

LB/Don/76/2016
AR 02/27

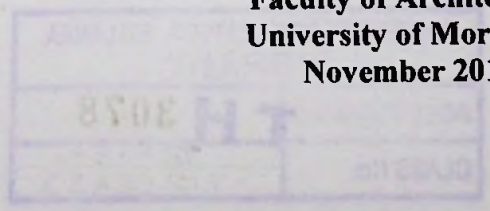
SUSTAINABILITY IN LANDSCAPE DESIGNS WITH SPECIAL REFERENCE TO LANDSCAPE MATERIALS

LIBRARY
UNIVERSITY OF MORATUWA, SRI LANKA
MORATUWA

A Dissertation Submitted
for the Degree of Master of Landscape Design
At the University of Moratuwa
In November 2013



E.M.M.S Ekanayake
Department of Architecture
Faculty of Architecture
University of Moratuwa
November 2013



72° 13"
712 (043)


TH 3078

TH 3078

Declaration

I hereby declare that this dissertation represents my own work, except where due acknowledgement is made. It has not previously included in a thesis, dissertation or report submitted to this university or any other institution for any degree, diploma or other qualification.

UOM Verified Signature


E.M.M.S Ekanayake
M.Sc. in Landscape Design
Department of Architecture
Faculty of Architecture
University of Moratuwa
November 2013

Forwarded by:

.....
Prof. Shiranee Balasuriya
Supervisor – MSc. Dissertations
Department of Architecture
Faculty of Architecture
University of Moratuwa

Acknowledgement

I wish to express my sincere gratitude to following for their valuable assistance and helpful ideas which gave me much encouragement to make this dissertation a reality.

First of all I wish to acknowledge Prof. Shiranee Balasooriya and Landscape Archt. Susira Udalamaththa for their unique support for this dissertation.

Secondly, my heartiest thankfulness goes to Dr. John Byrom for his valuable guidance given at every stages of this study. I gratefully acknowledge Landscape Archt. Shereen Amendra, Landscape Archt. Sujani Pilapitiya , Landscape Archt. Chamara Liyanage and Landscape Archt. Gihan Muthugala for their support and guidance.

I thank my friends Bandula, Damith, Poornima, Ruvani and Damayanthi for helping me in various ways.

Finally I am grateful to thank all others who supported me in every possible way to make this study success.

CONTENTS

Declaration	i
Acknowledgement	ii
Table of Contents	iii
List of Figures	vi
Abstract	viii
Introduction	ix
Chapter 01	01
Environmental impacts of landscape materials used in landscape designs in Sri Lanka.	
1.1 Ecological and economical impacts of plant species in landscape designs	01
1.1.1 Invasive Plant Species	01
1.1.2 Some Poisonous Plants of Sri Lanka	04
1.2 Common hard landscape materials	05
1.2.1 Trends in consumption	06
1.2.3 Environmental Impacts and Embodied Energies	09
1.3 Recycling and Reuse	11
1.3.1 Recycling of steel	11
1.3.2 Reuse of Steel	11
1.3.3 Recycling and Reuse of Concrete	11
1.3.4 Recycling of Concrete	12
1.3.5 Reuse of Concrete	12
Chapter 02	13
Concept of Sustainability and Sustainable Landscape Designs	
2. 1 Concept of Sustainability	13
2.1 .1 Definition	13
2.1.2 History	13
2.2 Sustainable landscape	14
2.2.1 Sustainable landscape principles	14
2.2.2 Sustainable landscape materials and techniques	15

2.2.2.1 Green Roofs	15
2.2.2.1.1 Extensive Green Roofs	16
2.2.2.1.2 Intensive Green Roofs	17
2.2.2.1.3 Potential Benefits	18
2.2.2.2 Green Walls	18
2.2.2.3 Green Façades	19
2.2.2.4 Living Walls	20
2.2.2.5 Permeable Pavements	21
2.2.2.6 Permeable Asphalt	22
2.2.2.7 Permeable Concrete	23
2.2.2.8 Storm water Run-off Infiltration Systems	24
2.2.2.9 Bioretention Basins/Rain Gardens	24
2.2.2.10 Vegetated Swales	24
2.2.2.11 Rainwater Harvesting	25
2.2.2.12 Constructed Wetlands	26
2.2.2.13 Xeriscaping	28
2.2.2.13.1 Technical Description	28
2.2.2.13.2 Planning & Design	29
2.2.2.13.3 Soil Improvement	29
2.2.2.13.4 Minimizing Turf	30
2.2.2.13.5 Appropriate Plant Selection	30
2.2.2.13.6 Efficient Irrigation	30
2.2.2.13.7 Use of Mulch	31
2.2.2.13.8 Maintenance	31
2.2.3 Sustainable landscape maintenance	32
2.2.4 Benefits of sustainable landscaping	32
Chapter 03	34
Case Studies.	
3.1 Sigiriya	34
3.2 Havelock City Project	38

Chapter 04	42
Conclusions	
Bibliography	43

List of Figures

Figure 01-Sources of emissions of air pollutants

Figure 02-Seasonal nitrate variations in shallow sand aquifers in Sri Lanka in areas under intensive fertilized irrigation

Figure 03-Noise levels of various equipments

Figure 04-Pesticide cycle

Figure 05 -*Ageratina riparia*

Figure 06-*Lantana camara*

Figure 07- *Salvinia molesta*

Figure 08-*wedelia trilobata*

Figure 09 - Hard landscape materials and their uses

Figure 10 - Trends of World and US Steel and Cement consumption

Figure 11- World and U.S. CO2 emissions due to steel and cement consumption

Figure 12- World per capita production of steel and cement

Figure 13- Projections of production

Figure 14- Embodied energy of materials per unit weight

Figure 15- Emission per unit weight of different structural construction materials

Figure 16- Extensive Green Roof on Chicago City Hall

Figure 17- Green Walls (Econoplas, 2007)

Figure 18- Living Billboard (Laumer, 2009)

Figure 19- Porous Concrete Sample (TecEco)

Figure 20 - Permeable vs. Impervious Asphalt (Adams, 2003)

Figure 21 - Porous Asphalt System (Smart Planet, 2009)

Figure 22 - Permeable Concrete vs. Conventional Asphalt (NRMCA, 2009)

Figure 23 - Vegetated Swale Example (Alameda, 2006)

Figure 24 - Rainwater Harvesting System (Zhang, 2008)

Figure 25 - Difference between ST, SSF, and VF Wetlands (Ghermandi, 2007)

Figure 26- Xeriscaping Example (Fuller, 2010)

Figure 27- The Sigiriya palace complex

Figure 28- Water gardens of Sigiriya

Figure 29- Water gardens of Sigiriya

Figure 30- Boulder gardens of Sigiriya

Figure 31- Boulder gardens of Sigiriya

Figure 32- Terrace gardens of Sigiriya

Figure 33- *Hamelia patence*

Figure 34 - *Scaveola thkkada*

Figure 35- *Arintinia asiatica*

Figure 36- Concrete pathways of Havelock City Project

Figure 37- Outdoor gymnasium of Havelock City Project of Havelock City Project

Abstract

In chapter 01, Environmental impacts of landscape materials used in landscape designs in Sri Lanka such as concrete, steel, timber, glass, clay and plants are described. In this chapter, the effect of exotic plants on eco systems and ecological influences of hard landscape materials are discussed.

The concept of Sustainability and Sustainable Landscape Design are explained in Chapter 02. Sustainable landscape materials and techniques are further discussed in this chapter.

Chapter 03 contains case studies. The traditional Sri Lankan landscape of Sigiriya and the modern Sri Lankan landscape of the Havelock city project are presented in ecological review in this chapter.

The study concludes in chapter 04 by emphasizing the importance of the use of sustainable materials and techniques in landscape designs. The environmental, economic and social consequences of ignoring resource depletion, global warming and associated climate change are likely to be the defining world issues of the 21st century and there is a strong link between such adverse environmental change, and potential social and economic collapse. After 150 years of industrialization, the developed world is it seems, principally responsible for the higher global temperatures that we are experiencing today through increased CO₂ and other greenhouse gas emissions. This rise in temperature and the subsequent changes in climate are set to profoundly alter the world's ecosystems, the places we live, and ultimately, how we live in the world. We must ensure that we move quickly to a more sustainable way of living.

The term of sustainability is defined as "improving the quality of human life while living within the carrying capacity of supporting eco-systems". Unsustainable practices have badly impacted on ecosystems and environments. The use of the sustainability concept in the landscape industry is mainly concerned in this study.