The Effect of Water Bodies as a Determinant Force in Generating Urban Form.

A Study on Creating a Symbiosis between the two with a case study of the Beira Lake, City of Colombo.

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139404R

Degree of Masters in Urban Design

2016

Department of Architecture

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- **WITH A STUDY ON CREATING A SYMBIOSIS BETWEEN THE TWO WITH A CASE STUDY OF THE BEIRA LAKE, CITY OF COLOMBO.**

Water bodies present in Urban Contexts has been a primary determinant force in the urban formation and settlement patterns. With the evolutionary patterns governing the cities, the presence of water bodies has been a primary generator bias, thus being a primary contributor to the character of the city and the urban morphology.

Urban form can be perceived as the pattern in which the city is formed where the street patterns and nodes are created, and the 03 dimensional built forms, which holistically forms the urban landscape. The perception of urban form has also been a key factor in the human response to the built massing, and fabric whereby the activity pattern is derived, with the sociological implications.

DECLARATION

I declare that this my own work and this dissertation does not incorporate without acknowledgment any material previously submitted for a Degree or Diploma in any University or any Institute of Higher Learning and to the best of my knowledge and belief it does not contain any materials previously published or written by another person except where acknowledgement is made in the text.

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ABSTRACT

ABSTRACT

The formation and regeneration of urban form is often a result of the response for the natural geophysical features that are present in an urban context, the subculture of the region, human behavioral patterns and their response. Nevertheless there are primary forces and secondary forces that becomes a resultant of regenerating urban forms in different parameters. In an era of rapid globalization and urban sprawl the need for sustainable urban form has been a widely spoken phenomenon in the last few decades. Regenerating cities in a meticulously planned manner; hence has been of prime importance which otherwise has resulted in many negative implications such as unsightly, polluted and unlivable cities in various parts of the world.

Water bodies and water features that are present in urban contexts has played a significant role in the formation of urban forms which has become the part and parcel of the urban fabric and the morphological patterns.

In regenerating urban form, the response to the natural elements, and the context has been a key feature in forming sustainable urban forms. Which has resulted in habitable, aesthetically appealing and environmentally friendly cities that has formed as functional cities. Such cities also become people friendly cities, with a sense of place and identity.

The human perception on urban forms and built fabric also has been another important dimension in the regeneration of sustainable urban forms and cities.

The core relationship between water bodies and urban forms results in a symbiosis; where if the two are responsive to each other collectively they will result in positive implications in the city. Where the livability the habitability and the urban aesthetics etc. will be enhanced in a significant manner. Hence the two components in an urban context the Urban form and the Water Body will form a Symbiosis where the two will have to co-exist in harmony and the latter will have to be responsive to the former, where the resultant will have positive implications on the city which inevitably will make it livable and sustainable.

A water body in an urban context is a ***static variable*** where the urban forms that are generated around the body are a ***dynamic variable*** unless the water body changes its form. It is also a hydrological urban space.

The study intends to carry out a literature survey of the water bodies and urban form in the European context and the Asian (local) context; where the water itself has played a pivotal role, in the formation of urban settlements. Thereby to develop a set of matrixes to assess the main water body; and its resultant urban form taken in for the case study.

This dissertation intends to carry out a study of the Beira lake Colombo, where the generation of urban form around the water body as a resultant, due to the functional and aesthetic aspects will be assessed where the final objective will be to investigate the merits the city would harness by creating responsive urban forms in relation to the water bodies, and also the non-responsive urban form can be a resultant of many other negative implication into the city.

Key words: Urban Form, Water Bodies, Symbiosis, Built Fabric, Urban Fabric, Urban street scape, built massing, Urban Built Landscape.

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Chapter One: Introduction

1.1. Topic Explanation

The Effect of Water Bodies as a Determinant Force in Generating Urban Form.

- **A Study on Creating a Symbiosis between the two with a case study of the Beira Lake, City of Colombo.**

Water bodies in an urban context play a key role in determining the profile of the urban fabric. As it is a responsive force, where the urban planning and urban design, would be governed by. Hence the response to the water body in generating urban form can create a symbolic relationship between the two key elements in a urban context, where the co-existence of the two in a harmonious manner will result in cities that are liveable, sustainable and environmentally sensitive over a length of time.

The Symbiosis formed between the two key elements of the urban context, will result in determining urban landscape and the built fabric, where the urban morphology will emerge with the urban built landscape, defining the identity of the city.

Hence the core relationship, between the water bodies that are present in urban contexts, and the urban forms are symbolic. Where by the water bodies has been a governing factor in the character of the city, forming a sense of place and a sense of identity. The visual impact of the urban form can often be a collective massing of the built up elements and the open spaces formed due to this massing, where the water features can be one of the determining forces for the built forms and streetscapes. This aspect latterly becomes a contributory factor for urban aesthetics.

Urban form generation is an evolutionary process of the formation of human settlement patterns in the growth of a city.

The formation of a city and its growth depends on many Para-meters, such as the geo physical features, the topography, climate, sociological aspirations, economic needs, and the spiritual aspects etc.

In determining the land use patterns of a city; the geo physical features and the topography plays a key role. The response to water bodies in urban contexts, in an appropriate manner will result in long term benefits for generating sustainable cities and sustainable urban forms which stand out serving the city in many aspects for a length of time, in a harmonious manner, with nature and the resources available. Hence this will have a positive impact in generating liveable cities that are responsive to nature and human habitation.

Which otherwise will result in a dilemma of urban forms and patterns which will have many negative implications resulting in polluted un-inhabitable, un-liveable cities.

Hence the appropriate response to water bodies present in urban contexts, affects the city in many ways. It will have major impact different aspects such as the city's urban character, functionality, identity, harmony with the environment with the built fabric and many other key factors that will bring long term benefits to the city and its community.

Cities that grow from time to time and they keep expanding and sprawling. Hence the consumption and usage of natural resources, to cater to the growing needs of the society may result in land degradation, environmental hazards and catastrophes that make the cities non conducive human habitation.

In this context the response to water bodies present in urban contexts, in the process of generating urban form plays a very important role in the smooth and sustainable functioning of a city.

- What can water bodies do to a city?
  Water bodies in an urban context can be a collection of water in a terrain or basin is it man-made or natural. With the natural flow of water into a basin or terrain which will form water body, in an urban context will be a key component in sustaining a community.

Definition of a Water Body:

- *According to Kathleen (1995) Water Body is a* ***body of water*** *or* ***water body*** *(often spelled* ***water body****) is any significant accumulation of water, generally on a planet's surface. The term most often refers to oceans, seas, and lakes, but it includes smaller pools of water such as ponds, wetlands, or more rarely, puddles. A body of water does*

not have to be still or contained; Rivers, streams, canals, and other geographical features where water moves from one place to another are also considered bodies of water. Most are naturally occurring geographical features, but some are artificial. There are types that can be either. For example, most reservoirs are created by engineering dams, but some natural lakes are used as reservoirs. Similarly, most harbours are naturally occurring bays, but some harbours have been created through construction. Bodies of water that are navigable are known as waterways. Some bodies of water collect and move water, such as rivers and streams, and others primarily hold water, such as lakes and oceans. The term body of water can also refer to a reservoir of water held by a plant, technically known as a phytotelma.(Kathleen T, 1995)

Urban Form:

Urban form is a broad definition of the elements of the city consisting of the built fabric and massing, which collectively gives the formation of the urban fabric.

- *Hence the urban form can be explained as the character of the built objects giving its identity, with as a holistic 03 dimensional object. The shape of the urban scope and its built elements. Hence it can be broadly classified as the profile of the built fabric in a city which gives the city a character and shape (Healy P, 2007).*

Urban M**orphology** is the study of the **form** of human settlements and the process of their formation and transformation. A study on urban morphology seeks to understand the spatial structure and character of a metropolitan area, city, town or village by examining the patterns of its component parts and the process of its development of the massing of buildings and settlement patterns (Conzen & *Alnwick, 1969*).

Urban Form Elements

The form of the town is established in the relation between the outdoors space and Buildings, which exist in a given landscape/soil. These are the elements to be Analysed in their relation to each other and with other urban elements.

• Great distribution of buildings and green areas throughout built and open spaces;

• The infrastructure outlines laying particular streets on the road infrastructure;

• The general definition of building typologies, their forms of association, and Distribution throughout the landscape/soil;

• The three-dimensional urban composition;

• The general reading and readability system for the space arising from the topographic Configuration and landscape characteristics.

Outdoors Space

Considering its morphologic definition, the outdoors space should be analysed.

• Circulation space - the circulation scheme for vehicles and pedestrians, analysed In terms of spatial formal expression as well as its access relations, that is, the roads' Circulation hierarchy and access to activities, type of access network connecting the Roads, their relation with the buildings and outdoors meeting spaces.

• Outdoors meeting space - urban being spaces - analysed based on dimensional Categories related with the type of private or public permanence as well as how they are Linked with the buildings and the spatial circulation system. The analysed categories In these outdoors meeting spaces are those of paved and non-paved (green areas) Spaces, as well as public and private spaces.

Buildings

The buildings are characterized according to their typological definition and forms of Association regarding their relation with outdoors spaces and the way buildings access The outdoors space.

(Valente-Pereira, 1982)

Urban design is the process of designing and shaping cities, towns and villages. In contrast to architecture, which focuses on the design of individual buildings, urban design deals with the larger scale of groups of buildings, streets and public spaces, whole neighbourhoods and districts, and entire cities, with the goal of making urban areas functional, attractive, and sustainable (*Boeing; et al, 2014*)

Urban design is an inter-disciplinary subject that utilizes elements of many built environment professions, including landscape architecture, urban planning, architecture, civil and municipal engineering. It is common for professionals in all these disciplines to practice in urban design. In more recent times different sub-strands of urban design have emerged such as strategic urban design, landscape urbanism, water-sensitive urban design, and sustainable urbanism.

Symbiosis

Symbiosis (from Greek σύν "together" and βίωσις "living") is close and often long-term interaction between two different biological species. In 1877 Albert Bernhard Frank used the word symbiosis (which previously had been used to depict people living together in community) to describe the mutualistic relationship in lichens. In 1879, the German mycologist Heinrich Anton de Bary defined it as "the living together of unlike organisms."

1. the living together in more or less intimate association or close union of two dissimilar organisms (as in parasitism or commensalism); especially : mutualism

2. a cooperative relationship (as between two persons or groups). i.e. the symbiosis…between the resident population and the immigrants

(*Burgess, Jeremy 1994*)

1.2. The need for the Research

Water bodies and urban form has a co-relationship that has existed for many years, where water is an indispensable element for human habitation. Human habitation cannot be sustained without water as a co-element.

Hence in cities water has catered in many aspects, with its contributory factors that stem from the catchment area, which has catered to the cities functional metabolism over the years. In cities that are sustainable and that has existed over length of time the urban form and built massing has been responsive to the water bodies and environmental elements that are present in the context. Hence sensitive urban design and urban planning which is responsive to the important parameters such as the geo physical features, topography, water bodies and climate etc. has been sustainable and liveable for many centuries. (water is an essential part for the human and community needs, and cultural and spiritual aspirations in a habitation.)

Amongst these responsive elements water is one of the key features that co-exist with the urban fabric in sustainable cities. Hence the response to water bodies plays an important role in planning and designing a city and looking after its futuristic needs.

Hence the core relationship between the two elements in and urban context, the urban form and the water bodies, plays an indispensable role in the sustenance of a city.

This coherent relationship will form a ***SYMBIOSIS*** for the healthy existence and sustenance of a city. Nevertheless if this core relationship is ignored, the many negative implications will dominate the sustenance of the city (which can be seen in many parts of the developing world).

Henceforth the core relationship will become indispensable, in generating healthy built form that will be sustainable over a length of time.

"In era of rapid globalization where environmental degradation is taking place at an alarming rate, the need to preserve the urban environments, with developments that are conducive to the region and the climate is a key issue". Land degradations and urban sprawl results in many negative implications those results in making non-conducive environments that are not human friendly and also results in placeless and timeless urban spaces. The response to water bodies and protection of the same with

potential threats due to urbanization is another key issue. Where the responsive urban form in harmony with the water bodies present in the urban context, can mitigate many negative implications that can threaten the well-being off the city (Elisabete, 2005).

"If there was a Paradise it included the whole world, which must be completely made over if we are to find and enjoy it once more"

Fernando Ortiz

The uses of responsive urban form with green spaces that are conducive to the region are of prime importance to the making of people friendly and healthy cities that are conducive for habitation and . healthy urban spaces.

In an era of globalization, the risk of standardization of particular housing/ transportation/ green elements can be a barrier to diversity and the citizen's sense of place. Therefore, today, more than ever, the research and the promotion of responsive urban forms that are sensitive to the local conditions and to the places history and culture assume a special importance. Hence the cities response to the water bodies and the orchestration of the urban fabric plays a key role in this regard.

1.3. Aim and Objectives

The contents of the research.

The research is amiable at investigating in the integration of water bodies and urban form that is generated within the vicinity of the former and the key features that are determinant in generating urban form giving its character and form. Which forms a coherent set of relationships that will benefit the cities in the long run. Hence this relationship between the two will be an indispensable aspect in the development scenarios in urbanism. With the growing population the urbanization taking place at an alarming rate the need for sustainable cities, which are environmentally responsive and sensitive are of prime concern. In this context if the matter is ignored the results can be adverse which will result in un-liveable unhealthy cities.

Hence the integrated usage of water in urbanization in a responsive sensitive manner is a key aspect that needs to be given due consideration, in the present era.

The research intends to carryout studies in cities that has existed for many decades or centuries with their transformations with diverse trends in different eras over the historicism.

- ***This dissertation intends to carry out a research and an in-depth study on the effects of responsive urban forms, to the water bodies that are present in urban contexts with the effects of greening cities creating a climate sensitive healthy built environment with the built fabric in the urban context in harmony with the natural elements in the region, thereby creating urban spaces with a sense of place and a sense of identity.***

URBAN FORM

---------- Co-relationship ----------forms a Symbiosis

WATER BODIES

This research is amiable at integrating the effects of water features present in an urban context. And the generation of urban forms in response to the water bodies, and within the precincts of these water massing. That will thus enable the sustenance of the city. Whereby the city itself becomes responsive to the natural features present in the region. Which will result in a healthy equilibrium between the built fabrics the natural features

Sustainable urban form and its core - relationship to the water features present in the context or vicinity, and the responsiveness of the urban forms would thus be a precipitation of creating healthy livable cities with greener and cleaner environment of planned properly.

In this context the emergence of urban aesthetics that are a direct result of the above scenario, will result in the generation, and of urban forms that enhances the human activities and interrelationships patterns with urban forms and urban contexts.

Nevertheless the urbanization with urban sprawl and the unplanned unhealthy, cities could be contained and mitigated with sustainable urban forms, that can be a metaphor of generating more habitable and human friendly urban form.

Thus the sustainable urban form can be regarded as a unifying thread merging elements in the urban context in a meaningful harmonious manner.

Urban form when defragmented could result many de-compartments, where urban form itself could be a unifying object in merging the elements in a city. (Hedmen, R. Jaszwski, A. 1984)

In generating the urban form it will constitute many fragments:

Some of which can be perceived in the following manner.

- As a 3D object.
- The Visual Aspect.
- The Geo-physical response.
- As a unifying thread.
- As and urban infill.
- As a wind barrier.
- As a part of the built landscapes.

The responsiveness to other elements could again result in, Cities that are harmonized with all elements unified to define a common theme. Thus the built fabric will inevitably result in the unifications and beautifications of a city, where the responsiveness of the functional elements would stimulate the minds of the people and thus will result as a residue of a habitable city.

The aspects of urban form as a visual object and the cohesive response, for the water features embedded in the city, would again create a symbolic meaning in a subtle manner. Where by the cohesion of these elements will also formulate and structure the urban spaces.

The Urban form in responsiveness to energy consumption and climate sensitiveness can further catalyse the resultant sustainable urban formation, whereby the residual effect can thus create a panorama of object beauty in the urban fabric.

1.4. Scope and Limitation

This research will examine the character and possible design approaches responsive to the water bodies in urban contexts. The relationship between urban form and water bodies present will be examined. The urban form around the Beira lake Colombo and its transformation will be considered. The case study will focus most of the elements of physical form rather than socio, cultural aspects. It will address the issues relevant to the character and form of the urban fabric around a water body. Special potentials of water front developments will be identified to guide urban form towards a context responsive design.

Availability of data: Data or information relevant to water body (the level at different seasons), landscape and land use are having several limitations. The scale of secondary data is not detail enough, not frequently updated and difficult to access.

- 1 Research Formulation
- 2 Understand the terminology (Literature review)
- 3 Analysis Issues, potentials, special features, overall context, over all shape and form
- 4 Conclusion and recommendation with Favorable design approaches and guidelines

Background knowledge: Most of the urban design theories, approaches, and principles are not detailed for urban context where water has played a key role in determining the built fabric of the context. There is a need to explore rare resources to accumulate knowledge relevant to water front developments.

Conducting field study: There is a need to carryout wide range of field studies. It requires making photographic survey, observation and site detailing. Aslo monitoring the fucntions of the precincts of the water body at different times of the year and day.

Time framework: This research is limited to a short period of time. Formulation the theoretical framework, research formulation, data collection, field survey, analysis and draw conclusion needs much more effort to deal within a three month of time.

In the case study the scope of the study area is limited to the immediate surroundings of the water body.

1.5. Methods of Study and procedures

The method of study will be to assess the cities form the Asian Context mainly form ancient Sri Lanka, and the Indian city and the cities form the European context and the city form Australia, which are all cities that has evolved in response to the water bodies.

Hence the relationship between the water bodies present and their co-relationship to the urban form that has emerged along the precincts and its transformation over the years will be assessed. Thereby to develop a set of matrixes of the underlying principles governing the formation of the urban form in response to the water bodies.

These matrixes will be used to assess the urban formation along the Beira Lake, Colombo, where the context of the water body will be evaluated with its present usage and the historical usage. There by to determine the repercussions the benefits and draw backs of responsive urban form to water bodies present in the urban context. And the use and misuse of the water bodies in urbanisation (with the evolving built fabric) and to assess their merits and demerits.

The application of the theoretical framework for the urban formation along the water bodies especially in relationship to the urban forms also is assessed.

Thus the findings form the case study will be made use to formulate the key strategies that should be adopted in to the generation of urban form along the precincts of the water bodies that are present in urban contexts.

THE CONTENTS OF THE RESEARCH.

Objectives and Aims.

The core relationship that exists which is an indispensible parameter for the sustenance of the cities. The Symbiosis created with the responsiveness to each other. Where if the co-relationship is maintained in an appropriate manner, the positive impact made on the city.

Which otherwise; if the relationship between the two is ignored and inappropriate response to each other will result in negative implications to the city.

- Investigate and evaluate the formations of urban forms, where the water bodies have become a determinant force, in the urban fabric that has resulted in the formation of urban morphological patterns.

Over the years in the formation of cities and urban forms has been determined by many factors; such as;

- Geo-physical features
- Sociological aspects
- Cultural aspects
- Functional aspects
- Environmental aspects

Water has also been a key element to sustain habitats and settlements. Hence the cities have emerged as effective resultant of the water features present.

The research intends to carry out studies on the evolution of cities in the Sri Lankan context and the European context, in its historical context to its present context. Where by the principles adopted in generating urban forms as a resultant of the water features, are subject to review, with their applicability in the historic context to the present context.

The co- relationship between the built fabric of the urban form and the effects of the water bodies to generate and regenerate urban form is an in-dispensable aspect in the sustenance of a city.

The psychology of space and the visual impact of the urban forms and urban spaces affect the functionalism of the city whereby, the urban infill spaces also create connectivity and a rhythm in urban spaces.

The generation of urban form in a meticulously planned manner plays a key role in the articulation of urban spaces and fabric.

Cities that are habitable and liveable contains a mixture of urban forms that are sustainable over the test of time and other wise responsive natural and geo climatic conditions of the region.

Over the years water has acted as a physical barrier or a catalyser of urban beauty where it has been utilized for many purposes. Whereby the City itself if formed by the elements of nature that is present to formulate the built fabric and urban land use patterns.

The research proposal is amiable and looking at urban form in a qualitative aspect rather than a quantitative aspect whereby the collective the qualities of water can be looked into the forming urban form that holistically formulates the datum of urban space.

The qualities of water too can be looked into in different aspects. I.e. the reflective quality of water can further be a symbolic metaphor in the sensory perception of responsiveness to urban form in an urban context.

Then the co-relationship between the urban built form and the presence of water as a sensory perception in the dwellers of a city and those who comes in contact with the city.

The perception of urban form can further be classified in many ways.

1. The visual perception
2. The holistic perception
3. The vibrant effect
4. The sensory perception
5. The feel of urban form in
6. The collective perception in terms of built objects in the city
7. The perception of urban aesthetics
8. Perception as a linkage in the city
9. Space syntax in an urban context
10. Cultural perception in a city reflecting it's time and era (sense of time and historicism)

- Goal of the Research :

The research is intended to carry out and in-depth analysis on the effects of water features:

- In generation of urban form, where by the historicism and the evolution of the urban forms when cities were evolving.
- The symbolic relationship to the water features where the urban form itself would have a core relationship between water and the built fabric.
- All in all that augurs well for the urban fabric.

- The human responsiveness which makes the city functional and the responsive elements that creates and interfaces between the two.
- the generation of urban forms that evolve with time
- The primary focus on the research will be to carry out a case study on the Beira lake Colombo.

  Where its historic evolution will be studied and the transformation and its effects in the urban form of the city.

Form the colonial history to the present era. Where the change of usage of the same will be researched in the transformation of the city. Transformation can thus be evaluated in terms of the economic factors, sociological cultural and environmental factors, the functional aspects etc.

Chapter Two: Theoretical Framework

Urban land usage and settlement patterns can be assessed in many theoretical bases. However the underlying causes of the formation of urban fabric in response to the water bodies that are present will have many commonalities in their underlying principles (Gean-Paul R, 2006). Water can have different meanings in different cultures. Hence the response to water may also differ according to the subculture of the regions.

Nevertheless water has been an essential commodity to sustain a community.

2.1. Usage of Water in Urban Space

Evaluate the potentiality of the water bodies to generate the responsive urban forms built fabric where by the water bodies it will be a metaphor in in the generation and regeneration of the built fabric that is in existence within the urban context.

The formation of the water body where the terrain (basin) it is created, will be a determinant factor in the urban built landscape. Where by the built forms and settlement patterns co-existence will depend on and subject to the quality of the water body if the former two have been responsive to the water elements.

Macro level planning in the city of Colombo :

The city of Colombo emerging as a transportation hub where the city itself will contain water gates as entry and exit points, to the area and region that should be taken in to account.

Understanding the set of Matrixes:

- The profile of the water body and the water mass
- Shape and formation of the water massing
- The surrounding land patterns and land use patterns.
- Activity patterns surrounding the Beira lake
- Nodes and morphology
- Buildings and its formation trends around the water body. (built forms and built landscapes)

Changing trends.

- Use and abuse of the water body
- The building patterns and trends with the responsiveness and non-responsiveness to the water bodies and to the context.
- Minimizing the threats to the water body and methods to enhance the potentiality of the water bodies

Line of Reasoning.

Water Bodies and Urban Form.

- The co-relationship between the two in forming and complementing each other.

- The importance of having water bodies in urban contexts.
  Their existnace
  Responding to water bodies
  Management of water bodies.

- The role of the Urban Designer - the importance of the urban designers and planners to respond to water bodies in generation urban forms plays a key role here in forming sustainable urban form and urban spaces.
- Water and Community – over the year's cities emerged near water bodies to sustain the community. Hence the usage of water has been a key component in sustaining a city and its existence.
- Futuristic needs - as water plays a key role in sustaining a community the management of water bodies for the future needs is of prime importance for the cities and their communities to exist.

In the above scenario the usage of water in urban contexts can be classified in the following aspects:

- Human habitation.
- Agriculture
- Transportation
- Water Management and Drainage
- Amenity
- Preservation of the vegetation and Urban Ecology
- Drainage and retention of water in the city (with the catchment areas)

Hence to meet the above parameters the responsiveness of the urban form and built fabric to then water bodies be it natural or man-made stays an indispensible aspect in the functionalism and sustenance of the city. Which otherwise will result in a diversity of problems that will be favorable for the futurism needs of the city.

What can Water Bodies do to Cities?

- Water retention
- Protection form natural disasters and catastrophes
- Beautification
- Recreation and Amenity
- Transportation
- Passive Cooling and maintaining equilibrium between the environmental elements and the urban fabric.
- Maintenance of the Urban Ecology
- Urban Infrastructure development
- Creation of landmarks in the city

The key usage of water in sustaining a community:

- Basic human needs (i.e. cooking, washing, cleaning etc.)
- Industry
- Mitigate flooding and natural disasters
- Fortification
- Enhance the potentiality for tourism

Management of water bodies in Urban Contexts can result in the positive implications as mentioned below.

- Creating responsive environments and habitable cities
- Sustainable cities
- Mitigation of Pollution
- Drainage of Water – waste water management and sewer disposal should be dealt with accordingly where the discharge of domestic and industrial wastage should not pollute the water bodies in the Urban contexts which can result in many health hazards

Transformation of Urban forms due to the presence of the water bodies.

One of the key roles that the water bodies have played in the cities is the Transformation of cities and their urban forms and built fabric.

- The transformation of the urban form and the urban character is a key aspect the water bodies can do over a length of time.
- Hence the urban forms responsiveness to the water bodies can change over the time periods. Often resulting in different ways in whcih it can respond to the water body in different ways, but in environmentally conducive manner.

2.2. Meaning of water in Urban Space

- Water can have different meanings in different contexts, be it cultural or a natural barrier in most cases.
- In the Sri Lankan context water has a strong agro-base where the catchment areas were preserved well to feed the other water bodies, which formed a network of irrigation. Hence the sustenance of the community was greatly dependent on the management of the irrigation a water bodies.
- In other European destinations such as Amsterdam water was a potential threat to the city due to the low lying area. Hence a series of canals were made to mitigate floods. Hence the prevention of catastrophes in an area or region is also a key element in managing water bodies.

2.3. Water and Urban Form generation

Examples will be drawn from the European and Australian context and the Asian context (Sri Lanka) where cities will be evaluated in the following aspects:

- Scenarios where water bodies are an indispensable element in the formation of the cities. (in determining urban forms is a city and the built landscape)
- Scenarios where water bodies which are naturally formed has been a prime force in the determination of the urban forms.
- In the reversible scenario an assessment of how urban form has been a determinant force in creating artificial water bodies (eg. The Kandy Lake). And its impact in the city.
- Hence the coherent and reversible relationship between the two main parameters of the study of (Urban form and Water Bodies) will be assessed in the local context and the overseas examples. Whereby if the two complement each other the sustenance of the city will make the city much more habitable for the users and the dwellers.
- Hence how and inseparable relationship between the two elements can affect the functionalism of the city. Where by the two elements will complement each other.

- With the literature survey the base will be made to identify the key responsive element in the water bodies that has been the determinant forces in the creation of urban forms and the morphological patterns.
- How water bodies have resulted in generating impeccable cities with its urban form which are responsive to nature.

2.4. Theoretical Analysis of the usage of water in urban context

Theoretical Framework.

There are many theories concerning Urban Design and Urban form. These are based on the design the application and the principles governing the generation of cities and their functions. Hence the theories in urban form rather depict the underlying principles that have affected the emergence of the city space and the urban fabric. Nevertheless the responsive elements that can be stipulated and the application of the principles governing the same would enable to understand the formation of cities, in its historical context and the present context.

One of the basic theories is the Keivn Lynch's principles of Urban Design where five elements were defined.

Key Theoretical approaches and Arguments.

Sustainable urban form envisages creating urban spaces that are in harmony with nature, which will be including the optimal uses of natural resources, without compromising the needs of the future. Addressing the issues of urban intervention and the urban infill in an environmentally and habitable manner pays a key role in this scenario" (Urban Habitat, 2016)

This will enable to form unhealthy urban spaces with the Urban Aesthetic which should be a subtle evolution of the historicism of the pace and the people friendly place with a sense of identity with the ear of time.

Today, the urban form is at the center stage, as one of the elements that can bring sustainability to the city. City and Regional Sustainability is perceived as a holistic approach that must include the physical planning of infrastructures, green spaces, and housing among other subject. Therefore, the city and the regional configuration is being perceived as the keystone in granting less commuting times, less pollution, increased liability of cities by its citizens, with this emphasis, new methodologies are proposed (for a comprehensive analysis of the work being published during the last five years, the listed references enhance the importance of this subject at the international arena).

The five elements defined by Kevin Lynch in his famous book the “Image of the City” in perceiving urban space. Whereby the users understood their surroundings in consistent and predictable ways which are as follows:

- **Paths**, the streets, sidewalks, trails, and other channels in which people travel;
- **Edges**, perceived boundaries such as walls, buildings, and shorelines;
- **Districts**, relatively large sections of the city distinguished by some identity or character;
- **Nodes**, focal points, intersections or loci;
- **Landmarks**, readily identifiable objects which serve as external reference points.

(Lynch K, 1984)

Hence the above parameters help in the users to perceive the city in a manner in which the elements on the urban fabric relates to the social fabric.

The understanding of the city’s urban design and urban planning principles (where the water bodies have played a key role, in the city formation) will help to develop a set of matrixes. Hence these matrixes will be a tool for the evaluation criteria.

2.5. Form generation in response to water and the human perception

The Potentiality of Urban spaces in Townscapes can be used as a catalyzer in enhancing the activity patterns and the functionalism of the city. Hereto the dynamism of the urban fabric plays a pivotal role in the creation and the urban spaces and the morphological patterns (Gandy M, 2004).

Nevertheless the urban-scapes of the medieval cities and the contemporary modern spaces plays an common role in the creation and fabrication of the built form which will be knitted to the streetscapes, (and the infrastructure facilities that are present) and to the built facades thus giving it the character of the urban spaces. Nevertheless the responsiveness to the natural

environment and the elements such as the water bodies thus enhances the potentiality of ecofriendly cities that will thus enable a zero carbon foot print.

Moreover the quality of the urban spaces and the urban ambiance in the same could again rejuvenate the spirits of the quality of urban life.

When the positive and the negative factors that are occurring in the daily functionalism of a city so being analyzed, where the activities can be categorized; the effect of the smooth functioning of the city can be further studied in depth.

The positive factors in the functioning of a city can be taken into account and the negative factors can be mitigated whereby the proper planning policies which will result in the articulation of urban space in an appropriate manner. Hence the creation of urban built form with sustainable urban form will contain coherent relationship with the perception of urban space which is conducive for human habitation and people friendliness.

Nevertheless the city fabric and the built fabric will be formed by the co-relationship between the built forms and the urban spaces and streetscapes, which can be a metaphor in achieving a harmony in the urbanscapes.

Perception of Urban Form

- Result in the human responsiveness for the built fabric whereby the urban spaces are being articulation in responsiveness for the psychological aspects of the users of the urban spaces.

- Nevertheless this can be a reversible process where the mindset of the people who comes in contact with the urban forms can be conditioned by the built fabric.

- And as per the former aspect the built fabric may evolve accordingly with the perception of the human elements that come in contact with them.

- The evolution of urban form may evolve over a lengthy period of time where by the urban form is shaped resembling the subculture of the region.

- Nevertheless the formation of the urban spaces takes place with the built fabric where by the built forms and the shapes are being taken into account.

Urban form can be passively built in order to articulate the built fabric, whereby the formation of the city can be a knitting of a series of elements comprising built forms and open spaces and other arteries that are molded in a subtle manner.

Safety is a prime concern of the people who dwell in the city, where by the nuances of the city life can be categorized as the positive and negative implications of the designing and planning of cities and the functioning of the cities.

Hence a cohesive integration between the urban aesthetics and the geo-physical features (i.e. natural terrain, climate sensitivity and other metaphors) also fall in common place. By knitting the elements together, the space syntax that is formed; further creates a sensory perception on the impact of urban form.

Chapter Three: Methodology

3.1 Research Problem and Research Question

The core relationship that exists which is an indispensible parameter for the sustenance of the cities (Roderick J, 2003). The Symbiosis created with the responsiveness to each other. Where if the co-relationship is maintained in an appropriate manner, the positive impact made on the city.

Which otherwise; if the relationship between the two is ignored and inappropriate response to each other will result in negative implications to the city.

- Investigate and evaluate the formations of urban forms, where the water bodies have become a determinant force, in the urban fabric that has resulted in the formation of urban morphological patterns.

3.2 Research Question

- **How the effectiveness of water bodies present in Urban Contexts; in acting as a primary determinant force and a metaphor, a responsive element in the formation and regeneration of Urban Form. How its existence and presence has been a core element in the sustenance of Urban Form forming a Symbiosis for the co-existence of the two.**

In the study the examples of the cities that are taken for the Literature review, the formation of Cities will be analyzed, where the presence of the water bodies, especially the inland static water bodies, has been effective in the formation of the urban forms and its morphological patterns. Over a length of time the regeneration of urban form in these cities in response to the static water bodies that are present will be studied.

Where the key elements of water bodies present that are the contributory factors for the formation of urban form and the settlement patterns, will be identified. Thereby to develop a set of matrixes to assess the key factors that are contributory in the regeneration of urban form that will be used as a tool to measure the effectiveness of the water body chosen for the case study.

The above research question can be further defragmented in the following manner:

- *How will the presence of water bodies present in urban contexts, help the transformation and sustenance of urban forms, and what are the key factors affecting the same?*
- *The determinant factors that will define the streetscapes, urban character, built-forms and morphological patterns.*
- *What are the factors with the effect of water features that determine the urban character of a city?*
- *What are management strategies that are to be adopted for the water bodies, in order to sustain the city's urban form and character?*

The potentiality of water bodies can be diversified in various aspects such as the aesthetic aspect, and the sustainability of the city.

Water is an essential commodity to sustain a community, where its main purpose is for consumption, and habitation of the community, other essential factors will be for the purpose of agriculture, production and industry (Ecological Society of America, 2003). Apart from these factors that are the needs to the community that dwell, within the city the water massing will also cater to the environmental quality of the city such as mitigating pollution and maintaining an environmental equilibrium. Also they help to maintain an environmental sustenance.

That are generated as a resultant, has played a symbolic role in the creation of cities that are unique and visually appealing.

3.3 Research Methodology

As mentioned in Chapter 01 (pg 10,11) the scope and Methodology of the research will be as follows :

Methods of Study and procedures

The method of study will be to assess the cities form the Asian Context mainly form ancient Sri Lanka, and the Indian city and the cities form the European context and the city form Australia, which are all cities that has evolved in response to the water bodies.

Hence the relationship between the water bodies present and their co-relationship to the urban form that has emerged along the precincts and its transformation over the years will be assessed. Thereby to develop a set of matrixes of the underlying principles governing the formation of the urban form in response to the water bodies.

These matrixes will be used to assess the urban formation along the Beira Lake, Colombo, where the context of the water body will be evaluated with its present usage and the historical usage. There by to determine the repercussions the benefits and draw backs of responsive urban form to water bodies present in the urban context. And the use and misuse of the water bodies in urbanization (with the evolving built fabric) and to assess their merits and demerits.

The application of the theoretical framework for the urban formation along the water bodies especially in relationship to the urban forms also is assessed.

Thus the findings form the case study will be made use to formulate the key strategies that should be adopted in to the generation of urban form along the precincts of the water bodies that are present in urban contexts.

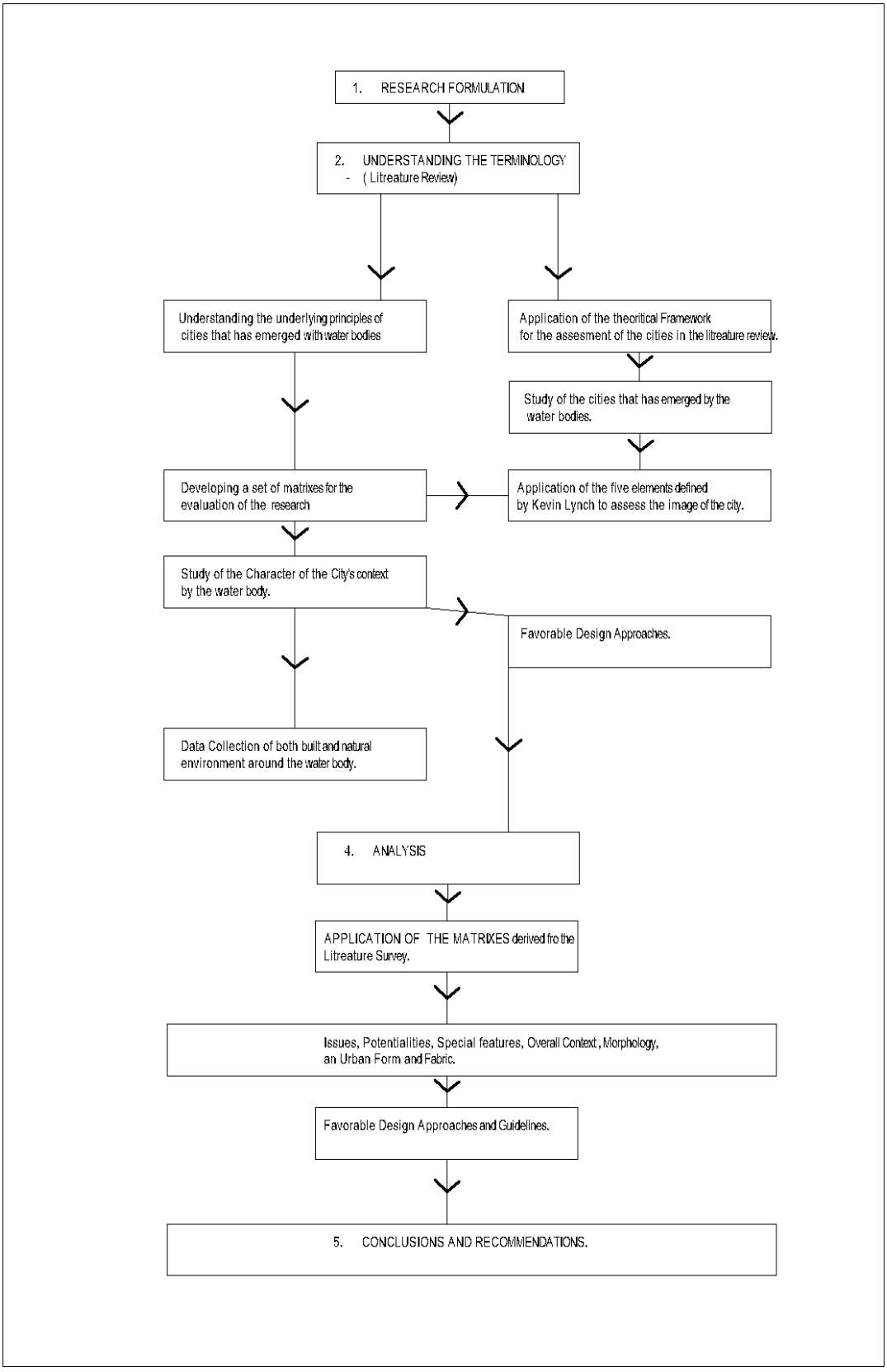

Figure 3.1: Methods and Procedure, Source: Author.

Methodology adopted :

- will be based on the following criteria :

Set of matrixes will be derived from the Litreture Review :

Understanding the set of Matrixes:

- The profile of the water body and the water mass
- Shape and formation of the water massing
- The surrounding land patterns and land use patterns.
- Activity patterns surrounding the Beira lake
- Nodes and morphology

- Buildings and its formation trends around the water body. (built forms and built landscapes) Changing trends.

- Use and abuse of the water body

- The building patterns and trends with the responsiveness and non-responsiveness to the water bodies and to the context.
- Minimizing the threats to the water body and methods to enhance the potentiality of the water bodies

- **The research will be carried out in the following methodology:**

Form the literature survey:

- The cities chosen as examples will be assessed accordingly with the following criteria

- The presence of the water bodies in the macro context
- Where the urban built form is placed – why it so done so
- The responsive elements (to the water bodies) in the urban fabric
- The benefits and draw backs
- How the core relationship is built
- Assess the merits and demerits of each other

Develop a set of matrixes bass on the above assessment

Case study:

The generation of Urban form in response to the water bodies creating a symbiosis between the two with a study of the Beira Lake and its context.

- Colombo city the macro environment (city and suburbs)
- The existing situation of the water body present
- The terrain and topography (gradient and the gravity flow)
- The usage of the water body for the city to function
- Water and how it has affected the city
- The contributory factors of the water body to generate urban forms.
- Urban morphological patterns and its emergence.

A historical assessment of what the Beira Lake has contributed to the city from its inception.

- The formation of the urban context due to the presence of the lake.
- The use of the lake in different eras
- Ten transformation of the urban character due to the presence of the Beira Lake.

Evaluation of the Urban forms in response to the water bodies available in the area in different eras of history.

The matrixes to assess the study and research:

- Assessment of the water body in terms of the connectivity to the city.
- the land usage along the water body
- urban character around the water body
- Urban formed that has emerged around the water body
- the topography and terrain
- Water levels

- Activity patterns
- The interface between the water body and the built massing.
- Public parks and amenity

Present Context of the Beira Lake.

- Transformation along the water body
- Forming development guide lines Streetscapes
- The body of water and the massing along the water body
- Streetscapes along the water mass
- The formation of street pattern along the water body
- Emergence of the clusters of buildings along the water mass forming an urban landscape

The SWOT analysis of the context around the Beira Lake will be carried out to assess the following:

SWOT Analysis will be based on the following aspects

- Strengths
- Weaknesses
- Opportunities
- Threats

- The positioning of the water body and how the water body is fed
- Activity pattern around the lake
- The urban form around the lake assessed for verticality and horizontality

- How the lake has become a responsive element in the city

The meaning of water around the Beira Lake should also be reviewed, in term of the following:

- Usage for amenity
- Spiritual
- Functional

Due to the presence of the water bodies the link between Urban Aesthetics and Urban Environments should also be assessed.

The water body in an urban context can be a cohesive element within the urban fabric where the element itself can be a catalyzer in crating several formations within the urban fabric such as the following:

- Permeability within the city scapes.
- Interfaces between the water body and the built fabric.
- public and semipublic spaces that are formed by the generation of the urban forms that is a resultant of the primary force created due to the presence of the water bodies.

As an element that controls urban sprawl and urban growth (containment).

Scope and Limitations :

As mentioned in chapter 01 (pg 10)

This research will examine the character and possible design approaches responsive to the water bodies in urban contexts. The relationship between urban form and water bodies present will be examined. The urban form around the Beira lake Colombo and its transformation will be considered. The case study will focus most of the elements of physical form rather than socio, cultural aspects. It will address the issues relevant to the character and form of the urban fabric around a water body. Special potentials of water front developments will be identified to guide urban form towards a context responsive design.

It is noteworthy to study the historic evolution of cities and the built formation in relation to the mass agglomeration and the socio cultural effect, that stem from the built spaces (UN, 2001). (i.e. the geek life was centered on the agora and the usage of piazzas and amphitheaters and open public squares and the integration of water bodies in to public spaces was of common place in most ancient cities.)

Ref :

The city as a meeting place is a common phenomenon in the recent past. What the city has to offer to the visitors, and how they responded contributed to the functionalism and activity pattern of the city. The users of it have a significant role to play in the quality of urban living.

- *The literature review will look in to the aspects of urban forms in water in urban spaces and urban formation in relation to the water features that are present (which are either natural or manmade)*
- *In this context the literature survey will be carried out in the Asian context and the European context, where by the study will be carried out in cities that are built form has emerged along the water features that are present naturally or manmade. In the Sri Lankan context which had a strong agriculture base hydraulic civilization, the emerging of cities based on this hydraulic civilization is to be studied in depth. the best examples can be quoted form the ancient capitals of Anuradhapura and Pollonnaruwa. And moreover the then fortified cities of*

Kandy and the cities of Sigiriya where water features were used for aesthetic purposes.

- *Moreover in the modern era the administrative cities and the commercial cities have formed urban spaces along the water features that are present in the urban spaces which have been used as an integration of urban forms as a public realm where by they form an interface for the commuters and users of the public of the urban spaces.*
- *Nevertheless the historic usage if the urban spaces along the water features has been diversified in the modern era where by the substance of urban forms has thus been a catalyzer in the regeneration of cities.*
- *Moreover in the modern era there has been a trend to incorporate water features in dwellings and urban spaces for various reasons where by the usage of these urban spaces are meant to formulate some of the basic key features that define the character of the city.*

The cities that are taken for the literature study will be form the ancient Sri Lanka, where the evolutionary pattern of the same will be assessed; this will be to ascertain the growth of the city with its urban form in relationship to the water features that are present.

There by to develop a set of matrixes to evaluate the formation of cities in relations to the water features.

The essential features in the water bodies present in urban contexts, and their responsiveness to generate urban forms will be a common ground to formulate a set of matrixes. And their benefits and draw backs will be other evaluation criteria to assess the futuristic development scenarios.

In the case study the water features in the city of Colombo will be assessed in a macro scale, and where the city has emerged, in a historic perspective. After wards the change of use and the miss-management net of the water features has resulted in adverse effects with many negative implications such as:

- Pollution and environmental degradation.
- Ad hoc buildings propping up in the inappropriate places.
- Dilution of the urban character causing a Dilemma of urban form.

- Placeless senseless developments taking place in an alarming manner.
- Urban aesthetics and streetscapes under threat resulting in unsightly cities.
- Catastrophes taking place such as flooding due to inappropriate land usage.

In such circumstances a SWOT analysis needs to be carried out to assess the drawbacks, of in-appropriate actions and decisions being taken by the governing bodies.

The proposed developments to be assessed based to the theories derived from the literature survey. The impact on the city's urban character and form, due to the proposed developments will also be assessed.

The case studies will be carried out at a macro level where the city of Colombo and its suburbs will be assessed. Threats to the ecologically sensitive areas (i.e. wet lands in the suburbs).

The main focus of the case study will be the Beira lake Colombo. Where the emergence of the urban forms around the basins of the water mass will be assessed. There after the transformation that has taken place with many negative implications, will be taken in to account with their causes. And the potential threats that were applicable for the water masses.

In the recent past Beira Lake came into the limelight with the beautification with the city of Colombo. Where many proposals were drawn up to beautify the city.

3.4 Research hypothesis

The purpose of this research is to address some of the vital burning issues that were widely spoken within the latter part of the last century and to date, all over the world, such as:

Land degradation, environmental pollution, global warming, deforestation etc. whereby Sustainable urban forms can bring in metaphors to create urban spaces and holistically make them environmentally sensitive, in a subtle manner.

Henceforth a solution needs to be sought for with the appropriate professional input, where aspects such as energy efficient buildings, green architecture have come into the limelight.

It is also noteworthy to state here that proper city planning can immensely help the smooth functioning of a city and economic growth, and inevitably help to reduce crime rates which otherwise would give rise to it.

Merging with the urban landscape and creating a healthy natural environment amidst the built environment.

It is noteworthy to state here that in the aforesaid aspects sustainable urban form and sustainable buildings has become phenomenal, in the arena to find a solution for these issues and to or a catalyzer to resolve them, in both macro climatic conditions and micro environments.

Therefore it is amiable in this research to investigate how these issues could be addressed through sustainable urban form; in different parameters such as:

- Environmentally friendly cities and buildings
- Urban Aesthetics tube tied up with historicism, and Modern Architecture and urbanity to be a gradual evolution of history. (Not merely a repetition of history)
- Sociological aspect, human behavioral patterns in a region and the Psychology of space.
- Development scenarios in terms of government policies and investment opportunities.
- Functionality and Pragmatic approach, stemming from the socio-culture of the region.

"*Achieving sustainable urban form" and "Designing the city and the region" (Jabareen Y R, 2006) is therefore a goal and goes beyond integrating the transportation and traffic elements and green spaces all these are shaped accordingly to a set of patterns that will grant sustainability and an image of the city that is perceived and lived as sustainable.*

The monotonous street facades could be revamped to have interactive spaces in between the clusters or rows of buildings could be made in to meaningful usage for public inter action further retain the residential character. The absence of these public spaces and the claustrophobic living has seemingly resulted in a many other negative implications such as teenage crimes and other aspects that are a direct result of this scenario.

- *Humanity has the ability to make development sustainable, - to ensure that city meets the needs of the present without compromising the ability of the future generations to meet their own needs. Sustainable development is not a fixed state of harmony, but rather a process of change in which the exploitation of resources the direction of*

investments, the orientation of technology and technological development, and institutional change are made consistent with the future as well as the present needs.

The formation of cities should further give emphasis for the following aspects and criteria:

- *Providing adequate shelter*
- *Improving the management of urban settlements*
- *Promoting sustainable land use planning and management.*
- *Providing environmentally sound infrastructure facilities.*
- *Promoting energy efficient technology, alternative and renewable energy, sources, and sustainable transportation systems.*
- *Enabling disaster prone countries to plan for and recover from natural disasters, Promoting sustainable construction industry activities*
- *Human resources development.*

3.5 Management of water bodies and their effects on Urban Form

The functionalism of the city is another aspect that should be carefully dealt with, where the management of water bodies are of paramount importance, which otherwise will result in water pollution and health hazards.

Careful management of the water body is also of key importance in maintaining healthy livable cities. Research has shown that certain cities that were once livable and green has latterly became polluted un livable cities due to the non-response to urban form and the mis-management of garbage in cities.

Chapter 4: Literature Review

4.1 Introduction to the Literature Review

If the cities are well positioned, well planned, well built, they aesthetically synchronize with nature. Well planned cities respond to the context and the natural elements, where there will be a harmony with the built fabric and the natural geo-physical features, which would enable sustenance in their co-existence. (Lynch, 1981)

However, cities with rapid growth in developing countries develop without planning. Hence the relationship between the built environment and nature has been threatened, and has resulted in many negative implications. Which is an alarming problem, giving rise to many globalized negative implications such as global warming, pollution, non-livable cities where the crime rate and health hazards are swelling. These issues need to be addressed globally in adopting city planning strategies and principles. When urbanized cities need more resources, they continuously expand, from the urban hub into suburbs in exurbs. This separates people more distantly from the natural landscape, where land degradation takes place at an alarming rate.

4.1.1 Assessment of Urban Form generation and settlement pattern in response to water feature present in Urban Context

The Literature Review will be carried out in cities in the Asian Context and the European context, where the emergence of urban form has significance as a resultant stemming from the presence of water bodies, present in the Urban Context.

Where by the water bodies has been a responsive force in the formation of the urban settlement patterns and the built massing and the holistically the urban fabric. Where the urban morphology has taken its shape with the water body as a primary determinant force.

Examples will be drawn from the European and Australian context and the Asian context (Sri Lanka) where cities will be evaluated in the following aspects:

- Scenarios where water bodies are an indispensable element in the formation of the cities. (in determining urban forms in a city and the built landscape). Especially in the cases

where inland static water bodies has been a primary determinant force in generating Urban form.

- Scenarios where water bodies which are naturally formed has been a prime force in the determination of the urban forms.

- In the reversible scenario an assessment of how urban form has been a determinant force in creating artificial water bodies (e.g. The Kandy Lake); and its impact to the city.

- Hence the coherent and reversible relationship between the two main parameters of the study of (Urban form and Water Bodies) will be assessed in the local context and the overseas examples. Whereby if the two complement each other the sustenance of the city will make the city much more habitable for the users and the dwellers.

- Hence how an inseparable relationship between the two elements can affect the functionalism of the city. Where by the two elements will complement each other.

- With the literature survey the basis will be made to identify the key responsive elements in the water bodies that has been the determinant forces in the creation of urban forms and the morphological patterns.

- How water bodies have resulted in generating impeccable cities with its urban form which are responsive to nature.

The cities that are reviewed in this chapter are

01. Anuradhapura – the ancient capital of Sri Lanka.
02. Polonnaruva – ancient capital of Sri Lanka
03. Kandy – The last bastion of the Sri Lankan kings
04. Sri Nagar – India
05. Lugano – a city in Southern Switzerland
06. Amsterdam – Capital of the Netherlands
07. Venice – Italy
08. Canberra - Australia

4.2 Sri Lankan context (Historic analysis)

EVOLUTION OF URBAN SETTLEMENTS AND CITIES IN SRI LANKA.

Sri Lanks's rich history dates back to over 2 and a half millennia (recorded history according to the great chronicle the Mahawamsa), with a rich agricultural civilization, where the country was self-sufficient, and hence was one of the richest in this part of the world in different eras. Nevertheless the history of the island dates far beyond that with the remaining evidence of the rich history to the pre Arian times. Where the traditional tribes that dwelled in the island had had a very rich civilization of their own, which has eventually died a natural death. Today the early settlers are known as the Vedda community are confined to the jungles in the eastern slopes of the central hills and they are confined to very small numbers.

The rich agro based hydraulic civilization of the island began with the arrival of the Arians from North India, where they penetrated to the hinterland of the island along the banks of the Mal-with-Oya River form the North Western coast. Establishment of village settlements took place, with a well-connected irrigation system that can be called unique to Sri Lanka.

With the external pressures due to foreign invasions the country's capital was forces to shift from place to place at different eras, in order of defensive strategies, where fortification was sought.

In the world history urban form responsive to water bodies, Sri Lanka contains fine examples as water has played a pivotal role in the in the sustenance of the cities with its rich agro based hydraulic civilization, which has formed a unique pattern of urban forms.

(National Science Foundation, 2000)

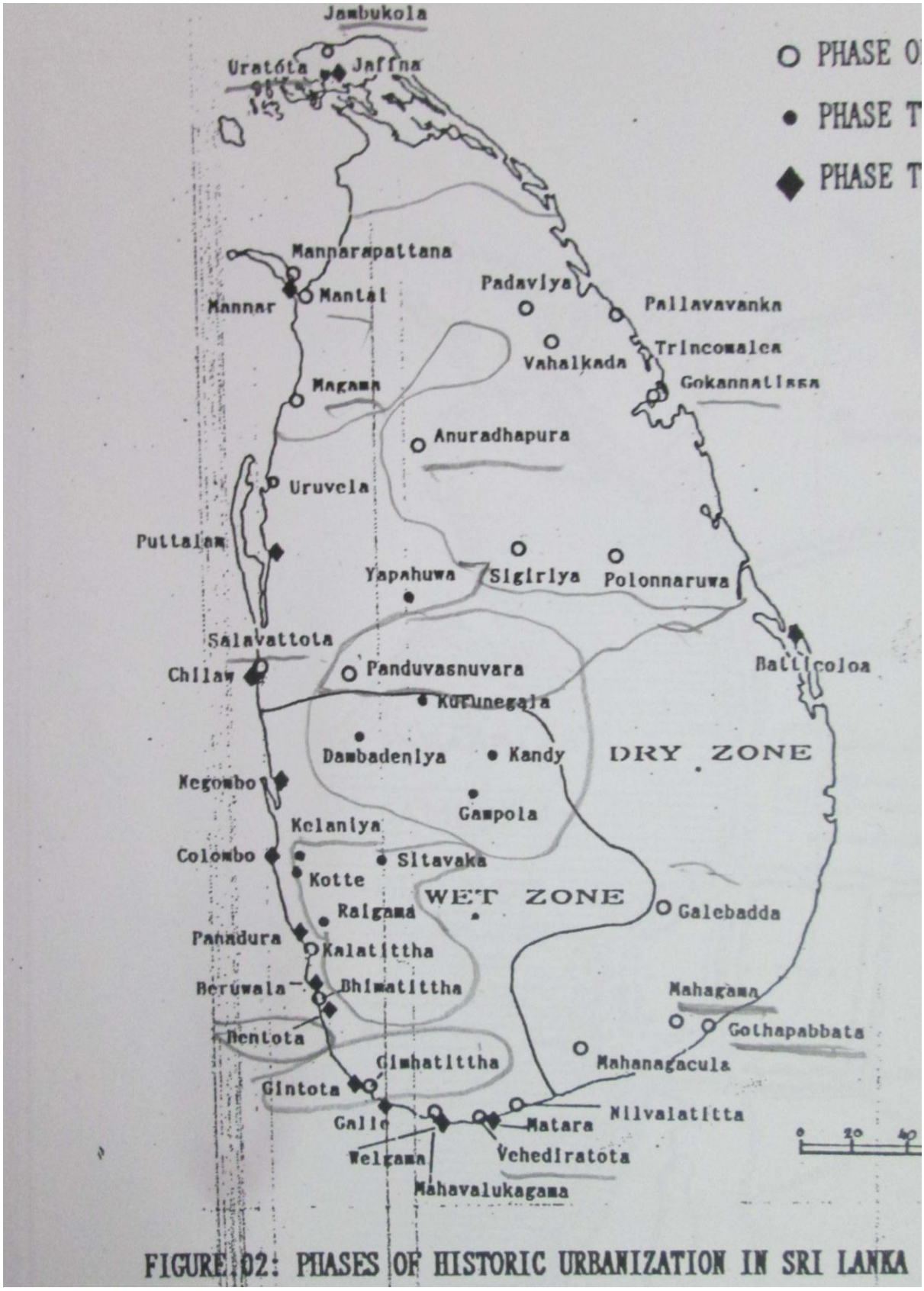

Figure 4.1: Phase of historic Urbanization of Sri Lanka, Source: Fifty years of Town Planning history of Sri Lanka, NPPD

THE HYDRAULIC CIVILLISATION OF SRI LANKA.

A series of large medium and small size reservoirs were built which were commonly referred as tanks. These tanks were mainly for the storage of water and the sustenance of the communities and human settlements and also for the agriculture. The series of tanks were built by the ancient Sinhalese kings for the aforesaid purposes.

A series of water tanks were, scattered around the dry zone built by these ancient kings, where a highly advanced irrigation network was formed, often boasting about the pride and advanced engineering technology that prevailed in the country during the respective eras. The well thought of irrigation systems with the series of tanks were meant of the storage of water especially during the dry season, where short rainfall was expected in the dry zone.

The tanks were supported by an intricate system of irrigation canals, where they sustained the agricultural economy for many centuries.

The brilliant irrigation system where the water was transported to long distances under gravity flow; was made possible by means of a cascading system, where water was received at the lower ends with a cascading system with a uniform gradient in the irrigation channels. Even the tanks in the micro catchment areas were carefully managed with water shed management strategies and principles, where the siltation was avoided.

Hence the irrigation network system that was well planned and managed with a climate responsive pattern was unique to Sri Lanka.

The principles that governed the irrigation network system was by means of this cascading system where the levels of water was well accounted for, and the gradient along the irrigation channels were also made good use of.

Henceforth the most significant city in the islands rich history in the city of Anuradhapura which was a medieval capital of Sri Lanka for over a period of 1200 years.

One of the key aspects of the ancient irrigation systems in Sri Lanka is the organization of small tanks into a cascading sequence which allowed greater efficiency in water usage.

Where the water from the upper part of the cascade flowed into a downstream tank for reuse in paddy fields. The system independency needed community effort and coordination, and the, independency of the cascade needed well-coordinated land and water resources.

In this context one of the unique of the profound knowledge of irrigation and the agriculture was the transformation of natural eco systems into agro eco system, maintaining an ecological equilibrium between the human activities and the environment.

(National Science Foundation, 2000, P 2-3)

4.2.1 Evaluation of Urban form and settlement pattern in Anuradhapura.

The City of Anuradhapura.

Anuradhapura located in the dry zone in the North Central province of Sri Lanka, was the first established kingdom in the country in the annals of history.

Being the throne of the Sinhalese kings for over 12 centuries, Anuradhapura period contains a rich history (According to the great chronicle the Mahawamsa) where the little remains of ruins indicate a very rich civilization, containing irrigation, agriculture, town planning, architecture and constriction technology.

The Anuradhapura kingdom is a fine vindication of village settlements transforming in to urban settlements, in the country. Where water has been a primary determinant force in the creation and planning of the city.

The city evolved around five tanks which stored water for irrigation and other reasons, which were named as follows

- Nuwara wewa
- Tissa Wewa
- Abhaya wewa (Basawakkulama)
- Bulankulama wewa
- Pulliyankulama Wewa

These gigantic tanks were a primary determinant force in the city planning systems, where the urban systems and the urban morphology of the areas evolved in response to the water bodies. (figure 4.3 & 4.4)

The Anuradhapura Kingdoms irrigation was mainly fed by the Malwathu Oya river which has a been a main component in the cities formation. The Arians who arrived on the North Western coast (Thambapanni the coastal area they landed) penetrated in to the main land along the banks of the Malwathu Oya, where they finally settled in Anuradhagama which was formed as a village settlement which was agro based(Seneviratne A, 2008). Anuradhagama later emerged to be a town which grew in the formation of a series of rings, where Bata trade took place (UNESCO, 1993).

Hence the formation of the city has direct resemblance to the water bodies and the tanks that are placed around the town.

The city of Anuradhapura

- The Anuradhapura Kingdom, named for its capital city, was the first established kingdom in ancient Sri Lanka. Founded by King Pandukabhaya in 377 BC.
- Invasions from South India were a constant threat throughout the Anuradhapura period.
- Because the kingdom was largely based on agriculture, the construction of irrigation works was a major achievement of the Anuradhapura Kingdom, ensuring water supply in the dry zone and helping the country grow mostly self-sufficient. Several kings, most notably Vasabha and Mahasena, built large reservoirs and canals, which created a vast and complex irrigation network in the Rajarata area throughout the Anuradhapura period. These constructions are an indication of the advanced technical and engineering skills used to create them.

  (http: www.cityofanuradhapura)

The city of Anuradhapura

In 543 BC, prince Vijaya (543–505 BC) arrived in Sri Lanka, having been banished from his homeland in India. He eventually brought the island under his control and established himself as king. After this, his retinue established villages and colonies throughout the country. One of these was established by Anuradha, a minister of King Vijaya, on the banks of a stream called Kolon and was named Anuradhagama.

In 377 BC, King Pandukabhaya (437–367 BC) made it his capital and developed it into a prosperous city based on irrigation and agriculture.

(http: www.historyofanuradhapura)

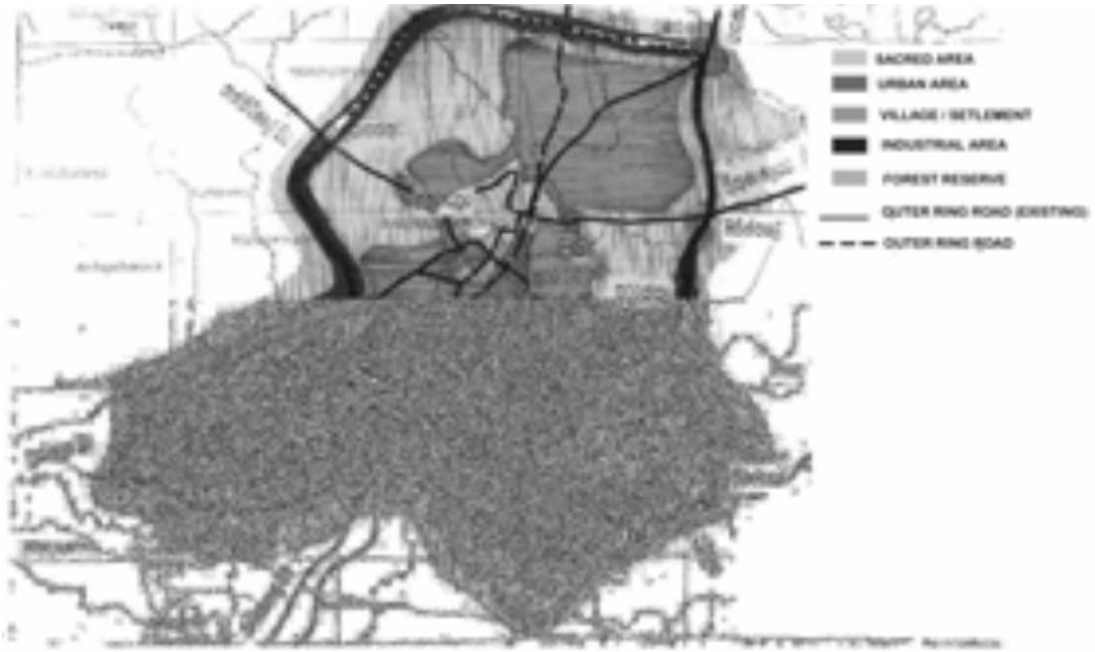

Figure 4.2: Map of ancient Anuradhapura, Source: www.ancientcityofanuradhapura.com

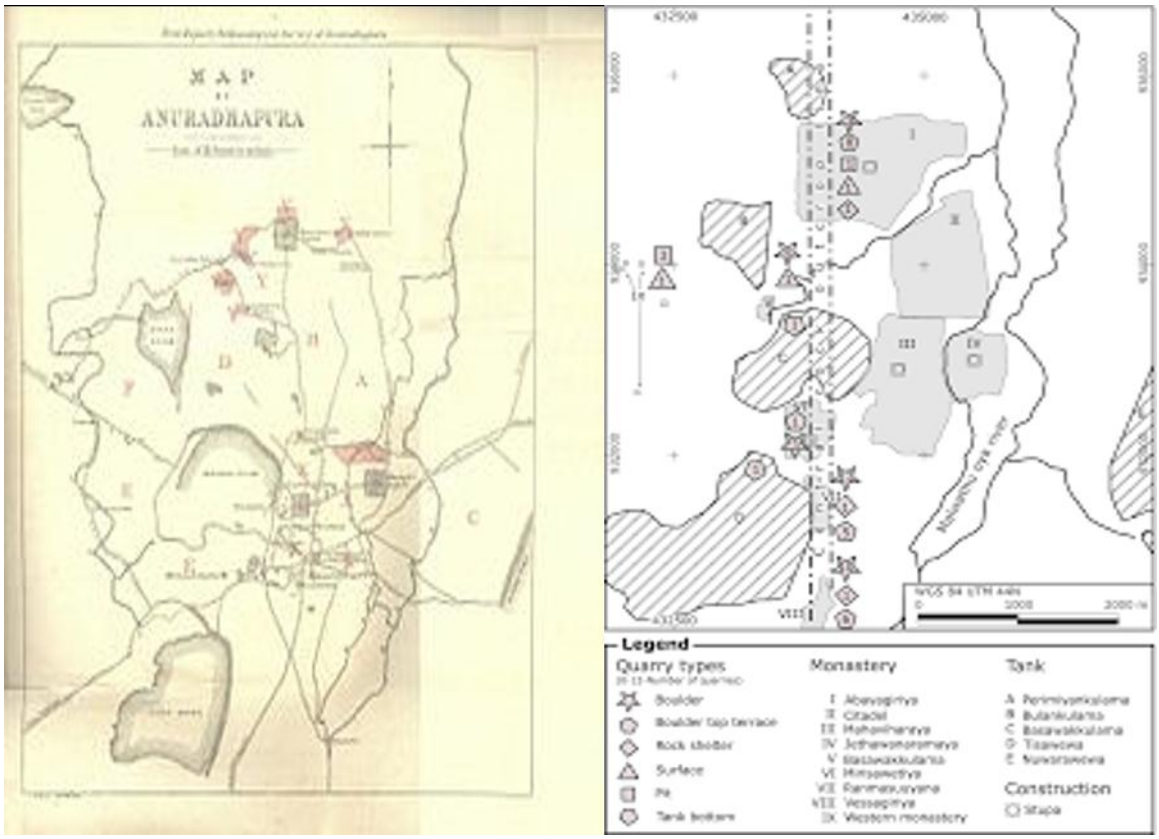

Figure 4.3: Map of Anuradhapura Historic City, Source: http: www.ancientcityofanuradhapura.com

The maps showing the formation of the city of Anuradhapura.

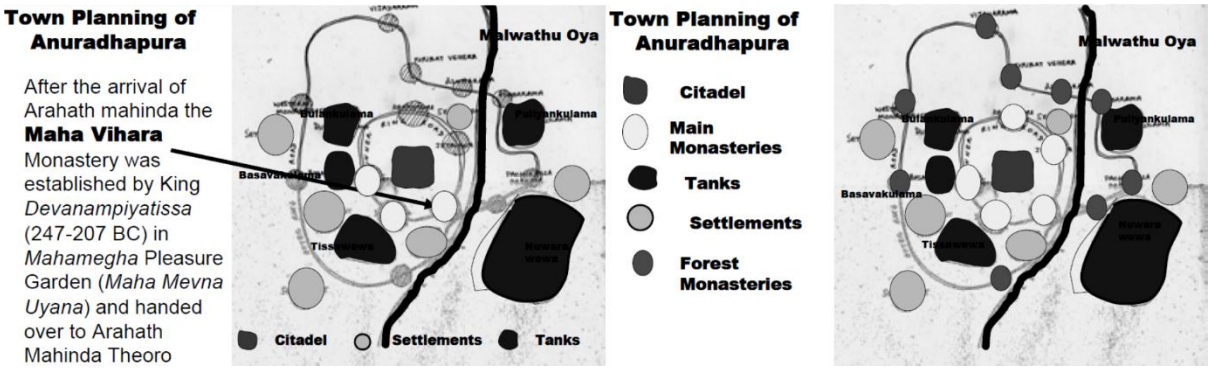

Figure 4.4: Town Planning of Anuradhapura, Source: Management systems for Anuradhapura and Galle - World Heritage Sites in Sri Lanka P.B. Mandawela

Figure 4.5: Stupa's of Anuradhapura seen across the tanks, Source: http: www.cityofanuradhapura

Figure 4.5 shows Stupa's of Anuradhapura seen across the tanks. Forming the land marks and identity of the city. Water acts as the foreground to the monuments,, where the form is highlighted)

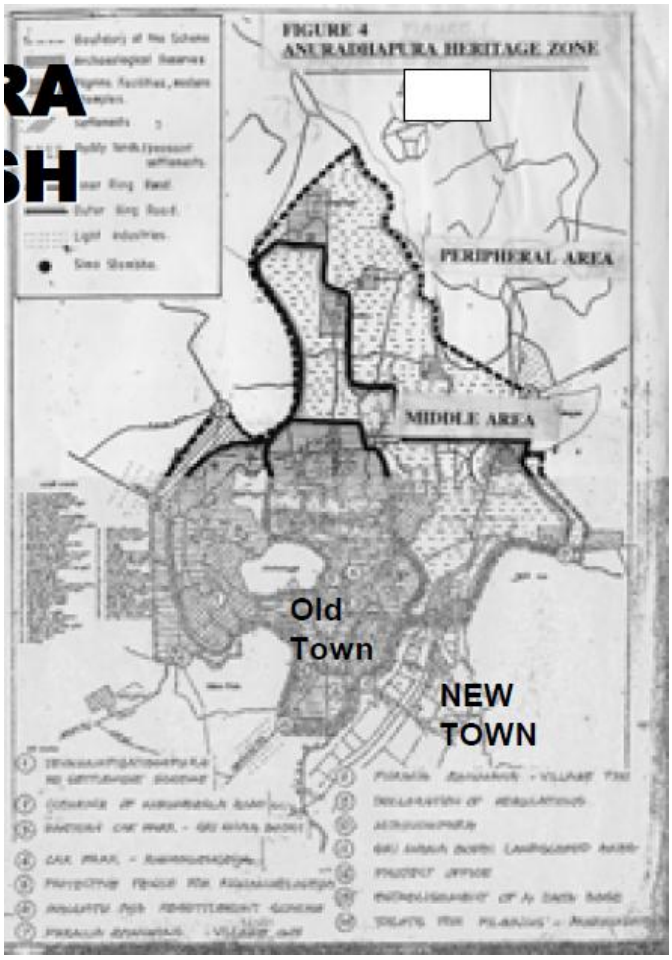

Figure 4.6: Anuradhapura New Town and Old Town, ***Source*** **:** SENEVIRATNE, A. (2008) – Ancient Anuradhapura – the Monastic City. Sarasavi Publications.

Analysis of the City of Anuradhapura

The city if Anuradhapura has emerged as a transformation of village settlements into an urban form, where it has formed a city gradually, restructuring its socio economic system, and vice a versa. On the other hand in the review of the emergence of the city of Anuradhapura it can be seen that the city has emerged with its transformations of the socio cultural and socio economic needs.

The key elements of the formation of the city of Anuradhapura is the series of rings that forced in a subtle way with the 05 main tanks networked for irrigation and agriculture.

The evolution of the urban massing and morphology and urban form of the city of Anuradhapura does not confine to one single water body. Where the 05 water bodies has collectively been a responsive force in the formation of the city, thus defining the districts in the form of the concentric rings. (figure 4.3 & 4.4)

Water has used as means of defense in many cities over the years. Hove ever the need for defense in ancient Sri Lanka came after the emergence of the Anuradhapura Kingdom. As the kingdom was thriving, and flourishing as a self-sufficient nation, in agro production and irrigation etc. latterly the kingdom came under constant threats form the South Indian rulers. Hence the e need for defense and fortification arose.

Anuradhapura cities evolution has been encompassed with the agro irrigational needs, and the socio cultural and spiritual aspects. Where the water bodies themselves has defined the land use patterns and the zoning of city. Giving the due prominence to the hierarchal buildings especially the religions stupa's where the water bodies have been in the fore ground of these gigantic monasteries and religious buildings.

The rings system that emerged with the networking of the water bodies centered the citadel which housed the throne and the palace complex of the kings.

The monastic complexes along the outer rings and the wood patches embedded alongside the tanks and the monasteries are a symbolic feature in the emergence of the city of Anuradhapura.

The Ancient city of Anuradhapura can be classified in the following aspects:

The major usages have been identified are

- Heritage areas

- Archaeological reserves

- Urban areas

- Industrial areas

- Forest reserves

- Settlements

- Highways

Cities Urban Planning strategies can even be adopted in the present context. Responsiveness to water and the spirituality of the sacred buildings being further emphasized and enhanced by the presence of the static water bodies, is a vital aspect in the city planning of Anuradhapura which has happed in a subtle manner rather than a forceful manner.

Furthermore the city forming a social structure, which shapes the city in the Holistic theory in Sociology " where society is formed by discrete individuals who behave in random order, coming together or common aspirations, where the city form takes place." Anuradhapura is a resemblance of this objective where the inner rings have formed to cater to the needed of the society.

The ring which has emerged as the networking of the lakes in the outer rings defines the districts for various activities.

Moreover the takes as a static variable has given rise to the urban forms defining its morphological patterns.

Table 4.1: The city of Anuradhapura – Sri Lanka

01.	Paths	Paths were defined by the streets that radiated for the city center where the palace complex and the citadel were located. These paths radiated towards the water bodies that were located in the outer rings.
02.	Edges	Edges were defined by the rings and the bunds of the water bodies, which has given the perception of directionality.
03.	Districts	Districts are defined by the concentric rings that have been formed. The formation of the rings emerged with the connection of the 05 main water bodies (the tanks) built for irrigation. Each ring defined the areas for different land use patterns.
04.	Nodes	The spiritual buildings depicted the nodes with the water as the foreground further enhancing the city.
05.	Landmarks	The stupa's and the dagobas with the monastic buildings have formed the landmarks of the city. A unique feature in the city of Anuradhapura is where the network of water bodies becoming an icon and a symbolic landmark in the city.

Source: Author

Urban Planning Character of the City in response to the water bodies:

- Unlike other cities that respond to a single water body the city of Anuradhapura has emerged in response to many water bodies that present. (main 05 tanks).
- The water itself sustained the community with its agro based settlement, but latterly water bodies became a dominant force in determining the urban planning and urban fabric. Where the city formed with a series of concentric rings.
- A fine resemblance of a series of water bodies that can form a city by its ring pattern and water being used for agriculture and irrigation, but simultaneously been used as a defining element of the boundaries of various activities of the urban formation, land use patterns and zoning.

- Even in the present era the growth and expansion of the city is governed by the water bodies where they act as the edges of the paths (the bunds) and the spiritual buildings as the nodes and landmarks.
- The containment of urban growth is also determined by the presence of the water bodies.
- The meaning of water for the general function human settlements is further used for definition of urban settlement patterns and land use patterns.

Matrixes:

The water bodies are being a key element in the determination of the urban land use patters defining many activities in forming districts in the form of a series of concentric rings.

Several water bodies collectively give a different meaning to the city formation and derive a subtle meaning.

4.2.2 Evolution of the City of Polonnaruwa

The second most ancient of Sri Lanka's kingdoms, Polonnaruwa was first declared the capital city by King Vijayabahu I, who defeated Chola invaders in 1070 to reunite the country once more under a local leader.

The Ancient City of Polonnaruwa has been declared a World Heritage Site.

While Vijayabahu's victory and shifting of kingdoms to the more strategic Polonnaruwa is considered significant. This was the resemblance of the Golden age of Polonnaruwa. Trade and agriculture flourished under the patronage of the king, who was so adamant that no drop of water falling from the heavens was to be wasted and each was to be used toward the development of the land. The Parakrama Samudra or the Sea of Parakrama, is of such a width that it is impossible to stand upon one shore and view the other side. It also encircles the main city like a ribbon, being both a moat against intruders and the lifeline of the people in times of peace.

The City of Polonnaruwa.

The City of Polonnaruwa covers and area extent of about 122 hectares, spread out to a distance of 05 kilo meters from North to South, and 03 Kilometers from East to West. Within this area are several groups of carefully planned out building complexes. Some fully and others partially excavated and conserved. The main city comprises a walled inner citadel and outer walled city provided with four main gateways. The ancient gates to the East and West of the wide boundary wall enclosing the present city have been unearthed during, the recent excavations of the of its northern, eastern and western sectors. (figure 4.7 & 4.8)

The wall has apparently been built in two different stages, the lower part, built earlier, appears to be well preserved, and has retained its original plaster works in situ.

The streets are laid out in a rectangular grid, oriented North South and East West. The walled citadel, containing the royal palace complex, covers an area of 10 acres. The buildings within the citadel and those outside it conform to their individual requirements, and are carefully planned on terraces.

The architects have taken advantage of the undulations of the site to set out terraces, avenues, and pathways at different levels. The building complexes were surrounded by forest reserves, and parks. Water and essential requirement in the dry zone, was provided by building large

reservoirs, and extensive network of tanks and channels. The great man-made lake Parakrama Samudra, 2500 hectares has a capacity of 134 million cubic meters.

The Architecture of Polonnaruwa is a continuation of the early Anuradhapura building tradition. The Polonnaruwa rulers attempted to create a new ideal, while following the older models. This is evident in the numerous building types that evolved in the 11th and 12th centuries.

(UNESCO, 1993, P-90-92)

Polonanruwa kingdom resembles the renaissance period of Sri Lankan history, where the country was known to be the richest in this part of the World where the island was called the " Granary of East".

Polonnaruwa was a well-fortified city with the Mahaweli ganaga where the natural barrier was formed to protect the city form potential invasions.

Nevertheless the Mahaveli Ganga which is the longest river in Sri Lanka is the main feeder to the tanks built by the kings in Sri Lanka in the Polonnaruwa region.

Agriculture and fortifications being the main strategies of forming the Capital city of Polonnaruwa the water bodies present around the city played a significant role in the urban planning and settlement pattern and the built forms of the city.

In response to water the city emerged as a rectangular shaped form along the North South direction.

The Hydrological System.

Legendry accounts suggest the existence of an agricultural community in and around Polonnaruwa, as early as the Anuradhapura period. However it is not until the construction of the tanks of Giritale, Minneriya and Kaudulla and the smaller tanks of Polonnaruwa, with their network of irrigation channels, and populous farming villages that came in to existence in the in the area.

The possibility of Trans basin diversion to bring water from the perennial rivers to supplement the rainwater of the tanks was realized when the Elehera channel was cut to connect Giritalle and Minneriya in the eighth century. (figure 4.7 & 4.8)

By the time Polonnaruwa came to be built the Parakama Samudra was created, there was considerable body of engineering experience in eth field of hydrology in the island. The supplementary water needed for the Parakrama Samudra is provided by a channel connected to Ambanganga, a tributary of Mahaveli.

An elaborate channel system carried the water to the fields and villages. The city of Polonnaruwa had its own water supply form the tank. Water conducted along the channels was stored in smaller tanks.

The monastery site has several brick built ponds, as well as miniature tanks with earthen bunds.

The breaching and consequent failure of the water storage and distribution system was probably one of the cause of the abandonment and subsequent destruction of the city. It took several centuries for the hydrological system to be reactivated. The large tank was restored and its colossal bunds and water channels repaired in 1950's.

(UNESCO, 1993, P111)

Inevitably the lake itself has become a primary determinant force in the urban planning and built fabric of the city.

Unlike in the city of Anuradhapura the city itself has been a responsive emergence if this single water body, where the land usage and zoning has been determined. Agriculture being given the prime importance, the spirituality has been further emphasized with the construction of the stupa's and the monasteries and shrines that are visible in thin ancient city.

The city has evolved in a rectangular shaped citadel, along the Eastern side of the lake.

The bund of the water body has been the definition of the edge of the city, and the segregation of the lands for agriculture and the citadel has been determined by the presence of the water mass. Village settlements, were also scatters along the outskirts if the lake.

The geometric form of the citadel in response to the water body and the axial streets and pathways alongside the citadel is a key feature in the city planning of Polonnaruwa.

The district of the city is defined by bund along the banks of the Parakrama Samudra and the citadel itself that contains the royal place complex and several other building complexes. The inner citadel and the outer citadel alongside define a more confined district.

The Parakrama Samudra Lake itself is an icon which has made it a land mark in the city as per Kevin Lynch's theory on the elements of the image of the city. The pathways within and outside the citadel further creates the movement pattern giving the due prominence to the water mass.

Further the nodal points are highlighted within the prominent buildings including the religions and royal buildings. Giving Polonaruwa ancient city the identity is its water mass where the entire layout and the planning of the city has been a resultant of the direct response to this water body.

The definition of the city's edges and the nodes districts paths and landmarks are a direct response to the water body.

The city itself has spread towards the east along the Eastern banks of the Parakrama Samudra. Where the eastern shore and the bund has been the definitive edge giving birth to the city. Where the core is the citadel.

The citadels shape and formation (rectangular shape) is a resultant of the response to the edge path of the eastern shore of the lake.

Even in the present context the expansion of the city takes place in response to the water mass. The new city has emerged south of the citadel.

Emergence of the city of Polonnaruwa is fine vindication of water body being a dominant force in the determination of urban form.

Especially evidence of the remains of the palace complexes depicts a multi storied complex, which is has a view of the water.

Using water as a primary defense strategy is evident in the formation of the city of Polnnaruwa.

(UNESCO, 1993)

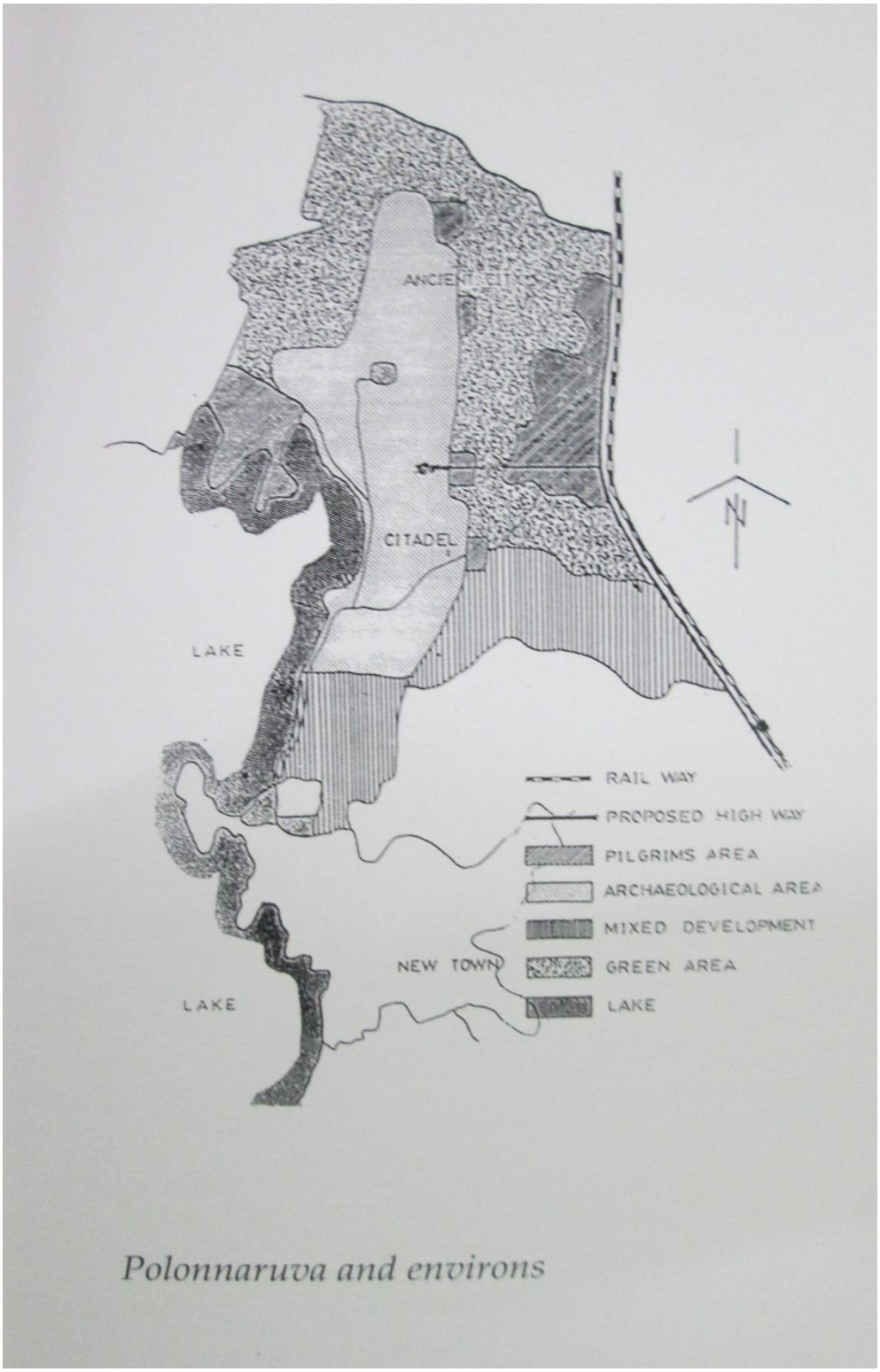

Figure 4.7: Polonnaruwa and Environment, Source: http: www.historyofpolonnaruwa

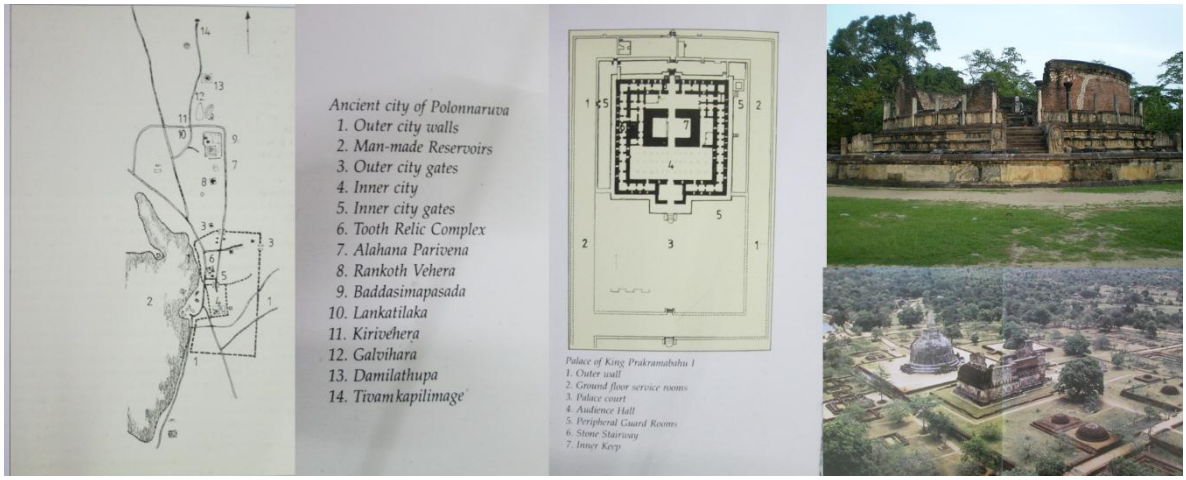

Figure 4.8: Map of Pollonnaruwa Sacred city, Source: Cultural Triangle of Sri Lanka. *"Ancient City of Polonnaruwa". World Heritage Convention, UNESCO. Retrieved 21 May 2015. The Cultural Triangle of Sri Lanka – UNESCO Publishing – CCF*

Analysis of the city of Polonnaruwa :

Although the city of Polonnaruwa was a garrison of the Sinhalese kings during the reins of the Anuradhapura Kingdom. The city gained its prominence when the capital was shifted to Polonnaruwa, where the renaissance period of Sri Lankan history is recorded. Although there were several lakes built by the kings of Anuradhapura period nearby the city of Polonnaruwa, the city's most prominent water body was the Parakrama Samudraya " sea of Parakrama" the capital city and its urban formation has evolved around this gigantic water body.

An era where the country was thriving with Agriculture, Polonnaruwa city can boast of this gigantic lake during the reins of the Great King Parakrama., where the lake itself has been a metaphor in the urban revival and the thriving of the city and the kingdom.

Inevitably the lake itself has become a primary determinant force in the urban planning and built fabric of the city.

Unlike in the city of Anuradhapura the city itself has been a responsive emergence if this single water body, where the land usage and zoning has been determined. Agriculture being given the prime importance, the spirituality has been further emphasized with the construction of the Stupas and the monasteries and shrines that are visible in thin ancient city.

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Emergence of the city of Polonnaruwa is fine vindication of water body being a dominant force in the determination of urban form.

Especially evidence of the remains of the palace complexes depicts a multi storied complex, which is has a view of the water.

Using water as a primary defense strategy is evident in the formation of the city of Polnnaruwa.

Table 4.1: The city of Polonnaruwa – Sri Lanka

01.	Paths	Pathways are formed within the citadel (the inner and outer), where the movement and accessibility is provided for various parts of the city. The city itself contains the inner paths and the outer pathways (in and out of the citadel) often directing to the significant buildings within the city.
02.	Edges	The Eastern banks of the Parakrama Samudra is the defining element of the edge of the city where the city has evolved in response to the bund of the water mass.
03.	Districts	The elongated district is defined in along the north South direction where the citadel is confined to.
04.	Nodes	Within the citadel are many nodes; with the significant buildings of royalty and the spiritual.
05.	Landmarks	The water body itself act as an ordinary land mark in the city, which is the main icon. And also the buildings and the monastic gardens within the citadel forms the other internal landmarks for one to orient himself within the city.

Source: Author

Urban Planning Character of the City in response to the water bodies:

- Polonnaruwa is a fine example of a city that was forced and design for protection from invading forces. Where the water that is generally used for irrigation and agriculture is used as a city designing element where the urban form is emerged from. This is in response to the water body that is present.
- The planning principles and the two dimensional urban form with its geometry is again determined by the gigantic water mass.
- The rectangular shaped citadel has taken its form in response to the shape of the water body. Where the appropriate land location for the city is determined by the presence of the water body.

Matrixes :

Polonnaruwa city is a fortified city that has emerged making use of water as a key element in determining the urban morphology and the land use pattern of the city.

This city of Pollonnaruwa depicts how the presence of a gigantic water mass, which caters to the basic needs of human habitation, has become a primary determinant force in the formation of a city, and its fortification. The water body defining the land usage pattern and the urban planning resulting in the urban morphology. The multiple usage of water is a key factor and a powerful force in urban form generation.

4.2.3 Evolution of the City of Kandy

The city of Kandy was the last bastion of the Sinhalese kings in ancient Sri Lanka.

Renowned as the hill capitol, even in the present era it is a very significant city. Hence the formation of the city with its historical evolution and its urban form town planning all had uniqueness.

A naturally fortified city, with its physical barriers, the city of Kandy took its place, when the kingdoms in the dry zone shifted due to ten prevailing foreign invasions, especially for from south India.

Fortification was one of the prime concerns in the establishment of a city in Kandy where the natural barriers were taken in to account. This was mainly due to the external pressures that the country was facing mainly by the South Indian kingdoms that reined during those eras.

Kandy was located in a basin in the central hills where there was natural fortification by Water Mountains and forest cover.

These barriers were called

- Jala Durga (Water barriers) - The Dumbara valley of the Mahaveli River
- Giri Durga (Mountainous barriers) - Bahirawakanda, and Hantane mountain ranges
- Wana Durga (Forrest barriers) - Udawattekelle forest cover

The city played a symbolic role in aspects of Administration and economy of the country, form the time of the ancient kings and the Colonial era and the prost independent period toady.

This city evolved around the palace complex of the kings, which is now a sacred place of worship where the tooth relic of the Lord Buddha is kept and venerated by many pilgrims throughput the year.

During the latter part of the Kandyan kingdom an artificial lake was created which is a significant landmark in the city; hence the city itself was transformed in to a celestial city where the reflection of the palace complex in the clouds makes the city aesthetically unique.

The city itself is centered on the palace complex and the Kandy Lake which are two significant landmarks and a central part in the urban fabric of the city.

The city's road network is form around a grid pattern and the lake drive with Dalada Veediya being the most prominent artery around the lake. (figure 4.12)

The city housed in a basin valley was unique it its urban form and arts and craftsmanship and the architecture (mainly depicting decorative timber works)

Unlike other cities the Kandy city's main water body the Kandy Lake was formed as a response to the existing urban form.

(Nimal S, 1993)

Figure 4.9: Kandy lake and city, Source: author

Kandyan Kingdom

The Royal Palace of KandySena Sammatha Wickramabahu (1473–1511) was the first king of the Kingdom of Kandy.

In 1592 Kandy became the capital city of the last remaining independent kingdom in the island after the coastal regions had been conquered by the Portuguese. Several invasions by

the Portuguese were repelled. After the Sinhalese–Portuguese War and the establishment of Dutch Ceylon, attempts by the Dutch to conquer the kingdom were repelled.

The kingdom tolerated a Dutch presence on the coast of Sri Lanka, although attacks were occasionally launched.

Figure 4.10: Dutch map of Kandy Approximately 1765, Source: http : www.historiccityofkandy.com

Dutch map of Kandy approximately 1765

The Dutch launched a better adapted force in January 1765. A peace treaty was signed in 1766. The Dutch remained in control of the coastal areas until 1796, when Great Britain took them over. British possession of these areas was formalized with the treaty of Amiens in 1802. The next year the British also invaded Kandy in what became known as the First Kandyan War, but were repulsed.

As the capital, Kandy had become home to the relic of the tooth of the Buddha which symbolizes a 4th-century tradition that used to be linked to the Sinhalese monarchy, since the protector of the relic was the ruler of the land. Thus the Royal Palace and the Temple of the Tooth were placed in close proximity to each other.

The last ruling dynasty of Kandy were the Nayaks. Kandy stayed independent until the early 19th century. In the Second Kandyan War, the British launched an invasion that met no resistance and reached the city on February 10, 1815. On March 2, 1815, a treaty known as

the Kandyan Convention was signed between the British and the Radalas (Kandyan aristocrats).

(the Cultural triangle of Sri Lanka)

Cityscape

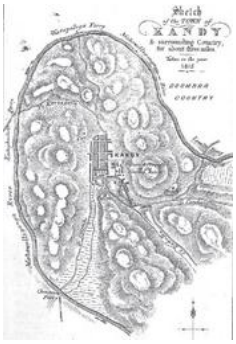

Figure 4.11: Sketch of the town of Kandy and Surrounding, Source: https://en.wikipedia.org/wiki/Kandy

Sketch of the town of Kandy and surrounding country for about three miles, in the year of 1815.

The city of Kandy lies at an elevation of 465 metres (1,526 ft) above sea level. Its plan developed around two open spaces: an elongated square, at the end of which are the administration buildings of the old capital, and an artificial lake that is quadrangular in form. A public garden adds to the openness of the city's spatial organization.

Kandy has now grown out to encompass Peradeniya, home to the University of Peradeniya and the Botanical Gardens, Katugastota to the north, and east to Kundasale, Tennekumbura and Gurudeniya.

Source* : *Seneviratna, Anuradha (1999). World Heritage City of Kandy, Sri Lanka: Conservation and Development Plan. Sri Lanka: Central Cultural Fund

Seneviratna, Anuradha (2008). Gateway to Kandy - Ancient monuments in the central hills of Sri Lanka

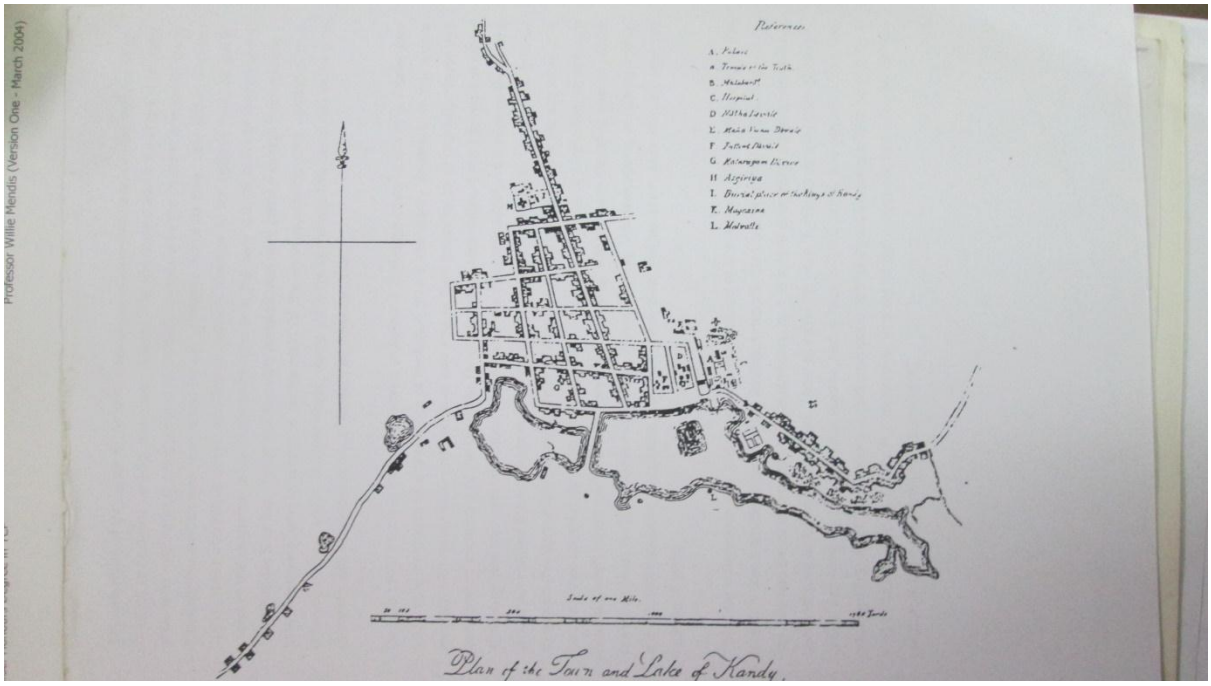

Figure 4.12: The Older map of Kandy City showing the grid street pattern, Source: ***Seneviratna, Anuradha (1999). World Heritage City of Kandy, Sri Lanka***

Analysis of the City of Kandy.

The city of Kandy emerging as a fortification city, one key element has been the Dumbara valley which is a part of the Mahaveli River. Towards the latter part of the Kingdom the marshy lands in the low lying area was transformed in to the lake which is the icon of Kandy even today. This defining the symbolic landmark and also giving the palace complex a higher prominence.

The city of Kandy's urban planning has emerged taking in to account the flat basin and valley where the royal palace complex and the ancillary buildings have been built with the central square forming the citadel.

The street patterns have emerged alongside the naturally fortified valley. In response to the geophysical features the streetscapes has emerged in a grid pattern.

As there is a clear uniqueness in the built form and its craftsmanship in the Kandyan era, the response to the geo physical factors and the climatic conditions resembles the authenticity of the urban for and architecture if the Kandyan era.

The Kandy Lake coming in to being has caused a major transformation in the identity and the uniqueness of the city and its urban form.

The urban fabric that was knitted with two surrounding landscapes in terms of the built forms and their scales and proportions, giving the authenticity of a Kandyan style.

The formation of the Kandy Lake in the later part of the kingdom has made a significant transformation to the city's urban fabric. Where the legibility of a city's urban form and morphology was changed drastically.

The Kandy lake took prime importance in the new map of Kandy and continues to be so to-date.

The lake re-defined a district and an edge to the city center, where the citadel was located. In reviewing the layouts of Kandy after the creation of this water mass it appears that the city of Kandy's urban morphology has emerged in response to this lake. (figure 4.12)

Hence the lake although was created in response to the existing urban morphology and fabric of the city has become a dominant force in the regeneration of the urban forms in Kandy.

Table 4.2: The city of Kandy – Sri Lanka

01.	Paths	Paths are the streets that are forced in a grid pattern in the city of Kandy. And the roadway around the Kandy lake
02.	Edges	The Kandy lake itself has formed and edge to the city (once it came into existence)
03.	Districts	The lake itself has defined a boundary of the district towards the north of the lake, where the city has evolved.
04.	Nodes	The water mass in one end has defined the nodes within the end of the streetscapes of the city of Kandy.
05.	Landmarks	The temple of the tooth the

Source: Author

Urban Planning Character of the City in response to the water bodies:

The Kandy Lake which was a later addition to the city which was already formed has latterly become a dominant element and the primary land mark in the city. Placed at the southern edge of the citadel, the lakes dominance has added meaning and redefined the city in a symbolic manner. Thus giving a much higher prominence to the palace complex which is now a sacred building housing the tooth relic.

However the perception of a visitor who experience Kandy would feel that this water body has been in existence form the inception of the city. Hence is a key determinant element in the urban regeneration of the city of Kandy.

Matrixes:

In the examples of the city of can it can be proven that the creation of an artificial lake after the city has formed (as a reversible process in comparison with other cities); the water ass has become a dominant element giving a new meaning to the city and its legibility.

Where the iconic buildings especially the temple of the tooth relic and the palace complex in the citadel is given a higher prominence.

With the coming in to being of the water mass and new developments of the city is g0verned by this key element. Where the urban fabric is now determined in and expansions.

4.2.4 Evolution of the City of Sri Nagar India.

Urban Land Transformation and Its Impact on Water Bodies of Srinagar City India

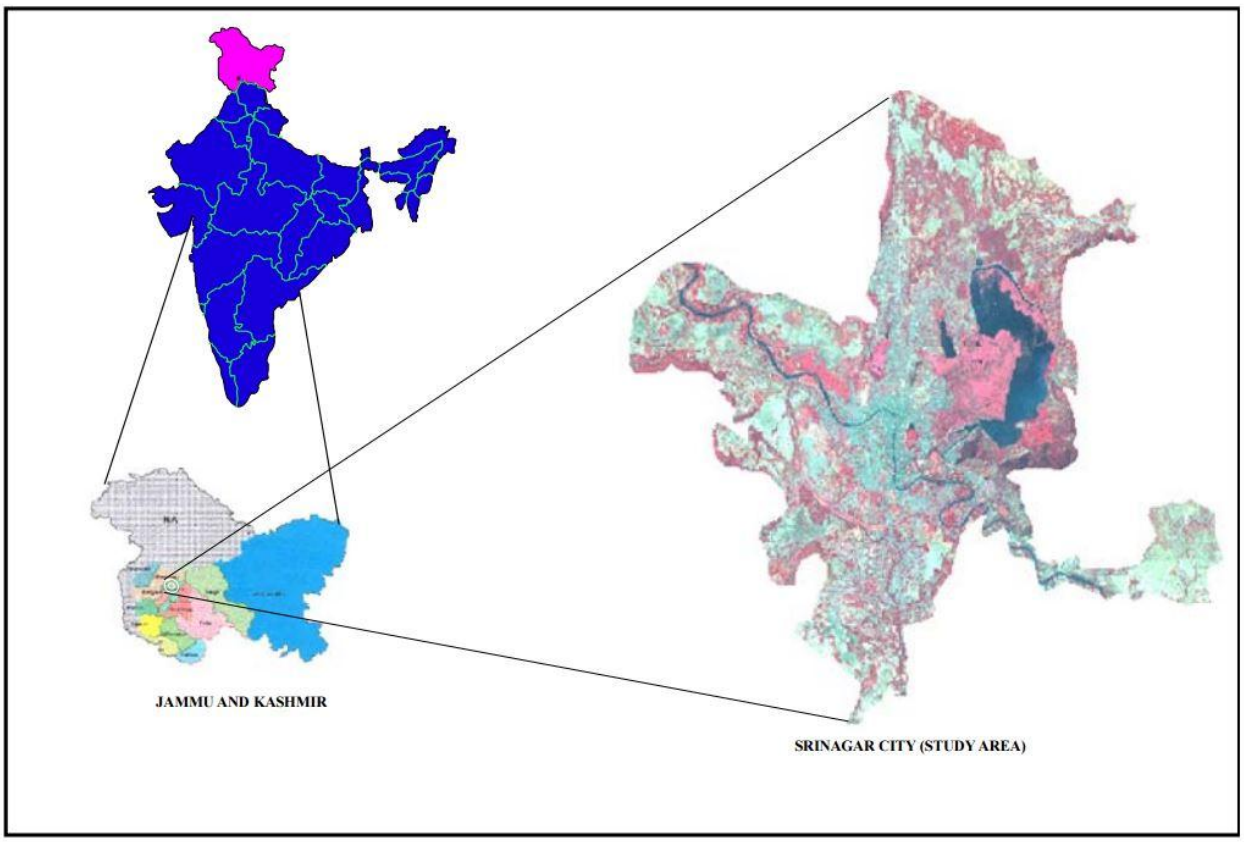

Figure 1. Location map of srinagar city.

Figure 4.13: Location map of Srinagar City, Source: Impact of Urban Land Transformation on Water Bodies in Srinagar City, Department of Geography, India.

The water bodies of Srinagar city are important landscapes of the city because they are not only tourist attractions but are embedded with city's economic, social and cultural existence. These water bodies are also crucial for ecological balance of the city.

The present study reveals that the expansion of Srinagar city and land transformation therein has severely affected the aerial extent of water bodies as well as the quality of water. The noticeable impacts and their consequences are as follows:

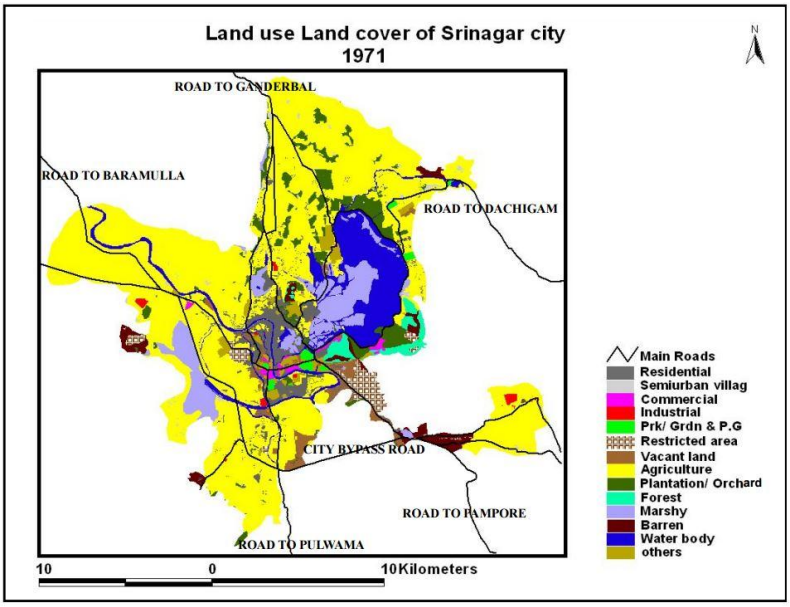

Figure 2. Land use land cover of srinagar city 1971.

Figure 4.14: Land use and land cover of Srinagar city 1971, Source: Impact of Urban Land Transformation on Water Bodies in Srinagar City, Department of Geography, India.

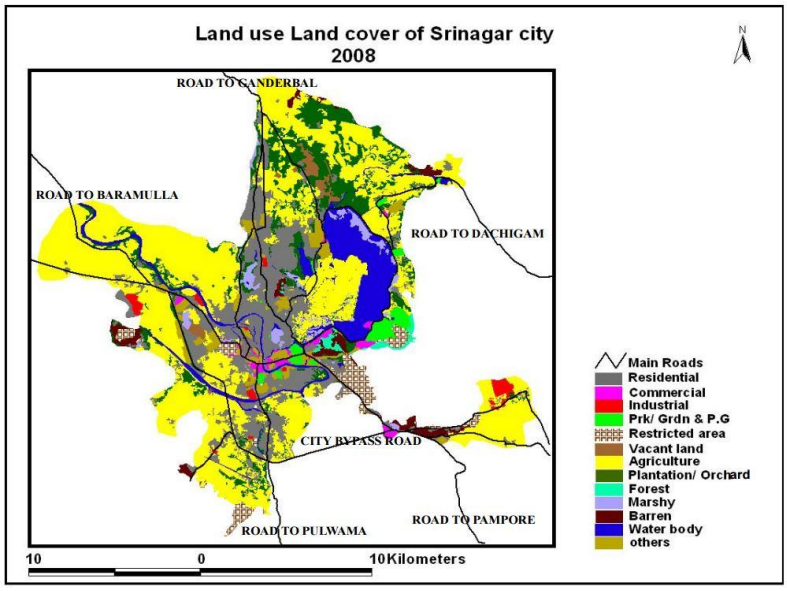

Figure 3. Land use land cover of srinagar city 2008.

Figure 4.15: land use and Land cover of Srinagar city 2008, Source: Impact of Urban Land Transformation on Water Bodies in Srinagar City, Department of Geography, India.

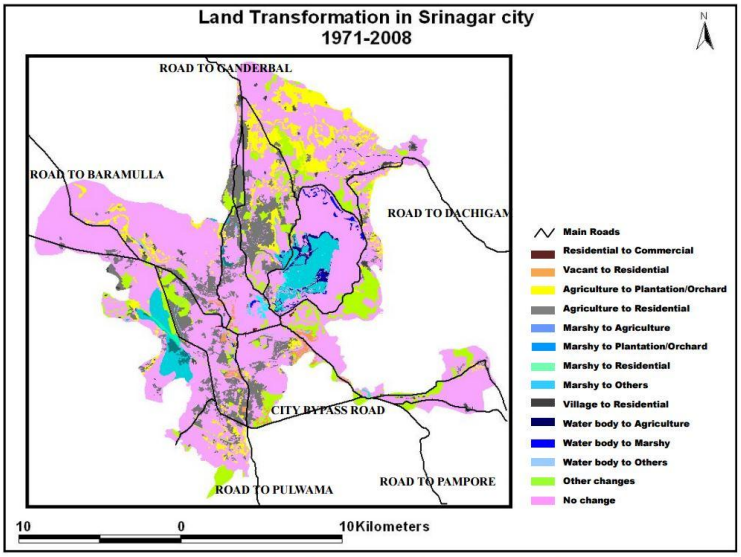

Figure 4. Land transformation in Srinagar city 1971-2008.

Figure 4.16: Land Transformation of Srinagar city 1971- 2008, Source: Impact of Urban Land Transformation on Water Bodies in Srinagar City, Department of Geography, India.

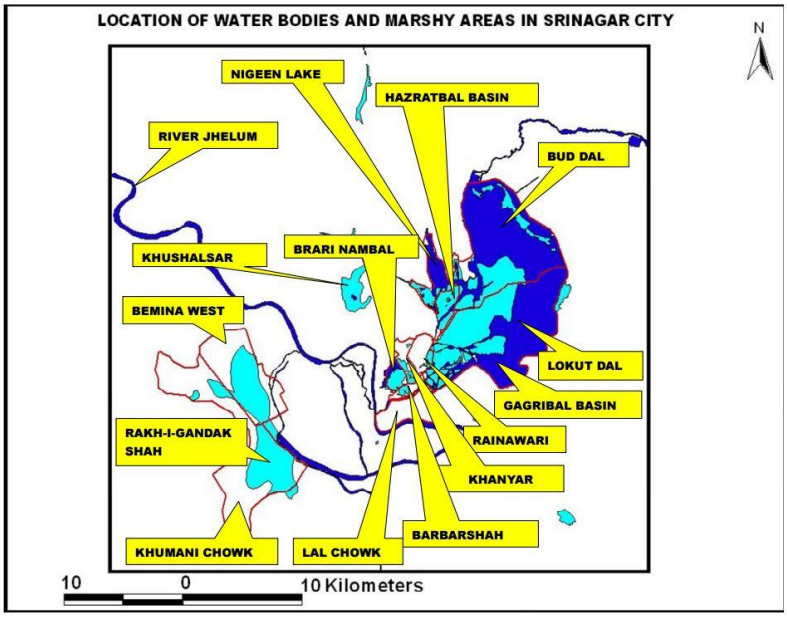

Figure 5. Location of water badies and marshy areas in srinagay city.

Figure 4.17: Location of water bodies and Marshy area in Srinagar city, Source: Impact of Urban Land Transformation on Water Bodies in Srinagar City, Department of Geography, India.

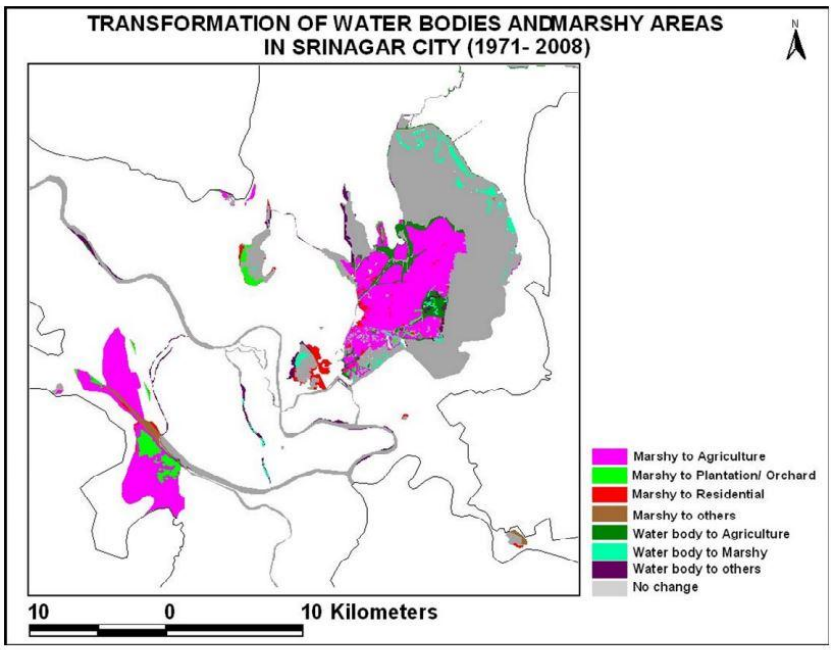

Figure 6. Location of water badies and marshy areas in srinagay city (1971-2008).

Figure 4.18: Location of water bodies and marshy areas in Srinagar city, Source: Impact of Urban Land Transformation on Water Bodies in Srinagar City, Department of Geography, India.

Water body to Agriculture: During the study period 148 hectares of area under water was transformed to agriculture

Water body to Marshy: The Srinagar city has observed 92 hectares of area under water was transformed to marshy lands.

Water body to Plantation/Orchard: This transformation has been observed on the east and the west banks of the Nigeen Lake where 7 hectares of water area has been converted into plantation.

Marshy to Agriculture: The Srinagar city has witnessed large scale land transformation of shallow marshy area. The Srinagar city has lost 1081 hectares of marshy area to agricultural lands.

Marshy to Plantation/Orchard: The Srinagar city has recorded 108 hectares of marshy land transformed plantation/ orchard class. This was mainly in the south of Khushalsar Lake in the north (33.5 hectares), south of Rakh-i- Gandakshah (34 hectares).

Marshy to others: Marshy land got also transformed to other class i.e., Educational, Governmental, Hospital and Religious class mostly, in the west of the study area at Bemina (29 hectares) and in the west Dal Lake (20 hectares).

Settlements around water bodies:

Has resulted in mushroom settlements around the water bodies

A large number of commercial and residential buildings such as hotels, guest houses and restaurants have sprung up in and around Lake Dal . These settlements spill all their wastes into the lakes. This results in increasing levels of pollution because of the ingress of untreated sewage and solid waste from the peripheral areas and from the hamlets into the lake resulting in sedimentation and excessive weed growth. Furthermore, reduction and clogging of water channels within the lake because of encroachments leads to reduction of fresh water inflow into the lake.

House boats in water bodies: House boats are one of the most preferred attractions of Srinagar city, presently there are more than 1 200 house boats inside Lake Dal.

These house boats also eject out their wastes directly into lake again resulting in sedimentation and excessive weed growth. At present, 1 200 house boats are inside Lake Dal and an estimated 9 000 metric tons of waste is annually disposed directly into Lake Dal.

Agricultural activity in and around water bodies: The hanjis (Dal dwellers) belong to poor socio-economic class of the city and they draw their livelihood from agricultural activities. These hanjis have illegally encroached upon the lake area by filling up the lake and transforming the lake in to floating gardens. These floating gardens are engaged for vegetable cultivation. This transformation leads not only to shrinking of lake area but agricultural activity also results in increased sedimentation of soil and chemicals in to the lake.

Rise in the influx of nutrients: The water bodies are also subject to pollution with influx of chemicals in them. Studies reveals that there are 15 major drains get emptied into the lake waters which are charged with nutrients and carry about 18.17 tons of phosphorous and 25 tons of inorganic nitrogen, enriching the lake waters and the sediments [18]. Even the water quality of river Jhelum has also got deteriorated due to the direct discharge of urban waste including both domestic and human excreta and almost every water body has now turned into the "Reservoir of Sewage" wastes and effluents [19]. The water tests have also found high level of pH value, total alkalinity, nitrogen and total phosphorous in the waters of Dal lake.

Impact of Urban Land Transformation on Water Bodies in Srinagar City, India

Growth of weeds in water bodies:
Shrinking of water bodies:
Local climatic change:
Occurrence of floods and water logging:

Conclusions The above investigation clearly points towards the fact that urban expansion has swallowed a significant proportion of the water bodies and the marshy areas of Srinagar city during the study period of 37 years (1971 - 2008) and the process is still continuing. Moreover, the quality of water is also deteriorating at an alarming rate. There is an urgent need to protect and preserve, once the "Paradise on Earth" for future generations. These water bodies are precious because they are not only tourist attractions but they also act as lifeline to the city as it provides livelihood to a large population, directly or indirectly. Thus, proper management is the need of the hour for both maintaining ecological balance as well as sustainability of Srinagar city.

Important measures were suggested for the sustainable management of water bodies in Srinagar city:

- Restricting any increase in the settlements in and around these water bodies and marshy lands. In this perspective, the governments' proactive approach is essential

because state high court in 2003 has already banned all kinds of constructional activities within 200 meters from the periphery of Lake Dal.

- Already settled population in and around the lake area should be relocated and rehabilitated outside the Lake Dal periphery
- Preserving the water bodies is to get rid from duckweed, water ferns, and algae. There must be sincere efforts to perform deweeding and dredging activities on periodic basis in the affected water bodies to maintain clean water.
- This city requires operational sewage treatment plants so that no untreated sewage is disposed off in any of the water bodies. Studies have also suggested using weed as raw material to produces organic manure; this will serve dual purpose of cleaning of water and utilizing the waste.

Sources : *Journal of Environmental Protection, 2011, 2, 142-153 doi:10.4236/jep.2011.22016 Published Online April 2011 (http://www.SciRP.org/journal/jep)* *JEP Impact of Urban Land Transformation on Water Bodies in Srinagar City, India* *Shahab Fazal, Arshad Amin Department of Geography, Aligarh University, Aligarh, India. Email: shahabfazal@rediffmail.com* *Received November 8th, 2010; revised December 24th, 2010; accepted February 19th, 2011.*

The Historical Evolution of the Sir Nagar city.

The city of Sri Nargar indicates an alarming concern in the developing world where the picturesque water bodies, come under constant threat. This is mainly due to the encroachment by low income settler and transformation of the water bodies due to various human activities. Especially waste being disposed to the water bodies form the residential dwelling clusters and industries.

The main water body in Sri Nagar city is the Dal Lake, which resembles a symbolic water mass.

The settlements and urban form has emerged over the years around this water mass, which is a district, and a land mark in the city.

The streetscapes and the pathways that provide access to the building clusters that has emerged around this water Mass., has over the years expanded in an ad hoc manner in a random order. Thus creating a dilemma in the city and a potential threat to the environmental quality.

The water mass that has been the, main attraction in the city is being transformed in to land parcels around it which are unsightly and undesirable for usage. This is due to the mismanagement of the water body.

The water bodies in Sri Nagar city India has been an attraction for the inception of the city, where the city itself has come under constant threat due to inappropriate human habitations and activities.

.

This is a growing and common problem in the developing world.

The Sri Nagar city itself has been a city that has emerged with the water bodies and thus the cities urban for and urban fabric has emerged with the land parcels that have been aside the water bodies.

Hence the potential threat to the water bodies can threaten the wellbeing of the city as well as the urban character of the city.

4.3 Literature Review - European Context

4.3.1 Formation of the city of Amsterdam.

THE CITY OF AMSTERDAM.

The city if Amsterdam is located in the Netherlands in Europe. Contains 219 sq.km extend of land. The city itself is a significant unique city with an endless parade of canals and pedestrian walkways which augurs well for people friendly urban spaces. The city itself is a city full of life where many activities take place along its streets and urban spaces.

One of the key features that make the city so prominent and unique is the water bodies and the street scrapes and the boulevards that makes the city a more pedestrian and people friendly city, that makes it attractive and also is outstanding amidst other European cities. The urban form that has emerged along the water bodies, contains a character of its own where the city itself is a unique creation by the water.

Amsterdam has been the capital city in the Netherlands for many centuries where the city itself is located by the coast along the estuary of the river Amstel.

The history of the city begins with a dam been built across the river Amstel.

Amsterdam today is a port city housing Europe's busiest harbor.

Hence the city of Amsterdam is significant for its own canal system

History: The area was first settled in 19th century. The city grew around a dam on the Amstel River. The river flowed into the Amstel through a sluice in the dam, while the canals served the purpose of water supply to the city. This place is inhabited mostly by craftsmen, traders and farmers. Amsterdam was granted a city charter around 1300 by the Bishop of Utrecht. This is the toll concession of the count of Holland, which states that the settlers in the area around the dam were relived from toll payments to Holland, as they transported their own goods. Amsterdam was under the jurisdiction of the Utrecht diocese. As such, they were bound to Holland by trade regulations.

(*http://citybreaths.com/tagged/Amsterdam)*

Figure 4.19: Pre-1600 inner city left, Today inner city right, Source: http://citybreaths.com/tagged/Amsterdam

Medieval period, 12th century flood destroyed a large part of the farmland. So the population turned to crafts, fishing and shipping to sustain itself. The construction of the dam turned the estuary of the Amstel into a natural port (Present day Denmark), the oldest port of the city.

The first big extension plan was formed in the first decade of the 17th century. The period was found as golden age of the city. The city was literally full after the Golden age started. It was decided to build a canal ring (1610 and 1660, two stages) around the old city and move the defense wall outward. The canal ring extension continued to release the pressure on its land. Due to the migration of rich Europeans the requirement for land continuously increased. The second extension was finished by the time city's immense prosperity had already started to decrease. It took almost two centuries (until around 1900) before all plots laid out were built on.

The nest large expansions were undertaken between 1920 and 1940, consisting of Plan Zuid, designed by Berlage, and Plan West. These developments included a lot of Amsterdam School architecture. (figure 4.21)

Figure 4.20*:* Large canal extension 1657 left, Canal ring today right, Source: http://citybreaths.com/tagged/Amsterdam

City wall of water was the Defense line of Amsterdam consists of 135km long circular defense at 15-20 km around the capital Amsterdam. It was built by the ministry of War mostly between 1881 and 1914. This was all done to defend the National Keep, the last line of defense, of the Kingdom of the Netherlands. Three superpowers; United Kingdom, Germany and France was the major foreign threat to Netherlands during Second World War II. (http://whc.unesco.org/en/list/759)

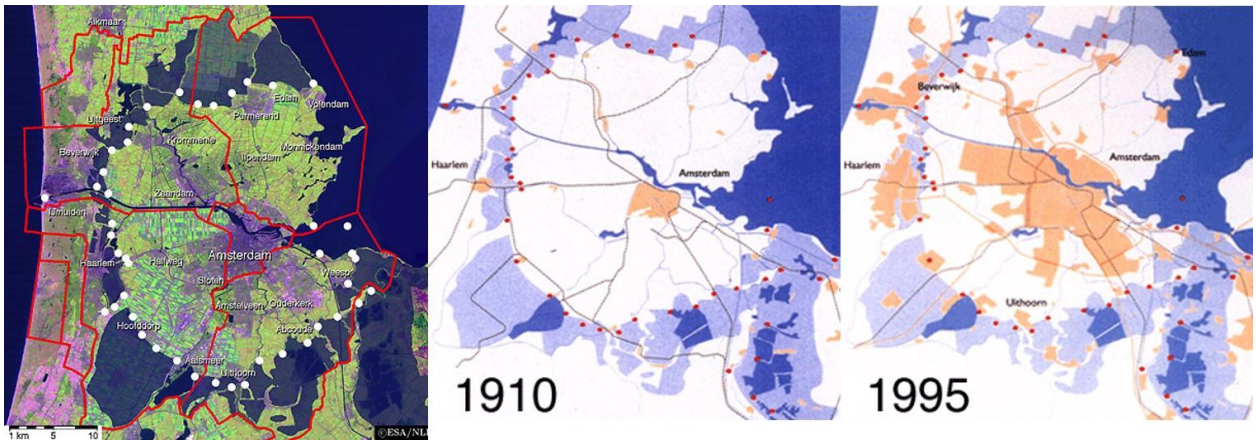

Figure 4.21*:* Defense line, Source*:* www.stelling-amsterdam.nl/english/common/introduction/

The City: Large part of Amsterdam are located below sea level, with certain polders set at more than 6 meters below. Urban density and built form is according to the land cluster by rings of canals. Now Amsterdam is one of the green city in Europe. The neighborhood in the city of Amsterdam have large portion of people in migrated to the city. The highest proportion of people born in Amsterdam lives in the adjacent garden village.

(http://whc.unesco.org/en/list/759.)

Figure 4.22: urban Density pattern, Source: www.slideshare.net/brooksp/spacematrix-presentation-nov-2011

Connectivity of the Amsterdam mainly ring of roads parallel to the canals linked through radial line of bridges. The activities contributing to high connectivity in Amsterdam. This city is a good example for elimination of motor transport. This city also called as Cycling Capital of Europe.

Figure 4.23: pictures of Amsterdam, Source: Author 2005

Sources : *http://citybreaths.com/tagged/Amsterdam*

http://whc.unesco.org/en/list/759

- *Anita Bouman–Eijs; Thijmen van Bree; Wouter Jonkhoff; Olaf Koops; Walter Manshanden; Elmer Rietveld (17 December 2012). De Top 20 van Europese grootstedelijke regio's 1995–2011; Randstad Holland in internationaal perspectief [Top 20 of European metropolitan regions 1995–2011; Randstad Holland compared internationally*

The city of Amsterdam.

The city of Amsterdam is a fine example of a city that has emerged over many centuries as a responsive factor to the water bodies. Where the urban settlement patterns and the urban forms has emerged in response to the water bodies.

The formation of the city is based on the main water body the river Amstel. A waterfront city where most parts of the city is below the mean sea level, the watershed management has been a growing concern in the designing of the city. Hence the dikes that has formed along the Southern banks of the river, has been the primary generating force for the canals to emerge.

The city's settlements and built fabric has been developing along these canals which has given its charter.

The radiating canal system form the dam that was built across the river Amstel, has created a unique character to the city where the canals themselves serve as the paths within the city defining the movement and hence is a dominating element, giving the city its identity.

The semicircular formation of the Canal networks along the banks of the river Amstel has created a web of dynamic water bodies where the street patterns embedded in them in the form of a web has again created a series of clusters and semi districts, within them.

The dynamic water bodies that has emerged along the area, has defined the threshold of the townscapes and the built massing where the urban charter has made it unique.

The streetscapes along the canals, thus define another series of paths, and the canals form the edges. This diabolic relationship between the two and the dual nature of the elements in the urban fabric defines the many parameters in different ways. Where the canals in one way act

as the paths and on the other and when the streets are paths, the canals become the edges. (figure 4.23)

Hence the city's urban elements thus contain a dual nature where they can cater in different ways.

Thus it can be seen form the review of Amsterdam that how the city scopes can be emerged along the water bodies that act as paths and edges. Furthermore the radiating streets create focal points to the nodes in the city.

Analysis of the City as per Kevin Lynch's five elements in the book "Image of the City"

Table 4.3: The city of Amsterdam - Netherlands

01.	Paths	The canal networks have created the paths where the movements of the city have been enabled. The dual nature of the water bodies, which are dynamic, can be seen in the city of Amsterdam. The streetscapes which run parallel to the canals act as the secondary pathways. Urban fabric of the streetscapes is emphasized along these canals and the streets that make the fore ground.
02.	Edges	Along the alleyways that connect to the clusters formed within the city the canals define the edges. The river Amstel also defines the edge of the city. Where the canal networking is radiated form the dikes that are created. The visibility of the street facades and the skyline of the city have been enhanced by the presence of the canals which are constantly used for the movements of the city.
03.	Districts	The river Amstel has been the main definitive edge of the district and the little clusters created by the series of canals and the water bodies. Mini districts are created within the web of the clusters defined by the canals and

		the streets.
04.	Nodes	Along the canals in the interconnections; has forced the nodes in the city, often the crossing and bridges also has visually formed the nodal points. Further the monumental building icons are also visible from the water bodies.
05.	Landmarks	The main landmarks of the city are formed by the connecting bridges which are also the nodal points. Along the canals the open areas of the city can also be visualized as the open land marks of the city, and the significant buildings.

Source: Author

Urban Planning Character of the City in response to the water bodies:

- Amsterdam resembles a unique character of urban planning where the migratory measures that are taken to combat the threat to the city of flooding, has been made use for the metabolism and functionalism of the city.
- The series of canals created has been the core element of the pathways of perceiving the city.
- Hence the urban built fabric and the morphology is an emergence responsive to the water bodies that are present.
- Without the canal water bodies acting as the paths the city could have a different character and meaning in its urban spaces and streetscapes.
- Hence the characteristic urban form which scale wise goes to about 04-05 stories is meaningful when read with the interface of the street and the canal water body.
- This city is a matrix to resemble a dynamic water body that flows, giving the subtle meaning to the urban form and deriving a unique identity.

Matrix: water body as a dynamic element in the functionalism of the city where movement and mobility is geared for defining the urban form, with a subtle meaning in a different angle. The perception of urban form can be through the movement along the water body which is a dynamic variable.

4.3.2 Formation of the city of Lugano

The City of Lugano.

The city of Lugano located along the Southern side of Switzerland, near the Italian border is another water front development. The city has emerged along the Lugano lake.

Lugano is a fine example on the emergence of a city along a water front with responsive urban forms.

The cityscape itself is has emerged as a response to the geophysical features that are present in the context where the water body (Lugano lake itself has taken prime importance) itself has been the primary responsive force.

- Lugano (dialectal Lügàn) is a city in the south of Switzerland, in the Italian-speaking canton of Ticino, which borders Italy. The population of the city proper was 60,815 as of December 2011, and the population of the urban agglomeration was over 145,000.
- It is the 9th largest city of Switzerland by population, the largest city in Ticino, and the largest Italian-speaking city outside of Italy.
  (Swiss Federal Statistical Office - STAT-TAB, online database – 2016.)

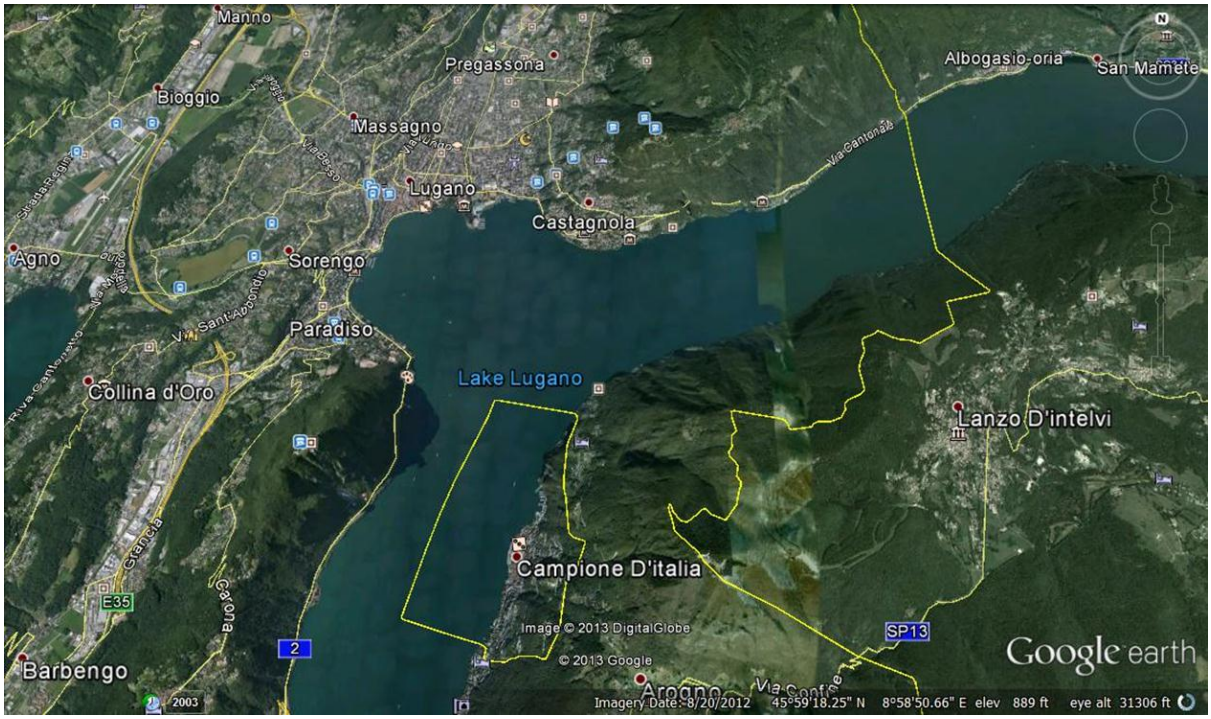

Figure 4.24: Arial Map of Lugano, Source: Swiss Federal Statistical Office - STAT-TAB, online database – 2016.

URBAN DESIGN PATTERNS OF CITY FORMATION.

City of Lugano – Switzerland.

The city lies on Lake Lugano, surrounded by the mountains of the Lugano Prealps. Its warm summers and the fact that in recent years it has attracted an ever growing number of celebrities, entertainers and successful athletes have given it the nickname of the "Monte Carlo of Switzerland". (figure 4.26)

Ref : "Svizzera – Lugano – Guida alle città svizzere" [Switzerland - Lugano - Swiss City Guides] (in Italian). Retrieved 24 November 2008.

Images from City of Geneva Switzerland – a city along the water.

Figure 4.25: Image from the city of Lugano- Switzerland, Source: Author 2016.

LUGANO City Switzerland :

The city of Lugano is located along the Southern side nearing the Italian boarder of Switzerland. A journey form Zurich to Lugano by rail is considered one of the finest Rail trips in the world.

With an endless parade of sceneries and mountain ranges and Pine forest, lush green vegetation and waterfalls. Lugarno lies at the edge of Lake Lugano, which is situated between

the lakes Lago Maggiore and Lago di Como, south of the Alps. It lies at the heart of the Sottoceneri, that part of the canton of Ticino that lies south of the Monte Ceneri Pass.

The city centre is located on the lake shore just to the west of where the River Cassarate enters the lake. The city's waterfront forms a crescent around the bay between the Brè (925m) and the San Salvatore (912m) mountains.

Because of the historical development of the city, incorporating some relatively distant suburbs but leaving other, nearer, suburbs as independent municipalities, the borders of the city are disparate. The city includes two exclaves, with Villa Luganese separated from the rest of the city by the municipality of Cadro, whilst a large and sparsely populated section of the city is on the east bank of Lake Lugano and separated from the city by that lake. Similarly, the inner-urban but independent municipality of Paradiso is a near-enclave, totally surrounded as it is by the city and the lake of Lugano.

Lugano has an area, as of 1997, of 32.09 square kilometers (12.39 sq mi). Of this area, 3.25 km2 (1.25 sq mi) or 10.1% is used for agricultural purposes, while 6.73 km2 (2.60 sq mi) or 21.0% is forested. Of the rest of the land, 4.48 km2 (1.73 sq mi) or 14.0% is settled (buildings or roads), 0.04 km2 (9.9 acres) or 0.1% is either rivers or lakes and 0.12 km2 (30 acres) or 0.4% is unproductive land.

(*Lugano (commune) in German, French and Italian in the online Historical Dictionary of Switzerland)*

Lugano is a city by the lake which resembles a fine blend of nature and built form harmonizing well complementing each other.

The vistas and visual corridors that are created in between the buildings and street facades are a fine vindication of this.

Water has played a pivotal role in the formation of this city along the mountains and valleys, where the urban settlement patterns are a resemblance of its responsiveness to the water bodies.

The history of the urban development of the city of Lugano can be subdivided into four phases. The medieval form lasted until the end of the eighteenth century. After the shift from the old to the new regime (1798-1847), the social scene changed, and the city expanded beyond the traditional urban circle of walls limited by the gates which were pulled down.

There was a change from the old form of the fortified borough to the open form of the modern city.

From 1880 to 1910 the city experienced, especially after the opening of Gotthard's railway line, an exceptional demographic increase. During those thirty years the population growth was almost 8000 inhabitants, going from 6949 to 14998 units.

From 1900 to 1945 the City underwent important urban changes caused by another demographic increase and economic pressure which really changed radically the structure of the old town centre and of whole districts.

Figure 4.26: Map of Lugano's urban morphological evolution, Source : *destinations.lugano.ch/en/lugano-citta-svizzera/lugano.html*

Lugano between the 15th and the 18th centuries

Figure 4.27: pictures of Lugano in the early days , Source: *destinations.lugano.ch/en/lugano-citta-svizzera/lugano.html*

Lugano Region is surrounded by mountains and a splendid lake, Lugano brings together all the characteristics of a metropolis of great style, despite maintaining the traits of a small city.

Most particular and striking is the large pedestrian area, which contains the historic center, full of splendid buildings.

Figure 4.28: Images of Lugano , Source: www:luganocitybythelake

The Lake of Lugano

Lago di Lugano, Ceresio, or constitutes, together with the 8000 surround, the greatest natural resource in the Region.

Its unique shape appears like a composition of different lakes and gulfs around Porlezza, Lugano, Capolago, Agno and Ponte Tresa.

The lake of Lugano extends 35 km from Porlezza to Ponte Tresa, with a maximum width of 3 km between Lugano and Cavallino and an average width of slightly over one kilometre. Its maximum depth is 279 metres, situated between Gandria and the opposite shore. The depth decreases considerably towards south, in particular from Campione towards the gulf of Agno and of Ponte Tresa. (figure 4.28 & 4.29)

(*"History of the City". City of Lugano. Retrieved 18 February 2009.)*

Figure 4.29: Images of Lugano, Source: Author 2005

A walk in the paths of Lugano to live with the nature. Pristine landscapes, endless forests, endless blue skies and mountains wearing the colours of the seasons. Authentic trails that make walking even with the mind. A land where nature and animals are still the protagonists and the mountains are like works of art carved by nature over the centuries. Walk through small towns, villages, mountains, parks, is the best way to know our history step by step.

Figure 4.30: Views of Lugano lake and urban form, Source: author 2006.

- *Sources - "Svizzera – Lugano – Guida alle città svizzere" [Switzerland - Lugano - Swiss City Guides] (in Italian). Retrieved 24 November 2008.*
- *"History of the City". City of Lugano. Retrieved 18 February 2009.*
- *Lugano (commune) in German, French and Italian in the online Historical Dictionary of Switzerland.*

The city of Lugano - Switzerland.

The city of Lugano in Southern Switzerland is a fine example of a water front development in response to the Lugarno Lake.

The city has emerged over many centuries over the history where the water mass has be used for many aspect. At in a stage the water body has been used for defense, and latterly it defines the edge of the city. Where the city formation responds to the water front, streetscapes and other landscapes emerge in response to the water mass.

The lake has also been a symbolic landmark in the city defining its edge.

That banks of the Lugano Lake,

The streets and alleyways in the city define the paths as per the five elements of a city in Kevin Lynches "image of a city". The focal points of most pathways that are perpendicular to the lake make the lake a nodal point while acting as a landscape element.

The mountains across the lake act as some of the focal points and nodes clearly visible across the lake along the streetscapes which are the paths.

Hence the city of Lugarno is a depicts fine urban planning, where the water body has been a form determining element, where the streets and paths that are created, are knitted to the natural elements, in the context.

The city itself has been radiating from the water body in its urban formation and morphology. Meticulous planning and urban designing can be seen in this city where the due respect is given to the water body.

Nevertheless the water body defining the edge of the city has played a key role in the urban planning system, where the orientation of the visitors is emerges from the lake.

The close relationship between the city and the lake, and the harmony that is been created between the two, has thus given the city its image. The visibility of the lake form many angles of the city where the water body has become the focus with the vistas that are created along the paths that radiate from the banks of the lake, is a fine juxtaposition, of water and urban form integration. To enhance this aspect further the built massing with the building facades that are generated along the streets further creates a tunnel effect that directs the focus on to the water body.

The banks of the lake have defined a threshold, which acts as at the edges of the district. Along then the banks of the lake an interface is created between the city and the lake, which is a catalyzer for the human integration in harmony with nature. This interface is created in a meticulously planned manner where the integration of urban form and water mass in responsive to each other is emphasized.

The building heights of the city have also emerged with the profile of the terrain and are responsive to the water body that is the key land mark in the city.

The steeping down effect towards the basin of the water mass the facades of the streetscapes of the streets in Lugano is a fine vindication of responsive urban form to water bodies. Thus maintaining the uniformity of the urban form with its scale and proportion.

The scale can increase within a reasonable distance for the water body where the prominence of the water body will be maintained. With the uniformly descending scale of the built massing towards the water body.

In the review of the city of Lugano, where the lake has been a static variable and the city and its urban fabric has been a dynamic variable, it can be observed, that how responsive urban form with in relation to the water mass can build and image to the city and give its character and identity. Furthermore how it can enhance the quality of life in the city.

Analysis of the City as per Kevin Lynch's five elements in the book " Image of the City"

Table 4.4: The city of Lugano – Switzerland

01.	Paths	Paths are created by the streets that radiates from that water body the Lugano lake. Most paths that radiates for the lake (the streets and alleyways) are visually focused to the lake creating a vista. Thus enabling a visitor to feel the connection.
02.	Edges	The banks of the lake create an edge to the city, where the growth of the city is contained. Hence space syntax is created by the presence of the lake. Forcing the city's urban form to grow in the opposite direction of the lake.
03.	Districts	The periphery of the lake defines one end of the district. A sense of boundary is created by the presence of the lake. Also the presence of the lake makes a conjunction of the interface between the water body and the urban form in the city where the streetscapes along the interface defines one boundary of the district.
04.	Nodes	The gradual terrain slopping down towards the basin of water enables to visually connect the path ways focused to a nodal point where the water itself acts as a backdrop to the mountains across the lake. Also the other ends of the pathways are often focused on to a monumental building which can be the dome or bell post of a church or a civic building at an elevation etc.
05.	Landmarks	The water body itself acts as the main landmark where the streets are focused to in one direction. There by the water body has been a feature in acting as a forecourt where the mountains across the lake and its greenery and the built fabric acts as the land marks. Hence the water body here enables to enhance the landmarks of the vicinity.

Source: Author

Urban Planning Character of the City in response to the water bodies:

- The city of Lugano in this context has been an emergence responsive to the water mass that is present, which has been the main static variable, in the city formation. The urban fabric has emerged in response to this metaphor.
- Hence the coexistence of the water body and the urban form in harmony to each other has formed the symbiosis within the context. And will still cater to be in the futuristic development scenarios.
- The lake has defined one end of the city and inevitably the city itself has been a water front development. And its urban regeneration will further be responsive to the static water body. If ignored in the future, it would create a dilemma and be a potential threat to the sustenance of the city.
- This is a definition for a city by the edge of inland water; the principles adopted can be made use for other cities located by a static water body elsewhere in the world in any climatic condition.

Matrix: water body as an edge defining element for the regeneration of urban for and urban morphological patters.

4.3.3 Formation of the city of Venice

Venice, Italy.

History: Venice is a city in northeastern Italy sited on a group of 118 small islands separated by canals and linked by bridges. It is located in the marshy Venetain Lagoon which stretches along the shoreline, between the mouths of the Po and the Piave Rivers. The city in its entirety is listed as a World Heritage Site, along with its lagoon. Venice has been known as the "City of Water", "City of Bridges", "The Floating City" and "City of Canals".

(UNESCO: Venice and its Lagoon, accessed:17 April 2012)

Figure 4.31: Aerial map of Venice, Source: *fromwayuphigh.com/venice-italy*

The Grand Canal is a canal in Venice, Italy. It forms one of the major water traffic corridors in the city. Public transport is provided by water buses and private water taxis, and many tourists explore the canal by gondola. At one end, the canal leads into the lagoon ndar the Santa Lucia railway station and the other end leads into Saint Mark Basin in between. It makes a large S-shape through the central district if Venice. It is 3,800 meters long, 30-90 meters wide, with an average depth of five meters. (Figure 4.31)

(Thomas F. Madden, Venice: A New History, Penguin, 2013)

Functional Relationship

Figure 4.32: Images of Venice, Source: https://en.wikipedia.org/wiki/Rialto_Bridg

128 Centimeters Below Average Sea Level,

Figure 4.33: Aerial view of Venice, Source: https://commons.wikimedia.org/.../File

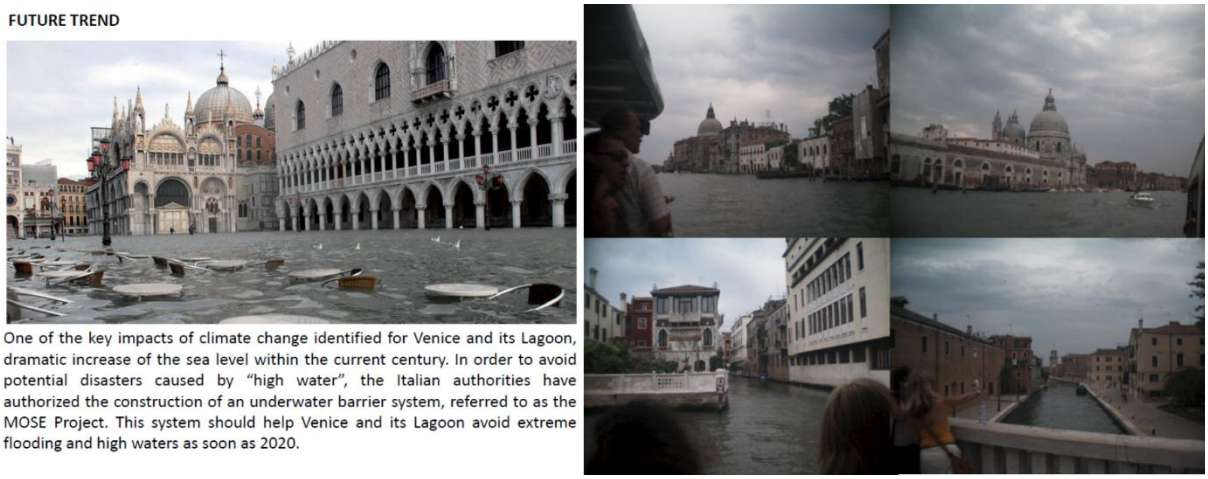

Figure 4.34: Images of Venice, Source: Author Compiled

Images of the city of Venice urban form by the waterways Source : Author 2006.

Source - UNESCO: Venice and its Lagoon, accessed:17 April 2012
- **Chambers, David (1992). Venice: A Documentary History. England: Oxford**
- **Thomas F. Madden, Venice: A New History, Penguin, 2013.**

Analysis of the City of Venice.

The city of Venice like Amsterdam is a water front development where the canals and water has been a determinant force in the formation of the urban fabric.

The canals creates the dynamism of the city which is a primarily the paths of the city where the urban form can be perceived.

The urban form has emerged in response to these dynamic water bodies.

The Venice although being a scenic tourist attraction in the present day, has emerged in response to the dangers and threats the city was confronted with, where the city was bound to go under water being located below the sea level.

Hence the city's canal network was formed to circumvent this problem and the city itself was transformed to an iconic unique city where the water oaths itself became the paths.

As the canals act as the streets in Venice the building massing is facing these canals;. And districts are created within this network of canals. Within the districts clustered by the canal networks, alley ways connect the internal areas.

Venice depicts a unique character where the building forms and street facades are viewed form the water and their frontage are alongside the water face.

The nodes of Venice are created by the end points of the canals (water bodies) where often they are focused on to monumental buildings with highracheal domes and other symbolic features.

Hence as the canals depict the pathways to perceive the city vistas are created along the waterways focusing n to the monuments.

The interfaces thus have been created like the pavements of a street in other cities, where the interactive urban spaces are created. Thus the uses can holistically perceive the city which is an endless parade of canals and urban built massing. Venice is a highly dense urban mass but the connectivity is created by the vistas which visually connects the other ends of the canals, with a tunnel effect.

The urban fabric of the city of Venice Is knitted with the water ways (canals) and the dense urban forms. Which are generally 3-5 stories high.

Hence the Urban Fabric is a series of dense built massing alongside the canals. The urban morphology of the city is also knitted with the canal networks. A city with less open areas the vistas along the water paths crates the permeability and the connectivity of the city.

The edges of the city can be observed as the main water bodies the seafront and the Grand Canal which intersect canal networks that defines the edges of the district.

Table 4.5: The city of Venice – Italy

01.	Paths	The canals act as the paths that create the movements of the city. Which enables the visual perception of the direction of the city. The dense building form is seen along these pathways. Connectivity of the water bodies indicates the connection of pathways. Interfaces along the canals area created between the buildings and the water bodies.
02.	Edges	The Grand canal and the sea front form the edges where the canals end.
03.	Districts	Small districts are formed within the clusters created

		between the canals and alleyways. Large districts are formed with the main water bodies and the holistic clusters embedded within.
04.	Nodes	Along the ends of the canals the focus is on to the monumental buildings or parts of the buildings, where the paths focus on to.
05.	Landmarks	The landmarks are the great canal and the sea at the other end where the city;' canals are connected to.

Source: Author

Urban Planning Character of the City in response to the water bodies:

- Venice depicts a unique urban character in the formation of its urban form, where the urban form is resilient, to the water bodies, and is a part and parcel of the urban fabric read in conjunction with the water body. If not for the canal system that is in palace with the urban form the streetscapes, will depict a different meaning and a different image of the. Hence the composition of the urban fabric in different ways will create a different meaning to the city and the image.

Matrixes:

The knitting of urban elements and the synthesizing method plays a key role in giving the urban fabric its own image and identity to the city. In a scenario where strips of water that is dynamic force the movement, embedded with the street facades in the form of a ribbon development will give a diverse perception as against a conventional aspect of streets being the paths.

4.3.4 Formation of the city of Canberra

Canberra, New South Wales, Australia.

THE CITY OF CANBERRA – AUSTRALIA.

Cabrera is an inland city, which is the national Capital of Australia, located in between the two main cities Melbourne and Sydney.

A city located by the lake Burly Griffin

The Canberra City emerges as a water find development along the banks of the Great lake Burly Griffin.

The formation of the city has taken a radial form where the streets are all connected to the center circle as seen in the city plan.

Hence the emergence of this city has great significance in the planning techniques and the land use patterns used.

- 01/01/1901 – Six Australian colonials formed a federation called :"Commonwealth of Australia"Decision was taken at Premiers conference to establish new federal capital within the border of New South Wales and be distant not less than one hundred miles from Sydney. The site was selected for the location of the nation's capital in 1908 as a compromise between rivals Sydney and Melbourne, Australia's two large cities.

("Sustainability issues in Canberra – background". ACT Government. 13 June 2012. Archived from the original on 26 April 2013.)

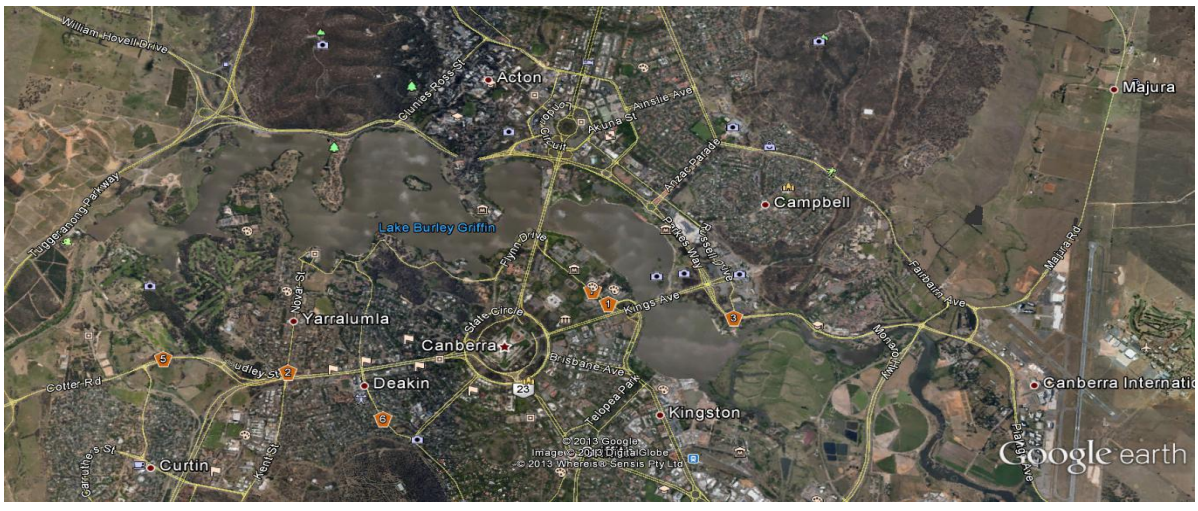

Figure 4.35: Aerial map of Canberra , Source: ("Sustainability issues in Canberra – background". ACT Government. 13 June 2012. Archived from the original on 26 April 2013.)

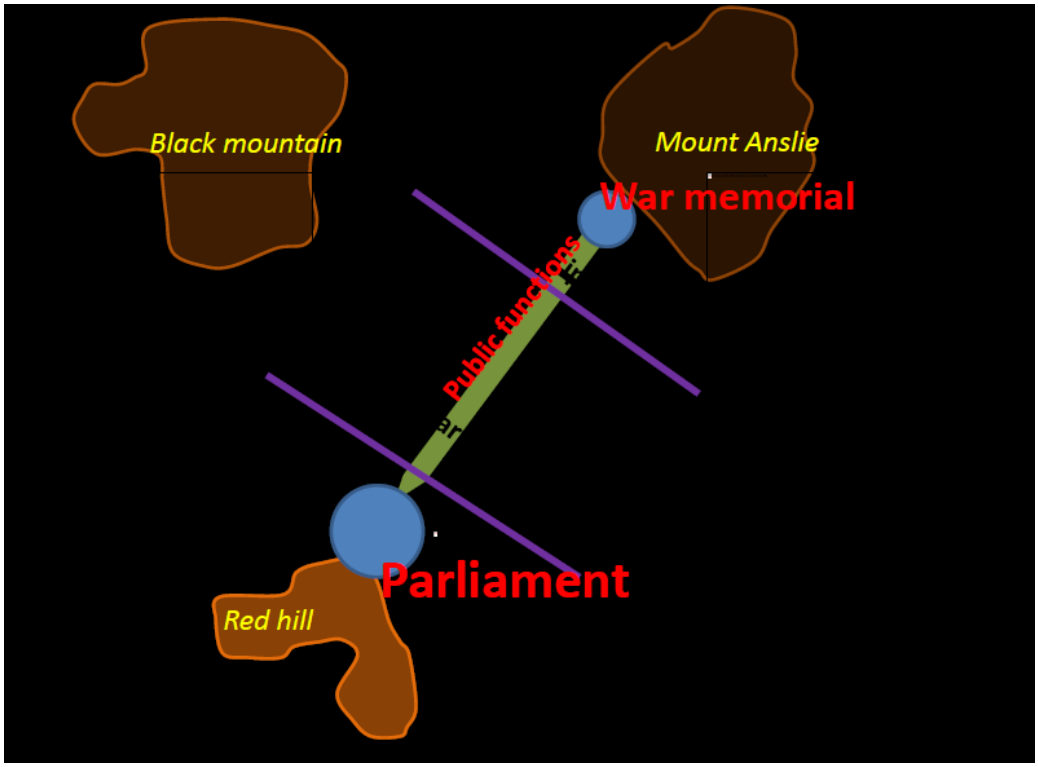

Figure 4.36: Conceptual sketch of Canberra, Source: Author.

The Image behind GRIFFIN…..

The site may be considered an irregular amphitheater with Mount Anslie at the north-east, flanked by Black Mountain and Mount Pleasant all forming the top galleries; with the slopes to the water, the auditorium - the waterway and flood-basin, the arena; with the southern slopes reflected in the basin, the terraced stage and setting of monumental Government structures sharply defined rising tier on tier to the culminating highest internal hill, Capital Hill; and with Mugga Mugga, Red Hill and the blue distant mountain ranges forming the back scene of the theatrical whole..."

Design was influenced by Garden City concept

Capital lies in an AMPHITHEATRE of hills out look towards North and South

Wheel spoken pattern rather than Grids

Concentric Hexagonal and Octagonal streets entering from several radii (Figure 4.35 & 4.37)

("Sustainability issues in Canberra – background". ACT Government. 13 June 2012. Archived from the original on 26 April 2013.) .

Figure 4.37: Map of the City of Canberra, Source: - Frei, Patricia. "Discussion on the Meaning of 'Canberra'". Canberra History Web. Patricia Frei. Archived from the original on 27 September 2013. Retrieved 11 August 2013.

All streets that are connected to this centered circle which houses some of the prominent Public and Administrative buildings has formed the city to emerge as a radial city where the streets are radiating form the center circle.

Hence in the Urban Morphological aspects the city itself has created sectors where the activities are imbibed within these sectors that formed through the reradiating streets along the town center.

The suburbs of the city are formed outside this sector. (Figure 4.35)

The City Urban formation consists of the connectivity between two significant nodes that is the London Circuit across the lake and the main circle that houses the parliament and the Capital Hill.

Hence the city of Canberra's Urban pattern is symbolic along the connectivity of these two circles where the city panning is based upon.

the two circles are connected along the Commonwealth Avenue which is a significant artery in the city's formation where the connectivity of the two sides s of the water body is made with though main streets the Kings Avenue and the Commonwealth Avenue.

These two streets have formed the main sector which is in the shape of a wedge and hence has formed its Urban Morphology where the significant land mass is encircled with ring roads concentric to the center of the circles.

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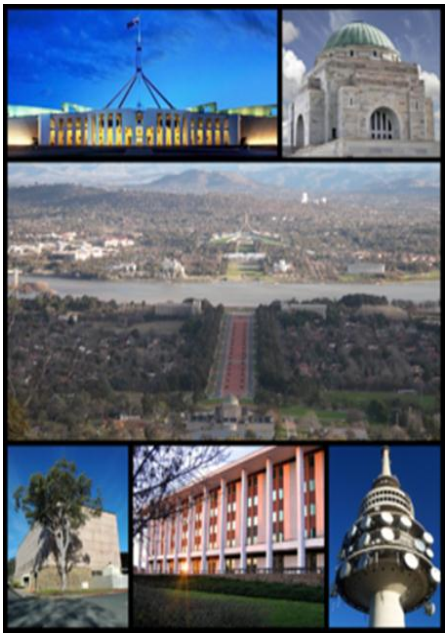
. 

Figure 4.38: Images of Canberra., Source: - Frei, Patricia. "Discussion on the Meaning of 'Canberra'". Canberra History Web. Patricia Frei. Archived from the original on 27 September 2013. Retrieved 11 August 2013.

The city has formed along the flat area along the surrounding hills and the axial street plays a symbolic role in the formation of thee streetscapes.

The Urban Morphology of the Canberra city is again formed by the symbolic relationship between the main arteries that radiates formed the main cities of the city that has defined that land usage along the sectors of the city.

Looking at the city planning the residential sector is embedded in the southern side of the city center along the sectors in the form of a wedges and arks that has been formed by the usage of the radiating street pattern defining the urban form.

History: The site was selected for the location of the nation's capital in 1908 as a compromise between rivals Sydney and Melbourn, Australia's two large cities. The decision to select Canberra by six Australian colonials to establish new federal capital within the border of New South Wales and be distant not less than one hundred miles from Sydney. The consideration to locate and design Canberra considered, climate has to be too cool than warm, port access but should not be located near to shore, city had to be on elevated land and had to be worthy to be capital of greater nation. The territory expected to contain not less than one

hundred square mile with uncontaminated by industrial major urban development and need to have aesthetic effect.

Walter Burley Griffin from Chicago, an American Landscape Architect, whose plan established a city for a population of 25 000 which be expected in time would grow to 75 000. The site may be considered an irregular amphitheater with Mount Ainslie at the north-east, flanked by Black Mountain and Mount Pleasant all forming the top galleries; with the slopes to the water, the auditorium - the waterway and flood-basin, the arena; with the southern slopes reflected in the basin, the terraced stage and setting of monumental Government structures sharply defined rising tier on tier to the culminating highest internal hill, Capital Hill; and with Mugga Mugga, Red Hill and the blue distant mountain ranges forming the back scene of the theatrical whole..."

(*Frei, Patricia. "Discussion on the Meaning of 'Canberra'". Canberra History Web. Patricia Frei. Archived from the original on 27 September 2013. Retrieved 11 August 2013.)*

Urban Structure:

The design of the city was influenced by Garden City Concept. Capital lines in an Amphitheatre of hills out look towards North and South wheel spoken pattern rather than grids. Concentric Hexagonal and Octagonal streets centering from several radials.

The word 'Canberra' is popularly claimed to derive from the word Kamgera of Canberry and mean "Meeting place" in the old Ngunnawal language of the local Ngabri people. Alternatively, the name was reported by Queanbevan newspaper owner John Gale in the 1860s to be an anglicisation of the indigenous name 'nganbra' or 'nganbira', referring to the Sullivans Creet flood plain between Mountain Ainslie and Black Mountain. This was a formation of a new federation for dream for the democracy.

(Frei, Patricia. "Discussion on the Meaning of 'Canberra'". Canberra History Web. Patricia Frei. Archived from the original on 27 September 2013. Retrieved 11 August 2013)

Sources :

- *"Sustainability issues in Canberra – background". ACT Government. 13 June 2012. Archived from the original on 26 April 2013.*

- *Frei, Patricia. "Discussion on the Meaning of 'Canberra'". Canberra History Web. Patricia Frei. Archived from the original on 27 September 2013. Retrieved 11 August 2013.*

Analysis of the cty of Canberra – Australia.

The formation of the city of Canberra Australia can be see a direct response to the Geo physical features in the context where the 03 mountains has been the primary form determinant forces for the city to emerge.

Nevertheless located within a valley the city to take its radiating shape, the presence of the water body "the Lake". The location of the city within this valley and water basin was a direct response to the water body. Where the shape of the water body has be a direct response force in the formation of the radiating pattern of the city, form the amphitheater.

Hence the city itself is a resemblance of and emergence of the water body that is present.

The water body also can be observed as an **edge** to the city, the urban planning has gone beyond penetrating this edge where the connectivity is been made, across the lake. The lake itself is a definition of a District and a landmark. (As per the Kevin Lynch's Theory on Image of a city)

Furthermore the city itself has formed a unique identity where the response to geophysical features and which are mainly the mountains the water body and the valleys has collectively been the responsive force in the urban form generation of the city. Nevertheless the water mass of the lake Burly Griffin has been a primary determinant force in the radial street pattern. Where the city itself was been shaped according to the shape of this lake.

In the futuristic development scenario of the city of Canberra, the response to the water b0ody the lake is an indispensible aspect where the City's urban form can be sustained and imageability is preserved.

Making use of the flat terrain along the water body, and containing the city with the mountains and drawing connections across the water mass present are some of the fundamental urban planning principles adopted in the formation of the city of Canberra.

Thus the water mass as per Kevin Lynch's theory has been used to define the imagebility of the city where it has been a key component in much aspect, for the people to relate to the city.

The water mass is a primary landmark and defines one end of the district that is formed.

The Nodes in the city that are created by the urban planning, has been determined in response to the water mass.

A significant feature in this city planning is, not limiting the city, by the edge of the water like in many other cities, but the paths penetrating to the water body which defines the edge of the district, continuing towards the other side of the lake.

Where the potentiality is harnessed to create the radiating cores across the lake. And its physical and visual connectivity, thus gives the character to the city/. Making use of the mountains as the backdrop to the iconic land marks in the built fabric, the water body further enhances the visibility if the iconic buildings of the city

Canberra is a fine Juxtaposition of the Districts Edges, path and nodes created, in the urban formation of the city. The water body itself, acts in many parameters within the above. Where the image of the city can be read where the water mass is a main feature, where all built fabric and urban morphology is being regenerated and shaped accordingly.

Table 4.6: The city of Canberra – Australia

01.	Paths	Radiates form the amphitheater formed in the valley. The paths are generated in response to the water body that is present.
02.	Edges	Defines the edge to the water body and the radiation of the streetscapes take the shape with the profile of the water body.
03.	Districts	Edges of the sub districts are defined on either side of the water body. But the water body acts as a threshold of the two districts, but an interface visually connecting the two.
04.	Nodes	The center of the rings housing the iconic buildings defines the nodes; also the peaks of the mountains also act as the nodes.
05.	Landmarks	Defined by the presence of the water body.

Source: Author

Urban Planning Character of the City in response to the water bodies:

- The presence of the water body has been a key feature in designing the radiating city, alongside the other geophysical features.
- Unlike other cities Canberra is a designed city using the garden city concept. Hence the core element and the force for the urban formation of the city are the mountain peaks and the water body located in the basin.

Matrix: a city's urban form can have a segregation of the districts and clusters with the presence of the water body yet having the connectivity visually. The water body acting as a unifying elements and simultaneously, defining the threshold between the urban fabrics.

4.4 Summary of the matrixes developed from the litreature review.

01. Anuradhapura – the ancient capital of Sri Lanka.

- ***The water bodies are being a key element in the determination of the urban land use patterns, defining many activities in forming districts in the form of a series of concentric rings.***
- ***Several water bodies collectively give a different meaning to the city formation and derive a subtle meaning.***

02. Polonnaruwa – ancient capital of Sri Lanka

- ***Polonnaruwa city is a fortified city that has emerged making use of water as a key element in determining the urban morphology and the land use pattern of the city.***
- ***The city of Polonnaruwa depicts how the presence of a gigantic water mass, which caters to the basic needs of human habitation, has become a primary determinant force in the formation of a city, and its fortification. The water body defining the land usage pattern and the urban planning resulting in the urban morphology. The multiple usage of water is a key factor and a powerful force in urban form generation.***

03. Kandy – The last bastion of the Sri Lankan kings

- ***In the examples of the city of can it can be proven that the creation of an artificial lake after the city has formed (as a reversible process in comparison with other cities); the water mass has become a dominant element giving a new meaning to the city and its legibility.***
- ***Where the iconic buildings especially the temple of the tooth relic and the palace complex in the citadel is given a higher prominence.***
- ***With the coming in to being of the water mass and new developments of the city is governed by this key element. Where the urban fabric is determined in the expansions of the city.***

04. Sri Nagar – India

- ***Transformation of water bodies in to low income settlements can result in a mismanagement of water bodies can result in a serious dilemma of diluting the urban form where the city can be unlivable and uninhabitable.***

05. Lugano – a city in Southern Switzerland

- ***Matrix : water body as an edge defining element for the regeneration of urban for and urban morphological patterns.***

06. Amsterdam – Capital of the Netherlands

- ***Matrix: water body as a dynamic element in the functionalism of the city where movement and mobility is geared for defining the urban form with a subtle meaning in a different angle. The perception of urban for can be through the movement along the water body which is a dynamic variable.***

07. Venice – Italy

- ***The knitting of urban elements and the synthesizing method plays a key role in giving the urban fabric its own image and identity to the city. In a scenario where strips of water that is dynamic forcing the movements, embedded with the street facades in the form of a ribbon development will give a diverse perception as against a conventional aspect of streets being the paths.***

08. Canberra - Australia

- ***Matrix: a city's urban form can have a segregation of the districts and clusters with the presence of the water body yet having the connectivity visually. The water body acting as a unifying elements and simultaneously, defining the threshold between the urban fabrics.***

Chapter 5: Case Study

5.1 City of Colombo

The city of Colombo is presently the largest in Sri Lanka and is the Commercial capital of the country.

A coastal city form its inception; the city formed during the colonial era dating back to the 16th century.

With the colonel ruling of the country for over 500 years the city of Colombo became the main commercial hub in the country, and hence became the capital. The city itself functioned as the capital of the country even after independence until 1982 where the administrative capital was shifted to Sri Jayawardanepura Kotte (which is located in the suburbs of the Colombo towards the east). Nevertheless Colombo still continues to function as the commercial capital of Sri Lanka.

Hence the evolution of the city of Colombo took place with the colonization of the island by the European invasions. Where a city was formed, and Colombo city itself emerged to be the largest city in the country.

- *Due to its large harbour and its strategic position along the East-West sea trade routes, Colombo was known to ancient traders 2,000 years ago. It was made the capital of the island when Sri Lanka was ceded to the British Empire in 1815, and its status as capital was retained when the nation became independent in 1948. In 1978, when administrative functions were moved to Sri Jayawardenepura Kotte, Colombo was designated as the commercial capital of Sri Lanka.*

  ("History of Colombo". Archived from the original on 2011-12-02. Retrieved 2007-03-21.)

The historical significance of Colombo, dates back to the kingdom of Kotte, where Colombo was a village along the Western coast, with a thick vegitation. However the presence of a natural harbor was the main attraction for the colonists to develop this region in to a city.

The Colombo Metropolitan area contains a population of 5.6 million today and hence the city has emerged to become the main financial hub of the country.

With the development of the port and the island being located in a strategic shipping route where the ships from the west to the Far East all had to pass through the island, the city itself has gained its significance. Hence the development of the urban scape has taken place along the city with the development of the road networks and the buildings along the sectors formed with the roads.

Figure 5.1: Map of the City of Colombo, (Source: http: www.colombotravelluxeasia.com)

- *The Colombo city's street pattern (figure 5.1) vindicates that the emergence of the city das radiated and polarized form the Colombo fort abutting he harbour. Where all streets are radiated and directional towards the Colombo Fort. The inland water bodies has also emerged in connection with the harbour. The emergence of this street pattern can be clearly observed as the formation of the urban morphological patterns.*
- *The Colombo Fort is see as an integral element in the city where all streets are directional towards it.*
- *The usage of water for fortification and internal transportation can be clearly seen in the map (figure 5.1)*

5.1.1 History of the Colombo city.

The city of Colombo has emerged as a unique city in Asia, with its multicultural and pluralistic society. Colombo emerged as a city with the colonization of the island with the European conquest. Where the city itself has developed as a port city; with all the commercial activities that has taken place along the port related commercial activities.

With the fall of the local kingdoms, with the European conquests, the islands economy took a dramatic change where the self-sufficient economy with the agro based civilization transformed in to an import export economy.

Prior to the European invasions the area the Colombo city was a part of the Kingdom of Kotte. Where trading with other countries were still carried out especially the Arab world and Persia, also along the silk route.

Hence the evidence has suggested that the mini port of Colombo has been used for these purposes.

- *This small seaport with a natural harbor was introduced as "Colombo" by the Portuguese in 1505 and is believed to be derived from the classical Sinhalese name Kolon thota, meaning "port on the river Kelani". It has also been suggested that the name may be derived from the Sinhalese name Kola-amba-thota which means "Harbor with leafy mango trees".*

("Colombo is the Commercial Capital.". Official Sri Lanka government website. Retrieved 2015-01-07.)

Along the Colonization the internal water bodies that were integrated; has played a significant role in transportation and economic factors and other aspects of urbanization in the city.

Colombo's rich History.

- *Due to its large harbor and its strategic position along the East-West sea trade routes, Colombo was known to ancient traders 2,000 years ago. It was made the capital of the island when Sri Lanka was ceded to the British Empire in 1815,and its status as capital was retained when the nation became independent in 1948. In 1978, when administrative functions were moved to Sri Jayawardenepura Kotte, Colombo was designated as the commercial capital of Sri Lanka.*

("Colombo is the Commercial Capital.". Official Sri Lanka government website. Retrieved 2015-01-07.)

5.1.2 Water Bodies along the city of Colombo.

The city of Colombo is bounded with water bodies and hence is symbolic of developing urban forms responsive to the water bodies.

- The northern side of the city is bounded by the Kelani river,
- The Southern side is bounded by the canals.
- The city itself contains a large water body which is called the Beira Lake. This manmade lake is a part and parcel of the Colombo city's urban landscape where the lake itself is segmented into many parts.
- The East Beira, the South West Beira and Galle Face Lake and West Beira.
- The Beira lake segments being the largest water body in the city of Colombo, is reconnected to other water bodies through the canal networks built during eth ducts period.
- The other main water body in the greater Colombo regions is the picturesque Diaywanna oya. This is located in an area in the outskirts of city of Colombo. Diyawanna oya came to the lime light with the construction of the new parliament on an island in the lake.

In a macro picture, all water bodies in the city of Colombo are inked to other water bodies especially the rivers and the canals.

The canals that are linked to the Beira lake that flows southwards of the city are connected to small lakes in the southern suburbs of the city (eg. Bellannwilla, Attaidya) and they are connected to the Bolgoda lake and the Panadura Ganga (River) which is located about 20 km's south of the city. Again all these water ways are connected by means of streamlets and canals to the Kalu Ganga which is one of the main arteries in the country.

Theses canals are connected to the Indian Ocean where they meets the seas with the outlets located within the city. (ex. Wellawatte canal and the Dehiwala canal.)

The Kalu ganaga is a significant river in the country that flows from the Adams peak in the centrally hills which is the 04th heights mountain peak in the country.

Form the northern side the water body is connected to the Kelani ganga which defines the northern boundary of the city of Colombo. The Hamilton canal connects the Kelani garage to the Negombo lagoon with a distance of about 28 km.

Further the Negombo lagoon is connected to the Chilaw lagoon through another canal and then connects to the Mudallam lagoon, all located in the North western province of Sri Lanka. Furthermore the waterways connects finally to the Puttalam Lagoon which is one of the largest lagoons in the country and then meets the Indian ocean through the Dutch bay and the Portugal bay in Kalipitiya.

- The Colombo cities water bodies can be defines as follows :

  Canal networks in the Colombo metropolitan area.

The Colombo metropolitan areas constitutes the following canals,

- St. Sebastian Canal
- Dematagoda Canal
- Serpantine Canal
- Wellawatte Canal
- Kirulapona Canal
- Dehiwala Canal
- Torrington South Canal
- Heen Ela – Kotte Ela Connection
- Bolgoda Canal
- Colombo Puttalam Canal
- Colombo Kalutara Canal

  These canals were connected to the other main water bodies in the cities metropolitan region. (figure 5.1)

That main water bodies were as follows :

Lakes

- The Beira Lake
- Diyawanna Oya (Kotte Lake)

(figure 5.1)

Rivers

- Kelani River
- Bolgoda River (part of the Panadura Ganga)
- Kalu River

To form the network of water bodies in the metropolitan region the main integrating channels were

- Heen ela
- Kollonnawa Ela
- Kotte Ela
- Mahawatte ela

(figure 5.2 & 5.5)

(Study of the Existing Urban Water in Colombo city – University of Moratuwa)

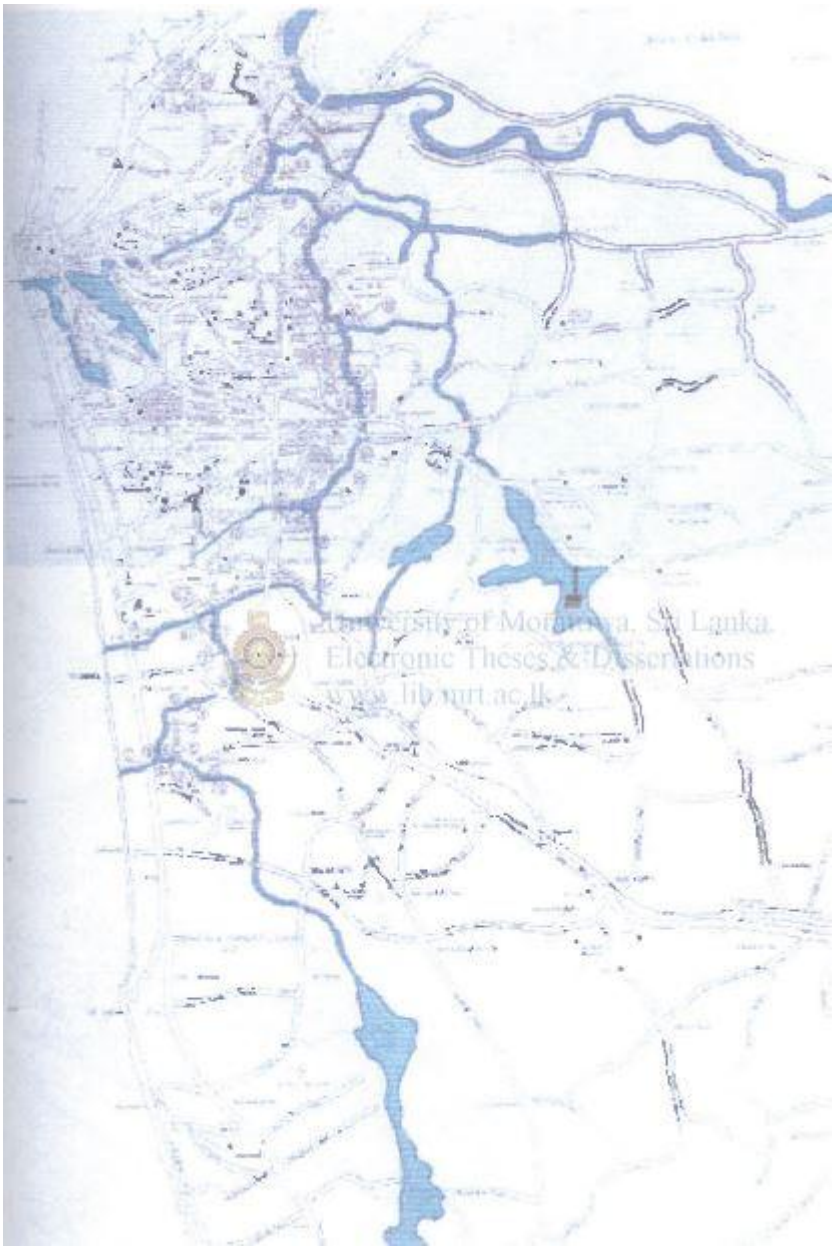


Figure 5.2: Map of the water bodies and their interconnection in the Colombo Metropolitan area, Source: Study of the Existing Urban Water in Colombo city – University of Moratuwa

5.2 Case study of the urban form generation along the Beira Lake

The Beira lake Colombo.

The Beira lake Colombo stemming from its Colonial significance is a picturesque landmark in the city of Colombo, defining its urban scape. Thus the lake is the most prominent internal water body in the city of which is inter connected to the other water bodies in the city and the greater Colombo area, such as the Kelani river, the Diyawanna Oya Kotte and the Bolgoda lake. The interconnections of this water body is made through a network of canals built during the Dutch period. Nevertheless the water body has become a part and parcel of the Colombo city's urban landscape and thus defining the urban settlement pattern and the morphology. (figure 5.5)

Beira Lake is hence a distinctive land mark in the city, for over 05 centuries (during the Colonial rule of the country) and once was a larger and deeper body of water which had a strategic relevance to the ancient Fort of Colombo. The lake has been gradually reduced to its present extent of about 65.4 ha from an estimated original. Extent of 162 ha mainly due to reclamation carried out for construction of warehouses. Beira Lake is a man-made shallow body of water connected to the Colombo harbour via the McCallum lock gates, to the Kelani Ganga via the St. Sebastian Canal and to the Indian Ocean by a semicircular spill-way. (figure 5.3)

Located in the heart of the city of Colombo the Beira Lake is in a highly urbanized catchment of 432 ha. Beira Lake covers 65.4 ha and comprises four main basins the East Lake, the Galle Face Lake, the West Lake and the South West Lake.

The Beira lake Colombo contains 04 basins which had evolved from its inception:

- The Great Beira. (East Beira lake)
- the Galle Face Lake
- West Lake
- South West Lake

Been the section of this scenic water body form the integrated water mass which has been a primary force in the generation of urban built land form and built massing of the city. (figure 5.4) (Sumana Saparamadu – http: www.therichhistoryofthebeiralake)

Figure 5.3: Aerial photograph of Beira Lake, Source: NOAA, U.S Navy, NGA, GEBCO and Digital Globe Google.

Figure 5.4: Aerial photograph of Beira Lake with 04 Basins, Source: NOAA, U.S Navy, NGA, GEBCO and Digital Globe Google.

The total surface area of the Beira Lake is estimated as 65.4 hectares (NARA, 1985). The four sub basins constituting the Beira Lake can clearly be identified. They are the East Lake, the Galle Face Lake, the West Lake and the South West Lake.

- The East Lake is the largest basin (46.2 ha) and accounts for more than 60% of the total lake surface area.
- The Galle Face Lake (2.7 ha) is adjacent to both East and West Lakes and the lake discharge (spillway) is located of the Western most section of this basin with a surface area of only 8.1 ha.
- The West Lake consists mostly of a narrow passage that connects the Galle Face Lake to the South West Lake. The surface area of the latter basin is approximately 11.4 ha and a small island is located at its centre.

The presence if this water body contains enormous potentiality for the development of the Colombo city which is a coastal sea front city.
The western border of the city is clearly demarcated by the Indian Ocean, along the west coast of the island.

5.2.1 The rich history of the Beira lake Colombo.

The lake "Beira" in the city of Colombo has been a symbol of the history of the Colombo city since its colonization. Hence the name is derived from the Portuguese language. The lake had been used for many purposes during different eras and hence the functionality of the lake has served many purposes over the centuries in the functionalism of the city.

The lakes rich history has further enriched the urbanization of the city of Colombo; nevertheless the mismanagement of this water body has also resulted in much negative implication to the city.

Formation of the Beira Lake –

Portuguese Era.

Beginnings of the Beira Lake dates back to the 16th century, where the Portuguese rulers of the Maritime Provinces used the water mass as a strategic transportation element and a defensive element to retain their conquered territory.

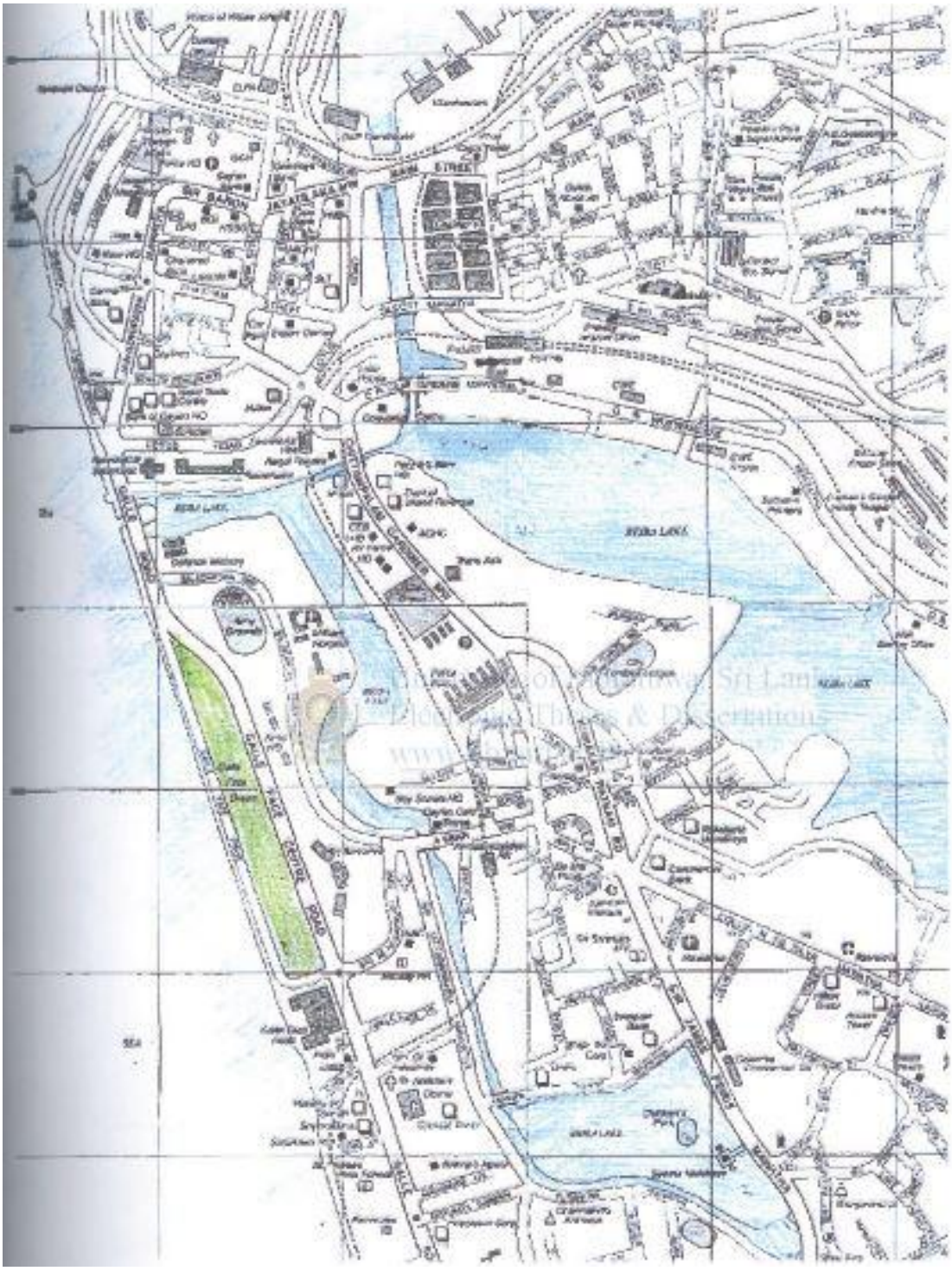


Figure 5.5: Map of Beira Lake indicating its 04 basins, Source: Study of the Existing Urban Water in Colombo city – University of Moratuwa

Initially the recorded history of the Colonial rule of the country states that the beginning of the urbanization of the Colombo with the urban settlements was when the Portuguese led by

Captain Lawrenzo De Almeida and his crew arrived in the island in the area known as Kolonthota (original name for Colombo area)

Where the branch the Kelani River (which defines the northern boundary of the Colombo city) known as the Colon ganga, was used to create a moat and built a fort bordering the Indian ocean and thereby built a fortified city inside this fortress. (The area is presently the Colombo Fort.)

A lake was formed by diverting the water from the Kolon Ganga, but building a dam across it, this is where the present Dam street is located, the name itself is derived form the history where the dam was built to create a lake.

Hence with the colonization of the city a fortress was built by the Portuguese, this is the area which is called Colombo Fort. As the recorded history of the Colombo City the fort has been fortified with a high wall, and protected by a moat, which was connected to the sea along the west coast. The Galle face lake of the Beira has bounded the fortress form the South and the other through the water channel of the Mc Cullum lock gate. Where the northern end connected to the sea through the harbour. (figure 5.6)

(Saparamadu S.- http :www.therichhistoryofthebeiralake.com)

Portuguese Era

As per the information recorded by Fr. Queyroz about the lake. In 1555, the Portuguese built some houses making Kolontota "a city surrounded by a 'Calapana' (a lake) nearly three leagues and a half in length." (A league is about three miles). The writer says that one had to cross the water to get to the city and that in some places the water was up to a man's waist.

In 1578 Mayadunna, the King of Sitawaka brought his army and camped on the bank of the lake. He wanted to cut off food supplies to the Portuguese, which were brought in boats, starve them and force them to surrender. He attempted to drain the lake but failed.

His son, Rajasingha be-sieged Colombo a few times and drained the lake twice by cutting canals, one of these is the San Sebastian canal in Maradana. The Portuguese did not surrender. (figure 5.6 & 5.10)

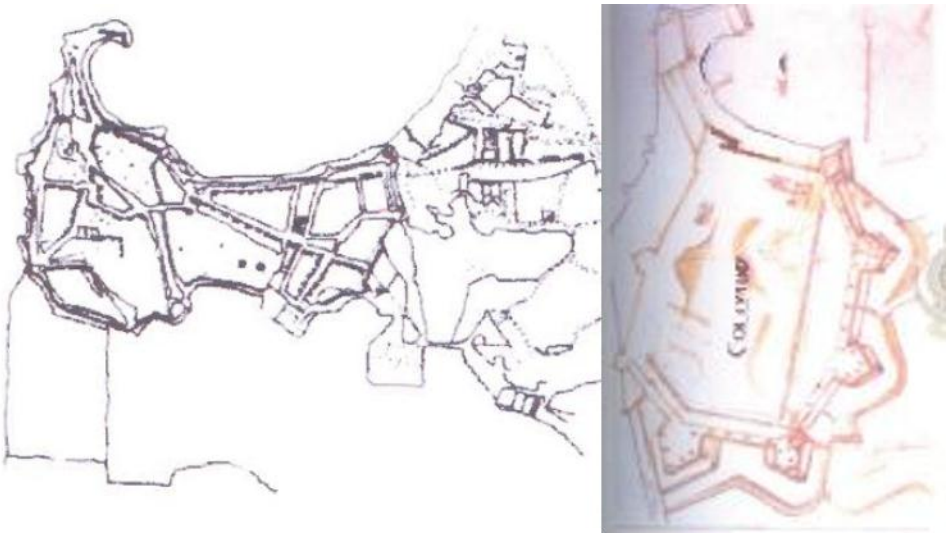


Figure 5.6: Plan of the Portuguese Fort in Colombo- Left, Plan of Dutch Fort I Colombo, Source: Study of the Existing Urban Water in Colombo city – University of Moratuwa

Figure 5.7: Map of Colombo Fort during British Period, Source: Study of the Existing Urban Water in Colombo city – University of Moratuwa

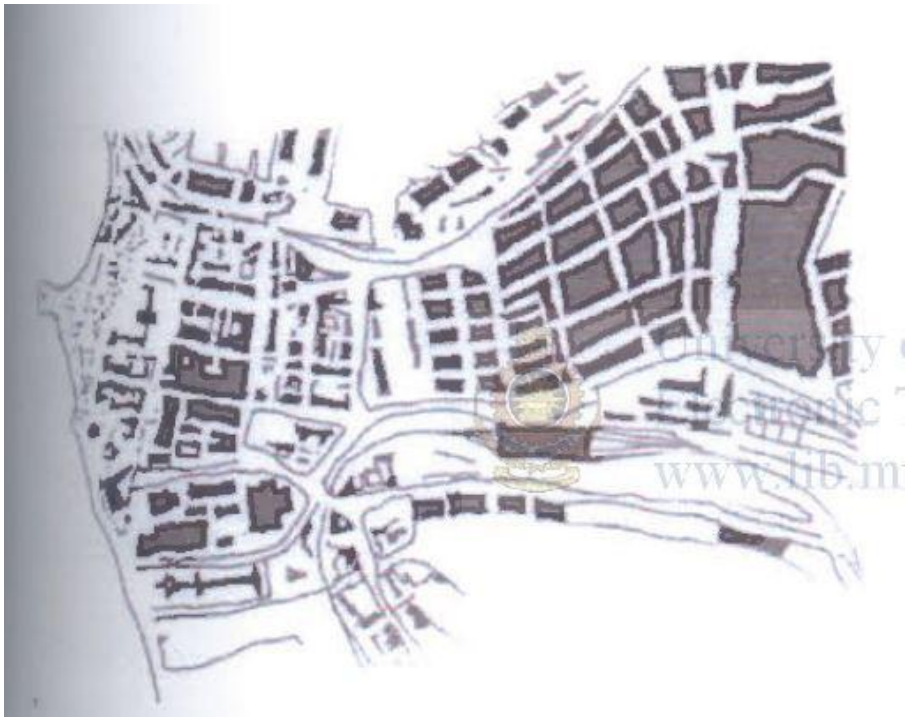


Figure 5.8: Map of Colombo during Post independent period, Source: Study of the Existing Urban Water in Colombo city – University of Moratuwa

Figure 5.9: Map of fortifications and the bay Colombo 17th Century, Source: Study of the Existing Urban Water in Colombo city – University of Moratuwa

There were, at that time, many islands in the lake. One island was large enough to have 600 coconut trees and a whole village. The present Polwatta, the suburb behind 'Temple Trees', the President's residence, must be part of that island.

The lake was the scene of many battles; first between the Sinhala and the Portuguese and later between the Portuguese and Dutch and Dutch and British. In 1656, the Dutch came in boats via the Kelani Ganga and attacked the Fort and the houses outside the Fort. For six months they kept on firing their guns. The wall surrounding the Fort was broken down and the churches, houses and store-houses inside the Fort were reduced to rubble. After seven months of fighting the Portuguese surrendered and with that their rule in Lanka ended.

(information recorded by Fr. Queyroz – www.therichhistoryofthebeiralake)

Dutch period

The Dutch who occupied the Fort subsequently didn't re-build the wall (The wall was built much later). Instead they built a fence-stockade - on higher ground some distance away from the old wall. The result - the Fort became smaller and the lake larger. The low-lying land outside the Fort was flooded and the lake now extended to Kayman's gate in the present day Pettah.

This part of the lake was infested with crocodiles, hence the name Kayman. An island in the Caribbean (West Indies) is known as Cayman island. The enlarged lake was connected by canals "with the Kelani river to the north and with Bolgoda lake and Panadura river to the south." The town outside the Fort was called Aut Stad. Today's Pettah is the Aut Stad.

The Dutch controlled Colombo and the low-country for 140 years from 1656. The British who were now in the Indian Ocean started attacking the Dutch in 1795. They too came across the lake. The Dutch fought back but it was not a long battle. On February 7, 1796 the Dutch surrendered and the period of Dutch rule in the low country ended. (Another 19 years passed before the British took full control of the whole of Lanka).

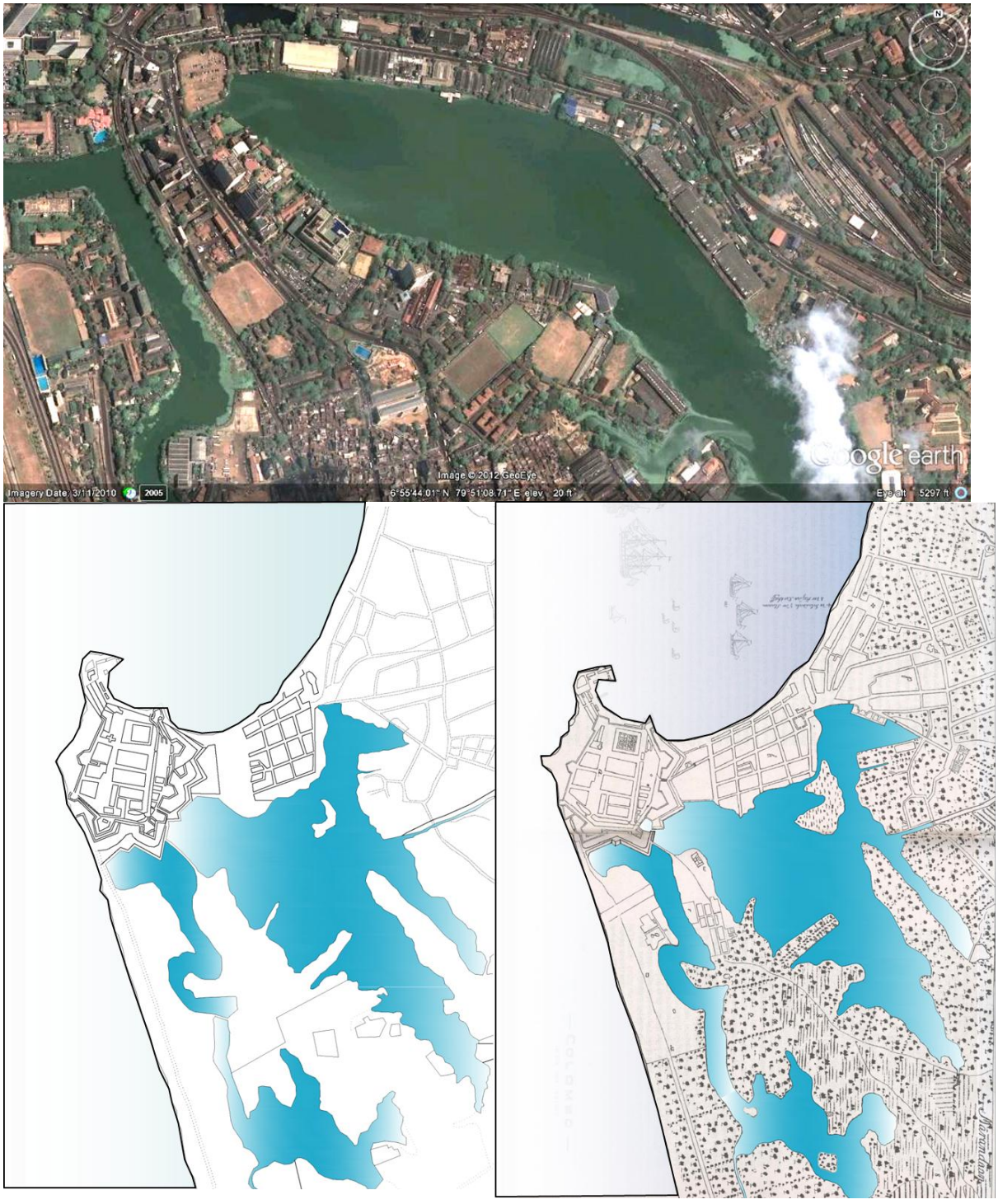


Figure 5.10: Map of Beira Lake during Portuguese Period, Source: Urban Development Authority

British period

When the British took control of Colombo the lake was 400 acres in extent. Here and there in the lake were small islands. Slave Island was one such island and it was called by that name because the slaves who worked in Dutch houses were sent there for the night. The Dutch had grown cinnamon on that island.Captain's Garden, the slightly high ground between Fort and Maradana Railway Stations, where there is a Hindu Kovil now, was an island then. In that island was a fresh water well that supplied drinking water to the officers and residents in the Fort.

From accounts left by army officers, by residents and visitors we learn that in the early days of British rule, the "blue lake of Colombo" was a beautiful place, that many streams fed the lake and it extended up to four or five miles in a north easterly direction. The lake was an ideal place for boating. Those residing on the banks of the lake went by boat to their work places in the Fort. For about fifty years Colombo didn't change much. The change came in the 1860s. The first train from Colombo to Ambepussa ran in 1865. The construction of the railway line must have started at least in early 1864. The railway station was at the eastern (Maradana) end of the lake. (figure 5.11)

Once the Colombo Municipal Council was established in 1865, about 20 years later land by the lake began to be sold to commercial companies. They wanted land on the lake front because it was easy to transport their goods - barrels of coffee and bales of cinnamon and spices - by boat to the harbour. The canal by Lake House on its left, is one canal along which the boats went to the harbour. Today only names remain to tell us what and what areas were part of the lake or its shore. The land where St. Joseph's College stands and the surrounding area was known as Suduwella - white sandy shore. There is still a Municipal ward by that name. Today there isn't any white sand left of that once white sandy shore.

As the population of Colombo increased so did the garbage. Much of it went into the lake and the water got polluted. The garbage on the bank gave out a horrible stench and was the breeding ground of mosquitoes and flies. The water was so polluted with more and more buildings coming up on the water front and the population increasing the lake got more and more polluted.

(Saparamadu S.- http :www.therichhistoryofthebeiralake.com)

Post-Independence

The selling of land on the lake front continued into the 1990. In the last two decades of the 20th century, hotels, banks and Government offices, came up on the banks of the lake, some five, six, storeys high. Now those going on D. R. Wijewardene Mawatha or Chittampalam A. Gardiner Mawatha hardly get a glimpse of the lake. Only the part of the lake where the 'Seema Malaka' is can be seen.Hotels, printing presses, food processing factories, beverage manufacturies and slums round the lake were diverting their polluted water into the lake. But, the major source of pollution was the raw sewage that was sent into the lake. (figure 5.8)

What was once an ornament to the city had by 1990s become a health hazard.Work on the restoration of the lake with World Bank aid started at the turn of the century. The lake was dredged, algae destroyed, algae eating fish introduced and underserved settlements by the lake, improved.

- ***The name***

It was only after 1927 that the lake began to be called Beira Lake. That year the word Beira appeared on a map. Until then the lake was called Colombo Lake or just the lake.Beira - it is an unusual word. What does it mean? Beira is a Portuguese word. There is in Portugal a province called Beira. (Times World Atlas map 76). As defined in the Portuguese dictionary that I looked up Beira is 'brink or bank of any water.' Beira is also the name of a coastal town in Mozambique, once a Portuguese colony. We have another Beira. Berathuduwa, Point de Beira near Balapitiya. It is interesting to find out how that village/town got that name.

(** http :www.therichhistoryofthebeiralake.com **)

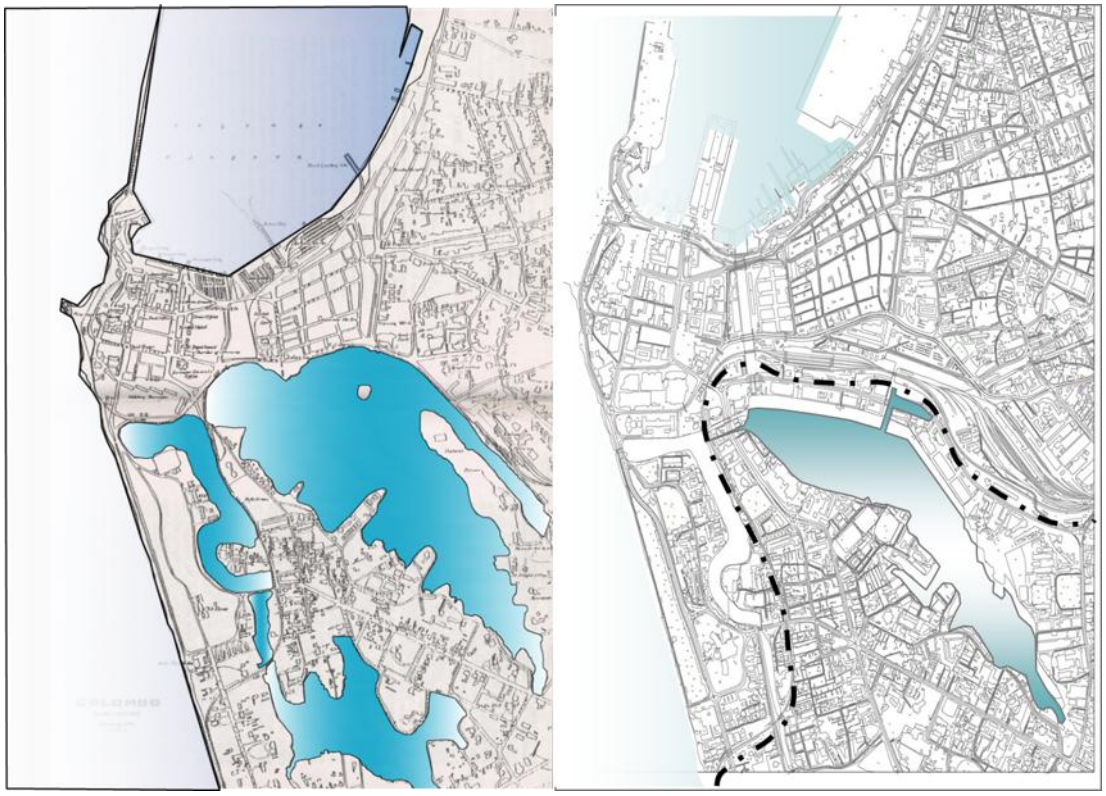


Figure 5.11: Map of Beira Lake during Early British Period- Left, Late British Period- Right, Source: Urban Development Authority

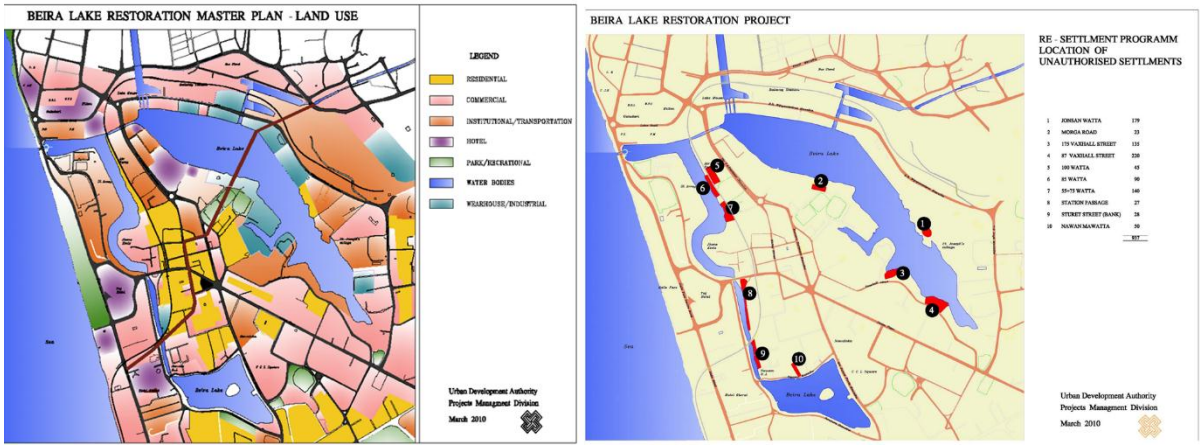


Figure 5.12: Beira Lake Restoration Master Plan- Land use- Left, Beira Lake Restoration Projects- Right, Source: Urban Development Authority

5.2.2 The Lake's Transformations.

Beira Lake after going through so many transformations over the centuries form the time of its birth has been a fine vindication, where the transformation of urban settlement patterns and urban built form has been governed by the presence of the water bodies.

The water body has not only been a primary form generator in the city but also a key element in the functionalism of the city.
Where by the water it-self present in the body has brought in different meaning to the city.
Where by the cities transportation system and the interconnections road network system all has been govern by the formation of this lake. (figure 5.11)

Hence the body of water itself is a governing factor for the city's urban formation and land use pattern and the functionalism.

The key segments of the Beira Lake have served different purposes at different times during the historicism.

As a defensive element, as a beautification process and as a transportation elements.
However the management or mismanagement of these water bodies may result in a major positive impact or a negative impact on the city and its users.

5.2.3 The Great Beira Lake (East Beira) :

The larger segment of the Beira lake is the Great Beira or the East lake. With an area extent of 46.2 ha. This is the largest segment of the Beira lake, where very many important arteries in the city encircle the water body.

The main road that circulate round the East Beira lake, is :

- D.R. Wijewardane Mawatha
- T.B. Mawatha (Darley Road)
- Dr. Colvin R. De Silva Mawatha. (Union Place)
- Vaxhaull Street
- Sir. Chiththampalam Gardiner Mawatha.
- Kumaran Ratnam Road

The road that encircle the water body contaisn a multitude of activities. Where different typologies of buildings have emerged over the years and at different eras.

The web of streetscapes around the lake has resulted in the creation of significant nodes and nodal points with unique landmarks in the city.

The multiple usage of the water body has been a contributory factor for the functionalism of the city and its urban formation.
The buildings as individual or clustered together have defined the city scape and the skyline of the city with the water body as the backdrop. Nevertheless the water body in the post-independence era of Sri Lanka has been a significant land mark in the city.

The road network around the lake intersects trough may wards in the Colombo city. (Colombo 02, 01, 10, and 07. Hence it had had a symbolic meaning in defining the city's urban character.

A study around the lake clearly indicates the appropriate and the inappropriate land usage along the water body. Where the responsive urban form and the nonresponsive urban form has resulted in diverse impacts on the city.

The responsive urban form has given the city a sense of place and a sense of identity. But the planning of the city that need to be more responsive to the urban landscape and the fabric has again been a concern for the city planners and the urban designers, where the city itself can be a composition of a dilemma.

The land use patterns around the lake :

The lake itself contains water sheds where the water the reservations around the lake have given rise to a diversity of usage, and which been resulted in the urban formation patterns. Hence the scale and proportion of the urban forms that has been a resultant of the function has been a contributory factor to define the characteristics of the city.

The formation and existence of urban form around the Beira lake (East lake).

- The East Beira Lake has played a very important role in defining the Urban Character of the city of Colombo. Especially in the Central Colombo and the southern end of North Colombo.
- This lake has been used for many functional aspects of the city such as transportation and amenity and drainage of water etc. It has even been used and misused over the years during the city's history.
- Nevertheless there has been a positive and negative impacts due to the presence of this magnificent water body in the city.
- The appropriate response to the water mass has resulted in positive implications to the city's urban form and character. And vies a versa the inappropriate response has created a negative impact.

In this case study it is intended to study the formation of this Water body and how the urban form has emerged around the lake. And their functional aspects, and how the streetscapes has formed.

Over the years how the usage of this water body has affected the city in many ways.

Identifying the potentialities of the lake and its banks will further enable to assess the futuristic development scenarios where by the lake itself will be catalyser in generating a responsive urban form thus creating a sustainable city and giving the city its identity and character, with a sense of place.

Over the years the non-responsiveness to this water body with the misuse of its potentialities has caused an alarming threat to the city with many negative impacts such as environmental pollution and health hazards.

The profile of the East Beira Lake.

The lake itself takes a dramatic shape which is housed along a basin in the city of Colombo. Where the main arteries forms a web of roadways in response to the water body. Catering to the intended activates with the water front developments the road network in the form of a web encircling the water body was given birth to many landscapes and nodal points and land marks in the city. (figure 5.13)

Thus the correlations ship between the water body and the urban form is a clear vindication here. Also the activities linked with the water body further has been a force in determining the urban form that is responsive to the water body.

The skyline of the city formed by the built landscapes of urban fabric is also a clear definition of city's scale and proportion of the built massing. The orchestration of the built fabric can also be seen when analysing the urban morphological patterns along the water body. (figure 5.13)

Figure 5.13: Map of the built fabric around the segments of the Beira Lake, Source: Author compiled, Base map from Suvey Department of Sri Lanka.

The Study of the lake and its surroundings. (East Beira)

The study of the building typologies that exist around the Beira Lake in the present context, the street pattern and the use of the building around the lake and its responsiveness and non-responsiveness will enable to understand the present status of the lake with its potential threats to the water body.

The survey of this water body commenced form the nodal point of Sir Chiththampalam Gardiner Mawatha, and D.R. Wijewardan Mawatha, where the lakes northern end is located. This nodal point is a significant juncture in the city where the two arteries meet. A significant land mark at this point is the old lake house building. (figure 5.24 & 5.25)

Carrying out the survey along D.R.Wijewardane mawatha, many commercial buildings can be seen on either side of the road.

The land along the Beria lake frontage is used mostly as commercial ware houses (which has been in existence for many decades since the British period. Along this Beira lake frontage of D.R.Wijewardane mawatha, a transformation of the building usage can be seen.
Where historical the precinct was purely used for storage with the ware houses. The Exhibition and convention centre, the Cey Nor restaurant, Ceylon Shipping line building, Ballys club and other casinos etc. the government took initiative to transform this area in to a night district witth the international casinos. (However this is a debatable issue where it can have many positive and negative implications on the lake.) (figure 5.25)

The other side of D.R. Wijewardane mawatha, is used for many administrative activities and also the railway line form the Colombo fort runs alongside connecting the Colombo Fort Railway station to the Maradana railway Station, and to its railway yard. These are the two main railway terminal points in Sri Lanka. Beyond this towards the northern end the Colombo harbour is met with the interconnected canal gate through Mc Cullum road and Olcott mawatha in Pettah, which meets the Colombo harbor. The Mc Cullum gate is also located at this end which connects the waters of the Beira to the Indian Ocean through the harbour. (figure 5.24 & 5.25)

Hence the interconnection between the transformational activities alongside the water body has taken common place where the urban form has emerged along this precinct with the water frontage.

As the road ends at another nodal point, where D.R. Wijewardane mawatha meets T.B. Jaya mawatha (Darley road).
Along the Darley road many congested commercial activities are seen, most of which are happening in a unplanned manner. This is mainly across the Darley road on the opposite side of the shores of the Beira lake frontage. Along the Beira lake edge many historic buildings can be seen. However new buildings that have been erected in the recent past can also be seen on this side (e.g. The HNB towers). Such buildings if responsive to the water body can be a catalyser and a dictator for the prevention of unplanned commercial developments, in the vicinity. Where they can have a significant influence, on the developments in the neighbouring sites. (figure 5.26)

Some of the most significant developments are St. Joseph's College, which has existed for over 100 years responsive to the water body. Also the elderly home run by the Catholic Church nunnery orders Little sisters of the Poor is located adjoining St. Joseph's College. Along T.B.Jaya Mawatha, many wearhouses are found facing the Beira Lake. This is along the stretch form St. Joseph's college to Union Place junction. (figure 5.32 & 5.33)

At the nodal point of this juncture, the Mahaveli building which was designed by Sri Lanka's master Architect Geoffrey Biwa is housed, this building is the first multi-story building designed by Bawa. The building is placed with a lawn in the foreground. (figure 5.34 & 5.35)

This nodal point where the Darley road meets the union place, as the Vauxhall Street also meets Union place at this juncture. (figure 5.37 , 5.38 & 5.39)
Vauxhall Street runs alongside the south western edge of the East Beira Lake. However there is very little indication in the present context that this artery runs along a water body in the city; as the road has been used for many commercial activities (mostly middle level and high end such as the Aitken Spence head office etc.) Where the building facades cover the water

body. Hence the road is not responsive to the water body, but only the buildings in-between the road and the banks of the lake are responsive.
Towards the end of the Vauxhall Street the Sri Lanka Insurance Co-proration building is found which is another land mark building in the city. At this juncture the Vauxhall Street meets the Kew Road where there is a broader gap between the road and the lake. And hence many by roads connect the road to the lake. Hence the distance is wider along the road and the water body. With many activities taking place in-between. (figure 5.40 & 5.41)

The last stretch along the survey is from the point of the Kew road connecting to Sir Chiththampalam Gardiner Mawatha, which is a significant road in the city of Colombo. this road defines the heart of Slave Island with many Governmental, Semi Governmental and Private institutions that are housed in.

Some of the significant buildings located within this road, are the Cinnamon Lakeside hotel, Head Quarters of the Sri Lanka Air Force, the department of Inland Revenue, Peoples Bank building etc. behind these buildings along a by road leading to the lake; the Colombo rowing Club was built. This is one of the oldest clubs in the country where sporting activities took place. On the opposite side of this road is the Ceylon Electricity Board Headquarters, the Lake House Bookshop, the Regal Cinema, National Housing Development Authority headquarters building are some significant buildings. Until the very end of this street facade there is no indication of the water body as the building's façade and the streetscapes entirely cover the water body. Until the nodal point where the D.R Wijewardane Mawatha junction is met the clearer view of the Beira Lake can be seen with its profile spreading in the eastwards direction and then taking a bend towards the south eastern direction. The urban form around the water body can be seen here, with its changing profile.

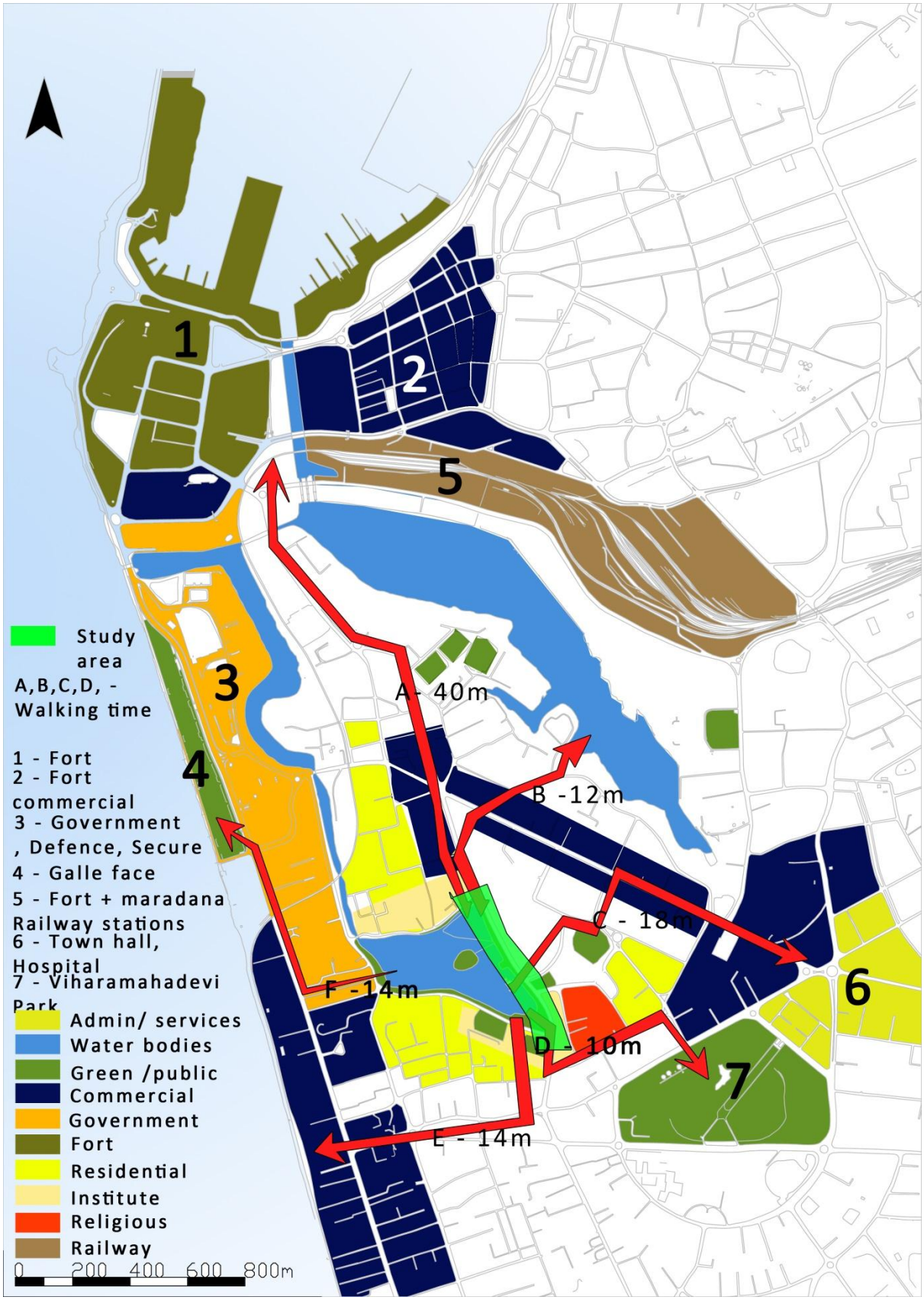


Figure 5.14: Land use pattern around the segments of Beira Lake, Source: Author compiled, Base map from Suvey Department of Sri Lanka.

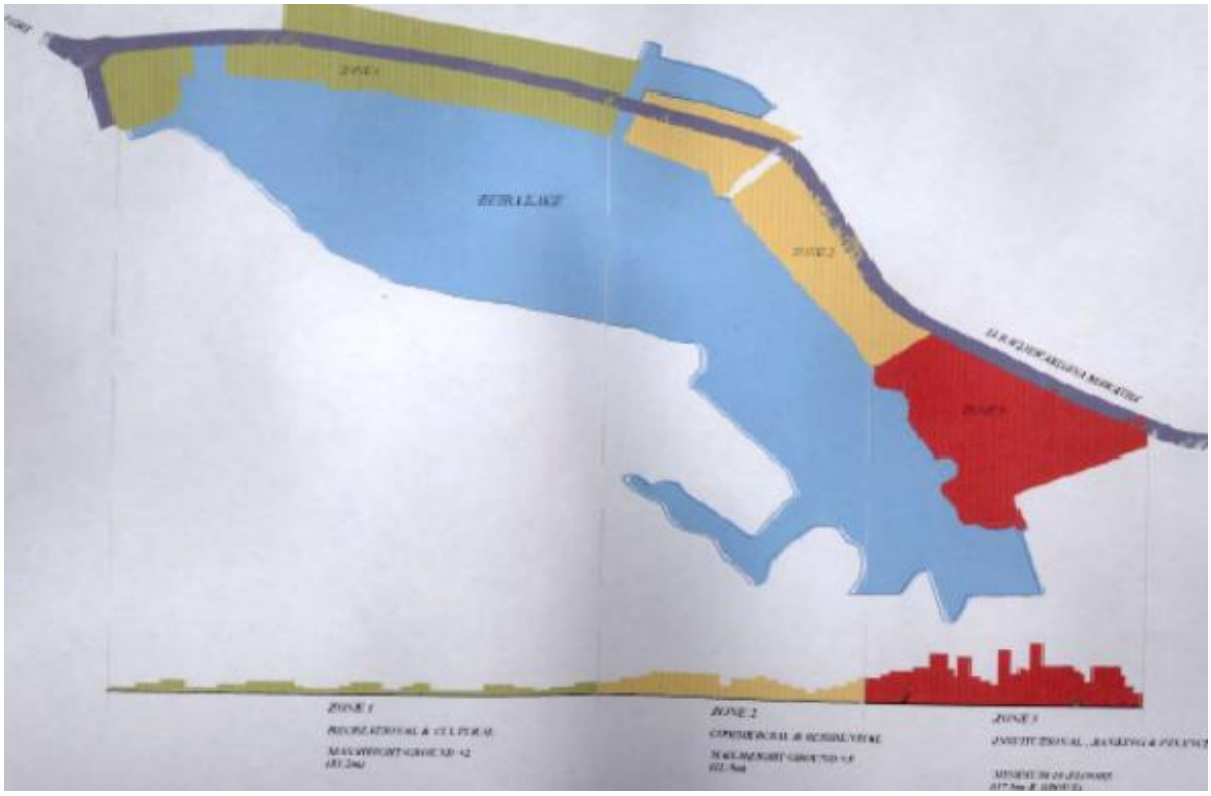


Figure 5.15: East Beira Lake- Existing Land Usage 2010, Source: Urban Development Authority.

Figure 5.16: East Beira Lake- Existing Land Usage 2010, Source: Urban Development Authority.

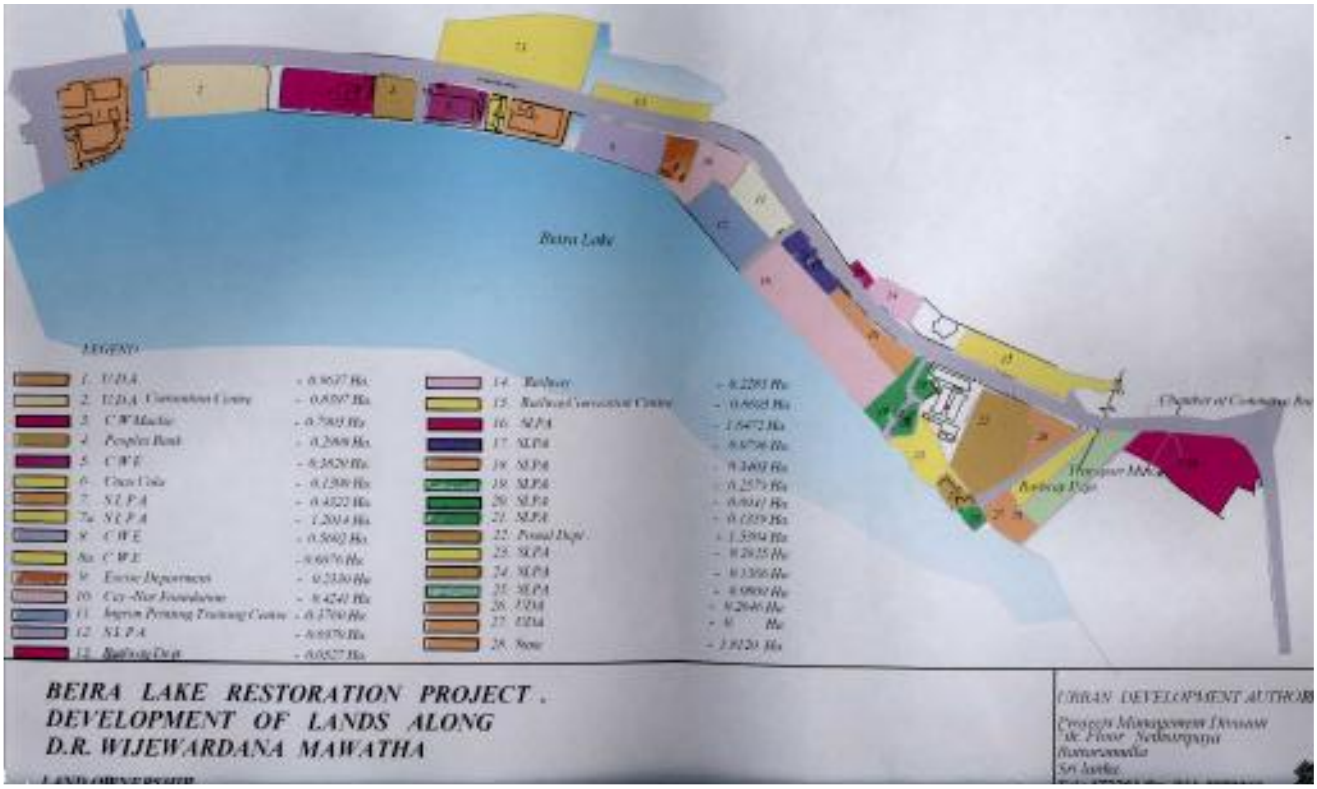


Figure 5.17: East Beira Lake- Existing Land Usage 2010, Source: Urban Development Authority.

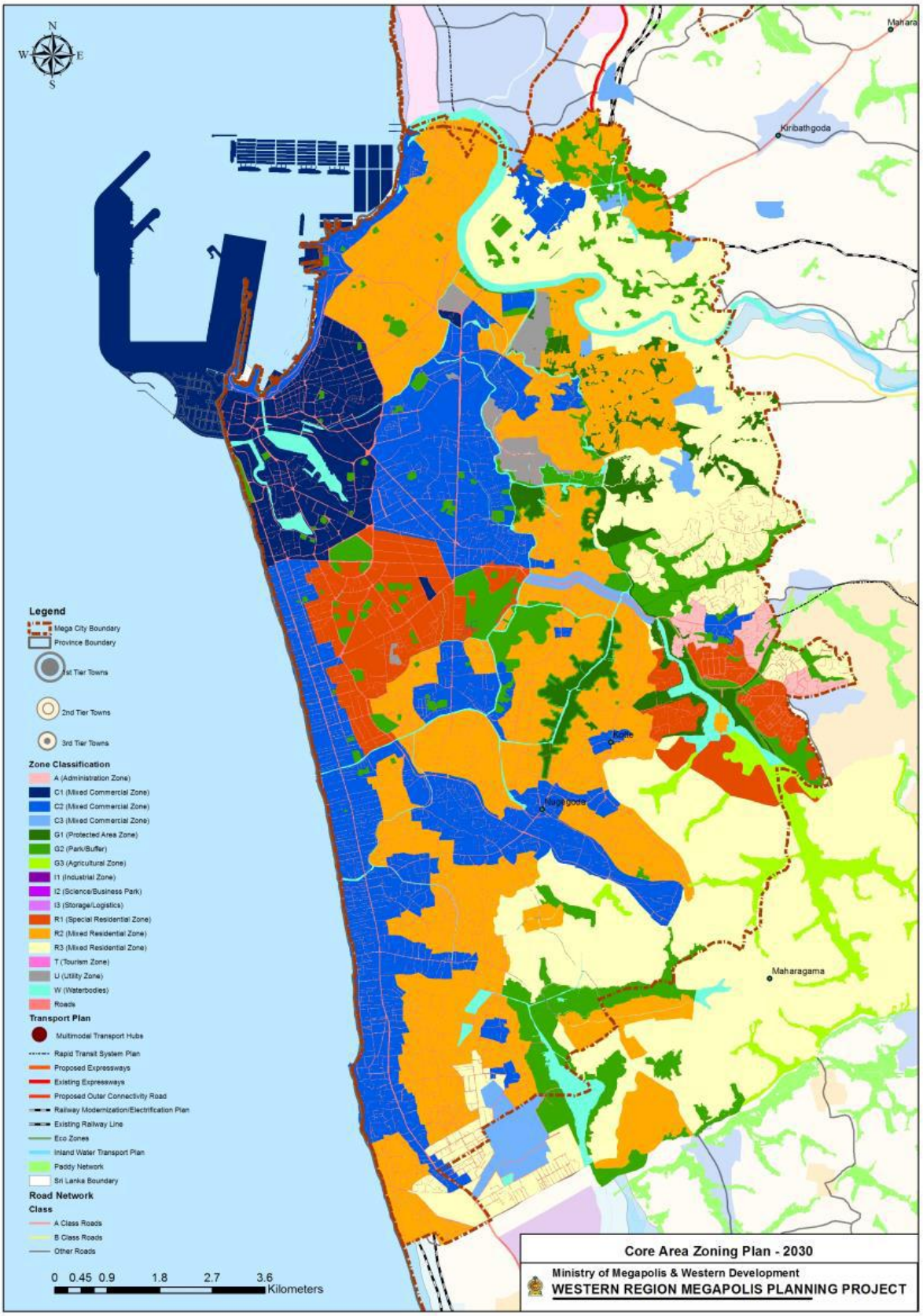


Figure 5.18: Proposed Zoning Plan for the Western Region Mega polis Project, Source: Ministry of Mega Police and Western Development.

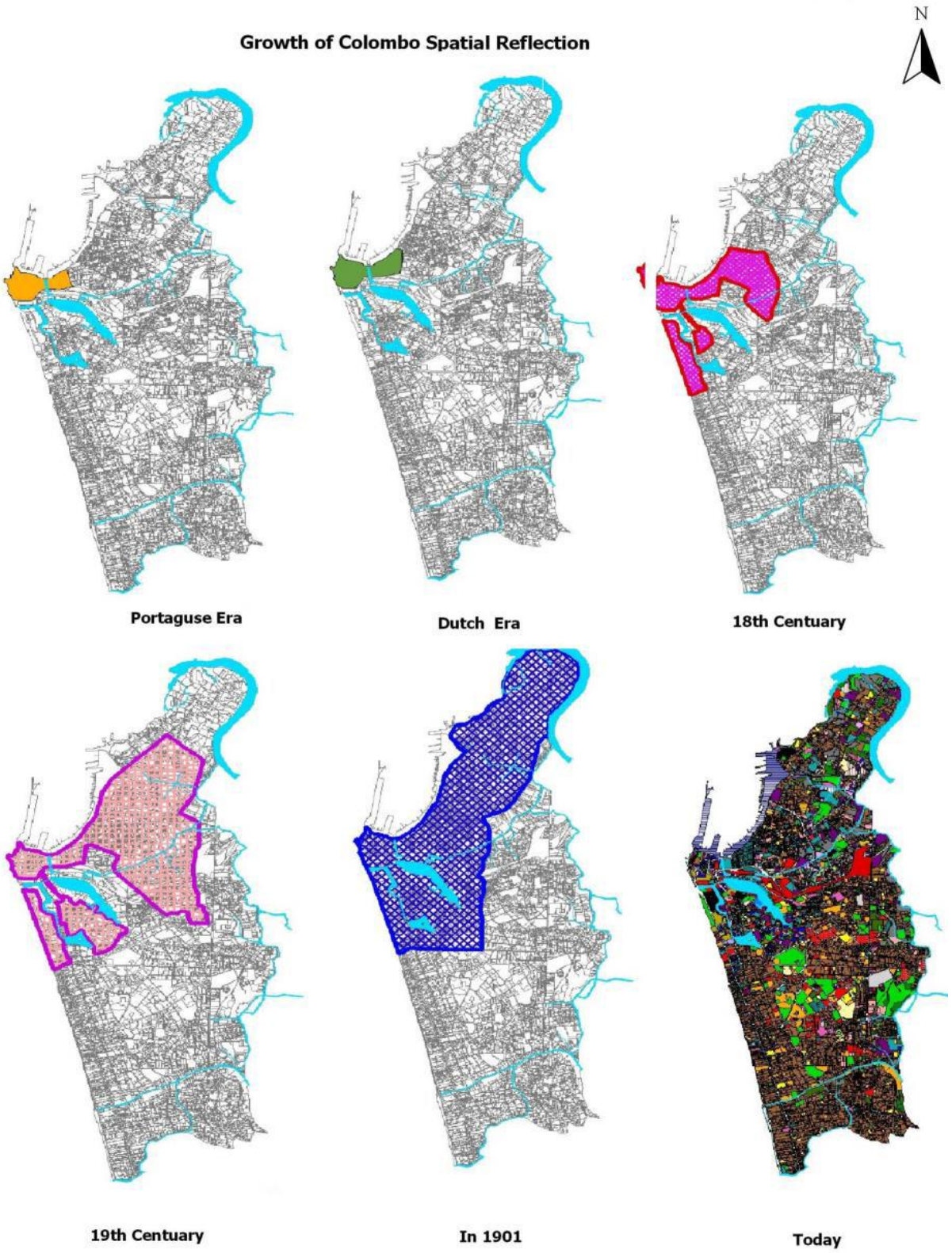


Figure 5.19: Recorded Plan for City of Colombo, Source: National Physical Planning Department

Figure 5.20: View from proposed financial centre around Beira Lake, Source: National Physical Planning Department.

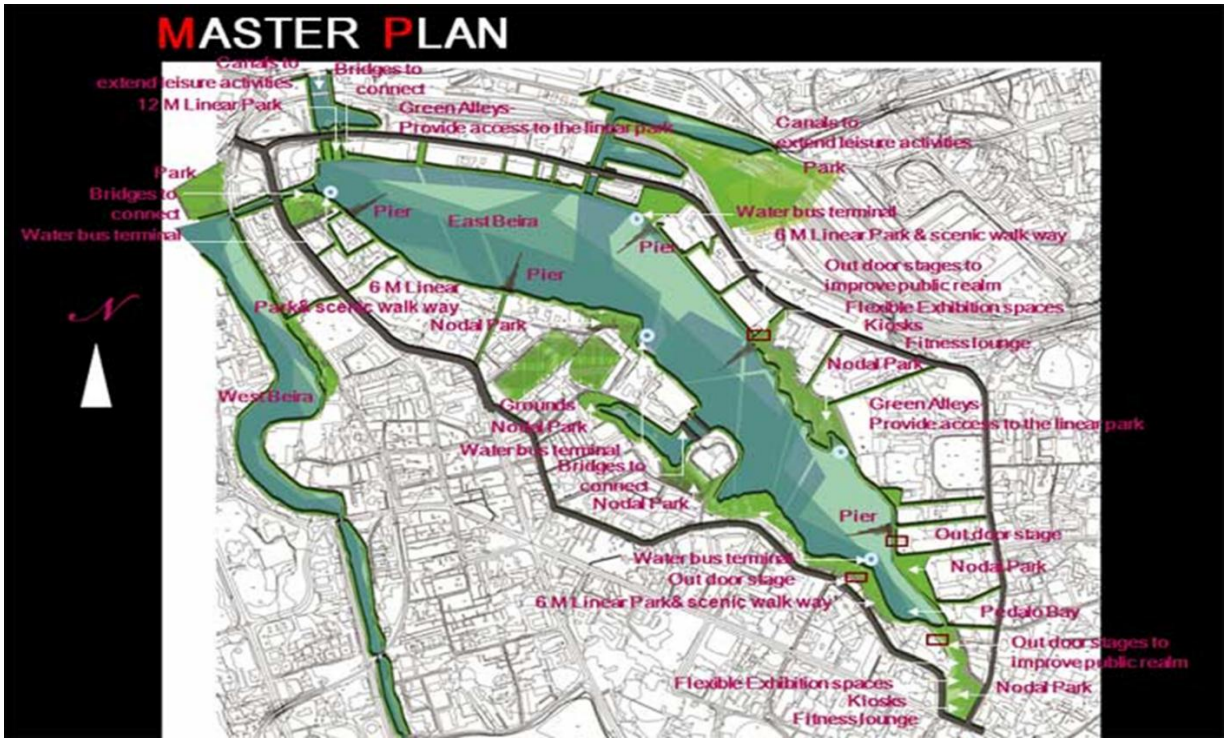


Figure 5.21: UDA Master Plan for the development of the East Beira Lake, Source: Urban Development Authority

Figure 5.22: Galle Face Lake of the Beira, Source: Author

Figure 5.23: Part of the West lake of Beira, Source: Author

Figure 5.24: The Mc Cullum gates connecting the water body to the Indian Ocean, Source: Author

Figure 5.25: Urban forms along the lake with the buildings on Sir Chithampalam Gardiner Mawatha, Source: Author

Figure 5.26: Back drop of the urban forms along the water body, Source: Author

Figure 5.27: Lotus tower as a responsive element to the water body, Source: Author

Figure 5.28: Junction where D.R .Wijewardane Mmawatha meets the Darley Road. , Source: Author

Figure 5.29: Drive along the Darley Road. , Source: Author

Figure 5.30: St. Joseph's College located along the Beira lake. , Source: Author

Figure 5.31: Views across the lake along the banks of the land along Darley Road. , Source: Author

Figure 5.32: Wear-houses along the Darley road with modern buildings defining the urban skyline. , Source: Author

Figure 5.33: Buildings projecting out wards form Vauxhall street. , Source: Author

Figure 5.34: The Sothern end of the lake , Source: Author

Figure 5.35: Urban form diversity viewed from the bank of Darley Road lands. Pictures taken form the proposed linear walkway. , Source: Author

Figure 5.36: St. Joseph's College buildings along the Beira front. , Source: Author

Figure 5.37: Street facades along the Darley road , Source: Author

Figure 5.38: Jucntion of Union place. , Source: Author

Figure 5.39: Mahaweli building in the vicinity. , Source: Author

Figure 5.40: Street facades along Vauxhall Street. , Source: Author

Figure 5.41: Lotus tower under construction along seen along Vauxhall Street. , Source: Author

Figure 5.42: Views of D.R. Wijewardane Mawatha. , Source: Author

5.2.4 The South West Lake of the Beira.

In the present context the most attractive section of the Beira Lake is the South West Lake which contains an area extent of 11.4 ha. The Eastern border of this lake abuts Sir. James Peiris Mawatha. Hence the beauty of the lake is clearly visible to the main road. Amidst a scenic vegetation along the streetscape the South West lake contains two islands out of which one is housed with the Seemamalakaya (temple in the water). Where the other housed a public park. Both islands are connected with a bridge form Sir James Peiris Mawatha.

The picturesque South West Lake of the Beira is encircled by 04 roads which form a dramatic lake drive where there are no barriers or buildings along the banks of the lake.

The roads that abut this lake are:

- Sir James Peiris Mawatha (form the Eastern border).
- Nawam Mawatha (form the Northern border)
- Sri Uttarananda Mawatha (form the Western side)
- Perahera Mawatha (form the Southern side)

Although the warehousing complexes were used here on the side opposite to the lake along Sir James Peiris Mawatha, these warehouses are being removed and new mega developments are taking place currently in response to the water body. (figure 5.44)

Figure 5.43: Elevated view off Built Massing., Source: Author

Figure 5.44: Map of West Beira Lake, Source: Author compiled, Base map from Suvey Department of Sri Lanka.

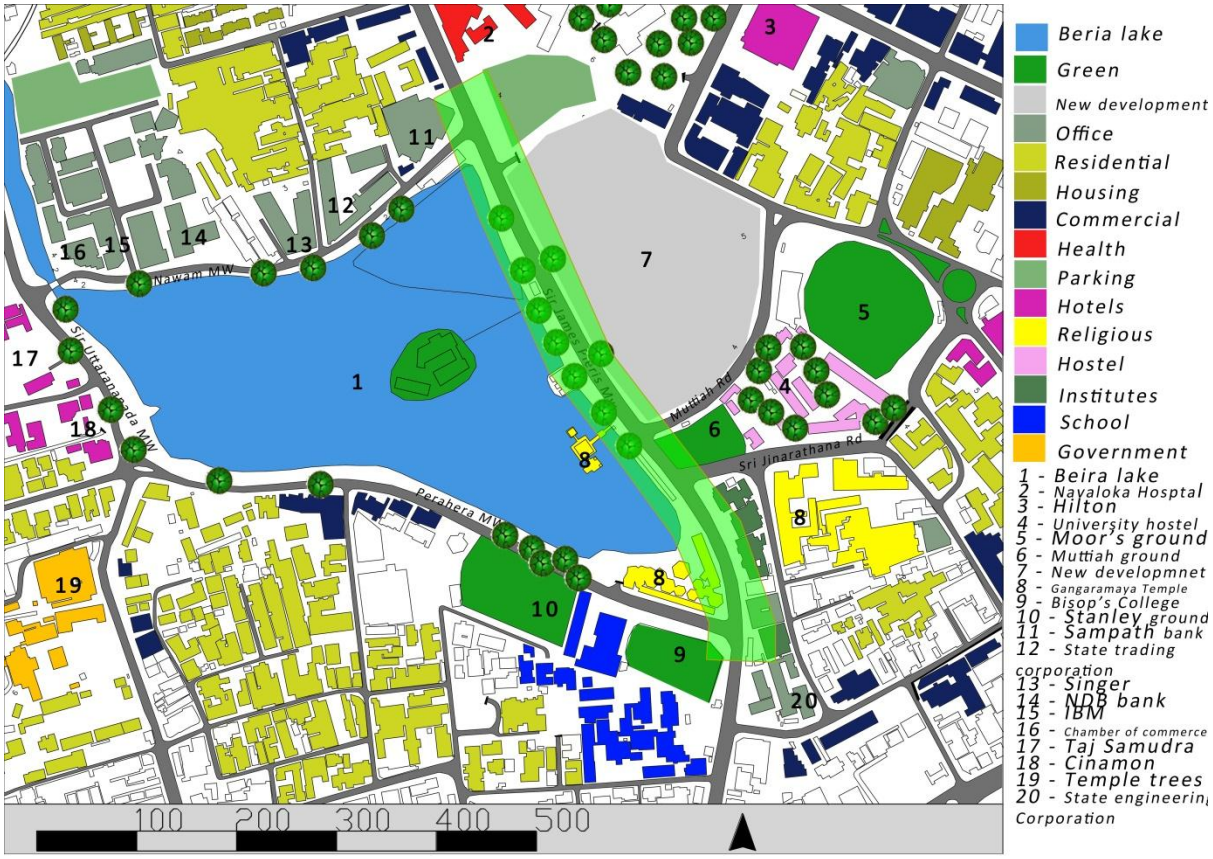


Figure 5.45: Land use pattern around the West Beira Lake, Source: Author compiled, Base map from Suvey Department of Sri Lanka.**Lake.**

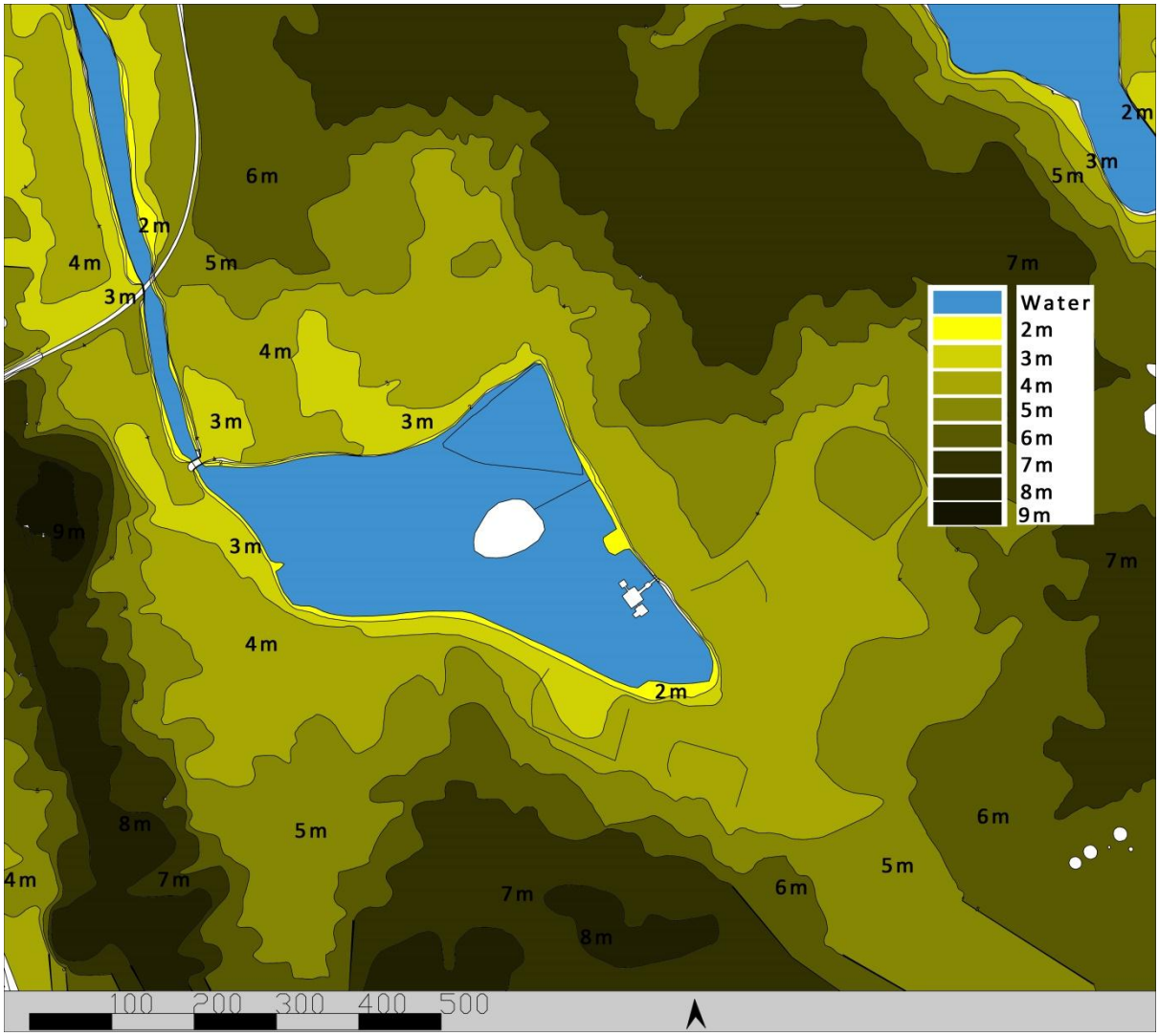


Figure 5.46: Terrain Contour of West Beira Lake, Source: Author compiled, Base map from Suvey Department of Sri Lanka.**Lake.**

The context

The context around the Beira Lake frontage located along Sir James Peiris Mawatha contain a multitude of activities that encircle the picturesque water body.

containing two islands one with the leisure and recreational spaces which has formed a children's play area and a lovers park and the which contain temples on the water called the SEEMA MALAKYA which is closely connected to the Ganagarama temple located in the vicinity. (figure 5.45 & 5.47)

the water body is surrounded by some significant roads along the precincts of it, mainly Sir James Peiris Mawatha which contains the access to the islands, and the Nawam mawatha towards the Northern side, and the Perahera Mawatha towards the South, and the extended R.A.De Mel mawatha towards the West.

the present activities along these arteries has created a unique sense of place giving the place a sense of recreational and relaxing atmosphere along a busy town which contains a limited number of parks and spaces for amenity. (figure 5.50 & 5.51)

The commercialized activities with a large number of medium rise office buildings are located along the Nawam mawatha, and the relatively tranquil atmosphere prevails along the extended R.A.de Mel Mawatha which is scenic drive along a back drop of recently developed high rise buildings in Colombo, which gives the water body a sense of enclosure as an internal water feature. Thus this section of the Beira Lake creates a huge breathing lung for the context, which has created a vast potentiality for the recreational activities and along the landscapes. (figure 5.43)

The potentialities of space for public urban spaces and amenities

As per the panoramic views seen at various altitudes the area encircling the water basin of the Beira Lake contains vast potentialities for urban development which creates a juncture of scenic beauty with the lustrous landscapes and the activities that encircle the water mass for leisure and recreation.

As per the symbolic relationship between the prominent buildings that that has formed the activities in the area such as the:

- Gangarama temple for spiritual worship, cultural pageants and rituals and tourism attractions etc.

- The Seemamalakaya temple on the water creates a sense of serenity for everyone and acts as a major attraction which is also a creation of the master Architect Geoffrey Bawa.

- The existing landscape walkways along the water front create a sense of leisure for the passes by and for those who wants to gather around the water for leisure.

- the commercial activities (offices banks etc.) that are happening in the square along the Nawam mawatha makes the area busy during the day on week days with the wide variety of activities that are embodies for the daily users.

- The Nawaloka Hospital in the vicinity contributes in a big way for the traffic generation at all times of the day.

And hence the long waiting patients in the OPD also use the areas along the water front.

- The Bishops College located in the southern side of the road is another contributor that forms the activities in the area.

Figure 5.47: Urban water bodies being used for spiritual purposes and amenity, Source: Author

Figure 5.47 shows urban water bodies being used for spiritual purposes and amenity. Also the water bodies used as a backdrop for the urban forms.

The land use pattern around the South West Beira Lake.

The picturesque lake is a fine landmark for the city of Colombo, where the water body is visible and used for public recreational activities.

Nevertheless the many building typologies that formed around this lake has escalated the land value of the area, with the presence of the shady trees in the vicinity, the lake itself contains enormous potentialities to transform the city into a unique urban scape.

Unlike the East Beira Lake the buildings around the segment of the lake, the buddings are comparatively responsive to the water mass. Which in return has carted a sense of space in the city around the precincts of the water body.

Hence the banks of the water body itself are a fine promontory in urban spaces. The interfaces that are created alongside the water body are a fine urban habitat that invites mass agglomeration in a tranquil setting. However still there is a lot of potential around this water body for the regeneration of urban form and urban fabric in response to the water body.

Figure 5.48: Old warehouses in front of the water body being demolished and the lands to be reused for hi-end developments, Source: Author

Figure 5.49: Urban waters as forecourt to reflect the built landscape, Source: Author

Figure 5.50: Interface along the Urban Waters for Public Activities, Source: Author

Figure 5.51: Galle Face lake of the Beira, Source: Author

Figure 5.52: West Beira Lake, Source: Author

Figure 5.53: New developments along the West Lake attracting high end investments. Image, Source: Author

The Beira lake Colombo has stood up for many mile stones in the annals of the history of Colombo, stemming from its origins, where the Portuguese created this lake for protection and fortification of the Colombo Fort.

The picturesque water body was a part and parcel of the urban landscape in the city of Colombo, where the cities beauty was centred around this lake which had several segments.

The lake itself has been a part and parcel of the cities amenity and public interaction.

Once the lager mass of water which was significantly reduced in size, due to the intervention of human activities and commercial activities. (which was potentially a threat to the city) This is due to the pollution and the foul odours that were emitted form the water body, due to the abrupt disposal of sewerage and dumping garbage, which had made the lake a breeding ground for mosquitoes.

The lake itself has been used as a mode of transport, prior to the railways being commissioned.

Hence it would have been a non-polluting mode of transportation where carbon emission was minimized.

The water body itself has created scenic vistas in the city where it has been unifying thread for the visual connectivity of different wards in the city.

Hence the visual permeability and connectivity has been a main contributor to the city by the Beira Lake.

Although the history of the lake reflects many battles across the water body, initially between the Portuguese and the Kotte kingdom, then by the Portuguese and the Dutch, and subsequently by the Dutch and the British.

The battles have been the main cause for the change of shape of the water body which has initially occupied a much larger extent in the city.

In assessing the potentialities in is important that a SWOT analysis being carried out around the urban space covering the water body, within its present context.

5.2.5 SWOT Analysis of the Beira Lake Colombo

- **In the East Beira lake (Great Beira).**

Strengths :

- The water body is encircled around a series of road networks in the town which are some of the key arteries that forms the connectivity in the town.
- Connects some of the main wards in the city, Pettah, Maradana, Slave Island, also a part of Borella and Town hall.
- Acts as a water retention area in the city.
- Could control the overcrowding of cities and urban sprawl, with unplanned ad hoc developments, by acting as a physical barrier.
- The water body could be used as a basin to drain out storm water and thereby to mitigate flooding in the city.
- Could be a contributory factor to have more open spaces in the city.
- A view of the Colombo's skyline can be seen with the horizon.

Weaknesses :

- A hidden water body in the city, where its maximum benefits are not exploited.
- The lake has no visual links to the streetscapes around it.
- Inappropriate buildings non responsive to the water body has emerged over the years.
- Many shanties and slums have emerged in various segments of the banks of the lake which is a major contributory factor for the pollution.
- Inappropriate industries have come up within the precincts of the lake.
- The typology of buildings that has been constructed over the years around the lake does not do any justice to the potentiality of the lake and the beauty of the water body.
- The buildings around the lake acts as a wall to the water body, cutting of the visual connectivity between the roads and the streetscapes.
- There are no public activities around the banks of the lake which are conducive to the wellbeing and sustenance of the water body.

Opportunities :

- Can be transformed in to a picturesque area in the city with linear parks and public entertainment activities.
- Could reflect the skyline of the city and the identity of the built landscape of the city.
- Could form urban green areas, with patches of vegetation, which will provide cleaner and fresh air to the city.
- Could be elements for passive cooling of the city.
- Could enhance public interaction and the potentiality for tourism in the city, with many entertainment activities.
- Could have pleasure activities such as boating and eating places if planned properly.
- The banks of the lake can be a part and parcel of the urban landscape around the lake.

Threats :

- Pollution of the water body due to inappropriate usage is the major threat to the lake.
- The lake is being treated as a backyard, by many of the buildings and users around the banks of the lake.
- The illegal constructions and the invasion of the squatters around the shores of the lake in scattered locations form a great threat to the lake where the shores are used in a nonconductive manner.
- The discharge of sewer to the lake and dumping garbage is also a potential risk to the wellbeing of the lake.
- In appropriate land usage around the shores of the lake with non-responsive urban form can be seen.

The South West Beira Lake bordering Nawam Mawatha and Sir James Peiris Mawatha.

The South West Beira Lake has been used for more appropriate usage in the recent past considering the misuse of this water body, which has taken place for many decades.

The lake itself stands as a significant landmark and a picturesque water body, and is also used for public recreational activities.

The lake has also attracted many birds, like pelican's stroke and ducks.

The Streetscapes around the water body has given a significant rise to the land values around the lake. Which has attracted many hi-end developments. Unlike the East Beira Lake this portion of the lake is clearly visible from all the roadways that surround it and hence adds to the scenic beauty of the city. The many buildings that have been erected with the views of the South West Beira lake has tried to capture the views of the water mass and the landscapes that surround it, by its banks.

SWOT Analysis:

Strengths :

- The lake itself is a picturesque water mass which is clearly viewed along the 04 roads that abuts it.
- There are no lands available for constructing buildings around the road frontage areas along the lake.
- The trees and the vegetation along the banks of the lake has made more attractive and slightly.
- The emergence of the financial district along Nawam Mawatha with many commercial developments (which has taken place since the 1980's) adds value to the land around the lake.
- The streetscapes along the lake is been used for many activities with public interaction. (e.g. the Nawam Perahera)
- The Location of the Seema Malakaya - on the island which forms a temple by the water, is a significant attraction and a vista in the city.
- The other large island has also housed a public park which was used as a children's park in the 1980's.

Weaknesses :

- In many areas around the lake the sewerage and drainage line can be seen discharging the sewer and drainage to the lake.
- The paddle boats that are used for public recreation, does not seem appropriate, the lakes carrying capacity should be taken in to account.
- As there is a level difference between the road ways and the water, the hidden areas below the road level and the lakes surface can give rise crimes especially in the night.

Opportunities :

- The opportunities are vast along this lake as it is not hidden form the roads. Public walkways, along the banks of the lake, with the visual connection to the roads along can be encouraged. (with proper management of the garbage and waste)
- The landscapes around the lake can significantly contribute to the scenic beauty of the city.
- Regulations could be formulated for all new buildings that are to be erected to be responsive to the lake. (e.g. the new mega developments such as the Altair building along the eastern side of Sir James Peiris Mawatha, which are trying to focus on the views and the sea can be a major contributory factor in regenerating urban forms)
- The cleanliness of the water can be maintained with the identification of the potential pollutants to the lake and adopting migratory measures.
- The water body can create a panorama of views along a wide cross section, of urban scapes crating visual corridors in the city. (e.g. across the Sir James Peiris Mawatha, where the land was owned by Colombo Commercial Company, which is now state owned up to Union place, and can be connected to the Galle road and the Western coast is carefully planned.)

Threats :

- Along the banks of the lake, many vendors area seen, if this is not controlled it can cause a serious threat to the lake, where many undesirable activities to the lake can take place.
- The buildings that are constructed on the South Western corner of the lake (owned by the Gangarama temple is a potential threat to the urban character.

- Along Perehera Mawatha there is a risk of many in-appropriate buildings emerge which needs to be regularized.

The West Beira Lake:

Which connects the South West Beira Lake to the Galle face lake, runs along other Slave island railway station, in the form of a broad canal.

This lakes potentiality has been exploited where the land is developed by John Keels Holdings as the Water Front Development Project which will contain hi-end star class hotels and luxury residencies.

The Galle Face Lake :

This component of the Beira Lake abutting the Old parliament resembles the threshold of Colombo fort to the South.

This part of the Beira Lake connected the West Beira Lake and flows the water of the Beira Lake to the Indian Ocean along the western shore.

This part of the lake appears like a water feature with fountains and the built fabric of the Sir Chiththampalam Gardiner Mawatha of Slave island can be viewed.

However there is potential for visual connection between the East Beira lake and the WEST Beira lake where the buildings are a barrier, which otherwise could have been planned out to create visual corridors.

5.2.6 Case Study Analysis.

The Beira Lake being interconnected water massing in the city of Colombo which has evolved from the colonial history has become in indispensible static element in the city of Colombo. Whereby the determination of the urban land usage patterns around the water massing can often seen in an inappropriate manner.

Nevertheless the potentialities of the water body is enormous that if the urban form is responsive to this element the city can be transferred in to a more habitable livable unique urban character where the city will have a sense of place and a sense of identity.

The dilemma that exists within the east briar lake with ad hoc developments that has taken place over the years can be reversed in a subtle way where the land usage pattern can be made used in to an appropriate manner, thus creating a visual thread, in order to enhance the amenity of the city and the beautification.

The holistic potentialities of the Beira Lake:

The four Segments of the Beira Lake can collectively derive a new meaning to the city of Colombo. Where the segments once interconnected, the water masses can be a powerful force in the regeneration of urban form. And the activity pattern embedded.

The segments of the lake can define a district to the city of Colombo as in the matrixes derived for the review of the city of Anuradhapura. Where a series of water bodies can holistically form and urban cluster, where the **edges of the district is defined by the segments of the water bodies.**

The main streetscapes of Union place, Sir Chithampalam Gardiner Mawatha, Vauxhall Street, Sir James Peiris Mawatha, can all be embedded within a remarkable cluster.

The canals can be the interconnecting elements of the district connecting the segments of these water bodies.

Thus the networks of the water bodies of the Beira with its segments can be a definitive force for the formation of the metabolism of the city. Where its movements and growth can be contain with space syntax with the presence of the water bodies.

A financial hub can be creating within the area contained by the district formed by the connected water bodies holistically. As in the case of Anuradhapura the matrix developed can be applied to the segment of the city of Colombo.\, where the precinct formed by the waters of the Beira, can contain a district.

Within the threshold of this district the urban landscape can be defined with paths of the open en spaces responsive to the water bodies. The four basins of the Beira can thus form the responsive urban district to the waters which can give the city of Colombo a new meaning with the urban form regeneration. (figure 5.5 and 5.13)

Nevertheless the urban form regeneration should be a resultant of the static water bodies of the Beira, where the visual connectivity should be maintained.

With new hi end developments taking shape in eth modern era the lakes segments should contribute to the amenity of the city which will not segregate the social classes.

Within the thresholds of the water bodies and the banks, the public walkways and paths should be created.

Visual permeability should also be formed where the visual corridors and axial pathways.

Holistically while a district can be formed by the segments of the Beira Lake within the city, the individual segments if dealt with appropriately in regenerating urban form can further enhance micro climes within the local context. Where the individual segments of the water bodies can harness greater potential forming the micro environments, with a symbiosis if urban form responsive to the water mass.

In this context the strengths that are accessed with the SWOT Analysis of the Beira lake segments, can be accentuated, where the urban land transformation can derive a new meaning to the segments of the city in a subtle way. Which should be done in a manner which will enhance the sustainability of the city and its urban forms.

Analogies could be drawn here with the matrixes derived for the review of the city of Lugano in Switzerland, where the water body has been a containing element, of urban growth. Where a core relationship has been formed with the interfaces between the water body and the city's urbanscapes. Thus the interface is the juxtaposition knitting the two elements forming the symbiosis.

The same principles can be adopted in the case of the segments of the Beira Lake, where the streetscapes can be responsive to the water bodies. Especially along the main arteries, that encircles the Beira Lake.

The land mass between the shores of the water and the street play a vital role, and should be used in a conducive manner which otherwise can cause a potential threat to the lake segments. Which can be observed in many parts of the city of Colombo where quality water and the eco system has been destroyed and caused a serious threat to the wellbeing often water body and the city.

In a holistic perception of the district contained within the water body the management of the watersheds are of prime importance, where the disposal of various effluents form the human activities and the buildings should be managed accordingly. Hence the in-corporation of public activities and green patches with open spaces will be deemed as an appropriate solution to mitigate this problem.

In the review derived from Amsterdam the threshold of the water bodies are used for human interaction with boulevards and cycle track s can be a migratory measure to combat the threat to the water bodies.

Moreover the holistic approach to form an urban district with the segments of the Beira lakes in Colombo can be further enhance the beautification of the city, by adding the peripheries to the outer ring of the district. This will enhance the identity of the built form contained within the district.

And the public activities along the shores of the water bodies will further enhance the visibility of the Urban for and the built fabric contained in the district.

Also the creating of visual paths through the built massing interconnecting the water bodies visually within the district will further created a sense of permeability. This will add more imagebility to the city where the people will perceive the urban form of the city in connection to the water bodies.

Thus the image of the city can be further catalyzed with the elements defined by Kevin Lynches creating more visual paths through the built massing, emphasizing more on the nodes and land marks of the city. Hence creating a perception of connectivity within the city of Colombo where the legibility will be further accentuated.

Within these built elemets of the city the fine gran and the course grain of the built fabric with the urban forms can be further emphasized.

Where the paths will form clusters of built forms enhancing their qualitative aspect.

Segments of the Beira Lake

When coming to the Individual Segments of the Beira Lake the East Beira Lake can contribute a lot to the city in terms of urban aesthetics, environmental quality and amenity, and human interaction in a manner that is conducive to the wellbeing of the city. However it is noteworthy to mention here that that land parcels around this segment of the East Beira Lake is inappropriately used over the years and hence great injustice has been done to the potentiality of the water body. Which can contribute a lot more to the city?

As per figure 5.13 the urban morphological pattern around the lake can be seen as a highly dense built massing which can cause a potential threat to lake.

Where the land parcel between the streets that encircle the water body and the shores of the lake has been densely built, which is an in appropriate cause of action. The aforesaid area could be the public interface between the water body and the urban form.

As in the case of the city of Lugano; where the water body has formed space syntax, the Lake itself in this context could have defined the edge of a district. The present observation is that the ad hoc developments of the city for various commercial activities has encroached the pristine land parcels causing a dangerous threat to the lake and the urban fabric of the city.

The dense building masses around the periphery of the lake has formed a wall, where the visual permeability and then connectivity is ben shut off, form the streets.

Ideally the water ass should be a major land mark like in the city of Kandy, id the developments around it were planned. Although measures are taken to restore the Beira Lake, the openness should be maintained with the visibility of it. And the urban parks planned should not be a mere closed up public park and walk way.

In the case of drawing an analogy from the city if Canberra, which is a designed city, the radiating amphitheaters emerged with the shape and profile of the lake. Hence a similar strategy can be adopted within the pockets of the land parcels along the East Beira Lake,

which are remaining. Also the landmark buildings in either side if the water body can be visually connected. Which is proposed by the authorities at present where the lotus tower is under construction across the lane (abutting DR Wijewardane Mawatha.)

Hence the radiating effect of the land marks on the either side if the building could be visually merged in to the paths of the city, forming the connectivity of the opposite banks of the lake.

The layering of the built massing around the periphery of the Beira lake needs to be done in a meaningful way where the scales of the urban built fabric correlates to the water body, taking in to account the topographic terrain that descends towards the water basin.

An analogy can be drawn for the review of the city of Lugano Switzerland. As at present the built forms has totally ignored this aspect where it is non-responsive to the water body. The present built forms has been erected as blind wall mainly due to the commercial activities that was abutting the lake.

The East Beira Lake is a static hydrological urban space, with vast potentialities for urban form regeneration. The water body can bring in a subtle meaning to the city in its visual interpretation of the urban fabric. This if the urban form and the urban massing and embedded in the urban fabric with the paths embedded is knitted in harmony to the water body; preserving the urban ecology.

Initially the water body being used as a source of defense due to the internal warfare, between the invading forces and the local kingdoms, the lake has catered as a beautifying element to the city, where the history reveals that this has been a key element in beautifying the city.

The lake itself defined an edge segmenting eth district s of the city, where the paths create within the district formed interfaces between the water body and the streets. The lake added to beauty of the city because of these urban interfaces.

Further the scales and the heights going in par with the profile of the lake the urban form had had a core relationship with the hydro space.

The lake thus catering for a wide variety of needs including the commercialized activities, such as water transportation, can be under potential threat, where the banks being encroached

by low income settlers who migrated to the city for employment in the labor force, has caused a threat to the lake. The lake having shrunk after the industrialisation of the city lost its pristine beauty resulting in a polluted water body.

The lake has been primary responsive element to formation of the street patterns of the city where the paths has emerged around the lake. The intersections of the streets paths of formed nodes in the city and the junctions which eventually contained monumental landmark colonial buildings.

If the potentiality of the water mass is harnessed the urban form with the new paths that can be created within the existing context can transform the city in to a remarkable change where the visual connectivity can be maintained.

As in the case of the city of Lugano and the historic city of Polonnaruwa, the lake can define and edge to a segment of a district in the city.

The South West Beira Lake - with the Semamalakaya Temple.

The south west segment of the Beira Lake defines a peripheral district in the city where the built form around it is responsive, to the water mass. Again a static variable in the urban fabric the water body itself has been an urban form regenerating force.

As in the recent past the land parcels around the lake has been a catalyzer in the formation of responsive urban forms where the space syntax is created by the presence of ten water body.

The promontory has been a symbolic land mark and visually a focal point with two picturesque islands placed in the lake.

The Colombo's changing skyline can be observed across the water where the profile of some intermediate risers of the build massing in the city along the edges of the water body can be thus seen. Hence the water body acts as a fore ground to the urban built fabric. Where the water basin of this segment of the lake is a visual interpretation of urban forms that is erected around the water body.

Ten streets around the lake further forms the threshold of the built massing defining the edges of a bio sphere that of formed around then lake. Hence the periphery of the water body has formed an urban landscape and a mini urban eco system, this is due to the fact the lake itself has been and attraction for many water birds.

Although the water body was under there due to the industrial waste being discharged in the past, but mitigatory measures has been taken to eliminate this undesirable activities and to preserve the beauty of the lake.

The water basin of this segment of the Beira Lake has the character of an urban amphitheater. Like in the case of the city of Canberra the urban built land marks are linked across the water massing.

The key factor is that the interface between the streetscapes adds the water mass remains un-built, which for the visual connectivity to the water body.

Hence the perception of the water mass by passerby helps to orient himself to the urban morphology and the street pattern in the segment of the city. The core relationship between the water body and the built urban fabric collectively has formed the 03dimentional image of the city (within the district that is formed by the presence of the water body) along its periphery.

The core element is the relationship of the water body to the starts that about its banks and the stepping down terrain and the built massing that forms the set back to the water mass.

Around the lake the scenic drive and a walkway has emerged with then built landscape and the vegetation around the lake furthered enhances the beauty.

And analogy can be drawn to the matrixes derived for the city of Kandy, where the lake has become an icon in the city.

Here in this segment of the lake the outer ring defines and urban skyline of the city, which in a conjunction of a core relationship of the ring of an urban form encircling a water mass, with the streets forcing the interface for interaction between the built fabric and the hydro space.

Chapter Six: Conclusion and Recommendations

CONCLUSION.

With the studies that were carried out in the research, it is evident that water bodies are a primary element that needs to be taken in to account in designing and planning cities. Hence it is of prime importance that the futuristic needs of the city needs to be accounted for in the initial designing and planning of a city.

Water plays a key role in maintaining a healthy equilibrium between the environmental quality and human activity in a city. Thereby the water bodies if responded and managed properly has a key role to play in an appropriate manner will be a prime force that will be determinant in generating livable sustainable cities. Or if ignored or the non-responsiveness to the water bodies will result in adverse effects in the city and its inhabitants.

In the literature review chapter the usage of water in different cultures were assessed. Where in the local context (Sri Lankan) the usage of water has been a primary responsive element in forming urban settlements in the country. Where the agro based hydraulic civilization played a key role in usage of water in urban contexts.

Hence along the water bodies how the village settlements were transformed gradually to urban settlements with the commercial actives that took place is a significant transformation in history.

As the kingdoms shifted the urban planning methodologies had to be adopted and revised with fortifications that were deemed necessary due to the south Indian invasions. Hence the water bodies in the capital cities played a pivotal role in the defensive aspects. Where the water itself has been a protective element.

Furthermore in the dry zone of Sri Lanka the water bodies that were present in and outside the cities and the citadels, catalyzed the growth and formation of forest patches which were instrumental in providing a cleaner and greener urban environment to the city.

In the city of Kandy the last bastion of the Sinhalese kings the usage of water for fortification as a natural barrier, and the creation of the Kandy Lake which was called the Milk Sea or the

“Kiri Muhuda”. The creation of this artificial lake was a resultant in highlighting the significant urban forms and prominent buildings in the city center, as per the king’s aspirations of forming a celestial city.

Tin the kingdoms of Pollonnaruwa the usage of water was primarily for the cultivations and the irrigation systems. Where the city formation took place in response to the tanks built by the kings for irrigation and cultivation.

Thence the hierarchal patterns of the buildings and typologies were formed with the urban planning. The primary determinant force here of the city planning methodologies was the water bodies that were built for irrigation.

The layering of the urban forms was again taken place along a ring pattern. Where by the city itself was formulated accordingly.

In the overseas examples the generation of urban form again took place in response to with the water bodies as a key determinant force.

Moreover the city of Amsterdam was a city built by the water frontage where the city itself contained a series of canals and water ways. The urban form was responsive for this water bodies. As the city was below the sea level a dam was built to mitigate flooding and hence the city itself was a protective form the water. Hence the natural mitigation of flooding.

The cities of Lugano in Switzerland is a fine example of impeccable cities that are highly responsive to the natural elements. Where there is a perfect harmony in the urban fabric, and its response to nature, also where the vernacular and traditional architecture complement each other. Hence the water bodies that are present in these urban contexts are fine responsive elements that can formulate a perfect equilibrium of built massing where the traditional and modern built fabric blends well to retain the cultural identity but define the city’s character and sense of place and identity.

In the local context the assessment from the historic cities where the cities emerged using water as a key element in forming built fabric. Water bodies had multiple usages in the cities functioning where the city itself was fortified during the battles that took place over the years.

Apart from using the water basins as moats for fortification of the forests and the city center where the administration took place. The water body was used for the beautification of the city where the urban ecology was maintained at a high level.

As result of the water bodies present the grid pattern of the urban streets formed where the city itself was a web of arteries and a series of street facades responsive to the water.

Hence the water body enabled the city of Colombo to sustain a garden city concept where the urban greenery was maintained.

Nevertheless the water body itself was a catalyzer in many positive implications to the city.

With the different typologies of activities and built forms emerging around the water body the cities functionalism changed.

With the infiltration of industries in to the primary residential and administrative zones in the city the water body was subject to large scale threats. Where by the discharge of industrial waste and domestic sewer was all in all causing environmental and health hazards to the city.

Hence the misuse of water bodies and inappropriate response can have very serious negative impacts on the city where the city itself can turn in a humanly unfriendly and unlivable city.

Hence the city urban fabric can be diluted (as in the case of Colombo city due to the misuse of the Beira Lake)

Undesirable land use can also give rise to the pollution and blockage of the drainage in the city and foul smells and odors that can be emitted from the water bodies may result in complete dilemma.

However the restoration of the Beira Lake tanking a significant turning point in the city will enable the city to regenerate its urban form. Where by the city itself will gain its lots glory and beauty.

Nevertheless it is evident with the excursive of the restoration of the Beira Lake that it is a tedious task to revamp the lake to its original state. Where the cots implications and the methodologies and the labor force that is needed is another strategic issue.

Hence the conclusion will be that the management of water bodies with the nation's policies and the formulation of the necessary regulations is a must where the water body itself is an indispensible force in the healthy formation of the city.

The urban interfaces that are created alongside the water body in between the built massing forms a very important urban space or and urban pocket. This interface can be a public space or an open landscape or an area for urban greenery.

The built forms that generate the backdrop of the water bodies also gain prominence to the city scape where the water itself is a defining element of urban space.

Hence the responsive urban form correlated to the water bodies present plays a key role in the futuristic sustenance of a city.

The Potentialities of the Breira Lake.

In asserting the findings for the case studies and the research observations made around the Beira lake the components of the Beira lake contains enormous potentialities to enrich the quality of life and character of the city of Colombo.

Mainly the waters of the Beira Lake which is a static variable can be a prominent force where the urban character could be defined. If the Urban forms that are regenerated along this water frontage in a responsive manner conducive to the environment and character of the city of Colombo, it can be a major transforming force in making the city of Colombo green and people friendly and sustainable, with a sense of place and identity.

The Urban form around the Beira Lake can be defined as a dynamic variable.

Hence the non-appropriate building typologies can be revamped (without demolishing the heritage buildings) which can enhance the public interaction between the water body and the streetscapes.

Moreover the Beira lake can act as a visual impetus in the city transforming the into more interactive dynamic city with public areas for mass agglomeration.

The potentiality of tourism can be further enhanced in the city where many activates can be introduced such as boating and rowing (which should be non-polluting and should not exceed the carrying capacity of the water body)

Moreover the lake itself could be a threshold of the city where interfaces area created between the built fabric and the streetscapes.

Creating interfaces between the water and built fabric.

The banks of the lake can be revamped in to a public interfaces.

These interfaces along the banks of the lakes should be for open spaces with public activates and landscapes. This will further enhance the cities liveability and the users will enjoy the activities in the city, much more than the present state.

- In the context inspiration can be drawn from the city of Amsterdam, where the interfaces created between the water bodies and the streetscapes enhance public activities such as cycling jogging etc.
- Also the urban form setback against the water bodies further emphasises the character of the city.
- As in the city of Lugano Switzerland the usage of the banks of Beira can again be a metaphor where the urban form is highlighted and characterised.
- Also the visual connections should be created to the water body to create linkages to the stress; of there is a significant gap between the water body and the streets.

The water levels should be monitored carefully during the raining season and the dry season where the provision is kept to mitigate flooding.

The Beira lakes potentiality especially around the West Beria lake (D.R. Wijewardane Mawatha) can transform the city in t a greener and more open areas with the visual corridors. That can enhance the amenity of the city by increasing the permeability of the city.

Furthermore the water body of the Beira Lake can be major contributory elements for the passive cooling of the city. Where the open space around the surface of the water can cool the

atmosphere and mitigate the forming of heat islands due to dense built massing that the city is being threatened with.

Analogies could be drawn from the examples in the literature review:

- The Kandy Lake where the water body is the focus of the city. And the streetscapes and built massing is centred on the lake. (Although the lake was created much later after the city was formed.
- Hence the Beira Lake could be the main focal point in the city where the roads are encircled around it. Which will create a picturesque landmark in the city. This applies to the East Beira Lake which is a hidden water body in the heart of the city.
- Visual connections can be made with pathways and alleyways
- The public liner walkways with patches of vegetation could be created along the banks of the lake, which will enhance the recreational spaces in the city.
- The visual connectivity created with the Beira Lake at center stage will form a major transformation in the city.
- Proposals are already underway by the Urban Development Authority (UDA) for the restoration of the Beira Lake. In this aspect the wear houses along the D.R.Wijewardane Mawatha are to be removed and Colombo's night life is to be enhanced with many activities linked with the tourism industry. (I.e. casinos restaurants, boating and boat piers etc.) These activities need to be dealt with accordingly where the carrying capacity of the water body needs to be taken into account. Waste management needs to be thoroughly dealt with where the quality if the water in the lake will not be impaired or polluted.
- As per the history of the lake the proper management of the lake has shown that the lake has been a major contributor with its positive implications to the metabolism and factionalism of the city giving the city's its pristine beauty.
- Vies a versa the mismanagement of the lake had had adverse effects on to the city with health hazards and environmental pollution taking place.
- Furthermore the lakes potentialities if exploited properly and responsiveness to the same will form a major catalyst to enhance the beauty and identity of the built fabric, with a cleaner environmental quality, which all in all will augur well for the factionalism and metabolism of the city.

The theories of Kevin Lynch can be adapted in to the Urban Transformation of the Beira Lake where the principle if applied can be a precipitator in the reforming and transformation of the city.

Whereby the users understood their surroundings in consistent and predictable ways which are as follows:

- **Paths**, the streets, sidewalks, trail, and other channels in which people travel;
- **Edges**, perceived boundaries such as walls, buildings, and shorelines;
- **Districts**, relatively large sections of the city distinguished by some identity or character;
- **Nodes**, focal points, intersections or loci;
- **Landmarks**, readily identifiable objects which serve as external reference points.

The visual paths and walking corridors in relation to the water body can be a major catalyser in creating visual permeability to the city. Enhance the walkability of the city and create spaces for public interaction.

- The linear walkways in the present context are only available in the South West Beira Lake. The East Beira Lake needs to be accommodated with these walkways.
- Edges – the edges of the East Beira Lake ate hidden at the present. Only the North Western edge along Sir Chiththampalm Gardiner Mawatha is visible giving a picturesque sight to the city. The South West Beira lakes also need to be treated accordingly.
- Districts – the land use patterns along the Beira Lake needs to be rethought where the precincts along the water body should be revamped with appropriate land usage and activities to be proposed. The formation of districts along the water body can merge the city in to a knitted urban scape.
- Nodes – along the East Beira Lake the Lotus tower which is under construction, can be seen as a nodal point.

- Landmarks – the housing of the temple in the water the Seema Malakaya is a significant land mark in the water, and also the commercial developments along this segments of the lake also creates a sense of place with a visual connectivity.

Also with matrixes developed for the literature survey the governing principles for urban form generation in response to the water bodies also can be applied where it is deemed appropriate.

- In the city planning principles of ancient city of Anuradhapura where a series of tanks were linked to form an irrigation network where the city was centred within the rings formed by the tanks. The principle is applicable in to the Beira lake with its interconnecting segments , where the urban spaces that are formed in-between thee segments of the lake can be used in as responsive urban form in the land use patterns and built massing, creating links in the city.
- The planning principles of Pollonnaruwa in response to the Parakrama Samudra can also be linked to the system where the cityscapes can be redesigned along the banks of the water body. And the threshold of the water body and the streets can be the public interface for activities and also protecting the water body with inappropriate buildings emerging.
- Also the principles of the city planning of Venice and Amsterdam can be another catalyser in the urban formation and creating the links between the Beira Lake. Which can form a major connectivity in the city and landscaping the narrower water bodies of the Beira Lake can thus enhance the beauty of the city and enable drainage.
- Also the strategies that were adopted in eth Sri Nagar city in urban transformation could be adapted to the revamp of the Beira Lake.

In the main aspects of merging the water bodies with urban forms creates space syntax where the two parameters creates a symbiosis for the sustenance of the city. The responsive ness to each other further creates the interface to enhance the quality of urban spaces knitted in the urban landscape and urban fabric.

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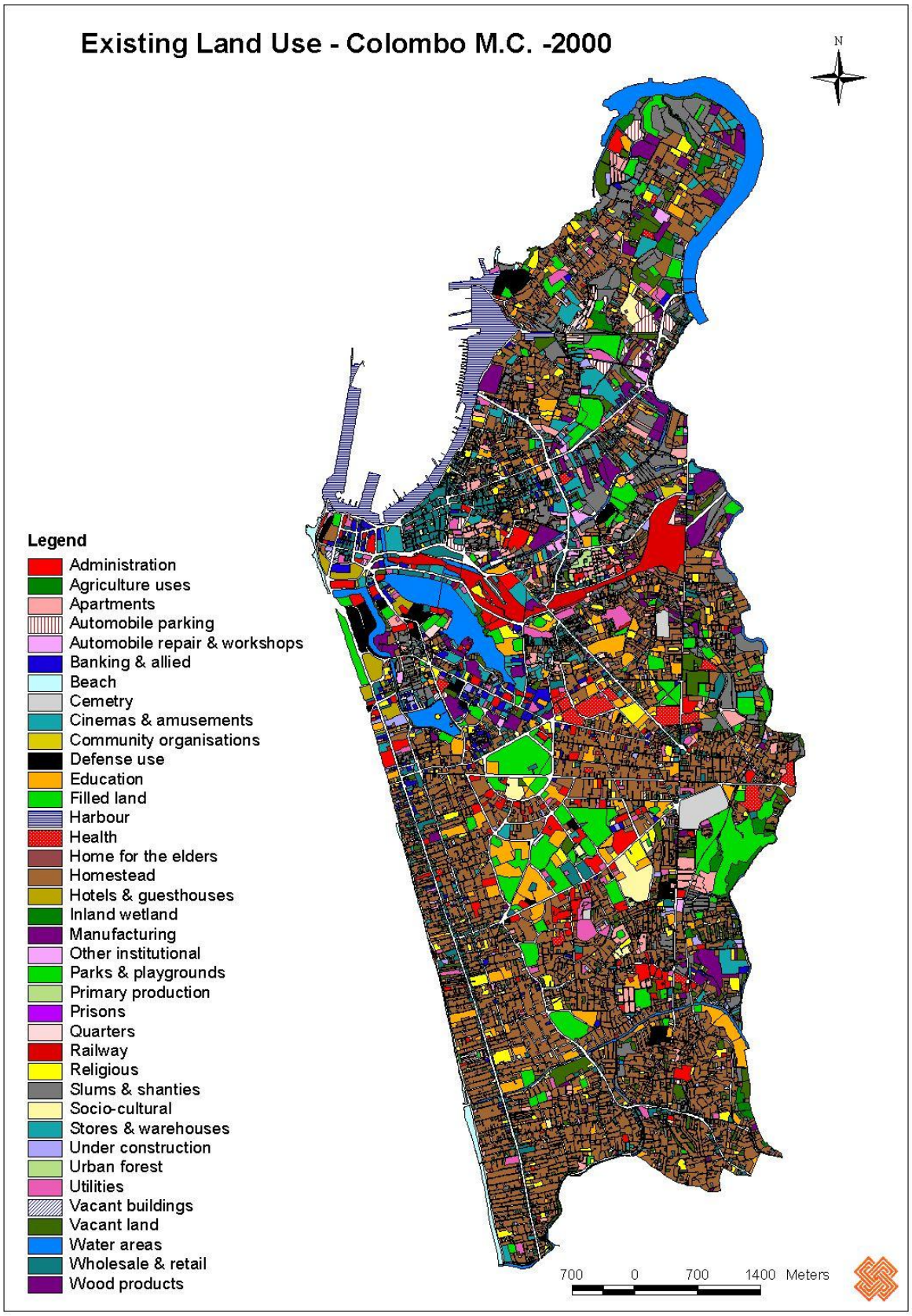
Appendix A: A

The Existing Land Use pattern around the Beira Lake, Colombo

Source : Beira Lake Restoration Study – Natural Resources of Sri Lanka (p 230)

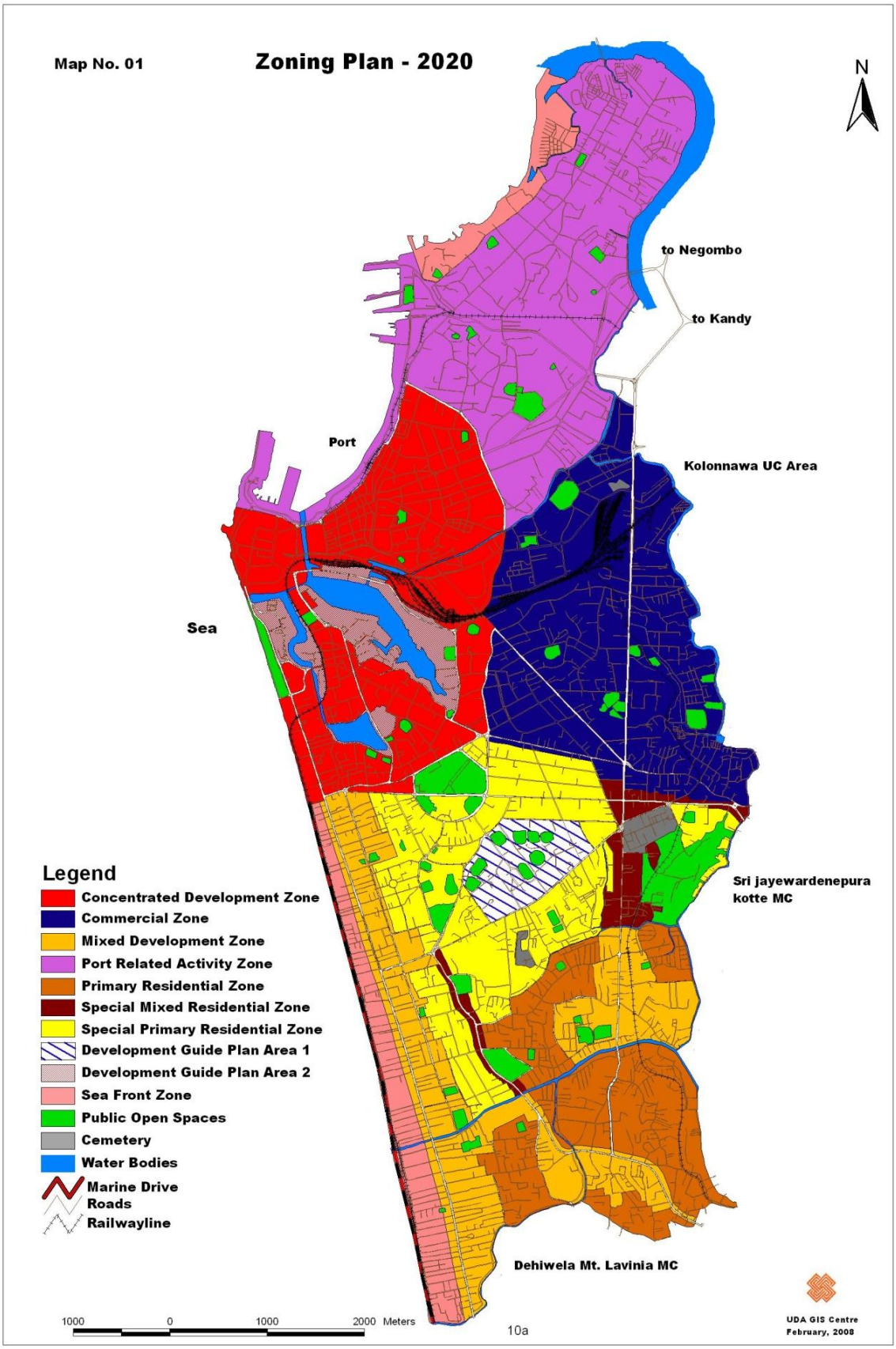
Base map – Urban Development Authority

Appendix B: B



Source : Urban Development Authority

Appendix C: C



Source : Urban Development Authority

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