



**Cairo University**  
**Faculty of Regional and Urban Planning**

**An Assessment Tool for Measuring Water Sensitivity of  
Residential Areas**

**A Thesis Submitted in Partial Fulfillment of the Requirements for  
M. Sc. Degree in Regional and Urban Planning**

**Department of Urban Design**

**Submitted by**  
**Nouran Moustafa Mohamed**  
Teaching Assistant at the Department of Urban Design

**Under the Supervision of**  
**Prof. Dr. Hesham Mohamed El Barmelgy**

Professor of Urban Design and  
Vice Dean of Education and Student Affairs  
Faculty of Regional and Urban Planning

**Dr. Noha Ahmed Abd El Aziz**  
Associate Professor of Urban Design  
Faculty of Regional and Urban  
Planning

**Dr. Marwah Seaway Hamed**  
Associate Professor of Urban Planning  
Faculty of Regional and Urban  
Planning

**July 2019**

**Accreditation and Acceptance**

**An Assessment Tool for Measuring Water Sensitivity of  
Residential Areas**

**A Thesis Submitted in Partial Fulfillment of the Requirements for  
M. Sc. Degree in Regional and Urban Planning**

Department of Urban Design

Field of Specialization Urban Design

Submitted by

**Nouran Moustafa Mohamed**

Demonstrator in the Department of Urban Design

**External Judge: Prof. Dr. Ahmed Mohamed Saed Shalaby**

**Internal Judge: Dr. Mohamed Reda Hagag**

**Main Supervisor: Prof. Dr. Hesham Mohamed El Barmelgy**

**Co- Supervisor: Dr. Marwah Seaway Hamed**

**Co-Supervisor: Dr. Noha Ahmed Abd El Aziz**

## **Acknowledgements**

I would like to express my deepest gratitude to my supervisors; Prof. Dr. Hesham El- Barmelgy, Dr. Marwah Seaway and Dr. Noha Ahmed Abd El Aziz, for their unrelenting patience and invaluable guidance. Their precious experience, extensive knowledge and unparalleled insight were imperative for the completion of this research. I am also very grateful to my friends and colleagues for their support, assistance and encouragement throughout the duration of the research. I would like to specially thank Nehal, Yasmin, Engy, Nouran and Lamia for always being there for me.

I am extremely grateful for my mother and father whose help cannot be overestimated. They were always there for me, believing in me and pushing me forward. I can never repay them for all the love and energy they gave me, and continue to. I am also grateful to Sarah, Mohamed, Zoza, Aunt Nahla, Un. Yousef , Ola, Omar, Donia, Ahmed, Sherief, Khaled and Dina for their incessant support and encouragement. And I am deeply indebted to my best friends Abeer, Heba, Safa, Radwa, Nada and Khloud for never wavering in their support and their belief in my abilities. I would also like to extend my deepest appreciation to all my friends and family and I wish them all the best.

## **Abstract**

Driven by the overwhelming forces of climate change, urbanization and population growth, the World is on the verge of a devastating water crisis and Egypt's water situation is among the most critical globally. Facing the impending water crisis requires a new innovative approach to urban water management, such as Water Sensitive Urban Design (WSUD). To facilitate the adoption of WSUD principles in the Egyptian Residential context, this study suggests a Water Sensitivity Assessment Tool for Residential Areas (WSAT-RA). The Assessment Tool draws on the assumption that in order to create sustainable innovation in technology, we must not focus on the technology itself, but rather investigate the function or services provided by a given technology.

The suggested tool operates by interlinking three key pillars: (i) water sensitivity objectives/criteria; (ii) influencing urban patterns; and (iii) WSUD strategies and measures. Where objectives and criteria represent the desired state or optimum condition. Secondly, influencing urban patterns represent characteristics of the local context that are expected to influence water sensitivity. Finally, WSUD strategies and measures are the possible set of solutions that is applicable to a certain case or design to enhance its water sensitivity. The resultant tool could be used by planners and urban designers to conduct baseline assessment, determine best possible solutions and assess progress towards water sensitivity.

To ensure better objectivity of the devised tool; a survey was conducted with professionals and researchers from the fields of water management and urban design. Based on the results of the survey the finalized form of the tool was developed and relative weights were set to the assessment criteria. Finally, the tool was used to assess the water sensitivity of three study areas (Maadi, Hadaak El\_Koba and Manshiat Nasser). In conclusion, variations in the water sensitivity scores between the three study areas was interlinked to dissimilarities in their social and urban structures. Based on which a group of WSUD recommendations were given for the diverse residential patterns.

### **Key words**

- Water Sensitive Urban Design
- Assessment Criteria
- Water-related Sustainability Objectives
- Water Management
- Influencing Factors
- Residential Water Consumption

## Summary

Water is the fuel of life, but a fuel that cannot be replaced nor substituted. However, as urban communities spread and populations grow, the impact on the natural environment. Alas, Egypt's water situation is among the most critical globally; threatening development, the national economy, and above all the livelihood of citizens. This study aimed to devise a tool to assess the water sensitivity of residential areas. The tool is meant to promote the adoption of a new more efficient approach to urban water management such as: Water Sensitive Urban Design (WSUD). The development of this tool involved two main steps: (i) theoretical study of literature; and (ii) analytical review of international case studies. The resultant "Water Sensitivity Assessment Tool for Residential Areas" (WSAT-RA) is intended to be used by planners and urban designers to:

- a. Conduct baseline assessment of existing areas and identify points of weaknesses
- b. Identify possible solutions and prioritize interventions to guide decision making
- c. Measure and quantify progress towards achieving a water sensitive city

The study reviewed the current and future projections of the Egyptian water mass balance, while focusing on the domestic water demand sector and the issues facing it. The study also analyzed the conventional urban water management approach and the drivers behind its apparent failure. Then a theoretical study was conducted of the international scientific literature in order to identify alternative new approaches for urban water management and identify their guiding principles and strategies. The identified principles were translated into assessment criteria and indicators, which acted as the base for the assessment tool. Then, a correlation Matrix was prepared to identify the impact of the different strategies on each of the assessment criteria.

The devised tool underwent two refinement stages, the first stage included an analytical study of three selected international case studies (Portland, Melbourne and Lima) to benefit from the implementation and practical experiences. The second stage drew on the results of a field survey conducted with water-related experts, planners and designers. The data collected from the survey were correlated with the results of the literature review and international case studies. Based on the correlation study the final set of assessment criteria were selected and weights were assigned based on their relative importance. The weighed criteria represent the finalized assessment tool.

**Finally**, the applicability and efficiency of the tool was tested by applying it to three residential areas in the Cairo governorate (Maadi, Hadaak El\_Koba and Manshiat Nasser). The result of the assessment uncovered variations in the overall water sensitivity performances of the three areas, as well as dissimilarities in the scores of each sensitivity dimension. The results of the comparative analysis of the three study areas helped to assess the variations in the water sensitivity of diverse residential patterns and therefore, determine priority areas that require immediate attention. Moreover, it was possible to identify a set of potential actions were recommended for enhancing the performance of water sensitivity in the diverse urban patterns.

In conclusion, the suggested Water Sensitivity Assessment Tool for Residential Areas proves to be applicable. However, its applicability is limited to residential areas especially in the Greater Cairo Region. The tool could be used by designers and planners to enhance the water sensitivity of residential areas, by identifying deficiencies in the conventional water management approach and suggesting a more efficient course that is case specific.

## Table of Contents

Abstract.....	i
Summary.....	
Table of Contents .....	i
List of Tables .....	vi
List of Figures.....	viii
<b>Introduction .....</b>	<b>xi</b>
i.    Research Problem .....	xi
ii.   Research Objectives.....	xii
iii.  Research Question .....	xii
iv.   Research Methodology .....	xiii
<b>1 Chapter 1 (The New Paradigm Shift in Water Management) .....</b>	<b>1</b>
1.1  Introduction.....	1
1.2  Water on Earth and the Natural Water Cycle .....	2
1.3  The Conventional Urban Water System .....	3
1.4  Failure of the Conventional Urban Water System .....	6
1.4.1  Growing Environmental Concerns .....	6
1.4.2  Aging and Overloaded System .....	7
1.4.3  Failure to Reach Peri-Urban and Rural Areas .....	7
1.4.4  Fragmented Management System .....	7
1.4.5  Long Planning Horizon .....	8
1.4.6  Competing Demands .....	8
1.5  The New Approaches to Water Management.....	8
1.1.1.  Green Infrastructure.....	10
1.1.2.  Decentralized and Hybrid Approach .....	14
1.1.3.  Integrated Urban Water Management .....	16
1.1.4.  Water Sensitive Urban Design .....	19
1.1.5.  Results of reviewing the new approaches to water management .....	22
1.6  Summary and Conclusion .....	27
<b>2 Chapter 2 (Residential Water Consumption and its Influencing Factors).....</b>	<b>29</b>
2.1  Introduction.....	29
2.2  Egypt’s Water Mass Balance .....	30
2.2.1  Water Resources .....	30
2.2.2  Water Demand.....	36
2.3  Residential Water Demand Sector .....	41

2.3.1	Reasons for Focusing on the Residential Sector .....	42
2.3.2	Drinking Water Service Sector.....	45
2.3.3	Domestic Water Consumption .....	47
2.4	Factors Influencing Residential Water Consumption.....	48
2.4.1	The Built environment and Urban Characteristics .....	50
2.4.2	Social and Demographic Characteristics.....	53
2.4.3	Environmental/ Climatic Parameters.....	56
2.5	Conclusion .....	58
<b>3</b>	<b>Chapter 3 (Developing the Tool: Sustainability Objectives &amp; Strategies).....</b>	<b>60</b>
3.1	Introduction.....	60
3.2	Review of Water Sustainability Goals.....	60
3.2.1	Agenda 21 .....	61
3.2.2	The European Union Water Framework Directive.....	63
3.2.3	The Millennium Development Goals .....	63
3.2.4	The World Water Council .....	64
3.2.5	Sustainable Development Goals.....	64
3.2.6	Egypt Vision 2030.....	65
3.2.7	Water Sensitive Cities Index .....	66
3.2.8	Water Poverty Index.....	67
3.2.9	City Blueprint .....	68
3.2.10	Watershed Sustainability Index.....	70
3.2.11	Sustainable Cities Water Index .....	70
3.2.12	Sustainability Rating Systems .....	71
3.3	Setting the Objectives for the Waster Sensitivity Assessment Tool.....	71
3.3.1	Ecosystem.....	74
3.3.2	Urban Water System.....	76
3.3.3	Socio-economic .....	76
3.3.4	Resilience and Adaptation to Climate Change .....	77
3.3.5	Place Making and Community Building .....	79
3.4	WSUD Tools and Strategies .....	79
3.4.1	Planning and Design Tools.....	79
3.4.2	Economic Tools.....	82
3.4.3	Social Tools .....	82
3.4.4	Smart Infrastructure and System-related Tools.....	83
3.4.5	Institutional and Legal Tools.....	84

3.5	Correlating WSUD strategies and sustainability objectives .....	85
3.6	Conclusion .....	88
<b>4</b>	<b>Chapter 4 (Refining the tool: International Case Studies) .....</b>	<b>89</b>
4.1	Introduction.....	89
4.2	Selection of Case Studies and analysis dimensions.....	89
4.3	Portland, Oregon, USA .....	90
4.3.1	Reason for Choosing .....	90
4.3.2	Introducing the case study .....	90
4.3.3	Water-related Challenges .....	91
4.3.4	WSUD Goals and Objectives .....	91
4.3.5	Strategies and Tools .....	93
4.4	Melbourne, Australia .....	94
4.4.1	Reason for Choosing Melbourne as a Case Study.....	94
4.4.2	Introducing the Case Study .....	94
4.4.3	Water-related Challenges .....	95
4.4.4	WSUD Goals and Objectives .....	95
4.4.5	Strategies and Tools .....	96
4.4.6	Urban Patterns .....	99
4.4.7	Results of the analysis of Melbourne .....	101
4.5	Lima, Peru.....	102
4.5.1	Reason for Choosing Melbourne as a Case Study.....	102
4.5.2	Introducing the Case Study .....	102
4.5.3	Water-related Challenges .....	102
4.5.4	WSUD Goals and Objectives .....	104
4.5.5	Strategies and Tools .....	104
4.5.6	Urban Patterns .....	112
4.5.7	Results of the analysis of Lima.....	113
4.6	Conclusion .....	113
<b>5</b>	<b>Chapter 5 (Second Stage Refinement of the Tool: Survey with Experts) .....</b>	<b>116</b>
5.1	Introduction.....	116
5.2	Preparations for conducting the Survey.....	117
5.2.1	Sampling of Respondents .....	117
5.2.2	The Questionnaire Design .....	117
5.3	Data presentation and analysis.....	118
5.3.1	Water issues in the residential sector.....	118



5.3.2	The characteristics that could impact the performance of the natural and urban water systems. ....	119
5.3.3	The Degree of Significance of Water-Related Sustainability Objectives .....	120
5.3.4	The Suitability of Some Strategies and Tools .....	121
5.4	Weighing and Finalizing the Assessment tool.....	122
5.5	Conclusion .....	129
<b>6</b>	<b>Chapter 6 (Applying the Developed Tool to Selected Study Areas)</b> .....	<b>130</b>
6.1	Introduction.....	130
6.2	Selection of Study Areas.....	130
6.3	Data Collection .....	132
6.3.1	Study Reports .....	133
6.3.2	Survey with Residents .....	133
6.3.3	Questionnaire with officials from HCWW.....	134
6.4	Calculating the scores .....	134
6.5	Discussion of Results for the three study areas .....	137
6.5.1	El Maadi .....	137
6.5.2	Hadaak El-Koba .....	139
6.5.3	Manshiat Nasser .....	142
6.6	Conclusion .....	144
<b>7</b>	<b>Chapter 7 (Conclusion and Recommendations)</b> .....	<b>145</b>
7.1	Research Finding and Results.....	145
7.1.1	The applicability of the Water Sensitivity Assessment tool.....	145
7.1.2	Connecting water sensitivity and urban patterns.....	151
7.1.3	Water Sensitivity Assessment Tool Efficiency .....	152
7.1.4	The Final Water Sensitivity Assessment Tool .....	153
7.2	Recommendations.....	154
7.2.1	Alternative water resource:.....	156
7.2.2	Involving the Private Sector .....	157
7.2.3	Promoting Public Participation.....	157
7.2.4	Providing Accurate Data .....	157
7.2.5	Blue-Green Infrastructure.....	158
7.3	Suggestions for Future Research .....	158
<b>Appendices</b> .....		
Appendix (1) New Approaches to Sustainable Urban Water Management .....		A-1
Appendix (2) Questionnaire Form for gathering the opinion of experts .....		A-2

Appendix (3) Online Survey with Experts .....	A-3
Appendix (4) Survey Conducted with HCWW officials for Study Areas Assessment .....	A-4
Appendix (5) Survey Conducted with Residents of the Study Areas .....	A-5
<b>Glossary</b> .....	159
<b>Acronyms</b> .....	161
<b>References</b> .....	162
<b>Arabic Summary</b> .....	
<b>Arabic Abstract</b> .....	

## List of Tables

Table 1-1: Principles of Green Infrastructure.....	12
Table 1-2: Benefits delivered by Green Infrastructure systems .....	13
Table 1-3: Decentralized Urban Water Systems proposes multiple benefits .....	15
Table 1-4: UWS dimensions and associated challenges facing decentralized systems. ....	16
Table 1-5: Principles of IUWM.....	17
Table 1-6: Categories of IUWM tools and strategies .....	18
Table 1-7: WSUD principles and objectives .....	20
Table 1-8: Shift in paradigm from conventional to WSUD .....	23
Table 1-9: Tools and Strategies applied within WSUD .....	24
Table 1-10: Benefits delivered by adopting WSUD principles and strategies .....	25
Table 1-11: The main shift in principles from the conventional approach to WSUD.....	27
Table 2-1: Water categories according to Quality.....	31
Table 2-2: Description of Egypt’s six aquifers systems .....	33
Table 2-3: Egypt’s most important Hydropower stations .....	40
Table 2-4: Correlation of WSUD & the Egyptian Residential Water Demand Sector .....	59
Table 3-1: A summary of water-related sustainability goals according to ‘Agenda 21’.....	62
Table 3-2: The European Union Water Framework Directive (EUWFD) Goals.....	63
Table 3-3: Targets of MDG 7 to be achieved by 2015.....	64
Table 3-4: The 12 key principles for water action at 6th World Water Forum.....	64
Table 3-5: Global targets of SDG 6 for the year 2030 .....	65
Table 3-6: Water-Related Sustainability Goals of Egypt Vision 2030. ....	66
Table 3-7: Summary of the WSC Index goals and indicators .....	67
Table 3-8: Components and Sub-components of the Water Poverty Index .....	68
Table 3-9: Indicators of the City Blueprint .....	69
Table 3-10: Components and Parameters of the Watershed Sustainability Index .....	70
Table 3-11: Elements of the Sustainable Cities Water Index .....	70
Table 3-12: Water sustainability indicators from building sustainability rating systems. ....	71
Table 3-13: Water-related sustainability objectives derived from reviewing international agendas and water indices. ....	73
Table 3-14: Goals, Objectives and Indicators of the Ecosystem Dimension .....	75
Table 3-15: Climate hazards and their effects on urban systems. ....	78
Table 3-16: Non-conventional sources of water and their benefits and challenges .....	80

Table 3-17: Some WSUD Treatment Measures and Tools .....	81
Table 3-18: Stages of Public Engagement.....	83
Table 3-19: Benefits of Public Engagement.....	83
Table 3-20: Key players in applying WSUD principles.....	84
Table 3-21: Correlation Matrix of WSUD strategies and sustainability objectives .....	86
Table 3-22: The development of WSUD principles.....	88
Table 4-1: Watershed Health Goals and Objectives.....	93
Table 4-2: Targets and Objectives included in the IWMP of the City of Melbourne .....	96
Table 4-3: WSUD strategies in Melbourne and their corresponding benefits. ....	97
Table 4-4: Qualities of the WSUD champions of Melbourne .....	98
Table 4-5: Enabling variables for the city of Melbourne .....	98
Table 4-6: Results of the study conducted by (Kuller et al. 2018).....	101
Table 4-7: The Water-related sustainability Goals set out by the City of Lima.....	104
Table 4-8: Tools Investigated within SWITCH .....	106
Table 4-9: The issues addressed within the SWITCH project in Lima .....	108
Table 4-10: Objectives of the Children’s park project in Lima.....	111
Table 4-11: The refined and updated assessment tool.....	114
Table 5-1: An example of a criterion score calculation .....	123
Table 5-2: Results of the literature review, international case studies and the survey to determine the final set of Criteria that would compose the WSAT .....	124
Table 5-3: Final Water Sensitivity Assessment Tool .....	127
Table 6-1: Variation in characteristics among the selected study areas .....	131
Table 6-2: Sources of data used to apply the WSAT on the study areas.....	132
Table 6-3: Calculated values of WSAT indicators for each of the three stud areas.....	135
Table 7-1: Impact of urban and social characteristics on Water Sensitivity Dimensions .....	151
Table 7-2: Tool efficiency according to certain characteristics .....	153
Table 7-3: The Final Water Sensitivity Assessment Tool.....	154
Table 7-4: Performance and Priority Actions for the different Urban Residential Patterns...	155
Table 7-5: Matrix of suggested WSUD strategies and water sensitivity criteria .....	156
Table A1-1: Design Objectives of Alternative Techniques.....	A1-4

## List of Figures

Figure 0-1: Research Methodology .....	xiii
Figure 1-1: Chapter (1) components and studies.....	1
Figure 1-2: All Earth's water, liquid fresh water, and water in lakes and rivers .....	2
Figure 1-3: Components of the Natural Water Cycle.....	3
Figure 1-4: Components of the Urban Water System .....	4
Figure 1-5: Resources required for the Urban Water System .....	5
Figure 1-6: Some of the major reasons behind the failure of the traditional UWS.....	6
Figure 1-7: Classification of urban water management terminology, based on their specificity and their primary focus.....	9
Figure 1-8: The GI is composed of a network of hubs and links. ....	11
Figure 1-9: Cascade model for linking ecosystems to human well-being.....	11
Figure 1-10: Disciplinary domains relevant to hybrid water systems .....	14
Figure 1-11: Pillars of the Water Sensitive City .....	21
Figure 1-12: Urban Water Management Transitions Framework .....	22
Figure 1-13: Basic steps of WSUD frameworks .....	26
Figure 1-14: Suggested framework for developing Water Sensitivity Assessment Tool.....	28
Figure 2-1: Identifying the Egyptian water mass balance .....	29
Figure 2-2: Egypt's total renewable freshwater and non-conventional water resources versus the total water demand (2016-2017).....	30
Figure 2-3: Egypt's water resources, renewable water resources and non-conventional water resources. ....	31
Figure 2-4: Groundwater Aquifers in Egypt .....	32
Figure 2-5: Average annual rainfall in Egypt (mm).....	34
Figure 2-6: The 'Water Comb' concept. ....	36
Figure 2-7: The water demand sectors in Egypt.....	37
Figure 2-8: Two main approaches to the water-energy nexus.....	39
Figure 2-9: Fresh water consumption in Egypt by different municipal user groups for the year 2011/2012 .....	41
Figure 2-10: Increase in the Egyptian Residential Water Demand from 2002 to 2017 .....	42
Figure 2-11: Global population and water withdrawal (by sector) over time. ....	43
Figure 2-12: Urban Population Percentage of Total Population (Global and Egypt). ....	44
Figure 2-13: Users' complaints regarding residential water service for Cairo.....	46

Figure 2-14: Percentage of non-revenue water nationally and in Cairo:.....	46
Figure 2-15: Water tariffs as a percentage of average monthly GDP. ....	47
Figure 2-16: Share of different micro-components of the Domestic water consumption.....	47
Figure 2-17: Per capita daily residential consumption of some countries.....	48
Figure 2-18: Urban Patterns and process, the examples provided are not exhaustive. ....	49
Figure 2-19: Residential Urban Patterns Characteristics.....	49
Figure 2-20: Urban Pattern Metrics related to Urban Form and the Built Environment.....	50
Figure 2-21: Urban Pattern Metrics related to Social and Demographic Characteristics. ....	53
Figure 2-22: Examples of inefficient consumer behavior .....	55
Figure 2-23: The new NASA forecasts of how global temperature and precipitation might change up to 2100.....	57
Figure 3-1: Methodology for identifying WSUD Strategies and WS Assessment Criteria ....	60
Figure 3-2: Sustainability Agendas and Indices reviewed in this study.....	61
Figure 3-3: Water Sustainability Goals suggested for the Assessment Tool .....	72
Figure 4-1: Methodology for refining the tool .....	89
Figure 4-2: Location and Map of the City of Portland .....	90
Figure 4-3: Stages and Steps in the Watershed Management Process .....	92
Figure 4-4: The key milestones of integrating GI systems in Portland including pioneering projects and policies .....	94
Figure 4-5: Map of the City of Melbourne.....	95
Figure 4-6: WSUD technologies and strategies in Melbourne.....	100
Figure 4-7: Map of Lima, Peru.....	102
Figure 4-8: Wastewater treatment plants in Lima. ....	103
Figure 4-9: Wastewater reuse projects in Lima and Callao according to SWITCH .....	105
Figure 4-10: Phases in the LiWA scenario process.....	107
Figure 4-11: Water-related changing forces .....	108
Figure 4-12: Example of using GIS to offer design recommendations within LEIS-tool.....	109
Figure 4-13: Poverty Map Metropolitan Lima, 2012. ....	110
Figure 4-14: Unequal water distribution in Lima.....	110
Figure 4-15: Wastewater Treatment Park – Children’s Park August 2014.....	110
Figure 4-16: Design of the Eco-Productive Park in Villa El Salvador.....	112
Figure 5-1: Survey Methodology .....	116
Figure 5-2: The most frequent water issues in the residential sector based on the respondents’ experience.....	118

Figure 5-3: The degree of influence of some factors on the Urban Water Cycle.....	120
Figure 5-4: The degree of significance of water-related sustainability objectives according to the respondents. ....	121
Figure 5-5: The suitability of some strategies in achieving the sustainability objectives and their aptness to the Egyptian context according to the respondents. ....	122
Figure 5-6: Scores of the three suggested reference levels .....	126
Figure 6-1: Study areas assessment methodology .....	130
Figure 6-2: Methodology for case studies selection .....	131
Figure 6-3: The three selected study areas are located in the Cairo Governorate .....	132
Figure 6-4: A map of El Maadi area Showing land use distribution.....	137
Figure 6-5: The water sensitivity criteria scores for the study area El Maadi.....	138
Figure 6-6: A map of Hadaak El-Kob area Showing land use distribution.....	140
Figure 6-7: The water sensitivity criteria scores for the study area Hadaak El-Kob.....	141
Figure 6-8: A map of Manshiat Nasser area Showing land use distribution.....	142
Figure 6-9: The water sensitivity criteria scores for the study area Manshiat Nasser.....	143
Figure 7-1: Comparison of the overall score between the three study areas and the suggested threshold values .....	146
Figure 7-2: Comparison between the areas' performance in the Ecosystem dimension.....	147
Figure 7-3: Comparison between the study areas' performance in the UWS dimension.....	148
Figure 7-4: Comparison between the study areas' performance in the Social dimension .....	149
Figure 7-5: Comparison between the areas' performance in the Resilience dimension .....	150
Figure 7-6: Comparison between the study areas' performance in the Urban dimension .....	150
Figure A1-1: Diagram of the flow of resources according to UHA.....	A1-2

## الملخص

يقف العالم على حافة أزمة مياه ، ويعد وضع المياه في مصر من بين الأكثر خطورة على مستوى العالم. مواجهة أزمة المياه الوشيكة يتطلب منهج جديد ومبتكر لإدارة المياه في المناطق الحضرية ، و رفع درجة الاستدامة المائية بها. لتسهيل عملية تطبيق و اعتماد مبادئ الاستدامة المائية في السياق السكني المصري ، تقترح هذه الدراسة أداة لقياس الكفاءة الاستهلاكية للمياه في المناطق السكنية المختلفة. تعتمد أداة القياس المقترحة على فرضية أنه من أجل تحقيق الاستدامة ، يجب ألا نركز على التكنولوجيا نفسها ، بل يجب علينا البحث عن الفوائد والخدمات التي توفرها تلك التكنولوجيا.

نعتمد الأداة المقترحة على ثلاثة ركائز رئيسية: (أ) أهداف / معايير الاستدامة المائية ؛ (ب) الأنماط العمرانية المؤثرة على الاستدامة ؛ و (ج) استراتيجيات والتكنولوجيات. حيث تمثل الأهداف والمعايير الحالة المطلوبة أو الوضع الأمثل. بينما تمثل الأنماط العمرانية خصائص الواقع المحلي المتوقع أن تؤثر على استدامة المياه. وأخيرًا ، فإن الاستراتيجيات والتكنولوجيات هي المجموعة الممكنة من الحلول المناسبة لحالة معينة أو تصميم معين لتعزيز استدامته المائية. يمكن استخدام الأداة المقترحة من قبل المخططين والمصممين العمرانيين لإجراء تقييم للوضع الحالي وتحديد أفضل الحلول الممكنة قياس التقدم نحو الاستدامة المائية.

لضمان موضوعية الأداة المقترحة ؛ تم إجراء استبيان مع الخبراء من مجالات إدارة المياه والتصميم العمراني. تناول الاستبيان ثلاث نقاط رئيسية: العوامل المؤثرة على الاستهلاك السكني للمياه، وأهداف ومعايير الاستدامة، وآليات و استراتيجيات تحقيق الاستدامة المائي. بناءً على نتائج الاستبيان ، تم تطوير الشكل النهائي للأداة وتعيين الأوزان النسبية لمعايير التقييم.

وأخيرًا ، تم استخدام الأداة لقياس استدامة المياه في ثلاث مناطق دراسية (المعادي وحدائق القبة ومنشية ناصر). تم اختيار مناطق الدراسة لتمثيل الاختلافات في الخصائص العمرانية والاجتماعية التي تم تحديدها في الأجزاء السابقة من البحث. ثم تم جمع البيانات لكل منطقة واستخدامها لحساب درجات استدامة المياه. تم عرض النتائج ومناقشتها فيما يتعلق بسياق كل منطقة ، وتمت مقارنة أداء حساسية المياه في مناطق الدراسة الثلاثة.

في الختام ، تم تطوير واختبار "أداة تقييم استدامة المياه" للمناطق السكنية. وتساعد هذه الأداة في تحديد المناطق ذات الأولوية والإجراءات التي تتطلب استجابة فورية. كما تساعد هذه الأداة في توجيه عملية اتخاذ القرار من خلال تحقيق التوازن بين الأهداف واختيار استراتيجيات التدخل الأنسب لكل حالة.



## المستخلص

يعرض هذا البحث أهمية اتباع منهج جديد ومبتكر لإدارة المياه في المناطق الحضرية، لرفع درجة الاستدامة المائية بها. ولتسهيل عملية تطبيق و اعتماد مبادئ الاستدامة المائية في السياق السكني المصري ، تقترح هذه الدراسة أداة لقياس الكفاءة الاستهلاكية للمياه في المناطق السكنية المختلفة. نعتمد الأداة المقترحة على ثلاثة ركائز رئيسية: (أ) أهداف / معايير الاستدامة المائية ؛ (ب) الأنماط العمرانية المؤثرة على الاستدامة ؛ و (ج) استراتيجيات والآليات المناسبة للحالات المختلفة. ويمكن استخدام الأداة المقترحة من قبل المخططين والمصممين العمرانيين لإجراء تقييم للوضع الحالي وتحديد أفضل الحلول الممكنة قياس التقدم نحو الاستدامة المائية.

ولذلك يعتمد البحث على المنهج التحليلي من خلال رصد وتحليل مبادئ وأهداف الاستدامة المائية المرتبطة بالواقع المصري، وآليات واستراتيجيات التعامل مع المناطق السكنية ذات الخصائص العمرانية والسكنية المختلفة، ويعتمد ذلك على دراسة تجريبية نظرية تعتمد على مجموعة من المبادئ والأهداف التي تساهم في تقييم الاستدامة المائية، ودعم عملية اتخاذ القرار من خلال تحديد الأولويات والمفاضلة بين إيجابيات وسلبيات آليات التعامل.

## الكلمات الدالة

- التصميم العمراني ذو الحساسية المائية
- معايير التقييم
- أهداف الاستدامة المتعلقة بالمياه
- ادارة المياه
- العوامل المؤثرة
- استهلاك المياه في القطاع السكني

## الموافقة و الاعتماد

### الاستدامة المائية في المناطق السكنية

(اداة لقياس الكفاءة الاستهلاكية للمياه)

رسالة مقدمة كجزء من متطلبات الحصول على درجة الماجستير  
في التخطيط الإقليمي و العمراني

قسم التصميم العمراني  
تخصص التصميم العمراني

أسم الباحثة

م/ نوران مصطفى محمد  
معيدة بقسم التصميم العمراني

المحكم الخارجي: أ.د/ أحمد محمد سعيد شلبي	كلية الهندسة - جامعة القاهرة
المحكم الداخلي: أ.م.د/ محمد رضا حجاج	كلية التخطيط العمراني - جامعة القاهرة
المشرف الرئيسي على الرسالة: أ.د/ هشام محمد البرملجي	كلية التخطيط العمراني - جامعة القاهرة
المشرف المشارك على الرسالة: أ.م.د/ مروة سيوييه حامد	كلية التخطيط العمراني - جامعة القاهرة
المشرف المشارك على الرسالة : أ.م.د/ نهى أحمد عبد العزيز	كلية التخطيط العمراني - جامعة القاهرة



جامعة القاهرة  
كلية التخطيط العمراني و الإقليمي

الاستدامة المائية في المناطق السكنية  
(اداة لقياس الكفاءة الاستهلاكية للمياه)

رسالة مقدمة كجزء من متطلبات الحصول على درجة الماجستير  
في التخطيط الإقليمي و العمراني

قسم التصميم العمراني

اسم الباحث

نوران مصطفى محمد  
معيده بقسم التصميم العمراني

تحت إشراف

أ.د/ هشام محمد البرملجي

أستاذ بقسم التصميم العمراني  
و وكيل الكلية لشئون التعليم و الطلاب  
كلية التخطيط الإقليمي و العمراني

أ.م.د/ نهى أحمد عبد العزيز

أستاذ مساعد بقسم التصميم العمراني  
كلية التخطيط الإقليمي و العمراني

أ.م.د/ مروة سيبويه حامد

أستاذ مساعد بقسم التخطيط العمراني  
كلية التخطيط الإقليمي و العمراني

يوليو 2019