

INFLUENCE OF URBAN LAKESCAPES IN MITIGATION OF MENTAL FATIGUE OF CITY DWELLERS: WITH SPECIAL REFERENCE TO SOUTH WEST BEIRA, DIYAWANNA, AND KANDY LAKE

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Abstract

The "urban lakescape" can be interpreted as a place where there is water and natural features in an urban setting. Mental fatigue mainly caused by urban-related causes is a major concern for the well-being of city dwellers. This study hypothesizes that the lakescapes can play a role in minimizing the mental fatigue of city dwellers by providing a restorative environment.

Therefore, this study focuses on identifying a set of urban lakescape attributes in urban waterbodies in two main cities in Sri Lanka (Colombo and Kandy) that can contribute to lowering mental fatigue. City dwellers' behavioral qualities and the above-mentioned attributes were used to formulate a theoretical framework to assess the impact of these elements on reducing mental fatigue.

A pilot study was carried out to identify the case study areas and three case studies (Colombo suburbs, Colombo inner city, Kandy inner city) were selected. The field study consisted of photographs, map analysis, and site observations to identify the influential factors on mental fatigue that were presented in the lakescape. A questionnaire was used to identify their level of mental fatigue and how it was affected by the lake scapes.

The results indicate that existing characteristics of lakescapes generally mitigate the mental fatigue of city dwellers. However, some characteristics (water quality, visual naturalness of water) need to be improved and some characteristics (sceneries of densified built forms) need to be minimized.

On this basis, it is recommended that a design strategy be used to develop lakescapes by largely maintaining the existing characteristics but improving the necessary characteristics as mentioned above to strengthen the positive mood states and minimize the mental fatigue of the city dwellers

Keywords: landscape, urban lakescape, city dwellers, mental fatigue, mitigation of mental fatigue

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Introduction

Urban lakescapes and mental fatigue of city dwellers

City dwellers (CD) in major cities in Sri Lanka tend to spend a large portion of their time indoors or in transit which may lead to mental fatigue. Mental fatigue (MF) is a health effect leading to different mental health problems among CD. Exposure to natural features can help us to reduce MF. Although urban landscape consists of a lot of man-made features, several natural features such as open green spaces, and water bodies can be seen in urban landscapes.

Urban lakescape is a socio-functional space for people-centered around open blue and green spaces that are surrounded by the built-up urban landscape. It is a type of space that most of the CD visit and influence in mitigation of MF. This study hypothesizes that the lakescapes can play a major role in minimizing the fatigue of CD by providing a restorative environment. To test that the study will first identify the UL attributes that affect the MF and then check their scale of impact in the Sri Lankan context. Due to the time and accessibility limitations imposed by the Covid pandemic case studies were limited to Colombo and Kandy and some of the interviews were carried out online.

Literature Review

Mental fatigue

MF is the main type of health impact (Velarde, Fry, and Tveit, 2007) and a common occurrence in modern life (Boksem, Meijman, and Lorist, 2005). The contemporary lifestyle has moved the CD away from natural landscapes and is frequently exposed to stimuli that might create MF (Luo, Xie, and Furuya, 2021). MF is a highly common phenomenon that can have significant effects on how well tasks are performed in the modern world (Boksem, Meijman, and Lorist, 2005). Fatigued people often report having trouble concentrating and paying attention to the work at hand.

Changes in mood, motivation, and information processing are signs of MF. Mood states may be influenced by MF and therefore mood scales can be used to measure MF. Visual Analogue Mood Scale (VAMS) (Fig. 1) is used to measure mood (Jaydari Fard and Lavender, 2019), and the Visual analogue scale (VAS) (Fig. 2) is used to measure pain (Huang *et al.*, 2020) can be adapted to measure (as a scale) the fatigue level as well.

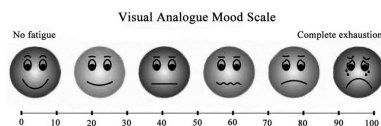


Figure 63: Visual Analogue Mood Scale (VAMS). Before and after each phase, participants' feelings about MF were assessed using VAMS (Jaydari Fard and Lavender, 2019).

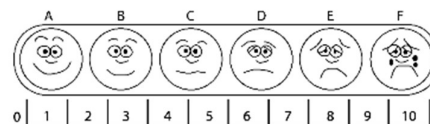


Figure 64: Visual analogue scale (VAS) used to measure pain levels (Huang *et al.*, 2020)

The level of pain shown in VAS (Huang *et al.*, 2020) can be codified as; 0 no pain, 1-3 Moderate and tolerate pain, 4-6 Evident pain but tolerate, and 7-10 Progressively intensive pain that is intolerable. So, combining the above 2 scales Scale for measuring metal fatigue can be developed which is indicated in Table 1.

Table 8: Ranges that show the level of mental fatigue

Range	Level of the pain
0	No fatigue
1-30	Moderate and tolerate fatigue
40-60	Evident fatigue but tolerate
70-100	Progressively intensive fatigue that is intolerable

Source: compiled by the author

Then people have to maintain their level of MF between 0-30. People who are in between the 40-60 range, need few treatments to mitigate their MF, and people who are in between the 70-100 range, need more treatment to mitigate their MF.

Moreover, Jaydari Fard and Lavender(2019) claimed people's positive and negative signs when fatigued. Due to that fatigued people can be identified in their behavior. "Concentration", "Energetic", "Feeling confident" and "Talkative" are identified as less fatigued, and "anxious", "Irritable", "Nervous" and "Sleepy" are identified as more fatigued.

Natural elements as influential factors in mitigating mental fatigue

Spending time in a natural landscape may help the body and mind recover from MF. Exposure to natural environments also helps most people's moods and focus, which is good for their psychological welfare (Greenwood and Gatersleben, 2016). Wilkie et(2020) stated that being in nature lessens bad moods and increases happy moods.

Green space (parks, urban forests, etc.) and blue space (water bodies), two major categories of environment, have won praise for their ability to restore wellness in urban settings (Luo, Xie, and Furuya, 2021). Empirical data also suggests that people are more likely to recover from their favorite landscape when they are fatigued (van den Berg, Koole, and van der Wulp, 2003). People who live in a building with lots of natural vegetation (trees and grass) tend to be less aggressive and violent than those who do not. So natural features in buildings can influence people's behavior positively, as shown by Berto et al (2010) as well.

Urban lakescape and the city

Urban lakes are essential for enhancing the city's biological environment and emphasizing its unique characteristics. Four main functions of UL can be identified: ecological, aesthetic, recreation, spiritual, and cultural.

There are two types of city lakescape composition; material and non-material. Urban lakescape consists of a lake body, lake surface, lake wetland, and lakefront area (Wu and Xie, 2011). The shape, sound, color, shadow, and external visual components of water in almost every lake give it, its unique personality and style (Bi, 2016). Its distribution is as fig.3;

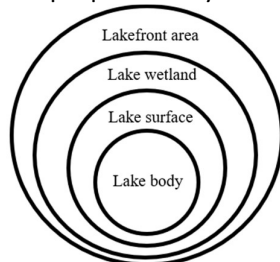


Figure 65: Distribution of UL (Wu and Xie, 2011)

The Lakefront is impacted by social and economic activities and the primary location for influencing the landscape is the green area of the lakefront (Bi, 2016). Biodiversity, lake beach, and islets with grasses can be seen in lake wetlands. The lake's surface is bearing water volume, water environment, and hydrology (Wu and Xie, 2011). While the CD immensely benefits from ULs it must be noted that a large number of UL in the developing world including Sri Lanka are highly polluted.

Urban lakescape attributes an influential factor in mitigating mental fatigue

People are most likely to recover from their preferred landscape when they are fatigued. The scenery of huge bodies of water like lakes is preferred by people (Luo, Xie, and Furuya, 2021). People's environmental preferences depend on environmental characteristics that may have functional value for the perceiver, such as restoring water quality (Kaplan, 1980). According to the above findings, it can be hypothesized as fig.4:

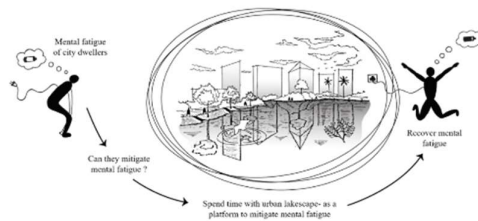


Figure 66: Urban lakescape as a platform to mitigate mental fatigue
 Source; compiled by the author

All of the water's visible surface in space is described as blue space and UL can be considered as an open blue space (Völker and Kistemann, 2011). Urban waterways can be recognized as a beneficial amenity for improving the quality of life in neighborhoods. Certain landscape characteristics of blue spaces might improve aesthetic preference or mental restoration to reduce MF brought on by focus.

Landscape characteristics that can influence MF:

- | | |
|--|--|
| <ul style="list-style-type: none"> • landscape elements • color contrast • percentage of vegetation cover • land vegetation types • perceived vegetation diversity • vegetation maintenance • percentage of water | <ul style="list-style-type: none"> • visual naturalness of water • accessibility of water • water quality • number of aquatic plants • man-made elements • water movement <p style="text-align: right;">(Zhao <i>et al.</i>, 2013)</p> |
|--|--|

In addition to that open blue spaces can provide an environment for fauna (birds etc.) and which in turn can also as a restorative element (Zhao, Xu, and Ye, 2018).

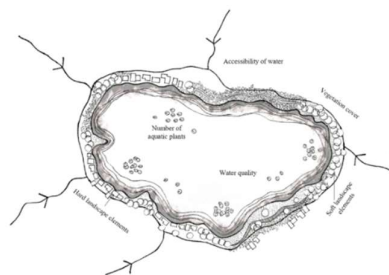


Figure 67: Map of urban lakescape that shows characteristics of UL
 Source; compiled by the author

Therefore, the qualities of water bodies, such as their quality, visual naturalness, and accessibility, are connected to the mental restoration of urban park blue space(UPBS) (Luo, Xie, and Furuya, 2021). Poor water quality brings back unpleasant odors in the minds of observers and lessens the attractiveness of UPBS and people like bodies of water with high quality and attractive natural characteristics(Zhao, Xu, and Ye, 2018). So, the qualities of the natural environment encourage a restorative experience, which can assist people in recovering from MF(Luo, Xie, and Furuya, 2021).

Moreover, Luo et al.(2021) stated that good water quality, the visual naturalness of water, and high vegetation diversity are preferred, and man-made elements as well as natural elements should be balanced to enhance the visual quality of UPBS.

Underlying theories and concept of the study

• Attention Restoration Theory (ART)

According to the ART, surroundings rich in natural components can help people recover from the MF brought on by urban environments(Wilkie *et al.*, 2020). For cognitive functioning, ART has emphasized the significance of recovering from MF and has proposed four components:

- fascination
- being away
- extent
- compatibility (Luo, Xie, and Furuya, 2021).

ART holds that environments with a greater presence and diversity of nature should be more restorative due to the inherently fascinating attributes they have. The main characteristic of a restorative environment is fascination. Fascinating environments stimulate effortless attention and enable directed attention to rest and be restored. Effortless attention can be focused on specific subjects and/or activities. The fascination may also be used to explore and make sense of an environment(Berto *et al.*, 2010).

Therefore, Berto et al (2010) claimed that the fascination factor that influences the MF of people is based on the condition of the environment. It can be a natural or constructed environment. But most of the researchers argue that there is a possibility to be a natural environment that enhances the fascination factor.

Topophilia - It was initially described by Tuan (1999) as the emotional connection that exists between people and a place or environment. A restorative environment is considered to be a place that offers recovery from mental stress or fatigue(Ogunseitani, 2005).According to confirmatory factor analyses, four main domains underlie topophilia: cognitive challenge ,ecodiversity , synesthetic tendency , and familiarity(Ogunseitani, 2005).

Ecodiversity under topophilia theory can increase the restorativeness of urban lakescapes. People can gain psychological well-being by recovering from MF (Ogunseitani, 2005).

Prospect Refuge Theory

Health effects like MF are associated with exposure to various types of landscapes visually(Velarde, Fry, and Tveit, 2007). The visual scale of landscape character can describe through prospect refuge theory(Ode, Tveit, and Fry, 2008). It is based on Appleton's description of the visual landscape, which separates it into prospects, refuges, and risks(Beery, Ingemar Jönsson, and Elmberg, 2015).

• Information Processing Model

Health effects like MF are associated with exposure to various types of landscapes visually (Velarde, Fry, and Tveit, 2007). The scale of the landscape character can be described through an information processing model. It depicts the landscape preference and experiences of people(Ode, Tveit, and Fry, 2008). Individuals prefer landscape scenes with characteristics that make the information offered easier to understand (Gimblett, Itami, and Fitzgibbon, 1985).

Theoretical framework

Table 2:Independent variables of fascination factor (Luo et al., 2021), (Wilkie et al., 2020)

Dependent	Independent
Fascination	<ul style="list-style-type: none"> Water quality Visual naturalness of water Soft landscape elements Hard landscape elements Color contrast Accessibility of water

Table 3:Independent variables of ecodiversity factor

Dependent	Independent
Ecodiversity	<ul style="list-style-type: none"> Percentage of vegetation cover Land vegetation type Number of aquatic plants Percentage of water Environment for bird song Perceived vegetation diversity

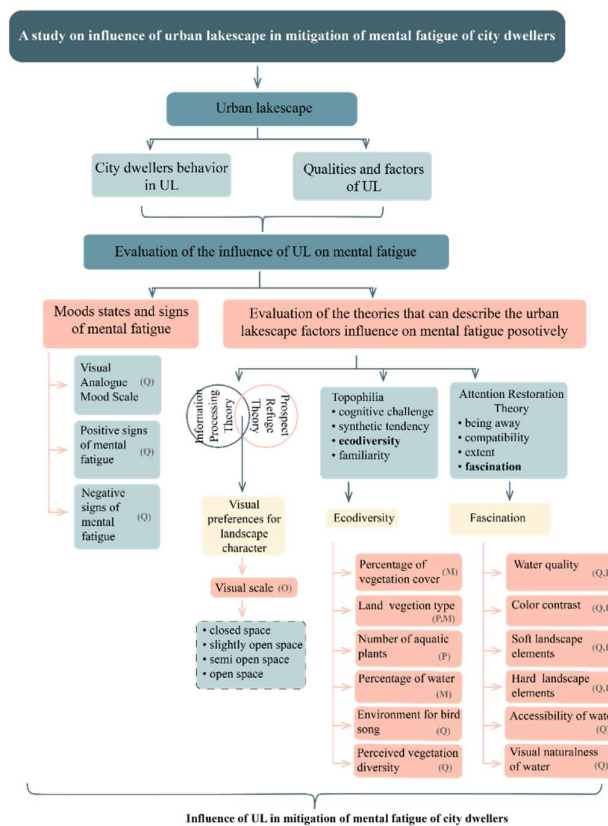
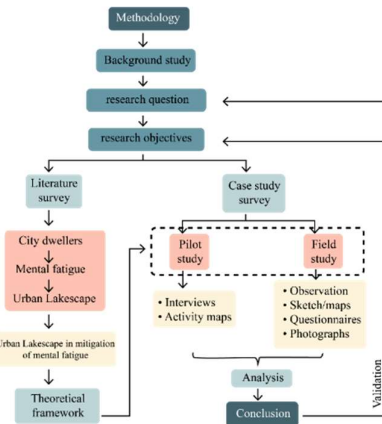


Figure 68: Theoretical framework
 Source; compiled by the author

Table 9:Scores of Characteristics of UL (Luo et al., 2021), (Zhao et al., 2018)

Characteristics of ULL	Scores (showing the order of negative to positive)
Water quality	Bad, moderate, good
Soft landscape elements	No trees, ample amount, somewhat, much
Hard landscape elements	much, somewhat, ample amount, no building
Color contrast	No, weak, clear, sharp
Accessibility of water	No water, difficult, neutral, easy
Percentage of vegetation cover	<25%=low,25-50%=moderate,50%=<=high
Land vegetation type	No vegetation, grasses and shrubs, only trees or tree with grass, mixed vegetation
Number of aquatic plants	None, few, more, almost cover
Percentage of water	<15%=low,15-50%=moderate,50%=<=high
Environment for bird song	Bad, moderate, good
Perceived vegetation diversity	Low, medium, high

Methodology of the Study



The field study program was conducted in the three ULs selected in Colombo, Kandy, and Sri Jayawardhanapura, where CD spent their free time.

ULs were observed on different days and were identified for their unique landscape characteristics and functionality for people. After photographs were taken, sketches were drawn. Maps were developed and analyzed using Adobe Illustrator and AutoCAD software.

Figure69: Methodology chart formulated for the research

Source; compiled by the author

Three separate questionnaires were prepared with the same set of questions for CD in Colombo, Kandy, and Sri Jayawardhanapura. Fifty CD were interviewed through a questionnaire in each UL. The interview checked visitors' improved mood after visiting the lake, comparing it with the original state of the visitors' mood before visiting the lake. And factors that influence MF of CD positively under the theoretical framework were checked. Most of them were interviewed on-site, but some of them were interviewed online to identify their mitigation level of MF after coming to the UL.

- In general, data presentation was done in one of the methods stated in the bar charts and pie charts.
- The photographic analysis was presented as labeled photographs, emphasizing the characteristics of ULs.
- Some sketches of sections were presented for analytical observations.
- Maps were shown in the context of cities and their case studies. And some maps were developed and presented. Analyzed maps of case studies were shown to have some characteristics of ULs.

Case study data analysis and findings

Three urban lakescapes were analyzed for the study. They are South West Beira, Diyawanna and Kandy lake. While two of these lakescapes are in the middle of the cities the third one; Diyawanna is located in rapidly emerging administrative complexes in Sri Jayewardhenapura, the political capital of Sri Lanka. All three lakescapes are popular destinations for city dwellers.

South West Beira (SWB) Lakescape, Colombo – Case study 1

Introduction of case study



Figure 70: Map of SWB
Source: Compiled by Author

Beira Lake in Colombo has 3 segments (South West Beira, East Beira, West Beira) and of these, the SWB is selected for the case study as it provided better accessibility and functionality for the city dwellers as compared to others. It is located in the heart of Colombo city. Due to urbanization, lake water is highly polluted. However, this lakescape supports a diverse range of flora and fauna that merge with the water.

The behavior of city dwellers in lakescape

- 1. VAMS** - People's mood states were measured through the questionnaire by interviewing CD. Their mood state was recorded between happy and neutral after coming to Beira.
- 2. Positive and negative signs of MF** - Positive and negative signs of MF were measured through the questionnaire by interviewing people. The greatest number of CD felt energetic after spending time in Beira and most of them showed positive signs of MF.

Analysis of characteristics of UL

- 1. Water quality** - Water quality was measured through a questionnaire and photographic analysis. And most of CD are not satisfied with the water quality of the lake.
- 2. Color contrast** - Color contrast was measured through a questionnaire and photographic analysis. People like to see colorful sceneries with the sunset and 64% of people strongly like to see colorful sceneries in the evening.
- 3. Soft landscape elements** - According to photographic and map analysis, an ample amount of soft landscape elements (eg: trees, shrubs, grass) can be seen around the lake. And 50% of people like to see the soft landscape elements that surround the lake.
- 4. Hard landscape elements** - According to photo and map analysis, many hard landscape elements (eg: houses, religious buildings, commercial buildings) are located around the surrounding environment. An equal amount of people ok's to see and don't like to see hard landscape elements.
- 5. Accessibility of water** - The accessibility of water was measured through the questionnaire and observation. Easy to access due to Gangarama Simamalakaya on the lake and boating facilities. But 34% of people like to visit the lake due to accessibility and 32% of people are neutral with the argument in the questionnaire.
- 6. Visual naturalness of water** - It was measured through the questionnaire. Most of them don't like to enjoy the visual naturalness of water.
- 7. Number of aquatic plants** - It was measured through photographic analysis. More aquatic plants can be captured. Some Heliconia and Cana varieties are floating on water and act as water-purifying plants.

8. Land vegetation type - It was measured through photographic analysis. The land vegetation type is mixed vegetation including plants, shrubs, and trees.

9. Perceived vegetation diversity

It was measured through the questionnaire Most city dwellers perceived vegetation diversity as medium diversity and they expect more vegetation around the lake.

10. Environment for bird song

It was measured through the questionnaire .46% disagree and 40% of people strongly disagree to listen to birds' songs because most of the birds around the lake are crows.

11. Percentage of water

$$\frac{(\text{Area of water cover}) \times 100\%}{\text{Area of lakescape}} = 84.4\%$$

The area of lakescape and area of water cover in South West Beira was measured through AutoCAD. It was measured for the map analysis.84.4% is the existing percentage and it is a good amount because it should be present above 60%.

12. Percentage of vegetation cover

$$\frac{(\text{Area of vegetation cover}) \times 100\%}{\text{Area of lakescape}} = 12.2\%$$

It was measured through the map analysis using AutoCAD.12.2% is the existing percentage and it is lower than 25%.

13. Visual scale

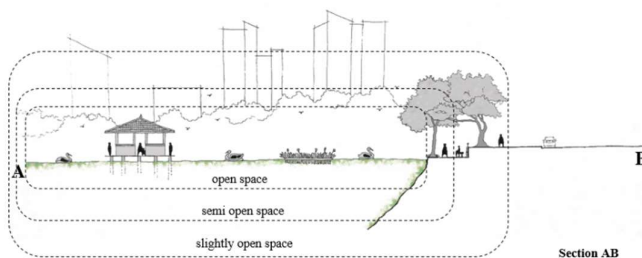


Fig. 71: Section of SWB
 Source: Compiled by author

This was measured through on-site observation. There are four measures for visual scale; closed space, slightly open space, semi-open space, and open space. This section shows how CD uses Beira lakescape according to visual scale and hasn't closed spaces. A few numbers of them use semi-open spaces and slightly open spaces. Most of the CD use open spaces (lake).

Analysis of the link between UL characteristics and CD

According to the above findings, three characteristics under the fascination factor are present in the lakescape.

- Soft landscape elements
- Accessibility of water
- Color contrast

And three characteristics under the eco-diversity factor present in lakescape.

- Land vegetation type
- Number of aquatic plants
- Percentage of water

Open space (Beira lake) is a visual scale under the visual preference for landscape characters in lakescape.

CD in Beira showed positive signs of MF but most of their mood states were between happy and neutral. So, they have to improve their mood states to mitigate MF.

Table 10: Characteristics that can improve in South West Beira lakescape
 Source: Compiled by author

factors of UL	characteristics of UL	description
fascination	water quality	must improve
	visual naturalness of water	
	hard landscape elements	must lower the visual sceneries of compacted buildings towards lakescape
ecodiversity	environment for bird song	can create the environment for bird song
	percentage of vegetation cover	must improve by adding more vegetation
	perceived vegetation diversity	must improve by adding more vegetation
The visual scale of the landscape character	visual scale <ul style="list-style-type: none"> • Semi-open space • slightly open space 	can strengthen the functionality of these spaces

That restorative environment in lakescape can be developed while improving other characteristics under visual preference of landscape character, ecodiversity, and fascination factor and maintaining existing characteristics mentioned.



Figure 72: Presence of factors that can influence MF positively as the design intervention (fascination, ecodiversity, visual scale of landscape character)

Source: Compiled by author

According to the research, missing factors in SWB can be implemented through a design. And some aspects of design that are valued by visitors in the existing lakescape can be preserved as it is for the mental well-being of the people. It can be demonstrated in fig.10;

Kandy Lakescape – Case Study 2

Introduction of case study

Kandy Lake is a man-made lake located in Kandy City. It is also known as the Sea of Milk. It was built by King Sri Wickrama Rajasinghe and is situated near the Temple of the Tooth.

The lake environment has shady pathways with trees such as *Ficus benjamina*, *Shorea robusta*, *Albizia saman*, etc. This space is a place for walking, sitting, and enjoying the scenery of the city and mountains. And it is a habitat for different kinds of birds.



Figure 73: Map of Kandy lakescape
 Source: Compiled by author

Due to urbanization, lake water is polluted, but it doesn't emit a bad odor. People can't drink water, but this water is used for different activities such as boating and passive recreation. And there is no fishing allowed on this protected lake.

The behavior of city dwellers in lake scape

1. **VAMS** - Most of CD's mood state was recorded as happy after coming to Kandy lakescape.
2. **Positive and negative signs of MF** - Most of them showed positive signs of MF after spending time in the Kandy lakescape.

Analysis of characteristics of UL

1. **Water quality** - 30% of people are satisfied with the water quality of the lake and 50% of people are neutral (ok) with the water quality of the lake.
2. **Color contrast** - People like to see colorful sceneries with the sunset and 46% of people strongly like to see colorful sceneries in the evening respectively.
3. **Soft landscape elements** - According to photographic analysis, much of the soft landscape elements (eg: trees, shrubs, grass) can be seen around the lake. 48% of people strongly like to see and 38% of people like to see soft landscape elements that are surrounded by the lake.
4. **Hard landscape elements** - According to photo analysis, many hard landscape elements (eg: houses, religious buildings, commercial buildings) are located around the surrounding environment. An equal amount of people ok's to see and don't like to see hard landscape elements.
5. **Accessibility of water** - People are walking and sitting around the lake. And the lake is provided boating facilities. So easy to access the water actively and passively. So, it motives to come to the lake and 54% of CD agree and 14% of them strongly agree with this argument.
6. **Visual naturalness of water** - 32% of CD strongly like and 50% like to enjoy the visual naturalness of water.
7. **Number of aquatic plants** - Few aquatic plants can be captured. Few Cana varieties are floating on water and act as water-purifying plants.
8. **Land vegetation type** - It is mixed vegetation with trees, grasses, and shrubs.
9. **Perceived vegetation diversity** - Most of CD perceived vegetation diversity as high diversity.
10. **Environment for bird song** - There are several bird species found on the lake, including the Indian cormorant, white egret crane, wood stork, and pelican. And most of CD like to listen to bird's song. 16% of people strongly prefer it and 42% of people prefer to listen to bird's songs.

11. Percentage of water

$$\frac{(\text{Area of water cover}) \times 100\%}{\text{Area of lakescape}} = 87.3\%$$

The area of the lake scape and the area of water cover in Kandy were measured through AutoCAD. 87.3% is the existing percentage and it is a good amount because it should be present above 60%.

12. Percentage of vegetation cover

$$\frac{(\text{Area of vegetation cover}) \times 100\%}{\text{Area of lakescape}} = 17.1\%$$

17.1% is the existing percentage and it is lower than 25%.

13. Visual scale

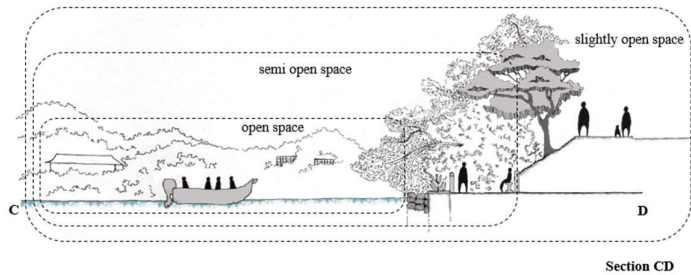


Figure 74: Section of Kandy lakescape
 Source: Compiled by author

This section shows how CD uses Kandy lakescape according to visual scale and hasn't closed spaces. Most of them use semi-open spaces and slightly open spaces. Few numbers of people use open spaces (lakes).

Analysis of the link between UL characteristics and CD

According to the above findings, four characteristics under the fascination factor are present in the Kandy lakescape.

According to the above findings, four characteristics under the fascination factor are present in the Kandy lakescape.

- Visual naturalness of water
- Soft landscape elements
- Accessibility of water
- Color contrast

And four characteristics under the ecodiversity factor present in lakescape.

- Land vegetation type
- Perceived vegetation diversity
- Environment for bird song
- Percentage of water

Slightly open space and semi-open space are the visual scale under the visual preference for landscape character in Lakescape.

CD in Kandy showed positive signs of MF and most of their mood state was happy. So, their mitigation level of MF is good but the restorative environment in the lakescape can be developed while improving other characteristics under visual preference of landscape character, ecodiversity, and fascination factor and maintaining existing characteristics that are mentioned for better recovery.

Table 11: Characteristics that can improve in Kandy lakescape
 Source: Compiled by author

Factors of UL	Characteristics of UL	Description
fascination	water quality	must improve
	hard landscape elements	must lower the visual sceneries of compacted buildings
ecodiversity	number of aquatic plants	can improve by adding plants
	percentage of vegetation cover	must improve by adding more vegetation
The visual scale of the landscape character	visual scale • open space	can strengthen the functionality of the space



Figure 75: Presence of factors that can influence MF positively as the design intervention (fascination, ecodiversity, visual scale of landscape character)

According to the research, missing factors in the Kandy lakescape can be implemented through a design. And some aspects of design that are valued by visitors in the existing lakescape can be preserved as it is for the mental well-being of the people. It can be demonstrated in fig.13.

Diyawanna Lakescape, Colombo – Case Study 3

Pilot study for case study selection

Earlier, Diyawanna was acting as a water fortress and showing wetland characteristics. It is located in Sri Jayewardenepura Kotte. There are eight islands in this lake. Due to the construction of the Sri Lankan Parliament Building on a man-made island in the middle of the lake, it is popular.

Diyawanna lakescape is a diversified area with different flora and fauna. Diyasaru Park, the National Sandalwood Garden, Beddagana Wetland Park, and Diyatha Uyana Park are some places that provide accessibility to people for recreation. Among them, Diyatha Uyana Park and lake are the places that most of them visit, as well as being considered a lakescape in an urban context. Therefore, it was taken into consideration.

Introduction of case study

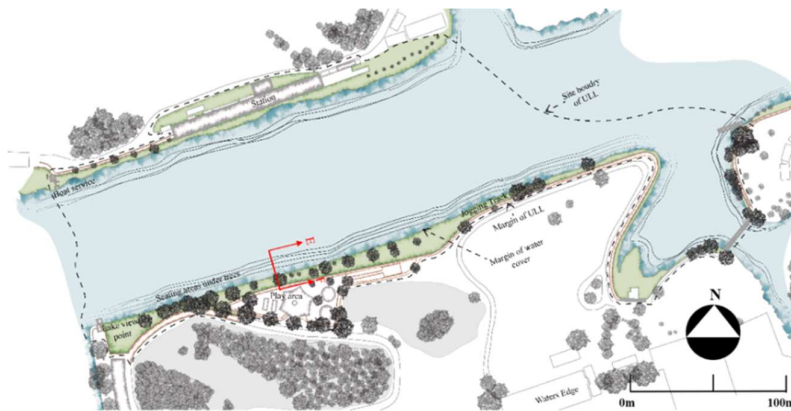


Figure 76: Map of Diyatha Uyana lake
Source: Compiled by author

Near the Water's Edge Hotel in Battaramulla, at the Polduwa junction, is where you may find Diyatha Uyana. On marshy land by the Diyawanna lake, the park has been developed. It was opened on September 15, 2012, and was constructed along the bank of Diyawanna Lake.

The behavior of city dwellers in lakescape

1. VAMS - 54% of CD changed their mood state to no fatigue after coming to Diyawanna lake.

2. Positive and negative signs of MF - The equal amount of CD felt energetic and focused after spending time in the lakescape.

Analysis of characteristics of UL

1. Water quality - Due to urbanization, the water quality of the lake is dirty but at a considerable level. And most people are satisfied with the water quality of the lake.

2. Color contrast - 52% of people like to see colorful sceneries with the sunset and 40% of people strongly like to see colorful sceneries in the evening respectively.

3. Soft landscape elements - An ample amount of soft landscape elements (eg: trees, shrubs, grass) can be seen around the lake. 48% of people strongly like to see and 38% of people like to see soft landscape elements that surrounded the lake.

4. Hard landscape elements - Few amounts of hard landscape elements (eg: houses, religious buildings, commercial buildings) are located around the surrounding environment. Most people like to see hard landscape elements located around the lakescape.

5. Accessibility of water - People are walking and sitting around the lake. And the lake is provided boating facilities. So easy to access the water actively and passively. So, accessibility of water motives to come to the lake and 52% of them agree and 28% of them strongly agree with this argument.

6. Visual naturalness of water - Most of CD (52%) strongly like to enjoy the visual naturalness of water.

7. Number of aquatic plants - Few aquatic plants can be captured but they are in different varieties.

8. Land vegetation type - It is mixed vegetation with trees, shrubs, grass, and plants.

9. Perceived vegetation diversity - Most of CD's perceived vegetation diversity is high diversity.

10. Environment for bird song - There are several bird species found on the lakescape. And most of CD like to listen to bird song. 53.1% of people strongly prefer and 42.9% of people prefer to listen to bird songs.

11. Percentage of water

$$\frac{(\text{Area of water cover}) \times 100\%}{\text{Area of lakescape}} = 76.5\%$$

76.5% is the existing percentage and it is a good amount because it should be present above 60%.

12. Percentage of vegetation cover

$$\frac{(\text{Area of vegetation cover}) \times 100\%}{\text{Area of lake landscape}} = 13.4\%$$

13.4% is the existing percentage and it is lower than 25%.

13. Visual scale

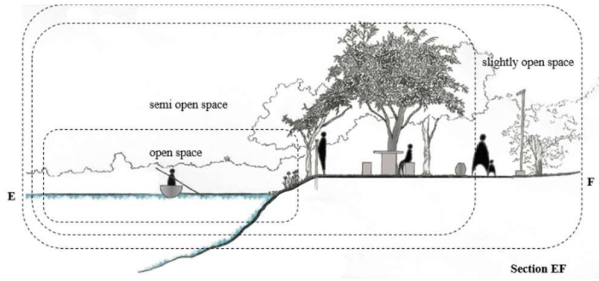


Figure 77: Section of Diyawanna lakescape
 Source: Compiled by author

This section shows how CD use Kandy lakescape according to visual scale and hasn't closed spaces. Most of them use open spaces and semi-open spaces. Few numbers of CD use slightly open spaces. Therefore, open spaces and semi-open spaces in Diyawanna influence on MF of CD under the visual scale.

This section shows how CD use Kandy lakescape according to visual scale and hasn't closed spaces. Most of them use open spaces and semi-open spaces. Few numbers of CD use slightly open spaces. Therefore, open spaces and semi-open spaces in Diyawanna influence on MF of CD under the visual scale.

Analysis of the link between UL characteristics and CD

According to the above findings, six characteristics under the fascination factor are present in the Diyawanna lakescape.

- Water quality
- Visual naturalness of water
- Soft landscape elements
- Hard landscape elements
- Accessibility of water
- Color contrast

And five characteristics under the ecodiversity factor present in lakescape.

- Land vegetation type
- Perceived vegetation diversity
- Environment for bird song
- Percentage of water

Slightly open space, semi-open space, and open space are the visual scale under the visual preference for landscape character in lakescape.

CD in Diyawanna showed positive signs of MF and most of the mood state was no fatigue. So, their mitigation level of MF is good but the restorative environment in the lakescape can be developed while improving other characteristics under ecodiversity and fascination factor and maintaining existing characteristics that are mentioned for better recovery.

Table 12: Characteristics that can improve in Diyawanna lakescape
 Source: Compiled by author

Factors of UL	Characteristics of UL	Description
ecodiversity	Number of aquatic plants	Can improve by adding plants
	Percentage of vegetation cover	Must improve by adding more vegetation



Figure 78: Presence of factors that can influence MF positively as the design intervention (ecodiversity)
 Source: Compiled by author

According to the research, missing factors in the Diyawanna lakescape can be implemented through a design. And some aspects of design that are valued by visitors in the existing lakescape can be preserved as it is for the mental well-being of the people. It can be demonstrated in fig.16;

Discussion

As mentioned in the introduction, this study hypothesizes that the lakescape can minimize the MF in CD by providing a restorative environment. So, the research problem is "How does UL mitigate the mental fatigue of city dwellers?". These are research questions.

- What is the impact of UL on the MF of CD?
- Does UL in Sri Lanka impact the MF of CD?
- What kind of landscape attributes (water, soft landscape elements, hard landscape elements) can help to reduce MF?
-

It was helped to identify their level of MF through mood states (VAMS) and positive and negative signs of MF.

According to the below graph, most of the CD in South West Beira, Kandy, and Diyawanna showed positive signs of MF. But their mood states changed as fig.18.

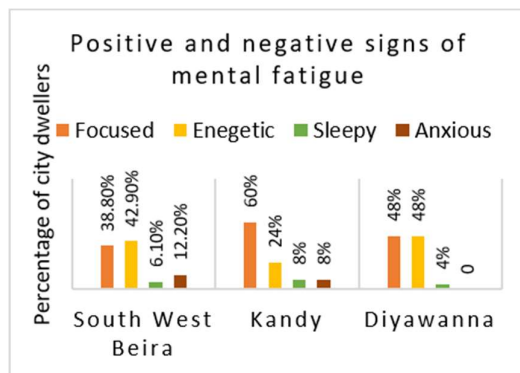


Figure 79: Positive and negative signs of MF
 Source: compiled by the author

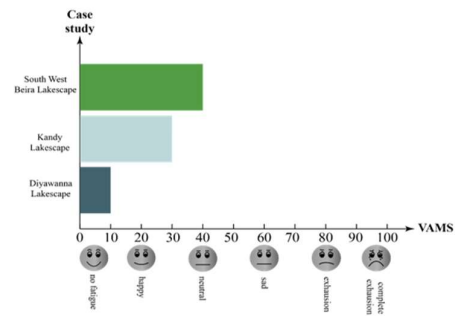


Figure 80: Moods states of CD in lakescapes
 Source: Compiled by author

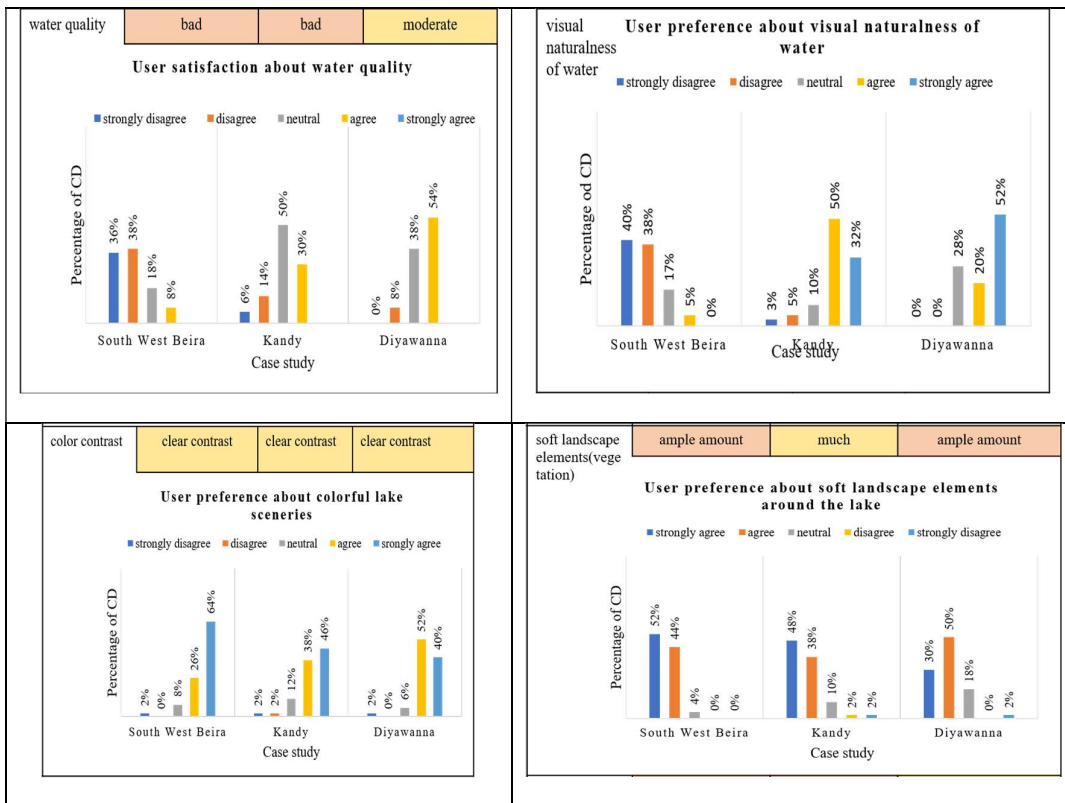
By CD Diyawanna and Kandy showed no fatigue and happy moods respectively and they are not signs of MF. Therefore, Diyawanna and Kandy have the potential to mitigate MF. But CD in South West Beira shows mood states between happy and neutral. It is a sign of MF and must be minimized. So, they want an improved lakescape to minimize MF.

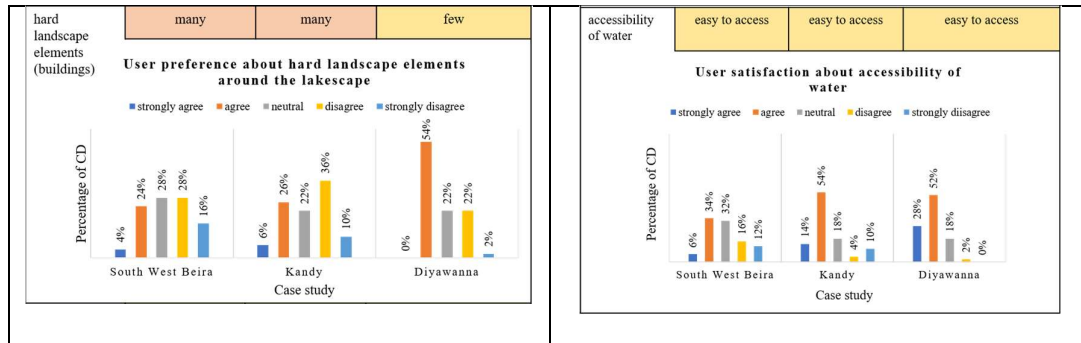
Table 13:CD behavior in UL
 Source: Compiled by author

CD behavior in UL	South West Beira	Kandy	Diyawanna
Mood states	Between happy and neutral	happy	No fatigue
Positive and negative signs of MF	Positive signs of MF were shown	Positive signs of MF were shown	Positive signs of MF were shown
Mitigation level of MF	Must improve	good	better

And also, the collected data supported the identification of qualities and factors of UL that influence MF positively. There are three factors were mentioned in the theoretical framework and under those factors, thirteen characteristics of UL were discussed. Six characteristics were measured under the fascination factor in every lakescape.

Table 14:Characteristics of fascination factor of lakescape
 Source: Compiled by author





According to this table, South West Beira lake water is polluted and CD are not satisfied with the water quality. Although lake water is polluted in Kandy lake people are satisfied with the water quality. Diyawanna lake water quality is good in condition than other lakes and people are satisfied. Although most of CD in South West Beira don't like to enjoy the visual naturalness of water most of CD in Kandy and Diyawanna like to enjoy the visual naturalness of water. Every lakescape shows colorful sceneries in the evening and most of CD in every lakescape prefer to see it.

All CD in lakescape like to see soft landscape elements around the lake but South West Beira and Diyawanna has ample amount of soft landscape elements. There are many buildings located around the Kandy and South West Beira lakescape and most of the le don't like to see them. But Diyawanna has a few amounts of buildings around the lakescape and CD like to see them. Easy to access to the water and most CD is satisfied with the accessibility of water.

Therefore, highlighted things in yellow color cells in the table should be maintained. And the water quality of South West Beira and Kandy should be improved. Soft landscape elements in South West Beira and Diyawanna should be improved by adding more. Sceneries of hard landscape elements towards the lakescape should be minimized in South West Beira and Kandy. Then fascination factor helped to build a restorative environment to minimize MF of CD.

Table 15: Visual preference for landscape character of CD
 Source: Compiled by author

Factors of UL	Characteristics of UL	South West Beira	Kandy	Diyawanna
Visual preference for landscape character	Visual scale	<ul style="list-style-type: none"> Open space 	<ul style="list-style-type: none"> Slightly open space Semi-open space 	<ul style="list-style-type: none"> Open spaces Slightly open spaces Semi-open spaces

Visual preference for landscape characters is another factor. It was measured through a visual scale. Above mentioned spaces in UL should be maintained to provide a restorative environment for people.

Table 16: Ecodiversity factor of lakescape
 Source: Compiled by author

Factor of UL	Characteristics of UL	South West Beira	Kandy	Diyawanna								
Ecodiversity	number of aquatic plants	more	few	few								
	land vegetation type	mixed	mixed	mixed								
	perceived vegetation diversity	medium diversity	high diversity	high diversity								
	environment for bird song	bad	good	good								
	percentage of vegetation cover	low	low	low								
percentage of vegetation cover in lakescape <p>Legend: South West Beira (green), Kandy (light blue), Diyawanna (dark blue)</p> <table border="1"> <caption>percentage of vegetation cover in lakescape</caption> <thead> <tr> <th>Case study</th> <th>Percentage of vegetation cover</th> </tr> </thead> <tbody> <tr> <td>South West Beira</td> <td>12.20%</td> </tr> <tr> <td>Kandy</td> <td>17.10%</td> </tr> <tr> <td>Diyawanna</td> <td>16.30%</td> </tr> </tbody> </table>					Case study	Percentage of vegetation cover	South West Beira	12.20%	Kandy	17.10%	Diyawanna	16.30%
Case study	Percentage of vegetation cover											
South West Beira	12.20%											
Kandy	17.10%											
Diyawanna	16.30%											
	percentage of water cover	high	high	high								
Percentage of water cover in lakescape <p>Legend: South West Beira (green), Kandy (light blue), Diyawanna (dark blue)</p> <table border="1"> <caption>Percentage of water cover in lakescape</caption> <thead> <tr> <th>Case study</th> <th>Percentage of water cover</th> </tr> </thead> <tbody> <tr> <td>South West Beira</td> <td>84.40%</td> </tr> <tr> <td>Kandy</td> <td>76.50%</td> </tr> <tr> <td>Diyawanna</td> <td>87.30%</td> </tr> </tbody> </table>					Case study	Percentage of water cover	South West Beira	84.40%	Kandy	76.50%	Diyawanna	87.30%
Case study	Percentage of water cover											
South West Beira	84.40%											
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Diyawanna	87.30%											

According to table 11, highlighted things in yellow color cells should be maintained, and highlighted things in pink color cells should be strengthened by adding new characteristics (vegetation, aquatic plants) to create a restorative environment.

In summary, seven characteristics in South West Beira, five characteristics in Kandy, and three characteristics in Diyawanna should be improved. By existing condition of the lakescape can be interpreted as follows.

Table 17: Existing condition of lakescape
Source: Compiled by author

Qualities and factors of UL	South West Beira	Kandy	Diyawanna
Existing condition	Must improve	Good	Better

These existing conditions are similar to the mitigation level of MF. Hence UL can play a major role in minimizing the MF of CD by providing a restorative environment. And the visual preference for landscape character, ecodiversity, and fascination factors helped to build restorative UL for CD and influence MF positively.

Conclusion

The results of this study indicate how ULs in Sri Lanka influence the mitigation of MF of CD. Findings show that Kandy and Diyawanna lakescapes have restorative environments to reduce MF. And the South West Beira lakescape must improve its environment for a better recovery of MF.

The mentioned lakescapes show different mitigation levels of MF and it is similar to the existing condition of lakescapes. Therefore, this study shown how CD reduce their MF after spending time in UL. According to the previous literature, researchers addressed open blue spaces and their impact on mental health. But this research discussed MF with ULs to fill the research gap. ART, PRT, IPT, and Topophilia theory were used to identify factors of UL that influenced MF. VAMS, positive and negative signs of MF were helped to identify CD behavior in UL. So, the developed theoretical framework can be applied to every ULs in the world to check whether they can influence the mitigation of MF or not.

Further research is needed to formulate design and improvement strategies for urban lakescapes that will positively contribute to reduce the MF of CD.

Opportunities and Future Recommendations

These results can be used as a design strategy to develop ULs by

- maintaining existing characteristics
- lowering some characteristics and
- strengthening new characteristics

of lakescapes to improve positive mood states and positive signs of MF of CD.

This would be a recommendation for future research studies for landscape architects and urban planners to investigate ULs and other different types of urban landscapes about other mental health problems like anxiety, mental disorder, and exhaustion.

Moreover, it provides new directions for future research to manage water quality, restore the ecosystem, adapt to climate change, and develop green infrastructure while protecting the lakescape for urban society.

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