Green façade at urban scale: Constructive and microclimate effects

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Introduction

Lack of vegetation in urban area ended up many damages like public health issues, urban run off, high urban temperature and finally UHI. The objective of this study is to figure out a sustainable and applicable solution to mitigate the high urban temperature caused by urbanization process in highly dense area in Ho Chi Minh city in Vietnam.

Reasearch questions:

• What are the aspects of urbanization that alter the urban temperature negatively?

Methodology

The methodology of this study includes diverse steps beginning from reviewing literatures done around this topic and rising understanding and knowledges to apply, gathering spatial and metereological data required, and application of the gathered data on the QGIS software and finally the simulation of the mean radiant temperature and analyzing the results by the use of SOLWEIG tool and raster statistical analyze tool to figure out the temperature differnce by the implementation of greenery on the urban







- How the application of green façade can contribute to the thermal comfort?
- Up to what extend the green façade is able to alter the urban temperature?

Literature review

Urbanization and its consequences:

Rapid urbanization has caused changes to the urban temperature due to the increasing human activities, changes in wind pattern, dimnishing the vegetation and changes in landuse type, and so forth. Increasing urban temperature and rapid urbanization ended up to damages namely:

- Increasing pan evaporation in urban area [1]
- Increasing evaporation due to land cover changes[2]
- Urban runoff due to the changes in soil characteristics. [3]
- Higher energy demand for cooling [4]
- Public health issues and death due to heat stroke. [5]

Green façade varsities worldwide:



building surface.

Case study

The chosen case study for this research in located in highly dense area in Ho Chi Minh city in Vietnam, district 1 and 11, with tropical hot and humid weather condition. The case studies include narrow alley and dnesly built up area with a mix of residential and commercial building.



District 1, Ho Chi Minh City [7]

District 11, Ho Chi Minh City [7]



Scenario: Green facade in urban renewal in HCMC

Focusing on bringing back the vegetation to the urban area to improve urban sustainability considering:

- Environment
- Aesthetic view

comparison of green wall systems.[6]

Classification of green walls, according to their construction characteristics.[6]

Category	Sub-category	Advantages	Disadvantages	The results of				DEM		g for Is	SVF (sky view	
Direct greening DIRECT GREEN FACADES	Traditional green façade	 No materials for irrigation, supporting Low cost Low environmental burden 	 Limited plant selection/climate adaptability Spontaneous vegetation development Scattered growth along surface 	Thermodynamic simulation: First method			mete	DSM meteorological data Emissivity		Parameters utilizing SOLWEIG in QG		DSM DSM bedo	
				The r	esults of first anal	ytical method							
a)b) Indirect greening	Continuous guiders	 Vegetation development guidance Low water consumption 	 Limited plant development Slow surface coverage High environmental burden of some materials 	Faça	ade Emiss	vity Albed	District 1	MRT District 1	Ma 1 MF Dis	RT N Strict 1	Minimum MRT District 1	Maximum MRT District 11	Mini MR7 Dist
	Modular trellis	Lightweight support	High installation cost	EXIS	ting 0.85 de	0.50	35,19	34,94	37,	,83 3	33,26	37,56	31,9
		 Vegetation development guidance Controlled irrigation/drainage Easy to assemble and maintenance 	 Limited plant selection High environmental burden of some materials 	Gree faça	en 0.95 de	0.3	32,53	32,67	34,	,54 2	29,18	35,23	28,4
				MR1 diffe	- rence		2.66	2.77	3.2	29 4	1.08	2.33	3.48
CONTINUOUS LIVING WALL	Felt pockets vertical gardens	 Uniform growth Flexible and lightweight Increased variety of plants Uniform water distribution 	 Complex implementation High water consumption Frequent maintenance 	Seco	nd method The sa paramet the first n	Parame ame ers as hethod	ters Points intere	s of est	Te th cc	emperatu e applica onsidering	re differer tion of gre g distance facade	ce due to en façade s from the	
				The results of second analytical method			od, district11	, district11 The re			results of second analytical method, district1		
Modular system	Trays	 Easily disassembled for maintenance Increased variety of plants Controlled irrigation and drainage 	 Limited space for root development High installation costs Complex implementation Surface forms limited to travs dimensions 	Point 1	MRT for the existing façade 34.75	MRT for the green façade 33.24	MRT difference 1.51	Poin 1	t MR exis 35.0	T for the sting façad 08	MRT fo le the gre façade 33.12	r MRT en differe 1.96	ence
	 Planter tiles Increased variety of plants Attractive design of modules 	 High installation costs Complex implementation Limited space for root 	2 3	34.48 34.27	32.12 31.32	2.36 2.95	2	34.8 34.8	88 80	32.43 32.09	2.45 2.71		
	Flexible bags Adaptive to sloped surfaces Gevel		 development Surface forms limited to tiles dimensions High installation costs Heavier solution due to growing media/limited to building maximum load 	 De-Fang, F. <i>et al.</i> (2022) Ali, A.K.M. and Ramahi, F.K Jiang, Y., Fu, P., & Weng, Q. <i>Heat Island impacts US EF</i> Lee, Y. Y., Din, M. F. M., Por Manso, M., & Castro-Gome KGBauko Institute, 2023 	"Effect of urbanization on the long-term cha M.A. (2020) "A study of the Effect of Urbanizati (2015). Assessing the impacts of Urbanization-A A. (2022, September 2). US EPA. <u>https://www.e</u> raj, M., Noor, Z. Z., Iwao, K., & Chelliapan, S. (20 s, J. (2015). Green wall systems: A review of the	nge in pan evaporation: A case st on on Annual Evaporation Rates in Ba ssociated Land Use/Cover change on pa.gov/heatislands/heat-island-impac 17). OVERVIEW OF URBAN HEAT ISLA r characteristics. <i>Renewable & Sustain</i>	dy of the Nanpan River Basin in C hdad City Using Remote Sensing," <i>Irac</i> and surface temperature and surface S ID (UHI) PHENOMENON TOWARDS HL <i>able Energy Reviews, 41</i> , 863–871. <u>htt</u>	nina," <i>Ecological Indicators</i> , 14 gi <i>Journal of Science</i> [Preprint]. Av moisture: a case study in the Mide MAN THERMAL COMFORT. <i>Enviro</i> <u>ps://doi.org/10.1016/j.rser.2014</u> .	5, p. 109631. Ava ailable at: <u>https://c</u> western United Sta onmental Engineeri 07.203	ailable at: https://doi.org/10.	.1016/j.ecolind.2022.109631. 8.29 . 80–4898. https://doi.org/10.339 . 16(9), 2097–2111. https://doi.o	/ <u>rs70404880</u> 3/10.30638/eemj.2017.217	
	Category Direct greening Direct Green Facades () Direct Green Facades () Direct Green Facades () Direct Green Facades () () () () () () () () () ()	Category Sub-category Direct greening Traditional green façade Indirect greening Continuous guiders Indirect greening Modular trellis Indirect greening Modular trellis Indirect greening Felt pockets output Felt pockets outp	Category Sub-category Advantages Direct greening Traditional • No materials for irrigation, supporting Indirect greening • Low cost • Low cost Indirect greening • Continuous • Vegetation development Indirect greening • Uightweight support • Vegetation development Indirect greening • Uightweight support • Vegetation development Indirect greening • Uightweight support • Vegetation development Indirect greening • Vegetation development • Vegetation development Indirect greening • Vertical gardens • Increased variety of plants Increased variety o	Category Sub-category Advantages Disadvantages Direct greening Traditional green facade * No materials for irrigation, supporting • Limited plant • Limited plant * Uniferct greening • Low environmental burden • Low environmental burden • Soptaneous vegetation development • Soptaneous vegetation development * Indirect greening Continuous • Vegetation development guidance • Limited plant development * Modular trellis • Lightweight support • Slow surface coverage • High environmental burden * Modular trellis • Lightweight support • Vegetation development • High environmental burden • Continuous system • Continuous system • Lightweight support • High environmental burden • Modular system Felt pockets • Uniform growth • Easity disassemble and maintenance • Complex implementation • Modular system If • Irrays • Easity disassemble for maintenance • High installation costs • Increased variety of plants • Increased variety of plants • High installation costs • Complex implementation • Ingin installation costs • Increased variety of plants •	Category Sub-category Advantages Disadvantages Diract greening memory Traditional green façade • No materials for irrigation, supporting Low cost • Limited plant • Sub-category First Indirect greening memory Continuous guiders • Vegetation development guidance • Limited plant development Scattered growth along surface • Limited plant development surface • Limited plant development socate coverage Indirect greening memory Continuous guiders • Vegetation development guidance • Limited plant development socate coverage • High environmental burden of some materials Modular trellis • Lightweight support Vegetation development guidance • Lightweight support • Vegetation development guidance • Lightweight support • Vegetation development guidance • Limited plant selection • High environmental burden of some materials • Limited plant selection • High environmental burden of some materials • Reg i aga Continuous system 1 Felt pockets 1 • Uniform growth • Flexible and lightweight • Uniform water distribution • Complex implementation • High installation costs • Frequent maintenance • High installation costs • Frequent maintenance 1 1 • Controlled irrigation of modules • Limited space for root development • High installation costs • Complex implementation • High installation costs • Co	Category Sub-category Advariages Disadvariages The results of the	Category Sub-category Advanages Disadvanages Direct greening merce reservation matrixed participation subject of the subject of the subj	Category Sub-category Advantages Disadvantages Diffect greening green lacade u Traditional green lacade u No materials for inigation, support tow cost Image for the cost sub-cost of the cost	Category Sub-category Advantages Disadvantages Direct greening unconservation Offendional green highed unconservation No materials for impain supporting . Limited plant adection(Limite daptability . Someworks wegatation surface The results of Thermodynamic surface DBM Indirect greening unconservation . Vegetation development guidens . Limited plant development guidens . High environmental burden of some materials . High environmental burden of some materials . Existing Green 0.85 0.50 3.3 3.2,657 Corthuous system undertainage Flazde and lightweight trainatestance . Uniform water distribution trainatestance . Limited space for root development trainatestance . Uniform mater distroot trainatestance . Complas	Category Sub-category Advantages Disadvantages Direct grooning met newstanding groon floaded upper newstanding upper n	Category Sub-category Advantages Disadvantages Direct greening put rest restance under details of inguide under	Category Sub-category Advantages Disadvantages Direct greening memory and the present fination and the present fination with the present fination	Catagory Sub-catagory Advantages Disadvantages Disadvantages Treationality Treationality All contages All contages Definition of the part index of the

- Urban temperature reduction
- Functional aspects of greenery in urban area
- New technologies of green system regarding the application and maintenance



Façade	Emissivity	Albedo	MRT District 1	MRT District 11	Maximum MRT District 1	Minimum MRT District 1	Maximum MRT District 11	Minimum MRT District 11
Existing façade	0.85	0.50	35,19	34,94	37,83	33,26	37,56	31,94
Green façade	0.95	0.3	32,53	32,67	34,54	29,18	35,23	28,46
MRT difference			2.66	2.77	3.29	4.08	2.33	3.48

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