the wide variety of green infrastructure definitions, there is a consensus on their classification categories according to the scale and role. Based on these criteria, a book entitled “Green Infrastructure: A Landscape Approach” classify green infrastructure as “an inter-connected network of green open spaces” that has the potential to play a restorative role concerning ecological system impairments. The other one is the “small-scale green systems” which are

designated specifically to manage storm water on an urban open space scale [33]. In a more detailed classification, [34], address “hubs” and “links” as the main constituents of the green infrastructure “system”. This classification is widely used in assigning roles to different natural landscaping spots according to their morphological configurations [35]– [38]. Table (III) shows a detailed description of both hubs and links and their subcategories. (They are used as a base of classifications in all [35]– [38] studies.

TABLE III
THE MAIN CONSTITUENTS OF THE GREEN INFRASTRUCTURE “SYSTEM”.

HUBS

- anchor green infrastructure networks
- provide an origin or destination for wildlife and ecological processes

Category	Abilities
- Reserves	- Large, protected areas,
- Managed native landscape	- Large publicly owned lands
- Working lands	- Private farms, forests, and ranches
- Regional parks and reserves	- Less extensive hubs of regional ecological significance
- Community parks and natural areas	- Smaller parks

LINKS

- the connections that tie the system together
- enable green infrastructure networks to work

Category	Abilities
- Landscape linkages	- Large protected natural areas, - Space for sites and for recreational use
- Conservation corridors	- Less extensive linear protected areas
- Greenways	- Resource conservation and/or recreational use
- Greenbelts	- A framework for development
- Eco belts	- Ease the zone of tension between urban and rural land uses

Source: the author after [34]–[38].

However, these generic types of hubs and nodes are to be redefined according to the specific configurations of urban settlements. And accordingly, limited types of these types could be seen in urban settlements. Community parks are the most common type of nodal green infrastructure in cities.

A study performed by [39] has reviewed more than 200 papers and come to conclude with eight planning principles for a successful green infrastructure [40]– [47]. These principles could be interpreted in the shadow of a deep understanding of green infrastructure as a “System” consisting of a network of “hubs” connected to each other by “links”. Table (IV) presents a detailed description of these principles and their correlated interpretations.

However, calls for ‘Reinvent our Cities’ after the Covid-19 pandemic have turned more attention to the importance of using green infrastructure potential to adopt an appropriate ‘local lifestyle’. This gives more insights to planners and architects to investigate the qualities that the city’s spatial structure can offer. In these regards, green infrastructure has proved its potential to help people enjoy their stay as near as possible to their homes [48]. Besides, this was a force behind introducing new types of greenery to cities. While the main aim was to move cities toward becoming more self-sufficient and resilient, the results show the emergence of new types of green

infrastructures such as the ‘Urban farms’ [49] which would have positive impacts on the city’s green spatial structure.

TABLE IV
PLANNING PRINCIPLES FOR A SUCCESSFUL GREEN INFRASTRUCTURE.

is crucial to sustaining species interactions and diversity, enables the migration of species, the dispersion of seeds, aims to create a well-connected green space network that can serve both humans and other species.
<ul style="list-style-type: none"> ■ Multi-functionality [41] <ul style="list-style-type: none"> - connects with a wide number of ecosystem services, - provides social, ecological, and economic functions and possesses a much higher resilience, - increases the effectiveness of spaces in urban areas. ■ Multi-scale [42] <ul style="list-style-type: none"> - ranges from a building perspective (e.g., green roofs), to a more regional and integrated perspective, - enhances interactions between and in urban spaces. ■ Integration [40], [41], [43], <ul style="list-style-type: none"> - links between green infrastructures and other urban structures. - considers connections between green and grey infrastructures, as well as the landscape interactions with the building environment. ■ Diversity [42], [44] <ul style="list-style-type: none"> - emphasizes the diversity of the solutions presented to solve a specific issue. - enhances the role and importance of blue infrastructures in green infrastructure planning. ■ Applicability [45] <ul style="list-style-type: none"> - must be considered in addition to adaptability and implementation, - being realistic, is the guarantee of its implementation and development. ■ Governance [40], [41], [46] <ul style="list-style-type: none"> - a collaboration between the government actors and the citizens in the planning processes as a guarantee for project success. ■ Continuity [41], [47] <ul style="list-style-type: none"> - post-implementation monitoring or empirical measurements of outcomes of the ecosystem services and functions - requires frequent investment, management, and updates, - must have a monitoring system and periodic reports on the evolution of the planned green projects.

Source: the author after [39]- [47].

IV. URBAN GREEN INFRASTRUCTURE MODEL (UGIM) FOR CHILDREN-NATURE CONNECTEDNESS

A study performed by the National Association of City Transportation Officials (NACTO) (2020) [48] entitled “Global Designing Cities Initiative: Designing Streets for Kids” defines eight needs children have to fulfill while using open spaces. These needs could be classified under four main categories: space definition and configurations, activities practiced in space, experiencing the space, and finally safety and security.

Spaces available for children and their caregivers have to be closely linked to their required activities. Their proximity and the type of activities they practice together (walking, holding hands, cycling side by side, ... etc.) require more space than generally needed. In addition, their slow speed as they are accompanied together has to be taken into consideration while designing spaces designated for both activities and rest. However, the convenience of these varieties of spaces works as a prerequisite for activities practiced freely in space.

The way children interact with their surrounding environment affects drastically their perception capabilities as regards their mental development. Studies have proved that the flexibility of a child’s brain would be at its most in the first five years of his life span. The well-prepared and treated spaces offer the potential for children to interact positively with the natural environment. This accordingly will initiate healthy habits and meaningful interpretations of the surroundings [5].

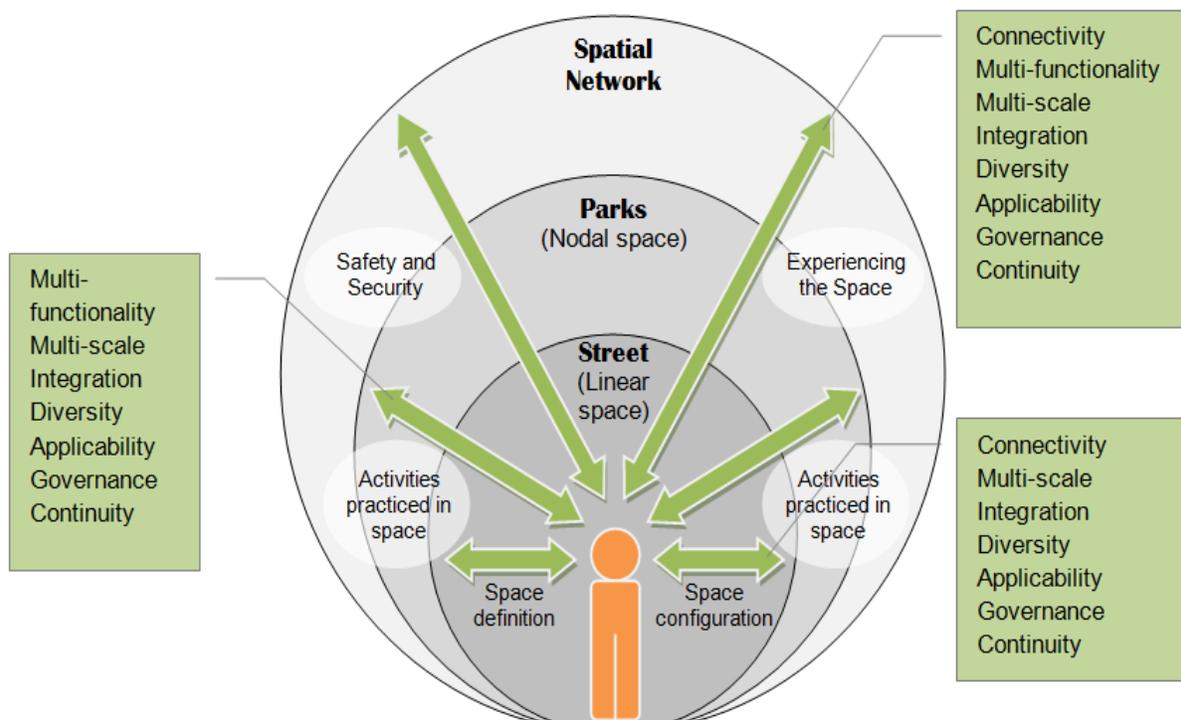
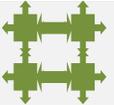


Fig. 2. Urban green infrastructure model (UGIM) for Children-nature connectedness. Source: the author.

TABLE V
Children-nature connectedness matrix

		Space definition and configurations	Activities practiced in space	Experiencing the space	Safety and security
- Streets (Linear Space)		- well defined corridors - elements of green infrastructure	- walking - playing - daily shopping activities	- natural systems	- safe movement corridors - pedestrian friendly streets
- Parks (Nodal Space)		- degree of accessibility - space identity - elements of green - blue infrastructure	- playing - recreational activities - animals' observing	- overwhelming nature experiences - exploration and testing natural phenomena	- following safety requirements in naturally dominant spaces
- Spatial Network		- degree of accessibility - networking and spatial connectivity	- daily school travelling - recreational activities	- continuing experiences. - managed transitions.	- avoid traffic interference. - safe crossings

Source: the author.

Moreover, offering children the potential to play as it is very important for their physical and mental development is very crucial. According to [39], outdoor circulation spaces (streets and squares), represent prospects for spontaneous learning while practicing daily activities (walking, waiting, ... etc.). This offers chances for unplanned play and interactions that could happen frequently and positively contribute to their cumulative gained experiences as they depend on themselves and make their own decisions.

This paper proposes a model that correlates all configurations and planning guidelines of green infrastructure types (linear elements, nodal points, and networks), and the abilities as developed over time and experience to move from just being “In Nature” to being “With Nature” to finally being “For Nature”. These interactions are to be addressed within a clear definition of all the space aspects: Space definition and configurations, Activities practiced in space, Experiencing the space, Safety, and security as shown in figure (2) and Table (V).

Promoting children’s connectedness from just being “in nature” to being “with nature” and then to being “for nature”, needs their environmental exposure increases in both time and intensity. This is a direct function of the potential that their surrounding environment presents. In this regard, the planning guidelines could be used to give insights into the contextual aspects that have the potential to increase this intensity. These aspects could be classified as either design or operational and management aspects. The former includes all of Connectivity, Multi-functionality, Multi-scale, Integration, and Diversity, whereas the latter includes Applicability, Governance, and Continuity. While these aspects are applicable on all open space scales (streets, parks, and spatial networks), their importance increases on the spatial network scale as the most responsible for creating an overwhelming natural experience.

V. APPLYING URBAN GREEN INFRASTRUCTURE MODEL (UGIM) TO SMOUHA DISTRICT

Smouha is one of the new residential districts to the southwest of Alexandria. Its history back to the beginning of

the 20th century. It was originally a vast swamp known as Mellahat Hadra (Hadra Saltworks) reclaimed by Joseph Smouha and named after him [51]. The original planning of Smouha suburbia followed the principles of Howard’s Garden Cities and was influenced by the urban planning of Welwyn garden city in England and Heliopolis in Egypt. Now this part of the city still has a number of its original planning features;(The Grand Stand, Smouha club, a few numbers of private villas) (fig.3.). Some of the original surrounding features still exist such as a large public park formed by the Nouzha and Antoniadis gardens and the location of El-Mahmoudia Canal which was later transformed to be El-Mahmoudia Axis (It has 6 to 8 lanes of traffic for each direction to change El-Mahmoudia canal from swampland to traffic artery). (fig. 4,5,6)



Fig. 3. The original planning of Smouha. Survey of Egypt, 1: 25,000, 1946. Source [29]



Fig. 4. The existing layout of Smouha district, Alexandria, Egypt. Source [Google Earth accessed 7/2022]

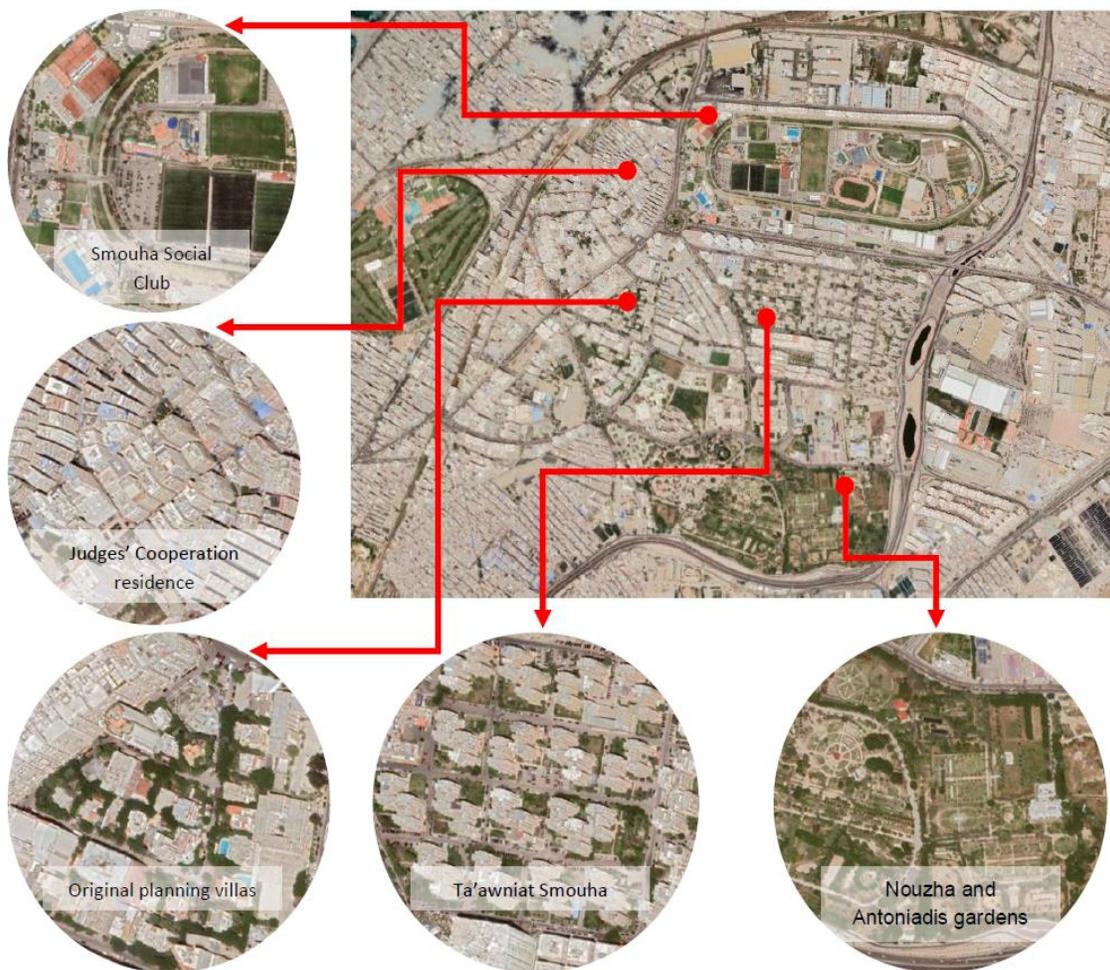


Fig. 5. Morphological analysis of Smouha's urban pattern. Source the author

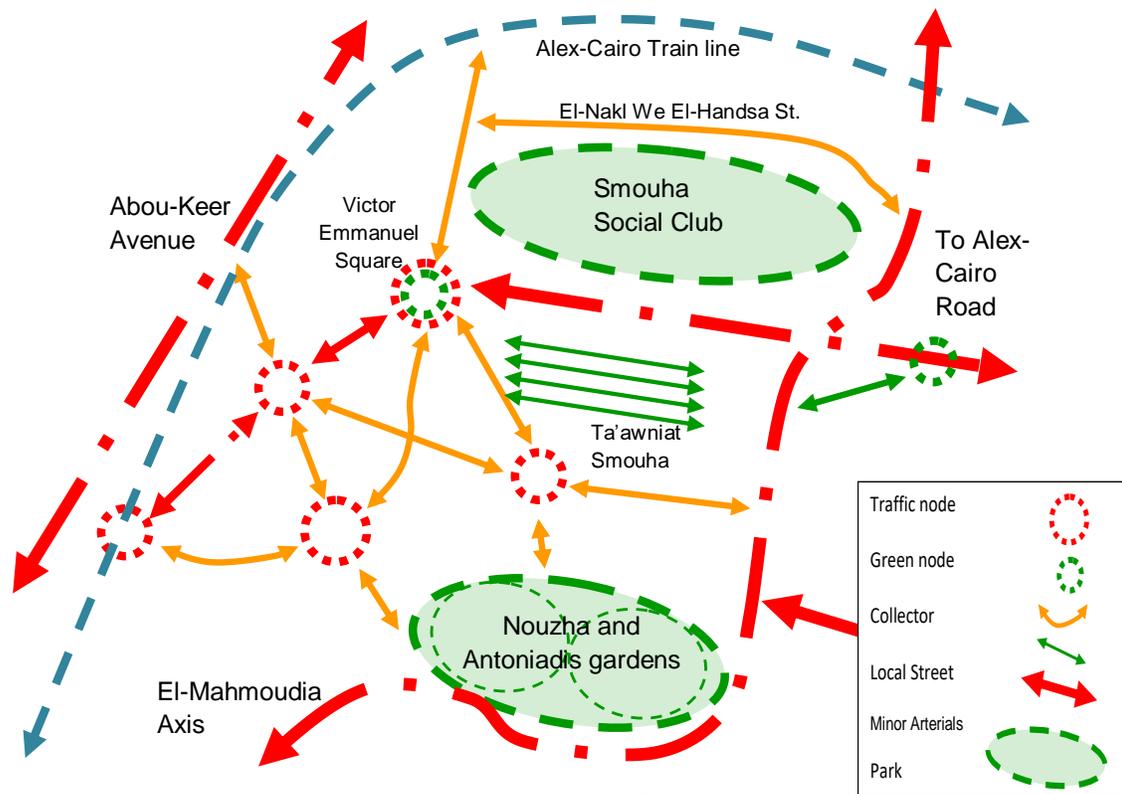


Fig. 6. Features of Smouha's urban pattern. Source the author

Reading the urban pattern of Smouha, the features of streets (linear elements), parks (nodal spaces), and spatial networks could be identified as follows:

- **The streets:** three categories could be identified; minor arterials, collectors, and local streets (fig. 7,8,9). The urban form of the Smouha district is shaped by the regulations and building codes that permit continuous urban masses and physically well-defined streets. Regardless of these well-defined corridors, elements of green infrastructure aren't seen clearly in either the minor arterials or the collectors. However, some types of green infrastructure elements could be seen in a few local streets. Activities practiced by children in these linear spaces are directly related to their configurations. Arterials don't give any chances for children to either walk or play while some collectors permit children to walk and go for some daily shopping activities. On a local street level, more chances are available for children to walk and practice many daily routine activities such as going to school or grocery shopping and even playing. These physical configurations and their correlated green infrastructure are the base for the potential children/nature interactions and accordingly their gained experiences. Local streets offer these experiences on a considerable scale compared to both minor arterials and collectors. What increases the quality of children-nature interactions is the safety they feel in local streets due to low traffic density and calming devices which couldn't be felt in both minor arterials and collectors. While all the streets in Smouha in all its different scales are not designed or equipped to work as pedestrian-friendly streets, the local ones by their

spatial configurations are much qualified to play this role (fig. 6).

- **The nodes:** two types could be identified; circulation nodes, and parks. As originally designed as a garden city suburbia, parks are one of the main features of Smouha. Two main green nodes are located to the north and the south of this part of the city. The north one is Smouha social club which comes after the Grand Stand. It is a gated social and athletic club accessible only to its members (fig. 11). Meanwhile, Nouzha and Antoniadis gardens are in the southern part of Smouha, and they have publicly accessed parks with affordable tickets prices (fig. 12). The Nouzha Park also is the location for Alexandria Zoo one of the main attractions for children not only from the surrounding area but from all of Alexandria and near governorates as well. As publicly accessible parks, Nouzha and Antoniadis are positive in all children-nature-related aspects. They have a wide variety of green-blue infrastructure elements which add to space identity and increase the potential for children to do activities related to playing, recreation, and animal feeding and observation. These extended areas of greenery offer children the chance to explore and test natural phenomena as being overwhelmed by nature experiences. Being away from traffic gives the children full freedom to do activities without fear. This is contrary to circulation nodes which extend over many street intersections. Regardless of the existence of small gardens at the heart of some of these nodes (Victor Emmanuel Square), they are not safely accessible to children and don't give the chance to children to interact freely with nature (fig. 10).



Fig. 7. Local streets in Smouha. Source the author



Fig. 8. Collector street in Smouha. Source the author



Fig. 9. Minor arterials in Smouha. Source the author



Fig. 10. Vector Emmanuel Square, Smouha. Source the author

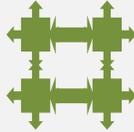


Fig. 11.(a) the Grand Stand Source [23], (b) Smouha Social Club, Smouha.



Fig. 12. Nouzha and Antoniadi gardens, Smouha. Source the author

TABLE VI
CHILDREN-NATURE CONNECTEDNESS MATRIX

		Space definition and configurations		Activities practiced in space			Experiencing the space	Safety and security		
		- well defined corridors	- elements of green infrastructure	- walking	- playing	- daily shopping activities	- natural systems	- safe movement corridors	- pedestrian friendly streets	
- Streets (linear space)										
	Minor Arterials	☑	☒	☒	☒	-	☒	☒	☒	
	Collectors	☑	-	☑	☒	☑	-	-	☒	
	Local streets	☑	☑	☑	☑	☑	☑	☑	-	
- Parks (Nodal space)		- degree of accessibility	- space identity	- elements of green-blue infrastructure	- playing	- recreational activities	- animals' observing	- overwhelming nature experiences	- exploration and testing natural phenomena	- following safety requirements in naturally dominant spaces
	Circulation Nodes	☒	☑	☒	-	-	-	-	-	☒
	Parks	☑	☑	☑	☑	☑	☑	☑	☑	☑
- Spatial Network		- degree of accessibility	- networking and spatial connectivity	- daily school travelling	- recreational activities	- continuing experiences.	- managed transitions.	- avoid traffic interference.	- safe crossings	
	Connection Pattern	☒	☒	-	-	☒	☒	☒	-	

☑ Values properly achieved, ☒ Values not achieved, Values are not required to be achieved - Source: the author

- Moving from just ‘being in nature’, to further degrees of being ‘with nature’ and ‘for nature’ requires continuous interactions with the overwhelmed natural environment which is realized on the spatial network scale. This scale of the study acquires the continuity of being in nature for long times and on a high frequency that guarantees the impacts of these experiences to deepen over time to approach being ‘for nature’ state. Regarding Smouha suburbia, being the extension of the old city of Alexandria with a dominance of car-oriented developments negatively affect the continuity of the elements of green infrastructure over its lands. Increasing the number of cars and the ill design of streets as pedestrian-friendly streets, especially for children negatively affect the ability of children to move beyond their limited residential shed. This deprives children of having deep continuous experiences in nature.

The previously discussed planning principles for a successful green infrastructure could be used in these regards as criteria for evaluating the performance of the spatial system of Smouha. However, the following table shows an evaluation of the green infrastructure spread over the spatial network (circulation “hubs” and parks connected to each other by “links”). In this table, the evaluation principles are divided into either design aspects or managerial aspects, which make it easier to determine the responsibilities of the stakeholders.

Reading (TABLE VII) shows that:

- Elements that are responsible for children to be ‘In Nature’ are existing on a considerable scale in both local streets and in parks. However, using a multi-scale intervention and the diversity of green infrastructure types represent the main deficiencies among other design aspects. On a different scale

park in Smouha shows an effective way for children to be ‘In Nature’ as they have multi-scale achievements concerning all design-related aspects.

- All aspects of the managerial scale show very low performance. This is generally applied to all spatial and

networking configurations except for some local streets that are well managed and looked after depending merely on their residents. The role of district administration and other related governmental agencies could hardly be seen in this suburbia.

TABLE VII
CHILDREN-NATURE CONNECTEDNESS MATRIX SOURCE [GOOGLE EARTH ACCESSED 7/2022]

		principles for a successful green infrastructure							
		- Design Aspects					- Management Aspects		
		Connectivity	Multi-functionality	Multi-scale	Integration	Diversity	Applicability	Governance	Continuity
-Streets (linear space)	Minor Arterials	☒	☒	☒	☒	☒	☒	☒	☒
	Collectors	☒	☑	-	-	-	☒	☒	☒
	Local streets	☑	☑	☒	☑	☒	-	☑	☑
- Parks (Nodal space)	Circulation Nodes	☒	☒	☒	☒	☒	☒	☒	-
	Parks	☑	☑	☑	☑	☑	-	-	-
-Spatial Network	Connection Pattern	☒	☒	-	-	-	☒	☒	☒

(☑) Values properly achieved, (☒) Values not achieved, Values are not required to be achieved - Source: the author

- Due to increasing densities and transforming Smouha from an originally planned garden city to a car-oriented community, connectivity on its multiple scales (physically and over time) is lost. This major defect is responsible for interrupting children’s experience ‘With Nature’ and works as a barrier to promoting this relationship to be ‘For Nature’.

VI. CONCLUSION

Connecting children to nature has proved many benefits for them personally and for the community’s future as well. One of these sustainability-related benefits is to create a generation that believes in the importance of nature and behaves accordingly. To become a nature proponent child, have to go through stepped degrees of interaction with nature. These steps start with just being ‘In Nature’. In a further step, more involvement in the natural environment, move children to be ‘With Nature’ stage, and finally, with more emergencies in nature domains, children move to the ‘For Nature’ state. Meanwhile, these are the findings of many related pieces of research; individual differences and preferences are crucial and have to be taken into consideration (out of the scope of this study).

Green infrastructure presents the potential to reconnect children to nature in cities. While it is originally developed as a

nature-based solution to environmental challenges (especially stormwater management), its role extended over time to cover many other domains. Among many classifications for green infrastructure, this paper uses a simple rather effective one. It uses morphological typology as an indicator of their performance and shows them as either linear or nodal elements. In addition, it builds on literature to define eight principles (Connectivity, Multi-functionality, Multi-scale, Integration, and Diversity (as design-related aspects), and Applicability, Governance, and Continuity, (as management-related aspects)) for green infrastructure to be successful.

The model developed in this paper to formulate the interconnectedness of children to their surrounding nature encompasses two successive stages. *The first* is a matrix that correlates outdoor space configurations -closely related to children’s desired needs and expected behaviors- to physical space classification used in the green infrastructure study. These configurations include space definition (which has to be well-defined, accessible, connected, and have identity), activities practiced in space (which have to accommodate daily functional and recreational activities), experiencing the space (have to show natural systems and give the chance to children to explore and test natural phenomena), finally safety and security (as a prerequisite of the success of all these interactions

in nature). *The second* is to link the gained experiences children have while practicing these interactions with design and management aspects of successful green infrastructure to move them from just being “*Inn Nature*” to being “*With Nature*” and finally “*For Nature*”.

Regarding Smouha,

As originally planned after the ‘Garden City’ principles, this southern neighborhood has the potential for applying the proposed model to reconnect children to nature in this part of Alexandria. The morphological analysis shows Smouha now as a car-oriented neighborhood with three street categories; minor arterials, collectors, and local streets, and two nodal spaces; circulation squares and recreational parks. Applying the model to Smouha shows the positive impact of local streets in offering a proper experience for children to be connected to nature. However, increasing densities and traffic volumes in both collectors and minor arterials threaten the continuity of children’s experiences and limit them from being expanded to have a completely overwhelming experience with nature. Parks in Smouha represent positive assets that support children-nature appropriate relations, but the lack of maintenance presents a severe threat. Finally, the management aspects of green infrastructure in Smouha show a very weak performance that affects negatively the other related design aspects.

Based on the above-mentioned conclusion this paper recommends that more planning efforts have to be practiced keeping a continuous environmental experience children face while practicing their periodic travel (daily, weekly, ...e tc.). This could be achieved by doing more in-depth studies for safety and security aspects that the urban spatial structure has to offer as a prerequisite for their contented existence in space. In addition, more attention has to be paid to maintenance specially for public facilities to keep their attraction potentials and help them play their role. As a further integrated part of this paper, more in-depth investigation for the managerial aspects concerning the provision, operation, and maintenance of the green infrastructure in the Egyptian urban context have to be performed.

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Title Arabic:

إعادة ارتباط الأطفال بالطبيعة في المدن: دور البنية التحتية الخضراء
دراسة حالة: منطقة سموحة، الإسكندرية، مصر

Arabic Abstract:

تعتبر الاستدامة – استنادا الي تعريفها- عن استثمار في المستقبل، وهو ما يفسر أهمية ربطها بالأطفال باعتبارهم المستقبل. فممارسة التنمية المستدامة يحتاج إلى ما هو أكثر من مجرد اتباع خطوات ومناهج جامدة حيث يتطلب إيمانا عميقا بالقضايا البيئية وتصديق بمقتضياتها وهو ما يجعل غرس مبادئ الوعي البيئي والسلوكيات الصحيحة في التعامل مع الطبيعة وقوانينها من الأهمية بمكان بالنسبة للأطفال.

يقوم هذا البحث بدراسة الإمكانيات التي يتيحها استخدام البنية التحتية الخضراء لإعادة ربط الأطفال بالطبيعة في المدن. وهو في هذا الإطار يقوم بتطوير نموذج يربط من جهة بين الجوانب الفراغية المرتبطة بممارسات الأطفال في المدينة والتي تشمل أساليب التحديد الفراغي وخصائصها -الأنشطة التي يمارسها الأطفال في الفراغات الخارجية -الأساليب التي يتفاعل بها الأطفال مع الفراغ الخارجي وأخيرا الأمن والأمان باعتبارهما قيمة أساسية لضمان استمرارية التجارب ونجاحها، وبين أنماط البنية التحتية الخضراء في المدينة من جهة أخرى مقسمة وفقا لطبيعتها إما كعنصر طولية أو مركزية أو شبكية (تشمل علاقة العنصرين السابقين معا). يتم تطوير هذا النموذج النظري في ضوء دراسة الصفات التصميمية والإدارية لعناصر البنية التحتية الحضرية والتي يعول عليها في إنجاز أدوارها والمساهمة في تطوير علاقة الطفل بالطبيعة من مجرد السماح له بالتواجد فيها كمرحلة أولى ثم التعامل معها كجزء منها كمرحلة ثانية وأخيرا الاعتقاد فيها ودعمها بصورة إيجابية.

يختبر البحث الإمكانيات التطبيقية للنموذج النظري المقترح بتطبيقه على منطقة سموحة – واحدة من الضواحي السكنية الجديدة بمدينة الإسكندرية - والتي تم تخطيطها وتصميمها على غرار نظريات المدن الحدائقية. من خلال الدراسة يخلص البحث إلى أنه بينما تمثل الشوارع المحلية والحدائق والمتنزهات في منطقة سموحة فرصة حقيقية لربط الأطفال بالطبيعة إلا أن الافتقار إلى الترابط بين العناصر الفراغية المختلفة بالمنطقة على مستوى التصميم وضعف القدرات المحلية على الإدارة الناجحة للأصول الغنية للمكان يمثلان نقاط ضعف واضحة تحول دون تطوير العلاقة بين الأطفال والطبيعة في سموحة بحيث تنتقل بهم من مجرد التواجد إلى التآثر ثم الاعتقاد فيها.